Final

Preliminary Design Report
Perris II Desalination Facility

Volume I

Prepared for

United States Army Corps of Engineers
Los Angeles District

In cooperation with

Eastern Municipal Water District

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Contents

Volume I – Preliminary Design Report

Section **Page**

Acronyms and Abbreviations ix

1 Introduction 1-1
1.1 Purpose and Background 1-1
1.2 Previous Preliminary Design Report 1-1
1.3 Project Description 1-2
1.3.1 Treatment Processes 1-2
1.3.2 Site Layout and Non-Process Facilities 1-4

2 Raw Water Supply Wells and Water Blending 2-1
2.1 Introduction 2-1
2.2 Raw Water Supply Wells 2-1
2.3 Well Water Quality and Blend Options 2-3
2.4 Water Quality Goals 2-3
2.5 System Integration 2-5

3 Treatment Process Facility 3-1
3.1 Introduction 3-1
3.1 Pretreatment 3-2
3.1.1 Iron and Manganese (Fe/Mn) Removal System 3-3
3.1.2 Acid 3-6
3.1.3 Threshold Inhibitor 3-6
3.1.4 Cartridge Filters 3-6
3.2 RO System 3-7
3.2.1 RO Feed Pumps 3-7
3.2.2 RO Trains 3-8
3.2.3 RO Membranes 3-10
3.2.4 Energy Recovery System 3-10
3.2.5 RO CIP System 3-13
3.2.6 RO Flush System 3-15
3.3 Post-Treatment 3-15
3.3.1 Decarbonation 3-16
3.3.2 Sodium Hydroxide 3-17
3.3.3 Disinfection 3-17
3.3.4 Corrosion Control 3-17
3.3.5 Fluoridation 3-18

4 Chemical Storage and Feed Systems 4-1
4.1 Introduction 4-1
4.2 Chemical Feed Systems 4-1

4.2.1 Safety Design on Chemical Feed Systems 4-1
4.2.2 Onsite Sodium Hypochlorite Generation 4-2
4.2.3 Sodium Bisulfite 4-4
4.2.4 Threshold Inhibitor 4-5
4.2.5 Sulfuric Acid 4-6
4.2.6 Citric Acid 4-7
4.2.7 Sodium Hydroxide 4-7
4.2.8 Corrosion Inhibitor 4-9
4.2.9 Aqueous Ammonia 4-9
4.2.10 Hydrofluosilicic Acid (Fluoride) 4-10

5 Clearwell and Finished Water Pump Station 5-1
5.1 Introduction 5-1
5.2 Clearwell and Chlorine Contact Time (CT) Requirements 5-1
5.2.1 CT Calculation 5-2
5.2.2 Chloramination 5-2
5.3 Finished Water Pump Station 5-3

6 Concentrate Pump Station and Concentrate Disposal 6-1
6.1 Introduction 6-1
6.2 Concentrate Pump Station 6-1

7 Civil and Site Layout 7-1
7.1 Introduction 7-1
7.2 Project Site 7-1
7.3 Site Layout Design Criteria 7-2
7.3.1 Infiltration Pond Design 7-3
7.3.2 Geotechnical Investigations 7-3
7.3.3 CLOMR-F Application 7-3
7.3.4 Fire Requirements 7-4
7.3.5 Existing Utilities 7-4

8 Architectural, Structural, and Building Mechanical Systems and Design Criteria 8-1
8.1 Architectural Design Criteria 8-1
8.1.1 Codes and Standards 8-1
8.1.2 Building Code Analysis 8-1
8.2 Structural Codes, Systems, and Materials 8-2
8.2.1 Structural Design Criteria 8-2
8.2.2 Foundation Criteria 8-4
8.2.3 Materials 8-4
8.2.4 References 8-5
8.2.5 Water-Holding Structures 8-5
8.2.6 Non-Water-Holding Structures 8-5
8.2.7 Deliverables 8-6
8.3 HVAC Systems 8-6
8.3.1 Design Criteria 8-6
8.3.2 Codes 8-6
8.3.3 Outdoor Design Conditions 8-7
8.3.4 Indoor Design Conditions 8-7

8.3.5 Building Pressurization 8-7
8.3.6 Ductwork 8-8
8.3.7 Administration Building Systems 8-8
8.3.8 RO and Chemical Storage/Feed Building Systems 8-8
8.3.9 Finished Water Pump Station 8-8
8.3.10 HVAC System Controls 8-9
8.4 Plumbing Systems 8-9
8.4.1 General Scope 8-9
8.4.2 Design Criteria 8-9
8.4.3 Building Plumbing Systems 8-10
8.5 Fire Protection 8-10
8.5.1 General Scope 8-10

9 Architectural Building Concepts and Miscellaneous Structures 9-1
9.1 Introduction 9-1
9.2 Buildings 9-1
9.2.1 Administration Building 9-1
9.2.2 RO Process and Chemical Storage/Feed Building 9-2
9.2.3 Finished Water Pump Station 9-3
9.3 Exterior Building Components and Treatment 9-3

10 Instrumentation and Control System 10-1
10.1 Introduction 10-1
10.1.1 Assumptions 10-1
10.1.2 Open Items 10-1
10.2 SCADA System 10-1
10.2.1 System Servers 10-1
10.2.2 Human-Machine Interface 10-2
10.2.3 Programmable Logic Controller Network 10-2
10.2.4 SCADA System Communications 10-3
10.2.5 TELCO Communications 10-3
10.2.6 SCADA System Power 10-4
10.3 Equipment/Instrumentation Tagging Convention 10-4
10.3.1 General 10-4
10.3.2 Unit Processes 10-4
10.3.3 Instrumentation 10-5
10.3.4 Equipment 10-5
10.3.5 Panels 10-5
10.4 General Monitoring Requirements 10-6
10.5 General Control Modes 10-6
10.6 Overall Control: Local vs. Remote 10-6
10.7 Plant Control Strategies 10-7
10.7.1 Starting Production (Drawings I-3, I-5) 10-7
10.7.2 Fe/Mn Filtration System Pressure (Drawing I-2) 10-8
10.7.3 Fe/Mn Filtration System Filters (Drawing I-3) 10-8
10.7.4 Fe/Mn Chemical Feed (Drawings I-2, I-3) 10-9
10.7.5 Fe/Mn Filter Backwash (Drawing I-3) 10-9

10.7.6 Fe/Mn Backwash Supply Tank and Pump System (Drawing I-12) 10-10
10.7.7 Reclaim Tank and Reclaim Pumps (Drawing I-12) 10-11
10.7.8 Starting RO Production (Drawings I-3, I-5) 10-12
10.7.9 Membrane Feed Bypass or "Blend Control" (Drawings I-4, I-10) 10-12
10.7.10 Raw Water pH Control (Drawing I-3, I-4, I-18) 10-12
10.7.11 Pretreatment Threshold Inhibitor (TI) Feed Control (Drawing I-3, I-4) 10-13
10.7.12 Cartridge Filter Differential Pressure (Drawing I-4) 10-13
10.7.13 Membrane Feed to Waste Control (Drawing I-4, I-5) 10-13
10.7.14 RO Feed Pumps (Drawing I-5) 10-13
10.7.15 Interstage Turbocharger (IT-32150) and Auxiliary Nozzle Valve (ANV-32151) - (Drawing I-6) 10-14
10.7.16 Membrane Permeate/Concentrate Flows and Recovery Control System (Drawing I-6, Train 1; Drawing I-7, Train 2) 10-14
10.7.17 Permeate to Waste Controls (Off-Spec Permeate) (Drawing I-6, Train 1; Drawing I-7, Train 2) 10-15
10.7.18 Decarbonator Bypass (Drawing I-9) 10-16
10.7.19 Post-Treatment Corrosion Inhibitor Feed Control (Drawing I-6, I-7, I-22) 10-16
10.7.20 Clearwell/ Finish Water Off-Spec Water (Drawing I-10) 10-16
10.7.21 Post-Disinfection Sodium Hypochlorite Feed Control (Drawing I-11, I-17) 10-16
10.7.22 Post-Treatment Ammonia Feed Control (Drawing I-11, 1-19) 10-16
10.7.23 Post-Treatment Fluoride Feed Control (Drawing I-11, I-23) 10-16
10.7.24 Final Metering (Drawing I-11, I-23) 10-16
10.7.25 Membrane Cleaning System (Drawing I-13) 10-17
10.7.26 Membrane Flushing (Drawing I-14) 10-18
10.7.27 Permeate Transfer Between Permeate and CIP Tanks (Drawings I-13,I-14) 10-19
10.7.28 Finished Water Pump Station (Drawing I-10) 10-20
10.7.29 Concentrate Pump Station (Drawing I-15) 10-21
10.8 Chemical Systems for Desalination Facility 10-22
10.8.1 Sodium Hypochlorite System (Drawings I-16, I-17) 10-23
10.8.2 Sulfuric Acid Storage, Transfer and Metering System (Drawing I-18) 10-24
10.8.3 Aqueous Ammonia Storage and Feed System (Drawing I-19) 10-24
10.8.4 Sodium Hydroxide (NaOH) Storage Transfer and Metering System (Drawing I-20) 10-25
10.8.5 Threshold Inhibitor (TI) Storage and Metering System (Drawing I-21) 10-26
10.8.6 Corrosion Inhibitor Storage and Metering System (Drawing I-22) 10-26
10.8.7 10.8.7 Hydrofluosilicic Acid (F) Storage, Day Tank, and Metering System (Drawing I-23) 10-26
10.8.8 Citric Acid Storage and Transfer System (Drawing I-24) 10-27

10.8.9 Sodium Bisulfate Storage, Transfer, and Metering System (Drawing I-25) 10-27

11 Electrical System 11-1
11.1 Introduction 11-1
11.1.1 Assumptions 11-1
11.1.2 Open Items 11-2
11.1.3 Electrical Analysis 11-3
11.2 Electrical Codes and Standards 11-3
11.2.1 Codes 11-3
11.2.2 Standards 11-4
11.2.3 Design Guides 11-4
11.2.4 Regulations 11-4
11.3 Utility Power Service 11-4
11.3.1 Alternative Approach 11-5
11.4 Power Distribution Criteria 11-6
11.4.1 Protective Devices 11-7
11.4.2 Ground Fault Protection 11-7
11.4.3 Available Short-Circuit Ratings 11-8
11.4.4 Harmonic Distortion 11-8
11.4.5 Equipment Construction 11-8
11.5 Motor Control Criteria 11-9
11.5.1 Adjustable-Speed Motor Applications 11-9
11.5.2 Constant-Speed Motor Applications 11-9
11.5.3 Control and Monitoring 11-10
11.5.4 Alternating Current (AC) Induction Motors 11-10
11.6 Standby Power Distribution Criteria 11-10
11.7 UPS (Uninterruptible Power Supply) System Criteria 11-10
11.8 General Lighting, Fire/Life Safety Design Criteria 11-11
11.8.1 Fire Detection and Notification 11-11
11.8.2 Exterior Lighting 11-12
11.8.3 Interior Lighting 11-12
11.9 Lightning Protection Design Criteria 11-13
11.10 Electrical Material and Methods Design Criteria 11-13
11.10.1 Raceway Systems 11-14
11.10.2 Wire and Cable 11-15
11.10.3 Fiber-Optic 11-15
11.11 Communication Criteria 11-15
11.12 Submetering 11-16
11.13 Security System 11-16
11.14 Grounding Criteria 11-17

12 Specifications 12-1

13 Cost Estimate 13-1
13.1 Purpose of Estimate 13-1
13.2 Overall Costs 13-1
13.3 Markups 13-1

13.4 Escalation Rate 13-1
13.5 Market Conditions 13-2
13.6 Estimate Classification 13-2
13.7 Cost Resources 13-2
13.8 Estimate Methodology 13-3
13.9 Labor Costs 13-3
13.10 Sales Tax 13-3
13.11 Allowance Costs 13-3
13.12 Major Assumptions 13-3
13.13 Excluded Costs 13-5

Tables

2-1 Summary of PDF II Raw Water Supply Wells 2-1
2-2 Average Concentration of Constituents in 10 Wells Supplying Water to PDF II 2-4
2-3 PDF II Water Quality Goals 2-5
3-1 PDF II Desalination Preliminary Process Flow 3-2
3-2 Preliminary Process Design Criteria for the Fe/Mn Removal System 3-4
3-3 Preliminary Process Design Criteria for the RO Feedwater Pretreatment System 3-6
3-4 Preliminary Process Design Criteria for RO Feed Pumps 3-8
3-5 Preliminary Process Design Criteria for RO 2-stage Process Trains 3-8
3-6 Summary of Performance Results for Recommended RO Membrane Elements 3-12
3-7 Summary of Energy Recovery System Evaluation 3-13
3-8 Preliminary Process Design Criteria for RO CIP System 3-14
3-9 Preliminary Process Design Criteria for RO Flush System 3-16
3-10 Preliminary Process Design Criteria for Decarbonator Tower 3-17
4-1 List of Chemicals and their Application at PDF II 4-1
4-2 Sodium Hypochlorite System Design Criteria 4-2
4-3 Sodium Bisulfite System Design Criteria 4-4
4-4 Threshold Inhibitor System Design Criteria 4-5
4-5 Sulfuric Acid System Design Criteria 4-6
4-6 Citric Acid System Design Criteria 4-7
4-7 Sodium Hydroxide System Design Criteria 4-7
4-8 Corrosion Inhibitor System Design Criteria 4-9
4-9 Aqueous Ammonia System Design Criteria 4-9
4-10 Hydrofluosilicic Acid (Fluoride) System Design Criteria 4-10

5-1 Clearwell System Design Criteria 5-1
5-2 Clearwell CT Calculations....5-2
5-3 Finished Water Pump Station Design Criteria 5-3
6-1 Concentrate Pump Station Design Criteria....6-2
8-1 Indoor Design Conditions 8-7
11-1 Load Summary....11-6
11-2 Electrical System Nominal Voltages 11-6
11-3 Electrical System Utilization Voltages....11-7
11-4 Adjustable Speed and Constant Speed Applications 11-9
11-5 Electrical Equipment Material Selection 11-13
11-6 Electrical Equipment and Material Derating....11-14

Figures

2-1 Eastern Municipal Water District Desalination Wells and Transmission Pipelines ..2-2
3-1 Schematic of Perris II Desalination Facility 3-1
3-2 Schematic of Fe/Mn Removal System....3-3
3-3 Process Flow Diagram for the RO System including Turbocharger 3-9
7-1 PDF II Site Layout....7-1

Appendixes

A Well Water Blends
B Technical Memorandum: Membrane Selection and Energy Recovery System Evaluation
C City of Perris – Summary of Requested Improvements
D City of Perris General Requirements and Design Calculations for the Infiltration Pond
E Technical Memorandum – Geotechnical Exploration and Recommendations
F Floodplain Requirements (CLOMR-F related documents)
G Administration Building Code Analysis
H Reverse Osmosis Building Code Analysis
I Finished Water Pump Station Code Analysis
J Laboratory Design Data
K Cost Estimate
L Technical Memorandum - Concentrate Pump Station, Findings and Recommendations

Volume II – Preliminary Design Drawings

Bound separately

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
A	amp(s)
AC	alternating current
ACI	American Concrete Institute
AI	Aggressive Index
AIC	available inrush current
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
BFE	base flood elevation
$CaCO_3$	calcium carbonate
CCPP	calcium carbonate precipitation potential
CCS	central computer system
CCT	chlorine contact tank
CDPH	California Department of Public Health
CIP	clean-in-place
CLOMR-F	Conditional Letter of Map Revision Based on Fill
CMU	concrete masonry unit
CO_2	carbon dioxide
CT	contact time
ECS	electronic control system
EMWD	Eastern Municipal Water District
ESR	electrical service requirement
FACP	fire alarm control panel
FDC	fire department connection
Fe/Mn	iron/manganese

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FRP	fiberglass reinforced plastic
ft^2	square feet
ft^3	cubic feet
FVNR	full-voltage nonreversing
FVR	full-voltage reversing
GFCI	ground fault circuit interrupter
gfd	gallons per day per square foot
gpm	gallons per minute
gpm/ft^2	gallons per minute per square foot
HDPE	high-density polyethylene
HMI	human-machine interface
HOA	HAND/OFF/AUTO
HTC	hydraulic turbocharger
HVAC	heating, ventilation, and air conditioning
HWL	high water level
I/O	input/output
IBP	interstage booster pump
IDF	information distribution facility
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ISA	Instrument Society of America
kips	thousands of pounds per square inch
kV	kilovolt(s)
kVA	kilovolt-ampere(s)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
LAN	local area network
lb	pound(s)
lb/day	pounds per day

LCP	local control panel
LOMR	Letter of Map Revision
LOMR-F	Letter of Map Revision Based on Fill
LSI	Langelier Saturation Index
LWL	Low Water Level
mA	milliampere(s)
MCC	motor control center
MCL	maximum contaminant level
MCP	master control panel
mg/L	milligrams per liter
mg-min/L	milligrams per minute per liter
mgd	million gallons per day
MHz	megahertz
mph	miles per hour
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NGVD	National Geodetic Vertical Datum
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
O&M	operation and maintenance
OD	outside diameter
off-spec	off-specification
ORP	oxidation reduction potential
P&ID	process and instrumentation diagram
pcf	pounds per cubic foot
PDF II	Perris II Desalination Facility
PDR	Preliminary Design Report
PID	proportional-integral-derivative
PLC	programmable logic controller
psf	pounds per square foot
psi	pounds per square inch

PVC	polyvinyl chloride
PVDF	polyvinylidene fluoride
PVRWRF	Perris Valley Regional Water Reclamation Facility
PX	pressure exchanger
RAS	remote access service
RGA	rigid galvanized aluminum
RIO	remote input/output
RO	reverse osmosis
RTU	remote telemetry unit
RVSS	reduced-voltage solid-state
SCADA	supervisory control and data acquisition
SCE	Southern California Edison
SES	service entrance switchboard
SSFR	second-stage flux ratio
SST	stainless steel
TDH	total dynamic head
TDS	total dissolved solids
TEFC	totally enclosed, fan-cooled
TI	threshold inhibitor
TVRI	Temescal Valley Regional Interceptor
TVSS	transient voltage surge suppressor
UL	Underwriters Laboratories, Inc.
UPS	uninterruptible power supply
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
V	volt(s)
VFD	variable frequency drive
VOIP	Voice Over Internet Protocol

SECTION 1

Introduction

1.1 Purpose and Background

The United States Army Corps of Engineers (USACE) Los Angeles District has entered into a partnership agreement with Eastern Municipal Water District (EMWD) to prepare the contract documents for the Perris II Desalination Facility (PDF II), in the City of Perris, Riverside County, California. The primary objectives of PDF II are to control salinity in the San Jacinto Basin and to supplement EMWD's potable water system. This Preliminary Design Report (PDR) includes design criteria for all unit processes, as well as EMWD's preferences and requirements. Preliminary design drawings are included in Volume II of this PDR.

EMWD currently owns and operates two desalination facilities. The Menifee Desalination Facility, with a plant capacity of 3 million gallons per day (mgd) at 70 percent recovery, was designed by CH2M HILL in 1999; operation of this facility began near the end of 2001. In 2001, EMWD again contracted CH2M HILL to design its second desalination facility, the Perris I Desalination Facility in the City of Perris, with a plant capacity of 5.0 mgd at 70 percent recovery. Plant capacity in this case means permeate production from the RO system plus the allowable pre-treated water bypass, which is approximately ten-percent of the permeate production.

The primary functions of these two facilities are to reduce the salt buildup in the groundwater and to utilize local groundwater supplies that are high in total dissolved solids (TDS) for potable purposes.

The addition of PDF II will allow EMWD to meet its goal of producing 12,000 acre-feet per year of drinking water from brackish water, which represents 8 percent of its total water supply. This also will help EMWD satisfy the increasing water supply demand in its service area.

1.2 Previous Preliminary Design Report

A draft PDR for PDF II was previously prepared by Parson Brinckerhoff in March 2007. This report outlined a basic understanding of the project and preliminary requirements of the 30 percent conceptual design. The design did not include the iron and manganese (Fe/Mn) removal system and was based on a plant production capacity of 3 mgd. The estimated facility construction cost in the Parson Brinckerhoff PDR was estimated at $14.8 million including a 20 percent contingency allowance. However, this estimate did not include costs associated with the Fe/Mn removal system, City of Perris streets improvements, detailed design, and construction administration.

1.3 Project Description

The PDF II will be located on the southwestern corner of the existing Perris Valley Regional Water Reclamation Facility (PVRWRF) lot. Concrete block walls will separate PDF II from the PVRWRF and from both Hull Road and Watson Road.

The source water for PDF II will be groundwater supplied by wells within the Perris South and Lakeview sub-basins. Plant production capacity is expected to be 3.5 mgd initially and 5.0 mgd at build out. This finished water will consist of RO permeate blended with pretreated groundwater (treated only by the Fe/Mn removal system) that is disinfected and stabilized.

In the initial phase, 3.0 mgd of reverse osmosis (RO) permeate will be produced through two RO trains and up to 0.5 mgd of pretreated water (bypassed around the RO system) will be blended with the RO permeate.

At the ultimate phase, 4.5 mgd of RO permeate will be produced through three RO trains and up to 0.5 mgd of pretreated water will be blended with the RO permeate.

The RO trains will be configured in two stages and will operate at a minimum recovery of 72 percent.

RO concentrate water will be disposed into the EMWD brine collection system, while startup and off-specification (off-spec) water will be discharged into a new percolation pond designed as part of this project. Finished product water (blended RO permeate and pretreated water that is chlorinated and stabilized) will be delivered to the existing water supply system by connecting to the existing Murrieta Road pipeline.

The PDF II will be fully automated and operational on a 24-hour-per-day, 7-days-per-week basis with a plant operator in attendance only during one 8-hour shift. Following are the major components of the PDF II design:

- Treatment processes
- Site layout and non-process facilities

1.3.1 Treatment Processes

The proposed treatment processes will include the following facilities or functions.

Iron and Manganese (Fe/Mn) Removal System

This system will be located upstream of the RO system and will be able to treat the entire RO feed flow. It will be similar in design to the Fe/Mn removal system currently being installed at the Menifee and Perris I Desalination Facilities and will include the following major components:

- Pressure granular media filter system
- Backwash tank and reclaim water tank

The design of the Fe/Mn removal system will include provisions for one additional media filter to be installed once the third RO train is in place. The chemicals needed for the Fe/Mn

system (chlorine for oxidation and sodium bisulfite for dechlorination) will be housed in the chemical storage and feed building.

RO System

This system will be located in the RO building and will include the following major components:

- Three cartridge filters with 5-micron cartridges
- Two high-pressure RO feed pumps equipped with variable frequency drives (VFDs); provision for one additional RO feed pump.
- Two 2-stage RO trains, each capable of producing up to 1.5 mgd of permeate and each equipped with an interstage turbocharger; provision for one additional RO train.
- Online sampling system including sample pumps, analyzers, bubble traps, and panels for process monitoring purposes. This will include measurements of conductivity, temperature, and pH.
- RO clean-in-place (CIP) system including tank, pump and cartridge filter.
- Fully automated flush system including permeate storage tank and pump.
- Pipe trenches under the RO trains with pipe headers.
- Decarbonator tower located downstream of the RO trains and designed to remove more than 95 percent of the carbon dioxide (CO_2). The decarbonator tower and air inlet filter will be located outdoors, and the air blower will be located inside the RO building.
- Chemical storage and feed system for each of the following chemicals:
  - Fluoride to be injected downstream of the finished water pump station.
  - Sodium hypochlorite to be injected downstream of the decarbonator for free chlorine disinfection of the finished water. Sodium hypochlorite also will be injected upstream of the Fe/Mn system to oxidize iron and manganese in the well water.
  - Sodium bisulfite to be injected downstream of the Fe/Mn system to dechlorinate the RO feedwater.
  - Sodium hydroxide to be injected downstream of the RO system to adjust pH and control corrosivity in the finished water Sodium hydroxide also will be used for the CIP system.
  - Threshold inhibitor (TI) and sulfuric acid will be injected into the RO feed for scale control.
  - Ammonia to be injected downstream of the clearwell to develop combined residual in the finished water.
  - Cleaning agents to be used during CIP of the RO trains.

Each of these chemical systems will have its own containment area and will consist of a storage tank(s), transfer or metering pumps, and associated piping and valves. All metering pump adjustments will be accessible from outside the containment areas and will be shielded by sliding plexiglass windows. The design of the chemical storage and feed systems will include provisions for the future increased treatment capacity once the third RO train is in place. These provisions include sizing the metering pumps for a full range of chemical dosing. The minimum dosing is when only one RO train is in operation and the maximum dosing is when all three RO trains are in operation. As such, the chemical storage tanks will store chemicals for the ultimate plant capacity.

- A chlorine contact tank for disinfection of the entire finished water flow designed to achieve the required "CT" (contact time x chlorine residual) based on the United States Environmental Protection Agency (USEPA) Disinfection Profiling and Benchmarking Guidance Manual. The chlorine contact tank will be below grade and covered with a concrete roof slab to prevent chlorine residual dissipation due to sunlight and introduction of dust or other foreign matter. Access hatches will be designed for maintenance activities. Disinfected water will flow to a finished water pump station containing vertical turbine pumps equipped with VFDs. The design of the chlorine contact tank and the finished water pump station will include provisions for the additional finished water flow rate once the third RO train is in place. Finished water will be pumped into the existing water supply system through a connection to the existing Murrieta Road pipeline.
- A concentrate pump station to discharge RO concentrate into EMWD's brine collection system. This pump station will have a below grade tank that will be equipped with vertical turbine pumps with VFD-driven electric motors. In order to comply with California Department of Public Health requirements, an air gap will be included to prevent any potential backflow from the brine pipeline to the treatment plant. The design of the concentrate pump station will consider the overall operation and hydraulic conditions of the brine collection system. The design of the concentrate pump station also will include provisions for the additional flow once the third RO train is in place.

1.3.2 Site Layout and Non-Process Facilities

The site layout and non-process components will consist of the following:

- Access roads and gates to ensure easy egress and ingress of vehicles, especially for chemical delivery purposes (chemical trucks up to 65 feet long).
- Grading, drainage, access roads, parking, yard piping, and landscaping. Recycled water from the PVRWRF will be used for landscape irrigation.
- A stand-alone wall along the perimeter of the site, security cameras, keycard-enabled doors, and outdoor lighting for security purposes.
- Percolation pond located north of the PDF II site to collect purged and off-spec water during the startup and normal operation of the plant. This pond is also sized to collect site runoff flow since there is no drainage collection system near the site.

- A concrete masonry unit (CMU) building to house the RO system and chemical storage and feed system described above (except for the decarbonator tower and salt tank) in addition to the following major components:
  - Electrical equipment
  - Heating, ventilation and air conditioning (HVAC) system
  - Instrumentation and controls
  - Local control room
  - Restroom
  - Maintenance shop and storage area
- A CMU administration building, which will be air conditioned. The spaces in this building will include the following major components:
  - Office
  - Conference/training room
  - Field laboratory
  - Break room
  - Restrooms with lockers and shower (one for men and one for women)
  - Control room (to house the supervisory control and data acquisition [SCADA] workstations and EMWD workstations)
  - Communications room (to house telephone, local area network [LAN], fire rack, security rack, SCADA rack, and all servers)
  - Electrical room
  - Mechanical room (to house the HVAC equipment and water heater)
- A CMU building to house the finished water pump station.

The PDF II electrical power supply and feed system will be supplied via switchgear directly from Southern California Edison (SCE). The design of the uninterruptible power supply (UPS) system will be based on a centralized UPS source.

The PDF II control systems will have a SCADA system consisting of programmable logic controllers (PLCs) connected through a communications system to computer workstations with human-machine interfaces (HMIs). The SCADA system will be able to communicate with the existing EMWD system. The fiber-optic system for the SCADA will be coordinated with the PVRWRF expansion project. A workstation with a historian server will be housed in the control room in the administration building. The historian will be compatible with all standards defined by EMWD. The communications system will include a telephone system and a computer LAN. The design of the electrical and control systems incorporates provisions for the future third RO train.

SECTION 2

Raw Water Supply Wells and Water Blending

2.1 Introduction

This section describes the raw well water supply system serving EMWD's existing and new desalination facilities. This section also discusses the well water quality and blend options, water quality goals, and system integration for PDF II.

2.2 Raw Water Supply Wells

PDF II source water will be supplied by a network of groundwater wells. The wells are located in three groundwater sub-basins: Perris South II, Menifee I, and Lakeview. The majority of the wells are located in Perris South II sub-basin. Figure 2-1 shows the location of the existing groundwater wells and transmission pipelines.

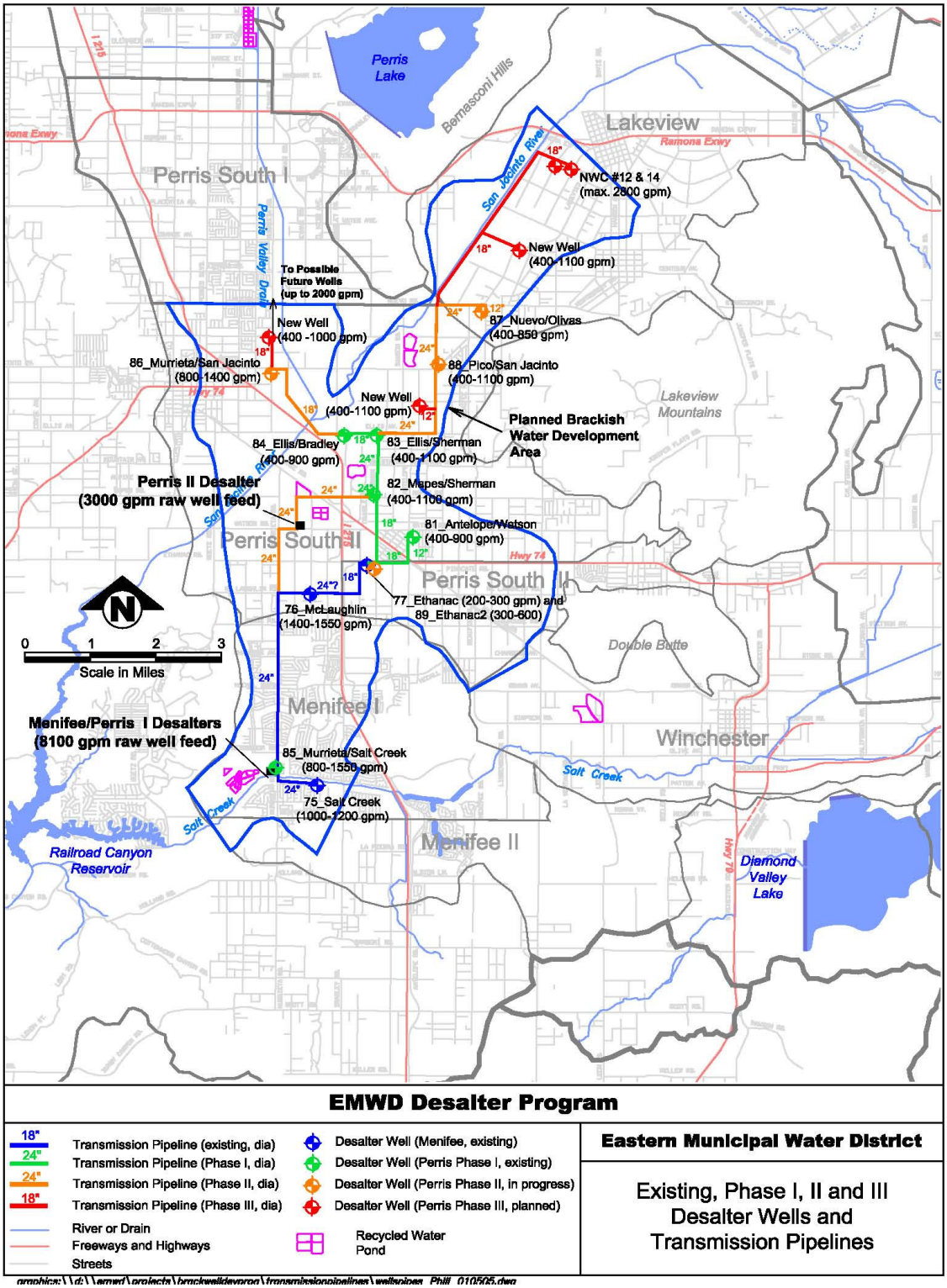
Currently, EMWD's network of wells includes a total of 12 wells. With the exception of Well 75 and Well 85, these wells can be used to supply PDF II (i.e., 10 wells can be used). Information on the existing raw water supply wells are summarized in Table 2-1. Meanwhile, EMWD is exploring the possibility of adding more wells to its system.

TABLE 2-1
Summary of PDF II Raw Water Supply Wells

Well Number	Design Flow (gpm)	Minimum Flow (gpm)	Pump Type	Pump Drive
76	1,600	1,400	Vertical Turbine	Constant Speed
77	250	200	Vertical Turbine	Constant Speed
81	750	400	Submersible	Variable Speed
82	1,000	400	Submersible	Variable Speed
83	750	400	Submersible	Variable Speed
84	750	400	Submersible	Variable Speed
86	1,300	800	Submersible	Variable Speed
87	750	400	Submersible	Variable Speed
88	1,000	400	Submersible	Variable Speed
89	500	300	Submersible	Variable Speed

gpm – gallons per minute

Figure 2-1 Eastern Municipal Water District Desalination Wells and Transmission Pipelines



2.3 Well Water Quality and Blend Options

Raw water quality to PDF II can change depending on the location of the wells. Generally, wells in the southern part of the sub-basin have higher reported levels of silica whereas wells in the northern part have correspondingly higher levels of TDS and iron. Water within the Perris South II and Lakeview sub-basins is generally characterized by high concentrations of TDS, silica, and in some cases, iron. Table 2-2 shows a summary of the water quality for each well. Water quality data are from sampling events that took place on or after June 1, 2006, with the exception of ammonia (as N) concentrations in wells 86, 87, and 88; sodium concentrations in wells 87 and 88; and strontium data in all wells. In addition, various testing and water quality data indicate that there are no regulated organic compounds, metals, and pesticides above primary maximum contaminant levels (MCLs) in any of the wells.

Raw water feed flows needed to operate PDF II will range from 1,620 to 4,690 gpm. In most cases, more than one well will be required to provide sufficient flow to the plant. Consequently, as different wells are operated and their flows blended to meet the plant's flow requirements, raw water quality will vary depending on which wells are in service. Table 2-2 shows the water quality for a blend of all ten wells that can serve PDF II. Eight other blend options were also considered and are presented in Appendix A. Raw water blends based on the following characteristics were developed to serve as the basis for the process design: low TDS, high TDS, high silica, low alkalinity and high alkalinity. Based on these characteristics, raw water quality that will serve PDF II will have silica and TDS concentrations as high as 63 milligrams per liter (mg/L) and 2,600 mg/L, respectively.

2.4 Water Quality Goals

Table 2-3 shows the selected California Department of Public Health (CDPH) MCLs that are of concern to this project.

TABLE 2-3
PDF II Water Quality Goals

Constituents	Water Quality Goals[1]
Temp – °F	---
pH	6.5 to 8.5
Chloride – mg/L	250
Bicarbonate – mg/L	Min 50 [2]
Sulfate – mg/L	250
Nitrate – mg/L	45
Barium – mg/L	1.0
TDS – mg/L	450

[1] Based on CDPH and EMWD criteria for drinking water quality.

[2] For corrosion control and not for drinking water quality compliance

°F – degrees Fahrenheit

TABLE 2-2
Average Concentration of Constituents in 10 Wells Supplying Water to PDF II

Constituent	Unit	Well 76	Well 77	Well 81	Well 82	Well 83	Well 84	Well 86	Well 87	Well 88	Well 89	Blend
Flow	Gpm	1,600	250	750	1,000	750	750	1,300	750	1,000	500	8,650
Ammonia as N	mg/L	1.00	1.00	1.00	1.00	1.00	1.00	0.50[a]	0.50[a]	0.50[a]	1.00	0.82
Ammonium Ion (NH_4)[b]	mg/L	1.29	1.29	1.29	1.29	1.29	1.29	0.64	0.64	0.64	1.29	1.06
Barium	µg/L	120	257	363	440	123	55	180	520	1,100	175	337
Bicarbonate (HCO_3)	mg/L	310	390	245	245	203	160	119	91.0	159	200	205
Boron	mg/L	0.10	0.20	0.08	0.10	0.20	0.63	0.50	0.30	0.30	0.10	0.26
Calcium	mg/L	380	220	148	255	330	280	400	310	330	117	304
Carbonate (CO_3)	mg/L	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Chloride	mg/L	748	494	301	618	1,013	1,503	1,505	1,073	1,010	233	918
Fluoride	mg/L	0.20	0.20	0.20	0.23	0.20	0.13	0.30	0.20	0.20	0.20	0.21
Magnesium	mg/L	110	55.0	41.5	64.3	56.5	59.5	110	51.0	82.0	31.0	75.2
Nitrate as N	mg/L	7.00	4.6	8.50	5.50	7.33	2.93	13.0	8.00	12.0	7.9	8.18
Nitrate Ion (NO_3)[b]	mg/L	31.0	20.4	37.6	24.4	32.4	13.0	57.6	35.4	53.1	34.9	36.2
Nitrite as N	mg/L	0.01	0.07	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01
Nitrite Ion (NO_2)[b]	mg/L	0.03	0.23	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.10	0.04
pH	pH Units	6.80	6.90	6.90	7.05	7.48	7.50	6.90	7.10	7.20	6.70	6.98
Potassium	mg/L	6.30	9.0	8.90	9.00	9.43	9.98	7.00	11.0	11.0	4.6	8.46
Reactive Silica	mg/L	53.8	55.4	50.9	55.4	31.9	23.3	38.0	24.0	37.0	66.8	43.1
Sodium	mg/L	130	200	84.3	128	345	750	360	300	180	80	252
Strontium [a]	µg/L	1,475	2,945	588	1,700	3,000	1,900	2,450	2,233	1,800	590	1,834
Sulfate	mg/L	243	70.0	41.8	47.3	115	224	130	40.0	16.0	64.0	114
Temperature at Collection	℃	21.6	22.3	21.8	21.4	21.6	21.5	21.3	23.0	22.5	22.0	21.8
Total Dissolved Solids	mg/L	2,038	1,460	872	1,448	2,290	2,810	2,594	2,026	1,979	782	1,944

[a] Based on samples collected prior to June 1, 2006.
[b] Calculated.
℃ – degrees Celsius

In addition, provisions will be made to include water bypassing the RO process to blend with the RO permeate. The maximum allowable blend ratio will be determined by CDPH and is expected to range between 10 and 15 percent of the RO permeate flow.

2.5 System Integration

The well supply system is a closed-loop system and therefore subject to the development of transient surge conditions related to the starting and stopping of individual wells and RO trains. The existing Menifee and Perris I Desalination Facilities rely on motor-actuated valves to vent excess pressure during startup or shutdown conditions and limit high-pressure conditions that might otherwise cause individual wells to shut down. The PDF II will incorporate similar provisions to relieve transient pressure conditions by installing hydraulically operated relief valves and pressure-sustaining valves. The final design should however incorporate a hydraulic analysis of the well supply system and various operating scenarios to define potential transient conditions. The purpose of the system integration is to integrate the hydraulic and water quality functions of well operations.

SECTION 3

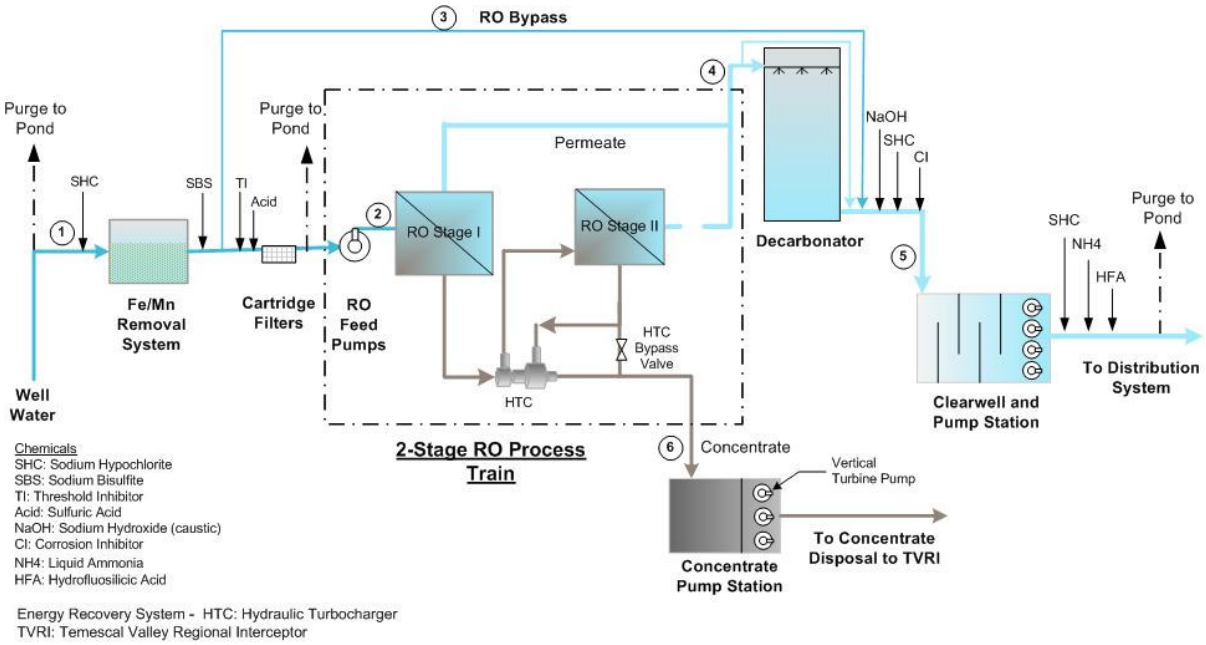
Treatment Process Facility

3.1 Introduction

PDF II will be EMWD's third desalination facility. Similar to Menifee and Perris I Desalination Facilities, RO is used as the desalination process. RO pre-treatment consists of Fe/Mn removal, chemical addition and cartridge filtration. RO post-treatment includes decarbonation, disinfection and stabilization.

Figure 3-1 provides a simplified schematic of PDF II.

Figure 3-1 Schematic of Perris II Desalination Facility



Well water will first be treated through the Fe/Mn removal system before splitting into two streams. The first stream will feed the RO system and is referred to as the *RO feedwater*. The second stream will bypass the RO system, blend with the RO permeate, and is referred to as the *RO bypass*.

After chemical addition and cartridge filtration, the RO feedwater is pressurized by the RO feed pump prior to entering the 2-stage RO system. The RO permeate will then be degasified to remove excess carbon dioxide. Post-decarbonator flow will blend with the RO bypass to produce blended (product) water, to which will be added caustic for pH adjustment and chlorine for disinfection. The product water will be pumped into the

distribution system. Prior to entering the system, additional chemicals will be added (fluoride and ammonia).

The RO concentrate (waste stream from the RO process) will be directed to a concentrate wet well and pumped into the Temescal Valley Regional Interceptor (TVRI). Table 3-1 summarizes the different unit processes flow rates.

TABLE 3-1
PDF II Desalination Preliminary Process Flow

Number [a]	Unit Process	Flow Rate - mgd	
		Initial Phase	Ultimate Phase
1	Fe/Mn Removal System Feed	4.5	6.8
2[b]	RO Feedwater	4.2	6.3
3	RO Bypass Water	0.5	0.5
4[b]	RO Permeate	3.0	4.5
5	Clearwell and Pump Station (Plant Finished Water)	3.5	5.0
6[b]	Concentrate Pump Station	1.2	1.8

[a] Numbers refer to the flow streams shown in Figure 3-1.

[b] Based on RO system recovery of 72 percent.

Unit processes, including the Fe/Mn removal system, cartridge filters, the decarbonator, and associated structures (i.e., clearwell and concentrate wet well); and the chemical storage and feed system will be designed for the plant future expansion (referred to as the ultimate phase). The RO system is a modular unit process, which will be designed for the initial phase and expanded by one additional module at the ultimate phase.

The high-quality RO permeate will allow blending with RO bypass and still meet the target water quality goals as required by CDPH and EMWD. The blending ratio may vary during plant operation based on actual water quality of the wells and the RO permeate quality. As shown in Table 3-1, the RO system will be designed for a permeate production of 3 mgd with provisions for future expansion to 4.5 mgd permeate. Allowing up to 0.5 mgd of RO bypass to be blended with the RO permeate will increase the PDF II capacity to 3.3 mgd at the initial phase and 5.0 mgd at the ultimate phase.

The following sections present the function, description, and design criteria for each unit process. Process and instrumentation diagrams (P&IDs) for all unit processes are included in the preliminary design drawings (Volume II of this PDR).

3.1 Pretreatment

As shown on Figure 3-1, raw water entering the facility will be pretreated prior to the RO system. The pretreatment will include Fe/Mn removal followed by chemical addition and cartridge filtration.

3.1.1 Iron and Manganese (Fe/Mn) Removal System

Iron (Fe) and manganese (Mn) are naturally occurring in groundwater. USEPA considers iron and manganese as secondary (or aesthetic) contaminants and non-hazardous to human health. However, these elements can affect the color, flavor, taste and appearance of water. Previous experience from operation of the Menifee and Perris I Desalination Facilities shows that removal of iron and manganese from the raw water can improve the downstream RO performance.

At PDF II, sodium hypochlorite is first dosed to the raw water upstream of the Fe/Mn removal system to oxidize the soluble and colloidal iron and manganese present in the well water. Oxidation converts these constituents into insoluble metal oxides that can be removed by filtration.

The filtration system consists of two duty and one standby horizontal pressure filter units (initial phase), a backwash tank, and a reclaim tank. A fourth filter will be added for the ultimate phase. The filter media is a proprietary blend of naturally occurring minerals that do not utilize greensand media or potassium permanganate. Figure 3-2 shows a simplified schematic of the Fe/Mn removal system.

The design details of the Fe/Mn removal system based on the Filtronics FHT-15 unit are presented in Table 3-2. The FHT-15 unit was selected based on the plant raw water flow and several field tests at the Perris I Desalination Facility using water from various wells.

Figure 3-2 Schematic of Fe/Mn Removal System

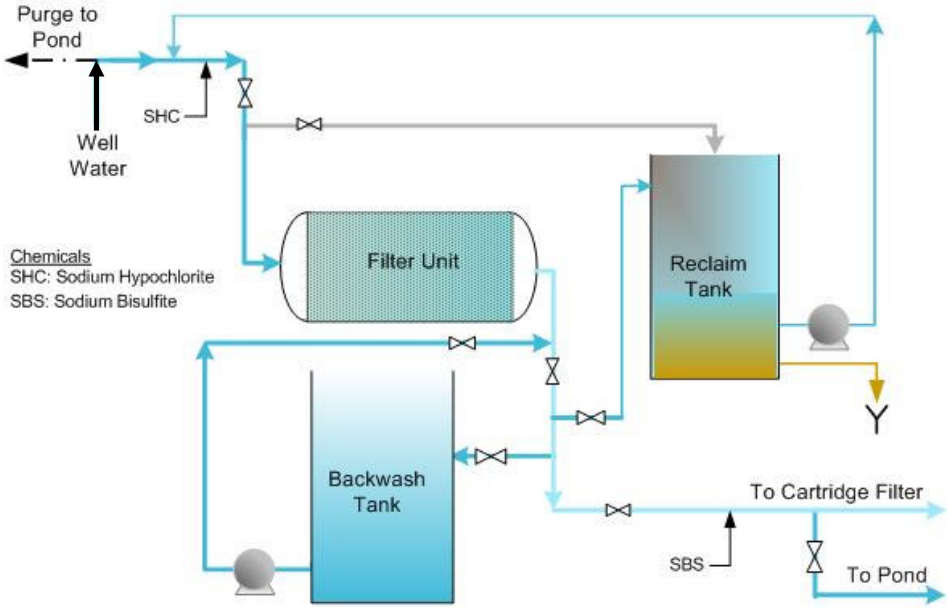


TABLE 3-2
Preliminary Process Design Criteria for the Fe/Mn Removal System

Unit Process	Parameter Criteria	
	Initial Phase	**Ultimate Phase**
Fe/Mn Removal System		
Total Raw Water Feed	3,243 gpm	4,688 gpm
Filters		
Number of Filters	3 (2 duty + 1 standby)	4 (3 duty + 1 standby)
Filter Type	Horizontal tank media filter	Horizontal tank media filter
Filter Manufacturer/ Model	Filtronics/FHT-15	Filtronics/FHT-15
Design capacity per Filter	1,850 gpm	1,850 gpm
Surface Area per Filter	125 ft^2	125 ft^2
Maximum Filtration Rate	14.8 gpm/ft^2	14.8 gpm/ft^2
Differential Pressure (DP) across each Filter-Clean	2 to 3 psi	2 to 3 psi
DP across each Filter-Dirty	10 psi	10 psi
DP across System	13 to 20 psi	13 to 20 psi
Backwash System		
Frequency	Once every 24 hrs	Once every 24 hrs
Duration	4 minutes	4 minutes
Flow needed per Filter	2,500 gpm	2,500 gpm
No. of Filters Backwashed per Backwash Cycle	1	1
Backwash Supply Tank		
Number of Tanks	1	1
Tank capacity	60,000 gallons	60,000 gallons
Backwash Pumping		
Number of Pumps	2 (1 duty + 1 standby)	2 (1 duty + 1 standby)
Pump Type	End suction centrifugal pump	End suction centrifugal pump
Pump Capacity	2,500 gpm	2,500 gpm
Pump Total Dynamic Head (TDH)	58 feet	58 feet
Pump Efficiency	70 percent	70 percent
Motor Horsepower	60	60
Motor Drive	Constant speed	Constant speed
Backwash Reclaim Tank		
Number of Tanks	1	1
Tank capacity	66,000 gallons	66,000 gallons
Number of Pumps	3 (2 duty + 1 standby)	3 (2 duty + 1 standby)
Pump Type	End suction centrifugal	End suction centrifugal
Pump Capacity	250 gpm	250 gpm

TABLE 3-2
Preliminary Process Design Criteria for the Fe/Mn Removal System

Unit Process	Parameter Criteria	
	Initial Phase	Ultimate Phase
Pump TDH	197 feet	197 feet
Pump Efficiency	70 percent	70 percent
Motor Horsepower	20	20
Motor Drive	VFD	VFD
Air Compressor Unit		
Number of Compressors	1	1
Motor Horsepower	7.5	7.5

gpm/ft^2 – gallons per minute per square foot
psi – pounds per square inch
Maximum bypass flow for both initial and ultimate phases is assumed 0.5 mgd.

The system is programmed to automatically backwash the filter units based on filtration time or when the differential pressure over the filter unit reaches a preset value. During the backwash cycle, the backwash water enters the filter bed at the bottom, fluidizing the bed and displacing Fe/Mn oxidized solids and other retained particles from the media. The upward flow of water then carries the displaced solids out of the filter and to the reclaim tank, leaving the media clean and ready for further use. The backwash cycle has a 4-minute duration.

Upon a shutdown, each filter is backwashed with chlorinated water (stored in the backwash tank) to maintain a clean, disinfected filter and to prevent short-circuiting or bacteriological growth in the filtration system while it is out of service.

Water used for backwash is discharged into a reclaim tank to allow for solids in the backwash to settle, which allows the supernatant to be recycled to the front end of the Fe/Mn removal system and blended with the well water.

The reclaim tank is sized to have a holding capacity for more than six backwash volumes per EMWD's request. Any time the water level is above the reclaim start level setpoint and a filter is in filtration, the reclaim timer begins its cycle. The reclaim timer cycle allows the residuals to settle. The average settling time is 20 to 60 minutes. The residuals are stored in the bottom of the reclaim tank, which is periodically drained to the sanitary sewer or to a vacuum truck and the contents hauled offsite for disposal. At the end of the cycle, the reclaim pump will start as long as a filter is in filtration and return the water reclaimed water to the head of the plant. The reclaim pumps are started by the filter control panel. The system control is described in detail in Section 10. Normally, more than 99 percent of the backwash water is recovered through decanting in the reclaim tank. USEPA limits the flow of reclaimed water to 10 percent of the water being filtered.

Filtered water exiting the Fe/Mn removal system will be dechlorinated with sodium bisulfite before it is directed to the downstream processes including the RO system.

3.1.2 Acid

The purpose of adding acid to the RO feedwater is to lower pH and alkalinity. Acid converts a portion of the bicarbonate in the feedwater to carbonic acid (CO_2), which lowers the pH of the water. Lower pH and bicarbonate alkalinity reduces the potential for calcium carbonate ($CaCO_3$) to become supersaturated through the RO process and form a precipitate in the RO elements and RO concentrate. Sulfuric acid is most commonly used for RO feedwater acidification because of it is low cost. Langelier Saturation Index (LSI) is used to determine the degree of acidification required to prevent $CaCO_3$ precipitation. Based on currently available well water quality data (Appendix A) and membrane manufacturer's computer models, acid dose was calculated for RO operation at 72 percent recovery. The models showed that acid addition will not be required at PDF II. This is supported by operational experience at the Perris I Desalination Facility indicating that carbonate scaling has not been an issue. However, raw water quality to PDF II may change over time and acid addition facilities will be provided in the event they may be needed in the future. However, no acid addition is planned in the near term.

3.1.3 Threshold Inhibitor

Threshold inhibitor (TI) is a polymeric substance that interferes with mineral precipitation, either by inhibiting the formation of the mineral crystals or by limiting the extent of crystal growth. Modern TIs are effective for a range of sparingly soluble minerals, including calcium sulfate (CaSO4), calcium fluoride (CaF2), barium sulfate (BaSO4), strontium sulfate (SrSO4), and silica (SiO2). TI addition at PDF II is required to control the precipitation of silica and CaCO3, primarily.

TI will be added in concentrations specified by the scale inhibitor manufacturer (typically 2 to 5 mg/L). TI will be injected ahead of the sulfuric acid injection and directly upstream of a in-line static mixer (and upstream of the cartridge filters). The in-line static mixer will ensure uniform distribution of the added chemicals throughout the bulk fluid stream.

3.1.4 Cartridge Filters

Cartridge filtration will be provided after chemical addition to remove suspended solids from the RO feedwater. The filters also serve as a mixing device for the pretreatment chemicals. The cartridge filters are not expected to take heavy solids loading. Most of the turbidity and silt should be removed at the wellhead through the blow-off process; however, monitoring the pressure differential across the cartridge filter can give early warning of potential problems. There will be three filters: two duty and one standby (Drawing I-4). The duty filters are sized for both the initial and ultimate plant capacities.

The criteria used to develop the pretreatment system design are listed in Table 3-3.

TABLE 3-3
Preliminary Process Design Criteria for the RO Feedwater Pretreatment System

Unit Process	Parameter Criteria
Cartridge Filters	
Numbers	3 (2 duty + 1 standby)
Capacity per Filter	2,330 gpm
Housing Material and Type	316 SST, horizontal
Element Size	2.5-inch nominal outside diameter (OD) filter element, 40 inches long
Element Material	Polypropylene
Number of Elements per Filter Housing	118
Element Loading Rate (gpm/10-inch equivalent)	4.9 gpm/10-inch equivalent
Filter Size	5 microns

3.2 RO System

The RO system removes dissolved solids from the brackish feedwater. Under a pressure differential across the RO membrane, water flows from feed side to permeate side, while salts are retained on the feed side. This produces a low-TDS "fresh" water (permeate) and a high-TDS concentrate that is disposed of by residual pressure to a concentrate pump station. The percent of RO feedwater converted to permeate is referred to as *recovery rate*. As the design recovery rate is maximized, the required capacities for raw water supply, pretreatment, feedwater pumping, and RO concentrate (reject) disposal facilities are minimized because less water is wasted as concentrate. However, as the recovery is increased, the concentration of salts in the RO system also increases. The addition of acid and TI can improve the RO system recovery.

The hydraulic loading rate of the membrane, known as flux, is another critical design parameter. Flux is commonly defined as the product flow rate in gallons per day divided by the membrane area (gallons per day per square foot [gfd]). The flux rate will be determined on a case-by-case basis as it is related to feedwater quality, target permeate water quality, membrane type, and capital and operation and maintenance (O&M) costs. Based on this, there is an optimum operating flux for every RO system, and operating above this optimum rate may increase membrane fouling potentials.

The RO system comprises RO high-pressure feed pumps, 2-stage RO trains, and interstage hydraulic turbochargers (turbos) for energy recovery. The purpose of the turbo is to balance flux between the two RO stages and reduce energy consumption required for RO feedwater pumping. The RO components are discussed in details in the following sub-sections.

3.2.1 RO Feed Pumps

The RO feed pump boosts the water to the pressure required by the RO system. The design pressure depends on the membrane element type, recovery, flux, turbo efficiency, and feed water quality. Each pump will be equipped with a VFD to provide the necessary feed

pressure to maintain permeate flow and recovery based on variations in the aforementioned parameters. The design criteria for the RO feed pumps are presented in Table 3-4.

TABLE 3-4
Preliminary Process Design Criteria for RO Feed Pumps

Unit Process	Parameter Criteria	
	Initial Phase	**Ultimate Phase**
RO Feed Pumps		
Number of Pumps	2	3
Pump Type	Vertical turbine	
Pump Material	316 SST	
Pump Capacity	1,450 gpm	
Pump TDH	370 feet	
Minimum Pump Efficiency	80 percent	
Motor Horsepower	200	
Motor Drive	VFD	

3.2.2 RO Trains

The RO system will consist of two 2-stage RO process trains for the initial phase and one additional train (three trains) for the ultimate phase. The available water quality data indicate a maximum TDS of 2,700 mg/L (see WQ1 in Appendix A). However, per EMWD's request, the system will be designed to operate at a TDS ranging from 1,700 mg/L to 3,500 mg/L to account for future water quality changes. The design criteria for the RO trains are presented in the Table 3-5.

TABLE 3-5
Preliminary Process Design Criteria for RO 2-Stage Process Trains

Unit Process	Parameter Criteria	
	Initial Phase	**Ultimate Phase**
RO Trains		
Number of RO Trains	2	3
RO System Design Parameters	**TDS Range – mg/L**	
RO Feedwater	1,700 to 3,500	
Flows per Train	**gpm (mgd)**	
Feedwater	1,450 (2.08)	
Permeate	1,045 (1.5)	
Concentrate	405 (0.58)	
Design RO Recovery	72 percent	
Number of Stages per Train	2	
Number of Pressure Vessels in Stage 1[a]	24 or 29 (for 6 elements per vessel)	
Number of Pressure Vessels in Stage 2[a]	12 or 14 (for 6 elements per vessel)	
Type of Vessels	Fiberglass reinforced plastic (FRP), side-port or multiport	
Number of Elements per Vessel	6 or 7	

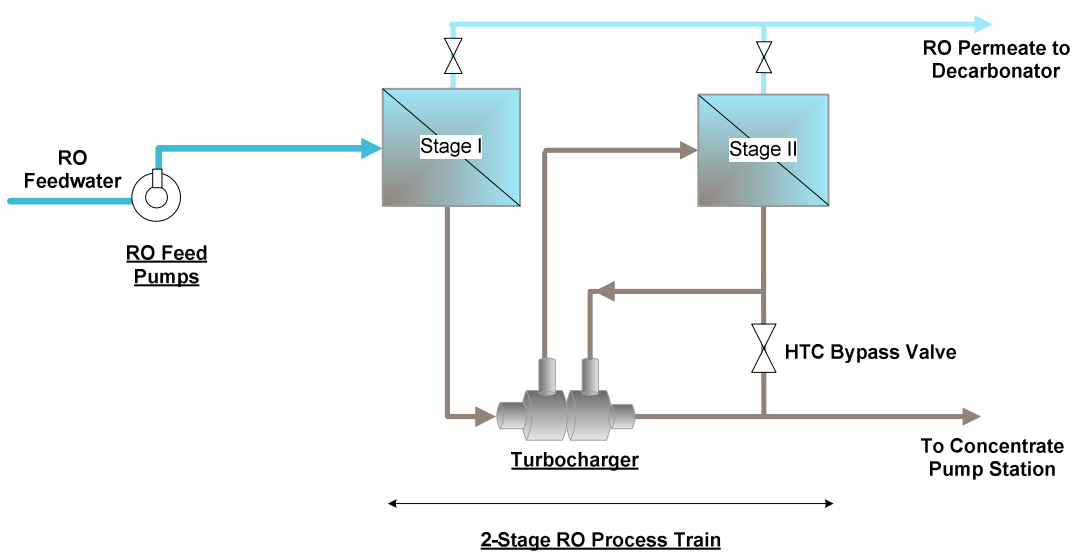
TABLE 3-5
Preliminary Process Design Criteria for RO 2-Stage Process Trains

Unit Process	Parameter Criteria	
	Initial Phase	**Ultimate Phase**
Element Size	8 inches in diameter; 40 inches long	
Element Surface Area	400 to 440 square feet (ft^2)	
Element Manufacturer	Filmtec, Hydranautics, Toray	
Minimum RO Permeate Back Pressure Assumed	15 psi	
Stage 1 Feed Pressure Range	120 to 180 psi	
Boosting Device	Hydraulic turbocharger	
Hydraulic Turbocharger Boost Available	42 to 64 psi	
Design Temperature	20°C to 22°C	
Average Flux	13.2 to 13.6 gfd	

[a]Number of vessels depends on element surface area.

Each train will be a self-contained treatment unit arranged in an approximate 2:1 array configuration with an interstage hydraulic turbocharger. Feed water will first be directed from the RO feed pump into Stage 1. The concentrate from Stage 1 will become the feedwater of Stage 2. The concentrate from the Stage 2 will be discharged into the brine pump station, from which it will be pumped into the TVRI. RO permeate from Stage 1 and Stage 2 will be combined and flow into a permeate header and then to the decarbonator. A simplified schematic of the RO system is shown in Figure 3-3.

Figure 3-3 Process Flow Diagram for the RO System including Turbocharger



Each membrane train will include an automated valve set to fail in a closed position if power is lost. A magnetic flowmeter and automated flow control valve on the membrane concentrate piping will control the recovery to each membrane train. An automatic flow control valve and a flowmeter on Stage 1 permeate piping will be used to create additional

permeate backpressure on Stage 1 in the event the turbo does not provide the described amount of flux balancing between stages.

3.2.3 RO Membranes

An evaluation of membrane elements for the RO system was performed prior to preparation of this PDR. Membrane elements from four membrane manufacturers were considered, with each having a surface area between 400 and 440 ft^2 and classified within three categories—ultra low pressure, low pressure, and high salt rejection—. A technical memorandum describing the evaluation process, as well as the recommended membrane elements, was submitted to EMWD by CH2M HILL in January 2008 (Appendix B).

The Koch membranes did not meet the selection criteria, whereas the FilmTec LE-440i, Hydranautics ESPA2+, and the Toray TMG20-430 showed the best permeate quality, required lowest feed pressure, least pressure boost needed for flux balancing, and highest potential for blending. The results of the membrane performance analysis are summarized in Table 3-6.

The lower range energy input shown in Table 3-6 indicates power consumption by a feed pump only when the interstage pressure boost for flux balancing is provided using a hydraulic turbocharger (HTC). The higher range energy input includes the power consumption of an interstage booster pump (IBP) with the feed pump. The blending ratio between 15 and 16 percent allows the membrane system to meet all specific water quality goals. However, total hardness in the finished water and other parameters such as LSI and CCPP should be considered to determine the acceptable and permitted blending ratio. All three manufacturers have a significant market share in brackish water desalination and supply RO elements to clients in the United States and overseas. The membrane selection, therefore, should be based on bid cost and projected life cycle cost.

3.2.4 Energy Recovery System

With the RO process, Stage 1 produces a greater flow of permeate than stage 2 because it operates at lower feedwater salinity and higher feed pressure. A high permeate flow in Stage 1 can cause accelerated fouling of the membrane elements and individual element recoveries that exceed the membrane manufacturer's recommend value. In contrast, too low a stage 2 flow can result increasing mineral precipitation (scaling), particularly in the trailing element. An imbalance in flow between the two stages can be alleviated by applying backpressure to the Stage 1 permeate stream. Applying permeate backpressure in Stage 1 wastes energy and increases membrane system feed pressure requirements. The preferred approach is to boost the pressure between the two stages. An interstage boost can be achieved either by (1) using a pump to increase the pressure of the stage 2 feed (interstage boost pump or IBP); or (2) using an energy recovery device (turbocharger [HTC] or pressure exchanger [PX]) to transfer residual pressure energy in the stage 2 concentrate to stage 2 feed, resulting in a pressure boost to the stage 2 feed. The main advantage to an energy recovery device is that it reduces the electrical energy consumption of the system because no additional power is required to achieve the stage 2 feed pressure increase.

TABLE 3-6
Summary of Performance Results for Recommended RO Membrane Elements

Membrane Manufacturer	Membrane Element	Surface Area (ft^2)	Average Flux (gfd)	Feed Pressure Range[1] (psi)	Maximum Required Pressure Boost (psi)	Total Energy Input Kilowatt Range[2]	Permeate Chloride [1] (mg/L)	Estimated Maximum Blending Ratio[3] (percent)	Blended (Permeate & Bypass) Hardness mg/L as $CaCO_3$
Dow (FilmTec)	LE-440i	440	13.2	140 to 160	54	100 to 113	27	16.0	210
Nitto Denko Hydranautics	ESPA2+	440	13.2	140 to 180	59	100 to 123	27	16.2	200
Toray Americas	TMG20-430	430	13.6	120 to 140	57	90 to 100	41	15.5	197

[1] Projected at 0 and 5 years when treating high-TDS feedwater.

[2] Total energy input range includes operation at 0 to 5 years using HTC.

[3] The estimated maximum feedwater bypass blend ratio is based on meeting all primary and secondary drinking water standards (chloride is the limiting constituent).

Evaluation of candidate energy recovery devices for PDF II was conducted prior to preparation of this PDR. The results of this evaluation were documented in a technical memorandum, which was submitted to EMWD. The technical memorandum (see Appendix B) describes the details of the evaluation and discusses each alternative. Based on this evaluation, CH2M HILL selected an HTC as the recommended energy recovery system for the RO system at PDF II. A comparison of the alternatives based on the construction, energy, and lifecycle costs, as well as the cost per 1,000 gallons of water produced, is provided in Table 3-7.

TABLE 3-7
Summary of Energy Recovery System Evaluation

Feedwater with TDS of 3,500 mg/L				
	System Cost			
System	Construction	Power	Life Cycle	Specific Cost per 1,000 Gallons
HTC	$63,000	$101,500	$1,227,000	$0.168
PX	$136,000	$95,900	$1,236,000	$0.169
IBP	$30,000	$123,700	$1,449,000	$0.198
Throttling Permeate Stream	$0	$136,300	$1,564,000	$0.214
Feedwater with TDS of 2,600 mg/L				
	System Cost			
System	Construction	Power	Life Cycle	Specific Cost per 1,000 Gallons
HTC	$63,000	$78,000	$957,000	$0.131
PX	$136,000	$76,400	$1,102,000	$0.139
IBP	$30,000	$93,400	$1,102,000	$0.151
Throttling Permeate Stream	$0	$98,400	$1,129,000	$0.155
Feedwater with TDS of 1,550 mg/L				
	System Cost			
System	Construction	Power	Life Cycle	Specific Cost per 1,000 Gallons
HTC	$63,000	$72,700	$897,000	$0.123
PX	$136,000	$79,000	$1,042,000	$0.143
IBP	$30,000	$83,100	$984,000	$0.135
Throttling Permeate Stream	$0	$88,400	$1,014,000	$0.139

Costs are based on the use of FilmTec LE-440i element.

Construction cost is based on an estimated installed major equipment cost.

Power cost is estimated based on $0.15/ kilowatt-hour (kWh), average feed pressure over life of the membrane elements, and per 1.0 mgd average finished water production.

Life cycle was estimated over a period of 20 years and an escalation rate of 6 percent.

Efficiency – Feed pump: 80 percent. Turbocharger: 64 percent. PX: 80 percent. Interstage booster pump (IBP): 75 percent

HTC is a simple system that reduces feed pressure requirements and overall energy consumption, and improves flux balancing. HTCs were installed on the RO trains at the Perris I Desalination Facility and have operated reliably. The new HTC design to be used at PDF II will incorporate higher system efficiency and better process control, as well as improved operation based on EMWD and CH2M HILL's better understanding of the feedwater quality, the outcome of the Perris I optimization project, and an improved well operation strategy. Optimal HTC efficiency is achieved when the TDS fluctuations are minimized. Therefore, optimization of the wellfield operation to manage variations in PDF II raw water TDS will be beneficial in maximizing operating efficiency of the HTCs.

3.2.5 RO CIP System

Chemical cleaning of the RO trains is required when membrane fouling or scaling occurs to the degree that a critical loss of performance occurs. Chemicals used for cleaning typically consist of organic or mineral acids and alkaline solutions consisting of simply dilute caustic or detergent/surfactant solutions sometimes containing chelating agents. The design criteria for the chemical cleaning (clean-in-place or CIP) system are shown in Table 3-8.

TABLE 3-8
Preliminary Process Design Criteria for RO CIP System

Unit Process	Parameter Criteria
RO CIP System	
Tank	1
Diameter	10 feet
Shell Height	10 feet
Capacity	4,000 gallons
Tank Material	FRP
Number of Heaters	1
Heater Power	200 kilowatts (kW)
Accessories	Level indicator and transmitter, Portable stairs
Pump	
Pump Type	Horizontal Centrifugal
Pump Material	316 SST
Number of Pumps	1
Pump Capacity	1,200 gpm
Pump TDH	150 feet
Flow for Stage 2 Cleaning	560 gpm
Motor Horsepower	75
Cartridge Filter	
Number of Filters	1
Flow Capacity per Filter	1,200 gpm
Housing Material and Type	316 SST Horizontal
Element Size	2.5-inch nominal OD filter element, 40 inches long
Element Material	Polypropylene
Number of Elements per Filter Housing	86
Element Loading Rate (gpm/10-inch equivalent)	3.5 gpm/10-inch equivalent
Filter Size	5 microns

Chemical cleaning is anticipated to be required once every three to six months. The CIP system operation is manual and controlled from a local field panel near the cleaning pump with continuous instrumentation monitoring for tank level, pH, temperature, flow, pressure, and pump status.

Cleaning solution will be prepared in a 4,000-gallon FRP cleaning tank (CIP tank) and recirculated by the cleaning pump through the pressure vessels on the RO train. The CIP cleaning solution is mixed within the cleaning tank using RO permeate for dilution water. The bulk chemicals are transferred to the CIP tank from drums using a transfer pump (liquid) or from bags through the top of the cleaning tank (dry). A platform adjacent to the tank will be provided for the addition of dry chemicals, if necessary. Liquid bulk chemicals include 50 percent citric acid and 50 percent sodium hydroxide solutions, which will be used to make up 2 percent citric acid and 0.1 percent sodium hydroxide cleaning solutions, respectively. Care should be taken to ensure that the chemicals used are certified under American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) Standard 60 for drinking water production, and do not contain oxidants or other substances harmful to the membranes. Care also should be taken to ensure a sanitary cleaning operation by maintaining a clean tank and feed systems, and by mixing sanitary quality cleaning solution. The chemicals are added after the dilution water is introduced into the CIP tank, and the cleaning recirculation pump is used to mix the chemicals prior to circulating the cleaning solution through the RO trains.

The cleaning solution is circulated at a low pressure of approximately 65 psi and a flow of 40 gpm per pressure vessel for 1 hour to clean each set of vessels. The first stage membranes require a total of 1,160 gpm[1]; and the second stage membranes require a minimum flow of 560 gpm[2]. The circulation pump is designed for a capacity of 1,200 gpm. The CIP pump is equipped with a VFD to provide the required flow range. The CIP tank is sized to allow 3 minutes of retention time at the cleaning flow rate (i.e., 3 minutes x 1,200 gpm = 3,600 gallons), plus an additional 2 feet of free board. A submerged immersion heater will be installed on the CIP tank and will be capable of raising the temperature of the cleaning solution from 25°C to approximately 40°C maximum within 3 hours.

The cleaning pipes are configured to allow the cleaning of either stage of the RO train. Valves are automated to direct the flow to selected stage within the RO train, and to direct the cleaning solution from the train back to the CIP tank. Most of the cleaning solution leaves the RO membranes on the concentrate side, due to the low pressures involved. Separate pipes are provided to collect the return cleaning solution from both permeate and concentrate sides of the membrane elements. The return piping is terminated near the bottom of the tank to reduce foaming. Once the cleaning solution has been spent, it will be gravity-drained to the concentrate pump station.

After cleaning of each stage (or one stage if that is all that is required), the RO train is flushed to displace the residual cleaning solution before being placed back into service.

[1] Assumes 29 vessels in stage 1.

[2] Assumes 14 vessels in stage 2.

3.2.6 RO Flush System

The RO flush system uses the RO permeate for system flushing, including the system piping, that occurs (1) during initial startup of an RO train to flush membrane preservative solution to waste, (2) following system shutdown to remove the concentrate from the membranes and prevent scaling, and (3) after a CIP cycle.

Isolation valves will be included on each membrane train to allow disposal of the off-specification membrane permeate to the new infiltration pond with an air gap. The design criteria for the RO flush system are shown in Table 3-9.

TABLE 3-9
Preliminary Process Design Criteria for RO Flush System

Unit Process	Parameter Criteria
RO Flush System	
Tank	1
Diameter	12 feet
Shell Height	18 feet
Capacity	12,500 gallons
Tank Material	FRP
Accessories	Level indicator and transmitter, ladder
Pump	
Pump Type	Horizontal end suction
Pump Material	316 SST
Number of Pumps	1
Pump Capacity	1,800 gpm
Pump TDH	150 feet
Motor Horsepower	125
Motor Drive	VFD

During initial flushing, cartridge filtered water will be used to flush the concentrate out of the RO system and into the concentrate disposal line, where it will then be discharged into the concentrate pump station.

3.3 Post-Treatment

The purpose of post-treatment is to properly stabilize and disinfect the blended water (blend of RO permeate and bypass). Post-treatment will include RO permeate decarbonation, pH adjustment, increasing the alkalinity, chlorination and ammoniation. Fluoride addition will take place following the post-treatment and prior to distribution. The following chemicals will be used in conjunction with post-treatment and fluoridation:

- Sodium hydroxide
- Sodium hypochlorite
- Corrosion inhibitor

- Liquid ammonia
- Hydrofluosilicic acid

The post-treatment processes are described in the following sections. The chemical storage and feed facilities are described in Section 4.

3.3.1 Decarbonation

Well water supplying the PDF II contains elevated levels of bicarbonate and CO_2. This naturally elevated CO_2, together with the additional CO_2 formed from RO feedwater acidification, results in high levels of CO_2 in both the RO permeate and blended water. To reduce CO_2, the RO permeate will be passed through a counter current, forced draft degasifer (decarbonator) where the CO_2 will be transferred from the liquid phase to the gas (air) phase. CO_2 removal increases the pH of the RO permeate, and therefore the blend, and minimizes the amount of caustic that must be added to achieve the desired finished water pH for corrosion control. Depending on levels of CO_2 and bicarbonate in the RO bypass and permeate streams, all or part of the RO permeate will be treated through the decarbonator. The decarbonator will be designed to remove more than 95 percent of the CO_2, with <10 mg/L remaining in the decarbonated permeate. Design criteria for the decarbonator system are listed in Table 3-10.

TABLE 3-10
Preliminary Process Design Criteria for Decarbonator System

Unit Process	Parameter Criteria
Decarbonator	
Treatment Capacity	3,125 gpm (4.5 mgd)
Number of Decarbonators	1
RO Permeate Bypass Flow	Bypass pipe sized to bypass 100 percent of flow
Influent Maximum CO_2 Concentration	160 mg/L
Influent pH	5.0 to 6.0
Decarbonator Tower Material	FRP
Decarbonator Diameter	12 feet
Decarbonator Height	25 feet
Number of Blowers	1
Blower Capacity	14,000 standard cubic feet per minute
Air to Water Ratio	30
CO_2 Removal Efficiency	> 95 percent
Blower Motor	15 horsepower

The decarbonator will be located outside the RO building, with a single air blower with motor located inside the RO building. The decarbonator will have a minimum of 11 feet packing depth to meet the CO_2 removal requirements. The packing material will consist of 2.5-inch-diameter, polypropylene material (MAS PAC FN-200 or equal).

3.3.2 Sodium Hydroxide

Following decarbonation, the pH of the blended water will still be lower than desired to minimize corrosion during finished water distribution as measured by it's tendency to dissolve calcium carbonate and corrode concrete structures or metal piping). The RO permeate, therefore, must be conditioned prior to entering the clearwell (chlorine contact tank). Two measures used to measure the corrosivity or aggressiveness of a water are the Langelier Saturation Index (LSI) and the Aggressive Index (AI). Neither index directly measure corrosivity, but instead provide a quantification of the tendency of a water to either dissolve or precipitate calcium carbonate. It is desirable for the finished water to have a CaCO3 precipitation potential so as to form a protective CaCO3 film on the structure or pipe wall to minimize corrosion. Therefore, a positive LSI is desired as this equates to a tendency for CaCO3 precipitation.

The AI, originally developed for monitoring the corrosivity of water toward asbestos cement pipe, is sometimes substituted for the LSI as an indicator of the corrosivity of water. The AI is derived from the actual pH, calcium hardness, and total alkalinity. Similar to the LSI, the AI is not a quantitative measure of corrosion, but is a general indicator of the tendency for corrosion to occur. An AI of 12 or above indicates nonaggressive (not corrosive) water. AI values below 10 indicate extremely aggressive (corrosive) conditions. Values of 10 to 11.9 suggest that the water is moderately aggressive.

To increase both the LSI and AI and reduce the corrosivity, sodium hydroxide (caustic) can be added to raise pH, LSI, and AI to make the finished water less aggressive.

3.3.3 Disinfection

Sodium hypochlorite is added to the blended water to create a free chlorine residual to achieve primary disinfection within the clearwell. The chlorine residual and hydraulic retention time within the clearwell (T10) have been determined to provide a "CT" that meets the requirements of the Surface Water Treatment Rule. Sodium hypochlorite will be dosed to the blended water directly downstream of the decarbonator; provisions for additional sodium hypochlorite injection as well as injection of aqueous ammonia, will be provided downstream of the clearwell. Capability for chemical injections will be provided to the plant blended water downstream of the decarbonator for sodium hypochlorite and downstream of the clearwell for sodium hypochlorite and aqueous ammonia. Sodium hypochlorite and aqueous ammonia storage and feed facilities are discussed in Section 4.

3.3.4 Corrosion Control

Given the anticipated variability in the alkalinity and CO2 of the plant raw water, it difficult to effectively control the corrosivity of the finished water through decarbonation and pH adjustment alone. To provide more robust control, a corrosion inhibitor feed system will be provided that can be used by the EMWD if needed. This will consist of a bulk storage tank and metering pumps for injection of a phosphate-based corrosion inhibitor. A blended ortho-poly phosphate blend chemical dosed to achieve a residual of 1 mg/L (as phosphate ion,f (PO_4^{-3}) is most typically employed for this purpose. Capability for corrosion inhibitor injection upstream of the clearwell will be provided.

A corrosion inhibitor system of similar design was installed at the Perris I Desalination Facility. To date, it has not been used and the operating staff has not reported issues with corrosion in the chlorine contact tank.

To prevent corrosion, coating the initial portion of the clearwell is recommended as an alternative to using corrosion inhibitor.

3.3.5 Fluoridation

Hydrofluosilicic acid is added to the finished water to provide a fluoride residual that reduces tooth decay. The target fluoride residual, according to CDPH rules, is approximately 0.8 mg/L as fluoride ion. The blended water will only have negligible fluoride concentrations. The target fluoride concentration will be provided by adding 0.8 mg/L of hydrofluosilicic acid to the finished water downstream of the clearwell and after NaOCl and NH_3 addition.

SECTION 4

Chemical Storage and Feed Systems

4.1 Introduction

Table 4-1 lists the chemicals that will be used at PDF II and stored in bulk in the chemical storage area.

TABLE 4-1
List of Chemicals and their Application at PDF II

Chemical – Abbreviation	Bulk Solution Concentration (percent)	Point of Application
Sodium Hypochlorite (SHC)	0.8%	Pre-Fe/Mn Removal System, Pre- and Post-Clearwell, Pre Decarbonator
Sodium Bisulfite (SBS)	25%	Post-Fe/Mn Removal System
Threshold Inhibitor (TI)	100%	Pre-Cartridge Filter
Sulfuric Acid (H2SO4)	93%	Pre-Cartridge Filter
Citric Acid (CA)	50%	For CIP Cleaning
Sodium Hydroxide (NaOH)	50%	Post-Decarbonator, for CIP Cleaning
Corrosion Inhibitor (CI)	100%	Post-Decarbonator
Aqueous Ammonia (NH4)	19%	Post-Clearwell
Hydrofluosilicic Acid (HFA)	25%	Post-Clearwell

Individual secondary concrete containment will be provided for each bulk storage tank and associated chemical metering pumps. All storage tanks and pump containment areas will be designed with a minimum 3-foot clearance for the equipment access areas. The feed system for each chemical will be designed with one duty and one standby for each injection point. The following subsections discuss specific design criteria for the chemical storage and feed systems.

4.2 Chemical Feed Systems

4.2.1 Safety Design on Chemical Feed Systems

The chemical feed systems will be designed for operational flexibility, safety, and SCADA control. The bulk chemical storage will be sized for the future expansion of the RO facility to 4.5 mgd (permeate capacity). A day tank will be used for fluoride to prevent overfeeding.

Chemical metering pumps, located in the secondary containment storage area, will be fed directly from the bulk chemical tanks in the storage area. All chemical metering pumps will be located adjacent to the containment walls in a configuration that allows operators to adjust pump operation without the need to step inside the containment area. Local pump control panels, data communication panels, and conduits will be located to provide unimpeded access to the metering pumps. The chemical lines will be double contained for runs outside their own concrete containment. Chemical metering pumps will be started either automatically or manually by an operator, and will shut off automatically based on RO train ON/OFF operations or low levels in the storage tanks.

All chemical pumps and their accessories—including valves, pressure gauges, pulsation dampeners, and calibration columns—will be mounted on common skids. The pump skid will be installed inside the concrete containment wall, such that the operator can reach the pump and its accessories when standing outside of the containment. A sliding plexiglass shield, mounted on top of the concrete containment wall, will shield the operator from the pumps. This sliding plexiglass will provide safety to personnel walking in the corridor between the chemical storage area and the RO Building. Operators are required to wear a safety face shield when performing calibration or maintenance on the metering pump. The operator must wear the safety face shield before he or she opens the safety sliding plexiglass.

4.2.2 Onsite Sodium Hypochlorite Generation

To satisfy disinfection requirements for PDF II, onsite sodium hypochlorite generators will be installed to meet sodium hypochlorite demand for the Fe/Mn removal system and disinfection at the clearwell. The design criteria for the sodium hypochlorite generators, daily sodium hypochlorite dosage required, and associated metering pumps are presented in Table 4-2.

TABLE 4-2
Sodium Hypochlorite System Design Criteria

Unit Process	Parameter Criteria
Sodium Hypochlorite Generation System	
Required Chlorine Upstream of Clearwell	2 to 3 mg/L
Chlorine Dosage Upstream of Fe/Mn Removal System	3 to 5 mg/L
Daily Chlorine Usage at Clearwell	125 pounds per day (lb/day)
Daily Chlorine Usage at Fe/Mn Removal System	291 lb/day
Salt Usage	1,248 lb/day
Salt Saturator Tank	
Tank Material	FRP
Tank Dimensions	8-foot diameter by 15-foot side wall height
Tank Capacity	23 tons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter
Hypochlorite Strength, Approximate	0.8 percent

TABLE 4-2
Sodium Hypochlorite System Design Criteria

Unit Process	Parameter Criteria
Injection Rate Upstream of Clearwell	17 to 77 gph
Injection Rate Upstream of Fe/Mn Removal System	34 to 180 gph
Metering Pump Upstream of Clearwell	
Pump Type	Diaphragm
Pump Head Material	PVDF
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	100 gph
Pump Design Discharge Pressure	120 psi
Motor	1 horsepower
Metering Pump Downstream of Clearwell	
Pump Type	Diaphragm
Pump Head Material	PVDF
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	100 gph
Pump Design Discharge Pressure	120 psi
Motor	1 horsepower, TEFC
Metering Pump Upstream of Fe/Mn Removal System	
Pump Type	Diaphragm
Pump Head Material	PVDF
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	250 gph
Pump Design Discharge Pressure	120 psi
Motor	2 horsepower, TEFC
Storage Tank	
Tank Material	FRP
Tank Dimensions	11.5-foot diameter by 9.5-foot side wall height
Tank Capacity	7,000 gallons
Minimum Days of Storage	2
Tank Accessories	Level indicator and transmitter
Pipe and Valving Material	Polyvinyl chloride (PVC) carrier and secondary containment

An onsite sodium hypochlorite generation system applies electric current to concentrated brine solution to create sodium hypochlorite. The system uses high-purity, food-grade salt that is dissolved in a brine tank and fed to hypochlorite generators. The process waste product, hydrogen gas, is disposed of by venting to the atmosphere above the roof level. The average venting quantity of hydrogen gas from a 450 lb/day chlorine generator is 0.53 cubic feet per minute.

The onsite generation facilities consist of a salt saturator (storage/brine tank), generators, a hypochlorite solution tank, air blowers, water softeners, and metering pumps. Routine maintenance with cleaning of generator electrodes is required (once every few months).

EMWD finished water, instead of the RO permeate, will be used to create the brine feed, such that the generators can still operate when the RO trains are shut down. The finished water needs to be softened to minimize electrode scaling. Sodium-based ion exchange softeners will be specified as part of the system.

The generated sodium hypochlorite is stored in an FRP storage tank with a 7,000-gallon capacity. This capacity is sufficient for 2 days of consumption at maximum daily usage. The strength of the sodium hypochlorite solution is approximately 0.8 percent chlorine by weight. The tank will be equipped with high and low level switches to control the generators on/off sequence. Concrete secondary containment for the day tank will be provided, although not required or regulated by the National Fire Code.

Three sets of metering pumps (two pumps per set – one duty plus one standby) will be provided for sodium hypochlorite injection. One set will be dedicated for injection to the feed line to the Fe/Mn removal system; one set will be dedicated for injection upstream of the clearwell; and one set will inject to the finished water line downstream of the clearwell.

4.2.3 Sodium Bisulfite

Sodium bisulfite ($NaHSO_3$) will be added downstream of the Fe/Mn removal system to neutralize residual chlorine present in the effluent from the Fe/Mn filters, converting the chlorine to chloride ion. Excess sodium bisulfite will be added to provide a continuous sulfur dioxide residual. A "zero center" residual analyzer device (provided by Filtronics) will be used for measuring and controlling the residuals after sodium bisulfite injection. The analyzer will measure both total chlorine and sulfur dioxide residual. The design criteria for the sodium bisulfite system is summarized in Table 4-3.

TABLE 4-3
Sodium Bisulfite System Design Criteria

Unit Process	Parameter Criteria
Sodium Bisulfite System	
Dosage	2 to 6 mg/L
Injection Rate	0.5 to 5 gph
Concentration	25 percent
Application/ Injection Point	Downstream of Fe/Mn filters
Metering Pumps	
Pump Type	Diaphragm
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	8 gph
Pump Design Discharge Pressure	120 psi
Motor	0.5 horsepower, TEFC

TABLE 4-3
Sodium Bisulfite System Design Criteria

Unit Process	Parameter Criteria
Storage Tank	
Tank Material	FRP
Tank Dimensions	8-foot diameter by 9.5-foot straight shell height
Tank Capacity	3,000 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter, heating panel, insulation
Pipe and Valving Material	316 SST carrier and secondary containment

4.2.4 Threshold Inhibitor

The TI will be an anionic co-polymer anti-foulant, or equal, and NSF-approved chemical for drinking water treatment. The design criteria for the TI storage and feed system are summarized in Table 4-4.

TABLE 4-4
Threshold Inhibitor System Design Criteria

Unit Process	Parameter Criteria
Threshold Inhibitor System	
Dosage	2 to 5 mg/L
Injection Rate	0.1 to 1 gph
Concentration	100 percent
Application/ Injection Point	Pre-cartridge filters
Metering Pumps	
Pump Type	Peristaltic
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	1.4 gph
Pump Design Discharge Pressure	120 psi
Motor	0.5 horsepower, TEFC
Discharge Flowmeter Type	Mass
Storage Tank	
Tank Material	FRP
Tank Dimensions	5-foot diameter by 7-foot 6-inch side wall height
Tank Capacity	1,000 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter
Pipe and Valving Material	316 SST carrier and secondary containment

The TI will be delivered and stored onsite in a 1,000-gallon storage tank. Two metering pumps (one duty and one standby) used for injection will be flow-paced with manual dosage adjustment. The metering pumps will be peristaltic pumps per EMWD's preference. A mass flowmeter will be installed on the injection line to ensure TI is being injected to the RO feed line. Due to the low dosages required, the mass flowmeter specified must indicate real-time flow measurements.

An alarm with RO train shutdown will be activated if the flowmeter detects an insufficient or no-chemical flow.

4.2.5 Sulfuric Acid

The design criteria for sulfuric acid storage and feed system are summarized in Table 4-5.

TABLE 4-5
Sulfuric Acid System Design Criteria

Unit Process	Parameter Criteria
Sulfuric Acid System	
Dosage	70.5 mg/L
Concentration	93 percent
Application/ Injection Point	Pre-cartridge filters
Metering Pumps	
Pump Type	Diaphragm
Pump Head Material	Alloy 20
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	4 gph
Pump Design Discharge Pressure	120 psi
Motor	1 horsepower, TEFC
Storage Tank	
Tank Material	Steel
Tank Dimensions	6-foot diameter by 7.5-foot side length
Tank Capacity	1,500 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter, desiccant dryer
Pipe and Valving Material	Alloy 20 carrier and secondary containment

A 1,500-gallon capacity storage tank will be designed with concrete containment to store 93 percent sulfuric acid. The design will include two chemical metering pumps, one duty and one standby to inject the acid into the RO feedwater. The metering pumps will be flow-paced, with feedback loop control based on pH. The sulfuric acid storage and feed system will be located within the chemical storage and feed area next to the RO building.

4.2.6 Citric Acid

Citric acid will be used with the CIP system for cleaning the RO trains. The system is sized based on the usage of approximately 150 gallons of citric acid per train per cleaning event. Assuming one CIP event every six months, the proposed 1,000 gallons tank will ensure a one-year storage capacity. The design criteria for the citric acid storage and feed system are summarized in Table 4-6.

TABLE 4-6
Citric Acid System Design Criteria

Unit Process	Parameter Criteria
Citric Acid System	
Concentration	50 percent
Application/ Injection Point	RO CIP
Volume Needed per Train per Cleaning Event	150 gallons
Transfer Pump for Clean-in-Place	
Pump Type	Horizontal end suction centrifugal
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	20 gpm
Pump TDH	25 feet
Motor	0.5 horsepower, TEFC
Storage Tank	
Tank Material	FRP
Tank Dimensions	5-foot diameter by 7.5-foot side wall height
Tank Capacity	1,000 gallons
Tank Accessories	Level indicator and transmitter
Pipe and Valving Material	316 SST carrier and secondary containment

Citric acid with 50 percent strength will be stored in a 1,000-gallon tank. There will be two transfer pumps (one duty and one standby) delivering the acid to the CIP tank. The CIP procedure is described in Section 3.

4.2.7 Sodium Hydroxide

The sodium hydroxide feed system will be used to stabilize the blended water through pH adjustment. It will also be used to prepare alkaline CIP solution for cleaning of the RO trains. The design criteria for the sodium hydroxide system are presented in Table 4-7.

TABLE 4-7
Sodium Hydroxide System Design Criteria

Unit Process	Parameter Criteria
Sodium Hydroxide System	
Dosage	1.1 to 10.2 mg/L
Injection Rate	0.1 to 2.8 gph
Concentration	50 percent
Application/ Injection Point	Post-decarbonator/pre-clearwell, RO CIP
Metering Pumps	
Pump Type	Diaphragm
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	3 gph
Pump Design Discharge Pressure	120 psi
Motor	0.5 horsepower, TEFC
Transfer Pump for RO Clean-in-Place	
Pump Type	Horizontal end suction centrifugal
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	4 gpm
Pump TDH	25 feet
Motor	0.5 horsepower, TEFC
Storage Tank	
Tank Material	FRP
Tank Dimensions	7-foot diameter by 8.5-foot side wall height
Tank Capacity	2,000 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter, insulation
Pipe and Valving Material	316 SST carrier and secondary containment

To meet the finished water pH at PDF II, a predicted dose of up to 10.2 mg/L of 100 percent sodium hydroxide will be needed to raise the finished water pH to 8.0. This maximum sodium hydroxide dose is based on conditioning a blend of 4.5 mgd RO permeate and 0.68 mgd RO bypass water (equivalent to 15 percent bypass).

The minimum sodium hydroxide demand (1.1 mg/L of 100 percent solution) is based on a water quality with the lowest CO_2 concentration (12 mg/L) to increase the pH of the finished water to only 7.5. The minimum sodium hydroxide dose is based on conditioning a blend of 4.5 mgd RO permeate and 0.45 mgd RO bypass water (equivalent to 10 percent bypass).

A 1,000-gallon insulated storage tank will be used to store the 50 percent sodium hydroxide solution. The stored chemical will meet the demand for finished water conditioning and membrane CIP. Two metering pumps, one duty and one standby will feed downstream of the decarbonator. Two transfer pumps (one duty and one standby) will transfer sodium hydroxide solution to the CIP tank.

4.2.8 Corrosion Inhibitor

If necessary, proprietary corrosion inhibitors or orthophosphate will be added to the water to increase the buffering capacity and provide 1 mg/L of phosphate ion (PO_4^{3-}) ion. The design criteria for the corrosion inhibitor system are listed in Table 4-8.

TABLE 4-8
Corrosion Inhibitor System Design Criteria

Unit Process	Parameter Criteria
Corrosion Inhibitor System	
Dosage	4 mg/L
Injection Rate	0.2 to 0.6 gph
Concentration	100 percent
Application/ Injection Point	Post decarbonator upstream of clearwell
Metering Pumps	
Pump Type	Diaphragm
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	2 gph
Pump Design Discharge Pressure	120 psi
Motor	0.5 horsepower, TEFC
Storage Tank	
Tank Material	FRP
Tank Dimensions	5-foot diameter by 7.5-foot side wall height
Tank Capacity	1,000 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter
Pipe and Valving Material	316 SST carrier and secondary containment

4.2.9 Aqueous Ammonia

Assuming a chlorine-to-ammonia ratio of 4.5, the aqueous ammonia dosage will range between 0.4 and 0.7 mg/L. The design criteria for the aqueous ammonia feed system are shown in Table 4-9.

TABLE 4-9
Aqueous Ammonia System Design Criteria

Unit Process	Parameter Criteria
Aqueous Ammonia System	
Dosage	0.4 to 0.7 mg/L
Injection Rate	0.2 to 1 gph
Concentration	19 percent
Application/ Injection Point	Post clearwell finished water
Metering Pumps	
Pump Type	Diaphragm
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	2 gph
Pump Design Discharge Pressure	150 psi
Motor	0.5 horsepower, TEFC
Storage Tank	
Tank Material	FRP
Tank Dimensions	5-foot diameter by 7.5-foot side wall height
Tank Capacity	1,000 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter, chiller, insulation
Pipe and Valving Material	316 SST carrier and secondary containment

A 1000-gallon FRP tank will be designed for aqueous ammonia bulk storage. An aqueous ammonia solution concentration of approximately 19 percent will be stored. Usage of a lower-than-20-percent solution would avoid the risk management/inventory requirements by regulations. A 50-gallon vapor scrubber tank containing water will be provided to catch any ammonia gases out of the vent of the bulk storage tank. Two metering pumps (one duty and one standby) will provide aqueous ammonia to the finished water line.

The aqueous ammonia storage tank will be equipped with a chiller capable of lowering the solution temperature from 85°F down to 50°F within 10 hours. The solution temperature will normally be maintained at an optimal range such that the solution will not cause odor nor pump cavitation, and at the same time is energy efficient. The chiller will be installed out of the flood zone in the containment.

4.2.10 Hydrofluosilicic Acid (Fluoride)

The fluoride dosage is based on an optimal dose of fluoride ion (F^-) of 0.8 mg/L. Fluoride in the form of hydrofluosilicic acid will be added to the finished water downstream of the clearwell prior to the distribution system. The design criteria for the fluoride system are shown in Table 4-10.

TABLE 4-10
Hydrofluosilicic Acid (Fluoride) System Design Criteria

Unit Process	Parameter Criteria
Hydrofluosilicic Acid (Fluoride) System	
Dosage	0.8 mg/L as fluoride ion or 1 mg/L as hydrofluosilicic acid
Injection Rate	0.2 to 1 gph
Concentration	25 percent
Application/ Injection Point	Post clearwell finished water
Metering Pumps	
Pump Type	Peristaltic
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	2 gph
Pump Design Discharge Pressure	150 psi
Motor	0.5 horsepower, TEFC
Transfer Pump	
Pump Type	Horizontal end suction centrifugal
Pump Head Material	316 SST
Number of Pumps	2 (1 duty + 1 standby)
Pump Design Capacity	5 gpm
Pump TDH	10 feet
Motor	0.25 horsepower, TEFC
Storage Tank	
Tank Material	FRP - Double wall
Tank Dimensions	5-foot diameter by 7.5-foot side wall height
Tank Capacity	1,000 gallons
Minimum Days of Storage	30
Tank Accessories	Level indicator and transmitter
Day Tank	
Tank Material	Polyethylene
Tank Dimensions	2-foot diameter by 3-foot straight shell height
Tank Capacity	35 gallons
Minimum Days of Storage	1
Tank Accessories	Level indicator, scale
Pipe and Valving Material	316 SST

The fluoride feed system will include a 1,000-gallon storage tank and a 35-gallon day tank. Per EMWD, CH2M HILL will specify the fluoride storage tank to be double-walled tank and to be contained in concrete containment area. The two metering pumps (one duty and one standby) feeding the finished water line will be peristaltic pumps per EMWD's request. The 35-gallon day tank will be on a scale for control.

SECTION 5

Clearwell and Finished Water Pump Station

5.1 Introduction

The CDPH is requiring EMWD to provide 4-log virus inactivation of the RO permeate in the event that any one of the supply wells is found to have biological contamination. In addition, it is also assumed that the bypass flow will follow the same requirement. To satisfy this requirement, free chlorine disinfection in the clearwell will be designed to meet the 4-log virus inactivation. The clearwell also will serve as a wet well for finished water pumps. Using vertical turbine pumps, the disinfected water will be discharged to the EMWD distribution system.

5.2 Clearwell and Chlorine Contact Time (CT) Requirements

The clearwell is a below grade, concrete structure that will receive up to 5 mgd of blended water flow. To minimize short-circuiting, baffles will be installed in the clearwell. The clearwell will be designed to provide disinfection by free chlorine and achieve a CT (chlorine residual x contact time) of 4.0. Because the clearwell will also serve as a wet well for finished water pumps, a minimum water depth of 8 feet will be required. Based on the CT of 4.0 and the required water depth, the clearwell will only require three passes. However, to ensure adequate hydraulic detention time, the clearwell will be designed to consist of five 5-foot-wide chlorine contact channels (passes), each 24 feet long. Only the first four passes are considered to be effective passes since the end channel will be adjacent to the finished water pump wet well. The extra pass provides a degree of conservatism relative to CT.

With a side water depth of 8 feet, the volume provided by the four passes is 3,830 cubic feet (ft^3), or 28,650 gallons for achieving the required CT. To prevent chlorine residual dissipation due to sunlight (ultraviolet light), the clearwell will be covered with a concrete roof slab. Covering of the wet well also will prevent introduction of dust and foreign matter to the disinfected water. Other features of the wet well are vents and a sump at the low point on the bottom to facilitate tank drainage. The design criteria for the clearwell are presented in Table 5-1.

TABLE 5-1
Clearwell System Design Criteria

Unit Process	Parameter Criteria
Disinfection	
Basis for Sizing	Achieve 4-log virus inactivation using free chlorine
Disinfection CT Required	4.0 mg-min/L
Minimum Water Temperature	15°C
pH	6 to 9
Design Flow	3,472 gpm

TABLE 5-1
Clearwell System Design Criteria

Unit Process	Parameter Criteria
Clearwell Chlorine Contact Volume (Baffled)	80,000 gal
Overall Clearwell Dimensions	31.5 feet long x 26.5 feet wide
Side Water Depth	8 feet
Channel (Pass) Length	24 feet
Channel (Pass) Width	5 feet
No. of Effective Passes	4
Design Free Chlorine Residual	0.96 mg/L
Clearwell CT	4.0
Baffling Factor	0.5

5.2.1 CT Calculation

For regulatory purposes, the adequacy of disinfection, as measured by (CT) is judged using the product of the final residual concentration of disinfectant (C in mg/L) and the contact time (T in minutes). In the case of free chlorine, the required CT to achieve 4-log virus inactivation is dependent on both water temperature and pH. A CT value of 4 must be met based on the USEPA Guidance Manual for Disinfection Profiling at 15°C and a pH between 6 to 9. Based on water temperature records at the Perris I Desalination Facility for the past 12 months, 15°C is considered the lowest temperature of the water. To achieve this CT requirement in the clearwell with four effective passes, free chlorine residual of approximately 0.96 mg/L is expected to be obtained at the end of the clearwell flow channel prior to entering the fifth channel adjacent to the finished water wet well.

Table 5-2 presents a summary of the CT calculations used to size the disinfection portion of the clearwell. Based on the minimum design water temperature and a pH range of 6-0, a CT of 4.0 is needed to achieve the necessary virus inactivation. Using a conservative baffling factor of 0.5, a minimum chlorine residual of 0.96 mg/L and a maximum flow at 3,472 gpm (5 mgd), the theoretical detention time to be provided through the four passes is 8.4 minutes. Additional CT is provided in the pipeline between the chlorine injection location and the clearwell, ensuring a safety factor on the CT provided versus that required.

5.2.2 Chloramination

Secondary disinfection of the finished water as it is pumped into the distribution system will be provided by chloramines. Ammonia will be dosed at the main discharge header of the finished water pumps to convert residual free chlorine to combined chlorine. The use of chloramines will ensure a stable chlorine residual throughout the distribution system while minimizing the formation of disinfection byproducts.

TABLE 5-2
Clearwell CT Calculations

Parameter	Requirements and Given Conditions
Virus Inactivation Requirement	4 log
Minimum Water Temperature	15°C
pH range	6 to 9
Residual Free Chlorine at end of Clearwell Contact	1 mg/L
Required CT[a]	4.0 mg-min/L
Minimum Contact Time (T10)	4.2 minutes
Baffling Factor (T10/T) [b]	0.5
Theoretical Detention Time (T)	8.3 minutes
Design Flow	5 mgd
Bulk Contact Volume	3,830 ft^3

[a] CT value is 4.0 per USEPA Guidance Manual for Disinfection Profiling.
[b] Average baffling condition - Baffled inlet or outlet with some intrabasin baffles.

5.3 Finished Water Pump Station

The finished water pump station consists of a belowgrade concrete wet well structure that is hydraulically connected to the clearwell. Located adjacent to the end channel of the clearwell, the finished water pump station receives disinfected water from the clearwell. The wet well will be equipped with access hatches for maintenance and instrumentation for level control.

From the finished water pump station, treated water is pumped to the EMWD distribution network through a common discharge header. For this purpose, the finished water pump station will be furnished with three vertical turbine pumps in lead/lag/standby configuration. Provisions will be made for the addition of a fourth pump for plant expansion to three RO membrane trains in the future. Each pump will be sized for 1,250 gpm of flow at approximately 245 feet of TDH to handle the total finished water flow of 2,431 gpm for the initial phase and 3,472 gpm for the ultimate phase. The pumps will be equipped with VFDs to maintain the level in the finished water pump station wet well. The design criteria for the finished water pumps are presented in Table 5-3.

TABLE 5-3
Finished Water Pump Station Design Criteria

Unit Process	Parameter Criteria	
Finished Water Pump Station	**Initial Phase**	**Ultimate Phase**
Design Flow	2,431 gpm	3,472 gpm
Number of Pumps	3 (2 duty + 1 standby)	4 (3 duty + 1 standby)
Pump Type	Vertical turbine	
Pump Material	316 SST	
Pump Capacity	1,250 gpm	
Pump Total Dynamic Head	245 feet	
Minimum Pump Efficiency	80 percent	
Motor Horsepower	125	
Motor Drive	VFD	

SECTION 6

Concentrate Pump Station and Concentrate Disposal

6.1 Introduction

The RO concentrate, commonly known as brine, from the RO membrane trains will be collected by a common pipe header and conveyed to a new concentrate pump station. The RO concentrate then will be pumped from this concentrate pump station to the TVRI for disposal. The design criteria and the features for the new concentrate pump station are described in detail below.

6.2 Concentrate Pump Station

The concentrate pump station will receive concentrate from the RO membrane trains for the purpose of discharging it to the TVRI. The concentrate will enter the pump station wet well through an air gap required by CDPH to prevent any potential cross-contamination of the treatment plant. In addition to the RO concentrate, the concentrate pump station will receive RO membrane train flushing water along with drains from the process and chemical storage facilities for disposal. However, these additional waste streams occur in irregular frequency and are minimal in volume when compared to the RO concentrate flow. As a result, the design flows for the new concentrate pump station will be based on the RO concentrate:

- 810 gpm of RO concentrate flow for the initial phase (two RO trains)
- 1,215 gpm of RO concentrate flow for the ultimate phase (three RO trains)

To provide a reasonable retention time needed for 1,215 gpm of RO concentrate flow, a maximum RO flush flow of 1,800 gpm for 3 to 5 minutes, and the space requirements for the pumps, the concentrate pump station will consist of a rectangular concrete wet well with internal dimensions of 20 feet wide by 20 feet long with a depth of 16 feet. Most of the concrete structure for the wet well will be below grade. Other features of the wet well include a sump to facilitate draining and hatches for maintenance access.

The pumps proposed for the concentrate pump station are vertical turbine pumps with 316 SST components for corrosion resistance. Vertical turbine pumps have been selected based on an investigation conducted by CH2M HILL to identify the best application; the findings and recommendations are presented in Appendix L. These pumps are to be provided with VFDs to maintain the level in the pump station wet well in combination with level instruments. Two pumps arranged in duty/standby configuration will be provided for the pump station for the initial phase. Each pump will be sized for 900 gpm of flow at approximately 175 feet of TDH to handle the total concentrate flow from the initial two RO trains, giving complete redundancy for the initial phase. For the future addition of a third RO train to PDF II, a third pump is required to maintain this redundancy. As a result, provisions for a third pump will be provided in the concentrate pump station.

Table 6-1 summarizes the design features for the new concentrate pump station required at PDF II for disposing RO concentrate to the TVRI.

TABLE 6-1
Concentrate Pump Station Design Criteria

Unit Process	Parameter Criteria	
Concentrate Pump Station	**Initial Phase**	**Ultimate Phase**
Design Flow	810 gpm	1,215 gpm
Number of Pumps	2 (1 duty + 1 standby)	3 (2 duty + 1 standby)
Wet Well Size	20 feet long x 20 feet wide x 16 feet deep	
Air Gap	Yes	
Pump Type	Vertical turbine	
Pump Material	316 SST	
Pump Capacity	900 gpm each	
Pump Total Dynamic Head	175 feet	
Minimum Pump Efficiency	80 percent	
Motor Horsepower	60	
Motor Drive	VFD	

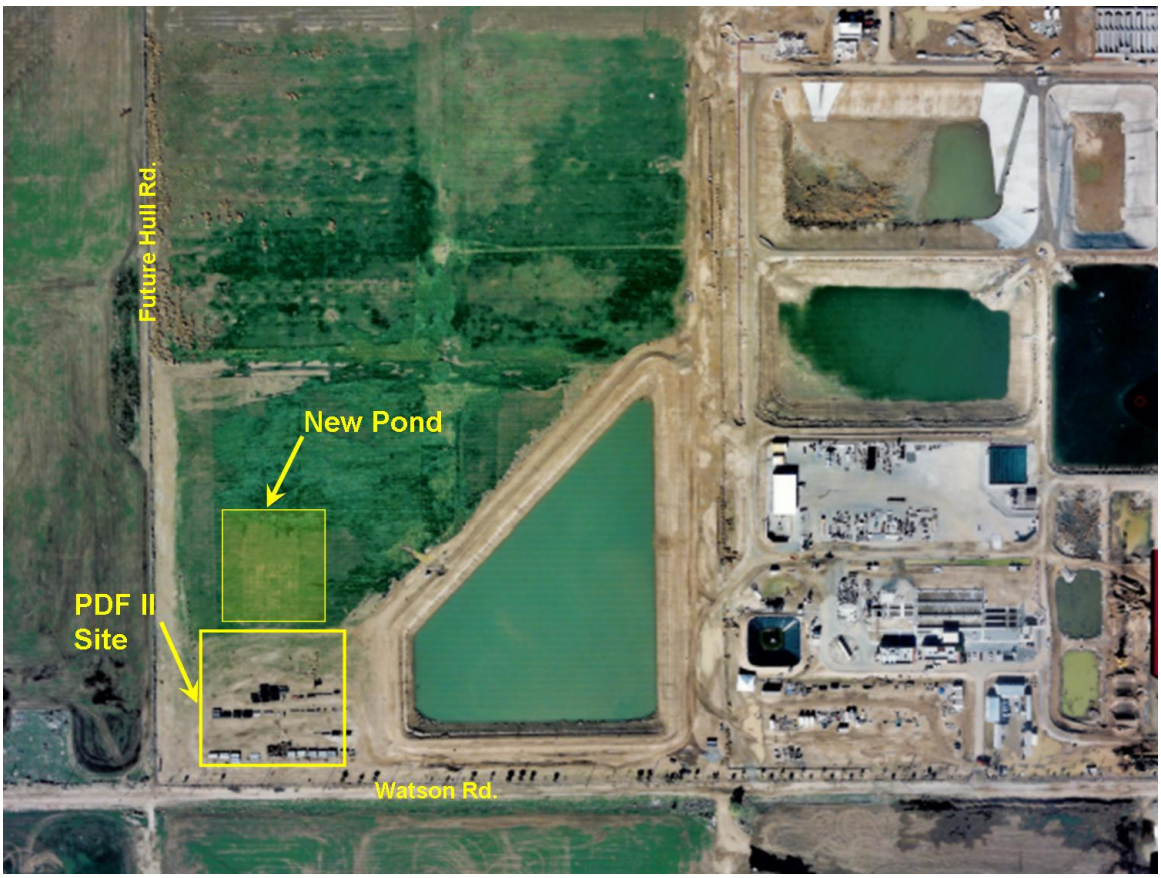
SECTION 7

Civil and Site Layout

7.1 Introduction

The proposed PDF II is located at the intersection of the future Hull Road and Watson Road in the City of Perris, Riverside County, California. The site is in Section 9, Township 5 South, Range 3 West, per assessor's map book 327, page 21. Figure 7-1 shows the site layout. The site location was established by EMWD. The PVRWRF is located east of the PDF II site along with a triangular detention pond.

Figure 7-1 PDF II Site Layout



7.2 Project Site

The site is bounded by Watson Road to the south, the future Hull Road to the west, the existing triangular pond to the east, and the existing Case Road pond to the north. It is anticipated that the north end of the existing triangular pond will serve as the north boundary of the PDF II project.

The site is currently flat with no existing structures or facilities. EMWD has an existing monitoring well (B3) located approximately 10 feet from the future Hull Road centerline. The existing ground topography slopes north at 1 to 2 percent.

7.3 Site Layout Design Criteria

The City of Perris has established design criteria for development projects within its boundaries. The City has a review matrix for the development review and permitting process. The Engineering Department has site development requirements for industrial sites. City Ordinance 878 outlines minimum requirements for site development when waiving and deferring construction of street improvements. This ordinance states that the owner shall dedicate property for street right-of-way plus additional footage for utilities, curb, gutter, sidewalks, street lights, and street paving. A summary of the City of Perris improvement requirements is shown in Appendix C. Also, City Ordinance 878 and the Engineering Department's site development guidelines are included in Appendix D, Exhibit D1 and D2, respectively.

The existing fence line west of the facility is very close to the surveyed centerline of the future Hull Road. The City plans to make Hull Road a local road with a total 60-foot-wide right-of-way. Meanwhile, Watson Road is projected to be a secondary arterial with a total right-of-way of 94 feet. The 60-foot right-of-way for local roads is included as Exhibit D3 in Appendix D and the 94-foot right-of-way is included as Exhibit D4.

The project site will be surrounded by an 8-foot-high CMU wall with decorative gates. The pond will be secured with a chain-link fence at the top of the berm. The chain-link fence will have gates and locks.

Inside the facility, there will be an administration building, a reverse osmosis/chemical building (RO), an iron/manganese treatment system, and two pump stations. The administration building will have approximately fifteen parking with two disabled parking spots. A 5′ wide sidewalk is proposed for the walk path from the parking area to the administration building. Curb ramps compliant with the American Disability Act will be constructed to provide access to the buildings. There will be a 6″ curb separating the interior roads and the gravel areas around the equipment pads. The RO building will have a 15′ wide concrete pad on the east side for the chemical loading area. There will also be an 18′ wide pad on the west side of the RO building for electrical equipment.

Roads within the limits of the PDF II site are at least 30 feet wide with 50 feet turning radiuses to accommodate chemical delivery trucks that are up to 65 feet long and emergency support vehicles. The entrance and exit ramps will have a maximum slope of 6 percent. There will be two 30′ wide ingress/egress locations with secure gates. The primary entrance will be from Watson Road.

The ground will be sloped at 5 percent for a distance of 10 feet from all buildings. Paved areas will be sloped at a minimum 1 percent and drain to inlets constructed at low points on the pad. Storm drains will convey the surface runoff to the infiltration pond. A gravel layer will surround the pump stations and the iron/manganese system.

The pond will contain off-spec water for operations purposes, but also will be able to contain the runoff from a 100-year storm event. Section 7.3.1 presents the infiltration pond design criteria.

The City also has flood protection requirements that require facilities to be built at least 1 foot above the 100-year flood level. It is anticipated that the site will be built approximately 5 to 6 feet above the existing ground due to flood plain requirements. The preliminary grades show 2:1 perimeter side slopes for the graded pad. Section 7.3.3 outlines the Conditional Letter of Map Revision Based on Fill (CLOMR-F) application.

7.3.1 Infiltration Pond Design

The proposed infiltration pond will be located north of the facility. The pond will serve a dual purpose in providing a drainage basin for stormwater and serving as an operations storage basin. The pond will be sized to contain a volume of up to 2 days of off-spec water from PDF II in addition to the runoff from a 100-year 24-hour storm event. Preliminary drainage calculations are per the Riverside County Hydrology Manual and are included in Appendix D, Exhibit D5. The Rational Method was used to calculate peak flows and a simplified hydrograph was constructed to determine flow volume from a 100-year 24- hour storm event. It is anticipated that 1,200,000 ft^3 of off-spec water will need to be contained in addition to 53,000 ft^3 of storm runoff. The tributary area for the drainage study is limited to the building pad and the pond area due to the elevated pad site. The side slopes are 3:1 inside the pond and 2:1 on the outside berm slopes to existing grade outside the pond. The pond is approximately 12.5 feet deep including a 5-foot berm above existing ground to match the facility elevation. The total pond depth is achieved by a combination of a 5 feet high berm above existing ground and an additional 7.5 feet of excavation. There is a 25-foot-wide access road around the perimeter of the berm. Preliminary pond sizing calculations are included in Appendix D, Exhibit D6.

There will be a temporary 18-inch overflow line from the proposed pond to the triangular pond to be used during startup and commissioning activities.

7.3.2 Geotechnical Investigations

CH2M HILL reviewed the existing geotechnical report prepared by Ninyo & Moore entitled *Perris II Desalination Facility 30% Concept Design, 1301 Case Road, Perris, California* dated October 28, 2005 and noted that additional investigations were required. Based on this, CH2M HILL conducted two borings and one infiltration testing to verify the design infiltration rate for the proposed site runoff/flush and off-specification pond. CH2M HILL prepared a Technical Memorandum (TM) containing the additional findings and recommendations to complement the information presented in the existing geotechnical report prepared by Ninyo & Moore. A copy of this TM is included in Appendix E.

7.3.3 CLOMR-F Application

The proposed Perris II Desalination Facility (PDF II) is located within a mapped floodplain. Mapped floodplains are regulated by the Federal Emergency Management Agency (FEMA) as part of the National Flood Insurance Program (NFIP). The City of Perris is a participating community in the NFIP and is the local floodplain administrator. FEMA develops Flood Insurance Rate Maps (FIRMs) that delineate lands that are at risk of being inundated by the

base flood, a flood event that has a 1-percent-annual-chance of being equaled or exceeded in any given year. These at risk lands are designated as Special Flood Hazard Areas (SFHAs).

The latest FIRM for the City of Perris available on the FEMA website is dated July 2, 1992. However, a Letter of Map Revision (LOMR) dated April 1, 2002, revised this map (See Appendix F). According to this FIRM (Community Panel No. 060258 0015D), the proposed PDF II site is located in the flood fringe of the SFHA, outside of the floodway (The floodway is comprised of the channel and adjacent overbank areas necessary to effectively convey floodwaters. The flood fringe consists of lands outside the floodway that are at or below the base flood elevation (BFE) that stores, but does not effectively convey, floodwaters). As shown in the LOMR dated April 1, 2002, the 100-year BFE has been determined at the PDF II site as 1,419 feet National Geodetic Vertical Datum (NGVD; 1929). To be removed from the SFHA, the proposed plant structures will be elevated with fill and founded on a graded pad at 1,420 feet NGVD, 1 foot above the BFE (See Appendix F).

To comply with the NFIP regulations, the Owner needs to obtain a Conditional Letter of Map Revision Based on Fill (CLOMR-F) and a Letter of Map Revision Based on Fill (LOMR-F). CH2M HILL has prepared an application for a Conditional Letter of Map Revision based on Fill (CLOMR-F) (See Appendix F). This application package includes the FEMA MT-1 Forms (Form 81-87 Series), all required attachments including the updated FIRM, and an $800 application fee. Additionally, the Owner needs to have the City of Perris complete the "Community Acknowledgement Form" to complete the application process. Once the application is complete, it should be sent to FEMA for review. FEMA has a maximum of 60 days to review the application. When the project is complete, the Owner needs to apply to FEMA for a LOMR-F. Once the LOMR-F is received, it should be submitted to the City for record, and can also be used to obtain a discount on flood insurance, if purchased.

7.3.4 Fire Requirements

Fire Protection Requirements

This facility will be required to have Fire Marshall approval of the fire access plan per the Riverside County Fire Code. All interior access roads will be sized to accommodate emergency response vehicles. A minimum 30-foot road width and 50-foot turning radius will be used in the design criteria. The access gates will have a minimum 20-foot clearance and knox boxes will be located outside the gates. A separate fire water line will serve the facility and all hydrants. Hydrants will be located a minimum of 300 feet apart per the Riverside County Fire Code Ordinance 787. Each building with occupancy requirements will have a fire department connection (FDC) and a post indicator valve (PIV).

7.3.5 Existing Utilities

There is an existing 24-inch raw water line approximately 10 feet east of the proposed Hull Road centerline. This line turns west at the intersections of Watson Road and Hull Road. In the Watson Road right-of-way, there is an existing telephone line, one 2-inch gas line, and one 12-inch water line on the north side of the centerline. The nearest power poles are No. 4064819E and No. 4064820E with voltages of 12 kilovolts (kV) and 33 kV, respectively. The nearest sewer lines are a 48-inch high-density polyethylene (HDPE) sewer at the intersection of Evans Road and Watson Road, and an 18-inch vitrified clay pipe sewer 270 feet east of Evans Road. Proposed sewer lines will connect to the existing manhole serving the 48-inch HDPE sewer line at the intersection of Evans Road and Watson Road.

SECTION 8

Architectural, Structural, and Building Mechanical Systems and Design Criteria

8.1 Architectural Design Criteria

8.1.1 Codes and Standards

- 2007 California Building Code
- 2007 California Fire Code
- 2007 California Energy Code
- Americans with Disabilities Act and International Code Council/ANSI A117.1

8.1.2 Building Code Analysis

Administration Building

- Code Analysis:
  - Occupancy Use: B
    Provide space for plant control and operation, conference and training for employees and visitors, laboratory, employee break area, restrooms, and associated mechanical and electrical rooms.
  - Occupancy Separation: N/A
  - Construction Type: IIB (sprinkled – elective)
  - Allowable Area, Height, and Number of Stories, at B: 23,000 ft^2, 55 feet, and 4 stories

Refer to Appendix G for a more detailed code analysis.

RO Process and Chemical Storage/Feed Building

- Code Analysis:
  - Occupancy Use: Mixed
    Provide space for associated mechanical and electrical rooms.
  - Occupancy Separation:
    - F-2 to H-3/H-4 = 2 hour (with automatic sprinkler system)
    - F-2 to H-2 = 3 hour (with automatic sprinkler system)
    - H-2 to H-3/H-4 = 1 hour (with automatic sprinkler system)
  - Construction Type: IIB (Sprinkled at chemical storage - required)

- Allowable Area, Height, and Number of Stories:
  - At F-2: 23,000 ft^2, 55 feet, and 3 stories
  - At H-2: 7,000 ft^2, 55 feet, and 1 story
  - At H-3: 14,000 ft^2, 55 feet, and 2 stories
  - At H-4: 17,500 ft^2, 55 feet, and 3 stories

- Hazardous Materials, Concentration, and Stored Amount:
  - Sodium hypochlorite (0.8 percent) 7,000 gallons; irritant
  - Sulfuric acid (93 percent) 3,000 gallons; water reactive, corrosive, toxic
  - TI (100 percent) 1,000 gallons
  - Sodium hydroxide (50 percent) 1,000 gallons; corrosive
  - Citric acid (50 percent) 1,000 gallons; irritant
  - Ortho-poly phosphate or corrosion inhibitor (100 percent) 1,000 gallons; corrosive
  - Aqueous ammonia (19 percent) 1,000 gallons; corrosive
  - Hydrofluosilicic acid (25 percent) 1,000 gallons; corrosive
  - Sodium bisulfite (25 percent) 3,000 gallons; irritant

Refer to Appendix H for a more detailed code analysis.

Finished Water Pump Station

- Code Analysis:
  - Occupancy Use: F-2
    Provide space for mechanical and electrical equipment.
  - Occupancy Separation: N/A
  - Construction Type: IIB (non-sprinkled)
  - Allowable Area, Height, and Number of Stories, at B: 23,000 ft^2, 55 feet, and 4 stories

Refer to Appendix I for a more detailed code analysis.

8.2 Structural Codes, Systems, and Materials

Design criteria will include building codes, design loadings, foundation criteria, material types and properties, references, and other special requirements. Structural concepts include project facility building systems and design principles for watertight concrete structures.

8.2.1 Structural Design Criteria

Code

2007 California Building Code as amended by local agencies.

Design Loads

Roof Live Loads

RO Process and Chemical Storage/Feed Building	20 psf
Chlorine contact tank (CCT) and pump station:	200 psf
Administration building:	20 psf

Roof Dead Loads

CCT and pump station:	
Actual concrete dead load	
Administration building:	
Single-ply membrane roofing	2 psf
Insulation	2 psf
1.5-inch metal decking	2 psf
Joist Framing	4 psf
Collateral (includes mechanical piping, ceiling grid and lights, etc.)	15 psf
Total Dead Load	25 psf

Note: Operating weight of any roof mounted equipment is to be added to the above Dead Loads

Floor Live Loads

Office/administration areas	50 psf
Electrical equipment areas	300 psf
Process areas (includes roof of clearwell)	200 psf
Walkways, platforms, and stairways	100 psf
Catwalks	50 psf

Seismic Parameters

Occupancy Category III (Table 1604.5)
Soil Site Class D (Geotechnical Report)
Mapped Site Spectral Responses:
Ss=1.50 g
S1=0.60 g
Design Site Spectral Responses:
SDS=1.00 g
SD1=0.60 g
Seismic Design Category D
Importance Factor = 1.25

Wind Parameters

90 mph, 3-second gust
Exposure C
Importance Factor=1.15

8.2.2 Foundation Criteria

Geotechnical Exploration and Recommendations for PDF II at PVRWRF in Perris, California, December 26, 2007 by CH2M HILL, INC.

Lateral Earth Pressures	
Active	40 pcf (Drained)
At-Rest	60 pcf (Drained)
Passive	360 pcf (Drained)
Soil Friction Factor Against Sliding	0.35
Allowable Bearing Pressure (1/3 increase to this permitted when using wind or seismic loads per California Building Code, Section 1612)	2,500 psf
Soil Unit Weight	120 pcf
Groundwater	

Approximately 45 feet below existing/proposed grade. Flotation is not a design consideration for any of the structures in this facility.

8.2.3 Materials

Concrete – Minimum 28 day compressive strength		f'c = 4,000 psi
Reinforcing Steel	ASTM A615, grade 60	Fy = 60 ksi
Steel		
W-shapes		Fy = 50 ksi
Plates, angles, shapes except W (including channels)		Fy = 36 ksi
Square or rectangular steel tubing		Fy = 46 ksi
Masonry		f'm = 1,500 psi
(Testing of units is required to use full value. Without testing, f'm = 750 psi)		
Bolts		
High-strength bolts		A325N
Machine or anchor bolts		A307
Stainless steel		A193, Type 316
Aluminum		Alloy 6061-T6
Stainless Steel		Type 316, Fy = 25 ksi

8.2.4 References

CH2M HILL Structural Design Guide.

American Concrete Institute (ACI). ACI 350, Design of Sanitary Structures, Latest Edition; and ACI 318, Building Code Requirements for Reinforced Concrete, Latest Edition.

American Institute of Steel Construction. Manual of Steel Construction, Latest Edition.

8.2.5 Water-Holding Structures

Reinforced concrete water-holding structures will be designed for strength, watertightness, and durability. Watertightness will be achieved by controlling cracking and by specifying a mix design that will produce dense concrete with minimal shrinkage. Serviceability requirements will be in accordance with ACI 350, Environmental Engineering Structures; ACI 318, Building Code for Reinforced Concrete; and CH2M HILL Standards for Water-Holding-Basin Design.

The major concrete water-holding structures include the CCT and concentrate pump station.

CCT and Concentrate Pump Station

These are both mostly buried reinforced concrete structures. The CCT is a water holding basin for chlorine contact. Structural design cases include the structure empty with soil backfill applied and no soil backfill with the structure full of liquid during the leak testing procedures.

8.2.6 Non-Water-Holding Structures

Administration Building

This facility will have load-bearing concrete block exterior walls supported on a concrete slab on grade foundation. Interior walls will utilize non-load-bearing metal studs. The roof framing system will consist of steel bar joists with metal decking. Refer to Section 9 for architectural concepts and additional information.

RO and Chemical Storage/Feed Building

This facility will have load-bearing concrete block exterior walls supported on a concrete slab on grade foundation. The slab will have equipment foundations, containment areas, and a concrete trench to house chemical feed lines and storage tanks. It will house the RO system and have control, electrical, and equipment storage rooms and chemical storage. The roof framing system will consist of steel bar joists with metal decking. Refer to Section 9 for architectural concepts and additional information.

Finished Water Pump Station

This facility will have load-bearing concrete block exterior walls partially supported on the roof of the CCT and slab on grade. The roof framing system will consist of steel bar joists with metal decking. Refer to Section 9 for architectural concepts and additional information.

8.2.7 Deliverables

Drawings

Where possible, drawings will be presented as follows:

1. Foundation Plan
2. Roof Framing Plan
3. Elevations
4. Wall Sections
5. Details

Standard Details

Standard details will dictate uniform concepts and philosophies to be used in the design. Typical standard details include but are not limited to the following:

- Arrangement of and method of detailing the horizontal reinforcing in concrete walls
- Framing member and footing schedules, format, and typical sections and bar designations
- Standard structural notes, abbreviations, lap splice/bend length tables, etc.
- Joint details
- Structural steel connections
- Fabricated metal details
- Typical reinforcing at openings
- Other details that provide for uniformity and that affect structural design

Calculations

Calculations will be prepared and assembled for submission. Calculations will be stamped and signed by a registered Civil or Structural Engineer, currently licensed in the State of California.

8.3 HVAC Systems

8.3.1 Design Criteria

Design criteria, general descriptions of the systems proposed for each building, and the proposed control strategy are presented. Process rooms will be ventilated to relieve heat buildup from process equipment during hot weather periods.

8.3.2 Codes

The HVAC systems design will be based on the following codes:

- 2007 California Building Code (2006 International Building Code with California Amendments)

- 2007 California Mechanical Code (2006 Uniform Mechanical Code with California Amendments)
- 2007 California Fire Code (2006 International Fire Code with California Amendments)
- 2007 California Energy Code

8.3.3 Outdoor Design Conditions

The following outside air design criteria will be used for the design:

Summer: Non-air-conditioned spaces: 101 °F (Dry Bulb), 68 °F (Wet Bulb)
Air-conditioned spaces: 115 °F (Dry Bulb), 70 °F (Wet Bulb)

Winter: 34°F (Dry Bulb)

8.3.4 Indoor Design Conditions

TABLE 8-1
Indoor Design Conditions

Building Area Description	Winter Design Dry Bulb Temperature	Summer Design Dry Bulb Temperature
Administration Building – Control Room, Conference Room, Break Room, Kitchen, Office, Reception, Laboratory, Electrical/ Communications Room, Mechanical Room, and Toilet Rooms	70°F	77°F
RO Building - RO Process Equipment Room, Maintenance Shop, Mechanical Room, and Chemical Storage	No heat	104°F
RO Building - Electrical Room	No heat	85°F
RO Building - Control Room and Toilet Room	70 °F	77 °F
Finished Water Pump Station	No heat	85 °F

8.3.5 Building Pressurization

HVAC systems will be designed to control building pressurization as follows:

- The door opening force will not exceed 15 lb. For a 3-foot by 7-foot door, this results in a differential pressure limit of about 0.14 inch water column across each door.
- Positive building pressure will be maintained in all air-conditioned rooms. The positive pressurization will help control migration of unconditioned air from the adjoining rooms and will help control infiltration of outside air into these parts of the buildings.
- The non-air-conditioned rooms will be under positive pressure when their heat removal ventilation fans are on. These rooms will be under neutral pressure when their fans are off.

8.3.6 Ductwork

General supply and exhaust air ductwork will be constructed of galvanized steel, with the following exceptions; exhaust ductwork from the toilet/shower rooms will be aluminum. Laboratory exhaust ductwork will be stainless steel.

8.3.7 Administration Building Systems

The administration building will be provided with heating and air conditioning for human comfort. The heating will cycle on when space temperature drops below 70°F (adjustable). For heating and cooling, split, heat pump, air conditioning systems will be provided, having outdoor air-cooled condensers for heat collection and rejection and indoor air-handling units for supplying heating and cooling air to the rooms. The cooling will cycle on when space temperature exceeds 77°F (adjustable).

The toilet rooms will be provided with an exhaust fan, which will run continuously when the air-handling unit supplying the lavatories is on.

Exhaust fans will be provided for the laboratory to remove chemical vapors from testing and maintain lower pressure in the laboratory than in adjacent rooms.

8.3.8 RO and Chemical Storage/Feed Building Systems

The control and toilet rooms will be provided with heating and air conditioning for human comfort. The heating will cycle on when space temperature drops below 70°F (adjustable). For heating and cooling, a split, heat pump, air conditioning system will be provided, having an outdoor air-cooled condenser for heat collection and rejection and an indoor air-handling unit for supplying heating and cooling air to the rooms. The cooling will cycle on when space temperature exceeds 77°F (adjustable). The toilet room will be provided with an exhaust fan, which will run continuously when the indoor air-handling unit is on.

The electrical room will be provided with air conditioning to maintain conditions required by the equipment. Heat generated by electrical equipment, located in this room, will be removed by an air conditioning system. The air conditioning will cycle on when space temperature exceeds 85°F (adjustable).

The reverse osmosis equipment room, maintenance shop, and chemical storage room will be provided with ventilation to remove heat from the space. Heat generated by mechanical and electrical equipment, located in the room, will be removed by a fan-powered ventilation system using filtered outside air. The heat-removal fan will cycle on when space temperature exceeds 80°F (adjustable).

8.3.9 Finished Water Pump Station

The pump room will be provided with air conditioning to maintain conditions required by the equipment. Heat generated by electrical equipment, located in this room, will be removed by an air conditioning system. The air conditioning will cycle on when space temperature exceeds 85°F (adjustable).

8.3.10 HVAC System Controls

HVAC systems will be operated through digital control systems. The HVAC control panel will be located in the HVAC equipment room or other appropriate location. The panel will be provided with ON/OFF or ON/OFF/AUTO switches for each fan unit, as is needed for each unit. HVAC equipment that requires thermostatic control will be provided with local control in the room served. Exhaust fans will be interlocked with their related supply unit to ensure that proper space pressurization is maintained. Outside air intake and exhaust openings in the building envelope will be provided with dampers to control airflow. Where motorized dampers are used, electric operators will be provided. These operators will be interlocked with the associated fan to operate as required by the active fan mode.

8.4 Plumbing Systems

8.4.1 General Scope

The plumbing system design for PDF II will include potable cold water, nonpotable cold water, potable hot water, sanitary drain and vents, and storm drain. The following codes and standards, as applicable, will be incorporated into each building plumbing design:

- State of California 2007 Plumbing Specialty Code Amendments to the Uniform Plumbing Code, 2000 Edition
- Uniform Plumbing Code, 2000 Edition
- American Society of Plumbing Engineers Standards
- ANSI

8.4.2 Design Criteria

Sanitary Sewer System

Plumbing fixtures will be gravity drained. The discharge will be piped to a site sewer main.

Barrier-Free Plumbing Fixtures

Plumbing fixtures suitable for use by the physically impaired will be provided where required. The project architect will determine the location and number of barrier-free plumbing fixtures.

Energy-Conservation Concepts

- Water-conserving plumbing fixtures and trim as required by the Uniform Plumbing Code
- Energy-efficient water heaters
- Insulated hot water piping

Cross-Connection Control

Reduced-pressure principle backflow preventers will be provided as required by the Uniform Plumbing Code and, as a minimum, for the following water systems:

- Cold water service to mechanical/process equipment
- Connection between potable water and non-potable water

8.4.3 Building Plumbing Systems

- Potable cold water (W1) serving building plumbing fixtures.
- Nonpotable cold water (W2) serving process and equipment.
- Potable hot water (HW) serving building plumbing fixtures.
- Process sample lines (various flow streams)
- Storm drain (SD) serving all roofed structures.
- Sanitary drain (D) and vent (V) serving building plumbing fixtures and floor drains.

8.5 Fire Protection

8.5.1 General Scope

Fire hydrants will be located at the site for firefighting protection. The fire hydrants will be supplied by an FDC that will be supplied from the water treatment plant site. The administration building and the chemical storage portion of the RO and chemical storage/feed building will have automatic fire sprinkler systems. The fire sprinkler system will be designed in accordance with the National Fire Protection Association (NFPA) 13, Standard for the Installation of Sprinkler Systems, authorities having jurisdiction, and EMWD's insurance underwriter. Fire sprinkler systems will be provided under a performance specification, with design and installation by a fire sprinkler system contractor. There may be a need to provide fire pumps and standby power.

The following codes and standards, as applicable, will be incorporated into building fire protection design:

- International Fire Code, 2006 Edition
- California Fire Code, 2007 Edition
- NFPA Standards, Latest Edition

SECTION 9

Architectural Building Concepts and Miscellaneous Structures

9.1 Introduction

The architectural concept for PDF II is to:

- Present an architectural image of quality and good design.
- Create a unified campus of buildings through the use of consistent architectural treatment.
- Use durable, low-maintenance, corrosion-resistant construction materials.
- Provide a functional and accessible facility that will meet the needs of the occupants and equipment.
- Provide daylighting for occupied spaces.

9.2 Buildings

9.2.1 Administration Building

The administration building will house administrative functions. The building will be one-story with a clerestory above the hall/reception area for daylighting and natural ventilation. The anticipated building size is approximately 72 feet wide by 84 feet long. The building walls will be load-bearing masonry with split-face texture and integral coloring. The structural roof system will consist of metal deck supported by parallel chord bar joists. A highly reflective single-ply roofing membrane will be installed over rigid insulation that is mechanically fastened to the metal deck. All interior surfaces exposed to view will be painted in light colors to enhance the lighting inside the building. Windows in the north, east, and south walls will provide natural daylight and offer a potential for natural ventilation.

The following rooms will be housed in the building:

- **Conference Room:** Will house a large conference table and a small base cabinet for food and drink serving. A pair of doors will be provided for access.
- **Control Room:** Will house a control console, associated equipment, and storage shelving. A single door will be provided for access.
- **Laboratory:** Will house base and wall cabinets and counters,, an emergency eye wash/shower, and additional equipment for testing. Refer to Appendix J for additional information. Two single doors will be provided for egress.

- **Office:** Will house a desk and shelf for the operations supervisor. A single door will be provided.
- **Break Room:** Will provide space for food preparation and employee dining and break. A small kitchenette and lunch table will be provided. Two single doors will be provided, one with direct access to an outdoor patio.
- **Women's Restroom/Locker Room:** Will house two toilets, one lavatory, three lockers, one shower, and additional toilet room accessories as appropriate. A single door will be provided for access.
- **Men's Restroom/Locker Room:** Will house one toilet, one urinal, one lavatory, three lockers, one shower, and additional toilet room accessories as appropriate. A single door will be provided for access.
- **Hall/Reception:** Will provide circulation space throughout the building as well as space for groups to congregate and sign in. A reception table and drinking fountain will be provided. A pair of doors at the main entrance and at the secondary entrance will be provided for egress and equipment access.
- **Mechanical Room:** Will house the HVAC equipment, fire sprinkler riser, water heater, service sink, and mop and broom holder. A pair of doors and a single door will be provided for access.
- **Electrical Room:** Will house the electrical equipment. A single door will be provided for egress and equipment removal.
- **Communications Room:** Will house SCADA and other communications equipment. A single door will be provided.

9.2.2 RO Process and Chemical Storage/Feed Building

The RO process and chemical storage/feed building will be one-story and approximately 90 feet wide by 179 feet long. The building walls will be load-bearing masonry with split-face texture and integral coloring. The structural roof system will consist of metal deck supported by parallel chord bar joists. A highly reflective single-ply roofing membrane will be installed over rigid insulation that is mechanically fastened to the metal deck. All interior surfaces exposed to view will be painted in light colors to enhance the lighting inside the building. Skylights will be provided for pump removal and daylighting. Large metal grilles or louvers will be provided in the chemical storage rooms to allow for ventilation and future equipment removal and installation.

The following rooms will be housed in the building:

- **RO Process Mechanical Room:** This room will provide space for the RO membrane equipment and associated pumps, piping, and support tanks. Four single door and five overhead coiling doors will be provided for egress and equipment access.
- **Control Room:** Will house a control console, associated equipment, and storage shelving. A single door will be provided for access.

- **Electrical Room:** Will house the electrical equipment. A pair of doors and two single doors will be provided for egress and equipment access.
- **Uni-Sex Restroom:** Will house one toilet, one lavatory, and additional toilet room accessories as appropriate. A single door will be provided for access. A mop sink, mop and broom holder, and shelving for janitorial supplies will also be provided.
- **Mechanical Room:** Will house the mechanical equipment. A pair of doors will be provided for access.
- **Maintenance Shop:** This room will provide space for laydown space, workbench, lockers, critical spare parts storage cabinets and racks, flamable liquid cabinet, and an owner-furnished compressor. An overhead coiling door, a pair of doors, and a single door will be provided for access.
- **Chemical Storage, Room #1:** This room will provide space for the chemical storage tanks, pumps, piping, safety shower/eye wash, blowers, etc.
- **Chemical Storage, Room #2:** This room will provide space for the sulfuric acid storage tank, pumps, piping and safety shower/eye wash.

9.2.3 Finished Water Pump Station

The Finished Water Pump Station will be an enclosed building and will be one-story and approximately 20 feet wide by 26 feet long. The building walls will be load-bearing masonry with split-face texture and integral coloring. The structural roof system will consist of metal deck supported by parallel chord bar joists. A highly reflective single-ply roofing membrane will be installed over rigid insulation that is mechanically fastened to the metal deck. All interior surfaces exposed to view will be painted in light colors to enhance the lighting inside the building.

The following rooms will be housed in the building:

- **Pump Room:** This room will provide space for the finished water pumps and associated analyzer equipment.
- **Electrical Room:** This room will provide space for electrical equipment.

9.3 Exterior Building Components and Treatment

Roof:	Single-ply roofing membrane at. Color: White. Standing seam sheet metal roofing panels with kynar finish at clerestory of administration building. Color: Bronze.
Walls:	Split-face and smooth-face CMU with integral color. Colors: Tan and brown.
Soffit:	Sheet metal soffit panels with kynar finish. Color: Bronze.
Doors:	Painted hollow metal. Aluminum storefront system with kynar finish at main entry to administration building. Aluminum overhead coiling doors with kynar finish. Where

	used, glazing will be insulated and laminated safety glass. Color: Bronze.
Door Hardware:	Mortise locksets with lever handles and satin stainless steel finish. Panic exit devices as required/appropriate.
Windows:	Fixed, aluminum windows with kynar finish and insulated and tinted glass and/or translucent wall panel windows at industrial spaces as appropriate. Operable, aluminum windows with kynar finish and insulated and tinted glass at administrative spaces. Frame Color: Bronze.
Louvers:	Aluminum with kynar finish and drainable blade louvers. Color: Bronze.
Roof Hatches and Skylights:	Aluminum with kynar finish and insulated. Color: Match roofing.
Signage:	TBD.

SECTION 10

Instrumentation and Control System

10.1 Introduction

This section presents the instrumentation and control design concepts for PDF II. It addresses the proposed SCADA system architecture, support systems, and monitoring and control concepts. This information will be utilized in the development of the final design documents including P&IDs, instrument installation details, specifications including input/output (I/O) and equipment lists and system testing documentation. The SCADA block diagram (Drawing I-1) is a representation of the major components, their network links, communication protocols, media types, and power supplies for the plant control and monitoring systems.

10.1.1 Assumptions

- Administrative network will be configured in coordination with EMWD. CH2M HILL will coordinate with EMWD regarding specifications for installation of Administration Open Rack, UPS, switch and Computers.
- PLC and HMI applications software will be coordinated with EMWD during the final design phase. CH2M HILL will assist EMWD perform Functional Testing of Loops and Programming together during Commissioning phase of the Project.

10.1.2 Open Items

- The Facility Identifier has not yet been provided by EMWD for tagging purposes.
- The open Administrative rack is to be italicized for future Voice over Internet Protocol (VoIP).
- Location of the RO PLC, control room versus the electrical room.

10.2 SCADA System

The major components of the SCADA system include the system servers, operator work stations (often referred to as human-machine interfaces [HMIs]), and the PLC network.

10.2.1 System Servers

Redundant RAID 5 servers will be provided for the SCADA system. The SCADA server will house the master database and all graphic displays. A separate RAID 10 server with tape backup will be provided for maintaining historical data for trends, report generation and daily backups. The servers will be located in the communications/information distribution facility (IDF) (or COMM room) of the administration building. The SCADA servers, switches, monitors, and keyboard will be rack-mounted in cabinets provided with front and rear access. An open rack assembly will be provided for the administrative

system switches and future Voice Over Internet Protocol (VOIP) hardware. Each enclosure will be provided with two dedicated 20-amp (A) alternating current (AC) circuit and outlet. The SCADA server software is yet to be determined in coordination with EMWD.

10.2.2 Human-Machine Interface

Monitoring and control functions will be performed remotely through the SCADA system HMI workstations and laptop computers. The HMI workstation (server client) will be a desktop personal computer with display monitor(s), keyboard, and mouse. The laptop computer will be provided and configured to remotely access the network to monitor and control plant conditions. Four desktop HMIs will be provided for the SCADA system and two for the administrative system. The three SCADA HMIs located in the administration building control room will be provided with dual display units. SCADA system full development licenses will be provided for the SCADA HMI in the RO control room and for one of the SCADA HMIs in the administration control room. Two laptop HMIs will be provided for remote access to the SCADA system by O&M personnel. A third maintenance laptop will be provided with a Controllogix full development license to modify control algorithms. All SCADA HMI workstations will be developed and will utilize common monitoring and control graphics.

Remote access service (RAS) modems will be provided for remote access and to facilitate auto dial-out and call-back.

A Kingfisher remote telemetry unit (RTU) cabinet with a radio will be proposed to allow PDF II to communicate with remote sites.

10.2.3 Programmable Logic Controller Network

Automatic and manual controls for most equipment will be implemented in local control panels (LCPs) utilizing PLCs provided by an instrumentation subcontractor or as part of standard package control systems furnished by equipment venders. Vendor PLCs will be provided for the Fe/Mn filtration and sodium hypochlorite generation systems.

The RO PLC will utilize the Allen-Bradley Controllogix processor. The Logix platform will be Allen-Bradley's latest offering and is currently being utilized at the Perris Water Treatment Plant. The Controllogix platform offers certain advantages over the previously utilized small logic controller (SLC) 4 and 5 platforms in that it eliminates block transfer read and write messages that are cumbersome, provides greater data throughput and faster PLC scan times, and provides transparent processor redundancy and symbolic addressing.

The RO PLC LCP will utilize redundant processors, power supplies, and communication modules. This PLC will be located in the RO building control room. The vendors will be required to provide PLCs based on the standard Allen Bradley Logix family of processors established for the project so that the hardware can be easily incorporated into the SCADA system. These PLCs are in LCPs located adjacent to their respective processes.

The PLCs will be provided with I/O to communicate with field hardware. The RO PLC will be provided with remote input/output (RIO) cabinets located in the RO and chemical process areas for monitoring and control of the process field devices. The RO PLC will

communicate with an RIO cabinet located inside the electrical room of the Finished Water Pump Station.

A Prosoft or Fieldserver serial communication card will be installed in the RO RIO chassis and will provide a networked system to monitor and control the valves within these process areas.

A Prosoft or Fieldserver serial communication card will be installed in the I/O rack of the RO PLC and will provide a networked system for motor control center (MCC) power monitors within the RO building electrical room.

Small vendor panels such as chemical metering pumps, which do not normally utilize PLCs for their control, will be required to provide necessary I/O for hard-wired connections to the PLC LCP or RIO cabinets.

10.2.4 SCADA System Communications

The Ethernet/Internet Protocol (IP) communication protocol will be used between the HMI, SCADA servers, PLCs, and administration building control room laser and Xerox printers. (Note: A laser printer will be provided with two service ports for independent Ethernet connections to the SCADA system server and the administration system server.) Category 6 copper cables will be run from the Ethernet switches and the servers, HMIs, and laptop and printer ports within the administration building. Category 6 copper cables also will be run from the Ethernet switches and the PLC and HMI located in the RO building. In addition, the VFD within the RO and Finished Water Pump Station electrical rooms will utilize the Ethernet/IP communications protocol and be connected to the SCADA system by Category 6 cable to the Ethernet switch. Fiber cable will be utilized between the administration building Ethernet switches and the remotely located PLCs. Patch panels will be provided for the conversion from copper to fiber at each end.

The ControlNet protocol over copper cable will be used between the redundant RO PLCs and the RIO provided for the monitoring of the RO trains, finished water pumps, and the process chemical feed and transfer pumps.

The Modbus protocol utilizing RS 485 2-wire copper will be used between the RO PLC I/O chassis and power monitoring modules in the RO electrical room and between the RO PLC I/O chassis and the EMWD furnished Kingfisher RTU providing remote communication to the SCADA system via a 450 MHz radio and a 900 MHz radio. This same serial protocol will be used to network the control valves on each RO train to the RO RIO cabinets.

10.2.5 TELCO Communications

A telecommunications backboard within the COMM Room of the administration building will provide telephone service for PDF II as shown on the SCADA block diagram. The current requirements are:

- Three lines for phone service within the administration building control room.
- One fax line for the fax machine in the administration building control room.
- Two dedicated lines for the fire alarm control panel in the administration building control room.

- One line for the security system control panel located in the IDF room.
- One line for an RAS modem to support the auto dialer function.
- Two lines for the RO building control room, one phone and one RAS modem for connection to the Fe/Mn filtration system.

10.2.6 SCADA System Power

All SCADA system equipment components will be protected from power surges by providing individual circuits breakers from an uninterruptible power supply (UPS) as shown on the SCADA Block Diagram. Separate UPSs will be provided in the electrical rooms of the administration and RO buildings to provide service to the SCADA system within the building. The administration UPS also will provide conditioned backup power for the security monitoring system and the administrative system hardware. The UPS battery will be sized to provide 90 minutes of backup power at full load. A separate battery cabinet is provided for this extended backup time. The UPS will be provided with a bypass switch should the unit fail or require maintenance/troubleshooting. The SCADA system will monitor the status of the UPS via Ethernet connections.

10.3 Equipment/Instrumentation Tagging Convention

10.3.1 General

The following numbering system will be used for the tagging of all process equipment, instruments, control valves, and relief valves shown on the P&IDs. All tags will be preceded by the prefix "X", which is a facility identifier used for PDF II. The tag number consists of a "unit process" number that indicates the process area where the device is located. The letters indicate the type of device and the second number is the "loop" number that defines functional groups of devices within a process and individual devices within a group.

Format: PP**LLL S**

Where:

P	= 2-digit unit process number; 10 to 90.
LLL	= 3-digit loop number; 001 to 999.
S	= Optional suffix letter (A to Z) for devices in the same loop associated with the same unit (e.g., multiple hand switches that control equipment, but provide different functions).
PP**LLL S**	= Not to exceed 32 characters

10.3.2 Unit Processes

The following unit process numbers will be used on the project:

10	Pretreated RO Feed
20	Misc. Systems: 20-Power, 21-Phone, 22-Security, 23-Fire, 24-HVAC
30	RO Treatment: 31-Train 1, 32-Train 2, 33-Train 3 (Future)

40 Decarbonator

50 RO Cleaning

55 RO Flushing

60 Chemical Systems: 61-Sodium Hypochlorite (NaOCL), 62-Aqueous Ammonia (NH3), 63-Threshold Inhibitor (TI), 64-Sulfuric Acid (H2SO4), 65-Sodium Hydroxide (NaOH), 66-Corrosion Inhibitor (CI), 67-Hydrofluosilicic Acid (F), 68-Citric Acid, 69-Sodium Bisulfate

70 Finished Water

80 RO Concentrate Pumping

90 Fe/Mn Filtration System

10.3.3 Instrumentation

Instruments (such as flowmeters, pressure gauges, and analyzers), control valves, and relief valves will have the letters of the tag based on Instrument Society of America (ISA) Standard S5.1, which provides for a two- to four-letter descriptor. The ISA standard table for letter descriptors is shown on the P&ID legend sheet. On the P&IDs, the tags will be shown inside a circle, or "bubble." On other drawings, specifications, and lists, the tag will be shown simply as a string of characters, such as, FIT-10110.

10.3.4 Equipment

Equipment, such as tanks, pumps and mixers, will have a one-letter descriptor that serves to distinguish between equipment and instruments that have the same number. Examples of one-letter descriptors include:

- Mechanical Equipment M
- Blower B
- Tank T
- Pump P
- Gate G

The complete list of mechanical equipment letter descriptors is shown on the P&ID legend sheet.

On the P&IDs, the tag will be shown inside a rectangle and a brief equipment description (typically two to four words) will be placed near the tag.

10.3.5 Panels

Panels will be numbered similar to equipment. The following letter descriptors will be used:

- Local control panels (field panels) LCP
- Variable frequency drive panels VFD

10.4 General Monitoring Requirements

All analog signals (flows, levels, pressures, conductivity, chlorine residual, pH, turbidity, etc.) connected to PLC I/O modules will be displayed on appropriate HMI graphic screens. Displays will be in engineering units. High and low alarms for analog signals will be displayed on the appropriate graphic screens.

All analog signals will be trended on HMI trend displays as real-time and historical trends.

All discrete signals (on/off, open/close) connected to PLC I/O modules will be displayed on appropriate HMI graphic screens.

Discrete alarm signals (fail, high, low, tripped, etc.) transmitted to the HMI via PLC I/O, or generated by the PLC will be displayed on the appropriate HMI graphic screens. All alarms will be maintained in the Historical Server with time and date stamp.

All pumps, Fe/Mn filter trains, RO trains, blowers, and miscellaneous equipment RUN times will be calculated and updated in the PLC system and transmitted to the HMI.

All timer settings, setpoints, and miscellaneous adjustments will be determined during application software development or plant startup. All settings and adjustments will be easily made through the HMI.

10.5 General Control Modes

Select equipment controlled by the PLC will have field-mounted selector switches that can be set for LOCAL or REMOTE operation. The REMOTE status of the selector switch will be an input to the PLC. In LOCAL mode, the operator will be able to control the equipment manually at the equipment location. This switch contact will be hardwired to the final control element and bypasses the HMI and PLC action. In REMOTE mode, the PLC will control the equipment in one of the two selected modes, MANUAL or AUTOMATIC via HMI faceplate graphics.

In REMOTE MANUAL mode, the operator will be able to operate the equipment manually from the HMI. There will be no PLC algorithm interlocks in effect, except for hardwired safety interlocks. In REMOTE AUTOMATIC mode, the equipment will be controlled by the PLC control algorithm interlocks.

If a final control device is called to operate in the REMOTE mode and the local switch is not in remote, a “NOT IN REMOTE” alarm will occur at the HMI.

If a final control device is called to operate in the REMOTE mode and the local switch is in remote, and the status input does not change for an adjustable preset time, the PLC subsystem will generate a “FAILED TO START” alarm and transmit to HMI.

10.6 Overall Control: Local vs. Remote

The Operator will have the capability of selecting whether the system is being controlled locally or whether the facility will be controlled from PDF I. This will be done by a “System Local/System Remote” selection pushbutton at the PDF II HMI.

"System Local" will allow controls and changes only from PDF II SCADA System. "System Remote" will allow control from both PDF II and the EMWD Central SCADA system. If both trains have been down, the system will only be allowed to start locally. The EMWD SCADA will have the capability to shut down the train(s) that is running or add a second train if one is already running. EMWD will have the capability to allow remote starting of the facility.

10.7 Plant Control Strategies

PDF II will be composed of several parts that work together to provide a final product water that goes into the EMWD distribution network. The following sections summarize basic control strategies for the plant facilities. All control will be exercised through the plant PLC with operator interface through the HMI or the offsite link through the Kingfisher PLC. The major components are the raw water well pumping system, Fe/Mn removal system, RO feed, two RO membrane trains, decarbonator, clearwell (CCT), finished water pump station, membrane cleaning and flushing systems, Fe/Mn backwash and reclaimed water systems, concentrate pump station, and the chemical storage and feed systems.

These descriptions include the functional requirements for the instruments, LCPs, and SCADA system. Refer to the process flow diagram and P&IDs when reading the loop descriptions for a better understanding of the system.

10.7.1 Starting Production (Drawings I-3, I-5)

The filtration system will be designed to treat water from a combination of desalination wells numbered 68, 76, 77, 81, 82, 83, 84, 86, 87, and 89.

The desalination facility RO PLC will control the operation of the desalination facility and interface with the wells, Fe/Mn removal system, RO membrane trains, and all support systems. Desired plant flow and LEAD RO train are entered at the Operators HMI. Depressing an "Initiate Production" transmits the desired flow rate to the Fe/Mn removal system master control panel (MCP) and gets the RO system ready for production by ensuring all equipment and valves necessary for the system to run are in auto, and by setting the valves in their correct positions. Initially, 2-FCV-10151 is fully opened and 2-FV-10211 and 2-FV-10221 are fully closed (see Drawing I-5). The operating RO trains are selected by the operator.

The MCP will determine the required number of Fe/Mn filters necessary to provide the desired flow rate as well as the flow rate per Fe/Mn filters and transmit the information to the RO PLC.

Based on the number of Fe/Mn filter vessels required, the MCP will verify the operating status of each filter vessel as follows: READY, NOT READY, and STANDBY. Each filter is provided with a HAND/OFF/AUTO (HOA) hand switch, which must be in the AUTO position. After determining that the required number of filter vessels is READY to operate, the MCP will check the status of all remaining filtration system alarm signals. If, after a preset adjustable time period, no alarm conditions exist, the MCP will transmit a "Filtration System Ready to Operate" signal to the RO PLC. If an alarm condition exists, the MCP will

transmit a "Filtration System Not Ready to Operate" signal to the RO PLC for further operator action.

Upon receipt of the "Filtration System Ready to Operate" signal from the MCP, the RO PLC will transmit staggered start signals to the required number of desalination wells to achieve the desired desalination facility flow rate.

10.7.2 Fe/Mn Filtration System Pressure (Drawing I-2)

The RO PLC will transmit a start signal to the MCP. As flow enters the Fe/Mn system, PRV-90101 on the raw water purge line will divert (waste) flow water flow to the pond and maintain an operating pressure of 80 psi. Should the pressure rise to 85 psi, the high-pressure relief valve (PRV-90102) will open, discharging the raw water to the pond.

10.7.3 Fe/Mn Filtration System Filters (Drawing I-3)

There are three Fe/Mn filters in the system. The tag numbers used below are for filter F-91100; the controls for F-91200 and 91300 are typical.

When the desired total rinse flow rate is achieved, the MCP will energize the "rinse/purge" solenoid valve (opening valve FV-91150) until the flow rate as measured by FIT-91110 reaches the supplier's preset minimum rinse rate for a preset minimum time period. After each required filter vessel has been adequately rinsed, the MCP will position the filter vessel valves to the "filtration" mode by de-energizing the purge valve solenoid and energizing the filter effluent valve (FV-91140).

Note: Each filter vessel will be "rinsed" before the filter vessel effluent is conveyed to the desalination facility, regardless of whether the filter vessel was "parked dirty" or "parked clean" after the previous plant operating cycle. Rinsing the filter vessels will ensure that the filter bed has been settled prior to initiating filtration and conveyance of effluent to the desalination facility.

An effluent rate-of-flow-control valve (FCV-91160) and effluent flowmeter (FIT-91110) on each filter vessel will be used to maintain the flow through the filter. The effluent flowmeter analog signal will input to an electronic control system (ECS), located at the MCP, for the rate of flow control valve. Based on the measured effluent flow rate and the flow rate setpoint, the ECS will cause the rate-of-flow-control valve to open/close (modulate) as necessary to achieve the desired filter vessel flow rate setpoint. The ECS setpoint will be adjustable locally at the ECS keypad or remotely by the MCP PLC. The flowmeter signal will be retransmitted by the ECS to the MCP PLC for monitoring and data storage.

Initially, when the required filter vessels are operating in the filtration mode, the flow rate from the desalination wells will increase gradually as additional wells are brought online. During this time, the effluent rate-of-flow-control valves will not be modulating to balance flow between the operating filter vessels. Once the MCP receives a signal from the RO PLC that all required desalination wells are operating, the effluent rate-of-flow-control valves will begin modulating to balance flow between the operating filter vessels. The balanced flow setpoint will be determined by the MCP based on the flow rate from the influent flow meter to the Fe/Mn removal facilities and the number of operating filter vessels. An adjustable deadband will be provided for achieving the balanced flow setpoint via the ECS

for the effluent rate-of-flow-control valve. As floc builds up within the filter, the ECS modulates the FCV-91160 to maintain flow within the deadband. If after a preset adjustable time delay, the flow signals from one or more filter vessels do not fall within the preset adjustable deadband, the MCP PLC will cause the filtration system to shut down and an alarm condition to be activated ("Effluent Rate of Flow Control Fail"). Manual reset will be required.

10.7.4 Fe/Mn Chemical Feed (Drawings I-2, I-3)

The raw water feed to the Fe/Mn filtration system will be monitored for chlorine residual (AE/AIT-90210), and the filter effluent flow is monitored for ORP (AE/AIT-90310). These signals, along with the filter system discharge flow (FE/FIT-90111) will be used to pace the injection of sodium hypochlorite to ensure proper generation of an Fe and Mn floc for removal by the filter.

The effluent will also be monitored by a "zero center" analyzer (AE/AIT-90410) that measures both sulfur dioxide residual and total chlorine. This signal, along with the filter system discharge flow (FE/FIT-90111) will be used to pace the injection of sodium bisulfate to ensure that the RO feed flow is free of any chlorine residual that could damage the RO membranes.

If free chlorine is detected in the Fe/Mn filter system effluent, the flow will be diverted to the pond by opening the treated-water-to-waste valve (FCV-90511) and closing the treated water valve (FCV-90610) if open, and initiating a shutdown of the operating RO train(s).

10.7.5 Fe/Mn Filter Backwash (Drawing I-3)

Filter backwash will be based on a preset maximum time of operation or preset maximum pressure drop across the filter as measured by a differential pressure switch (PDSH-91170) or manually at the MCP. Once any of these conditions occurs, a "standby" filter will be brought online ("rinse then "filtration"), and the filter will automatically begin the backwash cycle by energizing the backwash solenoid (SV-91130), which closes the filter feed inlet valve (FV-91110) and opens the backwash supply (FV-91130) and return (FV-91120) valves. The filter will be backwashed for a preset adjustable time. At completion of the backwash, the filter will be placed in the "standby" mode.

If backwash is required on multiple filter vessels, their backwash cycles will be staggered. The effluent flow rate established by the RO PLC from the Fe/Mn removal facility will be maintained at all times.

The signal from PDSH-91170 will be provided with an adjustable time delay to prevent unnecessary backwash. Filter controls will incorporate provisions to allow the filter to backwash only one time on headloss. If backwash does not correct the condition (high headloss), the MCP will shut down the respective filter vessel and an alarm condition will occur at the HMI. Manual reset will be required. Upon satisfactory completion of backwash, the elapsed time will reset.

Filtration ON, filtration OFF, backwash, backwash on headloss, backwash on time, rinse (purge), elapsed run time (since last backwash), inadequate backwash, effluent flow rate, and effluent rate-of-flow-control fail status will be controlled and displayed on the HMI.

Raw water influent flow rate, treated water effluent flow rate, raw water free chlorine residual, treated water free chlorine residual, treated water total chlorine residual, and treated water sulfur dioxide residual values will be recorded on an MCP digital chart recorder.

An "emergency stop" push button on the MCP will initiate a plant shutdown sequence; that is, filter valves will be closed, chemical feed pumps will be stopped, and backwash supply and recycle water pumps will be stopped.

10.7.6 Fe/Mn Backwash Supply Tank and Pump System (Drawing I-12)

A backwash supply tank containing filtered effluent from the Fe/Mn Filters and/or treated effluent from the desalination facility (W2), and the backwash pumps will be utilized to provide backwash water to the filter vessels. The flowmeter signal will be transmitted to the MCP for display and then retransmitted to the MCP PLC for monitoring, control action and data storage.

The backwash supply tank will be equipped with a level monitoring system to provide an analog level signal to the MCP PLC. Based on the tank analog level signal, the MCP PLC will be programmed to provide adjustable level setpoints as follows: Open Fill Valve Level (on falling tank level), Close Fill Valve Level (on rising tank level), Inhibit Backwash Level (on rising tank level), Low Water Level (on falling tank level), and High Water Level (on rising water level). An adjustable time delay will be provided for each tank level setpoint. Using the above-level setpoints, the MCP will provide the following monitoring and control:

LOCAL/REMOTE and OPEN/STOP/CLOSE selector switches will be provided to operate backwash supply tank fill valve on the treated water pipeline. A manual valve will be provided on the W2 water line to permit use of W2 water if treated water is not available.

With the switch in "REMOTE" Position – when tank water level falls to "Open Fill Valve Level," the MCP will close a dry contact to open the valve (start filling tank). When the tank level rises to "Close Fill Valve Level," the MCP PLC will open the dry contact to close the valve (stop filling tank). The open/close fill valve status will be displayed on the HMI.

"Inhibit Backwash Level" will cause the MCP to prevent backwash cycles and the backwash supply pumps from starting due to insufficient level in the tank. The MCP will activate an alarm condition. Manual reset of the alarm display will be required, but the pump will be allowed to start when the tank level rises above the "Inhibit Backwash Level."

"Low Water Level" (LWL) (alarm and stop pump level) will cause the MCP to activate an alarm condition and prevent the start of the backwash supply pumps or, if the filter is in backwash mode, will shut down the backwash supply pumps, backwash cycle, and respective filter. LWL alarm condition will require manual reset.

"High Water Level" (HWL) will cause the MCP to activate an alarm to indicate a malfunction of the tank fill valves. HWL also will cause the MCP to close the supply valves. Manual reset will be required.

Backwash supply pumps (one duty and one standby) will be provided with HOA switches. In AUTO, they will be interlocked with the backwash supply tank levels and pump

discharge flowmeter (FE/FIT-94110). The backwash flowmeter signal will be transmitted to the MCP for display and retransmitted to the PLC for monitoring and control action. In AUTO, the MCP will call the duty backwash pump to start when backwash is required. Duty and standby will be adjustable via the PLC HMI.

If after a preset adjustable time delay, the flow rate measured by the flowmeter is not within acceptable limits, the MCP will stop the backwash pump and activate an alarm condition (Backwash Rate-of-Flow-Control Fail) and shut down the respective filter in backwash mode. Manual reset will be required.

10.7.7 Reclaim Tank and Reclaim Pumps (Drawing I-12)

The reclaim tank will be monitored by a level transmitter that transmits a signal to the MCP for display and use by the MCP PLC. The MCP PLC will utilize the level signal to enable control of the reclaim pumps.

The reclaim pumps (two duty and one standby) will be provided with VFDs, each provided with a Local/Remote (L/R) switch. The discharge flow from each pump will be monitored and the signal transmitted to the MCP for display and MCP PLC control panel. The total reclaimed flow will be limited to 10 percent of the total plant flow.

In REMOTE, with the Fe/Mn filter in the filtration mode, a "Start Reclaim Pump(s)" level will cause the MCP PLC to start the required reclaim pumps after a preset adjustable time delay (0 to 8 hours) from completion of the last backwash cycle (to allow settling of solids). The pump speed will be adjusted to maintain the required flow rate. The MCP will provide pump stop signals if the filtration cycle stops or when the reclaim tank "Stop Reclaim Pumps" level is reached.

If the total plant flow rate changes during the filtration cycle, the MCP will start/stop the reclaim pumps accordingly. The pumping unit will be selected via the PLC HMI as "lead," "lag," or "standby."

Once the reclaim pumps are in operation, the MCP PLC will transmit a "Reclaim System Start" signal to the RO PLC. The RO PLC will adjust the total raw water flow rate to 90 percent (minimum). The MCP will then transmit speed control signals to the reclaim pump VFDs to vary the pump speed until the desired flow rate is achieved (0 to 10 percent of the total plant flow rate, adjustable via the MCP. When two reclaim pumps are operating simultaneously, the MCP will transmit matching speed signals to both VFDs. The minimum and maximum speed for all pumps will be adjustable. These values will be adjusted in the field based on actual operating conditions and actual pumps furnished.

If after a preset adjustable time delay, the flow rate from the respective reclaim pump flowmeter is not within acceptable limits, the MCP PLC will stop the reclaim pump(s) and generate an alarm "Reclaim Water Pump No. X, Rate of Flow Control Fail" and shut down the duty reclaim pumps. Manual reset will be required.

When the reclaim pumps are off, the RO PLC will return the total raw water flow rate to 100 percent of the desired plant flow rate.

10.7.8 Starting RO Production (Drawings I-3, I-5)

When the Fe/Mn effluent flow reaches the setpoint flow for one train and is chlorine-free as sensed by AE/AIT-90411, the dechlorinated treated water valve (FCV-90610) will be opened and hydraulically controlled to maintain a constant downstream pressure of 55 psi. This flow will be diverted to the ponds through the open RO waste valve (FCV-10151), and the pH loop for pH addition (if needed) will be initiated and TI addition begins.

Once the pH is stabilized (if acid is needed), valve FCV-10151 will start to close to build up pressure in the system. When the setpoint pressure is achieved, the flow valve for the selected lead train will be opened and the RO feed pump started.

10.7.9 Membrane Feed Bypass or "Blend Control" (Drawings I-4, I-10)

A certain volume of pretreated water will be blended with membrane permeate before it goes to the clearwell. This control loop will automatically maintain a preset "blend" using a PLC-programmed proportional-integral-derivative (PID) controller (AIC-70011). The PID algorithm will control the conductivity of the raw water/permeate blend by modulating valve FCV-10046. The PID process variable will be the blended water conductivity measured by AE/AIT-70011. The conductivity setpoint will be entered by the Operator based on water quality data. The output of controller AIC-70015 will be used to modulate valve FCV-10046. If the conductivity measured by AE/AIT-70015 is lower than the preset value, the PID algorithm will increase flow through the bypass by increasing the opening of FCV-10046.

There is a maximum bypass flow that will be allowed, as a percentage of total finished water flow. If the flow measured at FIT-10045 is equal to this maximum flow, the control for FCV-10046 will not be allowed to open more. If the flow measured at FIT-10045 is greater than the maximum flow, the control for FCV-10046 will modulate bypass flow to the setpoint.

The controller faceplate, process variable, controller output, setpoint and AUTO/MANUAL status will be displayed at the HMI

10.7.10 Raw Water pH Control (Drawing I-3, I-4, I-18)

A PID controller (AIC-10048) will control the speed of the selected sulfuric acid metering pump to maintain the preset raw water pH. The measured value for the PID loop comes from pH analyzer AE/AIT-10048. If the pH measured by AE/AIT-10048 is higher than the preset value, the selected sulfuric acid pump will increase the feed rate until the preset pH value is reached. If the pH measured by AE/AIT-10048 is lower than the preset value, the selected sulfuric acid pump will decrease the feed rate until the preset pH value is reached.

This pH control loop will be augmented to compensate for raw water flow changes. The speed of the metering pump will be adjusted to correspond to the treated water flow. The treated water flow will be measured by FE/FIT-90111 minus the bypass flow (FE/FIT-10045). Controller faceplates and all other associated variables will be displayed at the HMI.

10.7.11 Pretreatment Threshold Inhibitor (TI) Feed Control (Drawing I-3, I-4)

The speed of the selected scale inhibitor pump will be controlled proportional to the treated water flow measured by FE/FIT-90111 minus the bypass flow (FE/FIT-10045).

10.7.12 Cartridge Filter Differential Pressure (Drawing I-4)

The cartridge filter differential pressure will be computed in the PLC by using the upstream and downstream pressure transmitters (PIT-10050 and PIT-10122). The differential pressure will be displayed on the HMI and an operator-adjustable high differential pressure setpoint will result in an alarm at the HMI.

10.7.13 Membrane Feed to Waste Control (Drawing I-4, I-5)

During the initial first membrane startup, FCV-10151 will be controlled by FIC-10151 to maintain a flow equal to single-train rated flow. Later in the sequence, the valve will be fully closed and will remain closed during the startup of the second train.

During train operation, if the feed pump suction pressure (PIT-10122) exceeds an adjustable preset HIGH-HIGH pressure limit, the controller will OPEN valve FCV-10151 until the pressure is back to NORMAL value. The operator will generate an alarm indicating, "Feed to Waste Valve open due to High Suction Pressure" and modulate the valve to maintain NORMAL pressure. After an adjustable time (0 to 60 minutes), the operator will close the valve.

The controller faceplate, process variable, controller output, setpoint and AUTO/MANUAL status will be displayed at the HMI.

10.7.14 RO Feed Pumps (Drawing I-5)

There are two RO feed pumps (P-10210 and P-10220) driven by adjustable frequency drives VFD-10210 and VFD-10220. The tag numbers used below are for pump P-10210; the controls for P-10220 are typical.

Manual Operation

A START/LOCK-OUT-STOP switch will be provided near the pump to stop the drive. This will only be a control stop and will not be used as a safety lock-out. For maintenance purposes, standard lock-out/tag-out procedures at the MCC will be followed. The START/LOCK-OUT-STOP switch will be hard wired into the drive control circuits.

Manual operation of feed pumps will require certain prerequisite conditions, and the operator will have to ensure all safety interlocks. Similar safety interlocks will be programmed for the PLC start command.

When the switch is in LOCAL position, field STOP is not pushed and the drive is in MANUAL mode, the pump could start and stop and the speed will be manually controlled from the drive located in the electrical room.

When the local switch is in REMOTE position, field STOP is not pushed, and the drive is in AUTO mode, then the soft switch at the HMI will be used to start and stop the feed pump manually from the HMI. The speed could be controlled manually by putting controller

FIC-31107 in MANUAL and using the cursor on the face plate to control speed to maintain a desired total feed flow as measured by the sum of permeater flowmeters FE/FIT-31206, FE/FIT-31107, and concentrate flowmeter FE/FIT-31209.

Automatic Operation

The feed pump will always be manually started from the HMI when all prerequisite safety interlocks are satisfied and the sequence calls for starting the pump. Once started at the preset minimum speed, the PLC controller (FIC-31107) will be put in AUTO mode to control the speed to maintain the preset flow. EMWD will have the capability to operate the system from a remote location.

10.7.15 Interstage Turbocharger (IT-32150) and Auxiliary Nozzle Valve (ANV-32151) - (Drawing I-6)

There will be a turbocharger provided on each RO process train. The turbocharger, consisting of a pump and a turbine coupled together, is located between the two stages of a membrane train. The turbocharger boosts the pressure of the first stage concentrate by utilizing the pressure in the second stage concentrate. The turbocharger output will be controlled by an auxiliary nozzle valve that is an integral part of the turbocharger. The auxiliary nozzle valve and controller assembly are stand-alone systems that do not interface with the facility SCADA system.

10.7.16 Membrane Permeate/Concentrate Flows and Recovery Control System (Drawing I-6, Train 1; Drawing I-7, Train 2)

The SCADA system programmer will provide displays to allow membrane system parameter configuration, such as acceptable recovery range for each train, minimum concentrate flow, etc. This display will be password-protected to allow access to supervisory personnel only.

The operator will enter a TARGET percent recovery (Y) at the SCADA HMI. If the entered value of Y is out of the preset recovery range, it will generate an alarm and prompt the operator to select a value within the range. The operator will enter a percent TARGET permeate flow setpoint (Qp) at the SCADA HMI. Again, if the value is outside the range, it will generate an alarm and prompt the operator to re-enter a value within the range.

The operator will enter a minimum acceptable value of concentrate flow (Qc min) in the RO configuration display at the SCADA HMI.

Percent recovery is defined as follows:

$$Y = [Q_P/(Q_P+Q_c)]*100$$

Where Y = Percent Recovery

Q_p = Permeate Flow

Q_c = Concentrate Flow

Q_{ct} = Target Concentrate Flow

Q_{cm} = Minimum Concentrate Flow

Based on entered TARGET values of Y and Qp, targeted (maximum allowable) concentrate flow will be computed by the PLC algorithm as follows:

$Q_c = Q_p (100-Y)/Y$

If $Q_c < Q_{cm}$,

THEN use Q_{cm} as the concentrate flow setpoint.

1. Use PLC algorithm FIC output to modulate RO feed pump speed via VFD-10210 to maintain permeate flow Q_p setpoint. This control will be similar for both trains. Should a High-High pressure limit be reached, the operator will have to initiate train shutdown. Similarly, the operator will have to initiate train shutdown if the RO feed pump suction pressure drops below an operator-adjustable preset value.

2. Concentrate flow control will be achieved primarily by modulating FCV-31210 to keep the concentrate flow at target flow (Q_{ct}). The valve will open more if the Q_c measured by FIT-31209 is less than Q_{ct}. The amount of opening will be proportional to the variance (Q_{ct} - Q_c). On the other hand, if the concentrate flow is higher than the target value, the control valve will close proportional to the variance (Q_c - Q_{ct}).

3. The second stage flux ratio (SSFR) will be controlled by the first stage permeate control valve (FCV-31106). The SSFR is defined as follows:

   SSFR = Ratio of <u>Second Stage Permeate Flow as measured by FE/FIT- 31206 to</u> total flow as measured by the sum of FE/FIT-31206 and FE/FIT-31107.

   Operator will select a SSFR setpoint range by inputting minimum SSFR (SSFR min) and maximum SSFR (SSFR max). If the SSFR is within the range, no action will be initiated. If SSFR falls below SSFR min, then FCV-31106 will start closing to hold the SSFR at SSFR min. While modulating, the FCV will open if the SSFR rises above SSFR min. Once the FCV is back to a fully open position, it will be disengaged (an adjustable time delay of 0 to 60 seconds will be used). The FCV will not modulate until the SSFR falls below SSFR min again. If the SSFR increases above SSFR max, an alarm will be generated. FCV position, fully closed status, and fully open status will be indicated.

4. Controller faceplates, all setpoints, process variables and AUTO/MAN status, target recovery and actual recover will all be displayed at HMI.

10.7.17 Permeate to Waste Controls (Off-Spec Permeate) (Drawing I-6, Train 1; Drawing I-7, Train 2)

The capability to manually purge off-spec permeate to waste will be provided. This capability will be used mainly during initial commissioning, but can be used at any other time. Manual isolation valves (HV-31131 and HV-31132) will be provided on each side of a spool piece in the permeate to waste line. These valves will be normally closed. The spool piece will be provided with a tap and manual valve (HV-31130) to drain the contents of the spool when the isolation valves are closed. This permeate to waste line will be provided with an air gap at the pond.

10.7.18 Decarbonator Bypass (Drawing I-9)

Some RO permeate can be set to bypass the decarbonator. This is done to stabilize the pH and to minimize chemical usage. RO permeate has a low pH, and going through the decarbonator may raise the pH (alkaline) by removing CO_2. The operator will enter the desired flow for the bypass, measured by FE/FIT-40030, and the PLC controller FIC-40030 will adjust the decarbonator bypass valve FCV-40031 to maintain the desired flow setpoint.

10.7.19 Post-Treatment Corrosion Inhibitor Feed Control (Drawing I-6, I-7, I-22)

The speed of the selected metering pump will be controlled proportional to the total of the permeate water flowmeters (FE/FIT-31107, FE/FIT-31206, FE/FIT-32206 and FE/FIT-32107).

10.7.20 Clearwell/ Finish Water Off-Spec Water (Drawing I-10)

During the initial startup of the facility, water quality in the CCT may not satisfy criteria for delivery into the distribution system. Similar situations may occur during the maintenance, such as after cleaning of the CCT and/or finished water pump station clearwell. For those instances, operators will have the capability to discharge the off-spec water to the pond.

10.7.21 Post-Disinfection Sodium Hypochlorite Feed Control (Drawing I-11, I-17)

The objective of the post-disinfection sodium hypochlorite system is to provide minimum residual chlorine in the finished product water before it is delivered into the distribution network. The sodium hypochlorite feed rate will be proportional to the total flow of finished water as measured by FE/FIT-70211.

10.7.22 Post-Treatment Ammonia Feed Control (Drawing I-11, 1-19)

The ammonia dosage is a fixed ratio of the sodium hypochlorite dosage. Once the sodium hypochlorite per gallon of finished water flow is determined based on AIT 70013, the PLC will compute the ammonia dosage as a fraction of the hypochlorite dosage. The fraction "f" will be adjustable (from HMI), normally set in a range between 0.25 and 0.33. Using this relationship, the ammoniator pacing ratio, K, will be computed and used for ammoniator pacing.

10.7.23 Post-Treatment Fluoride Feed Control (Drawing I-11, I-23)

The objective of the post-fluidization is to provide a minimum residual fluoride in the finished product water before it is delivered into the distribution network. The hydrofluosilicic acid solution feed rate will be proportional to the flow of the finished water (FE/FIT-70211) and the fluoride concentration as measured by AE/AIT-70223.

10.7.24 Final Metering (Drawing I-11, I-23)

Plant finished water is monitored by a magnetic flowmeter (FE/FIT 70211) to be used in the chemical feed pump pacing for the post-treatment chemical addition. Plant W1 and W2 are withdrawn from the discharge header going to the plant distribution system. Plant use will be monitored by FE/FIT-70214.

10.7.25 Membrane Cleaning System (Drawing I-13)

The chemical preparation for the cleaning process will be a manual process performed in the field via LCP-50010, LCPs-65130 (Drawing I-20), and LCP-68110 (Drawing I-24) located adjacent to the CIP tank (TK-50010). LCP-50010 will be used to control and monitor the CIP cleaning operation, while LCP-65130 and LCP-68110 will be used to manually control the sodium hydroxide and citric acid transfer pumps and monitor the flow of chemical added to the CIP tank.

If dry chemicals are to be used, the operator will manually load the chemical bag contents into the CIP hopper during the mixing stage of the chemical preparation process.

The CIP tank (TK-50010) is used for the cleaning of RO membranes. The cleaning operation will be a manual operation with control capability from the HMI provided the associated control valve hand switches are in the REMOTE position.

Cleaning Cycles

The cleaning cycle will be performed manually and will consist of acid and caustic chemical wash/flush cycles. Each cycle will consist of a chemical wash followed by a permeate flush. The train will be sequentially washed, initially with a citric acid solution, then with a sodium hydroxide solution. Each cycle will require solution preparation, solution circulation, a membrane soak period, solution recirculation, then a permeate flush.

Solution Preparation and Cleaning

- Operator opens valve FV-50005 on the permeate makeup supply line.
- When the desired level is reached, operator STOPS permeate makeup water addition.
- Operator will ensure that the manual valve (HV-50043) to membrane system is CLOSED, manual recirc valve (HV-50044) is OPEN, and HV-50046 is CLOSED isolating the CIP tank from the permeate flush tank and creating a recirculation path for chemical mixing.
- At LCP-69110, the operator transfers the desired amount of chemical to be added to the CIP tank and starts the membrane cleaning pump (P-50020) using HS-50020B; operator adjusts the speed utilizing SHK-50010A to provide mixing of the added chemical. Operator observes pump status on LCP-50010.
- Operator turns electric heater (TE 50010) on and monitors the pH and temperature on AE/AIT-50023 (pH) and TIT-50022 (temperature), respectively on the LCP. The operator will continue the recirculation until complete mixing of the chemical is achieved and preset cleaning solution temperature is reached.
- Operator makes sure that all manual valves related to membrane cleaning for the selected train and stage are in proper position and verified/logged, in a standard operating procedure checklist.
- Operator Opens the valves to feed cleaning solution to membranes, CLOSES the recirculation valve, and adjusts pump speed to provide the required flow through the membrane.

- Operator observes temperature of the circulated chemical and stops the pump (P-50020) when the temperature is again at the desired level and leaves membranes to be soaked with the cleaning solution for a predetermined period of time.
- After soaking time expiration, the operator will start pump P-50020 to recirculate cleaning solution through the membrane system for a predetermined period of time that will constitute completion of the chemical treatment portion of the cleaning cycle.
- The above-described cycle may be repeated two more times.
- After the cleaning operation is complete, the operator shuts down the cleaning system by closing valves to membranes, opening the recirculation valve, stopping the cleaning pump, closing the permeate makeup supply, and closing HV-50043 to isolate the CIP tank for the permeate flush.
- Used cleaning solution will be discharged either into the concentrate pump station by opening FV-50002 and FV 50004, or returned back into TK-50010 and discharged into the sewer by opening the drain valve.
- The cleaning cycle will be finished by flushing fully one volume of permeate water through the stage. This is done manually via LCP-550010.
- The above process will be repeated for both chemicals and for both stages of the RO train.
- The operator positions the valves on the train and prepares the train for operation again.
- All data related to the cleaning system pH, temperature, cleaning solution flow, cleaning tank level, equipment status, water volume, quantity of chemicals used, alarms, and others are displayed on the HMI.

10.7.26 Membrane Flushing (Drawing I-14)

The membrane flushing process will be an automatic process. It will be used when taking a train out of service and as part of the membrane cleaning cycle. Flushing with permeate will be controlled from LCP-55010. The flushing system for taking a train out of service will be a two-step process: an initial flush with RO feedwater, then a final flush with permeate water In the cleaning process, only the permeate flush will be provided. In the cleaning process, each stage of the train will be individually flushed.

RO Flush Tank T-55010 will be used in flushing operations for the RO membranes. The flushing operation will be an automated operation with manual control capability from the HMI, provided the associated control valve hand switches are in the REMOTE position.

Out-of-Service Flushing Operation (Train 1, Typical for Train 2)

- Initial flushing will be done using raw water after the RO treatment system is stopped for a preset period of time. Final flushing will be done using permeate water immediately after initial flushing.
- Before flushing starts, adjust RO feed pump to the preset flush water flow rate.
- Valves FCV-31106, FV-31205, FCV-31210, FCV-31212, FV-32214, FCV-31111, FCV-31216, FCV-32104, FV-31104, and FV-50003 will fully close. Keep valves FV-31103, FV-31214,

and FV-50004 fully open. That will divert all flush water flow to the CCR line to the concentrate pump station sump in the RO building.

- After two volumes of the pressure vessels and piping water pass through, initial flushing is completed and final flushing will proceed.
- The RO feed pump is OFF and the RO inlet valve (FV-10211) is CLOSED.
- Train 1 flushing valve FV-10215 is OPENED and pump P-55020 is STARTED. This will flush the RO feed pump and RO train with permeate and discharge the flow to the CCR line to the concentrate pump station. After two volumes of pump can, pressure vessels, and piping water pass through, the pump will be shut OFF and all the valves will return to their normal positions for operation.
- FV-50003 by the cleaning tank is closed to prevent flush water from going back into the cleaning tank. FV-50004 is opened to allow the CCR line to drain to the sump.

CIP Permeate Flush

- The permeate flush tank is automatically filled to an adjustable predetermined level by OPENING FV-55001.
- CIP flushing is performed during the cleaning process of the RO membranes and is performed after each chemical cleaning step for each RO stage. The flushing process is a manual operation performed at LCP-55010.
- HV-55046 is CLOSED and HV-55047 is OPENED to create a path for permeate flow to the CF line.
- Ensure that valves FV-31110 and 31104 are OPENED, and valve FV-31103 is CLOSED, maintaining a path for permeate flow through Train 1, Stage 1 discharging the flow to the CCR line to the concentrate pump station sump in the RO building.
- Manually START the RO flush pump (P-55020) and adjust SPEED at the LCP to maintain the required flow through the first stage.
- After one volume of water of Stage 1 pressure vessels and piping water pass through, the pump will be shut OFF and the manual valves will be repositioned to permit an out-of-service flush to occur automatically, if required.
- Repeat the above steps for flushing Stage 2 utilizing FV-31215, FV-31114, and FV-31112 respectively for Stage 2 flushing.
- FV-50003 by the cleaning tank is closed to prevent flush water from going back into the cleaning tank. FV-50004 is opened to allow the CCR line to drain to the sump.

10.7.27 Permeate Transfer Between Permeate and CIP Tanks (Drawings I-13,I-14)

Manual valves will have to be positioned to perform this transfer. The operator will have to inhibit a flushing operation from automatically being initiated by the system by either inhibiting it at the HMI or by placing hand switch 50010A, CLEANING MODE/ NORMAL OPERATION (C/N) on the CIP LCP in the “C” position. The manual valves just prior to the cartridge filter for each pump system (HV-50043 and HV-55043) must be closed. Proper positioning of manual valves HV-50044, HV-50045, HV-55044, and HV-55045 will create a

direct line between the two tanks. To transfer permeate from one tank to the other, the operator must manually START the appropriate pump and monitor the tank levels at the HMI or in the field and shut off the pump when the tank level has reached the desired value. At the completion of the transfer, the operator must reset the valves to their prior positions.

10.7.28 Finished Water Pump Station (Drawing I-10)

The finished water pump station pumps will transfer product water from the clearwell to the distribution network based on EMWD's requirements (operator input). The VFD-driven pumps will operate within a preset range of maximum and minimum water levels in the clearwell.

Manual:

When the switch is in LOCAL position, field STOP is not pushed and the drive is in MANUAL mode, the pump will be started and stopped and the speed manually controlled from the drive located in the electrical room.

When the local switch is in REMOTE position, field STOP is not pushed, and the drive is in AUTO mode, then the soft switch at the HMI can be used to start and stop the feed pump manually from the HMI.

Automatic:

When the local switch is in REMOTE position, field STOP is not pushed, and the drive is in AUTO mode, when the soft M/A switch at the HMI in AUTO, the pumps will be controlled based on the PID control algorithm in the PLC, with pump sequence logic as follows:

- At a preset minimum level, start LEAD variable speed pump at 60 percent speed. PID controller measures level, compares to a setpoint, and based on error generates an output to control pump speed.
- Note that the level setpoint will be an adjustable level band 6 inches to 12 inches, instead of a single value. This dead band will allow reduced cycling of pumps.
- When the speed of the LEAD pump has reached 100 percent and the level is higher than the set level band, start LAG variable speed pump at 60 percent speed. Ramp down LEAD pump and ramp up LAG pump such that both pumps are working at a common speed.
- When both pumps are running at 100 percent speed and the level is rising above the set band, generate a HIGH-HIGH alarm at the HMI. Advise operators to shut down a train or reduce the product water flow.
- On falling level, follow the sequence in reverse.
- When level drops below cut-off level and both pumps are running at 60 percent speed, stop the LAG variable speed pump. On the low level in the clearwell, stop all pumps.
- Generate level alarm.

- Provide high and low level alarm, and pump status at HMIs. Provide controller faceplate for display of process variable, setpoint, controller output, AUTO/MANUAL status.
- Provide alternation of pumps using a 1/2/3 sequence following each cycle of operation and based on 24-hour pulse.
- When any of the local switches are not in REMOTE and AUTO position, those pumps will be considered out-of-service and the sequence will bypass these pumps.
- At HMIs, provide means for modifying PID turning constants, changing set level band.

When at least one pump is running, provide downstream sodium hypochlorite and ammonia feed control. Provide controller faceplates for PID loops and ratio control. When any of the local switches are not in AUTO or DISABLE position, those pumps will be considered out-of-service and the sequence will bypass these pumps.

10.7.29 Concentrate Pump Station (Drawing I-15)

The VFD pumps transfer RO concentrate from the concentrate pump station wet well to the TVRI. There are two concentrate pumps.

Manual:

When the switch is in LOCAL position, field STOP is not pushed and the drive is in MANUAL mode, the pump can be started and stopped and the speed manually controlled from the drive located in the electrical room.

When the local switch is in REMOTE position, field STOP is not pushed, and the drive is in AUTO mode, then the soft switch at the HMI can be used to start and stop the feed pump manually from the HMI.

Automatic:

When the local switch is in REMOTE position, field STOP is not pushed, and the drive is in AUTO mode, when the soft M/A switch at the HMI in AUTO, the pumps will be controlled based on the PID control algorithm in the PLC, with pump sequence logic as follows:

- At a preset minimum level, start DUTY variable speed pump at 60 percent speed. PID controller measures level, compares to a setpoint, and based on error generates an output to control pump speed.
- Note that the level setpoint will be an adjustable level band 6 inches to 12 inches, instead of a single value. This dead band will allow reduced cycling of pumps.
- Modulate speed of the pump based on output of PID algorithm. If the pump reaches 100 percent speed and the level is still rising above the set level band, generate a HIGH-HIGH alarm at the HMI. Advise operators to shut down a train.
- On falling level, when the level drops below the cut-off level and the pump is running at 60 percent speed, stop the pump.

- Generate a level alarm.
- Provide high and low level alarm, and pump status at HMIs. Provide controller faceplate for display of process variable, setpoint, controller output, AUTO/MANUAL status.
- Provide alternation of pumps using a 1/2 sequence following each cycle of operation and based on 24-hour pulse.
- At HMIs, provide means for modifying PID turning constants, changing set level band.

When any of the local switches are not in REMOTE, and AUTO position, those pumps will be considered out-of-service and the sequence will bypass these pumps.

10.8 Chemical Systems for Desalination Facility

There are typically two chemical feed pumps provided for each chemical application. Duty assignment selection will be operator adjustable from the HMI. Each pump will be driven by a VFD for effective speed control. The pump output rate may be further fine-tuned by manual adjustment of the stroke length. Fe/Mn pumps will be provided with an automatic stroke length adjustment. The hard-wired VFD signal interfaces are shown on Drawings I-16 through I-25.

Each pump can be isolated using manually operated hand valves.

Local Manual Operation of Metering Pumps

When the VFD Local/Remote switch is in LOCAL position, the pump can be started locally with local speed control. When the switch is in REMOTE, the PLC control will take over. The operator will have to ensure that all manual valves on the system are properly set for manual and automatic controls.

LOCAL-Manual operation will be used only for testing. For safety reasons, this will not be the normal or preferred mode of operation.

Automatic Operation of Metering Pumps

When the VFD switch is in REMOTE, the drive will respond to RUN command and speed and stroke, if applicable, control signal(s) from the PLC. The operation of the metering pumps from the PLC and HMI will be based on control requirements defined above.

All motor/drive RUN times will be computed in the PLC and reported to the HMI.

All digital inputs will be connected to the PLC reported to the HMI.

All analog inputs connected to the PLC will be converted to engineering units and reported to the HMI.

Safety Interlocks/Alarms

A pump discharge HIGH pressure will shut down the associated feed pump and provide an alarm at the HMI. A tank level switch low low (LSLL) condition will shut down the

associated feed pump and provide a shutdown alarm to the PLC for control action and display on the HMI.

Safety Interlocks/Alarms

A pump discharge HIGH pressure will shut down the associated feed pump and provide an alarm at the HMI. A tank low level (LSLL) condition will shut down the associated feed pump and provide a shutdown alarm to the PLC for control action and display on the HMI.

10.8.1 Sodium Hypochlorite System (Drawings I-16, I-17)

This system will consist of an onsite sodium hypochlorite generation system. This system will be a complete package as shown on Drawing I-13. PLC-240, supplied as part of the package, will control and monitor the hypochlorite generation system. PLC-240 will communicate with the main plant PLC using a Data Highway Plus data link. The data exchange requirement between the main PLC and PLC-240 will be coordinated by the Contractor to satisfy the requirements of the manufacturer. The package system will generate sodium hypochlorite and store it in storage tank TK-61020 (Drawing I-16).

Hypochlorite Metering Pump Control – Hypochlorite addition for Fe/Mn raw water (Drawing I-2): Hypochlorite will be added to increase the chlorine residual level required by the filtration process. Pumps P-61050 and P-61160 will be controlled as described in Section 10.7.4.

Hypochlorite Metering Pump Control – Primary Disinfection (Drawing I-9) for Permeate, Pumps P-61110 and P-611120: The pre-carbonator feed will be a manual operation. All hand valves will be normally set for feed to pre-chlorine contact tanks.

Hypochlorite Metering Pump Control – Final metering (Drawing I-11): This feed point will be used as a measure to boost the chlorine level prior to going to distribution if necessary. Feed pumps P-61130 and P-61140 will be controlled as specified in Section 10.7.21.

When FLOW PACED mode is selected, the automatic flow paced addition of sodium hypochlorite solution will be provided to the chlorine injection point, based on the following relationship to calculate the required sodium hypochlorite feed pump rate S:

$$\text{Rate} = [\text{Flow} * \text{Dose} * (60) * (74.5/71)] / [1{,}000{,}000 * \text{Conc} * \text{SG}]$$

Where:

Rate	=	Target NaOCl pump metering rate (gph)
Flow	=	Finished Water Flow (gpm)
Dose	=	Sodium Hypochlorite Dosage Setpoint (mg/L)
Conc	=	Sodium Hypochlorite Solution Concentration (percent)
SG	=	Sodium Hypochlorite Solution Specific Gravity

The sodium hypochlorite solution concentration is approximately 0.8 percent; its specific gravity is approximately 1.03 (may vary slightly). The 74.5/71 is a conversion factor from NaOCl to CL2.

The pump speed can be calculated using the equation below:

Speed (percent) = 100 * (Rate / NaOCl Pump Capacity at Max. Speed in gph)

All the above parameters will be operator-adjustable on a setup display.

10.8.2 Sulfuric Acid Storage, Transfer and Metering System (Drawing I-18)

Sulfuric Acid Storage

Sulfuric acid will be stored in tank TK-64010 located in the chemical storage area. Acid will be brought in by truck and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-64010) will be provided near the tank. The operator will note the tank level on LIT-64010 before starting the tank-filling operation. While loading, the operator will watch the level indicator and stop loading before the high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low level condition will be locally alarmed and transmitted to the HMI. The HIGH or LOW alarm will consist of a beacon light; operation of the beacon can be locally reset using RESET buttons.

Sulfuric Acid Metering Pumps

There are two acid-metering pumps (P-64110 and P-64120). These pumps will be controlled as described in Section 10.7.10.

10.8.3 Aqueous Ammonia Storage and Feed System (Drawing I-19)

Aqueous ammonia will be stored in tank TK-62010 located in the chemical storage area. Aqueous ammonia will be brought in by truck and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-62010) will be provided near the tank. The operator will note the tank level on LI-62010 before starting the tank-filling operation. While loading, the operator will watch the level indicator and stop loading before high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low-level condition will be locally alarmed and transmitted to the HMI. The HIGH or LOW alarm will consist of a beacon light; operation of the beacon can be locally reset using RESET buttons.

Aqueous Ammonia Metering Pumps

There are two aqueous ammonia metering pumps (P-62110 and P-62120). These pumps will be controlled as described in Section 10.7.22.

Ammonia scrubber system: A package scrubber system will be provided with the ammonia system. A low water level in the scrubber will be alarmed at the HMI.

For aqueous ammonia (NH3) injection:

Rate = [Flow * Dose * Ratio * (60)] / [1,000,000 * Conc * SG]

Where:

Rate	=	Target NH3 pump metering rate (gph)
Flow	=	Finished Water Flow (gpm)
Dose	=	Sodium Hypochlorite Primary Disinfection Dosage Setpoint (mg/L)
Ratio	=	Ammonia to Chlorine Addition Weight Ratio
Conc	=	Aqueous Ammonia Solution Concentration (percent)
SG	=	Aqueous Ammonia Solution Specific Gravity

The aqueous ammonia solution concentration is approximately 19 percent, and its specific gravity is approximately 0.926. The ammonia to chlorine addition weight ratio is an operator-adjustable value; the value is typically 0.2 to 0.25 (equivalent to a range between 5-to-1 and 4-to-1).

The pump speed can be calculated using the following equation:

Speed (percent) = 100 * (Rate / NH3 Pump Capacity at Max. Speed in gph)

10.8.4 Sodium Hydroxide (NaOH) Storage Transfer and Metering System (Drawing I-20)

NaOH Storage System

The operation and monitoring of the NaOH storage system is similar to that described for acid storage. An NaOH loading panel (LCP-65010) will be provided for the monitoring of loading operation. Alarms and level for the tank will be indicated on the local panel and transmitted to the HMI via the PLC system.

RO Post-Treatment NaOH Metering Pumps

Two VFD-controlled metering pumps (P-65110 and P-65120) will be dedicated for feeding NaOH to the finished water clearwell.

RO Cleaning Transfer Pumps

The NaOH transfer pumps (P-65210 and P-65220) will be controlled manually from LCP-68110 as specified in Section 10.7.25. The operator will select the desired pump to run from HS-65200. The pump discharge will be measured by a flowmeter (FE/FIT-65201) for display and totalized at the panel. The operator will set the desired total flow of chemical to be added to the RO cleaning tank on the totalizer and start the pump. The pump will run until the desired totalized flow is loaded into the cleaning tank. A contact from the totalizer will stop the pump. The operator must manually reset the totalizer before starting the pump. The NaOH and citric acid pumps will be interlocked to prohibit operation of the other.

10.8.5 Threshold Inhibitor (TI) Storage and Metering System (Drawing I-21)

Threshold Inhibitor Storage

TI will be stored in tank TK-63010 located in the chemical storage area. TI will be brought in by truck and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-63010) will be provided near the tank. The operator will note the tank level on LIT-63010 before starting the tank-filling operation. While loading, the operator will watch the level indicator and stop loading before the high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low-level condition will locally be alarmed and transmitted to the HMI. The HIGH or LOW alarm will consist of a beacon light; operation of the beacon can be locally reset using RESET buttons.

RO Pretreatment TI Metering Pumps

Two VFD-controlled metering pumps (P-63110 and P-63120) will be dedicated for feeding TI to the cartridge filters. The operation of these pumps will be as described in Section 10.7.11.

10.8.6 Corrosion Inhibitor Storage and Metering System (Drawing I-22)

Corrosion inhibitor will be stored in tank TK-66010 located in the chemical storage area. Corrosion inhibitor will be brought in by truck and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-66010) will be provided near the tank. The operator will note the tank level on LIT-66010 before starting the tank-filling operation. While loading, the operator will watch the level indicator and stop loading before the high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low level condition will locally be alarmed and transmitted to the HMI. The HIGH or LOW alarm consists of a beacon light; operation of the beacon can be locally reset using RESET buttons.

RO Post-Treatment Corrosion Inhibitor Metering Pumps

Two VFD controlled metering pumps (P-66110 and P-66120) will be dedicated for feeding corrosion inhibitor to the clearwell.

10.8.7 10.8.7 Hydrofluosilicic Acid (F) Storage, Day Tank, and Metering System (Drawing I-23)

Hydrofluosilicic acid will be stored in tank TK-67010 located in the chemical storage area. The acid will be brought in trucks and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-67010) will be provided near the tank. The operator will note the tank level on LIT-67010 before starting the tank-filling operation. While loading, he will watch the level indicator, and stop loading before the high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low-level condition will locally be alarmed and transmitted to the HMI. The HIGH or LOW alarm will consist of a beacon light; operation of the beacon can be locally reset using RESET buttons.

The day tank will be used to hold the volume of acid to be utilized in 1 day. The tank will be provided with a sight gauge and level switches to monitor and control the daily filling of the tank. A transfer valve (FV-67100) and transfer pump (P-67020) will be used to transfer the acid to the day tank. The pump will be controlled from LCP-67020. In AUTO, the transfer valve and pump will be operated to fill the day tank to the HI HI level (LSH-67020). A HI HI level will be alarmed at the HMI. A LO LO level will be interlocked with the acid feed pump operation.

Two VFD-controlled metering pumps will be dedicated for feeding hydrofluosilicic acid to the facilities finished water header. The operation of these pumps will be as described in Section 10.7.23.

10.8.8 Citric Acid Storage and Transfer System (Drawing I-24)

Citric acid will be stored in tank TK-68010 located in the chemical storage area. Acid will be brought in by truck and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-68010) will be provided near the tank. The operator will note the tank level on LIT-68010 before starting the tank-filling operation. While loading, the operator will watch the level indicator, and stop loading before the high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low-level condition will locally be alarmed and transmitted to the HMI. The HIGH or LOW alarm will consist of a beacon light; operation of the beacon can be locally reset using RESET buttons.

The citric acid transfer pumps (P-68210 and P-68220) will be controlled manually from LCP-68110 as described in Section 10.7.25. The operator will select the desired pump to run from HS-68110. The pump discharge will be measured by a flowmeter (FE/FIT-68111) for display, and totalized at the panel. The operator will set the desired total flow of chemical to be added to the RO cleaning tank on the totalizer and starts the pump. The pump will run until the desired totalized flow has been loaded into the cleaning tank. A contact from the totalizer will stop the pump. The operator must manually reset the totalizer before starting the pump. The NaOH and citric acid pumps will be interlocked to prohibit operation of the other.

10.8.9 Sodium Bisulfate Storage, Transfer, and Metering System (Drawing I-25)

Sodium bisulfate will be stored in tank TK-69010 located in the chemical storage area. Sodium bisulfate will be brought in by truck and loaded in the storage tank. A 2-inch truck connection will be provided for connection to the tank.

A truck-loading panel (LCP-69010) will be provided near the tank. The operator will note the tank level on LIT-69010 before starting the tank-filling operation. While loading, the operator will watch the level indicator, and stop loading before the high level is reached.

A high-level condition will be alarmed on the panel and reported to the HMI. Similarly, a low-level condition will locally be alarmed and transmitted to the PLC for control action and display on the HMI. The HIGH or LOW alarm will consist of a beacon light; operation of the beacon can be locally reset using RESET buttons.

There are two metering pumps (P-69110 and P-69120). These pumps will be controlled as specified in Section 10.7.4.

SECTION 11

Electrical System

11.1 Introduction

This section outlines assumptions, open items, and electrical analysis (calculations) to be performed. It also establishes basic design criteria for the PDF II electrical system. Electrical system design will include the development of legends, one-line diagrams, plan drawings, panel and raceway schedules, cable diagrams, control diagrams, riser diagrams, details, and specifications.

The electrical system will be designed to safely operate equipment within PDF II as identified in this report and summarized below:

- Process mechanical (pumps, mixers, compressors, control valves, filters, process package systems, heat trace, tank heaters)
- Facility mechanical (heaters, ventilation fans, air conditioners, sump pumps, sample pumps)
- Facility appliances (water coolers, vending machines, ovens, dishwashers, hot water heaters including instant heaters)
- Life safety (fire detection and notification equipment)
- Receptacles (maintenance, convenience, dedicated)
- Lighting (interior, exterior, backup)
- Instrumentation and control (field panels, control stations, instruments, computers, network switches, and PLCs)
- Administration (computers, network switches, telephones, copiers, fax machines)
- Security (cameras, computer, video monitors, access devices communications)

11.1.1 Assumptions

- PDF II is a noncritical site and does not require the installation of an alternative and/or standby power generation system (i.e., solar power, diesel engine generator, portable diesel engine generator).
- No paging or access points for wireless telephone systems are required. Operator communications will be via cell phone or two-way radios.
- EMWD-approved manufacturers of 18-pulse VFDs include Toshiba and ABB.
- EMWD-approved manufacturers of power distribution equipment include Eaton (Cutler-Hammer), Schneider Electric (Square-D), or GE.
- EMWD-approved manufacturers of motor control equipment include Eaton (Cutler-Hammer), Schneider Electric (Square-D), Allen-Bradley (Rockwell), or GE.

- "Specs Intact" will correspond with the standard format required by USACE.
- Power circuits for process instrumentation will be individually protected by a fuse or breaker so that the isolation of power to one instrument does not impact the operation of another.
- Intrusion monitoring will not be required for outdoor panels. Outdoor panels will be specified to incorporate the necessary provisions supporting security locks.
- Raceway systems associated with containment areas will be located above maximum containment spill lines.

11.1.2 Open Items

The following open items required additional coordination between CH2M HILL, EMWD, SCE, and Butsko Utility Design, Inc., and must be resolved prior to commencement of final design to prevent project delays and changes to project scope:

- Electrical service entrance topology:
  - Single (1) utility pad-mounted transformer powering single-ended service entrance switchboard or,
  - Two (2) utility pad-mounted transformers powering double-ended service entrance switchboard
  - Primary or secondary metering
- Electrical service primary system ratings and parameters:
  - Electrical utility pad-mounted utility transformer kilovolt-ampere (kVA) rating and impedance.
  - Electrical utility primary and or secondary three-phase (L-L) and single-phase (L-G) available short circuit current (AIC) (i.e. utility contribution, available fault current or duty) – Limit.
  - Electrical utility primary X/R (if available) for three-phase and ground faults.
  - Electrical utility motor starting kVA inrush limitations (if any).

CH2M HILL contacted Mr. Barry Guimond and Carl Richards with Butsko Utility Design, Inc., to begin the process of coordinating electrical service requirements.

The following open items required additional coordination between CH2M HILL, EMWD, and EMWD-approved system integrators and must be resolved prior to commencement of final design to prevent project delays and changes to project scope:

- Electrical system requirements supporting the installation of an EMWD Business Development (Administration) network. EMWD is developing standards for their Business Development (Administration) network, which will incorporate VOIP, servers, network switches, and communications within PDF II and other EMWD facilities. Communications will be over a fiber-optic backbone and/or infrastructure. The routing of fiber-optic conduits to the property line and within the facility to support administration networking is to be coordinated with EMWD.

- Coordination of AT&T telephone requirements. Currently there are two (2) options: extend AT&T telephone lines and service from the existing reclamation plant to PDF II, or AT&T will provide telephone service at property line of PDF II.
- Coordination of security system requirements including contractual roles and responsibilities for installation and integration of the security system. CH2M HILL contacted Ms. Shari Jacobs/SCC (EMWD-approved security system integrator) to begin the process of coordinating security system requirements.
- Coordination of fire detection and notification system requirements. CH2M HILL contacted Mr. Dan Yax/TYCO (EMWD-approved fire alarm system supplier) to begin the process of coordinating fire alarm system requirements.
- Room Classifications: Coordinate with design team regarding environmental classification for each building and process area.

11.1.3 Electrical Analysis

The following electrical system analysis will be performed through the duration of the project design:

- Electrical demand and connected load.
- Short circuit.
- Voltage drop.
- Equipment, protective device, conductor, and raceway sizing.
- Preliminary protective circuit coordination and ArcFlash classifications for power distribution and motor control equipment.
- Preliminary harmonics study.
- Lighting illumination, power usage (wattage/square-foot) and control.

The electrical system analysis will be performed using SKM Power Tools for Windows (PTW 32). The lighting analysis will be performed using AGI32 Lighting Analysis Software.

11.2 Electrical Codes and Standards

The electrical system design will be based on the most recently published codes and standards in accordance with EMWD directives, as discussed between CH2M HILL and EMWD on February 4, 2008.

11.2.1 Codes

- 2008 National Electrical Code (NEC)
- 2003 Life Safety Code (NFPA 101 HB85)
- International Fire Code
- 2007 National Electrical Safety Code (IEEE- C2)

11.2.2 Standards

- American National Standards Association (ANSI)
- National Electrical Manufacturers Association (NEMA)
- Institute of Electrical and Electronics Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)
- California Occupational Safety and Health Administration (Cal-OSHA)
- American Society for Testing and Materials (ASTM)
- Underwriters Laboratories, Inc. (UL)
- National Fire Protection Association (NFPA)
- Illuminating Engineering Society (IES) Lighting Handbook and RP-7 Recommended Practice for Industrial Lighting
- NFPA 780, Standard for the Installation of Lightning Protection Systems

11.2.3 Design Guides

- SCE Electrical Service Requirements (ESRs)
- CH2M HILL Electrical Best Practices

11.2.4 Regulations

- California Title 24

11.3 Utility Power Service

SCE will provide utility power service to PDF II. Coordination with SCE will be primarily conducted by EMWD and Butsko Utility Design, Inc. CH2M HILL will provide continual updates on utility power service requirements to both EMWD and Butsko Utility Design, Inc., to facilitate this coordination.

Utility power service will incorporate the installation of primary medium voltage feeders, utility pad-mounted transformer, EMWD service entrance switchboard (SES), grounding, primary and secondary raceways, utility and EMWD metering, surge protection, and trenching in accordance with SCE Electrical Service Specifications.

SCE ESRs identify roles and responsibilities for trenching primary and secondary raceways, site preparation, grounding, and assembly of utility power service equipment.

SCE will install a 12-kV – 480Y/277-volt (V) three-phase outdoor pad-mounted transformer (kVA rating to be determined) to supply 480Y/277 three-phase, four-wire service to an outdoor NEMA 250 Type 3R rated SES.

The SES will be mounted inside an environmentally controlled enclosure supporting equipment longevity and operator maintenance. The SES will incorporate fixed mounted

service main and group mounted feeder breakers, utility metering, EMWD metering, transient voltage surge suppression, and a 3-ϕ power protection relay.

The service entrance switchboard will distribute 480V three-phase, three-wire power to central power distribution equipment inside the RO Building, Finished Water Pump Station, and Administration Building. Power distribution equipment will be monitored by the facility SCADA system. SCADA will communicate with Digital Power Meters - mounted inside power distribution and motor control equipment - over a Modbus Network. SCADA system will be programmed to monitor and display: 3-ϕ kW, 3-ϕ kVAR, 3-ϕ and 1-ϕ CURRENT, 3-ϕ and 1-ϕ VOLTAGE, and alarm conditions. SCADA system will also monitor alarm status from Transient Voltage Surge Suppression devices, and power monitoring relays: Note: In the event of a surge, phase loss, under-voltage, over-voltage, or phase-reversal condition, an alarm will be generated at the facility process control system.

11.3.1 Alternative Approach

SCE ESR-3 states that the largest single 480V/277V three-phase secondary electrical service SCE will provide to a customer is 4,000 amps.

Preliminary electrical estimates identify connected loads approaching the 4,000-amp limit. The ultimate connected load - so it appears - will exceed the 4,000 ampere limitation as set by SCE. In accordance with National Electrical Code, low voltage service equipment will be sized based upon continuous and non-continuous connected loads.

The ultimate operating demand load may be less than 3,000 amperes and based solely on the operating load, SCE may chose to install a single 2,500 kVA transformer. Still, there is the required service rating may mismatch what the utility may provide. An alternative approach would be to request SCE to provide two (2) secondary electrical services for the proposed PDF II, with utility secondary service conductors routing from two (2) pad mounted transformers to a double-ended service switch (SES).

Note: The installation of a single 4,000-amp service poses the following concerns:

- Fault currents in excess of 65,000 at power distribution equipment.
- Stringent arc flash requirements.
- Single point of failure.
- Non-coordination of low voltage service entrance breaker and utility low voltage service entrance conductors.

The installation of two (2) pad-mounted transformers powering two (2) SESs would mitigate these concerns by dividing the connected load. The two (2) SESs would incorporate kirk-key interlocked fixed main and tie breakers such that connected loads could be operated from either pad-mounted transformer.

11.4 Power Distribution Criteria

The power distribution system will incorporate switchboards, power, and lighting panel boards, and MCCs installed inside the RO Building, Finished Water Pump Station, and Administration Building.

Switchboard(s) and MCCs will operate as distribution centers within the RO Building, Finished Water Pump Station, and Administration Building and power the following facilities:

- RO building
- Administration Building
- Finished water pump station
- Concentrate pump station
- Chemical storage facility
- Fe/Mn removal facility

The power distribution system will incorporate materials and equipment manufactured within the scope of standards published by UL or standards established by a nationally recognized testing laboratory or other acceptable organization. A summary of the estimated power load is provided in Table 11-1. Table 11-2 provides the electrical system nominal voltages. Table 11-3 lists the electrical system utilization voltages.

TABLE 11-1
Load Summary

Description	kVA	Amps	pF
Estimated Connected Load (full load)	3,531	4,247	Near Unity
Estimated Future Load (25% allowance included above)	513	617	Near Unity
Estimated Demand Load (80% of operating)	2,259	2,717	Near Unity
Service Entrance Design		4,000	

TABLE 11-2
Electrical System Nominal Voltages

Equipment or System	Voltage Phases
Service Primary	12.47 kV, 3-ϕ, 4-wire
Secondary Power	480V, 3-ϕ, 3-wire
Secondary Lighting/Power	208 Y/120 V, 3-ϕ, 4-wire & 120/240 V, 1-ϕ
UPS Output Power	120 V/240 V, 1-ϕ, 3-wire

Note: UPS will not provide 120 V, 1-ϕ power to process equipment and field mounted instruments.

TABLE 11-3
Electrical System Utilization Voltages

Equipment or System	Voltage Phases
Interior Lighting	120 V, 1-ϕ
Exterior Lighting	120/240 V, 1-ϕ
Heat Trace	120 V, 1-ϕ
Convenience Outlet	120 V, 1-ϕ
Motor Control	120 V, 1-ϕ
HVAC Equipment	460 V, 3-ϕ
Motors, less than 0.5 horsepower	115 V, 1-ϕ
Motors, 0.5 horsepower and Larger	460 V, 3-ϕ
Instruments	120 V, 1-ϕ

Note: UPS will not provide 120 V, 1-ϕ power to field mounted instruments.

11.4.1 Protective Devices

Power distribution equipment will incorporate the following types of protective devices:

- Fully programmable solid-state insulated case breakers 2,000 amps and above.
- Fully programmable solid state molded case breakers 400 amps and above.
- Adjustable instantaneous trip molded case breakers less than 400 amps and more than 100 amps.
- Fixed trip molded case breakers for less than 100 amps.
- 100 percent rated for 800 amps and above.
- Current limiting breakers (if AIC is above 65,000).
- Transient voltage surge suppressor (TVSS) monitored by the facility SCADA system.
- Digital power monitoring interfacing with the facility SCADA system.
- Power monitoring relays: In the event of a phase loss, under-voltage, over-voltage, unbalance, or phase-reversal condition, the facility process control system will inhibit automatic operation of process equipment and alarm, notifying EMWD of fault condition.
- Current-limiting fuses will be required as part of VFD and reduced-voltage solid-state starter assemblies.

11.4.2 Ground Fault Protection

Power distribution equipment will incorporate the following types of ground fault protection:

- Ground fault zone interlocked protection will be provided on all transformer secondary and service entrance breakers rated 1,000 amps or more, all feeder breakers rated

400 amps or more that are downstream of a circuit breaker equipped with ground fault protection, and motor branch circuit breakers for motors 100 horsepower and more – except motors operated by VFDs that will integrate ground fault protection.

- Ground fault protection provided on motor circuits will be instantaneous tripping type.
- Ground fault circuit interrupter (GFCI) protection, 5-mA protective devices will be installed for all outdoor mounted receptacles and as required by NEC 2008 for receptacles located indoors. Protective devices will be installed for all heat trace circuits.
- GFCI protection, 5-mA protective devices will be installed for all outdoor mounted receptacles and as required by NEC 2008 for receptacles located indoors.

11.4.3 Available Short-Circuit Ratings

Electrical equipment will be coordinated and rated to handle short-circuit fault currents at various points within the power distribution system. Current limiting fusing, where required, will be installed to provide additional protection for electronic equipment including soft starters and VFDs.

11.4.4 Harmonic Distortion

Non-linear loads (VFDs, electronic ballasts, & UPS) within the power distribution system will incorporate harmonic mitigation equipment. All VFDS will incorporate line reactors. Additional active harmonic filtering will be recommended, based upon the completion of preliminary harmonic analysis during final design. Actual active harmonic filtering will be recommended, based upon the completion of harmonic analysis during facility commissioning.

11.4.5 Equipment Construction

Power distribution equipment will incorporate:

- Tinned copper main and ground bus.
- TVSS monitored by the facility SCADA system.
- Digital power monitoring interfacing with the facility SCADA system.
- Power monitoring relays: In the event of a phase loss, under-voltage, over-voltage, or phase-reversal condition, and alarm will be generated at the facility process control system.

Dry-type indoor-mounted transformers will incorporate:

- Copper wound windings.
- Temperature rating 115°C rise.
- 15-kVA and larger transformers will comply with California Title 20 and Title 24.

11.5 Motor Control Criteria

Motor control will incorporate VFDs, combination full-voltage nonreversing (FVNR), full-voltage reversing (FVR), two-speed and reduced-voltage solid-state (RVSS) starters, control stations, and safety switches to operate process and facility motors. Adjustable speed and constant speed applications are summarized in Table 11-4.

TABLE 11-4
Adjustable Speed and Constant Speed Applications

AS and/or CS Applications	Horsepower (hp) Rating
Adjustable-Speed Application (AS)	75 horsepower and greater 18-pulse VFDs
Adjustable-Speed Application (AS)	Less than 75 horsepower 6-pulse VFDs
Constant-Speed Application (CS)	50 horsepower and greater RVSS starters
Constant-Speed Application (CS)	Less than 50 horsepower Full voltage starters

11.5.1 Adjustable-Speed Motor Applications

VFDs will be comprised of solid-state electronics, line reactors, current-limiting fuses, electronic overloads, control power transformer, indicating lights, and control switches. Drives will be 18-pulse and 6-pulse, pulse-width modulated. VFDs will incorporate Ethernet communications drivers to support network interface with the SCADA system.

11.5.2 Constant-Speed Motor Applications

Full voltage (across-the-line) combination motor starter assemblies will be comprised of motor circuit protector, thermal overloads, NEMA size contactor, control power transformer, indicating lights, and control switches. FVNR starter assemblies will be hardwired to the SCADA system.

RVSS motor starters will be composed of solid-state electronics with 100 percent speed external ** NEMA bypass contactor(s), current-limiting fuses, thermal magnetic breakers, electronic overloads, control power transformer, indicating lights, and control switches. RVSS motor starters will incorporate Ethernet and or Modbus communications drivers to support network interface with the SCADA system. **RVSS with built-in bypass starters are not recommended, due to lack of operational redundancy in the event of an RVSS failure.

MCCs will incorporate:

- Tinned copper main and ground bus
- NEMA Type 2B with NEMA rated starters
- Thermal-magnetic breakers for mains and feeders, magnetic-only for motor starters
- Electronic overloads, Class 20
- FVNR and RVSS starters

11.5.3 Control and Monitoring

Typical motor control and monitoring will include LOCAL-OFF-REMOTE, ON, OFF, START and STOP and FAIL. With the motor control switch set to LOCAL, the operator will be able to operate the motor manually at the motor starter. With the motor control switch set to REMOTE, the operator may manually START and STOP the motor at the SCADA system and/or allow the PLC to automatically START and STOP motor operation.

Special motor control and monitoring will include POWER, SPEED, and FAULT.

Disconnect switches will be located as required per NEC Article 430 and Article 440 in proximity to the motor loads for HVAC units and roof-mounted units.

11.5.4 Alternating Current (AC) Induction Motors

- AC induction motors will be specified as energy and/or premium efficient for all locations meeting the requirements of California Title 24 and NEMA standards.
- AC induction motors operated by VFDs will be specified inverter duty rated.
- AC induction motors installed outdoors in direct sunlight will be 50°C rated.
- AC induction motors will be specified for environmental locations.
- AC induction motors located outdoors will be provided with space heaters.
- AC induction motors 10-horsepower and larger will be candidates for the installation of winding thermal protection.
- AC induction motors 250-horsepower and larger and VFD-operated will be candidates for bearing thermal protection.

11.6 Standby Power Distribution Criteria

Standby power distribution in the form of a fixed and/or portable diesel engine generator will not be provided for PDF II.

Specialty systems such as fire alarm and egress lighting will be provided with integrated battery chargers and backup capability.

11.7 UPS (Uninterruptible Power Supply) System Criteria

UPS systems will incorporate distribution panels, line-interactive UPS, external manual bypass switches, and extended batteries to distribute UPS power to SCADA, security, and administration 120V loads. A manual bypass will provide for the manual transfer of loads to non-UPS power in the event of a UPS failure.

UPS systems will be sized to provide 90 minutes of backup power at full operating load. The UPS will be specified to incorporate communications drivers to support Ethernet communications with the SCADA system.

One (1) UPS system will be designed for operation of SCADA, security, telephone, communications, and administration 120V loads inside the RO building and associated

process facilities. The RO-UPS system will operate PLC, HMI, SCADA, and administration network switches and critical instrumentation. The RO-UPS will **not** be designed to operate process equipment such as field mounted instrumentation, valves, motor, heaters, and fans.

One (1) UPS system will be designed for operation of SCADA, security, telephone, and administration 120V loads inside the administration building. The ADMIN-UPS system will operate the PLC, HMI, SCADA, and administration critical instrumentation.

A separate rack-mounted UPS will be provided for the rack-mounted administration server computer and associated equipment. Specifications for this rack-mounted UPS will be provided by EMWD to CH2M HILL.

UPS will not be designed to operate equipment such as valves, motor, heaters, and fans.

The fire alarm control panel (FACP) will not be powered by UPS. FACP(s) will be provided with their own backup system (panel-mounted chargers and batteries) to support 90 minutes of backup operation in the event of a power failure in accordance with NFPA 72 and local fire codes.

11.8 General Lighting, Fire/Life Safety Design Criteria

11.8.1 Fire Detection and Notification

Fire detection and notification system design will be based on the installation of a Simplex Grinnell system conforming to the requirements of the Fire Marshall, NFPA, and Factory Mutual, and coordination with the local supplier and integrator.

The fire detection and notification system within the RO and administration buildings will incorporate addressable heat detectors, smoke detectors, manual pull-stations, visual and audible alarms, and sprinkler flow and valve tamper switches networked together.

> Note: The use of smoke detectors as part of fire detection will be limited to the administration building and process chemical areas.

A Main-FACP will be located inside the administration building to concentrate detection devices and alarms within the administration building. Two (2) dedicated phone lines will be routed to the Main-FACP.

A Remote-FACP will be installed in the RO Building and the Finished Water Pump Station Building to concentrate detection devices and alarms within the RO building and adjacent facilities and the electrical room of the Finished Water Pump Station Building. These Remote-FACP(s) will be networked with the Main-FACP located inside the administration building.

Fire detection and notification devices will be addressable.

FACPs will be provided with their own backup system (panel-mounted chargers and batteries) to support 90 minutes of backup operation in the event of a power failure in accordance with NFPA 72 and local fire codes.

Contract drawings will incorporate a riser diagram and identify locations of major fire equipment. Fire detection and notification system design will be performance based on final design to be completed by a licensed fire system designer.

11.8.2 Exterior Lighting

Exterior lighting will be designed to enhance security and allow for safe movement at building entrances, along roadways, in parking areas, and along sidewalks. Exterior lighting will be designed to support maintenance, inspection, and operation in outdoor process facilities. Sections of exterior lighting will be photo-electrically and SCADA controlled. The SCADA system will function as a time-clock and allow operators to manually or automatically control sections of exterior lighting from both local and remote locations.

Exterior lighting will consist of the following:

- Wall- and pole-mounted luminaries with low pressure sodium lamps
- Wall and anodized poles mounted no higher than 15 feet

11.8.3 Interior Lighting

Interior lighting will be designed in accordance with California Title 24, and to support maintenance, inspection, and operation of indoor process, control room, and office areas. Interior lighting will incorporate low-level, low-glare metal halide and fluorescent fixtures. Lighting in offices and control rooms will incorporate dimmable fluorescent fixtures.

Interior lighting controls will include motion sensors, manual switches, dimming devices, and SCADA.

Interior lighting will consist of the following:

- Fluorescent or metal-halide fixtures will have high-efficiency lamps and electronic ballasts.
- Fluorescent lamps will be cool white, energy-efficient, rapid start, extended life with 3,100 initial lumens.
- Process and electrical room area fluorescent lighting will be enclosed and gasketed, suitable for wet locations.
- Non-process dry area fluorescent lighting will be suspended ceiling lay-ins, surface mount, and recessed spots.

Lighting design and lighting placement will take into account accessibility and maintenance, which is of concern to EMWD operational staff, especially for process areas.

Emergency/standby lighting (battery-pack wall-mounted units or luminaries powered by integral battery-powered ballasts) will be installed adjacent to all exterior building doorways, providing 90 minutes of backup lighting facilitating safe egress from building in the event of a power failure. Emergency and exiting lighting units will be provided to facilitate directional egress lighting.

11.9 Lightning Protection Design Criteria

Electrical system design will incorporate power distribution service equipment with low-voltage surge protection in the form of TVSS. TVSS will be monitored by the SCADA system.

Electrical system design will incorporate lightning protection in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

Outdoor mounted instrumentation and signal circuits will incorporate low-voltage surge protection in the form of metal oxide varistors.

11.10 Electrical Material and Methods Design Criteria

The electrical system will incorporate materials and equipment manufactured within the scope of standards published by UL, or standards established by a nationally recognized testing laboratory or other acceptable organization.

Electrical materials and equipment will be selected and approved for their continuous operation within industrial environments and environmental classifications including those listed in Table 11-5.

TABLE 11-5
Electrical Equipment Material Selection

Environmental Condition	NEMA Rating
Indoor Industrial Dry and Dusty	NEMA 12
Indoor Damp, Non-Wash Down and Noncorrosive	NEMA 4
Indoor Wash-Down and/or Corrosive	NEMA 4X (SST)
Outdoor Wet and Corrosive	NEMA 4X (SST)
Outdoor Wet (Noncorrosive)	NEMA 4X (SST)

Electrical materials and equipment will be de-rated as appropriate for their continuous operation within the environments listed in Table 11-6.

TABLE 11-6
Electrical Equipment and Material De-Rating

Environmental Condition	Temperature	Altitudes (feet)
Interior Air Conditioned	20°F to 85°F	1,420
Interior Ventilation	20°F to 90°F	1,420
Exterior	20°F to 113°F	1,420

Electrical materials and methods – equipment enclosures, raceways, conductors, and wiring devices - will be selected and approved for environmental conditions including temperature, wet, damp, dust, corrosive, and area of classification.

11.10.1 Raceway Systems

Separate raceway systems (conduits, cable trays, manhole/handholes) will be used to support the installation of the following systems:

- **Medium voltage (MV) Power**
  - 15-kV power distribution
- **Low voltage (LV) Power**
  - 480-V power wiring
  - 120-V power and control wiring
- **Process Signal and Communications**
  - 24-V direct current (DC) discrete and analog control wiring
  - Ethernet, ControlNet, Modbus, and fiber-optic cables
  - Telephone
  - Security
- **Specialty Communications**
  - Fire Alarm

Raceway criteria will be as follows

- Concrete encased duct bank for 15-kV and for all ductbanks under roads
- PVC conduit for all underground duct bank, with PVC-coated rigid galvanized aluminum (RGA) for underground elbows and risers
- PVC-coated RGA for exposed interior noncorrosive process areas
- RGA for exposed interior noncorrosive non-process areas
- PVC-coated RGA for exterior and corrosive areas
- Electrical metallic tubing for concealed lighting and receptacles within administration building
- Minimum conduit size 3/4-inch
- Cable tray in electrical and other clean, interior spaces supporting networking cabling
- Concrete trenches in floor of RO building electrical room extending into process area.
- Conduits associated with each panel inside the electrical room will come out to a floor trench in front of each panel, with permanent tagging and access to process areas, similar to what was installed within Perris Water Filtration Plant.
- In containment areas, conduits will be located at the top of containment walls and above containment lines.

- Concrete trenches supporting the installation of electrical service cables between pad-mounted transformer and service entrance switchboard(s)
- All raceways will be tagged in accordance with EMWD requirements.

11.10.2 Wire and Cable

- Copper with XHHW-2 and THWN-2 insulation for indoor and outdoor applications
- Number 12 American Wire Gauge (AWG) minimum for power, Number 14 AWG minimum for control
- Number 16 AWG minimum for signal

11.10.3 Fiber-Optic

The electrical system will incorporate empty 3-inch Schedule 40 PVC conduits routed between the administration building and fiber-optic manhole at the property line. Additional routing of fiber-optic within PDF II in support of administration networking still needs to be coordinated with EMWD. Empty 3-inch Schedule 40 PVC conduits will require the installation of inner-ducting at this time. Placement of inner-ducting will be determined as part of the fiber-optic design.

The electrical system will incorporate 3-inch Schedule 40 PVC conduits routed between the RO, Finished Water Pump Station, and Administration Buildings and facilities in support of the installation of SCADA fiber-optic cables.

Note: Part of the fiber-optic upgrade at PVRWRF Expansion 3 involves running 2-inch conduit from the PVRWRF operations building to a junction box located just east of the northern point of the triangle pond (demarcation point), and installing a 24-strand multi-mode fiber-optic cable. EMWD has requested that a 24-strand single-mode fiber-optic cable be routed from the PDF II to the PVRWRF operations building.

11.11 Communication Criteria

The electrical system will incorporate conductor, cables, raceway systems (conduits and trays) to support installation of the following communication systems:

- PLC ControlNet communications
- SCADA Ethernet communications
- Modbus communications with package system flow control valves
- Modbus communications with digital power metering
- VFD Ethernet communications
- RVSS Ethernet or Modbus communications
- UPS Ethernet communications
- Business production (administration network) Ethernet communications

- Security Ethernet communications
- Telephone Company – AT&T (TELCO)

Required telephone (TELCO) lines include:

- Two (2) dedicated lines for FACP – administration building
- One (1) fax line – administration building
- One (1) backup line – administration building
- Three (3) telephone lines for each SCADA client station – administration building
- Two (2) telephone lines for RO building and Fe/Mn package system - RO building
- One (1) security system – administration building
- Two (2) administration business production system

The electrical system will incorporate the routing of telephone conduits between the TELCO service point at the property line and telephone management equipment within the administration building. Telephone conduits will route between telephone management equipment and required locations within administration and RO buildings. The TELCO provider for PDF II will be AT&T.

Telephones and network data ports will be provided to support connection of network and telephone at computer workstations, network devices, printers, copiers, and office walls.

11.12 Submetering

Electronic digital power metering will be installed to monitor sub-feeders of building power distribution and major process loads. Electronic digital power metering equipment will interface with the SCADA system.

11.13 Security System

Card access entry, intercom, and closed-caption television surveillance will be provided at the entrance gates with a video monitor in the control room. Card access entry will be provided at building doors. Intrusion detection will be provided for all building exterior doors and easily accessible windows.

Security monitors will be installed inside the SCADA control room. Security hardware will be placed inside the dedicated IDF room. The IDF room will be an environmentally controlled room for network servers, switches, security hardware, VOIP equipment, fiber racks, UPS, etc. This will be a secured room requiring special security access.

The location of additional cameras, motion sensors, knox boxes, and access devices still needs to be coordinated.

11.14 Grounding Criteria

The electrical power distribution system will incorporate a grounding electrode system that integrates a ground ring embedded inside the building footers bonding together metal piping, foundation rebar, and metal framing of structures and power distribution equipment.

- Electrical service neutral and neutrals of derived sources will be bonded to grounding electrode systems.
- TVSS and surge protection devices will be bonded to grounding electrode systems.
- Grounding rings of magnetic flowmeters will bonded to grounding electrode systems.
- Non-current-carrying parts of all electrical equipment, devices, panel boards, and metallic raceways will be bonded to grounding electrode system.
- Non-current-carrying parts of all mechanical equipment, to which electrical components are attached and may potentially become energized, will be bonded to grounding system including building metal structures, handrails, platforms, and stairs.

All raceways will be provided with equipment grounding conductor.

Instrumentation shielded conductors will be bonded in one location – process loop power source - for each instrument.

SECTION 12

Specifications

Below is a list of specification sections that are expected to be delivered as part of the PDF II. CH2M HILL will use USACE front end and technical sections and will complement them as needed with other sections specific to the project. Note that the front end sections are not shown in the table below. All sections will be prepared in accordance with the most recent SpecsIntact format.

Division 01 - General Requirements (by USACE)
01 11 00 Summary of Work
01 20 00.00 20 Price and Payment Procedures
01 20 01.00 10 Cost and Performance Report
01 22 00.00 10 Measurement and Payment
01 30 00 Administrative Requirements
01 31 19.00 40 Project Meetings
01 32 01.00 10 Project Schedule
01 32 16.00 20 Construction Progress Documentation
01 33 00 Submittal Procedures
01 35 23.00 40 Owner Safety Requirements
01 35 29 Safety and Occupational Health Requirements
01 45 00.00 20 Construction Quality Control
01 45 00.00 40 Quality Control
01 45 02.00 10 Quality Control System (QCS)
01 45 04.00 10 Contractor Quality Control
01 45 35 Special Inspection for Seismic-Resisting Systems
01 57 23.00 10 Storm Water Pollution Prevention Measures
01 77 00.00 20 Closeout Procedures
01 78 00.00 40 Closeout Submittals
01 78 23 Operation and Maintenance Data
Division 02 - Existing Conditions (by USACE)
02 35 27 Soil-Bentonite (S-B) Slurry Trench
02 66 10 Test Fill
Division 03 – Concrete (by USACE)
03 11 13.00 10 Structural Concrete Formwork
03 11 14.00 10 Formwork for Concrete
03 15 13.00 10 Expansion Joints, Contraction Joints, and Waterstops
03 15 14.00 10 Expansion, Contraction and Construction Joints in Concrete for Civil Works
03 20 01.00 10 Concrete Reinforcement
03 20 02 Steel Bars and Welded Wire Fabric for Concrete Reinforcement for Civil Works

03 30 00.00 20 Cast-In-Place Concrete
03 30 53.00 40 Miscellaneous Cast-In-Place Concrete
03 45 33 Precast Structural Concrete
Division 04 - Masonry (by USACE)
04 20 00 Masonry
Division 05 - Metals (by USACE)
05 05 23 Welding, Structural
05 12 00 Structural Steel
05 21 19 Open Web Steel Joist Framing
05 21 23 Steel Joist Girder Framing
05 30 00 Steel Decks
05 50 00 Metal: Miscellaneous and Fabrications
05 50 03.00 10 Metalwork Fabrication, Machine Work, Miscellaneous Provisions
05 50 04.00 10 Metals: Miscellaneous, Standard Articles, Shop Fabricated Items for Civil Works Structures
Division 06 – Wood Plastics and Composites (by USACE)
06 10 00 Rough Carpentry
06 20 00 Finish Carpentry
06 41 16.00 10 Laminate Clad Architectural Casework
Division 07 - Thermal and Moisture Protection (by USACE)
07 19 00 Water Repellents
07 21 13 Board and Block Insulation
07 21 16 Mineral Fiber Blanket Insulation
07 22 00 Roof and Deck Insulation
07 21 23 Loose Fill Thermal Insulation
07 41 13 Metal Roof Panels
07 53 23 Ethylene-Propylene-Diene-Monomer roofing
07 62 00 Flashing and Sheet Metal
07 84 00 Firestopping
07 92 00 Joint Sealants
Division 08 - Openings (by USACE)
08 11 13 Steel doors and Frames
08 11 16 Aluminum Doors and Frames
08 14 00 Wood Doors
08 33 23 Overhead Coiling Doors
08 51 13 Aluminum Windows
08 62 00 Skylights
08 71 00 Door Hardware
08 81 00 Glazing
08 91 00 Metal Wall Louvers

Division 09 - Finishes (by USACE)
09 06 90 Color Schedule
09 22 00 Support for Plaster and Gypsum Board
09 29 00 Gypsum Board
09 30 00 Ceramic Tile, Quarry Tile and Paver Tile
09 51 00 Acoustical Ceilings
09 65 00 Resilient Flooring
09 68 00 Carpet
09 90 00.00 Painting and Coating
09 96 00 High-Performance coatings
Division 10 - Specialties (by USACE)
10 14 01 Exterior Signage
10 14 02 Interior Signage
10 21 13 Toilet Compartments
10 28 13 Toilet Accessories
10 44 16 Fire Extinguishers
10 51 13 Metal Lockers
Division 11 - Equipment (by USACE)
11 53 00 Laboratory Equipment and Fumehoods
Division 12 - Furnishings (by USACE)
12 21 00 Window Blinds
12 48 13.13 Entrance Floor Mats
12 50 00 Furniture Systems
12 93 00 Site Furnishings
Division 21 - Fire Suppression (by USACE)
21 13 00.00 40 Fire Suppression Sprinkler Systems
Division 22 - Plumbing (by USACE)
22 00 00 Plumbing, General Purpose
22 05 48.00 20 Mechanical Sound, Vibration, and Seismic Control
22 07 10.00 20 Exterior Piping Insulation
22 07 19.00 40 Plumbing Piping Insulation
22 10 00.00 10 Vertical Pumps, Axial-Flow and Mixed-Flow Impeller-Type
22 10 00.00 40 Plumbing Piping and Pumps
22 11 23.00 10 Submersible Pump, Axial-Flow and Mixed-Flow Type
22 14 29.00 40 Sump Pumps
22 42 00.00 40 Commercial Plumbing Fixtures
Division 23 - Heating, Ventilating, and Air Conditioning (by USACE)
23 00 00.00 40 Heating, Ventilating and Air-Conditioning
23 00 00 Air Supply, Distribution, Ventilation, and Exhaust System
23 03 00.00 20 Basic Mechanical Materials and Methods
23 05 00.00 40 Common Work Results for HVAC

23 05 48.00 40 Vibration and Seismic Controls for HVAC Piping and Equipment
23 05 93.00 40 Testing, Adjusting and Balancing for HVAC Systems
23 07 00 Thermal Insulation for Mechanical Systems
23 07 13.00 40 Duct Insulation
23 08 00.00 10 Commissioning of HVAC Systems
23 08 00.00 20 HVAC Testing/Adjusting/Balancing
23 09 33.00 40 Electric and Electronic Control System for HVAC
23 09 53.00 20 Space Temperature Control Systems
23 30 13.00 20 Ductwork and Ductwork Accessories
23 31 11.11 40 Ducts, Low Pressure
23 31 13.20 40 Welding Metal Ductwork
23 35 19.00 20 Industrial Ventilation and Exhaust
23 81 23.00 20 Computer Room Air Conditioning Units
Division 26 - Electrical (by USACE)
26 00 00.00 20 Basic Electrical Materials and Methods
26 05 00.00 40 Common Work Results for Electrical
26 05 13.00 40 Medium-Voltage Cables
26 05 19.00 10 Insulated Wire and Cable
26 05 48.00 10 Seismic Protection for Electrical Equipment
26 05 73.00 40 Overcurrent Protective Devices
26 08 00 Apparatus Inspection and Testing
26 09 13 Power Monitoring System
26 09 23.00 40 Lighting Control Devices
26 11 13.00 20 Primary Unit Substations
26 12 19.10 Three-Phase Pad-Mounted Transformers
26 18 23.00 40 Medium-Voltage Surge Arresters
26 20 00 Interior Distribution System
26 23 00 Switchboards and Switchgear
26 24 16.00 40 Panelboards
26 24 19.00 40 Motor-Control Centers
26 26 00.00 40 Power Distribution Units
26 27 26.00 40 Wiring Devices
26 28 16.00 40 Enclosed Switches and Circuit Breakers
26 29 23 Variable Frequency Drive Systems
26 32 33.00 10 Uninterruptible Power Supply (UPS) System
26 32 33.00 20 Installation of Uninterruptible Power Supply (UPS) System
26 41 00.00 20 Lightning Protection System
26 41 00.00 40 Facility Lightning Protection
26 41 01.00 10 Lightning Protection System
26 42 13.00 20 Cathodic Protection
26 43 00 Transient Voltage Suppression

26 51 00 Interior Lighting
26 51 13.09 40 Fluorescent Luminaires
26 52 00.00 40 Emergency Lighting
26 53 00.00 40 Exit Signs
26 56 00 Exterior Lighting
26 60 13 Low-Voltage Motors
Division 27 - Communication (by USACE)
27 05 28.36 40 Cable Trays for Communications Systems
27 10 00 Building Telecommunications Cabling System
27 15 19.00 10 Wire Line Data Transmission System
27 21 00.00 20 Intercommunication System
27 21 10.00 10 Fiber Optic Data Transmission System
27 31 00.00 20 Administrative Telephone Equipment, Inside Plant
Division 28 - Electronic Safety and Security (by USACE)
28 05 26.00 40 Grounding and Bonding for Electronic Safety and Security
28 31 02.00 20 Fire Alarm Reporting Systems - Digital Communicators
28 31 74.00 20 Interior Fire Detection and Alarm System
Division 31 - Earthwork (by USACE)
31 00 00 Earthwork
31 11 00 Clearing and Grubbing
31 23 00.00 20 Excavation and Fill
31 32 11 Soil Surface Erosion Control
31 60 00 Foundation Preparation
Division 32 - Exterior Improvements (by USACE)
32 10 00 Concrete Pavement
32 11 23 Aggregate and/or Graded-Crushed Aggregate Base Course
32 11 24 Graded Crushed Aggregate Base Course for Pavement
32 11 26 Bituminous Base Course
32 15 00 Aggregate Surface Course
32 16 13 Concrete Sidewalks and Curbs and Gutters
32 17 23.00 20 Pavement Markings
32 31 00.00 10 Fencing
32 31 13.00 20 Chain Link Fences and Gates
32 84 24 Irrigation Sprinkler Systems
32 92 19 Seeding
32 92 23 Sodding
32 92 26 Sprigging
32 93 00 Exterior Plants
Division 33 - Utilities (by USACE)
33 40 01 Storm Drainage
33 60 01 Valves, Piping, and Equipment in Valve Manholes

Division 40 - Process Integration (by USACE)
40 05 13 Pipelines, Liquid Process Piping
40 17 26.00 20 Welding Pressure Piping
40 18 00.00 40 Vacuum Systems Process Piping
40 41 13.13 40 Process Piping Electrical Resistance Heat Tracing
40 42 13.26 40 Process Piping Insulation for Specialty Applications
40 95 00 Process Control
40 95 33.23 20 Fiber Optic Outside Plant Media
40 95 33.23 40 Fiber Optic Process Control Networks
40 99 90 Package Control Systems
Division 43 - Process Gas and Liquid Handling, Purification and Storage Equipment (by USACE)
43 21 39 Pumps: Water, Vertical Turbine
43 32 69 Chemical Feed Systems
Other Technical Sections Specific to the Project (by CH2M HILL)
Reverse Osmosis (RO) Treatment System
Iron and Manganese Removal System
On Site Sodium Hypochlorite Generation System
Fabricated Slide Gates
Horizontal End Suction Centrifugal Pumps
Sampling Pumps
Decarbonator Tower System
Fiberglass Reinforced Plastic (FRP) Vessel
Packing Media and Appurtenances
Air Supply Blowers

SECTION 13

Cost Estimate

13.1 Purpose of Estimate

The purpose of this Engineer's Estimate for Construction Cost is to establish an Engineer's opinion of probable cost.

13.2 Overall Costs

The following is a summary breakdown of the costs. See attached breakdown in Appendix K, Exhibits K-1 and K-2 for additional detailed information.

	Estimate Range	
Low Range	**Expected**	**High Range**
-20%		+30%
$26,045,000	**$32,600,000**	$42,325,000

13.3 Markups

The following typical contractor markups were applied to the Demolition Cost Estimate only:

Contractor Overhead	10 percent
Profit	8 percent
Mobilization/Bond/Insurance	5.7 percent
Estimate Contingency	25 percent
Escalation Rate	11.14 percent
Market Adjustment Factor	10 percent

13.4 Escalation Rate

The current construction market escalation rate is approximately 7 percent per year. Allowing for a period of time after a decision is made to decommission the project, documents, permits, and contracts will need to be prepared prior to work starting. We have allowed a period of approximately 6-9 months to accomplish this work. Calculated to the mid point of construction this results in an additional 6 percent cost to the total project.

13.5 Market Conditions

The current market conditions are drastically impacting the construction market, across the country. This is based upon recent bids and comparisons with Engineer's Estimates. Bids are being received that are from 10 percent to 20 percent and even 30 percent higher than the current engineer's estimates.

Despite the estimator's best practices and adjustments, bids are being driven by current market conditions. Currently at CH2M HILL, the estimating policy is to evaluate the local market resulting in a 5 percent to 15 percent Market adjustment factor, or even higher in some regions of the county. Appendix K, Exhibit K-3 contains the evaluation criteria used to evaluate market conditions. The market adjustment factor is above and beyond the typical contractor mark-ups, normal estimating contingency and current but normal escalation factors (7 percent per year) listed above. The Market Adjustment Factor covers:

- Busy Contractors
- Contractors selectively bidding jobs
- Contractors selectively choosing which Owners they want to do jobs for
- Premium Wages to keep skilled workers and management staff
- Availability of crafts/trades
- Volatile raw material markets
- Labor availability and uncertainty.
- Abnormal fuel impacts and uncertainty – Oil = $120 barrel, Gas $4.00/gallon

13.6 Estimate Classification

This cost estimate prepared is considered a Class IV estimate as defined by the American Association of Cost Engineering (AACE). Refer to Appendix K, Exhibit K-4 for more definition.

The cost estimates shown have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final cost of the project will depend upon the actual labor and material costs, competitive market conditions, final project costs, implementation schedule and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding. Our estimate is based on material, equipment, and labor pricing as of May 2008.

13.7 Cost Resources

The following is a list of the various cost resources used in the development of the cost estimate.

- R.S. Means
- Richardson Process Plant Estimating Standards
- Mechanical Contractors Association - Labor Manual

- National Electrical Contractors Association - Labor Unit Manual (NECA)
- CH2M HILL Historical Data
- Vendor Quotes on Equipment and Materials where appropriate.
- Estimator Judgment

Labor unit prices reflect a burdened rate, including: workers compensation, unemployment taxes, Fringe Benefits, and medical insurance.

13.8 Estimate Methodology

This cost estimate is considered a "bottoms up" type estimate, with detailed cost items and breakdown of Labor, Materials and Equipment. The estimate may include allowance cost and dollars per SF cost for certain components of the estimate.

13.9 Labor Costs

The estimate is based upon Los Angles, California labor rates.

13.10 Sales Tax

This estimate has been assumed to be subject to California sales tax at a rate of 8.25 percent.

13.11 Allowance Costs

The cost estimate includes the following allowances within the cost estimate:

- Permits and fees
- Electrical allowances, totaling ~8.5 percent of the total amount estimated, based on estimator judgment:
  - Lighting ~$233,000.
  - Security ~$55,000.
  - Phone head end equipment ~$23,000.
  - Fire/life safety system ~$51,000.
  - Convenience receptacles ~$112,000.

13.12 Major Assumptions

The estimate is based on the assumption the work will be done on a competitive bid basis and the contractor will have a reasonable amount of time to complete the work. All contractors are equal, with a reasonable project schedule, no overtime, work performed as under a single contract, and no liquidated damages.

This estimate was prepared during May 2008. As with all estimates it represents a snapshot in time of what is known about the project and expected to occur. The commodities and energy markets are extremely active at this point in time. Changes in either will have

dramatic affects to this estimate. Therefore, this estimate should be viewed in that light and if more than 180 days have passed, or there have been significant changes in the commodity markets, this estimate should be updated and reevaluated.

- Contractor will not be required to perform work using the same means or methods used to produce this estimate.
- Contractor will be allowed to use the most appropriate, safest, and efficient methods available to them at the time of performing the work.
- Fire Protection is based on ft^2
- Assumed Admin building to be Light Hazard
- Assumed RO building to be Ordinary Hazard I
- Assumed diesel Fire Pump for RO building
- Ductwork is based on ft^2 and estimators best judgment
- All Piping lengths and sizes are based on ft^2 and estimators best judgment
- Assumed all exposed RO concentrate pipes to be 316 Stainless Steel pipes
- Assumed all exposed Cleaning Feed/Flushing pipes to be 316 Stainless Steel Pipes
- Concrete pad for Storage tanks were assumed to be 24 inches high
- Estimate includes $50,000 allowance for unclassified small bore piping
- Assume all chemical pipes in the Chemical Building, such as sodium hydroxide, Fluoride, Ammonia, Citric Acid, are be 1-1/2 inch 316 Stainless Steel Pipe.
- The Sodium Hypochlorite Generation System Package includes cost for I&C panels
- Iron/manganese Removal System Package includes cost for I&C panels
- Assumed all exposed ROP pipes in RO Building are CLDI pipe
- Assumed all exposed FWS pipes in RO Building are CLDI pipe
- Assumed all exposed FL pipes in RO Building are CLDI pipe
- Assumed RW pipes are CLDI pipe
- Costs for transfer pumps for Sodium Hydroxide, Citric Acid, and Fluoride systems are included.
- Assumed all chemical storage tanks are FRP tanks
- Instrumentation circuits assumed to be 100 feet average distance -
- 120V power to instruments assumed to be 100 feet average distance
- Fiber to Perris I assumed to be within 2000 feet and partially via existing duct

- Vendor supplied instrumentation assumed to be loose, requiring field mounting and field wiring.
- Tray and tray cable method for power in RO building.
- Telco supplied phone service cable and terms.
- All LCPs except those designated as PICS supplied to be supplied with driven equipment (Augustus confirmed).

13.13 Excluded Costs

The cost estimate excludes the following costs:

- Non-construction or soft costs for design, services during construction, land, legal and owner administration costs.

Appendix A
Well Water Blends

Appendix B
Technical Memorandum: Membrane Selection and Energy Recovery System Evaluation

Appendix C
City of Perris – Summary of Requested Improvements

Appendix D
City of Perris General Requirements and Design Calculations for the Infiltration Pond

Appendix E
Technical Memorandum – Geotechnical Exploration and Recommendations

Appendix F
Floodplain Requirements (CLOMR-F related documents)

Appendix G
Administration Building Code Analysis

Appendix H
Reverse Osmosis Building Code Analysis

Appendix I
Finished Water Pump Station Code Analysis

Appendix J
Laboratory Design Data

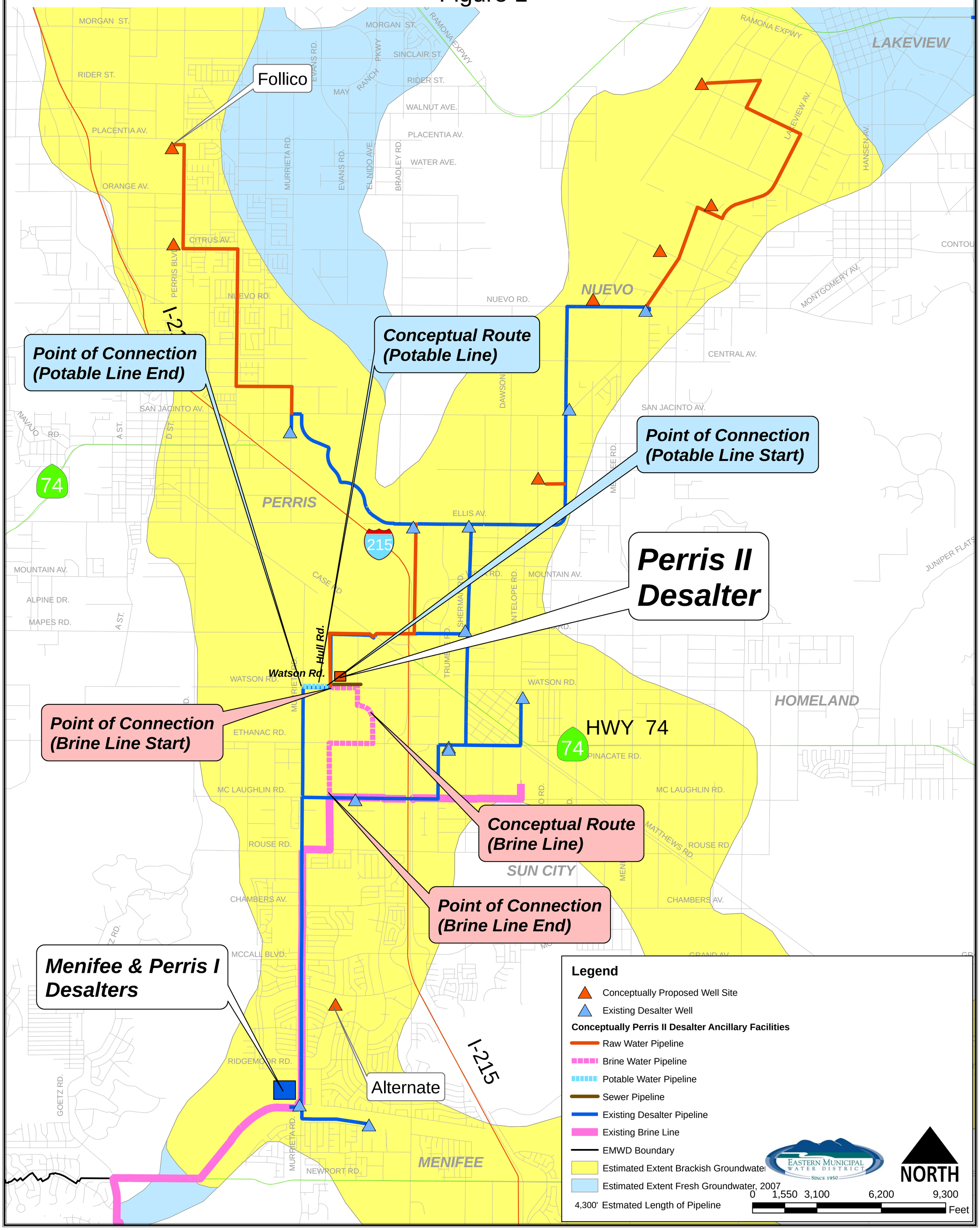
Appendix K
Cost Estimate

Appendix L
Technical Memorandum: Concentrate Pump Station Findings and Recommendations

Existing & Conceptually Proposed Facilities

Perris II Desalter Facilities

Figure 1



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Draft - Perris II Cost Illustration

December 28, 2009

	5.4 MGD Desalter (cumulative)						
Description	**Quantity**		**Unit**	**Unit Cost**		**Subtotal**	**Total Cost**
	Designed	**Planned**		**Designed**	**Planned**		
Desalter Feed Wells							$12,960,000
Drilling and Equipping	6		EA		$1,800,000	$10,800,000	
Engineering Support (10%)	1		LS		$1,080,000	$1,080,000	
Contingency (10%)	1		LS		$1,080,000	$1,080,000	
Offsite Water and Sewer							$601,200
18" Water line	1,800		LF		$170	$306,000	
10" Sewer line	1,300		LF		$150	$195,000	
Engineering Support (10%)	1		LS		$50,100	$50,100	
Contingency (10%)	1		LS		$50,100	$50,100	
Brine Pipeline							$2,550,000
18" Pipeline	12,500		LF		$170	$2,125,000	
Engineering Support (10%)	1		LS		$212,500	$212,500	
Contingency (10%)	1		LS		$212,500	$212,500	
Perris II Desalter Plant							$40,860,000
Design	1		EA		$5,700,000	$5,700,000	
Construction	1		EA		$29,300,000	$29,300,000	
Engineering Support (10%)	1		LS		$2,930,000	$2,930,000	
Contingency (10%)	1		LS		$2,930,000	$2,930,000	
Desalter Feed Pipelines							$19,638,282
Ph 1 24" PVC	11,647	16,630	LF	$205	$410	$9,205,935	
Ph 2 18" PVC	5,750	9,300	LF	$170	$360	$4,325,500	
Ph 2 12" PVC	5,415	9,100	LF	$120	$240	$2,833,800	
Engineering Support (10%)	1		LS		$1,636,524	$1,636,524	
Contingency (10%)	1		LS		$1,636,524	$1,636,524	
Desalter Feed Booster Station							$6,000,000
Construction	1		LS		$5,000,000	$5,000,000	
Engineering Support (10%)	1		LS		$500,000	$500,000	
Contingency (10%)	1		LS		$500,000	$500,000	
Subtotal						$82,609,482	
Brine Capacity Charges (2006-2007 basis)							$16,013,693
OC San District Capacity	1.93		MGD		$4,547,250	$8,776,193	
SARI Capacity	1.93		MGD		$3,750,000	$7,237,500	
Total							$98,623,175
Estimated Annual Production (AF)							6,048
Initial Estimated O&M Costs per AF							$644
Total Project Costs (No Grant Funding):							
Annualized Capital Cost							$6,415,579
Capital Cost per AF							$1,061
Total Cost per AF							$1,705

Notes:

1. Annualized capital costs based on 5% interest rate over 30 years.
2. Brine generation amounts supplied by Greg Kowalski, Dec. 21, 2009
3. OC Sanitation District capacity charge based on EMWD most recent purchases in 2007 ($3.75 Million per mgd)
4. SARI capacity charge based on EMWD most recent purchases in 2006 ($4,547,250 per MGD)
5 Federal funds cap at 25% of total project costs
6. Assumes Desalter runs at full capacity 365 days/yr
7. SRF rate based on 2.5% interest over 20 years
8. Planned pipeline costs assumed to be double designed cost.
9. Costs for 5.4 MGD desalter include 3.6 MGD desalter costs