Pure Water Monterey
A Groundwater Replenishment Project

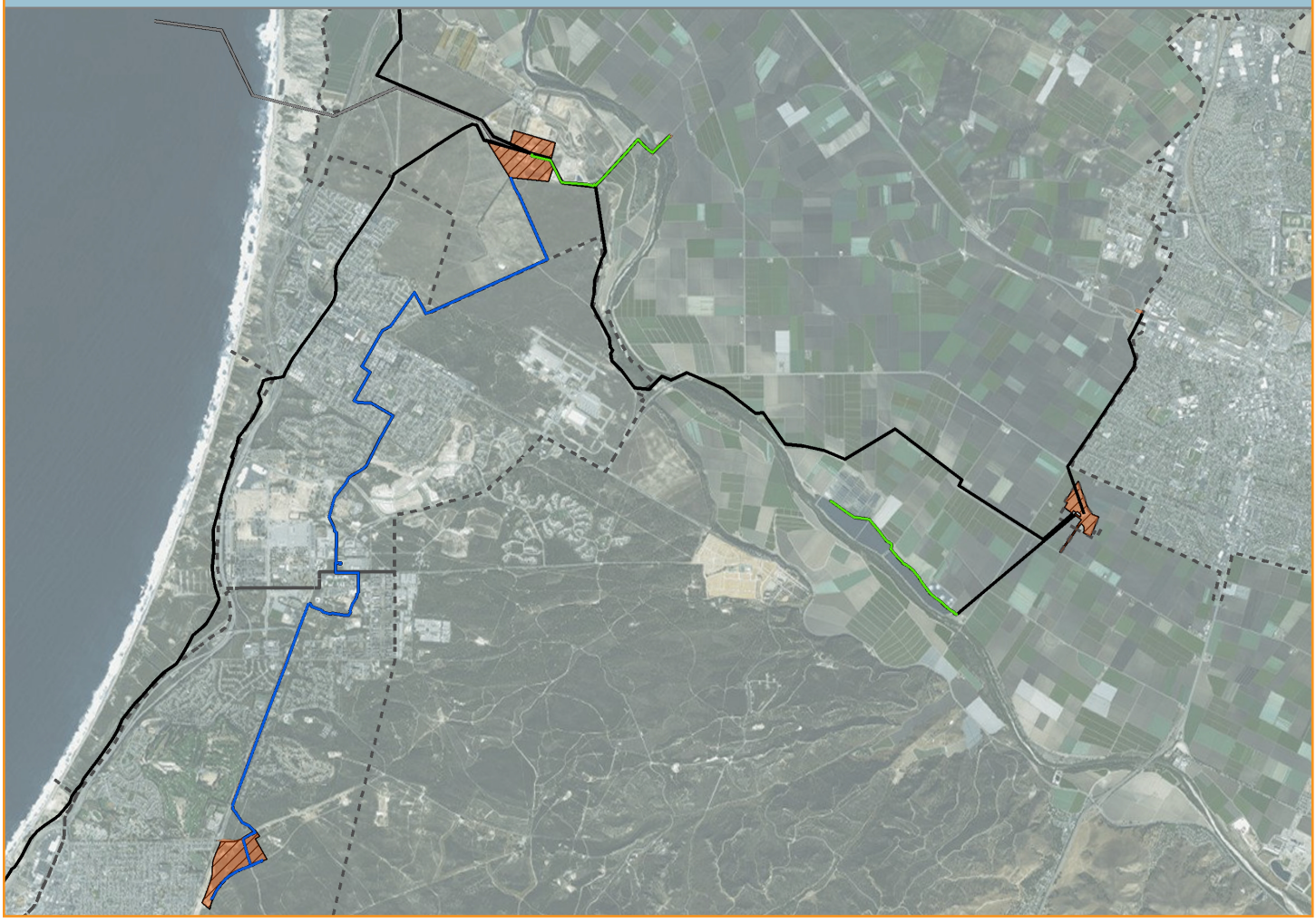
Partners for Pure Water Solutions
MRWPCA
Monterey Peninsula Water Management District

Revised Draft Engineering Report

Volume I: Engineering Report

Pure Water Monterey
Groundwater Replenishment Project

July 1, 2016



Nellor Environmental Associates, Inc.

Trussell Technologies Inc

TODD GROUNDWATER

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A Groundwater Replenishment Project

REVISED DRAFT ENGINEERING REPORT

VOLUME I: ENGINEERING REPORT

MRWPCA PURE WATER MONTEREY GROUNDWATER REPLENISHMENT PROJECT

July 1, 2016

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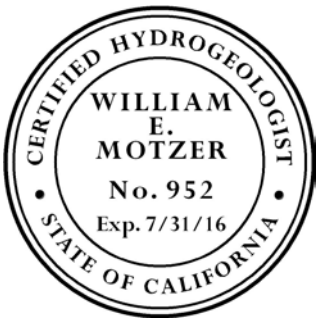


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APPENDIX C: Pure Water Monterey Groundwater Replenishment Project: Advanced Water Treatment Facility Piloting Report

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APPENDIX H: MRWPCA Advanced Water Treatment Demonstration Facility Operational Water Quality Parameters and Checklists

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APPENDIX J: White Paper: Potable Reuse Operator Training and Certification Framework

Acronyms

A	Ampere
AAL	Archived Advisory Level
AF	Acre-feet
AFY	Acre-feet per year
AGR	Agricultural water supply
AOC	Assimilable organic carbon
AOP	Advanced oxidation process
ASR	Aquifer Storage and Recovery
ASTM	American Society for Testing and Materials International
ATS	Automatic Transfer Switch
AWT	Advanced Water Treatment
BAF	Biologically activated filtration
BDP	Brine Differentiation Plots
bgs	Below ground surface
HCO_3^-	Bicarbonate ion
BOD_5	Biochemical oxygen demand – five day
BPA	Bisphenol A
BPS	Booster pump station
BPTC	Best Practicable Treatment or Control
°C	Degrees Centigrade
$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate
CalAm	California American Water Company
$Ca(OH)_2$	Hydrated lime
$CBOD_5$	Carbonaceous biochemical oxygen demand – five day
CFR	Code of Federal Regulations
CIP	Clean in place
CCLEAN	Central Coast Long-term Environmental Assessment Network
CCPP	Calcium Carbonate Precipitation Potential
CCR	California Code of Regulations
C_e	Treated water concentration
CECs	Constituents of emerging concern
CEPT	Chemically Enhanced Primary Treatment
CEQA	California Environmental Quality Act
cfm	Cubic feet per minute
CHG	Certified Hydrogeologist
C_i	Feed concentration

CIU	Categorical Industrial User
CO_2	Carbon dioxide
CSIP	Castroville Seawater Intrusion Project
CT	Concentration multiplied by the contact time
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
d	Day
DBPs	Disinfection by-products
DDW	State Water Resources Control Board Division of Drinking Water
DEET	N,N-diethyl-meta-toluamide
DFA	Division of Financial Assistance
2,6-DNT	Dinitrotoluene
DO_3	Dissolved ozone
DOC	Dissolved organic carbon
DWR	California Department of Water Resources
EC	Electrical conductivity
EDB	1,2-Dibromoethane
EED	Electrical energy dose
EE/O	Electrical energy per log order reduction
EFM	Enhanced flux maintenance
EIR	Environmental Impact Report
ELAP	Environmental Laboratory Accreditation Program
EPDM	Ethylene Propylene diene rubber
EQ	Equalization
ESCA	Environmental Services Cooperative Agreement
FDA	Food and Drug Administration
fps	Feet per second
FORA	Fort Ord Reuse Authority
FRP	Fiberglass reinforced plastic
FTAE	FactoryTalk Alarm and Event
ft/day	Feet per day
ft^2/day	Square feet per day
gpd/ft^2	Gallons per day per square foot
G:L	Gas to liquid ratio
gpd	Gallons per day
gph	Gallons per hour
gpm	Gallons per minute
GRRP	Groundwater Replenishment Reuse Project
GSE	Ground surface elevation

GWRS	Groundwater Replenishment System
H_2O_2	Hydrogen peroxide
HAA5	Haloacetic acids (five): monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid
HDPE	High density polyethylene
HMI	Human-machine Interface
HMX	cyclotetramethylene tetranitramine
hp	Horsepower
HRT	Hydraulic residence time
IAP	Independent Advisory Panel
I/O	Input and output
IU	Industrial user
IWTF	Industrial Waste Treatment Facility (source waters to this facility are generally referred to as agricultural wash water)
K or K_h	Horizontal hydraulic conductivity
kDa	kilodaltons
kV	Kilovolt
kW	Kilowatts
kWh/kgal	Kilowatt-hours per thousand gallons
lbs/day	Pounds per day
lb/gal	Pounds per gallon
lb/hr	Pounds per hour
LC-MS-MS	Liquid Chromatography Tandem Mass Spectrometry
LOX	Liquid oxygen
LPUV	Low pressure, high intensity UV
LSI	Langelier Saturation Index
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
LRV	Log reduction value
L:W	Length to width ratio
MCC	Motor control center
MCL	Maximum Contaminant Level
MCWRA	Monterey County Water Resources Agency
MEC	Measured Environmental Concentration
meq/L	milliequivalents per liter
mV	millivolts
MF	Membrane filtration
MFI	Modified Fouling Index
MFL	Million fibers per liter
MF/UF	Microfiltration/Ultrafiltration

mgd	Million gallons per day
mg/L	Milligrams per liter
MPA	Masters of Public Administration
MPN	Most probable number
MPUV	Medium pressure, high intensity UV
MPWMD	Monterey Peninsula Water Management District
MRL	Method Reporting Level
MRP	Monitoring and reporting program
MRWPCA	Monterey Regional Water Pollution Control Agency
msl	Mean sea level
MTL	Monitoring Trigger Level
MUN	Municipal and domestic supply
mV	Millivolts
N	Nitrogen
N/A	Not applicable
NaCl	Sodium chloride
NAE	National Academy of Engineering
NaOCl	Sodium hypochlorite
NaOH	Sodium hydroxide
ND	Not detected above MRL
NDMA	N-nitrosodimethylamine
NEPA	National Environmental Policy Act
ng/L	Nanograms per liter
NH_3	Ammonia
NL	Notification Level
nm	Namometers
NO_3	Nitrate
NOM	Natural organic matter
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric turbidity units
NWRI	National Water Research Institute
O	Oxygen
O_3:TOC	Ozone to Total Organic Carbon Ratio
OCWD	Orange County Water District
OEM	Original Equipment Manufacturers
O&M	Operation and maintenance
OOP	Operation Optimization Plan
ORP	Oxidation-reduction potential
OSS	Ozone system supplier

P	Phosphorus
P_L	Total lamp power
PCBs	Polychlorinated Biphenyls
PCI	Pretreatment Compliance Inspection
pCi/L	Picocuries per liter
PDT	Pressure decay test
P.E.	Professional Engineer
P.G.	Professional Geologist
PG&E	Pacific Gas and Electric Company
Ph.D.	Doctor of Philosophy
PLC	Programmable Logic Controller
PM	Preventative maintenance
PoLi	Pesticides of local interest
ppm	Parts per million
PRT	Pathogen Retention Time
psi	Pounds per square inch
psid	Pounds per square inch – differential
psig	Pounds per square inch gage
PSU	Power supply unit
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
PVDF	Polyvinylidene difluoride
PWPS	AWT Product Water Pump Station
Q	Flowrate
QA/QC	Quality assurance/quality control
REHS	Registered Environmental Health Specialist
RDX	Cyclotrimethylene trinitramine cyclonite
RF	Reverse filtration
RF/AS	Reverse filtration/air scrubbing
RMA	Running monthly average
RO	Reverse osmosis
rpm	Revolutions per minute
RRT	Response Retention Time
RTP	Regional Treatment Plant
RUWAP	Regional Urban Water Augmentation Project
RWC	Recycled Municipal Wastewater Contribution
RWQCB	Regional Water Quality Control Board
S	Storativity
SAR	Sodium Adsorption Ratio

SCADA	Supervisory control and data acquisition
scfm	Standard cubic feet per minute
scfh	Standard cubic feet per hour
SIU	Significant Industrial User
SM	Standard Methods for the Examination of Water and Wastewater
SNMP	Salt/Nutrient Management Plan
SOPs	Standard operating procedures
SRF	State Revolving Fund
SS	Stainless steel
SVRP	Salinas Valley Reclamation Project
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
T	Transmissivity
t_{10}	Time for 10% of the input concentration to be observed at the outlet of the system
TBD	To be determined
TDS	Total dissolved solids
TEFC	Totally enclosed fan-cooled
TIPS	Thermally induced phase separation
T&O	Taste and odor
TOC	Total organic carbon
TMF	Technical Managerial and Financial Assessment
TNT	2,4,5-trinitrotoluene
TSS	Total suspended solids
UCMR	Unregulated Contaminant Monitoring Rule
µg/L	microgram per liter
UIC	Underground Injection Control
µmohs/cm	Micromohs per centimeter equivalent to µS/cm
µS/cm	Microsiemens per centimeter
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet light
UV/H_2O_2	Ultraviolet light with hydrogen peroxide
UVI	Ulatrviolet light intensity
UVT	Ultraviolet light transmittance
VAC	Volts alternating current
VOC	Volatile organic chemicals (SVOC are semi- VOCs)
WDRs/WRRs	Waste Discharge Requirements/Water Reclamation Requirements
WQ	Water quality
WY	Water Year

1. PROJECT OVERVIEW

1.1. BACKGROUND

The Pure Water Monterey Groundwater Replenishment Project (Project) is a water supply project that will serve northern Monterey County, California. It will provide: (1) purified recycled water (product water) for replenishment of the Seaside Groundwater Basin (Seaside Basin) that serves as drinking water supply; and (2) recycled water to augment the existing Castroville Seawater Intrusion Project's (CSIP's) agricultural irrigation supply. The planned date for Project startup is late 2017/early 2018.

- **Replenishment of the Seaside Basin**. The Project will enable the California American Water Company (CalAm) to reduce its diversions from the Carmel River system by up to 3,500 acre-feet per year (AFY) by injecting the same amount of product water into the Seaside Basin. The product water will be produced at a new Advanced Water Treatment (AWT) Facility at the Monterey Regional Water Pollution Control Agency's (MRWPCA's) Regional Wastewater Treatment Plant (RTP) and will be conveyed to and injected into the Seaside Basin via a new pipeline and new well facilities. The injected water will then mix with the existing groundwater and be stored for future urban use (including use as a potable source of supply) by CalAm.

- **Additional recycled water for agricultural irrigation in northern Salinas Valley**. An existing tertiary recycled water facility at the RTP that is part of the Salinas Valley Reclamation Project (SVRP) will be provided additional source waters (treated first at the RTP) in order to provide supplementary tertiary recycled water for use in the CSIP agricultural irrigation system.[1] It is anticipated that in normal and wet years approximately 4,500 to 4,750 AFY of additional recycled water supply could be created for agricultural irrigation purposes. In drought conditions, the Project could provide up to 5,900 AFY for crop irrigation.

The Project will also include a drought reserve component to support greater use of the new supply for crop irrigation during dry years. The Project will provide an additional 200 AFY of product water that will be injected in the Seaside Basin in wet and normal years for up to five consecutive years. This will result in a "banked" drought reserve totaling up to 1,000 acre-feet (AF). During dry years, the Project will provide less than 3,500 AF of water to the Seaside Basin; however, CalAm will be able to extract the banked water to make up the difference to its supplies, such that its extractions and deliveries will not fall below 3,500 AFY. The source waters that are not sent to the AWT Facility during these dry years when water from the drought bank is being used by CalAm will be sent to the SVRP to increase supplies for CSIP.

The Project components include: conveyance of three potential types of source waters to the RTP for treatment; the new AWT Facility and other improvements to the RTP; a treated water conveyance

[1] The permitted design flow of the SVRP is 29.6 mgd (approximately 33,000 AFY), which can accommodate the supplementary flow for treatment. The tertiary recycled water is provided to 12,000 acres of farmland in the Salinas Valley primarily during the growing season (typically April through November). This project is subject to (1) Water Recycling Requirements issued to MRWPCA (Order 94-82) and (2) Recycled Water User Requirements (Order No. 97-52) issued to Monterey County Water Resources Agency by the Central Coast Regional Water Quality Control Board.

system, including pipelines and pump station; groundwater injection and monitoring wells; and potable water distribution system improvements. Construction of the Project is anticipated to require approximately 18 months, plus at least three months of testing and start-up.

The new source waters that will supplement the existing incoming wastewater flows are the following: (1) water from the City of Salinas industrial waste water system which is mostly referred to as the agricultural wash water system, (2) storm water flows from the southern part of Salinas, (3) surface water and agricultural tile drain water that is captured in the Reclamation Ditch, and (4) surface water and agricultural tile drain water that flows in the Blanco Drain. Most of these new source waters will be combined within the existing wastewater collection system before arriving at the RTP; water from Blanco Drain will be conveyed directly to the RTP. As part of the California Environmental Quality Act (CEQA) adopted Environmental Impact Report (EIR) for the Project, the assessment included these new sources as well as agricultural drainage water from Tembladero Slough and storm water diversions from the Lake El Estero facility in Monterey. Currently, grant/loan financing, design, engineering or permitting are not being pursued for Tembladero Slough, but may be reconsidered in the future. The Lake El Estero source is not planned for diversion for the Project, but may be reassessed in the future.

The Project will require modifications to existing facilities and construction of new physical facilities, briefly listed below.

- **Source water diversion and storage**. New facilities will be required to divert and convey the new source waters into and through the existing municipal wastewater collection system to the RTP.

- **Treatment facilities at the RTP**. A new AWT Facility will be constructed at the RTP site. This facility will include a full advanced treatment system that meets the requirements in Title 22. California Code of Regulations (CCR), Division 4. Environmental Health, Chapter 3. Water Recycling Criteria, Article 5.2. Indirect Potable Reuse: Groundwater Replenishment – Subsurface Application, amendments to Article 1 definitions, and amendments to Article 7 – Engineering Report and Operational Requirements. The terms “Title 22” or “Title 22 Criteria,” as used in this report, refer to the State Water Resources Control Board Division of Drinking Water (DDW) Water Recycling Criteria. The AWT Facility will consist of ozone pre-treatment, low-pressure membrane filtration, reverse osmosis treatment, advanced oxidation, and product water stabilization. There will also be modifications to the existing SVRP to optimize and enhance the delivery of recycled water to growers.

- **Product water conveyance**. A new pipeline, pump station and appurtenant facilities will be constructed to transport the product water from the RTP to the Seaside Groundwater Basin for injection.

- **Injection well facilities**. The injection facilities will include new injection and monitoring wells (in the shallow and deep aquifers), back-flush facilities, pipelines, electricity/power distribution facilities, and electrical/motor control buildings.

- **Distribution of groundwater from Seaside Basin**. CalAm water distribution system improvements will be needed to deliver the full yield of extracted groundwater to CalAm customers.

This Engineering Report addresses the replenishment of the Seaside Basin by injection of product water from the AWT Facility. A regional map showing the location of all project components is presented as **Figure 1.1**.[2]

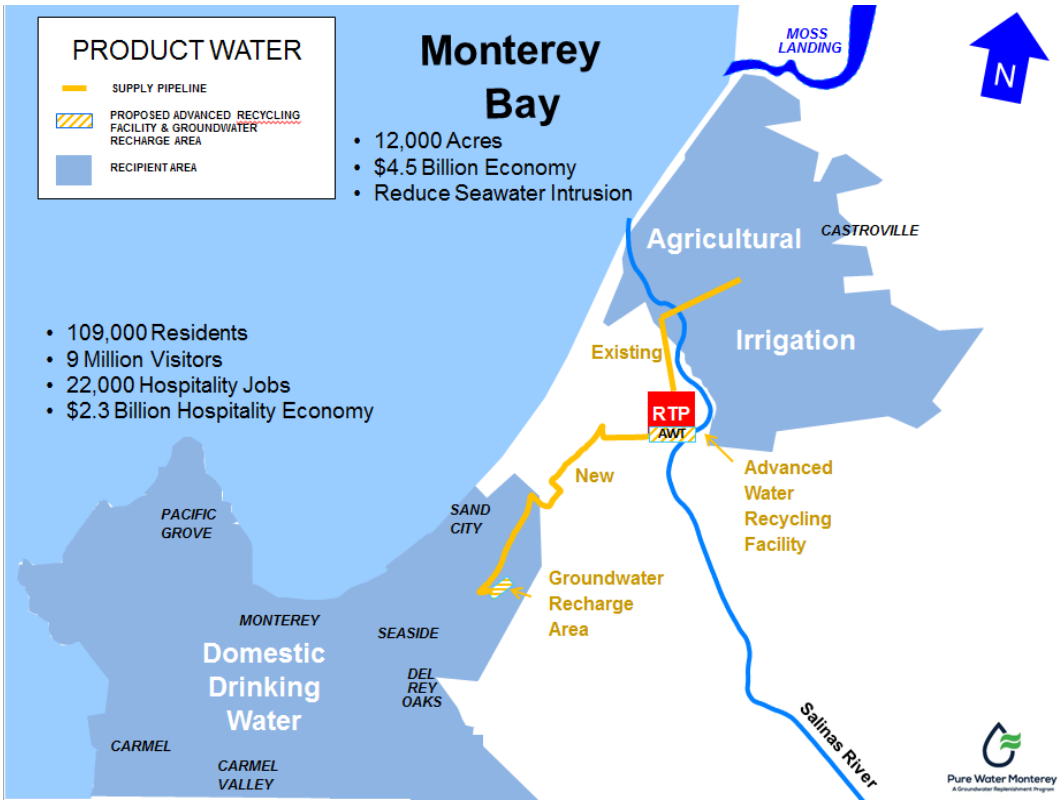


Figure 1-1. Project Facilities Overview

1.2. PUBLIC OUTREACH AND COORDINATION

MRWPCA's community outreach activities include updates to its website to provide information on facility tours and classroom presentations; new outreach materials on the RTP; materials regarding pharmacies offering drug take-back programs; participation/exhibits in community events; school outreach (presentations, materials, teacher curriculum training and workshops); RTP tours; commercials and advertising for controlling fats, oil and grease; and participation in the Monterey County Oil Recycling Program.

[2] This Engineering Report does not address Regional Water Quality Control Board Order No. 94-82, Water Reclamation Requirements for MRWPCA for use of recycled water for irrigation. Order No. 94-82 includes reclamation specifications for the amount of recycled water use (average daily flow over each month not to exceed 29.6 million gallons. *See* Reclamation Specifications B.1). The supplemental tertiary recycled water intended for irrigation as part of the Project does not exceed this requirement. Additional information on any potential changes in tertiary recycled water quality as a result of the source waters was provided in the EIR and is also addressed in this report in terms of secondary effluent quality.

As part of outreach for the Project, since 2008, MRWPCA staff has escorted interested members of the local community to visit the Orange County Water District's (OCWD's) Groundwater Replenishment System (GWRS). The tours introduced community leaders to a concept of replenishing the local aquifers with purified water.

Since 2013, MRWPCA has taken steps to implement a similar program. A small pilot AWT plant was installed in the fall of 2013 at the RTP to collect data on the quality of product water and information for design of the full-scale AWT Facility. In the fall of 2015, MRWPCA completed the installation of an AWT Demonstration Facility. This new permanent facility features all of the treatment technologies that will be included in the full-scale AWT Facility. It has been set up to facilitate tours and allow visitors to taste the product water. Tours of the facility began in August 2015 have been completed, and more visitors are expected to visit this facility in the near future.

As part of the CEQA public participation process for the adopted EIR for the Project, the following activities took place:

- Notices regarding the April 2015 Draft EIR were emailed to 700 agencies, interested organizations, and individuals; placed as newspaper advertisements; distributed to State agencies through the State Clearinghouse; placed in public locations such as libraries, MRWPCA's and Monterey Peninsula Water Management District's (MPWMD's) websites and offices, and key project sites; and posted with the Monterey County Clerk.
- Public meetings to provide information on the Project and CEQA process were held on May 20 and 21, 2015.
- The public was provided a 45-day comment period for the Draft EIR.
- Notices about the availability of the Final EIR were distributed in September 2015 to all entities that received the Draft EIR and,
- The Final EIR was certified and the Project was approved at a public hearing held on October 8, 2015.

1.3. INDEPENDENT ADVISORY PANEL

MRWPCA has contracted with the National Water Research Institute (NWRI) to form and coordinate the activities of an Independent Advisory Panel (IAP) to provide expert peer review of the technical, scientific, regulatory, policy, and outreach aspects of the Project.

The IAP is comprised of four experts in disciplines relevant to groundwater replenishment projects: engineering, regulatory criteria, public health, hydrogeology, risk assessment, and other relevant fields. The IAP members are:

- George Tchobanoglous, Ph.D., P.E., NAE; University of California, Davis (Davis, California).[3]
- Jean-François Debroux, Ph.D., Kennedy/Jenks Consultants (San Francisco, California).
- Martin B. Feeney, P.G. CHG, Consulting Hydrogeologist (Santa Barbara, California).[4]
- Michael P. Wehner, MPA, REHS, OCWD (Fountain Valley, California).[5]

[3] Ph.D. – Doctor of Philosophy, P.E. – Professional Engineer, NAE – National Academy of Engineering.
[4] P.G. – Professional Geologist, CHG – Certified Hydrogeologist.

For the first 16-month contract with NWRI, the IAP was tasked with providing specific input on:

- The proposed treatment technologies and operations, including the design and testing protocol for the pilot system.
- Review of the performance and operations of the pilot system.
- Review of water quality data from the pilot system.
- Feedback on the anticipated water quality of the full-scale AWT Facility based on pilot system results.
- Feedback on hydrodynamics, hydrology, and the fate and transport of constituents in the product water after subsurface application.
- Feedback on protection of public health and groundwater quality.
- Feedback on project planning, permitting, and public outreach.

The IAP held two meetings (October 2013 and May 2014) and provided two reports on their findings and recommendations (see **Appendix A**). Topics reviewed included source water characterization; the preliminary results of the pilot testing; information on groundwater quality, groundwater modeling, and the vadose zone leaching analysis; public outreach; water rights; and source control.

1.3.1. Concept Proposal

The IAP also reviewed and provided input on the conceptual project proposal submitted to DDW. In May 2014, MRWPCA submitted a proposal, which was first reviewed by the IAP. IAP comments were included in the concept proposal that was submitted to DDW. On June 5, 2014, DDW submitted a letter to MRWPCA that conditionally approved the Project proposal, subject to the following future submittal requirements:

- The Engineering Report, final design and Contingency Plan.
- The Operations Optimization Plan.
- The Response Plan.
- The Water Quality Monitoring Plan.
- Monitoring well program justification.
- Information on MRWPCA's technical and managerial capacity with a focus on treatment plant operators**.**

These topics are addressed in this Engineering Report. The Operations Optimization Plan is described in this report, but pursuant to the Title 22 Criteria, will be submitted prior to startup of operations. Copies of the proposal and DDW letter are presented in **Appendix B**.

1.3.2. Future IAP Activities

MRWPCA plans to extend the contract with NWRI for future IAP involvement with the Project, including review and advice regarding finalizing the Engineering Report, any issues that may arise as part of design and construction of the AWT Facility, and review of full-scale operations.

[5] MPA – Masters of Public Administration, REHS – Registered Environmental Health Specialist.

1.4. ENVIRONMENTAL COMPLIANCE

MRWPCA is the lead agency for purposes of environmental compliance. The CEQA process for the Project consisted of the following steps:

- September 2013: MRWPCA issued the Notice of Preparation and conducted EIR scoping.
- December 2014: MRWPCA issued the Supplemental Notice of Preparation.
- April 22, 2015: MRWPCA issued the Draft EIR (see http://purewatermonterey.org/reports-docs/deir/).
- April 22 through June 5, 2015: MRWPCA provided a 45-day public review period.
- September 25, 2015: MRWPCA issued the Final EIR.
- October 8, 2015: The MRWPCA Board of Directors certified the Final EIR (including Oct. 5, 2015 Errata to the Final EIR), adopted findings and approved mitigation measures, adopted a Statement of Overriding Considerations[6], and approved the Project.

The public outreach activities for the Draft and Final EIR were presented in **Section 1.3**.

The Final EIR, which was certified on October 8, 2015, consists of the written comments received on the Draft EIR, and presents responses to environmental issues raised in the comments. In addition to the responses to comments, the Final EIR contains revisions, updates, and clarifications in response to public comment on the Draft EIR. The Final EIR is available at the Project website (http://purewatermonterey.org/reports-docs/eir/).

It is possible that compliance with the National Environmental Policy Act (NEPA) may be required for the Project to receive an award of grant funding from the U.S. Bureau of Reclamation through the WaterSmart program or other grant program from another federal agency. Currently, it is unknown whether the Project will be required to comply with NEPA due to this or any other federal nexus.

The Project may be financed in part by a Clean Water State Revolving Fund (CWSRF or SRF) Loan, administered by the SWRCB, Division of Financial Assistance (DFA). As stated in the EIR and comments on the Draft EIR, the CWSRF Program is partially funded by the U.S. Environmental Protection Agency (U.S. EPA), and is subject to federal environmental regulations. All applicants seeking CWSRF financing must comply with CEQA and provide sufficient information so that the SWRCB can document compliance with federal environmental laws. The SWRCB calls this federal compliance "CEQA-Plus." The EIR was prepared to meet the CEQA-Plus requirements in order to be eligible for CWSRF loan funds. An Environmental Package (a portion of the CWSRF loan application) was submitted to the DFA on October 9, 2015, which further documented compliance with the federal requirements.

1.5. GROUNDWATER REPLENISHMENT PROJECT GOALS

The goals of the Project are to enable CalAm to reduce its diversions from the Carmel River system by up to 3,500 AFY by injecting the same amount of product water produced by the AWT Facility into the Seaside Basin. CalAm is under a SWRCB Cease and Desist Order (SWRCB Order No. 2009-0060) to secure replacement water supplies and cease over-pumping of the Carmel River by January 2017.

[6] The Statement of Overriding Considerations was issued for two unavoidable impacts related to construction noise, which could not be mitigated.

The Project will also include a drought reserve component by providing for an additional 200 AFY of product water that will be injected in the Seaside Basin in wet and normal years up to a total of 1,000 AF. Thus, the Project will inject up to 3,700 AF of product water into the Seaside Basin in some years, rather than the 3,500 AF needed for CalAm supplies. This will result in a "banked" drought reserve. During dry years, less than 3,500 AF of product water will be delivered to the Seaside Basin, and the source waters that are not sent to the AWT Facility will undergo tertiary treatment for agricultural irrigation when demand exists. CalAm will be able to extract the banked water to make up the difference to its supplies, such that its extractions and deliveries will not fall below 3,500 AFY.

1.6. MANAGERIAL AND TECHNICAL CAPABILITIES

As discussed in **Section 2**, one of the requirements of the Title 22 Criteria (Section 60320.200(f)), is that a project sponsor must demonstrate that it possesses adequate managerial and technical capability to comply with the regulations. DDW has developed a Technical Managerial and Financial Assessment (TMF) form in order to assess the managerial and technical capabilities of project sponsors for public drinking water supply systems. Portions of the requirements discussed in the TMF form apply to groundwater replenishment projects to satisfy the Title 22 Criteria for groundwater replenishment, including the requirements for information regarding the project operations including certified operators, training, and emergency response. The following sections of the Engineering Report address the TMF requirements applicable for the Project:

- **Section 13** – general operations.
- **Section 13.2** – training.
- **Section 13.3** – contingency plans for emergencies.

1.7. PURPOSE OF THIS REPORT

The purpose of this Engineering Report is to present detailed information on the Project and the overall plan for compliance with the Title 22 Criteria for groundwater replenishment by subsurface application.

2. PROJECT PARTICIPANTS AND REGULATIONS

2.1. PROJECT PARTICIPANTS

The project participant responsibilities are being defined by a water purchase agreement between MRWPCA, MPWMD, and CalAm that ultimately will be approved by the California Public Utilities Commission. As currently drafted (and not expected to change significantly as the agreement goes through further negotiation), MRWPCA will be responsible for the design, construction, operation, and ownership of facilities for the production of product water for the Project, including the RTP, AWT Facility, and Injection Facilities. MPWMD will buy product water from MRWPCA for the purpose of securing financing and paying for the operating costs of the Project. MPWMD will then sell the water to CalAm.

MRWPCA has entered into two separate agreements with the Monterey County Water Resources Agency (MCWRA) and the City of Salinas for source water from the jurisdictions of these two agencies. MCWRA applied to the SWRCB in April 2014, for appropriative water rights from the Blanco Drain, Reclamation Ditch, and Tembladero Slough. MRWPCA submitted revised applications on July 29, 2015. MCWRA's applications for these source waters were publicly noticed on December 18, 2015 for a 60-day comment period.

The City of Salinas source water required a wastewater change petition from the SWRCB because this source water was previously disposed of in percolation ponds adjacent to the Salinas River at the Industrial Waste Treatment Facility (IWTF). Accordingly, the City of Salinas filed a wastewater change petition with the SWRCB on October 9, 2015. The City of Salinas's petition was publicly noticed on November 3, 2015. Protests for the petition were due on November 18, 2015. No protests to the petition were submitted. The SWRCB issued an approval of this wastewater change petition on November 30, 2015.

Separate from the water purchase agreement, MRWPCA will continue to administer the source control program for industrial and commercial businesses and the new source waters to be diverted to the RTP. Additional information on the source control program is presented in **Section 4**.

Implementation of the Project will be achieved through the cooperative efforts of the agencies listed in Table 2-1.

Table 2-1: Project Participants

Project Participants	Roles
Federal Agencies	
U.S. Environmental Protection Agency	Administration of the Clean Water State Revolving Fund Loan program; maintains inventory of Class V injection wells as part of the Underground Injection Program
U.S. Army Corps	Approval of Clean Water Act Section 404 permit for fill of Waters of the U.S. at Reclamation Ditch and Blanco Drain
U.S. Fish and Wildlife Service	Biological Opinion for Compliance with Federal Endangered Species Act, Section 7
National Oceanic and Atmospheric Administration -National Marine Fisheries Service	Biological Opinion or concurrence letter for Compliance with Federal Endangered Species Act, Section 7
State of California Agencies	
State Water Resources Control Board - Division of Water Rights	Approval of water rights permits for diversions of surface water and Clean Water Act Section 401 Water Quality Certification program
State Water Resources Control Board - Division of Financial Assistance	Approval of CWSRF loan and Recycled Water Project Grant; federal action agency (with US EPA) for compliance with Section 7 Endangered Species act and Section 106 National Historic Preservation Act
State Water Resources Control Board – Division of Drinking Water	Approval of Project and Engineering Report, recommendations to Regional Water Quality Control Board for Project Waste Discharge Requirements/Water Reclamation Requirements
State Office of Historic Preservation	Letter of Concurrence of National Historic Preservation Act Section 106 Compliance
Regional Water Quality Control Board – Central Coast	Multiple permits: Modified National Pollutant Discharge Elimination System for the RTP, Waste Discharge Requirements/Water Recycling Requirements for use of recycled water for groundwater replenishment, other General Permits – low threat discharges and construction storm water
Department of Fish and Wildlife	Approval of a Streambed Alteration Agreement (Fish and Game Code Section 1602) and, potentially, California Endangered Species Act (Title 14, Sections 783.2 and 2081) Incidental Take Permit
State Lands Commission	Approval of land lease for Salinas River pipeline crossing needed for Blanco Drain diversion
Public Utilities Commission	Approval of Water Purchase Agreement for CalAm to purchase water produced and injected; State lead agency for the Monterey Peninsula Water Supply Project
California State University Monterey Bay	Approval of land lease, easement/right of way

Regional and Local Agencies/Districts	
Fort Ord Reuse Authority	Environmental Services Cooperative Agreement compliance and approval of easement/right of way for injection facilities
County of Monterey – Resource Management Agency	Approval of use permit(s) and/or grading permit(s) for Reclamation Ditch, Blanco Drain, 33-inch industrial wastewater pipeline slip-lining
County of Monterey – Planning Department	Approval of use permit(s) and/or grading permit(s) for RTP, AWTF, and product water conveyance system.
County of Monterey – Environmental Health	Approval of hazardous materials, etc. Responsible for the permitting of the construction, destruction, and repairs/modification of a domestic, irrigation, agricultural, cathodic protection, monitoring, or heat exchange wells
County of Monterey – Water Resources Agency	Agreements and/or land lease/easements/right of way for surface water diversions Reclamation Ditch and Blanco Drain diversions
City of Marina	Approval of easement/right of way
City of Salinas	Agreements for construction of improvements to the Salinas Industrial Waste Water Treatment Facility site; use/easements to improve the 33-inch industrial wastewater pipeline; interruptible rate approval
City of Seaside	Approval of easement/right of way
Marina Coast Water District	Approval of easement/right of way
Monterey Peninsula Water Management District	Approval of Water Distribution System Permit; Water Purchase Agreement and Operations and Maintenance Agreement(s) between MRWPCA, Monterey Peninsula Water Management District, and, possibly CalAm
Monterey Peninsula Regional Water Authority	Political support of Project and involvement in Settlement Agreement regarding the Monterey Peninsula Water Supply Project[a]
Seaside Basin Watermaster	Approval of storage agreement
Private Entities	
California American Water Company	Water Purchase Agreement; Operations and Maintenance Agreement(s) with MPWMD; Proponent of the Monterey Peninsula Water Supply Project[a]
Private Land Owners	Agreement for easement/right of way to access the Reclamation Ditch and Blanco Drain diversions sites; temporary use/access to the sites needed for slip-lining the 33-inch industrial pipelines

a. The Water Supply Project, which is being proposed by CalAm, would replace existing supplies that are constrained by legal decisions affecting the Carmel River and Seaside Basin water resources. The Water Supply Project would produce 9.6 million gallons per day of water from an ocean desalination facility; an alternative is to combine the Project with a smaller desalination facility (Variant Project) that would produce 6.4 million gallons per day of desalinated ocean water.

2.1.1. Division of Drinking Water

Final regulations for subsurface application of recycled water for groundwater replenishment are contained in the Title 22 Criteria. The groundwater replenishment regulations, which became effective June 18, 2014, establish the requirements applicable for obtaining approval and permitting of planned Groundwater Replenishment Reuse Projects (GRRPs). A summary of the Title 22 Criteria is presented in the following subsections.

2.1.1.1. General Requirements

Per Section 60320.200, prior to GRRP operation, the Project Sponsor must obtain DDW approval of a plan to provide an alternative source of drinking water or a DDW-approved treatment system for wells impacted by the GRRP. Provision of the alternative drinking water supply or well treatment will be needed if operation of the GRRP impacts a drinking water well so that it violates drinking water standards, has been degraded so that it is no longer a safe source of drinking water, or fails to meet the pathogen control requirements in CCR Title 22 Section 60320.208.

The Project Sponsor must ensure that the GRRP continuously uses full advanced treatment, in accordance with Section 60310.201, to treat the entire volume of recycled water prior to subsurface application.

The applied recycled water must be retained underground to meet the more stringent of the retention times determined for pathogen control (Section 60320.208) or response retention time (RRT) per Section 60320.224. The GRRP must be designed and operated such that water beyond the boundary established by the zone of controlled drinking water *well* construction (defined below) meets the Recycled Municipal Wastewater Contribution (RWC) requirements in Section 60320.216.

The Project Sponsor must provide a map that shows the location of the GRRP, monitoring wells established pursuant to CCR Title 22 Section 60320.226, and potable wells within two years travel time of the GRRP based on groundwater flow directions and velocities expected under GRRP operating conditions, and two zones:

- The boundary representing a *zone of controlled drinking water well construction* - the greatest of the horizontal and vertical distances reflecting the retention time for virus removal credit or the RRT.
- A *secondary boundary* representing a *zone of potential controlled drinking water well construction*, depicting the zone within which a well would extend the boundary of controlled drinking water well construction to include existing or potential drinking water wells, thus requiring more study and potential mitigation prior to drinking water well construction.

Prior to operating a GRRP, the Project Sponsor must collect at least four samples (one sample each quarter) from each potentially affected aquifer. The samples must be analyzed for the chemicals, contaminants, and characteristics specified in Sections 60320.210 (nitrogen compounds), 60320.212 (regulated constituents and physical characteristics), 60320.218 (total organic carbon or TOC), and 60320.220 (additional chemicals).

The Project Sponsor must ensure that recycled water used for the GRRP is from a wastewater management agency that is not in violation of effluent limits pertaining to groundwater replenishment as established in the agency's RWQCB permit. [*Note: not applicable for the Project because it is a new project and does not have a permit.*]

Prior to operations, the Project Sponsor must demonstrate adequate managerial and technical capability.

Prior to operations, the Project Sponsor must demonstrate that all treatment processes have been installed and can be operated to meet their intended function.

If a Project Sponsor is directed by DDW or the RWQCB to suspend recycled water application, it cannot resume without obtaining approval from DDW and the RWQCB.

2.1.1.2. Advanced Treatment Criteria

Per Section 60320.201, GRRPs that utilize subsurface application are required to use full advanced treatment (reverse osmosis [RO] and an advanced oxidation treatment process [AOP]) that, at a minimum, meets the criteria of CCR Title 22 Section 60320.201.

For RO, each membrane element must achieve a minimum sodium chloride (NaCl) rejection greater than or equal to 99.0% and an average (nominal) NaCl rejection greater than or equal to 99.2% using 2008 American Society for Testing and Materials International (ASTM) Method D4194-03 and the following substitute test conditions:

- Tests are operated at a recovery greater than or equal to 15%.
- NaCl rejection is based on three or more successive measurements.
- An influent pH between 6.5 and 8.0.
- An influent NaCl concentration less than or equal to 2,000 milligrams per liter (mg/L).

During the first 20 weeks of full-scale operation, the membrane must produce a permeate having no more than 5% of the sample results with TOC concentrations greater than 0.25 mg/L based on monitoring no less frequent than weekly.

To address when the integrity of RO process has been compromised, the Project Sponsor must propose for approval at least one form of continuous performance monitoring (for example, conductivity or TOC) as well as the associated surrogate and/or operational parameter limits and alarm settings.

To demonstrate that a sufficient oxidation process has been designed, the Title 22 Criteria allow two options for demonstration. Option 2 has been selected for the Project, which requires the Project Sponsor to conduct testing that includes challenge or spiking tests to demonstrate that the AOP process removes 0.5-log of 1,4-dioxane and establish surrogate or operational parameters that reflect whether the 0.5-log reduction of 1,4-dioxane is attained. The criteria specify that at least one surrogate or operational parameter must be capable of being monitored continuously.

The advanced treated recycled water must also meet drinking water maximum contaminant levels (MCLs).

2.1.1.3. Public Hearing

Per Section 60320.202, the Project Sponsor must hold a public hearing for a GRRP prior to DDW's submittal of its recommendations to the RWQCB for the GRRP's initial permit and any time an increase in maximum RWC has been proposed, but has not been addressed in a prior public hearing. The Project Sponsor must provide information it intends to present at the hearing to DDW for review and approval prior to the hearing and place the information on a website for public access 30 days prior to the hearing. The Project Sponsor must notify the downgradient potable water owners whose drinking water wells are within ten years of the GRRP based on groundwater flow directions and velocities.

2.1.1.4. Lab Analyses

Per Section 60320.204, analyses for contaminants with primary and secondary MCLs must be performed using drinking water methods.

2.1.1.5. Wastewater Source Control

Per Section 60320.206, entities that supply recycled water to a GRRP must administer a comprehensive source control program that includes: (1) an assessment of the fate of DDW and RWQCB-specified contaminants through the wastewater and recycled water treatment systems; (2) provisions for contaminant source investigations and contaminant monitoring that focus on DDW and RWQCB-specified contaminants; (3) an outreach program to industrial, commercial, and residential communities; and (4) an up-to-date inventory of contaminants.

2.1.1.6. Pathogenic Microorganism Control

Per Section 60320.208, the treatment system must achieve a 12-log enteric virus reduction, a 10-log *Giardia* cyst reduction, and a 10-log *Cryptosporidium* oocyst reduction using at least 3 treatment barriers. For each pathogen, a separate treatment process can only be credited up to a 6-log reduction and at least 3 processes must each achieve no less than a 1.0-log reduction. For each month retained underground as validated by a tracer test, the recycled water will be credited with a 1-log virus reduction.

To validate underground retention time, a tracer study must be conducted prior to the end of the third month of operation. The retention time represents the difference from when the water with the tracer is applied at the GRRP to when either 2% of the initially introduced tracer concentration has reached the downgradient monitoring point, or 10% of the peak tracer unit value is observed at the downgradient monitoring point. With DDW approval, an intrinsic tracer may be used in lieu of an added tracer with a credit of no more than 0.67-log per month provided.

If the effectiveness of a treatment train's ability to reduce enteric virus is less than 10-logs, or *Giardia* cyst or *Cryptosporidium* oocyst reduction is less than 8-logs, the Project Sponsor must

immediately notify DDW and the RWQCB, and discontinue application of recycled water unless directed otherwise by DDW or the RWQCB.

2.1.1.7. Nitrogen Compounds Control

Per Section 60320.210, the Project Sponsor must collect at least two total nitrogen samples each week at least three days apart (grab or 24-hour composite) from the recycled water or recharge water[7] before or after subsurface application. The analytical laboratory must analyze the sample within 72 hours and report results greater than 10 mg/L to the Project Sponsor within the same 72 hours. If the average of two consecutive samples exceeds 10 mg/L, the Project Sponsor must collect a confirmation sample and notify DDW and RWQCB within 48 hours of being notified of the results by the laboratory. The Project Sponsor must also investigate the cause of the exceedance, take actions to reduce the total nitrogen concentrations, and initiate monitoring for additional nitrogen compounds at different locations in the groundwater basin. If the average of four consecutive samples exceeds 10 mg/L, injection of recycled water must be suspended and not resumed until corrective actions are implemented and at least two consecutive samples are less than 10 mg/L.

2.1.1.8. Regulated Contaminants and Physical Characteristics Control

Per Section 60320.212, the Project Sponsor must monitor recycled water quarterly and meet all primary MCLs and action levels (except nitrogen compounds which are addressed by special provisions). For disinfection byproducts, compliance can be determined in the recharge water in lieu of recycled water if the fraction of recycled water in the recharge water is equal to or greater than the average fraction of recycled water in the recharge water applied over the quarter.[8] Compliance is based on the running annual average of quarterly samples. If the running four-week average exceeds the contaminants' MCL for 16 consecutive weeks, the Project Sponsor must notify DDW and the RWQCB within 48 hours of knowledge of the exceedance, and if directed by DDW or the RWQCB, suspend application of recycled water. If four quarterly results for asbestos are below detection, monitoring may be reduced to one sample every three years.

For a contaminant whose compliance with its MCL or action level is not based on a running annual average, if the average of the initial and confirmation sample is greater than the MCL or action level, the Project Sponsor must notify DDW and the RWQCB and initiate weekly sampling until four consecutive weekly results are below the MCL. If the running four-week average exceeds the contaminants MCL, the Project Sponsor must notify DDW and the RWQCB within 24 hours, and if directed by DDW or the RWQCB, suspend application of recycled water.

For constituents with secondary MCLs, the Project Sponsor must collect an annual recycled water sample. If the annual average exceeds a secondary MCL in California Health and Safety Code Table 64449-A or the upper limit in Table 64449-B, the Project Sponsor must initiate quarterly monitoring of the recycled water for the contaminant. If the running annual average of quarterly averaged

[7] Recharge water is the combination of recycled water and credited diluent water. Based on the proposed recycled water contribution of 100%, diluent water will not be used for the Project.
[8] *Ibid*.

results exceeds an MCL, the Project Sponsor must describe the reasons and any corrective actions in a report submitted to the RWQCB and DDW no later than 45 days following the quarter when the exceedance occurred. Annual monitoring may resume when the running annual average of quarterly results does not exceed a secondary MCL.

2.1.1.9. Dilution Water Requirements

Per Section 60320.214, the Project Sponsor must ensure diluent water (non-recycled water) meets primary MCLs, secondary MCLs (upper limit), and Notification Levels (NLs) through implementation of the Project Sponsor's DDW-approved monitoring plan. The plan must include actions to take if an MCL or NL is exceeded. *Note: the proposed RWC for the Project is 100%; use of diluent water is not proposed.*

2.1.1.10. Recycled Municipal Wastewater Contribution Requirements

Per Sections 60301.705 and 60320.214, the RWC is defined as follows:

- The RWC means the fraction equal to the quantity of recycled water applied at the GRRP divided by the sum of the quantity of recycled water and credited diluent water. Each month, the Project Sponsor must calculate the running monthly average (RMA) RWC based on the total volume of the recycled municipal wastewater and credited diluent water for the preceding 120 months.
- The initial maximum RWC, which may be up to 1.0, will be determined by DDW based on, but not limited to, DDW's review of the Engineering Report, information obtained as a result of the public hearings, and a Project Sponsor's demonstration that the treatment processes will reliably achieve a TOC concentration no greater than 0.5 mg/L. A GRRP may increase its maximum RWC if (1) it is approved by DDW and the RWQCB; (2) for the previous 52 weeks, the TOC 20-week running average has not exceeded 0.5; and (3) the permit allows the increase.

If the RMA exceeds its maximum RWC, the Project Sponsor must notify DDW and the RWQCB within seven days of knowledge of the exceedance and within 60 days implement corrective actions that may be required by DDW or the RWQCB, and submit a report to the regulators describing the reasons for the exceedance and corrective actions to avoid future exceedances. *Note: the Project Sponsor is proposing an initial maximum RWC of 1.0.*

2.1.1.11. Total Organic Carbon Requirements

Per Section 60320.218, the Project Sponsor must monitor TOC weekly in the applied recycled water prior to replenishment. For subsurface application projects, the TOC cannot exceed 0.5 mg/L based on (1) the 20-week running average of all TOC results; and (2) the average of the last four TOC results. If the GRRP exceeds the 20-week running average, the Project Sponsor must suspend operations until at least two consecutive results (three days apart) are less than the limit, notify DDW and RWQCB within seven days of suspending operations, and submit a report to the regulators within 60 days describing the reasons for the exceedance and corrective actions. If the GRRP exceeds the TOC limit based on the average of the last four results, the Project Sponsor must notify

DDW and RWQCB within 60 days and submit a report describing the reasons for the exceedance and corrective actions.

2.1.1.12. Additional Chemical and Contaminant Monitoring

Per Section 60320.220, the Project Sponsor must monitor recycled water and groundwater quarterly for Priority Pollutants, chemicals specified by DDW based on the Engineering Report, the affected groundwater basin, and the Project Sponsor's source control program. Each quarter, the Project Sponsor must monitor the recycled water for DDW-specified chemicals having NLs. Recharge water may be monitored instead if the fraction of recycled water in the recharge water is equal to or greater than the average fraction of recycled water in the recharge water applied over the quarter. If a result exceeds an NL, the Project Sponsor must collect a confirmation sample within 72 hours of notification of the result. If the average of the initial and confirmation sample is greater than the NL, the Project Sponsor must initiate weekly monitoring until the running 4-week average no longer exceeds the NL. If the running 4-week average is greater than the NL, the Project Sponsor must describe the reason and provide a schedule for corrective actions in a report submitted to the RWQCB and DDW no later than 45 days following the quarter in which the exceedance occurred. If the running 4-week average is greater than the NL for 16 consecutive weeks, the Project Sponsor must notify DDW and the RWQCB within 48 hours of receiving knowledge of the exceedance.

In addition, each year the Project Sponsor must monitor the recycled water for indicator compounds specified by DDW and RWQCB based on the review of the Engineering Report, the source control inventory, the affected groundwater basin(s), and an indicator compound's ability to characterize the presence of pharmaceuticals, endocrine disrupting chemicals, personal care projects, and the presence of wastewater, and the availability of analytical test methods.

Any detected compounds that are part of this additional contaminant monitoring program must be reported to DDW and RWQCB no later than the following quarter in which the results are received by the Project Sponsor.

2.1.1.13. Operation Optimization Plan

Per Section 60320.222, prior to operation, the Project Sponsor must submit an Operation Optimization Plan (OOP) to DDW and the RWQCB for review and approval. At a minimum, the OOP must identify the operations, maintenance, analytical methods, and monitoring necessary for the GRRP to meet regulatory requirements, as well as the reporting of monitoring results to DDW and the RWQCB. The OOP must be representative of current operations and updated as appropriate.

2.1.1.14. Response Retention Time

Per Section 60320.224, recycled water applied by a GRRP must be retained underground for a period of time necessary to allow a Project Sponsor sufficient response time to identify treatment failures and implement actions, including the plan to provide an alternative water supply or well-head treatment. The minimum allowable RRT is two months. To demonstrate that the actual retention time underground is no less than the required RRT, an added tracer or a DDW approved intrinsic tracer may be used. For each month of retention time estimated utilizing the approved

intrinsic tracer, a project sponsor shall receive no more than 0.67 months credit. The actual retention time is the time representing the difference between when the water containing the tracer is applied at the GRRP and when either 2% of the initially introduced tracer concentration has reached the downgradient monitoring point, or 10% of the peak tracer unit value arrives at the downgradient monitoring point.

2.1.1.15. Monitoring Well Requirements

Per Section 60320.226, the Project Sponsor must site and construct at least two monitoring wells downgradient of the GRRP. One monitoring well must be located between two weeks to six months travel time and at least 30 days upgradient of the nearest drinking water well, and one monitoring well must be located between the GRRP and the nearest downgradient drinking water well. The monitoring wells must allow for samples to be obtained independently from each aquifer and validated as receiving recharge water from the GRRP. For new projects, the Project Sponsor must collect two samples prior to GRRP operation[9] and at least one sample each quarter after operations begin. Each sample must be analyzed for nitrogen, nitrate, nitrite, secondary MCLs, Priority Pollutants, contaminants specified by DDW or the RWQCB taking into consideration the groundwater basin quality, the source control inventory, and the results of the recycled water monitoring.

If a quarterly monitoring result exceeds 80% of a nitrate, nitrite, or nitrate plus nitrite MCL, the Project Sponsor must collect another sample within 48 hours of being notified of the result and have it analyzed. If the average of the initial and confirmation sample exceeds an MCL, the Project Sponsor must notify DDW and the RWQCB within 24 hours of being advised by the laboratory of the result and discontinue application of recycled water until corrective actions are taken or evidence is provided to DDW and RWQCB that the contamination is not the result of the GRRP.

For DDW-specified chemical analyses completed in a month, the Project Sponsor must ensure the laboratory electronically submits results to DDW no later than 45 days after the end of the month in which monitoring occurred, in a manner such that data is readily uploaded to the DDW database.

2.1.1.16. Reporting

Per Section 60320.228, no later than six months after the end of each calendar year, the Project Sponsor must submit a report to DDW and the RWQCB that provides information including the project compliance status, any corrective actions or suspensions of recycled water applications, monitoring data, the location of the recharged recycled water, changes in operations or treatment, and predictions of RWCs for the next calendar year. Public water systems and drinking water well owners with downgradient sources potentially affected by the GRRP and within ten years

[9] Note: Title 22 Section 60320.200(c) requires the Project Sponsor to conduct background monitoring consisting of least four samples (one sample each quarter) from each potentially affected aquifer before operations begin for nitrogen compounds, regulated constituents and physical characteristics, TOC, Priority Pollutants, and any contaminants specified by DDW or the RWQCB taking into consideration the groundwater basin quality and the source control inventory.

groundwater travel time from the GRRP must be notified by direct mail and/or electronic mail of the availability of the report.

Every five years from the date of the initial approval of the Engineering Report, the Project Sponsor must update the report to address any project changes and submit the report to DDW and the RWQCB. The update must address anticipated increases in RWC, compliance with retention time requirements, descriptions of inconsistencies between previous groundwater modeling predictions and the observed values, and how subsequent predictions will be determined.

2.1.1.17. Alternatives

Per Section 60320.230, alternatives to any of the Title 22 Criteria provisions are allowed if the Project Sponsor demonstrates that the alternative provides the same level of public health protection; the alternative has been approved by DDW; and if required by DDW or the RWQCB, conducts a public hearing on the alternative, disseminates information, and receives public comments. Unless otherwise specified by DDW, the demonstration of public health protection must include a review by an independent scientific advisory panel.

2.1.2. Regional Water Quality Control Board Requirements

The Central Coast RWQCB is currently responsible for regulating recycled water discharges to groundwater, which are subject to state water quality regulations and statutes.

Waste Discharge Requirements/Water Recycling Requirements (WDRs/WRRs) issued by the RWQCB are required to implement applicable state water quality control policies and plans, including water quality objectives and implementation policies established in the Water Quality Control Plan for the Central Coast Basin (Basin Plan).[10] The Basin Plan designates beneficial uses and groundwater quality objectives on a sub-basin basis. Groundwater throughout the Central Coast Basin (except for the Soda Lake Sub-basin) is suitable for agricultural water supply (AGR), municipal and domestic supply (MUN), and industrial use. The Basin Plan has:

- General narrative groundwater objectives that apply to all groundwater for taste and odor and radioactivity.
- For MUN beneficial uses - groundwater criteria for bacteria and DDW primary and secondary MCLs.
- For AGR beneficial uses - objectives to protect soil productivity, irrigation, and livestock watering.

Permit limits for groundwater replenishment projects are set to ensure that groundwater does not contain concentrations of chemicals in amounts that adversely affect beneficial uses or degrade water quality. For some specific groundwater sub-basins, the Basin Plan establishes specific mineral water quality objectives for total dissolved solids (TDS), chloride, sulfate, boron, sodium, and

[10] See http://www.waterboards.ca.gov/rwqcb3/publications_forms/publications/basin_plan/.

nitrogen. No specific numeric objectives have been established in the Basin Plan for the Seaside Basin for these constituents other than those with MCLs.

2.2. STATE WATER RESOURCES CONTROL BOARD REQUIREMENTS

The California Water Code allows the SWRCB to adopt state policies for water quality control. There are two policies particularly relevant to groundwater replenishment projects: the Anti-degradation Policy and the Recycled Water Policy.

2.2.1. Anti-Degradation Policy

The state's Anti-degradation Policy is captured in Resolution No. 68-16, which is titled "Statement of Policy with Respect to Maintaining High Water Quality in California." It is also specifically cited in the Basin Plan. The first two sections of the Policy state that:

1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality water will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies.

2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to ensure that (a) pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained.

2.2.2. Recycled Water Policy

The Recycled Water Policy was adopted by the SWRCB in February 2009. It was subsequently amended in 2013 with regard to monitoring constituents of emerging concern (CECs) for groundwater replenishment projects. The Recycled Water Policy was a critical step in creating uniformity in how RWQCBs were individually interpreting and implementing Resolution 68-16 for water recycling projects, including groundwater replenishment projects. The critical provisions in the Policy related to groundwater replenishment projects are discussed in the following subsections.

2.2.2.1. Salt/Nutrient Management Plans

In recognition that some groundwater basins in the state contain salts and nutrients that exceed or threaten to exceed Basin Plan groundwater objectives, and that some Basin Plans do not have adequate implementation measures to achieve compliance, the Recycled Water Policy includes provisions for managing salts and nutrients on a regional or watershed basis through development of Salt/Nutrient Management Plans (SNMPs) rather than imposing requirements on individual recycled water projects (which had been the practice prior to adoption of the Recycled Water

Policy). Unfavorable groundwater salt and nutrient conditions can be caused by natural soils, discharges of waste, irrigation using surface water, groundwater, or recycled water, and water supply augmentation using surface or recycled water. Regulation of recycled water alone will not address these conditions.

SNMPs were to be developed for every groundwater basin/sub-basin by May 2014 (May 2016 with a RWQCB-approved extension). The SNMP must identify salt and nutrient sources; identify basin/sub-basin assimilative capacity and loading estimates; and evaluate the fate and transport of salts and nutrients. The SNMP must include implementation measures to manage salt and nutrient loadings in the basin on a sustainable basis and an anti-degradation analysis demonstrating that all recycling projects identified in the plan will collectively satisfy the requirements of Resolution No. 68-16. The SNMP must also include an appropriate cost effective network of monitoring locations to determine if salts, nutrients and other constituents of concern (as identified in the SNMPs) are consistent with applicable water quality objectives.

A SNMP has been prepared for the Seaside Basin to comply with the Recycled Water Policy (HydroMetrics, 2014a). The SNMP was developed with basin stakeholder input through the Seaside Basin Watermaster and has been adopted by the MPWMD. The SNMP was submitted to the RWQCB on July 9, 2014. The RWQCB has deemed the submittal to be sufficient and intends to use the SNMP for informing programmatic activities associated with work in the study area. The RWQCB does not intend to adopt it as a Basin Plan amendment.[11]

2.2.2.2. Groundwater Replenishment Provisions

The Recycled Water Policy includes specific provisions for approval of groundwater replenishment projects.

- Project must comply with the Title 22 Criteria for groundwater replenishment.
- Projects must monitor for Priority Pollutants in recycled water twice per year.
- Projects must implement a CEC monitoring program that is consistent with Attachment A of the Recycled Water Policy and DDW recommendations.

Nothing in the Recycled Water Policy limits the authority of the RWQCB to protect beneficial uses provided any proposed limitations for protection of public health may only be imposed following consultation with DDW, consistent with SWRCB Orders WQ 2005-0007 and 2006-0001.

Nothing in the Recycled Water Policy limits a RWQCB from imposing additional requirements for a groundwater replenishment project that has a substantial adverse effect on the fate and transport of a contaminant plume or changes the geochemistry of an aquifer causing dissolution of constituents.

[11] *See* September 15, 2014 email from Matt Keeling, RWQCB to Jonathan Lear, Joe Oliver, and Larry Hampson, MPWMD, regarding the Seaside Basin SNMP.

2.2.2.3. Anti-degradation and Assimilative Capacity

The Recycled Water Policy states that until such time as an SNMP is in effect, compliance with SWRCB Resolution No. 68-16 can be demonstrated by evaluating two assimilative capacity thresholds. A groundwater replenishment project that utilizes less than 10% of the available assimilative capacity in a groundwater basin/sub-basin (or multiple projects utilizing less than 20% of the available assimilative capacity in a groundwater basin/sub-basin) are only required to conduct an anti-degradation analysis verifying the use of the assimilative capacity. In the event a project or multiple projects utilize more than the designated fraction of the assimilative capacity (e.g., 10% for a single project or 20% for multiple projects), the project proponent must conduct a RWQCB-deemed acceptable anti-degradation analysis. A RWQCB has the discretionary authority to allocate assimilative capacity to groundwater replenishment projects.

2.2.2.4. Constituents of Emerging Concern

When adopted in 2009, this provision in the Recycled Water Policy acknowledged the need for more scientific information and work with respect to test methods and more specific determinations as to how CECs may impact public health or the environment. The SWRCB convened an expert panel, in consultation with DDW, to make recommendations for monitoring CECs in recycled water. The expert panel report was published in June 2010 with specific recommendations for CEC monitoring for groundwater replenishment projects.

The SWRCB amended the Recycled Water Policy in 2013 (Resolution No. 2013-0003) to include the Panel's recommended CEC monitoring program, including the final list of specific CECs and monitoring frequencies for groundwater replenishment projects (see Table 2-2), and procedures to evaluate the data and for responding to the monitoring results (see Table 2-3).

The CEC monitoring program also includes surrogates, which are measurable physical or chemical properties, such as chlorine residual or electrical conductivity (EC) that can be used to measure the effectiveness of trace organic compound removal by treatment process and/or provide an indication of a treatment process failure. Project proponents must propose surrogates to monitor on a case-by-case basis that are appropriate for the treatment process or processes. The recommended surrogates must be approved by the RWQCB in consultation with DDW.

For health-based CECs, the responses in Table 2-3 are based on comparing measured environmental concentrations (MECs) in recycled water after treatment (for subsurface application projects: RO or RO with AOP) to Monitoring Trigger Levels (MTLs). As previously discussed, the Title 22 Criteria include additional CEC monitoring requirements and monitoring locations.

Table 2-2: Recycled Water Policy - Monitoring for Constituents of Emerging Concern for Subsurface Application Groundwater Replenishment Projects

Constituent	Constituent Group	Relevance / Indicator Type	MRL (µg/L)[a,b]	MTL (µg/L)[c]
17β-estradiol	Steroid hormones	Health	0.001	0.0009
Caffeine	Stimulant	Health & Performance	0.05	0.35
NDMA[d]	Disinfection byproduct	Health & Performance	0.002	0.01
Triclosan	Antimicrobial	Health	0.05	0.35
DEET[e]	Personal care product	Performance	0.05	---[f]
Sucralose	Food additive	Performance	0.1	---[f]

a. MRL - the Method Reporting Limit.
b. Monitoring frequency is quarterly for the initial assessment phase; semi-annually for the baseline phase; and semi-annually to annually for the standard operation phase; CEC monitoring can be removed or increased based on the results.
c. µg/L – micrograms per liter.
d. NDMA – N-nitrosodimethylamine.
e. DEET - N,N-diethyl-meta-toluamide.
f. Not applicable.

Table 2-3: Recycled Water Policy - Thresholds and Response Actions for Health Based Indicators

MEC/MTL Threshold	Response Action
If greater than 75% of the MEC/MTL ratio results for a CEC are less than or equal to 0.1 during baseline monitoring phase and/or subsequent monitoring	(A) After completion of the baseline-monitoring phase, consider requesting removal of the CEC from the monitoring program.
If MEC/MTL ratio is greater than 0.1 and less than or equal to 1	(B) Continue to monitor.
If MEC/MTL ratio is greater than 1 and less than or equal to 10	(C) Check the data. Continue to monitor.
If MEC/MLT ratio is greater than 10 and less than or equal to 100	(D) Resample immediately and analyze to confirm CEC result. Continue to monitor.
If MEC/MLT ratio is greater than 100	(E) Resample immediately and analyze to confirm result. Continue to monitor. Contact the RWQCB and DDW to discuss additional actions. (Additional actions may include, but are not limited to, additional monitoring, toxicological studies, engineering removal studies, modification of facility operation, implementation of a source identification program, and monitoring at additional locations.)

2.3. FEDERAL REQUIREMENTS FOR GROUNDWATER REPLENISHMENT PROJECTS (UNDERGROUND INJECTION CONTROL)

At this time there are no Federal permitting requirements for surface application groundwater replenishment projects; the U.S. EPA's underground injection control (UIC) program does apply to injection wells, but has no permitting consequences for the Project. The UIC program has categorized injection wells into five classes, only one of which (Class V) applies to groundwater replenishment projects. Under the existing Federal regulations, Class V injection wells are "authorized by rule" which means they do not require a Federal permit if they do not endanger underground sources of drinking water and comply with other UIC program requirements. For California, U.S. EPA Region 9 is the permitting administrator for Class V wells. Any injection project planned in California must meet the State Sources of Drinking Water Policy, which ensures protection of groundwater quality for drinking water supplies, and therefore a Federal permit would not be necessary.[12] All Class V injection well owners in California are required to submit information to U.S. EPA Region 9 on the well for U.S. EPA's inventory.[13]

[12] See http://water.epa.gov/type/groundwater/uic/class5/frequentquestions.cfm#do_i.
[13] http://www.epa.gov/region9/water/groundwater/uic-classv.html, and http://www.epa.gov/region9/water/groundwater/injection-wells-register.html.

3. PROJECT FACILITIES

This section summarizes information, including design criteria, on the MRWPCA RTP and the AWT Facility unit processes and reliability features, product water transmission systems, and the Injection Facilities. The AWT Facility design information presented in this Engineering Report is based on the preliminary, "10-percent" design. A Request For Proposal (RFP) for a "60-percent" design was released in November 2015. MRWPCA is entering into a contract with the design firm.

3.1. REGIONAL TREATMENT PLANT

3.1.1. Overview of Monterey Regional Water Pollution Control Agency's System

MRWPCA, which currently serves a population of approximately 250,000, was created in 1972. MRWPCA consists of and provides regional wastewater treatment, disposal, and reclamation facilities for the cities of Monterey, Pacific Grove, Del Rey Oaks, Sand City, Marina, and Salinas; the Seaside County Sanitation District; the Castroville, Moss Landing, and Boronda Community Services Districts; and Fort Ord lands. Each member entity retains ownership and operating/maintenance responsibility for wastewater collection and transport systems up to the point of connection with interceptors owned and operated by MRWPCA. Residential, commercial, and industrial wastewater and some dry weather urban runoff are conveyed to the RTP for treatment. MRWPCA also accepts 30,000 to 50,000 gallons per day of brine by truck from businesses, which would otherwise discharge to the sanitary sewer system and into the RTP. These wastewaters include water softener regenerant waste and RO brines. Because irrigation uses of recycled water are sensitive to TDS, MRWPCA has sought to keep elevated TDS wastewaters segregated from the influent flow to the RTP. Brine wastes are held in a lined holding pond and ultimately discharged directly to or blended with secondary treatment wastewater before being discharged through MRWPCA's ocean outfall.

3.1.2. Regional Treatment Plant Facilities

The RTP is located in Marina, CA (see **Figure 3-1**). It has an average dry weather flow design treatment capacity of 29.6 million gallons per day (mgd) and a peak wet weather design capacity of 75.6 mgd, with an Outfall ultimate wet weather capacity of 81.2 mgd. It currently receives and treats approximately 15 mgd. An aerial image annotated with the key treatment facilities at the RTP is presented in **Figure 3-2**.



Figure 3-1. Regional Treatment Plant location

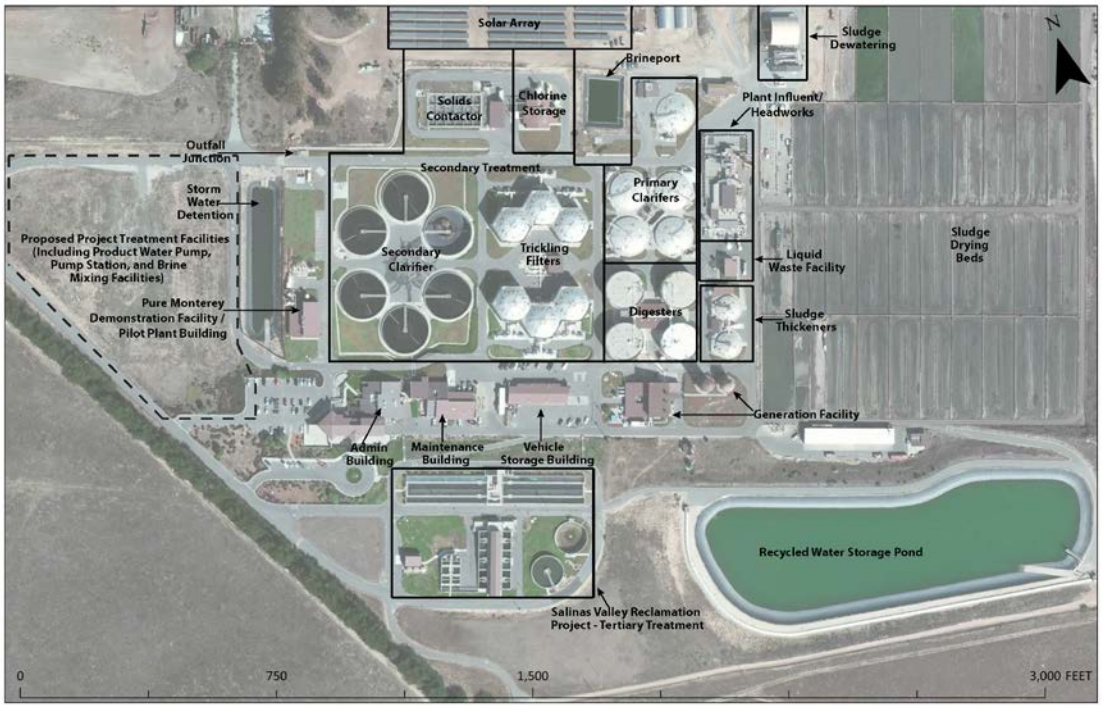


Figure 3-2. Existing Regional Treatment Plant facilities

Wastewater treatment at the RTP consists of aerated grit removal, primary clarifiers, trickling filters, solids contact, and secondary clarifiers. Undisinfected secondary clarifier effluent is (1) discharged to the ocean pursuant to National Pollutant Discharge Elimination System (NPDES) Permit (Order No. R3-2014-0013) or (2) used as influent for the co-located SVRP for production of tertiary recycled water.

In most winter months, secondary effluent is discharged to Monterey Bay through the ocean outfall, which includes a diffuser that extends 11,260 feet offshore at a depth of approximately 100 feet. The minimum initial dilution is 145 parts seawater to 1 part discharge water. The diffuser on the ocean outfall is designed to convey wet weather flows of up to 81.2 mgd.

In most months, tertiary recycled water is used for irrigation of 12,000 acres of farmland in the northern Salinas Valley pursuant to RWQCB Orders No. 94-82 (WRRs issued to MRWPCA) and No. 97-52 (User Requirements issued to the MCWRA). The existing facilities at the SVRP, including upstream treatment at the RTP, are designed to produce up to 29.6 mgd of tertiary recycled water; this volume of recycled water is authorized under Order No. 94-82. The SVRP includes an 80-AF storage pond that holds tertiary-treated wastewater and disinfected Salinas River water before it is distributed to farmland. The use of recycled water for irrigation reduces regional dependence on and use of local groundwater, which, in turn reduces groundwater pumping-related seawater intrusion into the Salinas Valley aquifers.

Sludge/biosolids are anaerobically digested and sent to two screw presses, which replaced a belt filter press and reduced the reliance on sludge drying beds. The holding lagoons and some of the drying beds may still be utilized in emergency situations. Dried solids are hauled to the Monterey Regional Waste Management District's landfill, adjacent to the RTP, where it is mixed with wood products and used for slope cover.

3.1.3. Regional Treatment Plant Flow Projections

In support of the EIR, a study was conducted to evaluate future projected flows to the RTP (Brezack & Associates, Inc., 2014). The analysis found that municipal wastewater flow to the RTP is projected to decrease to a range of 19.2 to 17.1 mgd. Actual municipal wastewater flows to the RTP have decreased to approximately 15 mgd showing that the study underestimated conservation and the effects of a four-year drought. The study may reflect the general trends and says that after 2030, flows may increase to a range of highs between 22.7 and 24.3 mgd. The future increase is dependent upon whether urban growth projections assumed in the 2014 projections are realized, which may not occur. As a result, to supply sufficient water for the Project and CSIP, new source waters will be diverted to the RTP as previously discussed in **Section 1**.

3.2. ADVANCED WATER TREATMENT FACILITY

There are no existing advanced treatment facilities permanently installed at the site of the new AWT Facility other than the Demonstration Facility. The full-scale AWT Facility will consist of the following major components[14]:

- Secondary effluent diversion structure,
- AWT Facility influent pump station,
- Ozonation (membrane filtration pretreatment),
- Membrane filtration (MF) feed water pump station (may not be needed),
- MF system,
- RO feed water pump station,
- RO system,
- Ultraviolet light (UV) with hydrogen peroxide AOP,
- Post treatment stabilization,
- Product water transmission facilities,
- Product water injection facilities,
- RO concentrate discharge facilities,

A simplified process flow diagram is shown in Figure 3-3**.**

[14] The optional upflow Biologically Active Filtration (BAF) system was included as a possible process in the 2014 Concept Proposal and was also addressed as part of the EIR; however, it was removed from the AWT Facility design through value engineering.

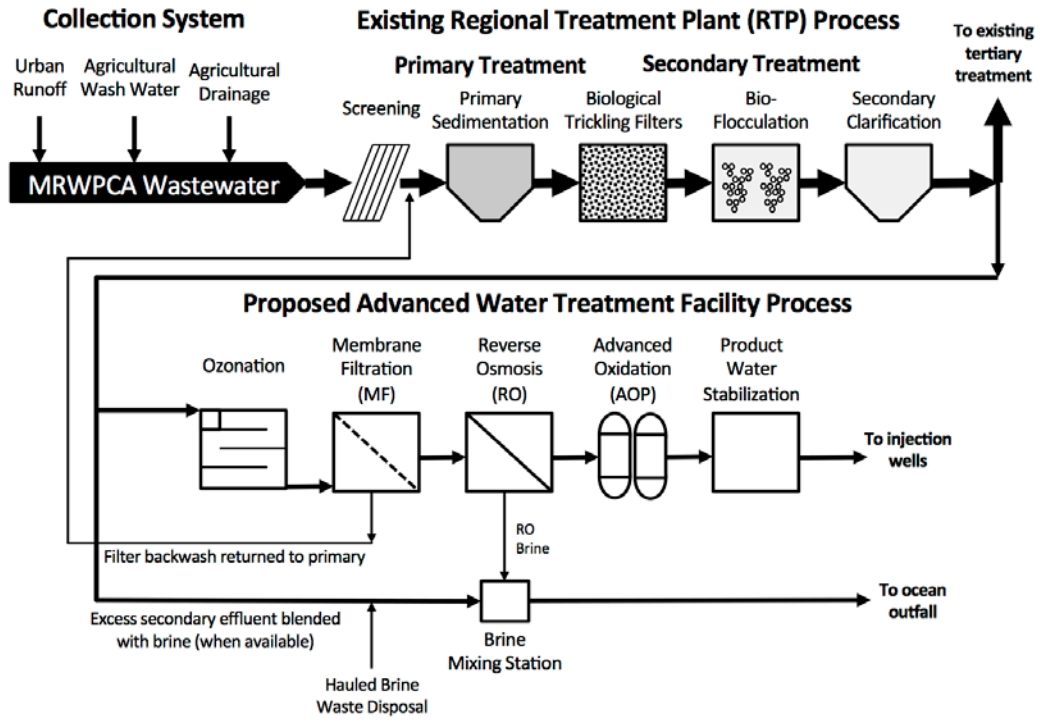


Figure 3-3. Simplified process flow diagram of existing MRWPCA RTP primary and secondary treatment and the AWT Facility

The planned treatment capacity of the AWT Facility is 4.0 mgd (e.g., the amount of product water produced will be 4.0 mgd). A process flow summary for the major treatment processes of the AWT Facility is provided in Table 3-1.

Table 3-1: AWT Facility Process Flow Summary

Treatment Process	Design Flows (mgd)
Ozonation Influent and Effluent	5.46
MF Feed	5.46
MF Filtrate	4.94
RO Feed	4.94
RO Permeate	4.0
AOP Influent and Effluent	4.0
Post Treatment Influent and Effluent	4.0

3.2.1. Secondary Effluent Diversion Structure and AWT Facility Influent Pump Station

Secondary effluent, pulled from between the secondary effluent Rapid Mix facility of the RTP and the SVRP diversion facility, will be diverted to the AWT Facility via the secondary effluent diversion structure and the AWT Facility influent pump station.

3.2.2. Membrane Filtration Pretreatment

Sodium hypochlorite will be dosed ahead of the ozone system to carry a residual through the AWT Facility. The target combined chlorine residual ahead of the RO system is 3 mg/L as Cl_2. Residual ammonia in the RTP secondary effluent will be present at sufficient concentrations to react with the sodium hypochlorite injected to form chloramines. Design criteria for the system are provided in Table 3-2.

Table 3-2: Sodium Hypochlorite Addition System

Sodium Hypochlorite Addition System[a]	
Sodium Hypochlorite Tank	
Number	1
Type	FRP
Capacity, gallons	9990
Sodium Hypochlorite Pumps	
Type	Hydraulic Diaphragm
Materials	PVC / PTFE
Capacity (gph)	20
Rated Pressure, psig	50

a. FRP - fiberglass reinforced plastic; PVC - Polyvinyl chloride; PTFE – polytetrafluoroethylene; gph – gallons per hour; psig – pounds per square inch gage.

3.2.3. Ozonation

The ozone treatment system will treat chloraminated secondary effluent from the RTP prior to filtration by the downstream MF system.

3.2.3.1. Ozone Pretreatment

Ozone pretreatment can provide a number of benefits to a potable reuse treatment system: (1) low-pressure membrane pretreatment, (2) CECs destruction, and (3) pathogen disinfection.

Ozonation prior to MF (also referred to as preozonation) can increase MF (e.g., ultrafiltration or microfiltration) run times and flux for some waters. Non-nitrified secondary effluent, such as the RTP effluent, contain large organic molecules (defined here as greater than 10 kilodaltons [kDa]), which rapidly foul low-pressure membranes, such as MF. Ozonation of these large organic molecules reduces their size to less than 1 kDa via oxidation, and allows them to pass through the MF system with minimal fouling (the organic molecules are then well-rejected by the downstream RO system). With the fouling potential of the water reduced by preozonation, the MF system run times are

increased and the MF system can be designed for higher fluxes. Long run times allow for less chemical usage and a greater recovery, while designing the MF system for a larger flux reduces the number of membrane modules required.

Preozonation can also reduce the concentration of CECs in the RO feed, which can both lead to a reduction in the concentration of known health-significant CECs in the RO permeate and lead to a reduction in the concentration of CECs in the RO concentrate that is ultimately discharged to the ocean.

3.2.3.2. Ozone Piloting Summary

Piloting and water quality sampling were conducted from 2013 to 2014 at the MRWPCA RTP to aid in the design of preozonation (see **Appendix C** for Pilot Report). Select key findings from that effort are summarized below:

- The downstream MF run time increased by approximately a factor of four with an ozone dose of 10 mg/L;
- The downstream MF run time was not adversely affected by higher ozone doses (e.g., 20 mg/L);
- Secondary effluent contained high concentrations of TOC (12 to 18 mg/L, typical for a non-nitrified secondary effluent), which will exert significant ozone demand;
- Significant CEC removal was observed at an ozone dose of 10 mg/L (an ozone to TOC ratio [O_3:TOC] of about 0.4; see Figure 3-4 for removal observed during pilot testing); and,
- Secondary effluent contained variable concentrations of nitrite (ranging from < 0.1 to 2.2 mg/L as Nitrogen [N]) due to partial nitrification in the RTP trickling filters, which will exert significant ozone demand (3.4 mg/L of ozone per 1 mg/L of nitrite as N); however, ozone dose control methods are available that automatically account for influent nitrite concentrations (*e.g.*, trimming to dissolved ozone residual).

The key treatment objectives for including ozone pretreatment (improved MF performance and significant CEC destruction) were both successfully demonstrated at an ozone dose of 10 mg/L; therefore, this was selected as the design ozone dose for the full-scale facility.

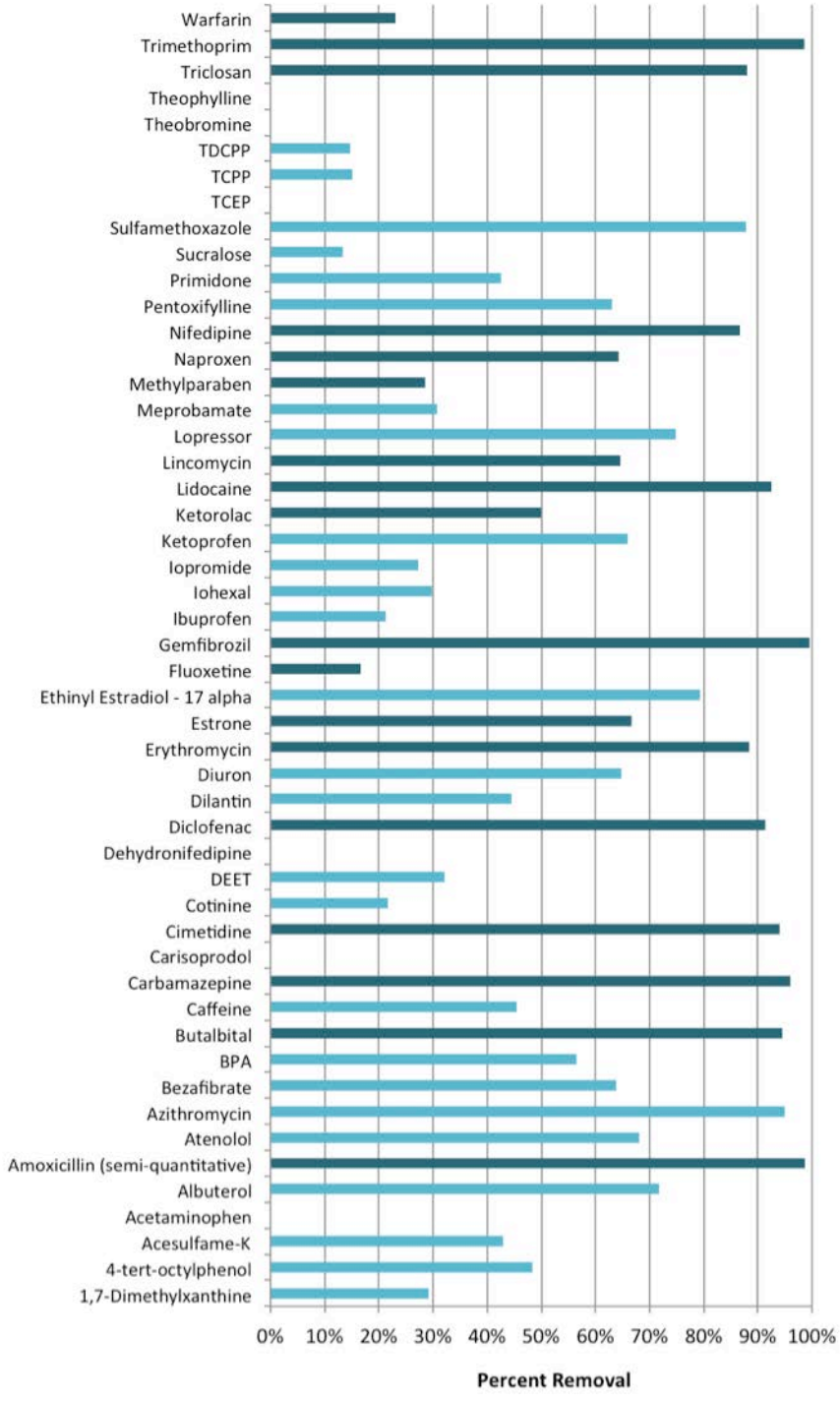


Figure 3-4. Median removal of CECs observed during piloting at an ozone dose of 10 mg/L, where dark bars indicate removal to below detection. Constituents with no bars were not removed.

3.2.3.3. Design Ozone Dose

The ozone system is being designed based on the ozone piloting, where an average applied ozone dose of 10 mg/L proved successful for MF pretreatment. From this average dose, a maximum and minimum design dose were selected, considering maximum and minimum design water qualities, average pilot water qualities, as well as full-scale and pilot-scale ozone transfer efficiencies. The following sections discuss the selection of the maximum and minimum design water quality and the full-scale design transfer efficiency.

3.2.3.3.1. Design Water Quality

Design water quality assumptions were developed from historical water quality data. Three years of dissolved organic carbon (DOC), total suspended solids (TSS) and nitrite data from January 2011 through May 2014 (24-hour composite samples)[15] were used in developing the design assumptions. TOC was estimated from the DOC and TSS data, and the 95th percentile value for TOC and nitrite were chosen as the maximum ozone design water qualities. The minimum value for both TOC and nitrite from these datasets were chosen as the minimum ozone design water qualities. These maximum and minimum design water qualities were compared to the average water quality conditions observed during the 10 mg/L phase of piloting to develop the design ozone doses, which were extracted from the same RTP 24-hour composite dataset (the development of the design ozone doses is discussed in the next section)[16]. A summary of the maximum and minimum design water qualities, and the average water qualities observed during piloting of the 10 mg/L applied ozone dose are shown in Table 3-3.

Table 3-3: Design and Pilot Water Quality

Parameter	Average piloting concentrations at 10 mg/L, applied	Max design concentration	Min design concentration
Nitrite (mg/L as N)	0.63	1.60	0
Estimated TOC(mg/L)	16.0	20.0	11

Nitrite exerts an immediate ozone demand on a 1:1 stoichiometric basis, thereby decreasing the concentration of ozone available for the oxidation of organics. When more nitrite is present, more ozone must be applied (e.g., an increase in nitrite concentration of 1 mg/L as N requires an increase of 3.4 mg/L transferred ozone). The design TOC concentration is factored into the design ozone dose by keeping the pilot O_3:TOC ratio constant. When the influent TOC increases, the ozone dose must also increase to maintain a sufficient O_3:TOC ratio to adequately reduce MF fouling; *e.g.*, if the TOC concentration doubles then the transferred ozone dose must double. The maximum and minimum design ozone doses take into account the maximum and minimum nitrite and TOC concentrations accordingly (design ozone doses are presented in **Subsection 3.2.3.3.3**).

[15] Nitrite data was from January 2011 to July 2014.
[16] The 10 mg/L phase of testing occurred over the following date range: 1/16/14 - 2/17/14, 2/26/14 - 3/13/14, and 4/7/14 - 5/19/14.

3.2.3.3.2. Transfer Efficiency

In addition to design water qualities, the design ozone doses factors in the difference in ozone transfer efficiency that can be achieved at full-scale compared to pilot-scale. The pilot transfer efficiency ranged from 94% to 96%, while full-scale transfer efficiencies utilizing sidestream injection (the injection system recommended for the AWT Facility, as discussed later) typically range from 70 to 80% (personal communication with Kerwin Rakness, Process Applications, Inc.[17]). To maintain the same transferred ozone dose, the full-scale applied ozone dose will be adjusted for the pilot and full-scale transfer efficiencies; *e.g.*, an applied ozone dose of 10 mg/L with a transfer efficiency of 96% will yield an equivalent transferred ozone dose as an applied ozone dose of 13.7 with a transfer efficiency of 70%.

3.2.3.3.3. Design Doses

The design ozone doses were developed based on the design water quality and the transfer efficiency as discussed above (see Table 3-4 for results). For context, these design ozone doses are higher than ozone doses required for drinking water disinfection (e.g., 1 - 4 mg/L) and higher than those required for sulfide removal in drinking water (e.g., 10 - 12 mg/L). The authors are aware of only one other utility that currently pretreats non-nitrified secondary effluent with ozone (the West Basin Municipal Water District); their design dose (16 mg/L) is similar to the doses in this design, albeit slightly lower due to differences in their secondary effluent TOC and nitrite concentrations.

Table 3-4: Design Applied Ozone Doses

Parameter	Value (mg/L)
Maximum design applied ozone dose	21.5
Average design applied ozone dose	13.7
Minimum design applied ozone dose	4.84

3.2.3.4. Design Flows

The design flows for the ozone system are a function of the recoveries of the downstream processes (Table 3-5 summarizes the design flows for the ozone system). The minimum flow was based on producing 1.3 mgd of RO permeate (one RO unit offline; online unit operating a recovery of 78% to maintain minimum cross-flow velocity)[18]. Although the ozone system must be able to turndown to the minimum flow, the AWT Facility is expected to operate closer to the design flow most of the time. The maximum and minimum flows impact the ozone equipment sizing and number of sidestream injectors. Flow surges from the downstream MF systems will be addressed through

[17] Mr. Rakness has specific experience in ozone equipment performance testing, ozone system automatic control strategy development, ozone design phase technical assistance, start-up and optimization training and assistance, and wastewater treatment plant evaluation, optimization and start-up assistance. He was author of *Ozone in Drinking Water Treatment: Design, Operation and Optimization* and was the primary author for the ozone section of the U.S. EPA *Disinfection Design Manual* for wastewater treatment.

[18] The minimum flow may be reduced to 1.17 mgd in the next phase of design as a minimum flow of 1.17 mgd may be required for the Project.

equalization (EQ) storage facilities upstream and downstream of the MF. The flow through the ozone system will only vary when the production set point is lowered from the design capacity of 4.0 mgd RO permeate.

Table 3-5: Ozone Design Flows

Parameter	Value (mgd)
Maximum flow	5.46
Minimum flow	1.85

3.2.3.5. Ozone Generator

Based on the design flows and applied ozone doses, a design capacity of the ozone generator was developed (Table 3-6). An ozone concentration of 12% was assumed, as preliminary analysis showed it to be the most cost effective concentration (preliminary analysis done in consultation with ozone system suppliers). Increasing the ozone concentration reduces liquid oxygen (LOX) consumption and the injector gas to liquid ratio. Ozone generators of this scale typically have a power turndown of approximately 20:1 or greater (while the gas flow system turndown is typically 10:1). To meet the design maximum and minimum doses and flows, a turndown of 13.2:1 is required from the design ozone capacity. Ozone production may become less efficient when the turndown exceeds 10:1, as suboptimal gas flows will be required (i.e., the result is a lower ozone concentration than design); however, the ozone system is rarely expected to turndown 13.2:1. The 13.2:1 turndown represents the low flow condition (when the RO permeate is 1.3 mgd) at the minimum ozone dose (4.8 mg/L).

Ozone generators typically require minimal regular maintenance, and failure is typically infrequent. Modern generators include fuses for each dielectric tube, which allows the generator to continue production if a dielectric tube fails. A redundant generator has not been included for the Project for a number of reasons. The AWT Facility may operate for short periods of time without preozonation with more frequent MF cleaning as needed. Further, the AWT Facility has a planned offline factor of 10%.

Table 3-6: Ozone Generator Design Criteria

Parameter	Value
Number of generators	1
Design ozone concentration (%, by weight)	12
Capacity at 12% by weight per generator (lbs/day)[a]	980
Ozone production turndown, of design capacity, min[b]	13.2:1

a. Pounds per day – lbs/day.
b. Required to meet the minimum dose at minimum flow, of the design capacity.

For ozone generation, the corona discharge process has now become standard in drinking water and wastewater treatment. Recommended ozone generator manufacturers are the following:

- Ozonia (Degremont Technologies)
- Fuji (Fuji Electric)
- Wedeco (a Xylem brand)
- Mitsubishi

The generator will come with a corresponding power supply unit (PSU) to supply power to the ozone generator. As discussed in the following subsection, the PSU and ozone generator will connect to the cooling water system to dissipate heat.

3.2.3.6. Cooling Water System

The ozone generator and PSU must be cooled to avoid overheating and dissipating excess heat into the surroundings. A closed loop cooling system with a plate and frame heat exchanger, interfacing with an open loop system will be used (design criteria are summarized in Table 3-7). The open water source used for the cooling system should be low in solids to reduce build up on the exchanger. A potential source for the open loop water is the MF filtrate. A filter will be included in the closed loop to ensure that particles are neither deposited in the ozone generator, nor the heat exchanger surface, if particles accidently enter the closed loop system (e.g., particles from maintenance activities).

Table 3-7: Cooling System Design Criteria

Parameter	Value
Heat exchanger type	Plate and frame
No. of cooling systems	1
Particle filter size	To be determined in consultation with OSS[a]
Closed loop cooling water temperature (°C), max[b]	84

a. Ozone system supplier - OSS
b. Degrees centigrade - °C. This temperature was assumed during preliminary design work. The temperature affects the ozone generator capacity (in addition to the ozone concentration).

3.2.3.7. Oxygen System

High-purity oxygen gas is fed to the ozone generator to achieve a high concentration of ozone gas. For this size system, the oxygen feed will be achieved through the use of offsite generation and delivery of LOX. A LOX system consists of a LOX storage tank, a pressure regulating system, vaporizers, and a nitrogen boost system, which is included to increase the efficiency of ozone generation.

3.2.3.7.1. LOX Delivery Scheduling

A level-sensor device in the LOX tank allows the LOX supplier to track usage. When the level reaches a predetermined capacity (e.g., 45%), a delivery truck is dispatched to refill the tank. Delivery trucks have a trailer capacity of 6,000 gallons, and deliveries can typically be made within 24 - 48 hours.

3.2.3.7.2. LOX Tank Size

The tank size is a function of the minimum allowable length of time between LOX deliveries. Table 3-8 shows a summary of various tanks sizes, and the storage capacity after the tanks have used enough LOX to receive a full truckload. LOX consumption at maximum flow and maximum dose was assumed (1,028 gallons per day [gpd] at 10% ozone), and the AWT Facility will require a LOX tank size of 13,000 gallons to achieve a conservative hold time in case of difficulties with dispatching LOX deliveries.

Table 3-8: Tank Sizing Options

Tank size[a] (gallons)	Days remaining after 6,000 gallons are used[b] (days)	Storage at maximum design dose (days)	Storage at average design dose (days)[c]
9,000	2.9	9	14
11,000	4.9	11	17
13,000	6.8	13	20

a. At 10% ozone concentration.
b. At maximum design dose.
c. LOX consumption at average design ozone dose at maximum flow is 656 gpd.

3.2.3.7.3. Vaporizers

Vaporizers volatilize the LOX and are chilled in the process. While one vaporizer is in operation, the second warms in ambient air to prepare for operation.

Design criteria for the LOX storage and vaporizers are shown in Table 3-9. These design criteria are based on an ozone concentration of 10%, as this is a conservative design scenario.

Table 3-9: LOX Design Criteria

Parameter[a]	Value
LOX consumption (gal/day)	656 at average design dose 1,028 at maximum design dose
Storage tank volume gallons	13,000
Storage time days	20 at average design dose 13 at maximum design dose
Number of tanks	1
Configuration	Horizontal or Vertical
Vaporizer type	Ambient air
Vaporizer size scfh, minimum, each[b]	4,927
Number of vaporizers	2 (1+1)

a. Design criteria based on 10% ozone concentration
b. Standard cubic feet per hour – scfh.

3.2.3.7.4. Pressure Regulating System

A pressure regulating system will be installed to regulate the delivered oxygen pressure coming from the LOX system.

3.2.3.8. Nitrogen Boost System

Nitrogen addition (0.5 to 2% nitrogen) with the gaseous oxygen improves ozone generation performance. Nitrogen is present in sufficient quantities in air; however, the air must be conditioned to remove moisture before sending it through the ozone generator. The nitrogen boost system will contain the following components:

- Duplex air compressors (sized for 1+1 capacity)
- Receiver tank
- Aftercooler
- Desiccant dryers (1+1)
- Particulate and oil coalescing filters

3.2.3.9. Ozone Injection System

Sidestream injection with a venturi injector will be used to inject ozone into the process water to mix the gaseous ozone with the sidestream flow. The sidestream injection system efficiency is a function of the gas to liquid (G:L) ratio. To achieve good mixing, the sidestream injection system will be designed for a low G:L ratio (i.e., 0.35 or less). Low sidestream injection G:L ratios are necessary to avoid low ozone transfer efficiencies when treating secondary effluent (personal communication with Jim Jackson of Mazzei Injector and Kerwin Rakness).

The low G:L ratio necessitates a large sidestream flow, given the proposed ozone doses. Although the ozone generator will be sized for 12% ozone concentration, the sidestream system will be designed for an ozone concentration of 10%. The ozone system may be operated at 10%, and the sidestream system must be sized to accommodate this set point. The transfer efficiency of the ozone sidestream system should only improve if the ozone concentration is increased to the design concentration of 12%. The large sidestream flow that comes with a G:L ratio of 0.35 or less is also necessary to avoid low ozone transfer efficiencies in secondary effluents (personal communication with Kerwin Rakness).

After injection, the sidestream flow is a combination of water, dissolved and gaseous ozone and oxygen, which is mixed with the bulk flow using a flash reactor where additional dissolution of the gaseous ozone occurs.

The sidestream bulk-flow mixing configuration will be designed to achieve dual-dissolution. The mixer (e.g., flash reactor) will be placed immediately upstream of the ozone contactor, such that the mixer discharges fine bubbles into the bottom of the ozone contactor. These fine bubbles allow for further dissolution in the ozone contactor. This method of injection and mixing maximizes mixing and dissolution time, and should exceed the mixing achieved during piloting (single injection point, injection quill, and one set of downstream mixers).

Multiple sidestream pumps, and corresponding injectors, will be installed to efficiently meet turndown requirements. After ozone comes in contact with the water, the system material will be comprised of 316 stainless steel or concrete, until the ozone is removed in the contactor or the downstream quenching system. The injection system design criteria are summarized in Table 3-10.

Table 3-10: Injection System Design Criteria

Parameter	Value
Injection system type	Sidestream injection
Injector type	Venturi injector
Venturi injectors, estimated number	3 (3+0)[a]
Venturi injector size, estimated inches	6
Sidestream pumps, estimated number	3 (3+0)
Pump flow estimate (gpm), each[b]	790
Sidestream injection G:L ratio, max	0.35
Mixers, minimum number	1
Mixer type	Flash Reactor
Transfer efficiency, minimum[c]	70%

a. 3 duty and 0 standby units
b. Estimate assumes an ozone concentration of 10%, which is recommended for sizing sidestream flow.
c. Transfer efficiency should be achieved for the design "worst-case" water quality, maximum flow, with the maximum design ozone dose, or equivalent.

3.2.3.10. Ozone Contactor

The ozone contactor (i.e., ozone basin) will provide head to the upstream mixing structure, facilitate ozone dissolution, provide contact time, and facilitate the removal of ozone off-gas. These features

of the ozone contactor are described in more detail in the following subsections. Ozone contactor design criteria are provided in Table 3-11.

3.2.3.10.1. Static Head

The upstream flash reactor requires backpressure to ensure that fine bubbles are created in the mixing process. Fine bubbles have a larger surface area to volume ratio than coarse bubbles, which increases ozone gas dissolution into the liquid stream. Increasing backpressure leads to finer bubbles and thus more efficient ozone gas dissolution (with diminishing returns at approximately 24 feet of pressure). The backpressure will be at least 12 feet. The backpressure is expected to come from the ozone contactor elevation (20 feet), and not from a head loss device, such as a valve downstream of the flash mixer.[19]

3.2.3.10.2. Ozone Dissolution

The ozone contactor will facilitate dissolution of the gaseous ozone because the flash reactor will be designed to discharge fine bubbles into the ozone contactor. The depth of the ozone contactor will aid this further dissolution. After the bubbles have contacted with the water in the first cell of the ozone contactor, the gas escapes from the liquid phase at the water surface over the first baffle. To facilitate fine bubbles for both optimum mixing and dissolution and extended contact time in the first cell of the contactor, the AWT Facility ozone contact basin will have a 20 foot water depth.

The length of pipe between the flash reactor and the ozone contactor will be minimized to avoid bubble accumulation at the crown of the contactor inlet piping. This length of piping will include a tee, two reducers (after the tee, to maintain high velocities in the pipe after the split in flow), two isolation valves (one for each contactor, downstream of the tee), and two ninety-degree elbows (one per contactor) to split the flow to the two ozone contactors. The tee will be placed immediately downstream of the flash reactor to split the flow while it is well mixed. Additional mixing will occur at the elbows, just before discharge into the contactors.

3.2.3.10.3. Contact Time

The ozone contactor will also provide contact time for the dissolved ozone to react and dissipate. After gaseous ozone mixes with the secondary effluent, it dissolves into the liquid. Most of the dissolved ozone will react rapidly (within seconds) with organics and other reduced chemicals, such as reduced iron, manganese, and nitrite; however, some organics require more time (multiple minutes). This reaction time must occur upstream of the membrane systems because membranes are sensitive to ozone, which may degrade their performance through the oxidation of the membrane surface. The ozone contactor will give time for the dissolved ozone to react with recalcitrant organics and time to dissipate before the ozonated effluent is discharged to the MF system.

The contact time at the pilot proved sufficient for dissipating the dissolved ozone residual for moderate ozone doses (hydraulic residence time [HRT] of 3 minutes, and assumed baffling efficiency of 90%: t_{10} of 2.7 minutes, where t_{10} is the time for 10% of an input concentration to be observed at

[19] A pipeline contactor, instead of a concrete basin, may be considered in the next phase of design if similar pretreatment can be obtained at a reduced cost.

the outlet of the contactor system). Given the imperative to not send a dissolved ozone residual downstream, the t_{10} was designed for 5.7 minutes, or greater, which is approximately twice the t_{10} observed during piloting. This extended contact time will act as a redundant barrier to the quenching system for protecting downstream membrane equipment.

3.2.3.10.4. Ozone Off-gas

The ozone contactor traps the ozone off-gas and directs it to the ozone destruct unit. Due to inefficiencies in mixing, limitations of ozone solubility, or variability in the ozone demand, not all of the injected ozone is dissolved into the liquid. Some of the applied ozone remains in the gaseous form, and some of the dissolved ozone may volatilize during contacting. This ozone gas is captured in the headspace of the ozone contactor and sent to the ozone destruct unit. Sufficient headspace will be provided to facilitate the movement of ozone gas, and the buildup of any foam. A headspace of 5 feet is typical, and will be used at the AWT Facility (B&V, 2010).

3.2.3.10.5. Contactor Configuration

An over-under contactor will be used at the AWT Facility because it can achieve reasonable baffling efficiencies, facilitate additional ozone dissolution, and allow for reasonable channel widths given the water depth constraint discussed previously (a schematic representation of an over-under baffled concrete contactor is shown in Figure 3-5.).

Table 3-11: General Ozone Contactor Design Criteria

Parameter	Value
Configuration	Over-under baffled concrete basin
Flash reactor backpressure feet	As close to 20 feet as feasible
Water Height feet	20
Pipe length connecting flash reactor to ozone contact basin	As short as is feasible
Contact time HRT, min	8.8
Water height to baffle separation ratio	≥ 4:1
Baffle separation to baffle gap ratio	1:1
Headspace feet	5

3.2.3.10.6. Baffling Efficiency

To maximize baffling efficiency, the water depth will be at least four times greater than the horizontal distance between baffles, which will be equal to the vertical distance between baffles and the basin floor or water surface (Crittenden, 2012). In addition, increasing the length to width ratio (L:W) tends to increase baffling efficiency in contacting basins, and so the number of baffles was chosen to reach a suitable L:W ratio.

The dimensions provided in Table 3-12 were selected based on the above discussion regarding baffling efficiency and other design considerations. The flow control device on the end of the ozone contactors will be a weir to keep the water depth at 20 feet.

Table 3-12: Specific Ozone Contactor Design Criteria

Parameter	Value
Basin Design	Closed concrete basin with over-under baffles
Influent Flow Rate mgd/tank	2.73
Contact Time minutes	8.8
Liquid Volume per tank gal	16,755
Head Space feet	5
Baffle Design	
Number	6
Gap Height feet	4
Spacing feet	4
Channel Dimensions:	
Channel width feet	4
Channel depth, water depth feet	20

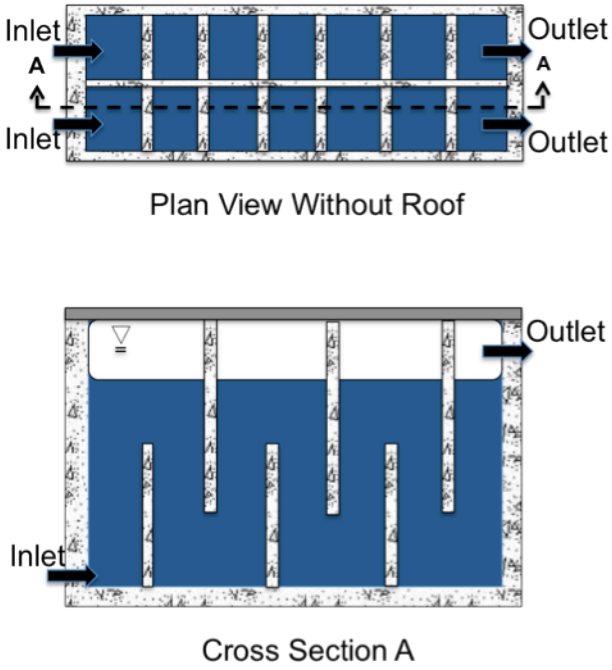


Figure 3-5. Conceptual plan and section view of the ozone contactor

3.2.3.10.7. Foam

The water quality received during pilot testing did not create excessive foam. Sprayers suspended from the ceiling of the ozone contact basin will be provided to knock down foam that does occur, as is needed. In particular, sprayers will keep foam from entering the ozone destruct system.

3.2.3.10.8. Flow Control

Modulating effluent weir gates will be installed on the contactors to adjust for discrepancies in head loss between the two contactors. The gate positions will be determined after installation, and will be a function of AWT Facility flow.

3.2.3.10.9. Overflow

The ozone contactor is the final component of the ozone system, and the ability to waste will be included for occasions when the ozone system flow exceeds the downstream flow and storage capacity. This overflow is expected to only be used on an emergency basis, and it will be directed to the MRWPCA RTP headworks or discharged through the ocean outfall.

3.2.3.11. Ozone Destruct System

Un-dissolved ozone that off-gases inside of the ozone contactor will be piped to the ozone destruct system. A blower will be installed to maintain a negative pressure in the headspace of the contactor. The design criteria for the ozone destruct system are shown in Table 3-13.

Large concentrations of ozone may be sent to the ozone destruct system when the ozone system is shut down and the generator is purged of gas with a high ozone concentration. In normal operation, the ozone destruct will only receive the gaseous ozone that did not dissolve into the bulk flow. The fraction of excess ozone should be low, as the specified transfer efficiency is greater than 70%. Gaseous ozone sensors will be located prior to and after the ozone destruct. The sensors upstream of the destruct will be used to calculate the ozone transfer efficiency, while the downstream sensors will be used to ensure ozone destruction.

Table 3-13: Ozone Destruct Design Criteria

Parameter	Value
Number of destructs	1
Maximum ozone concentration in ozone vent-gas, ppm[a]	0.05

a. Occupational Safety & Health Administration heavy work, 8-hour limit; parts per million – ppm.

3.2.3.12. Instrumentation

3.2.3.12.1. Sample Taps

Sample taps will be included immediately downstream of ozone injection, at a hydraulic residence time of 15 seconds and 30 seconds at design flow (assuming plug flow throughout the contactor),

and in the middle of each of the 7 cells in the ozone contactor.[20] Sample taps will also be included at the end of the ozone contactor, and after the quenching system (the quenching system will be used, if needed, to quench residual dissolved ozone). The sample lines from the contactor cells will be directed to instrumentation manifolds, which will have the ability to measure water from any of the sample points. Redundant instrumentation per manifold will be installed to maintain ozone control during instrumentation maintenance. The ozone effluent and quenching effluent sample times will lead to dedicated instruments to keep sample-piping length to a minimum, which will allow for a representative dissolved ozone concentration and an accurate dosing of the quenching chemical. The secondary effluent sample taps will go to a third set of instruments.

3.2.3.12.2. Instrumentation & Control

Instrumentation is required to monitor the ozone influent and effluent water quality, to control the ozone dose, and to control the ozone residual quenching system. Instruments will be provided for each contactor to help diagnose operational issues. The proposed instrument locations are summarized in Table 3-14.[21]

The ozone dose will be controlled by trimming to a dissolved ozone residual. This method of control leads to an automatic adjustment of ozone dose based on changes in ozone demand (e.g., caused by changes in nitrite or TOC concentrations), thereby maintaining the O_3:TOC ratio close to the O_3:TOC ratio associated with the design ozone dose and water quality. For example, if the nitrite or TOC concentrations in the ozone feed increase, and correspondingly increase the ozone demand, the ozone residual will decrease, which would cause the control system to respond by increasing the ozone dose until that the ozone residual reaches the ozone residual setpoint. This method of control (feed back) does not require online nitrite or TOC analyzers (feed forward) or grab samples, and bromate formation is minimized by maintaining the O_3:TOC ratio close to the design O_3:TOC ratio.

[20] The sample tap locations may be modified in the next phase of design based on experience at the Demonstration facility.

[21] Instrumentation may be modified in the next phase of design based on experience at the Demonstration facility.

Table 3-14: Sensors for Ozone Control

Sensor[a]	Number of sensors	Locations[b]
UVT	4	Secondary effluent (1+1), ozonated effluent (1+1)
Dissolved ozone	6	Contactor instrument manifold (2+2), ozone effluent, quench effluent
ORP[c]	7	Sec. effluent, contactor instrument manifold (2+2), ozone effluent, quench effluent

a. Ultraviolet light transmittance – UVT; Oxidation-reduction potential – ORP; sensors should be applicable to ozonated secondary effluents.
b. (Duty+standby)
c. 15 and 30 seconds at design flow (2.73 mgd per contactor); all sample taps should draw from the middle of the contactor.

3.2.3.13. Quenching System

An ozone quenching system is included to increase operational flexibility. The system will consist of one dissolved ozone (DO_3) sensor to measure the dissolved ozone before quenching, and DO_3 and ORP sensors after the quenching system to confirm adequate quenching. Quenching will be achieved with sodium bisulfite.

The system will be sized to quench a maximum of 0.5 mg/L of DO_3. Mixing will be provided immediately downstream of the quenching chemical addition. Rapid mixing allows the quenching agent to react more readily with the stronger oxidant, ozone, instead of consuming chloramines. The quenching system design criteria are shown in Table 3-15.

Table 3-15: Quenching System Design Criteria

Parameter	Units	Value
Number of quenching systems	duty + redundant	1+1
Quenching chemical	N/A	Sodium bisulfite
Maximum dose	mg/L	0.5
Minimum dose	mg/L	0.05

3.2.3.14. Layout and Materials

3.2.3.14.1. Layout

The following equipment will be placed indoors:

- Ozone generator
- Cooling water systems
- Power supply units
- Ozone control panel
- Nitrogen boost system

The following equipment may be placed outside, if necessary (ideally all equipment is located indoors due to the marine environment):

- LOX equipment
- Injection system (under a roof is recommended)
- Ozone destruct units

3.2.3.14.2. Materials

Wetted parts that may contact an ozone residual will be made out of one of the following materials:

- Stainless steel 316 or 316 L grade piping
- Concrete contactor
- Teflon gaskets
- PVC sample piping

3.2.4. Membrane Filtration Treatment System

The MF treatment system will process water pretreated by the ozone system to condition it further for downstream treatment by the RO system. The MF system is proficient at removing particulate matter from the RO feed water that will otherwise foul the RO process membranes. The system will include the following components:

- MF Feed pump station[22]
- Automatic strainers
- MF membrane process units
- Membrane backwash/reverse flush pumps
- Compressed air system
- Clean in place (CIP) system
- Enhanced flux maintenance (EFM) system
- Reverse filtration (RF) system

The system will have an installed capacity of 4.94 mgd, sufficient to support an RO system capacity of 4.0 mgd operating at 81% recovery. Individual subsystem components of the MF system are discussed in the following subsections.

3.2.4.1. Raw Water Characteristics

Assumed secondary effluent quality related to the MF and RO systems is shown in Table 3-16.

[22] The MF feed pump station may be removed in the next phase of design, as pressure may be provided through a pipeline contactor or from the ozone concrete contactor.

Table 3-16: Design Influent Quality

Assumed MF Influent Water Quality[a, b]		
Alkalinity (in $CaCO_3$ units)	mg/L	297.9
Ammonia as N	mg/L	33.1
Bromide	mg/L	0.2
Calcium	mg/L	57.3
Chloride	mg/L	233.0
Conductivity (Specific Conductance)	µS/cm	1593.5
Iron	mg/L	0.4
Magnesium	mg/L	21.3
Manganese	mg/L	0.053
Nitrate (as NO_3)	mg/L	27.3
Nitrite (as N)	mg /L	1.2
Nitrate + Nitrite as N	mg /L	7.1
pH	pH	7.5
Phosphate (Orthophosphate as P)	mg/L	3.8
Potassium	mg/L	20.0
Silica	mg/L	39.0
Sodium	mg/L	158.0
Sulfate	mg/L	89.3
Sulfide	mg/L	--
Temperature	°C	20.6
TDS	mg/L	821.2
Total hardness as $CaCO_3$	mg/L	234.7
Total Kjeldahl Nitrogen	mg/L	34.2
Total N	mg/L	41.2
Turbidity	NTU	3.3

a. Assumed MF influent water quality is the average of water quality grab samples collected during the first three-quarters of the piloting program, from December 10, 2013 to May 6, 2014, with number of samples per constituent ranging from 3 to 21.

b. Calcium carbonate - $CaCO_3$; Nitrate - NO_3; Phosphorus - P; Microsiemens per centimeter - µS/cm; Nephelometric turbidity units – NTU.

3.2.4.2. Membrane Filtration Feed Pump Station

The MF feed pump station will receive project source water pretreated by the ozone system and the addition of sodium hypochlorite upstream of the ozone system. The pump station will have a hydraulic residence time of roughly 20 minutes at 5.0 mgd. The MF feed pump station, and other facilities, may be designed for an RO product flow of 5.0 mgd, instead of 4.0 mgd, for symmetry

during a possible future upgrade to 10 mgd. The volume will be sufficient to equalize variable flows into the MF membrane units during normal cycles of filtration and backwash, allowing a steady flow through the upstream ozone system. The feed pumps will be vertical turbine type, configured in a 3 x 50% arrangement. The pumps will be equipped with variable speed drives to allow operation at variable flow and pressure conditions related to operating sequences of the MF units and auto-strainers. The variable speed drives will also operate when pressure fluctuations occur due to changes in permeability of the MF process membranes between CIP sequences. Design criteria for the MF feed pump station are provided in Table 3-17.

Table 3-17: MF Feed Pump Station

MF Pump Station[a]	
MF Feed Wet Well	
Type	Cast-in-place Concrete
Dimensions (feet)	20 x 35 x 18
Capacity (gal.)	94,250
MF Feed Pumps	
Number of Pumps	3
Operating Configuration	3 x 50%
Pump Type	Vertical Turbine
Materials of Construction	Standard Fitted
Pump Capacity (gpm)	2,670
Pump Head (feet)	100
Pump Motor Size (hp)	100
Pump Drive	Variable Speed

a. Gallons per minute – gpm; Horsepower – hp.

3.2.4.3. Automatic Strainers

The automatic strainers will provide particulate removal prior to the MF units and will also protect the hollow fiber membranes. The strainers are an automatic backwashing type, which can continue to filter water during the backwash process, which will be a cyclical process and last for roughly 30 seconds. The process can be triggered by time, differential pressure loss, or remote-manual initiation. The anticipated recovery of the automatic strainers is greater than 98%. Design criteria are presented in Table 3-18.

Table 3-18: Automatic Strainers

Automatic Strainers[a]	
Number of Strainers	3
Operating Configuration	3 x 50%
Type	Automatic, Self-Cleaning
Materials: Body Screen Backwash Valve Seals	 Epoxy coated carbon steel 316L SS Epoxy coated cast iron EPDM
Rated Capacity (gpm)	2,670
Maximum Pressure Drop at Rated Flow (psid)	1.4
Screen Size (Rating) (microns)	100 - 500
Screen Type	Weave wire
Flush Cycle Time (seconds)	30
Flush Volume per Cycle (gallons)	111
Recovery, %	>98
Drive	Fixed Speed
Motor Size (hp)	1/2

a. Ethylene Propylene diene rubber – EPDM; Pounds per square inch – differential - psid; Stainless steel – SS.

3.2.4.4. Membrane Filtration System

The piloting program revealed that the outside-in filtration path outperformed the inside-out alternative; and that the polyvinylidene difluoride (PVDF) membranes formed by thermally induced polymerization (as manufactured by Toray and Pall/Asahi) exhibited stable permeability at a flux rate of 30 gallons per day per square foot (gfd). Therefore, this type of MF system was selected for the AWT Facility (see design criteria in Table 3-19 for a Pall system).

The core of a typical MF system is the MF block, or unit. Each unit incorporates the following, which will be mounted on a coated steel frame:

- Hollow fiber MF membrane modules mounted vertically on high density polyethylene manifolds,
- Process flow piping and valves,
- Instruments, and
- Electrical and pneumatic panels.

Individual units will be connected via a manifold from one common feed, and a set of feed pumps operating on variable frequency drives will provide the influent flow (MF Feed Pumps described previously). The speed of these pumps will be adjusted to attain a desired filtrate flow rate, with modulating valves on each unit controlling its respective flow. The individual units are all equipped with cleaning and enhanced flux maintenance capabilities, process and control air, drains, scrub air connections and reverse flush headers to achieve the desired rate of system production.

During operation, MF system feed water will enter the bottom of a module and travel through large holes to the exterior of the fibers in the main body of the module. The feed water within the module housing permeates through the hollow fiber membranes into the interior lumens. The filtered water then exits through the top of the module and continues to the permeate connection.

Aside from normal operation, the two other automatic operating modes include:

1. Reverse filtration/air scrubbing (RF/AS): removes accumulated particulates from the membranes, and
2. Daily- EFM: restores permeability.

The RF/AS sequence occurs automatically after 15 minutes of filtration time and takes approximately 120 seconds to complete. The MF system will continuously cycle between filtration and RF/AS cycles with the exception of the daily EFM. Once per day, the modules are cleaned via an EFM cycle, which takes approximately 60 minutes to complete. Residuals from the RF/AS and EFM are sent to the RTP headworks, after quenching or pH neutralization, as necessary.

Table 3-19: Microfiltration System

MF Units[a]	
System Rated Capacity (mgd)	4.94
Number of MF Blocks (duty + redundant)	4+1 or 3+1
Number of MF Modules per Block	104 or 120
Number of Blocks per Support Skid	1
Membrane Type	0.1 – 0.01 micron PVDF
Module Model No.	UNA-620A
Membrane Area per Module (square feet)	538
Specific Design Flux (gfd)	30
Module Production at Rated Capacity (gpm/module)	8.3
RF/AS Cycle Interval (minutes)	15
RF/AS Cycle Duration (minutes)	1
RF Filtrate Flow (gpm/module)	8
AS Air Flow (scfm/module)	3
Feed Flush Cycle Duration (min.)	0.33
Feed Flush Flow (gpm/module)	18
Waste Volume per module per day (gallons)	1,150
EFM Frequency	NaOCl Once per day, Citric acid every 10 days
EFM Duration (minutes)	60
Minimum Recovery (%)	92

a. Standard cubic feet per minute – scfm; Sodium hypochlorite – NaOCl.

3.2.4.5. Compressed Air System

The main components of the compressed air system are listed in Table 3-20. Compressed air will be used in the MF system as process air during the periodic air scrub sequence and as control and valve

operating air throughout the system. The air used will be dry and oil-free, per the Instrument Society of America Standard S7.3.

Table 3-20: Compressed Air System

Compressed Air System	
Air Compressors[a]	
Number	2
Operating Configuration	2 x 100%
Type	Oil-free, air-cooled, rotary tooth
Capacity, scfm	79
Minimum Design Pressure, psig	145
Motor Size, hp	25
Maximum Motor Speed, rpm/Enclosure	3600/TEFC
Air Receiver	
Number	1
Type	Vertical cylindrical
Volume, gallons	620
Design Pressure, psig	150

a. Revolutions per minute – rpm; Totally enclosed fan-cooled – TEFC.

3.2.4.6. Clean-in-Place System

The function of the CIP system is to regenerate the membranes when they become fouled with constituents that are not removed by the periodic RF/AS and EFM sequences. The main components of the CIP system are summarized in Table 3-21, and the chemical transfer systems are detailed in Table 3-22. During the cleaning of a unit, the remaining units, including the dedicated spare unit, will maintain the maximum required system production level.

Table 3-21: Clean-in-Place System

CIP System[a]	
MF CIP Tanks	
Number	2
Type	FRP
Capacity (gallons)	2100
MF CIP Heater	
Number	2
Type	Flanged Immersion
Size (kW)	75
Panel Description	Contains heater contactor, controls, and misc. instruments
Enclosure	NEMA 4X SS
Strainer	
Number	1
Type	Inline Basket
Size	6-inch
Materials	PVC with EPDM gaskets
MF CIP Pump	
Number	1
Type	Horizontal Centrifugal
Materials	FRP
Capacity at Design Point (gpm)	420
Head at Design Point (feet)	60
Drive	Constant Speed
Motor Size (hp)	15
Maximum Motor Speed (rpm/Enclosure)	1800
Neutralization Tank	
Number	1
Type	FRP
Capacity (gallons)	4000
Neutralization Tank Mix Pump	
Number	1
Capacity at Design Point (gpm)	200
Head at Design Point (feet)	20
Motor Size (hp)	3

a. Kilowatts – kW.

Table 3-22: Chemical Transfer Systems

Chemical Transfer Systems	
Citric Acid	
Citric Acid Tank	1
Number	1
Type	Polyethylene
Capacity (gallons)	400
Citric Acid Pump	
Type	Mechanical Diaphragm
Materials	PVC
Rated Capacity (gpm)	5
Rated Pressure (psig)	50
Motor Size (hp)	0.75
Sodium Hydroxide	
Sodium Hydroxide Tank	
Number	1
Type	Polyethylene
Capacity, gallons	1600
Sodium Hydroxide Pump	
Type	Mechanical Diaphragm
Materials	PVC
Rated Capacity (gpm)	5
Rated Pressure (psig)	50
Motor Size (hp)	0.75
Sodium Hypochlorite	
Sodium Hypochlorite Tank	
Number	1
Type	FRP
Capacity (gallons)	9990
Sodium Hypochlorite Pump	
Type	Mechanical Diaphragm
Materials	PVC
Capacity (gpm)	5
Rated Pressure (psig)	50
Motor Size (hp)	0.75

3.2.4.7. Enhanced Flux Maintenance System

The EFM system will use the main CIP system for daily cleans. The most frequently used solution, sodium hydroxide (NaOH), will be stored in a tank fitted with two immersion heaters. This is to account for the number of units in the system and the shorter heating times between required cleanings.

3.2.4.8. Reverse Filtration System

The RF system is provided to perform routine regeneration of the membrane fibers (components are summarized in Table 3-23). The system reverses the flow of the MF system, moving filtrate from the inside of the fibers, through the membrane and to drain. The flow rate for this process will be approximately 8 gpm per module. The RF pumps will be equipped with variable speed drives to maintain the target flow over variable trans- membrane pressure losses through the MF modules based on the degree of fouling. The pumps will draw off the main filtrate manifold en route to the filtrate clear well.

Table 3-23: Reverse Filtration System

Reverse Filtration System	
Number of Pumps	2
Operating Configuration	2 x 100%
Type	Horizontal end suction centrifugal
Materials	Cast Iron Housing /316 SS Impeller
Capacity at Design Point (gpm)	835
Head at Design Point (feet)	92
Drive	Variable Speed
Motor Size (hp)	30
Max. Motor Speed (rpm)	1800

3.2.5. Reverse Osmosis Membrane Criteria and Performance Monitoring

The RO process is used to remove dissolved constituents such as dissolved salts, pathogens, pesticides, organics, pharmaceutical compounds, and other CECs. The RO system will include:

- Cartridge filters,
- RO membrane trains,
- RO CIP system, and
- RO membrane flush system.

The rated flow capacity will be from 1.6 to 4.0 mgd. The RO may turn down such that the RO permeate is below 1.6 mgd by reducing the recovery of the system. The minimum cross-flow velocity limits the low flow condition across the membranes. Preliminary planning efforts have projected scenarios where 1.3 mgd of AWT Facility production is desired. The RO system will meet this goal (1.3 mgd permeate) by reducing the recovery from 81% to 78%.

3.2.5.1. Reverse Osmosis Wet Well and Transfer Pump Station

Filtrate from the MF system will flow to a below-grade wet well for intermediate storage and pumping ahead of the RO system. The wet well provides equalization storage between variable rates of MF filtrate flow (due to backwash and cleaning cycles) and the continuous, stable flow required to the RO system. The target hydraulic residence time will be roughly 30 minutes at a design flow of 5.0 mgd. The pumps will be low-pressure transfer type, providing flow through the

pretreatment cartridge filters and chemical addition systems ahead of the inline high-pressure booster pumps feeding the RO membrane trains. The pumps will be fixed speed, with variable speed controls on the RO train booster pumps used to adjust the overall RO system pressure and flow requirements. Design criteria for the RO feed pump station are provided in Table 3-24.

Table 3-24: RO Feed Pump Station

RO Feed Pump Station	
MF Filtrate Wet Well	
Type	Cast-in-place Concrete
Dimensions (feet)	20 x 60 x 15
Capacity (gallons)	134,650
RO Transfer Pumps	
Number of Pumps	3
Operating Configuration	3 x 50%
Pump Type	Vertical Turbine
Materials of Construction	Standard Fitted
Pump Capacity (gpm)	1,715
Pump Head (feet)	92
Pump Motor Size (hp)	60
Pump Drive	Constant Speed

3.2.5.2. Pretreatment Facilities

RO pretreatment facilities will include cartridge filtration and the addition of sulfuric acid and a scale inhibitor (see Table 3-25). The cartridge filters will remove any large particles in the MF filtrate that could interfere with RO filtration. Sulfuric acid will be used to lower the feed pH to the RO system and help prevent mineral scaling with the assistance of the scale inhibitor (see Table 3-26). The primary scalants of concern are calcium phosphate and silica; pH adjustment (down to a set point as low as 6.0) will be the primary control of calcium phosphate scale, while the scale inhibitor will be relied on to prevent the scaling of silica. The above approach worked well in keeping scaling at a minimum during the six-month pilot test period and has been so far successful in the Demonstration Facility.

Table 3-25: RO Cartridge Filters

RO Cartridge Filters	
Number	3
Operating Configuration	3 x 50%
Type	Horizontal top inlet/end outlet housing; cylindrical depth cartridge elements
Cartridge Elements/Housing	176
Rated Capacity of Housing (mgd)	2.45
Max. Loading Rate, gpm/10-inch equivalent	3
Cartridge Element Rating (microns)	20
Materials	
Housing	316 SS
Cartridge Elements	Polypropylene

The cartridge filter vessels will be horizontal type to facilitate the loading and unloading of filter elements.

Table 3-26: Reverse Osmosis Chemical Systems

RO Chemical Systems	
Scale Inhibitor	
Scale Inhibitor Tank	
Number	1
Type	Polyethylene
Capacity (gallons)	470
Scale Inhibitor Pumps	
Type	Hydraulic Diaphragm
Materials	316 SS / PTFE
Capacity (gph)	11.5
Rated Pressure (psig)	100
Sulfuric Acid	
Sulfuric Acid Tank	
Number	2
Type	Horizontal Lined Steel
Capacity (gallons)	8200
Sulfuric Acid Pumps	
Type	Hydraulic Diaphragm
Materials	Alloy 20/PTFE
Capacity (gph)	56
Rated Pressure (psi[a])	100

a. Pounds per square inch – psi.

3.2.5.3. Reverse Osmosis Trains

The main RO system equipment will include two independent RO membrane trains[23]. Trains will be sized for 2.0 mgd of permeate production. Target recovery is 81% with a two-stage system. Each train will contain 60 pressure vessels in a 40:20 array. Each vessel contains seven 8-inch diameter by 40-inch long RO membrane elements. Vessels are arranged in a tree configuration with six trees per train with each tree containing ten vessels; each side of the tree contains five vertically-stacked vessels. Limiting the vessel height to six vessels or less allows access to any vessel within the rack from the normal operating floor, which is a convenience to operators.

The trains will be connected to common feed, permeate, concentrate, flush feed, flush waste, and cleaning system headers. Product water from each train will be combined and piped to the UV system reactors. Concentrate from the trains will be combined and sent to the existing RTP outfall for disposal. Cleaning and flushing residuals will be neutralized and sent to the plant waste equalization basin prior to return to the RTP headworks. Design criteria are provided in Table 3-27.

[23] Additional trains may be considered in the next design phase to achieve greater coverage of possible flow conditions.

Table 3-27: Reverse Osmosis System

RO System	
RO Feed Pumps	
Number	2
Operating Configuration	2 x 50% (one per train)
Type	Vertical Turbine
Materials	316 SS
Capacity at Design Point (gpm)	1715
Head at Design Point (feet)	150 - 580
Drive	Variable Speed
Motor Size (hp)	350
Max. Motor Speed (rpm/Enclosure)	1800/TEFC
RO Membrane Trains	
Number	2
Permeate Capacity (each), (mgd)	2.0
Recovery (%)	81
Pressure Vessel Array	40:20
Pressure Vessels	
Type	FRP, feed/concentrate side port configuration
Design Operating Pressure (psig)	450
Size	To contain seven 40-inch x 8- inch diameter elements
Membrane Elements	
Number (Total)	840
Element Type	Spiral Wound
Membrane Type	High Rejection, Polyamide composite
Element Length (inches)	40
Element Diameter (inches)	8
Min. Surface Area (square feet)	400
Average Rejection (%)	99.5
Average Flux at Rated Capacity (gfd)	12.0
Pressure Vessel Racks	
Number (per Train)	6
Type	T-style frames
Materials	Welded Steel
Concentrate Control Valves	
Type	Globe with anti-cavitation trim
Size, inches	3.0
Minimum Valve Coefficient	4.6
Maximum Valve Coefficient	86.7
Maximum Sound Level at any point, decibel A	80

3.2.5.4. Clean-in-Place System

The CIP system is an ancillary facility provided for in-situ chemical cleaning of the RO membranes. This permanently piped system will be used to prepare and recirculate a chemical cleaning solution independently through each stage of the RO membrane trains. The CIP system will be operated from a local control panel. See Table 3-28 for system components.

Cleaning chemicals will be loaded into the CIP tank using a bag loader or eductor for batching of dry fed chemicals directly to the tank, which will be diluted with RO permeate. The CIP pump will draw from the CIP tank and, to mix the contents, will be capable of circulating the solution to either the RO train or back to the CIP tank. The cleaning tank will be fitted with a pair of flanged immersion heaters to achieve the required temperature of the cleaning solution. A small liquid chemical addition system will be provided to adjust the cleaning solution pH if necessary. Two process lines are provided to the RO train; one pipeline is used to convey the cleaning solution to the membranes while the other is to return the cleaning solution to the CIP tank. Piping connections at each RO train allow for each membrane stage to be cleaned independently. Piping and valving at the CIP tank is provided to allow for (1) recirculation of the cleaning solution back to the tank, (2) sent to the MF system neutralization tank, or (3) sent directly to the plant waste equalization tank for return to the RTP.

A utility water service connection that meets DDW cross connection control requirements will be provided to allow use of potable water for preparation of the cleaning solution when RO permeate is not available. The CIP tank heaters are monitored and controlled by a tank-mounted thermocouple that is part of the heater unit.

Table 3-28: RO Clean-in-Place System

RO CIP	
CIP Tank	
Number	1
Type	FRP
Capacity (gallons)	7615
CIP Pump	
Type	Horizontal Centrifugal
Materials	316 SS
Capacity at Design Point (gpm)	1000
Head at Design Point (feet)	140
Drive	Variable Speed
Motor Size (hp)	60
Max. Motor Speed (rpm/Enclosure)	1800/TEFC
CIP Tank Heater	
Number	2
Type	Flanged Immersion
Size (kW)	125
Panel Description	Contains heater contactor, controls, and misc. instruments
Enclosure	NEMA 4X SS

3.2.5.5. Reverse Osmosis Membrane Flush System

The flush system is an ancillary facility provided for periodic *in-situ* flushing of the RO membranes. This permanently piped system will be used to displace residual feed and concentrate from the RO membranes on train shutdown. It can also be used to periodically displace stagnated solution during extended train shutdowns.

Source water for flushing will be RO permeate stored in an above grade storage tank. The tank will be continually filled and pumped into the UV system influent header to ensure it does not stagnate. A dedicated flush pump drawing from the tank will provide flow to the inlet side of the RO membrane feed pumps, which will pump the solution through the membrane pressure vessels. The majority of the flush supply will remain on the feed/concentrate side of the membrane elements due to the relatively low delivery pressure. A waste valve on the final concentrate line will be opened during flushing to discharge displaced waters to waste. To avoid the creation of backpressure during flushing, the permeate dump valve will also open to discharge accumulated permeate to waste.

A separate set of pumps will draw from the tank to maintain a clean flush supply between intermittent flushing. The solution will be pumped into the UV system feed header, or routed to the MF and RO cleaning systems for solution makeup and/or flushing. Design criteria for components of the flush system are provided in Table 3-29.

Table 3-29: RO Flush System

RO Flush System	
Flush Tank	
Number	1
Type	FRP
Capacity (gallons)	19500
Flush Pump	
Type	Horizontal Centrifugal
Materials	316 SS
Capacity at Design Point (gpm)	500
Head (feet)	120
Drive	Constant Speed
Motor Size (hp)	30
Max. Motor Speed (rpm/Enclosure)	1800/TEFC
Flush Transfer Pumps	
Type	Horizontal Centrifugal
Operating Configuration	2 x 100%
Materials	316 SS
Capacity at Design Point (gpm)	125
Head (feet)	50
Drive	Variable Speed
Motor Size (hp)	2.5
Max. Motor Speed (rpm/Enclosure)	1800/TEFC

3.2.6. Advanced Oxidation Process Design Option and Performance Monitoring

AOPs are those in which hydroxyl radicals are generated at ambient temperature and pressure in order to facilitate oxidation of organic compounds. Hydroxyl radicals react rapidly with organics, making AOP an effective strategy for reducing the concentration of specific trace organic compounds and recalcitrant compounds. Advantages of AOPs include their ability to significantly reduce the concentrations of many CECs to acceptable levels s, and the relatively short hydraulic residence time required. An AOP is also able to provide a high level of pathogen inactivation.

The AOP chosen for the Project is low pressure UV with hydrogen peroxide (UV/H_2O_2). It was selected for two reasons: (1) ozone is already used in the process train as a oxidant (it also provides disinfection), and (2) H_2O_2 is used as part of AOP systems in existing groundwater replenishment projects using full advanced treatment, and thus has a proven track record (for example, the OCSD's GWRS). The principle behind this process is that H_2O_2 reacts with UV light to form hydroxyl radicals, which then oxidize the target compounds.

3.2.6.1. Reduce Recalcitrant Compounds

In full advanced treatment, an AOP follows RO, which is capable of reducing the concentration of many organic and inorganic compounds to very low levels. However, some particularly recalcitrant, low molecular weight compounds are removed less effectively. Examples include NDMA and 1,4-

dioxane. During the pilot testing, NDMA removal through RO was approximately 40%. The Title 22 Criteria require a specific 0.5-log reduction for 1,4-dioxane. Thus, AOPs are designed to achieve a certain level of removal of preselected recalcitrant compounds, 1,4-dioxane and NDMA. DDW has established NLs for 1,4-dioxane (1 µg/L) and NDMA (10 nanograms per liter or ng/L).[24]

This concept of AOP as a treatment barrier is illustrated in Figure 3-6, which shows the log removal of various CECs based on an AOP dose required to achieve 0.5-log removal of 1,4-dioxane. If 0.5-log removal of 1,4-dioxane is achieved, 0.5-log or greater removal of CECs that appear in Figure 3-6 to the left of 1,4-dioxane will be accomplished. This is important because it demonstrates that the UV/H_2O_2 process provides an effective barrier against CECs in potable reuse applications.

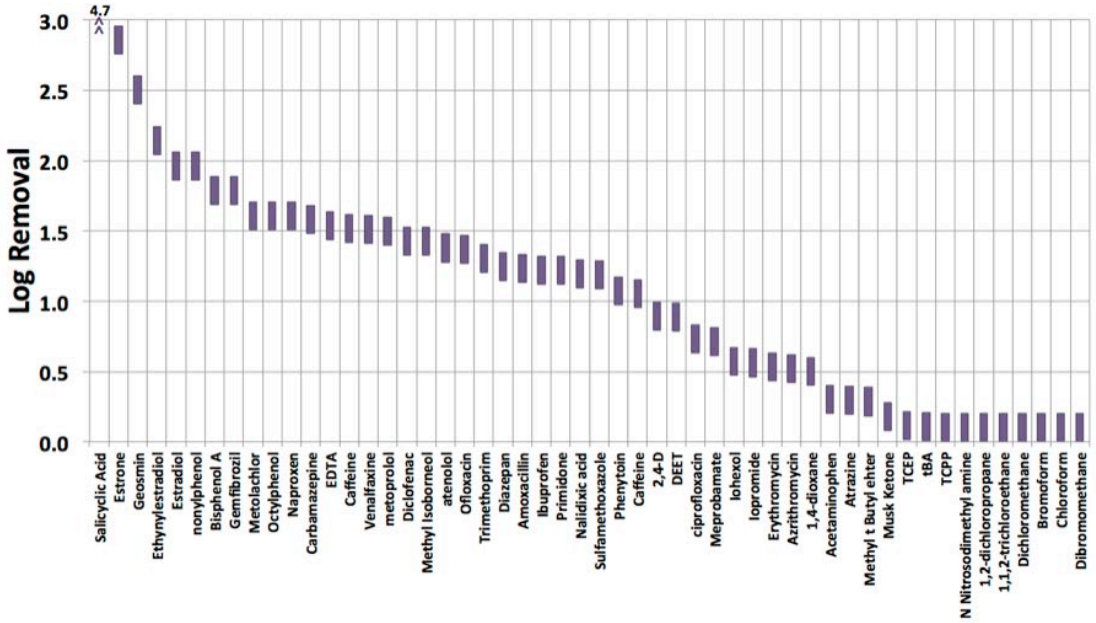


Figure 3-6. Log removal of CECs achieved when AOP dose removes 0.5-log 1,4-dioxane

3.2.6.2. Factors Affecting Advanced Oxidation Processes

Several factors affect the performance of AOPs by interfering with the production of hydroxyl radicals or by reacting with them. While these factors are of limited concern for the Project based on the high quality of RO permeate, additional information is provided in the following subsections for background.

3.2.6.2.1. Presence of Hydroxyl Radical Scavengers

The presence of bicarbonate and carbonate ions can reduce the efficacy of AOPs because these species are reactive with hydroxyl radicals. Although they react much slower than many organic

[24] Effective date February 4, 2015; see http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.shtml.

compounds, the concentrations of these hydroxyl radical scavengers are often orders of magnitude higher than those of the target compounds. Natural organic matter (NOM) also reacts with hydroxyl radicals, and can have a more detrimental impact on AOP performance than the carbonate species for some waters. Because bicarbonate, carbonate, and NOM are removed through the RO to a high degree, these are not a concern when performing AOP on RO permeate, making UV/AOP a very effective process for such applications.

3.2.6.2.2. Photolysis of Hydrogen Peroxide

In a UV/H_2O_2 process, oxidation is driven by the absorption of photons by H_2O_2 and the subsequent release of energy. The effectiveness of this process is dependent on the extent to which H_2O_2 undergoes photolysis. The presence of chemicals or organic molecules that absorb UV light can reduce the quantity of photons available to react with H_2O_2 and thus reduce the extent of oxidation. These constituents include NOM, NO_3, and iron, as well as the target compounds to a smaller degree (*e.g.*, CECs, 1,4-dioxane). While these compounds undergo photolysis due to UV exposure, the reduction of their concentrations is often more efficient via hydroxyl radicals generated by H_2O_2 photolysis, as many compounds are not amenable to UV photolysis alone in the absence of hydroxyl radicals. Hydroxyl radicals react rapidly with organics, and their second-order $^{\bullet}OH$ rate constants are generally several orders of magnitude faster than the rate constants for any conventional oxidant (Crittenden et al., 2012).

3.2.6.3. UV Lamp Technology

Two types of lamps were considered for this application: low pressure, high intensity (LPUV) lamps, and medium pressure, high intensity (MPUV) lamps. LPUV lamp technology was selected for the AOP system based on the following considerations:

- LPUV emits energy at one specific wavelength of 254 nanometers (nm), which is a wavelength that has been shown to be highly effective for NDMA destruction, and
- MPUV lamps have been shown to require higher energy inputs to achieve the same level of NDMA destruction as LPUV lamps.

MPUV lamps emit energy in the UV spectrum from 200 to 400 nm. Since H_2O_2 only absorbs photons in the 200-300 nm wavelength range, a portion of the energy emitted in the UV spectrum from 300 to 400 nm cannot be used to generate hydroxyl radicals.

3.2.6.4. Advanced Oxidation Process Design

The AWT Facility UV AOP system will be designed to handle 4 mgd flows and for specific log reductions of recalcitrant compounds, as defined in the following subsections.

3.2.6.4.1. 1,4-Dioxane Design Target

Based on the pilot testing, the concentration of 1,4-dioxane measured in the RO permeate was below the MRL of 1 µg/L, the same concentration as the NL. The 1,4-dioxane concentration target for the AOP system will be set to ½ the NL (0.5 µg/L).

3.2.6.4.2. NDMA Design Target

The NDMA design goal for the Project was set at 1 ng/L. Based on levels observed during piloting (a maximum NDMA concentration of 32 ng/L was observed in the RO permeate), the design removal for NDMA will be 1.5-log to achieve the goal of 1 ng/L.

3.2.6.5. Feed Water Quality

Based on the pilot testing results, the feed water quality for the UV/H_2O_2 AOP system is provided in Table 3-30.

Table 3-30: Advanced Oxidation Feed Water Quality

UV Peroxide AOP Feed Water Quality	
NDMA (ng/L)	≤ 50
1,4-dioxane (µg/L)	≤ 3
Temperature (degree C)	16-24
UV Transmittance at 254 nm	≥ 95%
Alkalinity (mg/L as $CaCO_3$)	≤ 20
TOC (mg/L)	≤ 0.5
TDS (mg/L)	≤ 60
TSS (mg/L)	< 1
pH	5-6.5
Calcium hardness (mg/L as $CaCO_3$)	≤ 5
Iron (mg/L)	< 0.1
Manganese (mg/L)	< 0.02

3.2.6.6. General UV Design Criteria

General design criteria for the UV/H_2O_2 system are defined in Table 3-31, which will apply to any competing manufacturer on the project. Trojan UV is currently the dominant manufacturer of reactors used in UV/AOP applications for advanced wastewater treatment, and is the manufacturer of the current MRWPCA Demonstration Facility's UV/AOP system. For this reason, more detailed design criteria will be presented for Trojan's UV reactor technology in the section that follows. Provided that the feed water quality conditions are consistent with the parameters defined in Table 3-30, the UV reactor will have a performance guarantee from the manufacturer that assures the criteria in Table 3-31 will be met.

Table 3-31: UV AOP System General Design Criteria

Parameter	Unit	Value
Flow rate	mgd	4.0
UV reactors	Number	Duty to achieve NDMA and 1,4-dioxane concentration reduction requirements (+standby for redundancy)
H_2O_2 dose	mg/L H_2O_2	2.5 - 6
UVT	% at 254 nm	≥ 95
NDMA reduction requirement	Log_{10} reduction	≥ 1.5-log
NDMA concentration in UV AOP treated water	ng/L	≤ 1
1,4-Dioxane reduction requirement	Log_{10} reduction	≥ 0.5-log
1,4-Dioxane concentration in UV AOP treated water	µg/L	≤ 0.5
UV dose	mJ/cm^2	Sufficient to achieve requirements above

Collimated beam bench testing has not yet been conducted on this water. In the absence of this testing, a manufacturer must use experience from similar projects to estimate the power required to meet the product water quality goals. Past studies have shown variation in the UV dose required to meet treatment targets. Given this variation, the UV/AOP system manufacturers may oversize their systems when providing a performance guarantee. Collimated beam bench testing may be conducted to limit oversizing and to minimize the risk of a full-scale installation that fails to meet the product water quality goals.

Pilot testing with a flow-through UV/H_2O_2 AOP system may also be done to improve the full-scale design. The manufacturers have models that, for example, use computational fluid dynamics to factor in hydraulic considerations and account for UV dose with the point source summation method, which can relate pilot scale results to full-scale reactors. This testing and analysis further refines the UV/AOP design and reduces risk.

One metric to compare competing technologies is the electrical energy per log order reduction (EE/O, typical units of kilowatt-hours per thousand gallons), shown in the following equation:

$$EE/O = EED / \log_{10}(C_i/C_e) = P_L/Q/\log_{10}(C_i/C_e)$$

where EED = electrical energy dose (kWh/kgal), C_i = feed concentration of a target constituent, C_e = treated water concentration of target constituent, P = total lamp power (kW), and Q = flowrate (mgd). A higher EE/O for the same condition is indicative that a process is more energy intensive to meet a given treatment target.

3.2.6.7. Ultraviolet Reactor

To determine the appropriate sizing and dosing for the UV system, Trojan uses a combination of past experience on projects with waters of similar quality, such as OCWD's GWRS, West Basin Municipal Water District's West Coast Basin Barrier Project, and the Water Replenishment District of Southern California's Alamitos Barrier Project, along with its own proprietary UV/AOP model that incorporates computational fluid dynamics to predict performance through optimization of optical and hydraulic parameters. With this approach, Trojan would establish the design UV power and H_2O_2 concentrations required to provide a performance guarantee of their UV/AOP system. Trojan's performance predictions for operational conditions required to achieve 1.5-log NDMA removal and 0.5-log 1,4-dioxane removal are as follows:

- UVT ≥ 95%: Total Lamp Power, P_L (kW) = 71 kW at H_2O_2 dose = 4.2 mg/L
- UVT ≥ 98%: Total Lamp Power, P_L (kW) = 60 kW at H_2O_2 dose = 2.9 mg/L

Full-scale commissioning testing will demonstrate the appropriate conditions for 0.5-log removal of 1,4-dioxane and 1.5-log removal of NDMA at a minimum UVT of 95%, and will include testing for surrogate and operational parameters. The protocol will be submitted to DDW for approval prior to testing.

The LPUV system is designed for a maximum flow rate of 4 mgd. Two duty reactors will be provided, along with one standby reactor, each containing two reactor zones with 72 lamps per reactor zone and a total of 288 lamps in the duty system (432 lamps total, including the standby reactor). Design criteria for a LPUV system from Trojan UV are provided in Table 3-32. The power delivered to each reactor zone in the UV system can be modulated to allow for turndown of the reactor zone from 100% to 60% power.

Table 3-32: Design Criteria for a Trojan UV System

Parameter	Unit	Value
UV system manufacturer	-	Trojan Technologies
UV oxidation system model	-	UVPhox
UV reactor model	-	D72AL75
Reactors (duty + standby)	Number	3
Reactors (duty)	Number	2
Reaction zones per reactor	Number	2
Operating configuration	-	In parallel
Design operating flow rate, total	mgd	4.0
Influent UVT at 253.7 nm	%	≥95
Influent temperature	°C	16-24
Lamps, total (duty + standby)	Number	432
Lamps, total (duty)	Number	288
Lamps per reactor	Number	144
Lamps per reactor zone	Number	72
Pressure drop through reactor at 2 mgd	inches	2-3
Turndown power level, per reactor zone	%	100% to 60% in 2% increments
Other turndown power control	-	Turn off 72-lamp reactor zone
Power per lamp	Watts	257
Total lamp power, P_L (duty + standby)	kW	111
Total lamp power, P_L (duty)	kW	74
Total lamp power, P_L, per reactor	kW	37
Total lamp power, P_L, per reaction zone	kW	19
Lamp power per reaction zone at 60% P_L	kW	11
Lamps per ballast	Number	2
Ballasts, total (duty + standby)	Number	216
Ballasts (duty)	Number	144
Power Distribution Centers, total (duty + standby)	Number	3
UV Intensity Sensors per reaction zone	Number	1
UV Intensity Sensors, total (duty + standby)	Number	6
UV Intensity Sensors, total (duty)	Number	4

3.2.6.8. Hydrogen Peroxide Feed System

H_2O_2 will be dosed upstream of the UV reactors, with a design dose range from 2.5-6 mg/L, as shown in Table 3-33. The H_2O_2 system will consist of two metering pumps (duty + standby), a 5,000-gallon chemical storage tank, chemical containment system, and an in-line static mixer. Hydrogen peroxide addition will be flow-paced at a dose controlled by the UV/AOP system. The design criteria for the H_2O_2 dosing system are summarized in Table 3-33.

Table 3-33: Design Criteria for Hydrogen Peroxide Dosing System

Parameter	Unit[a]	Value
Dosing Location	-	Combined feed to UV system
H_2O_2 dose range	mg/L	See General Design Criteria Table
Static mixer type	-	In-line
Expected H_2O_2 dose at 98% UVT	mg/L	2.9
H_2O_2 solution strength	%	50
Unit weight of H_2O_2	lb/gal	10.0
Basis for dosage	-	as H_2O_2
H_2O_2 storage tank volume	gallons	5,000
H_2O_2 dosing rate at 4 mgd at 6 mg/L H_2O_2	gph	1.7
H_2O_2 dosing rate at 4 mgd at 2.9 mg/L H_2O_2	gph	0.8
Storage at 6 mg/L H_2O_2	d	125

a. Pound per gallon – lb/gal; Day – d.

3.2.7. Product Water Stabilization

Several issues arise as a result of the softness and low alkalinity of RO permeate product water, including conveyance pipe corrosion, the potential for groundwater aquifer leaching and mineral mobilization, as well as changes in taste or smell that affect consumer acceptance. For these reasons, most advanced treatment facilities producing RO permeate practice pH and/or alkalinity adjustment as a control strategy for mitigating corrosion, leaching, and undesirable taste and odor (T&O).

3.2.7.1. Purpose

3.2.7.1.1. Minimize Corrosion in Conveyance Pipeline

The conveyance pipeline will transport water from the AWT Facility to the injection wells. Without post-treatment stabilization, corrosion may occur in the conveyance pipeline when certain pipeline materials are used, such as steel, iron, or cement mortar lining. Corrosion degrades the integrity of the pipeline and can lead to formation of corrosion by-products. These corrosion by-products may contribute to plugging of the injection site and may impact downstream T&O.

The following materials are being considered for use in the Project conveyance pipeline to the injection wells:

- High density polyethylene (HDPE)
- Cement mortar lined steel
- Ductile iron with cement mortar lining

The pipeline materials being considered are typically more resistant to corrosion because a protective coating (e.g., cement mortar lining) is being added to cover the iron or steel. However, over time, the protective coatings can be degraded through exposure to the aggressive water (soft,

low-alkalinity water typical of RO permeate). Sufficient degradation of the coatings will permit exposure of the RO permeate to the pipeline material.

3.2.7.1.2. Minimize Leaching in Groundwater Aquifer

Another issue with RO permeate is the potential for leaching of minerals and other chemicals present within the aquifer of the Seaside Basin. Leaching could impact the water quality by increasing dissolved solids or mobilizing unwanted compounds such as arsenic.

3.2.7.1.3. Consumer Acceptance

Consumer acceptance is important for the overall success of the project. Minimizing changes in water quality associated with taste, odor, and appearance can help maintain positive customer perception. For the Project, minimizing water quality changes that cause public concern is less of an issue because the RO product water from the AWT Facility will be blended with existing groundwater before it reaches consumers.

3.2.7.2. Post-treatment Parameters

The Langelier Saturation Index (LSI), Calcium Carbonate Precipitation Potential (CCPP), and the Aggressive Index all indicate the ability of a solution to dissolve or precipitate calcium carbonate mineral. Waters that tend to precipitate calcium carbonate (LSI > 0) may form a protective layer of calcium carbonate in the conveyance piping. Waters that tend to dissolve calcium carbonate can erode these protective layers, eventually exposing iron or steel. The ability of a solution to dissolve calcium carbonate is a function of pH, calcium concentration (related to hardness), carbonate concentration (related to alkalinity), temperature and TDS. The following is a description of the other water quality parameters that make up the post-treatment water quality goals:

- The chloride concentration relates to the corrosivity of the water with respect to iron and steel;
- The Modified Fouling Index (MFI) and turbidity are measurements of the particulate and colloidal make-up of the water, which relate to the particle loading of the water and may indicate the presence of pathogenic bacteria; and
- A chlorine residual is used to control biofilm growth in the conveyance pipeline and injection wellhead.

3.2.7.2.1. Post-Treatment Design Goals for AWT Facility

The post-treatment system will be designed to treat the entire 4 mgd flow from the RO system, including a turndown to 1.3 mgd. To minimize corrosion and control leaching in the aquifer, the post-treatment system will produce water with the characteristics shown in Table 3-34.

Table 3-34: Post Treatment Design Criteria

Parameter	Unit	Expected RO Permeate WQ[a]	RO Permeate WQ used for Design	Post Stabilization WQ Goals	WQ used for Equipment Design	WQ used for O&M Costs[b]
Temperature	(°C)	20 (16-24)	20	16 - 24	20	20
Alkalinity	(mg/L as $CaCO_3$)	10 (8-26)	8	40-80	80	50
pH		5.22 (5.04-6.05)	5.09	7.5-8.5	8.3	8.5
Calcium Hardness	(mg/L as CaCO3)	<1.25 (<1.25-2.5)	0.5	40-80	73	43
LSI	--	-6	-6	>0.1	0.15	0.15
CCPP	mg/L	--	--	0.5 to 2	--	--
Turbidity	NTU	<0.05 (<0.05-0.1)	< 0.05	Avg: <0.2 Max: <0.5	<0.2	<0.2
TDS	mg/L	<10 (<10-20)	10	--	35-45	25-30
Total Cl_2	mg/L	--	--	2-4	--	--
MFI	--	--	--	Avg: <1.25 Max: <2 *If LSI/CCPP and Total CL_2 met*: Avg: <2.1 Max: <2.5	Avg: <1.25 Max: <2 *If LSI/CCPP and Total CL_2 met*: Avg: <2.1 Max: <2.5	Avg: <1.25 Max: <2 *If LSI/CCPP and Total CL_2 met*: Avg: <2.1 Max: <2.5

a. WQ – Water Quality. The RO permeate water quality based on weekly water quality results from the RO piloting conducted between 12/2013 and 6/2014. The reported values show median (minimum-maximum) over this time period. Alkalinity and pH are difficult to measure accurately in waters with low ionic strength such as RO permeate); however, these values are in the range of typically observed values for similar systems.
b. Operation and maintenance – O&M.

3.2.7.3. Alternative Strategies for Post-stabilization Treatment

There are several options for adjusting the hardness, alkalinity and pH of the product water. One option is to use multiple chemical constituents to influence hardness, pH, and alkalinity individually (e.g., calcium chloride ($CaCl_2$), NaOH, and CO_2). Another option is to add chemicals that affect multiple post-stabilization water quality parameters simultaneously (e.g., pH, alkalinity and hardness). For example, hydrated lime ($Ca(OH)_2$) addition increases hardness, pH and alkalinity. Decarbonation and CO_2 injection are typically employed for pH adjustment. Alkalinity and hardness adjustment can be accomplished with lime addition or $CaCl_2$ and NaOH addition. The following sections provide more detail about these technologies, including a comparison between lime addition, and $CaCl_2$ and NaOH addition.

3.2.7.3.1. Cal-Flo Lime Slurry Storage and Delivery System

Cal-Flo systems offer a packaged pathway for providing $Ca(OH)_2$ for hardness, alkalinity and pH adjustment. The Cal-Flo system would consist of a lime slurry storage tank and feed system. Pre-made lime slurry would be delivered to the site and stored until used. The slurry is injected into the water after decarbonation and CO_2 injection[25]. Because the $Ca(OH)_2$ would be delivered in slurry form, plant operators do not need to use a lime slaker or other technology used to optimize the formation of lime slurry. This greatly reduces the complexity of lime addition operations, which in the past have created dangerous conditions due to the dust that can form from $Ca(OH)_2$ powders and the exothermic reaction that occurs during lime hydration from calcium oxide (quicklime). The Cal-Flo system also avoids the necessity of an expensive, large saturator, which is needed when using quicklime or $Ca(OH)_2$ powder.

3.2.7.3.2. Calcium Chloride and Sodium Hydroxide Addition

Another alternative that may be used to influence hardness and alkalinity in the RO permeate water is to feed $CaCl_2$ and NaOH into the water. The $CaCl_2$ dissociates and adds calcium hardness, whereas the NaOH increases the alkalinity and pH of the water.

3.2.7.4. Post-treatment Design Criteria

A process flow diagram of the proposed post-treatment process is presented in Figure 3-7. The following sections provide further detail on these treatment processes. Chemical feed pumps involved in this process will be able to turndown to low design dose at the minimum flow of 1.3 mgd from the high design doses at the maximum flow of 4.0 mgd.

[25] CO_2 injection may be removed in future phases of design, due to the cost and limited benefit.

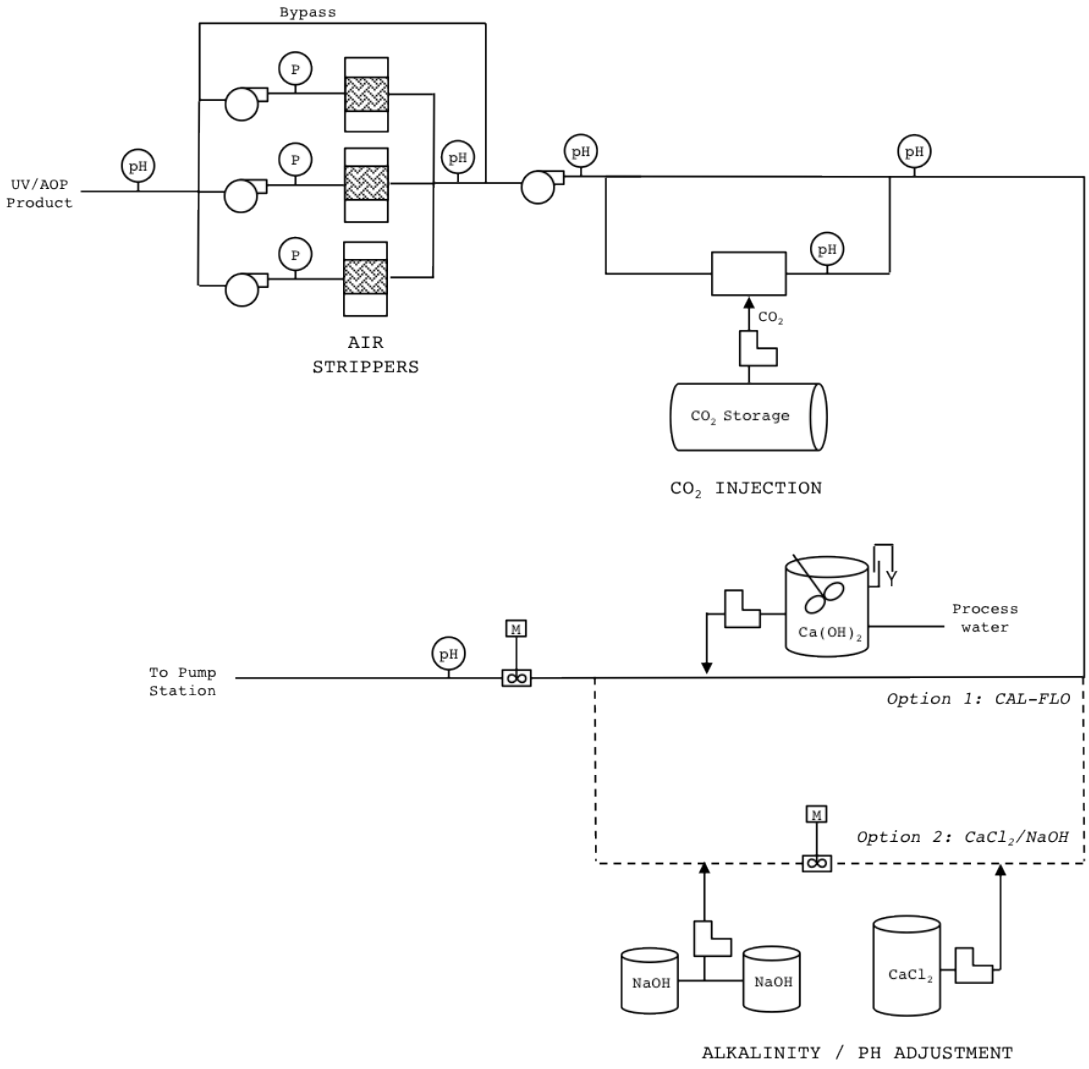


Figure 3-7. Process flow diagram of post-treatment strategy

3.2.7.5. Decarbonation

Decarbonation of the UV/AOP product water will be achieved through air stripping, which promotes the transfer of CO_2 out of the product water and into the atmosphere. By reducing CO_2 levels, the decarbonated water can more easily be manipulated to achieve the post-treatment water quality goals. The primary benefit is a reduction in the amount of chemicals needed to achieve the water quality targets. Modeling suggests that a range of flows between 65-95% of the 4 mgd flow (2.6 to 3.8 mgd) may require decarbonation prior to alkalinity and pH adjustment. To meet this range and provide added flexibility, the air stripping process has been designed to treat the entire 4 mgd flow from the UV/AOP process. A bypass line will be included to adjust the fraction of flow passing through the air stripper. The system will include one air stripper designed to treat the full flow (4 mgd). This stripper will have a weir influent flow structure to increase the turndown of the stripper

(typically 10:1 with the influent weir structure). Below a turndown of 10:1, the media may not fully wet and CO_2 removal becomes unreliable. The CO_2 injection system is included in the product water stabilization system to account for water quality conditions that necessitate turndowns greater than 10:1. In these events, the stripper can remove excess CO_2, while the injection system can restore the lost CO_2, if necessary. Table 3-35 provides the design criteria for the decarbonation process.

A redundant blower will be provided for continuous operation during blower maintenance. Stripper maintenance is typically negligible unless fouling occurs or the media is damaged. Media damage may occur if operations or maintenance staff walk on the media. This damage is not expected to occur during normal operation; however, if the media must be accessed, the manufacturer recommendation will be followed to avoid damage.

Fouling is not typically a concern when using RO permeate. However, the ability to occasionally apply chlorine (typically in the form of NaOCl) will be provided in case fouling occurs. The system will be able to dose 10 mg/L as Cl_2 for a brief period of time (e.g., one minute). The chlorine dosing system design will also take into account the potential for an increase in biologically available organic matter in the RO permeate from preozonation, which may require more frequent chlorine doses (e.g., daily). Biological growth may occur when assimilable organic carbon (AOC) concentrations exceed 20 µg/L. One measurement of the preozonated RO permeate during pilot testing using ozone doses higher than the design dose yielded an AOC of 50 µg/L. The chlorine dosing system will use small volumes of NaOCl (1 gallon or less at 12.5% strength), and it will be automatized to avoid the need for operator intervention.

Table 3-35: Decarbonation Design Criteria

Parameter	Units[a]	Value
Free CO_2 removal efficiency (minimum)	%	80%
Air strippers	Number	1
Air stripper flow	mgd	4
Diameter of stripping tower	feet	12
Height of tower, estimated	feet	31[b]
Inlet structure type	--	Weir
Packing material type	--	LANPAC-XL by Lantec
Packing depth	feet	13.5
Packing material size	inches	3.25 x 3.75
Air-to-water ratio	cfm/gpm	4.0
Blowers	Number	2
Blower motor size, each	hp	20
Blower capacity, each	scfm	11,200

a. Cubic feet per minute – cfm.
b. Assuming a sump height of 4 feet.

3.2.7.6. Carbon Dioxide Injection System

The pH of the water destined for post-treatment adjustment will be tightly controlled to ensure that the appropriate water quality goals are met after chemical addition. The performance of the air

strippers has been modeled and used for the design of the decarbonation system. However, precise control of the decarbonated water pH cannot be guaranteed through the air stripper given the dependence of the air stripping process on a number of factors including temperature, influent pH, and CO_2 removal efficiency. To provide an additional level of control of the decarbonated water pH, a CO_2 injection system has been included. This system will allow fine-tuning of the decarbonated water pH prior to chemical addition. Table 3-36 summarizes the CO_2 injection system design criteria.

Table 3-36: Carbon Dioxide Addition Design Criteria

Parameter	Units[a]	Value
CO_2 dose range	mg/L	0-50
Average CO_2 dosing (anticipated)	mg/L	< 10
Carbonic acid feed rate (maximum)	lb/hr	70
CO_2 storage tanks		
Total	Number	1
Capacity	lbs	12,000
Vaporizer and Heater, type	-	Electric vaporizer and vapor heater
Carrier water pumps		
Total	Number	1 duty + 1 standby
Pump power	hp	5

a. Pounds per hour – lb/hr.

3.2.7.7. Alkalinity, pH, and Hardness Adjustment

After air stripping, chemicals will be added to adjust the alkalinity, pH, and hardness of the decarbonated water. As discussed, two different options are evaluated in this report because the final alkali chemicals have not been selected. The first strategy is the Cal-Flo $Ca(OH)_2$ option.

3.2.7.7.1. Design Criteria for Cal-Flo Hydrated Lime Addition System

The Cal-Flo system provides a stable slurry of pre-prepared $Ca(OH)_2$ that can be used to directly adjust the pH, alkalinity, and calcium hardness of the process water. The system includes a continuously mixed, $Ca(OH)_2$ storage silo that maintains a slurry that can be injected directly into the process stream. The main advantages of the Cal-Flo system over conventional $Ca(OH)_2$ systems are that it greatly reduces equipment needs (eliminates dry lime storage, lime feed and slaking systems, and lime saturators) while providing significantly simplified operation. The high-quality slurry can be added directly to the process water while maintaining the water within specifications for turbidity and other particulate water quality goals. Table 3-37 summarizes the post-treatment lime addition design criteria for the Cal-Flo $Ca(OH)_2$ addition system.

Table 3-37: Cal-Flo Hydrated Lime Addition Design Criteria

Parameter	Units	Value
Design capacity	mgd	4
Average hydrated lime dose	mg/L as $Ca(OH)_2$	31.1
Average lime consumption	lbs/d	1040
Lime storage tanks	Number	1
Storage volume provided	gallons	20,000
Diameter	feet	12
Mixer	Number	1
Horsepower	hp	10
Type	-	2 axial flow, 1 radial flow impellers

3.2.7.7.2. Design Criteria for $CaCl_2$ and NaOH Addition System

The second chemical addition strategy—$CaCl_2$ and NaOH addition—offers an alternative to the Cal-Flo system, providing an option with lower capital costs and higher operational costs. The principal of the $CaCl_2$/NaOH strategy is that each of the various water quality parameters (pH, alkalinity, and calcium hardness) can be manipulated independently through the addition of the two chemicals: $CaCl_2$ provides a high level of control of calcium addition, while NaOH addition (in conjunction with decarbonation) provides independent manipulation of pH and alkalinity. The $CaCl_2$/NaOH design criteria are show in Table 3-38.

Table 3-38: $CaCl_2$/NaOH Addition Design Criteria

Parameter	Units	Value
Design capacity	mgd	4
Average $CaCl_2$ dose	mg/L as $CaCl_2$	47.2
Average $CaCl_2$ consumption	lbs/d	1555
Average NaOH dose	mg/L as NaOH	33.6
Average NaOH consumption	lbs/d	1121
$CaCl_2$ storage tanks	Number	1
Storage volume	gallons	20,000
NaOH storage tanks	Number	2
Storage volume, each	gallons	10,000
Storage volume, total	gallons	20,000
Chemical metering pumps	Number	1 duty + 1 standby

3.2.7.8. Secondary Disinfection

Chlorine addition may be required during product water stabilization (also known as secondary disinfection) to meet a preliminary total chlorine goal of 3 to 4 mg/L as Cl_2 entering the conveyance

system to achieve a preliminary goal of 1 mg/L as Cl_2 at the wellhead[26]. The chloramine residual will rapidly decay in the aquifer, prior to the water reaching the monitoring wells. Likewise, the residual ammonia will rapidly be oxidized.

Chlorine may be added in the form of sodium hypochlorite, since facilities for this chemical will already be included at the AWT Facility. The UV/AOP effluent chloramine concentration is expected to be 1 to 2 mg/L as Cl_2, given an RO feed setpoint of 3 to 5 mg/L as Cl_2 (assuming 0.3 log removal through UV/AOP and 80% removal through RO). The ammonia concentration available for chloramination formation is expected to yield an additional 2 to 4 mg/L as Cl_2 of secondary chloramination formation, assuming no ammonia removal technology is implemented upstream (*e.g.* nitrification in the trickling filters) and a typical Cl_2:N mass ratio of 4:1. Increasing the RO feed chloramine concentration beyond 5 mg/L risks diminishing UV/AOP performance. Secondary chlorine addition can help reach the total chlorine goal, although tight process control may be needed unless ammonia addition is also included, especially if ammonia removal is practiced upstream. If ammonia addition is included, operational flexibility would be increased.[27] The design criteria for secondary chlorination (without ammonia addition) are shown in Table 3-39.

Table 3-39: Secondary Disinfection Design Criteria

Parameter	Units	Value
Design capacity	mgd	4
Average NaOCl dose[a]	mg/L as Cl_2	2
Average NaOCl consumption	lbs Cl_2/d	67
Chemical metering pumps	#	1 duty + 1 standby

a. Dose is dependent on UV/AOP effluent ammonia and chloramine concentration.

3.2.8. Waste Collection and Disposal

Treatment process waste streams (except the RO concentrate) will be collected and routed to dedicated waste storage facilities for ultimate discharge to the RTP headworks. Rainwater from canopies will be collected in gutters and discharged at ground level. Proposed process waste collection facilities will include a central waste equalization tank along with chemical containment sumps installed in the chemical containment areas. In keeping with the corrosive nature of most process streams, waste collection/drainage pipe and fittings will be non-metallic. Lines external to chemical containment areas in sizes up to 12-inches will be PVC, HDPE or FRP. Within chemical areas, materials of waste collection lines will be PVDF, polypropylene, or PVC to match the chemical piping. All drain lines will be sized and sloped to carry the maximum anticipated waste flow, including process tank overflows where applicable. Criteria for the sump are provided in Table 3-40.

[26] The chlorine goal at the entrance to the conveyance system and at the wellhead will be further refined during later phases of design.
[27] Ammonia addition may be considered in the next phase of design.

Table 3-40: Waste Equalization Pump Station

Waste Equalization System	
Waste Equalization Wetwell	
Type	Cast in place concrete
Capacity, gallons	18850
Waste Transfer Pumps	
Type	Vertical Sump Pumps
Operating Configuration	2 x 100 percent
Materials	FRP
Capacity at Design Point, gpm	250
Head, feet	75
Drive	Variable Speed
Motor Size, hp	10
Max. Motor Speed, rpm/Enclosure	1800/TEFC

3.3. PREVENTIVE MAINTENANCE PROGRAM FOR TREATMENT FACILITIES

The MRWPCA Maintenance Department's mission is to effectively and efficiently maintain all equipment so that it remains in a safe, reliable, and well maintained condition for its internal and external customers.

3.3.1. Graduated Preventative Maintenance Program

The emphasis of the maintenance program is preventive rather than reactive maintenance. A strong preventive maintenance program effectively reduces overall maintenance costs by decreasing the number of, and the high cost of unpredictable repairs caused by reactive maintenance. MRWPCA uses a graduated preventative maintenance (PM) program that is based on the manufacturer's recommendations and modified based on their experience and their local environment. These PM practices maximize useful life, are cost efficient over the life of the asset, and ensures that their assets remain in serviceable operating condition.

Maintenance schedules are developed for each asset, based upon usage and manufacturer's recommendations. Each asset has PM tasks categorized as Weekly, Monthly, Semi-Annual or Annual, which include regular inspections. In addition, many assets also have "real-time" supervisory control and data acquisition (SCADA) condition monitoring installed and are subject to daily physical operational checks. All of this data will be monitored and tracked within the Agency Computerized Maintenance Management System program.

To assure optimum benefits, MRWPCA will continually review its maintenance practices to identify potential improvements to the program.

3.4. RECYCLED WATER TRANSMISSION FACILITIES

MRWPCA proposes to construct a pipeline to convey the product water from the AWT Facility to the Seaside Basin for groundwater replenishment (see **Figure 3-8)**. The alignment will generally follow the Regional Urban Water Augmentation Project (RUWAP) through the City of Marina and the middle of the Ft Ord area, now in the jurisdictions of the City of Marina, Fort Ord Reuse Authority (FORA) and the City of Seaside.

The first component of the AWT product water conveyance system is the AWT Product Water Pump Station (PWPS). The PWPS will be located within the site of the AWT Facility to be constructed within the current boundary of the RTP. The PWPS will pump product water into the pipeline. The conveyance pipeline system will require a booster pump station (BPS) to provide adequate pressure to convey the product water to the Injection Facilities area.

The BPS will be located on the east side of 5th Avenue, just south of 3rd Street in the City of Seaside. The pipeline will also include flow control valves, isolation valves, blow down structures for maintenance, air and vacuum release valves, and other appurtenant facilities.

3.4.1. General Design Criteria

The annual average volume of product water will be 3,500 AFY (see **Section 2** for discussion of drought reserve injection). On a constant, monthly basis this annual amount would be about 3.13 mgd. Several factors will affect the actual daily flow rates through the conveyance system. These factors include: seasonal variations; source water supply variations; down-time for maintenance of mechanical equipment of pumping systems and the AWT Facility; and maintenance of the injection wells. Hence, it is necessary and prudent to size facilities, particularly the conveyance pipeline, to handle these flow variations so as to result in the annual average recharge target volume of 3,500 AFY. Based on the best available data and reasonable projections, the estimated maximum future amount of source water for the Project may provide for a total peak product water delivery flow rate of approximately 4 mgd.

Taking into consideration these factors, it was determined that the maximum design flow for the product water pipeline will be 4 mgd. Using this design flow criterion, the pipeline size will be between 20 and 24 inches in diameter. Based on current availability of source water for the AWT Facility, operation of the Project indicates that the maximum daily flow will be about 4.0 mgd. This design flow rate compensates for AWT Facility shut-down periods for routine maintenance purposes, thus resulting in the Project being able to meet the total design annual average recharge volume of 3,500 AFY. This flow rate will be used in the design of the pump stations.

Other general design features include standby pumping units for pump stations; in-line isolation valves on the pipeline approximately every 2,000 feet, in case an unforeseen leak occurs or subsequent construction activities result in damage to the pipeline; compliance with DDW pipeline separation requirements; and remote monitoring of the BPS performance and pipeline pressure.

Additional information on the design criteria for each pump station and the pipeline are presented in the following subsections.

3.4.2. Conceptual Design of AWT Product Water Supply Pump Station

3.4.2.1. Background Information

The PWPS will receive flow from the AWT Facility. The product water will flow by gravity to the clearwell of the PWPS. The PWPS will pump the product water into the product water conveyance pipeline that will convey the water to the BPS, and ultimately to the Injection Facilities area. The BPS is discussed in **Section 3.4.3**.

3.4.2.2. Physical Description

The proposed location for the PWPS will be within the site of the AWT Facility. The PWPS will be cast-in-place, concrete-type structure. The pumps will be vertical-turbine type. Pumps will be mounted outdoors on a concrete deck over an intake clear well reservoir. Electrical and control equipment for the pumps will be housed in a small, electrical enclosure, located adjacent to the pump station. All electrical and control equipment within the enclosure will be located with easy access for maintenance.

Pump motors, discharge piping and valves, and monitoring and sampling equipment will be located on the deck area over the clear well. The PWPS will be rectangular in shape with the plan dimensions being determined based on pump and other equipment space requirements in the pump deck area and to a secondary extent, storage volume in the clear well. A physical footprint of approximately 30 feet by 40 feet is being provided for the pump station within the AWT Facility. The depth from the top of the deck to the invert of the clearwell will be approximately 15 feet. (The exact physical size (footprint) of the PWPS and clearwell capacity will be determined during final design.)

The PWPS will be designed for a maximum flow of 4.0 mgd.

3.4.2.3. Pump Station Discharge Pipeline

Sizing of the discharge pipeline (forcemain) and selecting the type and size of the pumps present certain challenges. The ground elevation at the PWPS site is about at Elevation 100. There are intermediate high points along the route. This is one of the reasons why the BPS is required. Also, friction loss in the pipeline will be one of the factors in the determination of the amount of horsepower required.

3.4.2.4. Pump Selection

Preliminary pump selection was based on the pipeline size of 24-inch diameter, ground profiles and static lifts (difference in ground elevations between pump station elevation and discharge elevation).

3.4.2.5. Mechanical Design Considerations

3.4.2.5.1. Surge Control

A surge tank will be provided. Detailed hydraulic transient analyses will be performed during the final design.

3.4.2.5.2. Valves and Appurtenances

Each pump discharge will have a manual isolation butterfly valve and a check valve. Due to the high discharge head and potential surge conditions, it is anticipated that the check valve will be the double-door, fast-acting, silent type. A manual isolation butterfly valve will also be provided on the discharge header downstream of the flow meter to isolate the meter from the transmission line.

Each pump discharge will also have an air release valve to release air on pump start-up. Air release valves will also be provided on the pump discharge header at high points where air may accumulate.

3.4.2.5.3. Electrical Design Considerations

Power supply to the motors will be 480-Volt, 3-phase, 60-Hertz power fed from a motor control center (MCC) located within an electrical equipment enclosure. A new additional power supply will be required for the AWT Facility and PWPS. The Pacific Gas and Electric Company (PG&E) or the Monterey Regional Waste Management District will provide this new service.

3.4.2.6. Instrumentation, Monitoring and Control Design Considerations

3.4.2.6.1. Pump Control

The PWPS pumps will be automatically controlled by the water level in the clear well. In that way, the pumps will match the combined water supply rate from the AWT Facility. Manual pump start and stop and speed control will also be provided at the AWT Facility by the Programmable Logic Controller (PLC).

Control interlocks with other systems will be as follows:

- All of the PWPS pumps will be automatically stopped on high pressure in the product water conveyance pipeline, or low level in the pump station clearwell.
- All of the PWPS pumps will be automatically stopped on detection of critical alarm conditions at any of the upstream or downstream conveyance systems.

Under any of the hydraulic or process performance alarm conditions that would shut down the pumps, the product water would be routed to MRWPCA's ocean outfall, headworks, or SVRP storage pond until the alarm conditions have been addressed and cleared.

3.4.2.6.2. Monitoring

The following monitoring tasks are proposed:

- The water level in the clearwell will be continuously monitored using an ultrasonic level sensor, with separate float switches for high and low level alarms in the event of failure of the level sensor. The water level signal will be used for pump control as described above.

- A magnetic flow meter will be provided on the PWPS discharge header to measure pump flow rate. The flow signal will be used for regulatory and product water inventory record keeping, for PWPS monitoring, and for pump control as described above.
- A pressure transducer will be provided on the PWPS discharge header to continuously measure header pressure for the purposes of monitoring pump operation and head conditions in the transmission system and feedback for BPS alarms for system shutdown.
- A locally indicating pressure gauge will be provided on the discharge header and on each pump discharge.

3.4.2.6.3. Equipment Protection

The following equipment protection measures will be considered in the final design:

- Monitoring of motor winding and bearing temperature with automatic pump shutdown on high temperature condition.
- Due to the relatively high operating pressures, providing pump vibration monitoring with automatic pump shut down on high vibration condition.

3.4.2.7. Preliminary Design Criteria

Preliminary design criteria for the PWPS are presented in Table 3-41.

Table 3-41: Product Water Pump Station Preliminary Design Criteria

Parameter	Units	RUWAP Alignment
System Pumping Requirements [a]		
Force main Diameter	inch	24
Design Capacity	mgd	4.0
Static head + 10 foot residual at BPS	feet	113
Design TDH, at design flow	feet	135
Velocity at design flow	fps	1.97
Pump Units		
Type	---	Vertical Turbine
Total/Duty/Standby	Number	3/2/1
Design capacity per pump	gpm	1,400
Minimum efficiency at design point	%	80
Stages per pump	Number	TBD
Pump operation	---	Variable
Minimum speed	rpm	TBD
Pump Motors		
Type	---	TEFC
Size, each unit	hp	60
Drive type	---	Variable Frequency Drive
Synchronous speed	rpm	1,800
Power supply	---	480-V/3-phase/60Hertz
Pump Discharge Piping		
Diameter	inch	14

Parameter	Units	RUWAP Alignment
Velocity at design flow/pump	fps	2.9
Pumps Discharge Header Piping		
Diameter	inch	24
Velocity at design flow	fps	1.97
Discharge Flow Metering		
Type	---	Magnetic
Size	inch	14
Velocity at design flow rate	fps	5.8

a. Feet per second – fps; To be determined – TBD.

3.4.3. Conceptual Design of AWT Product Water Supply Booster Pump Stations

3.4.3.1. Background Information

The Booster Pump Station (BPS) will receive flow from the first "leg" of the Product Water Conveyance Pipeline. The AWT product water will flow under pressure into the BPS into buried "pump cans" in which each booster pump will be placed. The BPS will not have a clearwell in contrast to the PWPS. The pipeline supplying the BPS will have residual pressure (about 5 to 10 psi) available to "prime" the booster pumps. The BPS will pump the AWT product water into the second "leg" of the Product Water Conveyance Pipeline that will convey the water to the Injection Facilities area.

3.4.3.2. Physical Description

The BPS will be mechanically and electrically very similar to the PWPS located at the AWT Facility. However, their structure will be different. As noted above, there will not be a clearwell. Rather, the pumps (vertical-turbine type) will mounted in "pump cans," buried under the pump station floor. Because of noise considerations, the pump motors and discharge piping will be housed in a building, constructed of split-faced block, or similar material with characteristics to dampen noise emission.

A physical footprint of approximately 30 feet by 40 feet is proposed for the booster pump station building. Additional space will be provided for maintenance access, electrical supply transformer and a surge tank.

The booster pump station will be designed for a maximum flow of 4.0 mgd.

3.4.3.3. Pump Station Discharge Pipeline

Selecting the type and size of the booster pumps present certain challenges. The ground elevation at the Injection Facilities area is approximately 440 feet above msl, which is about 240 to 255 feet above the elevation of the proposed BPS sites for the RUWAP and Coastal Alignments, respectively. The pipeline generally follows an uphill gradient from the BPS to the upper portion of the Injection Facilities area, for both of the alignments. Frictional losses are quite small compared with the static lifts of about 250 to 265 feet noted above. These static lifts include an additional 10 feet of residual pressure at the uppermost well cluster.

3.4.3.4. Pump Selection

Preliminary pump selection is based on the pipeline size of 24-inch diameter, ground profiles and static lifts (difference in ground elevations at the BPS sites and the Injection Facilities area).

3.4.3.4.1. Surge Control

The same controls will be applied as described in **Subsection 3.4.2.5.1**.

3.4.3.4.2. Valves and Appurtenances

The same controls will be applied as described in **Subsection 3.4.2.5.2**.

3.4.3.5. Electrical Design Considerations

Power supply to the motors will be 480-Volt, 3-phase, 60-Hertz power fed from a MCC located with the electrical equipment within the pump station building. A PG&E electrical transformer will be required at the site of the selected BPS. For the maximum design flow of 4.0 mgd, it is estimated that a transformer with a capacity of approximately 225 kilovolt amperes, should be adequate for either of the booster pump station options.

3.4.3.6. Instrumentation, Monitoring and Control Design Considerations

3.4.3.6.1. Pump Control

The BPS pumps will be automatically controlled by the water pressure in the inlet pipeline. In that way, the pumps will match the water flow rate from the PWPS. Manual pump start and stop and speed control will also be provided at the AWT Facility PLC.

Control interlocks with other systems will be as follows:

- All of the PWPS pumps will automatically stop on high pressure in the product water conveyance pipeline, or low pressure in the influent pipeline.
- All of the booster pumps will be automatically stopped on detection of critical alarm conditions in the upstream or downstream conveyance systems or in the recharge wells.
- Before the booster pump station can be shutdown, the PWPS at the AWT Facility would need to be shut down first.

3.4.3.6.2. Monitoring

This will involve the same monitoring tasks as described in **Subsection 3.4.2.6.2**, above, except as noted below.

There will be no wetwell in the booster pump station. Hence, the pressure in the incoming pipeline to the pump station will be continuously monitored.

3.4.3.6.3. Equipment Protection

The same equipment protection measures will apply as described in **Subsection 3.4.2.6.3** above.

3.4.3.7. Preliminary Design Criteria

Preliminary design criteria for the PWPS are presented in Table 3-42.

Table 3-42: AWT Product Water Booster Pump Stations Preliminary Design Criteria

Parameter	Units	RUWAP Alignment
System Pumping Requirements		
Force main diameter	inch	24
Design capacity	mgd	4.0
Design capacity	gpm	2,800
Static head + 10 ft residual at BPS	feet	247
Design total dynamic head, at design flow	feet	261
Velocity at design flow	fps	1.97
Pump Units		
Type	---	Vertical Turbine
Total/Duty/Standby	Number	3/2/1
Design capacity per pump	gpm	1,400
Minimum efficiency at design point	%	82
Stages per pump	No.	TBD
Pump operation	---	Variable
Minimum Speed	rpm	TBD
Pump Motors		
Type	---	TEFC
Size, each unit	hp	125
Drive type	---	Variable Frequency Drive
Synchronous speed	rpm	1,800
Power Supply	---	480-V/3-phase/60Hertz
Pump Discharge Piping		
Diameter	inch	14
Velocity at design flow/pump	fps	2.9
Pumps Discharge Header Piping		
Diameter	inch	24
Velocity at design flow	fps	1.97
Discharge Flow Metering		
Type	---	Magnetic
Size	inch	14
Velocity at design flow rate	fps	5.8

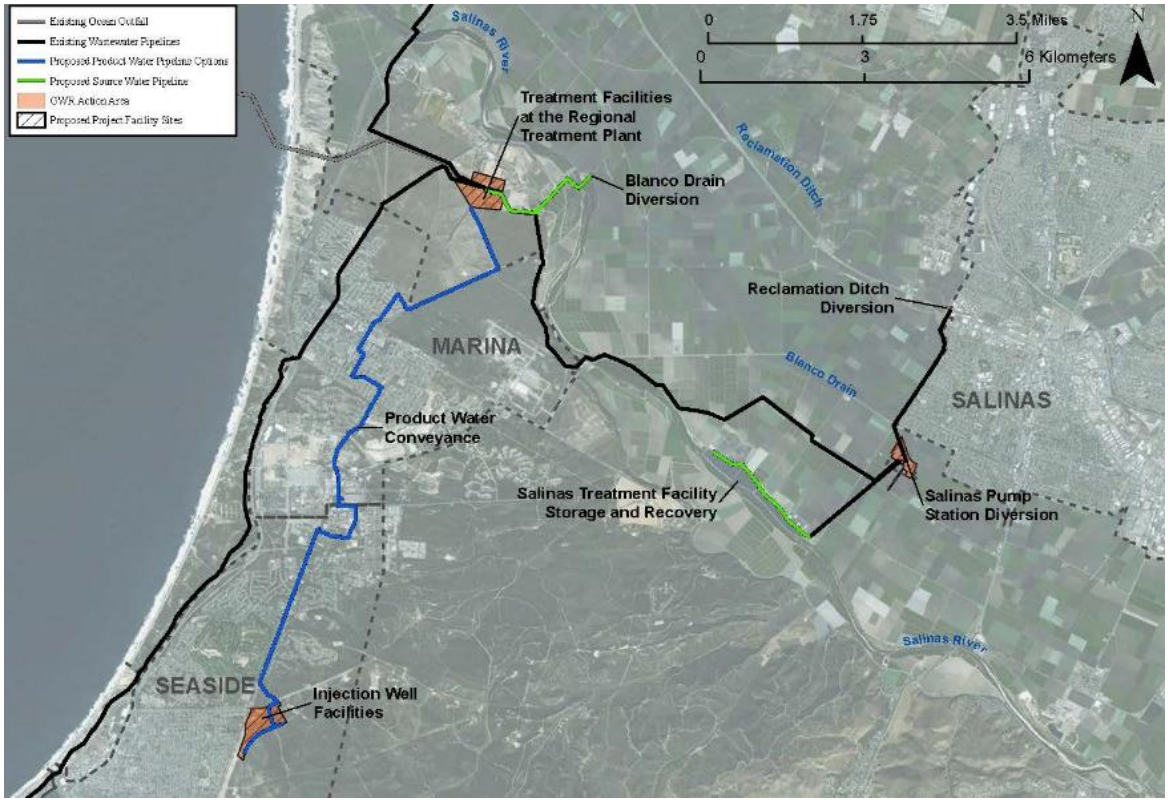


Figure 3-8. Product Water Transmission Facilities



Figure 3-9. Map of AWT Product Water Supply Pipeline to Proposed Injection Well Facilities

Figure by T. Gerald Cole, P.E., DRAFT

3.5. INJECTION FACILITIES

The Injection Facilities will be constructed along a strip of land on the eastern boundary of the City of Seaside, about 1.5 miles inland from Monterey Bay (Figures 3-8 and 3-9). As discussed in more detail in **Section 9**, the area is located within the Northern Inland Subarea of the Seaside Basin. Facilities will be located within an approximate 150-foot-wide corridor of land about 3,000 feet long, as shown by blue highlighting on Figure 3-10. This corridor is referred to herein as the Injection Facilities area or site.

The southwestern edge of the Injection Facilities area is approximately east 500 feet of General Jim Moore Boulevard, near the intersection with San Pablo Avenue (Figure 3-10). From that point, the area curves northeastward and upslope approximately 3,000 feet along two parcel boundaries, generally following existing unimproved roads of former Fort Ord lands. The northeastern edge of the site is approximately 2,200 feet east of General Jim Moore Boulevard and 1,200 feet south of Eucalyptus Road (Figure 3-10).

The Injection Facilities area covers a narrow strip of land within two larger parcels that are currently under the control of FORA. These parcels are scheduled to be conveyed to the City of Seaside for redevelopment upon completion of all remedial activities. Injection facilities have been located along parcel boundaries to minimize interference with future land use plans.

Planned Injection Facilities include the following components (Figure 3-10):

- Up to four deep injection wells (DIW-1 through DIW-4).
- Up to four vadose zone injection wells (VZW-1 through VZW-4).
- Up to six monitoring well clusters (MW-1 through MW-6).
- A shallow basin for discharge of well back-flushing water (back-flush basin).
- Water supply lines, electrical facilities, and other supporting appurtenances.

The number of wells required for Project operation is uncertain until well construction and testing begins. Well installation will be conducted using a phased approach. Phasing of wells and operational considerations are discussed in **Section 8**.


N
0
400
Scale in Feet
ASR 4
SMS-Shallow
SMS-Deep
ASR 3
Reservoir Well
FO-07 Shallow
FO-07 Deep
Eucalyptus Rd.
MRWPCA
MW-1
Military Ave.
General Jim Moore Blvd.
Paralta
MW-7
ASR-2
PRTIW
ASR MW-1
ASR-1
MW-2
VZW-1
DIW-1
MMP
MW-4
MW-1
VZW-2
DIW-2
Ord Grove Test
Ord Grove
MW-3
VZW-3
DIW-3
La Salle Ave.
VZW-4
DIW-4
MW-5
San Pablo Ave.
MW-6
Seaside 4
Legend
Proposed GWR Deep Injection Well
Proposed GWR Vadose Zone Well
Proposed Groundwater Monitoring Well
Backflushing Basin
Injection Facilities Area
Seaside Basin Production Well
Seaside Basin Monitoring Well
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Figure 3-10
GWR Project Wells
Injection Facilities Area

In addition to land use considerations, the Injection Facilities area was selected using the following hydrogeologic criteria for injection into Seaside Basin aquifers:

- Upgradient of existing CalAm production wells for efficient recovery of recharged product water that has comingled with both native groundwater and Monterey Peninsula Aquifer Storage Recovery (ASR)-injected water from the Carmel River system.
- Within areas of favorable aquifer properties for replenishment and groundwater production, such as relatively high transmissivity and sufficient aquifer thickness.
- Sufficiently deep water table to provide a large local storage volume.
- Close to pumping depressions[28] to provide replenishment water to areas of declining water levels.

3.5.1. Injection Wells

The conceptual layout and preliminary design for the Project injection wells are based, in part, on the amount of product water available for replenishment and the local hydrogeology. In general, the Project proposes to inject an annual average of 3,500 AFY into two aquifers, the shallower Paso Robles Aquifer and the deeper Santa Margarita Aquifer, both of which provide water supply from existing extraction wells. Vadose zone wells will be used for injection into the relatively shallow unconfined Paso Robles Aquifer. Deep injection wells will be used for injection into the deeper semi-confined to confined Santa Margarita Aquifer. Figure 3-10 shows the proposed locations for four vadose zone wells and four deep injection wells within the Injection Facilities area.

The average annual injection amount of 3,500 AFY will be allocated between the two aquifers in a manner consistent with the estimated amount of local extraction from each aquifer. Currently, the target allocation includes approximately 10% (350 AFY) into the unconfined Paso Robles Aquifer and approximately 90% (3,150 AFY) into the Santa Margarita Aquifer. **Section 8** provides more information on the total injection amounts and how the amounts vary with Project operation. **Section 9** describes the hydrogeologic framework and provides more detail on the two targeted aquifer systems. General injection well specifications are summarized in Table 3-43 as follows.

[28] Groundwater elevation contour maps illustrating areas of pumping depressions are presented in **Section 9** of this report.

Table 3-43: Injection Well Specifications

Project Specification[a]	Paso Robles Aquifer	Santa Margarita Aquifer
Recharge Method	Vadose Zone Well	Deep Injection Well
Groundwater Occurrence	Unconfined	Semi-Confined to Confined
Transmissivity	659 to 1,524 ft^2/day	11,377 to 13,947 ft^2/day
Hydraulic Conductivity	20 ft/day	63 ft/day
Maximum Number of Wells	4	4
Injection Capacity per Well	500 gpm	1,000 gpm
Total Injection Capacity	2,000 gpm	4,000 gpm
Extraction Capacity per well (for well maintenance)	N/A	2,000 gpm

a. Square feet per day - ft^2/day; Feet per day – ft/day.

The injection well locations are shown on Figure 3-10 along with other project components including the back-flush basin and monitoring wells. Estimates of ground surface elevation, depth to water and aquifer depths are summarized in Table 3-44 as follows.

Table 3-44: Proposed Project Wells

GWR PROJECT WELLS	GSE[a]	Groundwater Elevation[b]	Depth to Water	Paso Robles[c]		Santa Margarita		Well Depth
				Depth to Top	Depth to Base	Depth to Top	Depth to Base	
	ft, msl	ft, msl	ft, bgs	ft, bgs	ft, bgs	ft, bgs	ft, bgs	ft, bgs
Santa Margarita Deep Injection Wells (DIW)								
GWR-DIW-1	455	-22	477	425	645	700	1000	1020
GWR-DIW-2	395	-30	425	395	647	647	947	967
GWR-DIW-3	365	-30	395	365	605	605	865	885
GWR-DIW-4	299	-18	317	299	539	539	799	819
Average	378.5	-25	404	371	609	622.75	902.75	922.75
Paso Robles Vadose Zone Wells (VZW)								
GWR-VZW-1	397	-5	402	N/A	N/A	N/A	N/A	200
GWR-VZW-2	392	-20	412	N/A	N/A	N/A	N/A	200
GWR-VZW-3	357	-30	387	N/A	N/A	N/A	N/A	200
GWR-VZW-4	305	-20	325	N/A	N/A	N/A	N/A	150
Average	363	-19	382	N/A	N/A	N/A	N/A	187.5

[a]Ground Surface Elevation (GSE) based on Ord_Topo_Polyline shapefile from Marina Coast Water District, 2013.

[b]Water levels from July/August 2013 estimated from HydroMetrics WY 2013 SW Intrusion Analysis Report, December 2013, Figures 28 and 29.

[b]Groundwater elevation and depth to water represents the water table for the VZWs and the Santa Margarita potentiometric surface for DIWs.

[c]Aquifer geometry estimated from cross section analysis.

bgs = below ground surface; msl = mean sea level (negative indicates below sea level)

3.5.1.1. Deep Injection Wells

Key considerations for the design of the deep injection wells include:

- Sufficient capacity to accommodate delivered product water from the AWT Facility.

- Sufficient number of wells to allow for offline well maintenance and repairs.
- Adequate well spacing to minimize hydraulic mounding interference with adjacent deep injection wells or nearby ASR wells.
- Located close enough to existing production wells to allow for the efficient recovery of injected water.
- Located ample distance from downgradient production wells to comply with regulatory requirements regarding underground retention times for pathogen removal credit and response retention time (see **Sections 5 and 6**).

The manner in which these design considerations are incorporated into the Project is summarized in the following subsections.

3.5.1.1.1. Deep Injection Well Capacity

MPWMD has installed four successful deep injection (and recovery) wells at the nearby ASR project that are capable of sustained injection rates of about 1,500 gpm. Although the Injection Facilities area is within about 1,000 feet of the closest ASR well, actual aquifer performance at proposed well locations will need to be confirmed. In addition, the manner in which the deep injection wells will be operated may result in a slightly different well capacity than the ASR wells. Unlike ASR wells, the Project's deep injection wells will receive product water on a more continuous basis, will require a more consistent injection rate over time, and will not be used for recovery of injected water (although some pumping will occur for well maintenance), which will be accomplished through existing downgradient production wells.

In consideration of these factors, a design injection rate of 1,000 gpm – lower than the ASR rate of 1,500 gpm – has been selected for planning purposes. This rate will minimize local mounding and long-term stress on the wells. If a higher sustained injection rate can be justified after the Project wells have been drilled and tested, fewer wells may be needed to meet project objectives. Wells will be constructed using a phased approach (see **Section 8**).

3.5.1.1.2. Number of Deep Injection Wells

As discussed in more detail in **Section 8**, there will be some time periods when a maximum of 3,700 AFY of recycled water may be available for Seaside Basin recharge (more than the average of 3,500 AFY). The collective capacity of the deep injection wells must be capable of accepting the maximum daily injection rate for the Santa Margarita Aquifer, estimated at 2,179 gpm. With a maximum injection capacity of 1,000 gpm/well, three deep injection wells with a total design capacity of 3,000 gpm will be required. If wells could accommodate 1,100 gpm, two wells appear to be adequate for the maximum rate.

However, extra injection capacity will be desirable to account for well maintenance/down time and potential decreases in well capacity over time. Given the continuous nature of the injection, frequent pumping for well maintenance may be required to sustain injection rates. Accordingly, a maximum of four deep injection wells are intended for the project, designated as DIW-1 through DIW-4 on Figure 3-10. Using the relatively conservative rate of 1,000 gpm/well, four wells will provide a total operational capacity of 4,000 gpm, decreasing to 3,000 gpm when any one well goes offline.

3.5.1.1.3. Location and Spacing of Deep Injection Wells

The location and spacing of the deep injection wells was developed based on both technical and regulatory considerations. As shown on Figure 3-10, the spacing between wells is approximately 1,000 feet. This spacing is also maintained between each deep injection well and the closest downgradient production well. Because the injection wells will be operated continuously (except during routine maintenance), water levels are expected to rise or "mound" around the injection wells, which expands over time until steady state conditions are reached. As these groundwater mounds overlap in the subsurface, hydraulic gradients increase and injection rates may decrease as the well becomes less efficient. Increased spacing between wells (based on the aquifer's hydraulic properties) can minimize the impacts of this hydraulic interference. In addition, the spacing between the injection wells and downgradient production wells is considered to balance the timely recovery of product water with underground retention times as required by the Title 22 Criteria (see **Sections 5 and 6**).

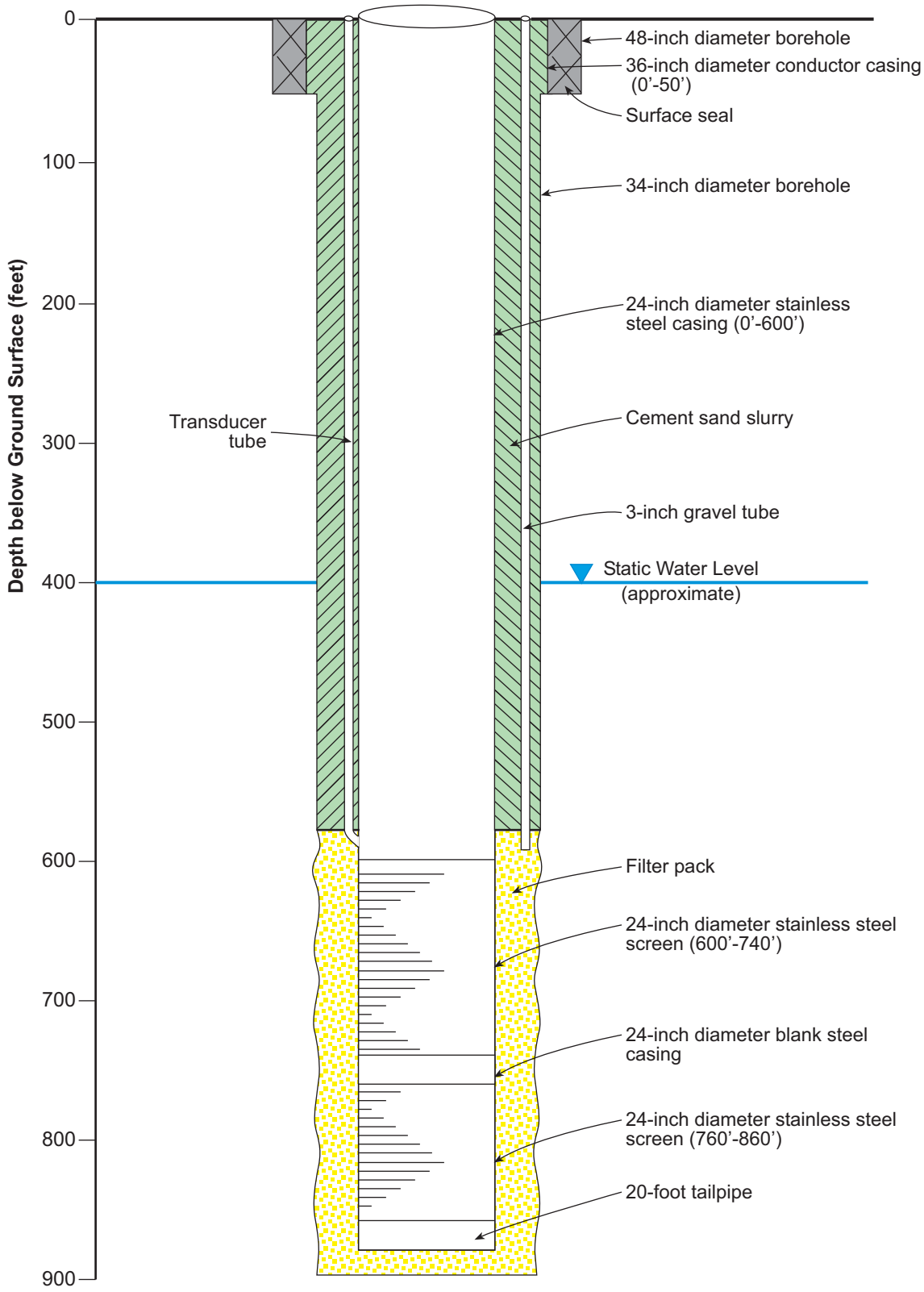
3.5.1.1.4. Deep Injection Well Design

Incorporating some of the successful design features already tested in MPWMD ASR wells, a preliminary well design for a deep injection well for the Project has been developed. The exact well depth, screen placement, and other design features may be modified based on field results during well construction. Current design criteria are summarized in Table 3-45 below. A preliminary deep injection well construction diagram is shown on Figure 3-11.

Table 3-45: Design Criteria Summary for Deep Injection Wells

Component/Parameter	Criteria
Number of Santa Margarita injection wells	Maximum of 4
Average depth to water	400 feet
Injection rate per well	1,000 gpm
Discharge rate per well	2,000 gpm
Average well depth	909 feet
Casing size and materials	18-inch outer diameter stainless steel
Screen assembly	230 feet stainless steel wire-wrap
Pump for back-flushing extraction	400 hp

Wells will be equipped with a downhole flow control valve to allow both injection and extraction to occur in each well. Each well will have a pump and motor (currently estimated at 400 hp) to allow pumping for well maintenance at a projected rate of 2,000 gpm. Pumped water will be discharged to a separate backflush pipeline to transmit water to the backflush basin, described in more detail in the following subsections.



Note: Some design components incorporated from Pueblo Water Resources, 2002.

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Figure 3-11
Proposed Deep Injection Well Design GWR Project

3.5.1.2. Vadose Zone Wells

Similar to deep injection wells, well capacity and well spacing are also key considerations for vadose zone wellfield design. However, pathways and transport of the product water to the water table and to subsequent downgradient extraction wells are also considered. Recent data from a MRWPCA field program were used to analyze a preliminary vadose zone well design and operational parameters for the Project. Complete results of the field program are presented in a separate report, attached to this Engineering Report as **Appendix I** (Todd Groundwater, 2015b). The proposed locations of vadose zone wells are shown on Figure 3-10 and discussed in more detail below. Wells will be phased during project construction and may include less wells based on initial well testing, product water allocation, and back-flushing schedule of the deep injection wells (which involves additional recharge via a back-flush basin). These and other factors are discussed in **Section 8**.

3.5.1.2.1. Well Capacity

MRWPCA collected site-specific data during a 2013-2014 field program to better assess potential injection capacity and optimize vadose zone well design for recharging the Paso Robles Aquifer. Based on core samples and geologic logging in monitoring well MRWPCA MW-1, the vadose zone appears more homogeneous and permeable than the underlying saturated zone of the Paso Robles Aquifer. Hydraulic conductivity data from core samples indicate the potential for high injection rates. An analysis of vadose zone well capacity presented in the field program report (included as **Appendix I**) (Todd Groundwater, 2015b) indicated that one vadose zone well alone could likely recharge the entire allocation of 242 gpm (based on allocation discussed in **Section 8**). The analysis suggests that with about 100 feet of screen, an injection rate of approximately 500 gpm could be achieved. This analysis is supported by the large storage capacity in the vadose zone beneath the Injection Facilities area, where the depth to water has averaged about 400 feet over recent years.

Thin, low-permeability silt and clay zones were more prevalent in the lower portions of the vadose zone that could potentially decrease injection rates or result in long travel times to the water table. A comparison of these zones with geologic descriptions in nearby production wells indicate that these layers are not likely continuous beneath the Injection Facilities area.

3.5.1.2.2. Number of Vadose Zone Wells

If the vadose zone wells meet the estimated injection capacity of 500 gpm, only one well would be needed to accommodate the anticipated delivery of product water. As shown in Table 8-1 (**Section 8**), the maximum injection rate estimated for the Paso Robles Aquifer is 242 gpm.

However, more than one well is recommended for several reasons. First, the long-term injection capacity of vadose zone wells is uncertain and may vary significantly across the Injection Facilities area. Vadose zone wells are subject to clogging and cannot be redeveloped using conventional techniques. Vadose zone wells are much less expensive than deep injection wells and can be incorporated into the Project at a much lower cost. In addition, the extra capacity will provide the Project with operational flexibility. If unanticipated well problems arise, additional vadose zone capacity will allow injection to continue while wells are being repaired or replaced. If monitoring indicates that certain target recharge areas are being under-supplied to the Paso Robles Aquifer, additional vadose zone wells will allow recharge to be targeted in specific areas. Accordingly, a

maximum of four vadose zone wells are being incorporated into the Project design. Construction of wells will be phased as discussed in **Section 8**.

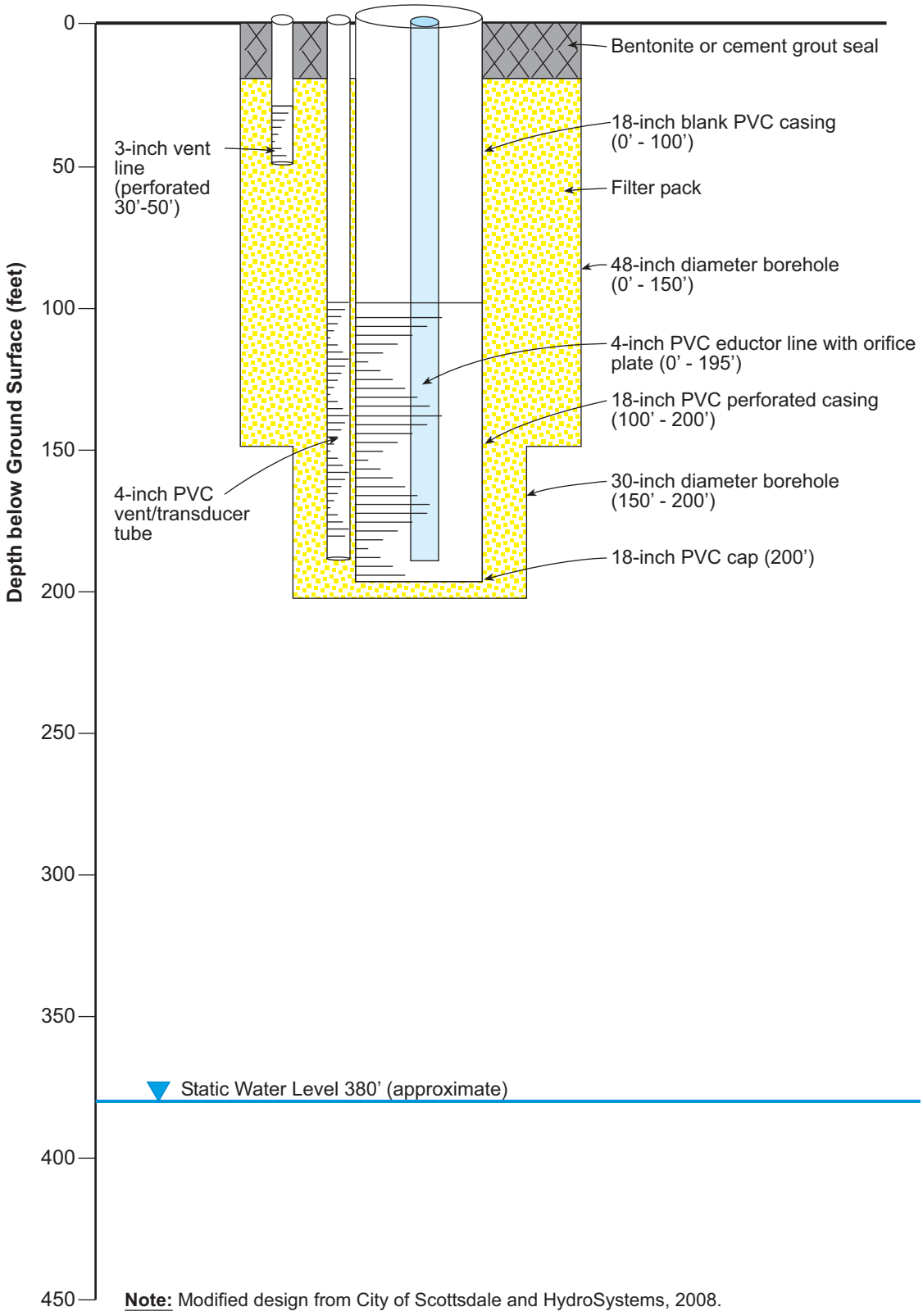
3.5.1.2.3. Spacing and Location of Vadose Zone Wells

The locations of the vadose zone wells along the 3,000 feet Injection Facilities area are less sensitive to the spacing criteria for deep injection wells. Travel time from vadose zone wells to downgradient production wells is much slower than from the deep injection wells. This is due to the increased travel time associated with vadose zone transport and slower average linear groundwater velocities in the Paso Robles Aquifer (due to lower permeability). In addition, the relatively low recharge volumes reduce the potential for significant well interference among closely-spaced wells. Additional information on travel time is provided in **Section 5**. Additional information on recharge volumes is provided in **Section 8**.

For planning purposes, it is proposed that one vadose zone well will be placed next to each of the four deep injection wells, resulting in a well spacing of 1,000 feet between vadose zone wells (Figure 3-10). This configuration provides some construction and operational conveniences in that deep and shallow wells would be in close proximity for monitoring and maintenance.

3.5.1.2.4. Preliminary Vadose Zone Well Design

A preliminary vadose zone well design has been developed that incorporates some of the appropriate design features from the City of Scottsdale's (Arizona) successful vadose zone wells at its Water Campus where more than 50 vadose zone wells have been installed. A schematic well design is shown on Figure 3-12. Most of the City of Scottsdale's recent vadose zone wells consist of a 30-inch to 48-inch diameter borehole containing a 12-inch to 18-inch PVC casing/screen assembly with approximately 100 feet of slotted screen. Wells were typically drilled to a depth of 150 to 180 feet and installed with a filter pack from the bottom of the well up to a surface seal. The vadose zone beneath Scottsdale consists of permeable alluvial sediments with the water table at a depth of approximately 400 feet, conditions similar to the Injection Facilities area (City of Scottsdale, personal communication, July 27, 2007).



Note: Modified design from City of Scottsdale and HydroSystems, 2008.

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Figure 3-12
Proposed Vadose Zone Well Design
GWR Project

Wells will be designed to accept product water via a 4-inch PVC casing referred to as an eductor line installed to the bottom of the well to prevent cascading water and air entrainment. The well design also incorporates transducer tubes, ventilation lines, and lines to access the gravel pack. Design criteria for the vadose zone wells are summarized in Table 3-46.

Table 3-46: Design Criteria for Proposed Vadose Zone Wells

Component/Parameter	Criteria
Number of wells	Maximum of 4
Average depth to water table	400 feet
Borehole diameter	48-inch to 150 feet; 30-inch to 200 feet
Casing/Screen diameter	18-inch PVC with 100 feet of slotted casing (100 slot)
Injection method	4-inch outer diameter PVC eductor line
Injection capacity	500 gpm
Annular material	Artificial filter pack or gravel
Monitoring equipment	Transducer

3.5.2. Back-Flush Basin

Deep injection wells will need to be pumped periodically to mitigate well clogging and to maintain injection capacity, a process known as back-flushing. To provide a location and mechanism to discharge the pumped water, a shallow basin will be constructed in the Injection Facilities area. Water will be piped to the basin from the deep injection wells, allowed to infiltrate the permeable sediments on the open basin bottom, and percolate down to the water table. By allowing the water to recharge, pumped water will be conserved. Vadose zone wells do not penetrate the saturated zone and are not involved in the back-flushing process.

The proposed basin has been sited between DIW-2 and DIW-3 (Figure 3-10) to take advantage of a relatively flat area as indicated by the ground surface elevation contours. Once access is available across the Injection Facilities area, the location of the basin may be slightly re-positioned based on actual surface conditions. The preliminary basin design developed by E2 Consulting Engineers, covers a footprint of approximately 125 feet by 125 feet and is approximately 5 feet deep.

3.5.2.1. Back-flush Basin Design Criteria

The basin will be constructed on the Aromas Sand, which comprises the upper 300- to 400-feet of vadose zone beneath the Injection Facilities area. This geologic unit was recently evaluated during drilling of the nearby monitoring well MRWPCA MW-1 (Figure 3-10). Core samples throughout the vadose zone were collected and analyzed for vertical permeability. Laboratory permeability values vary widely from more than 100 feet per day in the most permeable sand zones to less than 0.01

feet per day in silty clay intervals. However, samples above about 295 feet (about 100 feet above the current water table) contain very little fine-grained sediment (silt or clay). The lowest permeability value measured in this section is about 14 inches per hour (or 28 feet per day). MPWMD corroborated this laboratory infiltration rate with observed infiltration rates of about one foot/hour during the first hour of discharge at the existing ASR back-flush basin (located between ASR-1 and ASR-2 and about 1,000 feet from the Project's proposed back-flush basin location, see Figure 3-10).

Relatively rapid infiltration rates indicate that the basins will drain sufficiently between discharge events, allowing for drying and periodic tilling to break up any surficial clogging. For planning purposes, a design infiltration rate of six feet per day is assumed. That rate is judged reasonable, given that it is only about 20% of the lowest permeability value recorded in the upper 277 feet of the vadose zone.

3.5.2.2. Back-flushing Rates and Schedule

Back-flushing is typically conducted at pumping rates higher than injection rates. At the nearby ASR wellfield, MPWMD back-flushes the wells at about twice the injection rate. For planning purposes, it is assumed that the Project will also back-flush the deep injection wells at 2,000 gpm – twice the planned injection rate of 1,000 gpm.

The optimal back-flushing schedule and required pumping volumes will be determined once the injection wells are operational. The nearby MPWMD ASR wellfield site contains a small back-flush basin that holds approximately 240,000 gallons of water to accommodate several hours of weekly pumping. Because the Project recycled water will contain relatively low TSS or TDS, clogging rates of the deep injection wells may be lower than observed at nearby ASR wells.

However, because the Project wells are being completed in the same aquifer as the ASR wells, and because the injectate for the ASR project is also relatively low in solids content, weekly pumping for each well at a rate of 2,000 gpm is being assumed for planning purposes. If a well requires four hours of pumping at 2,000 gpm, approximately 480,000 gallons of water will need to be discharged per well per week. This schedule is conservative and may be modified once wells are in operation.

E2 Consulting Engineers developed a preliminary design of the project back-flush basin including an analysis of inflow and outflow to assure sufficient basin capacity (See Table 3-3 in E2, 2014). The basin design may be modified once injection well testing has been completed.

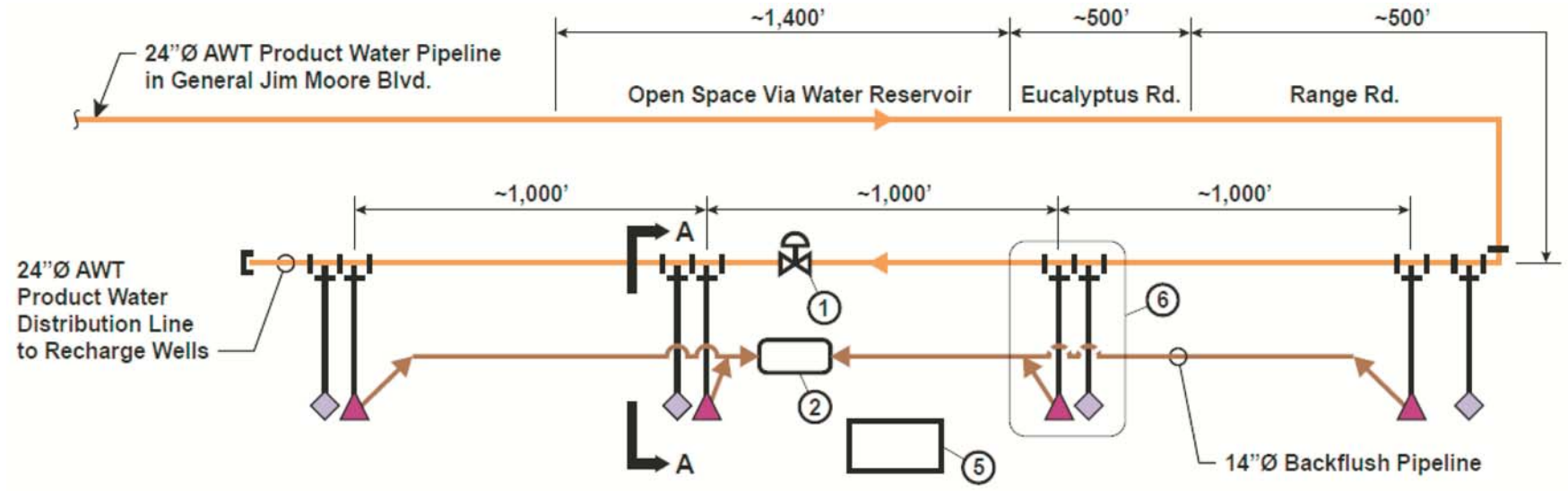
3.5.3. Water Supply Pipelines and Additional Support Facilities

As determined in the preliminary design of the Injection Facilities area by E2 Consulting Engineers, a 14-inch back-flush pipeline will be connected to the deep injection wells for conveyance to the back-flushing basin. Wells will also be tied into a 24-inch water supply pipeline by 12-inch and 8-inch feed lines for deep injection wells and vadose zone wells, respectively. Additional facilities include electrical connections, transformer, and electrical building(s).

Figure 3-13 provides a schematic diagram of the Injection Well Facilities plan. The diagram illustrates the tie of the 24-inch AWT product water pipeline with the 24-inch Product Water Distribution Line. The diagram also illustrates the connection of the deep injection wells with the 14-inch backflush pipeline that conveys pumped water to the backflushing basin (labeled backflush water storage and percolation pond on Figure 3-13). The connection to the 8-inch feed line for the vadose zone wells is illustrated on Section A-A.

Figure 3-14 shows a typical well access pad with a vadose zone well and a deep injection well, including connection to the 24-inch water distribution line and the 14-inch backflush pipeline (deep injection well only). Electrical lines including two power conduits and two instrument conduits are also shown on the diagram. Electrical power connections, as well as a Control and Instrumentation panel will be included at each well site (Figure 3-14).

Finally, a paved access road will be constructed from Eucalyptus Road across the Injection Facilities area to allow for service, operation, and well maintenance. Monitoring wells will be constructed both along the Injection Facilities road and downgradient within the proposed City of Seaside redevelopment area. Temporary access roads will be constructed to the monitoring wells. Access to monitoring wells may be modified as development proceeds across the area.

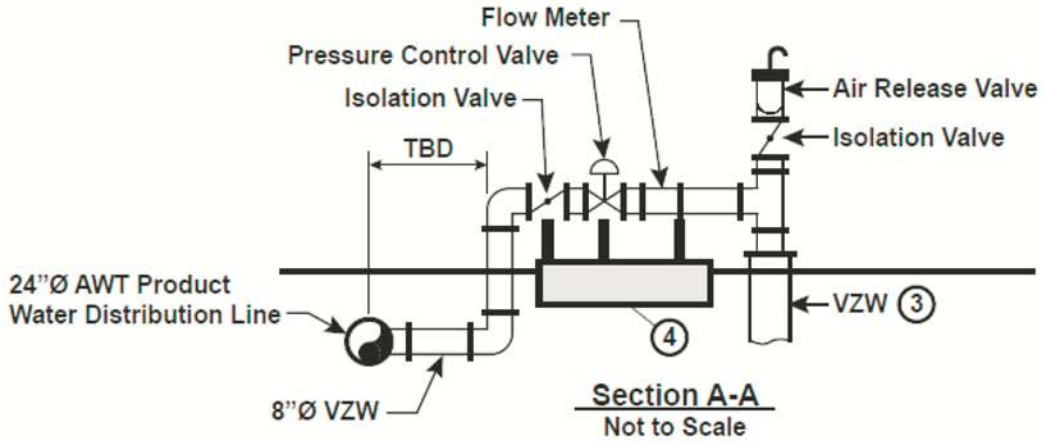


Conceptual Schematic Proposed Injection Wells Facilities Area Plan

Not to Scale

Legend

- Injection Well (INW)
- Vadose Zone Well (VZW)
- (1) Pressure Reducing Station
- (2) Backflush Water Storage and Percolation Pond (Size and Location TBD, Refer to Todd Groundwater and E2 for Details)
- (3) Refer to Todd Groundwater for Well Details
- (3) See Figure 6-A for Injection Well Piping Schematic
- (4) Concrete Pipe Support Pad - Typical for Above Ground Piping
- (5) Electrical Power Supply & Instrumentation Control Building
- (6) See Figure 6-B for Conceptual Site Plan of Typical Well Cluster (1 of 4)



Section A-A

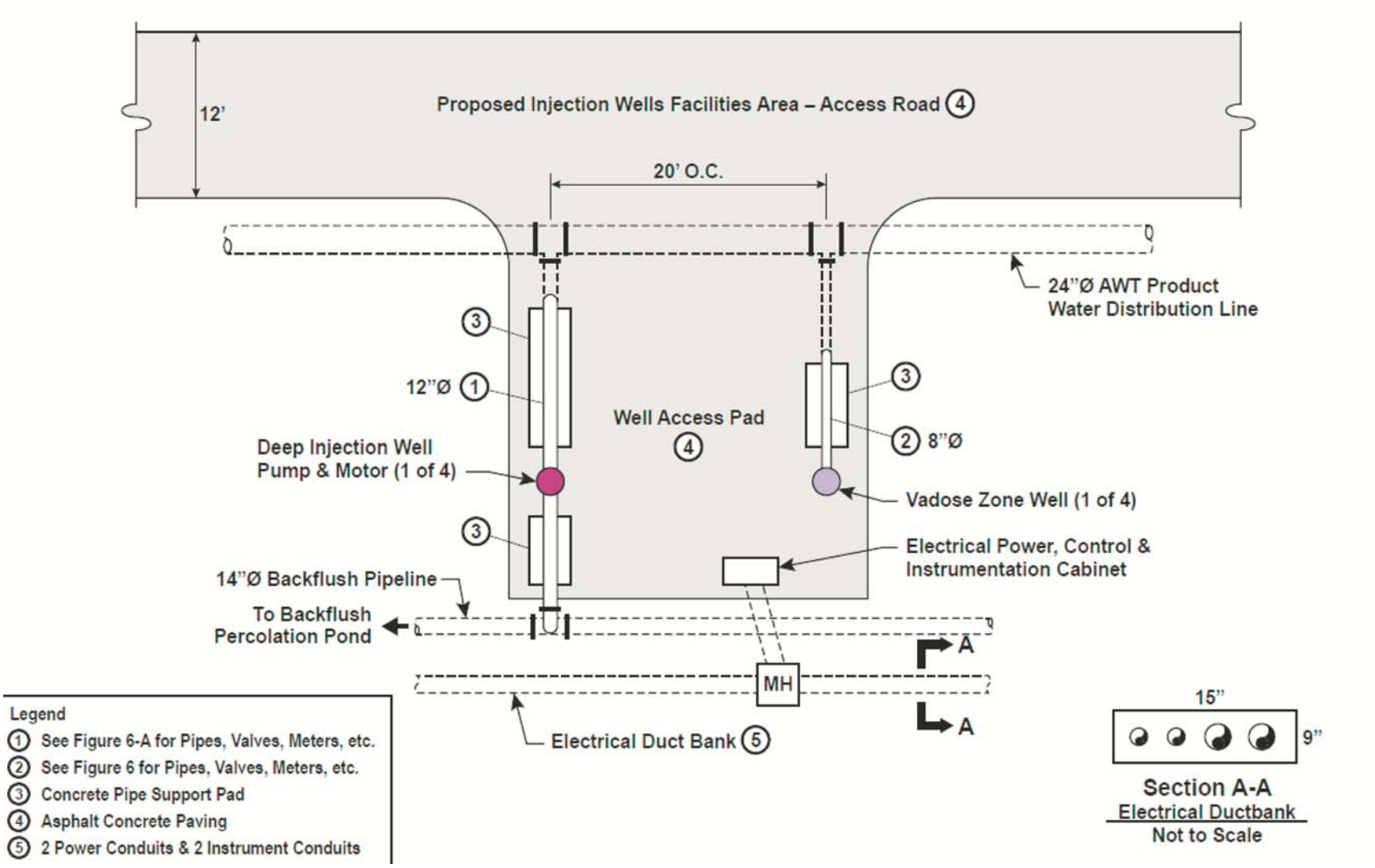
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Source: Cole, 2014.

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Figure 3-13
GWR
Injection Well
Facilities Area Plan



Source: Cole, 2014.

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Figure 3-14
Typical Well Cluster Site Plan

4. SOURCE WASTEWATER

This section describes MRWPCA pretreatment/source control program and information on the characteristics of secondary effluent produced at the RTP that will serve as feed water to the AWT Facility.

4.1. INDUSTRIAL PRETREATMENT AND SOURCE CONTROL PROGRAM

4.1.1. Legal Authority

MRWPCA administers an approved pretreatment program under NPDES Permit Order No. R3-2014-0013. The objectives of the program are: (1) to enhance MRWPCA's ability to comply with effluent discharge requirements and any other discharge criteria, which are required or authorized by state or federal law; (2) to derive the maximum public benefit by regulating the quality and quantity of wastewater discharged into the sewerage system; (3) to protect the public, the environment, MRWPCA personnel and facilities from potentially harmful industrial wastes; and (4) to ensure that industrial users pay their fair share of treatment operations and maintenance costs.

Activities to achieve these objectives are conducted in accordance with MRWPCA Ordinance No. 2008-01 (*An Ordinance Establishing Regulations for the Interception, Treatment and Disposal of Sewage and Wastewater; Providing for and Requiring Charges and Fees Therefore; and Fixing Penalties for Violation of Said Regulations* [Wastewater Discharge Ordinance]); Ordinance No. 2015-01 (*An Ordinance Establishing Rule and Regulations Regulating the Discharge of Hauled Wastes* [Hauled Waste Ordinance]), and federal pretreatment regulations pursuant to 40 Code of Federal Regulations Part 403 (40 Code of Federal Regulations [CFR] Part 403) and Sections 307 and 402 of the Clean Water Act (CWA). On October 26, 2015, MRWPCA adopted a new Interruptible Rate Structure that includes provisions that will address control measures for the new source waters for the Project.

4.1.2. Program Description

MRWPCA's program maintains a staff of 3 full-time positions, a Source Control Supervisor and two Source Control Inspectors that provide permitting, inspection, sample collection, sample analysis, review of data, response to incidents of noncompliance by industries or issues at the RTP, enforcement, development of program requirements, and administration (including record keeping and data management). The staff also provides contractual support for regulation of dischargers to the Salinas Industrial Waste Treatment Facility (IWTF) (referred to as "agricultural wash water") and member entity contract inspection services for the 2012 NPDES storm water permit.

MRWPCA has a small industrial base. The number and type of industries as of the end of 2015 per the *2015 Annual Pretreatment Report*[29] are summarized below in Table 4-1.

[29] Per the NPDES permit, MRWPCA submits the Annual Pretreatment Report to the Regional Board in January describing pretreatment activities for the prior year.

Table 4-1: MRWPCA Industrial Inventory

Classification[a]	Number	Type of Industry/Discharge
Significant Industrial Users (SIUs)		
Categorical Industrial Users (CIUs)	**0**	
Non-significant CIUs	**0**	
Non-categorical SIUs	**4**	
Mission Linen Supply #0300		Industrial laundry
Mission Linen Supply #2100		Industrial laundry
Sabor Farms, LLC		Agricultural wash water
Ocean Mist Farms		Ag Wash Water
Other Regulated IUs	**12**	
BCI Coca-Cola Bottling Co.		Groundwater
Chevron Corp.		Groundwater
City of Pacific Grove		Urban Runoff
Community Hospital of the Monterey Peninsula		Sanitary waste[b]
Culligan Water Conditioning		Regeneration of water softener resins
Monterey Bay Aquarium		Saline and sanitary waste
Natividad Medical Center		Sanitary waste[b]
Performance Agriculture		Groundwater
Pure Etch Co.		Groundwater
Salinas Tallow Co.		Cooking oil recycling
Salinas Valley Memorial Hospital		Sanitary waste[b]
Steinbeck Plaza/Cannery Row Co.		Groundwater
Total	**16**	

a. The USEPA defines significant industrial user in three ways: (a) an industrial user subject to Categorical Pretreatment Standards under 40 CFR Part 403.6 and 40 CFR, Chapter I, subchapter N. Any industry that falls under these categories is considered a SIU whether it has process discharge to the sewer or not. These industries are Categorical Industrial Users (CIUs); (b) Any industry which discharges an average of 25,000 gallons per day or more of process wastewater to the sewer system (excluding sanitary, contact cooling and boiler blowdown wastewater); and (c) any industry which is designated as such by the wastewater management agency on the basis that the industrial user has a reasonable potential for adversely affecting the operation of the collection system or treatment plant, or violating any pretreatment requirement.

MRWPCA has pretreatment standards for photo processors, x-ray developers, and printers that generate spent fixer solutions, including size specific silver recovery systems or hauling spent fixer solutions. For hospitals specifically, MRWPCA requires hospitals to implement a program for waste management and reduction based on the USEPA *Guidance Manual for Controlling Waste from Hospitals and Medical Facilities*. Hospitals are required to submit annual reports the list accomplishments from the past year and goals for the new year. MRWPCA maintains its industrial inventory by reviewing the phone book and online telephone information sites; referrals from the MRWPCA Customer Service Department for new or expanded sewer connections; building permit sign-offs from all member entity building inspection departments; and service area canvassing.

MRWPCA's industrial users are required to obtain a permit in order to discharge to the sewerage system. The permit includes discharge limits, prohibitions, monitoring requirements, and spill control,

reporting, and other provisions pursuant to the Wastewater Discharge Ordinance and/or federal regulations.

MRWPCA maintains an active monitoring program to ensure continued compliance by its industrial users. MRWPCA can, if needed, perform surveillance monitoring aimed at facilitating the detection of actual and potential problems caused by the illegal discharge of prohibited materials.

MRWPCA conducts a field inspection program, which includes visiting industrial facilities to investigate their compliance status, identifying industrial sources responsible for treatment plant upsets or incidents, and disseminating information on the pretreatment program to industrial users.

Industrial users that are found through inspection or monitoring to be out of compliance are subject to enforcement action by MRWPCA. Standardized enforcement procedures have been developed in MRWPCA's Enforcement Response Plan to achieve timely and effective compliance.

All waste haulers that dispose hauled wastes at the RTP must have and show proof of (1) registration as a septage or chemical toilet hauler with the County of Monterey Department of Public Health and (2) an MRWPCA Brine or Liquid Waste Hauler Discharge Permit in accordance with the Hauled Waste Ordinance. Limitations and prohibitions are contained in the Hauled Waste Ordinance. Prior to discharge to a receiving location, each load is tested for pH and a sample is collected for storage. When the receiving location is full, MRWPCA operations staff collects a sample and conduct a respirometer test. If it passes, the contents are pumped to the RTP. If the test fails, a respirometer test will be conducted on every stored sample to determine which hauler discharged the problem load and appropriate actions are taken against the hauling company. If the waste in the receiving location cannot be pumped into the RTP, the hauler is required to return to the RTP and pump out the waste for treatment or hauling to an appropriate disposal site.

MRWPCA has established local limits that apply to all discharges per Section 2.10.1 in the Wastewater Discharge Ordinance as shown in Table 4-2.

Table 4-2: MRWPCA Local Limits

Constituent	Local Limit mg/L
Arsenic	0.42
Cadmium	3.4
Copper	4.3
Cyanide	0.73
Lead	3.0
Mercury	0.018
Nickel	3.5
Silver	2.3
Total Chromium	2.7
Zinc	2.6
pH	6.0-10.5
Temp	<150 deg F
Phenol	8.1

MRWPCA has adopted narrative prohibitions related to toxic inorganic pollutants, toxic organic chemicals, oil and grease, ammonia, biochemical oxygen demand, and TSS. MRWPCA has also developed pretreatment standards (e.g., local limits) for silver for photo processors, x-ray developers and printers.

Prior to operation of the Project, the local limits will be evaluated for constituents relevant to potable reuse, including MCLs, NLs, CECs, and other pollutants of concern.

On May 8, 2013, Tetra Tech conducted a Pretreatment Compliance Inspection (PCI) on behalf of the Central Coast RWQCB. The results of the PCI included recommendations for minor changes to industrial user (IU) permit language regarding self-monitoring and submittal time frames for industrial user re-sampling. MRWPCA implemented these recommendations by September 9, 2013.

MRWPCA's community outreach activities, which include source control information, were summarized in **Section 1.2**. Additional activities directly related to the source control program include:

- MRWPCA's Got Drugs Program, which provides information to residents about proper disposal of medications and a list of pharmacies with take-back programs.
- Commercials and advertising for controlling fats, oils, and grease.
- Participation in the Monterey County Oil Recycling Program.
- Dissemination of information on Monterey County's household hazardous waste program and an on-line household hazardous waste disposal chart.

4.1.3. New Water Sources for the Regional Treatment Plant

The new source waters that will supplement the existing incoming wastewater flows are the following: (1) water from the City of Salinas agricultural wash water system (Salinas IWTF), (2) storm water flows from the southern part of Salinas, (3) surface water and agricultural tile drain water that is captured in the Reclamation Ditch and Tembladero Slough, and (4) surface water and agricultural tile drain water that flows in the Blanco Drain. Most of these new source waters will be combined within the existing wastewater collection system before arriving at the RTP; water from Blanco Drain will be conveyed directly to the RTP. As part of the EIR, the assessment included these new sources as well as storm water diversions from the Lake El Estero facility in Monterey. Grant/loan financing, design, engineering nor permitting are being pursued for Tembladero Slough, but may be reconsidered in the future. The Lake El Estero source is not planned for diversion for the Project, but may be reassessed in the future.

Source control plans to address these new water sources include (a) permitting the agricultural wash water and other industries that discharge to the Salinas IWTF; and (b) a new rate system that includes control mechanisms and prohibitions as described below.

4.1.3.1. Agricultural Washwater

The City of Salinas collects and treats wastewater from approximately 25 agricultural process and related businesses that heretofore were conveyed to the Salinas IWTF for biological treatment and discharge via percolation ponds. Prior to discharge to the RTP, these industrial facilities will be permitted as IUs by MRWPCA. Over 80% of the collected flows are from vegetable packers, with the

remainder originating from seafood processing, refrigerated warehousing, and manufacturing of ice and corrugated paper boxes.

4.1.3.2. Blanco Drain

The Blanco Drain is a man-made reclamation ditch draining approximately 6,400 acres of agricultural lands east of the City of Salinas. The watershed for the Blanco Drain is between the Salinas River and Alisal Slough, and discharges to the Salinas River. The Blanco Drain is separated from the Salinas River by a flap gate, which prevents high-water conditions in the Salinas River from migrating up the Blanco Drain channel. Summer flows in the Blanco Drain are generally tile drainage and runoff from irrigated agriculture. Winter flows include storm water runoff, although some fields remain in production and are irrigated year-round. The Project would include improvements that would enable water in the Blanco Drain to be diverted and conveyed to the RTP for treatment. The Monterey County Water Resources Agency has flood control responsibility for the natural and man-made storm water channels within the County, including the Blanco Drain and the Reclamation Ditch system in northern Monterey County.

4.1.3.3. Salinas Storm Water Collection System

Currently, storm water from urban areas in southern portions of the City of Salinas is collected and released to the Salinas River through an outfall near Davis Road. The runoff system currently drains an area of about 2.5 square miles and eventually flows to the Salinas River through a 66-inch gravity pipeline. The drainage area is virtually all within the developed portion of Salinas and does not appear to intercept water from non-urban areas. Therefore, flows are likely to be almost entirely from urban runoff. The climate of Salinas is semiarid, with the rainy season occurring from November through March. The Project would include improvements that would enable Salinas storm water to be conveyed to the RTP for treatment.

4.1.3.4. Reclamation Ditch

The Reclamation Ditch, created between 1917 and 1920, is a network of excavated earthen channels used to drain natural, urban, and agricultural runoff and agricultural tile drainage. The Reclamation Ditch watershed is approximately 157 square miles that includes headlands, agricultural areas, the City of Salinas and portions of Castroville and Prunedale. It collects water from Alisal Creek at Smith Lake southeast of the City of Salinas, Gabilan and Natividad Creeks within Salinas at Carr Lake, and Santa Rita Creek west of Salinas. The Reclamation Ditch is a major drainage channel that flows from east to west through Salinas and continues west where it drains into Tembladero Slough, thence to the Old Salinas River Channel, and ultimately into Moss Landing Harbor through the Potrero Road Tide Gates. Alisal, Gabilan and Natividad Creeks are seasonal in their upper reaches. The Reclamation Ditch is perennial downstream of agricultural and urban development. However, the presence of dry-season flow is a consequence of dry-season urban discharges and agricultural runoff and tile drain water. The Project would include improvements that would enable water from the Reclamation Ditch watershed to be diverted from the Reclamation Ditch at Davis Road Salinas to be conveyed to the RTP for treatment.

4.1.3.5. Interruptible Rate Program

On October 26, 2015, MRWPCA adopted a new Interruptible Rate Program for acceptance of the Project new water sources into the sewerage system on a seasonal or interruptible basis. MRWPCA has

developed eligibility criteria and conditions to qualify for this rate that include the following source control mechanisms:

- The interruptible rate discharger will be required to obtain and comply with a wastewater discharge permit issued by MRWPCA that includes discharge limits, prohibitions, self-monitoring, spill control, reporting and other provisions in accordance with the Wastewater Discharge Ordinance.

- The water source cannot contain domestic sewage as verified by MRWPCA's Source Control Division.

- The water source cannot be from a groundwater remediation site.

- The discharger must provide water quality data for the proposed discharge so that MRWPCA can determine if the discharge requirements per the Wastewater Discharge Ordinance, including compliance with MRWPCA's permits and protection of recycled water can be achieved. The permit application clarifies the number of samples, analyses, reporting levels, etc. The discharger will be responsible for the costs related to developing and implementing MRWPCA water quality objectives, including prohibitions that will allow MRWPCA to shut off the flow of source water.

- The discharger must allow MRWPCA to control the amount, timing, and duration of the discharge through motorized valves using a SCADA connection with MRWPCA's RTP and continuous flow metering. MRWPCA has the authority and access to reduce or terminate the discharge. The discharger, if needed, shall have pre-treatment for the removal of trash and/or other unacceptable discharges as identified in the newly created discharge permit.

- The discharger must have an alternative legal means of disposing of the wastewater should MRWPCA discontinue the diversion. MRWPCA will reduce or shut off flow when needed so that existing flow capacities of MRWPCA facilities will not be exceeded.

- The discharger will not be allowed to exceed the existing capacity of MRWPCA infrastructure, and will not be given an allocation or right to existing capacity.

- The discharger must agree to pay the appropriate fees associated with diverting and treating the water in accordance with the proposed Interruptible rate formula. These fees may include billing, source control and other administrative costs relating to this rate. Fees for MRWPCA to operate and maintain the diversion facilities will also be included in the rate.

- MRWPCA will inspect and monitor the discharge, and if necessary take enforcement action for permit violations in accordance with the Wastewater Discharge Ordinance and Enforcement Response Plan.

4.1.4. Compliance with Title 22 Source Control Requirements

While MRWPCA's Source Control Program to date has focused on protecting the RTP, ocean receiving water quality, and tertiary recycled water quality, the source control program will meet the Title 22 Criteria for groundwater replenishment as follows:

- **Contaminant Assessment.** The Project's pilot testing evaluated the fate of chemicals and contaminants through the RTP and treatment systems for the AWT Facility (*see* **Section 7**). The list of chemicals and contaminants evaluated included Priority Pollutants, constituents with MCLs and NLs, and CECs, and pesticides of local interest. Future studies will be conducted at the request of DDW and RWQCB or based on monitoring data collected by MRWPCA.

- **Contaminant Source Investigation.** MRWPCA will conduct investigations and monitoring (a) in the event of interference or pass through[30] at the RTP or AWT Facility, (b) at the request of DDW or RWQCB, or (c) based on monitoring data collected by MRWPCA.

- **Outreach:** MRWPCA currently administers an effective outreach program that consists of RTP facility tours, classroom presentations, information on the Project, information on pharmacies offering drug take-back programs, participation/exhibits in community events, school outreach (presentations, materials, teacher curriculum training and workshops), RTP tours, commercials and advertising for controlling fats, oil and grease, participation in the Monterey County Oil Recycling Program, and tours of the new AWT demonstration facility. These outreach efforts are similar to programs implemented by other agencies involved with potable reuse.

- **Contaminant Inventory.** MRWPCA's source control program tracks and identifies industrial users and discharges, including contaminants discharged through industrial monitoring. MRWPCA maintains its industrial inventory by reviewing the phone book and online telephone information sites, referrals from the MRWPCA Customer Service Department for new or expanded sewer connections, building permit sign-offs from all member entity building inspection departments, and service area canvassing. The inventory will also address the new source waters based on the results of the source water monitoring and subsequent monitoring when the source waters and any related industrial contributions are delivered to the RTP.

- **Annual Reporting.** MRWPCA currently prepares an annual report on the pretreatment program. Future reports will address compliance with the Title 22 source control provisions upon operation of the Project.

4.2. RAW WASTEWATER CHARACTERISTICS

4.2.1. Flows

In November 2015, MRWPCA analyzed the future monthly and annual availability of potential source waters not currently part of the MRWPCA system, including the Blanco Drain, Reclamation Ditch and

[30] Interference is defined as an industrial discharge which alone or in combination with a discharge or discharges from other sources (1) inhibits or disrupts the RTP or AWT Facility, their treatment processes or operations, the RTPs sludge processes, uses or disposal, or the use of recycled water and (2) is therefore a cause of a permit violation. Pass is defined as a discharge that exits the RTP or AWT Facility in quantities or concentrations, which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a permit violation.

agricultural wash water[31]. The predicted RTP flows are presented in Figure 4-1. and Table 4-3. Flows were also predicted for three different rainfall/water year types and management scenarios:

- **Normal/Wet – Building Reserve** considers flows when normal to above average rainfall is experienced, but AWT water is being stored in the Seaside Groundwater Basin to build a reserve supply;
- **Normal/Wet – Full Reserve** considers flows when normal to above average rainfall is experienced and the reserve supply is full; and
- **Drought** considers flows when below normal rainfall is experienced and there are higher demands for tertiary treated recycled water.

The total flows entering the RTP are relevant because some predictions regarding the water quality entering the AWT Facility are based on the blending that will occur with raw wastewater entering the RTP. In the summer, historical flows of secondary effluent will undergo tertiary treatment for delivery to CSIP recycled water customers. The AWT Facility will be able to utilize secondary effluent that is not directed to the CSIP recycled water customers. The predicted composition of source water flows available to the AWT Facility are shown in Figure 4-2**.**

[31] Flow predictions of diverted new source waters were based on estimated availability of the source waters, wastewater flows (based on average monthly municipal wastewater flows from January 2009 through December 2013), AWT Facility production levels, CSIP demands, and the RTP capacity.

Table 4-3: Predicted Availabilities for Source Waters entering the RTP (units in acre-ft)

	Month	Jan[a]	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal/Wet - Building Reserve	**Municipal WW**	1798	1678	1867	1796	1850	1799	1893	1888	1813	1844	1762	1776
	Ag Wash	0	0	0	355	413	563	435	444	369	0	0	0
	Blanco Drain	0	0	0	252	225	274	277	244	184	0	0	0
	Rec Ditch	0	0	0	162	97	89[b]	129	121	80	0	0	0
Normal/Wet - Full Reserve	**Municipal WW**	1798	1678	1867	1796	1850	1799	1893	1888	1813	1844	1762	1776
	Ag Wash	0	0	0	355	413	563	435	444	369	0	0	0
	Blanco Drain	0	0	0	252	225	274	277	244	184	0	0	0
	Rec Ditch	0	0	0	162	97	89[b]	129	121	80	0	0	0
Drought	**Municipal WW**	1725	1494	1645	1657	1722	1675	1748	1773	1715	1690	1634	1612
	Ag Wash	0	0	0	312	412	391	435	444	368	0	0	0
	Blanco Drain	0	0	246	252	225	274	277	244	184	168	133	0
	Rec Ditch	0	0	165	162	97	132	129	121	80	87	98	0

a. Based on average municipal wastewater flows from 2009 through 2013

b. 132 acre-ft is anticipated to be available from the Reclamation Ditch in June; however, the total flow would exceed the RTP capacity unless the Rec Ditch allocation is reduced to 89 acre-ft

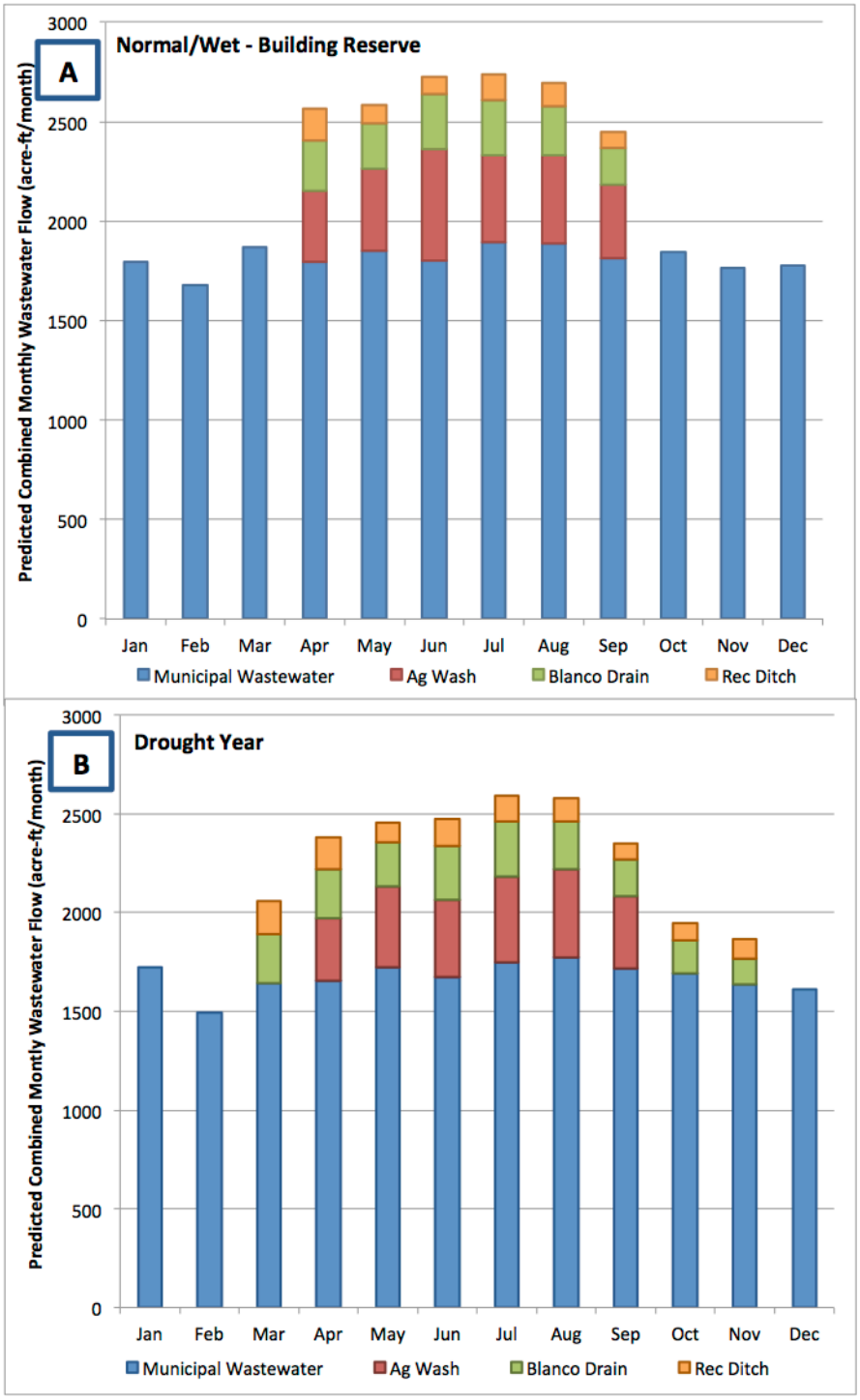


Figure 4-1. Predicted Availabilities for Source Waters entering the RTP during (A) Normal/Wet – Building Reserve and (B) Drought, with Average Wastewater Flow Rates from 2009 through 2013.

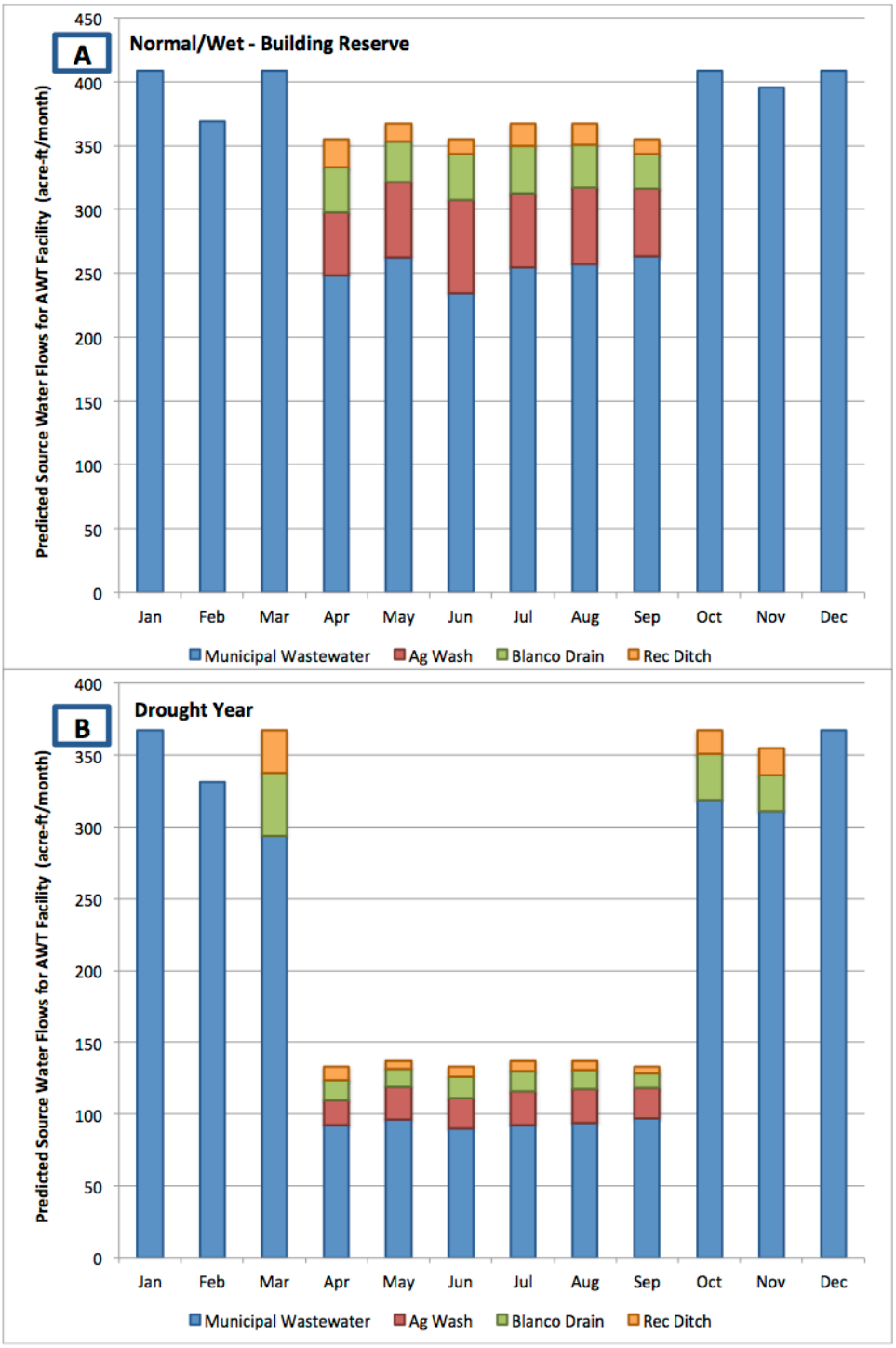


Figure 4-2. Predicted AWT Facility source water flows for use in the project during (A) Normal/Wet – Building Reserve and (B) Drought with average Wastewater Flow Rates from 2009 through 2013.

4.2.2. Water Quality

A monitoring program was conducted from July 2013 to June 2014 for five of the potential source waters (Trussell Technologies 2014b). Regular monthly and quarterly sampling was carried out for the RTP secondary effluent, agricultural wash water, and Blanco Drain drainage water. Limited sampling of stormwater from Lake El Estero was performed due to seasonal availability, and there was one sampling event for the Tembladero Slough drainage water.[32] The Reclamation Ditch was not sampled during the monitoring program. At the time the samples were collected, both Lake El Estero and Tembladero Slough were considered as potential sources waters for the Project. At this time neither source is planned to be used for the Project; however, the results of these sources have been included for historical context, and for use in estimating the Reclamation Ditch water quality.

4.2.2.1. Pathogenic Microorganisms

To protect public health, groundwater replenishment projects must inactivate or remove pathogenic microorganisms from the wastewater. The Title 22 Criteria for groundwater replenishment require minimum pathogenic log reductions of 12, 10, and 10 for viruses, *Giardia* cysts, and *Cryptosporidium* oocysts, respectively (i.e., 99.9999999999%, 99.99999999%, and 99.99999999% inactivation or removal, respectively).

During the 2013 to 2014 monitoring program, source waters were monitored for *Cryptosporidium* oocysts*, Giardia* cysts*,* total coliform, and *E. coli*. The source waters were not monitored for viruses based on the low number of indigenous virus expected to be present in runoff (Rajal et al., 2007) and RTP secondary effluent (Rose et al., 2004). Instead, indicator bacteria (total coliform and E. *coli*) were used as surrogates for virus. A summary of the concentrations of pathogens and indicator organisms measured in the source waters is presented in Table 4-4. In this context, untreated means the following:

- For the RTP effluent, prior to the AWT Facility treatment.
- For the other source waters, prior to treatment at the RTP/AWT Facility.

The concentrations of pathogens and indicator organisms are typical of an undisinfected secondary effluent.

[32] A Salinas stormwater sample was collected on December 2, 2014 and analyzed for an abridged set of chemical parameters, but these data were not included in this assessment.

Table 4-4: Summary of Pathogens Measured in Source Waters

Parameter [a]	Undisinfected RTP Secondary Effluent N = 4-11[b]	Agricultural Wash Water N = 3	Blanco Drain N = 4	Lake El Estero N = 1	Tembladero Slough N = 1
Cryptosporidium[c] (oocysts/L)	0.38 (<0.10 – 0.9)	<0.33 *(<0.2 – <0.38)*	0.185 (<0.18 – 0.2)	<0.3	<0.09
Giardia[c] (cysts/L)	<0.1 (<0.1 – 0.2)	<0.33 *(<0.2 – <0.38)*	<0.18 *(<0.09 – <0.19)*	<0.3	<0.09
Total coliform[d] (MPN/100 mL)	$7.1x10^5$ ($1.9x10^5$ – $1.6x10^6$)	$7.7x10^6$ ($6.2x10^5$ –$9.6x10^7$)	$4.3x10^4$ ($8.4x10^3$ –$2.0x10^6$)	$3.5x10^3$	$1.7x10^5$
E. coli[d] (MPN/100 mL)	$1.8x10^5$ ($2.9x10^4$ –$5.8x10^5$)	<20 (<20 – 18)	$2.4x10^2$ (75 – $2x10^3$)	<100	$7.5x10^2$

a. N is the number of samples; total coliform and *E. Coli* were sampled more frequently when range is shown.
b. Three of the total coliform and *E. Coli* samples and one of the *Cryptosporidium* and *Giardia* samples included diversion of agricultural wash water mixed with sewage and treated at the RTP.
c. Values are median values and data range (minimum concentration to maximum concentration) where applicable. Recoveries from one matrix spike test ranged from 19% to 51% for *Cryptosporidium* oocysts for the RTP secondary effluent, agricultural wash water and the Blanco Drain, and ranged from 27% to 48% for *Giardia* cysts for the agricultural wash water and the Blanco Drain, and was less than 0.092% for *Giardia* cysts for the RTP Secondary effluent.
d. Values are geometric means with the observed range (minimum concentration to maximum concentration) where applicable.

The source waters that were sampled are all expected to have a lower pathogenic microorganism counts than raw municipal wastewater. Therefore, adding the new source waters will not increase the concentrations of these organisms; the RTP and AWT Facility treatment technologies typical for groundwater replenishment projects will remove these organisms as demonstrated by existing groundwater replenishment projects elsewhere, and as discussed later in the report based on the pilot testing (*see* **Section 7)**.

4.2.2.2. Water Quality Constituents

The 2013 to 2014 source water sampling included a detailed characterization of the source waters. The source water sampling was designed to assess the full list of water quality parameters, including many that are not required to be monitored for groundwater replenishment projects. The types of constituents that were included in the source water monitoring program were:

- General water quality parameters, including total nitrogen and TOC;
- Constituents with California Primary and Secondary MCLs, namely
  - Inorganic chemicals,
  - Organic chemicals,
  - Disinfection by-products (DBPs), and
  - Radionuclides;
- Constituents with California action levels for lead and copper;
- Constituents with California NLs, namely

    - Current NLs as of December 14, 2010, and
    - Archived Advisory Levels (AALs)[33];
- Priority Pollutants;
- Constituents included in the USEPA Unregulated Contaminant Monitoring Rule (UCMR) Lists 1, 2 and 3 (excluding pathogenic organisms);
- Pesticides of local interest (PoLi) based on the agricultural activity/usage in the area[34]; and
- CECs.

As previously noted, the Title 22 Criteria include numeric water quality criteria for primary and secondary MCLs, total nitrogen and TOC, and action levels for lead and copper. The Title 22 Criteria also include requirements for numeric NLs based on the results of monitoring recycled water. For purposes of this project, the numeric NLs were used as compliance goals. Therefore, the source waters were analyzed for the constituents (also referred to as analytes) with regulatory criteria and goals.

The Title 22 Criteria require that the recycled water be monitored for additional constituents, but do not specify numeric criteria for the following: Priority Pollutants; chemicals specified by DDW based on the Engineering Report, affected groundwater basin, and source control program; and indicator chemicals to characterize the presence of CECs. Although the regulations do not require monitoring for AALs, contaminants included in the UCMR, PoLi, or all of the CECs sampled in the source waters, they were included in the source water sampling program to provide a comprehensive data set to evaluate source water quality and the performance of the pilot system.

During source water sampling and pilot testing programs, the sampling program evaluated a total of 435 analytes, including constituents with and without regulatory criteria/goals. Of these, 194 analytes were detected in at least one sample, and 241 were below detection limits in all of the source waters. The median concentration and concentration range of each analyte, as well as number of samples with positive detections, are provided in Appendix E. Some analytes are listed more than once in the appendix because different analytical techniques were used to determine their concentrations.

As previously noted, the Project includes the collection of a variety of new source waters that will be combined with existing incoming wastewater flows for conveyance to and treatment at the RTP. Constituent concentration reduction prior to use of the purified water for replenishment will occur in three ways.

1. In many cases, the blending of waters prior to treatment at the RTP will reduce concentrations of some constituents in each source water. Based on the predicted average monthly flows, the new source waters will comprise 0% to 34% of the RTP influent, depending on the month of the year and water type (building reserve or drought scenario). When additional source waters are being brought in to the RTP, they will receive dilution with municipal wastewater ranging from 8 parts wastewater and 1 part new source water to 3 parts wastewater and 1 part wastewater
2. The concentration of some constituents in the new source waters will be reduced prior to reaching the AWT Facility through the RTP primary and secondary treatment.
3. The secondary treated wastewater that is not sent to the SVRP tertiary treatment plant for agricultural irrigation will be treated at the AWT Facility, which will include ozonation, MF, RO,

[33] Per the H&S Code, advisory levels were renamed as NLs.

[34] Many of these constituents had applicable MCLs or AALs, and thus are addressed under those regulatory requirements/goals.

UV/AOP, and post treatment stabilization. These treatment technologies are typical for groundwater replenishment projects and will effectively remove these constituents as demonstrated by existing groundwater replenishment projects elsewhere and as discussed in the following sections of this report.

4.2.2.3. Constituents with Maximum Contaminant Levels and Notification Levels

Two monitoring frequencies were used for source water monitoring: (1) quarterly monitoring of all parameters to understand occurrence of the various constituents, and (2) monthly monitoring of a select list of constituents for understanding the variability of key design parameters. The quarterly sampling list for constituents/parameters with primary MCLs, secondary MCLs, and NLs are listed in Tables 4-5, 4-6, and 4-7, respectively.

Table 4-5: Constituents with Primary Maximum Contaminant Levels Included in the Source Water Monitoring

1,1-Dichloroethane	Carbon Tetrachloride	Nickel
1,1-Dichloroethylene	Chlordane	Nitrate[a]
1,1,1-Trichloroethane	Chlorite	Nitrate+Nitrite[a]
1,1,2-Trichloro-1,2,2-Trifluoroethane	Chromium	Nitrite (as N)[a]
1,1,2-Trichloroethane	cis-1,2-Dichloroethylene	Oxamyl
1,1,2,2-Tetrachloroethane	Cyanide	Pentachlorophenol
1,2-Dichlorobenzene	Dalapon	Perchlorate
1,2-Dichloroethane	Di(2-ethylhexyl)adipate	Picloram
1,2-Dichloropropane	Di(2-ethylhexyl)phthalate	Polychlorinated Biphenyls
1,2,4-Trichlorobenzene	Dibromochloropropane	Radium-226
1,3-Dichloropropene	Dichloromethane	Radium-228
1,4-Dichlorobenzene	Dinoseb	Selenium
2,3,7,8-TCDD	Diquat	Simazine
2,4-D	Endothall	Strontium-90
2,4,5-TP	Endrin	Styrene
Alachlor	Ethylbenzene	Tetrachloroethylene
Aluminum	Ethylene Dibromide	Thallium
Antimony	Fluoride	Thiobencarb
Arsenic	Glyphosate	Toluene
Asbestos	Gross Alpha Particle	Total Haloacetic acids
Atrazine	Heptachlor	Toxaphene
Barium	Heptachlor Epoxide	Total trihalomethanes
Bentazon	Hexachlorobenzene	trans-1,2-Dichloroethylene
Benzene	Lindane	Trichloroethylene
Benzo(a)pyrene	Hexachlorocyclopentadiene	Trichlorofluoromethane
Beryllium	Mercury	Tritium
Beta/photon emitters (K40 adjusted)	Methoxychlor	Uranium
Bromate	Methyl-tert-butyl ether	Vinyl Chloride
Cadmium	Molinate	Xylenes
Carbofuran	Monochlorobenzene	

a. The Title 22 Criteria for groundwater replenishment do not require that the MCLs for nitrate, nitrite, and nitrate + nitrite be met in recycled water. The regulations require that the total nitrogen concentration in the recycled water not exceed 10 mg/L as N. However, see later discussion in the report regarding compliance with Basin Plan MCL-based groundwater objectives, which include nitrate, nitrite, and nitrate + nitrite.

Table 4-6: Constituents with Secondary Maximum Contaminant Levels Included in the Source Water Monitoring

Aluminum	Iron	Thiobencarb
Chloride	Manganese	Total Dissolved Solids
Color	Methyl-tert-butyl ether	Turbidity
Conductivity	Odor-Threshold	Zinc
Copper	Silver	
Foaming Agents	Sulfate	

Table 4-7: Constituents with Notification Levels in the Source Water Monitoring

1,2,3-Trichloropropane	***Nitrosamines (List of 9)***[a]
1,2,4-Trimethylbenzene	N-nitrosodi-n-propylamine
1,3,5-Trimethylbenzene	N-nitrosodiethyamine
1,4-Dioxane	NDMA
2-Chlorotoluene	N-nitroso-di-n-butylamine
2,4,6-Trinitrotoluene	N-nitrosodiphenylamine
4-Chlorotoluene	N-nitrosomorpholine
Boron	N-nitrosopiperidine
Carbon disulfide	N-nitroso-methylethylamine
Chlorate	N-nitrosopyrrolidine
Diazinon	Naphthalene
Dichlorodifluoromethane (Freon 12)	n-Propylbenzene
Ethylene glycol	Propachlor
Formaldehyde	RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)
HMX (or Octogen)	sec-Butylbenzene
Isopropylbenzene	tert-Butylbenzene
Manganese	Tertiary butyl alcohol
Methyl isobutyl ketone	Vanadium
n-Butylbenzene	

a. The current list of NLs include only three nitrosamines: N-nitrosodiethyamine, NDMA, and N-nitrosodi-n-propylamine; the source water monitoring included a total of nine nitrosamine compounds.

A summary of the numbers of constituents/parameters with MCLs, NLs, and AALs detected[35] in each of the "untreated" source waters is presented in Table 4-8. In this context, untreated means the following:

- For the RTP effluent, after secondary treatment but prior to AWT Facility treatment.
- For the other source waters, prior to any treatment at the RTP/AWT Facility.

Table 4-8 also includes the numbers of constituents above their relevant regulatory limits, NLs or AALs.

[35] Detected means that the concentration was above the MRL. The MRL represents an estimate of the lowest concentration of a compound that can be detected in a sample for which the concentration can be quantified and reported with a reasonable degree of accuracy and precision.

Table 4-8: Number of Constituents with Maximum Contaminant Levels and Notification Levels Detected in Untreated Source Waters

Source Water	Number of Constituents Detected			
	Primary MCLs	Secondary MCLs	NLs	AALs
RTP Effluent	12 (1)[a]	12 (6)	9 (1)	3 (0)
Agricultural Wash Water	20 (5)	12 (8)	9 (2)	2 (0)
Blanco Drain	15 (2)	12 (9)	6 (0)	3 (1)
Lake El Estero	12 (0)	11 (7)	5 (0)	0 (0)
Tembladero Sough	13 (2)	9 (8)	3 (0)	1 (0)

a. Numbers in parentheses are the number of constituents detected (at least once) above a regulatory limit or advisory level.

Table 4-9 provides a comparison between the results of the untreated source water monitoring and the concentrations of constituents with primary and secondary MCLs that were determined to be above their regulatory limits in at least one sample in any of the untreated source waters. Very few constituents were above primary or secondary MCLs in the various untreated source waters. For the NLs, only two constituents were found in two of the five untreated source waters (RTP effluent and agricultural wash water) above the current NLs as shown in Table 4-9. For the AALs, only three constituents were detected with one above the advisory level (see Table 4-10). Treatment will occur through the primary and secondary processes at the RTP and AWT Facility. These treatment technologies are typical for groundwater replenishment projects and will remove these constituents to below regulatory levels and goals as demonstrated by existing groundwater replenishment projects elsewhere and as discussed later in the report.

Table 4-9: Constituents with Maximum Contaminant Levels above Regulatory Limits in at Least One Sample of any of the Untreated Source Waters

Source Water	Comparison to Primary MCLs			Comparison to Secondary MCLs		
	Constituent	Primary MCL	Highest Concentration Detected	Constituent	Secondary MCL	Highest Concentration Detected
RTP Effluent	Di-(2-ethylhexyl) phthalate	4 µg/L	78 µg/L	Color	15 units	75 units
				Conductivity (Specific Conductance)	900 µS/cm[a]	1623 µS/cm
				Iron	0.3 mg/L	0.537 mg/L
				Odor-Threshold	3 units	200 units
				TDS	500 mg/L[b]	803 mg/L
				Aluminum	0.2 mg/L	0.256 mg/L
Agricultural Wash Water	Fluoride	2 mg/L	31.9 mg/L	Chloride	250 mg/L[c]	292 mg/L
	1,3-Dichloropropene	0.5 µg/L	0.7 µg/L	Color	15 units	175 units
	Di(2-ethylhexyl)phthalate	4 µg/L	16 µg/L	Conductivity (Specific Conductance)	900 µS/cm[a]	1830 µS/cm
	~~Total h~~Haloacetic acids (HAA5~~s~~)	60 µg/L	390 µg/L	Iron	0.3 mg/L	0.875 mg/L
	Total trihalomethanes	80 µg/L	160 µg/L	Odor-Threshold	3 units	350 units
				TDS	500 mg/L[b]	1594 mg/L
				Turbidity	5 NTU	72 NTU
				Aluminum	0.2 mg/L	0.598 mg/L
Blanco Drain	Aluminum	1 mg/L	2.04 mg/L	Chloride	250 mg/L[c]	307 mg/L
	1,3-Dichloropropene	0.5 µg/L	0.62 µg/L	Color	15 units	85 units
				Conductivity (Specific Conductance)	900 µS/cm[a]	2929 µS/cm
				Iron	0.3 mg/L	3.891 mg/L
				Odor-Threshold	3 units	40 units
				Sulfate	250 mg/L[c]	530 mg/L
				TDS	500 mg/L[b]	2066 mg/L
				Turbidity	5 NTU	150 NTU
				Aluminum	0.2 mg/L	2.04 mg/L

Source Water	Comparison to Primary MCLs			Comparison to Secondary MCLs		
	Constituent	Primary MCL	Highest Concentration Detected	Constituent	Secondary MCL	Highest Concentration Detected
Lake El Estero	None		--	Chloride	250 mg/L[c]	514 mg/L
				Color	15 units	75 units
				Conductivity (Specific Conductance)	900 µS/cm[a]	2559 µS/cm
				Iron	0.3 mg/L	0.508 mg/L
				TDS	500 mg/L[b]	1506 mg/L
				Turbidity	5 NTU	18 NTU
				Aluminum	0.2 mg/L	0.402 mg/L
Tembladero Slough	Aluminum	1 mg/L	1.54 mg/L	Chloride	250 mg/L[c]	394 mg/L
	Di(2-ethylhexyl)phthalate	4 µg/L	78 µg/L	Color	15 units	175 units
				Conductivity (Specific Conductance)	900 µS/cm[a]	2939 µS/cm
				Iron	0.3 mg/L	2.962 mg/L
				Sulfate	250 mg/L[c]	412 mg/L
				TDS	500 mg/L[b]	1968 mg/L
				Turbidity	5 NTU	50 NTU
				Aluminum	0.2 mg/L	1.54 mg/L

a. Recommended consumer acceptance level; upper range 1600 µS/cm.
b. Recommended consumer acceptance level; upper range 1000 mg/L.
c. Recommended consumer acceptance level; upper range 500 mg/L**.**

Table 4-10: Constituents with Concentrations above Notification Levels or Archived Action Levels in at Least One Sample in any of the Untreated Source Waters

Source Water	Comparison to NLs			Comparison to AALs		
	Constituent	NL	Highest Levels Detected	Constituent	AAL	Highest Levels Detected
RTP Effluent	NDMA	10 ng/L	16 ng/L	None	---	---
Agricultural Wash Water	Formaldehyde NDMA	100 µ/L 10 ng/L	120 µg/L 340 ng/L	None	---	---
Blanco Drain	None	---		Dieldrin	0.002 µg/L	0.028 µg/L
Lake El Estero	None	---	--	None	---	---
Tembladero Slough	None	---	--	None	---	---

4.2.2.4. Lead and Copper Action Levels

The Title 22 Criteria require that recycled water used for groundwater replenishment not exceed the action levels for lead and copper, which are 0.015 mg/L and 1.3 mg/L, respectively. The maximum concentrations of lead and copper measured in any of the untreated source waters were 0.0018 mg/L, and 0.073 mg/L, respectively. Thus, the source water sampling program found that lead and copper were below their respective action levels in all of the untreated source waters sampled. Further, the Project will include post-treatment water stabilization, which will control corrosion and dissolution of minerals in the groundwater. The decarbonation process will reduce the inorganic carbon concentration and raise the pH, both of which decrease copper corrosion.

4.2.2.5. Total Organic Carbon

The Title 22 Criteria require that, prior to injection, the TOC concentration in recycled water not exceed 0.5 mg/L, based on the 20-week running average of all TOC results and the average of the last four TOC results. As shown in Table 4-11, the median concentration and range of TOC in the various untreated source waters are similar except for the agricultural wash water, which has a significantly higher TOC concentration. However, all of the untreated source waters will undergo treatment through the primary and secondary processes at the RTP and advanced treatment at the AWT Facility. These treatment technologies are typical for groundwater replenishment projects using subsurface application and will result in TOC concentrations at or below 0.5 mg/L. The RTP and the RO membranes are the primary barriers for TOC removal. The RTP will reduce the TOC concentration in the agricultural wash water through primary and secondary treatment. During the piloting program (described in **Section 7**), the TOC concentration in the RO permeate consistently was less than 0.5 mg/L when the system was operated in a manner consistent with how the full-scale system will be operated, even when the RTP was treating the agricultural wash water.

Table 4-11: Summary of Total Organic Carbon Concentrations Measured in Untreated Source Waters

Parameter[a]	RTP Effluent	Agricultural Wash Water	Blanco Drain	Lake El Estero	Tembladero Slough
TOC (mg/L)	15 (12-17)	295 (66-340)	3 (2.5-11)	14	8.8

a. Median values and data range (minimum concentration to maximum concentration) where applicable.

4.2.2.6. Total Nitrogen

The Title 22 Criteria require that the applied recycled water not exceed a total nitrogen concentration of 10 mg/L. Samples may be collected before or after subsurface application. As indicated in Table 4-Table 4-12, the total nitrogen concentration in untreated Lake El Estero water meets the requirement, while the other untreated source waters do not. However, after treatment at the AWT Facility, all of the source waters will meet the total nitrogen requirement based on the treatment technologies to be provided that are typical for groundwater replenishment projects. The average total nitrogen removal observed through the piloting program (*see* **Section 7**) was 94.3%, which is sufficient to reduce these concentrations to levels below 10 mg/L. The principal AWT Facility nitrogen removal mechanism will be reduction through the RO membranes.

Table 4-12: Summary of Total Nitrogen Concentrations in Untreated Source Waters

Parameter[a]	RTP Effluent	Agricultural Wash Water	Blanco Drain	Lake El Estero	Tembladero Slough
Total nitrogen (mg/L as N)	44.2 (35.7-50.5)	25.3 (19-51.1)	70.1 (63-77.3)	1.3	58

a. Median values and data range (minimum concentration to maximum concentration) where applicable.

4.2.2.7. Priority Pollutants

The Title 22 Criteria require that recycled water and groundwater (from downgradient monitoring wells) be monitored for Priority Pollutants (chemicals listed in 40 CFR Part 131.38, "Establishment of numeric criteria for priority toxic pollutants for the State of California") specified by DDW, based on the DDW's review of a project's engineering report. A total of 32 of the 126 Priority Pollutants were detected in the source waters sampling. Of the 32 chemicals detected, 19 were chemicals with either MCLs or NLs. As described later, 16 Priority Pollutants were found in the RO permeate after the pilot testing, all of which also had concomitant MCLs or NLs with permeate concentrations less than the MCLs or NLs.

4.2.2.8. Constituents of Emerging Concern

Constituents of emerging concern were evaluated using the Eurofins Eaton Analytical Liquid Chromatography Tandem Mass Spectrometry method that specifically addresses 92 constituents. The highest occurrence of CECs was in the RTP secondary effluent. This was expected, as these compounds are common in wastewater and are often not significantly removed by conventional primary and secondary wastewater treatment (see Figure 4-3). For the 92 CECs that were included in the Eurofins method, 59 were detected in at least one source water, with the maximum concentrations being observed in the RTP secondary effluent for 50 of the 59 constituents. Of the nine other constituents, five were seen at the highest concentration in the agricultural wash water, and the other four maximum

concentrations were detected in the drainage waters. It should be noted that for the new source waters, the concentrations presented in Figure 4 are raw water concentrations that do not take into account blending with the other waters and treatment reduction through the RTP primary and secondary treatment processes, nor treatment through the pilot test facility or full scale AWT Facility. CEC data collected for the untreated source waters are presented in **Appendix E**, and are further discussed with regard to the pilot testing in **Section 7**.

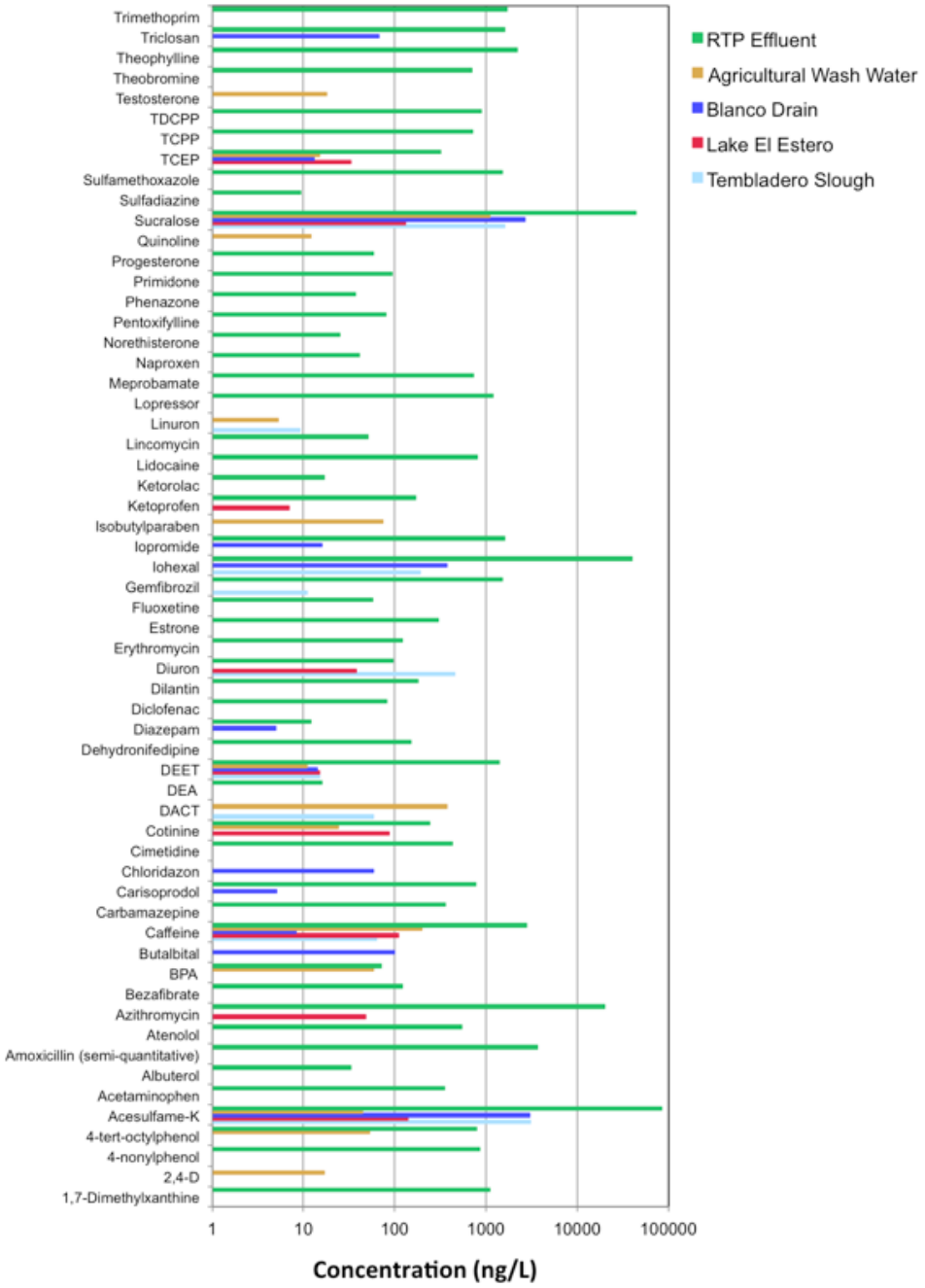


Figure 4-3. Constituents of Emerging Concern – Maximum Values Detected in the Waters included in the Source Water Sampling Program

4.2.2.9. NPDES Ocean Discharge Monitoring

The Monitoring and Reporting Program for the MRWPCA NPDES Permit R3-2014-0013 requires semi-annual monitoring of the effluent discharged to the ocean (see **Appendix F**). The water quality data for the previous five years is shown in Table 4-13.

Table 4-13: Water Quality Summary for the Ocean Outfall Discharge Water, January 2010 through February 2015 and NPDES Limits

Contaminant	Unit	Limit[a]	Median	Minimum	Maximum
Objectives for protection of marine aquatic life					
Cadmium (6-mo median)	µg/l	150	ND	ND	ND
Chromium (Hex) (6-mo median)	µg/l	290	25	0.03	49
Lead (6-mo median)	µg/l	290	ND	ND	ND
Selenium (6-mo median)	µg/l	2200	1.1	0.74	43
Silver (6-mo median)	µg/l	79	ND	ND	ND
Cyanide (6-mo median)	µg/l	150	41	3.2	65
Total Chlorine Residual (6-mo median)	µg/l	290	200	200	200
Acute Toxicity (daily maximum)	TUa	4.7	0.4	0	2.3
Chronic Toxicity (daily maximum)	TUc	150	40	40	80
Phenolic Compounds (non-Chlorinated) (6-mo median)	µg/l	4500	2.1	1.6	2.6
Endosulfan (6-mo median)	µg/l	1.3	ND	ND	ND
Endrin (6-mo median)	µg/l	0.29	ND	ND	ND
HCH (Hexachlorocyclohexane) (6-mo median)	µg/l	0.58	20	5.8	34
Radioactivity (Gross Beta)	pCi/L	[b]	10.1	3.32	79.3
Radioactivity (Gross Alpha)	pCi/L	[b]	6.23	2.82	457
Objectives for protection of human health - noncarcinogens					
Acrolein	µg/l	32000	ND	ND	ND
Antimony	mg/l	180	0.38	0.38	0.38
Bis (2-chloroethoxy) methane	µg/l	640	ND	ND	ND
Bis (2-chloroisopropyl) ether	mg/l	180	ND	ND	ND
Chlorobenzene	µg/l	83000	ND	ND	ND
Di-n-butyl phthalate	mg/l	510	ND	ND	ND
Dichlorobenzenes	mg/l	740	0.074	0.074	0.074
Diethyl phthalate	mg/l	4800	ND	ND	ND
Dimethyl phthalate	mg/l	20000	ND	ND	ND
4,6-dinitro-2-methylphenol	µg/l	32000	ND	ND	ND
2,4-Dinitrophenol	µg/l	580	ND	ND	ND
Ethylbenzene	mg/l	600	ND	ND	ND

Contaminant	Unit	Limit[a]	Median	Minimum	Maximum
Objectives for protection of marine aquatic life					
Fluoranthene	mg/l	2200	0.0032	0.0032	0.0032
Hexachlorocyclopentadiene	µg/l	8500	ND	ND	ND
Nitrobenzene	µg/l	720	ND	ND	ND
Thallium	µg/l	290	ND	ND	ND
Toluene	mg/l	12000	0.11	0.056	0.16
Tributyltin	ng/l	200	ND	ND	ND
1,1,1-Trichloroethane	mg/l	79000	ND	ND	ND
Objectives for protection of human health - carcinogens					
Acrylonitrile	µg/l	15	ND	ND	ND
Aldrin	ng/l	3.2	ND	ND	ND
Benzene	µg/l	860	ND	ND	ND
Benzidine	µg/l	0.010	ND	ND	ND
Beryllium	ng/l	4800	ND	ND	ND
Bis(2-chloroethyl)ether	µg/l	6.6	ND	ND	ND
Bis(2-ethyl-hexyl)phthalate	µg/l	510	1.1	0.36	28
Carbon tetrachloride	µg/l	130	ND	ND	ND
Chlordane	ng/l	3.4	ND	ND	ND
Chlorodibromomethane	µg/l	1300	ND	ND	ND
Chloroform	mg/l	19	0.22	0.22	0.22
1,4-Dichlorobenzene	µg/l	2600	ND	ND	ND
3,3-Dichlorobenzidine	ng/l	1200	ND	ND	ND
1,2-Dichloroethane	µg/l	4,100	ND	ND	ND
1,1-Dichloroethylene	µg/l	130	ND	ND	ND
Dichlorobromomethane	µg/L	910	ND	ND	ND
Dichloromethane (methylenechloride)	mg/l	66	0.075	0.075	0.075
1,3-dichloropropene	µg/l	1300	ND	ND	ND
Dieldrin	ng/l	5.8	ND	ND	ND
2,4-Dinitrotoluene	µg/l	380	ND	ND	ND
1,2-Diphenylhydrazine (azobenzene)	µg/l	23	ND	ND	ND
Halomethanes	mg/l	19	0.00073	0.00073	0.00073
Heptachlor	µg/l	0.0073	ND	ND	ND
Heptachlor Epoxide	µg/L	0.0029	ND	ND	ND
Hexachlorobenzene	ng/l	32	ND	ND	ND
Hexachlorobutadiene	µg/l	2000	ND	ND	ND
Hexachloroethane	µg/l	370	ND	ND	ND
Isophorone	µg/l	110000	ND	ND	ND

Contaminant	Unit	Limit[a]	Median	Minimum	Maximum
Objectives for protection of marine aquatic life					
N-Nitrosodimethylamine	µg/l	1100	ND	ND	ND
N-Nitrosodi-N-Propylamine	µg/L	55	ND	ND	ND
N-Nitrosodiphenylamine	µg/l	370	ND	ND	ND
PAHs	ng/l	1300	0.0116	0.0045	0.0186
PCBs	ng/l	2.8	ND	ND	ND
TCDD Equivalents	pg/l	0.57	2.9E-09	5.0E-12	2.8E-08
1,1,2,2-Tetrachloroethane	µg/l	340	ND	ND	ND
Tetrachloroethylene	µg/l	290	ND	ND	ND
Toxaphene	ng/l	31	ND	ND	ND
Trichloroethylene	µg/l	3900	ND	ND	ND
1,1,2-Trichloroethane	µg/l	1400	ND	ND	ND
2,4,6-Trichlorophenol	µg/l	42	ND	ND	ND
Vinyl chloride	µg/l	5300	ND	ND	ND

[a] Limit value represents the 30-day average limitation unless otherwise noted.

[b] Not to exceed limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5, Section 64443

5. PATHOGENIC MICROORGANISM CONTROL

As required by the Title 22 Criteria, the pathogen reduction requirements for groundwater replenishment projects are 12-log, 10-log, and 10-log reduction for viruses, *Giardia cysts*, and *Cryptosporidium oocysts*, respectively ("12/10/10"). In order to achieve these 12/10/10 pathogen log reduction values (LRVs), MRWPCA must utilize at least three separate treatment processes. Each treatment process can only receive up to 6-log reduction credit, and at least three processes must achieve at least 1.0-log reduction credit. Additionally, 1-log of virus credit can be earned for each month the water is retained underground. The pathogen removal proposed for each treatment process is discussed in the sections below. The combined LRVs for the Project will meet the Title 22 Criteria.

5.1. PRIMARY AND SECONDARY TREATMENT

MRWPCA's RTP secondary treatment consists of bar screens, grit removal, primary clarification, biological trickling filters, bio-flocculation (solids contact), and secondary clarification with optional Chemically Enhanced Phosphorous Removal (CEPT) facilities. The solids contact process is an aeration basin that operates a short solids retention time (SRT), which is used to improve the trickling filter effluent water quality. At this time, no credits for primary or secondary treatment are being pursued because of limited data from the RTP. This is conservative, though, as some degree of pathogen removal does occur during primary and secondary treatment. Rose, et al. (2004) reported that pathogen removals through secondary treatment were 96% - 99.9% for viruses and bacteria, 97.7% - 99.8% for *Giardia* cysts, and 0% - 99.4% for *Cryptosporidium* oocysts. None of the treatment facilities included in the 2004 Rose study employed the trickling filters-solid contact secondary process and only one facility included primary treatment, where particle-associated pathogens may be removed through sedimentation. The one treatment facility that had primary clarification also had a short SRT aeration basin for the secondary process. At this facility, pathogen removals through primary and secondary treatment were 96% - 99.9% for viruses and bacteria, 99.1% for *Giardia* cysts, and 94% for *Cryptosporidium* oocysts.

The limited sampling that was conducted for Giardia cysts and Cryptosporidium oocyst during the pilot sampling campaign is reported in Table 5-1, which summarizes results from the RTP influent the RTP secondary effluent.

Table 5-1: Pathogen and Pathogen Indicator Removal Observed through RTP, Ozone, MF, and RO during Pilot Testing

Parameter[a]	RTP Influent[c] N=6	Undisinfected RTP Secondary Effluent N=6-22[d]	Ozone Effluent N=6-25[d]	MF Effluent N=6-25[d]	RO Permeate N=27
Cryptosporidium (oocysts/L) Recovery[b]	<2 (1 - 8) *23%*	<0.35 *(<0.09 - 0.9)* *30%*	2.65[e] (0.3 – 23.3) 92%	*<0.09* *(<0.09 - <0.1)* *26%*	-- --
Giardia (cysts/L) Recovery[b]	8847 (1634 - 13626)[b]	<0.15 (<0.09 – 1.1) <0.092%	<0.2 (<0.09 – 4.4) 76%	*<0.09* *(<0.09 - <0.1)* *50%*	-- --
Total coliform (MPN/100 mL)	-- --	$2.8x10^5$ ($2.4x10^3$ – $1.6x10^6$)	$6.3x10^2$ ($5.5x10^1$ - $3.1x10^3$)	<1 (<1 – 71)[f]	<1 (<1 - <1)
E. Coli (MPN/100 mL)	-- --	$6.0x10^4$ ($4.9x10^2$ – $3.3x10^5$)	2.7x101 (<1 – $5.5x10^2$)	<1 (<1 - <1)	<1 (<1 -<1)

a. N is the number of samples; median values shown, with ranges in parentheses. Two of the protozoa samples and approximately ten of the bacteria samples included diversion of agricultural wash water mixed with sewage and treated at the RTP.
b. Recovery measured in one sample. ColorSeed not used on RTP influent matrix spike; thus, native giardia interfered (recovery of 658%).
c. Draft EPA method 1693, which omits the filtration step of EPA method 1623a, used for analysis.
d. Greater sampling frequency for total coliform and *E. Coli*
e. There were consistently higher concentrations of *Cryptosporidium* oocysts measured in the ozone effluent compared to the secondary effluent. This effect appears to be an artifact of the analysis in part, where the ozonation of the water seems to have dramatically improved method recovery.
f. The two total coliform detections in the MF effluent samples (71 and 2) are suspected to be due to sample contamination

5.2. AWT FACILITY

The AWT Facility treatment train includes ozone, MF, RO, and UV/H_2O_2 AOP. A discussion of the pathogen LRVs for each unit process is presented below.

5.2.1. Ozone

Ozonation is the first treatment process in the AWT Facility treatment train. Its primary purpose is to reduce the size of the large organic molecules in the secondary effluent, which will improve performance of the downstream MF system. Ozone also oxidizes CECs and pesticides, and provides pathogen inactivation. Although ozone has disinfection capability, no pathogen LRV credit is being pursued for the ozone process at this time. At the design ozone dose (10 mg/L) for the AWT Facility, the ozone demand of the water is high enough such that a measurable ozone residual cannot typically be carried through a significant length of time in the ozone contactor. A higher ozone dose and more ozone residual monitors would be required in order to achieve significant ozone CT (concentration multiplied by the contact time) credit.

If additional pathogen inactivation credit is needed for redundancy, ozone CT credit may be pursued. CT values for inactivation by ozone are provided in the USEPA drinking water Surface Water Treatment Rule (SWTR) Guidance Manual for *Giardia* cysts and virus, and in the USEPA Long Term 2 Enhanced

Surface Water Treatment Rule (LT2ESWTR) Toolbox Guidance Manual for *Cryptosporidium* oocysts. Equations derived from these CT tables are the following (U.S. EPA, 2010):

- *Cryptosporidium* oocyst log credit = $0.0397 \times (1.09757)^{Temperature(ºC)} \times CT$
- *Giardia* cyst log credit = $1.038 \times (1.0741)^{Temperature(ºC)} \times CT$
- Virus log credit = $2.1744 \times (1.0726)^{Temperature(ºC)} \times CT$

Substantially more ozone is required for *Cryptosporidium* oocyst inactivation than for either *Giardia* cysts or virus. For example, to receive 2-log virus inactivation credit at 25°C, a CT of only 0.160 mg/L-minute would be required, which would concurrently provide 1-log *Giardia* cyst inactivation but only 0.06-log *Cryptosporidium* oocyst inactivation.

5.2.2. Membrane Filtration

MF follows ozone in the AWT Facility process train. MF is used as a physical barrier for removal of pathogens. The membranes that were pilot tested had nominal pore size of 0.01 microns. For this project, 4-log removal credit for *Giardia* cysts and 4-log removal credit for *Cryptosporidium* oocysts are being sought, but no virus removal credit is being sought even though some particulate-associated viruses would be removed through MF. These LRVs are based on product-specific performance challenge tests conducted by the membrane manufacturer. Daily pressure decay tests (PDTs) will be conducted to confirm no broken fibers or other breach of membrane integrity, based on product-specific minimum test pressure and maximum allowable pressure decay. The membranes will be required to have passed the required challenge tests to demonstrate the desired 4-log *Giardia* cyst and *Cryptosporidium* oocyst removal.

Drinking water regulations provide a framework for Microfiltration/Ultrafiltration (MF/UF) to receive log removal credit for virus, *Giardia* cysts, and *Cryptosporidium* oocysts. Specifically, the California SWTR allows the use of MF/UF as an alternative filtration technology, provided the technology demonstrates at least 2-log *Giardia* cyst removal, 1-log virus removal, and 2-log *Cryptosporidium* oocyst removal and meets certain turbidity performance standards, per CCR, Title 22, Division 4, Environmental Health Chapter 17, Article 2, Section 64653(e). The State and Federal LT2ESWTR include additional regulations and guidance on achieving additional removal credit for *Cryptosporidium* oocysts. The LT2ESWTR Toolbox Guidance Manual (U.S. EPA, 2010) and Membrane Filtration Guidance Manual (U.S. EPA, 2005) provide detailed guidelines for performing the pathogen removal challenge tests on MF and UF to determine log removal credits (U.S. EPA, 2010). The daily PDT is performed to confirm the integrity of the membranes. A product specific minimum test pressure and a maximum allowable decay rate are used for the PDT, which is able to detect a 3-micron hole (i.e., the resolution of the test is 3-microns).

Given the pore size of the MF, 4-log removal credit for *Giardia* cysts and 4-log removal credit for *Cryptosporidium* oocysts are expected. Although the challenge tests confirm virus removal (0.5 to 1 LRV is typical), no credit is being pursued for virus removal for the Project. To receive pathogen reduction credit for the MF process, continuous monitoring of the system using online turbidimeters (i.e., indirect integrity monitoring) and daily PDTs (i.e., direct integrity monitoring) is necessary to ensure proper MF performance.

5.2.3. Reverse Osmosis

Additional pathogen removal credits for virus, *Giardia* cysts and *Cryptosporidium* oocysts are being sought through the RO membranes. RO process performance for pathogen removal will be confirmed by measuring a surrogate parameter (i.e., TOC, conductivity, or TDS) that demonstrates the RO

membrane integrity. LRVs of these parameters are used as a conservative estimate of pathogen removal.

During pilot testing, conductivity was measured continuously at both the RO feed and RO permeate, and TOC was measured by grab samples at the same locations. Conductivity log reductions were generally above 1.6-log as shown in Figure 5.1 below. Slightly higher ion rejection occurs at colder temperatures. Comparatively, somewhat higher conductivity reduction was seen during the pilot study than TOC reduction, with an average 1.53-log reduction (average conductivity reduction of 1.67 logs; ozone dose ahead of MF of 10 to 14 mg/L). Although log removals in excess of 1.5-logs were observed during piloting, a log removal credit of 1 will be conservatively assumed for RO.

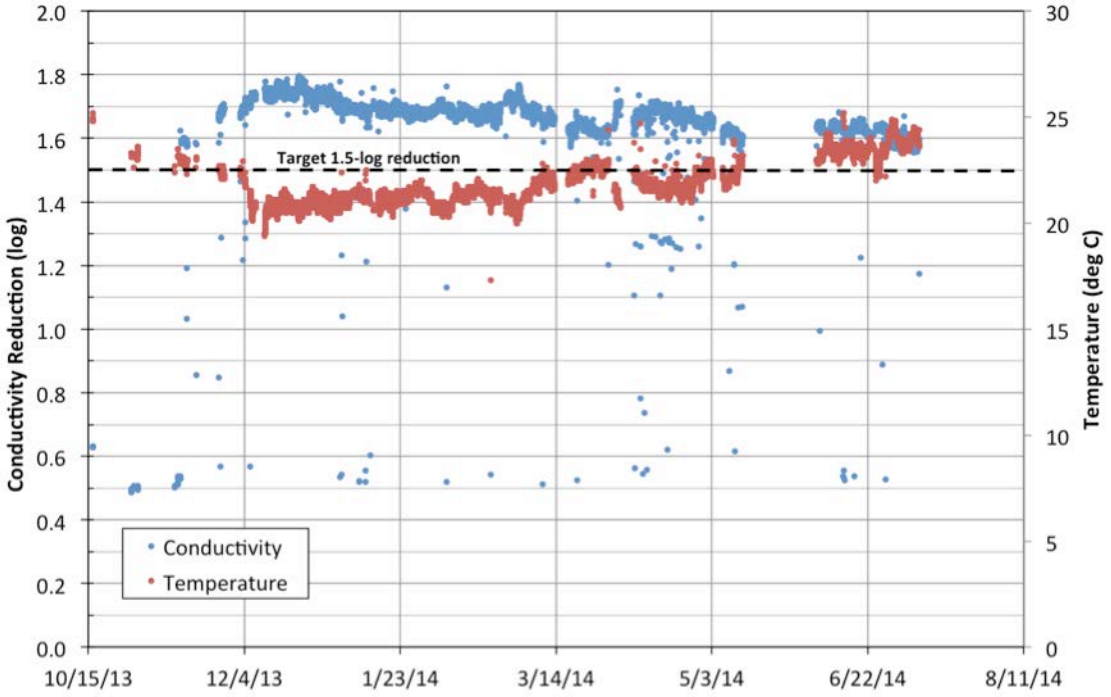


Figure 5-1. Conductivity Reduction during Pilot Testing

Continuous monitoring of conductivity is proposed for the AWT Facility since slightly greater reductions were seen during pilot testing. The target log reduction is met if the percent reduction of the daily average conductivity at the influent and effluent of the RO system is at least 96.8% (WRD, 2013).

5.2.4. Advanced Oxidation

The next treatment process is AOP using UV/H_2O_2 with an expected UV dose of approximately 1,000 mJ/cm^2, given that UV doses of 800 to 1,200 are typical for groundwater replenishment projects (the UV dose will be determined through collimated beam testing). Pathogen inactivation credit being pursued through the UV/AOP system are 6-log each for *Cryptosporidium* oocysts, *Giardia* cysts and virus. The design dose (*e.g.*, 1,000 mJ/cm^2) will be based on what is needed to achieve the required 0.5-log 1,4-dioxane reduction as well as other AOP goals (*e.g.*, NDMA removal), as discussed in **Section 3**.

For pathogen inactivation with UV/AOP, the USEPA's UV Disinfection Guidance Manual (U.S. EPA, 2006b) specifies the UV dose requirements for achieving up to 4-log *Cryptosporidium* oocyst, *Giardia*

cysts, and virus credit with UV disinfection. The UV doses are shown in the Table 5-2 below. With a dose of 800 to 1,200 mJ/cm^2 greater than 6-log inactivation of these pathogens is expected. Virus inactivation requires a higher UV dose than *Cryptosporidium* oocyst or *Giardia* cyst inactivation. Extrapolating the data in Table 5.2, a dose of 236 mJ/cm^2 is needed for 6-log virus inactivation, which is more than 3 to 5 times lower than the design UV dose.

Table 5-2: UV Dose Required for Pathogen Inactivation

Target Pathogens	Log Inactivation[a]							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

a. Source USEPA, 2006b.

Given the high dose of UV, it is not anticipated that small variability in process performance will have an impact on the ability of the system to meet the pathogen reduction targets for this system. To ensure the design dose is delivered, several parameters will be continuously measured—UV intensity (UVI), power, and UV transmittance (UVT)—to provide information about proper functioning of the system.

5.2.5. Chlorine Disinfection

Chloramines are planned to be used for post-stabilization secondary disinfection. The preliminary treatment goal is a total chlorine concentration of 3 to 4 mg/L as Cl_2 entering the conveyance pipeline. The chloramine concentration following UV/AOP is expected to be between 1 and 2 mg/L as Cl_2. Chlorine addition will likely be required to raise the concentration to the target 3 to 4 mg/L as Cl_2. If nitrification is not practiced through the RTP, the post-stabilization ammonia concentration may be high enough to yield 2 to 4 mg/L of chloramines as Cl_2 after chlorine boosting. The target finished water total chlorine concentration will be finalized during design of the AWT Facility, with a preliminary goal of 1.0 mg/L at the injection well head. Any residual chloramines and ammonia in the water will have degraded prior to any of the monitoring wells, so water extracted from the ARS wells will not contain chloramines.

At 20°C, a CT of 370 mg/L-min is needed for 1-log *Giardia* inactivation with chloramines, and a CT of 109 mg/L-min is needed for 1-log virus inactivation. Disinfection capabilities of free chlorine are superior to chloramines. With free chlorine, a CT of only 22 mg/L-min is needed for 1-log *Giardia* inactivation (pH of 7.5, temperature of 20ºC), and a CT of only 0.5 mg/L-min is needed for the same log virus inactivation. Even assuming a conveyance pipeline of 1 mile (at 5 fps), a CT of only 30 to 40 mg/L-min would be achieved with chloramine residuals of 1.7 to 2.3 mg/L as Cl_2—much less than needed for pursuing disinfection credit with chloramines.

At this time, no pathogen inactivation credit for final disinfection is being pursued since chloramines are planned for maintaining a disinfectant residual at the well head.

5.3. SUBSURFACE PATHOGEN REDUCTION CREDIT

The Project qualifies for a pathogen (virus) reduction credit associated with the time that product water remains underground (from injection to extraction). The Title 22 Criteria for groundwater replenishment by subsurface application allow for a 1-log virus reduction credit for each month underground. This allowance applies only when underground retention times are confirmed with an added tracer study. Other methods of estimating underground retention times are assigned less than 1-log reduction credit per month, with the actual reduction credit differing among various methodologies (see Table 60320.208, Title 22 Criteria).

Preliminary analytical estimates of local groundwater velocity suggest that product water injected into the Santa Margarita Aquifer (via deep injection wells) will remain underground for at least one year prior to extraction. Product water injected into the Paso Robles Aquifer (via vadose zone wells) will remain underground even longer due to vadose zone transport, lower permeability in the shallow aquifer, and farther to extraction wells.

Although this analytical estimate of at least one year provides a useful average for planning purposes, it does not represent the variability in underground retention times resulting from the highly dynamic local flow conditions. Groundwater flow beneath and downgradient of the injection facilities area is controlled in part by operation of the nearby ASR facilities; these wells inject, rest, and pump at intermittent time intervals depending on the availability of injectate from the Carmel River system, time since an injection cycle ended, demand by CalAm, and pumping from other production wells in the Seaside Basin. In order to evaluate the underground retention time under the full range of dynamic hydraulic conditions at the Injection Facilities area, a groundwater flow model was applied to the analysis.

5.3.1. Numerical Modeling of Underground Retention Time

The numerical model used to estimate underground retention times – referred to herein as the Watermaster Model – was developed, calibrated, and documented by the Seaside Basin Watermaster in 2009 (Hydrometrics, 2009). The Watermaster Model is a transient five–layer model built on the MODFLOW platform and calibrated over a 22-year period from January 1987 through December 2008. The model has been widely applied for numerous basin-wide groundwater management assessments and represents a technically-credible and accepted tool for simulating groundwater scenarios in the Seaside Basin (Hydrometrics, 2014a). Additional details of the Watermaster Model are summarized in **Section 9.1.3.2**.

For the Project, the Watermaster Model was used to simulate underground retention time (travel time) between each of the eight injection wells and the closest production well under varying hydrologic and pumping conditions. The modeling was conducted using the predictive model setup developed previously by the Watermaster for analyzing future conditions in the Seaside Basin. The predictive model covers a 33-year period from 2009 through 2041. The injection wells are currently anticipated to commence operations in 2017. For purposes of the modeling analysis, the injection was simulated as

beginning in October 2016 to cover the entire Water Year (WY)[36] 2017 and allow for a 25-year analysis of the Project.

Modeling incorporated recharge volumes and a monthly delivery schedule of product water to the eight injection wells, including a drought reserve account as described in more detail in **Section 8**. The delivery schedule was varied based on hydrology and the balance of the drought reserve account for every year of the simulation (see Table 8-1 and **Sections 8.1** through **8.3** for more information on the product water delivery schedule).

Modeling also incorporated reasonable assumptions of future operation of production wells in the Seaside Basin. Production wells were assumed to be pumping in the model based on court-allocated pumping and agreements associated with the Seaside Basin adjudication. CalAm production wells (and the ASR wells) were assumed to be the recovery (extraction) wells for the product water based on existing well capacity and water demand at any given time.

A quantitative assessment of future operations of the ASR Project was developed by MPWMD for the modeling. MPWMD operates the ASR facilities under cooperative agreements with CalAm. The ASR future operations assessment was based on historical hydrologic conditions on the Carmel River between 1987 and 2008 and approved rules of ASR operation. These criteria allowed MPWMD to predict both injection and recovery schedules at each ASR well over time. By incorporating this assessment into the model setup, the Project could be evaluated over a full range of ASR injection and recovery (pumping) conditions.

Particle tracking, a modeling process used to track the movement of product water in the groundwater system, was used to evaluate travel times. For the particle tracking analysis, "particles" (acting as simulated tracers of the recharged water) were released at each of the eight proposed injection well sites (four deep injection wells and four vadose zone wells) in every month of the 25-year simulation of the Project. This provided a comprehensive assessment of various travel times that could occur under numerous combinations of pumping and ASR operations. Particles were simulated as being released around the edges of each model cell that contained an injection well and were tracked as they flowed downgradient in the aquifers. Particles were tracked until they reached a cell containing a production well, where they were extracted from the system. Tracking from the edges of model cells (rather than at a well location within the cell) allows for a thorough examination of particle transport, but is also conservative in that it eliminates the additional distance a particle will travel between the actual well and the edge of a cell.

Documentation of model set-up and results were presented in a technical memorandum prepared by HydroMetrics Water Resources Inc. (HydroMetrics), the firm that developed and ran the Watermaster model in support of the Project. The complete technical memorandum is included as an appendix in the *Recharge Impacts Assessment Report*, prepared by Todd Groundwater (2015a); that report and its appendices are attached to this Engineering Report as Appendix D.

When a numerical model, such as the Watermaster Model, is used to demonstrate the underground retention time, the Title 22 Criteria require that the reduction credit be reduced to only 0.5 log per

[36] A WY is defined as October 1 through September 30, and is based on the annual precipitation pattern in California. The Water Year is designated by the calendar year in which it ends.

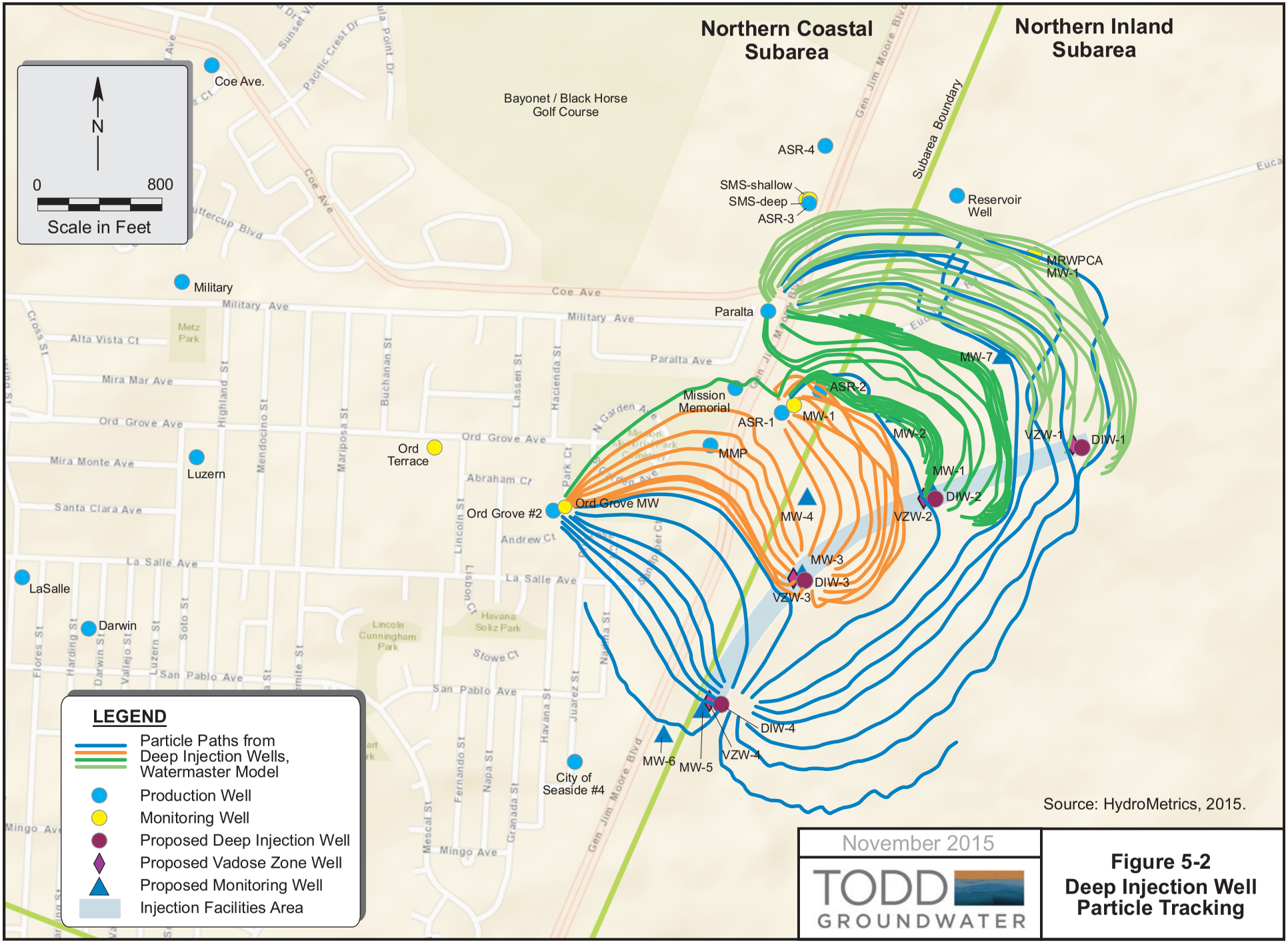
month to account for uncertainty in the method of analysis (Table 60320.208 in the regulations). For example, the model would need to demonstrate a travel time of one year to allow for a 6-log virus reduction credit.

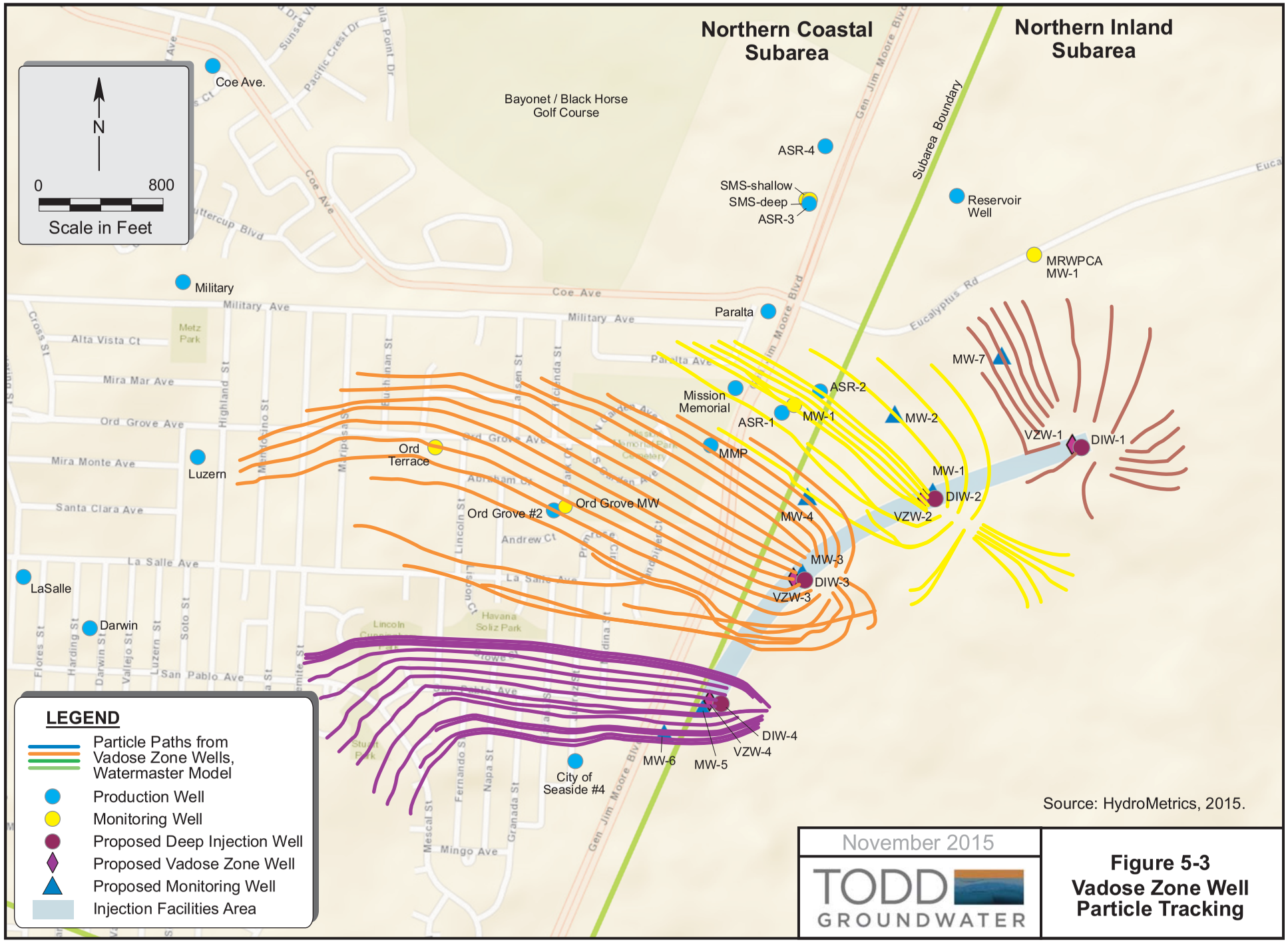
5.3.2. Underground Retention Time Modeling Results

The results of the particle tracking analysis confirmed that a travel time of at least one year from injection to extraction occurred for almost all of the wells during almost all of the 25-year simulation period. The fastest travel times for most injection wells were between about 2 years and 14 years. However, the fastest travel time for one deep injection well, DIW-3, was slightly less than one year (as fast as 327 days) during five years of the 25-year simulation. This occurred during simulated drought years when basin production was at its maximum and ASR wells were extracting stored water rather than injecting. Although these faster travel times occur during about 20% of the simulation period only, the fastest travel time is the focus of the analysis, consistent with a conservative approach. Some of the injected water in the vadose zone wells did not reach an extraction well throughout the 25-year simulation period, although injection added to overall groundwater in storage.

Particle tracking results for the fastest travel time period are illustrated on Figures 5-2 and 5-3 for the deep injection wells and vadose zone wells, respectively. Paths are colored separately for each well. As indicated by the jagged nature of some of the particle paths on Figure 5-2, groundwater flow is being influenced by the dynamic system created by changes in pumping and injection in both production and ASR wells. ASR wells repel the particles when injecting and attract the particles when pumping. Because the injection rates (about 1,500 gpm) and pumping rates (up to 3,000 gpm) at the ASR wells represent some of the highest rates for Seaside Basin wells, these wells significantly influence local hydraulic gradients. As illustrated on Figure 5-2, the fastest simulated flow paths (shortest lines) are from DIW-3 to the nearby ASR-1 well (paths shown in red). Flow paths from DIW-2 to ASR-1 are also relatively fast, but take a more circuitous route due to the injection in nearby DIW-3. Particles from DIW-2 are also transported to the Paralta production well, as are particles from DIW-1. Although difficult to see on Figure 5-2, DIW-1 also contributes particles to ASR-3. Most of the particles from DIW-4 (southernmost deep injection well) are transported to the downgradient production well called Ord Grove 2 (Figure 5-2).

As shown on Figure 5-3, simulated flow paths from vadose zone wells are not impacted by ASR operation, which influences primarily the deeper Santa Margarita Aquifer. Product water injected in the vadose zone wells flows downgradient unimpeded until arrival at wells that are at least partially screened in the Paso Robles Aquifer (e.g., Paralta, Luzern). Injection at VZW-1 does not arrive at any production well during the travel time simulation shown in Figure 5-3, but provides replenishment to the local Paso Robles Aquifer as water flows downgradient. Many of the particles do not reach extraction wells during the model simulation period and are not a factor in calculating the underground retention time. If all of the product water were injected into the vadose zone wells only, a 6-log virus reduction credit (or more) would be readily demonstrated.


Northern Coastal Subarea
Northern Inland Subarea
Subarea Boundary
N
0
800
Scale in Feet
Coe Ave.
Bayonet / Black Horse Golf Course
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
MRWPCA MW-1
Military
Military Ave
Coe Ave
Paralta
MW-7
Alta Vista Ct
Metz Park
Mira Mar Ave
Paralta Ave
Mission Memorial
ASR-2
ASR-1
MW-1
MW-2
VZW-1
DIW-1
Ord Grove Ave
Ord Terrace
MMP
Mira Monte Ave
Luzern
MW-1
DIW-2
Abraham Ct
Santa Clara Ave
Ord Grove #2
Ord Grove MW
MW-4
VZW-2
Andrew Ct
MW-3
La Salle Ave
LaSalle
DIW-3
VZW-3
Darwin
Lincoln Cunningham Park
Havana Soliz Park
Stowe Ct
San Pablo Ave
DIW-4
VZW-4
MW-6
MW-5
City of Seaside #4
Gen Jim Moore Blvd
Mingo Ave
Source: HydroMetrics, 2015.
LEGEND
Particle Paths from Deep Injection Wells, Watermaster Model
Production Well
Monitoring Well
Proposed Deep Injection Well
Proposed Vadose Zone Well
Proposed Monitoring Well
Injection Facilities Area
November 2015
TODD GROUNDWATER
Figure 5-2
Deep Injection Well Particle Tracking


Northern Coastal Subarea
Northern Inland Subarea
Subarea Boundary
N
0
800
Scale in Feet
Coe Ave.
Bayonet / Black Horse Golf Course
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
MRWPCA MW-1
Military
Military Ave
Coe Ave
Paralta
Eucalyptus Rd
Alta Vista Ct
Metz Park
Mira Mar Ave
Ord Grove Ave
Mira Monte Ave
Santa Clara Ave
La Salle Ave
San Pablo Ave
Mingo Ave
Mission Memorial
ASR-1
ASR-2
MW-1
MW-2
MW-7
VZW-1
DIW-1
MMP
Ord Terrace
Luzern
Ord Grove #2
Ord Grove MW
MW-4
VZW-2
DIW-2
MW-1
MW-3
DIW-3
VZW-3
LaSalle
Darwin
Havana Soliz Park
City of Seaside #4
MW-6
MW-5
VZW-4
DIW-4
LEGEND
Particle Paths from Vadose Zone Wells, Watermaster Model
Production Well
Monitoring Well
Proposed Deep Injection Well
Proposed Vadose Zone Well
Proposed Monitoring Well
Injection Facilities Area
Source: HydroMetrics, 2015.
November 2015
TODD GROUNDWATER
Figure 5-3
Vadose Zone Well
Particle Tracking

Results of the particle tracking are displayed in a different manner on Figures 5-4 and 5-5 for the deep injection wells and vadose zone wells, respectively. On these two figures, the spatial areas of injected water as it flows away from the injection well are shown for various time periods (90 days, 180 days, 270 days, and 260 days). Although model cells are not shown, the relatively fast travel times from DIW-3 to ASR-1 and DIW-2 to ASR-2 are readily illustrated by the 360-day extent (blue lines) of the injected water. The push of the injected water away from wells DIW-2 and DIW-1 from nearby injection is also illustrated on Figure 5-4. The more consistent radial flow patterns from the vadose zone wells are readily observed on Figure 5-5. Injected water moves away from the westernmost well, DIW-4, more quickly due to increased hydraulic gradients created by production wells to the west.

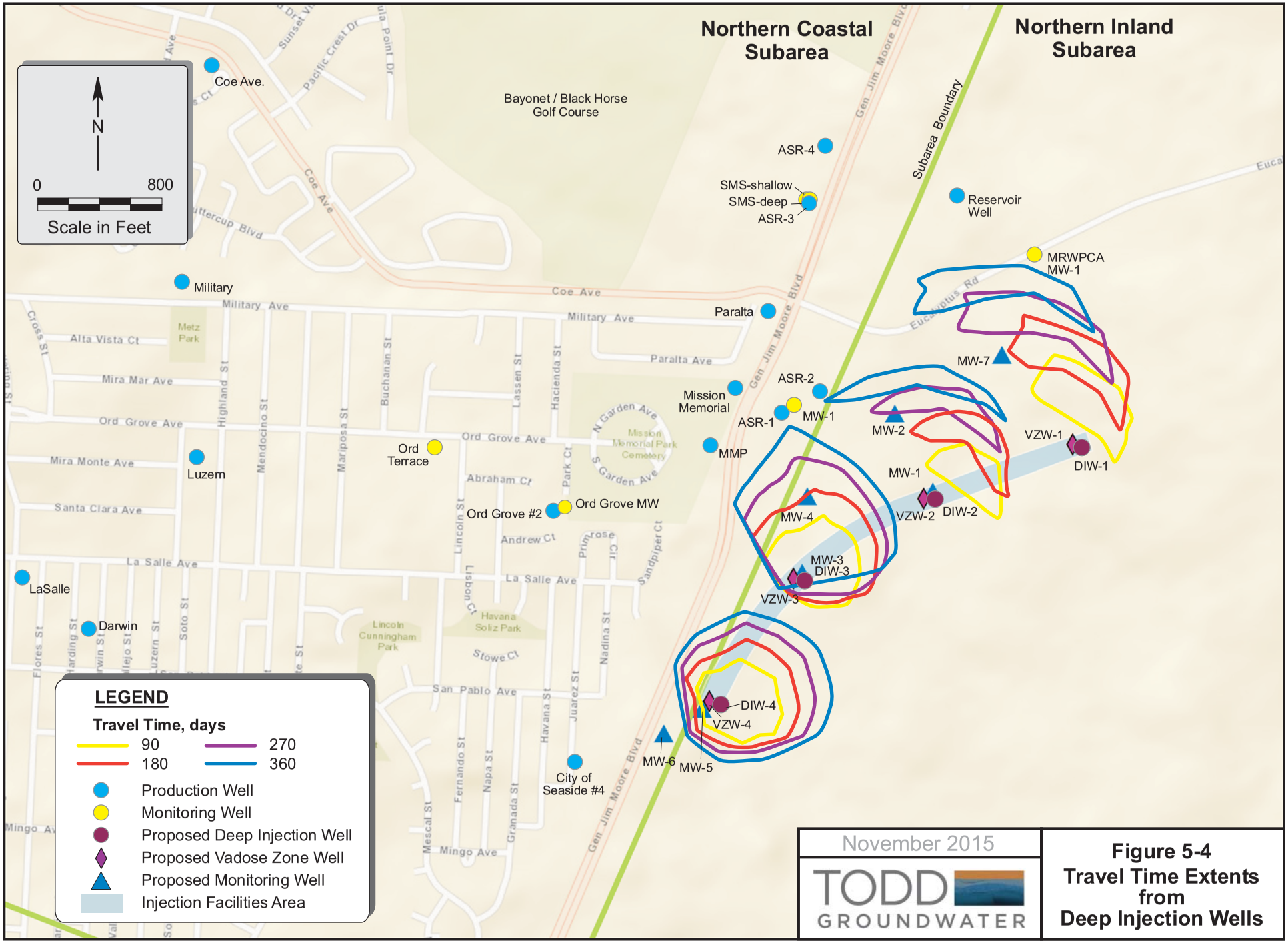
The fastest travel times to a downgradient extraction well for each of the injection wells were tabulated from the model as summarized in Table 5-3. Also included is the extraction well that first receives any injected water. The shading for each injection well in Table 5-3 generally corresponds to the colors of the respective well flow paths on Figures 5-2 and 5-4 to facilitate review.

Table 5-3: Simulated Fastest Travel Times between Injection and Extraction Wells

Extraction Well	Well of Origin of Particles with Fastest Travel Time (Days)							
	DIW-1	DIW-2	DIW-3	DIW-4	VZW-1	VZW-2	VZW-3	VZW-4
ASR 1&2	-[a]	371	327	1,780	-	-	-	-
ASR 3&4	724	-	-	3,074	-	-	-	-
Luzern	-	-	-	-	-	-	3,140	-
Ord Grove	3,718	1,952	1,052	1,497	-	-	-	4,250
Paralta	506	521	852	2,076	-	5,114	-	-

a. – no particle arrives at wells during the 25-year simulation period

Table 5-3 documents the fastest travel time from injection to extraction in days, which range from 327 days (DIW-3) to more than 5,000 days (about 14 years for VZW-2). For VZW-1, particles did not reach an extraction well during the 25-year simulation, primarily due to flat hydraulic gradients in an area of the Seaside Basin where very little pumping occurs in the Paso Robles Aquifer (see also VZW-1, the easternmost well, on Figure 5-3).


Northern Coastal Subarea
Northern Inland Subarea
Subarea Boundary
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Scale in Feet
Coe Ave.
Bayonet / Black Horse Golf Course
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
MRWPCA MW-1
Military
Military Ave
Coe Ave
Paralta
Paralta Ave
Eucalyptus Rd
MW-7
Alta Vista Ct
Metz Park
Mira Mar Ave
Ord Grove Ave
Mission Memorial
ASR-2
ASR-1
MW-1
MW-2
VZW-1
DIW-1
Mira Monte Ave
Luzern
Ord Terrace
MMP
Mission Memorial Park Cemetery
N Garden Ave
S Garden Ave
Abraham Ct
Santa Clara Ave
Ord Grove #2
Ord Grove MW
MW-4
VZW-2
DIW-2
Andrew Ct
Primrose Cir
Sandpiper Ct
La Salle Ave
MW-3
DIW-3
VZW-3
LaSalle
Darwin
Lincoln Cunningham Park
Havana Soliz Park
Stowe Ct
San Pablo Ave
DIW-4
VZW-4
MW-6
MW-5
City of Seaside #4
Mingo Ave
Gen Jim Moore Blvd
LEGEND
Travel Time, days
90
180
270
360
Production Well
Monitoring Well
Proposed Deep Injection Well
Proposed Vadose Zone Well
Proposed Monitoring Well
Injection Facilities Area
November 2015
TODD GROUNDWATER
Figure 5-4
Travel Time Extents from Deep Injection Wells

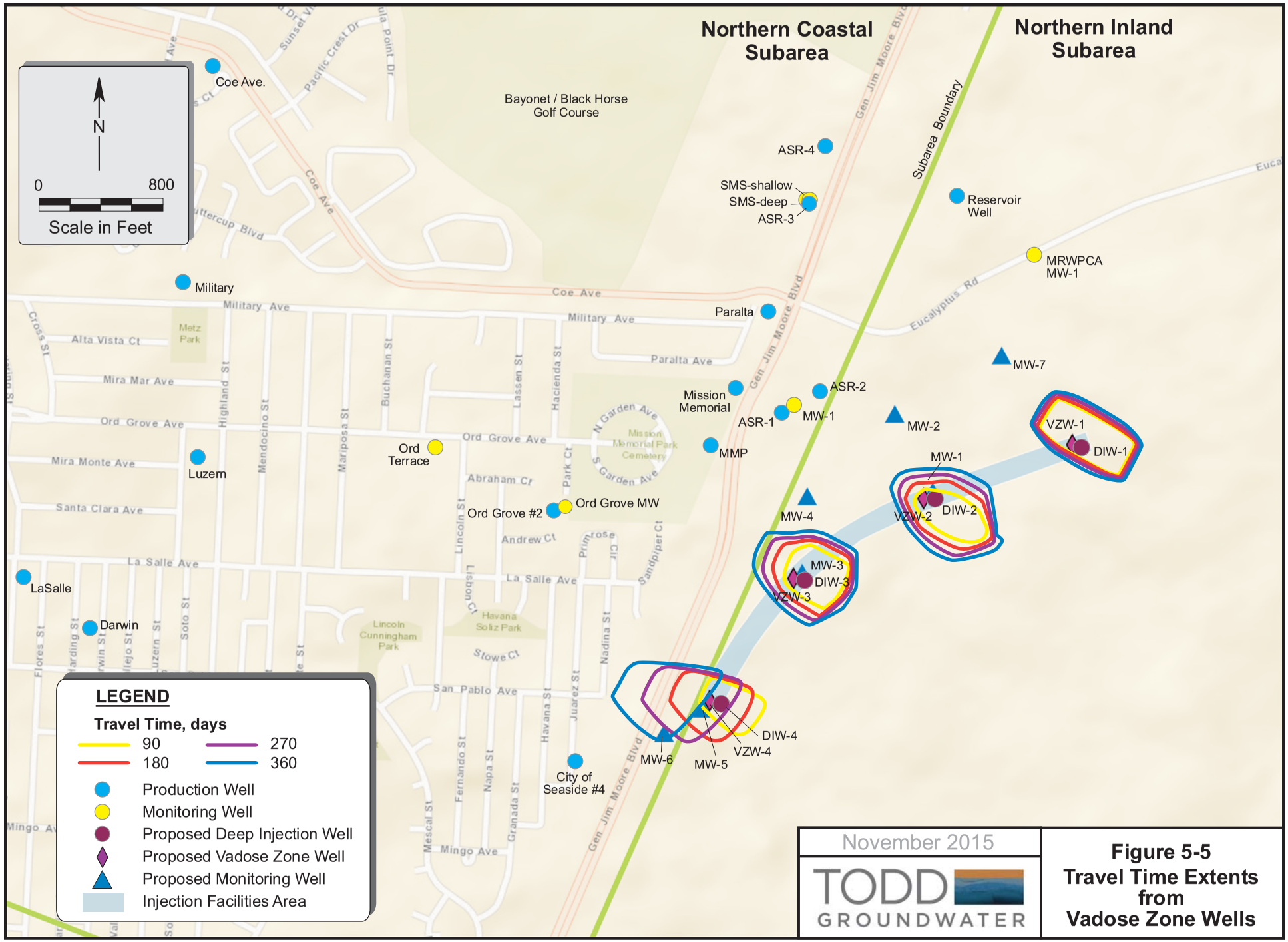


Figure 5-5
Travel Time Extents from Vadose Zone Wells

5.3.3. Pathogen Reduction Credit Requested

Based on the results of the modeling, it appears that injected water will remain in the groundwater system for at least six months, which will meet the requirements for a 6-log virus reduction credit if demonstrated by added tracer testing (or with a safety factor for intrinsic tracer testing). But because the demonstration of underground retention time with groundwater modeling requires a one-year travel time for conditional approval of the a 6-log reduction credit, a lower reduction credit is proposed. As described above, DIW-3 is approximately 38 days short of the one-year requirement under certain pumping conditions during five years of the 25-year simulation period. The underground retention time of 327 days from DIW-3 to the downgradient ASR wells is the controlling factor in the log reduction credit request.

Accordingly, a 5.4-log virus reduction credit is requested for the underground portion of the Project treatment process. The fastest travel time of 327 days represents approximately 10.8 months. With a virus reduction credit of 0.5-log per month, a 5.4-log reduction credit is derived.

5.3.4. Potential Modification of Virus Reduction Credit

The analysis that supports the 5.4-log virus reduction credit is highly conservative. As mentioned previously, the modeling releases and extracts the particle at the edges of the model cell rather than at the actual well location. With model cell dimension of 100 feet, the distance from the cell edge to the well could account for the extra 38 days of travel time needed for a 6-log virus reduction credit for the fast time periods associated with DIW-3. Further, only particles released in five separate months (each during a drought year for five out of 25 years) for that one well (DIW-3) exhibit the slightly less than one year travel time. The water injected during the months associated with fast travel times will mix with ambient groundwater and previously-injected water to mitigate the amount of low residence-time water at the production well. Finally, average underground retention times for all wells, including DIW-3, exceed the one-year minimum requirement as demonstrated by groundwater modeling. Given the conservative nature of the analysis and the conservative assumptions built into the Title 22 Criteria regarding travel times from modeling, actual underground retention times are assumed to exceed the six month minimum under all flow conditions.

In order to validate a 6-log virus reduction credit, a tracer test, rather than modeling alone, will be needed to demonstrate that the Project can meet a six-month underground retention time. Within the first three months after Project start-up, the underground retention time will be confirmed through tracer testing (see tracer test planning information in **Section 12.8** of this report). If tracer testing is successful, a 6-log reduction credit may be requested at that time.

5.4. PATHOGENIC MICROORGANISM CONTROL SUMMARY

The expected pathogen log removal credits for the Project are summarized in Table 5.4. Total pathogen removal credits for the Project meet and are expected to exceed the requirements set forth by the Title 22 Criteria of 12-log, 10-log, and 10-log for virus, *Giardia* cysts, and *Cryptosporidium* oocysts, respectively.

Table 5-4: Pathogen Log Removal Expectations and Requirements

Process	Treatment Confirmation	Log Reduction Credits		
		Virus	*Giardia*	*Crypto*
RTP Primary & Secondary[a]	Not pursuing credit	0	0	0
Ozone[a]	Not pursuing credit	0	0	0
MF	Daily PDT	0	4	4
RO	Online conductivity monitoring[b]	1	1	1
AOP (UV/H_2O_2)	800 to 1,200 mJ/cm^2	6	6	6
Final Disinfection-Chlorine[a]	Not pursuing credit	0	0	0
Underground Residence Time in Aquifer	6-month underground retention time[c]	5.4[b]	0	0
Requirement		**12**	**10**	**10**
Total Credit		**12.4**	**11**	**11**

a. May be included if additional credit for redundancy is needed.

b. Log removals may be calculated from removal of TDS through RO, and may be based on correlations between EC and TDS developed for the RO feed and permeate water quality. TOC monitors will also be included on the RO feed and permeate; however, conductivity is planned to be used for critical control point monitoring.

c. Actual residence time is expected to exceed 6 months. When the tracer test (using an intrinsic tracer) confirms the underground retention time of 10.8 months or greater, the Project would be credited with virus removal of 7.2-log (applying the 0.67 log safety factor for an intrinsic tracer listed in the California Recycled Water Regulations).

6. RESPONSE RETENTION TIME

In accordance with Title 22 Section 60320.224, a project sponsor must propose an RRT. The criteria state that the RRT can be no less than two months. The intent of the RRT is to allow ample time to identify any treatment failure so that inadequately treated recycled water does not enter a potable water system. The RRT also allows time, if necessary, to provide an alternative water supply or well head treatment in the event that a GRRP impacts a well, preventing it from being used as a potable water supply. This is accomplished by retaining recycled water underground while the issue is diagnosed and a resolution is implemented.

For planning purposes, a numerical model was used to predict the fastest travel times from recharge wells to downgradient production wells using the applicable safety factors in Title 22 Section 60320.224(d) to account for uncertainty in the method of analysis (discussed in **Sections 5.3 and 6.3**). This analysis demonstrated that an underground retention time of at least 5.4 months can be documented (10.8 month travel time corrected by the safety factor of 0.5 for modeling). To demonstrate that the actual retention time underground an added tracer or a DDW approved intrinsic tracer with a safety factor (0.67 month credit per month of time estimated using the intrinsic tracer) can be used. The tracer testing must be conducted prior to the third month of operation (see **Section 12.8**).

The response measure components of the proposed RRT (5.25 months) are presented and justified in **Section 6.2**. The proposed RRT is based on the following hypothetical worst-case scenario: immediately after a routine sample is taken for acutely toxic constituents, "off-specification" product water from the AWT Facility is inadvertently injected into the groundwater system. The proposed RRT of 5.25 months is composed of the following response measure components:

- Time to Identify Water Quality Problem and Complete Confirmation Sampling (see **Subsection 6.1.2**):
    - Identify: Time elapsed before product water exceedance is discovered is the sum of the (1) longest time elapsed between sample collection, and (2) longest time elapsed before laboratory results are shared with MRWPCA.
    - Confirm: Time needed to confirm (1) problem exists through additional sampling at AWT Facility and nearest monitoring well and (2) potential problem no longer exists by demonstrating four consecutive samples are below the MCL.
- Time to Assess Results with DDW and RWQCB (see **Subsection 6.1.3**):
    - Time needed to share findings and make decisions regarding appropriate response(s).
- Time to Procure Safe Interim Drinking Water Supply (see **Subsection 6.1.4**):
    - Time necessary to provide an interim water groundwater supply should DDW determine that the Project has impacted a drinking water well so that it can no longer be used as a drinking water supply.

The following subsections expand on these response components and provide the basis for the proposed RRT.

6.1. PROPOSED RESPONSE RETENTION TIME COMPONENTS

6.1.1. Proposed RRT Concept

The proposed RRT aims to protect public health by allowing for an interim safe drinking water source to be secured in the unlikely event that "off-specification" recycled water is injected into the ground with an emphasis on constituents that pose acute (short-term) health risks. Most chemical contaminants monitored in drinking water pose chronic (long-term) health risks (i.e., short-term exceedances of a limit would not result in adverse health consequences). Thus, the proposed RRT is based on microbial pathogens (using total coliform organisms as the indicator organism), nitrogen compounds (nitrate and nitrite), and perchlorate, because they represent acute risks (i.e., short-term health risks to the water consumers) that require immediate attention. These contaminants posing acute risks are similar to RRTs derived for other groundwater replenishment projects. If any of these constituents are measured above acceptable levels in product water (see Table 6-1), the response outlined in this section will be initiated.

Table 6-1: Acute Contaminants and Concentrations at which RRT Response is Initiated

Acute Parameters	Concentration	Units
Total coliform	2.2 (7-day median) 23 (in more than 1 sample in any 30-day period) 240 (any sample)	MPN/100mL
Nitrate (as N)	10.0	mg/L
Nitrite (as N)	1.0	mg/L
Perchlorate	0.006	mg/L

It is noteworthy that the exceedance of these acute parameters is highly unlikely as MRWPCA will incorporate the following safety features that are part of the Project: (1) continuous online monitoring of RO treatment with real-time results reviewed by the AWT Facility operators; (2) multiple levels of critical control points for AWT Facility operations, alarms, and unit process redundancy; and (3) the ability to shut down the AWT Facility at a moment's notice. Additionally, piloting results for the proposed AWT Facility support the reliability of the AWT Facility product water (see Table 6-2).

Table 6-2: Summary of Results from AWT Piloting – RO Permeate

Acute Parameters[a]	Number of Detects/ Total Number of Samples	Median (Range)	Units
Coliform	0/26	<1 (all non-detects)	MPN/100mL
Nitrate (as N)	17/26	<0.2 (<0.2 – 0.7)	mg/L
Nitrite (as N)	20/26	<0.1 (<0.1 – 0.4)	mg/L
Perchlorate	0/1	<0.002 (only 1 sample taken)	mg/L

[a] All of these constituents would be further reduced through UV/AOP treatment (UV/AOP was not included in the pilot testing).

6.1.2. Time to Identify Water Quality Problem and Complete Confirmation Sampling

Real-time tracking of critical control points at the AWT Facility serves to identify early signs of any treatment performance issues. The RRT however is based on the worst-case hypothetical scenario –

discovering the problem based on water quality results of an acutely toxic parameter that (1) is measured infrequently and (2) requires substantial time for the laboratory to analyze and notify MRWPCA of the results. The maximum time that could pass before a problem is identified is the sum of (1) time between sampling events and (2) time estimated by the contracted laboratory to analyze and report the results to MRWPCA. The time passed before a problem is identified varies depending on the acute water quality parameters, which may have different monitoring frequencies and different times for completion of analyses (see Table 6-3).

Table 6-3: Routine Monitoring Details for Acute Contaminants in AWT Effluent

Acute Parameters	Monitoring Frequency	Sample Delivery [a]	Analysis Time	Estimated Notification Time	Total Time to Identify Water Quality Problem[b,c]
Coliform	1/day	n/a	1 day	1 days	3 days
Nitrate	1/week	n/a	8 hours	2 days	10 days
Nitrite	1/week	n/a	8 hours	2 days	10 days
Perchlorate	1/month[d]	1 day	1 day	10 days	40 days

a. Coliform, nitrate, and nitrite to be completed by MRWCPA in their in-house laboratory. Perchlorate to be sent to Monterey Bay Analytical Services, who subcontracts either with McCampbell Analytical, Inc. or BSK Analytical Laboratories.
b. Total Time = Frequency + Sample Delivery + Analysis Time + Estimated Notification Time.
c. Total Time is rounded up to nearest whole day.
d. Because perchlorate is effectively removed by RO, a treatment step provided at the AWT Facility, the following is proposed: collect quarterly RTP secondary samples and monthly product water samples for 1 year. If the product water results are below detection and no perchlorate appears to be coming from the RTP, MRWPCA will request that the product water perchlorate sampling frequency be increased to quarterly without impacting the proposed RRT.

The laboratory turnaround estimates in Table 6-3 are conservative (i.e., longer than anticipated), and may be expedited by MRWPCA during time-sensitive situations. Based on Table 6-3, the greatest amount of time (40 days) is associated with the assessment of perchlorate.

If there is an exceedance in concentration of an acute parameter, MRWPCA will concurrently initiate confirmation sampling at the AWT Facility and the nearest down-gradient monitoring well. To the extent possible, the results for the confirmation samples will be expedited from the contracted laboratory. See Table 6-4 for timing of expedited turnarounds.

Table 6-4: Estimated Turnarounds for Expedited Assessment of Acute Contaminants

Acute Parameters	Sample Delivery [a]	Analysis Time	Estimated Notification Time	Total Time to Process Expedited Sample[b,c]
Coliform	N/A	1 day	1 day	2 days
Nitrate	N/A	8 hours	8 hours	1 days
Nitrite	N/A	8 hours	8 hours	1 days
Perchlorate	1 day	1 day	2 days	4 days

a. Coliform, nitrate, and nitrite to be completed by MRWCPA in their in-house laboratory. Perchlorate to be sent to Monterey Bay Analytical Services, who subcontracts with McCampbell Analytical.
b. Total Time = Sample Delivery + Analysis Time + Estimated Notification Time.
c. Total Time is rounded up to nearest whole day.

As part of the confirmation sampling efforts, MRWPCA will launch weekly monitoring of acute contaminants at two locations: (1) the AWT Facility product water and (2) the nearest monitoring well to the injection well. Both sites will be sampled weekly ahead of and during the theoretical arrival of the "off-specification" water at the monitoring well, as well as four weeks after the theoretical arrival at the monitoring well. The monitoring well provides early warning for the down-gradient potable production wells. Based on modeling results, travel time to the monitoring well (this monitoring well also serves as the monitoring well for the tracer test) is between 2 weeks to 1 month. The duration used for the RRT calculation is twice that predicted by the model to account of uncertainties, as set forth in Title 22 Section 60320.224(d). Pursuant to Title 22 Section 60320.212(d)(1), product water and monitoring well samples will be collected until four consecutive weekly results are below the contaminant's MCL.

The total time to identify water quality problem and complete confirmation sampling is 19 weeks and is the sum of:

- Longest time elapsed between sample collection (1 month);
- Longest turnaround for routine results (12 days);
- Travel time to monitoring well, doubled to account for uncertainty in numerical model (4 weeks x 2 = 8 weeks);
- Four consecutive weekly samples after passage of "off-specification" water at monitoring well to demonstrate all four concentrations are below contaminant's MCL (4 weeks); and
- Longest turnaround for expedited results (4 days).

6.1.3. Time to Assess Water Quality Results with DDW and RWQCB

The time required for MRWPACA, DDW, and RWQCB to assess the sample results and make decisions regarding the appropriate response(s) is estimated to be 1 week.

6.1.4. Time to Procure Safe Interim Drinking Water Supply

The time required for MRWPCA to collaborate and coordinate with regulatory agencies and stakeholders to suspend replenishment operations and, if necessary, to provide relief measures or an alternative water supply is estimated to be one week. MRWPCA has a response plan with remedial actions for plant operators if the product water cannot meet reuse or discharge standards, including immediate shutdown of recycled water deliveries. MRWPCA also has contingency plans for disposal of "off-specification" recycled water via the ocean outfall (this water will meet NPDES permit effluent limitations).

In addition to actions at the AWT Facility, MRWPCA will immediately implement appropriate steps in the proposed action plan (plan) outlined below to mitigate any potential impacts to the drinking water supply. Explanation and assumptions for each step of the plan are also provided.

Examples given in the plan focus on potential impacts to the closest downgradient drinking water wells, ASR-1 and ASR-2[37], both of which are located about 1,000 feet from the injection wellfield. However, the plan also applies to other potentially impacted downgradient wells. For other downgradient wells, the actions associated with the plan remain the same, but additional time would be available to mitigate impacts (given the longer travel times to other wells). Although the plan provides protection for both aquifers receiving injectate, actions target the Santa Margarita Aquifer first due to faster travel times, closer drinking water wells, and higher reliance on the deeper aquifer for water supply.

Because the AWT Facility will be shut down if the water quality problem cannot be immediately remedied, any potential impacts to the groundwater supply are anticipated to be of relatively short duration. However, the plan also covers the potential for long-term impacts through wellhead treatment and other actions (Steps 7 and 8).

1. Notify Well Owner and Coordinate Appropriate Actions

Once a water quality issue is identified, downgradient well owners will be notified immediately. The closest downgradient drinking water wells, ASR-1 and ASR-2, are operated by MPWMD for injection on behalf of CalAm. Both of these entitities are also involved in the Project as Project Participants (see Table 2-1). Because the most likely affected well owners and operators are Project partners, selection and implementation of effective actions will be more easily coordinated.

It is noted that ASR-1 is operated by CalAm for production of drinking water into their distribution system. Well ASR-2 is not yet permitted for drinking water production, but when that occurs, it will also be operated by CalAm through their water system permit. In the event that a problem is identified that could impact the quality of produced water from ASR-1 or ASR-2, MRWPCA will notify CalAm as soon as possible.

2. Confirmation Sampling in Monitoring Wells Adjacent to Injection Well Field

Monitoring wells adjacent to impacted Project injection wells will be sampled for the constituent(s) of concern. Recognizing that these monitoring wells are located within about a one-month travel time from injection, these wells function as sentry wells, allowing early detection of water quality problems. They provide a lead-time of about one year before injected product water would reasonably be assumed to arrive downgradient at a Santa Margarita Aquifer drinking water well (with even longer travel times for the Paso Robles Aquifer). This underground travel time will provide time for planning the necessary actions to prevent impacted groundwater from entering the drinking water supply.

3. Initiate Accelerated Groundwater Quality Sampling in Downgradient Monitoring Wells and Water Supply Wells; Anticipate Downgradient Water Supply Wells that may be Impacted

Additional downgradient monitoring wells, along with the closest water supply wells, will also be analyzed for the constituent(s) of concern. Depending on the circumstances associated with the impact, wells will be monitored at an appropriate frequency – weekly to monthly – until impacts are fully addressed. Detections at these monitoring wells would be expected to occur within about five months of the sentry wells and approximately six months prior to the anticipated arrival of impacted water at

[37] Although this well has not yet been permitted for use as a drinking water supply, it assumed that permitting will be completed prior to Project start up.

ASR-1 or ASR-2. Again, travel times will be much longer for other downgradient drinking water wells, especially those in the Paso Robles Aquifer. Also, any recent injection at the ASR wells will likely increase this lead time. Depending on the constituent and concentrations, this lead time would be sufficient for potential remedies such as taking preparatory actions to shut down a well, arrange for blending options, or secure wellhead treatment. Analyses for these constituents will also be conducted at other nearby monitoring wells, as appropriate (e.g., ASR-MW-1).

4. Suspend Operation of the Drinking Water Well if Impacted

Well production will be suspended if constituents of concern are detected in the drinking water well or adjacent monitoring well at concentrations deemed by DDW to make the well unsuitable as a drinking water source as a result of the Project. The drinking water well will be taken offline and sampled periodically (likely weekly, depending on concentrations) to examine changes over time and to determine if concentrations are returning to acceptable levels. For impacts to ASR wells, the well will be pumped to the adjacent backflushing basin, which has been shown to readily accommodate several hours of pumping (as is conducted periodically for backflushing the ASR well). The backflushing basin at the ASR-1 well site holds about 245,000 gallons of water and infiltrates at rates of more than 0.5 feet per hour. In addition, there are plans to expand the basin to more than 700,000 gallons. This capacity is more than sufficient for ongoing weekly sampling of the well as needed. While these actions are occurring, production will be shifted among other wells as described in Step 6.

5. Consider Blending Options

Depending on concentrations, blending is a potentially viable option that would allow the water supply to be quickly restored. This approach has been used throughout the state as a solution to dealing with groundwater contamination. Water quality sampling of the impacted well, in addition to previous and ongoing groundwater quality analyses at upgradient monitoring wells, will provide data to assess whether concentrations have been sufficiently diluted in the groundwater system. Data will also be used to determine when concentrations are reasonably expected to rise or dissipate and to determine if the blending (and the blending ratio) would allow for a well to be used for drinking water. Sampling will occur at a frequency selected in consultation with DDW in any well selected for blending to ensure that impacts are not seen in the blending well. For example, if ASR-1 (the closest drinking water supply well) is impacted, concentrations may be sufficiently low at nearby ASR-2 to consider blending to meet water quality goals. ASR-2 well could be pumped for blending without significantly spreading the impacted groundwater. By capturing the impacted groundwater locally at the ASR-1/ASR-2 well site, problematic constituents could be contained in a manner that prevents additional downgradient wells from being impacted, while meeting drinking water standards in the CalAm distribution system.

6. Shift Production from Impacted Well to other Existing Wells

A review of existing well capacities in the vicinity of the Project indicates that some excess capacity is likely available at any given time to shift production to a non-impacted well. This was the result of an analysis conducted in support of the Project EIR. That analysis considered specific capacities of existing wells along with reasonable assumptions for CalAm demand requirements from the Seaside Basin. The analysis also considered times when existing ASR wells would be required for ASR injection or recovery. Results of the analysis indicated that existing wells provide excess capacity under almost all of the recharge and recovery scenarios over a 32-year simulation period.

Data provided by CalAm to support the EIR analysis indicated that a total minimum capacity of 3,653 gpm is available from the five existing CalAm wells in coastal subareas: Luzern #2, Ord Grove #2, Paralta, Playa #3, and Plumas #4 (not including capacities of two low-capacity wells planned for abandonment by CalAm). Additional capacity is available from four existing ASR wells drilled at two well sites: ASR-1 and ASR-2 at the Santa Margarita well site; and ASR-3 and ASR-4 at the Seaside Middle School well site. It is recognized that only one ASR well (ASR-1) is permitted currently for drinking water supply, but additional permitting is anticipated to occur prior to Project operation. ASR wells are capable of pumping up to about 3,000 gpm each for backflushing purposes. However, both wells at each well site would not be pumped simultaneously due to hydraulic interference associated with the relatively close well spacing. Further, well capacities decrease with ongoing injection. As a conservative assumption, an ASR capacity of 1,750 gpm is assumed for each ASR well site (total 3,500 gpm for the two sites). Even with these reduced rates, existing CalAm basin wells and ASR wells are capable of more than 7,153 gpm, a rate more than sufficient to meet anticipated future CalAm demand in the Seaside Basin of approximately 9,100 AFY (about 5,642 gpm).

Further, it is noted that ASR wells are not operated full time. For example, the ASR wells were not operated in 2014 for either injection or recovery. If the closest downgradient wells (ASR-1 and ASR-2) were impacted during these time periods, no additional capacity within the system would be required until ASR injection and recovery began again. This would provide additional time for planning and remediation if such an impact occurred in the future.

In addition, several wells in the Seaside Basin are capable of providing potable water if permitted and re-commissioned to do so. These wells represent a potential backup water supply to accommodate demand if a drinking water well is offline temporarily. Several of these wells include the Reservoir Well, the MMP well, and the PRTIW well (among others). Most of these wells are screened in the Paso Robles Aquifer, where travel times from injection wells to drinking water wells are orders of magnitude longer (more than 8 years as indicated by groundwater modeling (see Table 5-3) and represent much lower amounts of Product water injectate. Although the capacity of these wells is relatively low, collectively, they could combine with other steps in the plan to shift production away from an impacted well while not exacerbating groundwater quality conditions.

7. Initiate Wellhead Treatment Planning and Secure Wellhead Treatment as Appropriate

Ongoing remedial actions by the U.S. Army in the former Fort Ord area demonstrate the ability for granular activated carbon or air stripping to remediate volatile organic chemicals (VOC) contamination. Such treatment facilities are commonplace and can be secured within several weeks on an emergency basis if needed. Permitting and re-routing of lines can be accomplished within a few months at the affected well site. Ion exchange and other technologies such as RO are also avilable within similar time frames. The type of treatment needed will be known approximately one year in advance, providing sufficient time for planning and implementation.

8. Continue Well Suspension, Provide Bottled Water, and/or Consider Additional Wells

It is unlikely that a water quality failure could not be remediated in a relatively short time frame (within months of detection) using the steps described above. Nonetheless, in the event that the options described above cannot be sufficiently implemented in the desired time frame, MRWPCA will work with project partners to secure bottled water, install additional wells, and/or replace the potable water supply in some other manner to ensure that drinking water demands can be met.

6.2. PROPOSED RESPONSE RETENTION TIME

The proposed RRT is 5. 25 months and consists of the time necessary to (1) identify water quality problems and complete confirmation sampling; (2) assess results and make decisions for appropriate responses based on DDW and RWQCB input; and (3) procure safe interim drinking water supply solution (including wellhead treatment), if needed (see Table 6-5).

The proposed RRT of 5.25 months is conservative and protects drinking water wells. The proposed RRT will be validated and potentially refined after the tracer test is completed and recycled water travel times are computed (described in **Section 6.3**).

Table 6-5: Summary of Proposed Response Retention Time

Factors Contributing to RRT	Duration in days[a]	Duration in weeks[b]	Duration in months[c]
#1: Time to identify water quality problem and complete confirmation sampling	**128**	**19**	**4.75**
Longest time between routine sampling frequency [d,e]	*28*	*4*	*1.0*
Longest turnaround routine sample results [f]	*12*	*2*	*0.5*
Travel time to nearest monitoring well [g]	*56*	*8*	*2.0*
Four consecutive samples less than MCL [h]	*28*	*4*	*1.0*
Longest turnaround for last expedited sample result [f]	*4*	*1*	*0.25*
#2: Time to assess results and make decisions for appropriate responses based on DDW and RWQCB input	**7**	**1**	**0.25**
#3: Time to procure safe interim drinking water supply	**7**	**1**	**0.25**
Proposed RRT [i]	**142**	**21**	**5. 25**

a. All durations rounded up to nearest whole day.
b. All durations rounded up to nearest whole week.
c. All durations rounded up to nearest 100th of a month.
d. Of the acute parameters, perchlorate is sampled least frequently. Quarterly perchlorate monitoring is specified within Title 22 Section 60320.212(a), however monthly was selected for RRT determination to reduce the response time.
e. Because perchlorate is effectively removed by RO (a treatment step provided at the AWT Facility), the following is proposed: collect quarterly RTP secondary samples and monthly product water samples for 1 year. If product water results are non-detect and no perchlorate appears to be coming from the RTP secondary effluent, MRWPCA will request that the perchlorate product water frequency be increased to quarterly without impacting the proposed RRT.
f. Perchlorate has the longest laboratory turnaround for both regular and expedited samples.
g. Per Title 22 Section 60320.224(d), the travel time to the monitoring well is doubled to account for the uncertainty of numerical model (4 weeks travel time x 2 safety factor = 8 weeks).
h. Pursuant to Title 22 Section 60320.212(d)(1), product water and monitoring well samples will be collected after passage of "off-specification" water at monitoring well until four consecutive weekly results are below the contaminant's MCL.
i. Proposed RRT = [Time to identify water quality problem and complete confirmation sampling] + [Time to assess results and make decisions for appropriate responses based on DDW and RWQCB input] + [Time to procure safe interim drinking water supply].

6.3. UNDERGROUND RETENTION TIME ANALYSIS

As described in **Section 5.3**, the underground retention time before injected water reaches a drinking water well varies considerably with the dynamic nature of the local groundwater system. Local hydraulic gradients are highly variable, controlled by intermittent injection and recovery operations of the downgradient ASR wellfields and other downgradient production wells. Numerical modeling was used to evaluate the travel time from each injection well to the closest downgradient extraction well over a 25-year simulation period, incorporating the full range of potential ASR operations. Modeling results indicate that the shortest travel time to the closest production well is about 327 days (about 10.8 months) and represent groundwater transport from deep injection well DIW-3 to extraction well ASR-1 (see **Section 5.3** for modeling details; see Section **9.1.3.2** for details on the Watermaster Model used in the analysis. Full model results are included in Appendix D).

The shortest travel time of 10.8 months was associated with drought conditions when the ASR wellfield was being operated for maximum recovery of stored water (see **Sections 5.3.1 and 5.3.2**). These conditions only occurred during five years of the 25-year simulation period and represent a conservative estimate to apply to the Project (see discussion in **Section 5.3.3**). A tracer test conducted after Project start-up is anticipated to confirm that representative travel times are longer.

Due to the uncertainty associated with numerical modeling, the Title 22 Criteria only allow for 0.5 months to be credited to the underground retention time for every month indicated by the modeling (Table in Section 60320.224(d)). With the shortest travel time of 10.8 months to the nearest extraction well, the underground retention time for the Project is 5.4 months, as summarized in Table 6-6.

Table 6-6: Underground Retention Time for Project

Analysis	Time
Shortest Travel Time in 25-year simulation period (DIW-3 to ASR-1; see Table 5-3)	10.8 months
Underground Retention Time Factor (numerical modeling)	0.5 month/model month
Underground Retention Time for Virus Reduction Credit	5.4 months
Application of the Underground Retention Time to the RRT	RRT $\leq$ 5.4 months

As shown above, the RRT of 5.25 months is shorter than the underground retention time to allow for response actions prior to potential water quality impacts at a drinking water well. To further inform the RRT derivation, the estimated travel time from injection wells to proposed downgradient monitoring wells, as indicated from the numerical modeling, is summarized in the following subsection.

6.3.1. Travel Times to Monitoring Wells

In compliance with the Title 22 Criteria, monitoring wells are proposed for the Project to detect short-term travel times (between two weeks and six months) and intermediate travel times between injection and extraction. Figure 3-10 (and other figures including 5-4) shows the locations of proposed monitoring wells associated with all injection well clusters. **Section 12** provides a more detailed description of the proposed groundwater monitoring program and proposed phasing of monitoring wells. The particle

tracking results presented in **Section 5.3.2** can be used to estimate the shortest travel time from any injection well to the proposed downgradient monitoring wells.

Figures 5-2 and 5-4 depict the estimated extent that the injected water has traveled away from the vadose zone wells and the deep injection wells, respectively, at various time intervals of 90, 180, 270, and 360 days. For the purposes of this analysis of travel time to monitoring wells, the modeled travel times are considered directly without applying the factor of 0.5 month credit per month from groundwater modeling. This analysis is not being used as justification for the RRT or the pathogen removal credit request, both of which required the factor to be applied. Rather, this analysis is presented to allow consideration of the best estimate of actual travel times. The analysis will also assist with tracer test planning, which will be conducted after project startup.

Table 6-7 lists the estimated travel time from each injection well to the closest monitoring wells, using the fastest simulated travel times from the particle tracking analysis. As indicated in the table, the monitoring wells proposed adjacent to the injection wells have a short estimated travel time that is generally less than 3 months (per the Title 22 Criteria monitoring well requirements that at least one well is located between two weeks and six months). Travel times to the downgradient monitoring well vary from about six months (180 days) to about three years (1,080 days), although less than about 9 months for three of the deep injection wells. Longer travel times for DIW-4 are suggested by the simulation because of geologic faulting represented in the model

Table 6-7: Simulated Fastest Travel Times between Injection and Monitoring Wells

Injection Well	Adjacent Monitoring Well		Downgradient Monitoring Well	
	Well Number	Estimated Travel Time (days)	Well Number	Estimated Travel Time (days)
DIW-1	N/A[a]	N/A[a]	MW-7	180
DIW-2	MW-1	<90	MW-2	270
DIW-3	MW-3	<90	MW-4	180
DIW-4	MW-5	90	MW-6	>360
VZW-1	N/A[a]	N/A[a]	MW-7	720
VZW-2	MW-1	90	MW-2	1,080
VZW-3	MW-3	<90	MW-4	450
VZW-4	MW-5	90	MW-6	360

a. No adjacent monitoring well at this location due to multi-year travel times to drinking water sources.

6.3.2. Tracer Study Requirements

Title 22 criteria require that a tracer study be used to demonstrate the underground retention times estimated in the above analysis. Details of the tracer testing will be based, in part, on groundwater quality data scheduled to be collected in Project monitoring wells prior to startup. In compliance with regulations, the tracer study shall be initiated prior to the third month of Project operation. Preliminary considerations for tracer test planning are discussed in **Section 12.8**.

7. AWT FACILITY RECYLED WATER QUALITY

A pilot-testing program was conducted between mid-October 2013 and mid-July 2014, with extensive sampling conducted between December 2013 and June 2014 (Trussell Technologies 2014a, attached as Appendix C). The pilot facility treated a flow of 30 gpm of undisinfected RTP secondary effluent with the goals of (1) evaluating the performance of the ozone-MF-RO portion of the proposed AWT Facility processes, and (2) developing design criteria for each unit process. Although AOP will be included in the AWT Facility, it was not included in the pilot testing and sampling program. Design of an AOP system typically does not typically require a pilot demonstration and sufficient information on treatment efficacy is available from existing groundwater replenishment projects. During the pilot testing and the source water sampling campaign, Salinas agricultural wash water (Salinas IWTF influent) was diverted to the RTP collection system where it mixed with untreated municipal wastewater from April 1, 2014 through the end of the sampling program. Data from this period are reflective of the blended water quality of these two sources. The results and details of the pilot testing are included in **Appendix C.**

The pilot facility treated the RTP secondary effluent with sodium hypochlorite (to form chloramines), ozone, MF, and RO. Water quality sampling during piloting included general water quality parameters, pathogens and pathogen indicators, disinfection byproducts, pesticides of local interest, priority pollutants, CECs, constituents with MCLs (inorganics, synthetic organic contaminants), NLs, AALs, and constituents on the UCMR lists (1 through 3) to determine the presence and removal of the constituents (also see **Subsection 4.2.4.2**).

Pilot water quality sampling results indicated that the AWT Facility product water is expected to meet all applicable regulations, including the Title 22 Criteria for groundwater replenishment, RWQCB Basin Plan objectives, MCLs, NLs, and AALs. The RO permeate met all requirements except NDMA, where concentrations were higher than the NL (e.g., 20-32 ng/L). However, the UV/AOP system will be designed to reduce NDMA by at least 1.5-log to achieve the target goal of 1 ng/L.

7.1. TOTAL NITROGEN

The Title 22 Criteria include a total nitrogen limit of 10 mg/L in the recycled water or recharge water (before or after injection), where the limit applies to the average of the results of two consecutive samples collected at least three days apart for each week. During the pilot study, the final pilot effluent consistently met the total nitrogen limit, where the total nitrogen ranged from 1.5 mg/L to 2.9 mg/L, significantly lower than the 10 mg/L regulatory limit (Figure 7-1.). After the addition of the agricultural wash water to the RTP in April 2014, the average pilot influent (RTP secondary effluent) total nitrogen decreased from 43.7 mg N/L to 34.8 mg N/L. This was expected because the wash water has a lower total nitrogen concentration compared to the typical RTP effluent.

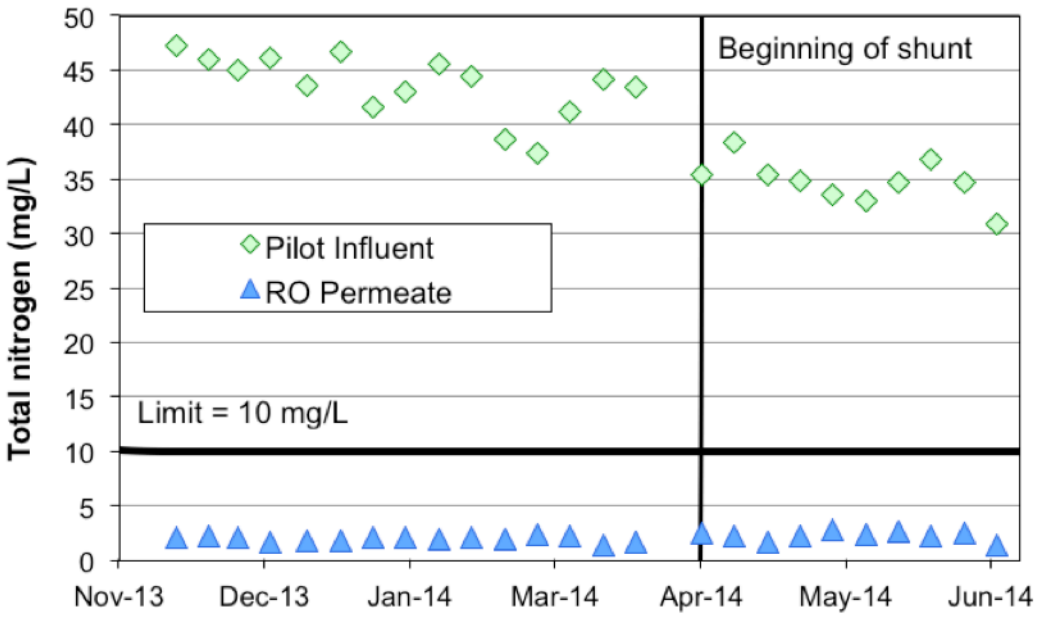


Figure 7-1. Removal of total nitrogen through the pilot

The Blanco Drain has elevated levels of nitrate – the median concentration observed during source water sampling was 68 mg N/L. These elevated nitrate concentrations contribute to the elevated total nitrogen concentration observed in the Blanco Drain (median of 70 mg/L), compared to the RTP effluent (median of 44 mg/L, where the RTP effluent total nitrogen is mostly comprised of ammonia). The Reclamation Ditch may also have elevated total nitrogen concentrations as it also receives agricultural tile drainage, in addition to runoff. The impact of the Blanco Drain, the Reclamation Ditch, and the agricultural wash water on the RTP effluent total nitrogen concentration can be conservatively estimated if it is assumed that nitrogen removal is not obtained in the RTP (actual total nitrogen removal in the RTP was 21% to 43% during a two-week study in October, 2015 using composite samples). Using the projected monthly flows, total nitrogen concentrations through the year were predicted. The results of the analysis are summarized in Table 7-1, including the highest monthly total nitrogen based on the median observed values and the maximum observed values. Despite the higher nitrate levels in the Blanco Drain, the maximum predicted total nitrogen under median conditions is about 12% higher than what has already been observed in the RTP effluent. The maximum predicted value, based on the maximum observed values, is 11% higher than the observed maximum in the RTP effluent (without Blanco Drain blending).

Table 7-1: Observed and Predicted Total Nitrogen Concentrations Calculated using Median and Maximum Values

Total N	RTP Effluent[a], mg/L	Blended Source Waters[a], mg/L
Median	44.2	49.4
Maximum	50.5	55.9

a. Blended concentrations based on predicted source water flows presented in **Section 4.2** and including RTP effluent, agricultural wash water, Blanco Drain, and Reclamation Ditch, where the Reclamation Ditch total nitrogen concentrations were assumed to be the greater of the Blanco drain or Tembladero Slough median and maximum concentrations as the Reclamation Ditch was not included in the source water sampling campaign.

The average total nitrogen removal through the pilot was 94.3%. Assuming this removal, a blended source water total nitrogen concentration of 49.4 mg/L would be reduced to 2.8 mg/L and total nitrogen of 55.9 mg/L will be reduced to 3.2 mg/L. Both of these concentrations are well below the Title 22 limit of 10 mg/L. Therefore, despite higher nitrate levels (and corresponding higher total nitrogen levels) in the Blanco Drain and potentially elevated total nitrogen concentrations in the Reclamation Ditch, the AWT Facility should readily meet the 10-mg/L total nitrogen effluent limit.

7.2. TOTAL ORGANIC CARBON

Section 60320.218 of the Title 22 Criteria specifies that the TOC concentration in the product water cannot exceed 0.5 mg/L based on:

- The 20-week running average of all TOC results; and
- The average of the last four TOC results.

As discussed in **Subsection 4.2.4.5**, the median concentration and range of TOC in the various untreated source waters are similar except for the agricultural wash water, which has a significantly higher TOC concentration. However, all of the untreated source waters will undergo treatment through the primary and secondary processes at the RTP and advanced treatment at the AWT Facility. In fact, a significant decrease in the RTP effluent TOC was observed during the time period of the agricultural wash water shunt (Salinas IWTF influent shunt), compared with values observed before the shunt: 14.8 ± 0.7 mg/L and 13.0 ± 0.7 mg/L (mean ± 95% confidence interval), for before and after the shunt testing, respectively (see Figure 7-2.), indicating that the TOC concentration in the agricultural wash water is significantly reduced through primary and secondary treatment. It is expected that the addition of low-TOC waters (e.g., Blanco Drain, and potentially in the future, Tembladero Slough, Lake El Estero) would only further decrease the TOC in the feed water to the AWT Facility via blending.

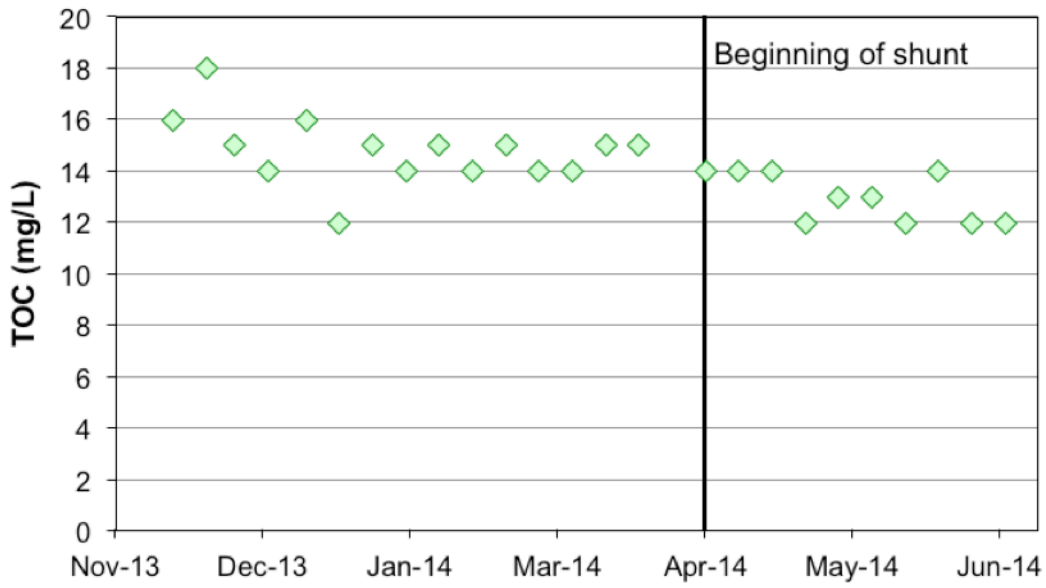


Figure 7-2. TOC concentrations entering the pilot

The key unit process in the AWT Facility that further reduces TOC is the RO system. The TOC concentrations in the RO permeate are impacted by the ozone dose used in the ozone pretreatment unit process. The TOC concentrations in the RO permeate at a time when ozone dose was 10 mg/L were consistently below 0.5 mg/L, ranging from 0.27 mg/L to 0.42 mg/L, including the period when the agricultural wash water was added to the municipal wastewater for treatment at the RTP (Figure 7-3.). However, when the ozone dose was increased to approximately 20 mg/L, the TOC concentration in some of the RO permeate samples exceeded 0.5 mg/L. This information helped in the selection of the design ozone dose chosen for the full-scale AWT Facility; namely, the lower dose of 10 mg/L, which, coupled with the expected reduction in TOC from blending with other low-TOC source waters, RTP primary and secondary treatment, and treatment through the other AWT Facility unit processes, will consistently produce product that meets the Title 22 TOC requirements.

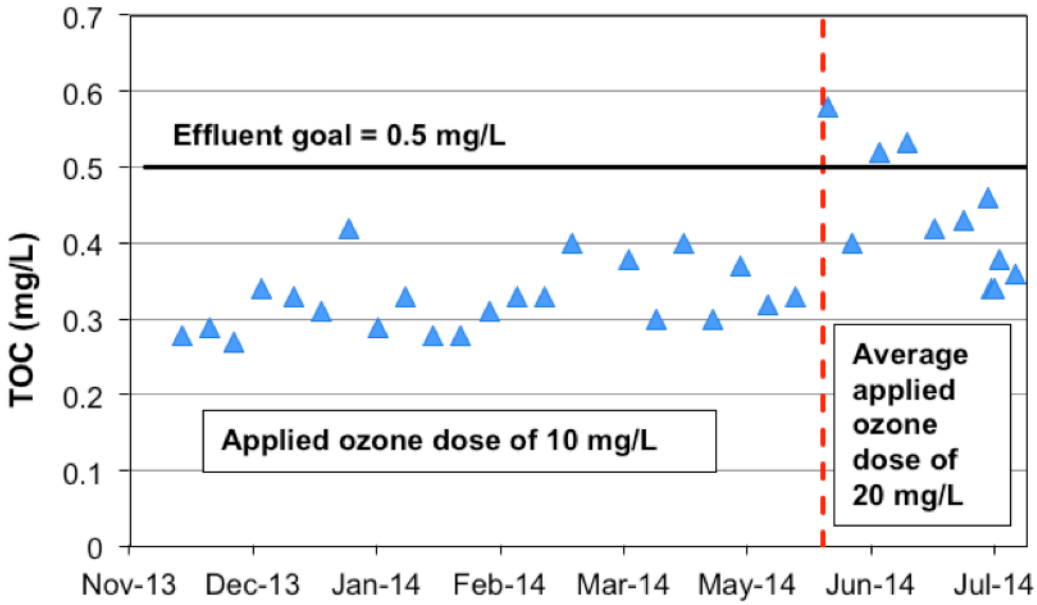


Figure 7-3. TOC concentrations in the pilot RO permeate. Increase in ozone dose started 5/20/14 and continued through the end of piloting

7.3. REGULATED CONSTITUENTS

In accordance with Title 22, the product water must meet primary and secondary drinking water MCLs. Results from the pilot testing indicate that the AWT Facility should produce water in compliance with all primary and secondary MCLs. A summary of the constituents detected in the RO permeate with primary and secondary MCLs is presented in Table 7-2. Fourteen constituents with MCLs were detected in the RO permeate at least once, as shown in Table , and with the exception of the odor threshold secondary MCL, none of them exceeded their regulatory limit. For the full-scale AWT Facility, odor will be reduced to levels below the MCL after UV/ H_2O AOP treatment (Agus et al., 2011). Thus, results of the pilot testing based on the ozone-MF-RO portion of the AWT Facility and the expected benefit from full-scale treatment with AOP show that the product water from the full-scale AWT Facility would comply with all of the MCLs that are required to be met for groundwater replenishment of recycled water. Based on the pilot performance for these constituents, source water quality data, RTP performance during pilot

testing, and source water flows, the inclusion of the additional source waters not used/treated by the pilot testing will also be able to be treated to meet the MCLs.

Although bromate formed during ozonation (from less than 1 µg/L to up to 9 µg/L; median 3.35 µg/L), RO effectively removed bromate and bromate was not detected in the RO permeate during the pilot plant sampling program. Pilot testing included a wide range of O_3:TOC ratios, including O_3:TOC ratios approximately two times larger than the O_3:TOC ratio associated with the design ozone dose and water quality. During pilot testing of these O_3:TOC ratios, the maximum bromate concentration in the ozone effluent was less than the MCL (maximum of 9 µg/L, compared to the MCL of 10 µg/L). Based on these piloting data, the bromate concentration in the AWT Facility ozone effluent is expected to be approximately 3 to 4 µg/L at the design O_3:TOC ratio.

Downstream of ozone, bromate removal through RO was observed to be as high as greater than 88.9% during piloting (similar, and greater, levels of removal were observed at West Basin Municipal Water District piloting, where pre-ozonation is also practiced). Conservatively assuming a removal of 88.9% through RO, the bromate concentration in the ozone effluent would have to be greater than 90 µg/L for bromate levels in the RO permeate to be at the MCL. Such levels in the ozone effluent are not expected given that they are ten times higher than the maximum concentration observed during piloting that included O_3:TOC ratios approximately twice as high as the design O_3:TOC ratio.

Table 7-2: Constituents with MCLs Detected in RO Permeate

Constituent	Unit	MCL	Median (Range)[a]
Secondary MCL Consumer Acceptance			
Chloride	mg/L	250	3 (<1 - 6)
Conductivity	µS/cm	900	38 (32 - 46)
Sulfate	mg/L	250	<1 (<1 – 1)
TDS	mg/L	500	<10 (<10 – 26)
Turbidity	NTU	5	<0.05 (<0.05 – 0.1)
Primary MCL Inorganics			
Aluminum	mg/L	0.2	<0.01 (<0.01 – 0.045)
Arsenic	mg/L	0.01	<0.001 (<0.001 – 0.002)
Chromium	mg/L	0.05	0.005
Cyanide	mg/L	0.15	<0.005 (<0.005 – 0.007)
Fluoride	mg/L	2	<0.1 (<0.1 – 0.2)
Nitrate	mg/L as N	10	<0.2 (<0.2 – 0.7)
Nitrite	mg/L as N	1	<0.1 (<0.1 – 0.4)
Nitrate + Nitrite	mg/L as N	10	0.55 (0.1 - 1.6)
Selenium	mg/L	0.1	<0.002 (<0.002 – 0.01)
Primary MCL Synthetic Organic Compounds			
Total trihalomethanes	µg/L	80	1.85 (0.68 – 5)
Primary MCL Radionuclides			
Radium-226	pCi/L[b]	5	0.298 ± 0.327

a. Parameters with no range were only sampled during one complete MCL sampling event.
b. Picocuries per liter - pCi/L.

There were several constituents that were measured above or close to their MCL in the untreated source waters that were not included in the piloting (i.e., Blanco Drain, Lake El Estero, and the Tembladero Slough – the latter two are not currently planned for use in the Project). However, based on predicted treatment through the RTP and AWT Facility, none of these constituents are expected to impact the ability of the product water to meet the Title 22 Criteria for compliance with MCLs.

7.4. BASIN PLAN OBJECTIVES

For the Seaside Basin, the Basin Plan includes general narrative groundwater objectives for taste and odor and radioactivity, and numeric objectives for:

- Bacteria - the median concentration of coliform organisms (*i.e.*, total coliform) over any seven-day period must be less than 2.2/100 mL; and
- Chemical constituents - groundwater shall not contain chemical concentrations in excess of primary and secondary MCLs.

As previously discussed, the RO permeate followed by AOP will meet all MCLs, the bacterial objective, and the narrative objectives. Based on the pilot testing, source water quality data, RTP performance during pilot testing, and source water flows, the inclusion of the additional source waters not diverted to the RTP and treated by the pilot testing will also be treated to meet the Basin Plan objectives.[38]

The Basin Plan also includes guidelines to protect soil productivity, irrigation, and livestock watering. With regard to salinity and chloride, the RO permeate concentrations from the pilot testing were below the guidelines. One of the Basin Plan guidelines is the Sodium Adsorption Ratio (SAR), which is used to determine if irrigation water affects the rate of water infiltration. It is not a constituent, but a calculated value based on the square root of the ratio of sodium to the average quantity of calcium plus magnesium, on an equivalence basis, adjusted for tendency precipitate or dissolve lime (RWQCB, 2011). The cations (calcium, magnesium, and sodium) used to derive an SAR will be removed by RO as part of the full-scale AWT Facility. Calcium will be dosed into the UV/AOP effluent (downstream of the RO permeate), which will lead to a favorably low SAR. SAR values in the pilot RO permeate ranged from 1.0 to 1.4, compared to strictest the SAR guideline of <3. The addition of calcium during product water stabilization would bring the SAR values to approximately 0.2 to 0.3. The potential addition of sodium hypochlorite for secondary disinfection would have no noticeable impact on the SAR values (0.2 to 0.3 would still be expected).

As discussed earlier, even considering the effects of blending all of the source waters prior to treatment, the predicted total nitrogen concentration (after secondary treatment at the RTP and treatment through the full-scale AWT Facility) will result in a maximum product water concentration of 3.2 mg/L. This concentration is below the individual guidelines for ammonia and nitrate.

[38] With regard to permitting the Project, it is important to acknowledge what a RWQCB must consider when establishing waste discharge requirements. Per California Water Code Section 13263(a), "[t]he requirements shall implement any relevant water quality control plans that have been adopted, and shall take into consideration the beneficial uses to be protected, the water quality objectives reasonably required for that purpose, other waste discharges, the need to prevent nuisance, and the provisions of Section 13241." WDR requirements should not be performance-based as a means of interpreting Best Practicable Treatment or Control (BPTC) per Resolution 68-16, the Anti-degradation Policy. The application of BPTC does not dictate the application of performance-based limits. As noted in SWRCB Order WQ 2014-090-DWQ-Corrected (General Waste Discharge Requirements for Recycled Water), BPTC is defined as "a combination of Title 22 and the Regional Water Board Water Quality Control Plans (Basin Plans)." See Finding 24, pg. 7.

The chemical stabilization process following AOP in the full-scale AWT Facility will influence bicarbonate and pH concentrations in the purified water. These concentrations will be within the Basin Plan Guidelines as demonstrated by existing groundwater replenishment projects elsewhere.

The Basin Plan includes water quality objectives for agricultural use for irrigation supply and livestock watering. The following demonstrates how the Project AWT product water would comply with those Basin Plan objectives:

- Of the 21 constituents with objectives, 14 have MCLs (aluminum, arsenic, beryllium, cadmium, chromium, fluoride, iron, manganese, mercury, nickel, nitrate+nitrite, nitrite, selenium, and zinc). All of the agricultural objectives are set at higher concentrations than the MCLs with the exception of zinc, fluoride and selenium; however, RO permeate test results from the pilot testing indicate the AWT Facility will achieve adequate removal of these constituents. In addition, the RO permeate for the MCL-based constituents either meets MCLs or meets the less stringent Basin Plan agricultural objectives. Lastly, the maximum zinc and selenium concentrations measured in the source waters were below the objectives, prior to treatment; the maximum predicted fluoride concentrations in the source waters, accounting for source water blending and based on measured values in the source waters, will be reduced to levels below the objective based on median removals of fluoride through RO observed during pilot testing.
- The Basin Plan also includes agricultural objectives for copper and lead. In the case of copper, the objectives for irrigation supply (0.2 mg/L) and livestock watering (0.5 mg/L) are more stringent than the drinking water action level (1.3 mg/L). The maximum concentrations of copper measured in any of the untreated source waters was 0.073 mg/L, which is below the agricultural objectives prior to advanced treatment. For lead, the Basin Plan objectives for irrigation supply (5.0 mg/L) and livestock watering (0.1 mg/L) are less stringent than the drinking water action level (0.015 mg/L). The maximum concentration of lead measured in any of the untreated source waters was 0.0018 mg/L, which is well below the agricultural objectives prior to advanced treatment. Thus, the source water sampling program found that lead and copper were below their respective agricultural basin plan objectives in all of the untreated source waters sampled.
- The Basin Plan includes agricultural objectives for two constituents with NLs: boron and vanadium. In the case of boron, the agricultural objective for irrigation supply (0.75 mg/L) is more stringent than the NL of 1 mg/L. Vanadium was not detected in the RO permeate from the pilot testing. The median boron concentration in the RO permeate was 0.18 mg/L (range 0.16 to 0.23 mg/L). Thus, the piloting testing found that boron and vanadium were below their respective agricultural basin plan objective in the RO permeate. Additionally, the maximum boron and vanadium concentrations measured in the source waters were below the objectives.
- The three remaining agricultural objectives do not have regulatory standards or goals: cobalt, lithium, and molybdenum. Studies of RO treatment have shown that it is effective in removing metals such as these from secondary wastewater. Cobalt and molybdenum were removed to below detection levels, and lithium was removed by 68% with a median concentration of 0.01 mg/L, which is below agricultural objectives for irrigation supply ranging from 0.075 to 2.5 mg/L (Department of Health, Western Australia, 2009).

The concentration of dissolved solids on the feed and permeate side of the RO membrane were measured to determine their removal during the RO process. Select results from this effort are summarized in Table 7-3. The concentration of these dissolved solids in the RO permeate were typically

below the detection limit, and thus the removal is often reported as greater than the indicated value. These data show robust removal of dissolved solids through the RO process, including a dramatic reduction in TDS. Based on this expected removal, the Project will comply with all Basin Plan standards, objectives, and guidelines.

Table 7-3: Removal of Select Dissolved Solids

Constituent	Average Removal
TDS	>98.6%
Chloride	>98.8%
Sulfate	>98.9%
Phosphate	>96.7%
Nitrate	>94.4%
Calcium	>99.1%
Magnesium	>97.8%
Sodium	97.2%
Potassium	>96.3%

7.5. OTHER RELEVANT CONSTITUENTS

7.5.1. Endocrine Disrupting Compounds, Pharmaceuticals and Other Chemicals

The panel list of CECs measured by the Eurofins Eaton Analytical Liquid Chromatography Tandem Mass Spectrometry (LC-MS-MS) method (92 constituents) was measured monthly in the pilot influent, ozone effluent, and RO permeate during pilot testing. Ozonation consistently reduced the concentrations of many of the CECs to levels below detection (*e.g.*, bisphenol A (BPA) and several of the pharmaceuticals); on average, there were approximately 40 CECs detected in the pilot influent and 26 detected in the ozone effluent. With a few exceptions described below, the RO removed the remaining CECs to below detection. In addition, the AWT Facility will include UV/AOP, which provides an additional barrier to destroy chemicals and pathogens (UV/AOP was not piloted, and therefore no grab samples were collected on UV/AOP effluent). The CEC removals observed across the pilot treatment system are shown in Figure 7-4.

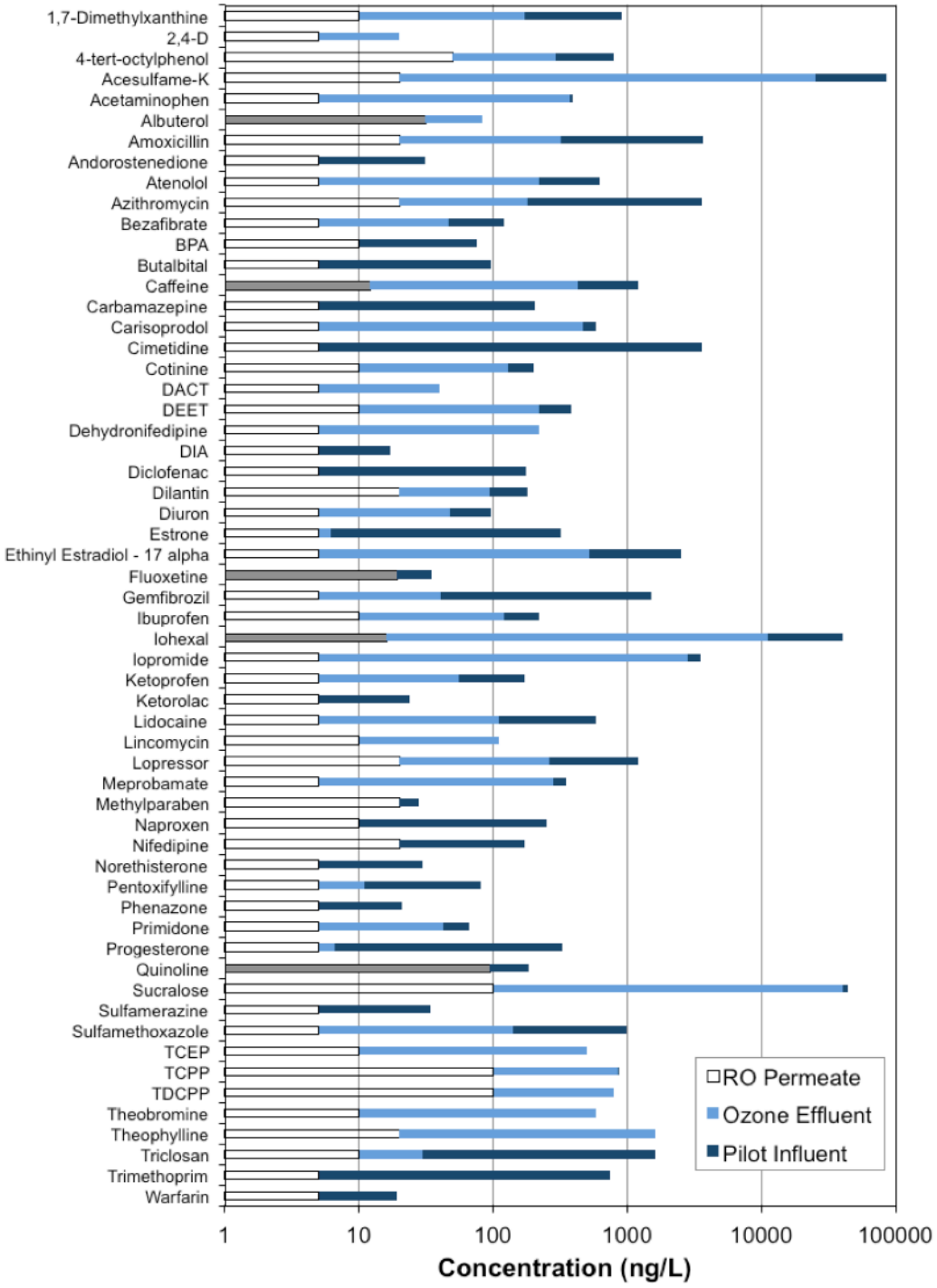


Figure 7-4. CEC Removal Demonstrated during Pilot Testing through Ozonation and Reverse Osmosis. Unfilled sections indicate results were below detection limit. All values shown are maximum detected values.

In three of the seven monthly sampling events, there were a few CECs detected in the RO permeate (not including previously discussed NDMA). These compounds were erythromycin, caffeine, iohexal, albuterol, carbadox, fluoxetine, and quinolone. In all cases, these compounds were detected in only one sample, and it is likely that several of the detections were actually false positives due to contamination. Specifically, erythromycin and carbadox (both antibiotics) were not detected in either the pilot influent or the ozone effluent, and thus the RO permeate detection is considered an anomaly. For quinoline (a chemical that has ubiquitous sources such as cigarette smoke and automobile exhaust, and is used in the production of dyes, paints, pharmaceuticals, and fragrances) and fluoxetine (an antidepressant), the RO permeate values exceeded the ozone effluent value, and it is strongly suspected that this is a false positive as well. The remaining compounds detected in the RO permeate, caffeine (a simulant), iohexal (a contrast agent), and albuterol (an asthma medication), were detected at concentrations near the detection limit and it is unclear whether or not they are actual values. For all of these compounds, it is important to keep in mind that (1) the concentrations detected were many orders of magnitude below any demonstrated health related levels, and (2) these compounds have all been shown to be effectively removed by UV/AOP (i.e., exceeding 90% for these compounds). It is expected that all of these compounds will be below current detection limits in the full-scale AWTF UV/AOP effluent and product water.

7.5.2. Constituents with Notification Levels

During pilot testing, the only constituent measured in the RO permeate above its NL or AAL was NDMA (see Table 7-4). However, the UV/AOP process is specifically designed to achieve 1.5-log removal (i.e., 96.8% removal) of NDMA. This level of removal will reduce the NDMA concentration to a range of approximately 0.63 to 1.0 ng/L (from the measured range of 20 to 32 ng/L present in the RO permeate), which is well below the NL. The detection limit for 1,4-dioxane makes it difficult to ascertain where the concentration in the RO permeate is in comparison to the NL (since the NL is equal to the detection limit). In addition to 1.5 log NDMA removal, the UV/AOP system will also be designed to achieve a minimum of 0.5 log removal of 1,4-dioxane, and thus providing assurance that the product water 1,4-dioxane concentration will be below the NL in the full-scale AWT facility product water.

Table 7-4: Constituents with NLs or AALs Detected in RO Permeate

Constituent	Unit	Limit	Median (Range)[a]
Boron	mg/L	1 (NL)	0.18 (0.16 – 0.23)
Formaldehyde	mg/L	0.1 (NL)	0.050 (0.028 – 0.071)
NDMA	ng/L	10 (NL)	27 (20 – 32)
N-Nitrosodi-n-Propylamine	ng/L	10 (NL)	<2 (<2 – 2.9)
Chloropicrin	µg/L	50 (AAL)	3.5
2,3,5,6-Tetrachloroterephthalate	mg/L	3.5 (AAL)	0.0001

a. Parameters with no range were sampled once during a complete NL/AAL sampling event.

7.5.3. Remaining Priority Pollutants

The Title 22 Criteria require that recycled water and groundwater (from down gradient monitoring wells) be monitored for Priority Pollutants (chemicals listed in 40 CFR Part 131.38, "Establishment of numeric criteria for priority toxic pollutants for the State of California") specified by DDW, based on DDW's review of the project's engineering report. Sixty-four Priority Pollutants were sampled and analyzed during the pilot plant sampling program. Of these constituents, a total of 16 Priority Pollutants were found in the RO permeate after the pilot testing, all of which had MCLs or NLs that are addressed elsewhere in this section. It is noted that of the 16 Priority Pollutants detected, only NDMA was found above its NL. As previously noted, the UV/AOP process, which will follow the RO process in the full-scale AWT Facility, will be designed to reduce the NDMA concentration to below the NL of 10 ng/L.

8. INJECTION OPERATIONS AND MAINTENANCE

The preliminary operation plan for injection into the Seaside Basin is summarized in this section. Prior to operation, a more detailed Operation Optimization Plan (OOP) will be prepared and submitted to DDW and the RWQCB for review and approval prior to Project startup. The OOP will contain more specifics on the operation and maintenance of the injection facilities, as well as final approved protocols for groundwater sampling.

8.1. DELIVERY/CONVEYANCE OF PRODUCT WATER TO SEASIDE BASIN

MRWPCA has evaluated the amounts and availability of the Project source waters and has developed estimates of monthly deliveries of product water to the Seasisde Basin. An average of 3,500 AFY is planned for delivery, but monthly amounts will vary based on hydrologic conditions.

Specifically, the Project will incorporate the concept of a drought reserve account. During wet and normal years, the project will convey an extra 200 AFY of advanced treated water (primarily during October-March) to the Seaside Basin for credit in the drought reserve account, up to a cumulative total of 1,000 AF. During dry conditions, the Project could reduce its deliveries to the Seaside Basin by as much water as had accumulated in the drought reserve. This amount of water will be treated to a tertiary level and delivered instead to CSIP for supplemental irrigation supply. During these reduced deliveries to the Seaside Basin, CalAm will continue to extract 3,500 AFY for municipal supply by using the water stored in the drought reserve account.

For further analysis, these operational guidelines have been translated into potential monthly delivery amounts to the Seaside Basin based on actual hydrologic conditions as discussed in more detail below.

8.2. DELIVERY SCHEDULES AND OPERATION OF THE DROUGHT RESERVE ACCOUNT

MRWPCA has considered the availability and amounts of source waters, capacity of the AWT Facility, minimum delivery targets, and operational guidelines discussed above in order to develop potential delivery schedules for recharge to the Seaside Basin. This analysis has identified eight potential delivery schedules that could occur, based on two water management decision points made in each year of Project operation. These eight delivery schedules are presented in Table 8-1. The two management decisions that determine appropriate deliveries to the Seaside Basin are described below.

Table 8-1: Product Water Available for Injection

	Product Water Delivery Schedules for Seaside Basin Injection		Acre-Feet per Month (AF/month)												Total AFY	Add to Reserve	Available in Reserve
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep			
1	Drought Reserve <1,000 AF	Wet/Normal Year	331	321	331	331	299	331	288	297	288	297	297	288	3,700	200	-
2	Drought Reserve 1,000 AF	Wet/Normal Year	297	288	297	297	268	297	288	297	288	297	297	288	3,500	-	-
3	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	255	263	255	263	263	255	3,500	200	200
4	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	222	229	222	229	229	222	3,300	200	400
5	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	189	196	189	196	196	189	3,100	200	600
6	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	156	162	156	162	162	156	2,900	200	800
7	Drought Reserve <1,000 AF	Drought Year	331	321	331	331	299	331	124	128	124	128	128	124	2,700	200	1,000
8	Drought Reserve 1,000 AF	Drought Year	297	288	297	297	268	297	124	128	124	128	128	124	2,500	-	1,000

Maximum Monthly Injection Rates	Injection Rates in Gallons per Minute (gpm)												Maximum (gpm)
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	
Santa Margarita Aquifer (90%)	2,175	2,179	2,175	2,175	2,175	2,175	1,955	1,951	1,955	1,951	1,951	1,955	2,179
Paso Robles Aquifer (10%)	242	242	242	242	242	242	217	217	217	217	217	217	242
Total	2,417	2,422	2,417	2,417	2,417	2,417	2,173	2,168	2,173	2,168	2,168	2,173	2,422

The first management decision will be made by October 1, the beginning of the Water Year (WY), and will dictate which of two delivery schedules is followed during October through March of that WY. The decision will be based on whether or not the drought reserve account is full (1,000 AF). If the account is full, the Project will deliver monthly amounts from October through March based on average annual deliveries. The two delivery schedules with a full reserve account are highlighted in purple in Table 8-1 and labeled Schedule 2 and Schedule 8). If the account balance is less than 1,000 AF on October 1, then an additional 200 AF will be delivered from October through March (highlighted in Table 8-1 in blue; for example, see October through March delivery schedules 1, and 3 through 7). For wet or normal years, these two recharge schedules will produce a total of 3,700 AFY (Schedule 1) or a total of 3,500 AFY (Schedule 2) (Table 8-1).

The second management decision will be made in early spring as to which schedule will be followed for deliveries in April through September. This decision will be based on whether or not the previous 6 months of precipitation has indicated a drought year and whether supplemental irrigation water is needed and available from the drought reserve account. This decision will be made by MCWRA. If it is a wet/normal year, the delivery will follow the April through September delivery schedule shown for both Schedule 1 and Schedule 2 (highlighted in orange in Table 8-1). However, if MCWRA requests water from the drought reserve account during a drought year, the delivery schedule for April through September will follow one of the drought delivery schedules shown in green in Table 8-1. The selection of the drought schedule will be based on the then-current balance in the drought reserve account (as of April 1 – see last column in Table 8-1).

8.3. MAXIMUM DELIVERY FOR RECHARGE

The maximum monthly amount of product water available from any of the eight potential delivery schedules in Table 8-1 has been converted to a maximum monthly injection rate in gpm for each aquifer. These rates are summarized in the lower portion of Table 8-1. The maximum injection rates are estimated for planning purposes to design recharge facilities that will accommodate peak flows and to inform the number and spacing of injection wells. As shown in Table 8-1, the total maximum injection rate for any of the schedules is 2,422 gpm (lower right in Table 8-1). Assuming 90% of the water is injected into the Santa Margarita Aquifer, deep injection wells need to accommodate an estimated peak flow of about 2,179 gpm. Assuming 10% of the water is injected into the Paso Robles Aquifer, the vadose zone wells will need to be capable of a collective injection rate up to about 242 gpm.

For the purposes of project planning and as part of the EIR analysis, recharge facilities are sized for these maximum rates incorporating conservative injection rates and allowing for down-time associated with well operation and maintenance. The installation of injection wells will be phased in order to determine actual injection capacity with more certainty. The total number of wells planned is assumed to be a maximum number; fewer wells may be capable of accommodating the full injection amounts, and testing of the Phase 1 wells will be used to determine the number of additional wells needed. As actual operation is refined, monthly injection amounts can be balanced with operation at the AWT Facility, as needed. This approach provides future project flexibility and allows inclusion of additional wells that may be needed for future operation. Phasing of the injection and monitoring wells is discussed in more detail below.

8.4. INJECTION WELL PHASING AND OPERATION

Well installation will be phased over time to match actual well capacity and product water availability over time. The conceptual well configuration described in **Section 3.5** and represented on Figure 3-10 represents a maximum Project well build-out as needed.

For the initial phase of well construction for the Project (referred to herein as Phase 1), MRWPCA plans to install two deep injection wells (DIW-2 and DIW-3), two vadose zone wells (VZW-2 and VZW-3) and four monitoring well clusters (MW-1, MW-2, MW-3, and MW-4). These Phase I wells are shown on Figure 8-1.

The conceptual well configuration for all Project wells, including the Phase I wells, has been presented to City of Seaside staff in several informational meetings, but has not yet been formally approved by FORA or the City of Seaside. The City of Seaside, through its Municipal Code, has placed prohibitions and restrictions on construction of wells on certain FORA parcels. However, the Injection Facilities will be located on parcels that currently do not restrict groundwater wells. MRWPCA will be working with the City of Seaside to include a restriction on the future installation of drinking water wells within the zones of controlled well construction and a secondary control zones, as described in **Section 10**.

8.4.1. Deep Injection Wells Installation and Operation

DIW-2 and DIW-3 have been identified as Phase I wells to test the local injection capacity of the Santa Margarita Aquifer. These locations also represent the most conservative approach for the tracer testing because of the relatively faster travel times to downgradient drinking water wells (see discussion in **Section 5.3** and Table 5-3).

As described above, an injection capacity of 2,179 gpm into the Santa Margarita Aquifer is needed to accommodate the maximum monthly deliveries identified in Table 8-1. At an injection rate of about 1,000 gpm (or slightly higher if testing confirms), at least two deep injection wells will be needed for the volumes associated with the Project.

Even if these two wells demonstrate that injection capacity can accommodate injection volumes associated with the Project, an additional back-up well may also be required to accommodate deliveries during times when wells are down for maintenance. Although the quality of the product water will result in a lower potential for clogging, some mitigation of clogging will still be required. As discussed in **Section 3**, this will be accomplished through routine backflushing, during which time the well will be unavailable for production. The amount and frequency of backflushing will be determined by monitoring of injection capacity during well testing and Project operation. This third well could be installed at the proposed locations of DIW-1 or DIW-4. An additional location for the third deep injection well may also be proposed, if warranted during final design.


N
0
400
Scale in Feet
ASR 4
SMS-Shallow
SMS-Deep
ASR 3
Reservoir Well
FO-07 Shallow
FO-07 Deep
Eucalyptus Rd.
MRWPCA
MW-1
Military Ave.
General Jim Moore Blvd.
Paralta
ASR-2
PRTIW
ASR MW-1
ASR-1
MW-2
MMP
MW-4
VZW-2
MW-1
DIW-2
Ord Grove Test
Ord Grove
MW-3
VZW-3
DIW-3
La Salle Ave.
San Pablo Ave.
Seaside 4
Legend
Phase 1 GWR Deep Injection Well
Phase 1 GWR Vadose Zone Well
Phase 1 Groundwater Monitoring Well
Backflushing Basin
Injection Facilities Area
Seaside Basin Production Well
Seaside Basin Monitoring Well
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TODD GROUNDWATER
Figure 8-1
Phase 1
GWR Project Wells

8.4.2. Vadose Zone Wells Installation and Operation

Vadose zone wells will also be installed in phases for the Project as needed. Exact well capacities are not yet available, although information gathered during a field program indicate that deep percolation is favorable at the Injection Facilities area. If the anticipated injection capacity of 500 gpm is demonstrated through testing, only one vadose zone well may be needed to accommodate the maximum monthly injection amount of 242 gpm. It is recognized that water pumped to the backflushing basin from deep injection wells will also serve to recharge the Paso Robles Aquifer and could assist in balancing allocation among aquifers.

However, because injection capacity and backflushing amounts are currently unknown, it seems reasonable to incorporate a second vadose zone well into the Phase I planning process. For convenience and land use efficiency, the two Phase I vadose zone well locations are proposed at the sites with the two Phase I deep injection wells. As shown on Figure 8-1, VZW-2 and VZW-3 are included in the Phase I well program.

8.5. INJECTION SUPPORT FACILITIES

Injection support facilities are described in **Section 3.5**. Information is summarized below with additional components relating to system operation.

8.5.1. Product Water Supply Pipelines and Electrical Service

As previously discussed in **Sections 3.4** and **3.5**, the product water will be transmitted via the AWT product water pipeline to the Injection Facilities area. There, the pipeline will connect to a local 24-inch diameter product water supply line to deliver water to the injection wells (see schematic diagram on Figure 3-13). This local water supply line will be constructed along the length of the Injection Facilities area, but may be constructed in phases, to support the phasing of injection wells. Deep injection wells will be tied into the local water supply line by a 12-inch diameter feed line and will also be connected to a 14-inch diameter backflush pipeline to transmit water pumped for maintenance to a backflush basin (see schematic diagram on Figure 3-14). Injection and discharge will be controlled downhole by a flow-control valve. The vadose zone wells will be connected to the 24-inch water supply line by an 8-inch diameter feed line. Vadose zone wells will not be connected to the backflush line.

Figure 3-14 also shows the electrical duct bank and the connections to an electrical cabinet, which will be constructed at each well site. The electrical equipment will include a main electrical power supply cabinet required for PG&E power supply, a transformer and motor controls. Power supply will be needed to drive only one injection pump motor at a time.

E2 Consulting Engineers evaluated the electrical requirements of the Injection Facilities (E2, 2014). PG&E has two circuits in the vicinity of the new wells. Connection to the circuits will be an underground feed from poles along General Jim Moore Boulevard. The electrical connection could be medium or low voltage service depending on the points of service. The well motors will be operated with a variable frequency drive (VFD). The voltage of the motor will be based on the distance from the VFD to each respective well pump.

E2 Consulting Engineers conducted a cost benefits analysis for various options for points of service for the electrical system (E2, 2014). That analysis indicated that the preferred option will be to install a low

voltage utility service and VFD panel for each well pump. Each well site will also have a transformer, utility service equipment and electrical control panels. This equipment will likely require a small building at each well pad in consideration of maintaining equipment away from the outdoor elements and managing visual effects, given that the area is targeted for redevelopment by the City of Seaside.

8.5.2. Backflush Basin

Several locations were evaluated for the backflush basin. Given the selection of the Phase I wells, the preferred location is that described in **Section 3.5** and shown on Figure 8-1. As discussed in more detail in **Section 3.5**, E2 Consulting Engineers prepared a preliminary design for the backflush basin including a water balance based on site infiltration rates (E2, 2014). The preliminary basin design covers a footprint of 125 feet by 125 feet with a three-foot water depth and 2-foot freeboard. Discharge water will be pumped from each deep injection well separately and conveyed to the backflush basin through a separate 12-inch diameter backflush pipeline. The well maintenance schedule is currently unknown and will be determined during operation as injection capacity is monitored.

8.6. OPERATIONS PLAN

Injection will occur in the Project wells on a mostly continual basis, controlled by the operations and maintenance schedules of the AWT Facility. An average of 3,500 AFY will be injected into the basin for downgradient recovery using existing wells. During normal and wet periods, up to 3,700 AFY may be injected depending on the then-current drought reserve account balance. Extraction will be maintained at 3,500 AFY. This amount will already be injected into the Seaside Basin prior to extraction. In this manner, adverse impacts to the basin will be avoided, a reliable water supply will be provided to CalAm, and the yield from the Seaside Basin will be significantly increased.

A deep injection well and vadose zone well (and, if applicable, local monitoring well) will be constructed in close proximity at up to four locations along the Injection Facilities area. Pipeline configuration will allow each well to be taken offline separately for maintenance including pumping for backflush operations.

To demonstrate Project performance, groundwater monitoring will be conducted in compliance with the WDRs/WRRs to be issued for the Project in accordance with DDW and RWQCB requirements. Phase I groundwater monitoring wells are shown on Figure 8-1. The proposed monitoring program is summarized in **Section 12**.

Injection Facilities will be subject to a 60% to 100% design phase, scheduled for completion by summer 2016. Based on final design and initial construction details, including preliminary well testing, a more detailed operations plan will be developed for the Project.

9. HYDROGEOLOGIC SETTING

The Injection Facilities are located on the coastal plain of Monterey Bay south of the Salinas River (Figure 9-1). As shown on Figure 9-1, the area overlies a portion of the Seaside Area Subbasin of the larger Salinas Valley Groundwater Basin (DWR, 2004). The Salinas Valley is an elongate intermountain valley that extends to the southwest of the area shown on Figure 9-1 for approximately 80 miles. The Seaside Area Subbasin as defined by the Department of Water Resources (DWR) includes the coastal communities of Seaside and Marina and a portion of the former Fort Ord military facility. The area is bounded by other subbasins of the Salinas Valley Groundwater basin including the 180/400 Aquifer Subbasin to the north and the Corral de Tierra Subbasin to the south. The western boundary is the Monterey Bay shoreline, although the aquifer system continues offshore (Figure 9-1).

For the purposes of local groundwater management and generally consistent with a court-appointed adjudication boundary, the local groundwater basin has been re-defined as a smaller area than the DWR-defined Seaside Area Subbasin. For consistency with jurisdictional and local agency terminology, this portion of the Seaside Area Subbasin is referred to as the Seaside Groundwater Basin, or simply Seaside Basin, in this report.

Groundwater conditions in the Seaside Basin were documented in a basin-wide study conducted for MPWMD (Yates, et al., 2005). As part of that study, investigators presented updated basin boundaries with four subareas that are generally aligned with hydrogeologic features such as the occurrence of bedrock, extent of aquifer systems, geologic faulting, and groundwater divides. Specifically, four subareas were delineated: Northern Coastal Subarea, Northern Inland Subarea, Southern Coastal Subarea, and Laguna Seca Subarea. The updated basin boundaries and four subarea boundaries are shown on Figures 9-1 and 9-2.

The northern boundary of the Seaside Basin is a groundwater divide and shifts somewhat over time. In addition, the northern boundary also differs somewhat from the boundary defined in the basin adjudication by the courts. However, all of these boundaries differences are minor and do not affect the project analysis. For consistency, the boundaries shown on all of the maps for this report are the updated boundaries from Yates (et al., 2005).

9.1. SEASIDE BASIN AND REGIONAL HYDROGEOLOGY

As shown by the aerial photograph on Figure 9-2, the coastal subareas of the Seaside Basin are urbanized and intersect portions of the Cities of Seaside, Monterey, Del Rey Oaks, and Sand City. The Bayonet & Black Horse Golf Courses are located in the northern portion of the Northern Coastal Subarea. Highway 1 crosses the coastal subareas near the coast. The Northern Inland Subarea is largely undeveloped and contains lands from the former Fort Ord facility. These lands extend into the northern portions of the Laguna Seca Subarea, bounded by development in Del Rey Oaks in the southwestern subarea and by Laguna Seca development and golf courses in the eastern subarea. The Injection Facilities area is located in northwestern portion of the Northern Inland Subarea near the boundary with the Northern Coastal Subarea, as highlighted on Figure 9-2.

9.1.1. Physical Setting

The ground surface elevation rises across the groundwater basin from sea level at the coast to more than 850 feet above mean sea level (msl) in the southeastern portions of the basin. Surface elevations in the western portion of the Northern Inland Subarea, including the Injection Facilities area, are generally between 300 feet msl and 500 feet msl.

The average annual precipitation for the Seaside Basin is approximately 15 inches per year (inland) to 17 inches per year (coastal). Much of the surface drainage in the Seaside Basin is internal with runoff pooling in small depressions between surficial sand dune deposits. There are no major drainageways in the Northern Inland Subarea. Runoff from precipitation at the Injection Facilities area flows overland generally to the west-southwest, consistent with ground surface elevations.

9.1.2. Geologic and Hydrogeologic Setting

The Seaside Basin consists of semi-consolidated to consolidated sedimentary units overlying relatively low permeability rocks of the Miocene Monterey Formation and older crystalline rocks. These low permeability units are generally used to define the base of the groundwater basin. The sedimentary units consist of marine sandstones of Tertiary age overlain by a complex Quaternary-age sequence of continental deposits and shallow Quaternary-age dune deposits. In general, the sedimentary units dip northward and thicken into the Salinas Valley.

The Seaside Basin has been structurally deformed by geologic folding and faulting. In particular, sedimentary units in the southern portion of the basin have been uplifted and displaced along the Ord Terrace and Seaside faults, which create some hydraulic separation, or compartmentalization, within the basin. Both faults are generally south of the Injection Facilities. However, one interpretation of the Ord Terrace fault trace (Yates, et al., 2005) indicates that the fault trends relatively close (within 1,000 feet) to the southern-most proposed Project injection wells (DIW-4 and VZW-4) and could potentially result in some hydraulic separation between the injection wells and the closest municipal well to the southwest, City of Seaside #4 (see wells on Figure 3-10) (see also information on nearby production wells in **Section 10**). This uncertainty will not affect the Project operations. As a conservative assumption, the hydrogeologic investigation assumes that the wells are hydraulically connected.

Two main sedimentary units provide groundwater supply to existing pumping wells in the Seaside Basin: the continental Quaternary-age (Pleistocene) Paso Robles Formation and the underlying Tertiary-age (Miocene) Santa Margarita Sandstone. Permeable units in these two geologic formations are referred to herein as the Paso Robles and the Santa Margarita Aquifers. Although the Santa Margarita Aquifer is more homogeneous than the Paso Robles Aquifer, both are defined by a series of stratified layers rather than a single continuous sand unit.

The two aquifers are overlain by Quaternary-age units including undifferentiated sediments, eolian sand deposits, and the consolidated Aromas Formation (DWR, February 2004; Yates et al., 2005). Although these shallow units are highly permeable in most areas, the deposits occur generally above the water table and are only saturated in coastal areas. As such, these shallow units do not contribute substantially to the basin's water supply.

Over-pumping of these two aquifers over time has resulted in declining water levels near the coast, increasing the potential for seawater intrusion. These conditions led to a court-administered

groundwater basin adjudication. Details regarding the adjudication and historical and current groundwater use are described in the following sections.

9.1.3. Seaside Basin Adjudication and Watermaster Activities

The Seaside Basin was adjudicated by the California Superior Court on March 27, 2006, establishing groundwater extraction rights in the basin. A court-appointed Watermaster has been formed to execute the requirements of the adjudication. The court decision requires a decrease in pumping after three years from the effective date of the adjudication and additional pumping reductions over time unless the Watermaster has secured additional outside sources of water for basin replenishment.

9.1.3.1. Seaside Basin Watermaster Groundwater Monitoring and Reporting

The Watermaster prepares annual reports to the court documenting annual groundwater extractions, groundwater storage, groundwater replenishment (if any) and other information on groundwater conditions including levels and quality. In cooperation with MPWMD, the Watermaster conducts a groundwater monitoring program to support these reporting requirements. For WY 2015, the monitoring program included water quality data from 12 basin monitoring wells, water levels in 76 monitoring and inactive production wells, and precipitation and streamflow data (Arroyo Del Rey) (MPWMD, 2015). Groundwater quality samples are analyzed for general minerals and certain parameters and constituents required for the annual seawater intrusion analysis.

In addition to these monitoring and reporting programs, the Seaside Basin Watermaster also conducts technical groundwater studies and analyses for groundwater basin management. For example, the Watermaster developed target water levels for key coastal wells to protect against seawater intrusion, referred to as protective levels (HydroMetrics, 2009). HydroMetrics produces annual reports analyzing water level and quality data to determine the potential for seawater intrusion (HydroMetrics, 2014). These Seawater Intrusion Analysis Reports also compare water levels to protective levels and report any indications of seawater intrusion. Although the potential for seawater intrusion remains a threat to basin water quality, no seawater intrusion has been observed as of the most recent analysis in December 2014 (HydroMetrics, 2014b).

9.1.3.2. Seaside Basin Watermaster Groundwater Model

In 2009, the Seaside Basin Watermaster completed construction of a numerical groundwater flow computer model for the basin using the model code MODFLOW 2005 (HydroMetrics, 2009). The Watermaster Model provides a basin-wide tool for determining protective water levels to prevent seawater intrusion and for evaluating various groundwater management strategies.

The Watermaster Model covers approximately 76 square miles of the Salinas Valley Groundwater Basin including the Seaside Basin. In order to represent the hydrostratigraphy and simulate three-dimensional flow in the basin, the model was constructed with five layers. Model layers generally correspond to observed hydrostratigraphic units[39] as follows:

[39] A hydrostratigraphic unit can be defined as a formation, part of a formation, or groups of formations in which there are similar hydraulic characteristics allowing for grouping into aquifers or confining layers (aquitards).

- Layer 1 - Older Dune deposits and Aromas Red Sand,
- Layers 2 and 3 - Upper and Middle Paso Robles Aquifer,
- Layer 4 - Basal clay layers (approximately 80 feet thick) typically observed in the Lower Paso Robles Formation, where present, and
- Layer 5 - Santa Margarita Aquifer (including the Purisima Formation where present).

The Watermaster Model is a transient model that has been calibrated over a 22-year period from January 1987 through December 2008 and is capable of simulating groundwater levels over a wide variety of hydrologic conditions. The model includes conditions that occurred during the drought period of the early 1990s and relatively wet periods such as 1998 and 2005. Boundary conditions and additional details on the Watermaster Model are documented in a report on model construction and calibration (HydroMetrics, 2009).

In 2014, the Watermaster Model was updated to include groundwater conditions through December 2013. Details and documentation of the model update were provided in a technical memorandum included as an attachment to the Seaside Basin Watermaster 2014 Annual Report (see Attachment 10 in Seaside Basin Watermaster, 2014).

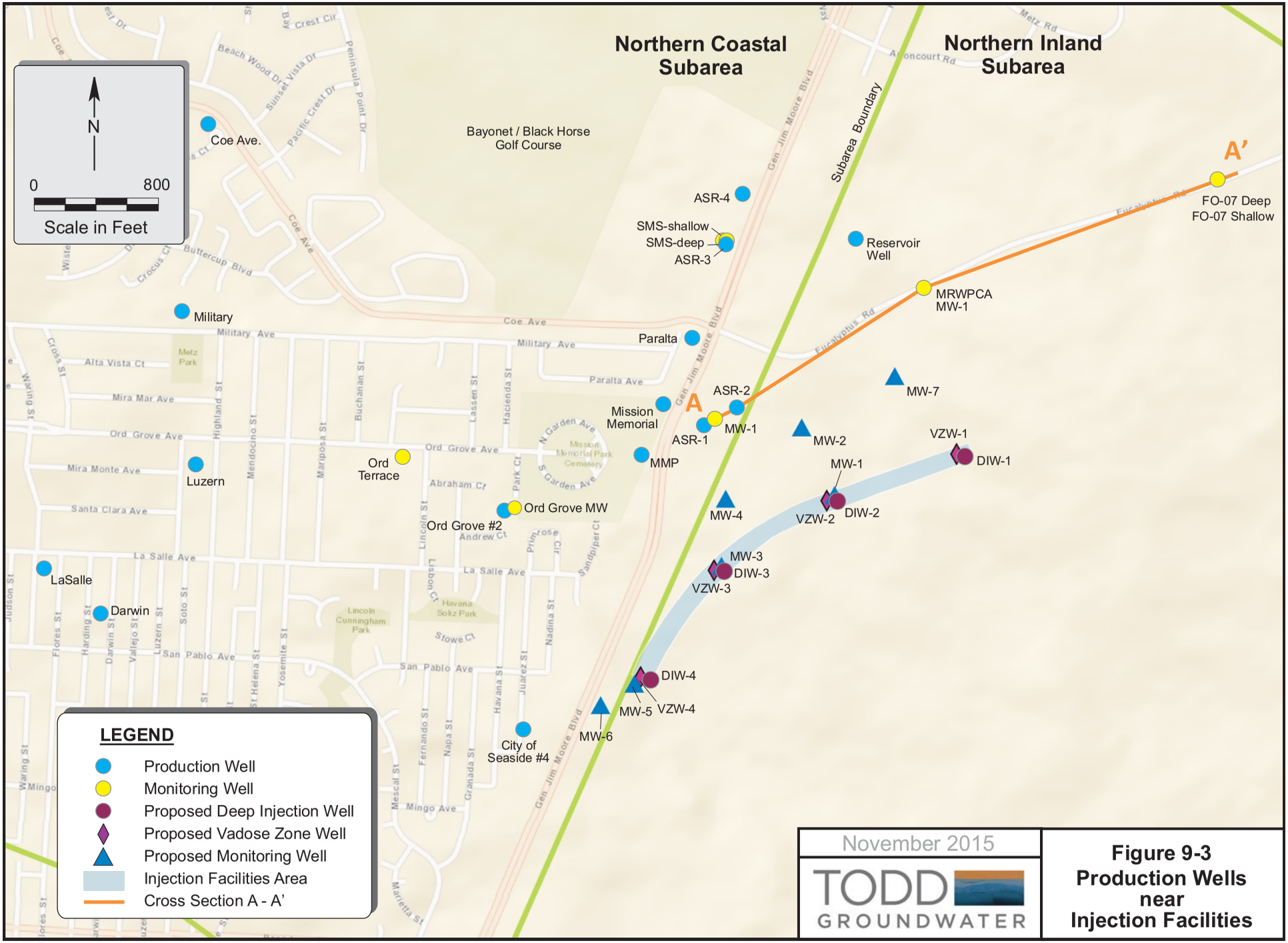
The model provides a valuable quantitative tool for the evaluation of the Project and potential impacts to basin water levels and wells. HydroMetrics, consultant to the Watermaster and author of the Watermaster Model, was contracted by MRWPCA to apply the model to simulate aquifer response to injection associated with the Project. Modeling results regarding Project injection impacts to water levels and groundwater quality are summarized in **Section 7**. The model was also applied to simulate the underground retention time in order to support the pathogen (i.e., virus) reduction credit requested in this report as well as the estimated response retention time provided prior to extraction of the recycled water. Modeling results for the underground retention time analysis are provided in **Section 5.3**.

9.1.4. Groundwater Use

Groundwater pumping in the Seaside Basin provides water supply for municipal, irrigation (primarily golf courses), and industrial uses. Historically, about 70 to 80% of the pumping has occurred in the Northern Coastal Subarea, with additional pumping occurring in the Laguna Seca Subarea supplemented by small amounts in the Southern Coastal Subarea. CalAm is the largest pumper in the basin accounting for about 80% of the groundwater pumped in WY 2014 (Seaside Basin Watermaster, 2014). Production wells in the Northern Coastal Subarea are shown on Figure 9-3.

Annual pumping in the Coastal subareas and total basin production over the last 20 years are shown on Figure 9-4. Over this time period, production in the Coastal subareas has averaged about 4,070 AFY and total basin production has averaged about 4,950 AFY.

Prior to basin adjudication in 2006, pumping exceeded sustainable yield and contributed to significant basin-wide water level declines. Over-pumping in the coastal subareas resulted in water levels declining below sea level at the coast, placing aquifers at risk of seawater intrusion. In particular, basin pumping increased after a 1995 order by the SWRCB placed constraints on out-of-basin supplies (Figure 9-4).

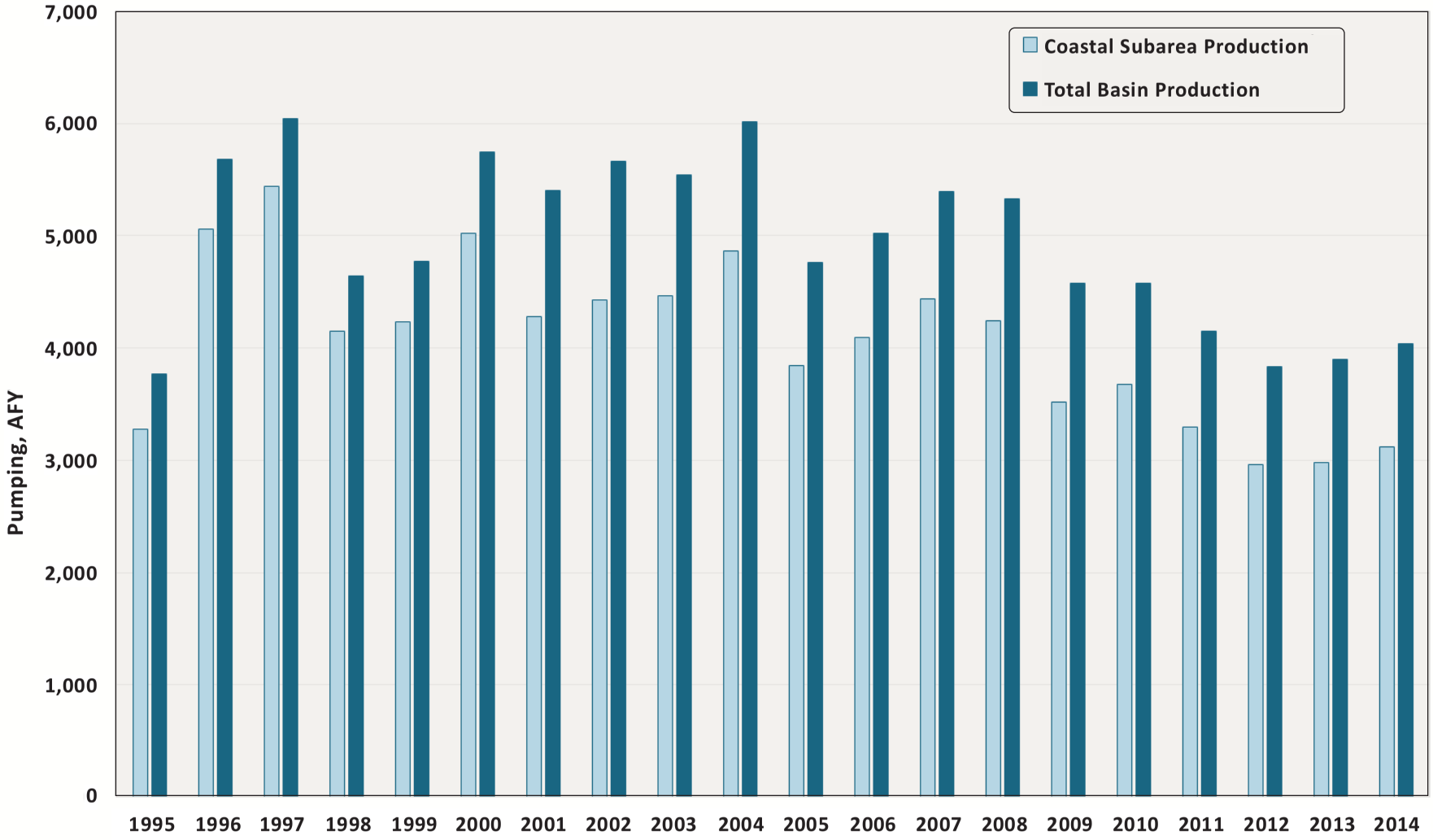


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Figure 9-3
Production Wells near Injection Facilities

Annual Production in Coastal Subareas and Basinwide Seaside Groundwater Basin



Notes: 1995 - 2001 data by Reporting Period (July 1 - June 30). 2001 - 2014 data by Water Year (October 1 - September 30).
Pumping data do not include ASR injection or recovery amounts.

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Figure 9-4
Coastal and Basin-wide Groundwater Production

Since 2008, groundwater pumping has declined. Pumping in coastal subareas averaged about 4,505 AFY from 1996 through 2008, but has decreased to about 3,260 AFY from 2009 through 2014 (Seaside Basin Watermaster production records). For comparison purposes, the court established a natural safe yield for the coastal subareas of between 1,973 AFY to 2,305 AFY during the Seaside Basin adjudication (California Superior Court, 2006).

The data in Figure 9-4 do not include production data from the nearby ASR Project where about 2,870 AF have been injected and recovered from 2010 through 2015. Although the ASR Project uses basin storage capacity, the water produced from ASR wells has been imported into the Seaside Basin and injected into the wells, resulting in no net basin production. Production wells in the vicinity of the Injection Facilities, including the ASR wells are the focus of the discussion in **Section 10**.

9.2. PROJECT AREA HYDROGEOLOGY

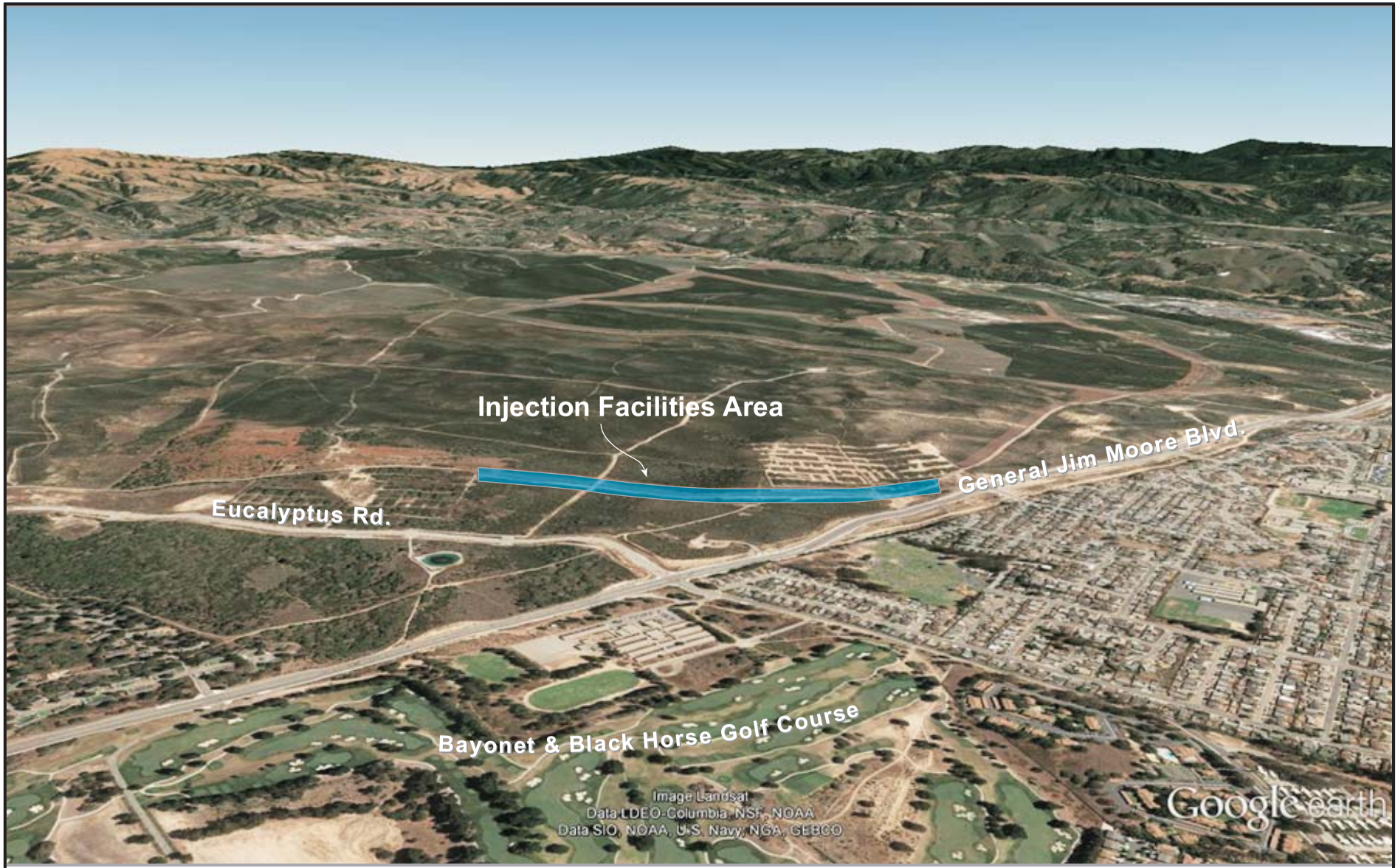
The proposed Injection Facilities are located within the Northern Inland Subarea but adjacent to the Northern Coastal Subarea where most of the basin's groundwater pumping occurs (see production wells on Figure 9-3). Although no wells currently exist within the Injection Facilities area, data from nearby wells were used to evaluate the local hydrogeology.

9.2.1. Physical Setting of the Injection Facilities Area

The Injection Facilities are located on inland mature sand dunes that slope westward toward Monterey Bay (Figure 9-2). The site is characterized by rolling hills and closed depressions. An oblique view of the Injection Facilities area illustrates the hummocky nature of the surrounding topography (Figure 9-5). The area is currently undeveloped and is cross-cut by unimproved roads and trails associated with former military activities (Figure 9-5). An access road to a small water reservoir is across Eucalyptus Road from the northern-portion of the proposed Injection Facilities area. This reservoir and adjacent groundwater well have been used historically for irrigation at the Bayonet and Black Horse golf courses west of General Jim Moore Boulevard (Figure 9-5).

Ground surface elevations along the Injection Facilities area vary from about 455 feet msl at proposed DIW-1 to about 300 feet msl at DIW-4. Elevations between DIW-2 and DIW-3 range from about 395 to 365 feet msl with elevations at the proposed back-flush basin (in between the two well locations) of approximately 375 feet msl. Along Eucalyptus Road north of the Injection Facilities, ground surface elevations vary from about 470 feet msl at the monitoring well identified as FO-7 to about 430 feet msl at the recently drilled monitoring well identified as MRWPCA MW-1. The ground slopes to about 340 feet msl at the intersection of Eucalyptus Road and General Jim Moore Boulevard (Figure 9-5).

The Injection Facilities area receives about 14.5 inches of annual rainfall (Yates, et al., 2005). Runoff on the rolling hills collects in low areas and provides recharge to the Seaside Basin. Recharge from deep percolation of rainfall (and minor amounts of irrigation) in the Northern Inland Subarea has averaged about 1,080 AFY from 2003 through 2007 (HydroMetrics, 2009). This amount represents 99% of the total recharge estimated for this undeveloped subarea (HydroMetrics, 2009).



View looking southeast.

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Figure 9-5
Oblique View
Injection Facilities Area

9.2.2. Land Use in the Injection Facilities Area

The Injection Facilities will be located on a portion of the former Fort Ord military base, which provided training and staging for U.S. troops from 1917 to 1994. The Project wells are located in the northwestern portion of a large upland area referred to as the Inland Ranges (HLA, 1994). As shown on Figure 9-6, the Inland Ranges consist of about 8,000 acres bounded by Eucalyptus Road to the north, Barloy Canyon Road to the east, South Boundary Road to the south, and General Jim Moore Boulevard to the west. For environmental investigation and remediation purposes on former Fort Ord lands, a portion of the area is also referred to as Site 39. The general area of the Inland Ranges, the Site 39 boundary, and the proposed injection wells are shown on Figure 9-6.

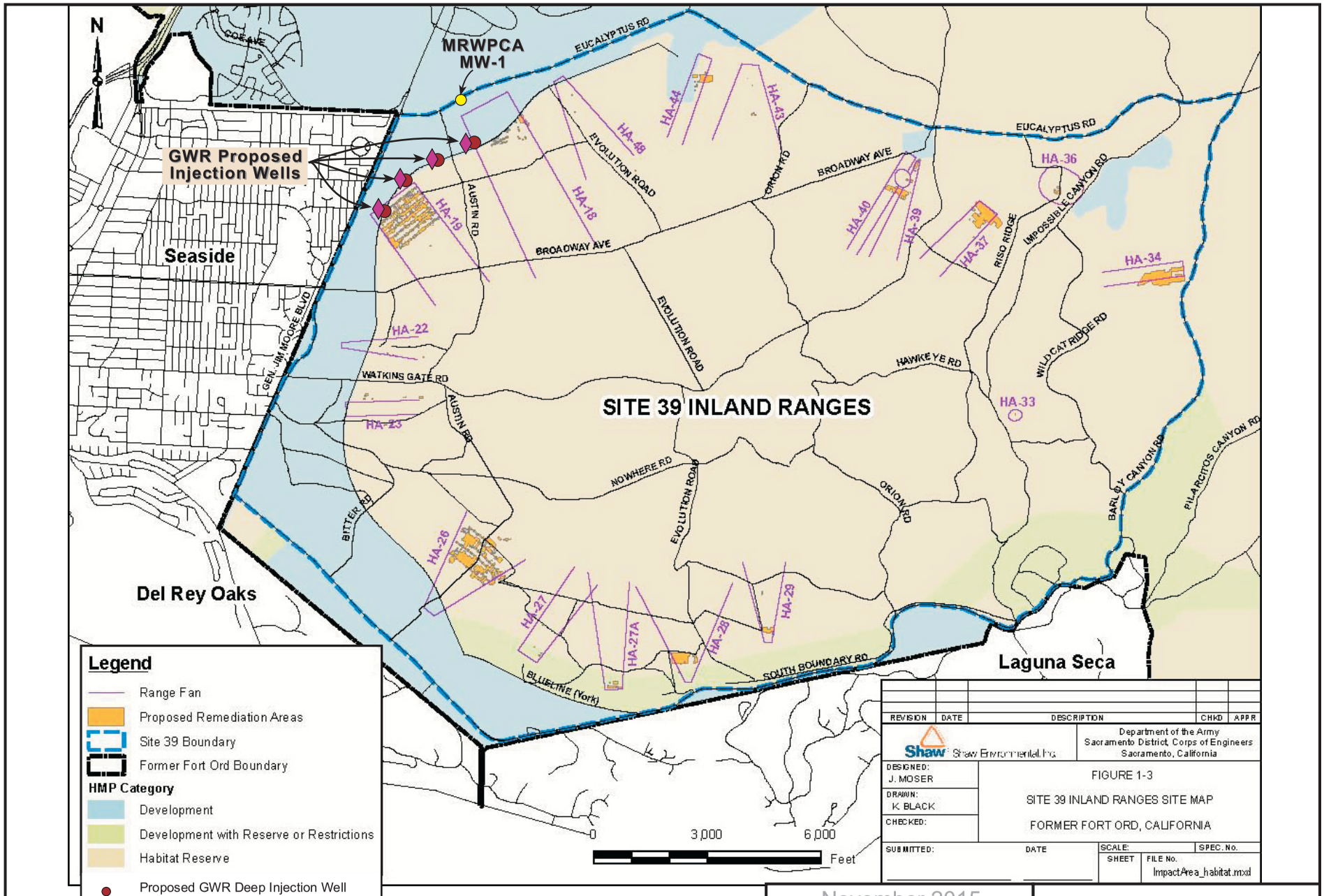
Site 39 contained at least 28 firing ranges that were used for small arms and high explosive ordnance training using rockets, artillery, mortars and grenades. Range 18 (HA-18) and Range 19 (HA-19) are the closest ranges to the Injection Facilities area (Figure 9-6).

Considerable expended and unexploded ordnance have been documented in various areas of Site 39. The specific ordnance types include rounds from shotguns, mortars, M74 rockets, recoilless rifles, aircraft, grenades, artillery, howitzers, mines, anti-tank weapons (bazookas), bombs, naval ordnance, Bangalore torpedoes, C-4, TNT, military dynamite, and shaped charges. Functions for these items included high explosives plus heat generating, armor piercing, white phosphorous, smoke tracer, illumination, incendiary, and photo flash devices.

Beginning in 1984, numerous environmental investigation and remediation activities have occurred on Site 39. During these investigations, metals and various compounds associated with explosives have been detected in soil. Remediation has been more extensive in areas targeted for redevelopment, an area that includes the Injection Facilities area. As shown on Figure 9-6, the Injection Facilities area is within and along the edge of areas targeted for development without restrictions (blue shaded area on Figure 9-6).

Most of these lands are now controlled by FORA, the organization responsible for the planning, financing, and implementing the conversion of former Fort Ord military lands to civilian activities. FORA has signed an Environmental Services Cooperative Agreement (ESCA) with the U. S. Army to allow transfer of approximately nine parcels (3,340 acres) to FORA that were associated with military munitions (e.g., unexploded ordnance or munitions and explosives of concern). Under ESCA, FORA is responsible for addressing munitions response actions. FORA and their contractors are working with regulatory agencies including the California Department of Toxic Substances Control and the U.S. EPA to complete munitions remediation activities.

The two ESCA parcels containing the Injection Facilities area, APN 031-151-048-000 and APN 031-211-001-000, are outlined on Figure 9-2. These two parcels will ultimately be transferred to the City of Seaside for redevelopment. Parcels adjacent to and south-southeast of the proposed Injection Facilities area will remain under the control of the U.S. Bureau of Land Management.



Modified from: Shaw Environmental, 2009.

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Figure 9-6
Former Fort Ord
Inland Ranges and
Proposed Injection Wells

The ESCA parcels that contain the Injection Facilities were less impacted by former Fort Ord activities than other parcels associated with Site 39 and have already been cleared of munitions and explosives of concern and approved for future development. The City of Seaside has an ordinance applicable to these and other former Fort Ord parcels, which requires a soil management plan for any soil disturbance and other parcel restrictions.

The Injection Facilities, purposefully located along the south-southeastern edge of the parcels, are not expected to interfere with future re-development by the City of Seaside (Figure 9-2). By spacing the wells along the parcel boundary, it is anticipated that any visual or noise concerns will be minimized.

9.2.3. Local Subsurface Conditions

Aquifer units and subsurface conditions in the vicinity of the Injection Facilities area are illustrated on a geologic Cross Section A-A' (Figure 9-7). The cross section location and corresponding wells are shown on Figure 9-3. Subsurface conditions and aquifer parameters near the Injection Facilities area are also summarized in Table 9-1 and discussed in the following sections.

Table 9-1: Anticipated Subsurface Conditions in the Injection Facilities Area

	Aromas Sand / Older Dune Deposits	Paso Robles Aquifer	Santa Margarita Aquifer	Data Sources[a]
Lithology	Fine brown sand, silty sand, some medium to coarse sand, minor silt and clay.	Heterogeneous package of interbeds of sand, silt, and clay mixtures. Average bed thickness of 25 feet.	Fine- to medium-grained well sorted sand to silty sand; sandy silt in lower portions of formation; minor clay.	1, 2, 3
Interval Thickness	400 feet	250 feet	280 feet	1, 2
Percent Sand	92%	52%	74%	2
Depth	Surface sediments	356 feet	609 feet	Fig.5; Ground surface elev.
Groundwater Conditions	unsaturated	unconfined	semi-confined	4, 5
Aquifer Parameters ***Transmissivity (T)***	Not applicable; unsaturated locally	659 ft^2/day to 1,524 ft^2/day	11,377 to 13,947 ft^2/day 24,003 ft^2/day	1, 5, 6, 7, 8, 9
Horiz. Hydraulic Conductivity (K_h)	350 ft/day	20 ft/day	63 ft/day	2, 6
Vertical Hydraulic Conductivity (K_v)	70 ft/day	0.66 ft/day to 16 ft/day	0.63 ft/day	1, 3, 7
Storativity (S)	0.24 to 0.40 (sand); 0.04 to 0.09 (silt; silty sand)	0.12	0.0018 0.00258	1, 4, 5
Average Coastal Subarea Production	Not applicable; unsaturated locally	Est. 500 AFY (15% of total coastal production)	Est. 2,500 AFY (85% of total coastal production)	9, 10
Area Water Levels Below Sea Level	Not applicable; unsaturated locally	900 acres	>2,000 acres	9

[a] *Data Sources: 1.Todd Groundwater, 2015; 2.Padre, 2002; 3. HydroMetrics, 2006; 4. ASR Systems, 2005; 5. MPWMD, 2002; 6. Yates et al., 2005; 7. Fugro, 1998. 8. HydroMetrics, 2009; 9. Hydrometrics, 2013; 10. MPWMD, 2014.*

9.2.4. Older Dune Sands/Aromas Sand

The shallowest geologic deposits in the Injection Facilities area are composed of recent and older eolian sands and older continental deposits of Pleistocene age. This undifferentiated sequence is referred to herein as Older Dune Sands/ Aromas Sand or Aromas Sand. The unit has been described as also including fluvial and coastal terrace deposits, as well as flood-plain and other basin deposits (Yates, et al., 2005; HydroMetrics, 2009).

A
Southwest

A'
Northeast

Proposed
Injection Wells

DIW-1
VZW-1

ASR-1

MRWPCA
MW-1

FO-7

Aromas Sand

Paso Robles Formation

Dual Induction - GR Log

Older Dune Sands/
Aromas Sand

January 2014

Water Table

Potentiometric Surface
(Santa Margarita)

Paso Robles
Aquifer

Santa Margarita
Aquifer

Santa Margarita Sandstone

Monterey Formation

Electric Log

Monterey
Formation

Aromas/
Older Dune
Sand

SEA
LEVEL

Elevation (feet MSL)

500
400
300
200
100
-100
-200
-300
-400
-500
-600

4,500 4,200 3,900 3,600 3,300 3,000 2,700 2,400 2,100 1,800 1,500 1,200 900 600 300 0

Distance (feet)

Vertical Exaggeration 2.4x

Screen interval

Water levels from July/August 2014 contour maps in HydroMetrics, December 2014.
Water table in MRWPCA MW-1 measured by Todd Groundwater, January 2014.

November 2015

TODD GROUNDWATER

Figure 9-7
Cross Section A - A'
Subsurface Conditions near Proposed Injection Wells

The entire thickness of the Aromas Sand was cored in a boring for a recently-installed monitoring well by Todd Groundwater adjacent to the Injection Facilities area (see MRWPCA MW-1 on Figure 9-3). The unit was described on a geologic log and selected core samples were analyzed at various laboratories to evaluate lithology and mineralogy, porosity and permeability, infiltration rates, leaching potential, and other factors. Complete laboratory results are documented and analyzed in a separate report (**Appendix D**).

Geologic core descriptions from MRWPCA MW-1 indicate that the Aromas Sand is approximately 400 feet thick adjacent to the Injection Facilities area and is composed primarily of fine-grain sand (about 92% sand) with minor amounts of silt and clay. The upper 300 feet is the most homogeneous with generally higher permeability values. As shown on Table 9-1, the unit is associated with relatively high horizontal hydraulic conductivity (350 ft/day) and vertical hydraulic conductivity (70 ft/day) as estimated from laboratory core data.

The geologic unit is illustrated on the cross section on Figure 9-7 and ranges from about 225 feet at ASR-1 to about 400 feet thick at MRWPCA MW-1 and monitoring well FO-7. Also shown on the cross section are geophysical logs (Dual Induction-GR log and Electric logs) for three existing wells. These logs provide readings of electrical (resistivity) measurements throughout the borehole. Although the logs are provided for illustrative purposes only (without ohm-meter or other electrical scales), log curves show relatively high readings in the Aromas Sand (shaded in orange) [40], generally indicative of higher permeability sediments (and, in this case, unsaturated conditions). The Aromas Sand is unsaturated in the Injection Facilities area as illustrated by the water levels shown on the cross section (water table and potentiometric surface, Figure 9-7).

Also projected onto the cross section are schematic diagrams of two injection wells, including a vadose zone well (VZW-1) and a deep injection well (DIW-1) (Figure 9-7). Details of the injection wells, including preliminary designs, are provided in **Section 3.5**.

9.2.5. Paso Robles Aquifer

Beneath the Aromas Sand is the Paso Robles Formation (Figure 9-7). The formation is heterogeneous and contains interbeds of sand, silt, and clay mixtures (Yates et al., 2005). Silt and clay layers are characterized by a variety of colors including yellow-brown, reddish brown, whitish gray, and dark bluish gray, indicating a variety of depositional and geochemical environments. These continentally-derived deposits are discontinuous and difficult to correlate from well to well in the basin. The formation is expected to average approximately 240 feet thick in the Injection Facilities area. Beneath this area, the water table occurs in the upper portion of the aquifer (Figure 9-7). The top of the Paso Robles is anticipated to be encountered at an average depth of about 370 feet beneath the Injection Facilities area.

The heterogeneous nature of the aquifer in the Injection Facilities area is illustrated on the resistivity logs on Figure 9-7. As shown from the logs, resistivity readings (right of the depth columns) are highly variable throughout the Paso Robles Aquifer, indicating interbeds of varying thicknesses. The upper 50

[40] Logs were unavailable in the upper portions of ASR-1 and FO-7 due to shallow surface casings. Log in MRWPCA MW-1 is a cased-hole induction log. For all three logs, resistivity measurements are shown to the right of the depth column and increase to the right.

to 100 feet of the aquifer appear to contain a higher percentage of sand, indicating relatively higher permeability. These sands are screened in MRWPCA MW-1. Below the upper sand unit, the formation becomes more heterogeneous and generally more fine-grained. A lower, more permeable layer in the Paso Robles Aquifer is screened in FO-7 at about 600 feet deep (about -125 feet msl). Using an approximate sand/silt boundary indicator of 25 ohm-meters on the electric log of a nearby Paso Robles test well, the overall Paso Robles Aquifer is estimated to contain about 52% sand (Table 9-1).

The ability of an aquifer to transmit, store, and yield reasonable quantities of water is reflected in aquifer parameters including transmissivity (T), horizontal hydraulic conductivity (K or K_h), and storativity (S). These parameters for the Paso Robles Aquifer have been compiled and reviewed by previous investigators in the basin (Fugro, 1997; Yates et al., 2005; HydroMetrics, 2009). In the Injection Facilities area, representative aquifer parameters include a T value of about 659 ft^2/day to 1,524 ft^2/day, a K value of 20 ft/day and an S value of 0.12 (dimensionless), reflecting an effective porosity of 12%. These parameters for the Paso Robles Aquifer are listed in Table 9-1.

9.2.6. Santa Margarita Aquifer

The Santa Margarita Sandstone of Pliocene/Miocene age underlies the Paso Robles Aquifer throughout most of the Seaside Basin. The aquifer consists of a poorly-consolidated marine sandstone approximately 250 feet thick in the Northern Coastal subarea of the basin. The unit has apparently been eroded near the southern basin boundary due to uplift from folding and faulting along the Seaside and Chupines faults (Yates et al., 2005).

The Miocene/Pliocene Purisima Formation overlies the Santa Margarita Sandstone in some areas. This unit has been described in more detail along the coast and has been grouped with the Santa Margarita Aquifer in Layer 5 of the basin groundwater model (HydroMetrics, 2009). The Purisima Formation is difficult to delineate using subsurface data and is either thin or not present beneath the Injection Facilities area.

The Santa Margarita Aquifer is shown on the cross section on Figure 9-7. The more homogeneous nature of the Santa Margarita Aquifer is illustrated on the geophysical logs for ASR-1 and FO-7. The aquifer is approximately 280 feet thick in the Injection Facilities area and contains about 74% sand (with the remainder containing sandy silt and minor clay). The aquifer is about 600 feet deep in the Injection Facilities area as indicated on Figure 9-7.

A review of Santa Margarita Aquifer parameters near the Injection Facilities area and in adjacent coastal areas indicated an average T value of 11,377 ft^2/day (Fugro, 1997; Padre, 2002). More recent aquifer tests in ASR-1 indicated a similar, but slightly higher, T value of 13,947 ft^2/day (Padre, 2002). The Watermaster Model has a T value of about 24,000 ft^2/day in the Injection Facilities area.

S values have been estimated at 0.0018 and 0.00258 (dimensionless) for the Santa Margarita Aquifer, indicating semi-confined to confined conditions. The confined nature of the aquifer suggests that groundwater replenishment can raise water levels more quickly and to higher levels than an equivalent amount of recharge in an unconfined aquifer. Parameters for the Santa Margarita Aquifer are summarized in Table 9-1.

9.2.7. Water Levels and Groundwater Flow Directions

Water levels have been monitored in the Seaside Basin for at least 25 years. These data document the decline of water levels from the mid-1990s into the 2000s with a recent partial recovery of water levels in some areas since the adjudication of the basin. In general, changes in water levels have occurred in response to changes in groundwater production and ASR operation. Long-term water level trends and fluctuations are indicated by three hydrographs presented on Figures 9-8 (PCA-West well) and 9-9 (wells FO-7 and Paralta Test Well). These well locations can be found on Figure 9-10. PCA-West is a cluster of two monitoring wells (one in each aquifer) located just west of Highway 1 in the central portion of the Northern Coastal Subarea. FO-7 is also a cluster of two monitoring wells located on Eucalyptus Blvd. on the eastern edge of the map on Figure 9-10. The Paralta Test Well is a monitoring well adjacent to the Paralta production well, located near the intersection of Coe Avenue and General Jim Moore Blvd. on Figure 9-10.

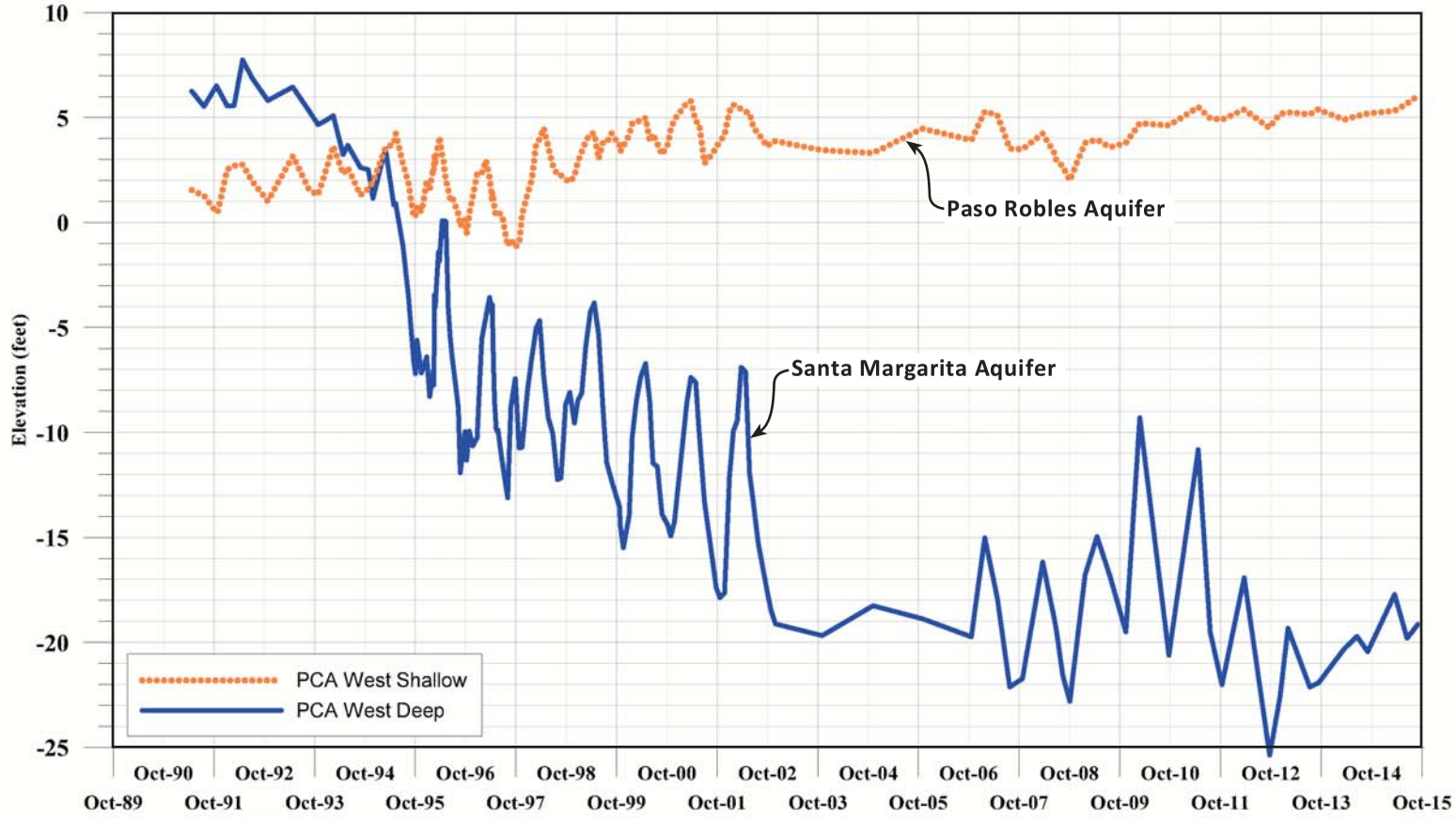
Figure 9-8 shows a long-term hydrograph of a well in the Northern Coastal Subarea, the PCA West well, to illustrate water level trends and fluctuations since 1989 in coastal areas of the basin. The curve highlighted in orange on Figure 9-9 represents water levels in the Paso Robles Aquifer and the lower curve represents water levels in the Santa Margarita Aquifer. Figure 9-9 shows hydrographs in two monitoring wells close to the Injection Facilities area, FO-7 and Paralta Test Well (located adjacent to the Paralta production well). Note that data for these wells are displayed from 1994 to 2013, a shorter time interval than shown for the PCA West Well on Figure 9-8. Similar to the PCA West well, FO-7 also consists of two monitoring points: a shallow well screened in the Paso Robles Aquifer, and a deep well screened in the Santa Margarita Aquifer. The Paralta Test well is screened in both aquifers and represents average water levels, although most of the water appears to be coming from the Santa Margarita Aquifer.

Seasonal fluctuations are readily seen on all of the hydrographs, resulting from changes in pumping throughout the basin. For the Paso Robles Aquifer, seasonal fluctuations of about 3 to 5 feet per year are typical with the highest water levels in the spring and lower water levels in the fall (Figures 9-8 and 9-9). Fluctuations are more pronounced in the Santa Margarita Aquifer and vary from about 6 to 15 feet per year in the PCA West well (Figure 9-8) and in monitoring well FO-7 (top of Figure 9-9). The Paralta Test Well (bottom of Figure 9-9) is adjacent to large pumping centers and indicates much large seasonal fluctuations up to about 20 to 30 feet.

Prior to groundwater development, groundwater flow directions were generally from inland areas toward the coast. Currently, groundwater flow patterns are controlled by local groundwater pumping and subarea pumping depressions. In addition, groundwater flow patterns are altered near certain subarea boundaries where geologic faulting and other discontinuities have compartmentalized groundwater. In particular, the boundary between northern and southern subareas appears to impede groundwater flow.

The Santa Margarita Aquifer is semi-confined by low permeability units in the basal sediments of the Paso Robles Aquifer. Although some leakage occurs, water levels are different in the two aquifers. Differences are less near wells that are pumping from both aquifers.

Water level contour maps for July/August 2014 are presented for the Paso Robles Aquifer and the Santa Margarita Aquifer on Figures 9-10 and 9-11, respectively. Hydrographs, water levels, and groundwater flow for each of aquifers are discussed in more detail below.



MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

PCA West (Deep) (15S/1E-15F2)

Screened from 825-875 in the Santa Margarita Sandstone (Tsm)
Wellhead Elevation 65.18 MSL
DWR Driller Log No. 338401
Datasource: MPWMD

PCA West (Shallow) (15S/1E-15F1)

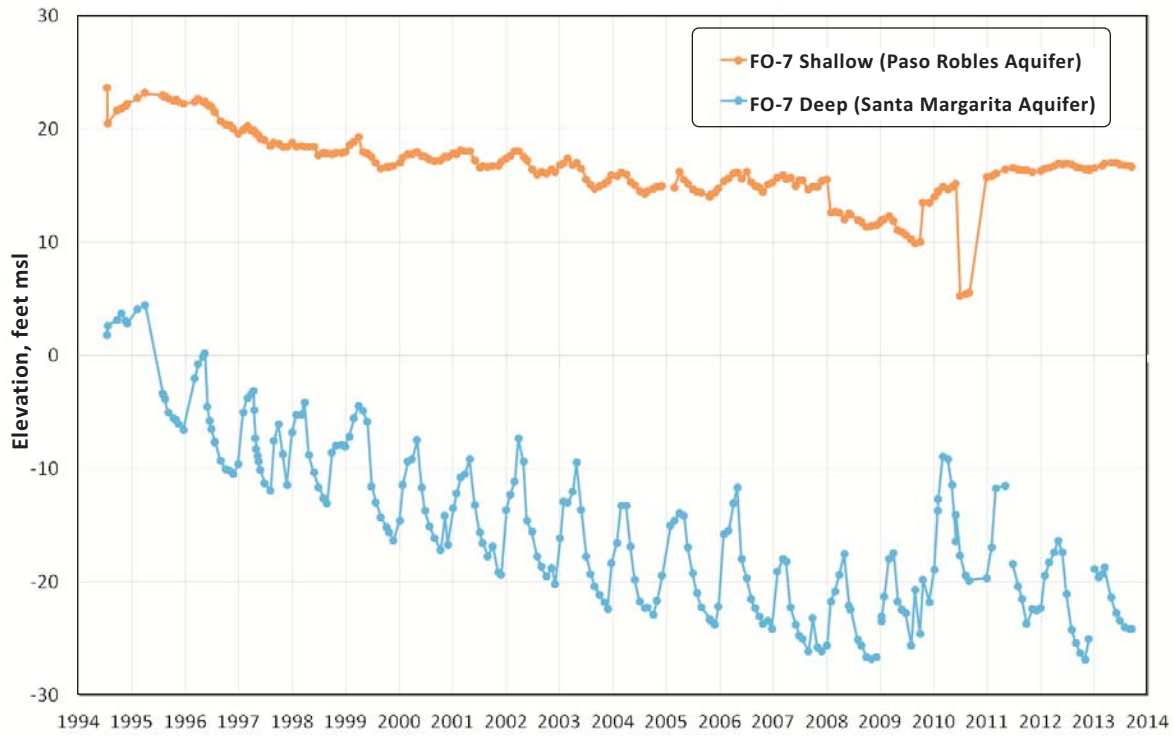
Screened from 525-575 in the Paso Robles Formation (QTp)
Wellhead Elevation 64.22 MSL
DWR Driller Log No. 338400
Datasource: MPWMD

November 2015

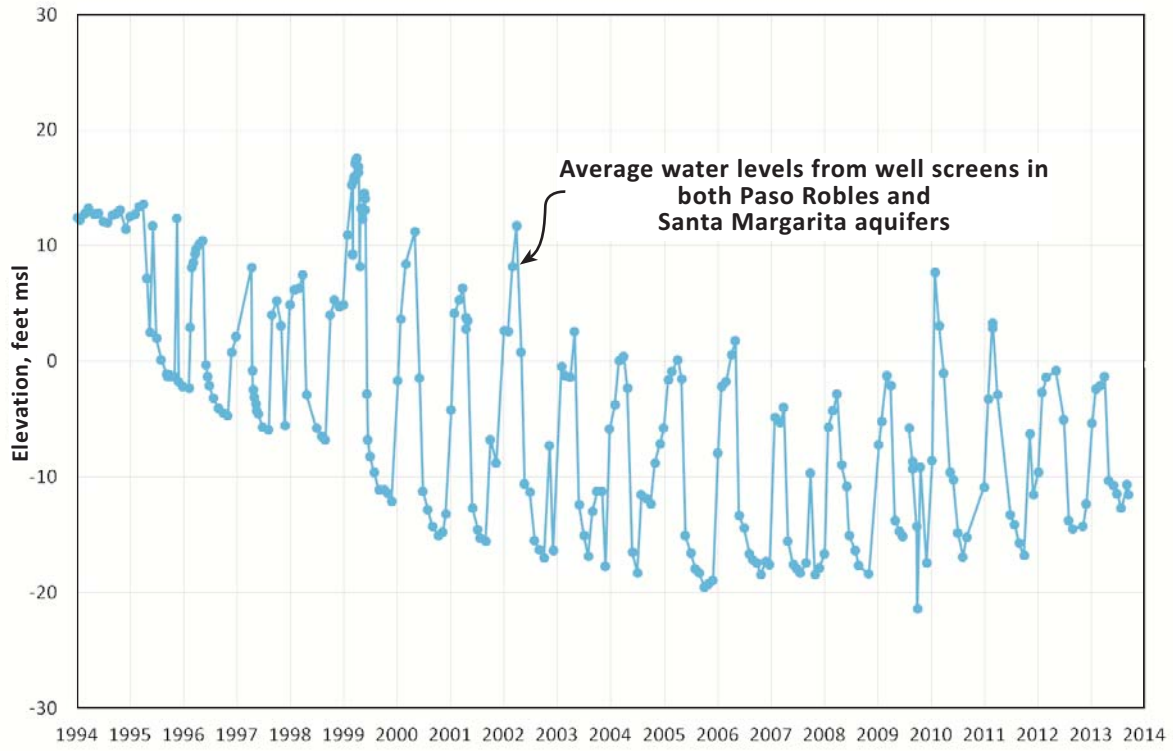
TODD GROUNDWATER

Figure 9-8
Long-term Hydrograph Northern Coastal Subarea

Water Levels in F0-7



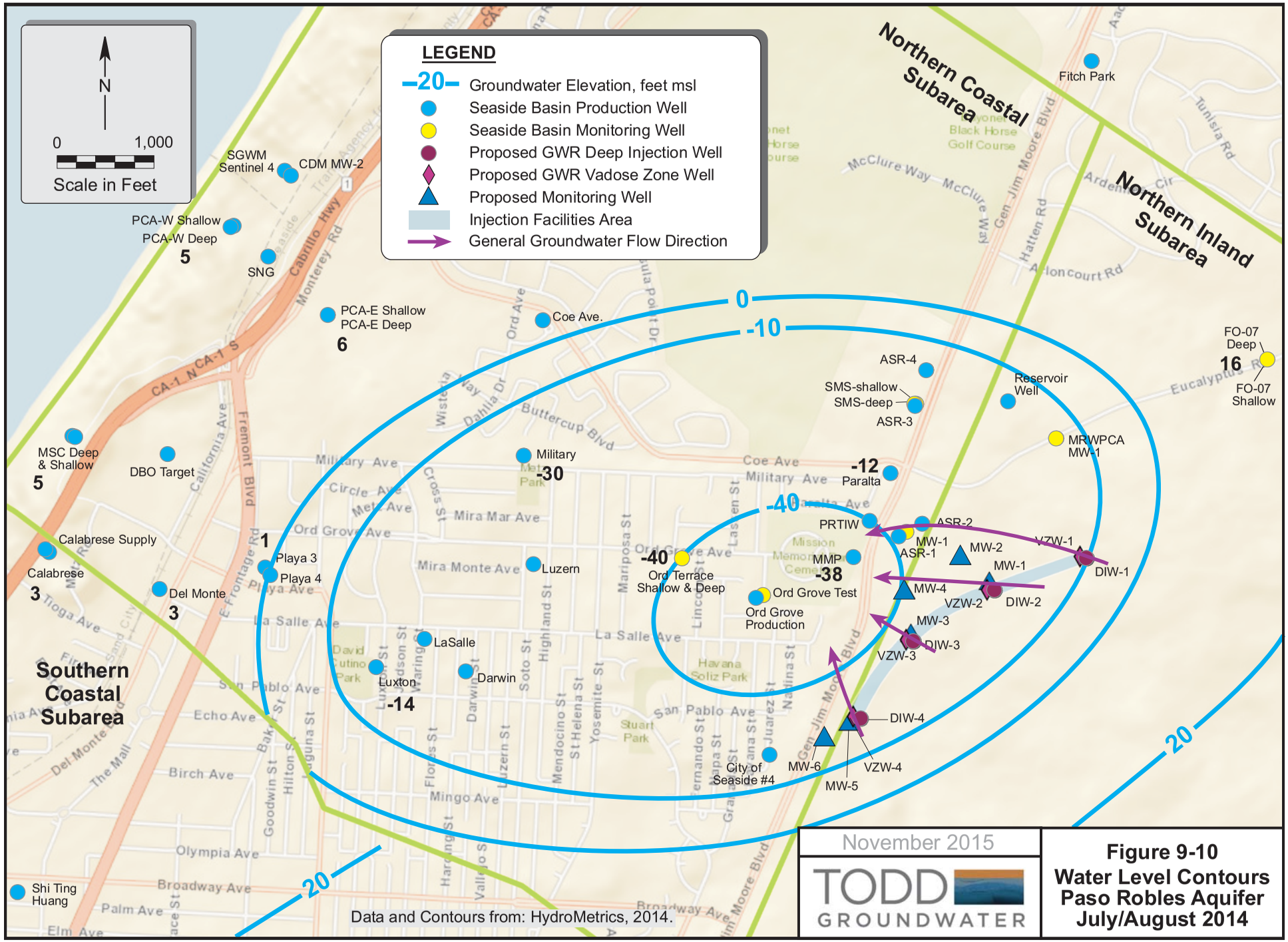
Water Levels in Paralta Test Well

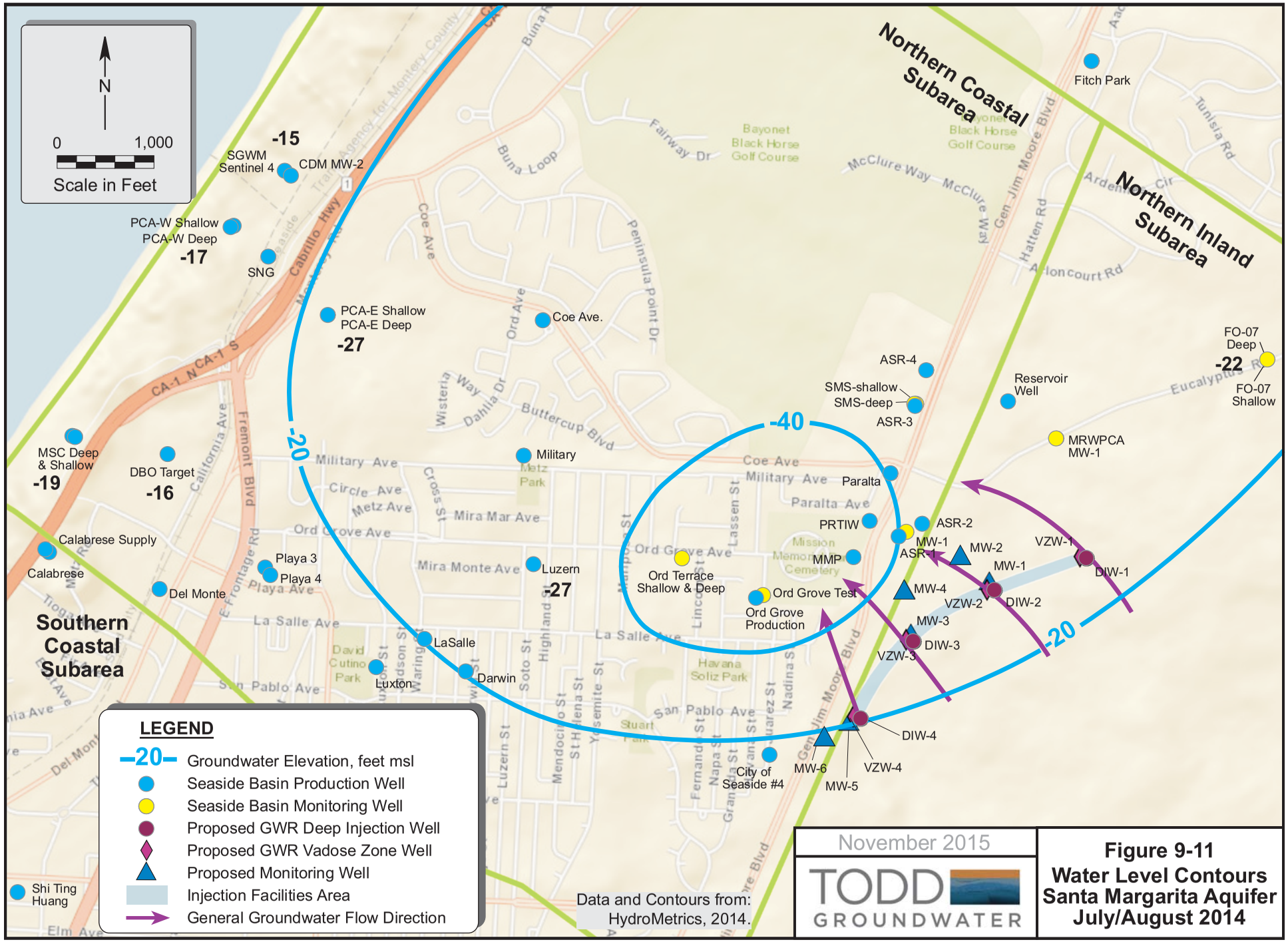


November 2015

TODD GROUNDWATER

Figure 9-9
Hydrographs near Injection Facilities Area


N
0
1,000
Scale in Feet
LEGEND
-20- Groundwater Elevation, feet msl
Seaside Basin Production Well
Seaside Basin Monitoring Well
Proposed GWR Deep Injection Well
Proposed GWR Vadose Zone Well
Proposed Monitoring Well
Injection Facilities Area
General Groundwater Flow Direction
Northern Coastal Subarea
Northern Inland Subarea
Southern Coastal Subarea
0
-10
-20
-30
-40
-12
-14
SGWM Sentinel 4
CDM MW-2
PCA-W Shallow
PCA-W Deep
5
SNG
PCA-E Shallow
PCA-E Deep
6
Coe Ave.
MSC Deep & Shallow
5
DBO Target
Calabrese Supply
Calabrese
3
Del Monte
3
Playa 3
Playa 4
1
Military
Luzern
LaSalle
Darwin
Luxton
Ord Terrace Shallow & Deep
Ord Grove Test
Ord Grove Production
PRTIW
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
Paralta
MRWPCA MW-1
ASR-2
ASR-1
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MMP
-38
VZW-1
VZW-2
VZW-3
VZW-4
DIW-1
DIW-2
DIW-3
DIW-4
City of Seaside #4
Fitch Park
FO-07 Deep
16
FO-07 Shallow
Shi Ting Huang
Data and Contours from: HydroMetrics, 2014.
November 2015
TODD GROUNDWATER
Figure 9-10
Water Level Contours
Paso Robles Aquifer
July/August 2014


N
0
1,000
Scale in Feet
Northern Coastal Subarea
Northern Inland Subarea
Southern Coastal Subarea
-15
SGWM Sentinel 4
CDM MW-2
PCA-W Shallow
PCA-W Deep
-17
SNG
PCA-E Shallow
PCA-E Deep
-27
Coe Ave.
-20
-40
-22
FO-07 Deep
FO-07 Shallow
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
MRWPCA MW-1
MSC Deep & Shallow
-19
DBO Target
-16
Military
Paralta
PRTIW
ASR-2
ASR-1
MW-1
MW-2
VZW-1
DIW-1
MW-1
MW-4
VZW-2
DIW-2
MW-3
DIW-3
VZW-3
MMP
Ord Terrace Shallow & Deep
Ord Grove Test
Ord Grove Production
Calabrese Supply
Calabrese
Del Monte
Playa 3
Playa 4
Luzern
-27
LaSalle
Darwin
Luxton
Fitch Park
Bayonet Black Horse Golf Course
Buna Loop
Fairway Dr
McClure Way
Coe Ave
Peninsula Point Dr
Ord Ave
Wisteria Way
Dahlia Dr
Buttercup Blvd
Military Ave
Circle Ave
Metz Ave
Cross St
Mira Mar Ave
Ord Grove Ave
Mira Monte Ave
Playa Ave
La Salle Ave
San Pablo Ave
Paralta Ave
Coe Ave
Lassen St
Lincoln St
Highland St
Soto St
Madison St
Maryal Dr
Luzern St
Mendocino St
St Helena St
Yosemite St
Fernando St
Napa St
Grant St
Suarez St
Nadina St
Gen Jim Moore Blvd
Hatten Rd
Ardenwood Cir
Tunisia Rd
Eucalyptus Rd
Aaronson Rd
Ardencourt Rd
Cabrillo Hwy
CA-1 N
CA-1 S
California Ave
Fremont Blvd
E Frontage Rd
Del Monte Ave
Elm Ave
David Cutino Park
Metz Park
Havana Soliz Park
Stuart Park
Mission Memorial Park Cemetery
City of Seaside #4
MW-6
MW-5
VZW-4
DIW-4
Shi Ting Huang
LEGEND
-20- Groundwater Elevation, feet msl
Seaside Basin Production Well
Seaside Basin Monitoring Well
Proposed GWR Deep Injection Well
Proposed GWR Vadose Zone Well
Proposed Monitoring Well
Injection Facilities Area
General Groundwater Flow Direction
Data and Contours from:
HydroMetrics, 2014.
November 2015
TODD GROUNDWATER
Figure 9-11
Water Level Contours
Santa Margarita Aquifer
July/August 2014

9.2.7.1. Water Levels and Groundwater Flow in the Paso Robles Aquifer

As shown on Figure 9-8, water levels in the Paso Robles Aquifer (PCA West – Shallow) have fluctuated between about minus 1 foot below msl to about 7 feet above msl over the last 24 years. Water levels declined below sea level in the mid-1990s in response to increases in groundwater production. Most of the subsequent groundwater production occurred in the deeper Santa Margarita Aquifer and water levels in the Paso Robles Aquifer rose near the coast. Since that time, water levels in the PCA well have stabilized at about two to seven feet above msl. Water levels in FO-7 (orange curve on top graph on Figure 9-9) illustrate water table conditions about 3,000 feet north of the Injection Facilities. Since 1994, the water table in FO-7 has declined from elevations above 20 feet msl in the mid-1990s to about 15 feet msl and have averaged 14.5 feet since 2006 (Figure 9-9). This decline is consistent with downgradient pumping in both aquifers that has created a localized pumping depression in the Northern Coastal Subarea.

Groundwater occurs as unconfined in the Paso Robles Aquifer and represents the water table throughout most of the northern subareas. Figure 9-10 shows a water level contour map for summer 2014 and indicates that water levels in the Paso Robles Aquifer are below sea level over much of the Northern Coastal Subarea and beneath the Injection Facilities area. A large pumping depression is indicated by the closed contour of 0 feet msl (sea level) on the water level contour map (contours from HydroMetrics, 2014b). This map, representing water levels measured in July and August 2014, shows water levels below msl covering an area of almost 1,000 acres (also covering about one-half of the Northern Coastal Subarea).

Groundwater flow in both the Northern Coastal and Northern Inland subareas is controlled by the depression. Shallow groundwater beneath the Injection Facilities area flows west/northwest toward the center of the depression where water levels are lower than - 40 feet below msl (see flow arrows on Figure 9-10). The anonymously low water level of -161 feet posted for the Ord Grove production well likely indicates local pumping impacts and is not representative of the local water levels in the aquifer. Based on the groundwater contours shown on Figure 9-10, hydraulic gradients in the vicinity of the Injection Facilities area are estimated at 0.025 feet/feet in the Paso Robles Aquifer.

Previous water level contour maps indicate that water levels have been relatively stable over the past year. Similar water level contour maps for the Paso Robles Aquifer during January/March 2014 and July/August 2013 are shown on the tops of Figures 9-12 and 9-13, respectively. For July/August 2013, a different scale allows for a more basin-wide view of water levels.

9.2.7.1. Water Levels and Groundwater Flow in the Santa Margarita Aquifer

Water levels have declined in the Santa Margarita Aquifer at a much faster rate than in the Paso Robles Aquifer. As shown on Figure 9-8, the potentiometric surface of the Santa Margarita Aquifer indicates a long-term decline in the PCA West (Deep) well since the mid-1990s with only seasonal recovery. In general, the rate of decline has been less since about 2006 as a result of the adjudication of the Seaside Basin and subsequent changes in pumping rates. Nonetheless, water levels have remained below sea level in the coastal PCA West (Deep) well since 1995, increasing the risk of seawater intrusion. The high rate of decline is likely related to both the increase in Santa Margarita Aquifer pumping as well as the lower S value of the semi-confined aquifer.

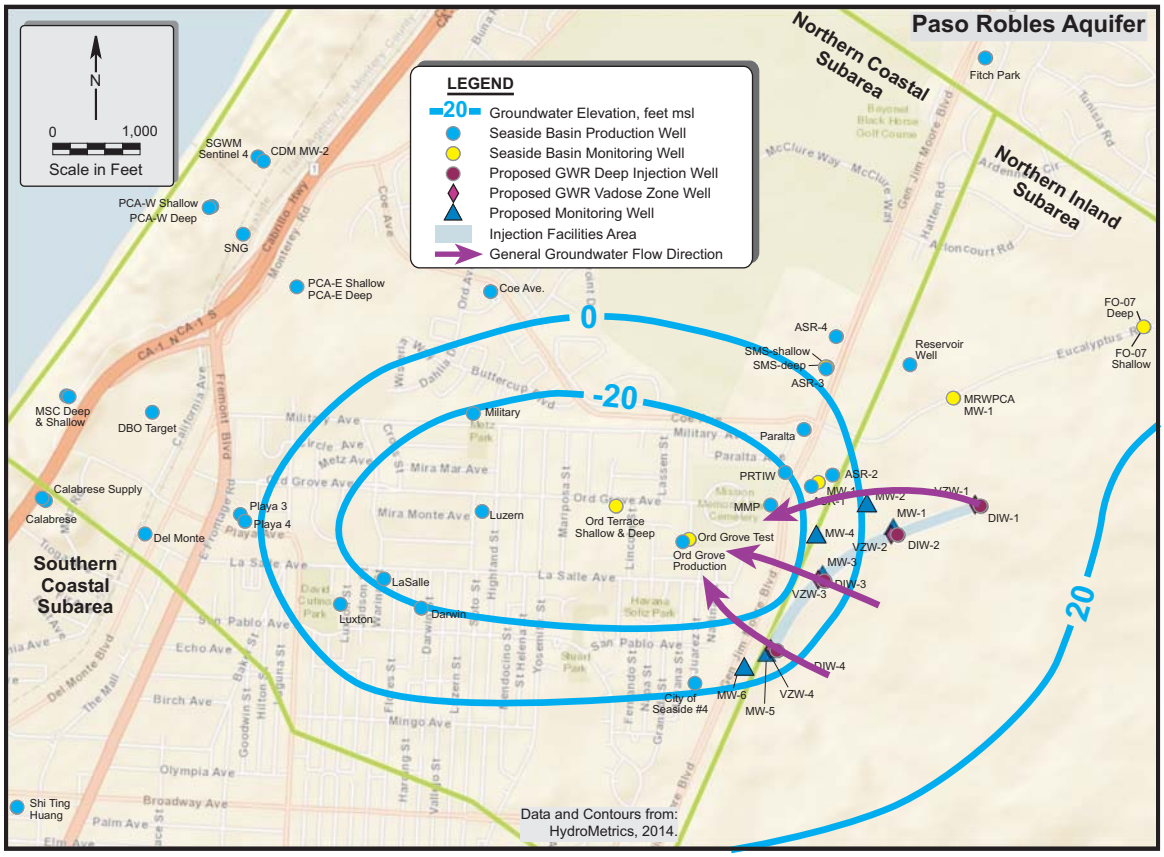
Figure 9-9 shows similar trends and fluctuations on two hydrographs from Santa Margarita wells closer to the Injection Facilities area (FO-7 is about 3,000 feet north and Paralta Test Well is about 1,300 feet to the northwest, see Figure 9-11 for well locations). Water levels in the Paralta Test Well are generally higher than in FO-7 (Deep), likely due to the well screens installed in both the Paso Robles and the Santa Margarita aquifers. Although the trends and fluctuations are more similar to the Santa Margarita water levels, the contribution from the Paso Robles Aquifer results in higher water levels overall. Water levels in the Paralta Test Well show greater seasonal fluctuations than observed in FO-7 due to its proximity to large pumping wells including the adjacent Paralta production well and nearby ASR wells.

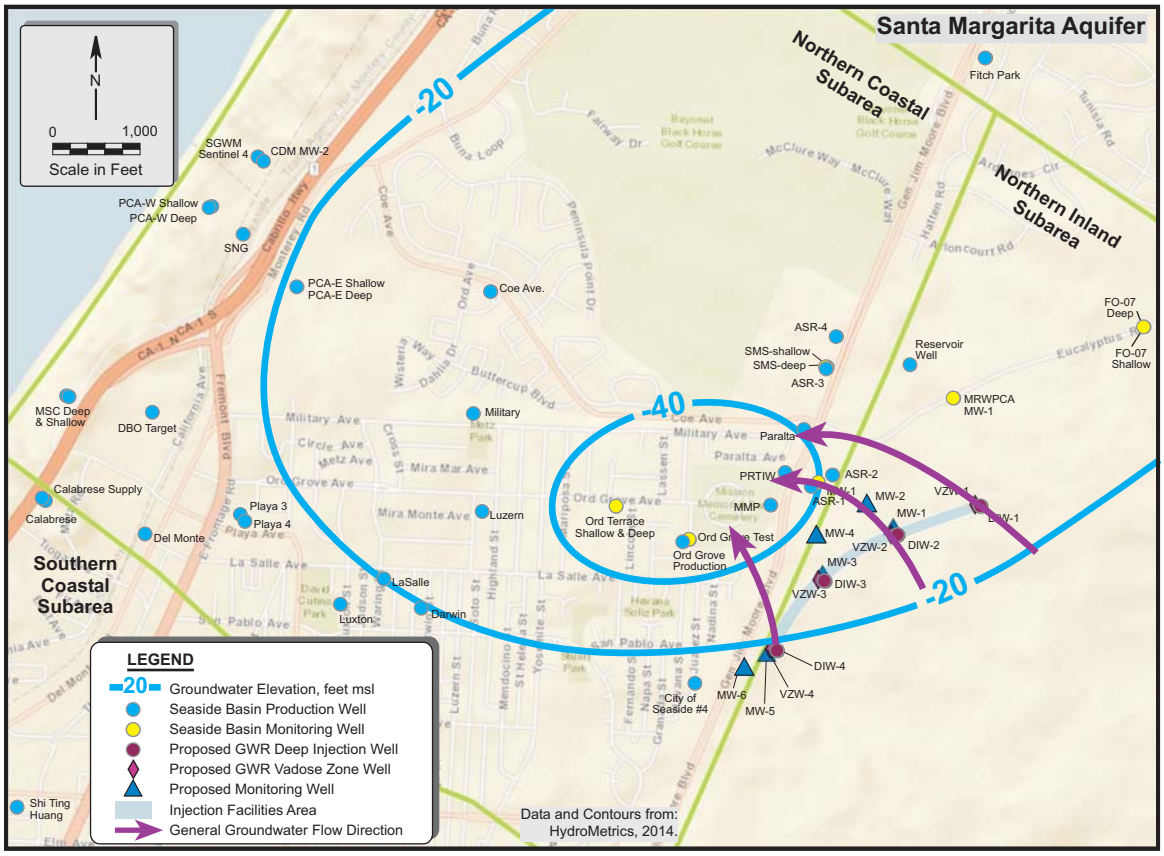
Figure 9-11 shows the widespread area of water level declines on a recent water level contour map for the Santa Margarita Aquifer (contours from HydroMetrics, 2014b). The map shows that water levels are below msl over almost all of the Northern Coastal Subarea and a portion of the Northern Inland Subarea. The lowest water levels are below -40 feet msl, similar to the low levels in the Paso Robles Aquifer (Figure 9-10). Water levels beneath the Injection Facilities area range from about -20 feet msl to about -30 feet msl.

The water level contour map also indicates that the pumping depression extends beyond the northern basin boundary but does not extend into the Southern Coastal subarea. Similar to conditions in the Paso Robles Aquifer, groundwater in the Santa Margarita Aquifer in the Southern Coastal Subarea appears to be compartmentalized by geologic faulting and relatively unaffected by pumping to the north.

Beneath the Injection Facilities area, groundwater flows west/northwest (see arrows on Figure 9-11). Flow directions are similar to groundwater flow directions in the Paso Robles Aquifer, but exhibit a slightly more northerly trajectory due to the additional pumping in the Santa Margarita Aquifer in the Paralta, ASR-3, and ASR-4 wells north of the Injection Facilities. The potentiometric surface for the Santa Margarita Aquifer is slightly lower than the water table in this area (typically about 5 to 10 feet), resulting in a downward vertical gradient. The average horizontal hydraulic gradient between the Injection Facilities area and the center of the pumping depression is estimated at 0.017 feet/feet to the west-northwest.

Previous water level contour maps over the past year indicate similar groundwater levels and flow directions. Water level contour maps for the Santa Margarita Aquifer during January/March 2014 and July/August 2013 are shown on the bottom graphs of Figures 9-12 and 9-13, respectively. For July/August 2013, a different scale allows for a more basin-wide view of water levels.

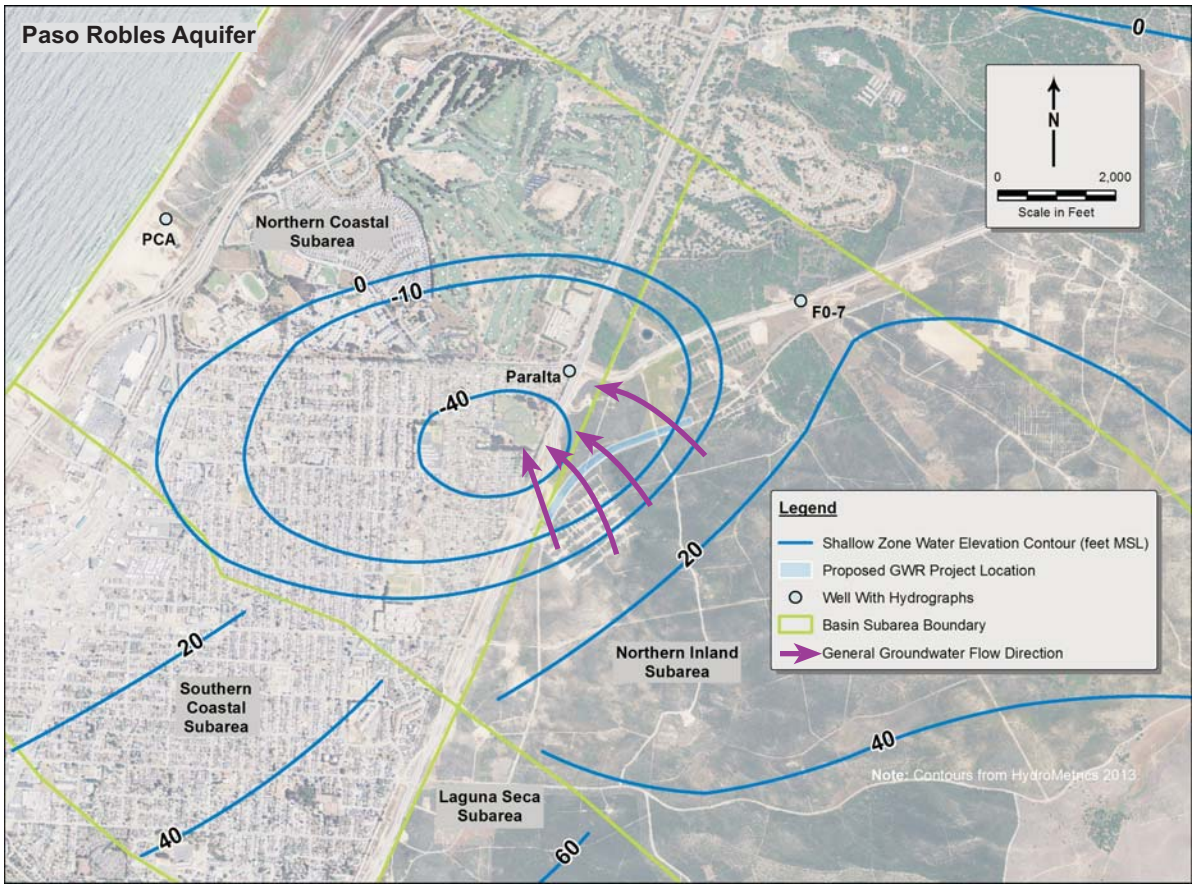


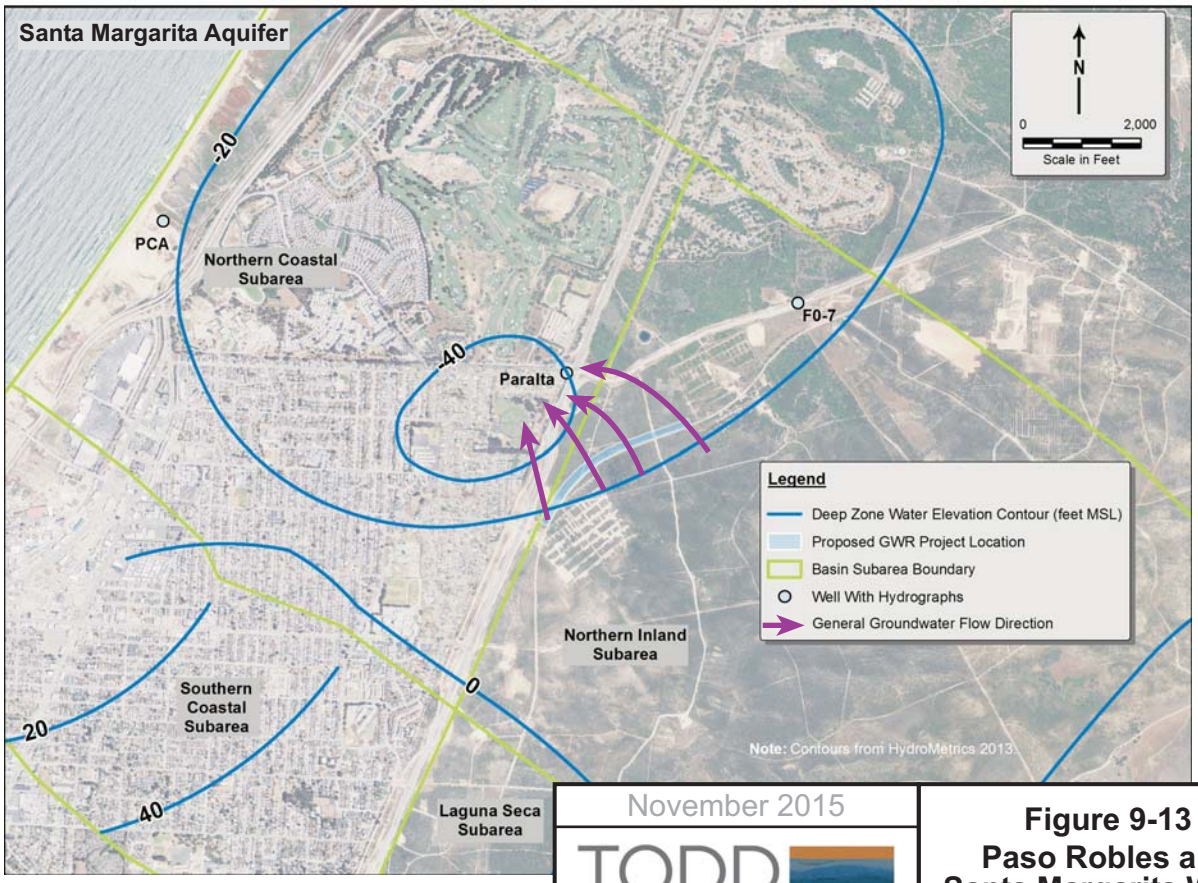


November 2015

TODD GROUNDWATER

Figure 9-12
Water Level Contours
Santa Margarita Aquifer
and Paso Robles Aquifer
January/March 2014





November 2015

TODD GROUNDWATER

Figure 9-13
Paso Robles and Santa Margarita Water Levels July/August 2013

9.3. GROUNDWATER BUDGET

Conceptually, the groundwater budget for the Seaside Basin is controlled primarily by surface recharge of the aquifer systems (and vertical leakage between aquifers), pumping from the aquifers, and subsurface inflows and outflows across subarea/basin boundaries. Additional smaller components of the groundwater budget have also been documented. Quantitative assessments of the various inflows and outflows were estimated by Yates (et al., 2005) and developed further by HydroMetrics (2009) for the construction of the Watermaster Model. In preparation of the SNMP for MPWMD, HydroMetrics incorporated additional groundwater budget components for the Seaside Basin and updated basin outflows including pumping (HydroMetrics, 2014a). Inflows and outflows from the SNMP groundwater budget are discussed below. The Seaside Basin groundwater budget is summarized at the end of the discussion in Table 9-2.

9.3.1. Inflows

The primary inflows into the groundwater basin considered in the MPWMD SNMP are listed below:

- Deep percolation of rainfall.
- Subsurface inflow from adjacent onshore areas.
- Subsurface inflow from offshore areas (where coastal water levels are below sea level).
- Imported water recharged into the basin (including ASR).
- Losses from water distribution systems.
- Losses from sewer system.
- Septic system return flows (primarily Laguna Seca Subarea).
- Irrigation return flows (landscaping and golf courses).
- Infiltration from stormwater ponds (coastal subareas).

The Paso Robles Aquifer is recharged primarily from surface infiltration of precipitation, as wells as surficial inflow from additional sources listed above (HydroMetrics, 2009). The primary area of recharge occurs in the eastern portion of the basin where the Paso Robles formation crops out at the surface, allowing rainfall to infiltrate directly into the aquifer units (Yates, et al., 2005). In the Injection Facilities area, recharge occurs by percolation through the surficial deposits of the Aromas Sand. In these undeveloped areas of the Northern Inland Subarea, inflows other than from rainfall are insignificant.

Most of the recharge to the Santa Margarita Aquifer is assumed to occur by leakage from the overlying Paso Robles Formation, especially in areas where the lower Paso Robles is relatively permeable (Yates, et al., 2005; HydroMetrics, 2009). Recharge also enters the Santa Margarita Aquifer from subsurface inflow from other subareas and north of the basin boundary. Although the Santa Margarita crops out east of the Seaside Groundwater Basin, recharge occurring in the outcrop area has been interpreted to flow with groundwater toward the Salinas Valley away from the Seaside Groundwater Basin.

9.3.2. Outflows

The primary outflows from the groundwater basin are listed below:

- Groundwater pumping.
- Subsurface outflow to onshore areas.
- Subsurface outflow to offshore areas.

The groundwater budget presented in the 2014 SNMP is reproduced in Table 9-2 below. The budget combines annual averages from selected recent time periods with the most representative data for each component. Almost all of the inflows represent average annual data from 2008 – 2012. Subsurface inflows and outflows were averaged from 2003 – 2007. Pumping (including ASR wells) and system losses are average annual amounts from 2011 - 2012.

Table 9-2: Seaside Basin Groundwater Budget

Water Balance Component	Northern Coastal	Northern Inland	Southern Coastal	Laguna Seca	Basin Total
INFLOWS (AFY)					
Precipitation	78	1,450	30	700	2,258
Groundwater Underflow					
From Onshore	2,850	0	450	180	180[a]
From Offshore	100	0	0	0	100
ASR Wells (Injection)	625	0	0	0	625
Water Distribution System Losses	411	0	21	46	478
Sewer Distribution System Losses	77	0	9	19	105
Septic Systems	0	0	5	22	27
Irrigation Infiltration					
Golf Courses	85	0	0	88	173
Landscaping	461	0	52	114	627
Recycled Water Irrigation	0	0	0	9	9
Storm Water	68	0	37	0	105
Total Inflow	***4,754***	***1,450***	***604***	***1,177***	***7,985***
OUTFLOWS (AFY)					
Groundwater Pumping	4,278	0	227	869	5,374
Groundwater Underflow					
To Onshore	0	2,060	790	450	N/A[a]
To Offshore	70	0	30	0	100
Total Outflow	***4,348***	***2,060***	***1,047***	***1,319***	***8,774***
Storage Change (Inflow – Outflow)	**406**	**-610**	**-443**	**-142**	**-789**

a. Values represent subsurface movement among subareas; basin total represents net value rather than a sum of the subareas.
Source: HydroMetrics, 2014a.

9.4. GROUNDWATER QUALITY

Groundwater in both the Paso Robles and Santa Margarita aquifers is used for drinking water supply and generally meets drinking water quality standards including primary MCLs. Elevated concentrations of manganese and hydrogen sulfide have been identified as exceeding secondary MCLs in some Santa Margarita Aquifer wells (Jones & Stokes, 2006). Groundwater chemistry varies throughout the basin and also varies between aquifer systems (HydroMetrics, 2014a). For the Project, the groundwater quality characterization focuses on the Northern Inland and Northern Coastal subareas. In these areas, groundwater is characterized as a sodium-bicarbonate type water. In general, mineral content and salinity, represented by TDS and chloride, are higher in the Santa Margarita Aquifer than in the Paso Robles Aquifer.

Groundwater quality data are available from several monitoring programs. Over the last 25 years, MPWMD has installed and sampled monitoring wells throughout the basin. The Seaside Basin Watermaster, through a cooperative agreement with MPWMD, conducts water quality monitoring with a focus on coastal wells and data needed for an annual analysis of potential sea water intrusion. In addition, MPWMD conducts a separate water quality monitoring program for the ASR Project as documented in the DDW-approved Sampling and Analysis Plan (Pueblo Water Resources, December 2012). Samples for this program include both local groundwater and injectate imported from the Carmel River basin. Finally, as part of its drinking water permit, CalAm monitors water quality from drinking water wells and its water distribution system. Except for the CalAm monitoring, other programs do not routinely monitor groundwater for constituents included in drinking water analyses as provided in CCR Title 22. None of the programs include all constituents required for monitoring a GRRP.

Data from these monitoring programs have been supplemented with analyses from six wells in the vicinity of the Injection Facilities area, which were sampled in January/February 2014. This sampling event was part of a field program conducted by MRWPCA to support the Project. Samples were analyzed for an expanded list of more than 275 separate constituents and parameters including those required by the Title 22 Criteria for groundwater replenishment. Additional analyses were included to investigate the potential presence of constituents of concern from former Fort Ord activities and to support hydrogeologic and geochemical evaluations. Additional details from the MRWPCA field program are presented more fully in a separate report, attached as **Appendix I** (Todd Groundwater, 2015b).

To provide some indication of future water quality for the product water, Trussell Technologies prepared a stabilized bench-scale sample of RO permeate from the pilot treatment facility. Although this sample does not reflect all of the source waters that will be part of the Project, the sample provides a useful surrogate to compare to groundwater quality and to support an analysis of potential impacts from the Project (**Section 11**).

9.4.1. Data Sources

In 2013, groundwater quality data were compiled from the monitoring programs described above to support the EIR for the Project. MPWMD provided an electronic database in Access© format that included groundwater quality data dating back to 1990. Data from 14 wells located relatively close to the Injection Facilities area were incorporated in the water quality characterization. CalAm provided groundwater quality data from eight nearby production wells in Excel© format from 2010 through 2013. These data were combined into a project database with data from the 2014 MRWPCA field program. The types of analyses, time periods, and formats for the groundwater quality data are summarized in Table 9-3.

Table 9-3: Source of Groundwater Quality Data

Water Quality Database	Data Source		
	MPWMD	Cal-Am	MRWPCA
# Wells	14	8	6
Time Period	1990-2012	2010 - 2013	2014
Anions	x	x	x
Metals (including major cations)	x	x	x
Conventional Chemistry Parameters	x	x	x
Chlorinated Pesticides and PCBs	x	x	x
Nitrogen and Phosphorus Pesticides	x	x	x
Organic Analytes[a]	x	x	x
Chlorinated Acids	x	x	x
Carbamates[b]		x	x
Volatile Organic Compounds (VOCs)	x	x	x
Semivolatile Organic Compounds		x	x
Haloacetic Acids		x	x
Herbicides		x	x
Nitroaromatics and Nitramines (Explosives)			x
Other (e.g., isotopes)			x

a. Organic Analytes – including 1,2-Dibromo-3-chloropropane, 1,2-Dibromoethane (EDB), diquat, endothall, glyphosate.

b. Carbamates – organic compounds derived from carbamic acids.

As indicated in the table above, the MRWPCA field program expanded the list of available analytes for six wells surrounding the Injection Facilities area, providing groundwater quality data for both the Paso Robles and the Santa Margarita aquifers. In addition, these analyses provide the only water quality data available for several wells, including an upgradient monitoring well for each aquifer (FO-7 shallow and FO-7 Deep) and a newly-installed monitoring well, MRWPCA MW-1, located about 1,200 feet north of the Injection Facilities area on Eucalyptus Road (see Figure 9-3). The wells sampled during the MRWPCA field program are summarized in Table 9-4 as follows.

Table 9-4: Wells Sampled in MRWPCA Field Program

Well[a]	Well Type	Screened Aquifer	Well Depth (feet, bgs)	Screen Interval (feet, bgs)[b]
MRWPCA MW-1	Monitoring	Paso Robles	521	421 - 446; 466 - 516
FO-7 Shallow	Monitoring	Paso Robles	650	600 - 640
FO-7 Deep	Monitoring	Santa Margarita	850	800 - 840
PRTIW	Irrigation	Paso Robles	460	345 - 445
ASR MW-1	Monitoring	Santa Margarita	740	480 - 590; 610 - 700
Seaside Muni 4	Production	Santa Margarita	560	330 - 350; 380 - 420; 430 - 470; 490 - 550

a. All wells sampled January/February 2014.

b. bgs = below ground surface.

Laboratory analyses of groundwater samples collected at these six wells are presented in **Appendix I**.

9.4.2. Pilot Water Quality

Trussell Technologies, Inc. (Williams, et al., 2014) provided an advanced treated recycled water sample to Todd Groundwater in support of the MRWPCA field program. The sample was developed to represent the product water quality for comparison to groundwater quality and to support geochemical modeling. The sample of RO permeate was collected from the MRWPCA pilot advanced water treatment plant. Trussell Technologies stabilized the RO permeate using a bench-scale post-treatment stabilization unit to better approximate the water quality anticipated for the product water from the proposed AWT Facility.

To develop the bench-scale water sample, Trussell Technologies conducted several stabilization steps to mimic goals established for the OCWD's GWRS, a similar project that uses advanced treatment to meet regulatory requirements. The first chemical stabilization step involved the addition of $CaCl_2$ and NaOH to increase alkalinity. Then, CO_2 gas was bubbled into the sample to decrease the pH to a target goal. This process produced approximately 32 L of product water for incorporation into the field program analyses.

The sample – referred to herein as stabilized pilot water sample – closely represents the final product water quality for the purposes of the field program objectives. The primary objective was to use representative recycled water samples to conduct laboratory leaching tests on vadose zone cores. These data have supported geochemical modeling (summarized in **Section 11**). Details of the leaching tests and geochemical modeling results are presented in a separate report on the field program, attached to this report as **Appendix I** (Todd Groundwater, 2015b).

The stabilized pilot water sample was analyzed for general minerals, physical characteristics, and metals by McCampbell Analytical Laboratory. The analytical methods and sample results are presented in Table 9-5.

Table 9-5: Stabilized Pilot Water Analysis

Analyte	Method	Units	MRL	Results	MCL or NL	Basin Plan Objective or Guideline[e]
Inorganics:						
Alkalinity (total)	SM 2320B	mg/L	0.10	37.4	---	---
Ammonia ((total as N)	EPA 350.1	mg/L	0.10	1.3	---	<5
Bicarbonate	SM 2320B	mg/L	1.00	37.4	---	<90
Carbonate	SM 2320B	mg/L	1.00	ND	---	---
Chloride	EPA 300.15	mg/L	1.00	21.0	250[b]	<106
Chlorine	SM 4500-Cl DE	mg/L	0.40	2.9	---	---
Dissolved oxygen @ 21.8 °C	SM 4500 OG	mg DO/L	1.00	8.94	---	---
Hydroxide	SM 2320B	mg/L	1.00	ND	---	---
Sulfate		mg/L	0.5	ND	250[b]	---
Physical Parameters:						
LSI @ 21.8 °C	calculated	–	–	–1.6	---	---
ORP @22.3 °C	SM 2580B	mV	10.0	629.0	---	---
pH @ 25 °C	SM 4500H+B	pH units	0.05	7.45	---	Normal Range
Specific conductivity @ 25 °C	SM 2510B	µmohs/cm or µS/cm	10.0	127.0	900[b]	<750
TDS	SM 2540C	mg/L	10.0	74.0	500[b]	480
Metals (cations):						
Antimony	EPA 200.8	µg/L	0.50	ND	6[c]	---
Arsenic	EPA 200.8	µg/L	0.50	ND	10[c]	100
Barium	EPA 200.8	µg/L	5.0	ND	1,000[c]	---
Beryllium	EPA 200.8	µg/L	0.50	ND	4[c]	100
Cadmium	EPA 200.8	µg/L	0.25	ND	5[c]	10
Calcium	EPA 200.8	µg/L	1,000	9,200	---	---
Chromium	EPA 200.8	µg/L	0.50	ND	50[c]	100
Cobalt	EPA 200.8	µg/L	0.50	ND	---	50
Copper	EPA 200.8	µg/L	0.50	ND	1,000[a]	200
Iron	EPA 200.8	µg/L	20.0	ND	300[a]	5,000
Lead	EPA 200.8	µg/L	0.50	ND	15[c]	5,000
Magnesium	EPA 200.8	µg/L	20.0	ND	---	---
Manganese	EPA 200.8	µg/L	20.0	ND	50[a]	200
Mercury	EPA 200.8	µg/L	0.025	0.032	2[c]	10
Molybdenum	EPA 200.8	µg/L	0.50	ND	---	10
Nickel	EPA 200.8	µg/L	0.50	ND	100[c]	200
Selenium	EPA 200.8	µg/L	0.50	ND	50[c]	20
Silver	EPA 200.8	µg/L	0.19	ND	100[a]	---
Sodium	EPA 200.8	µg/L	1,000	18,000	---	<69,000
Thallium	EPA 200.8	µg/L	0.50	ND	2[c]	---
Vanadium	EPA 200.8	µg/L	0.50	ND	50[d]	100
Zinc	EPA 200.8	µg/L	5.0	5.5	5,000[a]	

Pilot plant water provided by Trussell Technologies, Oakland, CA to Todd Groundwater on February 12, 2014. Laboratory analyses by McCampbell Analytical, Inc., Pittsburg, CA on February 13-26, 2014. Sulfate analysis proved by Trussell Technologies.

a. Secondary MCL.
b. Secondary MCL recommended range.
c. Primary MCL.
d. NL.
e. Basin Plan objectives for the protection of groundwater for municipal and domestic supply use are MCLs and not repeated in this column. The numbers in the column are the more stringent of the guidelines for irrigation or objectives for agricultural water use.
f. Part of SAR determination.

As shown in the table above, the stabilized pilot water meets all MCLs, NLs, and Basin Plan objectives for the analysis conducted.

9.4.3. Groundwater Quality Characterization

Existing data representing general groundwater chemistry were checked for accuracy and evaluated using various geochemical plotting techniques, as summarized in this subsection and provided on Figures 9-14 through 9-19. In addition the geochemical signature of the pilot water is compared to the signature of ambient groundwater.

9.4.3.1. *Geochemical Analysis and Methodology*

Major cation (calcium, magnesium, sodium, potassium) and anion (chloride, sulfate, bicarbonate and carbonate) analyses were plotted on standard Stiff, Trilinear (Piper), Schoeller diagrams (Hem, 1989), and Brine Differentiation (BDP) plots. Analyses reported in milligrams per liter (mg/L) were recalculated to milliequivalents per liter (meq/L) to evaluate water chemistry and possible sources of groundwater recharge. In the absence of total bicarbonate data, reported $CaCO_3$ concentrations were recalculated to bicarbonate (HCO_3^-) using a conversion factor from Hounslow (1995). To validate the general mineral data, a cation-anion balance error analysis was conducted using the groundwater data. The cation-anion balance indicated that most data were adequate to incorporate into the geochemical analysis. Where data were outside of acceptable balance criteria, the errors appeared to be associated with elevated metal concentrations resulting from anomalous high turbidity in the samples.

For geochemical plotting purposes, the most recent available data were used for wells near the Injection Facilities. The six wells included in the MRWPCA field program contained the most recent sampling (January or February 2014). Data from July 2012 through November 2013 were used for all other wells except the Ord Terrace well, which contained a more complete data set from September 2009.

9.4.3.2. Water Source Geochemical/Fingerprinting Diagrams

Stiff Diagrams are straight-line plots of cation and anion concentrations in meq/L. Data points are plotted along four parallel horizontal axes on each side of a vertical axis. Individual points are then connected to produce a polygonal pattern. The patterns or shapes of the polygons can be compared to typical standard patterns for groundwater or seawater or compared to polygons from other wells to identify samples of similar water chemistry.

The most recent water quality samples (2009 – 2014) were plotted as Stiff diagrams as shown on Figure 9-14. Diagrams are color-coded to indicate the aquifer represented by the polygons. Yellow and green Stiff diagrams indicate a well screened in the Paso Robles Aquifer or the Santa Margarita Aquifer, respectively, while the orange Stiff diagrams indicate groundwater contribution from both aquifers. Also shown on the map are Stiff diagrams for the treated Carmel River Basin injectate for the ASR wellfields (labeled ASR injectate) and the bench-scale stabilized sample of pilot water.

The stiff diagrams on Figure 9-14 show differences in the groundwater signatures between the shallow (Paso Robles) and deep (Santa Margarita) aquifers. In general, wells screened in the Paso Robles Aquifer show lower concentrations for all of the major ions plotted, especially calcium, chloride, HCO_3, magnesium, and sulfate. Concentrations of these ions are consistently higher in the deeper Santa Margarita Aquifer. Wells that are screened in both aquifers show a signature more similar to the deeper Santa Margarita water signature, indicating that the Santa Margarita Aquifer is contributing more water to the well than the Paso Robles Aquifer.

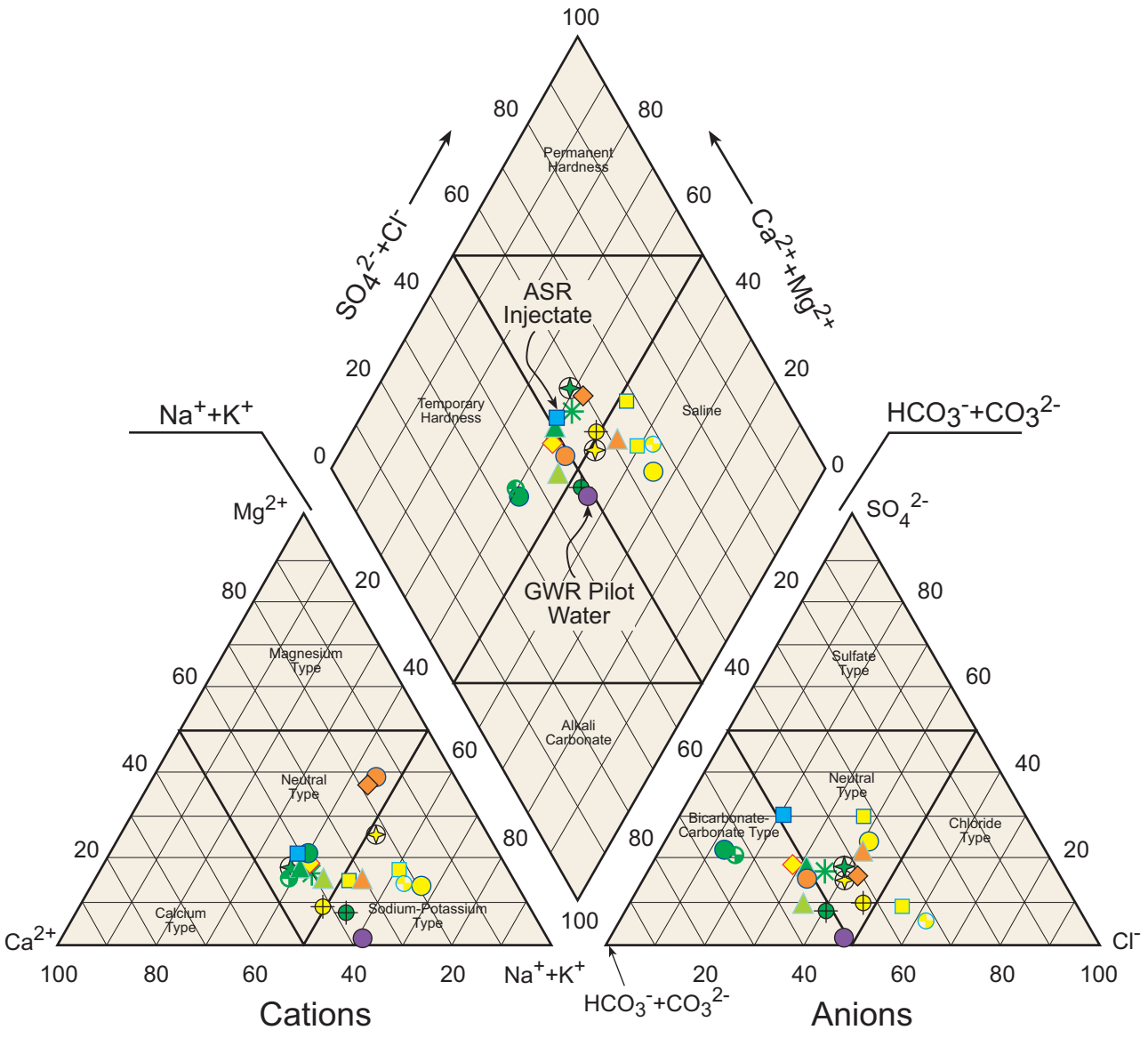
The ASR injectate has a geochemical signature that is different from most of the aquifer signatures in the Seaside Basin. Because the injectate is sourced from surface water (i.e., the Carmel River system water), the water chemistry is less mineralized than the Seaside Basin ambient groundwater. Overall ionic concentrations for the ASR injectate are lower than in the Santa Margarita Aquifer and the injectate appears to have slightly higher magnesium and sulfate than most wells in the Paso Robles Aquifer. Although not clearly demonstrated by the Stiff diagrams on Figure 9-14, the geochemical signature in the ASR wells vary considerably with ASR operation. As expected, wells exhibit signatures similar to ASR injectate during periods of injection (with chloride concentrations of about 30 mg/L) and return to signatures in the ambient groundwater during relatively long periods of non-injection or pumping (with chloride concentrations from about 120 mg/L to 140 mg/L)

The AWT pilot water has even lower relative mineral content than the ASR injectate. The signature is very distinct form other groundwater quality signatures and should be identifiable in groundwater samples from the Project's proposed monitoring wells.

Trilinear (Piper) Diagrams allow characterization of water chemistry and comparison of water quality analyses. Cation (calcium, magnesium, and sodium + potassium) concentrations in meq/L are expressed or normalized as a percentage of the total cations, which are plotted on a triangle in the lower left portion of the diagram. Total anions (CO_3+HCO_3, sulfate, and chloride) are plotted on a triangle in the lower right portion of the diagram. The cation-anion plots are then projected onto a central diamond-shaped area, combining both cation and anion distributions. Groundwater with similar geochemistry will generally plot together in similar locations; therefore, groundwater from different sources may be identified by their bulk or intrinsic chemical compositions, which also may be classified as to water type.

The water quality analytical data from wells shown on Figure 9-14 are plotted on the Trilinear diagram on Figure 9-15. Similar to the color coding on Figure 9-14, Figure 9-15 presents data from wells screened in the Paso Robles Aquifer with yellow symbols; wells in the Santa Margarita Aquifer are shown with green symbols; and wells screened in both aquifers are shown with orange symbols. Data from an ASR injectate sample (blue) and the bench-scale sample from the pilot plant (purple) are also included for comparison.

The Trilinear diagram (Figure 9-15) shows that groundwater in both aquifers range from neutral-type to sodium-potassium-type (for cations) and bicarbonate-carbonate-type, to neutral-type, to chloride-type (for anions). In the diamond portion of the diagram, the groundwater samples from both shallow and deep aquifers are generally clustered together toward the center, suggesting relatively similar water chemistry. There is some slight differentiation among the two aquifers. Most of the groundwater samples from the Paso Robles wells (yellow) group toward a more sodium-chloride (saline) signature (Figure 9-15).



Legend

Paso Robles Aquifer

- Darwin
- Military
- Seaside Middle School Shallow
- City of Seaside 4
- MRWPCA MW-1
- FO-7 Shallow
- PRITW Mission Memorial

Both Aquifers

- Paralta
- Luzern
- Ord Grove

Santa Margarita Aquifer

- ASR-2
- ASR-3
- Ord Terrace
- ASR-1
- Ord Terrace Shallow
- Seaside Middle School Deep
- FO-7 Deep
- ASR MW-1

ASR Injectate

- ASR Injectate - Carmel River
- GWR Pilot Water

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Figure 9-15
Trilinear Diagram
Groundwater Chemistry
near Injection Facilities

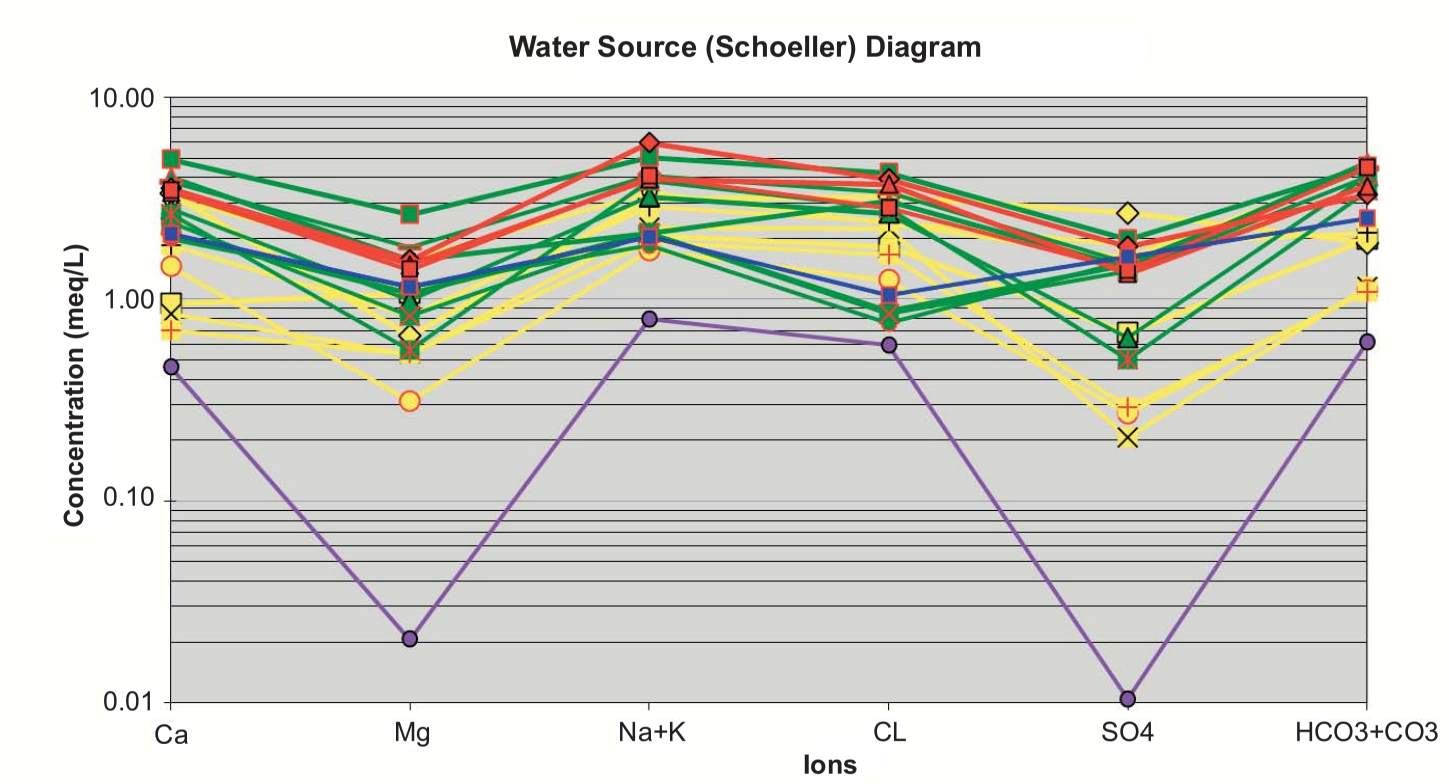
The ASR injectate appears slightly different than the groundwater signature, especially with respect to bicarbonate (lower) and sulfate (slightly higher). Several samples from ASR wells plot close to the ASR injectate sample, indicating mixing of the two waters.

The pilot water plots as sodium-potassium-type and bicarbonate-carbonate-type mostly because of the added calcium carbonate, $CaCl_2$ and CO_2 gas used to stabilize the AWT pilot water in this sample. The pilot water plots at the edge of other data points, mostly due to lower chloride and sulfate concentrations. Because the final full scale AWT Facility water will contain less calcium than the pilot water sample because the full-scale stabilization will not require the addition of calcium carbonate and $CaCl_2$ as was done for the bench-scale method of stabilization, the actual Trilinear signature of product water will likely be even more distinct from other samples.

Schoeller (Water Source/Fingerprint) Diagrams. Although the Trilinear diagram may be used to differentiate between overall water chemistry types, differences are often indistinguishable except in percentage amounts. Schoeller diagrams plot the meq/L of specific cations and anions and can offer a more detailed and different view of water chemistry. Schoeller diagrams are often used in conjunction with Trilinear diagrams for typing or fingerprinting different water sources. In general, water from similar sources (e.g., sources may include surface water, groundwater influenced by surface recharge, regional older groundwater) will often plot in a similar pattern on a Schoeller diagram.

Figure 9-16 shows a Schoeller diagram analysis for wells near the Injection Facilities. Samples are color-coded similar to the other diagrams to facilitate analysis. ASR injectate and pilot plant water analyses are also shown for comparison purposes.

The Schoeller diagram confirms the interpretation from the Stiff diagrams in that the Paso Robles Aquifer (yellow) contains groundwater at lower ionic concentrations than the Santa Margarita Aquifer (green). For wells screened in both aquifers (i.e., Paralta, Luzern, and Ord Grove – shown in orange), the Schoeller signature is more similar to the Santa Margarita Aquifer, indicating more contribution from that aquifer to the sample. However, because there is some overlap in the signatures, it also appears that there is infiltration/mixing of groundwater from the upper to lower aquifer. The ASR injectate (blue) also appears to be influencing the Santa Margarita Aquifer. The pilot plant water, shown for future comparison purposes only, has a unique signature with lower concentrations of magnesium and sulfate.



Legend

Paso Robles Aquifer
- Darwin
- Military
- Seaside Middle School Shallow
- MRWPCA MW-1
- PRITW Mission Memorial
- FO-7 Shallow
- City of Seaside 4

Santa Margarita Aquifer
- ASR-1
- ASR-2
- ASR-3
- Ord Terrace Shallow
- Ord Terrace Deep
- Seaside Middle School Deep
- FO-7 Deep
- ASR MW-1

Both Aquifers
- Luzern
- Ord Grove
- Paralta

- ASR Injectate - Carmel River
- GWR Pilot Water

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Figure 9-16
Schoeller Diagram
Wells near
Injection Facilities

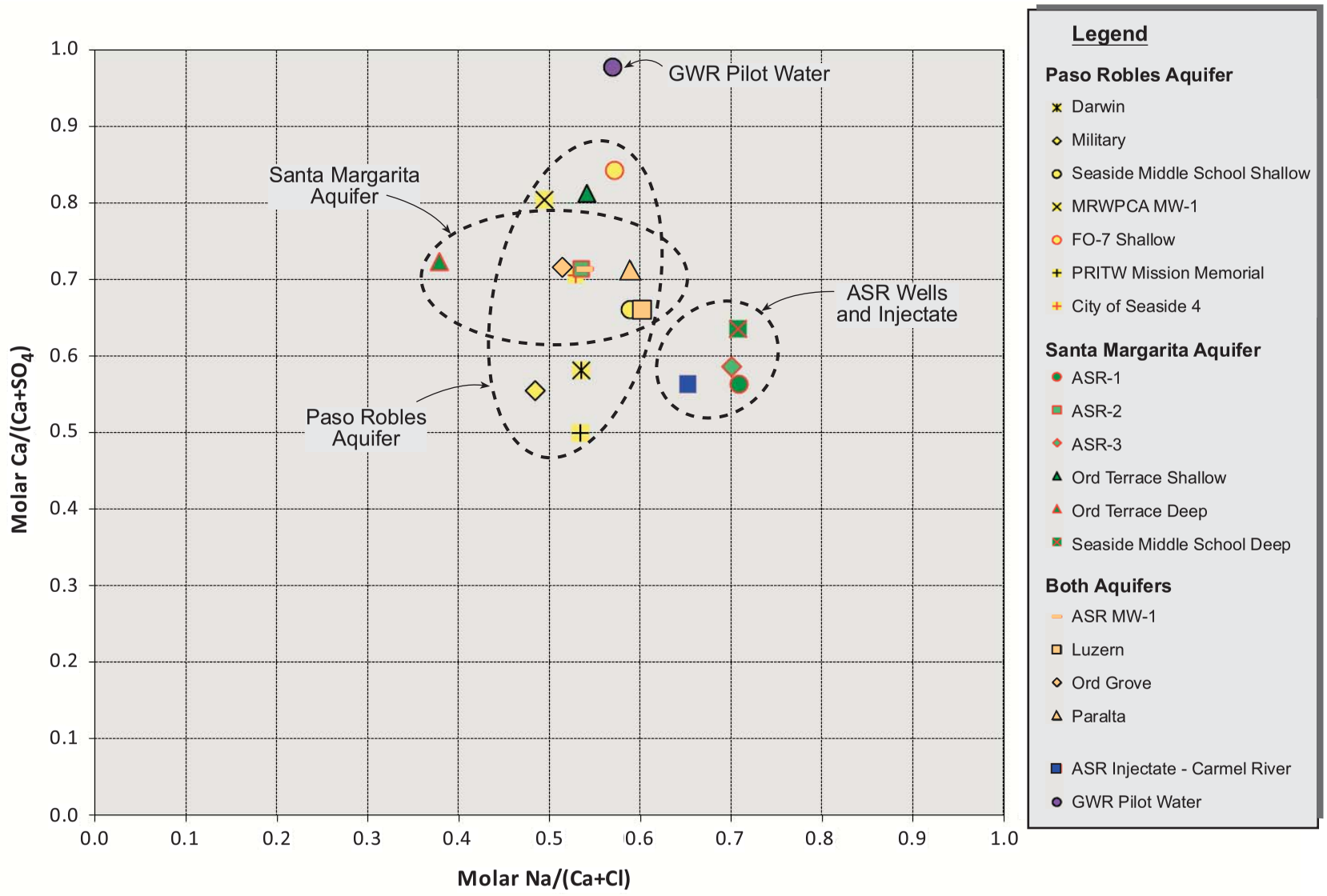
Brine Differentiation Plots. The BDP was developed by Hounslow (1995) to differentiate brine-contaminated waters from waters of other origins using major constituents commonly available in a water quality analysis. However, it has been widely used as another fingerprinting tool for differentiation of various groundwater chemistry. Molar concentrations of calcium divided by calcium plus sulfate on the vertical axis and sodium divided by sodium plus chloride on the horizontal axis are plotted on this type of diagram. Fields and mixing lines for brines, evaporates (i.e., precipitated salts), and seawater can be delineated, if applicable. One of the advantages of the BDP is that straight- and curved-line mixing ratios can be shown, particularly if end member concentrations (such seawater or brackish water) are known.[41]

The BDP on Figure 9-17 shows scattered analytical data for the wells near the Injection Facilities. Fields of various well groupings are delineated on the plot for ease of use. As shown, the ASR injectate and ASR wells plot in a distinct area compared to other wells. The BDP appears to be a better indicator than the other plots of the mixing of injectate with groundwater in the ASR wells where most of the injection has occurred (ASR-1 and ASR-2). Fields for the two aquifers appear to overlap. Wells screened in both aquifers plot within the central overlapping area, consistent with mixing of the two water chemistries.

Similar to the other geochemical plots, the BDP shows that the pilot water sample signature is quite distinctive and separate. This signature indicates that a similar BDP analysis conducted during and following a field tracer test with AWT injectate will be useful for identifying actual travel times of injected water. However, because the analysis is based on relative concentrations of cations in the water samples, BDP signatures can be altered during groundwater transport through cation exchange and other geochemical interactions in the groundwater system. Although the BDP plot appears useful for differentiating wells influenced by pilot water, it should not be relied upon alone for the tracer test analysis. But when combined with other geochemical analyses, the BDP is expected to yield useful information.

Collectively, the geochemical plots indicate that product water will likely be sufficiently distinct from groundwater to allow for use as an intrinsic tracer in tracking the injected recycled water in the subsurface. More information on the proposed tracer testing approach is provided in **Section 6**.

[41] End members are waters having two distinct isotopic or chemical compositions with other samples ranging between the two.



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Figure 9-17
Brine Differentiation Plot Wells near Injection Facilities

9.4.3.3. Concentrations of TDS in Groundwater

As indicated from the geochemical analysis, the ionic concentrations and water chemistry signatures for the Paso Robles Aquifer are slightly different than for the Santa Margarita Aquifer. This interpretation is also reflected in the concentrations of TDS in groundwater near the Injection Facilities area. Figure 9-18 includes recent (2012 - 2014) TDS concentration ranges for the samples used in the analysis.

Using the data ranges in the legend, Figure 9-18 indicates that all of the TDS measurements in the wells were below the California secondary MCL Upper Consumer Acceptance Contaminant Level Range of 1,000 mg/L, although some were above the Recommended Consumer Acceptance Contaminant Level Range of 500 mg/L. TDS levels ranged from 190 mg/L in FO-7 Shallow (Paso Robles Aquifer) to 668 mg/L in ASR-2 (Santa Margarita Aquifer during a period of recovery with only small amounts of prior injection).

In general, wells screened in the Paso Robles Aquifer have lower TDS concentrations than in the Santa Margarita Aquifer with the 500 mg/L level serving as a reasonable dividing concentration for comparative purposes. For example, all wells screened only in the Paso Robles Aquifer are below 500 mg/L (green on Figure 9-18). Most of the Santa Margarita wells have recent concentrations above 500 mg/L (yellow on Figure 9-18), except Paralta (screened in both aquifers), SMS Deep, ASR-3, and FO-7 Deep. Wells not affected by ASR injection do not show a wide variation in TDS concentrations over time.

9.4.4. Potential Constituents of Concern and Other Groundwater Analyses

To supplement the characterization of general groundwater chemistry, the water quality database was reviewed for potential constituents of concern including regulated constituents (those with MCLs). For the Project, additional potential constituents of concern also include those associated with former military activities at Fort Ord. Some of these constituents had not been analyzed previously in groundwater near the Injection Facilities area. To address this data gap, groundwater from the six wells sampled in the field program (Table 9-4 above) was analyzed for more than 275 constituents/parameters. In addition to regulated constituents and former Fort Ord constituents, the six groundwater samples were also analyzed for CECs as defined in the SWRCB Recycled Water Policy and other constituents not previously monitored routinely in local groundwater.

9.4.4.1. Constituents Exceeding California Primary MCLs

For the more than 275 constituents and parameters analyzed in each of the six wells for this monitoring event, only two wells, FO-7 Shallow and MRWPCA MW-1, detected any constituents that did not meet the California primary MCLs. These detections, along with turbidity values, are summarized in Table 9-6 below.

Table 9-6: Constituents Exceeding California Primary MCLs

Analyte	Method	Units	MDL	FO-7 Shallow	MRWPCA MW-1	California Primary MCL
Turbidity	SM2130B	NTU	0.040	550	71	5[a]
Aluminum (Al)	EPA 200.8	µg/L	8.0	3,700	2,700	1,000
Arsenic (As)	EPA 200.8	µg/L	0.28	210		10
Barium (Ba)	EPA 200.8	µg/L	0.12	1,200		1,000
Chromium (Cr) Total	EPA 200.8	µg/L	0.32	790		50
Lead (Pb) Total	EPA 200.8	µg/L	0.080	42		15
Gross Alpha	7110B	pCi/L	3.00	125 ±5		15
Gross Beta	7110B	pCi/L	4.0	114 ±2		50
Combined Radium	calculated	pCi/L	1.00	38.3 ±2.4		5

a. 5 NTU is a secondary MCL and is included on the table for comparison purposes as discussed in the text.

As shown in Table 9-6, the only constituents that were detected at concentrations above primary MCLs were five metals and several radiogenic parameters. These constituents are the ones most affected by elevated turbidity in groundwater samples; as shown on the table, the well with the most exceedances (FO-7 Shallow) is the well with the highest turbidity value (550 NTU). Further, the only other well with an exceedance (MRWPCA MW-1) also detected elevated turbidity (71 NTU). FO-7 Deep (data not shown in Table 9-6) did not detect any constituents above primary MCLs, but the slightly elevated turbidity value of 10 NTU correlated to slightly elevated detections in other metals. No exceedances of primary MCLs were recorded in any of the wells with turbidity values of 10 NTU or less. Complete laboratory analyses for the sampling event in the six wells are presented in Appendix I.

Due to the relatively slow velocities within groundwater systems and the natural filtering associated with aquifer materials, groundwater does not typically contain solids that will result in the elevated turbidity values shown above. Rather, it is more likely that aquifer particles or other solids are being

entrained in the groundwater samples and interfering with the laboratory analysis. Collectively, these data indicate that suspended small particles of aquifer material or pre-development solids are being analyzed by the laboratory methods (i.e., causing analysis interference) rather than dissolved constituents on which water quality standards are based. Therefore, the concentrations of certain metals and radiogenic parameters are not considered representative of actual concentrations in groundwater.

FO-7 and MRWPCA MW-1 are constructed with small-diameter casings that cannot accommodate large pumps; the deep water table has limited the ability to develop these three monitoring wells sufficiently in order to produce a turbid-free groundwater sample for analysis. In addition, FO-7 is a relatively older monitoring well (drilled in 1994) that has never been previously sampled for groundwater quality and may not be capable of producing turbid free water. As such, future sampling programs will incorporate techniques such as field filtering to minimize the effects of turbidity.

9.4.4.2. Former Fort Ord Constituents

Given the historical land use of the former Fort Ord lands, the MRWPCA field program included groundwater analyses for chemicals of concern associated with former Fort Ord activities. The six groundwater samples from the MRWPCA field program were analyzed for 17 explosive compounds (nitroaromatics and nitramines) by U.S. EPA Method 8330B. In addition, two metals associated with explosive compounds (beryllium and lead) were also analyzed. These data were compared to available California primary MCLs and NLs and are summarized in Table 9-7.

Table 9-7: Groundwater Analyses for Explosives and Associated Metals

Constituent	Wells with Detections	MRL	Detected or Reported Concentration	Primary MCL	NL	Comments
		µg/L				
Explosives[a]						
HMX	None	0.099-0.12	ND	None	350	
RDX	None	0.099-0.12	ND	None	0.3	
1,3,5- Ttrinitrobenzene	None	0.20-0.22	ND	None	None	
1,3-dinitobenzene	None	0.098-0.12	ND	None	None	
3,5-dinitoaniline	None	0.098-0.30	ND	None	None	
2,4,6 Trinitro-phenylmethyl-nitramine	None	0.10-0.12	ND	None	None	
Nitrobenzene	None	0.099-0.12	ND	None	None	
4-Amino-2,6-dinitrotoluene	None	0.098-0.11	ND	None	None	
2-amino-4,6-dinotrotoluene	None	0.098-0.11	ND	None	None	
TNT	None	0.098-0.11	ND	None	1	
2,6-DNT	FO-7 Shallow	0.20	0.070[c]	None	None	high turbidity
	FO-7 Deep	0.23	0.064[c]	None	None	slightly turbid
	ASR MW-1	0.10	0.037[c]	None	None	
2,4-DNT	None	0.10	ND	None	None	
2-nitrotoluene	None	0.11	ND	None	None	
4-nitrotoluene	None	0.098-0.12	ND	None	None	
3-nitrotoluene	None	0.098-0.12	ND	None	None	
Nnitroglycerine)	None	0.99-1.2	ND	None	None	
Pentaerythritol tetranitrate	None	0.49-0.56	ND	None	None	
Metals[b]						
Beryllium	ASR-2	0.050	0.7	4.0		
	FO-7 Shallow	0.020	0.68			high turbidity
	MRWPCA MW-1	0.020	0.044			turbid
Lead	ASR-1	0.020	0.78	15.0		
	ASR-2	0.010	3.0			
	FO-7 Shallow	0.020	**42.0**			high turbidity
	FO-7 Deep	0.080	1.3			slightly turbid
	PRTIW: Mission Memorial	0.020	0.061			
	MRWPCA MW-1	0.020	1.3			turbid
	Paralta	0.001	3.0			

a. Nitroaromatics and nitramines by U.S. EPA Method 8330B: Samples received and submitted by Alpha Analytical Laboratory, Ukiah, CA to ALS Environmental (ALS), Kelso, WA on February 5, 2014; analyzed by ALS on February 8, 2014.

b. Metals by U.S. EPA Method 200.8 analyzed by Alpha Analytical Laboratory, Ukiah, CA, February 5-11, 2014.

c. Constituent also detected in laboratory blank indicating a laboratory contaminant that may not be present in groundwater. All detections were below MRLs and are not quantifiable.

As shown in Table 9-7, the only explosive constituent detected in groundwater samples was 2,6-DNT (dinitrotoluene). This constituent was also detected in laboratory blank samples, which are samples of laboratory water (not groundwater) analyzed for quality assurance/quality control (QA/QC) purposes. Detections of this constituent at similar levels in the laboratory blank sample indicate that 2,6-DNT is likely a laboratory contaminant and not actually present in groundwater. Although the constituent may be present in several groundwater *samples*, the laboratory blank data suggest that it was introduced into the samples in the laboratory. Further, detections of 2,6-DNT in FO-7 Shallow, FO-7 Deep, and ASR MW-1 were below the laboratory reporting level (RL), meaning that the concentration of 2,6-DNT in samples is too low to be quantified. Given the laboratory QA/QC data for 2,6-DNT, the low levels of the detections, and the absence of additional explosives in groundwater, data indicate that groundwater has not been impacted locally from explosives associated with former Fort Ord activities.

For the metals analysis, both beryllium and lead – as naturally occurring substances – were detected in several groundwater wells above the reporting limits. Beryllium was detected in groundwater collected from ASR-2, FO-7 Shallow, and MRWPCA MW-1, although all of the detections met the California Primary MCL. Other wells in the database did not detect beryllium above the laboratory reporting limits.

Lead was also detected in groundwater collected from ASR-1, ASR-2, FO-7 Shallow, FO-7 Deep, Mission Memorial PRTIW, MRWPCA MW-1, and Paralta. The detection in FO-7 Shallow (42 µg/L) was above the MCL (15 µg/L), but appears anomalous with respect to other detections of lead in the database. The concentration of 42 µg/L is the highest concentration in the database by an order of magnitude, which included lead analyses from 13 wells sampled from 2011 through 2014. The second highest concentration was detected in ASR-2 at 3.0 µg/L (also included on Table 9-7). Except for FO-7 Shallow, all of the detections were below the MCL for lead.

As previously mentioned, the 2014 sampling of FO-7 Shallow was the first time that this small-diameter monitoring well had been sampled for water quality since its original sampling upon well completion. Sampling produced a highly turbid sample (550 NTU), likely relating to the inability to properly develop the well for water quality when installed in 1994 as a water level monitoring well. As such, the metals analytical data are likely the result of particle interference and are not likely representative of dissolved lead concentrations in groundwater.

Given the absence of explosives and the relatively low levels of beryllium and lead (with the exception of FO-7 Shallow where data appear to be inaccurate as explained above), the data do not indicate that former Fort Ord activities have impacted groundwater in the existing wells near the Injection Facilities area.

9.4.4.3. Constituents of Emerging Concern

As defined in the Recycled Water Policy, CECs are chemicals in personal care products, pharmaceuticals including antibiotics, antimicrobials, agricultural and household chemicals, hormones, food additives, transformation products and inorganic constituents. These chemicals have been detected in trace amounts in surface water, wastewater, recycled water, and groundwater and have been added to the monitoring requirements for any project involving groundwater replenishment using recycled water.

The SWRCB Recycled Water Policy CEC monitoring requirements were based on the recommendations of an expert panel and will be included in the monitoring program for the Project's permit (see **Section 12**). For injection projects that produce recycled water using RO and AOP, the monitoring requirements

in the Recycled Water Policy only apply to recycled water prior to and after treatment (no groundwater sampling). As part of the Title 22 Criteria for injection projects, a project sponsor must in the Engineering report recommend CECs for monitoring in product water and groundwater (see **Section 12**).

The following Recycled Water Policy CECs are health-based indicators, treatment/performance based indicators, or both as shown below:

- 17-*β*-estradiol - steroid hormone (health-based indicator)
- Caffeine – stimulant (health-based and performance-based indicator)
- NDMA – disinfection byproduct (health-based and performance-based indicator)
- Triclosan – antimicrobial (health-based indicator)
- DEET – personal care product (performance-based indicator)
- Sucralose – food additive (performance-based indicator)

None of the CECs currently have either primary MCLs for drinking water. For NDMA, the current NL is 10 ηg/L.

To provide baseline conditions for these CECs in the Seaside Basin, the six wells sampled in the recent MRWPCA field program were analyzed for the six CECs and other pharmaceuticals/personal care products included in U.S. EPA Laboratory Methods 1625M and 1694 (APCI and ESI+). Groundwater samples were analyzed from ASR MW-1, City of Seaside 4, FO-7 Shallow, FO-7 Deep, PRTIW Mission Memorial, and MRWPCA MW-1. Full results are provided in **Appendix D**. Detections of the six CECs are summarized in Table 9-8.

Table 9-8: Groundwater Sample Analyses for CECs

Constituent[a]	Wells with Detections[b]	Minimum Reporting Limit (RL)	Detected or Reported Concentration	Comments
		µg/L[c]		
NDMA	PRTIW (Mission Memorial)	0.002	0.0054	NL =0.01
17-β-estradiol	None	0.001	ND	
Triclosan	None	0.002	ND	
Caffeine	FO-7 Deep	0.001	0.0027	
	MRWPCA MW-1		0.0068	
DEET	FO-7 Deep	0.001	0.0023	
	MRWPCA MW-1		0.0060	
Sucralose	None	0.005	ND	

a. NDMA by U.S. EPA Method 1625M; 17-β-estradiol and triclosan by U.S. EPA Method 1694-APCI**;** caffeine, DEET, and sucralose by U.S. EPA 1694-ESI+.
b. Groundwater analyzed from wells ASR-1, City of Seaside 4, FO-7 Shallow, FO-7 Deep, PRTIW Mission Memorial, and MRWPCA MW-1.
c. Analyses reported on laboratory analytical data sheets in ng/L or parts per trillion. Converted to µg/L or parts per billion. Samples received by Alpha Analytical Laboratory, Ukiah, CA; submitted to Weck Laboratories, Inc. (Weck), City of Industry, CA, on February 5, 2014; analyzed by Weck from February 11 to February 19, 2014.

As indicated in Table 9-8, NDMA was detected in groundwater collected from the PRTIW well at 0.0054 µg/L (below the NL); caffeine was detected in FO-7 Deep and MRWPCA MW-1 at 0.0027 and 0.0068 µg/L, respectively (below the Drinking Water Equivalent Level [DWEL] of 0.35 µg/L per Anderson et al., 2010).[42] DEET was detected in FO-7 Deep and MRWPCA MW-1 at 0.0023 and 0.0060 µg/L, respectively (below the DWEL of 81 µg/L per Intertox, 2009). Estradiol (17-β), triclosan, and sucralose were not detected above reporting limits in groundwater collected from any of the six wells.

These data represent the first time that CECs have been analyzed in the Seaside Basin and serve as initial background data. The data will be confirmed through future groundwater sampling events that will support the monitoring program proposed in this Engineering Report. Nonetheless, only a few constituents were detected at very low levels (all less than 0.01 ug/L) and meet advisory or safe health concentrations.

9.4.4.4. Salts and Nutrients

A SNMP has been prepared for the Seaside Basin to comply with requirements in the SWRCB's Recycled Water Policy (HydroMetrics, 2014a). As documented in the SNMP and confirmed herein, ambient groundwater generally exceeds Basin Plan objectives for TDS in many areas of the basin, while nitrate and chloride concentrations generally meet Basin Plan objectives. TDS, nitrate, and chloride concentrations in the product water are expected to meet all Basin Plan objectives. Additional information on potential Project impacts to groundwater quality and details from the SNMP are provided in **Section 11.4**.

[42] The DWEL is the amount of a substance in drinking water that can be ingested daily over a lifetime without appreciable risk.

10. PRODUCTION AND MONITORING WELLS

Seaside Basin wells downgradient of the Injection Facilities area provide water supply for municipal, industrial, and irrigation purposes. There are also numerous monitoring wells upgradient and downgradient of the area. Most of these monitoring wells are part of either the ASR monitoring program or the basin-wide monitoring program, both of which are conducted by MPWMD in cooperation with Cal Am and the Seaside Basin Watermaster, respectively. Local production and monitoring wells are shown on Figure 10-1.

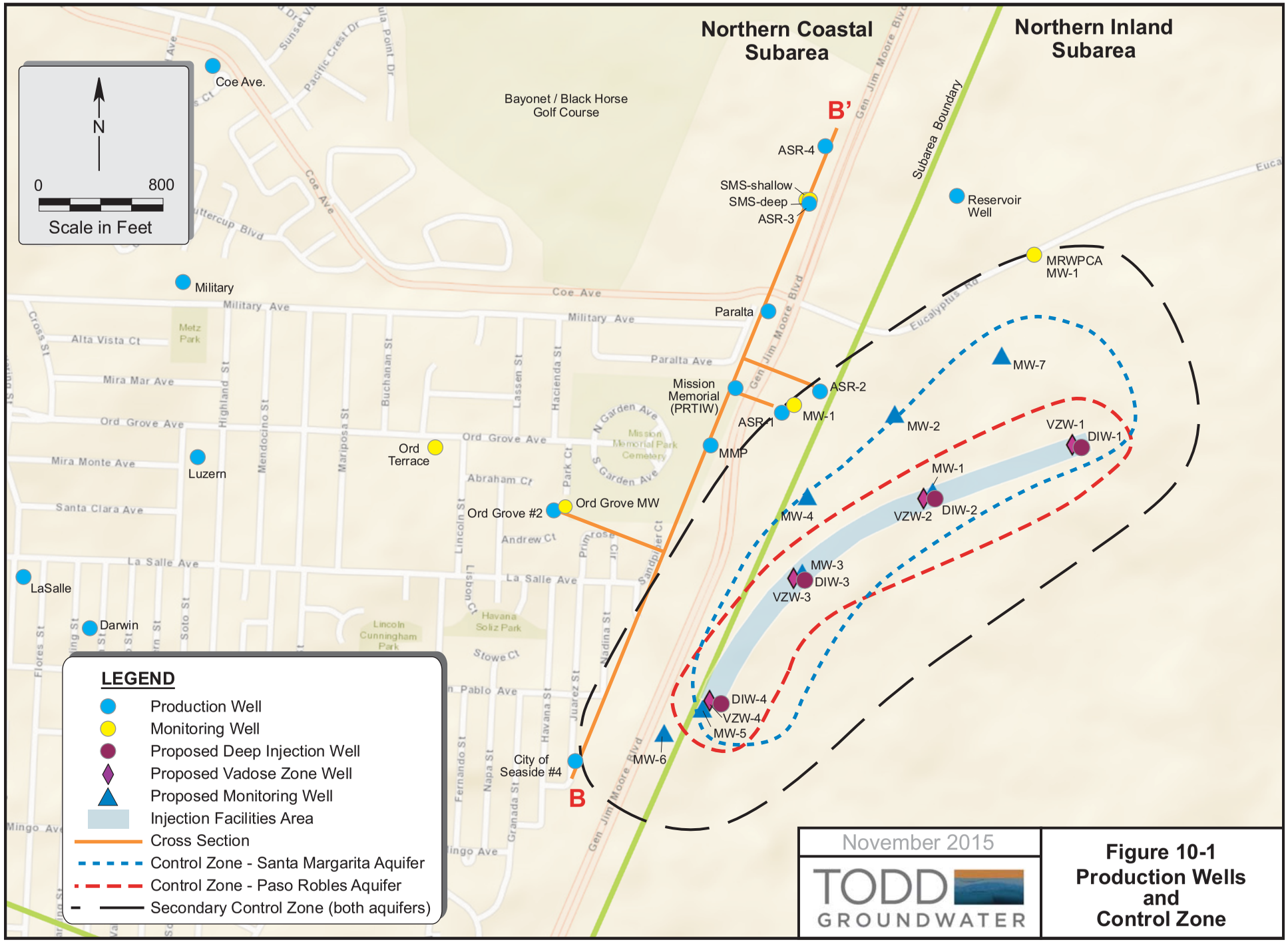
Most wells near the Injection Facilities are located in the adjacent Northern Coastal Subarea. The closest water supply wells include Seaside No. 4 (operated by the City of Seaside) and two ASR wells, ASR-1 and ASR-2, (operated by the MPWMD for CalAm). Each of these wells is located about 1,000 feet downgradient from a Project injection well (Figure 10-1).

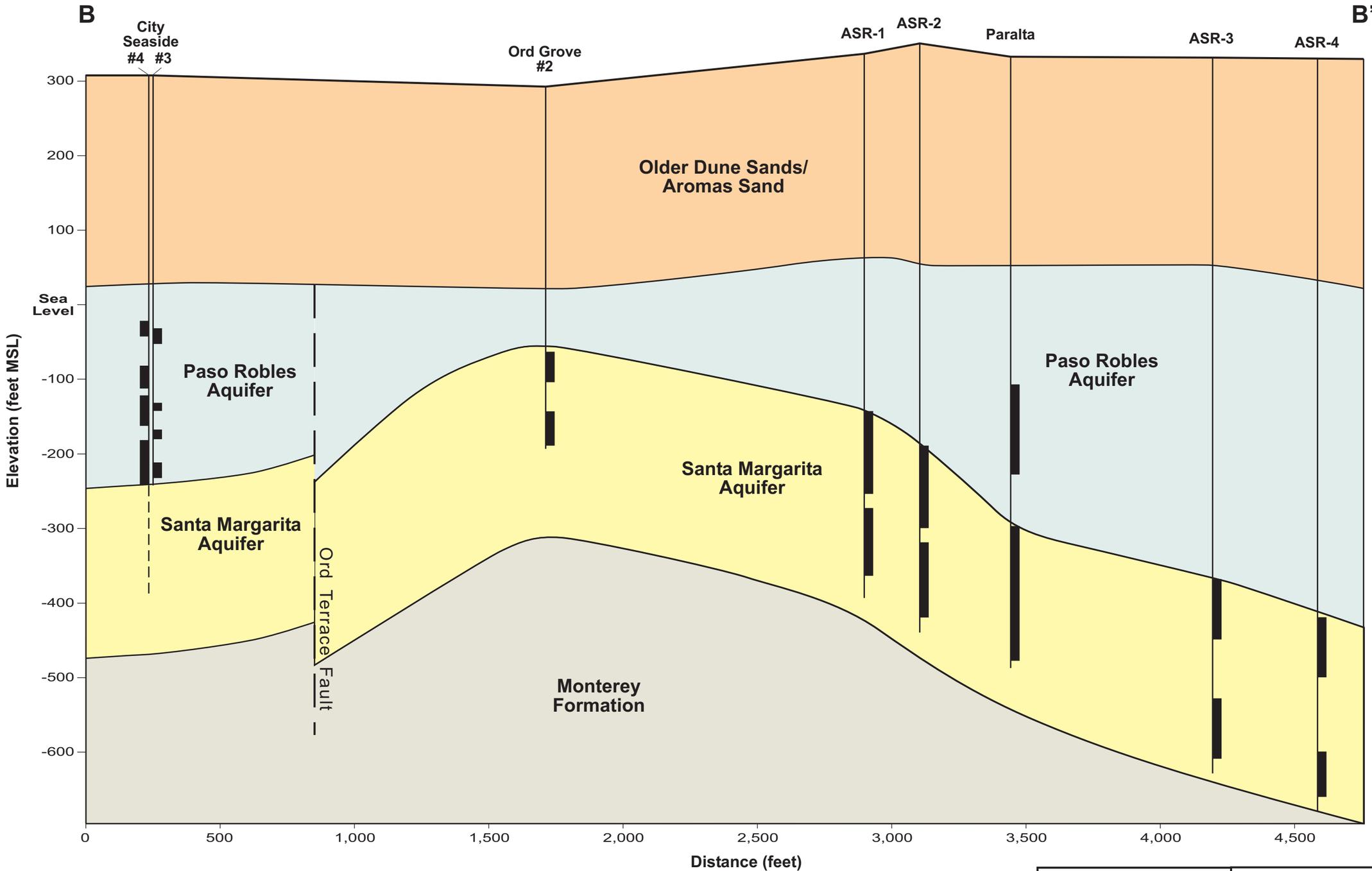
Wells within the Northern Inland Subarea include the Reservoir Well (an inactive irrigation well), and the recently-installed MRWPCA MW-1 monitoring well; both wells are screened in the upper Paso Robles Aquifer and monitor the local water table (Figure 10-1). An additional monitoring well cluster (FO-7 Shallow and FO-7 Deep) is located about 2,800 feet to the northeast of the Injection Facilities area along Eucalyptus Road (just west of the area shown on Figure 10-1).

10.1. PRODUCTION FROM EACH AQUIFER SYSTEM

Both aquifers are screened in downgradient production wells. The Paso Robles Aquifer is less productive than the Santa Margarita Aquifer, and is often screened in a well that is also screened in the Santa Margarita Aquifer. Near the Injection Facilities area, the Paso Robles is screened in production wells Paralta (which is also screened in the Santa Margarita Aquifer), PRTIW, MMP, and Seaside 4, all located within about 1,000 feet west of General Jim Moore Boulevard. The Paralta and Seaside 4 are drinking water wells. PRTIW and MMP are irrigation wells and are not used for drinking water supply.

Screened intervals in downgradient drinking water wells are shown on Cross Section B-B' on Figure 10-2. The cross section is oriented along General Jim Moore Boulevard from the Seaside 4 well in the southwest to ASR-4 in the northeast, as shown on Figure 10-1. In addition to the downgradient ASR wellfields, Paralta, and Seaside 4, the next closest downgradient drinking water well, Ord Grove 2, is also projected onto the section (Figure 10-2). The cross section shows the Older Dune Sands/Aromas Sand at the surface and extending to an approximate depth of 300 feet. The Paso Robles Aquifer and underlying Santa Margarita Aquifer are screened in the various wells as shown (Figure 10-2).


Northern Coastal Subarea
Northern Inland Subarea
Subarea Boundary
B'
B
N
0
800
Scale in Feet
Coe Ave.
Bayonet / Black Horse Golf Course
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
MRWPCA MW-1
Military
Military Ave
Coe Ave
Paralta
Paralta Ave
Mission Memorial (PRTIW)
ASR-2
ASR-1
MW-1
MMP
MW-7
MW-2
VZW-1
DIW-1
Ord Terrace
Luzern
Ord Grove Ave
Mira Monte Ave
Santa Clara Ave
Ord Grove #2
Ord Grove MW
Abraham Ct
Andrew Ct
La Salle Ave
LaSalle
Darwin
MW-4
VZW-2
DIW-2
MW-3
DIW-3
VZW-3
DIW-4
VZW-4
MW-5
MW-6
City of Seaside #4
Havana Soliz Park
Lincoln Cunningham Park
Stowe Ct
Pablo Ave
Mingo Ave
Eucalyptus Rd
Gen Jim Moore Blvd
LEGEND
Production Well
Monitoring Well
Proposed Deep Injection Well
Proposed Vadose Zone Well
Proposed Monitoring Well
Injection Facilities Area
Cross Section
Control Zone - Santa Margarita Aquifer
Control Zone - Paso Robles Aquifer
Secondary Control Zone (both aquifers)
November 2015
TODD GROUNDWATER
Figure 10-1
Production Wells and Control Zone



November 2015

TODD GROUNDWATER

Figure 10-2
Cross Section B - B'
Closest Downgradient Drinking Water Wells

All of the ASR wells are screened in the Santa Margarita Aquifer (Figure 10-2). As mentioned above, the Paralta well is also screened in the Paso Robles Aquifer. The Ord Grove #2 production well appears to be screened in the Santa Margarita Aquifer only, but the gravel pack allows some connection in the well to overlying sand layers in the Paso Robles Aquifer. As such, the Paso Robles Aquifer has been estimated to contribute a small amount of production to this well (also evidenced by groundwater quality data). Seaside 4 appears to be screened in the Paso Robles Aquifer only, although there is some uncertainty with the aquifer interpretation (Figure 10-2). Previous wells at this site extended down into the Santa Margarita Aquifer and flow from the deeper aquifer may also contribute some flow to wells at this location. The Watermaster Model simulates this well as pumping from both aquifers.

As shown on Figure 10-1, additional drinking water production wells are located within about one mile of the Injection Facilities area, including Military, Luzern, Darwin, and LaSalle wells. All of these wells are screened in the Paso Robles Aquifer; Luzern is also screened in the Santa Margarita Aquifer.

Because many wells are screened in both the Paso Robles Aquifer and the Santa Margarita Aquifer, the contribution of the Paso Robles Aquifer to basin production is not known with certainty. Estimates by previous investigators (Yates et al., 2005) indicate that an average of about 40% of the coastal area production was from the Paso Robles Aquifer in 2000 through 2003. However, with additional wells in the Santa Margarita Aquifer and changes in production over time, the current contribution from the Paso Robles Aquifer is estimated to be only about 20% of the basin pumping.

It is expected that this declining trend in Paso Robles Aquifer production will continue into the future. CalAm, the primary producer in the Coastal Subareas, has been shifting production from older wells that were primarily Paso Robles Aquifer wells, to the newer (and higher capacity) wells (i.e., Ord Grove, Paralta, ASR wells), which are primarily Santa Margarita Aquifer wells. This transition is the basis for allocating 90% of the product water to be injected into the Santa Margarita Aquifer and only 10% to the Paso Robles Aquifer (see Table 8-1 for a quantitative delivery schedule).

10.2. ASR OPERATION

The Monterey Peninsula ASR Project consists of four ASR wells and associated monitoring wells drilled at two locations along General Jim Moore Boulevard downgradient of the Injection Facilities area. ASR-1 and ASR-2 are the closest wells to the Injection Facilities, both located about 1,000 feet downgradient. ASR-3 and ASR-4 are located about 2,000 feet and 2,300 feet from the Injection Facilities, respectively. The wellfields are operated by MPWMD through an agreement with CalAm. As mentioned previously, the ASR wells inject treated imported water from the Carmel River Basin for seasonal storage and subsequent recovery for drinking water supply.

Currently, Carmel River Basin water (extracted from riverbank wells) is treated to drinking water standards and conveyed to the ASR wells for recharge when excess water is available (e.g., periods when flows in the Carmel River exceed fisheries bypass flow requirements). Two potential future ASR wells further to the north are also planned for injection of water from a proposed ocean desalination plant to be developed by CalAm.

ASR injection amounts vary from year to year depending on surface water availability; specifically, diversions from the Carmel River for ASR injection are limited to certain times of the year and are allowed only when minimum flows are present at certain gages on the Carmel River (i.e., to provide adequate fish passage). A regulatory order requires that the injected Carmel River water be extracted to

meet water demands; thus, the project is not operated for the long-term replenishment of basin aquifers (Seaside Basin Watermaster, 2012).

Table 10-1 summarizes annual ASR injection and recovery for the last five water years.

Table 10-1: Injection and Recovery Volumes, ASR Project

Water Year	ASR Injection (AFY)	ASR Recovery (AFY)
2010	1,110	0
2011	1,117	1,110
2012	131	1,117
2013	294	644
2014	0	0
2015	215	0
Total	2,867	2,871

10.3. Closest Drinking Water Supply Well

The closest drinking water well to each of the Project's proposed injection wells (and producing from the target aquifer) is listed in Table 10-2. Distances between the Project wells and production wells are measured on a surface map and do not reflect simulated travel times within the aquifer.

Table 10-2: Closest Drinking Water Wells to Injection Wells

Project Wells	Target Aquifer	Closest Downgradient Production Well	Approximate Distance (feet)
DIW-1	Santa Margarita	ASR-2	1,741
DIW-2	Santa Margarita	ASR-2	1,023
DIW-3	Santa Margarita	ASR-1	1,100
DIW-4	Santa Margarita	City of Seaside #4	1,022
VZW-1	Paso Robles	Paralta	2,157
VZW-2	Paso Robles	Ord Grove #2	2,412
VZW-3	Paso Robles	Ord Grove #2	1,626
VZW-4	Paso Robles	City of Seaside #4	963

10.4. Production Wells Within a Two-Year Travel Time

All downgradient drinking water wells that could potentially be reached by water injected into the Project injection wells within a two-year travel time have been analyzed in more detail pursuant to Title 22 Section 60320.200(e)(4). Because of the dynamic nature of the groundwater system resulting from intermittent ASR operation and variable downgradient pumping patterns with time, the two-year travel

time is not a fixed downgradient boundary. Rather, groundwater modeling indicates that the two-year travel time varies significantly throughout the 25-year simulation period as described in detail in **Section 5.3** of this report. To ensure that wells within a two-year travel time window are included in the analysis, the distances associated with the fastest one-year travel rates are doubled, providing an area of maximum extent within which to identify drinking water wells.

This approach is highly conservative in that the local hydraulic gradients are highest when ASR wells are in full operation, yet the wells will have to be non-operational to allow the injected product water to continue on a two-year travel path without being extracted. In other words, the conditions associated with the fastest travel times will result in extraction of the product water before a two-year travel time is complete. Conceptually, the two-year travel time used in this analysis will apply only if ASR-1 and ASR-2 wells were in full operation up to the time that product water arrived near the wells and then pumps were shut off such that product water will continue to migrate past the wells. The approach is even more conservative with respect to the vadose zone wells. Groundwater modeling indicates that none of the product water injected into the Paso Robles Aquifer intersects a Paso Robles-screened drinking water well within a two-year time frame (see Table 5-3). Nonetheless, this conservative approach accounts for a full range of potential of operations that will result in the fastest two-year travel times and includes the maximum number of production wells in the analysis.

The fastest one-year travel time is estimated at approximately 1,000 feet (DIW-3 to ASR-1; see Table 5-3); therefore, a zone downgradient of approximately 2,000 feet is applied. The drinking water wells are tabulated in Table 10-3.

Table 10-3: Drinking Water Wells within a Two-Year Travel Time

Drinking Water Well	Estimated Travel Time (years)	Producing Aquifer	Injection Well(s)
ASR-1 / ASR-2	1 year	Santa Margarita	DIW-2, DIW-3
ASR-3	2 years	Santa Margarita	DIW-1
Paralta	1.4 years	Santa Margarita / Paso Robles	DIW-1, DIW-2
Seaside 4	<2 years possible	Paso Robles	VZW-4, DIW-4

Seaside 4 is included in Table 10-3 although groundwater modeling suggests that injected product water does not reach the well in the two-year window. However, the well is included because of the hydrogeologic complexity associated with the local aquifers and the Ord Terrace fault, consistent with a conservative approach. The closest downgradient drinking water well not shown on Table 10-3 is the Ord Grove 2 well. As indicated in Table 5-3, the shortest travel time to that well was about 2.8 years.

10.5. CONTROL ZONE

As required by Title 22 Section 60320.200(e)(2), a zone of controlled well construction (control zone) must be delineated around the Project injection wells based on the longest of the travel times for pathogen control or RRT:

- Per **Section 5.4**, the proposed underground retention time for pathogenic microorganism control is 5.4 months.
- Per **Section 6.3**, the proposed RRT is 5.6 months.

Thus, the RRT of 5.6 months is the factor that will control how the control zone derivation is proposed. Because the travel times vary with changing downgradient wellfield operations, the shortest travel time periods described in **Section 5.3** are used. Specifically a zone representing the longest distance covered in six months (180 days) for each injection well is used to delineate the control zone for each aquifer.

As described previously, Figures 5-3 and 5-4 show the extents of groundwater transport for deep injection wells and vadose zone wells, respectively, for various time periods from 90 days to 360 days. These represent the shortest travel times (and associated longest distances) represented by groundwater conditions over a 25-year simulation period.

The areas representing the 180-day travel time for all Project injection wells shown on Figure 5-3 were combined to delineate a control zone for the Santa Margarita Aquifer. The extent for a 180-day travel period – the time period closest to the recommended RRT – is shown by the second inner-most concentric area delineated on Figure 5-3 (colored red). A control zone was developed by connecting the outer limits – upgradient and downgradient – from well to well. The resulting control zone for the Santa Margarita Aquifer is shown on Figure 10-1 (blue dashed line). The zone includes the three downgradient monitoring wells between the high-capacity ASR wellfields and the injection wells.

A similar methodology was used to delineate a control zone for the Paso Robles Aquifer. Connecting the outer portions of the 180-day travel time extents from Figure 5-4, results in the control zone shown on Figure 10-1 (dashed red line). The Paso Robles control zone includes all of the monitoring wells adjacent to the vadose zone wells. However, due to the much longer travel times in the Paso Robles Aquifer, the zone does not extend as far downgradient as the control zone for the Santa Margarita Aquifer. Because of lower hydraulic gradients, the injectate extends further upgradient in the Paso Robles Aquifer than in the Santa Margarita Aquifer near some of the vadose zone wells.

MRWPCA will work with the City of Seaside and the Monterey County Health Department, and FORA, if appropriate, to ensure that no production wells are constructed within these two control zones.

10.6. SECONDARY CONTROL ZONE BOUNDARY

As required by Title 22 Section 60320.200(e)(3), a secondary boundary must be delineated around the injection wells representing a zone of potential controlled drinking water well construction requiring further study prior to a production well being installed. A generalized secondary control zone is proposed as shown on Figure 10-1. This zone is defined by the closest downgradient wells and extends approximately 1,000 feet downgradient (northwest, west, and southwest) from the injection wells (with estimated underground retention times of generally one year or more, depending on well operation). Where no existing downgradient wells are within about 1,000 feet (north-northwest of DIW-1), the secondary control zone is extended approximately 1,200 feet to Eucalyptus Road in order to include the MRWPCA MW-1 monitoring well. The zone is narrower in an upgradient direction (about 600 to 800 feet) because injectate will not extend as far upgradient. The upgradient secondary control zone extends onto BLM lands where no future production wells would be expected to be drilled.

11. GROUNDWATER RECHARGE IMPACTS

Potential impacts to groundwater resulting from the Project were analyzed in a project-level EIR, certified in October 2015. The analysis was conducted using the Watermaster Model and focused on impacts to groundwater levels, quality, and storage. No unavoidable, significant impacts were identified with respect to groundwater. The objectives, assumptions, methodology, and results of the impacts analysis were presented in *Recharge Impacts Assessment Report* (Todd Groundwater, 2015a), provided as **Appendix D**.

The analysis of groundwater levels examined changes to water level hydrographs for key wells over the 25-year simulation period. The water level analysis also considered the potential for lowering water levels near the coast and exacerbating the potential for seawater intrusion. In addition to the risk for seawater intrusion, the groundwater quality analysis also incorporated results from geochemical modeling conducted for the MRWPCA field program. This modeling evaluated the potential for constituents in the vadose zone to be leached by percolating injectate, thereby impacting groundwater quality. The geochemical modeling also included the potential for adverse geochemical interactions between product water and groundwater. With respect to groundwater storage, no impacts were identified; extractions associated with the Project will not exceed amounts of injection.

The impacts analysis provided for the EIR is summarized in the following sections.

11.1. POTENTIAL IMPACTS TO GROUNDWATER LEVELS

Changes to groundwater levels in each aquifer system over the 25-year simulation period were evaluated. This included application of the groundwater model to assess water level declines that would adversely affect the use of existing wells or exacerbate seawater intrusion. The evaluation also considered short-term water level increases that could cause problems associated with high groundwater.

11.1.1. Impacts Analysis Methodology and Groundwater Modeling

To predict water level changes as a result of the Project, the Watermaster Model was used to simulate Project operation over a 25-year simulation period. The Watermaster Model is described in **Section 9.1.3.2** and model set up and simulation assumptions are described in **Section 5.3.1**. The Project modeling incorporated the proposed delivery schedule and drought reserve account described in **Section 8**. Specifically, the appropriate delivery schedule of the eight schedules shown on Table 8-1 was assigned to each year of Project operation in the modeling based on hydrology and the balance of the drought reserve account. As discussed previously, 90% of the available product water was injected into the Santa Margarita Aquifer and 10% was injected into the Paso Robles Aquifer. A technical memorandum describing the modeling objectives, assumptions, and results was included as *Appendix C* in the Recharge Impacts Assessment Report (Todd Groundwater, 2015a) – see **Appendix D** in this report.

11.1.2. Analysis of Potential Impacts to Groundwater Levels

Because the Project will inject water into the Seaside Basin for downgradient extraction, the project will result in both higher and lower water levels in existing basin wells over time depending on the timing of extraction and the buildup of storage in the basin. An examination of eight key production wells was completed by HydroMetrics and presented for the entire 33-year simulation period, which included 25

years of Project operation (HydroMetrics, 2015). These hydrographs illustrate simulated changes in water levels over time at various locations within the basin with and without Project operation.

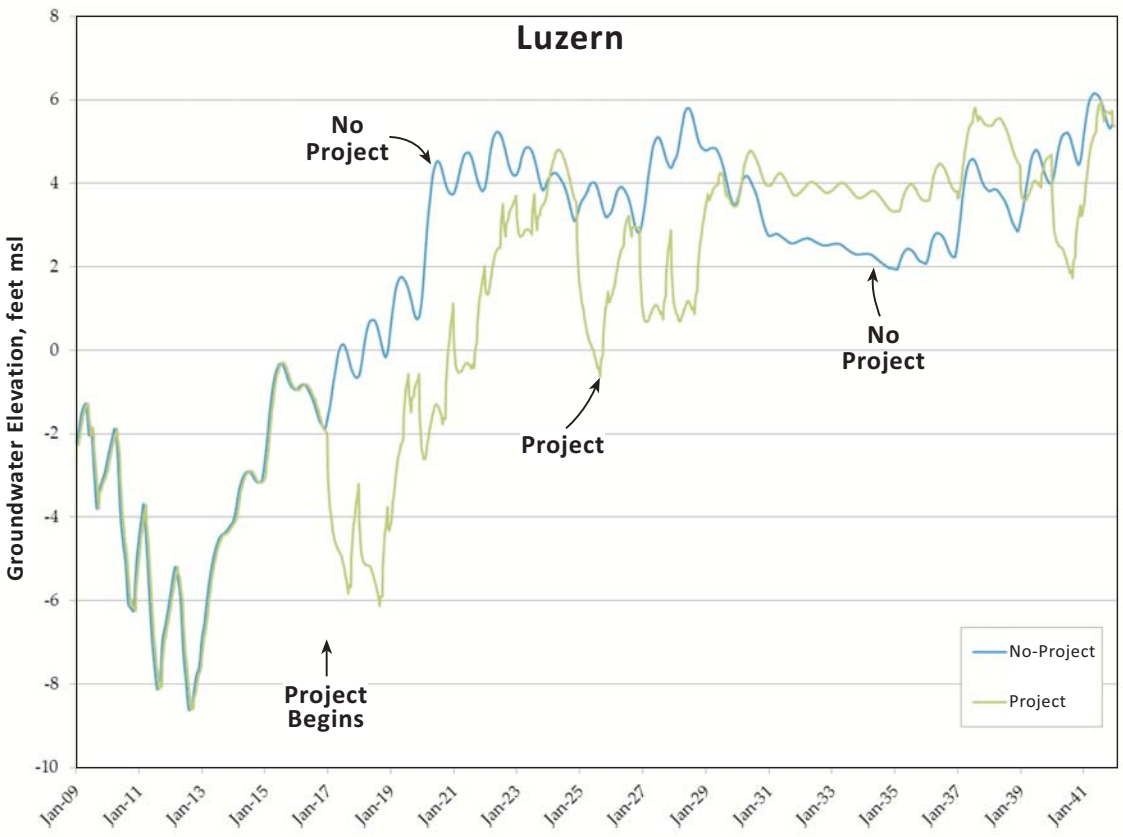
Four example hydrographs comparing the Project with a *No Project* scenario are presented on Figures 11-1 and 11-2, representing shallow (Paso Robles Aquifer) and deep water levels (Santa Margarita Aquifer), respectively. On both Figures 11-2 and 11-2, the *No Project* scenario is represented by the blue line and the Project scenario is represented by the green line. The Project is simulated to begin in late 2016 (WY 2017); prior to that time period, the water levels for the *No Project* and Project scenarios are the same (Figures 11-1 and 11-2). Hydrographs are discussed in more detail below.

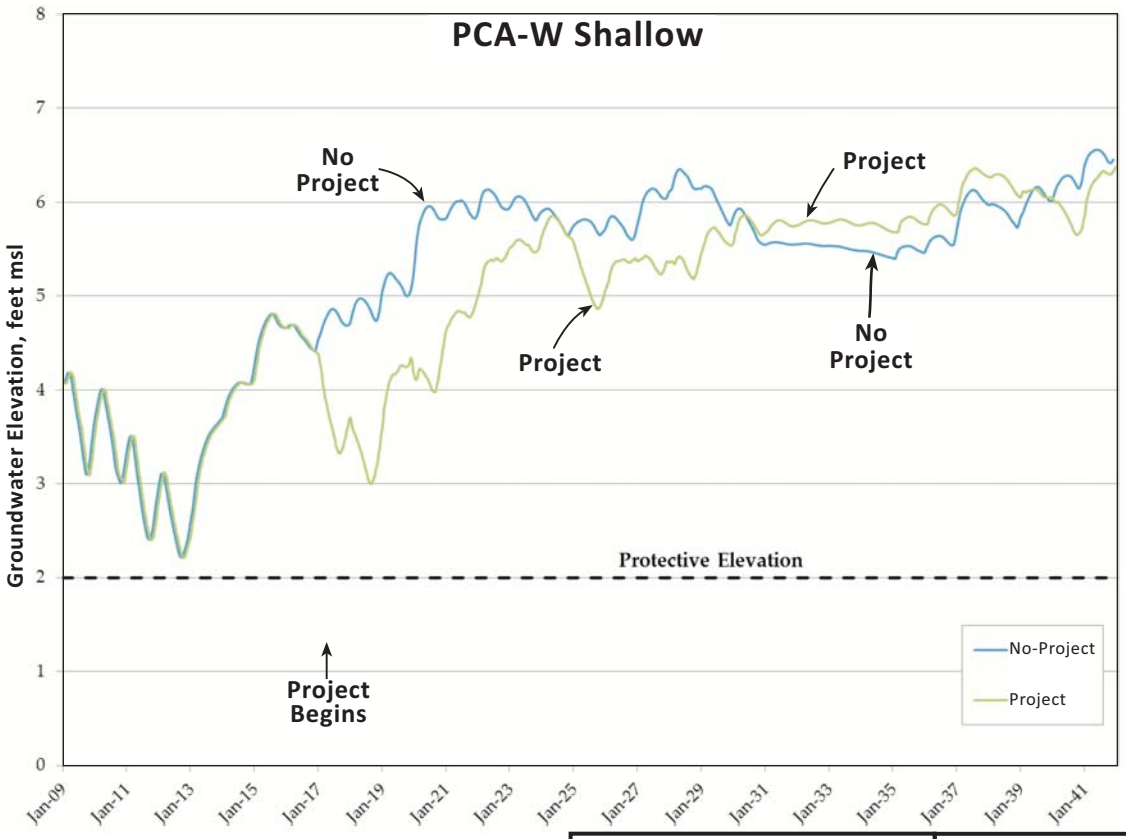
11.1.2.1. Impacts to Paso Robles Water Levels

Figure 11-1 documents changes in simulated water levels with and without Project operation, as illustrated by the Luzern and PCA-W Shallow wells (both screened in the Paso Robles Aquifer). Well locations are shown on the water level contour map for the Paso Robles Aquifer on Figure 9-10.

As shown on Figure 11-1, simulated water levels generally rise under both the Project and *No Project* conditions due to an overall decrease in basin pumping associated with the adjudication. After the Project is initiated, the Luzern well is pumped to recover the recharged water, although the water has not yet arrived in the vicinity of the well. This creates slightly lower simulated water levels (up to about seven feet) in early stages of the Project. This also occurs in the PCA-W Shallow well, but the difference is only a few feet because this well is not being pumped to recover Project water. With time, simulated water levels in the Luzern and PCA-W wells rise as the Project injectate moves downgradient toward these wells. The benefit of additional recharge is demonstrated by higher simulated water levels associated with the Project during drought conditions between 2030 and 2035 for both of these wells.

Importantly, simulated water levels do not fall below pre-project levels and do not fall below the Protective Elevation for seawater intrusion (see the Protective Elevation line on PCA-W Shallow well on Figure 11-1). These Protective Elevations have been determined by the Seaside Basin Watermaster to provide target water levels that are considered to protect the basin from the adverse consequences of seawater intrusion (HydroMetrics, 2009). Although other coastal wells remain below Protective Elevations with and without the Project, the changes predicted to be associated with the Project are demonstrated by the hydrograph of PCA-W Shallow, the closest coastal well. These data indicate that the Project will not exacerbate the risk for seawater intrusion compared to the *No Project* conditions.





Source: Hydrometrics, November 2014 in Appendix C

November 2015

TODD GROUNDWATER

Figure 11-1
Project Impacts to Shallow Water Levels

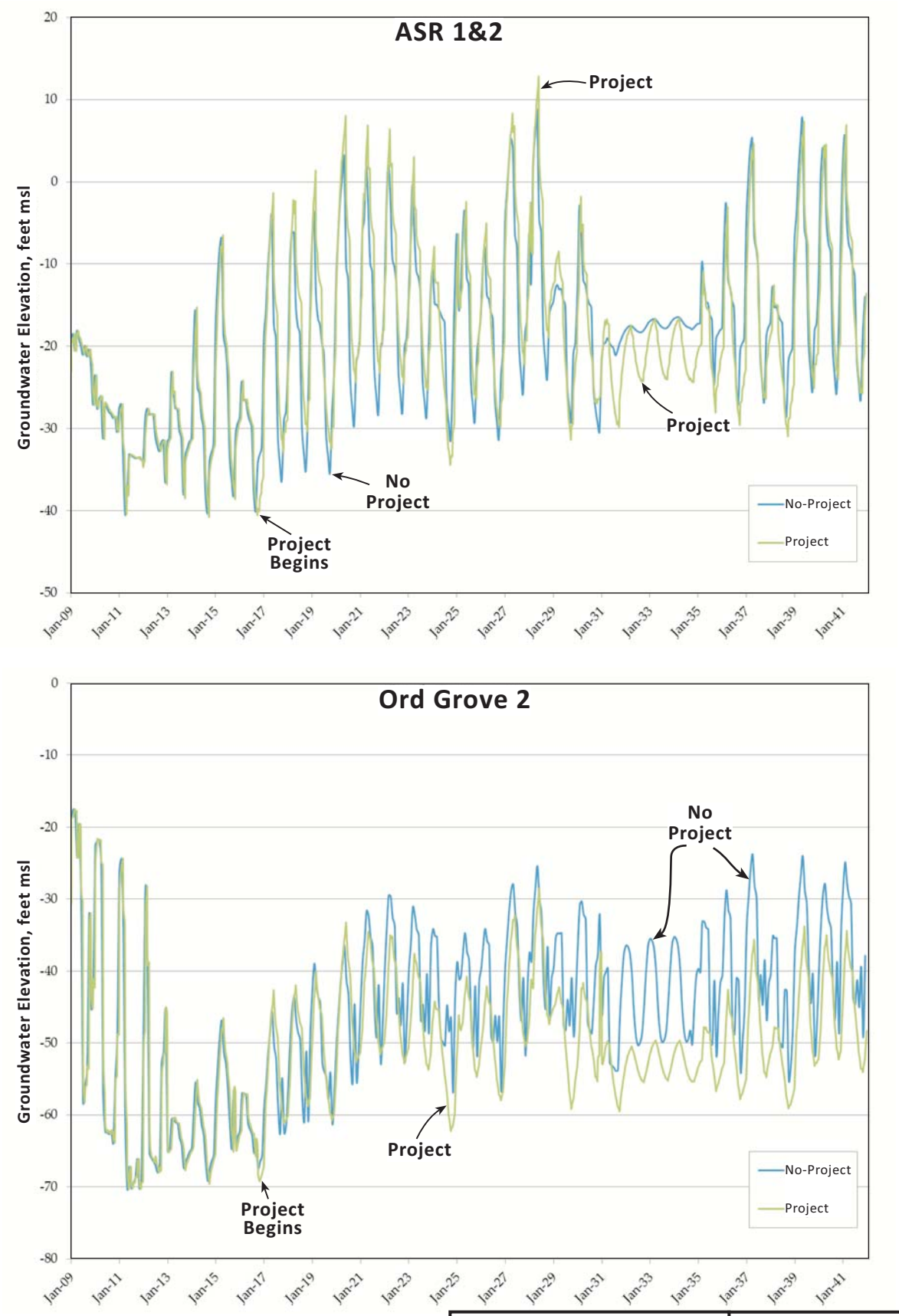
11.1.2.2. Impacts to Santa Margarita Water Levels

Figure 11-2 shows simulated water levels for the two ASR wells closest to the Injection Facilities (ASR-1 and ASR-2) and the downgradient production well, Ord Grove 2. Well locations and recent water level contours for the Santa Margarita Aquifer are shown on Figure 9-11 (Ord Grove 2 is labeled Ord Grove Production on Figure 9-11).

As shown on the hydrographs on Figure 11-2, simulated deep water levels rise in the ASR and Ord Grove wells soon after the Project is implemented in late 2016. Although simulated water levels continue to rise and fall due to seasonal fluctuation associated with water demand and pumping, water levels do not fall to the lower levels observed in 2011 – 2016 prior to project start-up. The overall rise in water levels under both the Project and *No Project* conditions primarily reflects the decrease in overall basin pumping as required under the adjudication. For the ASR wells, simulated water levels under the Project scenario are similar to or slightly higher than the *No Project* water levels.

An exception to this occurs during the drought cycle, generally represented by the time period 2031 – 2035, when simulated water levels associated with the Project are one to nine feet lower than under *No Project* conditions. During that time, the ASR wells are pumping to recover Project water under *Project* conditions, but the ASR wells are not operating under *No Project* conditions. ASR wells are idle during *No Project* conditions because, during drought conditions, no water is available to be extracted from the Carmel River Alluvial Aquifer and no stored water is available for ASR recovery. Because the simulated pumping for the Project conditions causes water levels in the wells to fluctuate more than for the *No Project* conditions, simulated water levels are lower on a seasonal basis under the Project conditions during a simulated drought cycle. This impact is seen as beneficial overall in that simulated water levels are not lowered significantly and only for a short duration, while simulated groundwater pumping and water supply has been increased during a drought. Under both scenarios, overall simulated water levels remain higher than current levels.

For the Ord Grove well (Figure 11-2), simulated water levels are relatively similar for the Project and *No Project* scenarios from project implementation to about 2029. At that time, the Project simulated water levels are generally lower (up to about 10 feet lower), but typically less than about five feet lower during the bottom of each pumping cycle. Again, this is due to the increased pumping allowed by the ongoing injection from the Project. Also, the simulated lower water levels during the drought cycle are higher than the low levels reached prior to the initiation of the Project. Because simulated water levels are higher than current levels while production is being increased in the basin, the Project is considered to have a beneficial impact on water supply without a significant adverse impact to groundwater levels and wells.



Source: Hydrometrics, November 2014 in Appendix C

November 2015

TODD GROUNDWATER

Figure 11-2
Project Impacts to Deep Water Levels

11.1.2.3. Groundwater Quantity

The modeling simulations of the Project recover only the water recharged to the aquifers. As such, the Project will not result in a significant change in groundwater storage in the basin because the water being injected will eventually be extracted for municipal use. Further, the Project will increase basin yield and groundwater supply. Figure 11-3 illustrates the movement of recharged water toward basin extraction wells.

11.2. POTENTIAL IMPACTS TO GROUNDWATER QUALITY

As described in the previous sections, the recycled water will be treated and stabilized to meet all drinking water quality objectives. Also discussed previously and shown in Table 9-5, concentrations of constituents in the pilot water sample, including TDS (74 mg/L) and nitrogen (1.3 mg/L as total N) all meet Basin Plan objectives (Table 9.5). Further, the product water is expected to be higher quality water than ambient groundwater with respect to TDS, chloride, nitrate, and other constituents (see analysis in **Section 9.4**). Accordingly, the Project will not result in groundwater failing to meet groundwater objectives or beneficial uses (including municipal water supply). Rather, the product water will have a beneficial effect on local groundwater quality.

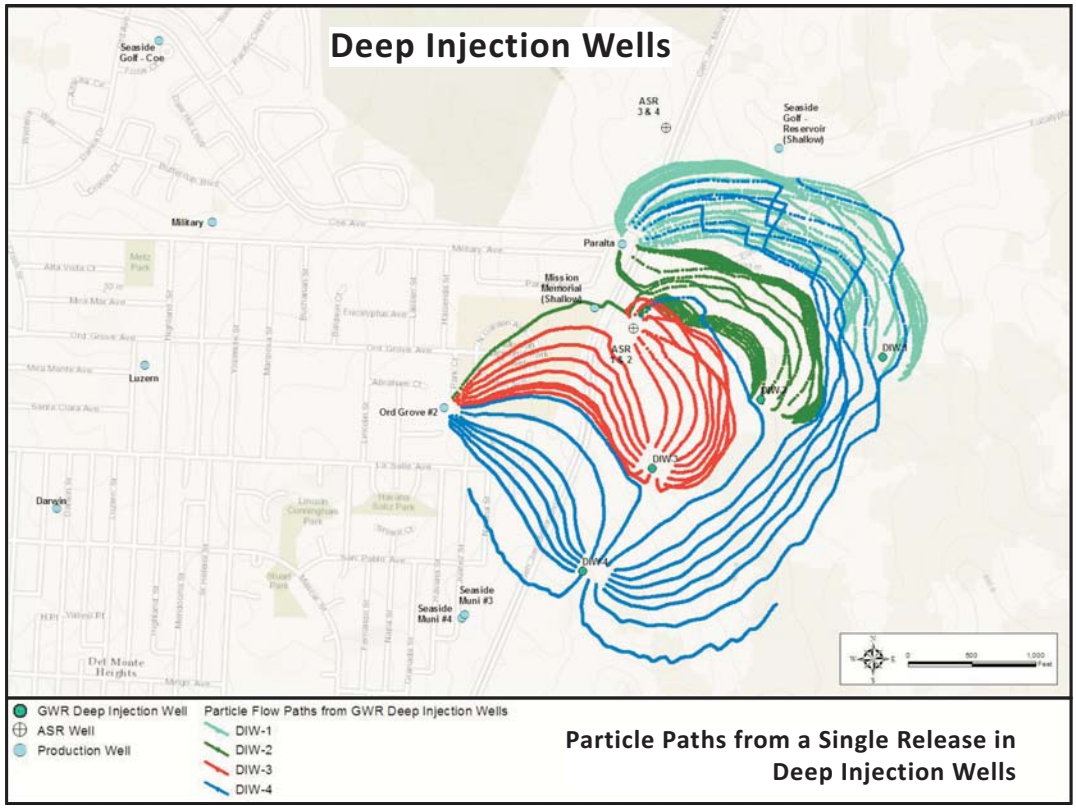
11.3. RECYCLED WATER CONTRIBUTION

MRWPCA is proposing a 100% RWC in conformance with Title 22 Section 60320.216 with no diluent water needed. Although product water will be mixing with groundwater, the impacts analysis shows that groundwater quality will not be adversely impacted. In addition, product water is of higher quality than groundwater with respect to mineral content and will actually improve overall groundwater quality locally.

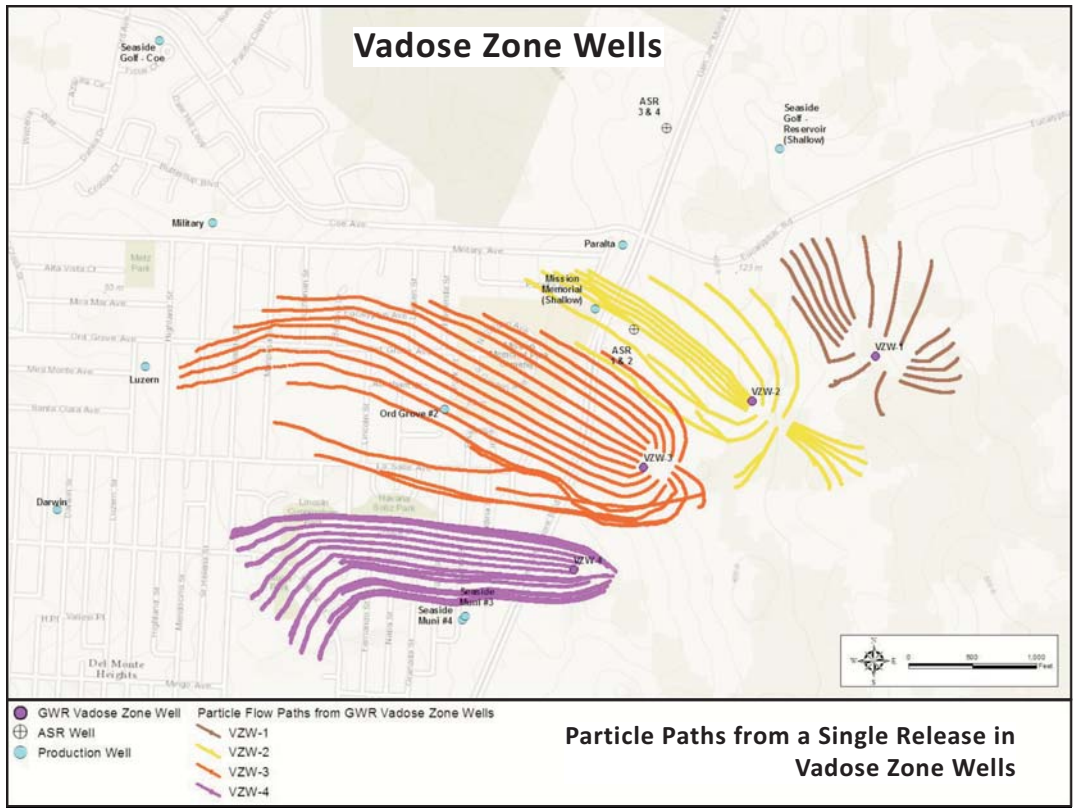
11.4. ANTI-DEGRADATION ASSESSMENT

As discussed in **Section 2.3.1**, the State Anti-degradation Policy was adopted to maintain high quality water resources to the maximum extent possible, especially when the quality of the water is higher than established by adopted policies (Resolution 68-16). As described in **Section 9.4.2**, groundwater in the Seaside Basin is highly mineralized, with elevated TDS and chloride concentrations throughout the basin compared to the product water.

A recent groundwater quality analysis for the SNMP indicates that current groundwater quality meets Basin Plan objectives (HydroMetrics, 2014a). But the SNMP determined that the groundwater quality does not meet the qualifications of high quality water as described in the Anti-degradation Policy and that an anti-degradation assessment is not needed. Further, the SNMP concluded that the product water will also meet Basin Plan objectives and is expected to contain much lower TDS and chloride concentrations than in ambient groundwater. Therefore, none of the Seaside Basin's assimilative capacity will be required by the Project. Existing groundwater quality and assimilative capacity for the Northern Inland Subarea as presented in the SNMP are summarized in Table 11-1. Also included in the table are assimilative capacity values for the groundwater basin.



Particle Paths from a Single Release in Deep Injection Wells



Particle Paths from a Single Release in Vadose Zone Wells

Source: Hydrometrics, November 2014 (See Technical Memorandum in Appendix C)

November 2015

TODD GROUNDWATER

Figure 11-3
Modeled Flowpaths From Project Wells

Table 11-1: Groundwater Quality and Assimilative Capacity, Northern Inland Subarea

Northern Inland Subarea	Paso Robles Aquifer	Santa Margarita Aquifer	Combined Aquifers	Water Quality Objectives	Subarea Assimilative Capacity	Basin-wide Assimilative Capacity
TDS, mg/L	344	327	336	500	164	-40
Chloride, mg/L	63	61	62	250	188	110
Nitrate (as N) mg/L	0.43	0.53	0.48	10	9.5	9.3

Source: modified from SNMP data (HydroMetrics, 2014a)

11.5. IMPACTS TO EXISTING GROUNDWATER CONTAMINATION

As previously described in **Section 9.4.3.2**, the Injection Facilities are located on former Fort Ord lands. The area, now under FORA control, has been cleared of munitions and explosives of concern and remedial actions have been completed. Analyses of vadose zone core and groundwater as part of the MRWPCA field program indicated that local groundwater adjacent to the Injection Facilities area had not been impacted by Fort Ord legacy constituents (see also Todd Groundwater, 2015). No known groundwater contamination exists beneath the Injection Facilities area.

A search of the surrounding area including the downgradient Northern Coastal Subarea was conducted on the California Department of Toxic Substances Control (DTSC) *EnviroStor* web site (www.envirostor.dtsc.ca.gov) and SWRCB *Geotracker* web site (http://geotracker.waterboards.ca.gov). The goal of the search was to identify any potential industrial sites or activities that could contribute to groundwater contamination from previous site uses, spills, and/or chemical releases. The focus was on downgradient areas where injection from the Project might mix, redirect, spread, or otherwise interfere with existing areas of groundwater contamination.

Both *EnviroStor* and *Geotracker* listed the 28,016-acre Fort Ord Military Reservation as an active Federal Superfund site and listed munitions as the contaminant of primary concern. Additionally, *Geotracker* identified two adjacent sites on the former Fort Ord lands as gasoline contamination sites: (1) the 14th Engineers Motor Pool and (2) Building 511. These are active sites currently undergoing investigations and are located about 1.8 miles to the northeast. However, both sites are outside of the Seaside Basin and are not a threat to groundwater in the Injection Facilities area.

Other environmental sites have been identified in the Seaside Basin, including numerous leaking underground storage tank sites, but none were in the Injection Facilities area or in areas expected to be impacted by the Project. Specifically, there were no environmental contaminant sites identified in the area between injection and downgradient extraction wells. The Project operation would not be expected to impact any contaminant plumes, if any, located outside of this area.

11.6. DISSOLUTION OF EXISTING CONTAMINANTS

As mentioned in **Section 9.4**, a field program conducted by MRWPCA in 2013-2014 included sampling and analysis of sediment cores, pilot water, and groundwater to support geochemical modeling. Specifically, the analysis involved the following:

- solid core extraction and leaching test analyses,
- development and analysis of a bench-scale stabilized product water sample,
- solid core mineralogical analysis (x-ray diffraction and x-ray fluorescence),
- core bulk chemical analysis,
- cation exchange capacity,
- geochemical modeling of vadose zone leaching using PHREEQC geochemical models developed by USGS (Parkhurst and Appelo, 2-013) and
- groundwater quality impacts analyzed through groundwater sampling, geochemical plotting techniques, and PHAST, a Windows based reactive transport groundwater model.

The purpose of the modeling was to evaluate the potential for dissolution (leaching) of existing constituents in the vadose zone (beneath vadose zone wells) that could impact groundwater quality. The geochemical compatibility of the product water and groundwater was also evaluated.

Geochemical modeling was conducted with a series of PHREEQC and PHAST geochemical model codes by Mahoney Geochemical Consulting LLC, Lakewood, CO (See *Appendix G in* Todd Groundwater, February 2015); this report is provided as **Appendix D**. The modeling was used to analyze the potential for leaching of chromium, arsenic, and lead from the vadose zone sediments (including samples from the Aromas Sand and Paso Robles Aquifer).

Chemical analyses identified chromium present in vadose zone sands in trace amounts as part of the hydrous ferric oxide coating of the quartz sand grains. Geochemical modeling predicted that these trace amounts of chromium could de-sorb into solution. However, this leaching was concluded to be a transient initial effect due to the low amounts of chromium present in the formation and would not persistent on a long-term basis. Conservative geochmical modeling indicated that groundwater concentrations may reach a maximum of 4 ug/L prior to depletion of the chromium source and that drinking water standards would not be violated. Predicted concentrations were substantially below the total chromium MCL of 50 µg/L.

Although arsenic and lead were also determined to be present in vadose zone sediments, those constituents were more strongly adsorbed to the oxides than chromium. Consequently, only small amounts are predicted to be released into solution as the injected water flows through the Aromas Sand, resulting in sustained but low concentrations of about 4 µg/L for arsenic and approximately 0.7 µg/L for lead. Concentrations in the zone of saturation meet water quality standards. None of the analyses indicated that groundwater concentrations would exceed regulatory standards for any of the leached constituents.

Additional geochemical analyses indicated that aquifer clogging from calcite precipitation will be unlikely due to the low concentrations of calcium and bicarbonate. Extensive biofouling of injection wells was also evaluated and determined to be unlikely given that the low concentrations of nitrogen and phosphorus in the AWT Facility product water will not tend to stimulate microbial growth.

In addition to impacts from the vadose zone wells, the analysis examined the potential for impacts to the Santa Margarita Aquifer from recharge into deep injection wells. Results indicated that the potential for such impacts were unlikely. Risk of trace metal desorption during injection of recycled water into the Santa Margarita Formation was inferred from previous studies of injected Carmel River water. The two injected water types have similar pH and oxidation-reduction potential, and are therefore expected to have similar effects with respect to adsorption/desorption processes. Previous studies found no indications that significant metal concentrations will be released into solution, and those results can reasonably be extended to injection of recycled water. Further, biofouling will not likely pose a problem for the injection wells because the injected water is very low in nitrogen and phosphorus and will not tend to stimulate microbial growth

None of the modeling results indicated that groundwater will be geochemically incompatible with product water or that the Project would have a significant impact on groundwater quality. Complete results of the geochemical analyses and modeling are presented in the draft report on the MRWPCA field program (Todd Groundwater, 2015b) and also attached to this report as **Appendix I**.

11.7. CONCLUSIONS OF THE PROJECT IMPACTS ASSESSMENT

Based on the groundwater characterization and pilot water quality presented in **Section 9.4**, and results from the MRWPCA field program including geochemical modeling (described above), no significant impacts to groundwater levels or quality are anticipated from the Project. Summary conclusions are offered below:

- The project water injection into the Seaside Basin will result in both higher and lower water levels in wells throughout the basin at various times. Although water levels will be slightly lower during some time periods, the difference is generally small and judged insignificant.
- Modeling indicates that the Project will not lower water levels below protective levels in coastal wells and will not exacerbate seawater intrusion.
- Stabilized pilot plant water samples and projected AWT Facility product water meet Title 22 Criteria for groundwater replenishment projects and Basin Plan groundwater quality standards, including drinking water MCLs. Further, the treatment processes to be incorporated into the AWT Facility will be selected and operated to ensure that all water quality standards will be met in both the product water and groundwater. A monitoring program will document project performance.
- The product water will be stabilized at the AWT Facility to ensure no adverse geochemical impacts. Geochemical modeling associated with the MRWPCA field program indicated that no adverse groundwater quality impacts are expected from leaching or other geochemical reactions.
- No documented groundwater contamination or contaminant plumes have been identified in the Injection Facilities area or downgradient between injection and groundwater extraction wells. Therefore, injection associated with the Project will not exacerbate existing groundwater contamination or cause plumes of contaminants to migrate.

Stabilized pilot plant water samples and projected AWT Facility product water exhibit much lower concentrations of TDS and chloride than in ambient groundwater and will be expected to provide a localized benefit to groundwater quality. Such a benefit will expand over time with continuous injection from the Project wells.

12. PROPOSED MONITORING AND REPORTING PROGRAM

The monitoring and reporting program (MRP) proposed in this section will be used to demonstrate compliance with Title 22 Criteria and other regulations that apply to the use of product water for groundwater replenishment. This section has the following structure:

- General Provisions
- AWT Facility Influent Quality
- RO Performance
- AOP Performance
- Pathogenic Microorganism Reduction
- Recycled Water Policy Advanced Treatment Requirements
- Product Water Quality
- Groundwater Quality
- Project Reports

12.1. GENERAL MONITORING PROVISIONS

The proposed MRP includes the following monitoring locations:

- AWT Facility influent (RTP secondary effluent)
- MF system
- RO feed
- RO permeate
- AOP feed
- AOP effluent
- AWT Facility effluent (product water) prior to injection
- Receiving groundwater

The Project Sponsor will ensure proper sampling and analyses by:

- Use of a laboratory that is DDW-approved, RWQCB-approved, or Environmental Laboratory Accreditation Program (ELAP)-certified for analyses of regulated constituents.
- Use of drinking water analytical methods for constituents with MCLs that are DDW-approved, as described in 40 CFR Part 141:
    - Analytical methods will be selected with MRLs lower than prescribed limitations or goals when practicable and feasible.
    - Calibration curves will be developed that include the MRL (or equivalent if there is a different treatment of samples relative to calibration standards) to avoid extrapolation beyond the lowest point of the calibration curve.
    - Allowable hold time limits as specified in 40 CFR Part 141 will be observed.
    - All QA/QC analyses will be completed on the same day samples are analyzed.

- Selection of the best available method for chemicals specified in the Title 22 Criteria without primary and secondary MCLs (listed in order of preference):
    - Drinking water method.
    - DDW-recommended methods.
    - Most sensitive of the U.S. EPA approved methods.
    - Most sensitive of the methods available from scientific literature and commercial laboratory (requires DDW-approval and RWQCB notification).
    - A method developed by the laboratory (requires DDW review/approval and RWQCB notification).
    - Wastewater analysis method – sample can be taken immediately prior to RO treatment to increase likelihood of detection (RWQCB notification).
- Use of sample dilution between 1 and 800 for bacteria analyses.
- Use of analytical methods that achieve SWRCB-specified MRLs for CEC monitoring required by the Recycled Water Policy.
- Prescribing the month in which routine monitoring occurs:
    - All quarterly monitoring in February, May, August, and November
    - All semi-annual monitoring of product water in February and August
    - All semi-annual monitoring of groundwater in May and November
    - Should MRWPCA need to deviate from these specified months, the RWQCB will be notified of the deviation and reason for deviation.
- Providing analytical results in the monitoring report submitted in accordance with MRP for the Project.
- MRWPCA will notify public water systems and drinking water well owners having downgradient source potentially affected by the Project and within a 10-year travel time from the Project of the availability of monitoring reports. Notification will be by direct mail and/or electronic mail. Other parties interested in receiving copies of the reports must notify MRWPCA in writing to be notified when the reports are available.

Reports produced as a part of the proposed MRP will at a minimum include:

- Analytical results for sampling locations and compliance with permit requirements or conditions.
- Location of each sampling station.
- A summary of sampling protocols and chain of custody procedures.
- Identification of laboratories conducting analyses.
- Analytical test methods and corresponding reporting limits (MRLs) and method detection limits (MDLs).
- A summary of QA/QC measures.

12.2. AWT FACILITY INFLUENT QUALITY MONITORING

AWT Facility influent is secondary-treated effluent from the RTP. The AWT Facility influent meets Title 22 Section 60320.201 requirements that specify the use of oxidized wastewater (a term defined in Title 22 Section 60301.650). RTP effluent is currently monitored in

accordance with RWQCB Order No. R3-2014-0013 (see **Appendix F**) and one of the routinely measured parameters is $CBOD_5$, which can serve as an indication of oxidized effluent. To date, all samples have consistently met effluent limits for $CBOD_5$, and the highest reported daily maximum value was 26 mg/L in September 2009, which is below the 85 mg/L daily maximum effluent limit. The influent sampling station will be located before secondary treated water enters the AWT Facility and prior to hypochlorite addition. Influent samples will be obtained on the same day that effluent samples from the RO system are obtained. The date and time of sampling will be reported with the analytical values determined. Table 12-1 constitutes the influent monitoring program.

Table 12-1: AWT Facility Influent Monitoring

Constituents	Units	Type of Sample	Minimum Frequency of Analysis
Flow	mgd	Recorder	Continuous[a]
pH	pH	Recorder	Continuous[a]
Turbidity	NTU	Recorder	Continuous[a]
TSS	mg/L	24-hour comp.	Daily
TOC	mg/L	24-hour comp.	Weekly
$CBOD_5$ 20°C	mg/L	24-hour comp.	Weekly
NDMA	ng/L	Grab	Quarterly

a. For those constituents that are continuously monitored, MRWPCA will report the monthly minimum and maximum, and daily average values.

12.3. RO Performance Monitoring

Per Title 22 Criteria MRWPCA is required to propose indicators and/or surrogates to evaluate AWT unit process performance. To satisfy Title 22 Section 60320.201(b), RO feed and permeate will be monitored continuously for EC using online meters. EC LRV is a surrogate that serves to monitor performance of the RO treatment process and provides an early warning of compromised integrity. Example critical, alarm, and shutdown setpoints are <1.5, ≤ 1.6, ≤ 1.55 EC LRV, respectively (see **Section 13** for details).

Reporting the effectiveness of the RO process will be in accordance with Title 22 Sections 60320.201(g) and (h). Within 60 days after the initial twelve months of full-scale operations, MRWPCA will submit a report to DDW and RWQCB regarding RO performance based on EC LRV and any accounts of process failure(s) based on critical, alarm, and shutdown setpoints and corresponding corrective action(s) taken. Additionally, each quarter for the duration of the replenishment operation, MRWPCA will provide the percentage of results that did not meet the EC operational limits. Since monitoring will be continuous, daily averages will be used for computation. MRWPCA will submit a report to DDW and RWQCB that explains the corrective action(s) planned or taken to reduce the percent to less than 10% and consult with DDW and if required comply with an alternative monitoring plan approved by DDW.

12.4. AOP PERFORMANCE MONITORING

UV/H_2O_2 AOP has been piloted multiple times by various agencies, including City of Los Angeles, Water Replenishment District of Southern California, OCWD, West Basin Municipal Water District, and City of San Diego. Since the Project is utilizing a previously piloted AOP option, it is not necessary to complete another pilot study for the Project. To satisfy Title 22 Section 60320.201(d) that a sufficient oxidation process has been implemented, MRWPCA will work with DDW to develop and implement a DDW-approved test plan during the commissioning phase. The testing will be conducted at a UVT of 95% and with hydrogen peroxide doses ranging from 2.5 to 6 mg/L. The testing will be used to demonstrate 0.5-log 1,4-dioxane concentration reduction and select surrogate(s) and/or operational parameter(s) that are capable of being monitored continuously, recorded, and have associated alarms that indicate treatment failure. Based on existing permitted subsurface application GRRPs (City of Los Angeles, Water Replenishment District of Southern California, and OCWD), the following surrogates and operational parameters may be considered:

- Total chlorine
- Free ammonia
- Total ammonia
- UV transmittance
- UV power usage
- UV intensity
- Electrical energy dose (EED)
- H_2O_2 dose
- Power per order of magnitude log removal (EE/O) based on UV dose
- UV dose

Reporting the effectiveness of the AOP process will be conducted in accordance with Title 22 Sections 60320.201(e) and (h). Within 60 days after the initial twelve months of full-scale operations, the MRWPCA will submit a report to DDW and RWQCB regarding AOP performance based on selected surrogate(s) and/or operational parameter(s) during demonstration testing, as well as a description of any process failure(s) and corresponding corrective action(s) taken. Additionally, each quarter for the duration of the replenishment operation, MRWPCA will calculate the percentage of results that did not meet the selected surrogate or operational parameter's operative limits to ensure AOP performance. If monitoring is continuous using online analyzers, daily averages will be used for computation. MRWPCA will submit a report to DDW and RWQCB that explains the corrective action(s) planned or taken to reduce the percent to less than 10% and consult with DDW and if required, comply with an alternative monitoring plan approved by DDW.

12.5. PATHOGENIC MICROORGANISM REDUCTION MONITORING

For the purpose of evaluating the performance of the treatment facilities/units with regards to pathogenic microorganism reduction (see **Section 5**), MRWPCA will include the results of the monitoring specified in **Table 12-2** in its compliance monitoring reports.

Table 12-2: Pathogenic Microorganism Control Compliance Monitoring

Unit Process	Integrity Measure	Monitoring Frequency	Reporting	
			Pass	Assumption
MF	Pressure decay LRV	Once every 24 hours of operation	≥4.0[a] log	MF is providing credited log reductions
RO	EC LRV reduction[b]	Continuous[c]	≥1.0 log	RO is providing credited log reductions
AOP	Calculated UV dose[d] H_2O_2 dose	Continuous[c]	800-1200 mJ/cm^{2}[e] 2.5-6 mg/L H_2O_2[e]	AOP is providing credited log reductions

a. Pressure decay rate value with an ending pressure that provides a resolution of 3 microns or less.
b. Daily EC reduction = $-\log(EC_{RO\ Permeate}/EC_{RO\ Feed})$.
c. Since monitoring will be continuous using online analyzers, daily averages will be used for computation.
d. The UV reactor outputs a calculated UV Dose using online measurements of AOP feed flow rate, UV transmittance, and UV intensity. The dose equation or validation report will be provided after the UV/AOP system supplier is selected, or after performance testing during start-up
e. Set points have not been established at this time, but are expected to be within the ranges shown.

To satisfy on-going compliance of pathogenic microorganism control at the AWT Facility per Title 22 Section 60320.208(c), MRWPCA will administer and monitor MF pressure decay tests, EC reduction through RO, and UV and H_2O_2 dose delivered through AOP. The log reduction achieved through the entire system will be determined each day and reported as "yes" if required log reductions were achieved or "no" if not achieved. If any of the three components (MF, RO, and AOP) do not pass, response measures specified in Title 22 Sections 60320.208(h) and (i) will be launched. Within 24 hours of becoming aware of the issue, MRWPCA will immediately investigate potential cause(s) and take corrective action(s). The DDW and RWQCB will be notified immediately if the AWT Facility fails to meet pathogen reduction criteria longer than four consecutive hours, or more than a total of eight hours during any seven-day period. Failures of shorter duration will be reported to the RWQCB no later than ten days after the month in which failure occurred. If the calculated overall log reduction drops below 10-logs for enteric virus, or 8-logs for *Giardia* cysts or *Cryptosporidium* oocysts, MRWPCA will immediately notify DDW and RWQCB, and discontinue application of product water for injection, unless directed otherwise by DDW or RWQCB.

12.6. Recycled Water Policy Advanced Treatment Requirements

The Recycled Water Policy requires monitoring for RO and AOP performance for subsurface application projects. These measures include CEC performance indicators, surrogate, and health-based CEC indicators. The purpose of this is to evaluate performance and integrity of

the RO and AOP processes, and to monitor CECs that are of toxicological relevance to human health. Performance indicators and surrogates are discussed in **Section 12.6.1** and Health-based CEC indicators are discussed in **Section 12.6.2**.

12.6.1. Performance Indicators and Surrogate

The monitoring requirements are project-specific and determined using a phased approach. The first phase is the Initial Assessment Monitoring and has a duration of one year. This phase is used to determine treatment effectiveness for the performance indicators specified in the Policy and for surrogate(s) selected with DDW input, and to evaluate their removals. During this phase, the Policy requires quarterly monitoring of four CEC indicators: caffeine, NDMA, DEET, and sucralose. MRWPCA is proposing to use EC as the performance surrogate.

After the one-year Initial Assessment Phase, the Baseline Monitoring Phase would begin, which lasts for three years. For the Baseline Monitoring Phase, MRWPCA recommends that the CEC indicators' monitoring frequencies be lowered to semi-annual, with the exception of NDMA, for which the quarterly monitoring frequency will be maintained. After the three-year Baseline Monitoring Phase, monitoring would shift to Standard Operating Monitoring, where per the Policy, the monitoring frequencies for the CEC indicators can be semi-annually or annually. For the Standard Operating period, MRWPCA proposes the monitoring frequencies shown in **Table 12-3**. For all monitoring phases, should a CEC indicator not be present at sufficient concentrations to use for performance assessments, MRWPCA will consult with DDW and RWQCB on other potential options.

Table 12-3: Performance Indicators and Proposed Surrogate for Recycled Water Policy – Standard Operating Monitoring

Parameter		Constituent Group	Sample Type	Monitoring Frequency[b]	Monitoring Location	
					RO Feed	Product Water for Injection
Performance Indicators[a]	Caffeine	Stimulant	Grab	Annually	X	X
	NDMA	Disinfection byproduct	Grab	Quarterly	X	X
	DEET	Personal care product	Grab	Annually	X	X
	Sucralose	Food additive	Grab	Annually	X	X
Surrogate	EC	N/A	Online	Continuously[c]	X	X

a. If a performance indicator is not present at sufficient concentrations to evaluate removal, MRWPCA will propose another option for DDW and RWQCB consideration.
b. Expected monitoring frequency for standard operations shown here, but for the Initial Monitoring Phase (the first year of the Project) all parameters will be sampled quarterly and for the Baseline Monitoring Phase (the next three years) all parameters will be sampled semi-annual except for NDMA, which will be quarterly.
c. Since EC monitoring will be continuous using online analyzers, daily averages will be used for percent removal computations.

Per the Recycled Water Policy:

> "Analytical methods for laboratory analysis of CECs shall be selected to achieve the reporting limits presented in Table 1 [of the Policy]. The analytical methods shall be based on methods published by the United States Environmental Protection Agency, methods certified by CDPH [DDW], or peer reviewed and published methods that have been reviewed by CDPH [DDW], including those published by voluntary consensus standards bodies such as the Standards Methods Committee and the American Society for Testing and Materials International. Any modifications to the published or certified methods shall be reviewed by CDPH [DDW] and subsequently submitted to the Regional Water Board in an updated quality assurance project plan."

The effectiveness of the RO and RO/AOP processes using the proposed surrogate and indicators will be reported as percent removal of the measured parameter:

$$\text{Percent Removed} = ([X_{\text{RO Feed}} - X_{\text{RO Permeate}}]/X_{\text{RO Feed}})\ (100)$$

During all phases, removal percentages for indicators and the proposed surrogate will be determined based on daily averages for EC and will be included in the MRP monitoring reports. Should the percentages change significantly over time, MRWPCA will evaluate any reasons for the change(s) and consult with DDW and RWQCB on response actions.

12.6.2. Health-Based CECs Indicators

The Recycled Water Policy requires measurement of health-based CECs, which are CECs with toxicological relevance to human health (see Table 12-4). The analytical methods to be used were previously discussed in **Subsection 12.6.1**.

Table 12-4: Health-Based CECs for SWRCB Recycled Water Policy – Standard Operation

Parameter	Constituent Group	Reporting Limit, µg/L	Monitoring Trigger Level, µg/L
17β-estrodial	Steroid	0.001	0.0009
Caffeine	Stimulant	0.05	0.35
NDMA	Disinfection byproduct	0.002	0.01
Triclosan	Antimicrobial	0.05	0.35

The monitoring requirements are project-specific and determined using the phased approach described under **Section 12.6.1**. For the Standard Operating period, MRWPCA proposes the monitoring frequencies shown in Table 12-6**.** For all monitoring phases, should

a CEC indicator not be present at sufficient concentrations to use for performance assessments, MRWPCA will consult with DDW and RWQCB on other potential options.

Table 7 in the Recycled Water Policy establishes response actions for health-based CEC indicators based on the ratio of measured MECs to the monitoring trigger levels (MTLs). Based on the results of the CEC monitoring, MRWPCA will take follow up actions including additional monitoring, discussion with DDW and RWQCB, and implementation of studies (see Table 12-5).

Table 12-5: Thresholds and Response Actions (Table 7 from Recycled Water Policy)

Ratio of MEC and MTL (MEC/MTL)	Response Action
If greater than 75% of the MEC/MTL ratio results for a CEC are less than or equal to 0.1 during the baseline monitoring phase and/or subsequent monitoring	A) After completion of the baseline monitoring phase, consider requesting removal of the CEC from the monitoring program.
If MEC/MTL ratio is greater than 0.1 and less than or equal to 1	B) Continue to monitor.
If MEC/MTL ratio is greater than 1 and less than or equal to 10	C) Check the data. Continue to monitor.
If MEC/MLT ratio is greater than 10 and less than or equal to 100	D) Resample immediately and analyze to confirm CEC result. Continue to monitor.
If MEC/MLT ratio is greater than 100	E) Resample immediately and analyze to confirm result. Continue to monitor. Contact the Regional Water Board and DDW to discuss additional actions. (Additional actions may include, but are not limited to, additional monitoring, toxicological studies, engineering removal studies, modification of facility operation, implementation of a source identification program, and monitoring at additional locations.)

Results will be included in monitoring reports submitted to DDW and RWQCB. In accordance with Title 22 Section 60320.220(e), a chemical or contaminant detected as a result of this monitoring effort will be reported to DDW and RWQCB no later than the quarter following the quarter in which the results are received by MRWPCA.

12.7. PRODUCT WATER – WATER QUALITY COMPLIANCE

Product water will be monitored for compliance purposes to ensure protection of public health and beneficial uses of groundwater. Process control parameters will also be monitored to facilitate operations of the AWT Facility (discussed in **Section 13**). For regulatory compliance, the product water will be monitored for:

- Compliance parameters defined in the Title 22 Criteria for:
    - Coliform bacteria
    - Total nitrogen
    - Regulated contaminants and physical characteristics
    - TOC
    - Additional monitoring requirements
        - Priority Pollutants
        - DDW-specified chemicals based on review of Engineering Report, affected groundwater basin, and source control assessments
        - DDW- and RWQCB-specified indicator compounds
- Recycled Water Policy health-based CECs
- Basin Plan water quality objectives
- Acutely toxic parameters monitored as a part of RRT response process (these are a subset of the regulated contaminants)

For each of the categories above, the monitoring frequency, sample type, and applicable regulations vary. The proposed monitoring is presented in Table 12-6.

Table 12-6: Proposed Product Water Compliance Monitoring Program

Category	Subcategory	Monitoring Frequency	Sample Type
Total coliform	Pathogen indicator	Daily	Grab
Total nitrogen (see **Section 12.7.1**)	Ammonia + Nitrite + Nitrate + Organic Nitrogen	Semi-weekly at least three days apart[a]	Grab or 24-hr composite
Regulated contaminants & physical characteristics - primary MCLs and action levels (see **Section 12.7.2**) Secondary MCLs	Inorganic chemicals Radionuclides Organic chemicals Disinfection byproducts Lead and copper Secondary contaminants	Monthly[b] Monthly[b] Monthly[b] Monthly[b] Monthly[b] Annually	Grab or 24-hr composite
TOC (see **Section 12.7.3**)	Organics surrogate	Weekly	24-hr composite[c]
Additional chemical & contaminants (see **Section 12.7.4**)	Priority Pollutants DDW specified chemicals Chemicals with NLs DDW specified indicators	Quarterly[d] Quarterly[d] Monthly[e] Annually	Not specified
Recycled Water Policy Health-based CECs (see **Section 12.6.2**)	17-estradiol, Caffeine, NDMA, Triclosan[f]	Quarterly[g]	Not specified
Basin Plan Specified Water Quality Objectives (see **Section 12.7.5**)	Constituents with primary and secondary MCLs Taste and odor Radionuclides TDS, chloride, nitrate Bacteria Additional Inorganic constituents (see Table 12-15)	Quarterly	Not specified
Acute chemicals (see **Section 6**)	Coliform Nitrate Nitrite Perchlorate	Daily Weekly Weekly Monthly[h]	Not specified

a. If conditions pursuant to Title 22 Section 60320.210(b) and (c) are met, semi-weekly sampling may be reduced to weekly; MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequency by letter.

b. Pursuant to Title 22 Section 60320.201(i), these will be monitored monthly and if no results exceed an MCL or action level for 12 consecutive months, a project sponsor can apply for a reduced monitoring frequency of no less than quarterly, with the exception of asbestos and perchlorate. Asbestos - if four consecutive quarterly results are below the 0.2 million fibers per liter (MFL) detection limit, the sampling frequency may be reduced to once every three years. Perchlorate - special monitoring approach is explained in **Section 6**. MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequencies by letter.

c. Grab samples may be used in lieu of 24-hour composite samples if MRWPCA demonstrates that a grab sample is representative of the water quality throughout a 24-hour period. MRWPCA requests

that the MRP allow for grab sampling to be effectuated pending DDW and RWQCB review if MRWPCA demonstrates that a grab sample is representative for the purposes of demonstrating compliance with the Title 22 Criteria. The MRP would allow for the change in sample type by written notification from the RWQCB Executive Officer.

d. MRWPCA may reduce the monitoring frequency to yearly based on DDW's review of the most recent two years of data; MRWPCA requests that that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequency by written notification, pending DDW review.
e. Pursuant to Title 22 Section 60320.201(i), these will be monitored monthly and if no results exceed an NL for twelve consecutive months, a project sponsor can apply for a reduced monitoring frequency to quarterly. After the second year of data is available, a project sponsor can request to reduce the monitoring frequency to yearly. MRWPCA is electing to continue quarterly monitoring for NDMA and 1,4-dioxane. MRWPCA requests that the MRP allow for the Executive Officer to reduce monitoring frequencies by letter, pending DDW review.
f. If health-based CECs are consistently absent during the Initial and Baseline Monitoring Phases, MRWPCA will propose a refined monitoring option for DDW and RWQCB consideration.
g. For the Initial Monitoring Phase (the first year of the Project): quarterly; for the Baseline Monitoring Phase (the next three years): semi-annual except for NDMA, which will be quarterly; for Standard Operation Monitoring: annually, except for NDMA, which will be quarterly.
h. As discussed **Section 6**, perchlorate will be sampled monthly, which is a shorter frequency than the quarterly monitoring required in Title 22 Section 60320.212(a). However, because perchlorate is effectively removed by RO, a treatment step provided at the AWT Facility, the following is proposed for the MRP: collect quarterly RTP secondary samples and monthly product water samples for 1 year. If product water results are non-detect and no perchlorate appears to be coming from the RTP, the MRP will allow MRWPCA to revise the product water perchlorate frequency from monthly to quarterly.

12.7.1. Nitrogen Compounds

To satisfy Title 22 Section 60320.210, MRWPCA will collect either grab or 24-hour composite samples from the product water prior to subsurface application for total nitrogen analysis. Total nitrogen is the sum of ammonia, nitrite, nitrate, and organic nitrogen concentrations. The sample will be collected semi-weekly with at least a 3-day gap between sampling events. The laboratory will be required to complete the analysis within 72 hours and report findings within 72 hours if the concentration exceeds 10 mg /L as N.

If the average of two consecutive measurements exceeds 10 mg /L as N, MRWPCA will:

- Collect a confirmation sample
- Notify DDW and RWQCB within 48 hours of being notified of the results by the laboratory
- Investigate the cause of exceedance and take corrective action to avoid further exceedances
- Initiate additional monitoring as described in the OOP

If the average of four consecutive measurements exceeds 10 mg /L as N, MRWPCA will suspend subsurface application of product water until corrective actions have been taken and at least two consecutive measurements are less than 10 mg /L as N.

The semi-weekly sampling frequency may be reduced if MRWPCA, using the most recent twelve months of data, is able to show that (1) the average of all results do not exceed 5 mg /L as N and (2) the average of a result and its confirmation sample (taken within 24 hours of receipt of the initial result) did not exceed 10 mg /L as N. However, if both of these conditions are not maintained, MRWPCA will revert to the original monitoring frequency and reduced frequency will not resume unless both conditions are met. MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequency by letter, with the caveat that the original frequency must resume if the conditions are not met.

12.7.2. Regulated Contaminants and Physical Characteristics

To satisfy Title 22 Section 60320.212, MRWPCA will assess product water for all constituents with MCLs and action levels (with the exception of nitrogen which is addressed by special provisions) to confirm that the product water meets regulatory levels (see Tables 12-7, 12-8, 12-9, 12-10, 12-11, and 12-12).

Table 12-7: Primary Maximum Contaminant Levels for Inorganic Chemicals

Analyte[a]	Units	Primary MCL
Aluminum	mg/L	1.0
Antimony	mg/L	0.006
Arsenic	mg/L	0.01
Asbestos	MFL for fibers exceeding 10 microns in length	7
Barium	mg/L	1.0
Beryllium	mg/L	0.004
Cadmium	mg/L	0.005
Chromium	mg/L	0.05
Cyanide	mg/L	0.15
Fluoride	mg/L	2.0
Hexavalent chromium	mg/L	0.010
Mercury	mg/L	0.002
Nickel	mg/L	0.1
Perchlorate[b]	mg/L	0.006
Selenium	mg/L	0.05
Thallium	mg/L	0.002

Source: Title 22 Section 64431

a. Pursuant to Title 22 Section 60320.201(i), these analytes will be monitored monthly and if no results exceed an MCL for 12 consecutive months, a project sponsor can apply for a reduced monitoring frequency of no less than quarterly, with the exception of asbestos and perchlorate. Asbestos - if four consecutive quarterly results are below the 0.2 million fibers per liter (MFL) detection limit, the sampling frequency may be reduced to once every three years. MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequencies by letter.

b. As discussed in **Section 6**, perchlorate will be sampled monthly, which is a shorter frequency than the quarterly monitoring required in Title 22 Section 60320.212(a). However, because perchlorate is effectively removed by reverse osmosis, a treatment step provided at the AWT Facility, the following is proposed: collect quarterly RTP secondary samples and monthly product water samples for 1 year. If product water results are non-detect and no perchlorate appears to be coming from the RTP, MRWPCA will request that product water frequency be increased to quarterly.

Table 12-8: Maximum Contaminant Levels for Radionuclides

Analyte[a]	Unit	MCL
Radium-226 and Radium-228	pCi/L	5
Gross Alpha Particle Activity (excluding radon and uranium)	pCi/L	15
Uranium	pCi/L	20
Beta/photon Emitters	millirem/year	4
Strontium-90	pCi/L	8
Tritium	pCi/L	20,000

Source: Title 22 Sections 64442 and 64443

a. Pursuant to Title 22 Section 60320.201(i), these analytes will be monitored monthly and if no results exceed an MCL for 12 consecutive months, a project sponsor can apply for a reduced monitoring frequency of no less than quarterly. MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce monitoring frequency by letter.

Table 12-9: Maximum Contaminant Levels for Organic Chemicals

Analyte[a]	Units	Primary MCL
a) Volatile Organic Chemicals		
Benzene	mg/L	0.001
Carbon Tetrachloride	mg/L	0.0005
1,2-Dichlorobenzene	mg/L	0.6
1,4-Dichlorobenzene	mg/L	0.005
1,1-Dichloroethane	mg/L	0.005
1,2-Dichloroethane	mg/L	0.0005
1,1-Dichloroethylene	mg/L	0.006
cis-1,2-Dichloroethylene	mg/L	0.006
trans-1,2-Dichloroethylene	mg/L	0.01
Dichloromethane	mg/L	0.005
1,2-Dichloropropane	mg/L	0.005
1,3-Dichloropropene	mg/L	0.0005
Ethylbenzene	mg/L	0.3
Methyl-*tert*-butyl ether	mg/L	0.013
Monochlorobenzene	mg/L	0.07
Styrene	mg/L	0.1
1,1,2,2-Tetrachloroethane	mg/L	0.001
Tetrachloroethylene	mg/L	0.005
Toluene	mg/L	0.15
1,2,4-Trichlorobenzene	mg/L	0.005
1,1,1-Trichloroethane	mg/L	0.200
1,1,2-Trichloroethane	mg/L	0.005
Trichloroethylene	mg/L	0.005
Trichlorofluoromethane	mg/L	0.15
1,1,2-Trichloro-1,2,2-Trifluoroethane	mg/L	1.2
Vinyl Chloride	mg/L	0.0005
Xylenes	mg/L	1.750
b) Non-Volatile Synthetic Organic Chemicals (SOCs)		
Alachlor	mg/L	0.002
Atrazine	mg/L	0.001
Bentazon	mg/L	0.018
Benzo(a)pyrene	mg/L	0.0002
Carbofuran	mg/L	0.018
Chlordane	mg/L	0.0001
2,4-D	mg/L	0.07
Dalapon	mg/L	0.2
Dibromochloropropane	mg/L	0.0002
Di(2-ethylhexyl)adipate	mg/L	0.4
Di(2-ethylhexyl)phthalate	mg/L	0.004
Dinoseb	mg/L	0.007
Diquat	mg/L	0.02
Endothall	mg/L	0.1
Endrin	mg/L	0.002
Ethylene Dibromide	mg/L	0.00005
Glyphosate	mg/L	0.7
Heptachlor	mg/L	0.00001

Analyte[a]	Units	Primary MCL
Heptachlor Epoxide	mg/L	0.00001
Hexachlorobenzene	mg/L	0.001
Hexachlorocyclopentadiene	mg/L	0.05
Lindane	mg/L	0.0002
Methoxychlor	mg/L	0.03
Molinate	mg/L	0.02
Oxamyl	mg/L	0.05
Pentachlorophenol	mg/L	0.001
Picloram	mg/L	0.5
Polychlorinated Biphenyls	mg/L	0.0005
Simazine	mg/L	0.004
Thiobencarb	mg/L	0.07
Toxaphene	mg/L	0.003
2,3,7,8-TCDD (Dioxin)	mg/L	$3x10^{-8}$
2,4,5-TP (Silvex)	mg/L	0.05

Source: Title 22 Section 64444

a. Pursuant to Title 22 Section 60320.201(i), these analytes will be monitored monthly and if no results exceed an MCL for 12 consecutive months, a project sponsor can apply for a reduced monitoring frequency of no less than quarterly. MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce monitoring frequency by letter.

Table 12-10: Maximum Contaminant Levels for Disinfection Byproducts

Analyte[a]	Units	MCL
Total trihalomethanes (TTHM)	mg/L	0.080
Bromodichloromethane		
Bromoform		
Chloroform		
Dibromochloromethane		
Haloacetic acids (five) (HAA5)	mg/L	0.060
Monochloroacetic Acid		
Dichloroacetic Acid		
Trichloroacetic Acid		
Monobromoacetic Acid		
Dibromoacetic Acid		
Bromate	mg/L	0.010
Chlorite	mg/L	1.0

Source: Title 22 Section 64533

a. Pursuant to Title 22 Section 60320.201(i), these analytes will be monitored monthly and if no results exceed an MCL for 12 consecutive months, a project sponsor can apply for a reduced monitoring frequency of no less than quarterly. MRWPCA requests that when the Title 22 conditions are met, that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequencies by letter.

Table 12-11: Action Levels for Lead and Copper

Analyte	Unit	Action Level
Lead	mg/L	0.015
Copper	mg/L	1.3

Source: Title 22 Section 64678

Table 12-12: Secondary Maximum Contaminant Levels and Upper Limits for Consumer Acceptance

Analyte[a]	Units	MCL/Upper Limit
Secondary MCL		
Aluminum	mg/L	0.2
Color	Units	15
Copper	mg/L	1.0
Foaming Agents (MBAS)	mg/L	0.5
Iron	mg/L	0.3
Manganese	mg/L	0.05
Methyl-*tert*-butyl ether (MTBE)	mg/L	0.005
Odor - Threshold	Units	3
Silver	mg/L	0.1
Thiobencarb	mg/L	0.001
Turbidity	NTU	5
Zinc	mg/L	5.0
Upper Limit		
Total Dissolved Solids	mg/L	1,000
Specific Conductance	µS/cm	1,600
Chloride	mg/L	500
Sulfate	mg/L	500

Source: Title 22 Section 64449

a. Pursuant to Title 22 Section 60320.212(c), these analytes will be monitored annually.

Pursuant to Title 22 Section 60320.212(d), if parameters with primary MCLs or action levels exceed their corresponding MCL or action level, MRWPCA will collect and submit a confirmation sample within 72 hours of being notified of results by the laboratory.

For a contaminant whose compliance with its MCL or action level is not based on a running annual average, if the average of the initial and confirmation sample exceeds the contaminant's MCL or action level, or the confirmation sample is not collected and analyzed, MWRPCA will notify DDW and RWQCB within 24 hours and initiate weekly monitoring until four consecutive weekly results are below the contaminant's MCL or action level. If the running four-week average exceeds the contaminant's MCL or action level, MRWPCA will notify DDW and RWQCB within 24 hours and, if directed by DDW or RWQCB, suspend application of the product water for subsurface application.

For a contaminant whose compliance with its MCL is based on a running annual average, if the average of the initial and confirmation sample exceeds the contaminant's MCL, or a confirmation sample is not collected and analyzed, MRWPCA will initiate weekly monitoring for the contaminant until the running four-week average no longer exceeds the contaminant's MCL. If the running four-week average exceeds

the contaminant's MCL, MRWPCA will describe the reason(s) for the exceedance and provide a schedule for completion of corrective actions in a report submitted to DDW and RWQCB no later than 45 days following the quarter in which the exceedance occurred. If the running four-week average exceeds the contaminant's MCL for sixteen consecutive weeks, MRWPCA will notify DDW and RWQCB within 48 hours of knowledge of the exceedance and, if directed by DDW or RWQCB, suspend application of the product water for subsurface application.

Pursuant to Title 22 Section 60320.212(e), if the annual average of parameters with secondary MCLs exceeds its corresponding MCL or upper limit, MRWPCA will initiate quarterly sampling for the given contaminant. If the running annual average of quarterly-averaged results exceeds the corresponding MCL or upper limit, MRWPCA will submit a report to DDW and RWQCB no later than 45 days following the quarter in which exceedance occurred. The report will include a description of the reason(s) for the exceedance and any corrective action(s) taken.

12.7.3. Total Organic Carbon

Pursuant to Title 22 Section 60320.218, MRWPCA will sample the product water prior to subsurface application for TOC at least once a week. Twenty-four hour composite samples will be taken, but grab samples may be used in lieu of 24-hour composite samples if MRWPCA demonstrates that a grab sample is representative of the water quality throughout a 24-hour period. MRWPCA requests that the MRP allow for grab sampling to be effectuated pending DDW and RWQCB review if MRWPCA demonstrates that a grab sample is representative for the purposes of demonstrating compliance with the Title 22 Criteria. The MRP would allow for the change in sample type by written notification from the RWQCB Executive Officer.

TOC compliance is based on (1) a 20-week running average and (2) the average of the last four samples. These averages may not exceed 0.5 mg/L TOC.

If the 20-week running average exceeds 0.5 mg/L, MRWPCA will:

- Immediately suspend replenishment operations until at least two consecutive samples taken three days apart are below 0.5 mg/L;
- Within seven days of suspension, notify the DDW and RWQCB; and
- Within 60 days of becoming aware of the original exceedance, submit a report to DDW and RWQCB with a description of the reason(s) for the exceedance and any corrective action(s) taken.

If the average of the last four samples exceeds 0.5 mg/L, MRWPCA will:

- Within 60 days of becoming aware of the original exceedance, submit a report to DDW and RWQCB with a description of the reason(s) for the exceedance and any corrective action(s) taken.

Because the Project is proposing an RWC of 1.0, meeting the TOC limits, as described above, will also serve as the method for evaluating RWC compliance.

12.7.4. Additional Chemicals and Contaminants

Pursuant to Title 22 Section 60320.220, additional monitoring requirements for the product water include:

- DDW-specified Priority Pollutants.
- DDW-specified chemicals based on a review of the Engineering Report, the affected groundwater basin, and any source control assessments.
- Contaminants with NLs.
- DDW- and RWQCB-specified indicator compounds.

If any parameters are detected as a part of this additional monitoring, MRWPCA will notify the DDW and RWQCB no later than the quarter following the quarter in which results were obtained.

Some of the constituents in the list of Priority Pollutants are already monitored as part of the MCL monitoring effort. Thus, MRWPCA will monitor the remaining Priority Pollutants shown in Table 12-13 quarterly in the product water. MRWPCA can reduce monitoring frequency to yearly based on DDW's review of the most recent two years of data. MRWPCA requests that the MRP allow for the RWQCB Executive Officer to reduce the monitoring frequency by written notification, pending DDW review.

Table 12-13: Remaining Priority Pollutants

Analyte
Pesticides
Aldrin
Dieldrin
4,4'-DDT
4,4'-DDE
4,4'-DDD
Alpha-endosulfan
Beta-endosulfan
Endosulfan sulfate
Endrin aldehyde
Alpha-BHC
Beta-BHC
Delta-BHC
Acid Extractibles
2,4,6-trichlorophenol
P-chloro-m-cresol
2-chlorophenol
2,4-dichlorophenol
2,4-dimethylphenol
2-nitrophenol
4-nitrophenol
2,4-dinitrophenol
4,6-dinitro-o-cresol
Phenol
Base/Neutral Extractibles
Acenaphthene

Analyte
Benzidine
Hexachloroethane
Bis(2-chloroethyl)ether
2-chloronaphthalene
1,3-dichlorobenzene
3,3'-dichlorobenzidine
2,4-dinitrotoluene
2,6-dinitrotoluene
1,2-diphenylhydrazine
Fluoranthene
4-chlorophenyl phenyl ether
4-bromophenyl phenyl ether
Bis(2-chloroisopropyl)ether
Bis(2-chloroethoxyl)methane
Hexachlorobutadiene
Isophorone
Nitrobenzene
N-nitrosodi-n-propylamine
N-nitrosodiphenylamine
Bis(2-ethylhexyl)phthalate
Butyl benzyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Diethyl phthalate
Dimethyl phthalate
Benzo(a)anthracene
Benzo(a)fluoranthene
Benzo(k)fluoranthene
Chrysene
Acenaphthylene
Anthracene
1,12-benzoperylene
Fluorene
Phenanthrene
1,2,5,6-dibenzanthracene
Indeno(1,2,3-cd)pyrene
Pyrene
Volatile Organics
Acrolein
Acrylonitrile
Chlorobenzene
Chloroethane
1,1-dichloroethylene
Methyl chloride
Methyl bromide
2-chloroethyl vinyl ether

Pursuant to Title 22 Section 60320.201(i), parameters with NLs (see Table 12-14) will be monitored monthly. If no results exceed an NL for 12 consecutive months, a project sponsor can apply for a reduced monitoring frequency to quarterly. After the second year of data are available, a project sponsor can request to reduce monitoring frequency to yearly based on DDW's review of the most recent two years of data for all parameters except NDMA and 1,4-dioxane, which will continue to be monitored quarterly. MRWPCA requests that the MRP allow for the Executive Officer to reduce monitoring frequencies by written notification, pending DDW review.

Table 12-14: Notification Levels (Last Updated December 14, 2010)

Analyte	Units	NL
Boron	mg/L	1
n-Butylbenzene	mg/L	0.26
sec-Butylbenzene	mg/L	0.26
tert-Butylbenzene	mg/L	0.26
Carbon disulfide	mg/L	0.16
Chlorate	mg/L	0.8
2-Chlorotoluene	mg/L	0.14
4-Chlorotoluene	mg/L	0.14
Diazinon	mg/L	0.0012
Dichlorodifluoromethane (Freon 12)	mg/L	1
1,4-Dioxane	mg/L	0.001
Ethylene glycol	mg/L	14
Formaldehyde	mg/L	0.1
HMX	mg/L	0.35
Isopropylbenzene	mg/L	0.77
Manganese	mg/L	0.5
Methyl isobutyl ketone (MIBK)	mg/L	0.12
Naphthalene	mg/L	0.017
N-Nitrosodiethylamine (NDEA)	mg/L	0.00001
N-Nitrosodimethylamine (NDMA)	mg/L	0.00001
N-Nitrosodi-n-propylamine (NDPA)	mg/L	0.00001
Propachlor	mg/L	0.09
n-Propylbenzene	mg/L	0.26
RDX	mg/L	0.0003
Tertiary butyl alcohol (TBA)	mg/L	0.012
1,2,3-Trichloropropane (1,2,3-TCP)	mg/L	0.000005
1,2,4-Trimethylbenzene	mg/L	0.33
1,3,5-Trimethylbenzene	mg/L	0.33
2,4,6-Trinitrotoluene (TNT)	mg/L	0.001
Vanadium	mg/L	0.05

If parameters with NLs exceed their corresponding NL, MRWPCA will collect and submit a confirmation sample within 72 hours of being notified of results by the laboratory. If the average of the initial and confirmation sample exceeds the corresponding NL, MRWPCA will initiate weekly monitoring until the running four-week average is below the NL. If the running four-week average exceeds the NL, MRWPCA will submit a report to DDW and RWQCB no later than 45 days following the quarter in which exceedance occurred. The report will include a description of the reason(s) for exceedance and any

corrective action(s) taken. If the running four-week average exceeds the NL for sixteen consecutive weeks, MRWPCA will notify DDW and RWQCB within 48 hours of identifying this exceedance.

DDW and RWQCB may specify Indicator compounds that are monitored annually. The indicator compounds are selected based on the following:

- Review of the engineering report;
- Review of the inventory developed as a part of the wastewater source control program;
- Review of the groundwater basin;
- The ability of indicator compounds to characterize the presence of pharmaceuticals, endocrine disrupting chemicals, personal care products, and other indicators of the presence of municipal wastewater; and
- Availability analytical methodologies.

As previously discussed, the MRWPCA industrial base is insignificant and there is no groundwater contamination in the Seaside Groundwater Basin. Per **Subsection 7.5.1**, the pilot testing looked at 92 CECs that were part of the analytical method used. Only a few CECs were detected in RO permeate as part of the pilot testing that were considered to be actual detections and not false positives: caffeine (a simulant), iohexal (a contrast agent), and albuterol (an asthma medication). All were detected at concentrations near the analytical method detection limit and it is unclear whether or not they were actual values. Moreover, all of these compounds are effectively removed by UV/AOP (i.e., exceeding 90% removal), and thus are very likely to be below levels of detection after UV/AOP. Thus, it is recommended that to satisfy Title 22 Section 60320.220(d) requirements for annual indicator monitoring, that the MRP focus on:

- The Recycled Water Policy performance-based and health-based CECs discussed in **Subsection 12.6**; and
- An annual scan of the product water using Eurofins Eaton Analytical Liquid Chromatography Tandem Mass Spectrometry method.

In accordance with Title 22 Section 60320.220(e), a chemical or contaminant detected as a result of this monitoring effort will be reported to DDW and RWQCB no later than the quarter following the quarter in which the results are received by MRWPCA.

12.7.5. Basin Plan Specified Water Quality Objectives

The Central Coast RWQCB has designated beneficial uses of municipal and domestic supply, agricultural water supply, and industrial use for all groundwaters in the region including the Seaside Subbasin (covers the Seaside Groundwater Basin as used in this document). Water quality constituents include:

- Taste and odor (narrative objective)
- Radionuclides (Title 22, Chapter 15, Article 5, Section 64443 Table 4)
- Bacteria (coliform organisms)
- Organic Chemicals (Title 22, Chapter 15, Article 5.5, Section 64444.5, Table 5)
- Chemical Constituents (Title 22, Chapter 15, Article 4, Section 64435 Tables 2 and 3)
- Agricultural supply objectives (Basin Plan Tables 3-3 and 3-4)

Although the Central Coast RWQCB Basin Plan establishes specific mineral water quality objectives for some groundwater basins, no specific numeric objectives have been established in the Basin Plan for the Seaside Basin for these constituents other than those with primary and secondary MCLs, along with specific constituents for irrigation supply.

These constituents have been combined and summarized in Table 12-15. Duplication of some constituents has been deleted with the most stringent water quality objective listed in the table. Initially, constituents will be monitored quarterly, unless required more frequent by other regulations.

Routine and annual monitoring reports submitted to DDW and RWQCB will include any detections of the monitored chemicals or contaminants in the product water.

12.8. GROUNDWATER MONITORING

New monitoring wells and a monitoring well program are incorporated into the Project to demonstrate ongoing project performance and to comply with the Title 22 Criteria. The objectives of the monitoring well program are to demonstrate compliance with the Title 22 and Basin Plan groundwater criteria and applicable state policies regarding protection of groundwater by:

- Siting one downgradient well with groundwater travel times (underground retention time) no less than two weeks and no more than six months from the injection wells (well also has to be greater than 30 days travel time from the nearest drinking water source).
- Siting an additional downgradient well between the Injection Facilities and the nearest downgradient potable water supply (in addition to the downgradient monitoring well used to demonstrate retention time).
- Monitoring groundwater levels and water quality; the well design will allow for sample collection from each aquifer receiving recycled water.
- Collecting baseline water quality samples prior to startup of the Project operation.

Monitoring wells will also be used to collect data as part of the tracer study (or studies) to demonstrate underground retention time for application to the pathogen reduction credit (**Section 5.3**) and the recommended RRT for the Project (**Section 6.5**).

12.8.1. Monitoring Well Locations and Design

Monitoring well installation will be phased to coincide with the phasing of the deep injection wells and vadose zone wells as described in **Section 8**. Initially, two monitoring well clusters will be installed at the site of the first two deep injection wells, DIW-2 and DIW-3 and vadose zone wells, VZW-2 and VZW-3. These Phase I monitoring wells are labeled MW-1, MW-2, MW-3, and MW-4 on Figure 12-1.

MW-1 and MW-3 will be drilled first to provide data for final depths and screen design in the Phase I deep injection wells (DIW-2 and DIW-3) and vadose zone wells (VZW-2 and VZW-3). These wells will also satisfy requirements for downgradient wells with travel times between two weeks and six months.

Table 12-15: Summary of Parameters to Satisfy Basin Plan Water Quality Objectives

Analyte	MCL or Basin Plan Objective (mg/L)	Frequency
Chlorinated Hydrocarbons		
Endrin	0.0002	Quarterly
Lindane	0.004	Quarterly
Methoxychlor	0.1	Quarterly
Toxaphene	0.005	Quarterly
Chlorophenoxys		
2,4-D	0.1	Quarterly
2,4,5-TP Silvex	0.01	Quarterly
Synthetics		
Atrazine	0.003	Quarterly
Bentazon	0.018	Quarterly
Benzene	0.001	Quarterly
Carbon Tetrachloride	0.0005	Quarterly
Carbofuran	0.018	Quarterly
Chlordane	0.0001	Quarterly
1,2-Dibromo-3-chloropropane	0.0002	Quarterly
1,4-Dichlorobenzene	0.005	Quarterly
1,1-Dichloroethane	0.005	Quarterly
1,2-Dichloroethane	0.0005	Quarterly
cis-1,2-Dichloroethylene	0.006	Quarterly
Inorganics		
Total Dissolved Solids	500	Quarterly
Chloride	250	Quarterly
Aluminum	1	Quarterly
Arsenic	0.01	Quarterly
Antimony	0.006	Quarterly
Asbestos	7 MFL	Quarterly
Barium	1	Quarterly
Beryllium	0.004	Quarterly
Boron	0.75	Quarterly
Cadmium	0.005	Quarterly
Cobalt	0.05	Quarterly
Copper	0.2	Quarterly
Chromium	0.05	Quarterly
Cyanide	0.15	Quarterly
Fluoride	1	Quarterly

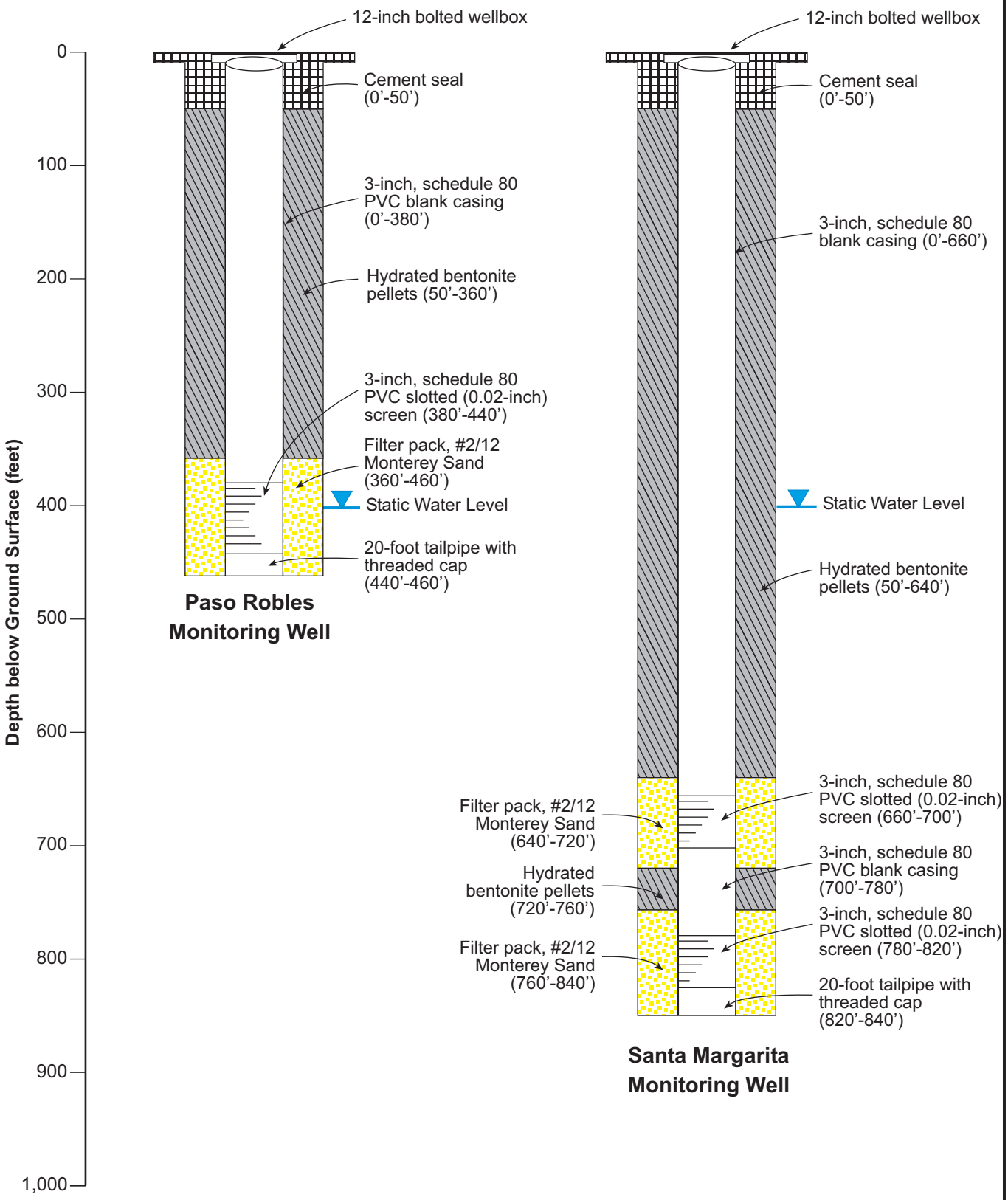
Analyte	MCL or Basin Plan Objective (mg/L)	Frequency
Iron	5	Quarterly
Lead	0.05	Quarterly
Lithium	2.5	Quarterly
Manganese	0.2	Quarterly
Mercury	0.002	Quarterly
Molybdenum	0.01	Quarterly
Nickel	0.1	Quarterly
Nitrate (as NO3)	45	Quarterly
Perchlorate	0.006	Quarterly
Selenium	0.01	Quarterly
Silver	0.05	Quarterly
Thallium	0.002	Quarterly
Vanadium	0.1	Quarterly
Zinc	2	Quarterly
Radionuclides	MCLs	Quarterly
Taste and odor	narrative	Quarterly
Coliform Bacteria	narrative	Quarterly


Northern Coastal Subarea
Northern Inland Subarea
Subarea Boundary
N
0
800
Scale in Feet
Coe Ave.
Bayonet / Black Horse Golf Course
ASR-4
SMS-shallow
SMS-deep
ASR-3
Reservoir Well
MRWPCA MW-1
Military
Military Ave
Coe Ave
Paralta
Eucalyptus Rd
MW-7
Mission Memorial
ASR-2
ASR-1
MW-1
MW-2
VZW-1
DIW-1
Ord Terrace
MMP
Luzern
Ord Grove Ave
Mira Monte Ave
Santa Clara Ave
Ord Grove #2
Ord Grove MW
MW-1
VZW-2
DIW-2
MW-4
MW-3
DIW-3
VZW-3
La Salle Ave
LaSalle
Darwin
Andrew Ct
San Pablo Ave
DIW-4
VZW-4
MW-5
MW-6
City of Seaside #4
Mingo Ave
LEGEND
Production Well
Monitoring Well
Proposed Deep Injection Well
Proposed Vadose Zone Well
Proposed Monitoring Well
Phase I Monitoring Well
Injection Facilities Area
November 2015
TODD GROUNDWATER
Figure 12-1
GWR Wells and Phase I Monitoring Wells

Two additional downgradient monitoring wells, MW-2 and MW-4, will also be installed in Phase I of the Project (Figure 12-1). These wells will be approximately 550 feet to 600 feet from the two sets of injection wells and will be placed between the injection wells and the nearest drinking water wells, ASR-1 and ASR-2. Monitoring wells have been placed along flow lines as indicated by water level contour maps and groundwater modeling (Figures 9-10, 9-11, 5-1 and 5-2). The Phase II monitoring wells will be proposed based on the location of additional injection wells and project operation information. For planning purposes, current locations of the additional Phase II monitoring wells MW-5, MW-6, and MW-7, are included on Figure 12-1. For the injection well cluster at DIW-1, no adjacent monitoring well is proposed. Travel times from this well are very long and one monitoring well is judged sufficient to document performance of this eastern-most injection well cluster. This assumes that a tracer test has been confirmed in the vicinity of the Phase I injection wells. Again, depending on future injection well locations, the proposed monitoring wells in Phase I may be capable of monitoring more than one set of injection wells.

At each monitoring well location, two adjacent, but separate boreholes will be drilled in close proximity (within about 20 feet) of each other at the same location – one for the Paso Robles Aquifer and one for the Santa Margarita Aquifer (referred to as a monitoring well cluster). For simplicity, each well cluster is referred to as one monitoring well in the text and on the figures. A preliminary monitoring well design based on ground surface elevations at DIW-2 is shown on Figure 12-2.

Existing wells MRWPCA MW-1 and FO-7 (shallow and deep) will provide upgradient data to support the monitoring program by serving as control wells (Figure 12-1). Sampling of these wells in January 2014 included an expanded analyte list to provide background water quality data.



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Figure 12-2
Proposed Monitoring Well Design
GWR Project

12.8.2. Monitoring Parameters and Sampling Frequency

A summary of the proposed groundwater constituents and parameters to be incorporated into the MRP for groundwater monitoring is provided in Table 12-16. Also included in Table 12-16 are the regulatory-accepted analytical methods to be used for each constituent or chemical group of constituents. The constituents in Table 12-16 are re-organized in Table 12-17 to provide information on sampling protocols for the analytical methods including container requirements, volumes, preservation techniques, and holding times, as applicable. Details of specialized groundwater sampling protocols are also included in **Appendix G**.

These constituents will be monitored in the monitoring wells, once installed. As required by the regulations, these constituents will be monitored quarterly prior to project start up and will be continued on a quarterly basis after start-up as part of the routine sampling program.

In addition to the routine monitoring program in Table 12-16, specialized sampling will be conducted prior to startup (anticipate four quarterly monitoring events). This program will add boron, cobalt, molybdenum, and taste to the monitoring parameters. In addition, explosives (EPA Method 8330b) will be included to continue sampling for constituents that may be associated with Fort Ord activities. These constituents will be analyzed for four quarters in available monitoring wells. If warranted, the constituents may also be continued at start-up and/or added to the routine sampling program.

Additional specialized sampling may be conducted to support tracer test planning once baseline groundwater quality has been established in site-specific monitoring wells (yet to be drilled). In addition to inorganic constituents in the routine monitoirng program (i.e., included on Tables 12-16 and 12-17), isotopic analyses are being explored for assistance in tracer testing. Further information is provided in **Section 12.10.3** regarding additional specialized isotopic sampling. Because the utility of these analyses are yet to be determined, isotopes are not currently included in the routing monitoring program (Tables 12-16 and 12-17).

As documented by the monitoring well design (Figure 12-2), the monitoring wells will be capable of sampling groundwater independently from each of the two aquifers receiving product water, as required by Title 22 Section 60320.226(3)(a) and (b).

Because there are no current data within the Injection Facilities area, the proposed groundwater quality monitoring program is preliminary. As required by the regulations, monitoring wells will be installed and sampled quarterly prior to project start-up. For the preliminary groundwater monitoring program, all monitoring parameters are proposed to be sampled and analyzed quarterly in each of the monitoring well clusters. After one year of data collection, monitoring parameters will be re-assessed for inclusion in the groundwater quality monitoring program. Site-specific detections and concentrations in groundwater will be compared to other water quality data associated with product water and downgradient ambient groundwater. At that time, modifications to either parameters or the frequency of analysis may be requested for approval by DDW, as allowed by the regulations.

Table 12-16: Groundwater Monitoring Parameters

Parameter	Method	Parameter	Method
INORGANIC		**OTHER**	
Aluminum	EPA 200.8	Color	SM2120B
Alkalinity	SM2320B	Conductivity (EC)	varies
Antimony	EPA 200.8	Hardness (calculated)	SM2340B
Arsenic (total)	EPA 200.8	MBAS	SM5540C
Asbestos for water	EPA 100.2	Odor	EPA 140.1
Barium (total)	EPA 200.8	pH	SM4500
Beryllium (total)	EPA 200.8	TDS	EPA 160.1
Bicarbonate	SM2320B	Turbidity	SM2130B
Bromate	EPA 300.1		
Calcium (total)	EPA 200.7	**RADIOGENIC**	
Carbonate	SM2320B	Gross Alpha	EPA 900.0
Cadmium (total)	EPA 200.8	Gross Beta	EPA 900.0
Chloride	EPA 300.0	Radium 226	EPA 903
Chlorite	EPA 300.1	Radium 228	EPA 904
Chromium (total)	EPA 200.8	Strontium 90	EPA 905
Chromium (III)	calculated	Tritium	EPA 906
Chromium (VI)	EPA 218.6	Uranium	EPA 908
Copper (total)	EPA 200.8	**ORGANICS**	
Cyanide (low Level)	10-204-00-1X	Nitrogen/Phosphorus Pesticides	EPA 507
Fluoride	EPA 300.0	Herbicides	EPA 515.1
Haloacetic acids	EPA 552.2	Carbamates	EPA 531.1
Hydroxide	SM2320B	Glyphsoate	EPA 547
Iron	EPA 200.8	Endothall	EPA 548.1
Lead	EPA 200.8	Diquat	EPA 549.2
Magnesium	EPA 200.7	VOCs	EPA 624
Manganese	EPA 200.8	EDB/DBCP	EPA 624
Mercury	EPA 245.1	TOC	SM5310C
Nickel	EPA 200.8	SVOCs (without PAHs)	EPA 625
Nitrate as NO_3	EPA 300	DEHA/DEHP	EPA 625
Nitrate as N	EPA 300	PAHs (PNAs)	EPA 625SIM
Nitrite as N	EPA 300	Dioxin 2378 TCDD	EPA 1613A
TKN	EPA 300.0		
Total Nitrogen	calculated	**INDICATOR/SUROGATES**	
Perchlorate	EPA 314.0	Nitrosamines	EPA 1625M
Potassium	EPA 200.7	Pharmaceuticals ESI positive	EPA 1694M
Selenium	EPA 200.8	Pharmaceuticals ESI negative	EPA 1694M
Sodium	EPA 200.7		
Sulfate	EPA 300.0		
Thallium (total)	EPA 200.8		
Vanadium	EPA 200.8		
Zinc	EPA 200.8		

Notes: Redundant analyses as required by Title 22 Sections 60320.200, 60320.201, 60320.208, 60230.212, 60320.218, and 60320.220 have been consolidated. Constituent in italics are intrinsic parameter ions.
VOC – volative organic chemical; SVOC – semi-VOC

Table 12-17: Summary of Groundwater Monitoring Constituents, Analytical Methods and Sampling Protocols

CONSTITUENT	METHOD	CONTAINER	PRESERVATION	MIN VOLUME	HOLD TIME
Nitrosamines	1625M	2 X 1L BRA	none	1L	7 days
PPCP ESI Positive	1695 ESI+	2 X 1L BRA	NaAzide/Asc	1L	28 days
PPCP ESI Positive	1695 ESI+	2 X 1L BRA	NaAzide/Asc	1L	28 days
1,4 -Dioxane	8270	2 x 1L BRA	none	1L	7 days
Pathogenic Microorganisms Control	a	a	a	a	**a**
Nitrate as N	300	500mL poly	none	100mL	48 hours
Nitrite as N				100mL	
TKN	SM4500-NorgB	500mL poly	H_2SO_4	200mL	28 days
Total Nitrogen calc.	calc	NA	NA	NA	NA
Aluminum	200.8	500mL poly	HNO_3	100mL	180 days
Antimony					
Arsenic					
Barium					
Beryllium					
Cadmium					
Chromium					
Copper					
Mercury	245.1			100mL	28 days
Nickel	200.8			100mL	180 days
Lead					
Selenium					
Thallium					
Chromium VI	218.6 DW	250mL poly	Na_2B_4 buffer	100mL	14 days
Asbestos	100.2	2 x 1L BRA	none	1L	48 hours
Cyanide	10-204-00-1X	250mL brown poly	NaOH	100mL	28 days
Perchlorate	314	500mL poly	none	100mL	28 days
Fluoride	300			100mL	
Radium 226	903	1L poly	HNO_3	1L	180 days
Radium 228	Ra-05	2 x 1L poly	HNO_3	2L	180 days
Gross Alpha	900	1L poly	none	1L	5 days
Gross Beta					
Uranium	908	1L poly	HNO_3	1L	180 days
Strontium 90	905	1L poly	HNO_3	1L	180 days
Tritium	906	2 x 125mL BRA	none	125mL	21 days
Volatile Organics	524.2	4 x 40mL	HCl	40mL	14 days
Fumigants	504.1	3 x 40mL	$Na_2S_2O_3$	40mL	14 days
NP Pesticides	507	2 x 1L BRA	none	1L	14 days
OP Pesticides & PCBs	508	2 x 1L BRA	none	1L	7 days
Herbicides	515.1	2 x 1L BRA	none	1L	14 days
Semivolatiles	525.2	2 x 1L BRA	HCl	1L	14 days
Carbamate Pesticides	531.1	125mL BRA	MCAA	125mL	28 days
Glyphosate	547	2 x 125mL BRA	none	125mL	14 days
Endothall	548.1	500mL BRA	none	250mL	7 days
Diquat	549	1L brown poly	none	1L	7 days
2,3,7,8-TCDD Dioxin	1613	2 x 1L BRA	none	1L	365 days
TTHM	524.2	3 x 40mL	Na_2S2O_3	40mL	14 days
HAA5	552	250mL BRA	NH_4Cl	125mL	14 days
Bromate	300.1	250mL poly	EDA	100mL	28 days
Chlorite	300.1			100mL	28 days
Color	SM2120B	500mL BRA	none	100mL	48 hours
Odor	140.1			100mL	24 hours

CONSTITUENT	METHOD	CONTAINER	PRESERVATION	MIN VOLUME	HOLD TIME
Turbidity	SM2130B			200mL	48 hours
MBAS	SM5540C	1/2 gallon poly	none	700mL	48 hours
TDS	SM2540C			300mL	7 days
EC	SM2510B			100mL	28 days
Chloride	300			100mL	28 days
Sulfate	300			100mL	28 days
Aluminum	200.8	500mL	HNO_3	100mL	180 days
Copper					
Iron					
Manganese					
Silver					
Zinc					
MTBE	524.2	4 x 40mL	HCl	40mL	14 days
Thiobencarb	507	2 x 1L BRA	none	1L	14 days
TOC	SM5310C	2 x 40mL	H_3PO_4	40mL	28 days
Volatile Organics	624	4 x 40mL	none	40mL	72 hours
Semivolatiles	625	2 x 1L BRA	none	1L	7 days
PNAs	625 SIM	2 x 1L BRA	none	1L	7 days
Pesticides & PCBs	608	2 x 1L BRA	none	1L	7 days
Mercury[b]	1631	500mL BRF Bagged	none	100mL	28 days
Arsenic	200.8	500mL poly	HNO_3	100mL	180 days
Cadmium					
Chromium					
Lead					
Selenium					
Silver					
Antimony					
Beryllium					
Copper					
Zinc					
Nickel					
Thallium					
Chrome III	calc	NA	NA	NA	NA
Chrome VI	218.6	250mL poly	$(NH_4)_2$ SO4	100mL	28 days
Asbestos	100.1	2 x 1L BRA	none	1L	48 hours
Cyanide	10-204-00-1X	250mL brown poly	NaOH	100mL	28 days
2,3,7,8-TCDD Dioxin	1613	2 x 1L BRA	none	1L	365 days

a. Table 60320.208 requires a tracer analysis either utilizing an added or intrinsic tracer.

b. Ultra-low level (ULL) analyses for Hg is required for surface water applications only, generally pertinent to inland waters (e.g., streams) protective to fish (40 CFR Part 131.). For groundwater, Hg analysis by EPA Method 245.1 is sufficient. BRA = Boston Round Amber Glass.

12.8.3. Groundwater Monitoring Program Reporting

Routine monitoring reports submitted to DDW and RWQCB will include any detections of the monitored chemicals or contaminants and any temporal trends observed in the monitoring wells. Additionally, information pertaining to the vertical and horizontal migration of the extent of the injected water (i.e., the *product water plume*) will also be provided in the monitoring reports. Public water systems and drinking water well owners with downgradient sources that could be potentially impacted.

If applicable, revised estimates of hydrogeologic conditions will be provided in annual reports, including the underground retention time and the amount of the product water in the aquifers and at the nearest drinking water well. The revised estimates will be based upon actual data collected during that year regarding recharge rates, hydrostatic head values, groundwater projection rates, basin storage changes, and any other data needed to revise the estimate of the underground retention time and the amount of the product water in the aquifers and at the nearest drinking water well. Significant differences, and the reasons for such differences, between the estimates presented in the approved Engineering Report (this document) and subsequently revised estimates, shall be clearly presented. The most recently available data will be used to predict the retention time of product water in the subsurface.

12.9. PROJECT REPORTS

Routine and annual reports will be submitted through the SWRCB's Geotracker using the appropriate electronic deliverable format, as well as emailed to DDW as a PDF.[43] MRWPCA will notify all downgradient public water systems and drinking water well owners of annual report availability by direct mail or electronic mail.[44]

Per Title 22 Section 60320.228(b), every five years from the date of approval of the Engineering Report, MRWPCA must update the report and submit it to DDW and RWQCB. At a minimum, the update must include the following information:

- A description of how the RWC requirements will be met (in this case – TOC compliance);
- Evidence that the retention time for pathogen control and RRT have been met; and
- A description of any inconsistencies between previous groundwater model predictions and the observed and/or measured values, as well as a description of how subsequent predictions will be accurately determined.

In addition, MRWPCA will provide an evaluation of the Project's ability to comply with all regulations and provisions over the previous five calendar years, and any changes to facilities, operations, or other pertinent Project elements/functions.

[43] If the file exceeds one megabyte, a CD containing the file will be mailed to DDW.

[44] Public water systems and drinking water well owners with downgradient sources potentially affected by the recharge project and within ten years groundwater travel time from the Project injection wells.

12.10. TRACER TEST PLANNING

Per the Title 22 Criteria, a tracer test will be conducted to validate underground retention time after Project startup. If approved by DDW, such a test can use an intrinsic tracer with an uncertainty factor applied (0.67 month credit per month of time estimated using the intrinsic tracer). An examination of the groundwater chemistry compared to a bench-scale pilot water sample indicates that there is sufficient distinction between the waters to allow for differentiation based on the intrinsic water chemistry (discussed in **Section 9.3**). Almost all of the geochemical plotting techniques developed as part of the groundwater quality characterization in **Section 9.3** demonstrate clear and distinct geochemical signatures of the pilot water (Figures 9-14 through 9-17).

This evaluation will be confirmed when product water from the AWT Facility is available. It is recognized that the actual product water chemistry may be slightly different than the pilot water sample analyzed in **Section 9.4**. Nonetheless, the RO treatment is expected to produce product water that is reliably lower in ionic content than ambient groundwater for either aquifer system. In particular, conservative anions such as chloride and sulfate are expected to be significantly lower in the product water and will provide good indicators of injectate transport to monitoring wells.

Given the relatively long travel times to the downgradient monitoring wells as documented in Table 6-2, it will be difficult to maintain an added tracer program that contributed a sufficient amount of tracer to compensate for the mixing of injectate with groundwater and the dynamic nature of the groundwater flow field. Some general considerations of tracer testing are discussed below to provide context for the planning of the tracer test. Details of a proposed tracer test will be developed after initial well testing and submitted to DDW for approval. Tracer testing will be initiated prior to the end of the third month of project operation as required by the Title 22 Criteria.

12.10.1. Tracer Test Considerations

Tracer testing conducted for the Project refers to the ability to differentiate product water from ambient groundwater as it moves downgradient in the groundwater system. Tracers associated with the product water can be some innate component or property of the product water (intrinsic) or it can be deliberately added to the product water (extrinsic) to allow tracking through sampling of local wells. An intrinsic tracer can be a component of either the product water or the groundwater; the key is that the tracer is sufficiently different in the two waters to allow identification of the water source. Note that for the product water, an intrinsic tracer can also be the absence or lower concentrations of a certain component that is consistently present at higher concentrations in groundwater.

Because of the advanced treatment of the product water, ionic concentrations and other properties are anticipated to be sufficiently distinct from groundwater to track its presence in wells. However, due to the relatively large volumes of groundwater in the basin, heterogeneity in the aquifers, and complexities in the groundwater flow regime in response to local ASR injection and pumping not associated with the Project, numerous tracers, both intrinsic and extrinsic, are being considered. Selected tracers will require confirmation of local groundwater quality beneath the Injection Facilities area prior to implementation of tracer testing. At this time, no groundwater quality data are available in the Injection Facilities area and data are limited throughout the remaining Northern Inland Subarea (areas upgradient of the Injection Facilities area). Prior to testing, water quality data will be collected in project monitoring wells (and other wells) for comparison to groundwater quality in the adjacent Northern Coastal Subarea, which is well-documented through ongoing monitoring programs (**Section 9.4**).

Desirable intrinsic tracers for the Project have the following attributes:

- consistently present (or absent) in product water with reliable concentrations,
- provides a sharp contrast with ambient groundwater quality,
- conservative in the groundwater system (neither sorbed or biologically and/or geochemically reactive and should have measureable and/or predictable physicochemical behavior (i.e., transport/fate), and
- cost-effective to analyze.

Desirable extrinsic tracers for the Project have the following additional attributes:

- non-toxic (human and environmental),
- provides a sharp contrast with ambient groundwater quality,
- conservative in the groundwater system (neither sorbed or biologically and/or geochemically reactive and should have measureable and/or predictable physicochemical behavior (i.e., transport/fate),
- cost effective to add sufficient doses to be detected in groundwater,
- reliable laboratory or field techniques to detect tracer in groundwater samples,
- regulatory acceptance, and
- relatively easy to obtain (sample) and cost-effective to analyze.

Table 12-18 provides a comprehensive listing of various types of tracers with key advantages and disadvantages of each listed in the comments section. The table also includes some extrinsic tracers that are documented as excellent tracers in published literature, but occur in the water source from an accidental or inadvertent activity, such as groundwater pollution or radioactive fallout from weapons testing programs. Once in groundwater, these constituents may function as excellent tracers that allow affected groundwater to be distinctive from unaffected groundwater or other water sources. These types of extrinsic tracers are included in the comprehensive listing below, but are obviously not acceptable tracers to be added to the groundwater basin. A discussion of the more likely tracers applicable to the Project is provided following the table.

Table 12-18: Summary of Groundwater Tracers

Tracer Type	Examples	Comments
Ionic Substances (Intrinsic Tracers)	Li^+, Na^+, K^+, Ca^{2+}, Mn^{2+}, Mg^{2+}, Ni^{2+}, NH_4^-(N), Br^-, Cl^-, I^-, SO_4^{2-}	• Generally occur naturally in surface water and groundwater. • Cations may be adsorbed or exchanged in clay. • The halogens Br^-, Cl^-, I^- are considered ideal tracers, generally moving at groundwater advection rates. • Halogen ratios are useful for identifying seawater. • Ionic ratios may be used to fingerprint and quantify different sources (e.g., seawater or imported injectate). • Ideal for use over long timescales (years). • Relatively inexpensive analytical costs.
Dyes (Extrinsic Tracers)	Fluorescein (green dye), Rhotamine B (orange dye, decertified for use in cosmetics by U.S. FDA in 1960s and considered toxic), Sulfo-rhodamine B (brilliant pink)	• Have been used as tracers for both surface water and groundwater since late 1800s. • Relatively inexpensive and simple to use. • Well-suited for karst environments. • Slower travel time than groundwater due to adsorption, particularly in alluvium. • Fluorescent dyes more suitable for groundwater usage. • Suspended sediments may cause interference and therefore measured concentrations may vary because of turbidity, but also from temperature, pH, $CaCO_3$ content, salinity, reactions with dissolved CO_2, and optical brighteners, etc. • May have some degree of toxicity. Rhotamine B not recommended due to its toxicity. • May require regulatory agency approval.
Soluble Compounds (Intrinsic or Extrinsic Tracers)	Silicic, boric, phosphoric, acetic acids, ethanol, sugars (e.g., sucrose, maltose, lactose, glucose), and glycerol (glycerin); Pharmaceuticals (e.g., 17β-estradiol) and Personal Care Products (e.g., DEET, Triclosan, caffeine, sucralose)	• Generally do not ionize or may only slightly ionize in groundwater. • Detected at low to medium concentrations. • May have some degree of toxicity; Boric acid is toxic to plants and humans. • Sugars are nontoxic, but removed in most RO systems. • Transport/fate is variable: alcohols, sugars, etc. may readily sorb to alluvial aquifer materials and may significantly degrade or decompose. • If introduced inadvertently in groundwater, may be useful as a tracer; however, most of these compounds are not applicable as an added tracer.

Table 12-18: Summary of Groundwater Tracers (continued)

Tracer Type	Examples	Comments
Gases (Intrinsic and Extrinsic Tracers)	Inert natural radioactive/radiogenic gases such as ^{222}Rn, ^{133}Xe, and ^{85}Kr injected into groundwater	• Natural and artificially produced gases that can be injected into groundwater. Considered to be extrinsic tracers due to low natural background concentrations. • Radon (^{222}Rn) has a short half-life (3.8 days) and is virtually absent in groundwater that has reached atmospheric equilibrium. • Low biological hazard; generally stable for years. • Legal and regulatory restrictions for injecting radioactive substances into groundwater.
	Inert noble gases including neon (Ne), krypton (Kr), xenon (Xe), helium (He) (intrinsic or extrinsic)	• Noble gases require specialized equipment and protocols (e.g., collection in copper tubing and analysis by a noble gas laboratory). • Some sorption onto clays and organic material by Kr and Xe. • Corrections required for excess air. • Expensive analysis; also requires constant monitoring. • Being used by Water Replenishment District of Southern California at seawater intrusion barriers.
	Nonreactive organic and inorganic anthropogenic gases (e.g., chlorofluorocarbons (CFCs) such as freon; sulfur hexafluoride (SF_6))	• CFCs released in large quantities to the atmosphere in 1940s and 1950s; useful for certain age of groundwater. • CFCs sorb strongly to organic matter; therefore, require careful sampling (no plastic tubing or bottles allowed) and analysis. • Legal and regulatory restrictions; not applicable for added tracers. • SF_6 is a considered nontoxic and safe for groundwater use, although the U.S. EPA and CARB consider it a potent greenhouse gas pollutant. CARB now prohibits its use as a tracer. • SF_6 occurs in urban areas and may affect groundwater. Corrections should be made for background concentrations.

Table 12-18: Summary of Groundwater Tracers (continued)

Tracer Type	Examples	Comments
Stable Isotopes (Intrinsic Tracers)	^{16}O, ^{17}O and ^{18}O and ^{1}H and ^{2}H (D) in water; ^{35}Cl and 37Cl in surface and groundwater, ^{14}N and ^{15}N for dissolved nitrate; ^{32}S, ^{34}S, and ^{36}S and ^{16}O and ^{18}O in SO_4^{2-}, ^{12}C and ^{13}C from CH_4, ^{10}B and ^{11}B, Sr^{87}/Sr^{86} ratios in seawater and brines	• Oxygen (O) and hydrogen (H and D) isotopes of water used to determine (fingerprint) water sources and trace large-scale movement and mixing of groundwater in basin studies. • Chlorine (Cl) isotopes used as a tracer of seawater and possibly agricultural sources. • Stable nitrogen (N) isotopes used to fingerprint groundwater nitrate sources (i.e., fertilizer, wastewater, atmospheric deposition). • Stable isotopes of sulfur (S) and oxygen (O) in sulfate are used to fingerprint groundwater sulfate sources (e.g., soil, wastewater, atmosphere). May be useful in tracing agricultural water and recycled sources. • Carbon (C) isotopes used to differentiate methane sources. • Boron (B) isotopes used for brines, seawater, and possibly reverse osmosis treated waters. • Strontium (Sr) isotopes for brines and seawater.
Radiogenic isotopes (Extrinsic Tracers)	^{2}H (T), ^{14}C, ^{32}P, ^{51}Cr, ^{60}Co, ^{82}Br, ^{85}Kr, ^{131}I, ^{198}Au,	• Radiogenic tracers that decay or give off gamma (γ) radiation are easier to detect than α or β radiation. • Injected in a form that is soluble and mobile in aqueous phase either as a neutral or ionic substance. • Rate of removal of radioactivity from groundwater is a function of the volume of the water moving through the well per unit time. • T in groundwater is a result of anthropogenic contamination from atmospheric nuclear bomb testing and could be considered as an intrinsic tracer. • Tritium (T) (with a half-life of ~12.4 years) used alone and with its radiogenic daughter ^{3}He to determine young (post atomic bomb) groundwater age. • ^{14}C (with a $t_{1/2}$ of 5,730 years) used to detect older groundwater; results from cosmic ray impact to naturally occurring atmospheric carbon. • Less useful as an added tracer. Legal and regulatory problems with injection of radioactive substances.

References: Hounslow (1995), Davis, et al. (1996); Hem (1989); CARB (1999); Lee (2009); Panno, et al. (2002), Gamlin, et al. (2001); Silva, et al. (2002), Davisson, et al. (2004); Trussell Technologies, Inc. (2004); Panno, et al. (2005), U.S. EPA (2006c); Clark, et al. (2007); Santella, et al. (2007); Kloppmann, et al. (2008a; 2008b); Schladow and Clark (2008); Scheehle (2008); Kloppmann, et al. (2009); Lee (2009; Anderson, et al. (2010); Kendall, et al. (2010).

12.10.2. Recommended Tracer Testing Parameters

Collectively, the comments in Table 6-3 identify naturally occurring monovalent anions, such as bromide (Br^-), chloride (Cl^-), and iodide (I^-), as excellent tracers in areas where concentrations are sufficiently different in the two source waters being compared (i.e., product water and groundwater). These monovalent anions make the best tracers because soils and aquifer materials generally have little to no anion exchange capacities.

For application, chloride is the best monovalent anion due to its relatively higher concentration in groundwater compared to the anticipated concentrations in product water. Bromide and iodide are less applicable due to relatively low concentrations in groundwater (bromide) and limited available historical data (iodide). In addition, a divalent anion, sulfate, also appears to be a candidate for differentiation of product water and groundwater. Finally, isotopic signatures may also provide useful information for distinction of the two source waters. Although current data are limited, additional sampling for certain isotopes is expected to reveal significantly different signatures; isotopic signatures are often significantly different between groundwater and surface water sources.

Therefore, a recommended intrinsic tracer testing program for the Project will likely focus on chloride, sulfate, and geochemical and isotopic signatures. This program will be further evaluated with analysis of the Project's monitoring wells, when installed. A detailed groundwater quality characterization is provided in **Section 9**. Specific ions and isotopes that may be applicable to a tracer testing program are summarized below.

The availability of reliable added tracers have become problematic in California. The use of sulfur hexafluoride has been banned by the California Air Resources Board due to its potency as a greenhouse gas. It is expected that final results from xenon gas added tracer testing at seawater intrusion barriers in Southern California will inform any decision regarding the potential for added tracer testing as an option in lieu of added tracer testing (Lawrence Livermore, 2016).

12.10.2.1. Chloride

Hem (1989) and Coplen, et al. (2006) noted that chloride is a "tame and subdued ion" when compared to other major ions. It makes an ideal tracer because the chloride anion:

(1) does not significantly enter into oxidation-reduction reactions,
(2) does not form solute complexes with other ions (unless concentrations are relatively high),
(3) does not form other salts of low solubility,
(4) is not significantly adsorbed on mineral surfaces,
(5) is involved in only a few vital biogeochemical processes, and
(6) has very little retardation.

The groundwater quality characterization discussion in **Section 9** illustrates differences in ionic concentrations between the Paso Robles Aquifer, the Santa Margarita Aquifer, ASR injectate, and pilot water (see Stiff Diagrams on Figure 9-14) and TDS concentrations on Figure 9-18). Chloride concentrations contribute significantly to these distinctions. Further chloride concentrations in product water are expected to be lower than found in groundwater, providing an excellent candidate for tracer testing for the Project. However, chloride concentrations downgradient of product water injection may

be influenced by low chloride concentrations from ASR injectate, which influences the historical statistics of chloride concentrations in the Seaside Basin. This suggests that chloride in ambient groundwater would be higher and even more distinct from Project injectate. Summary data for chloride concentrations are provided in Table 6-4 and discussed below.

Table 12-19: Summary of Chloride Concentrations in Groundwater and Injectate

Pilot Water	Northern Coastal Subarea Groundwater[a]	ASR Injectate[b]	Selected Downgradient Wells[b,c]
21 mg/L	62 mg/L	28 mg/L	110 mg/L

a. Average concentration from SNMP (HydroMetrics, 2014a). Data include ASR wells when being influenced by ASR injectate.
b. Average concentrations from 2010-2015.
c. Non-ASR downgradient wells including Ord Grove, Ord Terrace, and Paralta (screens in both Paso Robles and Santa Margarita Aquifers).

As indicated in Table 12-19, chloride concentrations in basin groundwater quality range between about 60 mg/L to more than 100 mg/L. Data downgradient from the Injection Facilities area indicate that the Paso Robles Aquifer concentrations are lower (average about 60 mg/L) than average concentrations in the Santa Margarita Aquifer (148 mg/L). However, as indicated by the notes below Table 12-18, groundwater data are complicated somewhat by wells screened in both aquifers and by wells containing ASR injectate.

Zones of similar chloride concentrations were delineated for the recently-completed SNMP (HydroMetrics, 2014a). These zones are reproduced on Figure 12-3 with the Injection Facilities area added. As shown on Figure 12-3, the Injection Facilities area resides within zones of average chloride concentrations of 63 mg/L for the Paso Robles (labeled Shallow on Figure 12-3) and 61 mg/L for the Santa Margarita Aquifer (labeled Deep on Figure 12-3). Note that on the Deep map, chloride concentrations average 148 mg/L a short distance away from the Injection Facilities area. Downgradient wells with lower concentrations are being influenced somewhat by ASR injection.

Although these data indicate that ASR injectate is similar to the Project's pilot water, chloride remains a viable candidate for intrinsic tracer testing. First, the chloride concentration in actual product water is expected to be lower than the pilot water sample referred to in Table 12-19. As explained in Section 9.4.2, pilot water was stabilized with calcium chloride for the bench scale sample, a process that will not apply to the actual product water (see Section 3.2.7). Pilot permeate samples contained chloride concentrations of <1 to 6 mg/L (median 3 mg/L). Minimal sodium hypochlorite may be added to the full-scale product water, but with concentrations only about 1 to 2 mg/L as chloride. No other chloride-containing chemical will be added for product water stabilization.

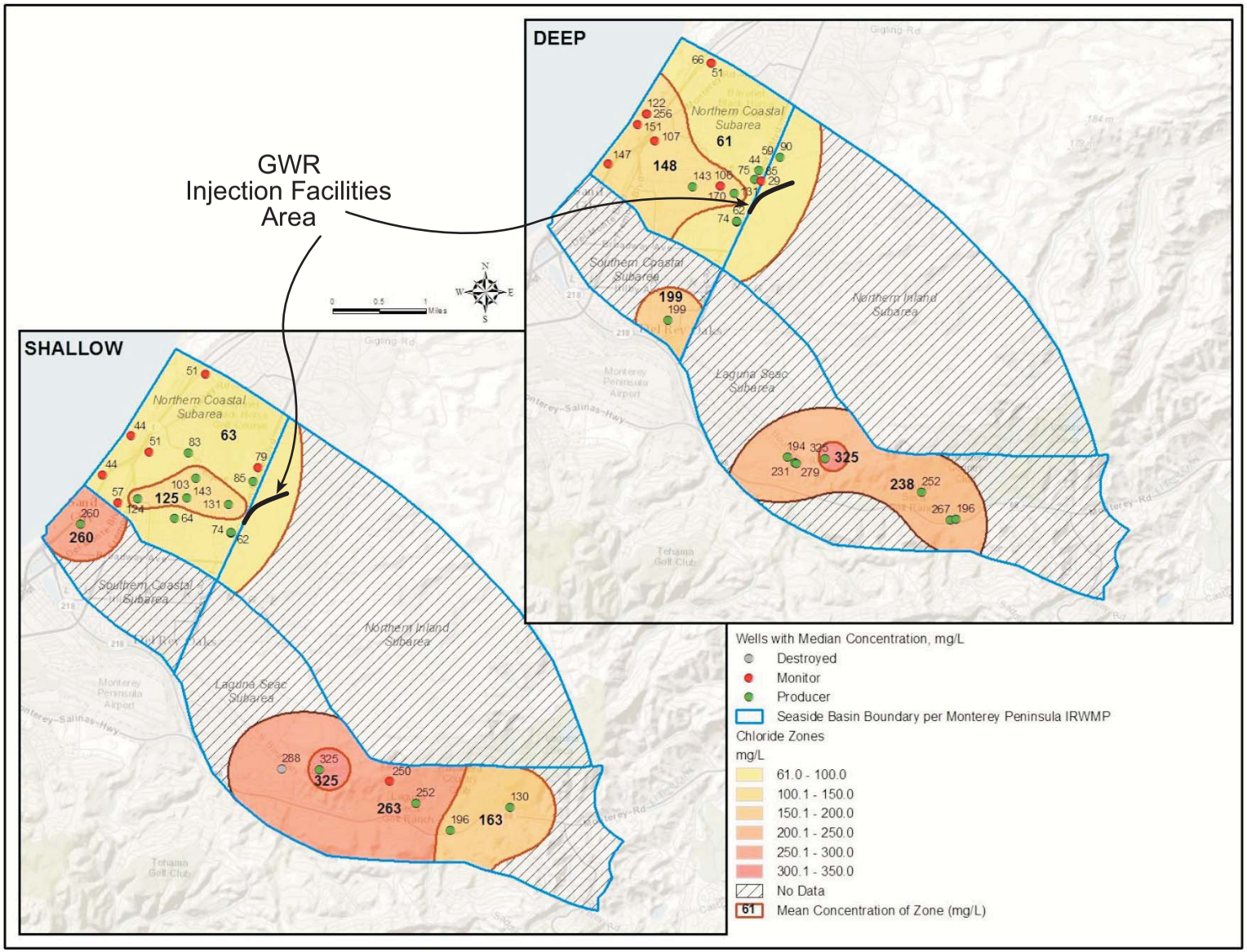


Figure 15: Water Quality Zones for Chloride

Modified from: HydroMetrics, 2014.

November 2015

TODD GROUNDWATER

Figure 12-3
Generalized Zones of Chloride Concentrations Seaside Basin

Second, the ASR wells do not inject continuously and are operated such that the injectate is extracted at high pumping rates relatively soon after injection (within a year; see Table 10-1). Given these conditions, it is unlikely that groundwater beneath the Injection Facilities Area has been impacted by ASR injectate. Hydraulic gradients in the vicinity of the ASR wells are higher than beneath the Project Injection Facilities Area and result in westerly to northwesterly downgradient groundwater flow at the ASR wells (see Figures 9-10 through 9-13). In addition, ASR recovery pumping would prevent significant upgradient migration.

Third, the presence or absence of injectate in the vicinity of the Project monitoring wells will be readily observed once wells have been drilled and sampled. As explained in Section 12.8.1, the monitoring wells are not yet installed. However, data from these wells will be available to inform the proposed tracer testing prior to project start up. If baseline groundwater sampling in the monitoring wells suggests that upgradient ASR injectate is capable of complicating the tracer test, then different constituents will be proposed.

Fourth, the Project will have a monitoring well close to the injection wells (within 50 feet). Background water quality data can be observed prior to, during, and after the tracer test is initiated. Arrival of Project injectate can be distinguished in this monitoring well by groundwater analyses prior to and during the test. Further, ASR operations and ASR wells, along with additional Project downgradient monitoring wells, will also be analyzed during the tracer test. These data will allow differentiation of the product water and ASR injectate by locations and concentrations.

Finally, chloride will not be relied on in isolation, but in combination with additional intrinsic tracers, overall water chemistry, and isotopic signatures. These multiple lines of evidence will add more certainty to the analysis.

12.10.2.2. Sulfate

Generally, once in groundwater most sulfur-containing compounds will form the sulfate anion (SO_4^{2-}) if oxidizing conditions occur. Sulfate concentrations in the Seaside Basin groundwater appear relatively consistent in samples reviewed from 2010 through 2015. Although sulfate concentrations in the Paso Robles Aquifer appear slightly lower than in the Santa Margarita Aquifer, concentrations in both aquifers are higher than the concentrations expected in the product water. Importantly, concentrations in product water are also expected to be significantly lower than in the ASR injectate, providing an opportunity to more clearly differentiate product water from groundwater affected by ASR injectate. Summary data for sulfate concentrations in ASR injectate and also in non-ASR groundwater wells from 2010 – 2015 are shown in Table 12-20. Also included in the table is the sulfate concentration from the pilot water.

Sulfate is also useful in that the isotopes of oxygen (^{16}O and ^{18}O) can also be analyzed (see discussion below) (Baldwin and Cook, 2004). Sulfur from such different sources can have different isotopic signatures, including sulfur contained in naturally occurring compounds in the atmosphere, soil, and sulfur-containing minerals in rocks (e.g., pyrite or iron sulfide). Anthropogenic sources include sulfur in fertilizers such as ammonium sulfate. Industrial processes can also contribute sulfur to the atmosphere, soils, and groundwater.

Table 12-20: Summary of Sulfate Concentrations in Groundwater and Injectate

Pilot Water	ASR Injectate[a]	Selected Downgradient Wells[a,b]
<0.5 mg/L	71 mg/L	58 mg/L

a. Average concentrations of sulfate from 2010-2015.
b. Non-ASR downgradient wells including Ord Grove, Ord Terrace, and Paralta (screens in both Paso Robles and Santa Margarita aquifers).

12.10.2.3. Water - Oxygen-Hydrogen (Deuterium) Isotopes

When the water molecule is separated into its principal isotopic components, signatures associated with different water sources can often be delineated. In the past decade, water isotope hydrology and hydrogeology (particularly isotopes of ^{16}O, ^{17}O ^{18}O, H, ^{2}H, and ^{3}H) has become useful for determining groundwater sources, exchange of solutes (between groundwater and lakes), direction of groundwater flow, residence time, and other hydrologic conditions such as flow paths and the static head measurement (Kendall, et al., 1995; Kendall and Krabbenhoft, 1995).

Water contains isotopes of oxygen, mostly as ^{16}O (99.76%) and ^{18}O (0.20%) and hydrogen, as hydronium (^{1}H) (99.985%) and deuterium (D or ^{2}H) (0.015%). Water that is largely composed of ^{16}O is less dense ("lighter") than water with a larger component of ^{18}O. Because water evaporation is temperature dependent, it condenses at different rates for different latitudes and climates; its atmospheric condensation is also temperature-dependent and, therefore the ratio of $^{18}O/^{16}O$ in rain and snow will change with latitude and elevation. The higher the latitude or the elevation, the lower the $\delta^{18}O$ values, which vary from approximately 0‰ at the equator to about –55‰ (in comparison to Standard Mean Ocean Water) at the poles (Henderson, 1982). The same is true for hydrogen and deuterium; for example, deuterium ratios are also directly proportional to $^{18}O/^{16}O$ ratio fractionation.

A plot of the $\delta^{18}O$ concentration versus the δD ($^{2}H/^{1}H$) will show unique characteristics for water samples collected from different climates, seasons, hydrologic basins, and other water sources. In particular, surface water sources are often distinguished from groundwater sources. Preliminary isotopic data were collected and analyzed during the MRWPCA field program. These data provide background information to be compared against isotopic analyses of product water when available.

12.10.3. Groundwater Monitoring of Tracer Testing Parameters

Parameters approved for tracer testing will be added to the monitoring program if not already included. Chloride and sulfate are already incorporated into the program. The inorganic program will be expanded to include all of the cation-anion analyses to support geochemical plotting techniques described in **Section 9.4**. Isotopic analyses will be collected and analyzed from monitoring wells prior to startup to determine basin-specific usefulness for tracer testing.

13. GENERAL OPERATIONS PLAN

The AWT Facility will be equipped with modern control and monitoring equipment, which will facilitate operation of the facility by highly trained operations staff to produce water supply that is reliably protective of public health. Standby equipment will be included, as needed, to facilitate both planned and unplanned service of equipment. An OOP will be developed for the facility that details Standard Operating Procedures (SOPs). An overview of the AWT Facility operations plan features is described in this section. If the product water does not meet permit requirements, pathogen performance, or advanced treatment criteria based on online monitoring parameters (*e.g.*, conductivity removal through RO, UV dose) and other critical control points (*e.g., MF DIT)*, the product water will be discharged to the MRWPCA outfall, returned to the RTP headworks, or pumped to SVRP, with the latter two options preferred to preserve the low-TDS water

In accordance with Title 22 Section 60320.200(g), prior to operations, MRWPCA will demonstrate that all treatment processes have been installed and can be operated to meet their intended function by undertaking actions including, but not limited to, the following:

- Develop a Startup/Commissioning Plan to verify the correct installation of equipment and document proper performance for equipment,
- Collect manufacturers' standard factory tests and results (*e.g.*, MF membrane pathogen removal testing, RO conductivity removal testing),
- Perform tests of all equipment to verify proper installations and functionalities,
- Perform partial and complete startups and shutdowns of partial process treatment trains and whole AWT Facility,
- Perform complete simulations of major and critical alarms, and
- Conduct startup and performance evaluation, including validation of the advanced oxidation process.

13.1. RTP AND AWT FACILITY SYSTEM CONTROLS AND RELIABILITY

13.1.1. Controls

MWRPCA employs a virtualized server/client SCADA system. The AWT Facility will be integrated into this system to allow for control and monitoring by MRWPCA. The SCADA system is under one Factorytalk Directory and is part of a Microsoft domain. Redundant Human-machine Interface (HMI) servers and FactoryTalk Alarm and Event (FTAE) servers, where the operators interface with the system, share a pair of redundant RSLinx data servers. The RSLinx data servers provide PLC data and alarms to the HMI servers and Factorytalk Historian, which records and saves the data.

Each process area (RTP, Pump Stations, SVRP, and CSIP) has a master ControlLogix PLC and the RTP includes a redundant PLC. These master PLCs act as gateways between other PLCs and remote input and output (I/O) to the SCADA system and Historian (MRWPCA 2015).

The local PLCs at the AWT Facility will control the unit processes to meet operational setpoints, to trigger alarms when thresholds are passed that require operator intervention, and to shutdown

down unit processes that threaten the safety of equipment, operators, or public health. These local PLCs will feed into a master Project PLC, which will feed into the existing SCADA network.

13.1.2. Redundancy

A 10% offline factor was assumed in selecting the AWT Facility design flow to meet production requirements (i.e., the AWT Facility only needs to be in production 90% of the time in order to meet production requirements). OCWD's GWRS, which has similar facilities, has an operating offline factor of approximately 6%. The offline factor allows for planned and unplanned downtime, such as preventative maintenance or RO train cleans.

The AWT Facility design criteria were developed to meet the 10% offline factor. These design criteria include MF pre-treatment (via ozonation), sustainable MF fluxes (with respect to cleaning needs), sustainable RO recoveries, and the incorporation of stand-by equipment for key processes. The AWT Facility design criteria are summarized in **Section 3**.

Ozone system. The ozone system is included in the AWT Facility process train to reduce MF fouling and to reduce the concentration of CECs and pesticides in product water and RO concentrate discharged to the ocean. The ozone system will inactivate pathogens; however, no regulatory credit will be sought for this inactivation as it is not required to meet the Title 22 pathogen LRVs (i.e., the AWT Facility can produce a product that is protective of public health when the ozone system is offline, as sufficient pathogen inactivation is obtained in downstream processes: MF, RO, UV/AOP, and travel time in the aquifer). MF fouling will temporarily increase when the ozone is offline; however, fouling will return to low levels when the ozone system is brought back online and cleans will be used to remove foulants from extended ozone system downtime. Accordingly, the ozone system has not been designed with same level of redundancy as the other treatment processes that are required for pathogen removal credits.

Standby LOX tanks, vaporizers, ozone generators, nitrogen boost systems, and ozone destructs rarely fail and due to the permissible ozone system downtime, they are not included. Spare parts will be held onsite to facilitate rapid repair of systems that require service. Three sidestream injection lines are included in the design, which will allow for continued ozone injection if an injection line requires service, albeit at a lower transfer efficiency.

The design ozone dose was selected after pilot testing ozone pre-treatment for a thermally induced phase separation (TIPS) PVDF low-pressure membrane. The design ozone dose accounts for differences in water quality and transfer efficiency between pilot testing and the AWT Facility. Given that the ozone dose was conservatively selected for poor water quality (high in nitrite and TOC) and the maximum expected flow, the ozone system will be able to address a wide spectrum of feed water conditions.

MF system. The MF system design allows for one standby block of membranes at peak flow while maintaining the design flux. This standby block can be brought online when one of the other blocks is removed from service for maintenance or a CIP. The design flux was based on the pilot testing and it is the flux that could be sustained for approximately one month prior to needing a CIP. Blocks of MF modules may be periodically removed from service for routine backflushes (e.g., every 15

minutes) and daily cleans; the MF system includes flow equalization upstream (MF feed wetwell) and downstream (MF filtrate wetwell) to allow the upstream and downstream processes (ozone and RO, respectively) to operate at constant flow during these regular backflushes and daily cleans, and the MF system flux was designed to meet the target, average MF system flowrate, despite temporarily suspensions in production during the regular backflushes and daily cleans. A standby automatic pre-strainer and a duplex compressed air system are also included to reduce downtime associated with automatic strainer and air compressor maintenance.

RO system. The RO system does not include a standby train for CIP events; rather, the offline time associated with RO CIP events was incorporated into the AWT Facility design offline factor. The CIP interval was demonstrated during the pilot test program at the design RO recovery with the secondary effluent during which time the agricultural washwater source water was shunted to the RTP for treatment. A standby cartridge filter is included to reduce downtime associated with cartridge filter maintenance.

UV/AOP system. The UV/AOP system includes a redundant reactor, which will be brought online if a duty reactor alarms out of service or if one is taken offline for service. The design UV fluence ("UV dose") is based on conservative 1,4-dioxane removal requirements and a conservative effluent NDMA goal. The NDMA removal goal was based on observed RO permeate NDMA concentrations during pilot testing. The UV fluence required to meet these goals will achieve significantly greater pathogen inactivation than the process is granted credit.

Product water stabilization. Product stabilization consists of decarbonation, CO_2 addition, as needed, and chemical addition[45]. Chemical addition will include a chemical that can add alkalinity and calcium, or separate chemicals that can achieve those goals. The decarbonator will include a redundant blower to minimize downtime associated with regular blower maintenance. A standby decarbonator is not required, as they rarely require removal from service for maintenance.

Chemical feed systems and pumps. Standby chemical feed metering pumps and water pumps are provided to minimize downtown and to ensure reliability of disinfection systems (e.g., UV/AOP).

Power supply. The RTP has a 21 kilovolt (kV) primary service. The 21 kV medium voltage switchgear has a main breaker and 2 x knife disconnect switches that supply a redundant set of 21 kV to 480 volts alternating current (VAC) transformers. During normal operation the A or B side transformer is selected. The A and B transformers feed 2 x 4000 ampere (A) 480 VAC main breakers. A 1500 kW emergency standby transformer supplies power to the RTP during a PG&E power loss. There are 3 x 580 kW 480 VAC cogeneration units powered by a biogas and natural gas blend. During normal operations 2 x 580 kW cogeneration units are in operation. The RTP administration building has a critical load emergency generator on an Automatic Transfer Switch (ATS) to supply power to the control room and server room if the RTP 1500 kW generator fails. The SVRP has a separate 21 kV service that is not connected to the RTP (MRWPCA 2015).

[45] The need for CO_2 addition may be re-evaluated during further stages of design; it may be possible to obtain sufficient pH control without CO_2 addition

The AWT Facility power will likely be supplied through a new PG&E utility connection to the RTP or through connection with the Monterey Regional Waste Management District power generation facilities. The system components would include a utility service, transformers, and switchgear. The major electrical loads will be from the new influent pumping, ozone generator, MF and RO feed water pumping, UV reactors, and product water pumping. The AWT Facility will not be able to utilize 480 VAC service from the RTP or the RTP cogeneration facility. The AWT Facility will require its own 21 kV service along with its own emergency generator.

RTP. The upstream RTP process includes bar screens (1/4 inch), aerated grit removal, primary clarification (5 clarifiers, with scum removal), CEPT facilities (ferric chloride), trickling filters towers (6 towers, 4 currently used; synthetic media), bioflocculation basins (also known as solids contact basins), and secondary clarification (6 clarifiers with scum removal), as well as solids handling facilities (gravity thickener, dissolve air flotation thickener, anaerobic digesters, screw presses, sludge drying beds, and sludge lagoons), all with an average dry weather and ultimate peak wet weather flow of 29.6 and 81 mgd, respectively. The average dry weather flow to the RTP will not exceed the permitted capacity of the RTP with the addition of the new source waters (the predicted flows range from 19 to 29.6 mgd, with an average flow of 24 mgd and a maximum flow of 29.6 mgd, where capacity is only reached for the month of June only). Unused secondary effluent is discharged through an ocean outfall.

Flow control and residuals. Operation of the AWT Facility benefits from diverting a constant flow of secondary effluent from the larger secondary effluent flow that goes to either the SVRP or the ocean outfall, thereby avoiding the operational challenges associated with variable flowrates. The AWT Facility will divert secondary effluent from a diversion structure located downstream of the secondary clarifier effluent channel and upstream of SVRP influent pump station diversion. Operation of the AWT Facility also benefits from being able to discharge waste flows (also known as recycle streams) back to the RTP headworks, thus decreasing the potential negative impact that could occur from recycled streams being handled at the AWT Facility. Recycle streams will be returned to the RTP headworks for treatment and dilution prior to ultimately being returned to the AWT Facility.

13.1.3. Robustness

Several treatment processes are included in the AWT Facility and these processes, as well as the travel time in the aquifer, provide treatment through a variety of mechanisms. Given that contaminant removal efficiency is largely impacted by the treatment mechanism (*e.g.*, , some contaminants are readily removed through RO, such as bromate, while others require UV/AOP to meet product water quality goals and requirements, such as NDMA), including a variety of treatment mechanisms facilitates the removal of a wide range of constituents.

AWT trains have evolved since the first potable reuse projects in California. One component that has changed over times is the robustness of potable reuse treatment trains. OCWD originally practiced groundwater injection of RO permeate; however, measurement of NDMA in the RO permeate lead to the inclusion of UV following RO. Later, measurement of 1,4-dioxane in the UV effluent lead to the addition of constituents that form hydroxyl radicals when exposed to UV light (e.g., H_2O_2), thereby achieving a UV/AOP process. The addition of ozone upstream of MF not only reduces MF

fouling, but also provides additional robustness by adding a new oxidation step into the treatment train, which can both inactivate pathogens and oxidize CECs. Table 13-1 summarizes the treatment mechanisms achieved through the AWT Facility and the groundwater aquifer. Table 13-2 summarizes the impact of the major processes on constituents of concern.

Table 13-1: AWT Facility and Aquifer Treatment Process Robustness through Multiple Treatment Mechanisms

Process	Biological oxidation	Sorption	Chemical oxidation	Physical removal	Physical degradation
RTP (primary & secondary)	✓	✓		✓ (Sed[a])	
Chloramination			✓		
Ozone			✓		
MF				✓	
RO				✓	
UV/AOP			✓		✓ (Photolysis)
Decarbonator				✓ (Stripping)	
Aquifer	✓	✓		✓	✓ (Hydrolysis)

a. Sedimentation.

Table 13-2: AWT Facility and Aquifer Treatment Barriers

Process	Chemical constituents					Pathogenic microorganisms		
	Nitrogen	TOC	DPBs	Inorganics	CECs	Bacteria	Viruses	Protozoa
RTP (primary & secondary)	✓	✓		✓	✓	✓	✓	✓
Ozone					✓	✓	✓	✓
MF		✓		✓[a]		✓	✓	✓
RO	✓	✓	✓	✓	✓	✓	✓	✓
UV/AOP	✓		✓		✓	✓	✓	✓
Aquifer						✓	✓	✓

a. Particulate inorganics (*e.g.*, iron and manganese)

13.1.4. Resiliency and Integrity Monitoring

The Project has multiple resiliency elements beginning with its source control program and efficacy of the RTP treatment processes to protect the feed water coming into the AWT Facility. Other features include monitoring of the AWT Facility treatment processes and AWT Facility product water quality to ensure that unit processes are performing as expected and that the AWT Facility is reliably producing water that is protective of public health. Monitoring will consist of grab samples, composite samples, and online instrumentation as discussed in **Section 12**. The treatment processes will have alarm setpoints, which will alert the attention of MRWPCA staff and shutdown processes when necessary. MRWPCA staff will also regularly review monitoring results and verify instrument readings. When monitoring results pass thresholds or alarm setpoints, staff will respond according to the OOP and SOPs.

Monitoring of the AWT Facility performance requires monitoring of surrogates that indicate the removal of pathogenic microorganisms and that demonstrate AOP performance. Pathogen microorganism removal credit will be claimed for three treatment processes: MF, RO, and UV/AOP. In addition, pathogen credit will be claimed for time spent in the aquifer following treatment in the AWT Facility. The AOP requirement to remove 1,4-dioxane and the MRWPCA goal to achieve 1.5 log removal of NDMA will result in a UV/AOP process that achieves significantly greater log removal than the maximum credited unit process removal of 6 logs per pathogen or pathogen class (enteric virus, *Cryptosporidium* oocysts, *Giardia* cysts). Thus, ensuring that the AOP requirements are met

ensures that the UV/AOP process meets its log removal requirements. Preliminary surrogates, critical limits, and example alarm setpoints, shutdown setpoints, and corrective actions are shown in Table 13-3.

Table 13-3: Preliminary Treatment Surrogates and Example Corrective Actions in Response to Treatment Failures

Process	Parameter(s)	Monitoring frequency	Critical limit	Alarm limit	Shutdown limit	Corrective actions
MF	Pressure decay LRV	Minimum of 1 per day	< 4.0	≤ 5.0	≤ 4.2	Confirm results. Remove modules from service. Assess fiber breakage. Isolate, repair or replace module.
RO	Conductivity LRV	Continuous (at least 1 measurement every 15 minutes)	< 1.50	≤ 1.60	≤ 1.55	Monitor individual RO trains. Remove train(s) from service. Verify analyzer accuracy. Conduct vessel probing. Investigate train performance and review operating practices. Replace membranes, if needed.
UV/AOP	UV dose (EED)[a] H_2O_2dose	Continuous (at least 1 measurement every 15 minutes)	< 1.5 LRV of NMDA < 0.5 LRV of 1,4-dioxane	1.32 LRV of NDMA 0.55 LRV of 1,4-dioxane	1.26 LRV of NMDA 0.52 LRV of 1,4-dioxane	Remove reactor from service. Check and replace lamps or ballasts as needed. Check and recalibrate sensors as needed. Check dosing system. Recalibrate pump.

a. Electrical energy dose – EED.

As discussed previously, TOC, total nitrogen, constituents with MCLs, lead, copper, Priority Pollutants, constituents with NLs, and indicator compounds indicative of pharmaceuticals, endocrine disrupting chemicals, personal care products, constituents regulated through source control, and other indicators of municipal wastewater will be monitored in the RO permeate or a downstream location prior to injection into the aquifer to verify product water quality and will also be monitored upstream as necessary to verify removal performance. MRWPCA staff will review results and take

corrective actions as necessary, which may include modifying treatment processes, removing units from service, or other actions as needed to improve performance.

In addition to the monitoring described above and in **Section 12**, other process and water quality parameters will be regularly monitored to support operation of the AWT Facility. These parameters will include levels (*e.g.*, chemical levels), flow rates, pressures, speeds (*e.g.*, pump motor speeds), residuals, concentrations, setpoints, and positions (*e.g.*, valve positions) for both the treatment processes and support systems. Parameters will be monitored through manual readings, on-line data, and laboratory analysis. Example water quality parameters include chloramine residual, ambient ozone concentration, ozone gas concentration, dissolved ozone residual, nitrite, ORP, pH, turbidity, and temperature. A final list of parameters that support operation of the AWT Facility will be detailed in the O&Ms and SOPs. Responses, based on monitoring results, may include the removal of processes from service, investigation of unusual results, and modification of treatment process setpoints to adapt to changing conditions.

Pathogenic microorganism concentration reduction failure. As discussed in **Section 12**, the log reductions achieved through the entire system will be determined each day and reported as "yes" if required log reductions were achieved or "no" if not achieved. If all three components (MF, RO, and AOP) do not pass, response measures specified in Title 22 Sections 60320.208(h) and (i) will be launched. Within 24 hours of becoming aware of the issue, MRWPCA will immediately investigate potential cause(s) and take corrective action(s). DDW and RWQCB will be notified immediately if the AWT Facility fails to meet pathogen reduction criteria longer than four consecutive hours, or more than a total of eight hours during any seven-day period. Failures of shorter duration will be reported to the RWQCB no later than ten days after the month in which failure occurred. If the calculated overall log reduction drops below 10-logs for enteric virus, or 8-logs for *Giardia* cysts or *Cryptosporidium* oocysts, MRWPCA will immediately notify DDW and RWQCB, and discontinue application of product water for injection, unless directed otherwise by DDW or RWQCB.

Nitrogen Compounds, Regulated Contaminants and Action Levels, NLs, TOC, Additional Chemicals, and CECs. Information on response actions including monitoring, investigations, and suspension of product water for injection for each of these contaminant categories is presented in **Section 12**. Regular water quality sample collection and online monitoring is conducted at the RTP for process control, which includes turbidity, TSS, BOD (soluble and total $CBOD_5$, and BOD_5), dissolved organic carbon, TSS, volatile suspended solids, ammonia, pH, temperature, dissolved oxygen and flow at various locations in the RTP. This regular monitoring facilitates control of RTP treatment processes.

The RTP has alarms to indicate issues with the primary and secondary facilities, including power failure, unusual water quality, and mechanical failures. The alarm devices are connected to uninterruptible power supplies (UPSs) so that they continue to work in a power failure. All alarms result in an audible alarm in the control room. The control room operator is a Grade III operator or higher or is being supervised by a Grade III or higher operator on site. The control room is staffed 24 hours per day every day. Depending on the nature of the alarm, the control room operator can deal with the issue himself, call in on-call personnel to deal with issue; or call the Chief Operator and/or managers. All alarms are recorded and printed and those records are maintained on paper and electronically. Alarms for the AWT Facility will also be routed to the control room.

13.2. TRAINING

13.2.1. O&M Manuals and SOPs

Training and O&M manuals will be provided by the engineering firm responsible for the 100% design of the AWT Facility, which will include training by the Original Equipment Manufacturers (OEMs) that provide equipment for the AWT Facility (for example, ozonation training will be conducted by the ozone system supplier). O&M manuals will be included in the MRWPCA Electronic O&M Manual, which is currently in production for all facilities located at the RTP site. The O&M manuals will include process descriptions, control descriptions, design criteria, routine duties, start-up and shut-down SOPs, alarms, an emergency response plan, operation and maintenance staffing plans, contact information, water quality sampling and testing plans, and equipment specifications for each section of the facility.

Training will include hands-on training for each component of the facility. MRWPCA staff will generate additional, internal SOPs to facilitate routine tasks, as needed. A select group of operators will initially be assigned to AWT Facility to quickly develop expertise on the AWT unit processes. Additionally, operators will be cycled through the AWT Facility to both ensure a broad range of expertise is available to support the AWT Facility and to facilitate an understanding of how the RTP treatment and the AWT Facility performance are interlinked. In addition to operating the RTP to meet ocean discharge requirements and provide a suitable influent to the SVRP, MRWPCA will operate the RTP to provide a suitable influent to the AWT Facility.

MRWPCA is developing a web-based O&M manual for the RTP, which provides easy access to graphics, photos, safety considerations, design criteria, general descriptions, major equipment, control strategies, alarms, P&IDs, SOPs, daily checklists, maintenance schedules, and troubleshooting information for each of the processes (*e.g.*, headworks, primary clarification). General information is also included, such as SCADA screens, reports, organizational charts, and emergency SOPs. A screenshot of an example page on the website is shown in Figure 13-1. The website will be extended to include the AWT Facilities during later phases of design.

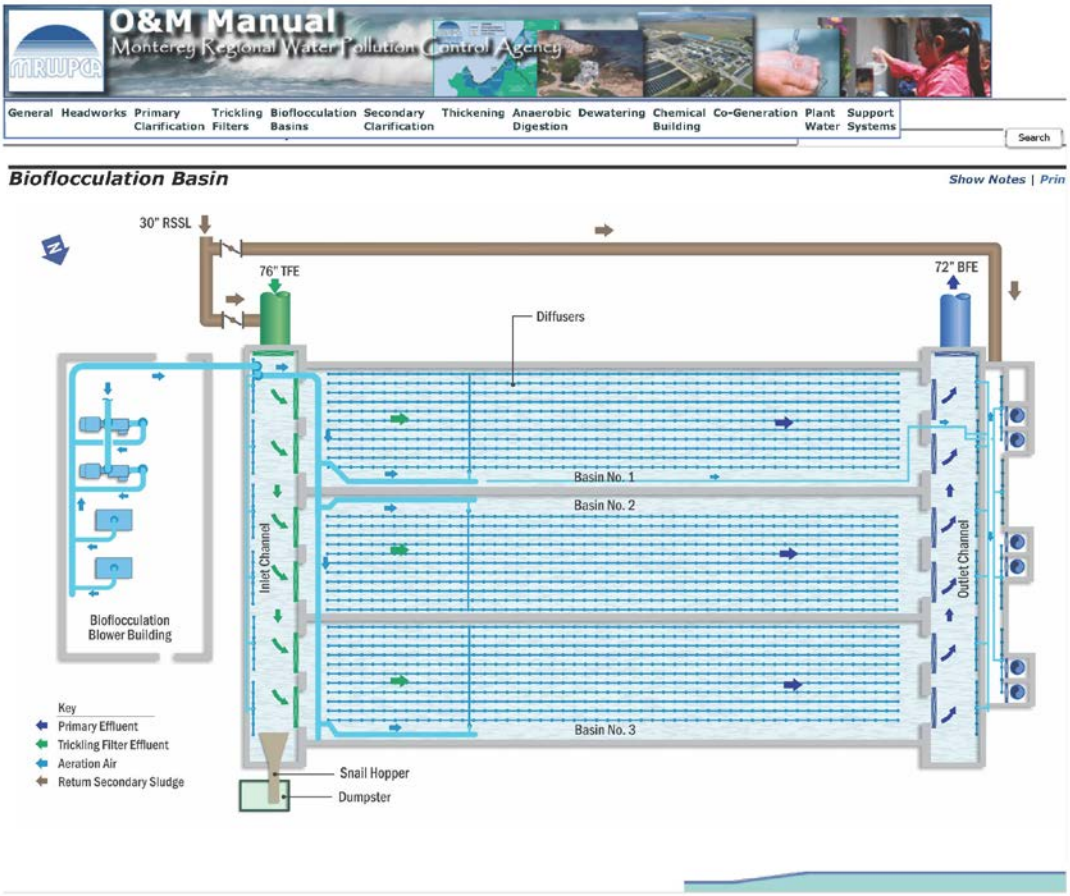


Figure 13-1. Screenshot of MRWPCA's web-based RTP O&M manual. Bioflocculation graphic shown; clicking on components opens windows with photos and equipment lists.

Operator certification for potable reuse treatment facilities is currently in development. Recently a white paper on potable reuse operator training and certification frameworks was published by the California Urban Water Agencies (see Appendix J for the white paper). A potable reuse certification program supplement to existing wastewater and water treatment operator certification programs was recommended in the White Paper. In the supplemental program, operators could be trained on multi-barrier advanced water treatment technologies, regulations, advanced monitoring, and emergency response. The operators of the AWT Facility will be certified through the Wastewater Operator Certification Program of the SWRCB Office of Operator Certification. As the SRWCB continues with the development of advanced water treatment certification programs, MRWPCA will follow the certification requirements. MRWPCA intends to have operators of the Project participate in the voluntary reuse operator training and certification program once it is developed.

13.2.2. Demonstration Facility

MRWPCA currently maintains and operates an AWT Demonstration Facility. This facility has pilot-scale treatment equipment that represent the full-scale AWT Facility equipment. The demonstration

facility treatment steps are pre-straining, chloramination, ozonation, MF, RO, UV/AOP, and product water stabilization. The demonstration facility has a UV/AOP effluent flow rate of 15 gpm, with a product water stabilization sidestream flowrate of approximately 1 gpm.

The demonstration facility receives secondary effluent from a submerged pump in the secondary clarifier effluent channel. Coarse strainers are used at the demonstration facility to remove snails that could clog pilot-scale equipment. Following straining, sodium hypochlorite is dosed to form chloramines. Following chloramination, the water travels through the ozone, MF, RO, and UV/AOP treatment process skids. After the skids, a sidestream flows through the product water tasting equipment, which includes chemical stabilization via a calcite filter, a cartridge filter, a small UV reactor, and a chiller. The ozone, MF, RO, and UV/AOP treatment skids are automated with PLC control and alarms. These skids, pretreatment equipment (chloramination) and post-treatment equipment are integrated through a master PLC, with interlocks.

In the operating the Demonstration facility, the operators measure several water quality parameters, including critical control points, critical operating points, and constituents in the product water (see Appendix H for draft Demonstration facility water quality monitoring schedules and operator checklists). Critical control point monitoring includes MF DIT LRV, RO electrical conductivity LRV, estimated UV/AOP 1,4-dioxane and NDMA removal calculations (based on UVT, UV intensity, and H_2O_2 pump speed), UV/AOP H_2O_2 residual, UVT, and UV power. Critical operating points include secondary effluent nitrite and TOC, ozone system dissolved ozone residual, chloramine residual, MF transmembrane pressure and total coliform removal, RO feed pH and anti-scalant flow, and stabilized pH and conductivity, as well as chemical levels, flows, pressures and meter verification. Product water quality monitoring includes TOC and total nitrogen.

The demonstration facility equipment and the control system mirror the design for the full-scale AWT Facility. MRWPCA staff are developing expertise through operation of the demonstration facility equipment, which will be invaluable for operation and control of the full-scale AWT Facility.

13.3. OPERATIONAL STRATEGIES AND CONTINGENCY PLANS

MPRWCA staff will follow the SOPs, O&M manuals, and the OOP for operation of the AWT Facility. The SOPs, O&M manuals, and OOP will include plans for normal operation, maintenance, cleanings, equipment failures, power outages, source water control upsets, RTP upsets or changes in performance, AWT Facility upsets or changes in performance, and challenges with conveyance, injection and extraction.

The RTP includes a biological secondary process, comprised of non-nitrifying trickling filters, bioflocculation (solids contact), and clarification. While the secondary process is typically stable, unforeseen upsets may occur which could impact the quality of feed water to the AWT Facility. Occasionally an upset or change in raw water quality requires elevated coagulant doses at the SVRP to reach filter effluent turbidity goals. If needed, coagulant is added to the RTP bioflocculation effluent to improve settleability in the secondary clarifiers. A similar strategy may be employed for the feed water to the AWT Facility, if beneficial (however, the MF system will be able to reliably produce a filtrate water quality significantly lower in solids and colloids over a wider range of feed

water qualities compared to the SVRP dual-media granular media filters). The ozone system will further provide pre-treatment to improve MF filterability during poor water quality events.

The RTP trickling filters are operated for carbon removal; however, partial nitrification can occur in the trickling filters under certain conditions. This partial nitrification can result in a nitrite residual in the secondary effluent, which exerts an ozone demand. The ozone system is designed for an elevated concentration of nitrite, and RTP operation may be adjusted to minimize nitrite formation, if necessary.

In the event of a power failure, a backup power system will be used to properly shutdown the AWT Facility and maintain power to key facilities, such as PLCs. If the AWT Facility shuts down (*e.g.*, water quality shutdown alarm, power failure), secondary effluent that would otherwise go to the AWT Facility will be diverted to the SVRP facilities, if sufficient capacity and demand is available, or the ocean outfall. In the event that the AWT Facility product water quality fails to meet regulatory requirements, MRWPCA will respond as described above (see Chapter 12) and in accordance with the Title 22 Criteria. These responses may include repeat sampling, notification to DDW and the RWQCB, and suspension of production. If production is suspended, off-specification water will be diverted to the MRWPCA outfall, returned to the RTP headworks, or pumped to SVRP. If off-specification water sent to the aquifer before production can be suspended, then the steps described in **Section 6** will be followed to ensure a safe interim drinking water supply (*e.g.*, monitoring, management, well-head treatment). An extensive Contingency Plan will be developed as part of the final design the AWT Facility.

14. REFERENCES

Agus, E., Lim, MH, Zhang, L, and Sedlak D.L. (2011). *Odorous compounds in municipal wastewater effluent and potable water reuse systems*. Environmental Science & Technology. v 45, pp 9347-9355.

Anderson, P., Denslow, N., Drewes, J.E., Olivieri, A., Schlenk, D., and Snyder, S. (2010). *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water; Recommendations of A Science Advisory Panel*. State Water Resources Control Board, Sacramento, CA, 85 p. with appendices.

Baldwin, J.A. and Cook, M.J. (2003, revised 2004). *Environmental Isotope Studies of Wastewater and Ground Water at Wastewater Land Treatment Sites in Idaho.* Technical Services Division, Idaho Department of Environmental Quality, Boise, ID, 34 p.

Black & Veatch Corporation (B&V). (2010). White's Handbook of Chlorination and Alternative Disinfectants, 5th Ed, Hoboken, NJ: John Wiley & Sons, Inc.

Brezack & Associates, Inc. (2014). *Monterey Regional Water Pollution Control Agency 40-Year Wastewater Flow Projections Report 2014 – 2054*. Prepared for the Monterey Regional Water Pollution Control Agency. June 2014.

California Air Resources Board (CARB). (2009). *State of California Air Resources Board Resolution 09-23, February 26, 2009*: CARB, Sacramento, CA, http://www.arb.ca.gov/regact/2009/nonsemi09/res0923.pdf, 3 p. with attachment.

California Department of Water Resources (DWR). (2004). *Salinas Valley Groundwater Basin, Seaside Area Subbasin, Central Coast Hydrologic Region, Salinas Valley Groundwater Basin*. California's Groundwater, Bulletin 118, last update February 27, 2004.

California Regional Water Quality Control Board, Central Coast Region (RWQCB). (2011). Water Quality Control Plan for the Central Coast Basin June 2011.

California State Water Resources Control Board (SWRCB). (2014). *Water Recycling Criteria*. Title 22, Division 4, Chapter 3, California Code of Regulations.

California Superior Court. (2006). California American Water, Plaintiff, vs. City of Seaside et al., Case No. M66343, Decision, Hon. Roger D. Randall, Ret., Filed March 27, 2006.

City of Scottsdale. (2007). Personal communication with Mr. Maurice Tatlow, July 27, 2007.

Clark, J.F. (2007). *Tracing Recharge Water from Spreading Ponds: A Decade of Studies*, in P. Fox (editor) *Management of Aquifer Recharge for Sustainability*: Proceedings of the 6th International Symposium on Management of Artificial Recharge of Groundwater, ISMAR6, Phoenix AZ USA, October 28th – November 2, 2007: ACACIA Publishing Inc., Phoenix, AZ, pp. 285-295.

Cole, T. Gerald, Consulting Engineer. (2014). *Administrative Draft Memorandum, MRWPCA Groundwater Replenishment Project, AWT Product Water Conveyance Facilities, Project Description and Conceptual Design*. Prepared for Monterey Regional Water Pollution Control Agency. Prepared by G. Gerald Cole, P.E., Consulting Engineer, January 31, 2014, revised Jun 1, 2014.

Coplen, T.B., Hopple, J.K., Bohlke, J.K., Peiser, H.S., Rieder, S.E., Krouse, H.R., Rosman, K.J.R., Ding, T., Cocke, R.D., Jr., Revesz, K.M., Lamberty, K.M., Taylor, P., and De Bievre, P. (2002, revised 2006). *Compilation of Minimum and Maximum Isotope Ratios of Selected Elements in Naturally Occurring Terrestrial Materials and Reagents.* U.S. Geological Survey (USGS) Water Investigations Report 01-4222, USGS, Reston, VA, 98 p.

Crittenden, J. C., R. R. Trussell, D. W. Hand, K. J. Howe, and G. Tchobanoglous. (2012). Water Treatment: Principles and Design, 3rd ed., MWH, John Wiley & Sons, Hoboken, NJ, 1901.

Davis, S.N., Campbell, D.J., Bentley, H.W., and Flynn, T.J. (1996). Ground Water Tracers. National Ground Water Association, Westerville, OH, 200 p.

Davisson, M.L., Hudson, G.B., Clark, J.F., Woodside, G., and Herndon, R. (2004). *Final Report on Isotope Tracer Investigations in the Forebay of the Orange County Groundwater Basin.* Lawrence Livermore National Laboratory (LLNL) Report No. UCRL-TR-201735, LLNL, Livermore, CA, 116 p.

E2 Consulting Engineers, Inc. (2014). *Technical Memorandum, Groundwater Replenishment (GWR) Project, Well Back-Flush Water Pumping, Conveyance and Storage Facilities*. Prepared for Monterey Regional Water Pollution Control Agency, August 7, 2014.

Fugro West, Inc. (Fugro). (1997). *Hydrogeologic Assessment, Seaside Coastal Groundwater Subareas, Phase III Update, Monterey County, California*. Prepared for Monterey Peninsula Water Management District, September 1997.

Gamlin, J.D., Clark, J.F., Woodside, G., Herndon, R. (2001). *Large-scale Tracing of Ground Water with Sulfur Hexafluoride*. Journal of Environmental Engineering, v. 127, pp. 170-174.

Harding Lawson Associates (HLA). (1994). *Draft Final Data Summary and Work Plan, Site 39 – Inland Ranges, Fort Ord, California*. Prepared for Department of the Army, Corps of Engineers, Sacramento, California, May 17, 1994.

Hem, J. D. (1989). *Study and Interpretation of the Chemical Characteristics of Natural Water*. USGS Water Supply Paper 2254, 263 p., 1989.

Henderson, P. (1982). *Inorganic Geochemistry.* Pergamon Press, New York, NY, 353 p.

Hounslow, A.W. (1995). *Water Quality Data: Analysis and Interpretation*. Lewis Publishers, Boca Raton, FL, 397 p.

HydroMetrics, WRI (HydroMetrics). (2015). Technical Memorandum, GWR Project EIR: Project Modeling Results, To: Bob Holden/MRWPCA, January 12, 2015.

HydroMetrics, WRI (HydroMetrics). (2014a). Seaside Groundwater Basin, Salt & Nutrient Management Plan, Prepared for Monterey Peninsula Water Management District, June 2014.

HydroMetrics, WRI. (HydroMetrics). (2014b). Water Year 2014, Seawater Intrusion Analysis Report, Seaside Basin, Monterey County, California, Prepared for Seaside Basin Watermaster, December 2014.

HydroMetrics, LLC. (HydroMetrics). (2009). Seaside Groundwater Basin Modeling and Protective Groundwater Elevations, Prepared for Seaside Basin Watermaster, November 6, 2009.

Jones & Stokes. (2006). Draft Monterey Peninsula Water Management District Aquifer Storage and Recovery Project, Environmental Impact Report/Environmental Assessment. Prepared for Monterey Peninsula Water Management District, SCH #2004121065, March 2006.

Kendall, C., and Krabbenhoft, D.P. (1995). Applications of Isotopes to Tracing Sources of Solutes and Water in Shallow Systems. IN *Groundwater Management: Proceedings of the Symposium Sponsored by the Water Resources Engineering Division, American Society of Civil Engineers*, editor R. J. Charbenau, 390 – 395. New York: American Society of Civil Engineers, 1995.

Kendall, C., Sklash, M.G, and Bullen, T.B. (1995). Isotope Tracers of Water and Solute Sources in Catchments. IN *Solute Modeling I: Catchment Systems*, editor T.E. Trudgill, 261 – 303. New York: Wiley, 1995.

Kendall, C., Young, M.B., and Silva, S.R. (2010). *Applications of Stable Isotopes for Regional to National-Scale Water Quality and Environmental Monitoring Programs*: in J.B. West, G.J. Bowen, T.E. Dawson, and K.P. Tu (editors), *Isoscapes: Understanding Movement, Pattern, and Process on Earth through Isotope Mapping*. Springer, New York, NY, pp. 89-111.

Kloppmann, W., Chikurel, H., Picot, G., Guttman, J., Pettenati, M., Aharoni, A., Guerrot, C., Millot, R., Gaus, I., and Wintgens, T. (2009). *B and Li Isotopes as Intrinsic Tracers for Injection Tests in Aquifer Storage and Recovery Systems*. Applied Geochemistry, v. 24, pp. 1214-1223.

Kloppmann, W., Vengosh, A., Guerrott, C., Millot, R., and Pankratov, I. (2008a). *Isotope and Ion Selectivity in Reverse Osmosis Desalination: Geochemical Tracers for Man-made Freshwater*. Environmental Science & Technology, v. 42, pp. 4723-4731.

Kloppmann, W., Van Houtte, Picot, G., Vandenbohede, A., Lebbe, I., Guerrot, C., Millot., Gaus, I., and Wintgens, T. (2008b). Monitoring Reverse Osmosis Treated Wastewater Recharge into a Coastal Aquifer by Environmental Isotopes (B, Li, O, H). Environmental Science & Technology, v. 42, pp. 8759-8765.

Lawrence Livermore National Laboratory. (2016) Draft *Final Report: Tracer Alternative Research Project*. LLNL-TR- 686918, March 2016.

Lee, W. (2009). *Selection and Testing of Tracers for Measuring Travel Times in Groundwater Aquifers Augmented with Reclaimed Water*. WateReuse Foundation, Alexandria, 74 p.

Monterey Peninsula Water Management District (MPWMD). (2015). *Seaside Basin Watermaster Memorandum 2015-02, Water Year 2015, Groundwater-Quality and Groundwater-Level Data Collected for the Seaside Groundwater Basin Watermaster*. November 6, 2015.

Monterey Regional Water Pollution Control Agency (MRWPCA). (2015). *MRWPCA SCADA and Power Overview*. November 8, 2015.

Padre Associates, Inc. (2002). *Summary of Operations, Well Construction and Testing, Santa Margarita Test Injection Well*. Prepared for Monterey Peninsula Water Management District (MPWMD), May 2002.

Panno, S.V., Hackley, K.C., Hwang, H.H., Greenberg, S., Krapac, I.G., Landsberger, S., and O'Kelly, D.J. (2002). *Source Identification of Sodium and Chloride Contamination in Natural Waters: Preliminary Results*. Southern Illinois University, Carbondale, IL, www.siu.edu/orda/igc/proceedings/02/panno.pdf, 25 p.

Panno, S.V., Hackley, K.C., Hwang, H.H., Greenberg, S.E., Krapac, I.G., and O'Kelly, D.J. (2005). *Characterization and Identification of Na-Cl Sources in Ground Water*: Ground Water, v. 44, n. 2, pp. 176-187.

Pueblo Water Resources (Pueblo). (2012). *Summary of Operations, Well Construction and Testing, Seaside Middle School Test Well*. Prepared for Monterey Peninsula Water Management District, March 2012.

Rajal, V.B, McSwain, B.S., Thompson, D.E., Leutenegger, C.M., Wuertz, S. (2007). *Molecular quantitative analysis of human viruses in California stormwater*. Water Research, 41: 19, pg. 4287-4298.

Rose, J.B., Farrah, S.R., Harwood, V.J., Levine, A.D., Lukasik, J., Menendez, P. and Scott, T.M. (2004). *Reduction of Pathogens, Indicator Bacteria, and Alternative Indicators by Wastewater Treatment and Reclamation Processes*. WERF 00-PUM-2T. Water Environment Research Foundation, Alexandria, VA.

Santella, N., Ho, D.T., Schlosser, P., and Stute, M. (2007). *Widespread Elevated Atmospheric SF_6 Mixing Ratios in the Northeastern United States: Implications for Groundwater Dating*: Journal of Hydrology, v. 349, issues 1-2, pp. 139-146.

Scheehle, E. (2008). *Sulfur Hexafluoride (SF_6) Use in Non-Utility and Non-Semiconductor Applications*: Draft Concept Paper, California Air Resources Board, Sacramento, CA, 9 p., http://www.arb.ca.gov/cc/sf6nonelec/sf6-draft-concept-paper.pdf.

Schladow, S.G. and Clark, J.F. (2008). *Use of Tracers to Quantify Subsurface Flow Through a Mining Pit*: Ecological Applications, v. 18, n. 8, pp. A55-A71.

Seaside Basin Watermaster. (2014). *Seaside Basin Watermaster Annual Report – 2014*, December 3, 2014.

Silva, S.R., Ging, P.B., Lee, R.W., Ebbert, J.C., Tesoriero, A.J., and Inkpen, E.L. (2002). *Forensic Application of Nitrogen and Oxygen Isotopes in Tracing Nitrate Sources in Urban Environments*. Environmental Forensics, v. 3, pp 125-130.

Snyder, S. (2007). Endocrine disruptors & pharmaceuticals: implications for the water industry. Presentation at the California State Water Resources Control Board, Sacramento, California: May.

Todd Groundwater. (2015a). *Recharge Impacts Assessment Report*, GWR Project, Prepared for Monterey Regional Water Pollution Control Agency, March 2015.

Todd Groundwater. (2015b). Draft *Hydrogeologic Field Investigation: MRWPCA Monitoring Well 1 (MW-1) Installation, Groundwater Quality Characterization, and Geochemical Assessment*, Monterey Peninsula Groundwater Replenishment (GWR) Project, Prepared for Monterey Regional Water Pollution Control Agency, February 28, 2015.

Trussell, R.R., Salveson, A., Snyder, S.A., Trussell, R.S., Gerrity, D., Pecson, B. (2013). *Potable Reuse: State of the Art Science Report and Equivalency Criteria for Treatment Trains*. WRRF Project 11-02, Alexandria, VA.

Trussell Technologies, Inc. (2014a). *Report: Pure Water Monterey Groundwater Recharge Project: Advanced Water Treatment Facility Piloting*, Prepared for MRWPCA, December 2014.

Trussell Technologies, Inc. (2014b). *Pure Water Monterey Groundwater Recharge Project: Source Water and Treated Water Quality*. Technical Memorandum. Prepared for the MRWPCA and MPWMD. September 2014.

Trussell Technologies, Inc. (2015). Technical Memorandum *Ocean Plan Compliance Assessment for the Pure Water Monterey Groundwater Replenishment Project*. Prepared for the MRWPCA, January 2015.

Trussell Technologies, Inc. (2004). *Using Anthropogenic Chemicals as Tracers in Groundwater*: A technical Memorandum. Prepared for the Los Angeles County Sanitation Districts, Whittier, CA, 9 p. with tables and figures.

U.S. Environmental Protection Agency U.S. EPA. (2010). Long Term 2 Enhanced Surface Water Treatment Rule Toolbox Guidance Manual, EPA 815-D-09-001, Washington, DC.

U.S. EPA. (2006a). National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule; Final Rule. 4 CFR Parts 9, 141, and 142.

U.S. EPA. (2006b). *Ultraviolet Disinfection Guidance Manual for the Final Long Term 2 Enhanced Surface Water Treatment Rule*. EPA 815-R-06-007. Washington, D.C.

U.S. EPA. (2006c). *High GWP Gases and Climate Change*: U.S. EPA, Washington, DC, 3 p., http://www.epa.gov/highgwp/scientific.html.

U.S. EPA. (2005). Membrane Filtration Guidance Manual, EPA 815-R-06-009, Washington, D.C.

U.S. EPA. (1998a). National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts; Final Rule. 40 CFR Parts 9, 141, and 142

U.S. EPA. (1998b). National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment. 40 CFR Parts 9, 141, and 142.

U.S. EPA. (1990). Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources, EPA/CN-68-01-6989, Washington, D.C.

Williams, G.J., Triolo, S., and Kenny, J. (2014). DRAFT – Communication MRWPCA – *Groundwater Replenishment (GWR) Project - Post-treatment Stabilization Bench-Top Protocol*. Memorandum from Trussell Technologies, Inc. to Todd Groundwater, 2 p., 2014.

Yates, Eugene B., Feeney, Martin B., Rosenberg, Lewis I. (2005). *Seaside Groundwater Basin: Update on Water Resource Conditions*. Prepared for Monterey Peninsula Water Management District, April 24, 2005.