SOUTH BAY ADVANCED RECYCLED WATER TREATMENT FACILITY

ENGINEER'S REPORT

December 2009

B&V Project No. 146071

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B&V Project 146071
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ENGINEER'S REPORT
South Bay Advanced Recycled Water Treatment Facility

To: Tim Nguyen, P.E., Project Manager
Santa Clara Valley Water District

From: Sanjay Reddy, P.E. Project Manager

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The information contained in this submittal has been checked for conformance with the Quality Assurance / Quality Control (QA/QC) Plan.

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EXECUTIVE SUMMARY

The Santa Clara Valley Water District (District) in cooperation with the City of San Jose (City) and other stakeholders is developing the South Bay Advanced Recycled Water Treatment Facility (ARWTF) Project (Project). The Project is an expansion of the existing South Bay Water Recycling (SBWR) system, which distributes disinfected filter (tertiary) effluent produced at the San Jose / Santa Clara (SJ/SC) Water Pollution Control Plant (WPCP). The objectives of the ARWTF Project are to produce high-purity recycled water that would reduce existing recycled water salinity and increase the marketability of the existing recycled water supply.

This Engineer's Report (Report) presents the preliminary design for the ARWTF, including results of capacity and process selection analyses and development of design requirements for the treatment processes, site planning, and various engineering disciplines. Also presented are a review of regulatory requirements, a discussion of operation strategies, and preliminary cost and schedule information. This Report was updated in December 2009 to reflect the current understanding of the Project and builds on the initial draft of this Engineer's Report (July 2007) as well as a series of meetings with the District, the City, and other Project stakeholders and interested parties. Much of the information provided herein is based on the results of a series of technical evaluations conducted between October 2006 and July 2007. This Executive Summary is organized in parallel with, and highlights the contents of the seven (7) main chapters of the Report, as described below.

General Requirements (Chapter 1)

The District manages both surface water and ground water systems in Santa Clara County (County) and supplies wholesale water to retailers including municipalities and private water companies. As the County's population continues to grow and demand for water increases, the District is looking for partnerships with the community to expand water recycling in the County.

In July 2001, the District adopted water recycling programs and policies with the goals to increase recycled water uses to account for five percent of the County's total water supply (20,000 acre-feet per year [ac-ft/yr]) by Year 2010 and ten percent (50,000 ac-ft/yr) by Year 2020. The ARWTF is among the portfolio of programs being implemented by the District to meet these goals.

The ARWTF is expected to provide the District and the City with multiple benefits, including:

- Increased reliability of recycled water supply for reuse
- Improved recycled water quality to increase its marketability
- Increased SBWR recycled water treatment capacity
- Greater public acceptance of recycled water
- Maximized water reuse alternatives
- Reduced discharges of treated effluent into San Francisco Bay, thus helping to preserve saltwater and tidal habitat

- Increased operational flexibility and capacity to the existing tertiary filters at the SJ/SC WPCP during winter months.

The proposed South Bay ARWTF would treat nitrified secondary effluent from the SJ/SC WPCP with advanced treatment processes consisting of microfiltration or ultrafiltration (MF/UF); reverse osmosis (RO); and ultraviolet (UV) disinfection to produce high-purity recycled water that would be blended with the existing recycled water supply. To improve the marketability of the recycled water, the District has established a goal that the SBWR system consistently provides a recycled water supply with a total dissolved solids (TDS) concentration of 500 milligrams per liter (mg/L). The high-purity recycled water produced from the ARWTF would be blended with existing SJ/SC WPCP disinfected tertiary effluent to meet SBWR Program recycled water demand and the TDS concentration goal.

The Project would be designed to have an initial (Phase I) production capacity of 8.0 million gallons per day (mgd) of high-purity recycled water, and would be readily expandable to 9.0 mgd. The proposed site is an undeveloped area owned by the SJ/SC WPCP east of the SBWR Transmission Pump Station (TPS) and is located across Zanker Road at the southeast corner of the SJ/SC WPCP.

ARWTF Capacity Evaluation and Treatment Process Selection (Chapter 2)

In 2004 the District retained B&V-Kennedy/Jenks Consultants team to conduct the advanced recycled water treatment (ARWT) Feasibility Study, which determined that recycled water use could be significantly expanded throughout the County. Based on the findings of the Feasibility Study, the District retained B&V in October 2006 to perform preliminary design of the ARWTF, which is presented in this Report. Information herein is based, in part, on the technical evaluations performed for the Project, as well as on results of meetings, workshops, and other public outreach activities.

B&V reviewed historical TDS concentration data for the SJ/SC WPCP tertiary effluent to determine the ARWTF TDS concentration to be used as the basis for achieving the overall blended recycled water SBWR TDS goal. In addition, historical SBWR recycled water demand data was reviewed to set the capacity basis for the ARWTF. Based on the recycled water quality demands and goals, an initial capacity analysis was developed for the ARWTF. Supply-demand balance calculations indicated that the required ARWTF treatment capacity would be approximately 6.9 mgd in order to meet a maximum day recycled water demand of 19.6 mgd. This capacity was used as a starting point in optimizing the ARWTF treatment capacity and Product Water Storage Tank capacity to meet diurnal recycled water demands for maximum week conditions. A second evaluation was conducted to optimize capacity by providing product water water storage. This optimization analysis developed an initial required ARWTF capacity of 6.6 mgd, with a 2.0 million gallon (MG) Product Water Storage Tank.

Subsequent to the two analyses described above, additional updated recycled water demand projections through 2030 were provided to the consultant team. The District's projected future recycled water use up to year 2030, as provided by SBWR staff, is presented on Figure ES-1.

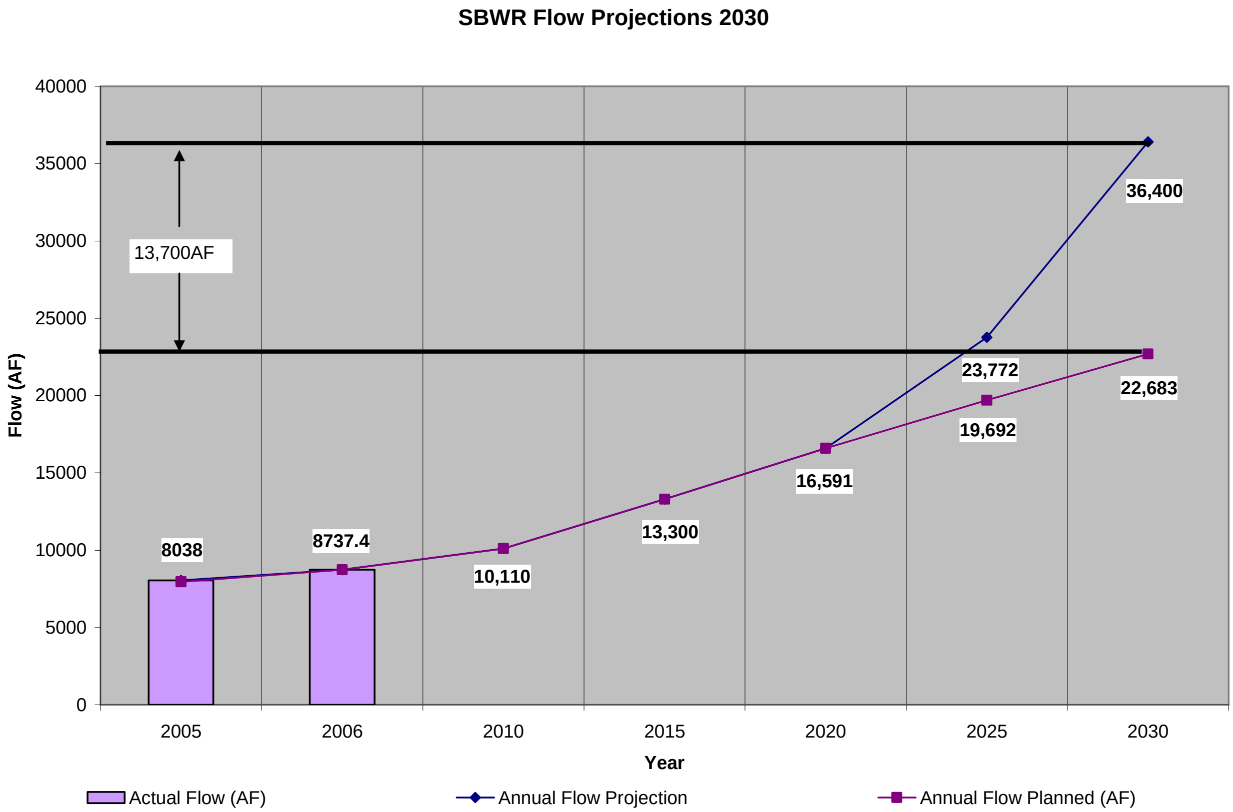


Figure ES-1: Projected Future SBWR Demand

The updated demand information indicated it would be prudent to reassess the optimum capacity for the ARWTF when brought on line (approximately Year 2012). Ten potential process scenario options (Options A through J) were developed collaboratively by the District, the City and B&V to evaluate capacity options for design of the ARWTF. As shown in Table ES-1, the options considered different process scenario capacities for the MF/UF, RO, and UV. For example, Option A assumed that 8 mgd would be treated with MF/UF and that 6.6 mgd would be treated with RO and UV treatment. In contrast, Option E assumed MF/UF and UV treatment for 21 mgd, but no RO. Three time frames and peak daily flow rates were considered: Year 2010, 21 mgd; Year 2015, 28 mgd; and Year 2020, 34 mgd. The options were evaluated against percent confidence in achieving the desired SBWR TDS concentration goal of 500 mg/L. A SBWR TDS concentration goal of 400 mg/L also was considered.

After discussions with the District and City staff, Option B – which would provide an MF/UF treatment capacity of 10 mgd, a RO treatment capacity of 8.0 mgd, and a UV treatment capacity of 8.0 mgd – was selected. Option B would meet the 500 mg/L SBWR TDS goal 99 percent of the time when the ARWTF is expected to be online. Option B also would provide the District with additional operating flexibility as it has the capability to meet a lower SBWR TDS goal of 400 mg/L 75 percent of the time in Year 2012. Therefore, an ARWTF treatment capacity of 8.0

mgd and a product water storage capacity of 2.25 MG were selected for the ARWTF. This capacity evaluation was based on the ARWTF producing recycled water with a TDS of 40 mg/L and blending with SJ/SC WPCP tertiary effluent with a TDS of 750 mg/L to produce a SBWR TDS of 400-500 mg/L.

The RO System would be designed for future expansion to 9.0 mgd by installing additional membranes on the existing units. In addition, it has since been decided to provide a UV System with a 10 mgd capacity to provide flexibility to treat the entire MF/UF flow through the UV System.

Table ES-1 also indicates that the Option B MF treatment capacity (in addition to the RO and UV) is capable of meeting projected Year 2015 winter SBWR recycled water demands without the need for blending with SJ/SC WPCP tertiary effluent. This would provide the City with the benefit of operational flexibility to the existing tertiary filters at the SJ/SC WPCP during winter months.

During summer months, when recycled water demand is high, the high purity recycled water produced from the ARWTF would be blended with the existing tertiary effluent from SJ/SC WPCP. To achieve the target SBWR TDS concentration of 500 mg/L in the blended recycled water, advanced recycled water treatment processes consisting of MF/UF, RO, and UV disinfection would be used. These processes are discussed throughout this Engineer's Report. Table ES-2 presents a summary of the treatment processes.

The SJ/SC WPCP treatment facilities include "secondary clarifiers" and "nitrification clarifiers", which were once operated in series. The secondary clarifiers and nitrification clarifiers are now operated in parallel. Both sets of clarifiers have maintained their original names, yet they both produce a nitrified secondary effluent.

Four SJ/SC WPCP feed water options are available for the ARWTF:

1) Secondary Clarifier effluent,
2) Nitrification Clarifier effluent,
3) Existing filter (tertiary) influent feed (blended nitrification and secondary clarifier effluent); and
4) Filter (tertiary) effluent.

Nitrification clarifier effluent from the SJ/SC WPCP was determined to be the most cost-effective feed water source for the ARWTF. If nitrification clarifiers are taken out of service, effluent from the secondary clarifiers would backflow to the nitrification clarifier effluent clarifier.

Typically, tertiary effluent would provide MF/UF feed water supply with better quality due to lower suspended solids concentration, resulting in higher operating requirements and lower cleaning frequencies. However, the TSS concentration data for the tertiary effluent at SJ/SC WPCP was not significantly lower than the nitrification clarifier effluent supply (only about 2 mg/L lower on average). In addition, pilot testing conducted for East Bay Municipal Utility

District's (EBMUD) Richmond Advanced Recycled Expansion (RARE) Water Project indicated that treating tertiary effluent only resulted in a marginal increase in system recovery compared to treating secondary effluent. A system recovery of 94 percent was achieved for the tertiary effluent, compared to 92.5 percent recovery when treating secondary effluent.

Additional benefits associated with using nitrification clarifier effluent include: (1) the ability to increase the tertiary treated water capacity (SBWR recycled water supply) needed during peak dry weather demand periods and (2) the flexibility to shut down the existing tertiary filtration system at SJ/SC WPCP and operate only the ARWTF during the low demand season (winter months). The SJ/SC WPCP then would be able to dedicate the tertiary filtration system for bay effluent, thus increasing the overall SJ/SC WPCP treatment capacity.

Rules and Regulations (Chapter 3)

The ARWTF would meet permitting and other requirements of a number of federal, state, and local entities including the U.S. Bureau of Reclamation, California Department of Public Health (DPH), California State Department of Environmental Protection Agency (EPA), California Department of Water Resources, California Regional Water Quality Control Board, San Francisco Bay Region, Santa Clara County Department of Environmental Health, Santa Clara Valley Water District, City San Jose, and City of San Jose Planning Division.

Table ES-1: TDS Confidence Matrix of Potential ARWTF Scenarios

				ARWTF PROCESS SCENARIO										
			Treatment	No Project	A	B	C	D	E	F	G	H	I	J
			MF	0	8	10	12	15	21	23	28	30	34	37
			RO	0	6.6	8	10	12	0	8	0	10	0	12
			UV	0	6.6	8	10	12	21	21	28	28	34	34
Year	Max Day Flow, mgd	Target TDS, mg/L	Confidence											
2010	21	500	99%											
			95%											
			75%											
		400	99%											
			95%											
			75%											
2015	28	500	99%											
			95%											
			75%											
		400	99%											
			95%											
			75%											
2020	34	500	99%											
			95%											
			75%											
		400	99%											
			95%											
			75%											
2010/2015/2020		750+/-	100%											
Other Water Quality Parameters	Low Turbidity		< 0.1 NTU		(2)	(2)	(2)	(2)						
	Full UV Disinfection													
	Added Total Filter Capacity (mgd)(1)			0	7	8	10	12	36	36	43	43	49	49
MF System can Meet Winter Flows (Dec-Apr)			2010											
			2015											
			2020											
MF can Meet Max Daily Recycled Water Demands			2010											
			2015											
			2020											

(1) Flow that can be filtered either by gravity or microfiltration

(2) Low turbidity goal of <0.1 NTU can be met during winter

Table ES-2: Summary of Phase I ARWTF Treatment Processes

Treatment Process	Function	Net Capacity (mgd)	Manufacturers	Special Requirements/Considerations
Microfiltration/ Ultrafiltration	Pretreatment of nitrified secondary effluent to reduce total suspended solids (TSS)	10.5	• Pall[1] • Siemens • GE • Krueger/Norit	• Preselection of MF/UF manufacturer is required for a firm basis of design
Reverse Osmosis	TDS reduction of nitrified secondary effluent	8[2]	• Hydranautics ESPA2 • Koch TFC-8822HR • Toray TMG-20	• Decarbonization process recommended downstream to adjust pH of product water
Ultraviolet Disinfection	Disinfection of product water	10	• Aquionics • ITT Wedeco, Inc.[3]	• NWRI Guidelines Apply • UV Validation required by DPH • Preselection of UV manufacturer is required for a firm basis of design

[1] During the preparation of this Engineer's Report, the Pall MF System was selected for the Project based on a competitive proposal process.
[2] 8 mgd is initial capacity, expandable to 9.0 mgd
[3] During the preparation of this Engineer's Report, the ITT Wedeco UV System was selected for the Project based on a competitive proposal process.

Key regulatory requirements affecting the Project are Title 17 of the California Code of Regulations (cross-connection control), Title 22 of the California Code of Regulations (use of recycled water), 2009 California DPH *"Treatment Technology Report for Recycled Water,"* American Water Works Association (AWWA) Guidelines for Distribution of Nonpotable Water, and National Water Research Institute (NWRI) and AWWA Research Foundation (AWWARF) Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse. Water reuse permits and National Pollutant Discharge Elimination System (NPDES) permits would be required.

A joint environmental assessment (EA) and initial study (IS) are required to comply with the environmental requirements established by both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). This document analyzes the environmental impacts of the ARWTF, presents feasible measures to reduce or avoid potential environmental impacts, and evaluates alternatives to the Project. The final EA/IS is expected to be issued for public review by January / February 2010.

AWRTF Treatment Capacity, Process Flow Schematic, and Hydraulic Analysis (Chapter 4)

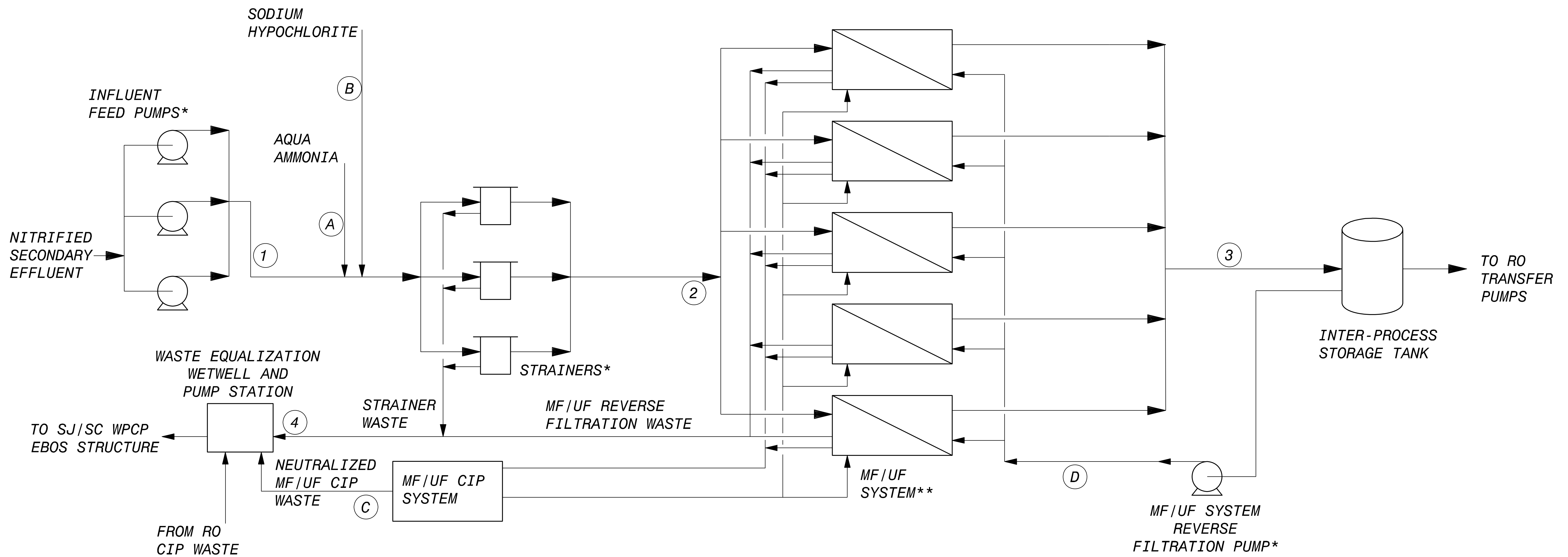
The treatment capacities for the Phase I ARWTF were estimated based on a future net production capacity of 9.0 mgd. The ARWTF will initially have a net production capacity of 8.0 mgd. The MF/UF and UV Systems will have net production capacities of 10.5 mgd and 10.0 mgd, respectively. The RO System will have an initial net production capacity of 8.0 mgd, but will be designed for future expansion to 9.0 mgd. The UV System is sized for 10.0 mgd to provide the flexibility to treat the entire MF/UF flow through the UV System. Treatment process flow rates are based on the following assumptions and are summarized in Table ES-3.

- The membrane filtration (MF/UF) system would operate at a minimum recovery of 90 percent.
- The RO System would operate at a design recovery of 85 percent.
- The RO System would have a salt rejection of 95 percent at the end of its operating life.

Process flow schematics for the ARWTF are presented on Figures ES-2 and ES-3. The ARWTF would treat nitrified secondary effluent from the SJ/SC WPCP and supply high-purity recycled water to the existing TPS for distribution into SBWR's existing recycled water distribution system.

Table ES-3: Summary of Phase I ARTWF Treatment Capacities

Treatment Process	Initial Design Condition	Future Design Condition
ARWTF Overall Net Production Capacity	8.0 mgd	9.0 mgd
MF/UF System[1]	11.7 mgd (feed) 10.5 mgd (filtrate)	11.7 mgd (feed) 10.5 mgd (filtrate)
Recovery	90%	90%
Backwash Waste	1.0 mgd	1.2 mgd
RO System	9.4 mgd (feed) 8.0 mgd (permeate)	10.5 mgd (feed) 9.0 mgd (permeate)
Recovery	85%	85%
RO Reject	1.4 mgd	1.5 mgd
UV System	10.0 mgd	10.0 mgd
Product Water Storage Tank (Useable Volume)	2.25 MG	2.25 MG



		Average Design Flows		Frequency
Stream ID	Stream Name	mgd	gpm	
1	MF/UF Feed	10.50	7,300	
2	MF/UF Pretreated Feed	10.50	7,300	
3	MF/UF Filtrate	9.40	6,530	
4	MF/UF Strainer and MF/UF Reverse Filtration Waste	1.04	720	
A	19.0 Percent Aqua Ammonia			Continuous
B	12.5 Percent Sodium Hypochlorite			Intermittent
C	MF/UF CIP			Intermittent
D	Reverse Filtration			Intermittent

* BASED ON INITIAL CAPACITY OF 8MGD.

* ONLY DUTY UNITS ARE SHOWN. STANDBY UNIT TO BE PROVIDED, IS NOT SHOWN ON FIGURE.

** THE NUMBER OF MF/UF UNITS WILL BE DETERMINED ONCE MF/UF VENDOR IS SELECTED.

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SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES

PROCESS FLOW DIAGRAM

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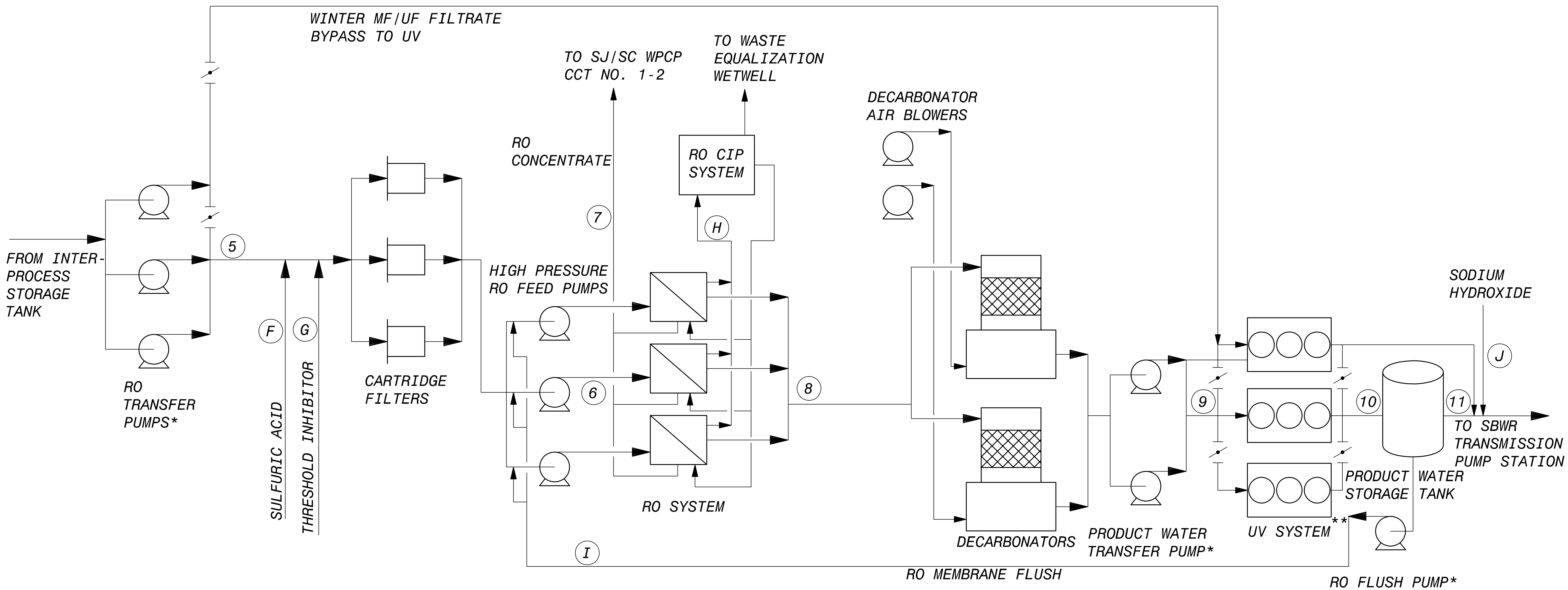

		Average Design Flows		Frequency
Stream ID	Stream Name	mgd	gpm	
5	RO Low Pressure Feed Water	9.40	6,530	
6	RO High Pressure Feed Water	9.40	6,530	
7	RO Concentrate	1.40	980	
8	RO Permeate	8.00	5,560	
9	Decarbonated Product Water	8.00	5,560	
10	UV Treated Water	8.00	5,560	
11	Product Water	8.00	5,560	
E	(NOT USED)			
F	93.0 Percent Sulfuric Acid			Continuous
G	Threshold Inhibitor			Continuous
H	RO CIP			Intermittent
I	System Shutdown Flush			As Required
J	25 Percent Sodium Hydroxide			Continuous

* BASED ON INITIAL CAPACITY OF 8MGD.

* ONLY DUTY UNITS ARE SHOWN. STANDBY UNIT TO BE PROVIDED, IS NOT SHOWN ON FIGURE.

** THE NUMBER OF UV UNITS WILL BE DETERMINED ONCE UV VENDOR IS SELECTED.

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PROCESS FLOW DIAGRAM

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A hydraulic profile for the ARWTF is presented on Figure ES-4. The ARWTF influent line would convey approximately 12 mgd of nitrified secondary effluent over 1,300 feet to the ARWTF site. The proposed tie-in is at the nitrification clarifier effluent channel at a location between SJ/SC WPCP's Nitrification Clarifiers No. 7 and 8. The ARWTF influent line would utilize available head to convey nitrified secondary effluent to the ARWTF site.

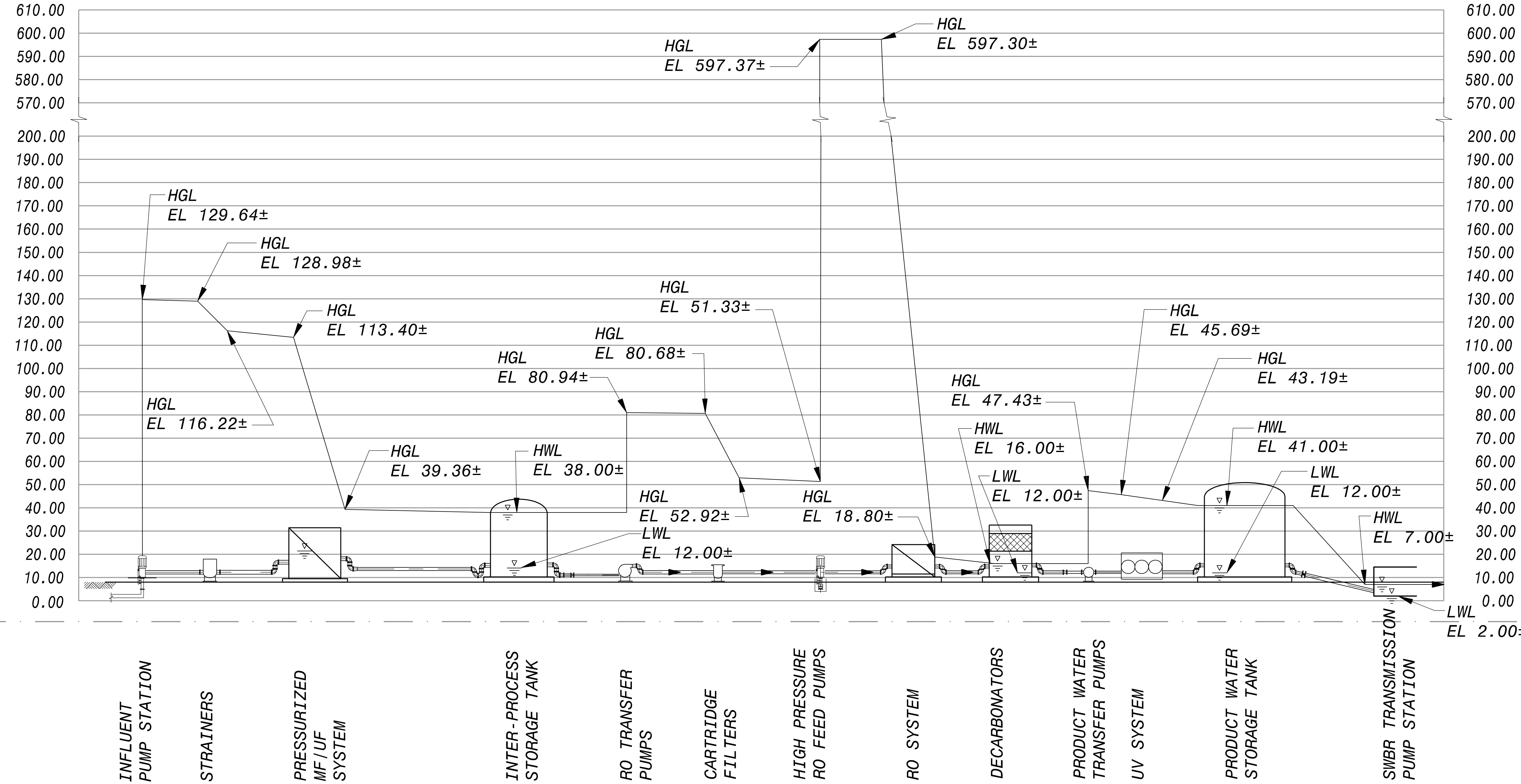
Operation Strategies (Chapter 5)

As discussed above, two different operation strategies – summer and winter – were developed to provide additional flexibility for the SBWR system and to increase the filter capacity at the SJ/SC WPCP during winter periods. For this Project, the summer period is defined from May through November and the winter period from December through April.

Recycled water demand in summer is approximately four times the demand experienced during winter months. Under summer operation mode, the ARWTF would utilize a MF/RO/UV treatment train to produce high-purity recycled water which would be blended with SJ/SC WPCP tertiary effluent to meet the summer recycled water demands and the target SBWR TDS goal of 500 mg/L. Nitrified secondary effluent from SJ/SC WPCP would be pretreated by MF/UF, then demineralized through the RO process, and disinfected through UV disinfection. The ARWTF product water would be stored in a 2.25 MG Product Water Storage Tank and then conveyed to the SBWR TPS to blend with SJ/SC WPCP tertiary effluent.

The ARWTF will initially have sufficient capacity to meet the low recycled water demand during the winter period without SJ/SC WPCP tertiary effluent supply, thus increasing the tertiary filter capacity at the SJ/SC WPCP for efficient disposal during winter periods. Preliminary evaluations indicated that the current ARWTF treatment capacities alone may not be sufficient to meet projected maximum day winter demands for Year 2015 and 2020. However, since the maximum day demand was projected based on 2006 recycled water demand trends, the District should re-evaluate the maximum day winter demands as it gets closer to the projected year to determine if supplemental SJ/SC WPCP tertiary effluent or additional treatment capacity at the ARWTF is needed.

During winter operations, the nitrified secondary effluent would be treated by MF/UF and a portion of the filtrate would bypass around the RO membranes and conveyed directly to the UV Disinfection System. The remainder of the flow would be sent to the RO membranes and then to UV disinfection. RO permeate and bypassed MF/UF filtrate would be blended downstream of the Product Water Storage Tank to meet the target SBWR TDS goal and recycled water demand. Bypass piping and isolation valves would be provided in the UV Disinfection System to dedicate a section of the UV System for disinfection of the MF/UF filtrate, and the remaining section of the UV System for disinfection of RO permeate.



HYDRAULIC PROFILE*

1" = 50'

*VERTICAL ELEVATIONS ARE BASED ON THE NGVD 29 DATUM.

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Santa Clara Valley Water District

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ADVANCED RECYCLED WATER TREATMENT FACILITIES
HYDRAULIC PROFILE

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Facilities Design Criteria (Chapter 6)

Chapter 6 of this report presents design criteria organized in the following subsections: Civil Site Design, Process/Mechanical Design, Architectural Design, Structural Design, Building Mechanical Design, Electrical Design, and Instrumentation and Control (I&C) Design. Chapter 6 includes the following civil, mechanical, and electrical layouts: (1) Civil Site layout, (2) Influent Pump Station and Autostrainers layout, (3) MF/RO/UV Process Structure layout, (4) Inter-Process Storage Tank, RO Transfer Pump Station, and Cartridge Filters layout, and (5) Power Distribution Functional Diagram Project Cost and Schedule (Chapter 7.)

Opinion of Probable Construction Cost (OPCC)

The OPCC is based on bids received on recent, similar B&V projects in California, quotes from major equipment suppliers and on current "Means Building Construction Cost Data" (Means.) Means publishes an updated edition annually, which provides nationwide unit price averages for materials and labor. Means also provides a cost index for several cities located in each state, which ensures accurate cost estimates for specific locations.

The OPCC was originally developed in April 2007, and was generated using 2007 construction costs for materials, equipment, and labor. Construction is expected to commence in September 2010 and the construction duration for this Project is expected to be 18 months. Therefore, this 2007 cost was updated for this revision of the Engineer's Report and escalated to the midpoint of construction (expected to be in June 2011) using a "Mid-point of Construction" factor of 2 percent per year.

The OPCC is broken down into two categories: (1) OPCC for ARWTF Plant and Off-Site Pipelines and (2) OPCC for Off-Site Power Feed. The total OPCC would be the combined OPCC for these two categories and is summarized in Table ES-4. Several major design changes have occurred since April 2007, which would impact the OPCC provided in the table below. Refer to Chapter 7 for additional information.

Opinion of Probable Annual O&M Cost

Opinion of Probable Annual O&M Cost is presented in Tables ES-5. These costs are based on initial projected annual average flows. Refer to Chapter 7 for additional information.

Table ES-4: Summary of Opinion of Probable Construction Cost[1]

1. OPCC for ARWTF and Off-site Pipelines	
1.1 December 2009 Update Facilities Cost – ARWTF and Off-Site Pipelines	$ 43,267,000
1.2 Escalation (2%) to Mid-point of Construction (June 2011)	$ 1,304,000
1.3 Subtotal OPCC for ARWTF and Off-site Pipelines	**$ 44,571,000[2]**
2. OPCC for Off-site Power Feed (based on 5kV service)	
2.1 December 2009 Off-site Power Feed Facilities	$ 2,184,000
2.2 Escalation (2%) to Mid-point of Construction (June 2011)	$ 66,000
2.3 Subtotal OPCC for Off-site Power Feed	**$ 2,250,000**
3. TOTAL OPCC (OPCC for ARWTF and Off-site Pipelines + OPCC for Off-site Power Feed)	**$ 46,821,000[2]**

[1] Costs do not include engineering or construction management services.
[2] Cost is based on 5 MF units per July 2009 proposal from Pall. If it is decided to install 8 MF units per Nov 2009 proposal from Pall, then OPCC for ARWTF and Off-site Pipelines (Item 1.3) would be $47,832,000 and the TOTAL OPCC (Item 3) would be $50,082,000.

Table ES-5: Probable O&M Cost Using Initial Average Annual Flow Rates

Description	Summer Months	Winter Months	Annual Cost
Energy	$1,260,000	$350,000	$1,610,000
Chemicals	$320,000	$110,000	$430,000
Labor	$760,000	$540,000	$1,300,000
Membranes and UV Lamp Replacement	NA	NA	$812,000
UV Lamps Replacement	NA	NA	$81,000
Miscellaneous Cost			
Tanks	NA	NA	$59,000
Parts replacement	NA	NA	$25,000
Total Annual O&M Cost (Year 2015)			**$4,317,000**

Project Schedule

The Project schedule would be maintained on Microsoft Project software and would be regularly updated to reflect the progress of the work. Key schedule milestones are indicated in Table ES-6 below.

Table ES-6: Summary of Key Milestones

Milestone	Date
Notice to Proceed (following Project delay)	October 2006
Draft Engineer's Report	July 2007
Final Engineer's Report	December 2009
30% Design Documents	October 2008
60% Design Documents	February 2010
90% Design Documents	April 2010
Final Design Documents	June 2010
Construction Start	September 2010
Construction Complete and Facilities Operational	Early 2012

1.0 GENERAL REQUIREMENTS

1.1 Overview

This Report serves as the basis for development of detailed design for the South Bay ARWTF Project. Design requirements are presented for the treatment processes, site planning, and various engineering disciplines. In addition, this Report presents a review of regulatory requirements, a proposed Opinion of Probable Construction Cost (OPCC), and a preliminary schedule. This Report was updated in December 2009 to reflect the current understanding of the Project and builds on the initial draft of this Engineer's Report (July 2007). The purpose of the Report is to provide an opportunity for all concerned parties, including the District, City, Black & Veatch (B&V) and its subconsultants, and regulatory agencies to understand the Project.

This chapter presents a brief description of the Project and summarizes Project methodology. A list of terms, abbreviations, and acronyms used herein is also provided. More detailed information on subjects introduced in this chapter is contained in subsequent chapters and appendices, as well as other referenced documents and reports.

1.2 Project Background

The District manages both surface water and ground water systems in Santa Clara County (County) and supplies wholesale water to retailers including municipalities and private water companies. The regional SJ/SC WPCP is operated by the City. The SJ/SC WPCP is one of the largest advanced wastewater treatment facilities providing secondary and advanced tertiary treatment in California with a treatment capacity of 167 mgd. Approximately ten percent of the SJ/SC WPCP wastewater, on average, is recycled through the SBWR system for landscaping, agricultural irrigation, and industrial uses. The remainder of treated water from the SJ/SC WPCP is discharged to the South San Francisco Bay, through the Artesian Slough.

As the County's population continues to grow and demand for water increases, the District is looking for partnerships with the community to expand water recycling in the County. The ARWTF Project, a cooperative program between the District and the City, is an expansion of the existing SBWR system. Objectives of the ARWTF Project are to produce high-purity recycled water that would reduce existing recycled water salinity and increase the marketability of the existing recycled water supply. The ARWTF is expected to provide the District and the City with multiple benefits, including:

- Increasing reliability of recycled water supply for reuse
- Improving recycled water quality to increase its marketability
- Increasing SBWR recycled water treatment capacity
- Improving public acceptance of recycled water
- Maximizing water reuse alternatives
- Reducing the amount of treated effluent discharges into San Francisco Bay, thus helping to preserve saltwater and tidal habitat
- Providing operational flexibility to the existing tertiary filters at the SJ/SC WPCP during winter months.

The District has contracted B&V to provide design services for the implementation of the ARWTF Project. The ARWTF Project would be designed to have an initial net production capacity of 8.0 million gallons per day (mgd) of high-purity recycled water, and would be readily expandable to 9.0 mgd.

1.3 Project Description

The proposed South Bay ARWTF would treat nitrified secondary effluent from the SJ/SC WPCP with advanced treatment processes consisting of MF/UF; RO; and UV disinfection to produce high-purity recycled water that would be blended with the existing recycled water supply. The scope of the ARWTF Project includes the design of civil/site work, process mechanical, yard piping, structural, architectural, geotechnical, building mechanical, electrical and instrumentation and controls for the treatment facilities designed under the Project.

The Project site is an undeveloped area owned by the SJ/SC WPCP east of the existing SBWR Transmission Pump Station (TPS) and is located across Zanker Road at the southeast corner of the SJ/SC WPCP. Figure 1-1 presents the Project Location Map.

1.4 Project Methodology

The findings in this report are based on two major efforts: ARWT Feasibility Study and ARWTF Preliminary Design. The Feasibility Study, prepared in 2004 by B&V and Kennedy/Jenks Consultants, is summarized in Table 1-1.

Table 1-1: Summary of Feasibility Study

Purpose	Technical Memoranda (TMs)	Key Findings
Investigate the feasibility of implementing an ARWT project.	• TM1 – Background Water Quality and Preliminary ARWT Technologies Assessment Characterization • TM2 – Market Assessment • TM3 – Stakeholder Involvement Plan • TM4 – Groundwater and Surface Water Resources and Facilities Assessment • TM5 – Regulatory Review and Integrated Permitting Strategy Plan • TM6 – Financial Analyses	• Recycled water use could be significantly expanded throughout the County • Recycled water quality is of chief importance to stakeholders • Either tertiary and/or advanced recycled water treatment (ARWT) would be required • ARWT could include (1) use of UV as an alternative disinfectant or (2) use of a desalting process to reduce TDS of product water • Successful recycled water projects include a multi-faceted approach that employs current technology, an understanding of system goals, community involvement, and continued scientific research

Figure 1-1: Project Location Map

Based on the findings of the Feasibility Study summarized in Table 1-1, the District retained B&V to perform preliminary design of the ARWTF, which is presented in this Report. Information in this Report is based, in part, on the technical evaluations performed, as well as on results of meetings, workshops, and other public outreach activities.

1.5 Codes and Standards

The latest editions of the following codes and standards apply to the design of the Project:

- American Society of Civil Engineers (ASCE) Standards
- American Water Works Association (AWWA) Standards
- American Society for Testing and Materials (ASTM) Standards
- Hydraulic Institute Standards (HIS)
- National Water Research Institute (NWRI) Guidelines
- California Code of Regulations (CCR) Title 17 and 22 Standards
- International Building Code (IBC)
- California Building Code (CBC)
- California Mechanical Code
- American Welding Society Standards
- National Earthquake Hazard Reduction Program (NEHRP)
- American Concrete Institute (ACI) Standards
- American Institute of Steel Construction Standards
- California Building Energy Efficiency Standards
- California Energy Code
- National Electrical Code
- California Electrical Code
- California Electrical Safety Code
- National Electrical Safety Code (NESC)
- Life Safety Code – National Fire Protection Agency (NFPA)
- California Fire Code
- National Fire Protection Agency (NFPA) recommended practices and manuals
- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) handbooks and standards
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA) handbooks
- American Society of Plumbing Engineers (ASPE) handbooks
- California Plumbing Code
- The City of San Jose Standards
- Santa Clara Valley Water District Standards

1.6 Drafting Standards and Procedures

Drawings would be produced to Black & Veatch drafting standards and compared with the City drafting requirements. Drawings would be prepared in AutoCAD 2008 3-D format. Review submittal (at 30, 60 and 90 percent designs) drawings would be on half-size sheets (11" x 17") and electronic copy of the drawings, in both AutoCAD format and PDF format, would be submitted on CD-ROM.

1.7 Abbreviations and Acronyms

The following abbreviations and acronyms are used in this report:

AASHTO	American Association of State Highway and Transportation Officials
ac-ft/yr	acre-feet per year
ACI	American Concrete Institute
ANSI	American National Standards Institute
AOP	Advanced Oxidation Process
ARWT	advanced recycled water treatment
ARWTF	Advanced Recycled Water Treatment Facility
AS	air scrub
ASCE	American Society of Civil Engineers
ASD	allowable stress design
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
AWG	American Wire Gage
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
B&V	Black & Veatch
CBC	California Building Code
CCR	California Code of Regulations
CCT	Chlorine Contact Tank
CDP	Criterium Decision Plus
CEBW	chemical enhanced backwash
CEQA	California Environmental Quality Act
CIP	clean-in-place
City	City of San Jose
County	Santa Clara County
DB	direct buried
DCS	Distributed Control System
DPH	California Department of Public Health
District	Santa Clara Valley Water District
DNA	deoxyribonucleic acid
E	Earthquake
EA	Environmental Assessment
EBMUD	East Bay Municipal Utility District
EBOS	Emergency Basin Overflow Structure
EDR	Electrodialysis Reversal
EFM	enhanced flux maintenance
EIR	Environmental Impact Report
EOA	Eisenberg, Olivieri and Associates, Inc.
EPA	California State Department of Environmental Protection Agency
EPDM	ethylene propylene diene
EPA	United States Environmental Protection Agency
EQ	equalization

fps	feet per second
FRP	fiberglass reinforced plastic
FTE	Full-time Equivalent
GE	General Electric Water and Process Technologies
gfd	gallons per square foot per day
gpd	gallons per day
gpm	gallons per minute
GTAW	gas-tungsten-arc weld
HID	high intensity discharge
HIS	Hydraulic Institute Standards
HP	high pressure
hp	horsepower
HVAC	heating, ventilating, and air conditioning
HWL	high water level
IBC	International Building Code
ICC-ES	International Code Council Evaluation Service
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineers Society
I&C	instrumentation and control
IS	Initial Study
ISA	Instrument Society of America
ksi	thousand pounds per square inch
kW	kilowatt
kWh	kilowatt-hour
LF	linear feet
LP	low pressure
LSI	Langelier Saturation Index
max	maximum
MBR	membrane bioreactor
MC	maintenance clean
MCCs	motor control centers
MF/UF	microfiltration / ultrafiltration
MF/UF-RO	microfiltration/ultrafiltration – reverse osmosis
MG	million gallons
mgd	million gallons per day
mg/L	milligrams per liter
MP	medium pressure
mph	mile per hour
MTCo	Mark Thomas and Company, Inc.
MW	maintenance wash
N	Number of duty Units Required
NEC	National Electrical code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act

NESC	National Electrical Safety Code
NF	nanofiltration
NFPA	National Fire Protection Association
nm	nanometers
NSF	National Science Foundation
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
NWRI	National Water Research Institute
O&M	operations and maintenance
OPCC	Opinion of Probable Construction Cost
OSHA	Occupational Safety and Health Act
pcf	pounds per cubic feet
PCS	Plant Control System
PDFD	Power Distribution Functional Diagram
PG&E	Pacific Gas and Electric Company
P&ID	piping and instrumentation drawings
PLC	programmable logic controller
PPCP	pharmaceutical and personal care products
Project	South Bay Advanced Recycled Water Treatment Facility Project
psf	pounds per square feet
psi	pounds per square inch
psig	pounds per square inch (gage)
PTFE	polytetrafluroethylene
PVC	polyvinyl chloride
PVDF	polyvinylidene fluoride
RARE	Richmond Advanced Recycled Expansion
Report	Engineer's Report
RF	Reverse Filtration
RFP	Request For Proposal
RGS	rigid galvanized steel
RO	reverse osmosis
SBWR	South Bay Water Recycling
SCVWD	Santa Clara Valley Water District
SDI	Silt Density Index
SE	Secondary Effluent
SJ/SC WPCP	San Jose/Santa Clara Water Pollution Control Plant
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SWPPP	Storm Water Pollution Prevention Plan
SPI	Separation Processes, Inc.
Study	ARWT Feasibility Study
TBD	To Be Determined
TDS	total dissolved solids
TE	tertiary effluent
TM	Technical Memoranda

TMP	trans-membrane pressure
TOC	total organic carbon
TPS	Transmission Pump Station
TSS	total suspended solids
UF	ultrafiltration
µg/L	micrograms per liter
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
USD	ultimate stress design
UV	ultraviolet light
V	volt
VFD	variable frequency drive
W	wind
WDRs	Waste Discharge Requirements
WPCP	Water Pollution Control Plant
WS	water surface

2.0 ADVANCED RECYCLED WATER TREATMENT CAPACITY EVALUATION AND TREATMENT PROCESS SELECTION

2.1 Overview

General overview of the SBWR program including results of the water quality and flow demand evaluation is presented in this chapter. A summary of capacity evaluation and treatment process selection studies conducted for the ARWTF is also presented. The chapter concludes with a summary of the evaluation of MF/UF, RO and UV treatment processes performed during the preliminary design.

2.2 South Bay Water Recycling Program

An overview of the existing SBWR System is presented in this section, followed by SBWR expansion goals.

2.2.1 Existing SBWR System

The SBWR system is a long-term program established to divert fresh water from the South San Francisco Bay to protect endangered species habitat. The recycled water is utilized for non-potable uses including irrigation of golf courses, parks, school properties, business parks, and agricultural lands, as well as for industrial processes and cooling tower uses. The existing SBWR system consists of the following facilities:

- A 108-inch diameter diversion pipeline from the SJ/SC WPCP to the SBWR TPS. This pipeline provides disinfected filtered effluent (tertiary effluent) from SJ/SC WPCP for use as recycled water.
- The SBWR TPS, which serves as the main pump station providing recycled water to the SBWR system.
- Over 100 miles of recycled water distribution pipeline system.
- Three (3) storage reservoirs.

During summer months of 2007, an average of 14.4 mgd of tertiary effluent produced from the SJ/SC WPCP was distributed to over 500 recycled water customers throughout the SBWR system for recycled water uses, preserving valuable surface and groundwater water for potable uses. For fiscal year 2006-2007, the SBWR program successfully distributed more than 3.25 billion gallons (10,000 acre-feet) for non-potable water uses, in lieu of using potable water.

2.2.2 SBWR System Expansion Goals

In July 2001, the District adopted new water recycling policies with the goals to increase recycled water uses to account for five percent of the County's total water supply (20,000 acre-feet per year {ac-ft/yr}) by Year 2010 and ten percent of the County's total water supply (50,000 ac-ft/yr) by Year 2020. To meet these goals, the District understands that expansion of the SBWR system to include advanced wastewater treatment facilities would be necessary to increase the volume of recycled water production and to improve the quality of recycled water produced.

In 2004, the District retained B&V-Kennedy/Jenks Consultants team to conduct the advanced recycled water treatment (ARWT) Feasibility Study (refer to Section 1.4). Based on the findings of the Feasibility Study, the District subsequently retained B&V in October 2006, to perform the preliminary and final design of the ARWTF.

2.3 SBWR Recycled Water Quality and Flow Demand Evaluation

This section reviews historical water quality data; in particular, the TDS concentration for the SJ/SC WPCP tertiary effluent. The tertiary effluent TDS concentration plays a significant role in evaluating the quantity of high-purity recycled water to be produced by the ARWTF.

Results of the ARWTF capacity analysis evaluation, based on the SBWR recycled water quality goals and demands, are also presented below.

2.3.1 SBWR Recycled Water Quality Evaluation

To increase the use of recycled water for non-potable uses and to increase its marketability to SBWR customers; the District has established a goal that the SBWR system consistently provides a recycled water supply with a TDS concentration of 500 milligrams per liter (mg/L). A high-purity recycled water source (ARWTF) is needed to blend with the SJ/SC WPCP tertiary effluent in order to meet the target SBWR TDS goal. Therefore, the SJ/SC WPCP tertiary effluent TDS concentration plays an important role in evaluating the capacity of the ARWTF as it influences the blending ratio of the high-purity recycled water to the tertiary effluent.

A plot of the historical TDS data of the SBWR system's recycled water from year 1999 to 2006 is provided on Figure 2-1. Currently the SBWR system is only supplied by SJ/SC WPCP tertiary effluent. Following a period of higher concentration during 1999 to 2002, the SBWR TDS concentration was consistently within a range of approximately 650 to 750 mg/L from 2003 to 2006 (Figure 2-1) indicating a stable trend in TDS concentration. The data from this period is used for further evaluation. The percentile distribution of TDS concentrations measured during 2003 to 2006 is shown on Figure 2-2. Available data for 2003 to 2006, for days when both TDS and flows were available is plotted on Figure 2-3. The TDS concentration exceeds 750 mg/L in very few instances during low and peak demand periods as indicated on Figure 2-3.

Based on Figure 2-2, a SJ/SC WPCP tertiary effluent TDS concentration of 750 mg/L was selected (90^{th} percentile of the available TDS data as indicated on Figure 2-2) for the ARWTF capacity evaluation.

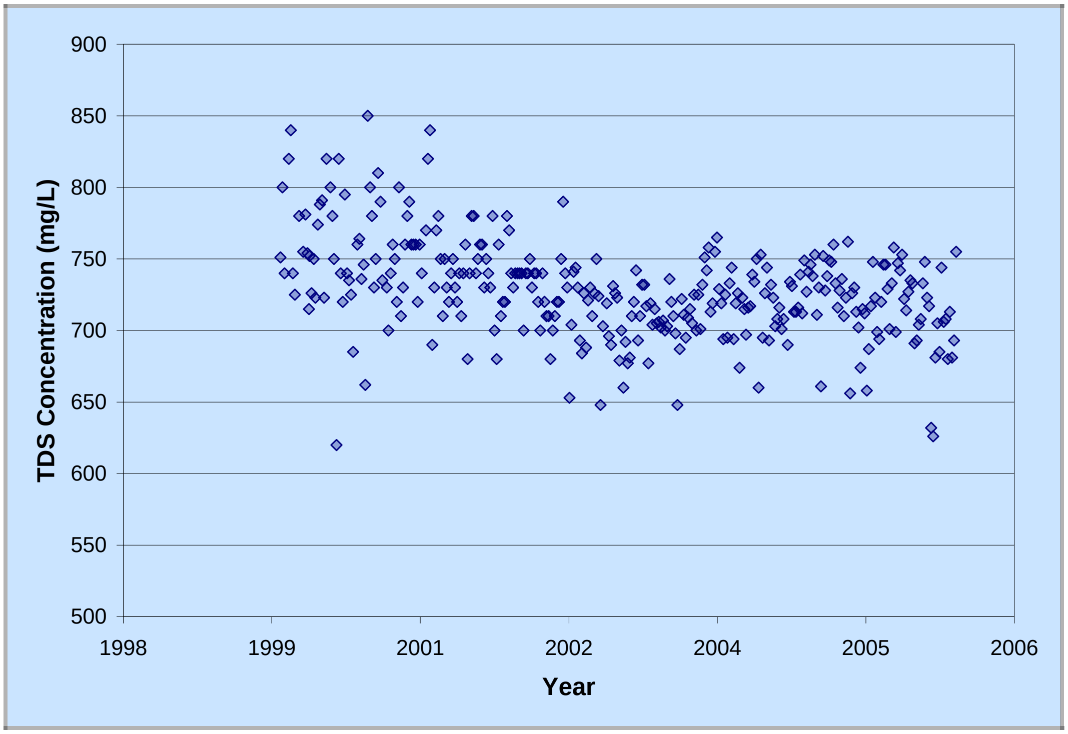

Figure 2-1: SJ/SC WPCP Tertiary Effluent Two-Month Average TDS Concentrations (1999-2006)

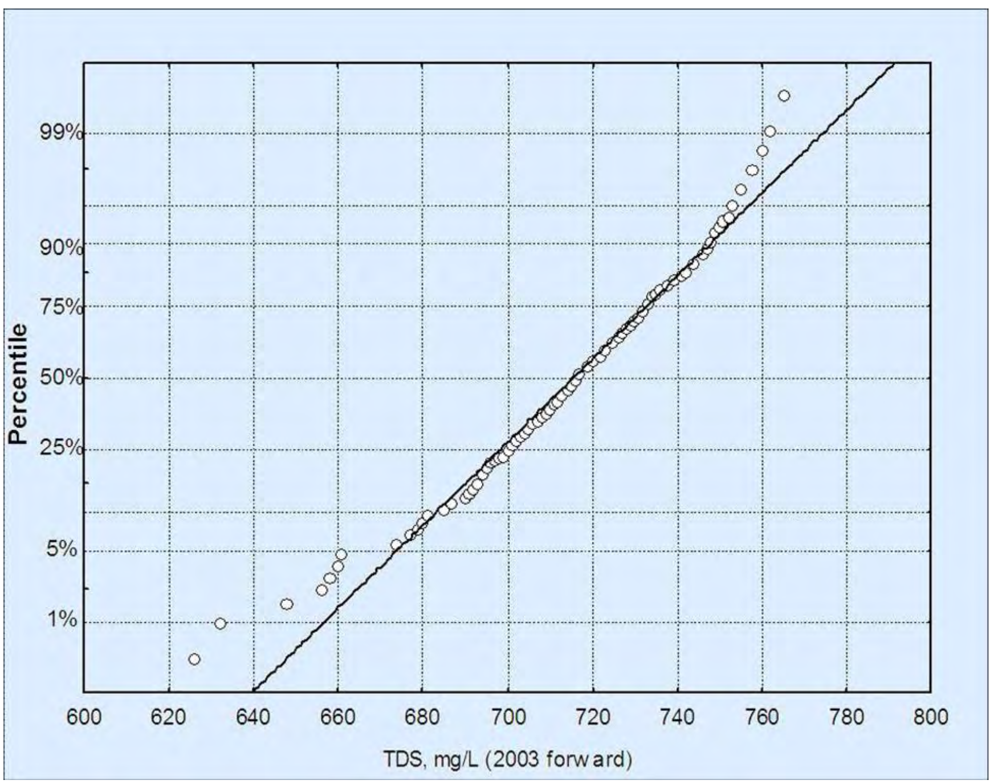

Figure 2-2: SJ/SC WPCP Tertiary Effluent TDS Distribution (2003-2006)

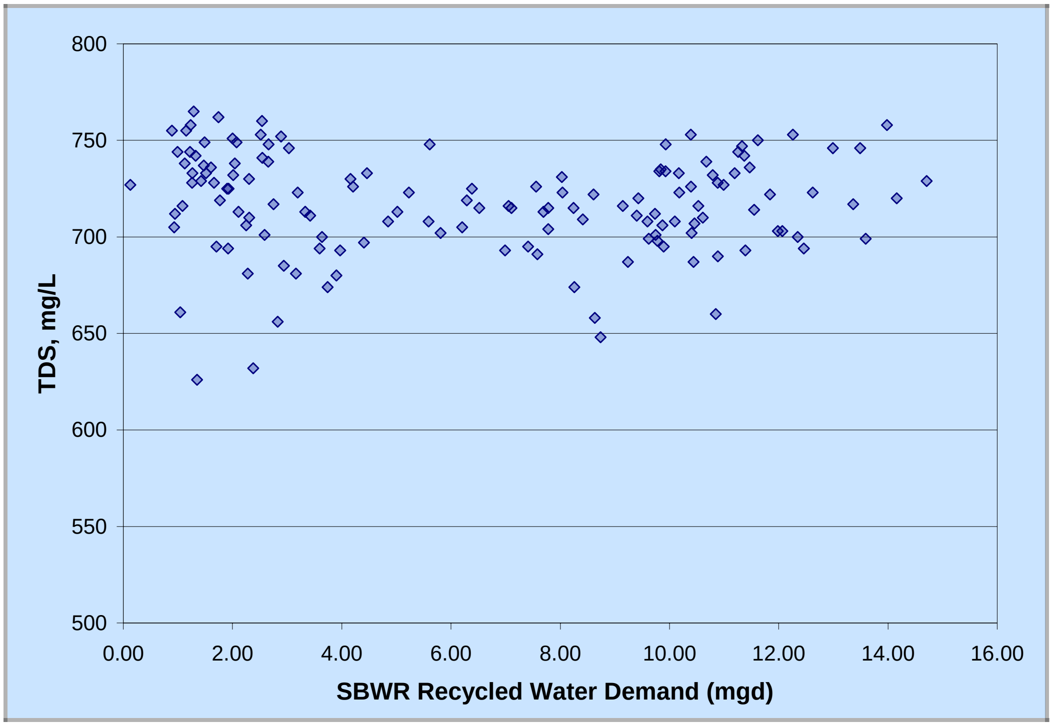

Figure 2-3: SBWR Demand vs. TDS Data (2003-2006)

2.3.2 SBWR Recycled Water Demand Evaluation

2.3.2.1 Historical Recycled Water Demand

SBWR Program recycled water use for fiscal years 1998-99 through 2006-2007 is shown in Figure 2-4. Over this period, the highest recycled water demand occurred in fiscal year 2006-2007. The increase in recycled water demand would likely continue as the District plans to expand its recycled water system to account for 10 percent of the total water supply by Year 2020.

Monthly SBWR recycled water demands are presented in Table 2-1. Peak recycled water demand occurs during the dry weather months (June through September), which is consistent with the daily demand presented in Figure 2-5.

Daily SBWR recycled water flows from July 2003 through August 2007 are shown on Figure 2-5. This figure shows that the daily recycled water demands increased over the years with peak demand occurring in dry weather months.

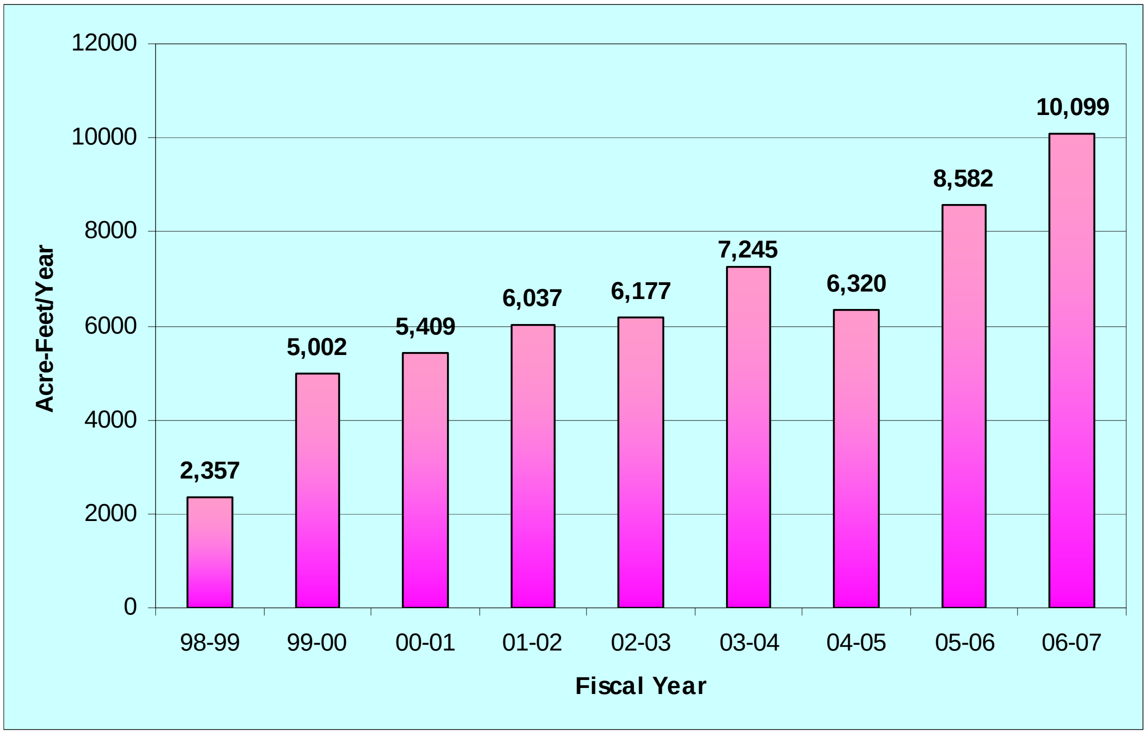

Figure 2-4: SBWR Program Annual Recycled Water Use

Table 2-1: Monthly SBWR Recycled Water Use

Fiscal Year Monthly Volumes (Acre-Feet)				
	2003-04	**2004-05**	**2005-06**	**2006-07**
Jul	1,080	1,106	1,215	1,508
Aug	962	983	1,247	1,348
Sep	835	892	1,102	1,120
Oct	676	445	981	938
Nov	221	197	631	480
Dec	134	230	394	327
Jan	137	183	141	392
Feb	132	163	308	304
Mar	414	206	237	465
Apr	719	374	157	784
May	938	618	948	1,142
Jun	995	922	1,220	1,291
Totals	7,245	6,320	8,582	10,099

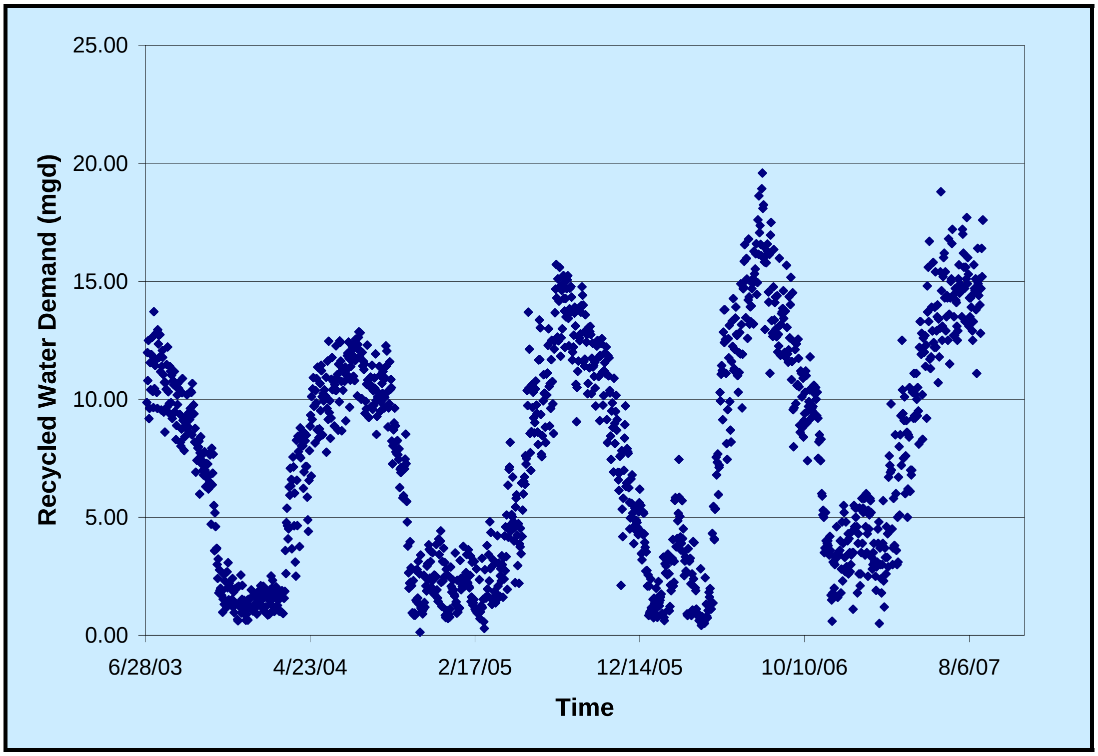

Figure 2-5: SBWR Daily Average Recycled Water Flows (July 2003 – August 2007)

The highest recorded recycled water demands, to date (based on data available in Figure 2-4 and Table 2-1), occurred during the June 2006 through September 2006 period. Refer to Figure 2-6 for SBWR recycled water demands during this period. The maximum day demand (19.6 mgd) and the maximum week demand (17.8 mgd) occurred in July 2006 (Table 2-2).

2.3.2.2 ARWTF Capacity Evaluation Flows

The initial capacity evaluation of the ARWTF was conducted using the latest available, one year historical recycled water use data (fiscal year 2005-2006), tabulated in Table 2-1. Note that subsequent to the completion of the capacity analysis, additional data was provided for fiscal year 2006-2007 and was not reflected on the initial capacity analysis. The SBWR recycled water demands in Table 2-2 were used to establish the initial ARWTF treatment capacity needed to meet maximum week and maximum day recycled water demands for the target SBWR TDS concentration of 500 mg/L.

Subsequent to the initial capacity analyses, an update of future SBWR recycled water demand projection data (Figure 2-7) as well as fiscal year 2006-2007 were provided to B&V for adjustment of the ARWTF treatment capacity to meet anticipated future recycled water demand projections.

2.3.3 Future Recycled Water Demand

The SBWR system has experienced an increase in annual average recycled water demand from its inception as indicated above in Figure 2-4. Currently, the SBWR Program is a major component of the District's recycled water portfolio. The District's projected future recycled water use up to year 2030, as provided by SBWR staff, is shown on Figure 2-7. The District plans on expanding existing recycled water programs and developing new recycled water treatment projects to meet the future recycled water demands.

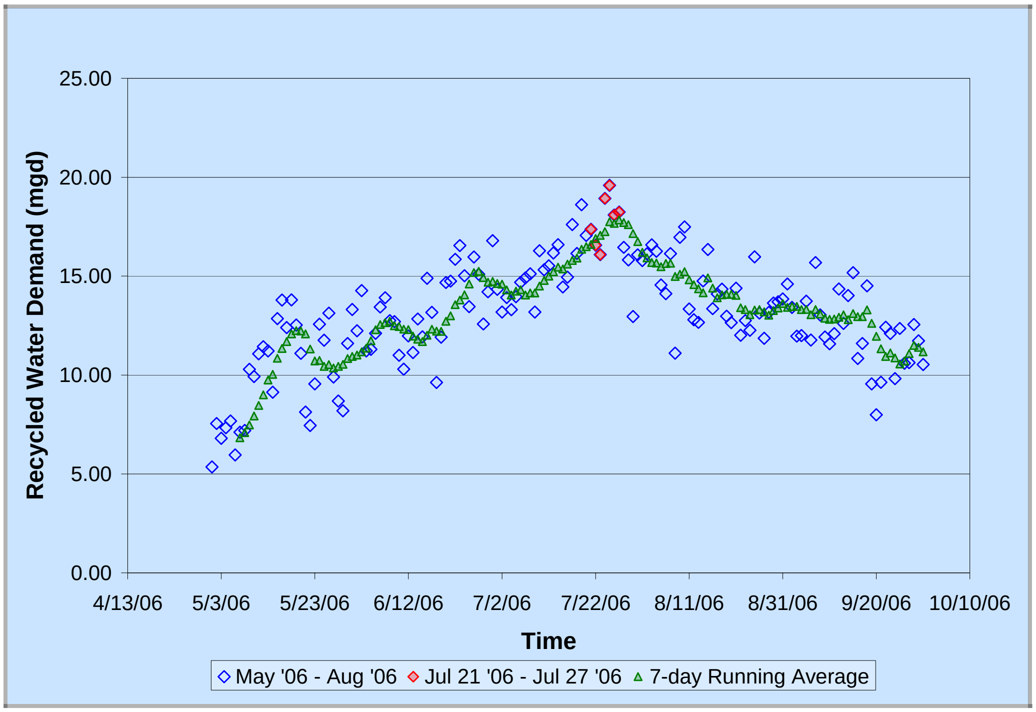

Figure 2-6: SBWR Daily Recycled Water Flows (May – September 2006)

Table 2-2: SBWR Recycled Water Demand for ARWTF Design[1]

Condition	Flow (mgd)
Annual Average Demand	8.0
Maximum Week Average Demand	17.8
Maximum Day Demand	19.6

[1]Based on data from October 2005 – September 2006

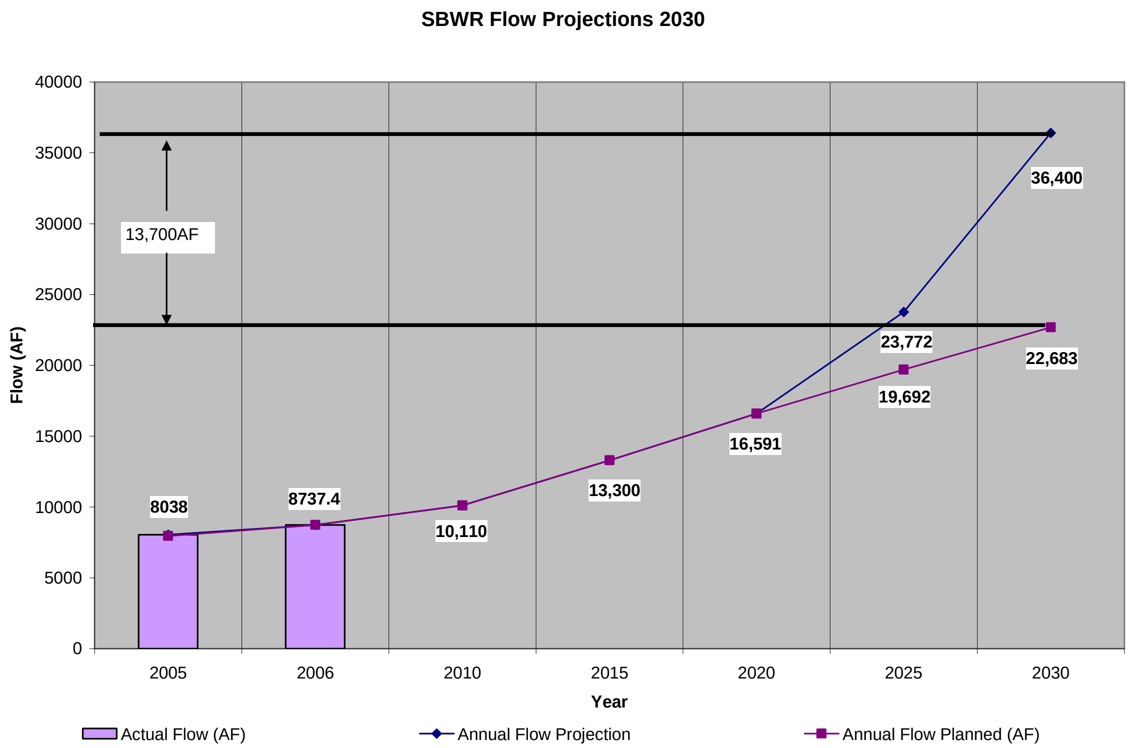

Figure 2-7: Projected Future SBWR Demand

2.4 Treatment Process Selection

The feed water quality parameters that have significant impact on the AWRTF treatment process selection are discussed below.

2.4.1 Selected Advanced Recycled Water Treatment Processes

The primary objective of the AWRTF is to reduce TDS, sodium, silica, organics, and other undesirable constituents from the recycled water. High concentrations of these constituents could limit the use of recycled water.

RO is the best available demineralization technology for removal of these dissolved constituents. Water treated by RO can be blended with tertiary effluent from the SJ/SC WPCP to reduce the concentrations of TDS and improve the overall quality of the recycled water. RO membranes are designed for removal of dissolved substances (i.e. mineral composition). Presence of foulants, such as particulate, or suspended solids, adversely affect performance of the RO membrane. Therefore, feedwater to RO systems must be pretreated to mitigate the potential foulants. Since the mid 1990s, the MF/UF process has become the industry standard practice for pretreatment of RO feed in wastewater applications because of their ability to consistently provide a near-absolute barrier to particulate material.

In addition to MF/UF pretreatment and RO membrane treatment, UV disinfection will also be provided at the ARWTF to fulfill California DPH disinfection requirements for recycled water. DPH requirements are presented in Chapter 3. MF/UF, RO and UV treatment processes are described in more detail in Section 6.3 Process Mechanical Design.

2.4.2 Feed Water Quality Considerations

The SJ/SC WPCP treatment facilities include "secondary clarifiers" and "nitrification clarifiers" which were once operated in series. The secondary clarifiers and nitrification clarifiers are now operated in parallel. Both sets of clarifiers have maintained their original names, yet they both produce a nitrified secondary effluent.

Four SJ/SC WPCP feed water options are available for the ARWTF:

1. Secondary clarifier effluent;
2. Nitrification clarifier effluent;
3. Existing filter (tertiary) influent feed (blended nitrification and secondary clarifier effluent); and
4. Filter (tertiary) effluent.

With the total suspended solids (TSS) concentration being one of the critical parameters in MF/UF system design, the TSS concentrations for the four potential feed water sources were evaluated and summarized in Table 2-3. SJ/SC WPCP's nitrification clarifier effluent has a consistently lower (based on minimum to maximum ranges) TSS concentration compared to the secondary clarifier effluent. The reason for this is that the nitrification clarifiers are newer and have a more efficient settling mechanism. The TSS concentration of the tertiary effluent is in general, lower than the secondary clarifier and nitrification clarifier effluent. Typically, tertiary effluent would provide feed water with better quality due to lower suspended solids concentration, resulting in higher operating recoveries and lower cleaning frequencies. However, the TSS data shown in Table 2-3 indicates that the average TSS concentration for the nitrification clarifier effluent is not significantly higher than the tertiary effluent supply.

There are several reasons for not using tertiary effluent as feed water for the ARWTF, including (1) the ability to increase the tertiary treated water capacity (SBWR recycled water supply) needed during peak dry weather demand period and (2) the flexibility to shut down the existing tertiary filtration system at SJ/SC WPCP and operate only the ARWTF during the low demand season. In addition, pilot testing conducted for East Bay Municipal Utility District's (EBMUD) Richmond Advanced Recycled Expansion (RARE) Water Project indicated that treating tertiary effluent only resulted in a marginal increase in system recovery compared to treating secondary effluent. A system recovery of 94 percent was achieved when treating the tertiary effluent, compared to 92.5 percent recovery when treating secondary effluent.

Table 2-3: SJ/SC WPCP Effluent TSS Data (mg/L)

TSS	Nitrification Clarifier Effluent[1]	Secondary Clarifier Effluent A[1]	Secondary Clarifier Effluent B[1]	Tertiary Influent Feed[2]	Tertiary Effluent[2]
Average	3.97	5.76	7.09	7.68	2.03
Maximum	11.00	24.00	26.00	65.00	34.00
Minimum	2.00	2.00	3.00	0.10	0.20
90th Percentile	6.00	9.00	11.00	10.00	2.80
95th Percentile	7.00	10.00	12.00	10.00	3.20

[1] Data obtained from March 2006 through November 2006.
[2] Data obtained from 2001-2005. Three data points where the TSS concentration was over 100 mg/L were eliminated as they are not representative of typical tertiary effluent water quality.

Based on an analysis of suspended solids, B&V's experience with MF/UF applications on water sources high in suspended solids, and discussions with MF/UF manufacturers, the recommended feed water supply for the ARWTF was identified as SJ/SC WPCP nitrification clarifier effluent. By treating the nitrification clarifier effluent from the SJ/SC WPCP with MF/UF, RO, and UV disinfection, the ARWTF is expected to produce high-purity recycled water with TDS concentration of approximately 40 mg/L.

Secondary clarifier effluent is hydraulically connected to the nitrification clarifier effluent channel (point of tie-in for Influent Pipeline). Therefore, if the nitrification clarifiers are taken out of service for maintenance, effluent from the secondary clarifiers would backflow to the nitrification effluent channel, providing supply to the ARWTF. At least one of the two secondary clarifier batteries would need to remain in operation for this to occur.

2.4.3 Technical Evaluations

B&V performed several technical evaluations during the preliminary design. Summary of the decisions made based on results of these evaluations and workshops conducted with the District and the City are presented below in Table 2-4.

Table 2-4: Summary of Project Decisions

Basis	Project Decision (s)
Capacity Evaluation	The Phase I ARWTF capacity would be 8 mgd (initial) and expandable to 9 mgd (future), to reflect updated information on recycled water demands through 2015.
Pretreatment System Evaluation	Four (4) MF/UF manufacturers were short-listed. A manufacturer was selected through a membrane preselection process. Selection was based on experience and a life cycle cost evaluation.
RO System Evaluation	At least three (3) RO membrane manufacturer's systems are available in the market for ARWTF. Contractor would determine preferred manufacturer prior to construction.
Disinfection System Evaluation	Two (2) UV manufacturers were short-listed. A manufacturer was selected through a UV preselection process (based on a life cycle cost evaluation).
Siting Alternatives Evaluation	SBWR TPS site was selected for ARWTF as it facilitates future expansion at SJ/SC WPCP.

Brief summaries of the Capacity Evaluation, Pretreatment System Evaluation, RO System Evaluation, and the Disinfection System Evaluation are presented in this section. A summary of the Siting Alternatives Evaluation is presented in Chapter 6.

2.5 ARWTF Capacity Evaluation

An evaluation on the capacity of ARWTF was performed. Results of the capacity analyses are summarized in Table 2-5. The initial and optimized capacity analyses were performed using SBWR's historical recycled water demand data as stated in the scope of work. The optimal ARWTF treatment and storage capacity, based on fiscal year 2005-2006 data, for SBWR recycled water demand was approximately 6.6 mgd with a 2.0 MG Product Water Storage Tank.

Subsequent to the initial and optimized capacity analyses, an update of future SBWR recycled water demand projection data (Figure 2-7) as well as fiscal year 2006-2007 were provided to B&V for adjustment of the ARWTF treatment capacity to meet anticipated future recycled water demand projections. A total of ten ARWTF process scenarios were evaluated to meet the projected future SBWR recycled water demands through year 2020. Evaluations of the ten scenarios are summarized in Table 2-6. After discussions with the District and City staff, a decision was made that the SBWR should meet a target TDS goal of 500 mg/L and 400 mg/L, 99 percent and 75 percent of the time, respectively when the ARWTF comes online in Year 2012. The ARWTF would also have sufficient capacity to meet the target SBWR TDS goal of 500 mg/L greater than 95 percent of the time in Year 2015. An MF/UF treatment capacity of 10.0 mgd, a RO treatment capacity of 8.0 mgd, a UV treatment capacity of 8.0 mgd, and a product water storage capacity of 2.25 MG were selected for the ARWTF (presented as Option B in Table 2-6). This capacity evaluation was based on the ARWTF producing recycled water with a TDS of 40 mg/L and blending with SJ/SC WPCP tertiary effluent with a TDS of 750 mg/L to produce a SBWR TDS of 400-500 mg/L.

The RO System would be designed for future expansion to 9.0 mgd by installing additional membranes on the existing units. In addition, it has been since decided to provide a UV System with a 10.0 mgd capacity to provide flexibility to treat the entire MF/UF flow through the UV System.

Table 2-6 indicates that the Option B MF treatment capacity (in addition to RO and UV) is capable of meeting projected Year 2015 winter SBWR recycled water demands without the need for blending with SJ/SC WPCP tertiary effluent. This would provide the City with the benefit of operational flexibility to the existing tertiary filters at the SJ/SC WPCP during winter months.

During summer months, when recycled water demand is high, the high-purity recycled water produced from the ARWTF would be blended with the existing tertiary effluent from SJ/SC WPCP to achieve the target SBWR TDS concentration of 500 mg/L in the blended recycled water.

Table 2-5: Summary of Preliminary Capacity Analyses

Analysis	Evaluation Criteria	Results		
		ARWTF Capacity	Storage Capacity	Remarks
Initial ARWTF Capacity Analysis[1]	• ARWTF treatment capacity would be sufficient to meet maximum day demand. • Mass balance calculations estimating blended supply from ARWTF would assume TDS concentration of 750 mg/L for SJ/SC WPCP tertiary effluent and 40 mg/L for ARWTF product water	6.9 mgd	0 MG	The ARWTF would be able to meet maximum day recycled water demand
Optimized Capacity Analysis Assuming Storage Options[1]	• ARWTF treatment and product water storage capacity would be sufficient to meet diurnal demands during maximum week demand period • ARWTF Product Water Storage Tank would never fall below zero during the maximum week recycled water demand period • ARWTF Product Water Storage Tank would be filled to its design volume during the last day of the maximum week recycled water demand as safety factor to meet target SBWR TDS goal	6.6 mgd	2 MG	The ARWTF would be able to meet diurnal, maximum week recycled water demands and maintain storage capacity at the end of the week.
Capacity Evaluation for Future SBWR Demand[2]	• Year 2010 target 500 mg/L TDS confidence >95% • Year 2010 target 400 mg/L TDS confidence >75% • Year 2015 target 500 mg/L TDS confidence >95% • ARWTF treatment capacity would be sufficient to meet average winter (December through April) SBWR recycled water demand without blending with SJ/SC WPCP tertiary effluent.	8.0 mgd	2.25 MG	The ARWTF would be able to meet target SBWR TDS goals up to year 2015 and meet winter SBWR recycled water demands by itself.

[1] Analysis performed using recycled water demand data (2005-2006).

[2] Analysis performed after receiving 2006-2007 SBWR recycled water demand projections.

Table 2-6: TDS Confidence Matrix of Potential ARWTF Scenarios

				ARWTF PROCESS SCENARIO										
			Treatment	No Project	A	B	C	D	E	F	G	H	I	J
			MF	0	8	10	12	15	21	23	28	30	34	37
			RO	0	6.6	8	10	12	0	8	0	10	0	12
			UV	0	6.6	8	10	12	21	21	28	28	34	34
Year	Max Day Flow, mgd	Target TDS, mg/L	Confidence											
2010	21	500	99%											
			95%											
			75%											
		400	99%											
			95%											
			75%											
2015	28	500	99%											
			95%											
			75%											
		400	99%											
			95%											
			75%											
2020	34	500	99%											
			95%											
			75%											
		400	99%											
			95%											
			75%											
2010/2015/2020		750+/-	100%											
Other Water Quality Parameters	Low Turbidity		< 0.1 NTU		(2)	(2)	(2)	(2)						
	Full UV Disinfection													
	Added Total Filter Capacity (mgd)(1)			0	7	8	10	12	36	36	43	43	49	49
MF System can Meet Winter Flows (Dec-Apr)			2010											
			2015											
			2020											
MF can Meet Max Daily Recycled Water Demands			2010											
			2015											
			2020											

(1) Flow that can be filtered either by gravity or microfiltration

(2) Low turbidity goal of <0.1 NTU can be met during winter

2.6 MF/UF Treatment Evaluation

To minimize membrane fouling and to promote effective operation of the RO membrane process, a very high quality RO feed is required. Targeted values of RO feed water quality are summarized in Table 2-7. MF/UF pretreatment would achieve the targeted RO feed water quality specified in Table 2-7.

Table 2-7: Required RO Feed Stream Water Quality

Parameter	Value
Turbidity, NTU	<0.2, average (24 hours) <0.5, instantaneous
Maximum Filtered Water Silt Density Index (SDI)	<3.0, 98% of the time <4.0, at any time

The silt density index (SDI) is the most widely used fouling index that assesses the tendency for a given feed stream to foul a RO membrane. It is a useful qualitative indicator of the need for pretreatment and treatability of RO feed. The SDI is measured in a standard timed filtration test, and it is a sensitive guarantor of adequate MF/UF performance ahead of an RO System.

A detailed evaluation on the application of MF/UF treatment process as pretreatment for RO feed was performed. Review of the MF/UF technology, membrane manufacturers, pilot testing, and equipment preselection approach were included as part of the evaluation. Use of Membrane BioReactors (MBR) within the existing SJ/SC WPCP activated sludge process in lieu of MF/UF treatment was also considered. However, it was determined that the use of MBRs would result in higher capital and operation and maintenance (O&M) costs compared to implementing an MF/UF System ahead of the RO treatment process. Implementation of MBRs was therefore determined to not be cost-effective and was not evaluated further for the Project.

2.6.1 MF/UF Process

The primary function of the MF/UF process is to remove suspended solids and colloidal particles in the ARWTF feed water to produce an MF/UF filtrate that meets the RO feed water quality requirements. MF/UF provides a physical barrier with membrane pore sizes of approximately 0.1 µm for MF membranes and 0.01 µm for UF membranes. Due to such small pore sizes, MF/UF membranes are capable of achieving high quality feed water with very low turbidity. Further, with the ability to test the integrity of these membranes on a regular basis, consistent production of high quality filtrate is possible. Therefore RO feed water quality parameters listed in Table 2-7 can be met through the use of MF/UF membranes. The basis for design of the MF/UF System would be determined by the source water quality, treatment capacity, and MF/UF filtrate (i.e. RO feed stream) water quality.

2.6.2 MF/UF Manufacturers

Several MF/UF systems are currently available in the market and are approved by DPH in meeting Title 22 recycled water requirements[1], including:

- General Electric (GE) Water and Process Technologies – Zenon System
- Siemens Water Technology – Memcor System (Siemens)
- Pall Corporation (Pall)
- Krueger/Norit Americas Incorporated

Each of these MF/UF manufacturers can furnish all of the necessary components to operate their proprietary designed systems as a complete package. However, each MF/UF manufacturer has its unique configuration, layout, footprint, and ancillary facility requirements. Typically, it is impractical to design around two or more MF/UF manufacturers due to cost and schedule.

Based on their previous experience, GE, Pall, and Siemens would be expected to be able to supply an MF/UF system capable of providing a reliable, long-term operation for the ARWTF. As discussed in Section 6.3, submerged MF/UF systems are no longer being considered for the ARWTF. Therefore, GE was not considered in the preselection process described in the following section.

2.6.3 MF/UF Pilot Testing and Equipment Preselection

The District/City conducted an MF-RO versus electrodialysis reversal (EDR) pilot testing program in 2004. However, the focus of the 2004 pilot testing program was to evaluate and compare two different advanced tertiary treatment alternatives, MF-RO versus EDR, for treating SJ/SC WPCP's tertiary effluent. The pilot study did not evaluate or compare the performance of different MF/UF pretreatment systems or use secondary effluent as its feed water source. Therefore, relevant design information for the MF/UF System cannot be extracted from the pilot study.

MF/UF system manufacturers have indicated that pilot testing before the equipment preselection process is not necessary for the ARWTF Project due to their considerable experience in treating secondary effluent. The MF/UF manufacturers could establish the operating flux, recovery, and other design parameters necessary from their past experience. To ensure that the quality of the nitrified secondary effluent from the SJ/SC WPCP is bracketed within the quality of previous facilities that use their systems, a fifty gallon sample of the nitrified secondary effluent would be sent to the selected manufacturer to conduct their own water quality analyses. B&V has provided an upper threshold for certain critical design parameters such as flux and cleaning interval, based on experiences from other facilities that treat water sources with quality similar to this Project. The current design / construction schedule does not allow for pilot testing.

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[1] "*Treatment Technology Report for Recycled Water*," prepared by the State of California – Health and Human Services Agency, California Department of Public Health, February 2009.

In November 2009, two MF/UF manufacturers submitted proposals (in response to an RFP) without the need to pilot test. Evaluation was done based on a twenty (20) year life cycle cost as well as previous experience. Pall was the selected MF/UF manufacturer for the Project.

2.7 RO System Evaluation

A detailed evaluation of the application of RO membrane process for treatment of MF/UF filtrate, including review of the RO technology and RO membrane manufacturers, was performed.

2.7.1 RO Process

RO is a cross-flow process in which inlet feed water is continuously separated into two streams—a purified product stream (permeate) and a concentrated waste stream (concentrate). The separation process occurs across a semi-permeable membrane due to a physical parameter known as the *osmotic pressure gradient*. The pressure gradient develops between aqueous solutions of differing salinities separated by a semi-permeable membrane and causes water to flow from the less concentrated side to the more concentrated side to reach a state of equilibrium (absence of a pressure gradient). Because the water transport is pressure driven based, the natural gradient can be reversed by applying a pressure greater than the natural osmotic pressure to the more concentrated solution—forcing the flow of water to the less concentrated side. This reversal of the natural osmotic flow characterizes the RO process.

2.7.2 RO Membrane Manufacturers

Several RO membrane systems are currently available in the market. While the RO process has been identified as the optimum treatment process for removal of dissolved solids from a municipal effluent, several grades or classifications of RO membrane are available, which can result in substantial differences in operating and capital costs. Additionally, products from different membrane suppliers, seemingly of the same type or classification (e.g. low pressure RO), often experience dramatically different fouling trends in operation on municipal effluents. For this reason, it is recommended that RO membranes be considered based on the results of controlled demonstration testing on MF/UF treated secondary or tertiary effluent.

Low-pressure RO membrane systems manufactured by the following manufacturers were evaluated:

- Hydranautics ESPA2
- Koch TFC-8822HR
- Toray TMG-20

These proposed RO membrane vendors have proven products applicable to the Project to support a competitive bid. The Project team would continue to monitor developments in the RO membrane reuse market and update recommendations as the design progresses. Recommended process membranes are all high rejection polyamide composite type, with an anticipated initial operating pressure around 100 pounds per square inches gauge (psig). The system would incorporate a fouling allowance of 150 psig based on experience at other RO systems in recycling applications.

2.7.3 Recommended RO System Design Criteria

During preliminary design of the Project, available source water quality data for the nitrified secondary effluent was examined and a preliminary design for the RO System and related subsystems was developed. The Project source water is adequately characterized for this stage of the Project and was proven through previous pilot test work to be amenable to RO treatment. The process design would still benefit from additional historical water quality data, including maximum anticipated constituent levels along with data on specific constituents (e.g., phosphate). The proposed MF/UF System is expected to provide adequate pretreatment ahead of the RO System and should insure stable operation based on experience at similar facilities.

The proposed RO System for the Phase I ARWTF would have an initial production capacity of 8.0 mgd. An RO System design incorporating three 2.67 mgd RO trains (all duty) is recommended for the initial 8.0 mgd system. Support racks for each of the RO trains would be designed to include additional space for housing additional pressure vessels. Such design would allow easy expansion of the three RO trains to 3.0 mgd capacity each.

The RO trains would be designed based on an operating flux level of 12.0 gallons per square foot per day (gfd) to minimize the capital cost while insuring stable performance. Based on the initial characterization of the feed supply, the system would be capable of stable operation at a recovery of 85 percent with the addition of sulfuric acid and a threshold inhibitor.

The product water from the RO System would contain an excess of carbon dioxide (based on water quality data gathered previously during the pilot test conducted by the District) and comparatively low levels of hardness and alkalinity. A product stabilization scheme incorporating forced-draft decarbonation and sodium hydroxide injection in product water downstream of decarbonation process is recommended.

2.8 Disinfection System Evaluation

A detailed evaluation of available disinfection alternatives for the ARWTF, to meet the California DPH disinfection requirements, was performed. These alternatives included the use of chlorine and UV radiation, both of which are DPH approved technologies for recycled water disinfection. The use of advanced oxidation processes (AOPs) for their ability to achieve high level disinfection requirements and removal of contaminants of emerging concern was also evaluated.

2.8.1 Chlorine Disinfection Process

Chlorine, either as a gas or a liquid, is the most widely used chemical for disinfection as it is inexpensive and has been very effective for the inactivation of microorganisms. DPH requires a CT value, which is the product of the disinfectant concentration (C) and contact time (T), of 450 mg*min/L with a modal contact time of not less than 90 minutes based on peak dry weather flows. Existing SBWR system meets DPH disinfection requirements using a 4,300 foot long, 108-inch diameter pipeline between the chlorine contact basins at the SJ/SC WPCP and SBWR TPS. Historically, the average and daily maximum flowrates through the SBWR pipeline have been 20 mgd and 28 mgd, respectively. To meet the CT value of 450 mg*min/L, the maximum flowrate through the 108-inch diameter pipeline must not exceed 31 mgd with a 5 mg/L residual.

The following two options for chlorine disinfection of ARWTF RO permeate were evaluated:

1. Use the existing SJ/SC WPCP chlorine disinfection system
2. Construct a new chlorine contact basin near ARWTF dedicated solely for the ARWTF product water and a new pipeline to deliver the chlorinated ARWTF water to the SBWR TPS

2.8.2 UV Disinfection Process

UV disinfection is a physical process that uses specific wavelengths of electromagnetic radiation to inactivate microorganisms by damaging the DNA. Wavelengths ranging from 200 to 300 nanometers (nm) are readily absorbed, effectively inactivating certain pathogens found in water and wastewater by rendering them unable to replicate. The dose of UV light is measured as the product of intensity and exposure time and is reported as millijoules per square centimeter (mJ/cm^2).

2.8.2.1 UV System Design Considerations

The UV System would be located downstream of the RO System but would also treat water from the MF/UF bypass line during the winter months. Therefore, the entire UV System would be designed to treat MF/UF filtrate quality water.

When using MF/UF treatment upstream of UV treatment, the NWRI guidelines apply. The guidelines for the UV effluent include:

1. The design dose for UV System shall be at least 80 mJ/cm^2 under maximum day flow.
2. The effluent turbidity shall be equal to or less than 0.2 NTU 95 percent of the time, not to exceed 0.5 NTU.
3. The permeate UV transmittance shall be 65 percent or greater at 254 nm.

2.8.2.2 UV Validation

One of the key issues for UV implementation is validation. Prior to implementation, the UV reactors must be validated for acceptance by DPH at the operating conditions. Validation establishes the UV reactor's performance by measuring the inactivation of a given organism for set values of UV transmittance, power, and a range of flow rates. The NWRI guideline provides the recommended protocol for validating the UV equipment performance for a reuse application.

Validation procedures for reclaimed (recycled) water disinfection allow for the comparison of pilot-scale reactor velocity profiles to the full-scale reactor velocity profiles. A velocity profile is a measure of the variability of the flow velocity across a cross-section perpendicular to the flow. If the profiles are similar, the same UV reactor in the same configuration but in a larger size can be installed in the full-scale system. If the two profiles are not similar enough to be approved by DPH, then scale-up is not allowed. To avoid this, DPH has approved a "check-point bioassay" procedure. The procedure is a limited performance test in that it compares full-scale performance to the validated pilot performance using several flowrates and transmittance values. If the full-scale performance results are similar to the pilot-scale results, the utility has the opportunity to install the same configured reactor, but at a larger size to accommodate more flow through the system.

2.8.2.3 Other Design Considerations

According to NWRI guidelines, at a minimum, two reactors must be simultaneously operated in any online reactor train. Also, a standby reactor train is required. However, as an alternative to standby equipment, adequate storage or other contingency arrangements can be provided to deal with the flow during UV Disinfection System failure. NWRI regulations require one of the following:

- 24-hour storage if standby equipment replacement is available onsite
- Appropriate long-term alternate storage (e.g., 20 days) or disposal provisions
- Other reliability mechanism, if approved by the appropriate regulatory agencies

2.8.2.4 UV Technology Options

The UV system market for water and wastewater disinfection is dominated by five manufacturers:

- Aquionics
- Calgon Carbon Corporation
- Infilco Degremont (IDI)/Ozonia
- ITT Wedeco, Inc.
- Trojan Technologies, Inc.

The UV systems produced by each manufacturer differ primarily in the lamp type used, validated capacity range, and configuration. The UV manufacturers were contacted to provide information on a UV system capable of treating 10.0 mgd at a UV transmittance of 65 percent. In addition, the UV manufacturers were asked if they have received conditional acceptance from DPH. Aquionics and ITT Wedeco, Inc., are currently the only enclosed reactor type manufacturers with conditional DPH acceptance, and are therefore the only manufacturers being considered for the Project.

In December 2009, two UV manufacturers submitted proposals (in response to an RFP). Evaluation was done based on a twenty (20) year life cycle cost. ITT Wedeco, Inc. was the selected UV manufacturer for the Project.

2.8.3 Advanced Oxidation Process

Groundwater recharge is one of the many potential applications of high purity recycled water. N-nitrosodimethylamine NDMA and 1, 4 dioxane are organic contaminants that are being regulated in groundwater recharge. UV / Hydrogen Peroxide, an advanced oxidation process (AOP), is the best available treatment technology for mitigating these two contaminants and therefore was evaluated. AOP refers to processes in which oxidation of organic contaminants occurs primarily through reactions with hydroxyl radicals. NDMA absorbs UV light. Therefore, UV alone is cable of reducing NDMA concentration. When hydrogen peroxide is added to water and irradiated with UV light, hydroxyl radical is formed to reduce 1, 4 dioxane concentration.

The District has requested for the installation of a ten (10) to twenty (20) gpm side-stream UV/Hydrogen Peroxide AOP system, which would be operated as a demonstration system for studying the reduction of emerging contaminants for future potential groundwater recharge using recycled water. If future phases of the ARWTF are to be used for groundwater recharge, UV could pair with hydrogen peroxide to form the UV/Hydrogen Peroxide AOP. The data obtained from this demonstration system would be necessary for the design and installation of an AOP system for Phase II and other future phases.

This AOP process requires a higher UV dose to achieve the same treatment capacity when compared with conventional UV disinfection. Therefore, in order to convert the Phase I UV System to AOP, the closed vessel UV System would need to be salvaged and replaced with a UV system designed for AOP.

2.8.4 Findings

The primary findings of the UV Disinfection System evaluation are presented below.

- The combined flow of ARWTF RO permeate (8.0 mgd initial) and SJ/SC WPCP daily maximum tertiary effluent (28 mgd) would exceed the existing SBWR chlorine disinfection system capacity of 31 mgd. Therefore, the blended flow would not be able to meet DPH tertiary recycled water disinfection requirements.
- Capital cost for construction of a new chlorine contact basin dedicated for the ARWTF and a new pipeline contactor to deliver the chlorinated recycled water to the SBWR TPS would be very high. The installation of a new UV Disinfection System is more cost effective.
- DPH recycled water disinfection requirements can be fulfilled using a UV Disinfection System to treat both RO permeate and MF/UF filtrate.
- Per DPH requirements, UV reactor must be validated using NWRI guidelines.
- Closed vessel UV systems offer several advantages over open channel UV systems. Closed vessel systems have a smaller footprint, which reduces the cost of the Process Structure. Furthermore, closed vessel systems are more cost effective and complex because they don't require the design and installation of concrete basins to house the UV lamps. In addition, the use of a closed vessel UV system would eliminate the need for a pump station downstream of the UV

system. The primary disadvantage of closed vessel UV systems is that there are only two systems (Aquionics and ITT Wedeco, Inc.) that have DPH certification. Both manufacturers are viable options, and a competitive proposal (in response to an RFP) was obtained for both manufacturers. Both proposals were evaluated based on a twenty (20) year present worth cost, and ITT Wedeco, Inc., was selected for the Project.

3.0 REGULATORY AND PERMITTING REQUIREMENTS

3.1 Overview

This chapter presents the regulatory and permitting requirements applicable for the ARWTF Project.

3.2 General

The ARWTF would treat nitrified secondary effluent from the SJ/SC WPCP with advanced tertiary treatment consisting of MF/UF pretreatment, RO membrane desalination, and UV disinfection to produce high-purity recycled water. The treated recycled water from the ARWTF would be blended with the recycled water (tertiary effluent) from SJ/SC WPCP to meet the target TDS concentration objective of 500 mg/L. The water quality of recycled water would also meet applicable federal and state regulations.

3.3 Jurisdictional Entities

The ARWTF, which is a collaborative effort between the District, the City, and the SBWR program, would meet requirements of the following entities:

- California Department of Public Health (DPH)
- California State Department of Environmental Protection Agency (EPA)
- California Department of Water Resources (DWR)
- San Francisco Bay Regional Water Quality Control Board (RWQCB)
- Santa Clara County Department of Environmental Health
- Santa Clara Valley Water District (SCVWD)
- City of San Jose and SJ/SC WPCP

3.4 Regulatory Requirements

Federal and state recycled water regulations influence process selection, design, and operation of recycled water projects. Some of the key current regulations impacting the ARWTF are highlighted as follows:

1. Title 17 of the California Code of Regulations: Outlines the requirements of a cross-connection control program.
2. Title 22 of the California Code of Regulations (Title 22): Current regulations pertaining to recycled water are stated in Chapter 3 of Division 4 in the Title 22 document. Specifically, Title 22 regulates the following aspects of recycled water activities:
    - Process and water quality definitions (Water Recycling Criteria)
    - Design and operational requirements, including treatment requirements
    - Allowable uses for recycled water
    - Groundwater recharge

Treatment technologies that comply with treatment requirements of the California Recycled Water Criteria are included in the Treatment Technology Report[1]. This report summarizes design criteria for filtration and disinfection equipment which may be used in recycled water applications including groundwater recharge.

To facilitate regulatory compliance, the facilities design would also meet the following guidelines:

- Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse[2]: Specified guidelines applicable to UV disinfection on filtered wastewater.
- American Water Works Association (AWWA) Guidelines for Distribution of Non-potable Water.

3.5 Permitting Requirements

3.5.1 General

The Project would require permitting by a number of state, regional, and local agencies. Permitting requirements and coordination expected for the ARWTF Project are presented in the following sections.

3.5.2 Recycled Water Permitting

Primary recycled water permitting requirements associated to the South Bay ARWTF Project are:

- National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) Compliance – A joint environmental assessment (EA) and initial study (IS) is required to comply with the environmental requirements established by both the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). This document analyzes the environmental impacts of the ARWTF, presents feasible measures to reduce or avoid potential environmental impacts, and evaluates alternatives to the Project. The final EA/IS is expected to be issued for public review by January / February 2010.
- Engineering Report - The current State of California Water Recycling Criteria (adopted in December 2000) requires the submission of an engineering report to the California Regional Water Quality Control Board and DPH before recycled water projects are implemented. These reports must also be amended prior to any modification to existing projects. The purpose of an engineering report is to describe the manner by which a project will comply with the Water Recycling

[1] *"Treatment Technology Report for Recycled Water,"* prepared by The State of California – Health and Human Services Agency, California Department of Public Health, February 2009.

[2] National Water Research Institute (NWRI) and American Water Works Research Foundation (AWWRF). "Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse." Second Edition. Fountain Valley, CA. NWRI. May 2003.

Criteria. This report has to be approved by DPH before the Regional Board can issue a water reuse permit.

- Amendment to Existing Water Reuse Permit (as applicable) – Issued by the Regional Board with DPH review and approval.

3.5.3 Additional Permitting

In addition to recycled water permitting, other permits potentially required for the Project are listed on Table 3-1.

Table 3-1: ARWTF Project Potential Permitting Requirements

Agency	Name of Permit	Remarks
City of San Jose Planning Division	Design Review and Building Permit	B&V would send complete design documents to the City planning division for review and approval.
Regional Water Quality Control Board	National Pollutant Discharge Elimination System *(NPDES) General Discharge Requirements for Discharge or Reuse of Extracted Brackish Groundwater and Reverse Osmosis Concentrate Resulting from Treatment of Groundwater by Reverse Osmosis and Discharge or Reuse of Extracted and Treated Groundwater Resulting from Structural Dewatering*	A Notice of Intent (NOI) would need to be submitted and, if appropriate, the Regional Board would issue this permit.
Regional Water Quality Control Board	*NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit-Water Quality Order 99-08-DWQ)*	A NOI would need to be submitted and, if appropriate, the Regional Board would issue this permit. Among the requirements of this permit, the construction contractor would need to develop, submit, and comply with a Storm Water Pollution Prevention Plan (SWPPP) that meets the requirements of this permit.
	Waste Discharge Requirements (WDRs) for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities	A NOI would need to be submitted and, if appropriate, the Regional Board would issue this permit. Among the requirements of this permit, the Plant Operations Staff would need to develop, submit, and comply with a SWPPP that meets the requirements of this permit.
Regional Water Quality Control Board	NPDES Permit	Any permit modifications required to the current NPDES Permit to accommodate RO concentrate from the ARWTF would be investigated.

Permits related to construction activities would be listed in the design documents and obtaining these permits would be the construction contractor's responsibility.

3.5.4 Utility Coordination

In addition, utility coordination would be conducted with the following agencies:

- City of San Jose, Department of Public Works
- South Bay Water Recycling (SBWR)
- Santa Clara Valley Water District
- Pacific Gas and Electric (PG&E)
- AT&T Telephone Services
- Other Utilities as required

4.0 ARWTF TREATMENT CAPACITY, PROCESS FLOW SCHEMATIC AND HYDRAULIC ANALYSIS

4.1 Overview

This chapter presents a discussion on the treatment capacity, process flow schematic and hydraulic analysis for the ARWTF.

4.2 ARWTF Treatment Capacity

The treatment capacities for the Phase I ARWTF were estimated based on a future net production capacity of 9.0 mgd. The ARWTF will initially have a net production capacity of 8.0 mgd. The MF/UF and UV Systems will have net production capacities of 10.5 mgd and 10 mgd, respectively. The RO System will have an initial net production capacity of 8.0 mgd, but will be designed for future expansion to 9.0 mgd. The UV System is sized for 10 mgd to provide the flexibility to treat the entire MF/UF flow through the UV System. Treatment process flow rates are based on the following assumptions and are summarized in Table 4-1.

- The membrane filtration (MF/UF) System would operate at a minimum recovery of 90 percent.
- The RO System would operate at a design recovery of 85 percent and would have a salt rejection of 95 percent at the end of its operating life.

The future design condition would be used for hydraulic design of each treatment process and for the design of the chemical storage and feed facilities.

Table 4-1: Summary of Phase I ARWTF Treatment Capacities

Treatment Process	Initial Phase I Design Condition	Future Phase I Design Condition
ARWTF Overall Net Production Capacity	8.0 mgd	9.0 mgd
MF/UF System[1]	11.7 mgd (feed) 10.5 mgd (filtrate)	11.7 mgd (feed) 10.5 mgd (filtrate)
Recovery	90%	90%
Backwash Waste	1.0 mgd	1.2 mgd
RO System	9.5 mgd (feed) 8.0 mgd (permeate)	10.5 mgd (feed) 9.0 mgd (permeate)
Recovery	85%	85%
RO Reject	1.5 mgd	1.5 mgd
UV System[2]	10.0 mgd	10.0 mgd
Product Water Storage Tank (Useable Volume)	2.25 MG	2.25 MG

1 The MF/UF System would not operate at full capacity during the initial Phase I design condition. The MF/UF feed would be 10.4 mgd and the MF/UF filtrate would be 9.4 mgd.

2 The UV System would operate at 8 mgd during the initial Phase I design condition and 9 mgd during the future Phase I design condition.

4.3 Process Flow Schematic

Process flow schematics for the ARWTF are presented on Figures 4-1 and 4-2. The ARWTF would receive nitrified secondary effluent from the SJ/SC WPCP and provide high-purity recycled water to the existing TPS for distribution into SBWR's existing recycled water distribution system.

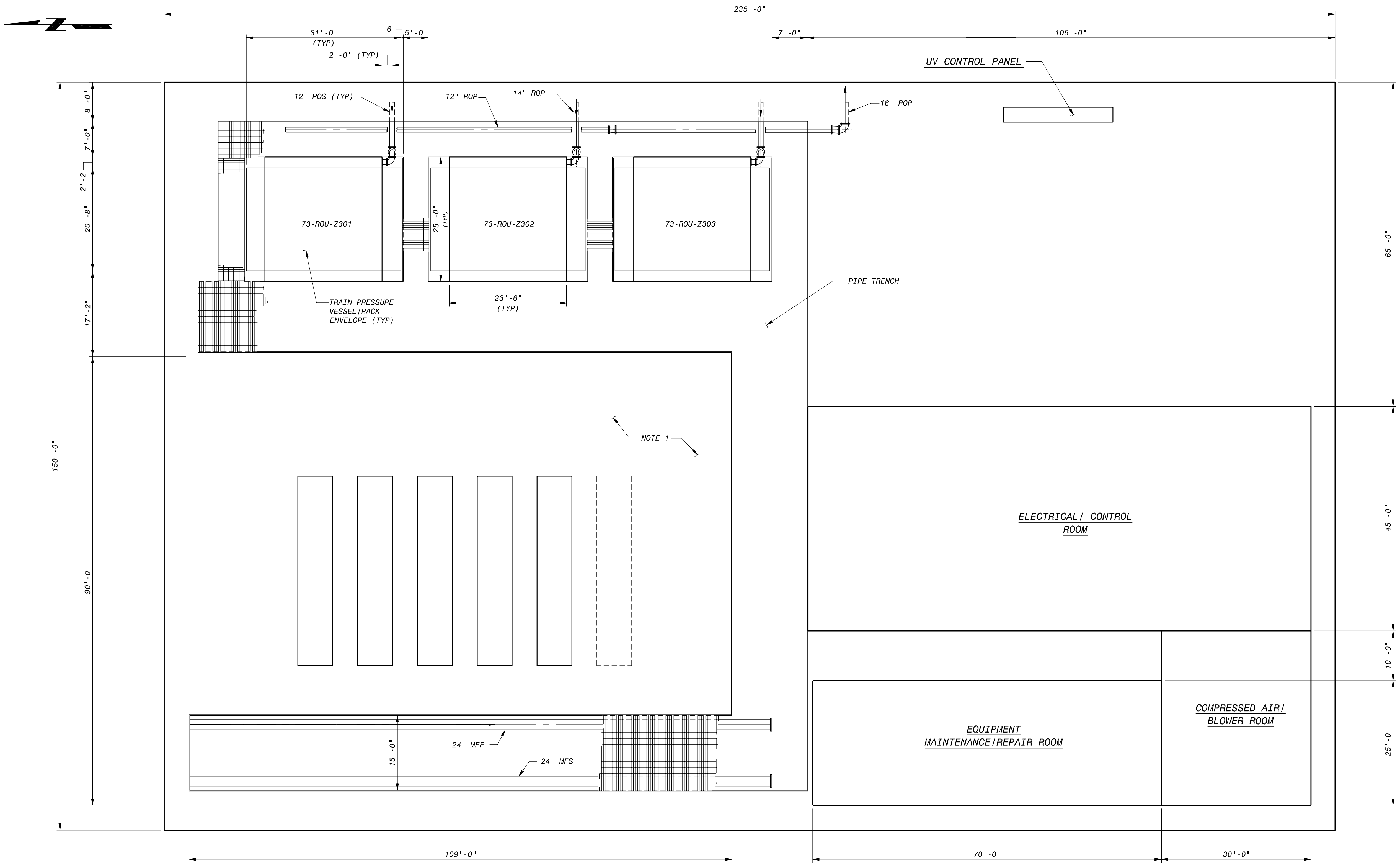
A new 36-inch ARWTF influent pipeline would be constructed to tap into the existing nitrified secondary effluent channel near Nitrification Clarifiers No. 7 and No. 8 at the SJ/SC WPCP. The ARWTF influent pipeline would convey nitrified secondary effluent by gravity to the ARWTF site for treatment using MF/UF membranes followed by RO and UV disinfection to produce high-purity recycled water. The AWRTF influent would be pumped by vertical diffusion vane Influent Pumps to the MF/UF System for pretreatment. Automatic strainers would be provided upstream of the automatic strainers to protect them against large debris that may damage the membranes. Sodium hypochlorite and aqua ammonia would be introduced upstream of the MF/UF membranes to form a monochloramine residual in the MF/UF feed stream to minimize biofouling. The Inter-Process Storage Tank would provide equalization of the MF/UF filtrate for the downstream RO membrane process. The Inter-Process Storage Tank would also be used to supply MF/UF filtrate for reverse filtration (RF) of the MF/UF membranes

Threshold inhibitor and sulfuric acid are added to the RO feed stream to minimize inorganic scaling of the RO membranes. The RO Transfer Pumps would pump MF/UF filtrate from the Inter-Process Storage Tank through the Cartridge Filters. High-pressure RO Feed Pumps would boost the pressure through the RO System, while maintaining sufficient residual pressure on the permeate side to feed the downstream decarbonators. Decarbonation Towers are provided to strip carbon dioxide from the RO permeate to increase the pH. After decarbonation, the RO permeate is pumped through the UV Disinfection System by the Product Water Transfer Pumps and stored in the Product Water Storage Tank. Sodium hydroxide would be added to the final product water to increase the alkalinity, prior to sending it via gravity to the SBWR TPS. The Product Water Storage Tank would also provide water for RO membrane flush.

Waste streams from the automatic strainers, MF/UF reverse filtration , MF/UF Clean-In-Place (CIP) System, RO CIP System and RO shutdown flush, as well as stormwater flows, would be sent to a central Waste Equalization Wetwell and pumped to the SJ/SC WPCP Emergency Basin Overflow Structure (EBOS), which is part of the WPCP headworks. The RO reject stream would be routed directly to the head of Chlorine Contact Tank (CCT) Nos. 1-2 for dilution with WPCP filter (tertiary) effluent and ultimate discharge to the Bay.

NOTE:

1. SPACE ALLOCATED FOR MICROFILTRATION SYSTEM. VENDOR TO BE SELECTED BETWEEN 30% AND 60% DESIGN.



PLAN
3/32" = 1'-0"

PRELIMINARY – NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	APPR.
	WORK IN PROGRESS		

BLACK & VEATCH
Black & Veatch Corporation
Walnut Creek, California

DATE
DESIGN MNT
DRAWN JMM
CHECKED

ENGINEERING CERTIFICATION
REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES
MECHANICAL
MF/RO/UV PROCESS BUILDING
PIPING PLAN AND OVERALL LAYOUT

SCALE
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BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER 146071
SHEET CODE: B&V FIG 6-3
CITY
DISTRICT
OF 345

DOCUMENT NUMBER: D-CNST D-CNST-ATTE-TEXT

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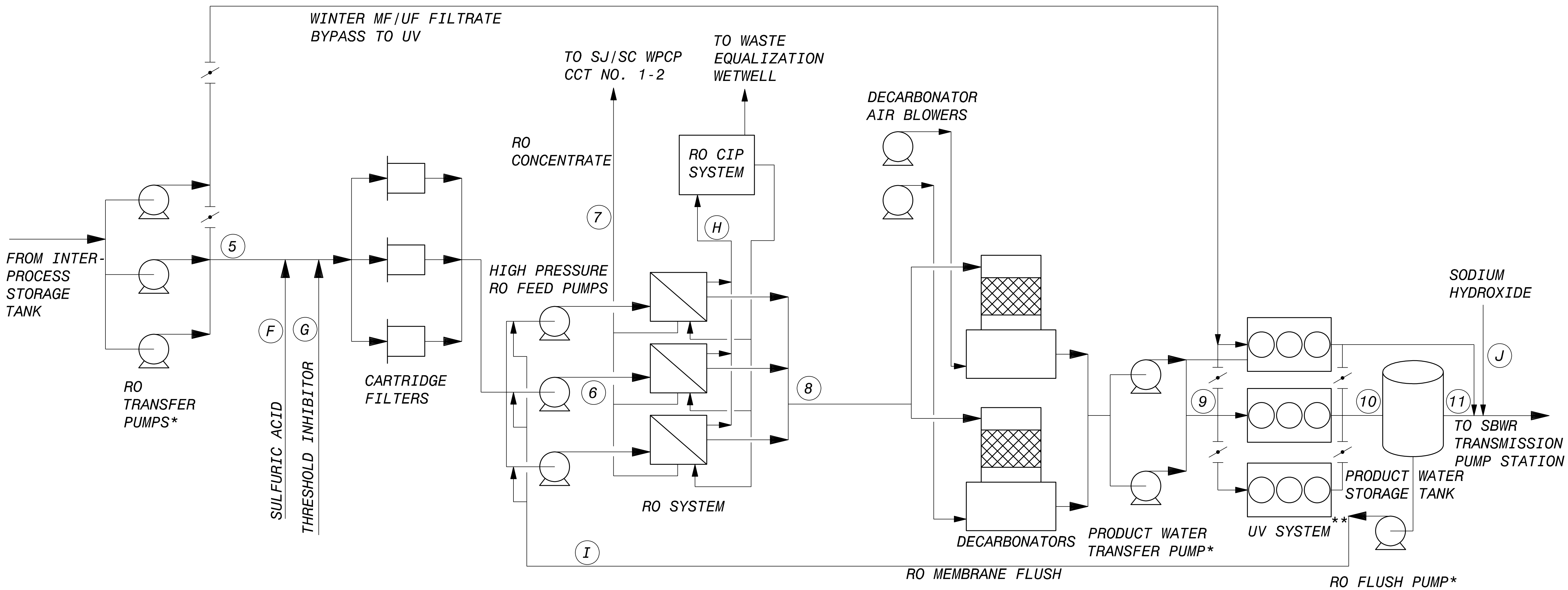

Stream ID	Stream Name	Average Design Flows		Frequency
		mgd	gpm	
5	RO Low Pressure Feed Water	9.40	6,530	
6	RO High Pressure Feed Water	9.40	6,530	
7	RO Concentrate	1.40	980	
8	RO Permeate	8.00	5,560	
9	Decarbonated Product Water	8.00	5,560	
10	UV Treated Water	8.00	5,560	
11	Product Water	8.00	5,560	
E	(NOT USED)			
F	93.0 Percent Sulfuric Acid			Continuous
G	Threshold Inhibitor			Continuous
H	RO CIP			Intermittent
I	System Shutdown Flush			As Required
J	25 Percent Sodium Hydroxide			Continuous

* BASED ON INITIAL CAPACITY OF 8MGD.

* ONLY DUTY UNITS ARE SHOWN. STANDBY UNIT TO BE PROVIDED, IS NOT SHOWN ON FIGURE.

** THE NUMBER OF UV UNITS WILL BE DETERMINED ONCE UV VENDOR IS SELECTED.

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	WORK IN PROGRESS		

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Black & Veatch Corporation
Walnut Creek, California

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DESIGN
DRAWN
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ENGINEERING CERTIFICATION
REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:
SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES
PROCESS FLOW DIAGRAM

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PROJECT NUMBER 146071
SHEET CODE: B&V FIG 4-2
CITY
DISTRICT
OF 345

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4.4 Hydraulic Design

A hydraulic profile for the ARWTF is presented on Figure 4-3. The hydraulic profile was developed for the future ARWTF net production capacity of 9.0 mgd, and at the MF/UF and RO recoveries specified in Section 4.2.

The ARWTF influent line would convey approximately 12 mgd of nitrified secondary effluent over 1,300 feet to the ARWTF site. The proposed tie-in is at the nitrification clarifier effluent channel at a location between SJ/SC WPCP's Nitrification Clarifiers No. 7 and 8. The ARWTF influent line would utilize available head to convey nitrified secondary effluent to the ARWTF site.

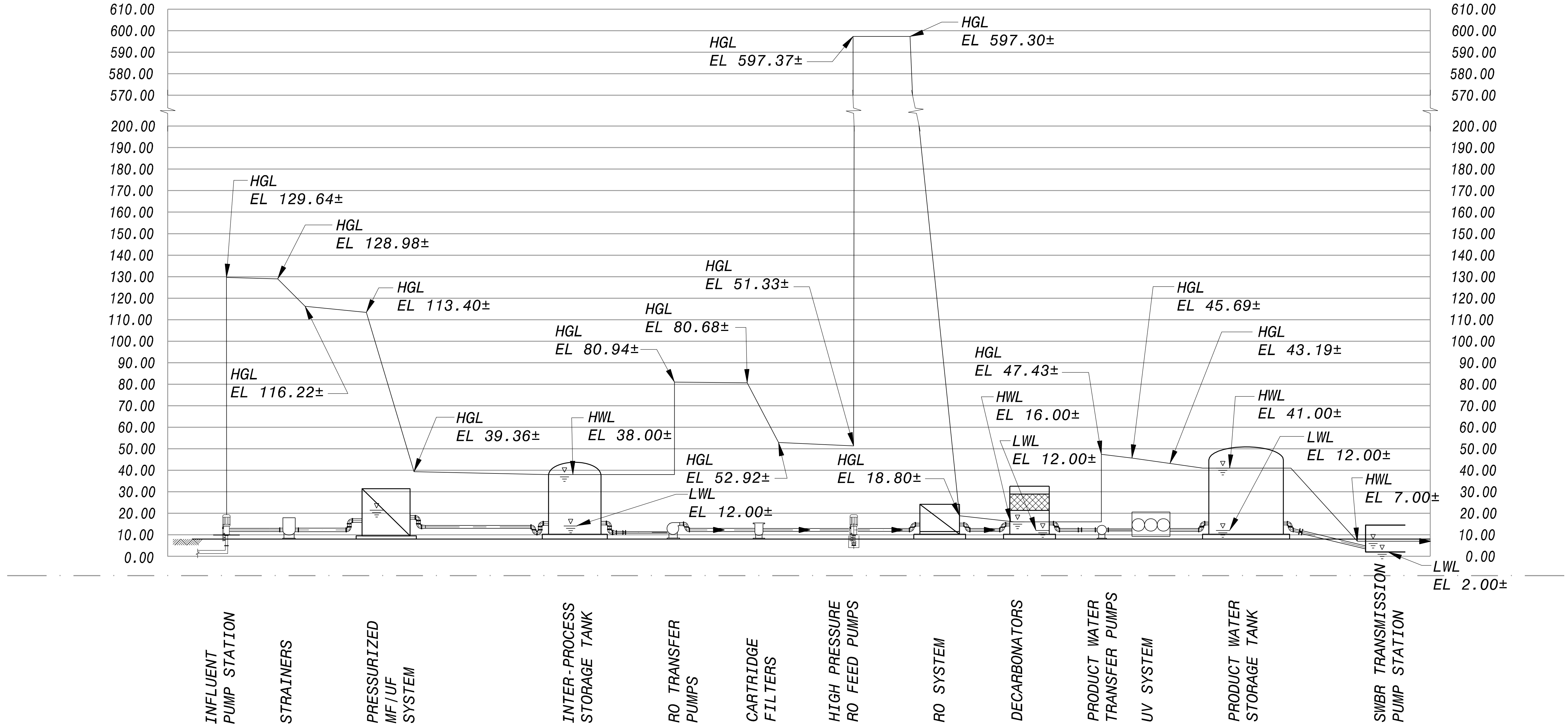
Preliminary hydraulic profiles through the ARWTF treatment processes were developed based on the following criteria, expressed as pounds per square inch (psi):

- Headloss through Automatic Strainers = 5.5 psi
- Feed pressure for pressurized MF/UF membranes = 32 psi
- Headloss through Cartridge Filters = 12 psi
- Feed Pressure for RO membranes = 250 psi

Key elevations for the ARWTF are presented in Table 4-2.

Table 4-2: Summary of Key Elevations

Location	Elevation (NGVD 29), ft	Elevation (NAVD 88), ft
Nitrification clarifier 7 and 8 water surface (WS) elevation	6.0	8.7
Invert elevation of influent pipe at ARWTF Influent Pump Station	-3.0	-0.3
Site elevation (built-up above 100-yr flood elevation)	10.8	13.5
Inter-Process Storage Tank high water level (HWL)	37.8	40.5
Product Water Storage Tank HWL	41.8	44.5



HYDRAULIC PROFILE*

1" = 50'

*VERTICAL ELEVATIONS ARE BASED ON THE NGVD 29 DATUM.

PRELIMINARY – NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	APPR.
	WORK IN PROGRESS		

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Black & Veatch Corporation
Walnut Creek, California

DATE
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ENGINEERING CERTIFICATION
REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES
HYDRAULIC PROFILE

SCALE

VERIFY SCALES
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PROJECT NUMBER 146071
SHEET CODE: B&V FIG 4-3
CITY
DISTRICT
OF 345

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5.0 SYSTEM OPERATION

5.1 Overview

This chapter presents a discussion on the operation strategies for the ARWTF during summer and winter periods.

5.2 Operating Strategy

Two different operation strategies were developed to provide additional flexibility for the SBWR system and to increase the tertiary filter capacity at the SJ/SC WPCP during winter periods. The two operation strategies for summer and winter operations are described in more detail below. For this Project, the summer period is defined from May through November and the winter period from December through April. SBWR recycled water demands for summer and winter periods are summarized in Table 5-1.

Table 5-1: SBWR Recycled Water Demands – Summer and Winter

Period	Year 2006, mgd		Projected Year 2010, mgd		Projected Year 2015, mgd		Projected Year 2020, mgd	
	Avg.	Max Day	Avg.	Max Day	Avg.	Max Day	Avg.	Max Day
Summer (May-Nov)	11.80	19.60	13.20	20.70	17.50	27.40	21.80	34.00
Winter (Dec-April)	2.70	7.50	3.00	8.30	4.00	11.00	4.90	13.70
Annual	8.00	19.60	9.00	20.70	11.90	27.40	14.80	34.00

5.3 Summer Operation

During the summer months (May-November), the SBWR system experiences nearly four times the recycled water demand, on average, than during winter months. Therefore, under the summer operation mode, the ARWTF would utilize the MF/RO/UV treatment train to produce high-purity recycled water, which would be blended with SJ/SC WPCP tertiary effluent to meet the summer recycled water demands and the target SBWR TDS goal of 500 mg/L. The recycled water supply sources for the SBWR system during summer operations are summarized in Table 5-2. As noted in Chapter 4, the ARWTF will have a future net production capacity of 9.0 mgd, which is not considered in the table below.

Table 5-2: SBWR Supply Sources – Summer Operation

Supply Source	Projected Year 2010 Flows, mgd		Projected Year 2015 Flows, mgd		Projected Year 2020 Flows, mgd	
	Avg.	Max Day	Avg.	Max Day(1)	Avg.	Max Day(1)
ARWTF MF/RO/UV	6.50	8.00	8.00	8.00	8.00	8.00
SJ/SC WPCP Tertiary Effluent	6.70	12.70	9.50	19.40	13.80	26.10
Total Combined Flow	**13.20**	**20.70**	**17.50**	**27.40**	**21.80**	**34.10**

(1) ARWTF MF/RO/UV capacity may be less than desired to meet target SBWR TDS.

For summer operations, nitrified secondary effluent from SJ/SC WPCP conveyed to the ARWTF would be pretreated by MF/UF, then demineralized through the RO process, and disinfected through UV disinfection. The ARWTF product water would be stored in a 2.25 MG (useable volume) Product Water Storage Tank and flow paced, using a flow control valve, to the SBWR TPS to blend with SJ/SC WPCP tertiary effluent. A schematic of the summer operation scenario is provided on Figure 5-1.

5.4 Winter Operation

The low recycled water demand during the winter period (December-April) would enable the ARWTF to meet this demand on its own, without blending with the SJ/SC WPCP tertiary effluent and also capable of meeting a lower SBWR TDS goal of 400 mg/L (with the exception of maximum winter flows in Year 2020). This would increase the tertiary filter capacity at the SJ/SC WPCP during winter periods. The recycled water supply sources for the SBWR system during winter operations are summarized in Table 5-3.

Table 5-3: SBWR Supply Sources – Winter Operation

Supply Source	Projected Year 2010 Flows, mgd		Projected Year 2015 Flows, mgd		Projected Year 2020 Flows, mgd	
	Avg.	Max Day	Avg.	Max Day(1)	Avg.	Max Day(1)
ARWTF MF/UV	1.00	4.20	2.00	4.00	2.50	4.60
ARWTF MF/RO/UV	2.00	4.10	2.00	5.40	2.40	4.80
SJ/SC WPCP Tertiary Effluent	0.00	0.00	0.00	1.60	0.00	4.30
Total Combined Flow	**3.00**	**8.30**	**4.00**	**11.00**	**4.90**	**13.70**

(1) ARWTF capacity may be insufficient to meet entire maximum day recycled water demand.

As indicated above in Table 5-3, the initial ARWTF treatment capacities alone may not be sufficient to meet projected maximum day winter demands for year 2015 and 2020. If so, tertiary effluent from the SJ/SC WPCP would supplement flows from the ARWTF. Since the maximum day demand was projected based on 2006 recycled water demand trends, it is recommended that the District re-evaluate the maximum day winter demands as it gets closer to the projected year to determine if supplemental SJ/SC WPCP tertiary effluent or additional treatment capacity at the ARWTF is needed.

During winter operations, nitrified secondary effluent from SJ/SC WPCP would be treated by the MF/UF membranes at the ARWTF, but only a portion of the MF/UF filtrate would be demineralized by the RO process. The remainder of the MF/UF filtrate would be bypassed around the RO membranes and conveyed directly to the UV disinfection process. Bypass piping and isolation valves would be provided in the UV Disinfection System to dedicate a section of the UV System for disinfection of the MF/UF filtrate, and the remaining section of the UV System for disinfection of the RO permeate. The recommended flow split would result in a blended TDS in the range of 400 mg/L to 500 mg/L. During the summer, the entire RO permeate flow would be treated by the UV System. A schematic of the winter operation scenario is provided on Figure 5-2.

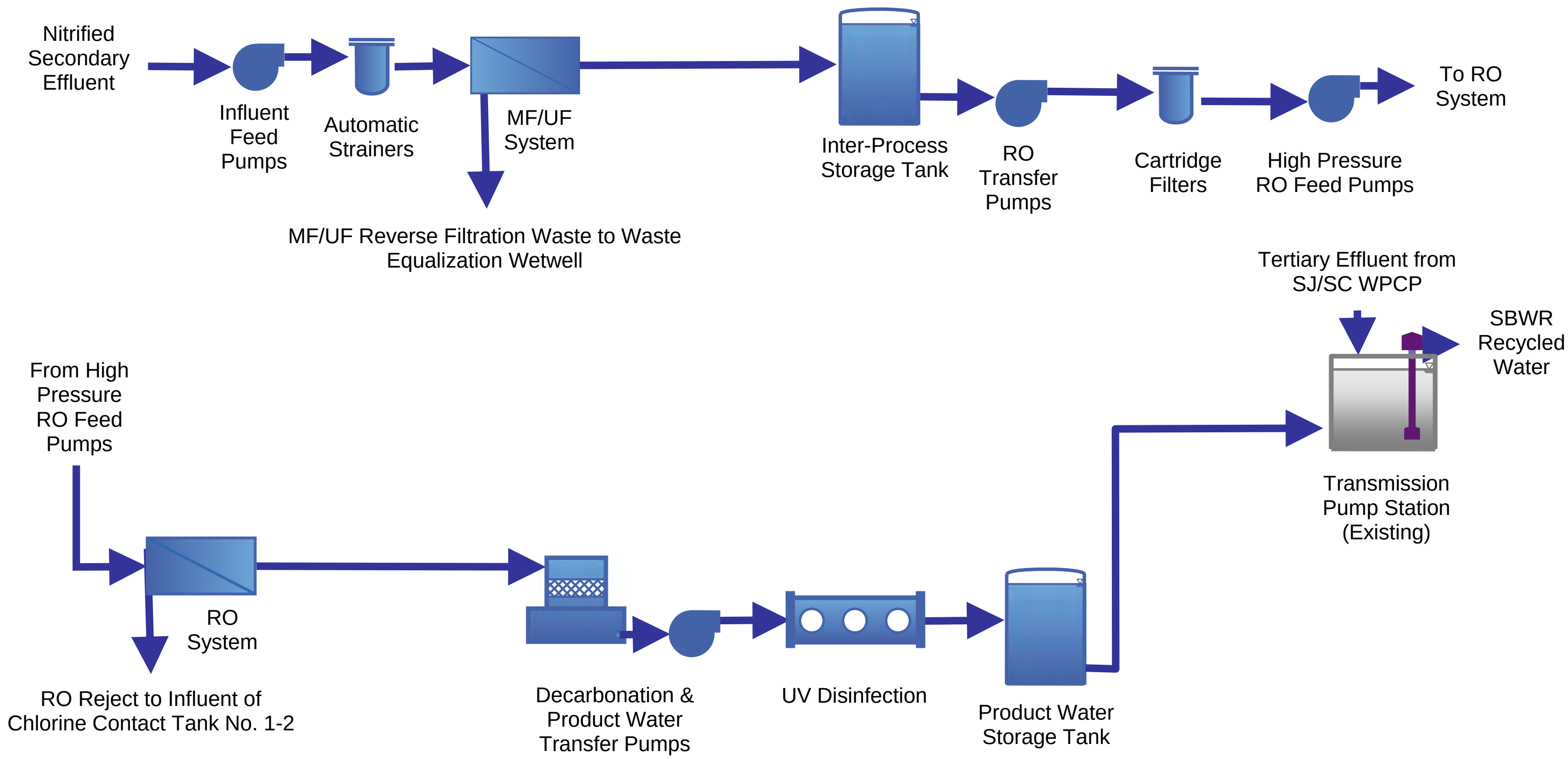


Figure 5-1: Proposed ARWTF Summer Operating Scenario

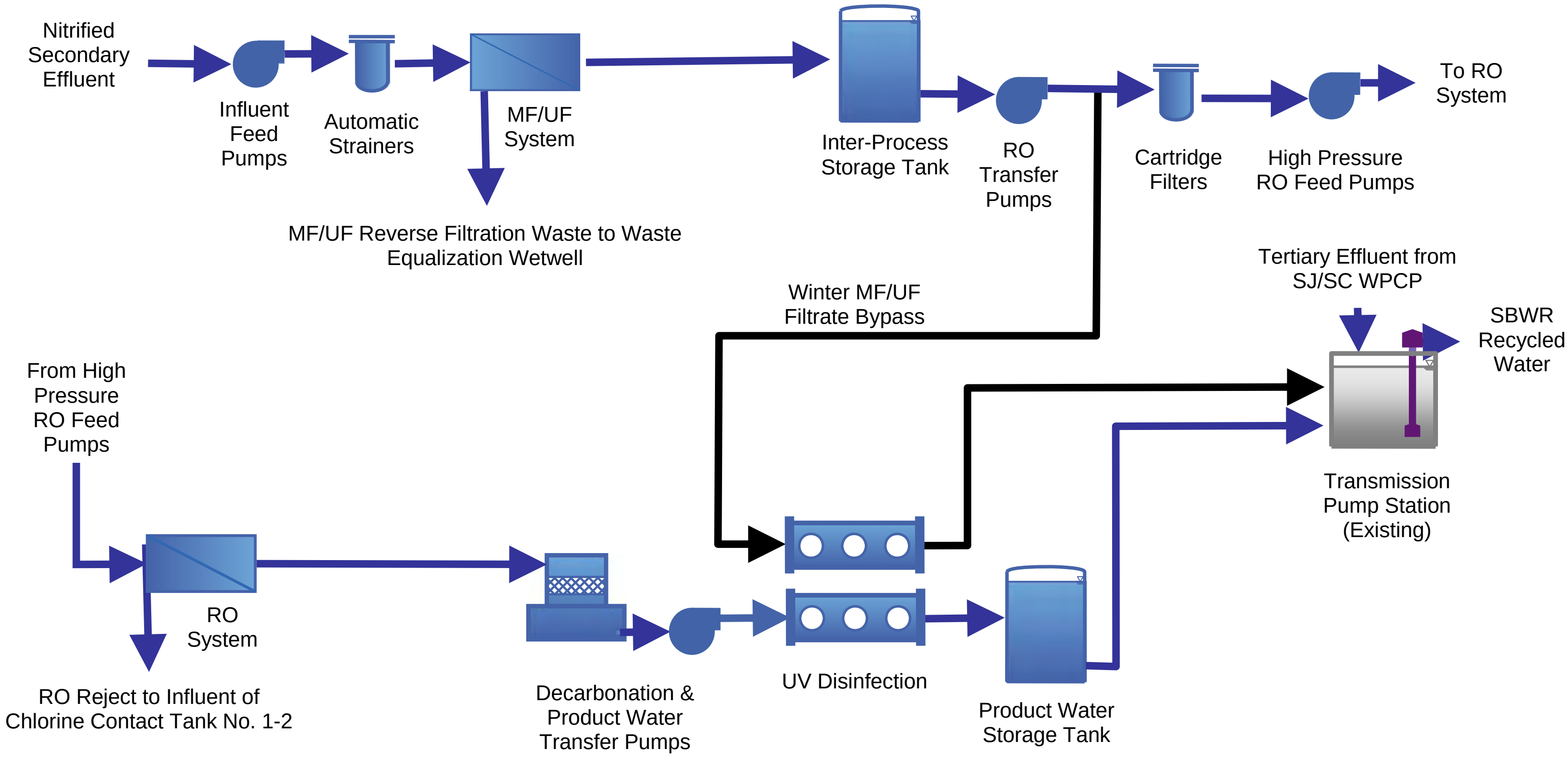


Figure 5-2: Proposed ARWTF Winter Operating Scenario

6.0 FACILITIES DESIGN CRITERIA

6.1 Overview

This section presents design criteria for the Phase I ARWTF Project components including civil/site, process mechanical, architectural, structural, building mechanical, electrical, and instrumentation and controls (I&C) design.

A brief description of the major facilities is presented in Table 6-1.

Table 6-1: Phase I ARWTF Project Facilities Summary

Facilities	Description
Influent (MF Feed) Pump Station	The Influent Pump Station would consist of four vertical diffusion vane type pumps, which would provide the driving pressure required by the MF/UF System. An Automatic Strainer would be provided on the discharge of each Influent Pump to remove larger suspended solids, which can damage the MF/UF membranes. The pumps and strainers would be supported on a reinforced concrete mat foundation.
MF/RO/UV Process Structure	The Process Structure would be a new pre-engineered metal building and would be designed to house the major components of the MF/UF, RO and UV treatment processes. The building also would include an electrical/control room and an area for equipment maintenance and repair.
MF/UF CIP Area	The MF/UF CIP Area would consist of a reinforced concrete chemical containment area to house the chemical tanks and metering pumps. This facility would also house a neutralization system to neutralize and dechlorinate spent MF/UF cleaning chemical solutions before discharging to the Waste Equalization Wetwell. A pre-engineered metal canopy would be provided to cover the area.
Inter-Process Storage Tank	The Inter-Process Storage Tank would be an above grade, vertical, cylindrical, welded steel tank. The tank would be provided with a ringwall foundation with piles as recommended by the geotechnical engineer.
MF/UF Chemical Storage and Feed Facilities	The MF/UF Chemical Storage and Feed Facilities would consist of an Aqua Ammonia System and a Sodium Hypochlorite System, with each chemical system located within its own reinforced concrete containment area and supported on a reinforced concrete mat foundation. A pre-engineered metal canopy would be provided to cover the area.

Facilities	Description
RO Chemical Storage and Feed Facilities	The RO Chemical Storage and Feed Facilities would consist of a Sulfuric Acid System, Threshold Inhibitor System, and Sodium Hydroxide System, with each chemical system located within its own reinforced concrete containment area and supported on a reinforced concrete mat foundation. A pre-engineered metal canopy would be provided to cover the area.
RO Transfer Pump Station	The RO Transfer Pump Station would consist of four horizontal end suction centrifugal pumps and would be supported on a reinforced concrete mat foundation.
RO Cartridge Filters	The RO Cartridge Filters would consist of three horizontal pressure vessels located on the discharge of RO Transfer Pumps.
High Pressure RO Pump Station	The High Pressure (HP) RO Pump Station would consist of three vertical diffusion vane type RO feed pumps and would be supported on a reinforced concrete mat foundation. These pumps would provide the driving pressure required by the RO system.
RO CIP Area	The RO CIP Area would consist of two cleaning tanks with heaters, two circulation pumps and one pH adjustment dosing pump located within a reinforced concrete containment area and on a reinforced concrete mat foundation. A pre-engineered metal canopy would be provided to cover the area.
RO Decarbonator Towers and Product Water Transfer Pumps	The two RO Decarbonator Towers would be above grade, vertical, cylindrical, fiberglass reinforced plastic (FRP) towers supported on a reinforced concrete mat foundation. The Decarbonator Towers would be provided with two centrifugal blowers, and three horizontal split case product water transfer pumps.
Waste Equalization Pump Station	The Waste Equalization Wetwell would be a below grade concrete basin supported on a pile foundation as recommended by the geotechnical engineer. Vertical turbine waste pumps would sit on top of the wetwell for conveying waste to the SJ/SC WPCP Emergency Basin Overflow Structure (EBOS.) From there, the waste would be conveyed to the WPCP headworks.
Product Water Storage Tank	The Product Water Storage Tank would be an above grade, vertical, cylindrical, welded steel or stainless steel tank. The tank would be provided with a ringwall foundation with piles as recommended by the geotechnical engineer.

6.2 Civil Site Design

6.2.1 General

This section presents the civil site design criteria and describes the general layout of the site for the ARWTF. Preliminary information regarding, site development, site survey, existing site conditions, grading, site drainage, and site access is provided.

6.2.2 Site Location Evaluation

A site location evaluation was performed during the predesign phase of the ARWTF Project. Two potential Project site locations were identified for constructing the ARWTF. The first site location was at the SJ/SC WPCP just north of the existing electrical substation and south of the existing Chlorine Contact Tanks and Filter Building. The other site location was at the undeveloped area east of the existing SBWR TPS located across Zanker Road at the southeast corner of SJ/SC WPCP. Conceptual ARWTF site layouts were developed for these site locations and an alternative analysis was performed using the Criterium Decision Plus (CDP) software.

Based on results of the CDP analysis and discussions with the City, it was determined that the area between the existing electrical substation and the existing Chlorine Contactor Chamber and Filter Building at SJ/SC WPCP would need to be reserved for potential future expansion of the filters and other improvements at the SJ/SC WPCP. Also considering that the ARWTF may need to be expanded in the future, it has been decided by the City and the District to locate the ARWTF east of the existing TPS.

A preliminary overall site layout of the ARWTF (Phase I only) is shown on Figure 6-1. The Phase I ARWTF site is approximately five acres. All treatment facilities shown for the Phase I ARWTF are based on the initial and future net production capacities as indicated in Chapter 4 of this report.

6.2.3 Datum, Site Control and Survey

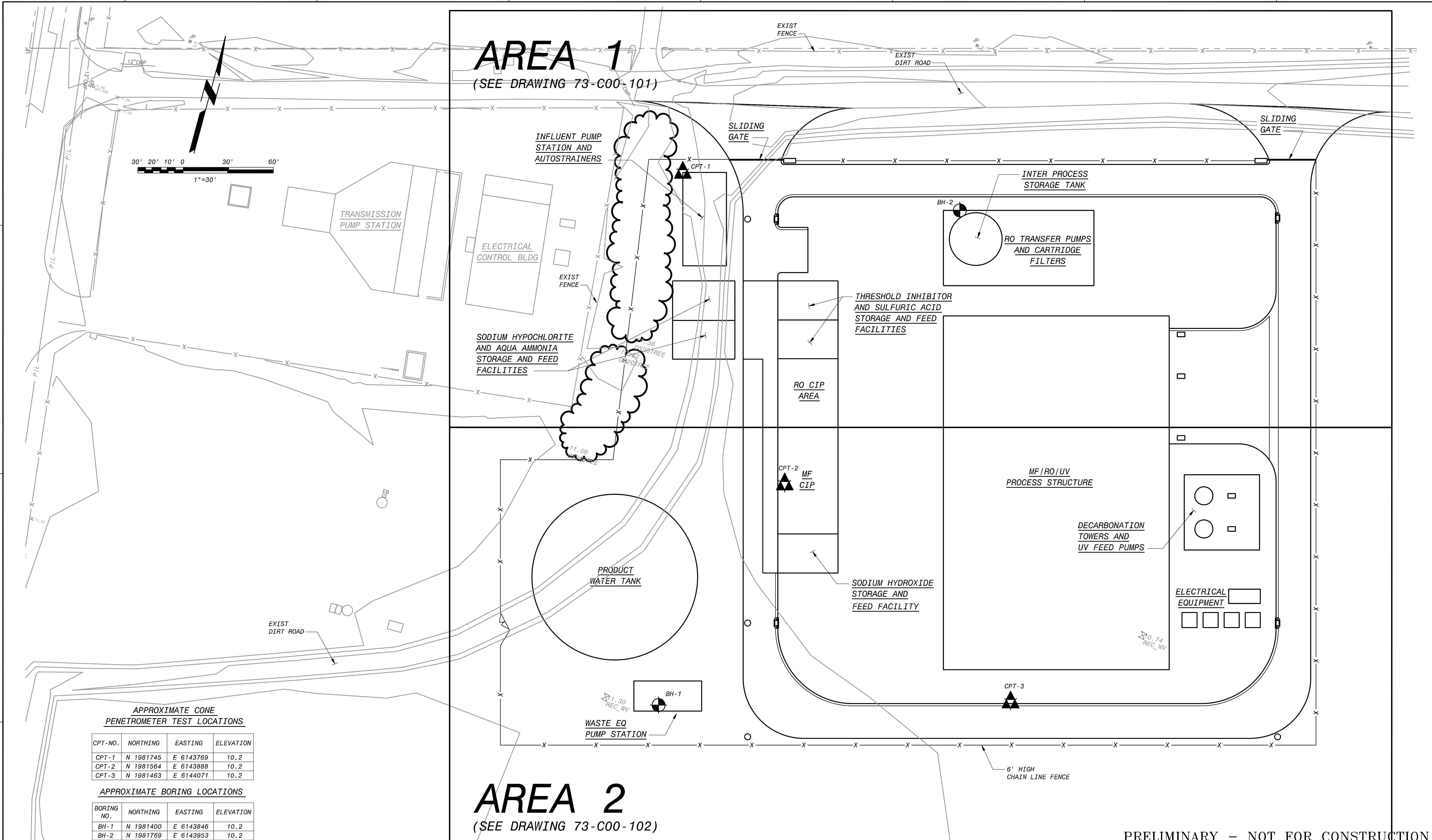
Horizontal coordinates would be based on California State Plane Zone 3 NAD 83. In July 2008, the City of San Jose advised the District and Black & Veatch that the City would be standardizing on NAVD 88 for their vertical datum. The final contract documents would be based on NAVD 88 as the vertical datum. This Engineer's Report provides elevations in both the NAVD 88 and NGVD 29 vertical datums. NAVD 88 is approximately 2.7 feet above NAVD 29 at the ARWTF location.

Existing structures, utilities, roadways, and landscaping features would be located in both horizontal and vertical planes with respect to existing benchmarks and existing contours. Topographic mapping for the ARWTF site has been prepared by Mark Thomas and Company, Inc. (MTCo) based on existing benchmarks.

6.2.4 Existing Site Conditions

Geotechnical investigations at the TPS and the SJ/SC WPCP were performed in the past and the following two geotechnical reports are available for review:

- Geotechnical Consultants, Inc. (GTC), 1996, Geotechnical Report, Transmission Pump Station, San Jose, California, dated January 4.
- URS, Inc., 2003, Wet Weather Reliability Improvements Project, San Jose/Santa Clara Water Pollution Control Plant, San Jose, California, November 18.



APPROXIMATE CONE PENETROMETER TEST LOCATIONS

CPT-NO.	NORTHING	EASTING	ELEVATION
CPT-1	N 1981745	E 6143769	10.2
CPT-2	N 1981564	E 6143888	10.2
CPT-3	N 1981463	E 6144071	10.2

APPROXIMATE BORING LOCATIONS

BORING NO.	NORTHING	EASTING	ELEVATION
BH-1	N 1981400	E 6143846	10.2
BH-2	N 1981769	E 6143953	10.2

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DATE
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ENGINEERING CERTIFICATION
REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:
SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES
CIVIL
SITE LAYOUT

SCALE
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PROJECT NUMBER 146071
SHEET CODE: B&V FIG 6-1
CITY
DISTRICT
OF 345

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To adequately evaluate geotechnical concerns for the ARWTF Project, B&V has subcontracted URS, Inc., to conduct a geotechnical investigation[1] of the ARWTF site to obtain additional geotechnical data. URS, Inc. finalized a geotechnical report which summarizes findings made during the geotechnical investigation of the site.

6.2.5 Site Grading

Site grading would be conducted in accordance with the City's grading and drainage requirements. The ARWTF site is an undeveloped, unpaved area. The existing site is relatively flat, and the average site elevation is approximately 7.8 feet, NGVD 29 (10.5 feet, NAVD 88).

As part of a separate earthwork contract, the ARWTF site would be raised to an approximate elevation of 10.8 feet, NGVD 29 (13.5 feet, NAVD 88) to bring the site above the existing 100-year floodplain (approximate elevation of 9 feet, NGVD 29 [11.7, NAVD 88]). An additional 4.5 feet of surcharge fill would be placed in the areas where the pile supported structures would be located. The surcharge fill should extend at least 10 feet beyond the limits of the proposed pile supported facilities. Surcharging should occur for a period of three to four months. This separate earthwork contract would be executed sometime around April 2010, to allow the surcharge preloading period to end before the ARWTF construction starts in September 2010.

6.2.6 Site Stormwater Drainage

A stormwater collection system would be designed as required to route stormwater from the ARWTF site to the waste equalization wetwell. To avoid ponding of rainfall on the paved surfaces at the ARWTF site, construction of the final grades and pavements at the site would be sloped to direct surface water to the perimeter of the site, away from foundations and slabs. Unpaved areas of the proposed treatment plant site would be provided with crushed rock, which would promote infiltration of stormwater into the underlying soil. All covered facilities (canopies and Process Structure) would be provided with a roof drainage system consisting of downspouts and gutters for discharge to the surrounding grade. The roof of Product Water Storage Tank and Inter-Process Storage Tank would be sloped to facilitate drainage of rain water.

6.2.7 Site Utilities

Utility services required for the ARWTF site would include: potable water, non-potable recycled water, sewer, storm drain, fire water, electricity, and telephone. Utility research would be performed to collect data during final design.

6.2.8 Site Access

Entrance to the ARWTF would be from the dirt road to the North of the TPS. An access road, which would tie into the dirt road, would be provided for vehicular access to the various on-site structures including tanks, pump stations, chemical areas, and the Process

[1] "*Geotechnical Investigation – Advanced Recycled Water Treatment Facilities,*" prepared by URS, October 2009.

Structure. The access road would allow one-way movement of service vehicles and equipment through the site. Concrete pads would be provided along the access road for trucks unloading chemicals to the bulk chemical facilities. A chain link fence would be provided around the site perimeter for security purposes.

6.3 Process/Mechanical Design

6.3.1 General

This Chapter presents the process mechanical design criteria for the ARWTF. The design criteria contained in this section is preliminary, and will be updated, where appropriate, throughout final design phase.

6.3.2 Design Codes and Standards

In addition to regulatory and permitting requirements specified in Chapter 3 of the Report, the mechanical/process design of the ARWTF Project will conform to the latest edition of the codes and standards shown in Table 6-2.

6.3.3 Equipment Identification

Tag identification numbers would be assigned to all major equipment. The tagging system has been developed based on the City of San Jose's standard tagging convention.

6.3.4 Influent Pump Station

The ARWTF Influent Pump Station would consist of four (4) vertical diffusion vane pumps and four (4) Automatic Strainers, supported on a reinforced concrete mat foundation. The Influent Pumps would also serve as the MF/UF feed pumps. Layout of the Influent Pump Station is provided on Figure 6-2.

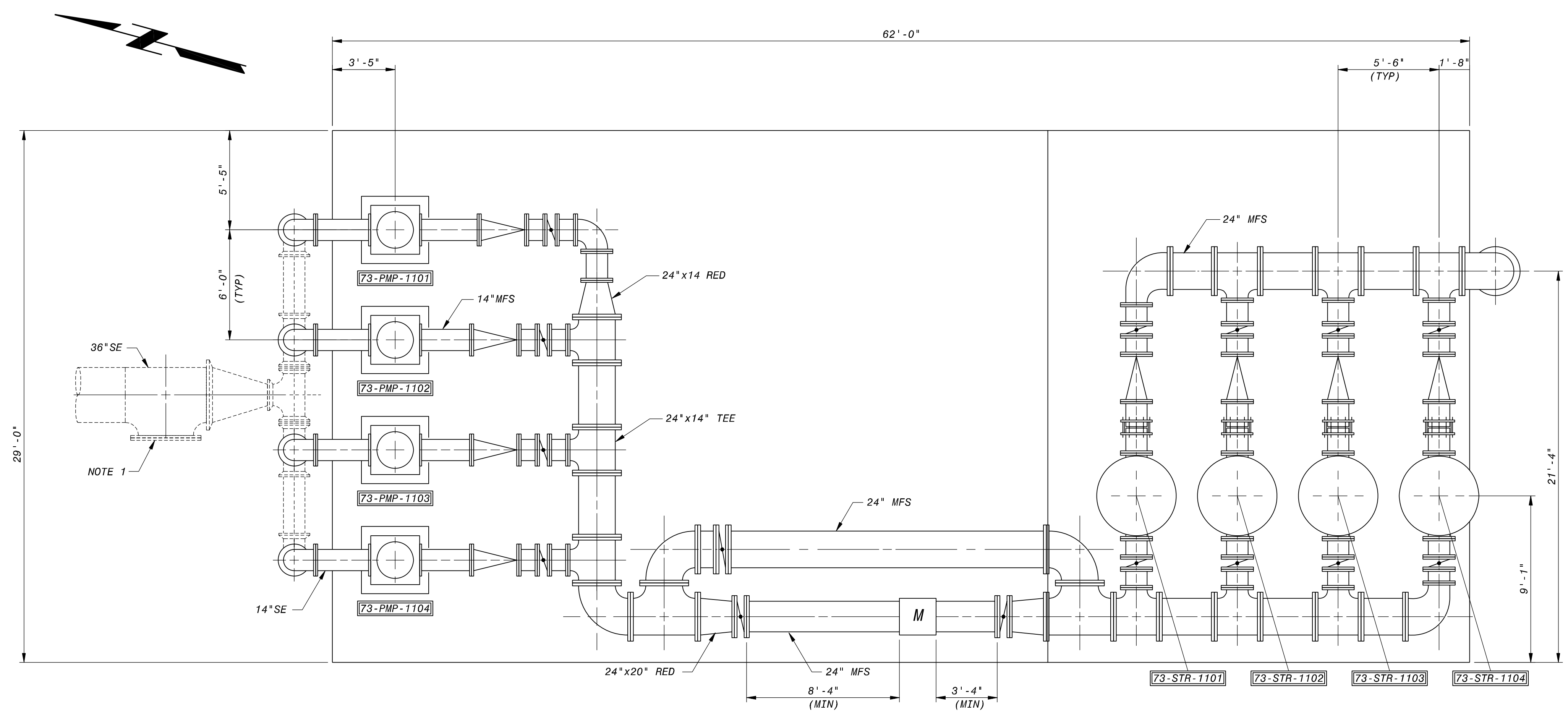
Nitrified secondary effluent from the SJ/SC WPCP would flow by gravity to the Influent Pump Station and be pumped through Automatic Strainers prior to entering the MF/UF membrane units. The strainers would be automatic backwash strainers programmed to backwash based on either time or excess differential pressure. Influent feed water would be used for Automatic Strainer backwash, and strainer backwash waste would be routed to the Waste Equalization Wetwell. The design criteria of the Influent Feed Pumps and Automatic Strainers are summarized in Table 6-3. A process flow diagram for the ARWTF is presented in Figure 4-2 (Chapter 4).

Table 6-2: Applicable Process/Mechanical Codes and Standards

Code / Standard	Application and Project Impact
NFPA Recommended Practices and Manuals	Develops codes and standards to reduce the impact of fire and other hazards.
ASHRAE Handbooks and Standards	Publishes standards and guidelines for the design of heating, ventilation, and air-conditioning (HVAC) systems.
ASPE Handbooks	Standards established to protect humans from the hazards associated with plumbing systems by regulating and controlling the design and construction of such facilities.
AWWA Standards	Provides standard practice and testing procedures used by the water industry. Topics range from source waters, water treatment, and piping and accessories.
California Fire Code	Standards established to protect humans from the hazards of fire explosion, and to minimize the problems associated with the storage and use of hazardous chemicals and equipment.
California Mechanical Code	Standards established to protect human well-being by regulating the design and construction of ventilating, cooling, and heat generating equipment.
City of San Jose Standards	City's applicable standards would be adhered to in the design of the facilities for ARWTF Project.
HIS	Publishes standards and guidelines for the design of pumping systems and facilities.
OSHA Standards Manual	Ensures safe working conditions by providing employees knowledge about the hazards that exist in their work environment. It also provides a way for employees to report unsafe work conditions.
SMACNA Handbooks	Standards address all areas of the sheet metal industry. The handbooks address safety, industry issues, labor relations, etc.
SCVWD Standards	District's applicable standards would be adhered to in the design of the facilities for ARWTF Project.
NFPA Uniform Fire Code	Allows for the review of design / construction plans for fire protection systems. Regulates fire and safety education for employees of the building. Sets access requirements for fire department operations.

NOTE:

1. BLIND FLANGE FOR FUTURE CONNECTION TO PHASE II INFLUENT PUMP STATION.



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Walnut Creek, California

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ENGINEERING CERTIFICATION
REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES

MECHANICAL
INFLUENT PUMP STATION AND AUTOSTRAINERS
PLAN

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PROJECT NUMBER 146071
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OF 345

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Table 6-3: Influent Pump Station and Automatic Strainer Design Criteria

Parameter	Value
Influent Feed Pumps	
Quantity	Four (3 duty, 1 standby)
Manufacturers	Flowserve, Gould, or approved equal
Type	Vertical diffusion vane
Material	TBD
Capacity each, gpm	2,750
Rated Head, feet	175 +/-
Drive	Two (2) Variable Frequency Drive (VFD) Two (2) Constant Speed
Power, hp	200 (Tentative)
Automatic Strainers	
Quantity	Four (3 duty, 1 standby)
Manufacturers	Amiad, Fluid Engineering, or approved equal
Type	Inline, Auto-Backwashing
Material	Carbon Steel/Stainless Steel
Screen Opening Size	500 micron
Capacity, gpm	2,750 @1.3 psi drop (clean condition headloss)
Power, hp	2

6.3.5 MF/UF System

MF/UF treatment process would be provided as pretreatment process for the ARWTF Project. The MF/UF process is used to remove suspended/colloidal solids from the nitrified secondary effluent and provide a stable, high-quality feed stream for the RO System.

The MF/UF system will include the following components:

- Membrane Units
- Compressed Air System
- Reverse Filtration (i.e., Backwash System)
- Maintenance Wash System (MW) (i.e., Enhanced Flux Maintenance (EFM) or Chemical Enhanced Backwash (CEBW) Systems)
- Cleaning-in-Place (CIP) System

6.3.5.1 Membrane Units

At the time the draft Engineer's Report was submitted (July 2007), both pressurized and submerged MF/UF systems were being considered. A decision was made in June 2009 to no longer consider the submerged MF/UF system. In addition to expediting the schedule and design, the pressure membrane configuration for this size plant will also have a lower construction cost for at least 2 reasons: (1) the system will not require expensive coated steel or stainless steel membrane tanks and (2) the system will not need a taller Process

Structure to enclose the submerged membrane tanks. In addition, previous data have shown that pressure systems have a cost advantage for lower capacity facilities, especially with treatment trains less than or equal to 2.5 mgd.

For this Project, the MF/UF system would be designed for the number of duty units required (N) to maintain a net production capacity of 10.5 mgd. The maximum instantaneous flux would not exceed 40 gfd.

Pressurized MF/UF Units. The membranes for the pressurized MF/UF system are installed within pressure vessels, arranged in racks, and placed on a concrete slab. Three pressurized MF/UF systems were considered for the Project: the Microza membranes by Pall Corporation, the Memcor CP system by Siemens, and the X-flow membranes by Krueger/Norit. Based on proposals received in November 2009, the Pall MF/UF System has been preselected for the Project.

A pressurized MF/UF system requires an external driving pressure to push the feed water through the MF/UF membranes to produce filtrate under variable conditions due to membrane fouling and the resultant varying operating pressures. This external driving pressure is provided by the Influent Pumps. The Influent Pumps operate on VFDs to maintain a constant production rate through various stages of membrane fouling. Individual MF/UF membrane modules would be arranged on discrete skids with common feed, filtrate, reverse filtration, cleaning and air supply connections, forming a single unit.

The design criteria for the pressurized MF/UF membranes are summarized in Table 6-4.

Layout of pressurized MF units in the ARWTF Process Structure, based on the Pall system is shown on Figure 6-3.

Table 6-4: Pressurized MF Membrane Design Criteria

Parameter	Value
Manufacturer	Pall or Siemens
Net Filtrate Production Capacity, gpm	7,300 (on a 24-hour basis)
No. of MF/UF Units (N design)	Five (Pall) – tentative[1] Six (Siemens)
No. of Membrane Modules per Unit	114 per rack, 570 total (Pall) – tentative[1] 240 per unit, 1,440 total (Siemens)
No. of Units per Support Skid	One
Membrane Type	Polyvinylidene fluoride (PVDF)
Membrane Configuration	Hollow Fiber, outside-in flow pattern
Module Model No.	UNA-620A (Pall) L20V (Siemens)
Membrane Area per Module, ft^2 (based on outside fiber diameter)	530 (Pall) 410 (Siemens)
Maximum Instantaneous Flux, gfd	Not to exceed 40
Module Production at Rated Capacity, gpm / module	12.8± (Pall), net on 24-hr basis- tentative[1] 5.1± (Siemens), net on 24-hr basis
Reverse Filtration (RF)/Air Scrub (AS) Cycle Interval, minutes	32± (Pall) 22± (Siemens)
RF Waste, gal/day	500,000± (Pall) 670,000± (Siemens)
MW frequency, hours	48±
CIP frequency, days	30±
Transmembrane Pressure (just before CIP), psi	25± (Pall) 20± (Siemens)
Minimum Recovery, percent	90

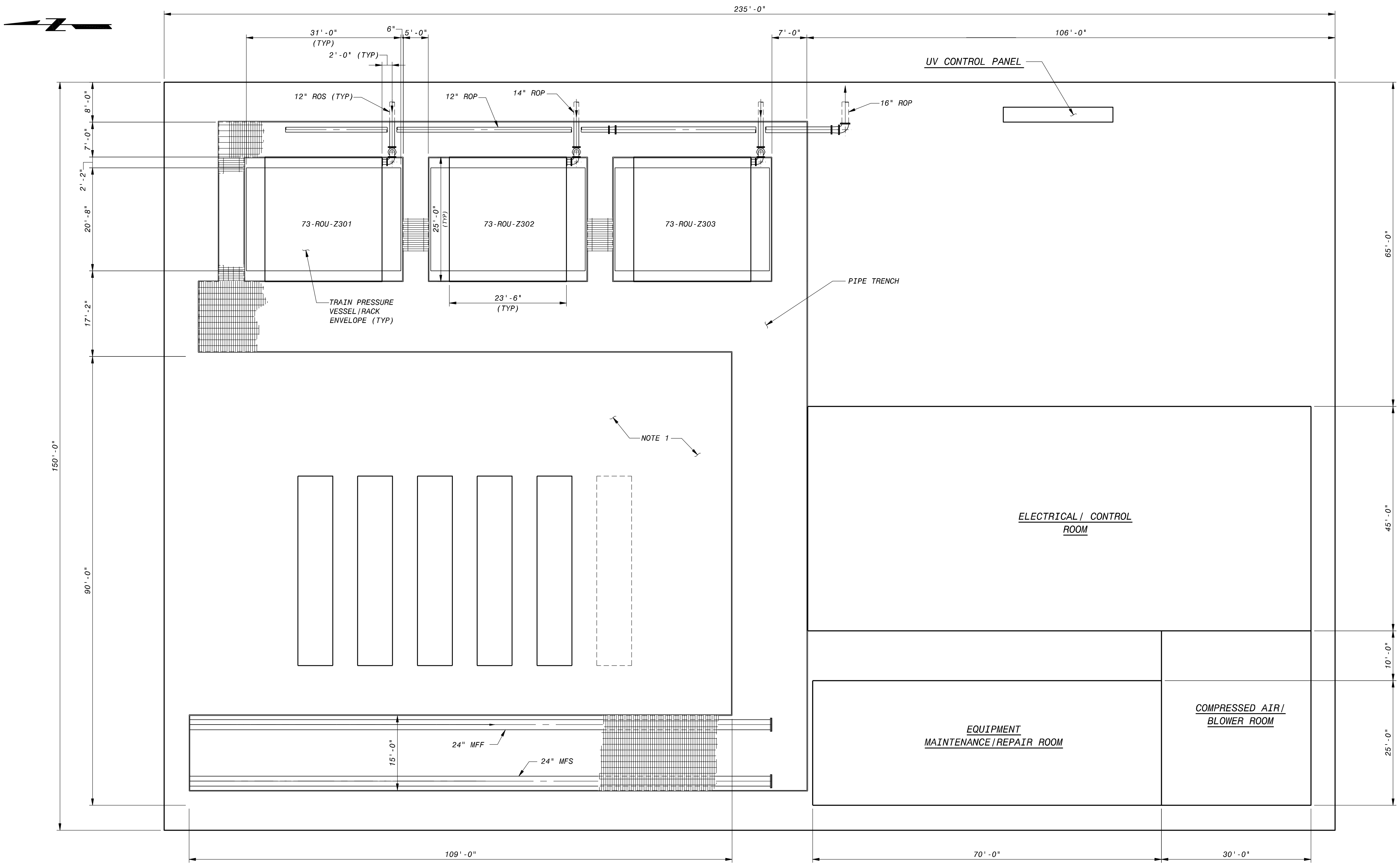
[1] Based on July 2009 proposal from Pall. Pall's recent November 2009 proposal for 8 MF units is currently being considered.

6.3.5.2 Compressed Air System

Compressed air is used in the MF/UF system for both control and process service. Control air is used for pneumatically actuated valves mounted on the units and related support systems (e.g., the CIP system). Process air use includes both scour air used as part of the membrane reverse filtration process (air scrub); and test air used for verification of membrane integrity. The design criteria for the compressed air system are provided in Table 6-5.

NOTE:

1. SPACE ALLOCATED FOR MICROFILTRATION SYSTEM. VENDOR TO BE SELECTED BETWEEN 30% AND 60% DESIGN.



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REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES

MECHANICAL
MF/RO/UV PROCESS BUILDING
PIPING PLAN AND OVERALL LAYOUT

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6.3.5.3 Reverse Filtration Process

Backwash of the MF/UF membranes is provided through reverse filtration (RF), which is a cyclical regenerative process that restores membrane permeability during normal operation. The RF process is intended to help maximize unit operation between required in-place cleaning sequences.

The RF process is conducted following 15-30 minutes of on-line filtration and includes reverse flow of filtrate through the membrane modules and, depending on the MF/UF system, may be coupled with an air scour. The RF sequence would take the unit offline for 120-250 seconds (depending on the MF/UF system) to complete the process. Supply for the RF sequence could be drawn from either the MF/UF filtrate line or from the Inter-Process Storage Tank. The Pall system requires pumps for conducting RF, while the Siemens system uses the compressors to reverse the flow of filtrate through the membrane modules. Waste from the RF process would be transferred to the Waste Equalization Wetwell. The design criteria for the RF pumps are summarized in Table 6-6. This table only applies to the Pall system.

Table 6-5: Compressed Air System Design Criteria

Parameter	Value
Air Compressors	
Quantity	Two (1 operating, 1 standby)
Manufacturers	Atlas Copco, Kaiser, or approved equal
Type	Single stage, air cooled, oil injected, rotary screw with integral refrigerated dryers
Capacity, scfm	110 +/- (Pall) 200 +/- (Siemens)
Minimum Design Pressure, psig	150
Motor Size, hp	10 +/- (Pall) 50 (Siemens)
Air Receiver Tank	
Quantity	One (Pall) Two (Siemens)
Type	Vertical, cylindrical
Material	Epoxy lined steel
Volume, gallons	1040 (Pall) 1040 (Process Air) (Siemens) 200 (Control Air) (Siemens)
Design Pressure, psig	200
Control Air Regulator Assembly	
Quantity	Two (incorporates redundant filters and regulators)
Type	Mechanical pressure
Minimum Design Inlet Pressure, psig	175
Secondary Max. Pressure, psig	100
Air Supply Filter Assemblies	
Quantity	Two (1 per compressor)
Manufacturers	Atlas Copco, Pall, or approved equal
Description	Oil removal/membrane air filters with integral supports and accessories
Unit Mounted Pneumatic Control Panels	
Number	Eight (Pall) Six (Siemens)
Material	Stainless steel
Description	Houses valve control solenoids for skid mounted flow valves; miscellaneous accessories
Enclosure	National Electrical Manufacturers Association (NEMA) 4X solenoids; stainless steel flat panel

Table 6-6: MF/UF Reverse Filtration Pump Design Criteria

Parameter	Value
Reverse Filtration Pump[1]	
Quantity	Two (1 duty, 1 standby)
Manufacturers	Goulds Pumps, Flowserve, or approved equal
Type	Horizontal end suction centrifugal, America National Standards Institute (ANSI)
Material	Ductile Iron
Capacity, gpm	900
Rated Head, feet	70
Drive	VFD
Power, hp	25

[1] Only applies to the Pall MF/UF system

6.3.5.4 Maintenance Wash (MW)

A MW sequence would be conducted once every two days to maximize the operation of the MF/UF system until the longer clean-in-place (CIP) sequence is required. A MW is a simple backwash cycle that lasts about 45 to 60 minutes using a heated, dilute chemical cleaning solution (i.e. chlorine) re-circulated through the unit. Design and operation of the MW system is specific to each MF/UF system.

6.3.5.5 Clean-in-Place (CIP) System

A CIP system would be provided to periodically clean the MF/UF process membranes in-situ when the RF and MW sequences are no longer effective in removing foulants from the membrane surface. The gauge of fouling would be the trans-membrane pressure (TMP). A CIP is needed when the operating TMP reaches a value predetermined by the manufacturer, and is specific to each MF/UF system. A CIP would be required once a month.

The CIP solutions could be prepared in one of the following ways:

1. Pall: The cleaning system would consist of separate acid and caustic cleaning solution preparation and circulation systems.
2. Siemens: The cleaning system would consist of a heated water tank where the acid and caustic cleaning solution would be injected inline to be mixed with the heated water solution, which would be circulated through the MF/UF units.

CIP solutions would be made using RO permeate to avoid precipitation of hardness and other constituents in a high pH environment. Acid cleaning would be conducted first to remove any inorganic foulants present in the membrane modules using a 20,000 mg/L citric acid solution (Pall), or a 10,000 mg/L sulfuric acid solution (Siemens). A caustic solution would be introduced to the MF/UF membrane unit following the acid cleaning using a 10,000 mg/L sodium hydroxide / 2,000 mg/L sodium hypochlorite solution (Pall), or a 600 mg/L sodium hypochlorite solution (Siemens). Depending on the type of membrane and cleaning procedures, the entire cleaning process would take approximately 3 to 6 hours from the time a single unit is taken offline and the time it is returned to service. Two (2) operators would be needed to conduct a CIP. Waste cleaning solutions from the CIP and MW processes would be sent to a neutralization tank. Small volumes of sodium hydroxide, sulfuric acid, and sodium bisulfite would be used for pH neutralization and dechlorination of the CIP and MW solutions. Neutralized waste would then be sent to the Waste Equalization Wetwell for disposal. Equipment associated with the MF/UF CIP system is summarized in Table 6-7.

Table 6-7: MF/UF CIP System Design Criteria

Parameter	Value
MF/UF CIP Tanks	
Quantity	Two (Pall) One (Siemens)
Type	Vertical, cylindrical, domed top
Material	Fiberglass Reinforced Plastic (FRP)
Capacity, gallons	3000 (Pall) 5200 (Siemens)
MF/UF CIP Heaters	
Quantity	Two (Pall) One (Siemens)
Manufacturers	Watlow, Chromolox or approved equal
Type	Flanged immersion
Material	Incoloy (acid tank); Inconel (caustic tank)
Size, KW	63 (Pall) 160 (Siemens)
Strainer	
Quantity	Two (Pall) 0 (Siemens)
Manufacturers	Hayward, Spears, or approved equal
Type	Inline basket
Material	Polyvinyl Chloride (PVC) with Ethyl Propylene Diene Monomer (EPDM) seals

MF/UF CIP Pumps	
Quantity	Four (2 duty, 2 standby) (Pall) Two (1 duty, 1 standby) (Siemens)
Manufacturers	Fybroc, Flowserve, or approved equal
Type	Horizontal end suction centrifugal
Material	FRP
Capacity, gpm	400 (Pall) 1440 (Siemens)
Rated Head, feet	80 (Pall) 40 (Siemens)
Drive	Constant speed
Size, hp	15 (Pall) 20 (Siemens)

6.3.6 Inter-Process Storage Tank

An Inter-Process Storage Tank would be provided between the MF/UF and RO Systems to equalize the MF/UF filtrate. The tank would be sized to hold feed flow to the RO membranes, at ultimate capacity for a minimum of 30 minutes. A preliminary layout of the Inter-Process Storage Tank, RO Transfer Pumps, and Cartridge Filters is shown on Figure 6-4. The Inter-Process Storage Tank would also be used as a filtrate supply for the MF/UF Reverse Filtration Pumps, as required. Provisions would be made in terms of space for a temporary tank and connections to allow maintenance and cleaning of the Inter-Process Storage Tank. The design criteria for the Inter-Process Storage Tank are summarized in Table 6-8.

Table 6-8: Inter-Process Storage Tank Design Criteria

Parameter	Value
Quantity	One
Description/Operating Parameters	
Tank Type	Welded steel, cylindrical, above grade
Reference Standards	AWWA D100/D102
Total Tank Sidewall Height, feet	34
Tank Diameter, feet	40
Storage Duration, minutes	30
Storage Capacity (Useable), gallons	250,000
Design Requirements	
Seismic Design	Refer to Section 6.5, "Structural Design"
Tank Anchorage	Tank anchored to reinforced concrete foundation
Tank Design	To be prepared by manufacturer and stamped by Registered California P.E.

Appurtenances	
Field Welds	Field welds to be randomly spot tested by radiography
Interior Coating	National Science Foundation (NSF) approved epoxy enamel; e.g. Carboline Carboguard 891 or equal
Exterior Coating	Suitable epoxy enamel coating system; e.g. Carboline Carboguard 890/133VOC or equal. The exterior coating shall be suitable to protect against UV rays.

6.3.7 RO System

The RO treatment process would be provided for demineralization of the MF/UF filtrate for the ARWTF Project. RO is a cross-flow process in which inlet feed water is continuously separated into two streams – a purified product stream (permeate) and a concentrated waste stream (concentrate). The RO process achieves demineralization by accelerating the transport of water across a semi-permeable membrane while impeding the transport of salt.

The initial design of the RO System for Phase I ARWTF is based on a peak production rate of 8.0 mgd consisting of three units each of 2.67 mgd capacity. The capacity of the RO System can be increased to 9.0 mgd capacity by installing additional membranes on the existing units. The RO System would include the following components:

- RO Transfer Pumps
- Sulfuric Acid Feed System
- Threshold Inhibitor Feed System
- Cartridge Filters
- High Pressure RO Feed Pumps
- RO Membrane Trains
- Decarbonators
- RO Product Water Transfer Pumps
- RO Membrane Flush System
- RO Membrane CIP System

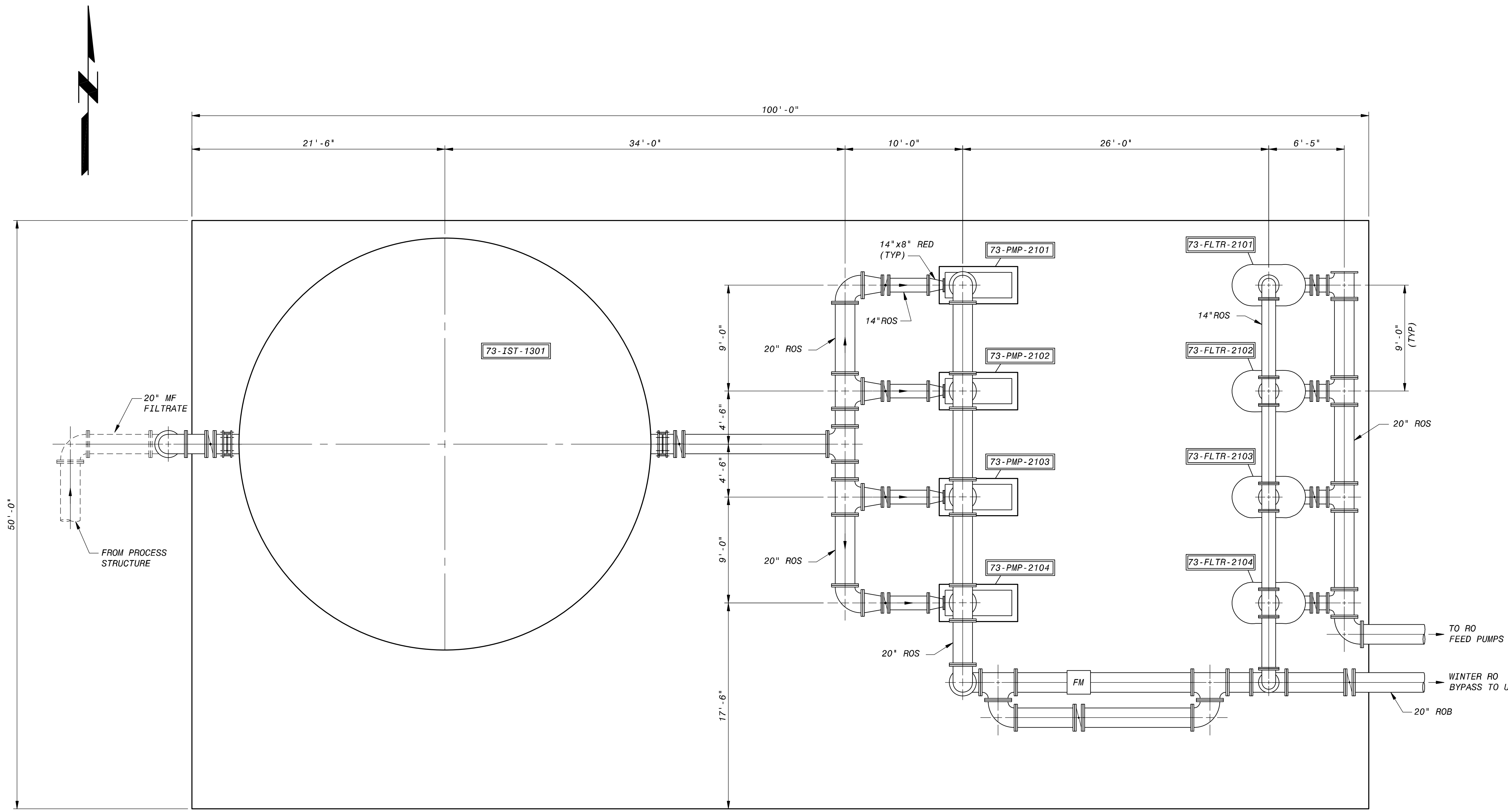
Individual system components are discussed separately in sections below.

6.3.7.1 RO Transfer Pumps

The RO Transfer Pumps would be provided to pump the MF/UF filtrate stored in the Inter-Process Storage Tank through the Cartridge Filters to the high pressure RO feed pumps. The transfer pumps would discharge the RO feed through a common header to the downstream Cartridge Filters. The pumps would be constant speed, with flow restricted by controls on the RO trains. Design criteria for the pumps are presented in Table 6-9.

Table 6-9: RO Low Pressure Feed Pump Design Criteria

Parameter	Value
Quantity	Four (3 duty, 1 standby)
Manufacturers	Goulds, Flowserve, or approved equal
Type	Horizontal end suction, centrifugal
Material	Ductile Iron
Rated Capacity per unit, gpm	2,480
Rated Head, feet	100
Drive	Constant speed
Motor size, hp	100



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REGISTERED PROFESSIONAL ENGINEER DANIEL C. LOPEZ No. C 054330 Exp. 12/31/11 CIVIL STATE OF CALIFORNIA

SOUTH BAY WATER RECYCLING
CITY OF SAN JOSE CAPITAL OF SILICON VALLEY
Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:
SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES
MECHANICAL
INTER-PROCESS STORAGE TANK, RO TRANSFER PUMP STATION AND CARTRIDGE FILTERS - PLAN

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6.3.7.2 Cartridge Filters

Cartridge Filters with polypropylene wound elements are recommended immediately ahead of the RO System to guard against solids entering the system between the processes from process tanks, gaskets, chemical impurities and other like causes. The spiral wound RO elements can be easily clogged by suspended solids and debris, shortening membrane life. Cartridge Filters would be provided upstream of the RO System to protect the RO membranes from long-term solids deposition (particulate fouling). Filter media would consist of wound hollow-core polypropylene elements and should be disposed when differential pressure rises from a clean state of roughly 2-4 psi to a fouled condition of up to 15 psi. Flows may bypass the Cartridge Filters when the filters are taken out of service for short periods of time for maintenance and/or cartridge replacement. Plant capacity would thus be maintained with all filters out of service. Design criteria for the Cartridge Filters are provided in Table 6-10. Layout of the RO Transfer Pumps and Cartridge Filters is shown on Figure 6-4.

Table 6-10: Cartridge Filter Design Criteria

Parameter	Value
Quantity	Three (3 duty)
Manufacturers	Parker Hannifin, Plenty, or approved equal
Type	Horizontal pressure vessel
Material	Stainless steel / polypropylene
Rated Capacity per unit, gpm	2,480
Loading Rate, gpm/10-inch equivalent	3.1
Nominal Pore Size, µm	20

6.3.7.3 High Pressure RO Feed Pumps

After the RO feed stream passes through the Cartridge Filters, high pressure RO feed pumps would boost the pretreated RO feed water to the operating pressure required for the RO membrane trains. Each RO train would be served by its own, dedicated high pressure feed pump to allow for different operation conditions on the individual membrane trains depending on the degree of membrane fouling. The high pressure RO feed pumps would be equipped with variable frequency drives and the speed of each pump would be controlled to maintain a permeate flow set point from the associated membrane train.

Initial operating pressure with new membrane is expected to be around 100 psig. Typically, for municipal effluents, significant increase in operating pressure or RO System is observed during the first few months, as membranes are fouled by various constituents in the feed water. After this period, the operating pressure required to maintain the permeate flow remains relatively steady. Historical operating experience at other utilities indicates an expected average operating pressure over the life of the membranes of 180 psig. A fouling allowance of 150 psig would be recommended based on past experience in similar applications to maximize membrane life. Design flow of the pumps is targeted to meet design requirements for the membrane trains in regard to recovery and operating flux. Design criteria for the high pressure RO feed pumps are summarized in Table 6-11.

Table 6-11: High Pressure RO Feed Pump Design Criteria

Parameter	Value
Quantity	Three (3 duty)
Manufacturers	Afton, Flowserve, Goulds, or approved equal
Type	Vertical centrifugal
Material	Stainless steel
Rated Capacity per unit, gpm	2,480
Rated Head, feet	560[1]
Drive	VFD
Power, hp	500

[1] If the 9.0 mgd maximum RO production capacity for Phase I ARWTF is desired, the proposed feed pumps could serve the expanded 3.0 mgd trains, but at a lower maximum developed head of 540 feet. During detailed design, feasibility of using pumps with higher rated head to meet the head requirement of the expanded trains would be evaluated.

6.3.7.4 RO Membrane Trains

RO is a membrane process designed to remove dissolved constituents from the process feed water. For the Phase I ARWTF Project, three trains (all duty), each with nominal capacity of 2.67 mgd, are proposed to make up the 8.0 mgd system capacity. Each train would initially have 52 pressure vessels in the first bank and 28 pressure vessels in the second bank. The pressure vessels would be installed on welded steel rack for support. The racks would be designed with dedicated space to allow addition of pressure vessels to each bank (8 to the first bank; 2 to the second bank), expanding each of the trains to a capacity of 3.0 mgd. The design criteria for the RO trains are provided in Table 6-12.

Layout of RO trains in the ARWTF Process Structure is shown on Figure 6-3.

Table 6-12: RO Membrane Design Criteria

Parameter		Value
General		
Quantity (N design)		Three (3 duty)
Design Capacity, RO Permeate, mgd		2.67, expandable to 3.0
Design Recovery, %		85
Pressure Vessel Racks		
Number of Pressure Vessels per Train		80, expandable to 90
Number of First Stage Pressure Vessels		52, expandable to 60
Number of Second Stage Pressure Vessels		28, expandable to 30
Number of Membrane Elements per Vessel		Seven
Design Pressure, psig		450
Manufacturers		Codeline, Progressive Composites, or approved equal
Membrane Elements		
Number of Elements per Train		560, expandable to 630
Area per Element, sq. ft.		400
Nominal Design Flux, gfd		12
Element Type		High rejection polyamide composite
Average Salt Rejection, %		>99.5
Manufacturers		Hydranautics, Koch, or Toray
Concentrate Control Valves		
Valve Type		Cage-Guided Globe with Anti-Cavitation Trim
Materials	Body Cage Plug Stem Seat Seals	Type 316L stainless steel 17-4 PH Type 420 stainless steel Type 316 stainless steel 17-4 PH PTFE
Size, inches		3.0
Maximum Rated Cv		85
Design Flow, gpm		245 – 294
Rated Pressure Drop, psi		200
Actuator		Electric modulating
Manufacturer		Fisher, Masoneilan, or approved equal

6.3.7.5 RO Permeate Decarbonators and Transfer Pump Station

The acidification of feed water to the RO System increases carbon dioxide concentration in the feed water. Carbon dioxide would not be removed by the RO membranes and would remain in an equal concentration in both the final concentrate and permeate streams. With the RO membranes removing majority of the hardness and alkalinity from the feed water, excessive amounts of carbon dioxide present in the RO permeate stream would result in low pH. A decarbonator could be used to strip excess carbon dioxide thus increase the pH of the product water. A decarbonator is essentially a packed tower with counter-current air flow generated by a centrifugal blower. Permeate from the RO trains would enter the top of the tower and be sprayed over plastic packing material. The RO permeate would cascade down the packing and be contacted by a counter-current air flow from the base of the tower which would strip out the carbon dioxide. Decarbonated RO permeate would collect in a sump at the base of the tower and be pumped by the transfer pumps to the UV disinfection system. Design criteria for the Decarbonator and Product Water Transfer Pumps are summarized in Table 6-13.

Table 6-13: Product Water Decarbonators and Product Water Transfer Pump Station Design Criteria

Parameter	Value
Product Water Decarbonators – Tower	
Quantity	Two (2 duty)
Type	Forced draft
Materials Tower Packing	 FRP Polypropylene
Capacity, gpm	1,850 – 2,800
Outlet Carbon Dioxide Concentration, mg/L	<5
Carbon Dioxide Removal Efficiency, %	90
Outlet pH	6.7
Tower Diameter, feet	12
Tower Height (Straight Shell), feet	20
Manufacturers	DEI Systems, Paramount Fabricators, or approved equal
Product Water Decarbonators – Blower	
Quantity	Two (2 duty)
Type	Centrifugal
Blower Capacity, cfm	8,325
Static Pressure, inches w.c.	2
Materials	Steel
Size, hp	7.5
Manufacturers	New York Blower, Hartzell Fan, or approved equal
Product Water Transfer Pump Station	
Quantity	Three (2 duty, 1 standby)
Manufacturers	Goulds, Patterson, Flowserve, or approved equal
Type	Horizontal split case centrifugal
Material	Type 316 stainless steel
Rated Head, feet	60
Capacity per unit, gpm	3,200
Type of Drive	VFD
Size, hp	75

6.3.7.6 RO Membrane Flush System

When an RO train is shut down, residual feed water is retained in the membrane elements. If the train is to remain off-line for a period in excess of 30 minutes, the membranes should be flushed with permeate (product water) to insure against fouling. The permeate flush is a low flow process in which two pressure-vessel volume exchanges would be pumped through the train to waste. The system would activate automatically following a shutdown if the train was not re-started in a prescribed period (typically 20 minutes). Operators may also manually initiate flushing of an off-line train. Once started, the flush sequence would open automated valves on the feed, permeate and concentrate headers for the train and would start the flush pump. The flush pump would run for a prescribed period and then stop, at which point the valves would be closed. The flush pump would draw suction from the final Product Water Storage Tank. If multiple trains were shutdown, they would be flushed sequentially. Design criteria for the flush pump are provided in Table 6-14.

Table 6-14: RO Flush Pump Design Criteria

Parameter	Value
Quantity	Two (1 duty, 1 spare)
Manufacturers	Goulds, Flowserve, or approved equal
Type	Horizontal centrifugal
Material	Stainless steel
Capacity per unit, gpm	480
Rated head, feet	115
Sizes, hp	25

6.3.7.7 RO Membrane CIP System

Similar to the MF/UF system, periodic cleaning of the RO membrane elements would be required to restore permeability. The RO membranes are typically cleaned when permeability has reduced approximately to 85 percent of initial stabilized operating conditions. However, a sudden substantial drop in permeability may be grounds for cleaning sooner. Typical cleaning frequency varies from once every three to six months to once a year.

Different formulations of cleaning solution are used depending on the suspected nature of the accumulated foulant. In some instances, a trial cleaning of a single membrane element or analysis of the membrane surface is required to determine the recommended cleaning. In most cases, cleaning solutions can be prepared from commercially available products; though sometimes proprietary solutions are used.

The RO CIP system would consist of two solution preparation tanks and a circulation pump. The tanks would be designed to allow bulk loading of dry chemical through a hopper installed in the top of the tank accessible by platform. Dry chemical feed is often preferred due to the high volume of chemicals required; however, the RO CIP system could be designed to accommodate the addition of pre-prepared liquid cleaning solutions as well. The tank would be equipped with immersion heaters to allow heating of the solution. In addition to temperature, solution pH would also be monitored and a small chemical addition dose system would be provided to allow adjustment of pH using a 55 gallon drum of weak acid or caustic.

Prepared solutions would be circulated through the RO train being cleaned using the RO CIP pump and permanently piped connections to each train. The process would involve displacement of residual water in the train to waste, filling with cleaning solution, recirculation, soaking (potentially), and a final flush of cleaning solution from the train. The RO CIP system would be designed to clean a single train at a time, with each stage within a train cleaned individually. The first stage would be split for cleaning purposes to reduce the required flow. A complete CIP process could take 5 to 12 hours. The cleaning process would be controlled locally from a stand-alone control panel and must be supervised by two (2) operators continuously. The design criteria for the RO cleaning system are summarized in Table 6-15.

6.3.8 Chemical Storage and Feed Facilities

6.3.8.1 General Design Criteria

Chemical storage and feed facilities at the ARWTF would be located outdoors in chemical containment areas as indicated on Figure 6-1, Site Layout. The chemical storage and feed facilities would follow the general design criteria summarized in Table 6-16.

6.3.8.2 Sodium Hypochlorite Feed System

Sodium hypochlorite would be fed to the following processes:

- Dosing to the MF/UF feed water upstream of Automatic Strainers.
- Preparation of MF/UF CIP and MW solutions.

The design criteria for the Sodium Hypochlorite Feed System are provided in Table 6-17. Two half-capacity storage tanks are proposed for redundancy. The combined storage volume of the two tanks would provide for 30 days of supply at the 9.0 mgd system production requirement. Metering pumps would be sized to support the 9.0 mgd system production requirement. In order to centralize the Phase I and Phase II chemical systems, space would be reserved adjacent to this facility for the Phase II sodium hypochlorite containment structure.

The design criteria for the MF/UF sodium hypochlorite transfer pump used to prepare MF/UF CIP solution are provided in Table 6-18.

6.3.8.3 Aqua Ammonia Feed System

In advanced water treatment plants, biofouling is a problem for MF/UF and RO Membranes Systems when operating without the chloramine residual. Therefore, for the ARWTF, aqua ammonia would be added along with sodium hypochlorite (upstream of the Automatic Strainers) to form a 2 to 3 mg/L combined chlorine residual (monochloramine) in the MF/UF feed water. Aqua ammonia would be added in a fixed proportion to sodium hypochlorite to ensure all of the hypochlorite is combined with ammonia to avoid the presence of free residual chlorine. The combined storage volume of the two tanks would provide for 30 days of supply at the 9.0 mgd system production requirement. Metering pumps would be sized to support the 9.0 mgd system production requirement. In order to centralize the Phase I and Phase II chemical systems, space would be reserved adjacent to this facility for the Phase II aqua ammonia containment structure. Design criteria for the Aqua Ammonia Feed System are summarized in Table 6-19.

Table 6-15: RO Membrane Cleaning System Design Criteria

Parameter	Value
RO CIP Tanks	
Quantity	Two
Manufacturers	DEI Systems, Daniel Mechanical, or approved equal.
Type	Vertical, cylindrical, flat top
Material	FRP
Capacity per unit, gallons	5,875
Tank Height, feet	10
Tank Diameter, feet	10
RO CIP Tank Heaters	
Quantity	Two (1 lead, 1 lag)
Manufacturers	Chromolox, Watlow, or approved equal
Type	Flanged immersion
Material	Incoloy
Size, kW	120
RO CIP Circulation Pumps	
Quantity	Two (1 duty, 1 spare)
Manufacturers	Goulds, Flowserve, or approved equal
Type	Horizontal centrifugal
Material	Stainless steel
Capacity per unit, gpm	1,200
Rated Head, feet	140
Size, hp	60
RO CIP pH Adjustment Dose Pump	
Quantity	One
Manufacturers	LMI, Pulsafeeder, or approved equal.
Type	Solenoid actuated diaphragm
Material	PVC head; polytetrafluroethylene (PTFE) diaphragm
Capacity per unit, gph	6.0

Table 6-16: General Chemical Feed and Storage Design Criteria

Parameter	Value
Chemical Storage	
Bulk Chemical Storage Capacity	Minimum of 30 days storage at 9.0 mgd plant production capacity at average chemical doses.
Containment	Each chemical secondary containment area would be sized for the largest tank plus the accumulated rainfall from a 25 year recurring storm, having 24 hour duration (per requirements of International Fire Code).
Sump	The containment shall have a sump with provisions for a portable submersible pump.
Chemical Feed Pumps	
Pump Type	Diaphragm metering pumps
Pump Drive	VFD, Motor, or Solenoid
Stroke Adjustment (Manual)	10:1
Speed Adjustment (Automatic)	5:1
Total Capacity Adjustment	50:1
Chemical Feed Pipes	
Chemical Feed Pipes	All buried pipe in pipe trenches with double containment. Pipes that contain incompatible chemicals shall be in separate pipe trenches.
Chemical Feed Pipe Leak Detection	TBD during detail design (based on pipe routing)

6.3.8.4 MF Citric Acid System

Citric acid is one of the MF/UF CIP chemicals that remove inorganic foulants from the surface of the MF/UF membranes. Citric acid would be stored in a dedicated tote, and citric acid solution would be fed into the CIP supply to MF/UF membranes. This system would be located in the MF CIP containment structure. The design criteria for Citric Acid System are summarized in Table 6-20.

6.3.8.5 MF CIP Sodium Hydroxide System

Sodium hydroxide (caustic) is another cleaning chemical for the MF/UF system. Similar to citric acid, sodium hydroxide solution would be transferred from a tote using a transfer pump. This system would be located in the MF CIP containment structure. The design criteria for the MF Sodium Hydroxide System are summarized in Table 6-21.

Table 6-17: Sodium Hypochlorite Feed System Design Criteria (for MF/UF Feed)

Parameter	Value
Sodium Hypochlorite	
Delivery Form	12.5% concentration, SG = 1.20
Dose, mg/L of chlorine	5-8
Process Flow Range, gpm	500-7,300
Required Metering Range, gph of 12.5% sodium hypochlorite	0.70-24
Monthly Use, gallons of 12.5% sodium hypochlorite	5,800 (based on 2015 annual average recycled water demand)
Sodium Hypochlorite Storage	
Quantity	Two
Type	Vertical, cylindrical
Material	FRP
Useable Capacity each tank, gallons	5,700
Sodium Hypochlorite Feed Pump	
Quantity	Two (1 duty, 1 standby)
Manufacturer	Milton Roy, Pulsafeeder, or approved equal
Type	Diaphragm
Material	PVC
Capacity, gph	30

Table 6-18: Sodium Hypochlorite System Design Criteria (for MF/UF CIP and MW)

Parameter	Value
Sodium Hypochlorite	
Delivery Form	12.5% concentration, SG =1.2
CIP Dose, mg/L of chlorine	2,000 (Pall) 600 (Siemens)
Maintenance Wash Dose, mg/L of chlorine	500 (Pall) 100 (Siemens)
Total Monthly Use, gallons of 12.5% sodium hypochlorite	320 (Pall) 62 (Siemens)
Sodium Hypochlorite CIP Transfer Pump	
Quantity	Two (1 duty, 1 standby)
Manufacturer	Milton Roy, Pulsafeeder, or approved equal
Type	Diaphragm
Capacity, gpm	12 (Pall) 4 (Siemens)
Material	PVC head; PTFE diaphragm
Rated Head, feet	TBD
Size, hp	TBD

Table 6-19: Aqua Ammonia Feed System Design Criteria

Parameter	Value
Aqua Ammonia	
Delivery Form	19.0% concentration, SG = 0.926
Dose Ratio	0.25 Ammonia: Chlorine (1.25 – 2.0 mg/L)
Process Flow Range, gpm	500-7,300
Required Metering Range, gph of 19% aqua ammonia	0.20-5.00
Monthly Use, gallons of 19% aqua ammonia	1,600 (based on 2015 annual average)
Aqua Ammonia Storage	
Quantity	Two
Type	Horizontal cylindrical
Material	Carbon steel
Useable Capacity each tank, gallons	2,300

Aqua Ammonia Feed Pump	
Quantity	Two (1 duty, 1 standby)
Manufacturers	Milton Roy, Pulsafeeder, or approved equal
Type	Diaphragm
Material	Stainless steel
Capacity, gph	5

6.3.8.6 Product Water Sodium Hydroxide System

The low levels of hardness and alkalinity in the RO permeate would not be entirely offset when blended with the SJ/SC WPCP tertiary effluent. Therefore, even with the decarbonation of the RO permeate, the blended ARWTF product water and SJ/SC WPCP tertiary effluent would be corrosive. To limit the potential of corrosion in the recycled water distribution pipeline, sodium hydroxide should be added to the final ARWTF product water to increase its pH to 8.1. Due to the quantities of ARWTF product water involved, it would be most economical to accept liquid sodium hydroxide deliveries as a 50 percent solution. For storage, however, dilution of the bulk deliveries to a 25 percent solution by weight to limit the crystallization and freezing of the solution at moderately low temperatures (55^{0} F) and to avoid the need for heat tracing and insulation of storage tanks and piping is recommended.

Storage tanks for sodium hydroxide would be sized to provide 30-days projected supply at the 9.0 mgd system production requirement. Tank sizing in this case would also accommodate the need to dilute up to 6,000 gallon deliveries of 50 percent solution while maintaining a useable supply in the tank. Metering pumps would be sized to support the 9.0 mgd system production requirement.

In order to centralize the Phase I and Phase II chemical systems, space would be reserved adjacent to this facility for the Phase II sodium hydroxide containment structure. Design criteria for the Sodium Hydroxide Feed System are provided in Table 6-22.

Table 6-20: Citric Acid System Design Criteria (for MF/UF CIP)

Parameter	Value
Citric Acid	
Delivery Form	35-50% concentration, SG = 1.24-1.50
Feed Concentration	2% Solution
Monthly Use, gallons of 50% citric acid	345 (Pall) 172 (Siemens)
Citric Acid Tote	
Quantity	One (Pall) One (Siemens)
Manufacturers	Clawson Container Co., Hawman, or approved equal
Material	Stainless steel storage tote
Capacity, gallons	200 to 400 gallons per tote
Citric Acid Transfer Pump – From Citric Acid Tote to Acid Tank	
Quantity	2 (1 duty, 1 standby)
Manufacturers	LMI, Pulsafeeder, or approved equal
Type	Diaphragm
Capacity, gpm	35 (Pall) 18 (Siemens)
Material	PVC Head; PTFE diaphragm
Rated Head, feet	TBD
Size, hp	TBD

6.3.8.7 Sulfuric Acid Feed System

Sulfuric acid would be added in the feed stream to the RO process (downstream of the RO Transfer Pumps and upstream of the Cartridge Filters) to maintain the desired pH of RO feed water to around 7.0 to minimize scaling of the RO membranes. Scaling occurs when sparingly soluble salts in the feed stream are rejected by the RO membranes and concentrated beyond their solubility limit. To minimize membrane scaling, the pH of the feed stream should be adjusted to be lower than the saturation pH for calcium carbonate ($CaCO_3$), as indicated by the Langelier Saturation Index (LSI). Based on SJ/SC WPCP water quality data available at this point (extracted from the Pilot Study Report), total hardness of the RO feed water is estimated to be 278 mg/L as $CaCO_3$ and the LSI is -0.17 at feed water pH of 7.3, which is slightly under-saturated. The design criteria for the Sulfuric Acid Feed System are summarized in Table 6-23. Storage tank sizing is based on 30 days supply at the 9.0 mgd system production requirement. Metering pumps would be sized to support the 9.0 mgd system production requirement.

In order to centralize the Phase I and Phase II chemical systems, space would be reserved adjacent to this facility for Phase II sulfuric acid containment structure.

In addition to RO process pH control, sulfuric acid may be used by the Siemen's CIP system as an alternative to citric acid. The current design includes citric acid, although sulfuric acid may be used as an alternative.

Table 6-21: Sodium Hydroxide System Design Criteria (for MF/UF CIP)

Parameter	Value
Sodium Hydroxide (caustic)	
Delivery Form	25% concentration, SG=1.27
Feed Concentration	1% solution
Monthly Use, gallons of 25% Sodium Hydroxide	235 (Pall) 348 (Siemens)
Caustic Tote	
Quantity	One (Pall) One (Siemens)
Manufacturer	Clawson Container Co., Hawman, or approved equal
Type	Stainless steel tote
Capacity, gallons	400 gallons
Caustic Transfer Pump – from Tote to CIP Caustic Tank	
Number	Two (1 installed, 1 standby)
Manufacturer	Milton Roy, Pulsafeeder, or approved equal
Type	Mechanical diaphragm
Capacity, gpm	24 (Pall) 35 (Siemens)
Material	Stainless steel head; PTFE diaphragm
Rated Head, feet	TBD
Size, hp	TBD

Table 6-22: Product Water Sodium Hydroxide Feed System Design Criteria

Parameter	Value
Sodium Hydroxide	
Delivery Form	Liquid, 50 percent
Metering Form	Liquid, 25 percent
Dose, mg/L of 100% NaOH	12 - 15
Required metering range, gph of 25% NaOH	4.68 – 49.0
Process Flow Range	2,080 – 17,400 gpm
Sodium Hydroxide Storage	
Quantity	Two
Manufacturer	DEI Systems, Daniel Mechanical
Type	Vertical cylindrical
Material	Steel (unlined)
Capacity, gallons per tank	9,100
Sodium Hydroxide Pumps	
Quantity	Two (1 duty, 1 standby)
Manufacturer	Milton Roy, Pulsafeeder
Type	Diaphragm
Material	Stainless steel
Capacity, each	49.0 gph

Table 6-23: Sulfuric Acid Feed System Design Criteria

Parameter	Value
Sulfuric Acid	
Delivery Form	93% concentration, SG = 1.83
Dose, mg/L of 100% sulfuric acid	16
Process Flow Range, gpm	1,630 – 9,800
Sulfuric Acid Storage	
Quantity	One
Type	Horizontal cylindrical
Material	Carbon steel, lined
Useable Capacity, gallons	2,290
Sulfuric Acid Pump	
Quantity	Two (1 duty, 1 standby)
Manufacturers	Milton Roy, Pulsafeeder, or approved equal
Type	Hydraulic diaphragm
Material	Alloy 20
Capacity, gph	6.9

6.3.8.8 Threshold Inhibitor Feed System

Threshold inhibitor (antiscalant) addition would be provided in the RO feed water to minimize/prevent inorganic scaling on the membrane surface. The inhibitor would be added downstream of the RO Transfer Pumps and upstream of the Cartridge Filters to increase the solubility limit (or saturation concentration) of sparing soluble salts in the concentrate stream to prevent precipitation of salt crystals, allowing for a higher recovery within the RO process. The design criteria for the Threshold Inhibitor System are summarized in Table 6-24. The storage tank is sized to provide for 30 days of supply at the 9.0 mgd system production requirement. Metering pumps would be sized to support the 9.0 mgd system production requirement.

In order to centralize the Phase I and Phase II chemical systems, space would be reserved adjacent to this facility for the Phase II threshold inhibitor containment structure.

6.3.9 UV System

An enclosed UV System would provide the disinfection needed to meet California DPH disinfection requirements for recycled water. Both the Aquionics (medium pressure system) and ITT Wedeco (low pressure-high output system) systems were considered for this Project. ITT Wedeco has since been named the preselected UV manufacturer for the Project. The UV System would be located in the Process Structure, downstream of RO and would treat the RO permeate as well as the filtrate from the MF/UF System during the winter months. The RO permeate treated by the UV System would be sent to the Product Water Storage Tank, while the filtrate from the MF/UF System treated by the UV System would be sent directly to the TPS.

A small ten (10) to twenty (20) gpm side-stream advanced oxidation process (AOP), consisting of UV/Hydrogen Peroxide would also be provided. The purpose of the side-stream AOP system is to operate as a separate demonstration study for emerging contaminant reduction. This demonstration system would be located in the Process Structure with the UV System.

Table 6-24: Threshold Inhibitor (Antiscalant) Feed System Design Criteria

Parameter	Value
Threshold Inhibitor	
Delivery Form	Liquid, 100 percent
Dose, mg/L of 100% threshold inhibitor	2-5
Process Flow Range, gpm	1,630 – 9,800
Threshold Inhibitor Storage	
Quantity	One
Manufacturers	DEI Systems, Daniel Mechanical, or approved equal
Type	Vertical cylindrical
Material	FRP
Useable Capacity, gallons	1,320
Mixer	Top mount
Materials	Type 316 stainless steel
Threshold Inhibitor Feed Pump	
Quantity	Two (1 duty, 1 standby)
Manufacturers	Milton Roy, Pulsafeeder, or approved equal
Type	Diaphragm
Material	Stainless steel
Capacity, gph	2.1

The UV System must be designed under the worst-case operating conditions (e.g., flow rate, water quality), which is represented by the filtrate from the MF/UF system. The MF/UF system does remove particles, but viruses remain the pathogen of concern. Therefore, a UV dose of 80 mJ/cm^2 is required by NWRI guidelines. The design transmittance of the UV System would be based on 65 percent, the recommended value by NWRI and at this time. The design criteria for the UV System are summarized in Table 6-25.

Table 6-25: UV Equipment Design Criteria

Criteria	Value
Design Flow, mgd	10
Minimum flow rate, mgd	1.75
Average flow rate, mgd	9.0
Design UV transmittance, %	65
Design dose, mJ/cm^2	80
Minimum number of reactors per treatment train	2
Maximum headloss through train, in. W.C.	40
Approved by California DPH as meeting Title 22 Recycled Water Requirements	Yes

Table 6-26 summarizes the design information provided by Aquionics and ITT Wedeco in December 2009.

Table 6-26: Aquionics and ITT Wedeco UV Equipment Design Criteria

Criteria	Value
Aquionics	
Number of treatment trains	Four (3 duty, 1 standby)
Number of reactors per train	Two
Reactor capacity, mgd	3.0
Maximum headloss through reactor, inches	<24
Approved by California DPH as meeting Title 22 Recycled Water Requirements	Yes
Maximum distance from UV reactor to power module	300 feet
Lamp type	Medium pressure
Number of lamps per reactor	12
Lamp Wattage, W	5000
ITT Wedeco	
Number of treatment trains	Six (5 duty, 1 standby)
Number of reactors per train	2
Reactor capacity, mgd	1.0
Maximum headloss through reactor, inches	24
Approved by California DPH as meeting Title 22 Recycled Water Requirements	Yes
Maximum distance from UV reactor to power module	70 feet
Lamp type	Low Pressure – High Output
Number of lamps per reactor	40
Lamp Wattage, W	300

Reliability design is an important consideration because system component failure can be expected with any treatment process. California regulations require one of the following strategies to ensure properly treated water:

1. 24-hour storage if standby equipment replacement is available onsite.
2. Appropriate long-term alternate storage (e.g., 20 days) or disposal provisions.
3. Other reliability mechanisms (i.e., providing a redundant treatment train or sending the untreated water to waste), if approved by the appropriate regulatory agencies.

The UV System will be provided with a redundant treatment train.

Each UV reactor would include the following components:

- Stainless steel UV reactor with lifting hooks
- UV lamps with quartz sleeves
- Transformers or ballasts
- UV intensity monitors
- Cleaning system for quartz sleeves, either automatic or manual
- Pressure gages on the reactor inlet and outlet for measuring headloss
- Air release valve
- Drain connection
- A cooling water connection (for equipment requiring cooling water flow during startup) with solenoid valve for draining the water through the UV reactor. Pumps would be provided to return the cooling water to the header upstream of the UV units so it would not need to be wasted onsite
- Power distribution center and system control center with a step-down transformer for low-voltage (less than 480 volts) equipment

For the Aquionics UV reactor, only one UV intensity monitor is provided per reactor train. In this arrangement, it is assumed that all lamps age the same. However, each lamp is tied to a current sensor that alarms if the current drops out or the lamp fails. The number of UV intensity monitors provided per reactor or treatment train will vary with the UV manufacturer.

6.3.10 Product Water Storage Tank

A 2.25 MG Product Water Storage Tank would be provided to store UV disinfected RO permeate. The Product Water Storage Tank would be used to equalize daily diurnal recycled water demands and would be sized to meet maximum week SBWR recycled water demand conditions. The design criteria for the Product Water Storage Tank are summarized in Table 6-27. A coated carbon steel tank has been proposed for the ARWTF. Depending on the coating frequency, a stainless steel tank may prove to have a lower present worth cost. This will be investigated and discussed with the District during the final design phase.

Table 6-27: Product Water Storage Tank Design Criteria

Parameter	Value
Quantity	One
Description/Operating Parameters	
Tank Type	Welded carbon steel, vertical, cylindrical, above grade
Reference Standards	AWWA D100/D102
Total Tank Sidewall Height, feet	38
Tank Diameter, feet	110
Storage Duration, hrs	Six
Useable Storage Capacity, gallons	2.25 MG
Design Requirements	
Seismic Design	Refer to Section 6.5, Structural Design
Tank Anchorage	Tank anchored to reinforced concrete foundation
Tank Design	To be prepared by manufacturer and stamped by Registered California P.E.
Appurtenances	
Field Welds	Field welds to be randomly spot tested by radiography
Interior Coating	NSF approved epoxy enamel; e.g. Carboline Carboguard 891 or equal
Exterior Coating	Suitable epoxy enamel coating system; e.g. Carboline Carboguard 890/133VOC or equal. The exterior coating shall be suitable to protect against UV rays.

6.3.11 Waste Stream Management

6.3.11.1 Waste Equalization

A Waste Equalization Wetwell would be provided to equalize selected waste streams generated at the ARWTF prior to disposal. Careful coordination with the geotechnical engineer is required when selecting the depth of the wetwell. Anticipated waste streams that would be sent to the Waste Equalization Wetwell are:

- Automatic Strainer backwash
- MF/UF CIP and reverse filtration (RF) wastes
- RO CIP and system shut-down flush wastes
- Stormwater flows

MF/UF reverse filtration waste would be the primary flow component sent to the Waste Equalization Wetwell. The combined waste from the Waste Equalization Wetwell would be transferred to the SJ/SC WPCP Emergency Basin Overflow Structure (EBOS) prior to being conveyed to the headworks. The Waste Equalization Wetwell sizing is based on equalizing projected waste flows, primarily from the MF/UF reverse filtration sequence, to maintain an average continuous discharge rate of 620 gpm. The continuous discharge rate of 620 gpm was estimated using the largest reverse filtration waste generated from the MF/UF systems being considered for the ARWTF Project (15 minute cycle time and approximately 1,900 gallons per reverse filtration per unit).

Separate pumps will be dedicated for stormwater flows. These pumps will be designed to handle a 100-year flood event, and will only operate during heavy rain events.

The design criteria for the Waste Equalization System are summarized in Table 6-28.

Table 6-28: Waste Equalization System Design Criteria

Parameter	Value
Waste Equalization Wetwell	
Quantity	One
Type	Below grade, wetwell
Material	Concrete
Total Wetwell Height, feet	TBD
Wetwell Length, feet	TBD
Wetwell Width, feet	TBD
RF Storage Duration, minutes	90
Stormwater Storage Duration, minutes	30
Storage Capacity (Useable), gallons	85,000
Waste Equalization Pumps	
Quantity	Two (1 duty, 1 standby)
Type	Vertical Turbine
Capacity, gpm	700 gpm
Rated Head, feet	TBD
Drive	VFD
Power, hp	TBD

6.3.11.2 RO Concentrate Disposal

The RO concentrate (reject) stream would be sent upstream of the Chlorine Contact Tanks No. 1-2 at SJ/SC WPCP, where it would be blended with the plant effluent for discharge to the Bay. A sampling station is to be installed for the collection of RO concentrate samples before being discharged to the CCTs.

An analysis to examine the likely impact of the RO concentrate stream on the final effluent quality from the SJ/SC WPCP was performed by Eisenberg, Olivieri and Associates, Inc. (EOA). The analysis used a mass balance model to determine pollutant concentrations in the RO concentrate stream and the combined final effluent discharge streams. Conventional pollutants (CBOD, TSS, and ammonia) and toxic pollutants that are regulated (or potentially regulated) under the SJ/SC WPCP's NPDES Permit were considered in the analysis. Results of the analysis indicate that the initial ARWTF

Project would not create any significant compliance issues to SJ/SC WPCP's NPDES permit. A detailed description of the analysis is provided in a Technical Memorandum (prepared by EOA), and included in Appendix B of this Report.

In addition, toxicity testing is being conducted from December 2009 to February 2010 with RO Concentrate created from a 250 gpd RO pilot unit. The results of this study will be available in March 2010. A copy of the RO pilot toxicity test workplan is provided in Appendix C of this Report.

6.3.11.3 Chemical Spill Disposal

Liquid chemical feed and storage areas would be provided with spill containment curbs or pits, for each chemical, which would drain to a dry sump within the containment area. If a chemical spill were to occur at the containment area, the contained liquid would be pumped from the containment area to a tanker truck by use of a portable pump for proper disposal.

6.3.12 Process Pipelines

Pipelines would be sized based on a design velocity of two to eight feet per second (fps) at design flows. The upper velocity range would occur during the summer (high flow period) and the lower velocity range would occur during the winter (low flow period). Preliminary design criteria and sizes of the major pipelines are summarized in Table 6-29. The flows indicated in Table 6-29 are for the future ARWTF capacity of 9mgd. The design criteria and sizing would be refined during the final design phase of the Project. A figure showing major off-site pipelines is presented in Appendix D of this report.

6.3.12.1 Pipe Materials, Joints, and Fittings

Steel pipe would be in accordance with AWWA M11 and C200 standards. All steel pipe joints would be a bell and spigot lap with a full fillet weld made along the outside surface. Where required for added restraint, such as areas susceptible to liquefaction and settlement or required to restrain thrust, an inner fillet weld is recommended, thus creating a double welded lap joint. Butt strap joints would be permitted for field closure joints only. Field welding would be performed in accordance with AWWA C206. All welds would be visually inspected, and approximately one-third of the welds would be tested using a non-destructive test method.

Table 6-29. ARWTF Major Pipelines

ARWTF Pipeline	Initial Phase I Design Flows (mgd)	Future Phase I Design Flows (mgd)	Size (inches)	Segment	Pipeline Length (LF)
Secondary Effluent (Influent)[1]	10.5	11.7	36	Nitrified secondary effluent at SJ/SC WPCP to ARWTF Influent Pump Station	1,300
MF/UF Feed	10.5	11.7	24	Influent Pump Station to MF/UF system	~300
RO Feed	9.5	10.5	20	RO Transfer Pumps to RO System	~300
RO Concentrate	1.5	1.5	12	ARWTF RO System to CCT Nos. 1-2 at SJ/SC WPCP	4,900
Plant Waste[1]	2.6	2.7	16	ARWTF Waste EQ Wetwell to the EBOS at SJ/SC WPCP	3,000

[1] The ARWTF Secondary Effluent (Influent) and ARWTF Plant Waste pipelines would be sized for Phase I and Phase II of the ARWTF. The flows indicated are for Phase I only.

Insulating joints would be used to electrically isolate the steel pipeline from: 1) other metallic pipelines; 2) interconnections between pipe sections of dissimilar materials; 3) structures such as a pump station or tank.

All steel pipes would have fabricated steel fittings conforming to AWWA C208. The thickness would be based on internal pressure with an allowable stress not to exceed 50 percent of the yield strength. Flanges would be used for connections at pumps, valves, or other appurtenances.

Ductile iron pipe would conform to the requirements of ANSI/AWWA C151/A21.51. Rubber-gasket joints, both mechanical and push-on type, would conform to the requirements of ANSI/AWWA C111/A21.11 and would have the same pressure rating as the pipe or fittings of which they are a part. Flanged joints for ductile iron pipe would conform to the requirements of ANSI/AWWA C115/A21.15. The minimum class thickness for pipe barrels with threaded flanges is Class 53 for all pipe sizes. Fittings for ductile iron pipe would conform to ANSI/AWWA C110 and ANSI/AWWA C153/A21.3.

PVC sewer pipe would conform to the requirements of ASTM D3034, SDR 35, Cell Classification 12454. PVC pressure pipe would conform to the requirements of ANSI/AWWA C900 with cast iron pipe outside diameter or SDR 14 as required by the

City. Fittings for PVC pressure pipe would be cast iron conforming to ANSI/AWWA C110/A21.10.

PVC chemical piping would be schedule 80 in accordance with ASTM D1785. CPVC chemical piping would be Schedule 80 in accordance with ASTM F441.

Stainless steel piping would be Type 316 conforming to ASTM A403. Fittings would be butt weld type, in accordance with ASTM A403. Welding would be gas-tungsten-arc weld type (GTAW). Pipe would be Schedule 10, except in areas where grooved pipe couplings are required, in which case Schedule 40 nipples would be provided.

Fiberglass reinforced plastic (FRP) piping would have a design internal pressure rating of 150 psi as specified in ASTM D2310. Buried pipe and fittings shall be designed in accordance with AWWA Manual M45 to withstand the simultaneous application of the external loading and internal pressure. Pipe design must be based on long term hydrostatic strength as determined by ASTM D 2992. Pipe would conform to ASTM D2310, Type 1 standard for Machine-Made Reinforced Thermosetting Resin Pipe and include an interior liner at least 0.110 mils thick. Fittings would conform to Commercial Standard PS15-69. Bends would be long-radius (1-1/2 times pipe diameter), formed over a removable mold. Filament wound fittings would be of the same thickness specified for adjoining pipe. Hand lay-up fittings would be of the minimum pipe wall thickness specified in PS15-69 for the applicable pressure class.

6.3.12.2 Steel Pipe Design

The pipeline design would be performed in accordance with AWWA criteria and supplemented by project-specific pipeline criteria.

Steel plate would be continuously cast, fully kilned, fine grain steel conforming to ASTM A36 or ASTM A1011, Grades 33 or 36. To maintain superior ductility, grades higher than 36 would not be permitted.

Pipe wall thickness would be designed to resist the maximum value determined from the following specified criteria:

- Internal pressure
- External pressure/vacuum
- Handling
- External loads/deflection
- Minimum thickness of 3/16 inch

Design of the pipe for external loading would consider the depth of earth cover, live loads, and construction loads. If the pipe were below the groundwater table, buckling and flotation of pipe would be reviewed.

Live load impacts would depend on local traffic conditions, type of construction loads, and depth of cover over the pipe. Concentrated live loads are generally caused by truckwheel loads. Distributed live loads are caused by surcharges such as piles of material and temporary structures. Live load impacts, which are added to dead load when applicable, are generally based on American Association of State Highway and Transportation Officials (AASHTO) HS-20 truck loads. There would be no live load effect for HS-20 loads when the earth cover exceeds 8 feet. Minimum pipe wall thickness is an important consideration in protection against collapse or buckling due to internal vacuum. Pipe wall thickness has only a small effect on the earth load carrying capability of buried pipe and some effect on long-term corrosion resistance. Therefore, the minimum wall thickness would be based on protection against collapse due to internal vacuum and on adequate stiffness for proper handling.

6.3.12.3 Ductile Iron Pipe Design

Ductile iron pipe is designed as a flexible pipe and for unlimited trench width for all pipe sizes. Earth load computations are based on the weight of the solid prism above the pipe. It is assumed the pipe would be installed in proper embedment and that, due to pipe flexibility, the plane of equal settlement would occur at the top of the pipe (transition case, zero shear at the sides of the soil prism). A detailed analysis would be performed, when necessary, when the pipe was supported on bents, brackets, or any unyielding foundation where the adjacent soil could settle more than the solid prism above the pipe.

Working (or operating) pressures for the design of the ductile iron pipe would be the maximum sustained internal pressure in the pipe. Total pressure would be the working (or operating) pressure plus an allowance for surge pressure. The test pressure for ductile iron pipe design would be specified as a minimum of 150 psi or 1.5 times the working pressure, whichever is higher.

6.3.12.4 Linings, Coatings, and Corrosion Protection

All buried steel and ductile iron pipe would be lined and coated for internal and external corrosion protection. Pipe lining for either steel or ductile iron pipe would be shop-applied cement mortar per AWWA C205, with joint repair provided in the field per AWWA C205. The pipe coating and embedment system for steel pipe should be 80 mils thick dielectric tape system in accordance with AWWA C214 and aggregate base with rounded particles embedment.

A cathodic protection system would also be evaluated. A galvanic anode type system would be considered for the various portions of the pipeline. A recommendation for the type and location of cathodic protection system would be made during detailed design.

PVC piping above grade would be painted for UV light resistance. FRP piping would be manufactured with a UV light inhibitor and painted as well. Welds in stainless steel piping would be pickled and passivated. Portions of the stainless steel piping assemblies may be electropolished or bead blasted for additional surface corrosion resistance.

6.3.12.5 Valves

Butterfly Valves. Selection of the pressure class rating of the valves would be based on the maximum combined pressure considering pump shutoff head, maximum hydraulic grade line, static head, and surge pressure.

High pressure pump discharge valves (RO feed pumps) or high cycling valves would be High Performance type 316 stainless steel butterfly valves conforming to ANSI, Class 300 service.

AWWA C504 butterfly valves would be provided for isolation at pump suctions and discharges and to isolate processes. Isolation valves would be manually operated by a handwheel, with the exception of process isolation valves for the MF and RO Systems. Butterfly valves would be lined with fusion-bonded epoxy and epoxy coated. Pneumatically operated butterfly valves would be provided for select valves within the MF/UF system. These valves would be provided with pneumatic cylinder actuators. Process isolation valves in the MF and RO Systems would be resilient seated valves with EPDM liners and stainless steel discs.

Gate Valves. Gate valves would meet the requirements of ANSI Class 300 when required to meet system pressure requirements. Resilient gate valves for drainage piping would be in accordance to AWWA C509. All valves that have direct buried installations would be manually actuated via buried valve actuators equipped with a standard AWWA 2-inch wrench nut.

Check Valves. Check valves would be provided on the discharge of pumps and would be sized to meet the capacity of the pump. Check valves in contact with acidified feedwater upstream of the RO System or plant finished water would be of stainless steel construction.

Automatic Valve Actuators. All automatic valve actuators would be pneumatic cylinder actuators manufactured by Hanna, Dezurik or Pratt.

6.4 Architectural Design

6.4.1 General

This section presents the architectural design criteria for the ARWTF Project. The architectural design would conform to the current editions of applicable architectural standards and codes.

6.4.2 Applicable Codes, Standards, and References

The architectural design would conform to the current editions of the applicable standards and codes. These codes are listed in Table 6-30 with their application and impact to the Project. The Process Structure would be covered by the California Building Code (CBC), 2007 Edition.

Table 6-30: Applicable Architectural Codes and Standards

Code / Standard	Application and Project Impact
California Building Code, 2007 Edition	Applies to Process Structure.
Americans with Disabilities Act	The Process Structure would be covered by the Americans with Disabilities Act (ADA) which is enforced by the courts. Because this facility would not be open to the public, the facility would not generally be designed for Accessibility. However, door widths and thresholds would be designed to the Accessibility standards of CBC.

6.4.3 Process Structure

The Process Structure would be a pre-engineered metal building approximately 150 feet wide by 235 feet long in plan dimensions. The height of the Process Structure would be determined during final design.

The Process Structure would house the major MF/UF, RO, and UV equipment. A separate electrical/control room would be provided to house the electrical equipment including panels, and MCCs, and control panel and workstation. A separate equipment/maintenance repair room would be provided. Restroom and shower facilities, similar to those installed at the TPS, would also be provided. The electrical and control room would be air conditioned and the remaining areas of the building would be ventilated.

6.4.4 Construction Materials and Finishes

The MBS would be comprised of a steel structure which would support walls and roofs made of modular sheets of corrugated steel.

Walls and Roofs

The corrugated steel wall and roof panels are available in various proprietary standard patterns from MBS manufacturers. The panels would be factory pre-finished panels from the design manufacturer. Final selection of the panels would be from submittals during construction. Color selections would be made from manufacturer standards or, at SJ/SC WPCP request, a custom color. Most manufacturers offer several color selections, though custom colors could increase cost. Corrosion resistant finishes would be provided. The exterior wall adjacent to the roll-up door would be protected by bollards. Standard MBS translucent panels would be distributed on the roof to provide controlled natural light to the process area. Because the building would usually be unoccupied, windows would be limited.

Insulation

Where insulation is required, MBS manufacturers provide insulation blankets with a vapor barrier and vinyl cover sheet. They are attached to the steel frame prior to installing the exterior metal wall and roof panels. These blankets are normally left exposed on the interior side of the building. For this reason, the insulation blankets below eight feet above the floor would be specified heavy duty to resist the abuses of long use.

Doors and Windows

Doors and windows, typically aluminum, would be selected from the MBS manufacturer's standards. Roll-down doors are typically made of interlocking steel ribs.

6.5 Structural Design

6.5.1 General

This section presents the structural design criteria for the ARWTF Project. The intent of this section is to define the design loads of the building to ensure all components of the Project would meet structural code requirements (code level forces) for life safety.

6.5.2 Applicable Codes, Standards, and References

The design codes, standards, and references in Table 6-31 are applicable for the design of structures for the Project.

Table 6-31: Applicable Structural Codes and Standards

Code / Standard	Application and Project Impact
California Building Code (CBC), 2007 Edition.	Specifies minimum structural design loads and design requirements for new facilities constructed in California. This code refers to International Building Code (IBC) 2006 for many criteria, which contains more specific details.
American Society of Civil Engineers (ASCE) Standard No. 7-05, "Minimum Design Loads for Buildings and Other Structures."	Specifies minimum structural design loads and design requirements for new facilities constructed in the U.S.
ACI 318-06 "Building Code Requirements for Reinforced Concrete."	Specifies generic minimum design criteria for reinforced concrete structures.
ACI 350 "Code Requirements for Environmental Engineering Concrete Structures."	Contains minimum design criteria for environmental and liquid retaining concrete structures to provide concrete crack and leakage control measures.
ACI 302.1R-04, "Guide for Concrete Floor and Slab Construction."	Provides specific guidelines for design of new reinforced concrete slabs on grade with considerations such as seepage, expansion and contraction, subgrade requirements and water tightness included.
American Institute of Steel Construction Manual of Steel Construction, 13th Edition.	Specifies minimum structural design criteria for structural steel buildings.
ASTM Standards.	Specifies minimum strength and ductility criteria for materials used for structural design. Typical materials included are structural steel shapes and plates and steel bolts.
American Welding Society Standards.	Provides guidelines for design and construction of structural steel welding.

6.5.3 Project Facilities Description

The new structures for the ARWTF Project would include the following facilities:

- A pre-engineering metal building (Process Structure)
- Two large welded steel tanks (Inter-Process and Product Water Storage tanks)
- Waste Equalization Wetwell
- Several concrete containment areas, with overhead canopies, for chemical feed facilities
- Pad mounted Influent Pump Station, and Automatic Strainers
- Pad mounted RO Transfer Pumps and Cartridge Filters
- Pad mounted Decarbonation Towers and Product Water Transfer Pumps
- Can-type RO High Pressure Feed Pumps
- Pad mounted electrical equipment
- Other miscellaneous yard structures

6.5.4 Geotechnical Criteria

B&V's subconsultant, URS has performed a geotechnical investigation of the ARWTF site and had prepared a final geotechnical report that summarizes the results of the investigation. Findings and recommendations from the geotechnical investigation would form the basis for the structural design criteria of the ARWTF Project structures.

Sidewalls of chemical containment areas and structures below grade would be designed to resist the lateral earth pressures determined based on the soil analysis.

The structural design of Process Structure foundation would comply with the applicable structural codes and soil bearing capacity and backfill criteria specified in the final geotechnical report. Subgrade preparation, backfill requirements, and soil drainage provisions would be specified consistent with the recommendations of the geotechnical investigation report.

6.5.4.1 Seismic Design

The major active seismic fault that lies closest to the ARWTF site would be identified in the geotechnical investigation. The peak ground acceleration for rock at the site and the probability of exceedance would also be estimated in the geotechnical investigation.

6.5.4.2 Foundation Design

It is anticipated that foundations for lightly loaded structures including the Process Structure, chemical containment structures, and pump stations would be conventional spread footings with slab on grade construction. The Product Water Storage Tank, Inter-Process Storage Tank and Waste Equalization Wetwell would be founded on pre-stressed concrete piles.

Additional factors for consideration in the foundation design would include: (1) determination of any limiting absolute or relative maximum allowable foundation settlements to ensure safe operation of the entire facility and (2) identification of the location of existing buried underground concrete structures and utilities, especially where new piles would be constructed.

The types of foundations that would be considered for design include the following:

- Concrete mat foundation for majority of ARWTF structures
- Concrete pile and grade beam foundation as needed for the Product Water Storage Tank and Inter-Process Storage Tank.

Concrete Mat Foundations. New concrete mat foundations would be designed based on the expected design loadings for the various facilities and the recommended soil bearing allowable pressure determined by the geotechnical investigation.

New Concrete Piles. The large Product Water Storage Tank and Inter-Process Storage Tank would require a new concrete pile and grade beam design. Minimum below grade depth of the new concrete piles would be determined during final design.

6.5.5 Design Loads

The following loads would be used for design of structures for this Project.

6.5.5.1 Load Definitions

D	Dead Load (material weights and fixed equipment)
E	Earthquake (seismic) Load
E_m	Estimated Maximum Earthquake Force (ASCE 7-05 Section 12.43)
f_1	Coefficient defined in 2007 CBC Section 1605.2.1
F	Fluid Loads
H	Lateral Pressure of Soil and Water in Soil Loads
L	Live Load (except roof live load)
L_r	Roof Live Load
W	Wind Load

Note that snow (S), ponding (P), and thermal (T) induced loads are not applicable to the Project based on the site location and inherent design characteristics of structures that would prevent ponding and thermal loads.

6.5.5.2 Design Loads

The design loads for dead (D), live (L), fluid (F), wind (W), and earthquake/seismic (E) loads are included as Table 6-32.

6.5.5.3 Load Combinations

The load combinations used for reinforced concrete, steel, and masonry structural design are included as Table 6-33.

6.5.6 Material Properties

The types of materials considered for structural design are indicated in Table 6-34.

6.5.7 Acceptance Criteria

The acceptance criteria for ensuring that structural designs meet the CBC and IBC design requirements are summarized in Table 6-36.

Table 6-32: Design Loads

Design Load	Value
Dead Loads (D)	
Structure Weight	
Concrete	150 pound per cubic feet (pcf)
Steel	490 pcf
Aluminum	165 pcf
Interior Stud Walls or Permanent Partition Walls	10 pounds per square feet (psf) (wall surface area)
Equipment	Actual weight per vendor
Live Loads (L)	
Roof	20 psf minimum (no reduction allowed)
Stairs	100 psf minimum
Access Platforms and Walkways	100 psf minimum
Storage	250 psf (heavy storage)
	150 psf (light storage) minimum
Slab on Grade	150 psf minimum
Traffic Area	HS20-44 Vehicle Load
Fluid Loads (F)	
Hydrostatic Loads	water density = 62.4 pcf
Buoyancy Uplift	ground water table at 8 feet[1] below finished grade
Wind Loads (W)	
Basic Wind Speed	85 miles per hour (mph)
Exposure	C
Importance Factor I_w	1.15
Wind Loads Factor	ASCE 7-05 Section 6.5.11
Earthquake (Seismic) Loads (E)	
Seismic Coefficients	
Building Classification	IBC Table 1604.5
Site Class	Sd
Site Coefficient (F_a)	1.0
Site Coefficient (F_v)	1.5
Site Coefficients SMs and SDs	SMs = 1.5 and SDs = 1.0
Site Coefficients SM1 and SD1	SM1 = 0.9 and SD1 = 0.6
Importance Factors	
Structures	I = 1.25
Equipment	I_p = 1.5
Response Modification Coefficient (R)	
Structures	ASCE 7-05 Table 12.2-1
Equipment	ASCE 7-05 Table 15.4-2

[1] Ground water table elevation at Project site is approximately 5' below existing grade. After the site elevation is raised 3', the groundwater table will be 8' below the finished grade.

Table 6-33: Load Combinations

Loading Combination	Reference
Reinforced Concrete - Strength Design (SD) Method	
U = 1.4D + 1.7L + 1.4F	ACI 318, Appendix C
U = 1.4D + 1.7L + 1.7H + 1.4F	ACI 318, Appendix C
U = .9D + 1.7H + 1.4F	ACI 318, Appendix C
U = .75 (1.4D + 1.7L + 1.4F)+ 1.6W	ACI 318, Appendix C
U = .75 (1.4D + 1.7L + 1.4F)+ 1.0E	ACI 318, Appendix C
U = .9D ± 1.3W	ACI 318, Appendix C
U = 1.2D + 1.0E + f_1L	CBC Section 1605.2, EQN: 16-5
U = 0.9D + 1.6W +1.6H	CBC Section 1605.2, EQN: 16-6
U = 0.9D + 1.0E +1.6H	CBC Section 1605.2, EQN: 16-7
U = 1.2D + f_1 L + 1.0 E_m	CBC Section 1605.4, EQN: 16-22
U = .9D ± 1.0 E_m	CBC Section 1605.4, EQN: 16-23
Steel Design - Allowable Stress Design (ASD) Method	
D + L + F + H	CBC Section 1605.3, EQN: 16-9
D + L_r + F + H	CBC Section 1605.3, EQN: 16-10
D + 0.75L +0.75L_r+ F + H	CBC Section 1605.3, EQN: 16-11
D + 0.75L + 0.75L_r +0.75W + H + F	CBC Section 1605.3, EQN: 16-12
D + 0.75L + 0.75L_r +0.7E + H + F	CBC Section 1605.3, EQN: 16-13
1.2D + f_1 L + 1.0 E_m	CBC Section 1605.4, EQN: 16-22
.9D ± 1.0 E_m	CBC Section 1605.4, EQN: 16-23
Masonry Design – ASD Method	
The same loading combinations listed for steel also apply to masonry design.	

6.5.7.1 Design Methods

The Ultimate Stress Design (USD) method would be used for design of reinforced concrete structures including walls, slabs, beams, columns, and foundations. Concrete liquid containing structures must use a 1.3 durability factor in accordance with ACI 350. The ASD method would be used for the design of steel and masonry structures. The foundations for all structures would use the actual unfactored loads and the ASD method for sizing footings, piles, slab on grade, and concrete mat foundations.

6.5.7.2 Deflection Criteria

The maximum allowable deflection for elevated slabs and beams would be as follows:

Live Load (L) only	L/360
Total Load (D + L)	L/240
Metal Roof (L)	L/240
Metal Roof Deck (D + L)	L/180

Table 6-34: Material Properties

Material	Reference
Reinforced Concrete	
Compressive Strength, f'_C = 4,000 psi	
Reinforcing Steel	ASTM A615, Grade 60
Masonry	
Hollow Concrete Units	ASTM C90, Grade N, Type I ($f'm$ = 1,500 psi)
Mortar	ASTM C270, Type S, 2,000 psi @ 28 days
Grout	ASTM C476, 2,000 psi @ 28 days
Reinforcing Steel	ASTM A615, Grade 60
Structural Steel and Miscellaneous Metals	
Wide Flange (W) Members	ASTM A992 (f_y = 50 thousand pounds per square inch {ksi})
Structural Tubing	ASTM 501 (f_y = 46 ksi)
Steel Pipe	ASTM A53, Type E, Grade B (f_y = 35 ksi)
Shapes Other Then Those Above	ASTM A36 (f_y = 36 ksi)
Structural Steel Plate	ASTM A36 (f_y = 36 ksi)
Weld Electrodes	E70xx (f_u = 70 ksi)
Metal Bolts	ASTM A307 Minimum, unless noted otherwise
High Strength Bolts	ASTM A325
Aluminum Shapes and Plates	6061-T6

Table 6-35: Acceptance Criteria for Structural Designs

Criterion		Value
Maximum allowable soil pressure	Normal D, L, F, H loading for slab/mat foundation combinations	1,500 psf
	Wind or seismic loading combinations only	2,000 psf
Maximum pile allowable		Per Geotechnical Report
Minimum factor of safety for normal (D, L, F, H) loading against buoyancy uplift, sliding, and overturning		1.5
Loading combinations for earthquake (E) or wind (W)	Sliding	E - 1.1; W - 1.5
	Overturning	E - 1.0; W - 1.5
Sliding resistance: soil against concrete friction coefficient		0.35
No net uplift is allowed on any portion of the foundation.		
Ground water table is at 8' below finished site grade.		

6.5.7.3 Design Allowables

For concrete USD, the factored design loads would cause bending moment, shear and axial loads in members which must be less than or equal to the strength reduction factor (ϕ) times the member capabilities, as determined per Chapter 9.3 of ASCE 7-05.

For structural steel and masonry ASD, the resulting unfactored design loads would cause bending, shear and axial stresses in members which must be less than or equal to the allowables determined as per Chapters 21 (masonry) and 22 (steel) of 2007 CBC.

For loading combinations including wind (W) or earthquake (E) design loads, the allowable could be increased by 33 percent to account for the short-term duration of these loads as allowed in 2007 CBC.

6.5.7.4 Foundation Design Criteria

Foundation design would be acceptable provided it meets the entire acceptance criteria specified in Table 6-35.

6.5.7.5 Pipe and Equipment Supports

The design of small pipe and miscellaneous equipment supports would be performed by the Contractor in accordance with a performance design specification. The contract documents would indicate the general locations and nature of the supports to be designed by the Contractor, while design force requirements and criteria would be provided in the specifications. The design of all pipe supports for pipes larger than 12 inches is the responsibility of the engineer.

6.5.8 Special Inspection

Special inspections would be provided by Contractor and Construction Manager in accordance with CBC section 1701 for the following constructions:

- Cast-in-place concrete, except concrete with a compressive strength (f'_C) of less than 2,500 psi or site-work concrete.
- Placement of concrete reinforcing steel.
- Earthwork including excavations, backfill compaction and grading.
- Pile driving.
- Embedded plates with welded studs or anchor bolts. Anchors embedded in concrete would be designed to take advantage of the special inspection requirement.
- Shop and field welding of structural steel, reinforcing steel, metal deck, and headed concrete anchors.
- High-strength bolted connections.
- Where required by the respective International Code Council Evaluation Service (ICC-ES) evaluation report, special inspection would be required for mechanical couplers, expansion anchors, and adhesive anchors. Expansion anchor and adhesive anchors would be ICC-ES approved and would be designed based on ICC-ES allowable loads.
- Concrete masonry structures, with the assumption that full stresses were used in the design.

6.6 Building Mechanical Design

6.6.1 General

This section describes the basis of mechanical design associated with the plumbing, HVAC, and fire protection systems associated with the Prefabricated Metal Process Structure. The selection of the systems would be based on flexibility, operating efficiency, local support, and performance as well as site and specific requirements identified by the Project team.

General building mechanical design parameters are as follows:

- Storm drainage would be removed from the MF/RO/UV Process Structure through downspouts and gutters.
- General floor drainage would be provided in the process area of the Process Structure. Individual floor drains would be provided where appropriate.
- The process area, equipment maintenance/repair room and compressed air/blower room of the Process Structure would be served by an intermittent ventilation system.
- The electrical/control room of the Process Structure would be served by a packaged air conditioning system.
- Space heating would be provided by unit heater in the electrical/control room of the Process Structure.
- Protection of the potable water system would be in accordance with local codes.
- A fire sprinkler system for the Process Structure is required. The City Fire Department would allow the use of recycled water for fire suppression.

6.6.2 Applicable Codes, Standards, and References

Mechanical design would conform to the latest editions of the applicable standards and codes listed in Table 6-36.

The Process Structure and all equipment would be designed for compliance with the mechanical requirements of the latest version of California Code of Regulation, Title 24, Building Standards Code.

6.6.3 Design Criteria

The Building Mechanical design criteria are as indicated in Table 6-37.

6.6.4 Plumbing Design

The following subsections provide a description of the plumbing systems.

6.6.4.1 Storm Drainage Design

Storm drainage would be removed from the structure roof through gutters and downspouts discharging to grade. Stormwater flows would be collected and then conveyed to the Waste Equalization Wetwell. For additional information, refer to Section 6.3.11, Waste Stream Management, and Section 6.2.6, Site Stormwater Drainage.

Table 6-36: Applicable Building Mechanical Codes and Standards

Code / Standard	Application and Project Impact
NFPA Recommended Practices and Manuals.	• Mechanical equipment guidelines • Fire protection guidelines
ASHRAE Handbooks and Standards.	• Building load analysis procedures • Mechanical equipment efficiency guidelines • Ductwork distribution guidelines • Minimum outdoor air requirements
Part 5, California Plumbing Code, 2007 Edition, based on the Uniform Plumbing Code, 2006 Edition, with City of San Jose Amendments.	• Defines plumbing system design and installation requirements
Part 4, California Mechanical Code, 2007Edition, based on the Uniform Mechanical Code, 2006 Edition with City of San Jose Amendments.	• Defines mechanical equipment design and installation requirements
2008 California Title 24 - Building Energy Efficiency Standards.	• Defines energy efficiency standards for new building construction. • Defines weather data to be used in conjunction with the building load analysis
American Society of Plumbing Engineers Handbooks	• Plumbing drainage and water supply guidelines • Plumbing equipment selection guidelines
SMACNA Handbooks	• Ductwork design guidelines
Part 9, California Fire Code, 2007 Edition based on the International Fire Code, 2006 Edition with City of San Jose Amendments.	• Defines fire prevention system

Table 6-37: Building Mechanical Design Criteria

Criteria		Value
Site Elevation[1]	NGVD 29 (NAVD 88), feet	10.8 (13.5)
Site Location	North Latitude, degrees West Longitude, degrees	37.4 121.9
Ambient Design Temperatures [2]	Climate Zone Winter, median of extremes dry bulb, °F Summer, 0.50 percent design dry bulb/mean coincident wet bulb, °F	4 29 86/66
Climatic Data	Mean Daily Dry Bulb Temperature Range, °F	26
Rainfall Intensity [3]	Actual, inches/hour Design, inches/hour	1.5 3.0

[1] The existing site elevation is 7.8 feet, NGVD 29 (10.5 feet, NAVD 88). The entire site will be raised 3 feet to bring the site above the 100 yr flood elevation. For additional information, refer to Section 6.2.5, Site Grading.

[2] The winter and summer design temperatures are based on information from the Title 24 manual, Appendix C for the City of San Jose, located in Santa Clara County.

[3] The actual rainfall intensity rate is based on a 60 minute duration and 100 year return period.

6.6.4.2 Sanitary Drainage Design

General floor drainage would be provided in the process area of the Process Structure. Funnel receptors would be located adjacent to equipment with equipment drains where practical and would be located to serve multiple equipment drains. All floor drains, funnel receptors, and plumbing fixtures would be provided with traps and vents. The floor drains would be collected in a localized sump along with process drainage and analyzer waste flows from the MF, RO and UV Systems. These and other sanitary flows would be discharged to the existing sanitary sewer system.

Where individual vents cannot be provided for each trap due to physical constraints, a combination waste and vent system would be utilized. Indirect waste would drain to a funnel receptor or other approved device.

Outdoor liquid chemical feed and storage areas would be provided with spill containment curbs or pits, with separate pits for each chemical, which would drain to a dry sump within the containment area. A portable sump pump would be used to pump any liquid that accumulates in the containment area to a funnel receptor outside the containment area. If a chemical spill were to occur, the contained liquid would be pumped from the containment area to a tanker truck for proper disposal.

6.6.4.3 Potable and Non-Potable Water Systems

Protection of the potable water system would be in accordance with local codes. If potable water pressure exceeds 80 psig, a pressure reducing station would be required to reduce the water pressure.

An electric water heater with a thermostatic mixing valve would be provided to maintain the temperature of the potable water to be supplied to the emergency shower/eyewash fixtures in the range of 60°F to 90°F.

Hose faucets and wall hydrants would be provided in areas that would require periodic washdown. In lieu of potable water, use of recycled water produced at ARWTF for periodic washdown would be investigated. A recycled water line would be located at the Project site. A tie-in to the existing 16-inch SBWR recycled water line at a location immediately south of the TPS would be bade to provide recycled water to the site.

6.6.4.4 Plumbing Fixtures

Plumbing fixtures would be selected for durability, ease of maintenance and housekeeping, and low water consumption. Water heaters located downstream from a backflow prevention device would be protected by use of an expansion tank.

6.6.5 Heating, Ventilating and Air Conditioning

The following is a description of the HVAC systems.

6.6.5.1 Indoor Design Conditions

Indoor design conditions are summarized in Table 6-38.

Table 6-38: Indoor Design Conditions

Area	Design Temperatures (°F)[1]			Ventilation Requirements
	Summer	Winter		
	Design	Design	Set Point	
Process Area	94	NA	NA	6 (intermittently)[2]
Electrical Control Room	90	55	55	3,4
Compressed Air/Blower Room	94	NA	NA	6 (intermittently)[2]
Equipment Maintenance/Repair Room	94	NA	NA	6 (intermittently)[2]

1 Indoor conditions reflect operating temperatures for personnel comfort, code/standard requirements, or equipment protection.
2 The ventilation system would be sized on the more restrictive of the ac/hr listed or the airflow required to maintain the indoor design temperature based on the summer outside design temperature.
3 The ventilation rate would be based on the exhaust requirements or as required by ASHRAE 62, whichever is more stringent.
4 Space would be air conditioned.
5 The exhaust rate would be based on the most stringent requirement of: 0.5 cfm per square foot of floor area; 50 cfm per water closet or urinal; or 100 cfm minimum.

6.6.5.2 Heating Systems

Space heating in the electrical room would be provided by a packaged heat pump with auxiliary electric heating coil.

6.6.5.3 Ventilating Systems

The process area, compressed air/blower room, and the storage room of the Process Structure would each be served by an intermittent ventilation system. The intermittent system would consist of power wall fans or duct fans and intake louvers. The ventilation system would be designed to promote removal of exhaust air from all portions of the ventilated space and avoid short-circuiting of supply and exhaust air within the space. Control dampers in the supply and exhaust systems would be used to isolate the spaces from ambient conditions upon system shutdown. The system would be controlled by a local "ON-OFF-AUTO" selector switch. When the switch is in the "AUTO" position, control would be from a thermostat.

6.6.5.4 Air Conditioning Systems

The electrical/control room of the Process Structure would be served by packaged air conditioning units. The packaged unit would be located at grade next to the Process Structure. An individual space thermostat would control each packaged unit.

6.6.6 Fire Protection

Where required by the NFPA, California Fire Code, or local jurisdiction, the Process Structure would be provided with a sprinkler system, with specific requirements determined during final design. The fire protection system would meet NFPA requirements. A fire protection system may be required at each of the chemical facilities, because these facilities are protected by overhead canopies.

Recycled water from the SBWR system would be used for fire protection at the ARWTF site. This would require the installation of an emergency backup firewater pump, which would be located at the TPS. This pump would run off of the ARWTF power distribution system so that fire suppression water would always be available in the event that the TPS temporarily loses its electrical supply.

6.7 Electrical Criteria

6.7.1 General

This section presents the general electrical design criteria for the electrical power system for the Project. The intent is to provide a safe and reliable means of delivering and distributing power while maintaining ease of maintenance as much as possible. The following criteria also address a number of other electrical requirements not specifically related to power delivery.

6.7.2 Codes and Standards

Electrical design will conform to the latest editions of the following applicable standards and codes:

- Construction Schedule, State of California, Title 24, Part 3 Electrical Code.
- State of California, Title 24, Part 6 Energy Code.
- State of California, Title 8, Industrial Relations, Chapter 4, Electrical Safety Orders.
- National Electrical Code (NEC - NFPA 70).
- National Electrical Safety Code (NESC).
- Life Safety Code (NFPA-101-HB).
- City of San Jose Design Standards

Standards and codes of the following organizations will also govern, where applicable:

- ANSI.
- Illuminating Engineers Society (IES).
- Instrument Society of America (ISA).
- NEMA.
- Institute of Electrical and Electronic Engineers (IEEE).
- Insulated Cable Engineers Association (ICEA).
- National Electrical Testing Association (NETA)
- OSHA.
- ASTM.
- Underwriters Laboratory (UL).

Applicable Federal and local codes and UL listing requirements will be followed. Exit signs, emergency egress lighting, and emergency lighting power supply will conform to requirements of the local code authority.

6.7.3 Power Distribution Planning

The design of the power distribution system for the Project will follow the current design guidelines as recognized by IEEE and current industry standards.

6.7.4 Emergency Power Requirements

The ARWTF, in this initial phase, is not considered a critical facility and as such does not require emergency backup power for operation of treatment processes.

6.7.5 ARWTF Electrical Distribution

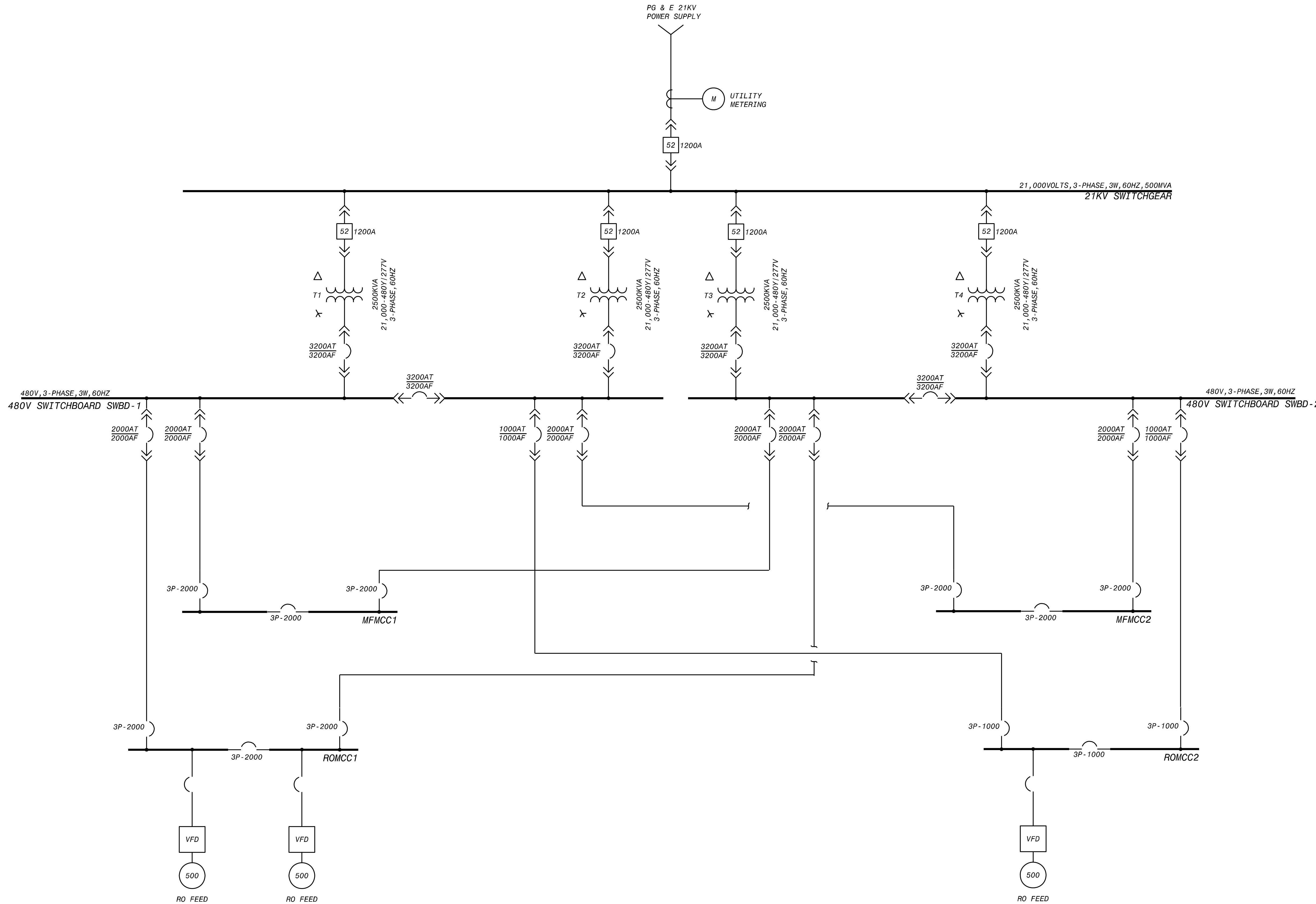
The power distribution for the ARWTF would be as shown on *Figure 6-5*, Power Distribution Functional Diagram (PDFD).

The power distribution system would support the ARWTF Project and meet power requirements of the Project's initial capacity. B&V's subconsultant YEI conducted an evaluation of various power sources available for ARWTF and presented results of the evaluation to the District and the City. Based on the study and subsequent discussions with the District and the City, it is determined that the 21 kV power supply from PG&E would be used as power feed for the ARWTF.

Power at 21 kV would be tapped off by PG&E from an existing overhead 21 kV line in close proximity to the facility and power the 21kV switchgear. The outdoor NEMA3R (non-walk-in) switchgear would house a main incoming circuit breaker and four feeder breakers to distribute power to the facility. The total power would be distributed through four transformers. Each transformer would step down the incoming power at 21 kV to power at 480 V and would be sized to support 50 percent of total power requirements.

Thus four 480 V feeders each rated for 50 percent power capacity would serve ARWTF Project. Out of the four feeders, two feeders would connect to 480 V switchboard SWBD 1 and the remaining two 480 V feeders would connect to 480 V switchboard SWBD 2.

Under normal operating conditions, each of the 480 V feeders would supply one-quarter of the ARWTF plant electrical loads. The total capacity of two feeders would be sized to support the complete plant electrical load. Thus, in effect the four feeders would provide 2 x 100 percent redundant power feeds. Each of the feeders would terminate at one end of the two double ended 480 V switchboard line-ups. Each line up of switchboards would be a main-tie-main configuration. The switchboards would power the motor control centers (MCCs) as shown on Figure 6-5. Provisions for additional switchboard sections and breaker line-ups would be included for potential future equipment. The switchboards would be located indoors for environmental protection and ease of maintenance. Outdoor switchboard with enclosures could be considered during detailed design considering the space requirements during the detailed design of the plant layout.



PRELIMINARY – NOT FOR CONSTRUCTION

REV	DESCRIPTION	DATE	APPR.
	WORK IN PROGRESS		

BLACK & VEATCH

Black & Veatch Corporation
Walnut Creek, California

DATE

DESIGN

DRAWN

CHECKED

ENGINEERING CERTIFICATION

SOUTH BAY WATER RECYCLING

CITY OF SAN JOSE CAPITAL OF SILICON VALLEY

Santa Clara Valley Water District

PROJECT NAME AND SHEET DESCRIPTION:

SANTA CLARA VALLEY WATER DISTRICT
ADVANCED RECYCLED WATER TREATMENT FACILITIES

ELECTRICAL
POWER DISTRIBUTION FUNCTIONAL DIAGRAM

SCALE

VERIFY SCALES
0 1"
BAR IS ONE INCH ON ORIGINAL DRAWING IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROJECT NUMBER

SHEET CODE:
B&V FIG 6-5
CITY
DISTRICT
OF 345

USERNAME: mar17242 Thu 17 Dec 2009 08:13am
FILENAME: C:\Cygnet\Cache\146071\3-E00-001

MAR17242, 12/16/2009 8:13:27 PM
146071-E-H0000KFBW

D-CNST D-CNST-ATTE-TEXT
DOCUMENT NUMBER:

The various process and support structures would be provided with 480V MCCs to distribute power and control to pump motors, other process equipment, and auxiliary power loads including plumbing, HVAC, and power and lighting transformers and panels. The power and lighting transformers and panels would be mounted separately from the MCCs within the buildings and would supply power to the low voltage power and lighting loads. In areas that do not contain many motors, a 480V power center may be used. All electrical power to equipment, panels, load centers, and MCCs would have the ability to be locked out to isolate the equipment from its power supply.

6.7.6 Distribution/Utilization Voltages

The following distribution and equipment utilization voltages and ratings would generally be used. Depending on the specific equipment requirements determined in design, there may be some exceptions to the following numbers:

Plant distribution	480 volts, three-phase
Motors, 1/2 hp to 900 hp	480 volts, three-phase
Motors, less than 1/2 hp	120 volts, single-phase
Motor Control	120 volts, single-phase
Lighting	120 volts, single-phase
Convenience Outlets	120 volts, single-phase

6.7.7 Uninterruptible Power Supply

One common, plant-wide Uninterruptible Power Supply (UPS) would be designed to provide power to the essential instrumentation, monitoring equipment, programmable logic controllers, and the operator workstations to keep them energized through momentary power interruption. The UPS would be sized to accommodate these loads for a minimum of 15 minutes.

6.7.8 Low Voltage Switchboards

Indoor draw-out switchboards would be used to distribute power to the MCCs and the load centers on the Project. The switchboards would be 480V, three-phase, three-wire and shall have copper phase buses and a copper ground bus. Switchboards would be specified as manufactured by Cutler-Hammer, General Electric, or Square D without exception. Switchboards would be a split bus, main-tie-main configuration with independent power sources on each bus. Each switchboard would be rated to handle short circuit currents equal to or in excess of the available fault current. Switchboards would be provided with remote racking devices, power circuit breakers and power quality monitoring equipment. All switchboard breakers would have solid state trip units with long-time (L), short-time (S), instantaneous (I) and ground-fault (G) protection functions. Main and tie breakers would be electrically operated. A key interlock would be used for the main-tie-main to prevent parallel source power feed to the main breakers. Spare breakers and spaces would be included in the switchboard line-up for future expansion.

6.7.9 Low Voltage MCCs and Starters

Indoor, class II, type B wiring MCCs would be used in areas that would contain multiple motors. Supply circuits to MCCs would be 480 volts, 3-phase, four-wire. MCCs would be provided with copper phase buses and a copper ground bus. All MCCs would be specified as manufactured by Cutler-Hammer, General Electric, or Square D without exception. Spares and empty spaces would be provided in each MCC (5 percent spares and 10 percent spaces). Transient voltage surge suppressors would be provided integral to each MCC assembly.

Solid-state reduced voltage motor starters may be utilized where required due to power utility requirements. It is anticipated that motors 100 hp and above may require solid-state reduced voltage starters. This would be evaluated in the detailed design phase.

Except for packaged and HVAC equipment, motor starters would generally be located within the MCCs. Starters would include a green indicating light for OFF, a red indicating light for RUNNING, and an amber indicating light for TROUBLE or FAILURE (where applicable). The indicator lights would be push-to-test type.

6.7.10 Motors and Variable Frequency Drives (VFD)

Motors would be specified with "NEMA Premium" high efficiency ratings. Motor enclosures would be suitable for the environment in which they are installed. Motors driven by VFD would be inverter-duty rated. All motors five hp and larger would be provided with integral space heaters. The heaters would be designed to operate on 120V ac power from the associated motor starter.

VFDs would be pulse width modulated, clean-power type. They would be fed from a dedicated 480V, three-phase feeder. A harmonic analysis would be provided on the connected bus serving VFDs. Drives for motors smaller than 100 hp would be 6-pulse type. Drives for motors 100 hp and larger would be 18-pulse type drives to minimize harmonics.

6.7.11 Panelboards

Power distribution panel boards or power centers, if required in design, would be 480Y/277-volt, 3-phase, four-wire type with a main circuit breaker. Lighting panel boards would be 208Y/120V, 3-phase, four-wire type with the main circuit breaker sized to match the lighting transformer capacity. Each panel board would have a minimum of 20 percent spare breakers with spaces, bus work, and terminations to complete the standard size panel board. Transient voltage surge suppressors would be provided integral to each panel assembly.

6.7.12 Convenience Receptacles

Convenience receptacles for general service would be wall mounted. Provisions for receptacles at all air conditioning units and air handling units would be made as required by the NEC.

Convenience receptacles would generally be mounted 18-inches above floors, except convenience receptacles outdoors, or in garages, shops, storerooms, or rooms where equipment may be hosed down would be mounted 48-inches above the floor or grade.

Weatherproof receptacles would be utilized outdoors, in chemical feed and storage areas, and in wet and damp locations. Receptacles installed outdoors and in restrooms would be provided with ground fault circuit interrupting capability.

6.7.13 Raceways

The specific type of raceway for the ARWTF would be chosen for use in various locations in the facility based on exposure to moisture, temperature, corrosion, voltage, and susceptibility to damage. Underground duct banks consisting of direct buried (DB) type conduits capped with concrete encasement would be provided for most circuits that are routed outside of building structures. Duct banks would include ten percent spare conduits.

The following general guidelines would be used for raceway sizing, selection, and installation:

- Conduit would be sized based on XHHW insulation for all conductors 600 volts and below.
- The minimum diameter of exposed conduit in all areas would be 3/4 inch.
- Raceways in duct banks would generally not be smaller than 2-inches.
- Raceways in walls and ceilings of control rooms, offices, and all areas with finished interiors would be concealed.
- The number of conduit bends would be limited to an equivalent of 270 degrees on long runs.
- Exterior, exposed conduit would be PVC-coated rigid galvanized steel.
- Exterior, underground, direct-buried and concrete-encased conduit would be of the Utility Duct (PVC) type.
- Interior, exposed conduit would be rigid galvanized steel (RGS).
- PVC Schedule 40 conduit would be used for corrosive chemical areas.
- Interior, concealed conduit would be EMT in frame construction and finished ceiling spaces.

6.7.14 Cable

All lighting, power, and control wiring rated 600 volts and below would use stranded copper conductors with XHHW insulation. Individual No. 14 American Wire Gage

(AWG) conductors would be used for discrete control circuits, unless it is practical to use multi-conductor cables to group control circuits. Cables would have 600V insulation.

Twisted-shielded pair control cable with 16 AWG individual stranded copper conductors, PVC insulation, and an aluminum Mylar tape shield around the pair would be used for analog signals. Multi-pair cables would be used where grouping of circuits is practical. Cables would be provided with 600V insulation.

6.7.15 Grounding and Lightning Protection

The electrical system and equipment would be grounded in compliance with the NFPA NEC. Conductors would be minimum No. 4/0 AWG copper, for interconnecting ground rods and for connections to transformers, MCCs, and switchboard. A grounding ring would be provided around all new buildings and major structures. Electrical equipment, devices, panel boards, and metallic raceways that do not carry current would be connected to the ground conductors. Transformer neutrals of wye-connected transformers would be solidly grounded through a grounding conductor connected to the grounding system.

A ground wire would be installed in all raceways that contain power conductors. A lightning risk factor calculation would be prepared for the Project. If the calculated risk of lightning strike is substantial, lightning protection systems meeting the requirements of NFPA 780, Standard for Lightning Protection Systems, would be provided for the appropriate buildings or structures.

6.7.16 Lighting Requirements

Lighting levels in the facilities would be provided following the recommended levels as suggested in the IES Handbook, and in accordance with the State of California Title 24 requirements.

In general, the following suggested foot-candle levels would be the target levels for design and would be further evaluated in the detailed design. Suggested levels are:

Area	Foot-Candle
Office	70
Process, inside	30
Process, outside	5
Storage, inside	10
Walkway	5
General site	1

The following general types of light source would be used to provide the proposed foot-candle levels:

Area	Light Source
Office	Fluorescent
Process, above 14 feet mounting height	High Intensity Discharge (HID)
Storage, inside	Fluorescent
Walkway, inside	Fluorescent
Walkway, outside	High Pressure Sodium
General site	High Pressure Sodium

Where fluorescent lights are indicated, fixtures with electronic ballasts and energy-saver T8 lamps would be used. Outdoor lighting would use luminaries with individual photocells. High bay lighting fixtures would use HID lights with metal halide, instant-on, lamps.

6.7.17 Telephone Requirements

A telephone conduit would be provided between the existing SJ/SC WPCP telephone system and the new telephone system. This would enable integration of the new telephone system with the existing telephone system. The telephone wiring, equipment and evaluation of the existing telephone system would be provided by others.

The addition of a new telephone service for the ARWTF may be required if there is insufficient capacity at the WPCP. This will be developed further during the final design phase.

6.7.18 Fire Alarm System

Fire alarm systems would be provided and modified as required in buildings to meet current code requirements. Where required, smoke detectors, sprinkler flow switches, heat detectors, audible and visual alarms, and manual fire stations would be connected to a central fire alarm control panel, as required.

6.7.19 Security System

Security system equipment would be provided for the ARWTF facilities and the site. B&V will coordinate with the City to review security requirements and finalize the security system configuration. As an example, the security system devices may include closed circuit television security cameras, door contact switches, and a security monitoring panels. The specific type and level of security protection would be coordinated with the City.

6.7.20 Load Analysis

The major electrical loads for the Project have been identified and are summarized below. The load estimation is preliminary and detailed load analysis would be performed during detailed design.

Influent Pumps, MF System & Misc. loads	800 kVA
High-Pressure RO Pumps	1500 kVA
RO System and Misc. loads	1250 kVA
UV System	420 kVA
I&C, HVAC, Plumbing, & Lighting	400 kVA
Contingency (10%)	400 kVA
Total ARWTF Electric Load	4770 kVA

6.7.21 Short-Circuit/Voltage Drop Analysis

For purposes of design, estimated short-circuit levels and steady-state voltage drops would be calculated using a computer-based program. Short-circuit values obtained would be used to specify the appropriate short-circuit ratings for electrical equipment. Design would be based on maximum voltage drops of 3 percent for branch voltages and 5 percent for bus voltages under steady-state conditions.

6.7.22 Harmonics Analysis

Since VFDs would be used in the Project, a harmonics analysis on the power distribution system would be specified to be performed by the VFD manufacturer. The purpose of the analysis would be to ensure that the total harmonic voltage and current distortion limits would not exceed those outlined in IEEE 519.

6.7.23 Cathodic Protection and Freeze Protection

Cathodic protection and freeze protection would be incorporated in electrical design as required.

6.8 Instrumentation and Control Design Criteria

6.8.1 General

This section presents the design criteria for the I&C systems associated with the ARWTF Project. The ARWTF would include a new automated Plant Control System (PCS). The recycled water treatment plant process monitoring and control systems would consist of I&C systems designed for automatic and manual control of the plant via the PCS. The design would stress efficient monitoring and control of equipment and process conditions. The system design would anticipate and facilitate the integration of future plant expansions. All of the I&C work would be in accordance with local codes, the criteria outlined in this section, and other requirements applicable to the I&C design of a recycled water treatment facility. The I&C systems would follow the SJ/SC WPCP conventions for control panel layouts, PLC and field devices, and other I&C requirements. A Distributed Control System (DCS) conforming to SJ/SC WPCP specifications would be provided for the ARWTF. The control system would be developed closely in conjunction with the City and system supplier to ensure a consistent design approach.

6.8.2 Codes and Standards

The I&C design would conform to the latest editions of the applicable standards and codes as shown in Table 6-39.

Table 6-39: Applicable Instrumentation and Control Codes and Standards

Code / Standard	Application and Project Impact
State of California, Title 24, Part 3 Electrical Code	• Electrical equipment and installation requirements/restrictions imposed by California • Based on the National Electric Code (NFPA 70)
State of California, Title 8, Industrial Relations, Chapter 4, Electrical Safety Orders	• Defines minimum safety requirements for installation, demolition and maintenance of electrical equipment
NEC - NFPA 70	• Defines electrical equipment and installation requirements/ restrictions in order to safeguard persons and property from the hazards of electricity
Life Safety Code (NFPA-101-HB)	• Defines requirements to deal with fire and non-fire emergencies within a building or facility • Defines requirements for emergency egress lighting and egress labeling • Defines requirements for protection when dealing with motor fuel storage

Standards and codes of the following organizations would also govern, where applicable:

- ANSI
- IES
- ISA
- NEMA
- IEEE
- ICEA
- OSHA
- ASTM
- UL

Applicable federal and local codes and UL listing requirements would be followed.

6.8.3 PCS Overview

The PCS would use a DCS architecture designed as a node to the existing DCS Control System of the Plant and to have a standardized components and software. The DCS system would be an ABB System Six Distributed Control System consisting of a S-800 Controller, Operator Workstation, and Remote filed I/O subsystems communicating directly to the Controller. The DCS Controller would communicate with other equipment manufacturer (OEM) PLCs via Modbus network. This DCS would provide all monitoring, control, and data acquisition functions (with the exception of OEM supplied, PLC control based sub-systems) for the plant control system in the Windows environment.

The DCS Controller would be connected to the existing Plant DCS redundantly via the Ethernet for remote monitoring and server access.

An Operator Workstation would be provided and configured to accommodate all PCS functions. The DCS Controller would communicate with the remote I/O units (RIO) and other PLCs in the network. Field Junction Boxes with S-800 RIOs to be located close to the process equipment. Hardwired inputs and outputs from field devices and equipment would be wired and routed to the Field Junction boxes. There would be no hardwired inputs and outputs between the PLC packaged controls and the DCS Controller. For packaged systems with multiple PLCs, the packaged system design would be such that the DCS would have to communicate with only one designated master PLC.

Industry standard personal computer-based operator workstation units would provide the primary operator interaction with the process, and allow for ease of maintenance and expansion for future growth.

The DCS controller and workstation would be located in the ARWTF control room. All DCS equipment such as the controller, RIOs, workstation, etc would conform to WPCP specifications.

6.8.4 System Architecture

The System Architecture is shown on drawing 73-I00-003 as the Control System Block Diagram. The DCS system is consist of a single ABB S-800 Controller mounted in the DCU Panel. The Controller will provide the primary controls and monitoring of the Influent Pump Station, RO Units, Chemical Feed, Effluent, and other ancillary equipment.

Field Boxes with Remote I/O units will be provided in each areas mentioned above. Each Remote I/O units will be connected individually to the DCS Controller via Profibus. The Controller rack will have Profibus interface modules to communicate with the field RIO units.

The DCS Controller will communicate with the OEM PLCs such as MF/UF Master PLC and UV PLCs on a Modbus network. This will allow the DCS full monitoring of these systems and provide minimal system command controls.

The DCS Controller will have at least two Ethernet ports for redundant Ethernet interface to the existing Plant DCS. The ARWTF DCS system will be connected to the existing Plant DCS at the TPS Control Room and Nitrification Control Room Ethernet Switches.

An Operator HMI Workstation will be provided in the Control Room connected to the Ethernet network. The Workstation will serve as the primary control and monitoring interface to the ARWTF. Existing HMI database, graphics, and Historian servers will be utilized.

The DCS will be used to create and maintain control strategies, process graphics, point records, I/O placement, and report generators while providing setpoint control of all PLC sub-systems.

The primary system functions provided by the DCS would include:

- Database implementation, including interface with DCS Controller and original equipment manufacturer (OEM) supplied PLCs to maintain real-time field data.
- Graphics display of process, manually entered, and remotely received data.
- Trending of process data.
- Historical data collection functions, including an interface to store data in an Open Datadase Connectivity (ODBC) compliant database.
- Report generation tools to generate reports from the system data (including manually entered data). The report tools would include interfaces to spreadsheets or databases and third-party reporting software.
- Alarm management tools to generate on-screen alarms and to record alarms and operator events (hardcopy printouts and software logging).
- Alarm paging software to automatically page on-site and off-site personnel when alarms occur.

Manufacturers and suppliers of other systems may also provide PLC-based equipment for their systems. These packaged systems PLCs would be required to follow the City's standards and conventions for programming, HMI development, and communications with the PCS-DCS system. The packaged system PLCs would be capable of stand-alone control of the associated equipment, but would generally operate based on setpoints and start/stop requests from the DCS controller. Once the packaged PLC receives the setpoint adjustments or start/stop requests from the DCS controller, the local PLC would perform the actual adjustment to the process equipment. Programming software for the PLCs would be installed on a laptop- or notebook-style computer to be used by the contractor for programming and starting up the system. The computer would be turned over to the City at the end of the Project for its use in maintaining and troubleshooting the system HMI and PLCs. All PLCs would be required to use the same programming software to provide standardization of the plant.

6.8.5 System Reliability

System reliability would be ensured in several ways, depending on the function of the control component. The following list describes the measures taken to ensure reliability.

- DCS processors for the primary process control or OEM-supplied equipment.
- HMI on major processes.
- Multiple operator and engineering workstations.
- All critical systems would be powered from a common UPS that would feed all critical loads.
- Each node on the system (controller, PLCs and workstations) would monitor all components and communication links. DCS controllers and PLCs would be programmed to respond appropriately (assume fail-safe logic or shut down) if communications are lost or a related component fails. Alarms would be generated when equipment or communication links fail.
- Hand control stations would be provided to allow control at the field level in the event of a control system failure.

Future system expansion would only be limited by performance issues related to the communications links. As a minimum, the system would be capable of a PLC/DCS and I/O expansion of three times the initial implementation, without adversely affecting system performance (communications response time).

6.8.6 Instrumentation

Plant instrumentation would be provided for monitoring of the process and control of the equipment systems. Additional instrumentation would be provided to alarm abnormal system operation, pending problems, or safety hazard conditions. Where possible, instruments would be microprocessor based 'smart' instruments, which can be calibrated and maintained through a digital Highway Addressable Remote Transducer (HART) interface. Standard analog signals would be 4-20 mA dc. The instrumentation to be provided would be indicated on the P&IDs and would include the following major instrument systems:

- Level and flow instrumentation for pump control.
- Raw water flow meters.
- Turbidity, pH, temperature, and conductivity measurement on raw water.
- Finished water turbidity, pH, and particle count monitoring of product water discharge flow.
- High purity recycled water storage tank level instruments.
- Magnetic flowmeters for distribution flow rates.
- Chemical storage level instruments.

The flow meters would have a minimum flow of approximately one ft/sec to maintain an accuracy of 1/2 percent of actual reading.

The City would provide standard or preferred instrumentation manufacturers/models during the detailed design.

6.8.7 Control Modes and Control Basis

In general, all equipment at the ARWTF would be operated in one or more of the following control modes:

- Local Manual: The equipment would be manually controlled locally or from a nearby Motor Control Center (MCC), local device control panel, or hand station.
- Local Automatic: The equipment would be automatically controlled locally through some physical interlocking scheme in the local device control panel.
- Remote Manual: The equipment would be controlled manually through the DCS based on commands issued from a DCS workstation. Such commands are received by the local DCS controller and converted into physical outputs to field devices.
- Remote Automatic: The equipment would be automatically controlled by the DCS based on process setpoints issued from the operator workstations. The system PLC or DCS Controller would automatically adjust process equipment to meet the process setpoint.

The control mode would be selectable where applicable based on local/remote and auto/manual switches located at the devices, MCC, and/or device control panels. Selector switch position feedback would be wired to the DCS Controller or sub-system PLC, allowing an operator using the operator workstation to know whether a device was automatically controlled and determine if control from the operator workstation was active.

Some non-process equipment would be provided with local manual controls only. This includes equipment such as compressors and HVAC equipment. Packaged equipment items that are normally provided with local automatic controls would be specified with such. The DCS would be used to monitor packaged equipment and, where applicable, would provide remote initiation of the packaged controls. In general, the DCS would not provide parallel controls matching those provided with the packaged equipment, but would provide monitoring of status and/or alarm conditions with setpoint control.

The I&C designer would create simple text based control descriptions in concert with sample HMI screens to depict the intended screen development layout and standards to be used in defining the controller and operator workstation programming requirements. These descriptions would be included as a part of the Contract Documents. The Contract Documents would mandate a conference, held between the City, the Engineer, the OEM supplier and the PCS supplier, to discuss control descriptions, equipment numbering and tagging, standards and conventions to be used in creating the HMI operator workstation display screens and PLC algorithms. More detailed operational descriptions may be required to be developed by the contractor for detailed programming.

6.8.8 Provisions for Remote Monitoring and Automatic Operations

The PCS would be designed with provisions for remote monitoring and operation from the existing SJ/SC WPCP to support unattended plant operation. All major systems would be controlled by the DCS controller and sub-system PLCs to operate in full automatic mode, based on desired setpoints (flow rate, water quality, dosage, etc.). The operations staff may override the automatic control or adjust the setpoints.

The controls would be programmed to start backup or standby equipment if the primary equipment were not available or failed. All equipment would be designed to assume a fail-safe mode if the associated PLC fails or if a network communication failure occurs with DCS. The sub-system PLCs would keep the last setting on a power failure and would automatically restart the process on a power failure with appropriate time delays between equipment starts.

6.8.9 Plant Control System Security

The PCS would be designed to meet existing City data network standards. At a minimum the system shall include the utilization of authentification with role based access control (RBAC). RBAC assigns personnel to certain roles and then allows access to various password protected levels assigned to those roles. Security features would also include "hardening" by closing unused ports and services, intrusion detection systems, and antivirus software. Additional security requirements specific to City standards would be outlined for the DCS and specified for each sub-system vendor.

6.8.10 Document Production Standards

I&C drawings would be prepared per drafting standards and procedures specified in Chapter 1.

6.8.10.1 Process & Instrumentation Drawings

Process and Instrumentation drawings (P&IDs) would be provided to show a detailed graphical representation of the interconnection of process equipment and the instrumentation used to control the process. The instrument symbols used in these drawings are generally based on Instrument Society of America (ISA) Standard S5.1 and the SJ/SC WPCP conventions.

6.8.10.2 Input/Output Listing

Input/Output listing would provide a tabulation to show minimum, maximum, range, units, etc. of all input and output data to be routed to and monitored by the DCS Controller.

6.8.10.3 Instrumentation Device Schedule

A complete instrumentation device schedule would be prepared and included in the Contract Documents.

6.8.10.4 As-Built Drawings, O&M Manuals and Loop Drawings

As-built drawings, O&M manuals and loop drawings would be prepared and submitted at the completion of Project construction.

7.0 PROJECT COST AND SCHEDULE

7.1 Overview

This chapter presents a preliminary opinion of probable construction cost (OPCC), a preliminary opinion of probable annual O&M cost, and a preliminary Project schedule. This OPCC was developed in April 2007 and had been escalated to the previous mid-point of construction (April 2009). The OPCC presented in this chapter has since been updated for this version of the Engineer's Report.

Due to the state of the U.S. and global economy since the issue of the Draft Engineer's Report in 2007, it is difficult to determine where the construction and materials markets will be when construction commences. The current (December 2009) construction market is very competitive and favorable for the District and the City.

7.2 Opinion of Probable Construction Cost

The OPCC is based on bids received on recent, similar B&V projects in California, quotes from major equipment suppliers and on current "Means Building Construction Cost Data" (Means). Means publishes an updated edition annually, which provides current nationwide unit price averages for materials and labor. Means also provides a cost index for several cities located in each state, which allows for accurate cost estimates for specific locations.
The OPCC is broken down into two categories:
OPCC for ARWTF

- Plant and Off-Site Pipelines, and
- OPCC for Off-Site Power Feed

The total OPCC would be the combined OPCC for these two categories and is presented at the end of this chapter. The basis of the OPCC is presented below.

7.2.1 *General*

The OPCC was developed in April 2007 and was generated using 2007 construction costs for materials, equipment, and labor. Construction is expected to commence in September 2010 and the construction duration for this Project is expected to be 18 months. To provide a more realistic representation of the OPCC, the 2007 cost was escalated to the current anticipated mid-point of construction (expected to be in June 2011) using a factor of five percent per year.

Several major design changes have occurred since April 2007. These changes impact the OPCC provided in this section, and are listed below.

- The Process Structure changed from a canopy with masonry walls to a prefabricated metal building.

- The Waste Equalization Wetwell changed from a gravity discharge to a nearby sewer to a pumped discharge system. This system will pump the waste approximately 3,500 feet to the SJ/SC WPCP EBOS structure.
- Pile supports were added to the Inter-Process Storage Tank and Waste Equalization Wetwell in accordance with the geotechnical recommendations.
- The power supply changed from a 5kV service to a 21kV service.

7.2.2 *OPCC for ARWTF Plant and Off-Site Pipelines*

The OPCC for ARWTF plant and off-site pipelines is summarized in Table 7-1 and includes the following:

Facilities Cost

- Sitework
- TPS Control Building Modifications
- Process Area Structure
- Influent Feed Pump Station
- MF System and ancillary equipment
- MF Chemical Feed Facilities
- Inter-Process Storage Tank
- RO System
- Decarbonator and Product Water Transfer Pumps
- UV System
- Product Water Storage Tank
- Plant Electrical
- Instrumentation
- Off-site Piping
- Other costs
  - Project Design Allowance included as 10 percent of the Facilities Cost (excluding Plant Electrical cost which has the design allowance built into it)
  - Project contingency as 10 percent of the Facilities Cost

Additional Costs

The following additional items are included in the OPCC:

- General Requirements included as 12 percent of the Facilities Cost

7.2.3 *OPCC for Off-Site Power Feed*

The cost associated with off-site power feed is summarized in Table 7-1 and consists of the following:

- 21 kV Power Distribution cost including
  - Switchgear
  - Duct banks, conduits, and cables
  - Circuit breakers and other electrical accessories

Table 7-1: Summary of Opinion of Probable Construction Cost[1]

1. OPCC for ARWTF and Off-site Pipelines	
1.1 December 2009 Update Facilities Cost – ARWTF and Off-Site Pipelines 1.2 Escalation (2%) to Mid-point of Construction (June 2011)	$ 43,267,000 $ 1,304,000
1.3 Subtotal OPCC for ARWTF and Off-site Pipelines	**$ 44,571,000[2]**
2. OPCC for Off-site Power Feed (based on 21 kV service)	
2.1 December 2009 Off-site Power Feed Facilities 2.2 Escalation (2%) to Mid-point of Construction (June 2011)	$ 2,184,000 $ 66,000
2.3 Subtotal OPCC for Off-site Power Feed	**$ 2,250,000**
3. TOTAL OPCC (OPCC for ARWTF and Off-site Pipelines + OPCC for Off-site Power Feed)	**$ 46,821,000[2]**

[1] Costs do not include engineering or construction management services.
[2] Cost is based on 5 MF units per July 2009 proposal from Pall. If it is decided to install 8 MF units per November 2009 proposal from Pall, then OPCC for ARWTF and Off-site Pipelines (Item 1.3) would be $47,832,000 and the TOTAL OPCC (Item 3) would be $50,082,000.

7.3 Opinion of Probable Annual O&M Cost

The annual O&M costs presented in this section include the following:

- Energy cost associated with operating the treatment process equipment including pumps, MF/UF System, RO System, UV Disinfection System, and chemical feed equipment
- Chemical cost
- Membrane replacement cost for MF/UF, RO, and Cartridge Filters
- Replacement cost for UV lamps and accessories

- Miscellaneous Costs including
  - Parts and maintenance cost for process equipment
  - Cost for maintenance, including painting, of Product Water Storage Tank

The opinion of probable O&M cost presented in Table 7-5 is based on initial projected annual average flows. The O&M cost is based on the annual average flows presented in Table 7-2.

Table 7-2: O&M Cost Flow Assumptions

	Summer (May – Nov.)	Winter (Dec. – Apr.)
MF Feed	10.5 mgd	4.8 mgd
RO Feed	9.4 mgd	2.3 mgd
RO Permeate	8.0 mgd	2.0 mgd
UV Feed	8.0 mgd	4.0 mgd

7.3.1 *Basis of O&M Cost Calculations*

The annual O&M costs presented in this section are calculated based on the following assumptions:

General

- Project life of 20 years is used
- Interest rate of 5 percent per year is used
- Inflation rate of 3 percent per year is used
- Energy, chemical, and labor costs are based on 2007 rates adjusted to 2012 annual O&M costs
- 2007 rates used are as follows:
  - Energy – $0.15/kw-hr from PG&E
  - Labor – $100/hr including Benefits (provided by the City)
  - Chemical costs provided by the City and chemical vendors
- Annual O&M costs are broken down into summer O&M costs (covering May to November time period) and Winter O&M costs (covering December to April time period)
- Any fees associated with disposal of the waste streams (e.g. RO reject, MF/UF reverse filtration waste, MF CIP waste, stormwater, sanitary sewer) returned to the SJ/SC WPCP are not included

Energy Cost

- Energy cost was calculated based on 24 hours of operation per day
- Energy cost was calculated for the following major process equipment:
  - Plant Influent Pumps
  - Microfiltration Pumps
  - Ancillary MF/UF Equipment

- RO Transfer Pumps
- RO High Pressure Pumps
- Product Water Transfer Pumps
- Ancillary Reverse Osmosis Equipment
- UV Lamps

Chemical Cost

- Chemical cost was calculated for the following chemicals:
  - Aqueous Ammonia upstream of MF/UF System
  - Sodium Hypochlorite upstream of MF/UF System
  - Sodium Hypochlorite for MF/UF System Clean-in-Place (CIP)
  - Citric Acid for MF/UF System CIP
  - Sodium Bisulfite for CIP waste neutralization
  - Sodium Hydroxide (Caustic) for CIP waste neutralization
  - Sodium Hypochlorite for MF/UF System Maintenance wash (MW)
  - Citric Acid for MF/UF System MW
  - Sulfuric Acid upstream of RO System
  - Threshold Inhibitor upstream of RO System
  - Sodium Hydroxide for RO Permeate
- Dosages for the chemical associated with the MF/UF system were determined by the B&V team based on past experience.

Labor Cost

- The operations and maintenance staff for the ARWTF is assumed to consist of the following:
  - Operations Staff – Two and a half (2.5) Operators working 8 hours a day, 7 days a week
  - Maintenance Staff – One (1) Maintenance Person working 8 hours a day, 7 days a week

Membranes and UV Lamp and Accessories Replacement Cost

- It is assumed that the MF/UF and RO membranes will be replaced every five (5) years.
- For the UV system, the following information provided by the UV manufacturers is used:
  - Average UV lamp life = 8000 hours
  - Average UV wiper life = 1 year (continuous operation)
  - Average UV sleeve life = 3 years (continuous operation)

Miscellaneous Costs

- Annual cost for parts and maintenance of process equipment is assumed as 0.5 percent of the capital equipment cost.
- For the Product Water Storage Tank, the interior is assumed to be recoated every ten (10) years and the tank exterior is assumed to be recoated every fifteen (15) years.

7.3.2 *Review of Probable Annual O&M Costs*

A summary of probable annual O&M costs are presented in Table 7-3.

Table 7-3: Probable O&M Cost Using Initial Average Annual Flow Rates

Description	Summer Months	Winter Months	Annual Cost
Energy	$1,260,000	$350,000	$1,610,000
Chemicals	$320,000	$110,000	$430,000
Labor	$760,000	$540,000	$1,300,000
MF and RO Membranes and Cartridge Filters Replacement			$812,000
UV Lamps Replacement			$81,000
Miscellaneous Cost			
Tanks			$59,000
Parts Replacement			$25,000
Total Initial Annual O&M Cost			**$4,317,000**

7.4 Preliminary Project Schedule

This section presents the preliminary Project schedule for the ARWTF. The Project schedule was created in Microsoft Project and will be updated to reflect the progress of the work. The schedule covers the preliminary and detailed design phases, bid phase, and construction. A detailed Project schedule is presented in Appendix A. Major Project milestones are presented in Table 7-4.

Table 7-4: Summary of Key Milestones

Milestone	Date
Notice to Proceed	October 2006
Draft Engineer's Report	July 2007
Final Engineer's Report (Update)	December 2009
30% Design Documents	October 2008
60% Design Documents	February 2010
90% Design Documents	April 2010
Final Design Documents	June 2010
Construction Start	September 2010
Construction Complete and Facilities Operational	Early 2012

Appendix A
Project Schedule

Updated October 29, 2009

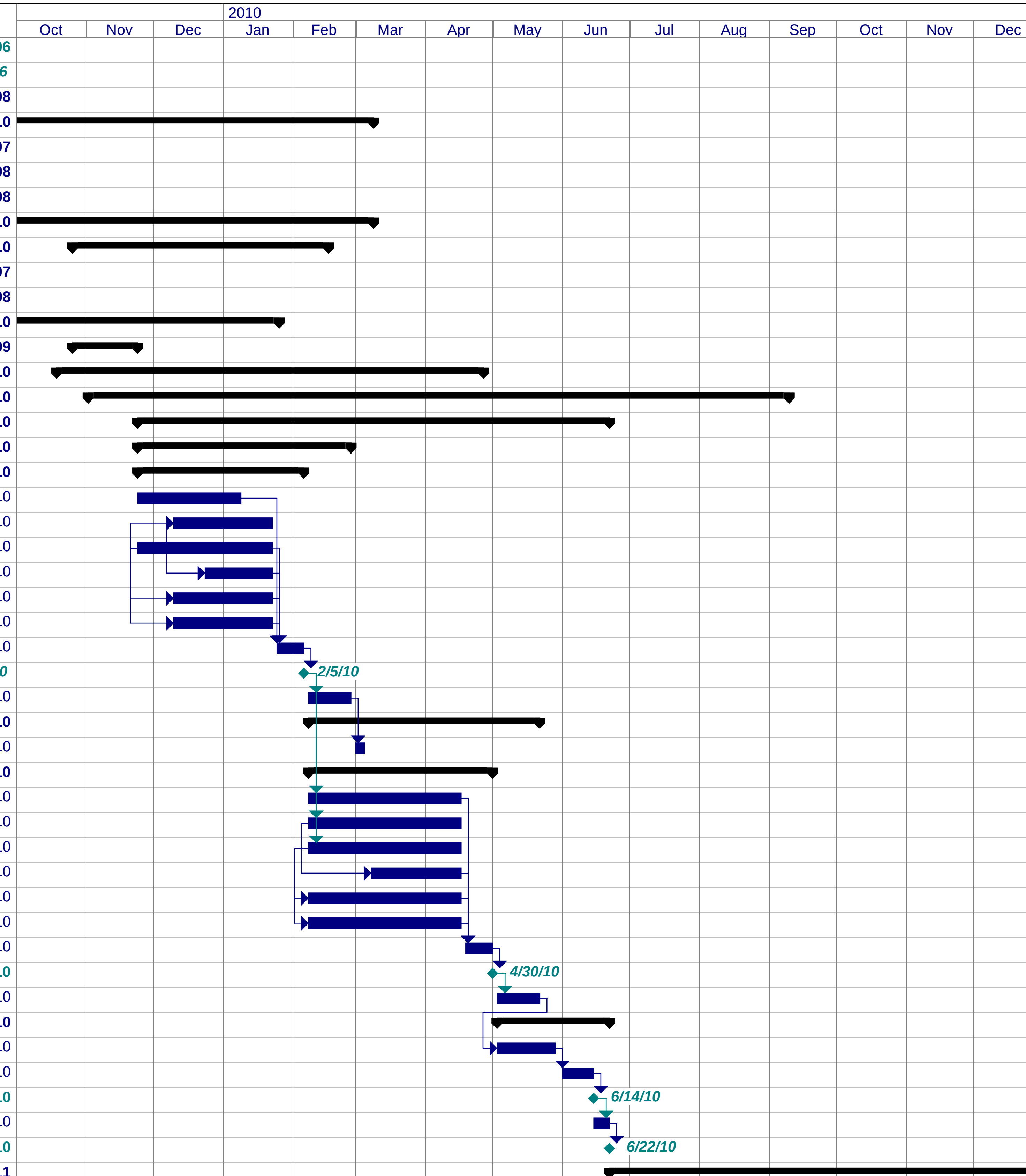
Design Phase Summary

Santa Clara Valley Water District/City of San Jose

South Bay Advanced Recycled Water Treatment Facility

PROJECT SCHEDULE

ID		Task Name	Duration	Start	Finish
1	✓	*Notice To Proceed*	0 d	Fri 10/13/06	Fri 10/13/06
2	✓	*Project Team Kickoff Meeting*	0 d	Fri 10/13/06	Fri 10/13/06
3	✓	**Task 1 - Project Management**	515 d	Fri 11/17/06	Fri 11/14/08
30		**Task 2 - Preliminary Design Service / Engineer's Report**	876 d	Fri 10/13/06	Mon 3/8/10
31	✓	**Task 2.1 - Refine Project Description**	102 d	Fri 10/13/06	Fri 3/9/07
35	✓	**Task 2.2 - Preliminary Investigations and Engineer's Report**	404 d	Fri 10/20/06	Thu 5/15/08
61	✓	**Task 2.3 - Development of 30% Design**	90 d	Fri 5/16/08	Thu 9/18/08
68		**Task 2.4 - Membrane Filtration System RFP**	842 d	Mon 12/4/06	Mon 3/8/10
91		**UV System RFP**	78 d	Mon 10/26/09	Tue 2/16/10
107	✓	**Task 2.5 - Site Survey**	49 d	Mon 6/11/07	Fri 8/17/07
110	✓	**Task 2.6 - Geotechnical Study**	67 d	Mon 4/14/08	Tue 7/15/08
114		**Task 2.7 - CEQA Documents**	590 d	Tue 10/16/07	Tue 1/26/10
124		**30% Design Update**	21 d	Mon 10/26/09	Mon 11/23/09
128		**Toxicity Testing**	132 d	Mon 10/19/09	Mon 4/26/10
141		**Early Earthwork Construction Contract**	217 d	Mon 11/2/09	Thu 9/9/10
148		**Task 3 - Project Design**	145 d	Tue 11/24/09	Tue 6/22/10
149		**Task 3.1 - 60% Design Submittal**	65 d	Tue 11/24/09	Fri 2/26/10
150		**Prepare 60% Design Documents**	50 d	Tue 11/24/09	Fri 2/5/10
151		Prepare 60% Design Documents- Civil	6 w	Tue 11/24/09	Fri 1/8/10
152		Prepare 60% Design Documents- Arch/Struct	6 w	Thu 12/10/09	Fri 1/22/10
153		Prepare 60% Design Documents- Mech Process	8 w	Tue 11/24/09	Fri 1/22/10
154		Prepare 60% Design Documents- Mech Bldg	4 w	Thu 12/24/09	Fri 1/22/10
155		Prepare 60% Design Documents- Electrical	6 w	Thu 12/10/09	Fri 1/22/10
156		Prepare 60% Design Documents- Instrumentation	6 w	Thu 12/10/09	Fri 1/22/10
157		B&V QC & Edit QC Comments	2 w	Mon 1/25/10	Fri 2/5/10
158		*Deliverable due District - 60% Design Submittal*	0 d	Fri 2/5/10	Fri 2/5/10
159		District Review and Workshop	3 w	Mon 2/8/10	Fri 2/26/10
160		**Task 3.2 - 90% Design Submittal**	75 d	Mon 2/8/10	Fri 5/21/10
161		Address Client Comments	4 d	Mon 3/1/10	Thu 3/4/10
162		**Prepare 90% Design Documents**	60 d	Mon 2/8/10	Fri 4/30/10
163		Prepare 90% Design Documents- Civil	10 w	Mon 2/8/10	Fri 4/16/10
164		Prepare 90% Design Documents- Arch/Struct	10 w	Mon 2/8/10	Fri 4/16/10
165		Prepare 90% Design Documents- Mech Process	10 w	Mon 2/8/10	Fri 4/16/10
166		Prepare 90% Design Documents- Mech Bldg	6 w	Mon 3/8/10	Fri 4/16/10
167		Prepare 90% Design Documents- Instrumentation	10 w	Mon 2/8/10	Fri 4/16/10
168		Prepare 90% Design Documents- Electrical	10 w	Mon 2/8/10	Fri 4/16/10
169		B&V QC & Edit QC Comments	2 w	Mon 4/19/10	Fri 4/30/10
170		*Deliverable due District - 90% Design Submittal*	0 d	Fri 4/30/10	Fri 4/30/10
171		District review	3 w	Mon 5/3/10	Fri 5/21/10
172		**Task 3.3 - 100% Design Submittal**	35 d	Mon 5/3/10	Tue 6/22/10
173		Prepare 100% Design Documents	4 w	Mon 5/3/10	Fri 5/28/10
174		B&V QC & Edit QC Comments	2 w	Tue 6/1/10	Mon 6/14/10
175		*Deliverable due District - 100% Design Submittal*	0 d	Mon 6/14/10	Mon 6/14/10
176		District review	5 d	Tue 6/15/10	Mon 6/21/10
177		Board Approval to Advertise	0 d	Tue 6/22/10	Tue 6/22/10
178		**Task 5 - Construction Services Submittal Review**	387 d	Tue 6/22/10	Thu 12/29/11



Appendix B
Impact of RO Concentrate Stream on WPCP Effluent Quality

Eisenberg, Olivieri & Associates
Environmental and Public Health Engineering

TECHNICAL MEMORANDUM

TO:	Sanjay Reddy, Black & Veatch
FROM:	Ray Goebel & Tom Hall
DATE:	March 28, 2008
SUBJECT:	**South Bay Advanced Recycled Water Treatment Facility – Impact of RO Concentrate Stream on WPCP Effluent Quality**

Introduction

The Santa Clara Valley Water District (SCVWD) and San Jose/Santa Clara Water Pollution Plant (WPCP) are planning to construct a facility to reduce salinity levels in recycled water (RW) produced at the WPCP. The facility will utilize microfiltration (MF) and reverse osmosis (RO) to meet Title 22 filtration requirements for disinfected tertiary RW and to reduce salinity levels in the recycled water (RW) product. RW from these systems will be disinfected and delivered to the South Bay Water Recycling distribution system. The MF waste stream will be returned to the plant for processing, while the RO waste stream will be recombined with the WPCP effluent stream for discharge to the Bay.

Under subcontract to Separation Processes, Inc (SPI), EOA examined the likely impact of the RO concentrate stream on final effluent quality from the WPCP. The analysis considers conventional pollutants (CBOD, TSS and ammonia) and toxic pollutants which are regulated (or potentially regulated) under the WPCP's NPDES Permit. The analysis uses a mass balance model to determine pollutant concentrations in the RO concentrate (reject) and combined final plant effluent discharge streams. The projections are based on historic WPCP effluent quality and flow data, plus projected flows and performance data for the MF/RO system.

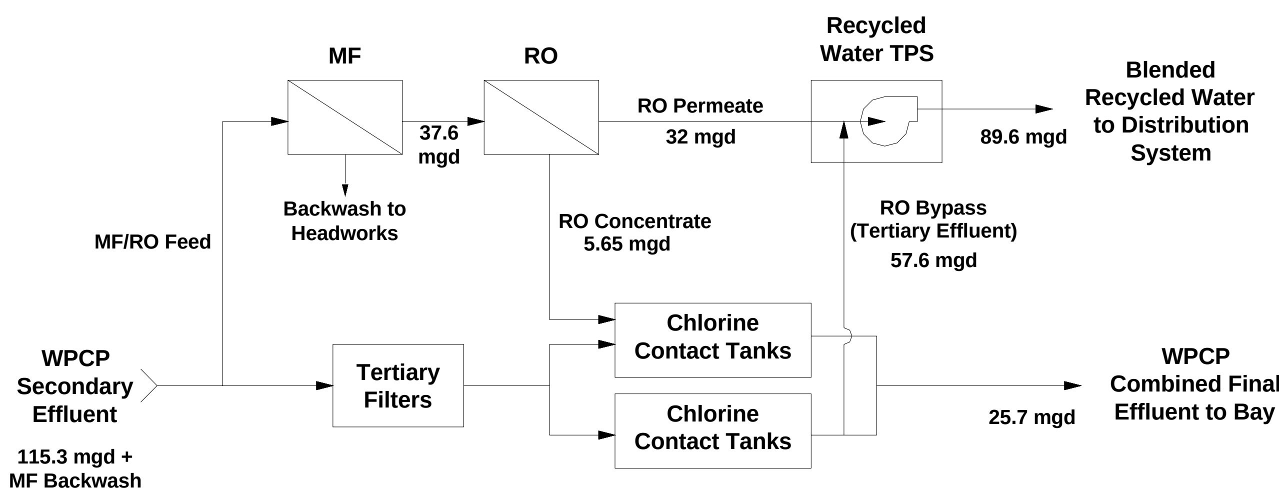
An analysis was conducted in Spring 2007 for a project that would blend 8 mgd RO product (permeate) with a slightly greater amount of tertiary effluent, to produce a total of 16.8 mgd blended recycled water. A similar analysis was conducted for a 12 mgd RO product scenario. These projects would have only a minor impact on pollutant concentrations in final effluent discharged to the Bay, raising those concentrations by about 8% and 13%, respectively, from current levels.

In January 2008, EOA was asked to evaluate the impacts of a much larger project, consisting of up to 40 mgd of RO permeate, with the final recycled water blend consisting of 1.8 part tertiary effluent to 1 part RO permeate. The 1:1.8 "blend ratio" is designed to produce a total dissolved solids (TDS) concentration of approximately 500 mg/L in the recycled water. This memo addresses the impacts of the larger project.

Process Description

Figure 1 is a schematic of the proposed system, showing only those elements essential to the mass balance analysis. Flows to the MF/RO system will be diverted from the WPCP's secondary effluent stream. MF backwash will be returned to the plant headworks, while the RO concentrate stream will be rerouted to the chlorine contact tanks and blended back into the WPCP effluent for discharge to the Bay. The RO permeate will be combined with the "RO Bypass" stream (filtered tertiary effluent). These streams will be disinfected to meet Title 22 requirements and pumped into the recycled water (RW) distribution system. For purposes of illustration, the flows associated with a 32 mgd RO permeate project are indicated in Figure 1.

Figure 1. Process Flow Schematic
For 115.3 mgd Effluent + Recycled Water, 32 mgd RO Permeate



Mass Balance Model

The spreadsheet model used for this evaluation of RO concentrate impacts on final effluent quality performed a mass balance to determine the mass and concentration of pollutants in the RO feed, permeate and concentrate streams. Inputs to the model include:

- Flows: WPCP secondary effluent, RO system feed, RO "bypass"
- Water Quality Data: Historic WPCP final effluent data is used to characterize pollutant concentrations in both the MF/RO feed and in the plant effluent prior to recombining of the RO concentrate.
- RO System Performance: hydraulic recovery and pollutant rejection rates
- NPDES effluent limits or water quality objectives at the point of discharge

The RO concentrate stream is mathematically combined with the remaining final effluent stream to determine combined final effluent flow and concentrations.[1] These concentrations are then compared to the NPDES effluent limits or the applicable water quality to determine if operation under the specified conditions will impact current or future compliance.

Model Input Data

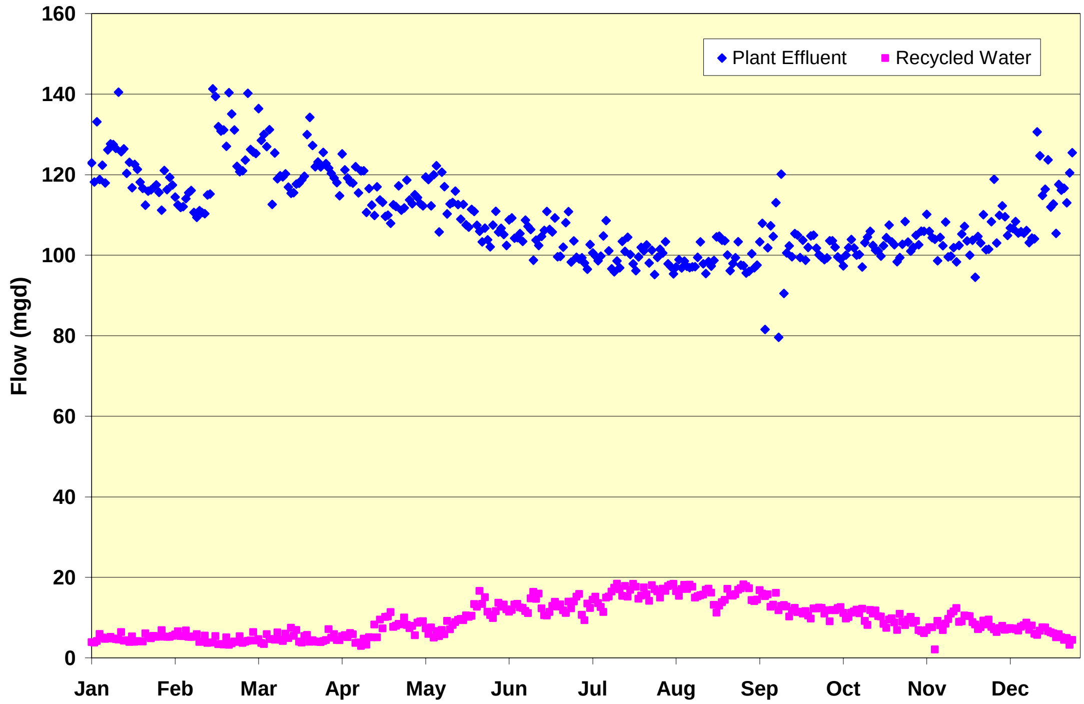
Flows

RO permeate flows up to 40 mgd were specified, with a fixed blend ratio of 1.8 parts tertiary effluent to 1 part RO permeate. Under the minimum summertime flow conditions described below, the final effluent consists of 100% RO concentrate (i.e. no tertiary effluent remains for blending with the reject) at a RO permeate flow of 38.7 mgd, effectively capping the maximum possible size of a single stage RO project for this minimum flow condition.

EOA examined historic WPCP effluent and RW flow data to identify a reasonable worst case minimum flow condition for use in the mass balance. Historic (2001-2005) flow data provided by the WPCP staff was supplemented by additional (2006) data derived from the electronic reporting system (ERS) database used to report self-monitoring data to the RWQCB. As expected, the minimum flow (sum of historic plant discharge flow plus RW flow) occurs during the summer. In 2005 and 2006, the minimum plant effluent flows occurred in August, when the monthly average flows (excluding RW) were 99.1 mgd and 101.7 mgd, respectively. The average monthly RW flow also peaked in August 2005 at 16.2 mgd (2006 RW flow data were not available). Within these months, daily flows for the both the plant effluent and recycled water were very consistent, indicating that the use of monthly average values is sufficiently conservative. On this basis, the August 2005 flow of 115.3 mgd was selected as a typical worst case condition for use in the mass balance. Figure 2 shows the pattern of plant effluent and RW (Transmission Pump Station) flows during 2005.

[1] The mass balance does not explicitly account for the waste stream produced from the MF system. However, because historic (filtered) effluent data are being used to characterize secondary effluent concentrations, the mass balance in essence assumes that pollutants currently removed by the sand filters will continue to be removed by the MF system.

Figure 2. WPCP Flows - 2005



RO System Performance

SPI provided typical performance data for the MF/RO system. The MF/RO flow recovery is assumed to be 85% (i.e. 85% of the feed passes through as RO product, 15% to concentrate). The rejection rate for pollutants was estimated to be 99% for metals and 95% for cyanide. EOA assumed 99% removal for CBOD, and TSS, and 90% for ammonia. As a result of these assumption, pollutant levels in the RO concentrate are approximate five times those of RO feed stream. For reasons described below, organics were not evaluated using the mass balance approach.

In specifying the 1.8:1 blend ratio, the designers have assumed a secondary effluent TDS of 750 mg/L, and an RO permeate TDS of 50 mg/L (will initially be lower, but increasing to that level over time).

Pollutant Concentrations

Historic plant final effluent data was used to characterize both the MF/RO feed stream and the plant effluent stream prior to recombining with the RO concentrate. EOA extracted priority pollutant data from the ERS database. For metals and conventional pollutants, a four-year (2004-2007) data set was used, except as noted in table footnotes. For organics, a larger six year data set was used because of the fewer number of available values per year. The later data included all CTR priority pollutants plus tributyltin, diazonon, and chlorpyrifos. The only data censoring that was performed was to exclude certain high-detection limit non-detect (ND) results, in cases where inclusion of these values (particularly where mixed DLs are present) would significantly skew the resulting statistical measures. Values listed as ND were conservatively evaluated at the detection limit. Estimated ("DNQ") values were evaluated at the estimated value.

Table 1 summarizes data for metals and cyanide. A more complete statistical summary is provided in Appendix A. For copper and nickel, statistical summaries were developed for both individual (daily) and monthly average values. For other constituents, the summaries reflect individual values only. The number of non-detect and DNQ values in the data set were very low. As a result, the data are highly amenable to a mass balance approach for predicting the impacts of the MF/RO project. The large number of data points allow the "worst case" percentile concentrations to be estimated with a relatively high level of confidence.[2]

Table 2 summarizes the data for the conventional pollutants cBOD, TSS, ammonia, and oil & grease. A more complete statistical summary is provided in Appendix A. For cBOD and TSS, both daily and monthly average values were evaluated. The datasets of daily CBOD and TSS values are quite large, allowing accurate characterization even at high (e.g. 99th) percentile concentrations. For ammonia and oil & grease, only monthly averages are evaluated, since samples are normally collected on a monthly (ammonia) or quarterly (oil & grease) basis.

Table 3 summarizes the data for organics, showing only those pollutants for which at least one value was detectable. A complete summary for organics is included in Attachment A. In the case of organics, the data set consists almost entirely of non-detect results, so that a mass balance approach is largely meaningless. A better approach is to examine pollutants with detectable values, and to qualitatively assess the impact of the project on those pollutants. The column headed "Max. with 32 mgd RO Project is included to aid in that discussion. (See "Model Results – Organics" section).

For TDS, a constant value of 750 mg/L was used for all percentiles, as data for calculating actual percentiles was not readily available. The TDS of the final blended effluent discharge is of interest relative to salt marsh conversion and mitigation issues.

[2] The percentile values used for this analysis were determined by ranking the actual data, as opposed to statistical estimates based on an assumed distribution.

Table 1. Metals Data Summary, 2004 - 2007

	Number of Results	WPCP Effluent Concentration, ug/L				Effluent Limit or WQO
		Average	90%ile	95%ile	99%ile	
Arsenic	56	1.1	1.5	1.7	2.1	36
Cadmium	42	0.05	0.08	0.15	0.21	7
Chromium VI	8	0.53	0.67	0.68	0.70	200
Copper - daily max.	180	2.9	4.4	4.8	5.7	18
Copper - monthly avg	50	2.7	4.1	4.2	4.8	12
Lead	43	0.5	0.8	1.0	1.4	8.5
Mercury	47	0.0017	0.0024	0.0027	0.0040	0.025[1]
Nickel - daily max	200	6.4	8.0	9.0	10.8	34
Nickel - monthly avg		6.3	7.2	7.5	8.7	25
Selenium	57	0.43	0.60	0.66	0.93	5
Silver	45	0.04	0.07	0.11	0.17	2
Zinc	65	38	60	68	82	170
Cyanide	28	2.2	3.0	3.2	3.4	7[2]

1. Limit from mercury Watershed Permit. Trigger value is 0.011 ug/L.
2. Expected permit limit using cyanide site-specific objective

Table 2. Conventional Pollutant Data Summary, 2004 - 2007

		WPCP Effluent Concentration, mg/L				Effluent Limit
		Average	90%ile	95%ile	99%ile	
CBOD - daily max	461	2.8	4.0	4.0	5.0	20
CBOD - monthly avg	48	2.8	3.4	4.0	4.1	10
TSS - daily max	645	2.0	3.0	6.2	8.9	20
TSS - monthly avg	48	1.8	2.3	2.6	6.2	10
Ammonia-N	48	0.4	0.6	0.6	0.8	3.0

Table 3. Summary of WPCP Effluent Organics Data, 2002 - 2007, Detected Values Only

All values are ug/L except dioxins and furans, which are pg/L

CTR	Pollutant	Total # Values	# of Qual. Values[1]	Average[2]	Maximum[3]	Max. w/ 32 mgd RO Project[4]	W.Q. Objective[5]
20	Bromoform (Tribromomethane)	7	2	< 0.37	0.69	1.54	380
23	Chlorodibromomethane	8	0	1.93	3.5	7.8	34
26	Chloroform	12	0	4.87	10	22.3	-
27	Dichlorobromomethane	8	0	3.49	5.9	13.2	46
35	Chloromethane (Methyl Chloride)	5	4	< 0.33	0.04	0.089	-
36	Methylene Chloride[6]	7	2	< 0.34	0.8	1.8	1600
39	Toluene	7	2	< 0.54	0.9	2.0	200,000
68	Bis(2-ethylhexyl)phthalate	8	5	< 0.81	2	4.5	5.9
102	Aldrin	13	12	< 0.01	**0.032**[7]	**0.0729**	0.00014
103	A-BHC	7	6	< 0.00	0.0046	0.010	0.013
114	Endosulfan Sulfate	7	6	< 0.01	0.016	0.036	240
117	Heptachlor	11	10	< 0.01	**0.038**	**0.085**	0.00021
16f	1,2,3,4,6,7,8-HpCDD	9	8	< 1.54	6.77	15.1	-
16g	OCDD	10	4	< 7.74	51.6	115.1	-
16h	2,3,7,8-TCDF	10	8	< 1.23	6.25	13.9	-
16q	OCDF	9	6	< 1.85	7.34	16.4	-
16-TEQ	TCDD-TEQ[8]	9	2	< 0.083	**0.394**	**0.879**	0.014[9]
A	Trybutyltin[10]	63	61	< 0.002	0.005	0.010	-

Notes:

1. Qualified values include values flagged as "ND", "<", or "DNQ".
2. Averages computed with NDs, <s and DNQs evaluated at the detection limit.
3. Where dataset consists of both detected and non-detected values, the highest detected value is listed.
4. Estimated values based on 2.23 concentration factor. See "Model Results" discussion.
5. CTR objective for human health, consumption of organisms only
6. One non-detect value with very high DL excluded
7. Aldrin value was from March 2002.
8. TEQ value calculated by EOA. Listed value (<0.603 pg/L) may have been incorrectly calculated.
9. CTR objective is for 2,3,7,8-TCDD, but has been applied to TCDD-TEQ in recent Region 2 NPDES permits.
10. Tributyltin average includes eignt values at <0.01.

Rationale for Selecting Pollutant Concentration Percentiles

EOA evaluated impacts of the RO system on final effluent quality over the range of flows based on average, 95th percentile and 99th percentile pollutant concentrations. Bearing in mind that the analysis was done for worst-case minimum flow conditions, a 95th percentile concentration was selected as a reasonable "worst-case" concentration for comparison to average monthly effluent limitations (or criterion continuous concentration water quality objectives), while the 99th percentile was selected for comparison to daily maximum effluent limitations for copper, nickel, BOD and TSS. These are the same criteria used by the Water Board for assessing feasibility of compliance with water quality based effluent limitations. An argument could made that more conservative (higher) percentiles should be used to represent worst-case conditions, however, EOA believes that the use of a minimum flow condition (which occurs less than 10% of the time) provides a sufficient addition factor of safety for the selected percentiles. In the final analysis, as the project size increases above 32 mgd RO permeate flow, final effluent discharge concentrations are much more sensitive to project size than to the percentile used to characterize pollutant concentrations.

Effluent Limits or Water Quality Objectives

NPDES Permit effluent limits or applicable water quality objectives are also indicated on Tables 1-3. For the compliance evaluation, effluent limits from the current NPDES Permit (Order R2-2003-0085) were used for copper and nickel, and the evaluation is performed relative to both average monthly and daily maximum limits. For mercury, the concentration limit from the recently adopted mercury watershed permit was used. For the remaining metals, the more stringent of the CTR freshwater or saltwater objectives (criterion continuous concentration) is listed.[3] The comparison of model results to average monthly limits (or CCC objectives) is conservative in cases where multiple samples are collected each month. A review of the data indicate that except for copper and nickel, one sample per month is generally the norm for metals.

For cyanide, the next Permit's expected monthly average concentration limit, based on the recently adopted Basin Plan Amendments for Cyanide, was used. The expected value is 7 ug/L. The mass balance approach may not be completely valid for cyanide, as some portion of the cyanide in final effluent is generated during disinfection, and thus levels in the RO concentrate (and the blended final effluent) would be lower than predicted by the mass balance.

For CBOD and TSS, model results were evaluated against both the daily maximum and monthly average effluent limits. For organics, the applicable CTR human health objective (for consumption of organisms only) is listed. The Permit has interim daily maximum effluent limits for dieldrin, 4,4'-DDE, heptachlor epoxide, benzo(b)flouoranthene, and indeno(1,2,3-cd)pyrene which are numerically equal to the Permit-specified minimum detection level (ML) for these compounds. However, none of these pollutants were present at detectable levels in the 2002-2007 data set.

[3] Exceeding a water quality criterion would trigger a determination of "reasonable potential" in the subsequent NPDES Permit renewal process, which would result in the new Permit having an effluent limit for that pollutant. For shallow water dischargers such as the SJ/SC WPCP, the effluent limit would be numerically close to the criterion, except in the case of metals, where the application of site-specific translators could result in effluent limits that are higher than the objective.

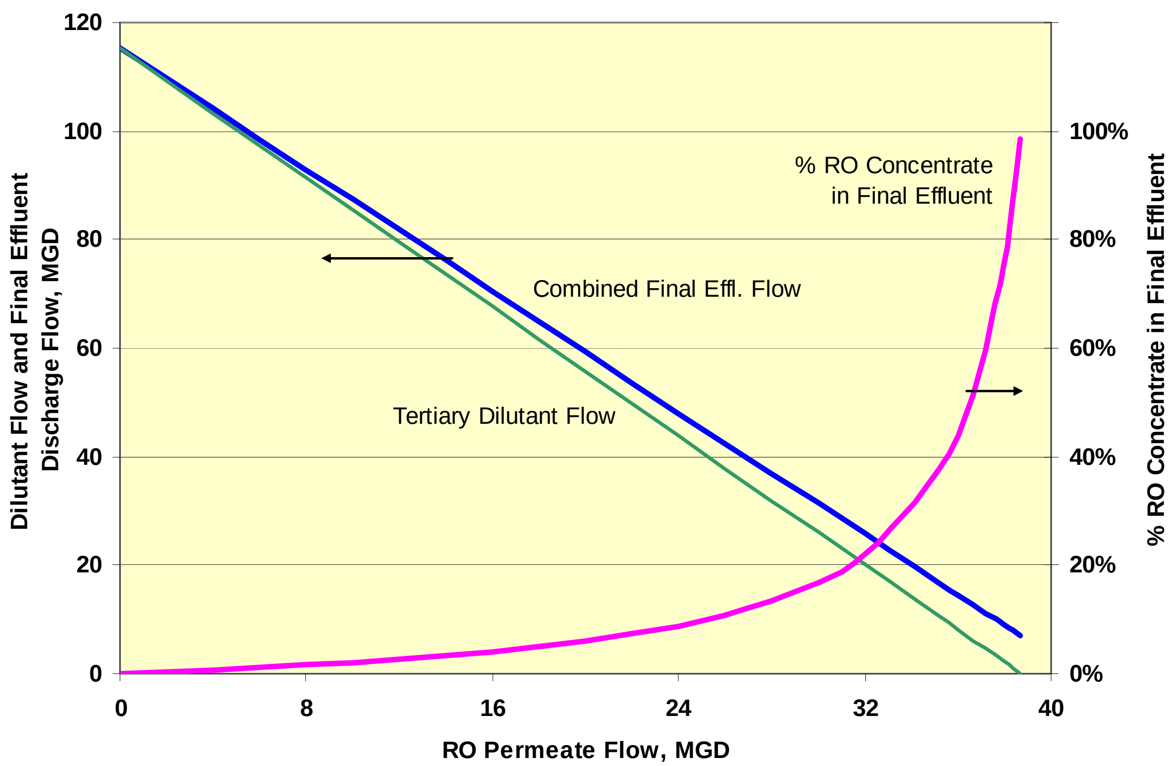
Model Results

The concentrating effect of the RO process on pollutants is determined primarily by the RO rejection rate, which describes the relative amounts of RO permeate and RO concentrate. For a rejection rate of 85% (85% permeate and 15% concentrate), the RO concentrate pollutant concentrations are approximately five time higher than in the feed stream. In the final plant effluent discharged to the Bay, these pollutant concentrations are reduced (diluted) by mixing with the tertiary effluent that remains after the "RO bypass" stream is diverted for blending with the RO product water. The final effluent discharge concentrations depend strongly on the amount of tertiary effluent available for dilution, and the overall impact of the RO system can, to a large extent, be understood by examining changes in the volume of this flow stream as the project size increases.

Figure 2 illustrates that both the tertiary effluent dilutant and final effluent discharge flows decrease linearly as project size (RO permeate flow) increases. Also shown in Figure 2 is the percentage of RO concentrate in the final effluent stream, which increases sharply at RO permeate flows above 32 mgd, to 100% RO concentrate at an RO permeate flow of 38.7 mgd. Note that Figure 2 is for the minimum plant flow condition of 115.3 mgd. The curves in Figure 2 all shift to the right as the plant flow value increases.

Figure 3. Impact of Project Size on Tertiary Effluent Dilutant Flow and Bay Discharge Flow

WPCP Plant Flow = 115.3 mgd; Blend Ratio = 1.8:1



Metals and Cyanide

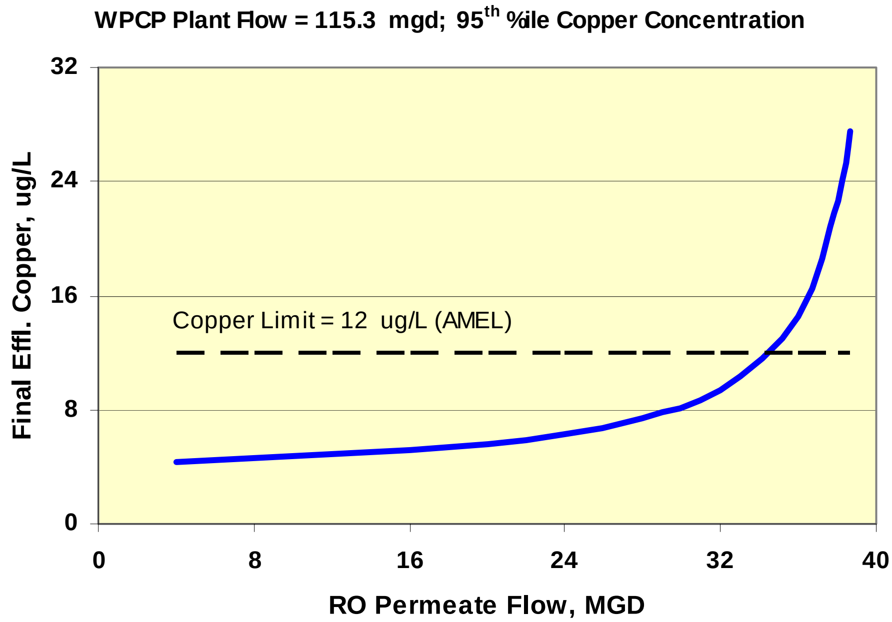
Table B-1 in Appendix B is a typical model result printout for a 32 mgd RO Permeate project, based on a plant flow of 115.3 mgd (minimum plant flow condition) and 95th percentile concentrations. Tables B-2 through B-5 list the blended final effluent concentrations for the 8, 16, 32 mgd projects at all percentile concentration evaluated..

For the specified minimum flow value of 115.3 mgd, the results based on average (mean) concentrations indicate no compliance problems until the RP permeate flow is above 35 mgd. Cyanide is the first to exceed the expected permit limit at about 35 mgd, followed by nickel, which exceeds the average monthly limit at 36.9 mgd.[4] As indicated previously, actual effluent cyanide concentrations may be lower than those calculated by the model.

For 95th percentile concentrations, compliance problems emerge at lower RO permeate flows. Cyanide exceeds the expected limit at 31.8 mgd. Zinc exceeds the water quality objective at 33.3 mgd, while copper exceeds the average monthly effluent limit at 34.6 mgd. For 99th percentile concentrations, cyanide and zinc exceed the effluent limit or WQO at 31.1 mgd, while copper and nickel exceed their respective daily maximum effluent limits at 35.5 mgd.

Figure 4 shows the projected increase blended final effluent copper as project size increases. As expected, the curve closely resembles the"% RO Concentrate in Final Effluent" curve in Figure 3.

Figure 4. Projected Copper Concentration in Blended Final Effluent

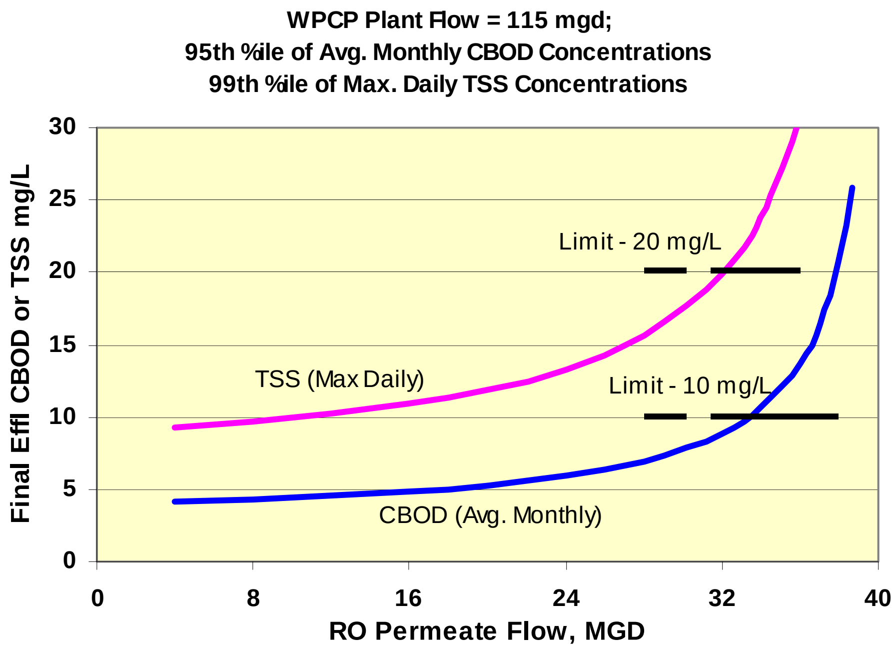


[4] Results for average concentration values are presented only to illustrate the earlier point regarding sensitivity to dilutant flow, and not to suggest that average concentrations should be used to gauge compliance.

Conventional Pollutants

Results for conventional pollutants are also listed on Tables B-2 through B-5. Results are similar to those for metals, with compliance problems starting at around the 32 mgd project size. At just above 32 mgd, the 99th percentile TSS concentration exceeds the maximum daily TSS limit.[5] The next compliance obstacle is the 95th percentile CBOD value, which exceeds the average monthly CBOD limit at 33.4 mgd. Figure 5 shows the projected blended final effluent concentrations over the range of project sizes for these parameters. Compliance problems for ammonia do not emerge until RO permeate flows exceed 37 mgd.

Figure 5. Projected TSS and CBOD Concentrations in Blended Final Effluent

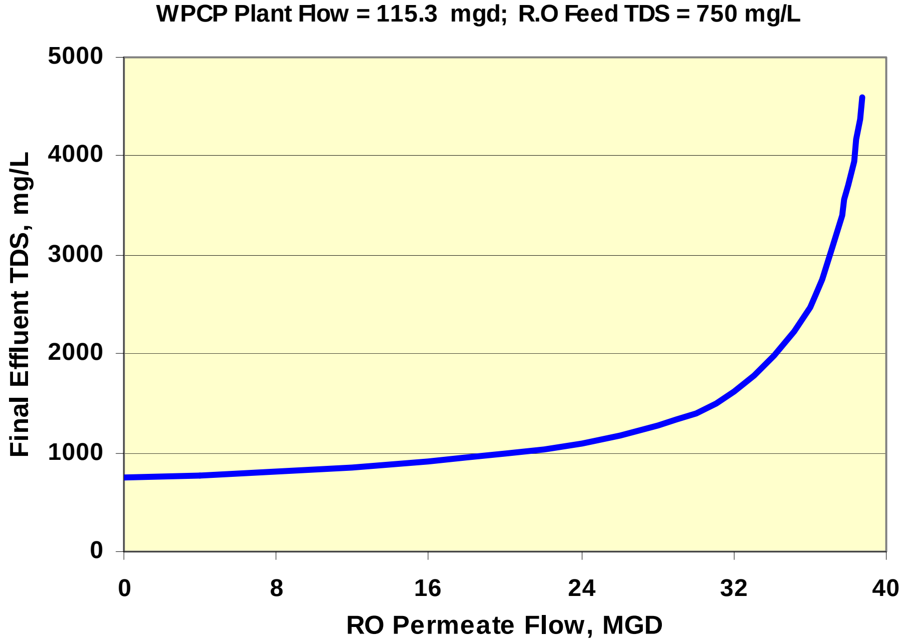


TDS

Figure 6 shows the projected blended final effluent TDS concentrations over the range of project sizes. For a 32 mgd RO permeate project, the projected TDS concentration is 1610 mg/L.

[5] Note that if the 99th percentile TSS concentrations are compared to the monthly average TSS limit, rather than the maximum daily limit as suggested, TSS would exceed the limit at project size of 26.5 mgd RO Permeate. For reasons previously stated, EOA believes this comparison is overly conservative.

Figure 6. Projected TDS Concentration in Blended Final Effluent



Organics

As indicated above, the data set for organics consists almost entirely of non-detect values, and is not really amenable to a mass balance evaluation. However, the summary data in Table 3 can be reviewed to identify pollutants for which an increase in final effluent concentration corresponding to a 32 mgd RO project (a factor of 2.3) might be problematic.[6] (Such a comparison should be considered approximate given the uncertainty is the underlying data). That review indicates that, except for most pollutants, the maximum historic effluent concentrations are far below the applicable objectives, so that the project would have no impact on compliance for these pollutants. A possible exception to this assessment could occur if a compound which has historically never been detected and which has a WQO below the detection limit was rendered detectable by the project. This scenario can only be assessed by analyzing effluent samples that have been concentrated through sample preparation methods or pilot RO studies.

For two pollutants (bis(2-ethylhexyl) phthalate and A-BHC), the projected concentrations for a 32 mgd RO project are within 25% of the WQO. (Note that for A-BHC, this observation is based on a single detected value, and thus subject to much uncertainty. Bis(2-ethylhexyl) phthalate is detected more frequently in effluent samples, and thus a more likely to pose an actual compliance issue). For three pollutants (aldrin, heptachlor, and TCDD-TEQ), the maximum historic values already exceeded the applicable water objective. In each case, the exceeding values are so far above the objective that doubling in concentration would have no bearing on compliance or reasonable potential. Note that for aldrin and heptachlor, the single exceeding values for each are

[6] To the extent that removal of organics by the RO system might be less than 99%, the percent increase of the pollutant concentration in the final effluent could be less than these amounts.

the only detected values in the respective data sets, and may not be representative of actual effluent concentrations. For TCDD-TEQ, the variability in the historic data is so great (many orders of magnitude) that the increased concentration resulting from an RO project unlikely to have any impact on compliance from a practical perspective.

Summary and Conclusions

EOA evaluated the probable impacts on WPCP final effluent discharge quality from blending of RO concentrate generated by the proposed South Bay Advanced Recycled Water Treatment Facility into the WPCP's final effluent stream. The evaluation covered a range of possible project sizes up to 40 mgd of RO Permeate. The project plan calls for blending RO permeate with tertiary plant effluent in at a ratio of 1 to 1.8, in order to reduce TSD levels in the recycled water to 500 mg/L. Based on historic flow data, EOA identified a typical minimum flow condition of 115.3 mgd for use in the evaluation. For this plant flow and the specified RO performance and blend ratio, the percentage of RO concentrate in the final effluent increases gradually to about 20% at a project size of 32 mgd RO permeate (nearly 90 mgd of blended recycled water), and increases rapidly to 100% RO concentrate at 38.7 mgd RO Permeate.

A spreadsheet model was used top perform a mass balance, wherein final effluent concentrations were calculated based on the concentration and flow of RO concentrate and the remaining tertiary effluent after diversions to the recycled water system. EOA examined historic WPCP effluent data to characterize expected pollutant concentrations in the RO feed and tertiary effluent dilutant streams. In order to evaluate plausible worst-case scenarios, percentile concentrations were determined for metals, cyanide, and conventional pollutants. In conjunction with the minimum flow condition, EOA recommends use of the 95^{th} percentile concentration to evaluate compliance relative to average monthly effluent limits, and 99^{th} percentiles for maximum daily effluent limits. For constituents with no effluent limits, EOA compared the blended final effluent concentrations to the applicable water quality objectives (WQOs). (Unless special conditions were applied to the project by the Water Board, concentrations that exceeded WQOs would trigger "reasonable potential" and would result in effluent limits in the subsequent permit). The mass balance approach was not used for organics, which were dominated by non-detect values. Organics were instead evaluated qualitatively.

Neither acute nor chronic toxicity are amenable to analysis by the mass balance approach or by qualitative assessment. EOA recommends that whole effluent toxicity impacts be assessed through screening studies using RO concentrate/tertiary effluent blends generated from benchtop or pilot-scale RO units.

The mass balance analysis indicated likely compliance problems (or exceeding water quality objective) starting at around 32 mgd RO permeate flow. Between 32 and 35 mgd, cyanide, copper, nickel, zinc, TSS and CBOD exceed the applicable effluent limitations, and zinc exceeds the water quality objective. 32 mgd RO permeate (90 mgd total recycled water) would represent a quite large project.

The analysis of historic effluent data for trace organics revealed no likely compliance issues for 109 of the 114 compounds examined. Of the remaining five, the concentrations of two compounds (bis(2-ethylhexyl) phthalate and A-BHC) could increase to levels that might be of concern. (Of these two, bis(2-ethylhexyl) phthalate is more likely to pose an actual compliance issue). For the remaining three pollutants (aldrin, heptachlor, and TCDD-TEQ), one or more maximum historic values exceeded the applicable water objectives. However, for these three, the existing data indicate that a 2.3-fold increase in historic effluent concentrations (which occurs at a project size of 32 mgd RO product) would have no bearing on (i.e. would not change) compliance or reasonable potential.

Overall, the analysis indicates that a project up to about 32 mgd RO permeate should not pose compliance problems with respect to the discharge of RO concentrated blended into the remaining WPCP tertiary effluent plant stream. This conclusion applies to individual conventional or toxic pollutants. Potential Impacts on whole effluent toxicity need to be evaluated separately. A phased approach to project implementation, wherein MF/RO capacity is added in increments, will provide the opportunity to verify the findings from this analysis and more accurately identify the factors that limit the maximum feasible project size based on discharge considerations.

Attachments:

A. Statistical summaries of WPCP effluent data
B. Example spreadsheet model printouts and summary of model results

Attachment A

Statistical Summaries of WPCP Effluent Data

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Table A-1. Summary of WPCP Final Effluent Concentration Data for Metals and Cyanide, 2004-2007[1]

All results are ug/L

	Arsenic	Cadmium	Cr VI	Copper-Daily	Copper-Mo. Avg.	Lead	Mercury[2]	Nickel Daily	Nickel Mo. Avg.	Selenium	Silver	Zinc	Cyanide
# of samples	56	42	8	184	50	43	47	200	48	57	45	65	28
# ND's	0	5	0	0	0	0	0	1	0	0	6	0	1
# DNQ's	0	39	3	0	0	4	0	0	0	0	38	0	23
Minimum	0.40	0.01	0.33	1.50	1.65	0.15	0.0002	4.0	5.0	0.19	0.010	21.3	1
Maximum	2.27	0.23	0.70	9.54	4.98	1.36	0.0049	12.3	9.2	1.18	0.170	85.0	3.4
Median	1.12	0.03	0.51	2.60	2.50	0.43	0.0016	6.0	6.2	0.39	0.027	31.3	2.1
Geo. Mean	1.08	0.03	0.51	2.87	2.58	0.40	0.0016	6.2	6.2	0.41	0.029	35.5	2.10
Average	1.13	0.05	0.53	2.91	2.68	0.46	0.0017	6.4	6.3	0.43	0.038	38.2	2.17
Std. Dev.	0.34	0.05	0.12	1.07	0.80	0.28	0.0024	1.3	0.8	0.15	0.035	15.6	0.56
C.V.	0.30	0.98	0.23	0.37	0.30	0.60	1.3627	0.20	0.13	0.35	0.916	0.41	0.26
90th %ile	1.50	0.08	0.67	4.41	4.07	0.80	0.0024	8.0	7.2	0.60	0.066	60.4	3
95th %ile	1.70	0.15	0.68	4.74	4.23	1.03	0.0027	9.0	7.5	0.66	0.112	68.5	3.20
99th %ile	2.07	0.21	0.70	5.65	4.76	1.36	0.0040	10.8	8.7	0.93	0.166	81.8	3.37

1. Results for cyanide are Nov 2005-December 2007 only, all at low detection limit.
2. "13267" monitoring dataset, one sample/month.
3. Non-detect values with high detection limits were excluced.

Table A-2
San Jose/Santa Clara WPCP Organics Data, 2002 - 2007

All values are ug/L except dioxins and furans, which are pg/L
Shaded values are those withat least one detected or DNQ value.

CTR	Pollutant	Total # Values	# of Qual. Values[1]	Average[2]	Maximum[3]
17	Acrolein	5	5	< 1.73	< 5
18	Acrylonitrile	5	5	< 1.09	< 2
19	Benzene	5	5	< 0.26	< 0.7
20	Bromoform (Tribromomethane)	7	2	< 0.37	0.69
21	Carbon tetrachloride	5	5	< 0.28	< 0.75
22	Chlorobenzene	5	5	< 0.25	< 0.63
23	Chlorodibromomethane	8	0	1.93	3.5
24	Chloroethane (Ethyl Chloride)	5	5	< 0.31	< 0.92
25	2-Chloroethylvinylether	5	5	< 0.32	< 1
26	Chloroform	12	0	4.87	10
27	Dichlorobromomethane	8	0	3.49	5.9
28	1,1-dichloroethane (ethylidene chloride)	5	5	< 0.27	< 0.73
29	1,2-Dichloroethane	5	5	< 0.28	< 0.75
30	1,1-Dichloroethylene	5	5	< 0.29	< 0.74
31	1,2-Dichloropropane	5	5	< 2.16	< 10
33	Ethylbenzene	5	5	< 0.26	< 0.65
34	Bromomethane (Methyl Bromide)	4	4	< 0.37	< 0.84
35	Chloromethane (Methyl Chloride)	5	4	< 0.33	0.04
36	Methylene Chloride	7	2	< 0.34	0.8
37	1,1,2,2-Tetrachloroethane	5	5	< 0.29	< 0.79
38	Tetrachloroethylene	5	5	< 0.29	< 0.82
39	Toluene	7	2	< 0.54	0.9
40	TRANS-1,2-dichloroethylene	5	5	< 0.29	< 0.77
41	1,1,1-Trichloroethane (Methyl Chloroform)	5	5	< 0.27	< 0.75
42	1,1,2-Trichloroethane (Vinyl Trichloride)	5	5	< 0.28	< 0.73
43	Trichloroethene	5	5	< 0.27	< 0.69
44	Vinyl chloride	5	5	< 0.33	< 1
45	2-Chlorophenol	7	7	< 0.80	< 2
46	2,4-Dichlorophenol	7	7	< 0.78	< 1
47	2,4-Dimethylphenol (Xylenol Isomer)	7	7	< 0.93	< 2
48	4,6,-Dinitro-2-methylphenol	7	7	< 1.56	< 5
49	2,4,- Dinitrophenol	6	6	< 1.05	< 1.2
50	2-Nitrophenol	7	7	< 1.85	< 5
51	4-Nitrophenol	7	7	< 1.36	< 5
52	4-chloro-3-methylphenol	7	7	< 0.79	< 1
53	Pentachlorophenol	7	7	< 1.00	< 1.7
54	Phenol	7	7	< 0.63	< 1
55	2,4,6-Trichlorophenol	7	7	< 1.44	< 5
56	Acenaphthene	9	9	< 0.09	< 0.3
57	acenaphtylene	19	19	< 0.11	< 0.27
58	anthracene	19	19	< 0.27	< 3
59	Benzidine	7	7	< 3.06	< 10
60	1,2,-benzo(a)Anthracene	19	19	< 0.14	< 0.3
61	benzo[a]pyrene	19	19	< 0.16	< 0.3
62	3,4-benzo(b)fluoranthene	24	24	< 0.15	< 0.3
63	1,12-benzo(g,h,i)perylene	19	19	< 0.11	< 0.31
64	benzo[k]fluoranthene	19	19	< 0.13	< 0.3
65	Bis(2-chloroethoxy)methane	7	7	< 1.21	< 5
66	Bis(2-chloroethyl)ether	7	7	< 1.26	< 5

CTR	Pollutant	Total # Values	# of Qual. Values[1]	Average[2]	Maximum[3]
67	Bis(2-chlorisopropyl)ether	7	7	< 1.18	< 5
68	Bis(2-ethylhexyl)phthalate	8	5	< 0.81	2
69	4-Bromophenyl-Phenylether	7	7	< 1.27	< 5
70	Butylbenzyl Phthalate (BBP)	7	7	< 1.61	< 5
71	2-Chloronaphthalene	7	7	< 1.27	< 5
72	4-Chlorophenyl-Phenylether	7	7	< 1.21	< 5
73	chrysene	19	19	< 0.14	< 0.401
74	dibenzo[ah]Anthracene	19	19	< 0.11	< 0.282
75	1,2-Dichlorobenzene	5	5	< 0.28	< 0.77
76	1,3-Dichlorobenzene	5	5	< 2.15	< 10
77	1,4-Dichlorobenzene	6	3	< 2.00	10
78	3,3-Dichlorobenzidine	7	7	< 1.60	< 5
79	Diethyl phthalate	7	7	< 0.90	< 2
80	Dimethyl phthalate	7	7	< 0.77	< 2
81	Di-n-butyl Phthalate	7	7	< 1.23	< 5
82	2,4-Dinitrotoluene	7	7	< 1.32	< 5
83	2,6-Dinitrotoluene	7	7	< 1.22	< 5
84	DI-N-Octyl Phthalate (Dioctyl Phthalate)	7	7	< 1.63	< 5
85	1,2-Diphenylhydrazine	7	7	< 0.66	< 1
86	Fluoranthene	9	9	< 0.04	< 0.05
87	fluorene	19	19	< 0.08	< 0.146
88	Hexachlorobenzene	11	11	< 0.89	< 2.5
89	Hexachlorobutadiene	7	7	< 0.67	< 1
90	Hexachlorocyclopentadiene	7	7	< 1.95	< 5
91	Hexachloroethane	7	7	< 0.86	< 1.33
92	indeno[1,2,3-cd]pyrene	24	24	< 0.06	< 0.24
93	Isophorone	7	7	< 0.60	< 1
94	Naphthalene (Tar Camphor)	9	9	< 0.08	< 0.2
95	Nitrobenzene (Oil of Mirbane)	7	7	< 0.69	< 1
96	N-nitrosodimethylamine	7	7	< 1.39	< 5
97	N-Nitrosodi-N-Propylamine	7	7	< 0.73	< 1
98	N-nitrosodiphenylamine	7	7	< 0.58	< 1
99	phenanthrene	19	19	< 0.06	< 0.171
100	pyrene	19	19	< 0.06	< 0.205
101	1,2,4-Trichlorobenzene	7	7	< 1.36	< 5
102	Aldrin	13	12	< 0.01	0.032
103	A-BHC	7	6	< 0.00	0.0046
104	B-BHC	6	6	< 0.00	< 0.005
105	G-BHC (Lindane)	6	6	< 0.00	< 0.01
106	Delta-BHC (C-BHC)	6	6	< 0.00	< 0.005
107	Chlordane	10	10	< 0.02	< 0.1
108	4,4'-DDT	6	6	< 0.00	< 0.01
109	4,4'-DDE	10	10	< 0.01	< 0.01
110	4,4'-DDD	6	6	< 0.00	< 0.01
111	Dieldrin	14	14	< 0.01	< 0.01
112	Endosulfan (alpha)	6	6	< 0.00	< 0.01
113	Endosulfan (beta)	6	6	< 0.00	< 0.01
114	Endosulfan Sulfate	7	6	< 0.01	0.016
115	Endrin	10	10	< 0.01	< 0.02
116	Endrin Aldehyde	6	6	< 0.00	< 0.01
117	Heptachlor	11	10	< 0.01	0.038
118	Heptachlor Epoxide	14	14	< 0.01	< 0.1
119	PCB-1016 (Aroclor)	10	10	< 0.09	< 0.2
120	PCB-1221 (Aroclor)	10	10	< 0.11	< 0.2

CTR	Pollutant	Total # Values	# of Qual. Values[1]	Average[2]	Maximum[3]
121	PCB-1232 (Aroclor)	6	6	< 0.04	< 0.06
122	PCB-1242 (Aroclor)	10	10	< 0.10	< 0.2
123	PCB-1248 (Aroclor)	10	10	< 0.10	< 0.2
124	PCB-1254 (Aroclor)	10	10	< 0.09	< 0.2
125	PCB-1260 (Aroclor)	10	10	< 0.09	< 0.2
126	Toxaphene	10	10	< 0.36	< 2
16a	2,3,7,8-TCDD	11	11	< 0.42	< 1.25
16b	1,2,3,7,8-PeCDD	9	9	< 0.80	< 2.81
16c	1,2,3,4,7,8-HxCDD	9	9	< 0.61	< 1.75
16d	1,2,3,6,7,8-HxCDD	9	9	< 0.69	< 1.87
16e	1,2,3,7,8,9-HxCDD	9	9	< 0.87	< 2.71
16f	1,2,3,4,6,7,8-HpCDD	9	8	< 1.54	6.77
16g	OCDD	10	4	< 7.74	51.6
16h	2,3,7,8-TCDF	10	8	< 1.23	6.25
16i	1,2,3,7,8-PeCDF	9	9	< 0.67	< 2.25
16j	2,3,4,7,8-PeCDF	9	9	< 0.65	< 2.38
16k	1,2,3,4,7,8-HxCDF	9	9	< 0.71	< 2.38
16l	1,2,3,6,7,8-HxCDF	9	9	< 0.67	< 2.44
16m	2,3,4,6,7,8-HxCDF	9	9	< 0.71	< 3.06
16n	1,2,3,7,8,9-HxCDF	9	9	< 0.70	< 2.31
16o	1,2,3,4,6,7,8-HpCDF	9	8	< 1.14	3.57
16p	1,2,3,4,7,8,9-HpCDF	9	9	< 0.83	< 3.13
16q	OCDF	9	6	< 1.85	7.34
16-TEQ	TCDD-TEQ[4]	9	2	< 0.083	**0.394**
32-cis	cis-1,3-Dichloropropene	5	5	< 0.25	< 0.63
32-tran	trans-1,3-Dichloropropene	5	5	< 0.26	< 0.66
A	Trybutyltin[5]	63	61	< 0.002	0.005
B	Chlorpyrifos	6	6	< 0.038	< 0.064
C	Diazinon	5	5	< 0.041	< 0.067

1. Qualified values defined as "ND" or "<".
2. Averages computed with "ND" and "<" values evaluated at the detection limit. DNQs evaluated at the estimated value.
3. Where dataset consists of both detected and non-detected values, the highest detected value is listed.
4. Second highest value in database. Highest value (<0.603 pg/L) appears to have been incorrectly calculated.
5. Two high detection limit tributyltin values (<0.01) excluded from summary statistics.

Table A-3. SJ/SC Dioxins and Furans Data from Water Board Electronic Reporting System (ERS), 2002 - 2007

CTR	Pollutant	TEF	05-Mar-02	03-Sep-02	04-Mar-03	08-Mar-04	08-Mar-05
16a	2,3,7,8-TCDD	1	< 0.233	< 0.565	< 0.355	ND 0.465 *	< 1.25
16b	1,2,3,7,8-PeCDD	1	< 0.938	< 0.369	< 0.584	ND 2.81	
16c	1,2,3,4,7,8-HxCDD	0.1	< 0.666	< 0.584	< 0.208	ND 1.75	
16d	1,2,3,6,7,8-HxCDD	0.1	< 0.763	< 0.594	< 0.212	ND 1.87	
16e	1,2,3,7,8,9-HxCDD	0.1	< 0.662	< 0.586	< 0.361	ND 2.71	
16f	1,2,3,4,6,7,8-HpCDD	0.01	< 0.901	< 0.816	< 0.357	ND 3.05	
16g	OCDD	0.0001	9.7	2.38	< 1.32	2.68	DNQ 1.58
16h	2,3,7,8-TCDF	0.1	0.343	< 0.481	3.94	ND 0.294 *	< 6.25
16i	1,2,3,7,8-PeCDF	0.05	< 0.474	< 0.568	< 0.243	ND 2.25	
16j	2,3,4,7,8-PeCDF	0.5	< 0.406	< 0.461	< 0.245	ND 2.38	
16k	1,2,3,4,7,8-HxCDF	0.1	< 0.396	< 0.163	< 0.686	ND 2.38	
16l	1,2,3,6,7,8-HxCDF	0.1	< 0.4	< 0.167	< 0.687	ND 2.44	
16m	2,3,4,6,7,8-HxCDF	0.1	< 0.448	< 0.197	< 0.542	ND 3.06	
16n	1,2,3,7,8,9-HxCDF	0.1	< 0.552	< 0.304	< 0.579	ND 2.31	
16o	1,2,3,4,6,7,8-HpCDF	0.01	< 0.73	< 0.314	< 0.435	ND 3.57	
16p	1,2,3,4,7,8,9-HpCDF	0.01	< 1.06	< 0.426	< 0.697	ND 3.13	
16q	OCDF	0.0001	< 1.05	< 1.18		2.06	DNQ 0.611
16-TEQ	TCDD-TEQ, reported		< **0.035**	**0.00024**	< **0.603**	**0.000268**	**0.000219**
16-TEQ	TCDD-TEQ, EOA calc.		**0.035**	**0.00024**	**0.394**	**0.000474**	**0.000219**

CTR	Pollutant	TEF	07-Sep-05	07-Mar-06	07-Sep-06	06-Mar-07	05-Sep-07
16a	2,3,7,8-TCDD	1	< 0.3799406 *	< 0.145 *	< 0.192 *	< 0.192 *	< 0.192 *
16b	1,2,3,7,8-PeCDD	1	< 1.425828	< 0.568	< 0.0242	< 0.242	< 0.242
16c	1,2,3,4,7,8-HxCDD	0.1	< 1.330278	< 0.527	< 0.128	< 0.128	< 0.128
16d	1,2,3,6,7,8-HxCDD	0.1	< 1.857588	< 0.553	< 0.106	< 0.106	< 0.106
16e	1,2,3,7,8,9-HxCDD	0.1	< 2.034669	< 0.707	< 0.258	< 0.258	< 0.258
16f	1,2,3,4,6,7,8-HpCDD	0.01	< 1.315903	6.77	< 0.231	< 0.231	< 0.231
16g	OCDD	0.0001	DNQ 2.53	51.6	< 1.86	< 1.86	< 1.86
16h	2,3,7,8-TCDF	0.1	< 0.3899127 *	< 0.148 *	< 0.135 *	< 0.135 *	< 0.135 *
16i	1,2,3,7,8-PeCDF	0.05	< 1.255998	< 0.758	< 0.172	< 0.172	< 0.172
16j	2,3,4,7,8-PeCDF	0.5	< 1.491278	< 0.35	< 0.172	< 0.172	< 0.172
16k	1,2,3,4,7,8-HxCDF	0.1	< 1.618956	< 0.41	< 0.236	< 0.236	< 0.236
16l	1,2,3,6,7,8-HxCDF	0.1	< 1.333902	< 0.505	< 0.163	< 0.163	< 0.163
16m	2,3,4,6,7,8-HxCDF	0.1	< 1.13	< 0.376	< 0.198	< 0.198	< 0.198
16n	1,2,3,7,8,9-HxCDF	0.1	< 1.52	< 0.573	< 0.154	< 0.154	< 0.154
16o	1,2,3,4,6,7,8-HpCDF	0.01	< 1.796544	DNQ 2.45	< 0.333	< 0.333	< 0.333
16p	1,2,3,4,7,8,9-HpCDF	0.01	< 1.082697	< 0.43	< 0.206	< 0.206	< 0.206
16q	OCDF	0.0001	< 3.151752	7.34	< 0.405	< 0.405	< 0.405
16-TEQ	TCDD-TEQ, reported		**0.00596**	**0.0981**	**0.000**	**0.000**	**0.000**
16-TEQ	TCDD-TEQ, EOA calc.		**0.000253**	**0.0981**	**0.000**	**0.000**	**0.000**

* Values were reported in the ERS on both "E-001" and "EPA 1613" sheets, but at different reporting limits. The value with the lower reporting limit was listed.

In addition to the above, a value for 2,3,7,8-TCDD of <0.637 pg/L was reported (on the ERS E-001 sheet) on 9/8/04. Discrepancies in calculated TEQ values are highlighted.

Table A-4. Summary of WPCP Final Effluent Concentration Data for Conventional Pollutants, 2004-2007

All results are mg/L

	CBOD Daily	CBOD Monthly	TSS Daily	TSS Monthly	NH3	Oil & Grease
# of samples	461	48	645	48	48	25
# ND's	104	22	97	22	2	22
Minimum	2.00	2.00	1.00	1.05	0.21	5.0
Maximum	5.00	4.25	12.90	7.14	0.90	5.0
Median	3.00	2.83	1.70	1.68	0.40	5.0
Geo. Mean	2.64	2.76	1.68	1.69	0.42	5.0
Average	2.75	2.81	1.98	1.84	0.44	5.0
Std. Deviation	0.82	0.58	1.58	1.02	0.12	0.0
Coeff. of Variation	0.30	0.20	0.80	0.56	0.28	0.0
90th %ile	4.00	3.37	3.00	2.33	0.60	5.0
95th %ile	4.00	3.97	6.18	2.61	0.60	5.0
99th %ile	5.00	4.31	8.91	6.20	0.76	5.0

Ammonia and O&G values represent both daily maximum and monthly average.

Percentiles are based on ranked individual values (Excel percentile function).

Attachment B

Example Spreadsheet Model Printouts and Summary of Model Results

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Table B-1a. Impact of RO Reject on WPCP Final Effluent Quality (Metals and Cyanide)
RO Permeate Flow = 32 mgd; Final Effluent Data are 95%ile Values

Specified Values:		
RO Permeate Flow =	32.0	mgd
Secondary Effluent Flow =	115.3	mgd[1]
Tert. Effl/RO Perm. Blend Ratio	1.8	
RO Flow Recovery =	85%	
Final Effluent Conc. Data =	95%ile	values[2]

RO Feed Flow =	37.65	mgd
Adj. Secondary Effluent Flow =	57.7	mgd (Flow after deducting Tert. Effl./RO Bypass Flow)
Tert. Effl./RO Bypass Flow =	57.6	mgd
RO Reject Flow =	5.65	mgd
Total RW Blended Flow =	89.6	mgd (Includes RO Bypass Flow + RO Permeate Flow)
Combined Final Effluent Flow =	25.7	mgd (Final E-001 Discharge Flow Including RO Reject)

Pollutant	**Historic Final Effluent[2]**		**RO Feed**		**RO Rejection[4] %**	**Permeate**		**RO Concentrate**		**Combined Final Effluent[2]**		**NPDES Permit Limits ug/l**	**Adj. CTR WQOs for RPA ug/l**
	Conc. ug/l	**Mass lb/day**	**Conc. ug/l**	**Mass lb/day**		**Conc. ug/l**	**Mass lb/day**	**Conc. ug/l**	**Mass lb/day**	**Conc. ug/l**	**Mass lb/day**		
Arsenic	1.70	0.82	1.70	0.535	99%	0.02	0.005	11.2	0.529	3.80	0.81		36
Cadmium	0.15	0.07	0.15	0.046	99%	0.00	0.000	0.97	0.046	0.328	0.07		7
Chromium VI	0.68	0.33	0.68	0.214	99%	0.01	0.002	4.5	0.212	1.52	0.33		200
Copper - max. daily	4.74	2.28	4.74	1.489	99%	0.06	0.015	31.3	1.474	10.6	2.27	18	
Copper - avg. monthly	4.23	2.03	4.23	1.328	99%	0.05	0.013	27.9	1.314	9.43	2.02	12	13[7]
Lead	1.03	0.50	1.03	0.323	99%	0.01	0.003	6.8	0.320	2.30	0.49		8.52
Mercury[5]	0.0027	0.0013	0.0027	0.0009	99%	0.000	0.000	0.018	0.0008	0.0061	0.0013	0.023	0.051
Nickel - max. daily	9.00	4.33	9.00	2.826	99%	0.11	0.028	59.4	2.798	20.1	4.30	34	
Nickel - avg. monthly	7.48	3.60	7.48	2.347	99%	0.09	0.023	49.3	2.324	16.7	3.57	25	27[7]
Selenium	0.66	0.32	0.66	0.208	99%	0.01	0.002	4.4	0.206	1.48	0.32		5
Silver	0.112	0.054	0.11	0.035	99%	0.00	0.000	0.7	0.035	0.250	0.054		2.24
Zinc	68	33.0	68	21.50	99%	0.8	0.215	452	21.29	153	32.7		170
Cyanide-SSO/BPA[6]	3.2	1.54	3.2	1.003	99%	0.0	0.010	21	0.993	**7.1**	1.53	7.0	2.9[7]

Notes:

1. Equivalent to the secondary effl. flow (minus MF backwash) before any recycled water or RO system diversions. Value listed is avg. from minimum discharge flow month (8/2005).
2. Historic NPDES effluent from RWQCB ERS database, used to represent Sec. Effluent prior to RO System. Based on individual values from Jan 2004 - Dec 2006, except as noted in text.
3. Combined Final effluent (including RO reject) to outfall E-001. Values that exceed NPDES Permit or WQO-based limits are indicated in **bold**.
4. Defined as: Rejection = (1-Permeate Conc./Feed Conc) * 100. Note: Other definitions are sometimes used for rejection.
5. Mercury data is from "13267" dataset, monthly average values. Effluent limit is from Mercury Watershed Permit (AMEL).
6. Expected average monthly effluent limit (AMEL) under cyanide Site Specific Objectives/Basin Plan Amendment. Dataset is low DL "13267" monitoring data only.
7. Based on a constant TDS value of 750 mg/L at all percentiles. Rejection rate (93.3%) is the expected long-term value.

Table B-1b. Impact of RO Reject on WPCP Final Effluent Quality (Conventional Pollutants)

RO Permeate Flow = 32 mgd; Final Effluent Data are 99%ile Values

Specified Values:		
RO Permeate Flow =	32.0	mgd
Secondary Effluent Flow =	115.3	mgd[1]
Tert. Effl/RO Perm. Blend Ratio	1.8	
RO Flow Recovery =	85%	
Final Effluent Conc. Data =	99%ile	values[2]

RO Feed Flow =	37.65	mgd
Adj. Secondary Effluent Flow =	57.7	mgd (Flow after deducting Tert. Effl./RO Bypass Flow)
Tert. Effl./RO Bypass Flow =	57.6	mgd
RO Reject Flow =	5.65	mgd
Total RW Blended Flow =	89.6	mgd (Includes RO Bypass Flow + RO Permeate Flow)
Combined Final Effluent Flow =	25.7	mgd (Final E-001 Discharge Flow Including RO Reject)

Pollutant	**Historic Final Effluent[2]**		**RO Feed**		**RO Rejection[4]**	**RO Concentrate**		**Combined Final Effluent[2]**		**NPDES Permit Limits**
	Conc. mg/l	**Mass lb/day**	**Conc. ug/l**	**Mass lb/day**	**%**	**Conc. ug/l**	**Mass lb/day**	**Conc. ug/l**	**Mass lb/day**	**mg/l**
CBOD - max. daily	5.00	2406	5.00	1570	99%	33.0	1554	11.15	2390	20
CBOD - avg. monthly	4.31	2073	4.31	1353	99%	28.4	1339	9.61	2060	10
TSS - max. daily	8.91	4289	8.91	2798	99%	58.8	2770	19.88	4261	20
TSS - avg. monthly	6.20	2981	6.20	1945	99%	40.9	1926	**13.82**	2962	10
Ammonia-N	0.76	365	0.76	238	90%	4.6	214	1.59	341	3
TDS	750	360,914	750	235,482	93%	4,665	219,705	1,610	345,136	-

Notes:

1. Equivalent to the secondary effl. flow (minus MF backwash) before any recycled water or RO system diversions. Value listed is avg. from minimum discharge flow month (8/2005).
2. Historic NPDES effluent from RWQCB ERS database, used to represent Sec. Effluent prior to RO System. Based on individual values from Jan 2004 - Dec 2006, except as notec
3. Combined Final effluent (including RO reject) to outfall E-001. Values that exceed NPDES Permit or WQO-based limits are indicated in **bold**.
4. Defined as: Rejection = (1-Permeate Conc./Feed Conc) * 100. Note: Other definitions are sometimes used for rejection.

Table B-2. Mass Balance Results for 8 MGD RO Permeate Project

	WPCP Blended Effluent Concentration, ug/L				Effluent Limit or WQO
	Average	90%ile	95%ile	99%ile	
Arsenic	1.23	1.6	1.8	2.2	36
Cadmium	0.050	0.09	0.16	0.22	7
Chromium VI	0.57	0.72	0.74	0.76	200
Copper - daily max.	3.2	4.8	5.1	6.1	18
Copper - monthly avg	2.91	4.4	4.6	5.2	12
Lead	0.50	0.9	1.1	1.5	8.5
Mercury	0.0019	0.0026	0.0030	0.0044	0.025
Nickel - daily max	6.9	8.7	9.8	11.7	34
Nickel - monthly avg	6.8	7.8	8.1	9.4	25
Selenium	0.47	0.65	0.72	1.01	5
Silver	0.042	0.07	0.12	0.18	2
Zinc	41	66	74	89	170
Cyanide	2.4	3.3	3.5	3.7	7

	WPCP Effluent Concentration, mg/L				Effluent Limit
	Average	90%ile	95%ile	99%ile	
CBOD - daily max	3.0	4.3	4.3	5.4	20
CBOD - monthly avg	3.1	3.7	4.3	4.7	10
TSS - daily max	2.2	3.3	6.7	9.7	20
TSS - monthly avg	2.0	2.5	2.8	6.7	10
Ammonia-N	0.5	0.6	0.6	0.8	3.0
TDS	809	-	-	-	-

Specified Values:

RO Permeate Flow = 8 mgd
Sec. Effluent Flow = 115.3 mgd
Tert. Effluent / RO Perm. Blend Ratio = 1.8
RO Flow Recovery = 85%

Calculated Flows (mgd)

RO Feed Flow = 9.41
Adj. Secondary Effluent Flow = 100.9
Tert. Effl./RO Bypass Flow = 14.4
RO Reject Flow = 1.4
Total RW Blended Flow = 22.4
Combined Final Effl. Flow = 92.9

Table B-3. Mass Balance Results for 16 MGD RO Permeate Project

	WPCP Blended Effluent Concentration, ug/L				Effluent Limit or WQO
	Average	90%ile	95%ile	99%ile	
Arsenic	1.39	1.8	2.1	2.5	36
Cadmium	0.057	0.10	0.18	0.25	7
Chromium VI	0.65	0.82	0.84	0.85	200
Copper - daily max.	3.6	5.4	5.8	6.9	18
Copper - monthly avg	3.28	5.0	5.2	5.8	12
Lead	0.57	1.0	1.3	1.7	8.5
Mercury	0.0021	0.0029	0.0033	0.0049	0.025
Nickel - daily max	7.8	9.8	11.0	13.2	34
Nickel - monthly avg	7.7	8.8	9.2	10.6	25
Selenium	0.53	0.74	0.81	1.14	5
Silver	0.047	0.08	0.14	0.20	2
Zinc	47	74	84	100	170
Cyanide	2.7	3.7	3.9	4.1	7

	WPCP Effluent Concentration, mg/L				Effluent Limit
	Average	90%ile	95%ile	99%ile	
CBOD - daily max	3.4	4.9	4.9	6.1	20
CBOD - monthly avg	3.4	4.1	4.9	5.3	10
TSS - daily max	2.4	3.7	7.6	10.9	20
TSS - monthly avg	2.3	2.9	3.2	7.6	10
Ammonia-N	0.5	0.7	0.7	0.9	3.0
TDS	907	-	-	-	-

Specified Values:

RO Permeate Flow = 16 mgd
Sec. Effluent Flow = 115.3 mgd
Tert. Effluent / RO Perm. Blend Ratio = 1.8
RO Flow Recovery = 85%

Calculated Flows (mgd)

RO Feed Flow = 18.8
Adj. Secondary Effluent Flow = 86.5
Tert. Effl./RO Bypass Flow = 28.8
RO Reject Flow = 2.8
Total RW Blended Flow = 44.8
Combined Final Effl. Flow = 70.5

Table B-4. Mass Balance Results for 24 MGD RO Permeate Project

	WPCP Blended Effluent Concentration, ug/L				Effluent Limit or WQO
	Average	90%ile	95%ile	99%ile	
Arsenic	1.69	2.2	2.5	3.1	36
Cadmium	0.069	0.12	0.22	0.31	7
Chromium VI	0.79	0.99	1.02	1.04	200
Copper - daily max.	4.3	6.6	7.1	8.4	18
Copper - monthly avg	4.00	6.1	6.3	7.1	12
Lead	0.69	1.2	1.5	2.0	8.5
Mercury	0.0026	0.0035	0.0041	0.0060	0.025
Nickel - daily max	9.5	11.9	13.4	16.1	34
Nickel - monthly avg	9.3	10.7	11.2	13.0	25
Selenium	0.64	0.90	0.99	1.39	5
Silver	0.057	0.10	0.17	0.25	2
Zinc	57	90	102	122	170
Cyanide	3.2	4.5	4.8	5.0	7

	WPCP Effluent Concentration, mg/L				Effluent Limit
	Average	90%ile	95%ile	99%ile	
CBOD - daily max	4.1	6.0	6.0	7.5	20
CBOD - monthly avg	4.2	5.0	5.9	6.4	10
TSS - daily max	3.0	4.5	9.2	13.3	20
TSS - monthly avg	2.7	3.5	3.9	9.3	10
Ammonia-N	0.6	0.9	0.9	1.1	3.0
TDS	1095	-	-	-	-

Specified Values:

RO Permeate Flow = 24 mgd
Sec. Effluent Flow = 115.3 mgd
Tert. Effluent / RO Perm. Blend Ratio = 1.8
RO Flow Recovery = 85%

Calculated Flows (mgd)

RO Feed Flow = 28.2
Adj. Secondary Effluent Flow = 72.1
Tert. Effl./RO Bypass Flow = 43.2
RO Reject Flow = 4.2
Total RW Blended Flow = 67.2
Combined Final Effl. Flow = 48.1

Table B-5. Mass Balance Results for 32 MGD RO Permeate Project

	WPCP Blended Effluent Concentration, ug/L				Effluent Limit or WQO
	Average	**90%ile**	**95%ile**	**99%ile**	
Arsenic	2.5	3.3	3.8	4.6	36
Cadmium	0.10	0.18	0.33	0.46	7
Chromium VI	1.18	1.48	1.52	1.55	200
Copper - daily max.	6.5	9.8	10.6	12.6	18
Copper - monthly avg	6.0	9.1	9.4	10.6	12
Lead	1.0	1.8	2.3	3.0	8.5
Mercury	0.0039	0.0053	0.0061	0.0090	0.025
Nickel - daily max	14.3	17.8	20.1	24.1	34
Nickel - monthly avg	13.9	16.0	16.7	19.4	25
Selenium	0.96	1.35	1.48	2.08	5
Silver	0.09	0.15	0.25	0.37	2
Zinc	85	135	153	**182**	170
Cyanide	4.8	6.7	**7.1**	**7.5**	7

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	WPCP Effluent Concentration, mg/L				Effluent Limit
	Average	**90%ile**	**95%ile**	**99%ile**	
CBOD - daily max	6.1	8.9	8.9	11.2	20
CBOD - monthly avg	6.3	7.5	8.9	9.6	10
TSS - daily max	4.4	6.7	13.8	19.9	20
TSS - monthly avg	4.1	5.2	5.8	**13.8**	10
Ammonia-N	0.9	1.3	1.3	1.6	3.0
TDS	1610	-	-	-	-

Specified Values:

RO Permeate Flow = 32 mgd
Sec. Effluent Flow = 115.3 mgd
Tert. Effluent / RO Perm. Blend Ratio = 1.8
RO Flow Recovery = 85%

Calculated Flows (mgd)

RO Feed Flow = 37.65
Adj. Secondary Effluent Flow = 57.7
Tert. Effl./RO Bypass Flow = 57.6
RO Reject Flow = 5.65
Total RW Blended Flow = 89.6
Combined Final Effl. Flow = 25.7

Appendix C
RO Pilot Toxicity Test Workplan

Eisenberg, Olivieri & Associates
Environmental and Public Health Engineering

TECHNICAL MEMORANDUM

TO: Sanjay Reddy and Dan Lopez, Black & Veatch

FROM: Tom Hall, EOA
Scott Ogle, PER

DATE: October 30, 2009

SUBJECT: **South Bay Advanced Recycled Water Treatment Facility Project – DRAFT PILOT TOXICITY TESTING WORKPLAN**

INTRODUCTION

The Santa Clara Valley Water District (SCVWD) and San Jose/Santa Clara Water Pollution Plant (WPCP) are planning to construct a facility to reduce salinity levels in recycled water (RW) produced at the WPCP. The facility will utilize microfiltration (MF) and reverse osmosis (RO) to meet Title 22 filtration requirements for disinfected tertiary RW and to reduce salinity levels in the recycled water (RW) product. RW from these systems will be disinfected and delivered to the South Bay Water Recycling distribution system. The MF waste stream will be returned to the plant for processing, while the RO waste stream (RO reject) will be recombined with the WPCP effluent stream for discharge to the Bay.

Previously, EOA examined the likely impact of the RO reject on final effluent quality from the WPCP. The analysis considered conventional pollutants (CBOD, TSS and ammonia) and toxic pollutants which are regulated (or potentially regulated) under the WPCP's NPDES Permit. The analysis used a mass balance model to determine pollutant concentrations in the RO reject and the combined final plant effluent discharge streams. The projections were based on historic WPCP effluent quality and flow data, plus projected flows and performance data for the MF/RO system.

The initial analysis was for a Phase 1 project that would blend 8 mgd of RO product (permeate) with a slightly greater amount of tertiary effluent, to produce a total of 16.8 mgd blended recycled water. The project was shown to have only a minor impact on pollutant concentrations in the final effluent discharged to the Bay, raising concentrations by about 8% from current levels (see May 22, 2007 EOA Technical Memorandum). Under those assumed flow and operational conditions, the combined final effluent would contain approximately 1.4 percent RO reject.

The current 8 mgd scenario calls for an increase in the volume of tertiary effluent to be blended with the RO permeate from 8.7 mgd to 14.4 mgd (1.8 to 1 blend ratio) to achieve a target blended recycled water TDS concentration of approximately 500 mg/L. This scenario slightly raises the amount of RO reject in the combined effluent, to 1.5% (Figure 1).

In September 2009, EOA conducted a similar mass balance evaluation of the impacts of a potential future 32 mgd RO permeate project. This 32 mgd project would continue to blend 8 mgd of RO permeate with tertiary effluent (i.e. Phase 1 project) but direct the remaining 24 mgd for other future uses (Figure 2). Under the otherwise same assumed flow and operational conditions as in Phase 1, the combined final effluent of the 32 mgd project would contain approximately 8.7 percent RO reject.

{Note: If all the 32 mgd of RO permeate were instead blended with tertiary effluent for delivery into the recycled water distribution system, the effluent would contain about 20 percent RO reject. See EOA Technical Memo of March 28, 2008.}

Figures 1 and 2 are WPCP process flow schematics of the currently proposed 8 and 32 mgd RO systems, respectively, showing key elements of the mass balance analysis. Feedwater flows to the MF/RO system will be from the WPCP secondary effluent stream. MF backwash will be returned to the plant headworks. The RO reject stream will be routed to the head of the serpentine chlorine contact tanks and blended with the tertiary filtered effluent. The combined chlorinated RO reject/tertiary effluent stream will be dechlorinated and discharged to the Bay at the permitted EFF-001 discharge location. The RO permeate will be combined with the "RO Bypass" stream (filtered tertiary effluent). These streams will be disinfected to meet Title 22 requirements and pumped into the recycled water distribution system. For the 32 mgd RO permeate project, 24 mgd of the RO permeate will be delivered for other future uses (i.e. other than for TDS blend down).

Figure 1. Process Flow Schematic - 8 mgd RO Permeate Project
Final Effluent Contains 1.5% RO Reject

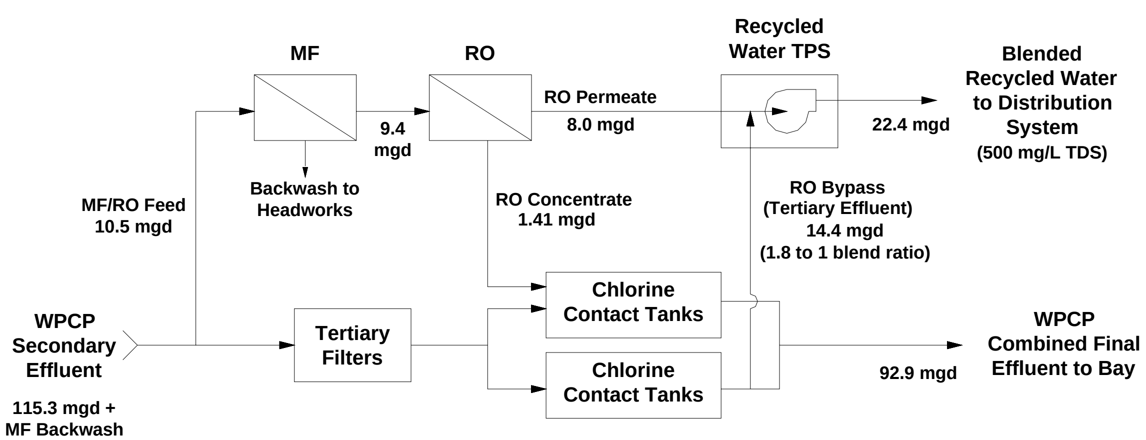
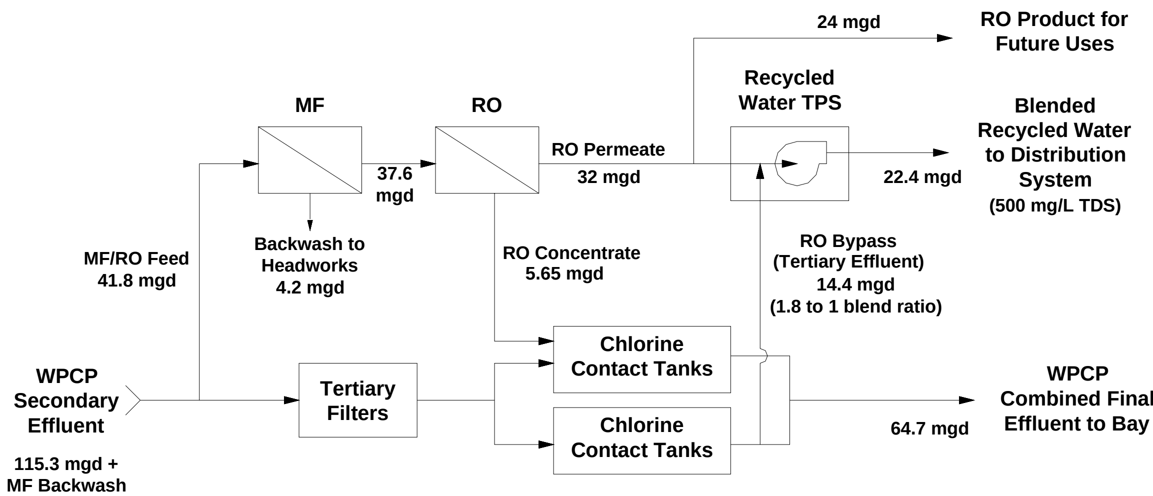


Figure 2. Process Flow Schematic - 32 mgd RO Permeate Project
Final Effluent Contains 8.7% RO Reject



RO PILOT TESTING

Whole Effluent Toxicity

As noted above, mass balance spreadsheet models were developed and used to evaluate projected blended effluent concentrations under different design and operational scenarios. There were no likely compliance issues identified based on comparison of projected blended effluent qualities to current and probable future NPDES permit effluent limits.

However, it is not possible to use this mass balance approach to predict in advance the potential impacts of RO reject/effluent blends on Whole Effluent Toxicity (WET) testing that is also required by the SJ/SC WPCP NPDES permit (Order No. R2-2009-0038). Neither acute nor chronic toxicity are amenable to analysis by the mass balance approach or by qualitative assessment. Therefore, to evaluate the effects the RO reject could have on the ability of the combined discharge to meet NPDES permit effluent acute and chronic WET requirements, screening level laboratory toxicity testing studies need to be undertaken using RO reject/final effluent blends generated from bench-top or pilot-scale RO units.

There are at least two other RO recycled water pilot projects that have previously been conducted in the Bay area in support of projects proposing to discharge RO reject into WPCP effluent streams. The City of Benicia intermittently operated on a batch basis a small pilot RO facility to generate RO reject used for testing the toxicity of a range of RO reject/effluent blends. EBMUD operated a 12-15 gpm pilot MF/RO continuously for about two months in mid-2005. EBMUD performed three rounds of acute toxicity testing and two rounds of chronic toxicity testing (and associated toxic pollutant testing) to assess the impact of adding RO reject to effluent discharged from the Chevron Richmond refinery wastewater treatment plant. Both the Benicia and EBMUD pilot project work plans were developed with consultant assistance and presented to Regional Water Board (RWB) staff to keep them apprised of the RO projects.

This workplan includes three rounds of approximately monthly 1) acute toxicity testing, 2) chronic toxicity testing, and 3) California Toxics Rule (CTR) priority pollutant testing beginning in December 2009 (Table 1). A contingency fourth round of testing has been provided in the event that unexpected test results occur, or in case there is interest in testing a different percentage RO reject to effluent blend (e.g., from a 16 mgd RO project), or in using a different source water (e.g., chlorinated/dechlorinated final effluent instead of undisinfected secondary effluent).

The basic pilot testing framework is shown in Table 1 below. Specific dates will be selected in consultation with the RO pilot testing workgroup. Toxicity testing will be conducted by Pacific EcoRisk (PER). For each round, static renewal acute toxicity tests run for 96-hours, chronic toxicity tests run from two to seven days, and priority pollutant samples will be collected on one day out of the seven day total test period. Ideally, the pilot testing dates would coincide (or at least overlap with) the dates of routine monthly acute (flow-through) and chronic toxicity testing conducted by the SJ/SC WPCP.

The monthly schedule shown assumes that the earliest that the pilot RO equipment could be purchased, delivered, installed, and fully operational would be early December. Thereafter it is assumed that it will take approximately one month for each round of testing to conduct the specified tests, generate and check the test results, review the results, determine what if any changes to make for the next round of testing, and for the logistical preparation needed to initiate the next round of RO operation and toxicity testing. While it may be possible to reduce this monthly interval slightly from a laboratory testing standpoint, various holidays during this period will complicate the scheduling logistics.

Table 1. Acute Toxicity, Chronic Toxicity and Priority Pollutant Testing Dates (2009 – 2010)

Testing Period	Acute Toxicity	Chronic Toxicity	Priority Pollutants
Round 1	December x – x	December x - x	December x
Round 2	January x – x	January x – x	January x
Round 3	February x - x	February x - x	February x
Round 4 (if required)	TBD	TBD	TBD

Final WPCP effluent and RO reject will need to be collected and generated, respectively, for seven consecutive days. This is necessary because three of the chronic toxicity tests extend for seven days (Table 2) and test protocols require that the test solutions for the test organisms be renewed daily with fresh sample from each 24-hour period. PER will make arrangements for picking up each day’s samples at the WPCP and for preparing the RO reject and final effluent blends to be used for testing.

The estimated minimum necessary RO reject and final effluent sample volumes for the toxicity tests alone are shown in Table 2. Additional volumes (to be provided by SJ/SC WPCP laboratory staff) will be needed to conduct the priority pollutant and mineral analyses shown in Table 4. Preliminary estimates are that the additional volumes needed of each will be in the 10 liter range.

Table 2. Toxicity Testing Sample Volumes

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
RO Reject (L)	3	1.5	3	1.5	1.5	1.5	1.5
Final Effluent (L)	90	30	80	30	30	30	30

The tests listed in Table 3 are described below. As a QA measure, each test will include "Effluent Control" testing (which will consist of testing of the 100% effluent without any RO reject blended in) to determine if the effluent itself is contributing any toxicity; note that if the RO reject-effluent tests can be scheduled to run concurrently with ongoing SJ/SC WPCP WET testing, the SJ/SC WPCP test(s) could serve as the "Effluent Control" test(s).

Table 3. Toxicity Test Species and Number of Tests

Test Species	Test Duration (days)	Reference Toxicant Test	SJ/SC WPCP 100% Effluent	SJ/SC WPCP 100% Effluent Salinity Control	1.5% RO Reject/ SJ/SC Effluent Blend	9% RO Reject/ SJ/SC Effluent Blend
Acute Toxicity						
Rainbow Trout (*Onchorhynchus mykiss*)	4	3	3	0	3	3
Inland Silverside Minnow (*Menidia beryllina*)	4	3	3	0	3	3
Chronic Toxicity						
Water Flea (*Ceriodaphnia dubia*)	7	3	3	6	3	3
Fathead Minnow (*Pimephales promelas)*	7	3	3	6	3	3
Inland Silverside Minnow (*Menidia beryllina*)	7	3	3	0	3	3
Alga (marine diatom) (*Thalassiosira pseudonana*)	4	3	3	0	3	3
Mussel (optional) (*Mytilus galloprovincialis)*	2	TBD	TBD	0	TBD	TBD

a - The 1.5% RO reject blend test represents final effluent conditions that would be seen when operating the proposed 8 mgd RO permeate project.

b - The 9% RO reject blend test represents final effluent conditions that would be seen when operating the proposed 32 mgd RO permeate project.

c – For each round of testing, there will be two Salinity Controls tested for each of the freshwater species: one at the salinity of the 1.5% RO reject blend, and one at the salinity of the 9% RO reject blend.

As additional QA measures, “Salinity Controls” (in which the salinity of unadulterated SJ/SC WPCP effluent is adjusted to mirror that of the RO reject-effluent blends) will be run for the freshwater test organisms to determine if increases in test solution salinity due to addition of the RO reject is, in and of itself, responsible for any increase in toxicity (credit suggestion to Pete Schafer, San Jose); the “Salinity Controls” will be tested at the 100% effluent concentration only. Note that the SJ/SC WPCP NPDES permit requires concurrent reference toxicity testing to ensure that each particular batch of test organisms being used is responding to toxicant stress in a typical and consistent fashion (i.e., the organisms are not unusually less sensitive or more sensitive to toxicant stress); again, if the RO reject-effluent tests can be scheduled to run concurrently with ongoing SJ/SC WPCP WET testing, the SJ/SC WPCP’s reference toxicant tests(s) could serve as the reference toxicant testing for the RO reject-effluent test(s) as well.

Acute Toxicity Test Species. The SJ/SC WPCP NPDES permit requires monthly flow-through acute toxicity compliance monitoring in 100% effluent with rainbow trout (*Onchorhynchus mykiss*). It is not feasible to conduct flow-through testing under the pilot testing RO reject/effluent blend conditions. Therefore the contract laboratory will conduct acute (96-hour) static renewal (with renewal at 48 hours) testing with rainbow trout. Because mixing RO reject with WPCP effluent has the potential to increase the combined effluent salinity to levels that may stress freshwater fish such as rainbow trout, the estuarine/marine species *Menidia beryllina* (inland silversides) will also be tested in concurrent acute 96-hour static renewal acute bioassays (again with renewal at 48 hours).

The *Menidia* testing will help evaluate whether the increased (five- to seven-fold) salinity and/or altered relative concentrations of non-toxic minerals (e.g., calcium, magnesium, chlorides) from the RO reject may itself be a source of stress and toxicity to freshwater fish species. In the *Menidia* testing protocol, the test solution has high quality artificial sea salt added to the RO-reject-effluent blends to bring the salinity conditions up to that of the testing conditions.

If toxicity is observed in the freshwater test Salinity Controls, or if increased toxicity is observed with the freshwater species but not the estuarine species, that would support the hypothesis that it was the increased (or altered relative percentage) ion (salt) concentrations in the RO reject that were likely responsible. If increased toxicity were observed in both the rainbow trout/fathead minnow tests and the *Menidia* tests that might support an alternative hypothesis that elevated levels of toxic metals or organics in the RO reject were responsible.

Chronic Toxicity Test Species. The SJ/SC WPCP NPDES permit requires chronic toxicity compliance monitoring monthly with the freshwater crustacean *Ceriodaphnia dubia*. The NPDES permit specifies that "*The Discharger shall conduct tests with a control and five effluent concentrations (including 100% effluent) and using a dilution factor >/= 0.5*" and that a concurrent reference toxicant test be conducted with each test. All the chronic tests except the “Salinity Control” tests will be dilution series tests. If it turns out after Round 1 that the incremental salinity represented by the 1.5% and/or the 9% RO reject blends causes toxicity, dilution series may also be run in subsequent “Salinity Control” tests.

The WPCP typically conducts their chronic toxicity testing in-house. *Ceriodaphnia* has been found to be the most sensitive species based on several past (including the most recent 2007-2008) species screening studies that are required every five years by the NPDES permit. The other species tested in the last WPCP screening study were the fathead minnow, the mussel (*Mytilus*), *Menidia*, and the diatom *Thalassiosira*, per species screening study requirements that the testing include at least one plant, one invertebrate, and one fish.

An issue raised during prior RO reject pilot toxicity testing projects was that adding RO reject to the tertiary effluent might alter the character (e.g., ionic matrix) of the combined final effluent to the point where a different test species other than the current species might be more sensitive. To address this concern, three additional chronic species will be tested by the contract laboratory concurrently with their testing of the freshwater *Ceriodaphnia;* the freshwater fathead minnow, the marine/estuarine fish *Menidia* and marine diatom *Thalassiosira*.

Use of these four organisms (Table 3) almost replicates the suite of organisms used by the WPCP in the last chronic toxicity species screening study. The NPDES permit requires that another screening study by completed either by five years before the permit expires (i.e. by November 30, 2013) or "Subsequent to any significant change in the nature of the effluent discharged through changes in sources or treatment." If one additional species (such as *Mytilus*) were added to the Round 1 testing, the three rounds of monthly testing shown in Table 1 would then fulfill the requirements for the required screening test (i.e. one round of testing with five species and two rounds conducted monthly using the three most sensitive species found in the first round) and could save the SJ/SC WPCP the costs of doing another chronic species screening study at some later time prior to the 2013 deadline.

Priority Pollutant Monitoring

The SJ/SC WPCP final effluent (EFF-001) and the pilot RO reject stream will be monitored for one day during each of the three 7-day testing rounds (i.e. for a total of three daily monitoring events) for the full suite of California Toxics Rule (CTR) priority pollutants that the WPCP NPDES permit requires monitoring for twice a year (Table 4). Standard minerals will also be monitored to evaluate the extent to which the relative proportions (ionic balance) may be changed in the RO reject compared to the final effluent.

These data are intended to be used to characterize the 100% RO reject quality and to help investigate the cause(s) of any observed toxicity. The measured metals data will also be used to recompute projected combined final effluent concentrations using the mass balance spreadsheet model. These pilot study based mass balance values will then be compared to the values previously calculated using historic effluent quality and calculated RO reject values.

The data will similarly be used to perform Reasonable Potential Analyses (RPA) on the calculated concentrations in the two proposed combined RO reject/final effluent blends (i.e. 1.5% and 9%). This will be done to determine if the addition of RO reject to the WPCP effluent would raise concentrations to a level that would trigger Reasonable Potential (RP) (i.e. exceed any CTR water quality objectives) and thereby require that the Regional Water Board (RWB) include new effluent limitations in the WPCP NPDES during the next NPDES permit reissuance (2014) that would not otherwise be required if the RO reject were not present. Based on the mass balance calculations there would not be problems complying with any such new limits; there would be one or more additional effluent limits in the permit if RP were triggered.

The SJ/SC WPCP laboratory responsible for either conducting the Table 4 analyses or for arranging for analyses to be conducted by a contract lab. The SJ/SC WPCP laboratory will provide estimates of the volumes of final effluent and RO reject needed to conduct the Table 4 analyses. These volumes need to be added to those shown in Table 2 to determine the total volumes that will need to be collected for each round of testing. It is assumed that the SJ/SC WPCP laboratory will provide all necessary sample bottles, labels, and chain of custody forms. Pilot plant staff will fill the bottles provided and SJ/SC laboratory staff will collect the samples for analysis either at their laboratory or for delivery to and analysis by a contract laboratory.

Table 4. Pilot Test CTR Priority Pollutant Monitoring

ONE DAY COMPOSITE SAMPLE PER ROUND
Standard Minerals Package (a)
As & Se by Hydride AA (SM 3114) or (EPA 200.8 in DRC Mode)
CTR Metals (EPA 200.8)
Nitric Acid Digestion for Metals (EPA 200.2)
Hg (EPA 1631)
ONE DAY GRAB SAMPLES PER ROUND
Cyanide (EPA 3352)
Full Dioxin EQ (EPA 1613)
PAHs (EPA 610)
VOAs (EPA 624)
BNA (EPA 625)
Organophosphate Pesticides (EPA 614)
Pyrethroid Pesticides (EPA 632)
Tributyltin (Batelle N-0959-2606)
Hexavalent Chromium (EPA 7196)

(a) Standard Minerals Package includes pH, alkalinity, conductivity, chloride, ammonia, nitrate and nitrite as N, sulfate, TDS, Total phosphate, boron, iron, calcium, magnesium, hardness, sodium, potassium, and silica.

Pilot Plant Description

A small RO pilot unit will be operated to generate reject water with which to conduct acute and chronic toxicity testing of the two RO reject/effluent blends that model the most likely blended discharge scenarios for the proposed 8 mgd and 32 mgd RO permeate projects. A secondary effluent (prior to chlorination and filtration) composite sample of approximately 20 liters (plus the Table 4 priority pollutant analysis volume on one day per Round) will be collected from the Filter Influent Pump Station wetwell using the existing sample lines.

Sampling from this location will model most closely the secondary effluent that will be diverted to the full scale RO facilities and thus produce RO reject that will be most similar to that produced by the full scale RO facilities.

This secondary effluent sample will be used as feedwater for the approximately 250 gpd RO pilot unit which will be operated as a batch process daily for seven days during each round to generate the necessary (Table 2) RO reject sample volume for toxicity testing. The RO unit will be run from approximately 9 am to 10 am on each of the seven days to allow for pickup of the final effluent and RO reject samples by PER by 11:00 am each day. The largest RO reject volumes will be needed on days one and three of each round as noted above.

As noted above, on one day of each Round, additional RO reject and final effluent will need to be collected to conduct the priority pollutant analyses shown in Table 4. The actual additional volumes needed will depend on the laboratory conducting the analyses, particularly for the RO reject (since the samples will likely need to be diluted prior to analysis). A preliminary volume estimate is approximately 10 liters each on the priority pollutant testing day. The SJ/SC WPCP will need to provide the actual volumes they will require.

The full scale RO project reject is proposed to be discharged into the inlet of the serpentine chlorine contact basins and combined with and chlorinated and dechlorinated together with the tertiary (filtered secondary) effluent. The proposed pilot testing plan approximates this as closely as possible by using chlorinated/dechlorinated final effluent as the toxicity testing “blend” water along with the RO reject from treating the secondary effluent stream. This approach captures the impacts from chlorinating and dechlorinating the tertiary effluent but does not capture any potential effects that may result from chlorinating and dechlorinating the RO reject.

However, since the RO reject is only ~1.5% or ~9% of the total final effluent flow, it is likely that potential impacts on effluent quality from chlorinating and dechlorinating the RO reject would be overwhelmed (masked) by the impacts of chlorinating and dechlorinating the much larger volume of tertiary effluent. The only way to more closely approximate the full scale operation would be for PER to make up the 1.5% and 9% bulk blend solutions each day at the lab, then chlorinate them at the typical WPCP dosage, hold them for the typical WPCP serpentine basin contact time, then dechlorinate them at the typical WPCP level. This would be both time consuming and introduces several additional variables (and opportunities for experimental error) into the protocol and still not fully replicate full-scale chlorination/dechlorination conditions.

The SJ/SC WPCP NPDES permit specifies that final effluent (EFF-001) samples for chronic toxicity and metals be 24-hour flow composites. To be most representative of compliance monitoring, and particularly if the WPCP chooses to use the 100% effluent chronic toxicity test results to fulfill its NPDES screening test requirements, it would be desirable to obtain 24-hour composite samples of the final effluent. The NPDES permit allows for 24 hourly grab samples to be collected and combined to prepare a 24-hour composite sample.

Given the large volumes of final effluent required by the toxicity testing, the sample pump and control apparatus from two ISCO type samplers (to be provided by the WPCP) will be used to collect these approximately hourly samples from both the final effluent and secondary effluent (it is assumed that flow signals will not be available to be used to trigger for the pilot testing). The samples will be collected in large carboys or plastic tanks. All samples will need to be refrigerated or chilled.

Alternatively, if it is not feasible to collect composite samples, WPCP final effluent quality is believed to be quite consistent over a 24-hour period. Therefore it may be adequate, for purposes of this short-term pilot test, to collect the sample volumes needed per day over a relatively short period of time (i.e. large grab samples). The final effluent sample could be collected an appropriate number of hours after the secondary effluent sample for the RO feedwater were collected, to reflect the nominal time for secondary effluent to transit through the tertiary filters and the chlorine contact tank to the final effluent sampling location. This would approximate sampling and testing the same batch of water in the RO reject and the final effluent.

Attachments:

A. Updated 8 mgd RO Mass Balance with ~500 mg/L TDS Blended Recycled Water
B. Updated 32 mgd RO Mass Balance with 8 mgd ~500 mg/L TDS Blended Recycled Water and 24 mgd Diverted for Future Uses
C. PER Acute and Chronic Toxicity Testing Protocols

Attachment A

Updated 8 mgd RO Mass Balance with ~500 mg/L TDS Blended Recycled Water

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Attachment A. Impact of RO Reject on WPCP Final Effluent Quality (Metals and Cyanide)

RO Permeate Flow = 8 mgd; RO Permeate Diversion = 0 mgd; Final Effluent Data are 95%ile Values

Specified Values:		
Total RO Permeate Flow =	8.0	mgd
RO Permeate Diversion =	0.0	mgd
Secondary Effluent Flow =	115.3	mgd[1]
Tert. Effl/RO Perm. Blend Ratio	1.8	
RO Flow Recovery =	85%	
Final Effluent Conc. Data =	95%ile	values[2]

RO Feed Flow =	9.41	mgd
Adj. Secondary Effluent Flow =	100.9	mgd (Flow after deducting Tert. Effl./RO Bypass Flow)
RO Permeate Avail. for Blending =	8.0	mgd
Tert. Effl./RO Bypass Flow =	14.4	mgd
RO Reject Flow =	1.41	mgd
Total RW Blended Flow =	22.4	mgd (Includes RO Bypass Flow + Avail. RO Permeate Flow)
Combined Final Effluent Flow =	92.9	mgd (Final E-001 Discharge Flow Including RO Reject)

Pollutant	Historic Final Effluent[2]		RO Feed		RO Rejection[4]	RO Concentrate		Combined Final Effluent[2]		NPDES Permit Limits	Adj. CTR WQOs for RPA
	Conc. ug/l	Mass lb/day	Conc. ug/l	Mass lb/day	%	Conc. ug/l	Mass lb/day	Conc. ug/l	Mass lb/day	ug/l	ug/l
Arsenic	1.70	1.43	1.70	0.134	99%	11.2	0.132	1.85	1.43		36
Cadmium	0.15	0.12	0.15	0.012	99%	0.97	0.011	0.160	0.12		7
Chromium VI	0.68	0.57	0.68	0.054	99%	4.5	0.053	0.74	0.57		200
Copper - max. daily	4.74	3.99	4.74	0.372	99%	31.3	0.368	5.1	3.99	19	
Copper - avg. monthly	4.23	3.56	4.23	0.332	99%	27.9	0.329	4.59	3.55	11	
Lead	1.03	0.87	1.03	0.081	99%	6.8	0.080	1.12	0.87		8.52
Mercury[5]	0.0027	0.0023	0.0027	0.0002	99%	0.018	0.0002	0.0030	0.0023	0.023	
Nickel - max. daily	9.00	7.57	9.00	0.706	99%	59.4	0.699	9.8	7.57	33	
Nickel - avg. monthly	7.48	6.29	7.48	0.587	99%	49.3	0.581	8.1	6.28	25	
Selenium	0.66	0.56	0.66	0.052	99%	4.4	0.052	0.72	0.56		5
Silver	0.112	0.094	0.11	0.009	99%	0.7	0.009	0.122	0.094		2.24
Zinc	68	57.6	68	5.38	99%	452	5.32	74	57.6		170
Cyanide[6]	3.2	2.69	3.2	0.251	99%	21	0.248	3.5	2.69	5.7	

Notes:

1. Equivalent to the secondary effl. flow (minus MF backwash) before any recycled water or RO system diversions. Value listed is avg. from minimum discharge flow month (8/2005).
2. Historic NPDES effluent from RWQCB ERS database, used to represent Sec. Effluent prior to RO System. Based on individual values from Jan 2004 - Dec 2006, except as noted in
3. Combined Final effluent (including RO reject) to outfall E-001. Values that exceed NPDES Permit or WQO-based limits are indicated in **bold**.
4. Defined as: Rejection = (1-Permeate Conc./Feed Conc) * 100. Note: Other definitions are sometimes used for rejection.
5. Mercury data is from "13267" dataset, monthly average values. Effluent limit is from Mercury Watershed Permit (AMEL).
6. Dataset is low DL "13267" monitoring data only. Model probably overestimates combined final effluent cyanide concentration.

Attachment B

Updated 32 mgd RO Mass Balance with ~500 mg/L TDS Blended Recycled Water and 24 mgd Diverted for Future Uses

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Attachment B. Impact of RO Reject on WPCP Final Effluent Quality (Metals and Cyanide)

RO Permeate Flow = 32 mgd; RO Permeate Diversion = 24 mgd; Final Effluent Data are 95%ile Values

Specified Values:		
Total RO Permeate Flow =	32.0	mgd
RO Permeate Diversion =	24.0	mgd
Secondary Effluent Flow =	115.3	mgd[1]
Tert. Effl/RO Perm. Blend Ratio	1.8	
RO Flow Recovery =	85%	
Final Effluent Conc. Data =	95%ile	values[2]

RO Feed Flow =	37.65	mgd
Adj. Secondary Effluent Flow =	100.9	mgd (Flow after deducting Tert. Effl./RO Bypass Flow)
RO Permeate Avail. for Blending =	8.0	mgd
Tert. Effl./RO Bypass Flow =	14.4	mgd
RO Reject Flow =	5.65	mgd
Total RW Blended Flow =	46.4	mgd (Includes RO Bypass Flow + Avail. RO Permeate Flow)
Combined Final Effluent Flow =	68.9	mgd (Final E-001 Discharge Flow Including RO Reject)

Pollutant	Historic Final Effluent[2]		RO Feed		RO Rejection[4]	RO Concentrate		Combined Final Effluent[2]		NPDES Permit Limits	Adj. CTR WQOs for RPA
	Conc. ug/l	Mass lb/day	Conc. ug/l	Mass lb/day	%	Conc. ug/l	Mass lb/day	Conc. ug/l	Mass lb/day	ug/l	ug/l
Arsenic	1.70	1.43	1.70	0.535	99%	11.2	0.529	2.48	1.43		36
Cadmium	0.15	0.12	0.15	0.046	99%	0.97	0.046	0.215	0.12		7
Chromium VI	0.68	0.57	0.68	0.214	99%	4.5	0.212	1.00	0.57		200
Copper - max. daily	4.74	3.99	4.74	1.489	99%	31.3	1.474	6.9	3.97	19	
Copper - avg. monthly	4.23	3.56	4.23	1.328	99%	27.9	1.314	6.17	3.55	11	
Lead	1.03	0.87	1.03	0.323	99%	6.8	0.320	1.50	0.86		8.52
Mercury[5]	0.0027	0.0023	0.0027	0.0009	99%	0.018	0.0008	0.0040	0.0023	0.023	
Nickel - max. daily	9.00	7.57	9.00	2.826	99%	59.4	2.798	13.1	7.55	33	
Nickel - avg. monthly	7.48	6.29	7.48	2.347	99%	49.3	2.324	10.9	6.27	25	
Selenium	0.66	0.56	0.66	0.208	99%	4.4	0.206	0.97	0.56		5
Silver	0.112	0.094	0.11	0.035	99%	0.7	0.035	0.163	0.094		2.24
Zinc	68	57.6	68	21.50	99%	452	21.29	100	57.4		170
Cyanide[6]	3.2	2.69	3.2	1.003	99%	21	0.993	4.7	2.68	5.7	

Notes:

1. Equivalent to the secondary effl. flow (minus MF backwash) before any recycled water or RO system diversions. Value listed is avg. from minimum discharge flow month (8/2005).
2. Historic NPDES effluent from RWQCB ERS database, used to represent Sec. Effluent prior to RO System. Based on individual values from Jan 2004 - Dec 2006, except as noted in
3. Combined Final effluent (including RO reject) to outfall E-001. Values that exceed NPDES Permit or WQO-based limits are indicated in **bold**.
4. Defined as: Rejection = (1-Permeate Conc./Feed Conc) * 100. Note: Other definitions are sometimes used for rejection.
5. Mercury data is from "13267" dataset, monthly average values. Effluent limit is from Mercury Watershed Permit (AMEL).
6. Dataset is low DL "13267" monitoring data only. Model probably overestimates combined final effluent cyanide concentration.

Attachment C

PER Acute and Chronic Toxicity Testing Protocols

PACIFIC ECORISK LABORATORY PROTOCOLS

Receipt and Handling of the RO Brine Samples

Samples of the RO Brine will be collected into appropriately-cleaned sample containers; basic water quality data (temperature, pH, conductivity) will recorded at that time. The sample will be transported and delivered, on ice and under chain-of-custody, to the PER testing laboratory in Fairfield on the day of sample collection. Upon receipt at the testing laboratory, aliquots of the sample will be collected for analysis of initial water quality characteristics. The remainder of the sample will be stored at 0-6˚C, except when being used to prepare test solutions.

Acute Toxicity Testing with Rainbow Trout

The rainbow trout used in this test will be obtained from a commercial supplier. These fish will be maintained at 12°C in aerated aquaria containing EPA synthetic moderately-hard water prior to their use in this testing. During this pre-test period, the fish will be fed trout chow *ad libitum*.

The Lab Control water for this test will consist of EPA synthetic “moderately hard” water, prepared by addition of reagent-grade chemicals to reverse-osmosis, de-ionized water. The RO Brine sample will be tested at the 100% concentration only. Water quality characteristics (pH, dissolved oxygen [D.O.], and conductivity) will be determined for each treatment test solution prior to the start of the test.

There will be 2 replicates at each test treatment, each replicate consisting of 4-L of test solution in a 6-L HDPE beaker. The test will be initiated by randomly allocating 10 rainbow trout into each replicate. The replicate beakers will be then placed in a temperature-controlled room at 12°C under a 16L:8D photoperiod.

Each replicate container will be examined daily, and the number of live fish in each will be recorded. Fresh test solutions will be prepared on Day 2 of the test, and will be characterized as before; that same day, approximately 80% of the old media in each replicate container will be carefully poured out and replaced with the fresh test solution. “Old” water quality characteristics (pH, D.O., and conductivity) will be measured for the old test solution that had been discarded from one randomly selected replicate at each treatment.

After 96 (±2) hrs, the test will be terminated and the number of live fish in each replicate will be determined. The resulting survival data will be analyzed to evaluate any impairment due to the RO Brine; all statistical analyses will be performed using the CETIS® statistical software (TidePool Scientific, McKinleyville, CA).

Acute Reference Toxicant Testing of the Rainbow Trout

In order to assess the sensitivity of the rainbow trout to toxic stress, a reference toxicant test will be performed concurrently with the RO Brine test. The reference toxicant test will be performed similarly to the RO Brine test except that test solutions will consist of Lab Control water spiked with NaCl at concentrations of 2.5, 5, 10, 15, and 20 gm/L. The resulting test response data will be statistically analyzed to determine key dose-response point estimates; all statistical analyses will be made using the CETIS® software. These response endpoints will be then compared to the "typical response" range established by the mean ± 2 SD of the point estimates generated by the most recent previous reference toxicant tests performed by PER.

Acute Toxicity Testing with Larval *Menidia beryllina*

The *Menidia beryllina* used in these tests will be obtained from a commercial supplier. These fish will be maintained at 20˚C in aerated aquaria containing artificial seawater at a salinity of 25 ppt prior to their use in the tests. During this pre-test period, the fish will be fed brine shrimp nauplii *ad libitum*.

The Lab Control water for these tests will consist of reverse-osmosis, de-ionized (RO/DI) water salted up to a salinity of 25 ppt using a commercial artificial sea salt (Crystal Sea®-bioassay grade). The RO Brine samples will be tested at the 100% concentration only. Routine "new" water quality characteristics (pH, dissolved oxygen [D.O.], and salinity) will be measured for each treatment test solution prior to use in these tests.

There will be 2 replicates at each treatment level, each replicate consisting of 400 mL of test solution in a 600-mL glass beaker. The tests will be initiated by randomly allocating 10 *Menidia beryllina* into each replicate beaker. The beakers will be randomly positioned in a temperature-controlled room at 20˚C under a 16L:8D photoperiod.

Each replicate container will be examined daily, and the number of live fish in each will be recorded. Fresh test solutions will be prepared on Day 2 of the test, and will be characterized as before; that same day, approximately 80% of the old media in each replicate container will be carefully poured out and replaced with the fresh test solution. "Old" water quality characteristics (pH, D.O., and conductivity) will be measured for the old test solution that had been discarded from one randomly selected replicate at each treatment.

After 96 (±2) hrs, the test will be terminated and the number of surviving organisms will be determined. The resulting survival data will be analyzed to evaluate any impairments due to the RO Brine; all statistical analyses will be performed using the CETIS® statistical software.

Acute Reference Toxicant Testing of the Larval *Menidia beryllina*

In order to assess the sensitivity of the fish test organisms to toxic stress, a concurrent reference toxicant test will be performed. This reference toxicant test will be performed similarly to the RO Brine tests, except that test solutions will consist of Lab Control (25 ppt water) spiked with KCl at concentrations of 0.125, 0.25, 0.5, 1, and 2 gm/L. After 96 (±2) hrs exposure, the survival data will be evaluated. The resulting test response data will be analyzed to determine key dose-response point estimates; all statistical analyses will be made using the CETIS® software. These response endpoints will be then compared to the "typical response" range established by the 20 most-recently performed tests.

Survival and Reproduction Toxicity Testing with *Ceriodaphnia dubia*

The short-term chronic *Ceriodaphnia* test consists of exposing individual females to a series of RO Brine dilutions for the length of time it takes for the Control treatment females to produce 3 broods (typically 6-8 days), after which effects on survival and reproduction are evaluated. The specific procedures used in this test are described below.

The Control/dilution water for this test will consist of Lab Water (comprised of a mixture of commercial spring waters [80% deionized water:20% Perrier]. The Control/dilution water and the RO Brine samples will be used to prepare daily test solutions at the designated test treatment concentrations. For each test treatment, a 200 mL aliquot of test solution will be amended with the alga *Selenastrum capricornutum* and Yeast-Cerophyll-Trout Food (YCT) to provide food for the test organisms. "New" water quality characteristics (pH, D.O., and conductivity) will be measured on these food-amended test solutions prior to use in this testing.

There will be 10 replicates for each test treatment, each replicate consisting of 15 mL of test solution in a 30-mL plastic cup. These "3-brood" tests will be initiated by allocating one neonate (<24 hrs old) *Ceriodaphnia*, obtained from in-house laboratory cultures, into each replicate cup. The test replicate cups will be placed into a temperature-controlled room at 25˚C, under cool white fluorescent lighting on a 16L:8D photoperiod.

Each day of the test, fresh test solutions will be prepared and characterized as before, and a "new" set of replicate cups will be prepared. The original test replicate cups will be examined, with surviving "original" individual organisms being transferred to the corresponding new cup. The contents of each of the remaining "old" replicate cups will be carefully examined and the number of neonate offspring produced by each original organism will be determined, after which the "old" water quality characteristics (pH, D.O., and conductivity) will be measured for the old media from one randomly-selected replicate at each treatment.

After it is determined that ≥60% of the *Ceriodaphnia* in the Receiving Water Control treatment had produced their third brood of offspring, the test will be terminated. The resulting survival and reproduction data will be analyzed to evaluate any impairment caused by the RO Brine; all statistical analyses will be performed using the CETIS® statistical software.

Reference Toxicant Testing of the *Ceriodaphnia dubia*

In order to assess the sensitivity of the test organisms to toxic stress, a reference toxicant test will be performed concurrently with the RO Brine test. The reference toxicant test will be performed similarly to the RO Brine test except that test solutions will consist of Lab Control water spiked with NaCl at test concentrations of 250, 500, 1000, 1500, and 2000 mg/L. The resulting test response data will be statistically analyzed to determine key dose-response point estimates; all statistical analyses will be made using the CETIS® software. These response endpoints will be then compared to the "typical response" range established by the mean ± 2 SD of the point estimates generated by the most recent previous reference toxicant tests performed by PER.

Survival and Growth Toxicity Testing with Larval Fathead Minnows

The short-term chronic fathead minnow test consists of exposing larval fish to a series of RO Brine dilutions for 7 days, after which effects on survival and growth are evaluated. The specific procedures used in this testing are described below.

The larval fathead minnows used in this test will be obtained from a commercial supplier; upon receipt at the testing lab, the larval fish will be maintained in aerated tanks of US EPA moderately-hard water at 25˚C, and will be fed brine shrimp nauplii *ad libitum*.

The Control/dilution water for this test will consist of Lab Water (comprised of EPA synthetic moderately-hard water). The Control/dilution water and the RO Brine samples will be used to prepare daily test solutions at the designated test treatment concentrations. "New" water quality characteristics (pH, D.O., and conductivity) will be measured on these test solutions prior to use in the test.

There will be 4 replicates for each test treatment, each replicate consisting of 400 mL of test solution in a 600-mL glass beaker. The test will be initiated by randomly allocating 10 larval fathead minnows (<48 hrs old) into each replicate. The replicate beakers will be placed in a temperature-controlled room at 25˚C, under cool-white fluorescent lighting on a 16L:8D photoperiod. The test fish will be fed brine shrimp nauplii twice daily.

Each day of the test, fresh test solutions will be prepared for each treatment, and water quality characteristics will be determined as before. The replicate beakers will be examined, with any dead animals, uneaten food, wastes, and other detritus being removed. The number of live fish in each replicate will be determined and then approximately 80% of the old test media in each beaker will be carefully poured out and replaced with fresh test solution. "Old" water quality characteristics (pH, D.O., and conductivity) will be measured on the old test water that had been discarded from one randomly-selected replicate at each treatment.

After 7 days exposure, the test will be terminated and the number of live fish in each replicate beaker will be recorded. The fish from each replicate will be then carefully euthanized in methanol, rinsed in de-ionized water, and transferred to a pre-dried and pre-tared weighing pan.

These fish will be then dried at 100°C for ~24 hrs and re-weighed to determine the total weight of fish in each replicate; the total weight will be then divided by the initial number of fish per replicate (n=10) to determine the "biomass value". The resulting survival and growth ("biomass value") data will be analyzed to evaluate any reductions caused by the RO Brine; all statistical analyses will be performed using the CETIS® statistical software.

Reference Toxicant Testing of the Larval Fathead Minnows

In order to assess the sensitivity of the fish to toxic stress, a reference toxicant test will be performed. The reference toxicant test will be performed similarly to the RO Brine test, except that test solutions will consist of "Lab Control" media spiked with NaCl at test concentrations of 0.75, 1.5, 3, 6, and 9 gm/L. The resulting test response data will be analyzed to determine key dose-response point estimates; all statistical analyses will be made using the CETIS® software. These response endpoints will be then compared to the 'typical response' range established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by PER.

Larval Fish Survival and Growth Toxicity Testing with *Menidia beryllina*

The short-term chronic *Menidia beryllina* test consists of exposing larval fish to a series of RO Brine dilutions for 7 days, after which effects on survival and growth are evaluated. The specific procedures used in this testing are described below.

The larval fish used in this bioassay will be obtained from a commercial supplier. These fish will be maintained at 25˚C in aerated aquaria containing Lab Control water (described below) prior to their use in this test. During this pre-test period, the fish will be fed brine shrimp nauplii *ad libitum*.

The Lab Control/dilution water for this bioassay will be prepared by salting up reverse-osmosis, de-ionized water to a salinity of 25 ppt using a commercial artificial sea salt (Crystal Sea® - bioassay grade). The Lab Control/dilution water and the RO Brine samples will be used to prepare daily test solutions at the designated RO Brine concentrations. "New" water quality characteristics (pH, D.O., and conductivity) will be measured on these test solutions prior to use in the test.

There will be 4 replicates for the Lab Control and each RO Brine treatment, each replicate consisting of 400 mL of test media in a 600-mL glass beaker. This test will be initiated by randomly allocating 10 fish into each replicate. These replicate beakers will be placed in a temperature-controlled room at 25°C, under cool-white fluorescent lighting on a 16L:8D photoperiod. The test fish will be fed brine shrimp nauplii twice daily.

Each day of the test, fresh test solutions will be prepared and characterized as before. The replicate beakers containing the larval fish will be examined, with any dead animals, uneaten food, wastes, and other detritus being removed. The number of live fish in each replicate will be determined and then approximately 80% of the test media in each beaker will be carefully poured out and replaced with fresh media. “Old” water quality characteristics (pH, D.O., and conductivity) will be measured on the old test water collected from one randomly selected replicate at each treatment.

After 7 days exposure, the number of live fish in each replicate beaker will be recorded. Then, the fish from each replicate will be carefully euthanized in methanol, rinsed in de-ionized water, and transferred to a pre-dried and pre-tared weighing pan. These will be then dried at 100¤C for >24 hrs and re-weighed to determine the total weight of fish in each replicate. The total weight will be then divided by the initial number of fish per replicate (n=10) to determine the “biomass value”. The resulting survival and growth data will be analyzed to determine any impairment, or toxicity, caused by the RO Brine. All statistical analyses will be performed using the CETIS® statistical software.

Reference Toxicant Testing of the *Menidia beryllina*
In order to assess the sensitivity of the fish test organisms to toxic stress, a reference toxicant test will be performed concurrently with the RO Brine test. This reference toxicant test will be performed similarly to the RO Brine toxicity test, except that test solutions will consist of Lab Control (25 ppt water) spiked with KCl at concentrations of 0.5, 1, 1.25, 1.5, and 2 gm/L. The resulting test response data will be analyzed to determine key dose-response point estimates; all statistical analyses will be made using the CETIS® software. These response endpoints will be then compared to the typical response range established by the mean ± 2 SD of the point estimates generated by the 20 most recent previous reference toxicant tests performed by PER.

Chronic Algal Growth Toxicity testing with *Thalassiosira pseudonana*

The short-term chronic diatom toxicity test consists of exposing *Thalassiosira pseudonana* to dilutions of the RO Brine for ~96-hrs, after which the effects on cell growth are evaluated. The specific procedures used in this testing are described below.

The Lab Control water for these tests will consist of natural seawater (obtained from the U.C. Granite Canyon Marine Laboratory) adjusted up to the test salinity. The Lab Control water and ambient waters will be filtered through sterile 0.45 µm filters, and then spiked with nutrients (as per ASTM guidelines). The filtered and nutrient-amended Lab Control/dilution water and RO Brine will then be used to prepare daily test solutions at the designated concentrations of RO Brine. Water quality characteristics will be measured on the resulting test solutions prior to use in this testing.

There will be 4 replicates at each test treatment, each replicate consisting of a 250-mL glass Erlenmeyer flask containing 100 mL of test solution; an additional replicate will be established at each test treatment for the measurement of test solution water quality characteristics during the test and at test termination. Each flask will be inoculated to an initial diatom cell density of 20,000 cells/mL from a from a laboratory culture of *Thalassiosira* that is maintained in log growth phase. These flasks will be loosely-capped and randomly positioned within a temperature-controlled room at 20°C, under continuous illumination from cool-white fluorescent bulbs.

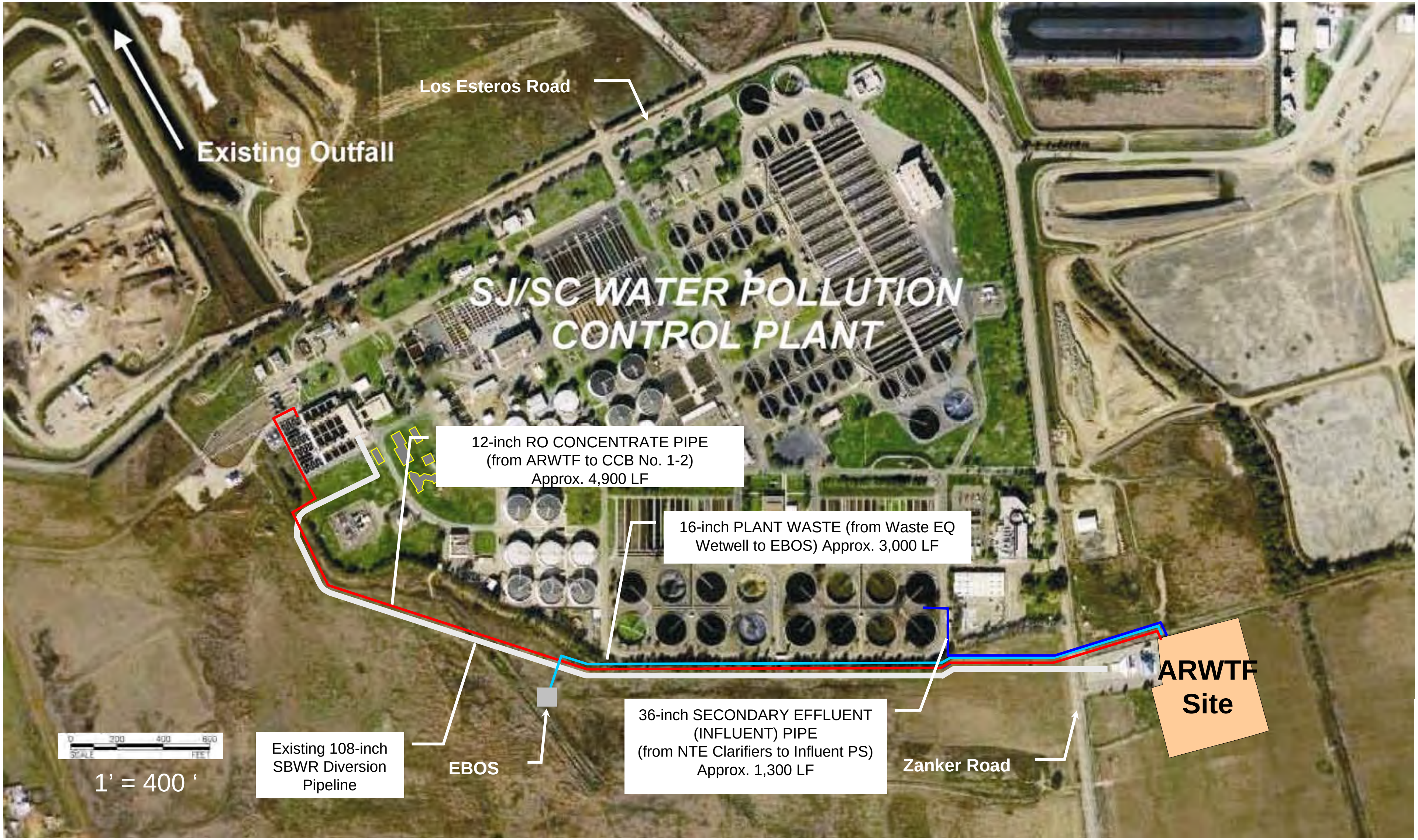
Each replicate flask will be shaken once daily. The temperature and pH will be determined daily for the designated "water quality" replicate at each treatment.

After 96 (+2) hrs exposure, the algal cell density in each replicate flask will be determined by microscopic analysis. The resulting cell density data will be analyzed to determine any growth impairment, or toxicity, caused by the RO Brine; all statistical analyses will be performed using CETIS® statistical software.

Reference Toxicant Testing of the *Thalassiosira pseudonana*

In order to assess the sensitivity of the *Thalassiosira* to toxic stress, a reference toxicant test will be performed concurrently with the RO Brine test. The reference toxicant test will be performed similarly to the RO Brine test except that test solutions consisted of Lab Control water spiked with KCl. The resulting test response data will be statistically analyzed to determine key dose-response point estimates; all statistical analyses will be performed using the CETIS® software. These response endpoints will be compared to the "typical response" range established by the mean ± 2 SD of the point estimates generated by the most recent previous reference toxicant tests performed by PER.

Appendix D
Off-Site Piping Figure


Los Esteros Road
Existing Outfall
SJ/SC WATER POLLUTION CONTROL PLANT
12-inch RO CONCENTRATE PIPE (from ARWTF to CCB No. 1-2) Approx. 4,900 LF
16-inch PLANT WASTE (from Waste EQ Wetwell to EBOS) Approx. 3,000 LF
ARWTF Site
36-inch SECONDARY EFFLUENT (INFLUENT) PIPE (from NTE Clarifiers to Influent PS) Approx. 1,300 LF
Zanker Road
EBOS
Existing 108-inch SBWR Diversion Pipeline
1' = 400 '