Recycled Water Master Plan

West Basin Municipal Water District

January 14, 2022

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ACRONYMS AND ABBREVIATIONS

%	percent
µS/cm	microsiemens per centimeter
AA	annual average
AB	Assembly Bill
ADD	average day demand
AF	acre-feet
afy	acre-feet per year
AOP	advanced oxidation process
aSAR	adjusted sodium adsorption ratio
AWT	advanced water treatment
BAF or Biofor	biological aerated filter
Barrier	Advanced Purified Water
BF	Boiler feed
BPS	booster pump station
$CaCO_3$	calcium carbonate
CAS	conventional activated sludge
CBMWD	Central Basin Municipal Water District
CCB	chlorine contact basin
CCP	critical control point
CCR	California Code of Regulations
CEC	constituents of emerging concern
CEPT	chemically enhanced primary treatment
CIMP	Capital Implementation Master Plan
CIP	Capital Improvement Program
Cl	chlorine or chlorination
CML	Cement Mortar Lined
CNTP	Chevron Nitrification Treatment Plant
CO_2	carbon dioxide
CoF	Consequence of Failure
CRA	Colorado River Aqueduct
CTR	California Toxics Rule
DCS	distributed control system
DCTWRP	Donald C. Tillman Water Reclamation Plant
DDW	Division of Drinking Water
dia	Diameter
DIP	ductile iron pipe
DPR	direct potable reuse
EC	electrical conductivity
ECLWRF	Edward C. Little Water Recycling Facility
EPS	extended period analysis
FAT	full advanced treatment
$FeCl_3$	ferric chloride
FRP	fiberglass reinforced piping
ft	feet
GBT	gravity belt thickener
gfd/psi	gallons per square foot per day per psi
GIS	United States Geological Information System
gph	gallons per hour
gpm	gallons per minute
GWA	groundwater augmentation
GWR	groundwater recharge
HDPE	high density polyethylene

HP	horsepower
HPBF	high pressure boiler feed
HPOAS	high purity oxygen activated sludge
HRC or Densadeg	high-rate clarifier
HSEPS	Hyperion Secondary Effluent Pump Station
HWRP	Hyperion Water Reclamation Plant
KHSRA	Kenneth Hahn State Recreational Area
In	Inches
IPR	indirect potable reuse
JMMCRWRP	Juanita Millender-McDonald Carson Regional Water Recycling Plant
JWPCP	Joint Water Pollution Control Plant
LAAFP	Los Angeles Aqueduct Filtration Plant
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation Districts
LADWP	Los Angeles Department of Water & Power
LAGWRP	Los Angeles-Glendale Water Reclamation Plant
LASAN	Los Angeles Bureau of Sanitation
lbs/day	pounds per day
LBWD	Long Beach Water Department
LoF	Likelihood of Failure
LOX	liquid oxygen
LPBF	low pressure boiler feed
LRV	log removal value
LSPS	Lago Seco Pump Station
Master Plan	Recycled Water Master Plan
MBR	membrane bioreactor
MCL	maximum contaminant level
MCRT	mean cell retention time
MD	maximum day
MDD	maximum day demand
MF	microfiltration
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
MM	maximum month
MMD	maximum month demand
mmho/cm	millimhos per centimeter
MW	maximum week
MWD	Metropolitan Water District of Southern California
NaOCl	sodium hypochlorite
NaOH	sodium hydroxide
NDMA	N-Nitrosodimethylamine
NDN	nitrification and denitrification
NdN	nitrification-denitrification
ng/L	nanograms per liter
NH_3	ammonia
NH_3-N	ammonia as nitrogen
Nitrified	Nitrified Water
NL	notification level
NO_3-N	nitrate as nitrogen
NPDES	National Pollutant Discharge Elimination System
NPF	normalized permeate flow
NPR	non-potable reuse
NSP	normalized salt passage

NTU	Nephelometric Turbidity Unit
O&M	operation and maintenance
PATTP	probabilistic analysis of treatment train performance
PDR	Preliminary Design Report
POLB	Port of Long Beach
Policy	Recycled Water Policy
PP	polypropylene
PRS	pipe risk score
PRV	pressure reducing valve
psi	pounds per square inch
PTHRC	pretreatment high-rate clarifiers
PUF	Pall ultrafiltration
PVC	polyvinyl chloride
PVDF	polyvinylidene fluoride
R&R	rehabilitation and replacement
RFP	Request for Proposals
RO	reverse osmosis
RPM	rotations per minute
RRT	response retention time
RWA	raw water augmentation
RWC	recycled water contribution
RWMP	Recycled Water Master Plan
RWQCB	Regional Water Quality Control Board
S.U.	standard pH units
SAT	soil aquifer treatment
SB	Senate Bill
SCADA	supervisory control and data acquisition
SHS	solids handling system
SNMP	Salt and Nutrient Management Plan
SRT	solids retention time
SWA	surface water augmentation
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDH	total demand headloss
TDS	total dissolved solids
Title 22	Disinfected Tertiary Water
TIWRF	Terminal Island Water Reclamation Facility
TM	technical memorandum
tMBR	tertiary membrane bioreactor
TMP	transmembrane pressure
TN	total nitrogen
TOC	total organic carbon
TORC	Torrance Refinery Company LLC
TRWRP	Torrance Refinery Water Recycling Plant
TSS	Total Suspended Solids
TWA	treated water augmentation
UF	ultrafiltration
USACE	United States Army Corp of Engineers
UV	ultraviolet
UV-AOP	ultraviolet/advanced oxidation process
VFD	variable frequency drive
WCBBP	West Coast Basin Barrier Project
WDR	Waste Discharge Requirement
West Basin	West Basin Municipal Water District

WR^2	moment of inertia, measured in pounds per square foot (lb/ft^2)
WRD	Water Replenishment District of Southern California
WSP	welded steel pipe

Chapter 1 Introduction

1.1 Authorization and Purpose

On January 10, 2020, the West Basin Municipal Water District (West Basin) Board of Directors authorized the General Manager to enter into an agreement with HDR Engineering, Inc. for the development of a Recycled Water Master Plan (Master Plan). The Master Plan evaluates existing and future system conditions to identify and prioritize the potential construction of new facilities and delivery laterals. The Master Plan provides a roadmap for the implementation of an updated Capital Improvement Program and allows West Basin to effectively plan for changing water supply, demand, and regulatory conditions over a 20-year planning horizon.

1.2 Background

Faced with a declining groundwater table and over-reliance on water from the West Coast Groundwater Basin in the 1940s, water authorities recommended the establishment of a local municipal water district. In 1947, voters approved their recommendation and West Basin was formed. A year later, West Basin became a member agency of Metropolitan Water District of Southern California (MWDSC), a 26-member agency that provides the region with imported water. It is the sixth largest water district in California, serving approximately 885,000 residents.[1]

West Basin provides drinking and recycled water to customers within its 185-square mile service area in southwest Los Angeles County, shown in Figure 1-1. West Basin's mission is to "provide a safe and reliable supply of high-quality water to the communities we serve." The ***Water for Tomorrow Program*** is West Basin's approach to addressing and securing the service area's water future. *Water for Tomorrow* brings new emphasis to West Basin's commitment to:

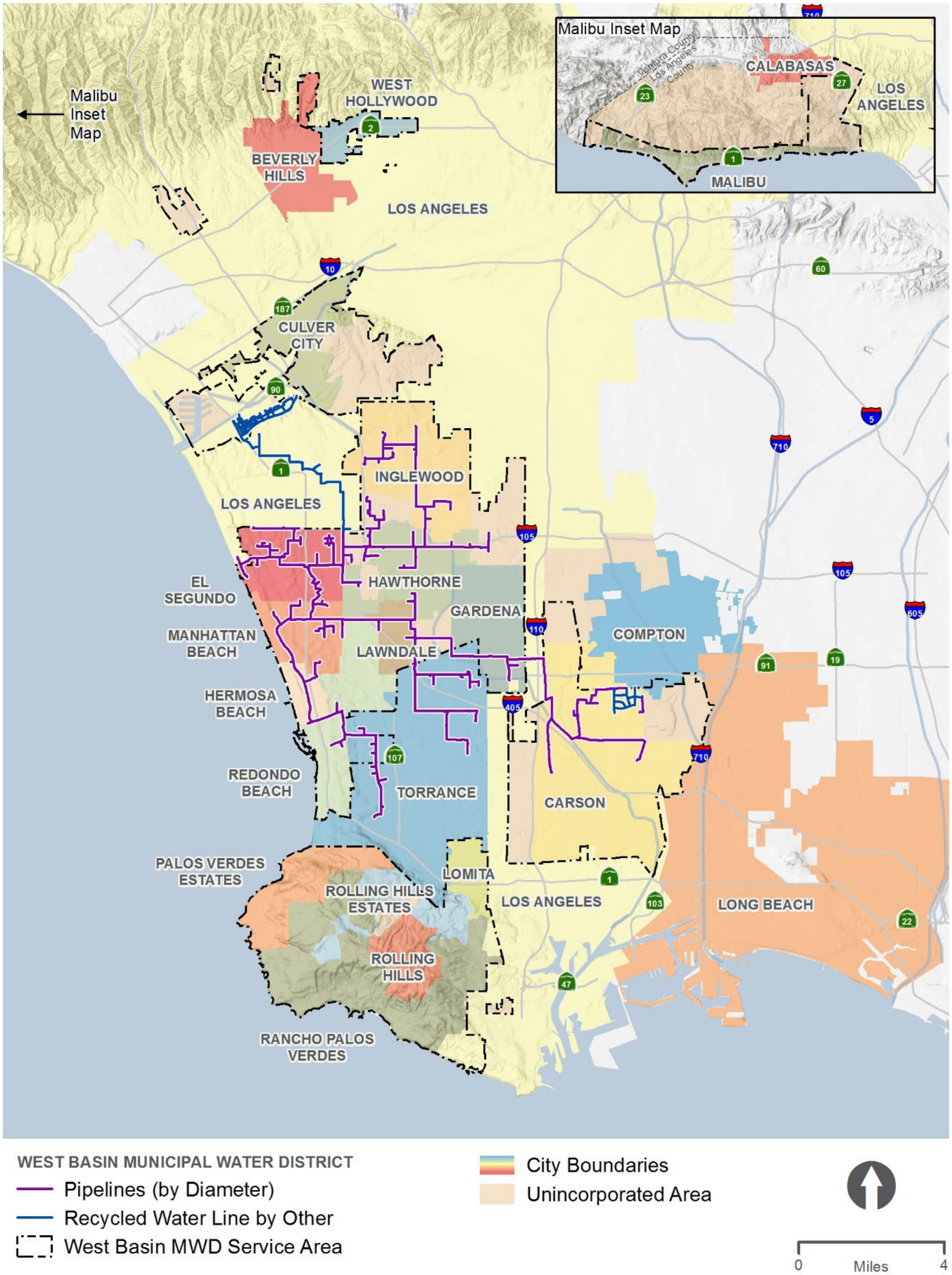
- Protect the District's existing water supply;
- Diversify and augment the District's water supply portfolio; and
- Innovate to prepare for the future.

Recycled water is the cornerstone of West Basin's efforts to increase water reliability by augmenting local supplies. As a result of the extreme drought of the late 1980s and early 1990s, West Basin leaders decided to diversify the agency's water portfolio to include conservation and water reuse to provide a more reliable supply of water for future generations.

In 1992, West Basin received state and federal funding to design and build a world-class, state-of-the-art water recycling treatment facility in the City of El Segundo, with its own water education center. The facility is capable of producing up to 40 million gallons (MG) of useable, treated, recycled water every day, conserving enough drinking water to meet the needs of 80,000 households for a year. The award-winning Edward C. Little Water Recycling Facility (ECLWRF) also houses a 60,000-square-foot solar power generating system that has reduced emissions of carbon dioxide by over 356 tons in one year's time. To date, $600 million in local, state, and federal funds have been invested in this effort.

[1] West Basin MWD 2019 Comprehensive Annual Financial Report

Figure 1-1. West Basin Municipal Water District Service Area



West Basin receives secondary effluent from the City of Los Angeles's Hyperion Water Reclamation Plant (HWRP). West Basin's ECLWRF and its four satellite treatment facilities produce five types of customer-tailored, fit-for-purpose recycled water. West Basin provides recycled water to more than 400 industrial commercial and public facilities via more than 100 miles of dedicated purple pipe distribution system. Recycled water customers include oil refineries, other industrial facilities, commercial buildings, golf courses, parks, school districts, and Caltrans. Treated water is also provided to the Water Replenishment District of Southern California (WRD) for a seawater intrusion barrier to protect the local groundwater basin.

From 2010 through 2019, West Basin has produced more than 300,000 acre feet (AF) of recycled water. Since its inception, West Basin has saved enough drinking water to meet the annual water needs of nearly 8.3 million people and diverted that same amount of partially treated sewage from being discharged to Santa Monica Bay.

1.3 Scope of Work

The preparation of this Recycled Water Master Plan included the following tasks:

1. Comprehensive Data Collection and Review
2. Demand Development Analysis
3. Development of a Customer Database
4. Existing and Future Treatment Plant Evaluation
5. Development of Hydraulic Modeling and Master Planning Criteria
6. Update and Calibration of the Hydraulic Model
7. Preparation of User's Manual for the Hydraulic Models
8. Existing System Analysis
9. Future System Alternatives Analysis
10. Development of Capital Improvement Program
11. Development of the Draft and Final Report Document
12. Project Management, Meetings, and Presentations

1.4 Report Organization

The Recycled Water Master Plan has been structured to help the reader easily locate and identify information needed regarding West Basin's recycled water system. The report contains nine chapters, followed by appendices that include supporting documentation for the information presented in the report.

The report chapters are briefly described below:

Chapter 1 – Introduction. This chapter presents the goals and objectives of the Recycled Water Master Plan.

Chapter 2 – Existing System Description. This chapter presents an overview of the components and connectivity of West Basin's recycled water distribution systems and treatment facilities.

Chapter 3 – Recycled Water Demands. . This chapter provides an updated recycled water user database of existing and potential new customers, their estimated recycled water demands, user type, diurnal patterns, water quality needs, and seasonal peaking factors.

Chapter 4 – Recycled Water Supplies. This chapter provides a summary of the historical, existing, and projected recycled water supplies required to meet the future recycled water demand.

Chapter 5 – Planning and Evaluation Criteria. This chapter summarizes the criteria established for the development of the hydraulic/water quality models and for the analysis of the master plan facilities.

Chapter 6 – Model Development. This chapter describes the development and calibration of West Basin's recycled water distribution hydraulic model. The model calibration included hydraulic calibration and a water quality calibration of the Title 22 system model. As part of this project, a single hydraulic model was created to incorporate the following systems:

- Title 22 Distribution System
- West Coast Barrier Water System
- Hyperion Secondary Effluent Pumping System (HSEPS)
- Chevron Low Pressure Boiler Feed System (LPBF)
- Chevron High Pressure Boiler Feed System (HPBF)
- Chevron Nitrified Water System
- Juanita Millender-McDonald Carson Regional Water Recycling Plant Brine Line
- Edward C. Little Water Recycling Facility Brine Line
- Juanita Millender-McDonald Carson LPBF System
- Juanita Millender-McDonald Carson Nitrified Water System

Chapter 7 – Existing System Evaluation**.** This chapter presents results of the analyses of the existing hydraulic distribution systems and treatment systems. Recommended improvements are noted.

Chapter 8 – Future System Analysis**.** This chapter presents results of the analyses of the future hydraulic distribution systems and treatment systems. Alternative scenarios for future expansion of recycled water service from West Basin are presented.

Chapter 9 – Capital Improvement Program**.** This chapter presents the Capital Improvement Program (CIP) for the West Basin recycled water treatment and distribution systems, including cost analysis and scheduling of potential future facility improvements through 2040. The CIP has been prepared to assist West Basin in planning and budgeting for the recycled water distribution system and treatment plant rehabilitation and replacement (R&R) projects through year 2030.

Report references are included in **Appendix A**. Additional appendices are referenced throughout the report.

1.5 Acknowledgements

The combined contributions of the West Basin Municipal Water District Recycled Water Master Plan project team and the consultant team were invaluable for completing this project. This page recognizes the hard work of the participants who contributed to this effort.

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Chapter 2 Existing System Description

2.1 Overview of Recycled Water Program

This chapter describes West Basin's existing recycled water supplies and water recycling treatment and distribution facilities.

The Los Angeles Bureau of Sanitation's (LASAN) Hyperion Water Reclamation Plant (HWRP), located at the southeast corner of Vista Del Mar and Imperial Highway, is currently the sole source of supply for West Basin's water recycling treatment facilities and recycled water distribution systems.

West Basin owns and operates the Hyperion Secondary Effluent Pump Station (HSEPS) located at HWRP which conveys secondary effluent for further treatment at West Basin's water recycling facilities.

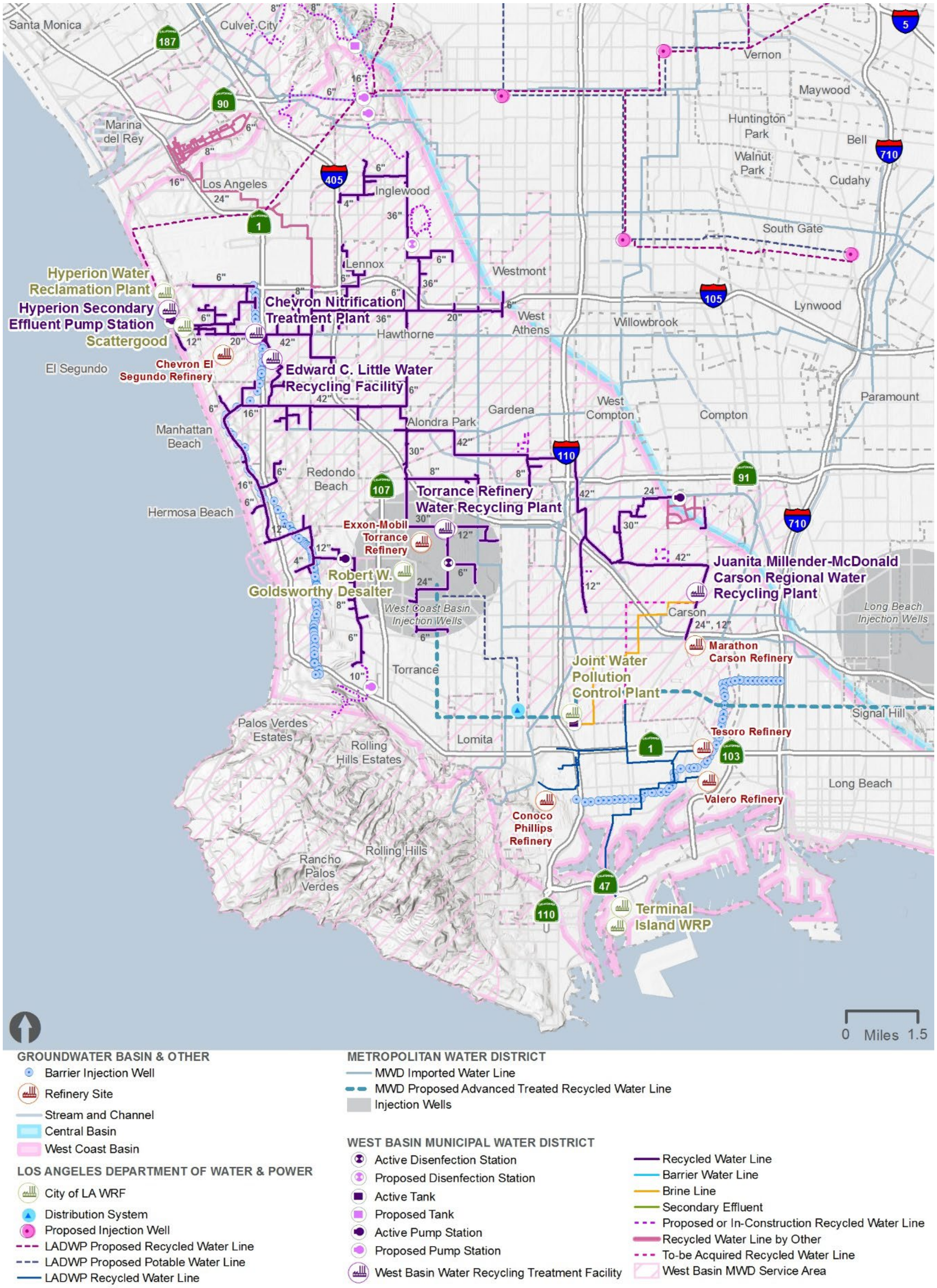
In addition to the HSEPS, West Basin also operates the following four water recycling treatment facilities:

- Edward C. Little Water Recycling Facility (ECLWRF) in El Segundo
- Chevron Nitrification Treatment Plant (CNTP) in El Segundo
- Torrance Refinery Water Recycling Plant (TRWRP) in Torrance
- Juanita Millender-McDonald Carson Regional Water Recycling Plant (JMMCRWRP) in Carson

The CNTP, TRWRP, and JMMCRWRP are generally referred to as the Satellite Plants and are described in detail later in this chapter. For the purposes of this chapter, the HSEPS is grouped with West Basin's water recycling treatment facilities because it is the beginning of West Basin's water recycling operations and the sole source of secondary effluent supply. The locations of these facilities are shown in Figure 2-1.

Suez Water Environmental Services, Inc. (Suez) provides Operations and Maintenance of West Basin recycled water facilities under a contract that extends through December 31, 2024. In April and May 2020, HDR conducted virtual interviews and site visits with West Basin and Suez staff to better comprehend and assess the existing water recycling treatment facilities. A summary of those site visits is provided in Appendix B and the findings were incorporated into this Master Plan.

Figure 2-1. Locations of West Basin Water Recycling Treatment Facilities



2.1.1 Existing Water Recycling Treatment Capacities

The ECLWRF receives secondary effluent directly from the HWRP via a 60-inch diameter force main from the HSEPS and produces disinfected tertiary water (or Title 22) for industrial and irrigation applications. The remaining satellite treatment plants further treat Title 22 recycled water produced at ECLWRF for specific refinery customers for cooling towers and boiler feed (BF) applications. The ECLWRF and Satellite Plants allow West Basin to produce five types of designer water to meet end user water quality needs:

1. Disinfected tertiary water for recycled water irrigation (Title 22)
2. Nitrified water for cooling towers (Nitrified)
3. Advanced purified recycled water for groundwater barrier injection and protection from seawater intrusion (Barrier)
4. Single Pass reverse osmosis (RO) water for LPBF
5. Double Pass RO water for HPBF

The existing capacities of West Basin's treatment facilities are summarized in Table 2-1. It should be noted that the treatment capacities listed in Table 2-1 refer to all finished water qualities produced by each facility. Although the HSEPS is a pump station, it was grouped in with West Basin's treatment facilities because it is the beginning of West Basin's treatment process by feeding secondary effluent from HWRP to ECLWRF. The simplified inter-facility process flow schematic shown in Figure 2-2 identifies the average production of each type of designer water for reuse from 2016 to 2019.

Table 2-1. West Basin Water Recycling Treatment Facility Capacities

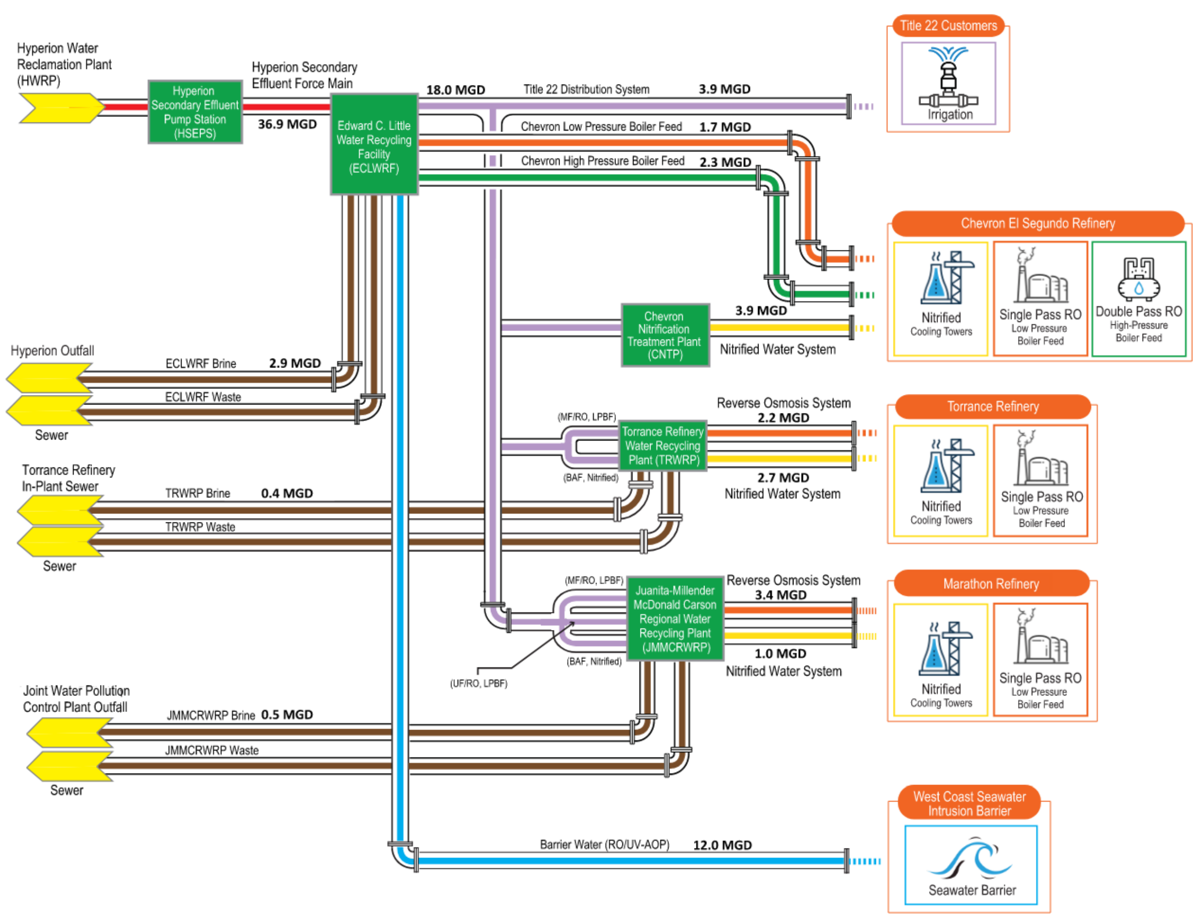
West Basin Facility	Existing Capacity (mgd)	Potential Expansion Proposed in 2009 RWMP[b] (mgd)	Near-Term Capacity (mgd)
HSEPS	**70.0[a]**	**--**	**--**
ECLWRF	**62.4**	**--**	**--**
Title 22	40.0	--	--
Barrier	17.5	--	--
Chevron LPBF (+ NRG)	1.7 (+ 0.5)	--	--
Chevron HPBF	2.6	--	--
CNTP	**4.9**	**1.5[b]**	**6.4**
Nitrified	4.9	1.5[b]	6.4
TRWRP	**8.1**	**--**	**--**
Nitrified	4.9	--	--
LPBF	3.2	--	--

Table 2-1. West Basin Water Recycling Treatment Facility Capacities

West Basin Facility	Existing Capacity (mgd)	Potential Expansion Proposed in 2009 RWMP[b] (mgd)	Near-Term Capacity (mgd)
JMMCRWRP	**6.0**	**17.0[b]**	**23.0**
Nitrified	1.0	1.5[c]	2.5[c]
LPBF	5.0	--	--
- Microfiltration (MF)	4.0	--	--
- Pall Ultrafiltration (PUF)	1.0	--	--

[a] West Basin is contractually limited to 70 mgd average; HSEPS firm pumping capacity is 109 mgd but is currently limited to 72 MGD based on available electrical transformer capacity to power three pumps in total.
[b] Expansion capacity from West Basin Recycled Water Master Plan (RWMP) (Carollo, 2009).
[c] JMMCRWRP Phase II Expansion capacity to install membrane bioreactor (MBR) system; design completed in 2017. In June 2020, construction was put on hold.

Figure 2-2. West Basin Recycled Water Process Flow Schematic



[a] Based on available data from 2016 to 2019, including daily average flow (2016 to 2019) and weekly SCADA data from March to December 2019 and excluding certain significant events and omitted data due to downtime.
[b] Waste flow is assumed negligible at less than 0.1% of the influent flow.

2.2 Hyperion Water Reclamation Plant

The HWRP is LASAN's largest water reclamation plant that treats sewage from the City of Los Angeles and many other cities in Los Angeles County. Solids residual flows produced by LASAN's Donald C. Tillman Water Reclamation Plant (80 mgd capacity) and Los Angeles-Glendale Water Reclamation Plant (20 mgd capacity) are discharged back into the sewer for treatment at HWRP.

A study performed by LASAN (Carollo, 2012) identified the following influent flows for HWRP:

- Minimum flow of 100 mgd
- Average dry weather flow capacity of 280 mgd
- Maximum monthly flow of 450 mgd

Since this study was performed, the HWRP influent flow has decreased to about 250 mgd (average) and 330 mgd (peak) in 2020, while the low flows are only slightly lower, between 90 to 100 mgd.

A portion of HWRP secondary effluent is pumped by the HSEPS through a 60-inch diameter force main approximately three miles to the ECLWRF, while the remainder is reused at HWRP or discharged to the ocean outfall. Because HWRP is the sole source of water supply for ECLWRF, West Basin is heavily reliant on the flow and water quality of HWRP secondary effluent. Additionally, treatment system operations and programmatic decisions made by LASAN that affect HWRP secondary effluent are likely to have downstream implications to West Basin facilities.

2.2.1 HWRP Treatment Process Impacts

The HWRP is a high purity oxygen wastewater treatment plant, which does not oxidize ammonia and has a low solids retention time (SRT), or mean cell retention time (MCRT), of 1 to 2 days. For comparison, a conventional activated sludge (CAS) treatment plant can have an SRT ranging from 3 to 15 days but typically has a target SRT of 4 to 6 days. A membrane bioreactor (MBR) treatment process can have a longer SRT of 10 to 15 days. In general, a longer SRT results in the formation of more stable and larger microbial population for biological treatment of organics from wastewater.

Interviews conducted with West Basin and Suez Operations staff indicated that the high purity oxygen treatment process effectively treats smaller organic molecules; however, the larger organic molecules with longer chains remain in the secondary effluent and total organic carbon (TOC) concentrations are increasing in ECLWRF influent. Additionally, HWRP secondary effluent has elevated, as well as variable levels of turbidity and iron, both of which affect membrane performance at ECLWRF. Suez staff indicated that HWRP's chemically enhanced primary treatment (CEPT) process doses high amounts of ferric chloride.

Potential Future of HWRP

The Hyperion Water Reuse and Resiliency Program was formed as a partnership between the Los Angeles Department of Water & Power (LADWP), LASAN, Water Replenishment District of Southern California (WRD), and Metropolitan Water District of Southern California (MWD). LADWP released the following statement in September 2019:

> *To address the need for a resilient and independent water supply for Los Angeles, LADWP is pursuing a major initiative aimed at maximizing production of purified water from Hyperion Water Reclamation Plant to replenish the city's groundwater basins. The Hyperion Water Reuse and Resiliency Program will help meet Mayor*

Garcetti's 2019 Green New Deal goal to recycle 100% of available treated wastewater for beneficial reuse from Hyperion by 2035.

There are several components of the program, including production of up to 170 mgd of advanced treated water at HWRP, storage of up to 450,000 acre-feet (AF) in local groundwater basins for groundwater augmentation (GWA), and potential conveyance to the Los Angeles Aqueduct Filtration Plant (LAAFP) and MWD's Regional Recycled Water Program's Backbone System.

The Hyperion Nitrified-Denitrified (NdN) MBR Pilot Facility is a joint effort between LASAN and West Basin. This 1-mgd pilot facility will evaluate MBR, reverse osmosis (RO), and advanced oxidation process (AOP) for two years. The pilot is an important step to determine log removal value (LRV) credits with the California Division of Drinking Water (DDW) and LASAN's future plans to install an MBR to treat all HWRP flow.

MBR upgrades at HWRP would occur in two phases. The first phase has a potential start date of 2030 and would include flows received by West Basin. The timeline to implement the second phase and provide MBR treatment for the remaining HWRP flows is between 2035 and 2040.

It should be noted that West Basin has not yet received official confirmation or commitment from LASAN regarding future HWRP improvements that would affect ECLWRF influent flow or water quality.

2.2.2 Hyperion Secondary Effluent Pump Station

In 1991, West Basin contracted with the City of Los Angeles to receive up to 51 mgd of secondary effluent from the HWRP for tertiary treatment by West Basin at the ECLWRF. In 2011, that agreement was amended, allowing West Basin to increase the capacity of the HSEPS to 70 mgd and requiring West Basin to provide sufficient electrical supply to operate the pump station. From 2016 through 2019, West Basin received on average 36.8 mgd (41,200 acre-feet per year [afy]) of secondary effluent from HWRP.

According to the previous 2009 West Basin Recycled Water Master Plan (RWMP), HWRP treats wastewater from two separate sources: coastal sewers with higher total dissolved solids (TDS) and inland sewers with lower TDS. HWRP maintains separation of these two distinct sources resulting in the south biological reactors and clarifiers receiving the lower TDS water (900 mg/L average), constituting about 75 percent of the total plant flow. The HSEPS currently pulls source water from the lower TDS effluent channel, but future growth in supply requirements may call for flows from the higher TDS effluent channel.

West Basin's HSEPS, located at the southwest corner of the HWRP, provides the only source of water for West Basin's recycled water system. Secondary treated effluent is pumped from the HSEPS to ECLWRF via a 60-inch diameter force main. Improvements to the HSEPS were recently completed in 2019, which increased the firm pumping capacity of the pump station from 51 mgd to 109 mgd and provided a secondary power supply source for increased reliability. Note that current transformer capacity at the HSEPS currently limits the maximum pumping capacity to 72 mgd.

The HSEPS currently includes four original vertical turbine pumps and three new vertical turbine pumps, the last of which was installed in 2019. A 3-megawatt emergency generator was installed with the HSEPS improvements. Combinations of flow splits are possible, including all flow from the original pump station with the new pump station off, and up to 72 mgd from the new pumps with the balance provided by the original pump station. The firm capacity is limited by available power to the site; the 34.5 kilovolt (kV) transformer is capable of powering three 800 horsepower (hp) pumps (72 mgd) at any given time. Table 2-2 summarizes the HSEPS pump characteristics.

Table 2-2. HSEPS Pump Characteristics

Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Total WR^2 ($lb\text{-}ft^2$)
1	Floway	MKM/N	10,400	147	15.438	84	500	Constant	409
2	Floway	MKM/N	10,400	147	15.438	84	500	Constant	409
3	Floway	28FKM	14,600	175	11.75	84	800	Variable	750
4	Johnston	33NLC	14,600	180	21.25	84	800	Constant	730
5	Goulds	26GHXC	14,583	181	17.34	85.8	800	Variable	730
6	Goulds	26GHXC	14,583	181	17.34	85.8	800	Variable	730
7	Goulds	26GHXC	14,583	181	17.34	85.8	800	Variable	730

Operating pressure on the discharge side of the pumps depends on the flow of secondary effluent being pumped. During August 2020, flows averaged 38.6 mgd, with an average discharge pressure of 57.6 psi at the pump station and 14.0 psi at ECLWRF. An evaluation of the condition of the current pump station was conducted in November 2020. Those findings are described in the HSEPS Condition Assessment Technical Memorandum, which can be found in Appendix C.

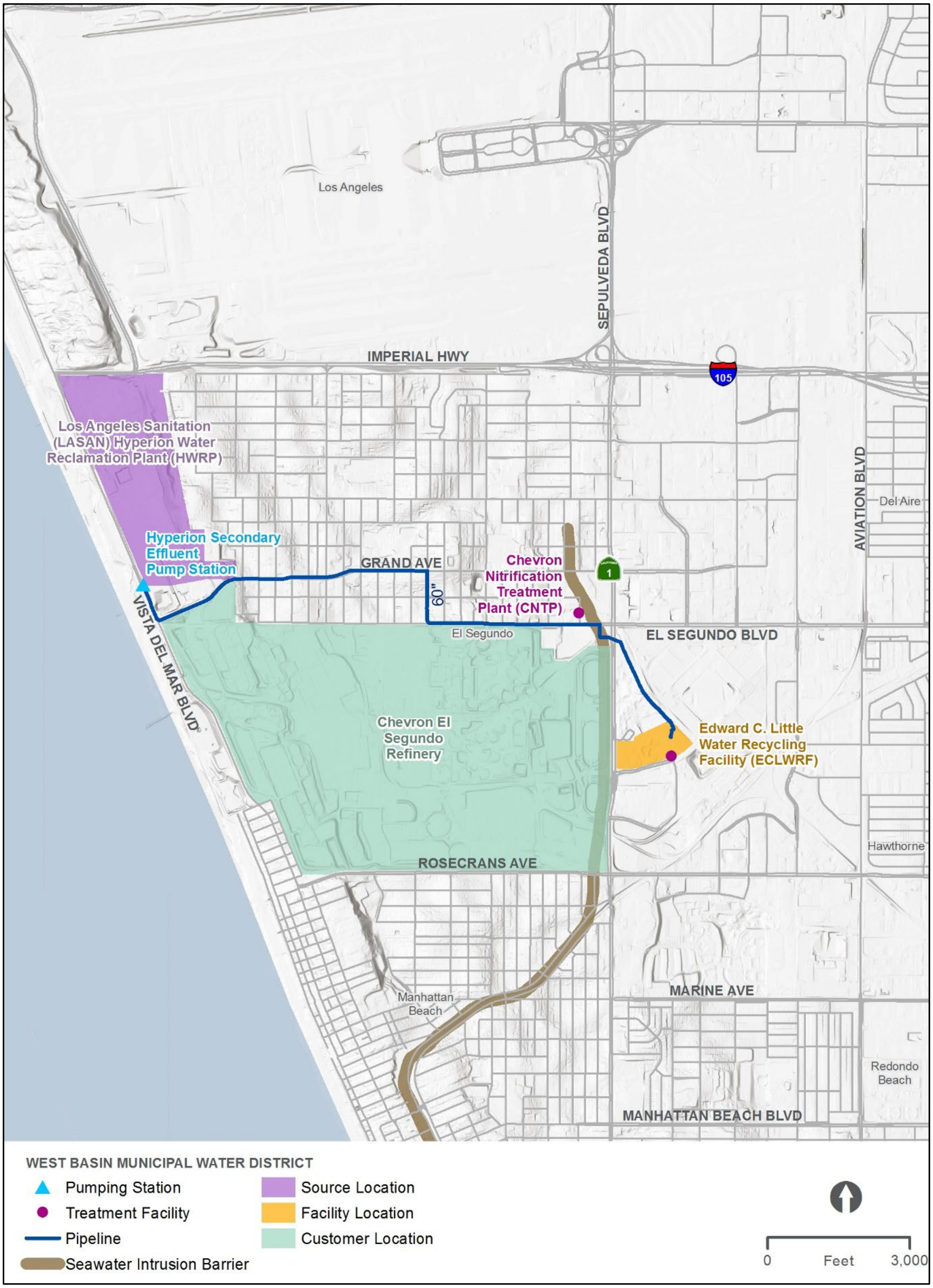
2.2.3 Hyperion Secondary Effluent Force Main

The 60-inch diameter polyvinyl chloride (PVC) lined reinforced concrete pressure pipe force main conveys secondary effluent from the HSEPS to ECLWRF. Portions of the pipeline were constructed in 1992 and 1995. The force main is approximately 14,770 lineal feet (2.80 miles) long with a static lift of approximately 87 feet. There are ten vacuum valve locations along the pipeline, and no isolation valves. The alignment of the force main is shown in Figure 2-3.

As noted during the calibration of the hydraulic model, in August 2020, the force main experienced average and maximum velocities of 2.8 feet per second (fps) and 3.3 fps, respectively, based on 15-minute SCADA system data sampling intervals.

A surge analysis of the HSEPS system was conducted in 2017 that predicted a maximum surge pressure head of 221 feet and a minimum surge pressure head of -22 feet for a fraction of a second at flows of 50, 54, and 60 mgd. Controlled venting features and redundant valves were recommended to be provided for the vacuum valves anticipated to open during a surge event. Confirmation from the pipe designer that the force main would be able to withstand the predicted maximum and minimum pressures was also recommended (Flow Science, 2017).

Figure 2-3. HSEPS Force Main Alignment



2.3 Edward C. Little Water Recycling Facility

In 1995, the ECLWRF began producing recycled water in the City of El Segundo and is the largest recycled water facility of its kind producing four types of designer water (Title 22, Barrier, LPBF, and HPBF) on-site. West Basin's Satellite Plants further treat Title 22 effluent from ECLWRF to produce the fifth type of Nitrified water (Table 2-3). The ECLWRF has experienced five major construction phases (Phase I, II, III, IV, and V), with the latest major expansion being completed in 2014. The Pall MF Expansion Project was completed in 2019 as an expansion to the Phase V. This highlights West Basin's continued efforts to make additional improvements to meet the unique needs of their municipal, commercial, and industrial customers and supply the West Coast Basin Seawater Barrier system.

The process flow schematic in Figure 2-4 shows the ECLWRF treatment trains and the phased expansions to produce the different types of water tailored toward West Basin's end users. The ECLWRF receives all secondary effluent conveyed by the HSEPS and splits influent flow between the Title 22 treatment process and the microfiltration/reverse osmosis (MF/RO) treatment processes.

Table 2-3. Types of Designer Water Produced at West Basin Facilities

West Basin Facility	Designer (Product) Water Types	End User
ECLWRF • Source water: HWRP secondary effluent	Title 22 • HRC, tertiary media filter, Cl disinfection	• Non-potable irrigation (residential, commercial, industrial) • Satellite Plants
	Barrier Water • Ozone, MF, RO, UV-AOP, decarbonation, Cl	• Groundwater injection for West Coast Basin Seawater Barrier
	LPBF Water • Ozone, MF, RO (Single Pass), decarbonation	• LPBF water for Chevron refinery
	HPBF Water • Ozone, MF, RO (Double Pass), decarbonation	• HPBF water for Chevron refinery
CNTP • Source water: ECLWRF Title 22 effluent	Nitrified Water • BAF	• Ammonia-free water for cooling towers at Chevron refinery
TRWRP • Source water: ECLWRF Title 22 effluent	Nitrified Water • BAF	• Ammonia-free water for cooling towers at Torrance refinery
	BF Water • MF, RO (Single Pass), decarbonation	• BF water for Torrance refinery
JMMCRWRP • Source water: ECLWRF Title 22 effluent	Nitrified Water • BAF	• Ammonia-free water for cooling towers at Marathon refinery
	BF Water • MF, RO (Single Pass), decarbonation	• BF water for Marathon refinery

Source/Notes: BAF = biologically aerated filter; Cl = chlorine; HRC = high-rate clarifier; MF = microfiltration; RO = reverse osmosis; UV-AOP = ultraviolet advanced oxidation process

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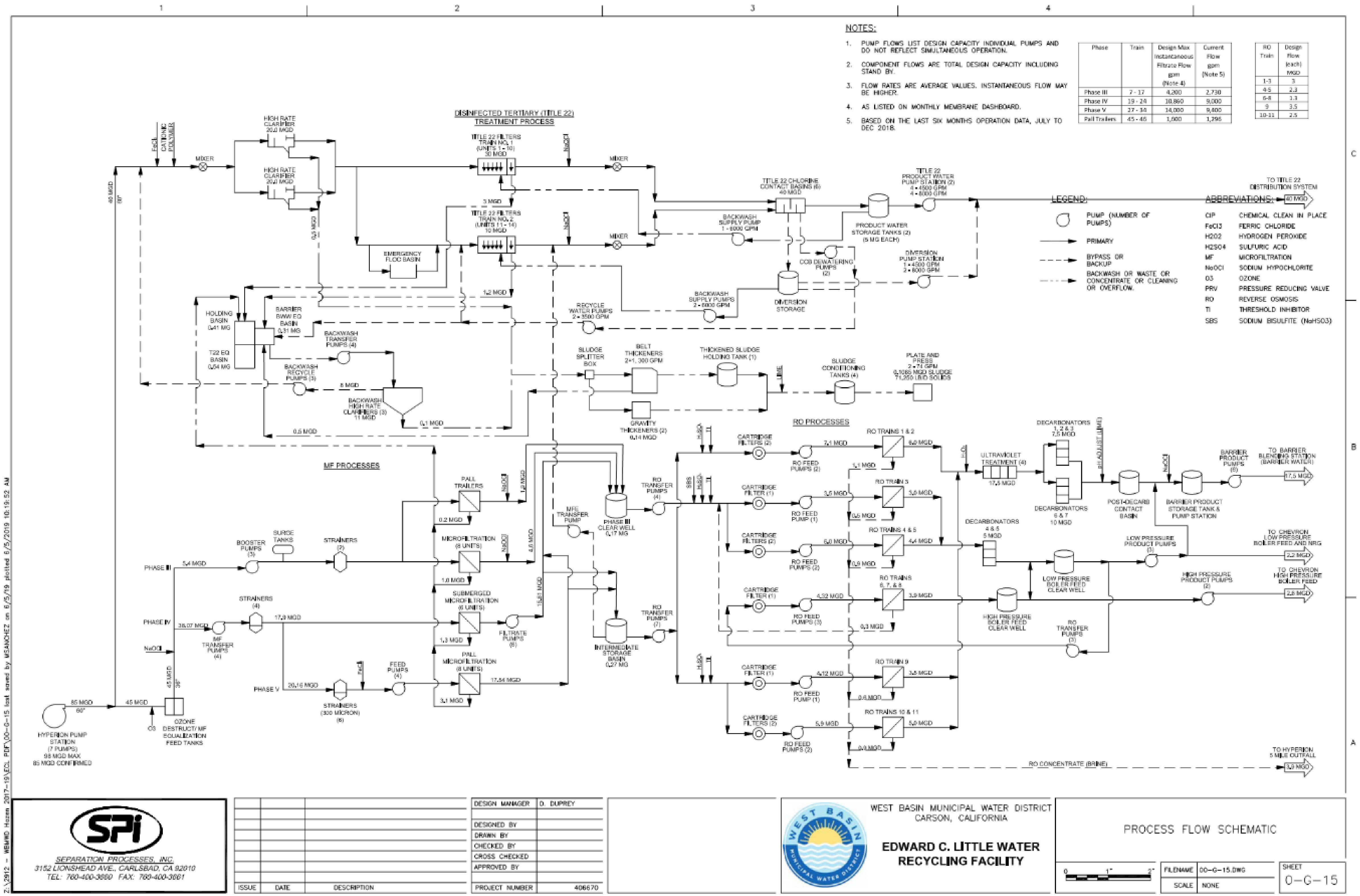
Figure 2-4. ECLWRF Process Flow Schematic



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2.3.1 Title 22 Treatment Process

For the Title 22 treatment process, ECLWRF influent mixes with return waste flow and is dosed with coagulant (ferric chloride) and flocculant (cationic polymer) prior to entering the high-rate clarifiers (HRC), which are referred to as the pretreatment Densadegs. The return waste flow is overflow from three smaller HRCs, referred to as the backwash waste Densadegs, that treat backwash waste and MF backwash generated on-site.

West Basin and Suez staff interviews indicate that this return waste flow is relatively constant throughout the year; therefore, the internal waste can constitute 20 to 40 percent of the blended influent to the Title 22 treatment process based on seasonal demand for Title 22 water. Solids residual flows from the Densadegs go to the solids handling building for thickening, hauling, and disposal. West Basin is currently performing a Solids Handling Study to evaluate alternatives for solids handling and disposal at ECLWRF. Depending on the results of this study, West Basin may replace the plate and frame filter presses with centrifuges or may stop dewatering of solids altogether at ECLWRF and sending solids to the sewer.

HRC effluent flows into the tertiary mono-media (anthracite) filters prior to the chlorine contact basin (CCB). There are two types of tertiary media filters at ECLWRF: Title 22 filters and converted Title 22 filters. The converted Title 22 filters have a deeper anthracite bed (4 to 6 feet); having previously been used as pretreatment for the Barrier water.

West Basin has two on-site product tanks to store disinfected tertiary water until it is conveyed by the product water pump station to the Title 22 distribution system. Some of the Title 22 water is reused on-site as backwash water supply for the filters and other purposes.

2.3.2 MF/RO Treatment Process

For the MF/RO treatment process, influent is dosed with ozone and enters a contact basin prior to MF treatment. Ozone is generated on-site from liquid oxygen (LOX) storage tanks. After ozone pretreatment, flow is also dosed with chlorine (average of 8 mg/L) that combines with the ammonia in HWRP secondary effluent to create chloramines prior to entering the MF membranes.

The Phase V expansion incorporated ozone (up to 12 mg/L) based on a study that concluded that ozone pretreatment breaks down larger organics into smaller chains that decrease fouling potentials on the MF membranes and reduced cleaning cycles. At the time of the study, ECLWRF had only MF membranes that were made of polypropylene (PP) material, which could not handle a more aggressive chemical cleaning that includes the use of chlorine (i.e., sodium hypochlorite, NaOCl).

West Basin later determined that higher ozone doses increased breakthrough of TOC, caused TOC excursions in RO permeate for Barrier water, and increased demand in the UV-AOP because of the increased formation of NDMA. Therefore, ozone doses are currently kept to 4 mg/L (West Basin and Suez, 2017). At these doses, Suez staff indicate that they do not see a significant improvement in membrane performance or reduced cleanings. Additionally, ECLWRF has replaced PP membranes with polyvinylidene fluoride (PVDF) MF membranes, which can use a higher concentration of sodium hypochlorite (2,000 to 3,000 mg/L) to more effectively clean organic foulants.

MF membrane trains were installed at ECLWRF as part of Phase II, III, IV, and V expansions and the Pall MF Expansion Project added membranes to increase capacity. MF pretreatment includes either 300- or 500-micron strainers, autostrainers, and chloramination.

- Phase II MF units are beyond useful life and were decommissioned in 2018.

- Phase III MF units are currently in standby mode and serve as Chevron BF backup MF system.
- Phase IV MF units are submerged membranes that experience fouling issues when influent iron is above 0.3 mg/L due to ferric chloride usage at HWRP.
- Phase V MF units, similar to all MF units, are pressurized membranes that can experience rapid rises in transmembrane pressure (TMP) rise without proper pretreatment (i.e. chloramination and additional coagulation with ferric chloride addition).
- Pall MF Expansion MF units are the same Phase V pressurized membranes system. Two units were added to the Phase V system in 2019.

MF effluent is first collected in two holding basins (intermediate storage basin and MF clearwell) prior to being pumped to the RO trains for further processing. MF effluent is dosed with sulfuric acid and a scale inhibitor upstream of the cartridge filters to lower pH and mitigate silica sulfate scaling potential. RO feed pumps pressurize flow to the 11 RO membrane trains installed during the five construction phases of ECLWRF. Although some improvements and rehabilitation could be made to the older RO trains to improve operation efficiencies and to optimize performance, however, Suez Operations staff indicate that in general, the RO process functions well. Single Pass RO permeate is split to three separate downstream treatment processes:

- UV-AOP system that doses hydrogen peroxide with UV photolysis for advanced oxidation to destroy harmful trace constituents, decarbonation to raise pH, sodium hypochlorite dose for residual (3 to 5 mg/L) and then pumped to the West Coast Basin Seawater Barrier.
- Decarbonation to raise pH and then pumped to the Chevron refinery as LPBF water.
- Second pass RO treatment (Trains 6, 7, and 8) and then pumped to the Chevron refinery as HPBF water.

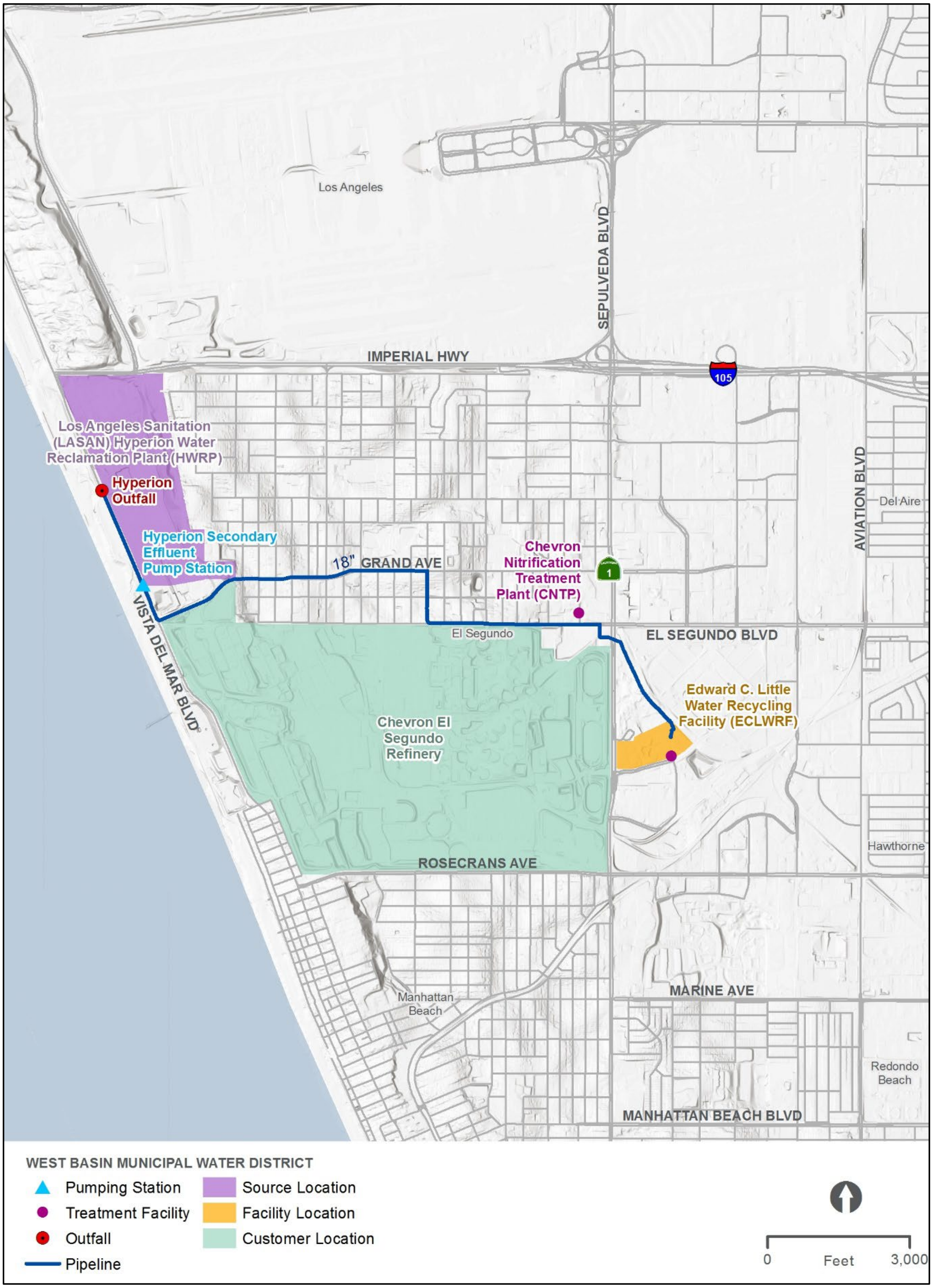
RO brine flows are conveyed through a brine line to the Hyperion ocean outfall.

The clean-in-place Waste Neutralization Tank receives and neutralizes clean-in-place waste flows from the maintenance and recovery citric acid membrane chemical cleanings. The neutralized waste is discharged to the LA County Sanitation Districts (LACSD) sewer line.

2.3.3 ECLWRF Brine Line

The ECLWRF Brine Line (Figure 2-5) conveys RO concentrate from ECLWRF to the Hyperion Outfall located at the HWRP. The brine line consists of 18-inch diameter high density polyethylene (HDPE) pipe and extends about 15,310 lineal feet (2.90 miles) north and west from ECLWRF to the City of Los Angeles’s HWRP along the alignment shown in Figure 2-5. The brine flow from ECLWRF discharges into a manifold located above the outfall at the HWRP. From 2016 through 2019, ECLWRF discharged an average of 2.9 mgd of brine flow to the Hyperion Outfall.

Figure 2-5. ECLWRF Brine Line Alignment



2.4 Title 22 Distribution System

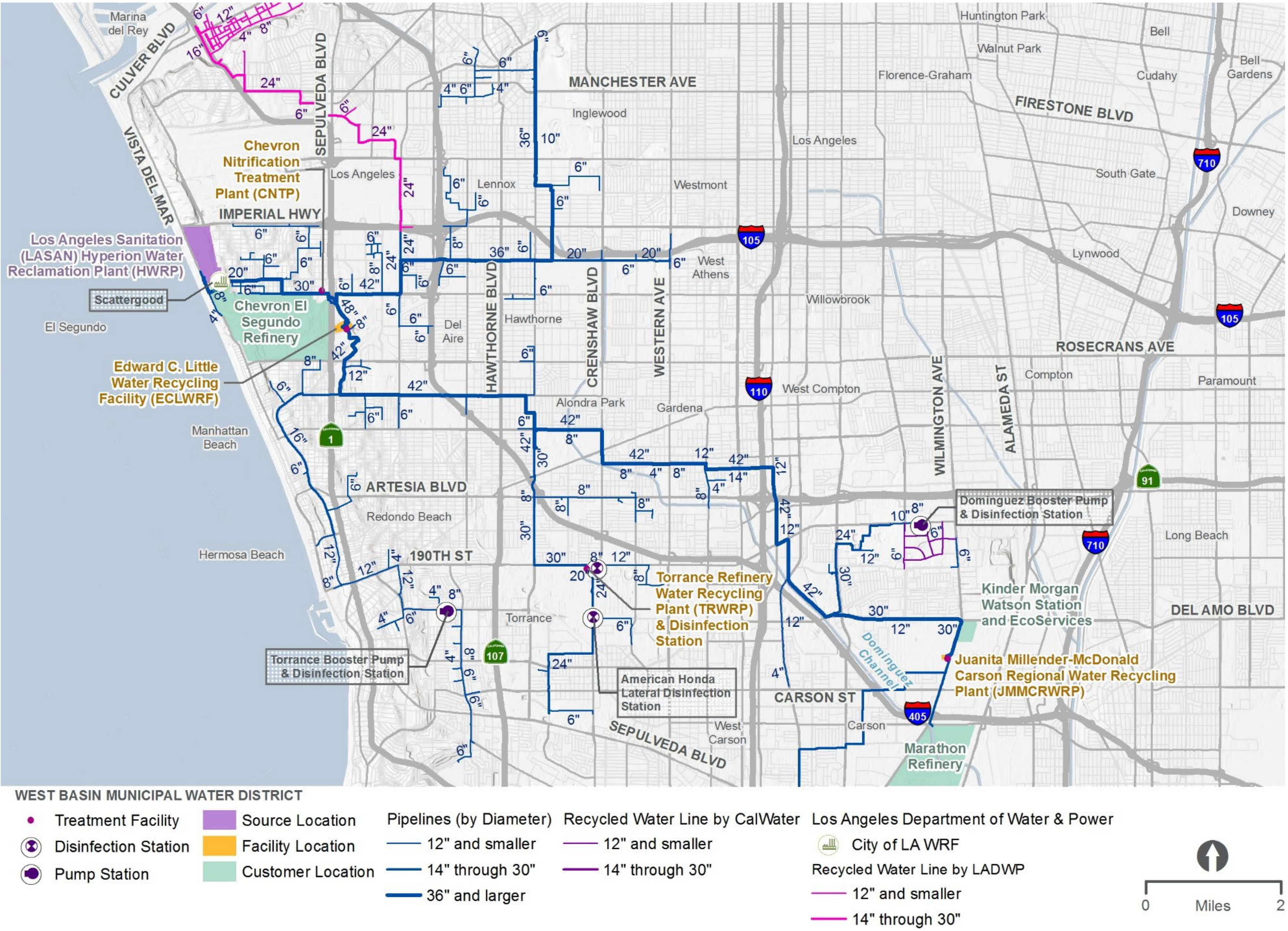
The West Basin service area encompasses approximately 185 square miles including 17 cities serving a population of about one million. The 17 cities along with unincorporated areas served by West Basin include:

- City of El Segundo
- City of Inglewood
- City of Manhattan Beach
- City of Redondo Beach
- City of Hermosa Beach
- City of Lawndale
- City of Gardena
- City of Carson
- City of Hawthorne
- City of Compton
- City of Lomita
- City of Palos Verde Estates
- City of Rolling Hills
- City of Rancho Palos Verdes
- City of Rolling Hills Estates
- City of West Hollywood
- City of Malibu
- Unincorporated Los Angeles County

In addition, West Basin serves the Cities of Los Angeles and Torrance with recycled water, which are outside of West Basin's service area. As the terrain of the initial area served by the recycled water system is mainly flat, the distribution system was designed as a single closed pressure zone. Therefore, the existing distribution system does not have any intermediate pumping or storage facilities, other than pumping and storage facilities at some of the treatment facilities and the Torrance and Dominguez booster pump stations that serve small areas at the end of the distribution system. The various types of recycled water product are directly pumped from the treatment facilities to the customer sites. This current system configuration has been shown to limit West Basin's operational strategies and can cause problems with surge and water quality throughout the distribution system.

As shown on the overall system schematic in Figure 2-6, the Title 22 Distribution System conveys recycled water from ECLWRF to Title 22 customers as well as the satellite treatment facilities: the JMMCRWRP in Carson, the TRWRP in Torrance, and the CNTP in El Segundo. During the calendar year of 2019, ECLWRF distributed an average of 18.4 mgd of recycled water through its Title 22 distribution system. From 2016 through 2019, daily flows ranged from approximately 12.5 to 25 mgd. Title 22 product water flows distinctly peak during the summer months and dip during the winter months, because irrigation users (i.e., golf courses, parks) utilize more water during warmer months.

Figure 2-6. Title 22 Distribution System



2.4.1 Title 22 Product Water Storage

The Title 22 Product Water Storage Tanks, located at ECLWRF, consist of two 5.0-million-gallon (MG) circular storage reservoirs. The reservoirs attenuate daily peaking of customer demands.

2.4.2 Title 22 Product Water Pump Stations

The Title 22 Product Water Pump Station at ECLWRF supplies flow to the entire Title 22 distribution system. Since the distribution system does not have floating storage, the pump station also provides pressure to the entire Title 22 distribution system.

The Title 22 Product Water Pump Station consists of two separate pump stations, one at each of the storage tanks, each with two constant speed pumps and two variable speed pumps with characteristics as summarized in Table 2-4. The firm capacity, which is the pumping capacity without the largest pump in operation, is calculated to be 43,500 gallons per minute (gpm) (62.64 mgd).

Backup pumping capacity is provided by the Diversion Pump Station with a single 4,500-gpm variable speed pump and two 8,000-gpm constant speed pumps.

The effluent pumping system consists of two constant speed pumps rated at 8,000 gpm (11.52 mgd), two variable frequency drive (VFD) pumps rated at 8,000 gpm (11.52 mgd), three VFD pumps rated at 4,500 gpm (6.48 mgd), and one VFD pump rated at 6,000 gpm (8.64 mgd). The variable speed pumps control the distribution line pressure to 85 pounds per square inch (psi) at the pump station. During high demand periods, additional pumps are placed online to maintain the pressure set point (Title 22 Water Storage and Effluent Pumping SOP, West Basin).

Table 2-4. Title 22 Product Water Pump Station Pump Characteristics

Tank No.	Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable/ Constant Speed	Type	Total WR^2 ($lb\text{-}ft^2$)*
1	2	Johnston	20EC	4,500	280	15.438	84.6	500 @ 1170	Variable	4 Stage Vertical Turbine	106.03
1	3	Johnston	20EC	4,500	280	15.438	84.6	500 @ 1170	Variable	4 Stage Vertical Turbine	106.03
1	5	Johnston	25NMC	8,000	280	16.188	91.1	700 @ 1185	Constant	4 Stage Vertical Turbine	171.21
1	6	Johnston	25NMC	8,000	280	16.188	91.1	700 @ 1185	Constant	4 Stage Vertical Turbine	171.21
2	1	Johnston	20EC	4,500	280	15.438	84.6	500 @ 1170	Variable	4 Stage Vertical Turbine	106.03
2	2	Sulzer	20CC	6,000	293	15.5	87	500 @ 1780	Variable	2 Stage Vertical Turbine	56.98
2	3	Sulzer	24EC	8,000	293	18.375	86.5	700 @ 1185	Constant	3 Stage Vertical Turbine	171.21
2	4	Johnston	25NMC	8,000	280	16.188	91.4	700 @ 1185	Constant	4 Stage Vertical Turbine	171.21

* Total WR^2, or moment of inertia, estimated by calculating motor moment of inertia, typically the largest contributor to the pump moment of inertia.

2.4.3 Title 22 Pipelines

The Title 22 distribution system represents the majority of the pipelines within West Basin's various distribution systems. Table 2-5 presents the Title 22 distribution system pipelines by material and diameter.

Table 2-5 indicates polyvinyl chloride (PVC) as the most prevalent pipeline material constituting approximately half of the Title 22 system. About a quarter of the system is ductile iron pipe (DIP), while approximately one-fifth of the system is welded steel pipe (WSP). Three percent of the system is Cement Mortar Lined (CML) pipe, and four percent is of unknown material.

Table 2-5. Title 22 Distribution System Pipeline Summary

Pipe Diameter (in)	Pipe Material (feet)					Total Length	
	CML	DIP	PVC	WSP	Unknown	(feet)	(miles)
4		24	15,079		36	15,139	2.9
6		8,294	121,222	2,284		131,801	25.0
8		1,256	34,684		4,025	39,965	7.6
10	119		2,699			2,818	0.5
12	1,078	4,481	17,376	325	10,800	34,060	6.5
14					5	5	< 0.0
16		16,269		75	10	16,354	3.1
18		58				58	< 0.0
20		16,870	1,532		5	18,407	3.5
24	10,363		2,297	463	2	13,125	2.5
30		17,472	926	5,794	15	24,207	4.6
36	163	18,508	186	11,205		30,062	5.7
42		26,185		58,820		85,005	16.1
48		1,897				1,897	0.4
Total Length	**11,723**	**111,314**	**196,001**	**78,966**	**14,898**	**412,903**	**78.2**
Percent Material	**3%**	**27%**	**47%**	**19%**	**4%**	**100%**	

2.4.4 Booster Pump Stations

There are two booster pump stations (BPS) in the Title 22 system, with pump characteristics summarized in Table 2-6; one boosts pressure to serve the Dominguez Hills area in the City of Carson and the other boosts pressure to serve the Anza Lateral area in the City of Torrance, as shown in Figure 2-6.

Dominguez Hills BPS

The Dominguez Hills BPS is located in the City of Carson near the intersection of Victoria Street and Bishop Avenue. The booster pump station was constructed to provide recycled water to the Dominguez Technology Center, in the City of Carson. The booster pump station project included a 20-foot by 30-foot concrete masonry building, two 40-hp vertical turbine pumps, one 7.5-hp jockey pump, a sodium hypochlorite disinfection system, surge tanks, suction and discharge piping, instrumentation, and programming.

Torrance BPS

The Torrance BPS and disinfecting facility were constructed in 2012 to support the Anza Lateral area that currently serves 12 customers. The site is on the property of West High School. The booster pump station includes five pumps and was designed to distribute 229 acre-feet of recycled water per year to local parks, schools, and cemeteries for landscape irrigation use. As of 2020, the pump station had yet to be activated as system pressures downstream of the pump station are sufficient to satisfy customer demands. The District anticipates activating this pump station to offset the headloss associated with future system expansion and the addition of demands downstream of the pump station. However, the disinfection station at this site is currently in operation.

Table 2-6. Booster Pump Station Characteristics

Booster Pump Station	Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Diameter (in)	Efficiency (%)	Power/ Speed (HP @ RPM)
Dominguez Hills	1	Goulds	3656M [1]	150	73	8.625	65	7.5 @1750
	2	Flowserve	10EML [2]	450	204	8	80	40 @1750
	3	Flowserve	10EML [2]	450	204	8	80	40 @1750
Torrance	1	Peerless	9LA [3]	375	260	6.47	80.1	40 @1782
	2	Peerless	9LA [3]	375	260	6.47	80.1	40 @1782
	3	Peerless	9LA [3]	375	260	6.47	80.1	40 @1782
	4	Peerless	6LB [4]	150	106	3.82	69.1	10 @3510
	5	Peerless	6LB [4]	150	106	3.82	69.1	10 @3510

[1] Dominguez Hills BPS Pump 1 is constant speed, single-stage centrifugal design.
[2] Dominguez Hills BPS Pumps 2 and 3 are variable speed, five-stage vertical turbine design.
[3] Torrance Hills BPS Pumps 1-3 are variable speed, eight-stage vertical turbine design.
[4] Torrance Hills BPS Pumps 4-5 are variable speed, two-stage vertical turbine design.

2.4.5 Disinfection Stations

West Basin operates four disinfection stations within its Title 22 distribution system to boost chlorine residuals in laterals experiencing water quality issues. The need for additional chlorine injection is the result of the low velocities and long stagnation periods in the larger transmission pipelines installed to accommodate future potential demand. The resulting lower chlorine residuals are suspected of allowing microbial growth in the distribution system. Other water quality issues are experienced by customers located further away from the treatment facilities and disinfection stations, where strength of the chlorine residuals degrade to levels well below what is required for effective application. Locations of the disinfection stations are shown in Figure 2-6 and include the two booster pump stations described in Section 4.4.

The American Honda Lateral Disinfection Station is located in the City of Torrance near the intersection of Crenshaw Boulevard and Del Amo Boulevard. The disinfection station operates daily from 12:00 am to 4:00 am and introduces a 12.5 percent hypochlorite solution via a chlorine pump with a capacity of 2.0 gallons per hour (gph).

The Torrance Refinery Chlorine Disinfection Station is located downstream of the TRWRP connection to the Title 22 system, west of 190th Street and Crenshaw Boulevard. The disinfection station operates continuously and introduces a 12.5 percent hypochlorite solution via a chlorine pump with a capacity of 2.0 gph.

The Dominguez Hills BPS includes a disinfection station. The disinfection station operates daily from 12:00 am to 4:00 am and introduces a 12.5 percent hypochlorite solution via a chlorine pump with a capacity of 5.05 gph.

The Torrance BPS includes a disinfection station and is located in the City of Torrance near the intersection of Crenshaw Boulevard and Del Amo Boulevard. The disinfection station operates daily from 12:00 am to 4:00 am and introduces a 12.5 percent hypochlorite solution via a chlorine pump with a capacity of 0.95 gph.

The disinfection stations provide an effective means of mitigating residual losses. However, the ability to maintain effective chlorine residual and water quality depends on consistent daily usage of recycled water and minimizing the age of the water in the system.

2.4.6 Recent and Planned Title 22 System Expansions

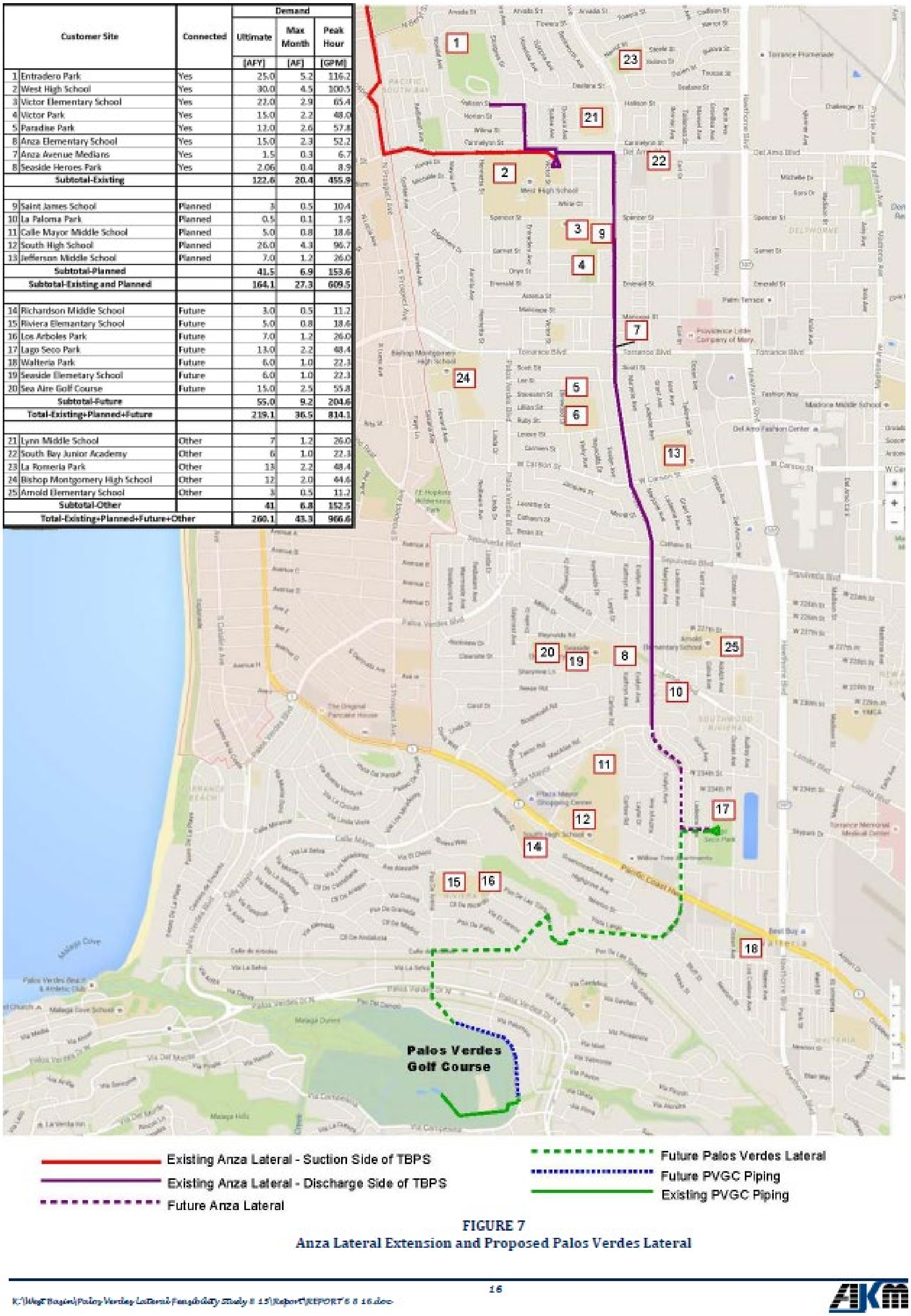
West Basin and the U.S. Army Corps of Engineers (USACE) - Los Angeles District have collaborated on multiple lateral projects, including the construction of the Anza Avenue Lateral and Imperial Avenue Lateral. The Anza Avenue Lateral Project included the installation of 14,500 feet of 8-inch diameter, 6-inch diameter, and 4-inch diameter recycled water pipeline, providing recycled water to parks and schools for landscape irrigation applications within the City of Torrance. The Imperial Avenue Lateral Project included the installation of 4,700 feet of 6-inch diameter recycled water pipeline, providing recycled water to parks and greenbelt for landscape irrigation application along Imperial Avenue in the City of El Segundo. West Basin and USACE continue to work together on future lateral projects.

Additional feasibility studies have been conducted for expansion of the recycled water distribution system since the last master plan, as described in the following sections. Some of these studies have moved forward to the design and construction stages.

Palos Verdes Lateral Feasibility Study and Preliminary Design Report

Completed in 2016, the Palos Verdes Lateral Feasibility Study (AKM Consulting Engineers, 2016) evaluated the feasibility of utilizing West Basin's Torrance Booster Pump Station and Anza Lateral to provide recycled water service to Palos Verdes Golf Course (PVGC) and other potential customers (Figure 2-7). Note that since the completion of this study, refinements to this alignment have been made as some of these customers have been connected.

Figure 2-7. Proposed Palos Verdes Lateral Alignment



	Customer Site	Connected	Demand		
			Ultimate	Max Month	Peak Hour
			[AFY]	[AF]	[GPM]
1	Entradero Park	Yes	25.0	5.2	116.2
2	West High School	Yes	30.0	4.5	100.5
3	Victor Elementary School	Yes	22.0	2.9	65.4
4	Victor Park	Yes	15.0	2.2	48.0
5	Paradise Park	Yes	12.0	2.6	57.8
6	Anza Elementary School	Yes	15.0	2.3	52.2
7	Anza Avenue Medians	Yes	1.5	0.3	6.7
8	Seaside Heroes Park	Yes	2.06	0.4	8.9
	Subtotal-Existing		122.6	20.4	455.9
9	Saint James School	Planned	3	0.5	10.4
10	La Paloma Park	Planned	0.5	0.1	1.9
11	Calle Mayor Middle School	Planned	5.0	0.8	18.6
12	South High School	Planned	26.0	4.3	96.7
13	Jefferson Middle School	Planned	7.0	1.2	26.0
	Subtotal-Planned		41.5	6.9	153.6
	Subtotal-Existing and Planned		164.1	27.3	609.5
14	Richardson Middle School	Future	3.0	0.5	11.2
15	Riviera Elemantary School	Future	5.0	0.8	18.6
16	Los Arboles Park	Future	7.0	1.2	26.0
17	Lago Seco Park	Future	13.0	2.2	48.4
18	Walteria Park	Future	6.0	1.0	22.3
19	Seaside Elemetary School	Future	6.0	1.0	22.3
20	Sea Aire Golf Course	Future	15.0	2.5	55.8
	Subtotal-Future		55.0	9.2	204.6
	Total-Existing+Planned+Future		219.1	36.5	814.1
21	Lynn Middle School	Other	7	1.2	26.0
22	South Bay Junior Academy	Other	6	1.0	22.3
23	La Romeria Park	Other	13	2.2	48.4
24	Bishop Montgomery High School	Other	12	2.0	44.6
25	Arnold Elementary School	Other	3	0.5	11.2
	Subtotal-Other		41	6.8	152.5
	Total-Existing+Planned+Future+Other		260.1	43.3	966.6

Source: AKM, 2016

According to the study, there were five planned recycled water customers (Saint James School, La Paloma Park, Calle Mayor Middle School, South High School, and Jefferson Middle School), with an average demand of 41.5 afy. West Basin identified seven potential customers (Richardson Middle School, Riviera Elementary School, Los Arboles Park, Lago Seco Park, Walteria Park, Seaside Elementary School and Sea Aire Golf Course) with an average demand of 55.0 afy. There are five other customers (Lynn Middle School, South Bay Junior Academy, La Romeria Park, Bishop Montgomery High School, and Arnold Elementary School), identified in the City of Torrance's Recycled Water Master Plan as potential recycled water customers. If all these customers are provided recycled water service from the Anza Lateral and the future Palos Verdes Lateral, a total of 239 afy will be served. At the time of this Master Plan, twelve customers (Entradero Park, West High School, Victor Elementary School, St. James Catholic School, Victor Park, Paradise Park, Anza Elementary, a portion of the Anza Medians, Seaside Heroes Park, La Paloma Park, Calle Mayor Middle School, South High School) have been connected to recycled water system; Jefferson Middle School is not yet connected.

PVGC desires to receive recycled water from West Basin near Via Colusa and Paseo del Campo through an extension of service on their property from Via Colusa/Paseo del Campo. In order to optimize the pipe size and minimize pumping costs, demands to PVGC are anticipated be provided over a 15-hour period when there are no other demands on the Anza/Palos Verdes Lateral.

With the maximum pressure of 132 psi at the discharge header (approximate hydraulic grade elevation of 405 feet), the existing Torrance Booster Pump Station cannot convey flows to the existing PVGC reservoir, which will have a highwater elevation of approximately 450 feet. The Torrance Booster Pump Station can provide the peak hour nighttime demands with three main pumps at a total head of 288 feet with the pumps operating at full speed. It can also provide the daytime flow of 500 gpm to PVGC with two pumps at a total head of 301 feet at full pump speed. The pump speeds will need to be adjusted to provide a constant pressure on the discharge side based upon the suction pressure.

Delivery to PVGC will require a new in-line booster pump station, recommended to be located at Lago Seco Park. To connect, the Anza Lateral pipeline would be extended south along Anza Avenue to 236th Street, and east to Lago Seco Park to the pump station site. The discharge pipe would follow 236th Street and Anza Avenue, cross Pacific Coast Highway, and continue along Vista Montana, Paseo de Las Tortugas, Calle de Arboles, and Via Colusa to the PVGC at Paseo del Campo.

The cost of the Anza Lateral Extension and Palos Verdes Lateral Pipeline was estimated to be $7.05 million, and cost of the Lago Seco Booster Pump Station was estimated to be $2.84 million. Service laterals to the additional 17 identified customers were estimated to cost $5.74 million.

In 2018, West Basin retained KEH & Associates, Inc. to prepare a Preliminary Design Report (KEH, 2018), which included an analysis of the proposed Lago Seco Pump Station using the District's hydraulic model. The analysis demonstrated that the proposed pump station, supplied by the Torrance Booster Pump Station was adequate for delivering the estimated nighttime and daytime supplies based on the constraints and performance data available at the time. This report proposed an alternative configuration of the pump station based on proposed cost savings, improved operability and aesthetic benefit to the City of Torrance.

According to the PDR, the Lago Seco Pump Station (LSPS) would be near the intersection of Ocean Avenue and 238th Street in the City of Torrance. It will operate in series with the existing Torrance Booster Pump Station to deliver water to an open reservoir at the PVGC (Day Operation). The secondary mode of operation will be to provide irrigation flows to several recycled water customers (Night Operation). The LSPS will include two sets of pumps to meet these two modes of operation. The pumps selected are summarized in Table 2-7.

Table 2-7. Lago Seco Pump Design Criteria

Design Element/Description	Value/Unit
Day Pumping	
Number of Pumps	3 (2 duty + 1 standby)
Design Flow Rate Per Pump	250 gpm
Design TDH	330 feet
Type of Pump	Centrifugal
Model Number (or equal)	Grundfos CR64
Control	VFD
Night Pumping	
Number of Pumps	2 (1 duty + 1 standby)
Design Flow Rate Per Pump	70 gpm
Design TDH	220 feet
Type of Pump	Centrifugal
Model Number (or equal)	Grundfos CR15
Control	VFD

Kenneth Hahn Recycled Water Lateral Feasibility Study

Completed in 2017, the Kenneth Hahn Recycled Water Lateral Feasibility Study (Lee & Ro, 2017) evaluated an ultimate build-out of the existing Los Angeles County recycled water service area, extending north into the California American Water service area to the northerly extent of Kenneth Hahn State Recreational Area (KHSRA), the greater Baldwin Hills service area and potentially into Culver City.

The current southern Los Angeles County recycled water service area terminates at an existing 36-inch diameter recycled water pipeline located at the intersection of Florence Avenue and Prairie Avenue, in the City of Inglewood. Portions of Los Angeles County, including the KHSRA, the City of Baldwin Hills, Culver City, and portions of the City of Los Angeles currently use potable water for irrigation purposes. The study was commissioned by West Basin, in conjunction with California American Water Company, Golden State Water Company, Los Angeles Department of Water and Power (LADWP), and Los Angeles County Parks and Recreation.

The study identified 631.5 afy in recycled water demand, which was subsequently refined by West Basin staff to take into account drought related reductions in irrigation water uses at the proposed sites and revised to 511.3 afy. The locations of the sites and proposed alignment of the pipelines are shown in Figure 2-8 below. A pump station would be located where the pipeline crosses into Los Angeles County, and a 1 MG storage tank would be located in the vicinity of the KHSRA. The proposed project was divided into four phases and planning level costs were developed, as shown in Table 2-8 below. West Basin is currently moving forward with predesign of Phase 1.

Table 2-8. Kenneth Hahn Recycled Water Lateral Project Costs

Facility	Phase 1 ($ millions)	Phase 2a ($ millions)	Phase 2b ($ millions)	Phase 3 ($ millions)
Pipelines and Appurtenances	4.85	3.87	1.03	1.81
Pump Station (300 HP)	1.05	-	-	-
Storage (1 MG)	1.20	-	-	-
Land Costs	0.95	1.06	0.32	-
Additional Construction (54%)	4.35	2.66	0.74	0.98
Construction Total	**12.40**	**7.59**	**2.09**	**2.79**
Engineering and Admin (22%)	3.21	1.89	0.51	0.83
Total with Eng and Admin	**15.61**	9.44	2.60	3.47
Annual O&M	0.37	0.07	0.05	0.06

Source: Lee & Ro, 2017, Attachment 1, Construction Cost Details

Figure 2-8. Proposed Kenneth Hahn Recycled Water Lateral Alignment

Source: Lee & Ro, 2017, Attachment 2 – Updated Demand Map

Torrance Recycled Water System Expansion Feasibility Study

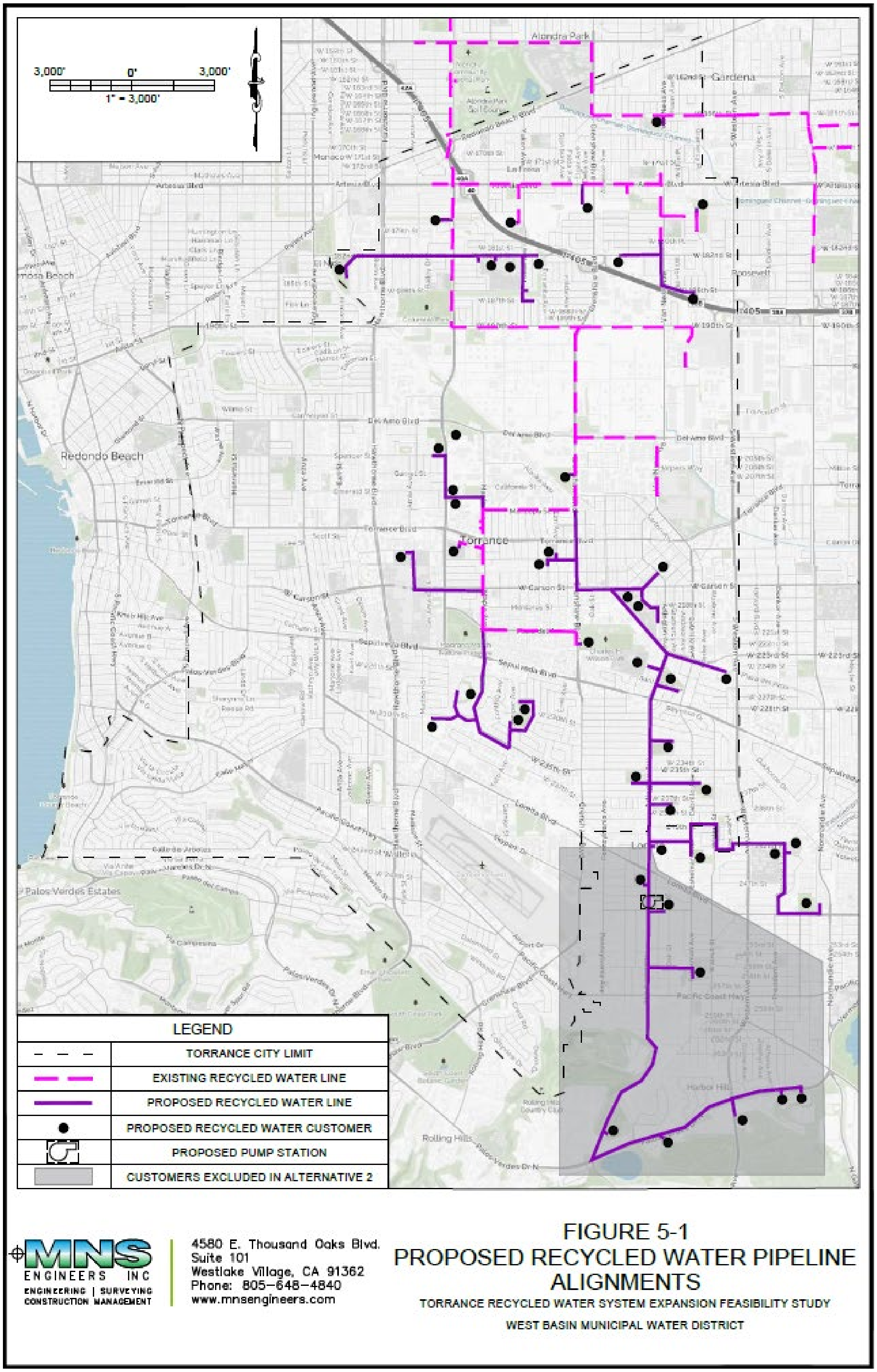
Completed in 2017, the Torrance Recycled Water System Expansion Feasibility Study (MNS Engineers, 2017) evaluated opportunities to provide tertiary treated recycled water to customers located in the City of Torrance and surrounding areas, including the City of Lomita, Harbor City, San Pedro, Rolling Hills Estates, and Rancho Palos Verdes.

Two alternative conceptual designs were developed. The proposed alignments are shown in Figure 2-9.

- Alternative 1, to be constructed in four phases to serve 923 afy at a cost of $38 million, includes approximately 100,000 feet of 4-inch through 18-inch recycled water mains to serve all the identified potential recycled water customers. The fourth phase includes a pump station to provide service to the southern-most area of Rancho Palos Verdes and Harbor City. The cost per AF was estimated to be $1,698.
- Alternative 2, to be constructed in three phases to serve 501 afy at a cost of $26.5 million, includes approximately 75,000 feet of 4-inch through 10-inch recycled water mains and omits customers in Rancho Palos Verdes and Harbor City to reduce overall infrastructure requirements, allowing reduced pipe diameters in Phase 3. The cost per AF was estimated to be $2,147.

Although the total cost for Alternative 1 is more than Alternative 2, the cost per AF of recycled water served in Alternative 1 is less than Alternative 2 by approximately $450/AF.

Figure 2-9. Proposed Torrance Recycled Water Pipeline Alignment



City of Redondo Beach Recycled Water Expansion Assessment Study

Completed in 2017, the City of Redondo Beach Recycled Water Expansion Assessment Study (Woodard & Curran, 2018, version 2) evaluated the expansion of West Basin's recycled water distribution system to serve additional sites or customers within the City of Redondo Beach. For this study, the City of Redondo Beach staff identified customers with non-potable irrigation demands. These customers were grouped into three major clusters: Northern, Mid-City and Southern, with demands of 61.1 afy, 0.72 afy and 56.8 afy, respectively.

The recycled water pipeline alignments for the Northern, Mid-City, and Southern customers were developed as six separate projects for this study. Project 1 serves Northern customers, Project 2 serves Mid-City customers, and Project 3 through Project 6 serve Southern customers.

- Project 1 comprises 7 potential phases with over 5 miles of new piping. The total project cost is $5.7 million to serve 61.1 afy of demand.
- Project 2 is one phase with 3 separate laterals. The total project cost is $676,000 to serve 0.7 afy of demand.
- Project 3 comprises 3 potential phases with over 2 miles of new piping. The total project cost is $2.4 million to serve 18.8 afy of demand.
- As an alternative to Project 3, Project 4 comprises 4 potential phases with 2 miles of new piping. The total project cost is $2.3 million to serve the same 18.8 afy of demand as of Project 3.
- Project 5 is a single-phase project with a total cost of a little over $1.6 million to serve 38 afy of demand.
- As an alternative to Project 3, but with some potential to serve additional customers farther south, Project 6 is a single-phase project with a total cost of over $2.4 million to serve 45.6 afy of demand.

Project 1 alignment to serve the Northern customers is shown in Figure 2-10. Alternative 1 for the Mid-City and Southern customers serves the most combined volume under Projects 4 and 5; these project alignments are shown in Figure 2-11.

Figure 2-10. Proposed Redondo Beach Northern Alignment (Project 1)

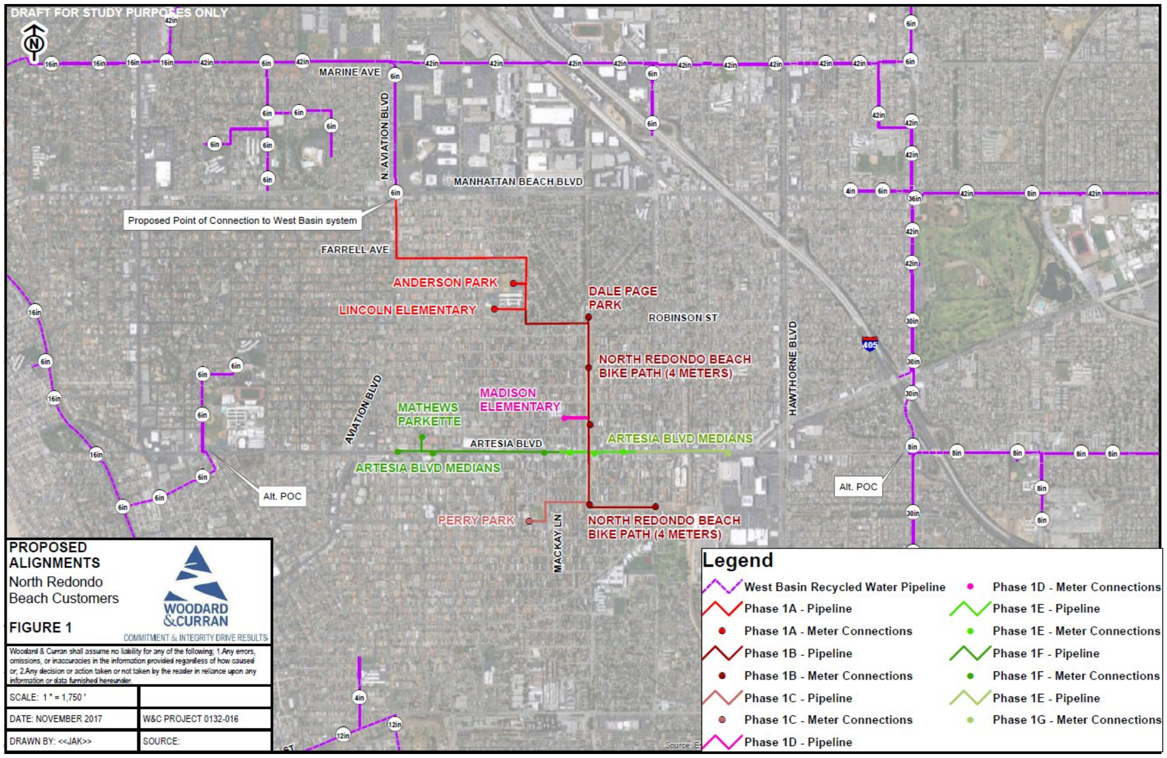
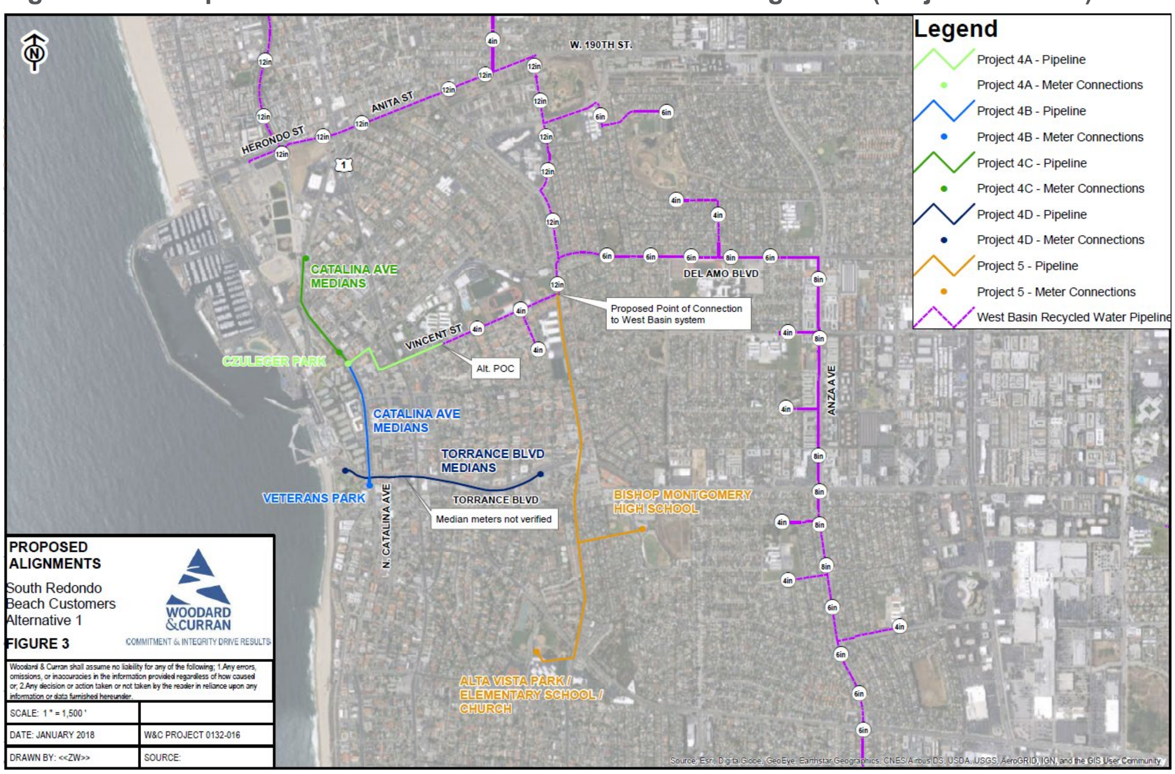


Figure 2-11. Proposed Redondo Beach Mid and Southern Alignment (Projects 4 and 5)



Source: Woodard & Curran, 2018, Figures 1 and 3

2.5 West Coast Basin Seawater Barrier Water System

For over 50 years, the West Coast Basin Seawater Barrier Project (WCBBP) has been operated to protect groundwater from seawater intrusion. The West Coast Basin Seawater Barrier consists of 157 injection wells, along with 296 observation wells, strategically located to prevent seawater intrusion into the West Coast Groundwater Basin. Since 1995, a blend of potable and advanced treated recycled water has been injected: up to 50 percent (5,600 acre-feet per year [AFY] or 5 million gallons per day [MGD]) of advanced-treated recycled water was permitted for injection into the Barrier. In 2006, the WCBBP was permitted to receive 100 percent advanced-treated recycled water (19,600 AFY or 17.5 MGD)

Potable and advanced treated recycled water for the WCBBP is supplied at the Blend Stations, located in the City of El Segundo, as shown in Figure 2-12. As part of LACDWP, the Los Angeles County Flood Control District (LACFCD) owns and maintains the West Coast Basin Seawater Barrier, from the Blend Stations to the injection wells. The Water Replenishment District of Southern California (WRD) purchases all the water that is injected into the Barrier.

West Basin supplies advanced-treated recycled water (Barrier Water) from ECLWRF to the West Basin BlendStation, where the Barrier Water is blended with imported potable water from Metropolitan WaterDistrict of Southern California (MWD). The percentage of recycled water has been steadily increasing since 1995, and as of 2020, the five-year running average recycled water contribution exceeds 70 percent of overall supply to the Seawater Intrusion Barrier.

West Basin has made significant infrastructure improvement with Phase V construction and Phase V expansion projects to increase recycled water injected into the Barrier with the goal of achieving 100 percent recycled water injection and provide a more reliable, high quality source of water to the aquifer.

Prior to the Los Angeles Regional Water Quality Control Board (RWQCB) approval of 100 percent recycled water injection, West Basin had to satisfy California DDW requirements verifying travel time through, and recycled water content in, one or more of the three West Coast Basin aquifers. Specifically, the District had to demonstrate 60 percent recycled water content in a monitoring well located within a 12-month travel time from the barrier, in order to provide an early-warning system and to demonstrate understanding of the groundwater flow regime. (Todd Groundwater, 2014)

The West Coast Basin Seawater Barrier Water System consists of the Barrier Product Water Pump Station at ECLWRF and the West Basin Barrier Water Pipeline, conveying Barrier water from ECLWRF to the Blend Station, which supplies recycled water to the West Coast Basin Seawater Barrier. Figure 2-12 shows the West Coast Barrier System as well as the location of the West Coast Basin Seawater Barrier.

Figure 2-12. West Coast Barrier Water System

2.5.1 Barrier Product Water Pump Station

The Barrier Product Water Pump Station contains six constant speed pumps with a firm capacity of 10,500 gpm (15.1 mgd). Equalization is provided by a 55,000-gallon clear well with approximately 0.5 MG of additional product water storage. Table 2-9 summarizes the individual pump characteristics.

A control valve on the discharge pipe of the pump station maintains an approximate pressure of 70 psi on the downstream side of the valve. On the upstream side of the valve, the pump discharge pressure is approximately 85 psi.

2.5.2 West Coast Barrier Water System

The Barrier Water Pipeline, consisting of 4,720 feet (0.89 miles) of 30-inch diameter cement mortar lined (CML) and coated steel transmission main, conveys the Barrier water from ECLWRF to the Blend Station, located north of the treatment facility on El Segundo Boulevard west of Nash Street in the City of El Segundo.

2.5.3 Blend Stations

Barrier Water from ECLWRF is blended at two blending stations with imported water from MWD, provided at the imported water connection WB-28 at about 90 psi. In the past 5 years, the blended water consists of approximately 75 percent barrier water from ECLWRF and 25 percent imported water from MWD. Recently in 2021, recycled water percent has been consistently at 95 percent and above. The operation is flow-based with the Los Angeles County controlling the flow rates.

Table 2-9. Barrier Product Water Pump Station Characteristics

Pump No.	Manufacturer	Year	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Type	Total WR^2 ($lb\text{-}ft^2$)*
1	Johnston	1995	16CMC	1,750	220	11.5	86.2	300 @1790	Constant	6 stage Vertical Turbine	26.53
2	Johnston	1995	16CMC	1,750	220	11.5	86.2	300 @1790	Constant	6 stage Vertical Turbine	26.53
3	Goulds	1995	20EHC	4,200	176	12.5	87.9	300 @1180	Constant	3 stage Vertical Turbine	49.16
4	Sulzer	2006	18CC	3,500	220	12.9	61	150 @1790	Constant	2 stage Vertical Turbine	9.51
5	Sulzer	2006	18CC	3,500	220	12.9	61	150 @1790	Constant	2 stage Vertical Turbine	9.51
6	Patterson	2011	17JHC	3,500	240	10.75	81.2	270 @3332	Constant	3 stage Vertical Turbine	9.05

* Total WR^2, or moment of inertia, estimated by calculating motor moment of inertia, typically the largest contributor to the pump moment of inertia.

2.6 Chevron Nitrification Treatment Plant

Title 22 water from ECLWRF flows through a separate pipeline 1 mile north of ECLWRF to the CNTP to produce 4.9 mgd of Nitrified water for cooling towers at the Chevron El Segundo Refinery, currently owned by Chevron Corporation. The CNTP has four upflow biological aerated filters (BAF), also referred to as Biofors, that perform nitrification to convert influent ammonia to nitrite and nitrate. Sodium bisulfite, sodium hydroxide, and carbon dioxide are dosed upstream of the Biofors to remove the chlorine residual, add alkalinity, and raise pH to mitigate nozzle scaling, respectively. A process flow schematic of the CNTP is provided in Figure 2-13.

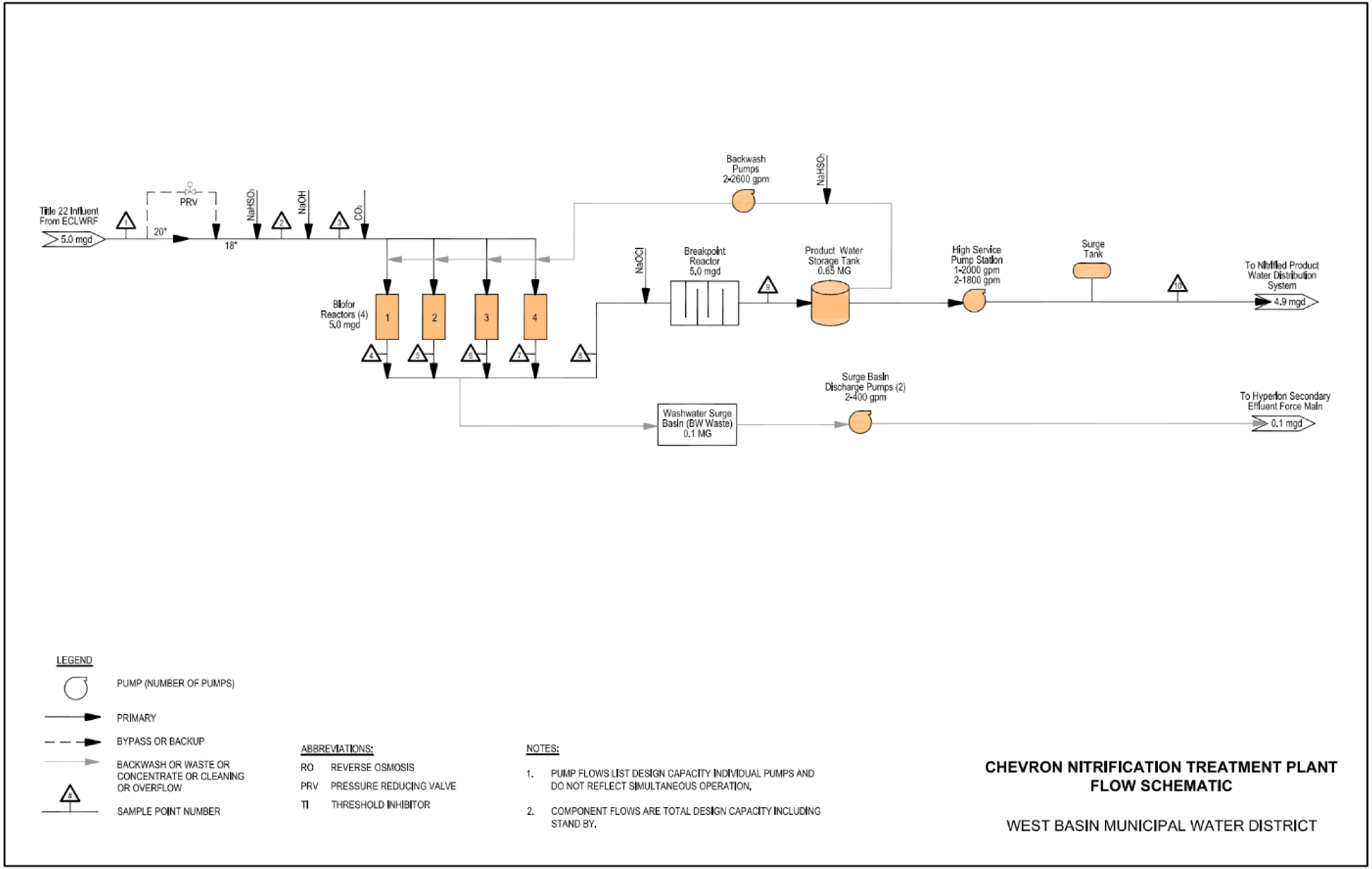
The Biofor units are sized based on ammonia loading and were designed to treat 1.25 mgd per Biofor with original design ammonia concentrations of 18 to 22 mg/L in 1994. Since then, HWRP secondary effluent ammonia concentrations have increased to 45 mg/L on average, which subsequently increases concentrations in Title 22 water and CNTP influent. The CNTP continues to operate at 1.25 mgd per unit with double the ammonia concentration resulting in ammonia breakthrough in Biofor effluent. Biofor effluent is dosed with sodium hypochlorite into a breakpoint reactor to provide enough contact time to convert any remaining ammonia into chloramines. Between 2015 and 2019, the combined Biofor effluent had an average ammonia concentration between 3.5 mg/L and 6.5 mg/L and the total cost of sodium hypochlorite used for breakpoint chlorination at CNTP ranged between $220,000 and $433,000.

The ammonia-free (<0.1 mg/L), Nitrified water from the CNTP is pumped to the Chevron Refinery for the cooling towers. A portion of the water is dosed with sodium bisulfite and used as backwash supply, while backwash waste is discharged back to the Hyperion secondary effluent force main that enters ECLWRF.

Cooling towers perform blowdowns to maintain efficient heat transfer and prevent scaling and corrosion due to concentration of TDS, silica, and other constituents. Blowdown waste is discharged into the sewers that flow to the wastewater treatment plant. If this constitutes a portion of the HWRP secondary effluent that flows back into ECLWRF, then there is potential for increasing TDS concentrations and other constituents over time.

During the staff interviews and site visit, West Basin and Suez Operations staff indicated that space is limited on-site. Additionally, the chemical addition systems require upgrades to separate the containment for reactive chemicals. The pumps, piping, and panels are in need of replacement due to age and corrosion. Suez staff indicated that the CNTP electrical system is in need of an upgrade because it has a common grounding wire that introduces safety and code compliance concerns.

Figure 2-13. CNTP Process Flow Schematic



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2.6.1 Chevron Refinery Systems

The Chevron El Segundo Refinery, located adjacent to ECLWRF across Pacific Coast Highway, receives three high purity water qualities, which include Nitrified, Industrial Single Pass RO, and Industrial Double Pass RO. These three recycled water products are conveyed in three separate distribution systems (Figure 2-14 through Figure 2-16) from ECLWRF and the Chevron Nitrification Facility to the refinery for BF and cooling tower applications: the Chevron HPBF Water system, the Chevron LPBF Water system, and the Chevron Nitrified Water system. These product water pipeline alignments are shown later in this section in Table 2-13 and Table 2-14, respectively.

Figure 2-14. Chevron Refinery High Pressure Boiler Feed Water System

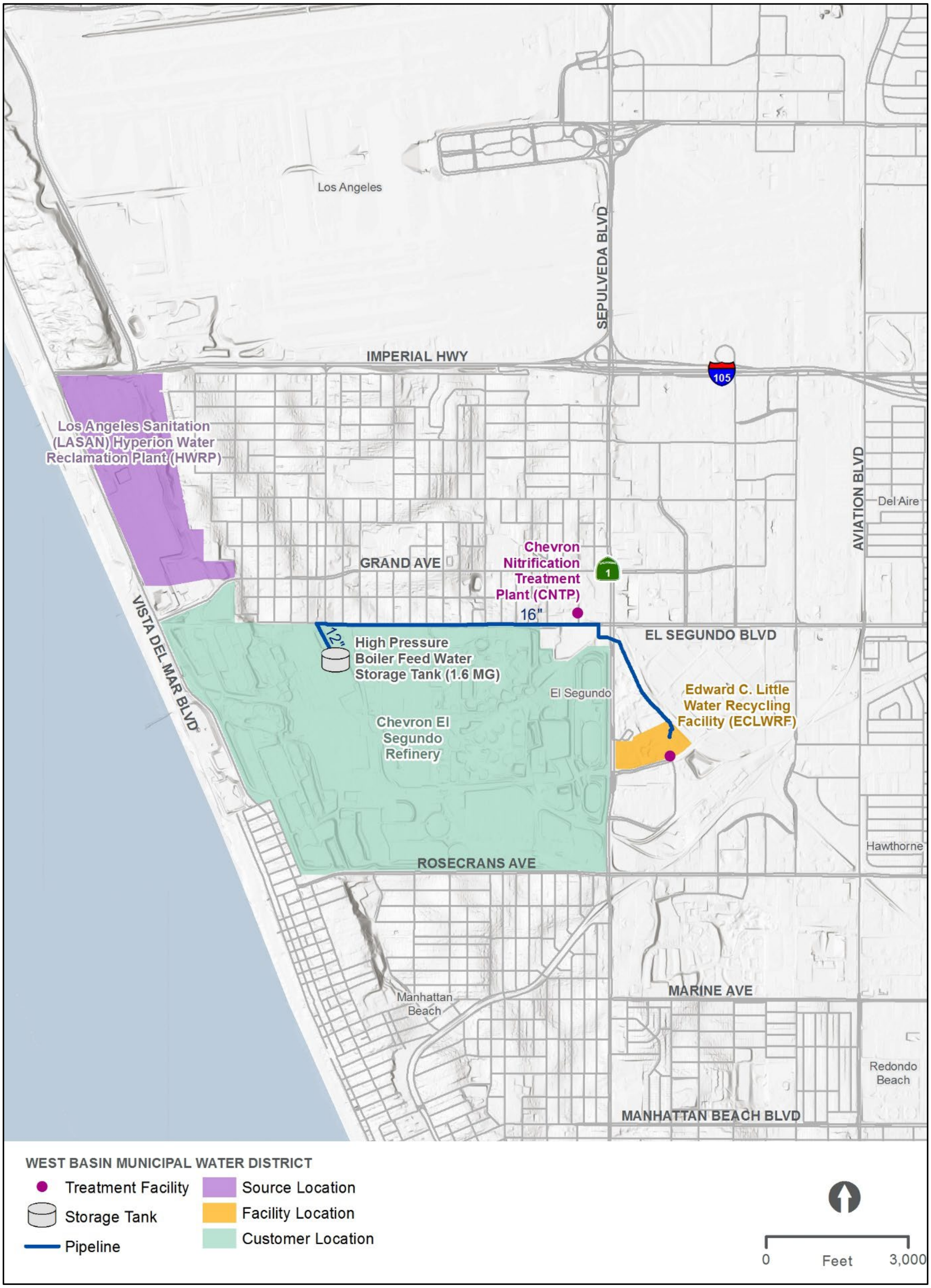


Figure 2-15. Chevron Refinery Low Pressure Boiler Feed Water System

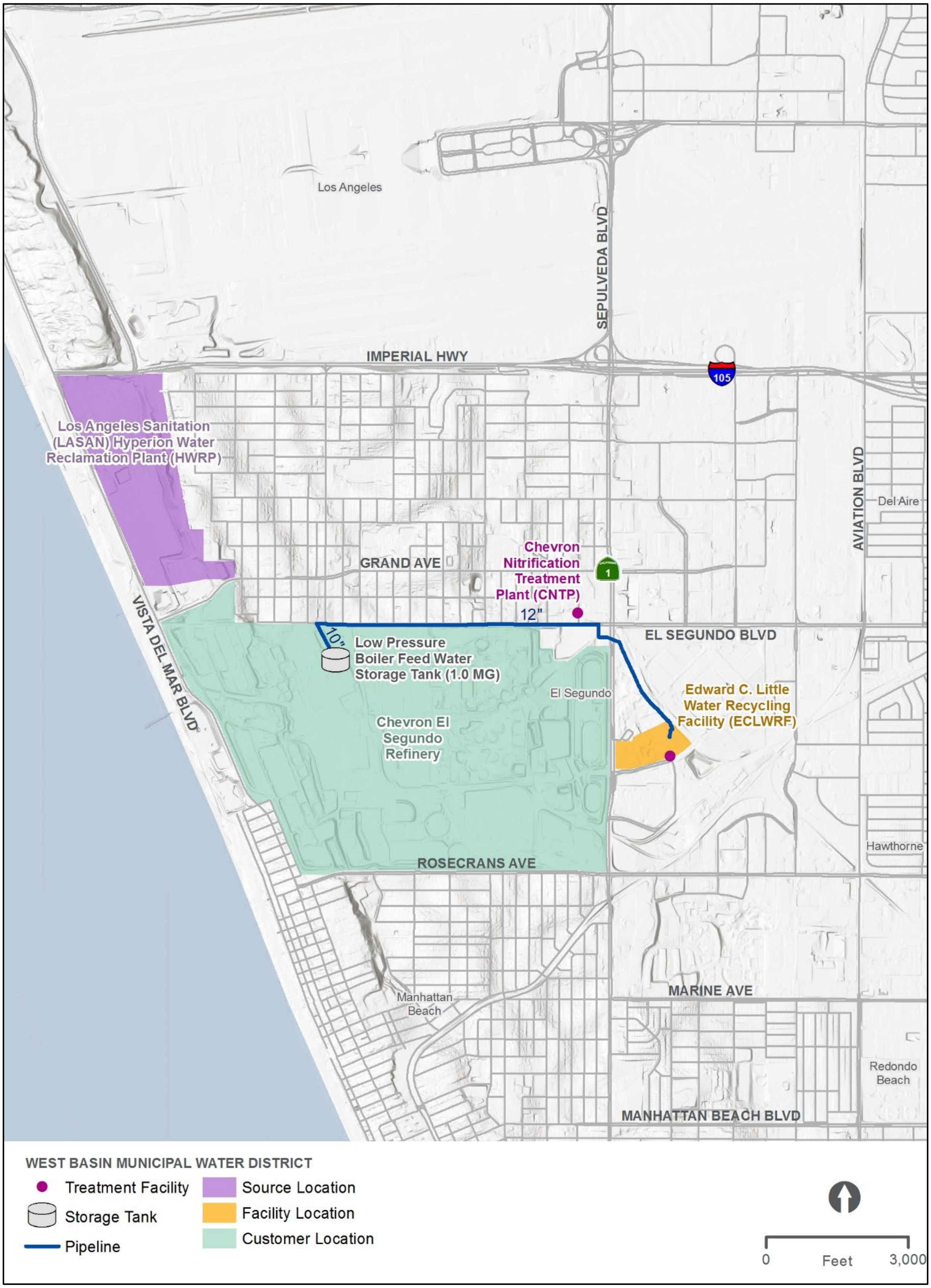
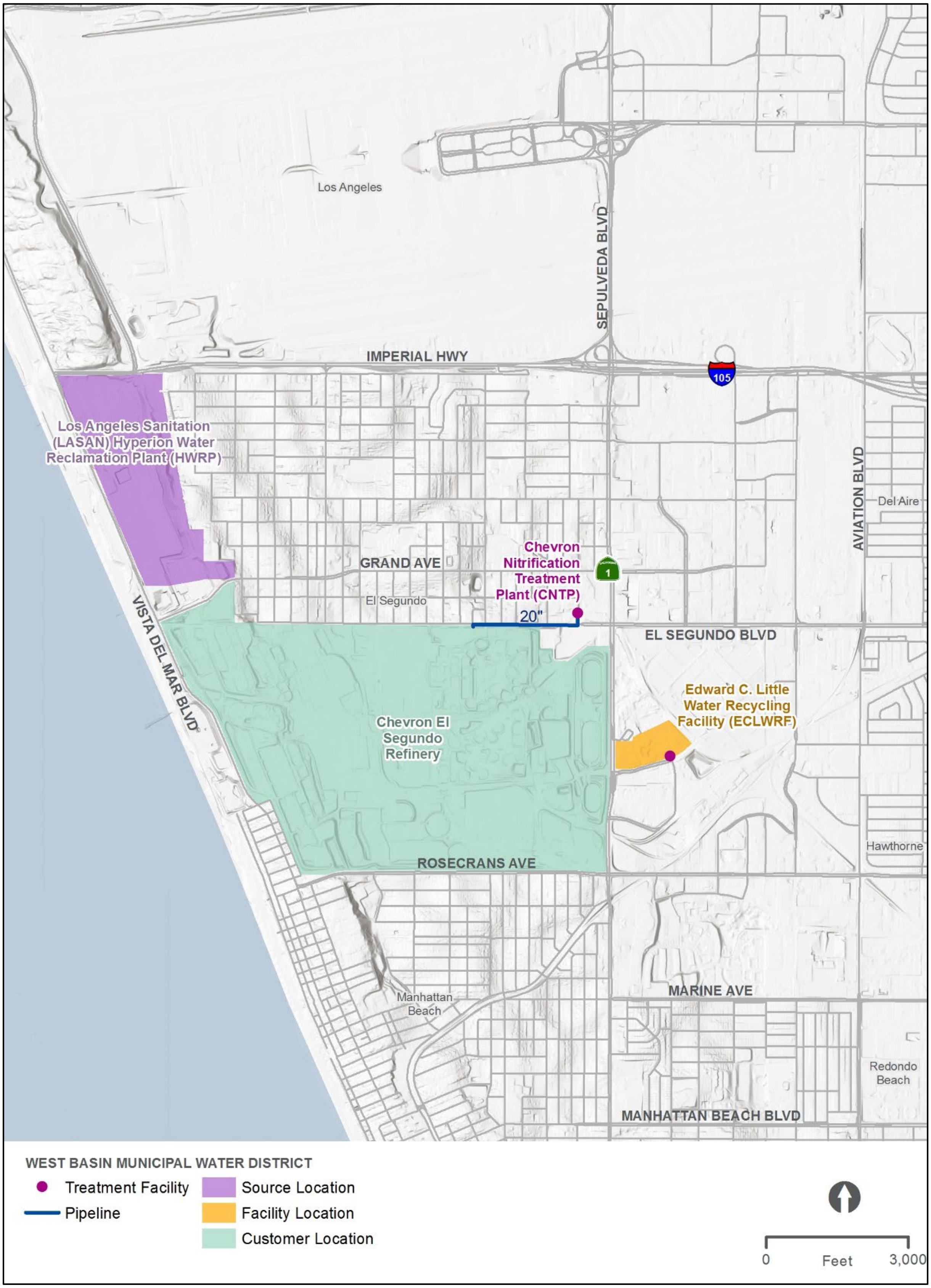


Figure 2-16. Chevron Refinery Nitrified Water System



Chevron High Pressure Boiler Feed System

The Chevron HPBF pipeline consists of a 12-inch and 16-inch diameter PVC pipeline that conveys Double Pass RO water from the HPBF Product Pump Station at ECLWRF to the Chevron on-site HPBF Storage Tank. The pipe starts out as 12 inches in diameter at ECLWRF (265 feet) and continues as a 16-inch diameter pipe from the boundary of ECLWRF to the boundary of the Chevron El Segundo Refinery (8,860 feet). The pipe decreases to 12 inches in diameter on the refinery property (905 feet). The total pipe length is approximately 10,030 feet (1.90 miles). Figure 2-14 shows the pipeline alignment from ECLWRF to the Chevron on-site HPBF Storage Tank.

The Chevron HPBF Product Pump Station consists of two variable speed, vertical turbine pumps. The pump station has a firm capacity of 1,800 gpm. Table 2-10 summarizes the individual pump characteristics.

Chevron Low Pressure Boiler Feed System

The Chevron LPBF pipeline consists of a 10-inch and 12-inch diameter PVC pipeline that conveys LPBF RO water from the LPBF Product Pump Station at ECLWRF to the Chevron on-site LPBF Water Storage Tank. The pipe starts out as 10 inches in diameter at ECLWRF (440 feet) and continues as a 12-inch diameter pipe from the boundary of ECLWRF to the boundary of the Chevron El Segundo Refinery (8,860 feet). The pipe returns to 10 inches in diameter on the refinery property (1,100 feet). The total pipe length is approximately 10,400 feet (1.97 miles). Figure 2-15 shows the pipeline alignment from ECLWRF to the Chevron on-site LPBF Storage Tank.

The Chevron LPBF Product Pump Station consists of three variable speed, vertical turbine pumps. The pump station has a firm capacity of 1,200 gpm. Table 2-11 summarizes the individual pump characteristics.

Chevron Nitrification System

The Chevron Nitrified Water System Pipeline consists of approximately 2,750 lineal feet (0.52 miles) of 20-inch diameter pipe that conveys Nitrified water from the Chevron Nitrification Facility to the cooling towers located at various sites within the Chevron El Segundo Refinery. Figure 2-16 shows the pipeline alignment from the Chevron Nitrification Facility to the gate at the refinery.

The Chevron Nitrified Water Storage Tank provides suction to the High Service Pump Station. The High Service Pump Station contains three pumps that pump the water to the cooling towers.

The Chevron Nitrified Water Product Pump Station, which is also referred to as the High Service Pump Station, consists of three vertical turbine pumps. Two pumps are constant speed and one pump is variable speed. The pump station has a firm capacity of 3,600 gpm. Table 2-12 summarizes the individual pump characteristics.

Table 2-10. Chevron HPBF Individual Pump Characteristics

Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Vertical Turbine Type	Total WR^2 ($lb\text{-}ft^2$)
1	Afton	GSV	1,800	152	14	80.1	100@1725	Variable	2 stage	5.9
2	Afton	GSV	1,800	152	14	80.1	100@1725	Variable	2 stage	5.9

Table 2-11. Chevron LPBF Individual Pump Characteristics

Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Vertical Turbine Type	Total WR^2 ($lb\text{-}ft^2$)
1	Afton	GSV	600	186	10	82	40@1700	Variable	5 stage	3
2	Afton	GSV	600	186	10	82	40@1700	Variable	5 stage	3
3	Afton	GSV	600	186	10	82	40@1700	Variable	5 stage	3

Table 2-12. Chevron Nitrified Water System Individual Pump Characteristics

Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Vertical Turbine Type	Total WR^2 ($lb\text{-}ft^2$)
1	Ingersoll	15M154	2,100	200	NA	83	150@1775	Variable	3 stage	9.63
2	Ingersoll	15M154	1,800	200	NA	86	150@1775	Constant	2 stage	9.63
3	Ingersoll	15M154	1,800	200	NA	86	150@1775	Constant	2 stage	9.63

2.7 Torrance Refinery Water Recycling Plant

The TRWRP began operating in 1998 and is located in the City of Torrance on land leased from the Torrance Refinery, which was purchased from the ExxonMobil Oil Corporation by the Torrance Refinery Company LLC (TORC) in July 2016, and is now owned by PBF Energy. The TRWRP pulls ECLWRF Title 22 water off the recycled water distribution system to produce up to 4.9 mgd of Nitrified water for cooling towers and up to 3.2 mgd of LPBF water at the Torrance Refinery.

A process flow schematic of TRWRP is shown in Figure 2-17 and consists of a BAF treatment process and an MF/RO treatment process. In the event of an issue with the Title 22 supply, this plant has a swivel ell to switch to backup potable water that discharges directly into the Nitrified product water tank, ahead of the MF system, and the MF filtrate break tank.

The BAF system at TRWRP consists of four Biofor units, which are sized the same as those at the CNTP. Biofor influent consists of Title 22 water blended with MF backwash waste, which is high in iron and solids. The TRWRP Biofors have the same issues as those at the CNTP regarding breakthrough of ammonia due to increased influent concentrations. Sodium hypochlorite addition and a breakpoint reactor converts ammonia to chloramines prior to discharge of Nitrified water to cooling towers in the Torrance Refinery. Backwash waste is discharged through the Torrance Refinery in-plant sewer which is then discharged to the Los Angeles County Sanitation District (LACSD) sewer system.

The MF/RO treatment process starts with 500-micron strainers. The MF membranes at TRWRP are PP material, and if replaced, would be changed to PVDF to allow more aggressive and more effective chemical cleans with chlorine. MF effluent is pumped to the RO process followed by decarbonation for distribution as LPBF water. Only three of the four RO trains are operated simultaneously for redundancy.

In general, the MF/RO system (membranes, housings, piping, and supports) is in poor condition due to age and would require a significant rehabilitation to restore reliable production of BF water. Additionally, the existing MF system cannot accommodate replacement membranes from many of the qualified manufacturers available in the market today. RO concentrate (brine) is discharged to the Torrance Refinery in-plant sewer system, which Suez staff believe flows to the Van Ness ocean outfall.

The RO system has only a single point of power supply, which is a high risk for potential power failure that could stop production of all LPBF water for the refinery. A project is being considered to provide backup power to the Nitrified water system, but not the LPBF system. West Basin indicated that the refinery is not as concerned with maintaining LPBF water, as it is a relatively low priority, since it is not currently an issue and they have historically experienced short duration power outages.

In February 2015, an explosion occurred at the Torrance Refinery, and while it did not damage the TRWRP, it significantly reduced recycled water demand at TRWRP for several months. Subsequent replacement and changes to process equipment within the refinery continue to keep the demand low for LPBF water.

2.7.1 Torrance Refinery Pipelines and Pump Stations

The TRWRP provides Nitrified and Single Pass RO water to the Torrance Refinery for cooling tower and BF applications. TRWRP is located within the Torrance Refinery in the City of Torrance and began operation in 1998. Average influent to the TRWRP from 2016 through 2019 was 5.7 mgd. The TRWRP treats Title 22 recycled water from ECLWRF with microfiltration and RO to produce Single Pass RO, or BF water. The TRWRP also uses nitrification to remove ammonia to provide Nitrified water for cooling tower applications. All pipelines and pump stations are located on the refinery site and are owned and operated by the refinery.

2.8 Juanita Millender-McDonald Carson Regional Water Recycling Plant

The JMMCRWRP is West Basin’s southernmost satellite plant located in the City of Carson and began operating in 2000. The plant is supplied Title 22 water produced at ECLWRF from the recycled water distribution system to produce up to 1.25 mgd of Nitrified water for cooling towers and up to 5.0 mgd of LPBF water at the Carson Refinery, currently owned by the Marathon Petroleum Corporation (Marathon). The refinery has access to groundwater wells that may be used around the refinery instead of purchasing recycled water from West Basin; therefore, wet years may allow the refinery to pump more well water and reduce demand for recycled water.

A process flow schematic of JMMCRWRP is shown in Figure 2-18, which is similar to the TRWRP. The JMMCRWRP consists of a BAF treatment process and an MF/UF and RO treatment process. In the event of an issue with the Title 22 supply, this plant has a swivel ell to switch to backup potable water as a supply source to both treatment process trains.

The BAF system at JMMCRWRP has one Biofor unit sized the same as those at the CNTP and TRWRP. Biofor influent consists of Title 22 water blended with MF backwash waste and has the same issues as those at the other Satellite Plants regarding ammonia breakthrough due to increased concentrations from HWRP. Sodium hypochlorite addition and a breakpoint reactor converts ammonia to chloramines prior to discharge. Unlike the TRWRP, the higher percentage of MF backwash waste in Biofor feed to JMMCRWRP results in reduced water quality. The JMMCRWRP has the ability to blend RO permeate into the Nitrified water to reduce TDS to the cooling towers in the refinery. Biofor backwash waste is discharged to the LACSD sewer system.

The JMMCRWRP has MF membranes and ultrafiltration (UF) membranes as pretreatment for the RO system. The UF membranes are in a portable container that runs parallel to the MF system and can treat up to 1 mgd. Both the MF and UF membranes are PVDF material and are due for a replacement soon. MF and UF filtrate is collected in a common tank and pumped to the RO process followed by decarbonation for distribution as LPBF water.

RO concentrate (brine) is discharged 1.25 miles south to the LACSD Joint Water Pollution Control Plant (JWPCP). A previous study evaluated the feasibility of using JWPCP effluent as source water to the JMMCRWRP and determined it best to maintain source water from ECLWRF because the JWPCP is also a high-purity oxygen plant with a short SRT (like HWRP), but has higher TDS levels due to more industrial contribution to sewers.

Treatment and conveyance components of the JMMCRWRP do not have a fully redundant power supply for critical assets, such as the product pumps. This is a high risk for potential power failure that could stop supply of LPBF and/or Nitrified water to the refinery. As part of the Phase II Expansion Project starting in June 2021, a new standby 600kW generator will be installed to provide redundant power. Specifically, the generator will power Panel H96, Panel H97, a RO flush pump, a 40HP Biofor process blower, and two (2) 200HP RO product water pumps. This is planned to be online by March 2023.

Unlike many of other West Basin's treatment facilities, the JMMCRWRP has land available for potential expansion. The treatment processes occupy only 2 acres of the site's total 4.7 acres. West Basin completed the design of the JMMCRWRP Phase II Expansion Project in 2017, which incorporated a 2 mgd capacity tertiary MBR (tMBR) treatment process to reliably produce a total of 2.45 mgd of Nitrified water from the tMBR and offloaded Biofor unit. The tMBR and CEMF systems are intended to increase capacity and improve reliability of the recycled water deliveries to Marathon.

On March 19, 2020, Governor Gavin Newsom issued a stay-at-home order due to the rapid increase in the number of COVID-19 cases in an effort to slow the spread. From early to mid-2020, the White House Administration and governors in other states implemented similar orders and guidelines. This caused a significant and sudden drop in demand for oil and gasoline, which decreased production for refineries around the world.

As the economic impacts of COVID-19 continued through 2020, Marathon's ability to commit an investment to the Phase II Expansion Project and installation of a tMBR system continued to be delayed. On January 5, 2021, Marathon confirmed that the current economic climate will not allow them to commit funds to the construction of the tMBR system at this time.

Given Marathon's inability to proceed at this point with the tMBR system, West Basin decided to proceed with the construction of the CEMF portion of the Phase II Expansion Project, including other ancillary improvements. This will allow necessary upgrades and capacity expansion to be implemented at the Carson satellite facility, and allow West Basin to utilize the SRF loan/grant funding under the SWRCB imposed deadlines.

Figure 2-17. TRWRP Process Flow Schematic

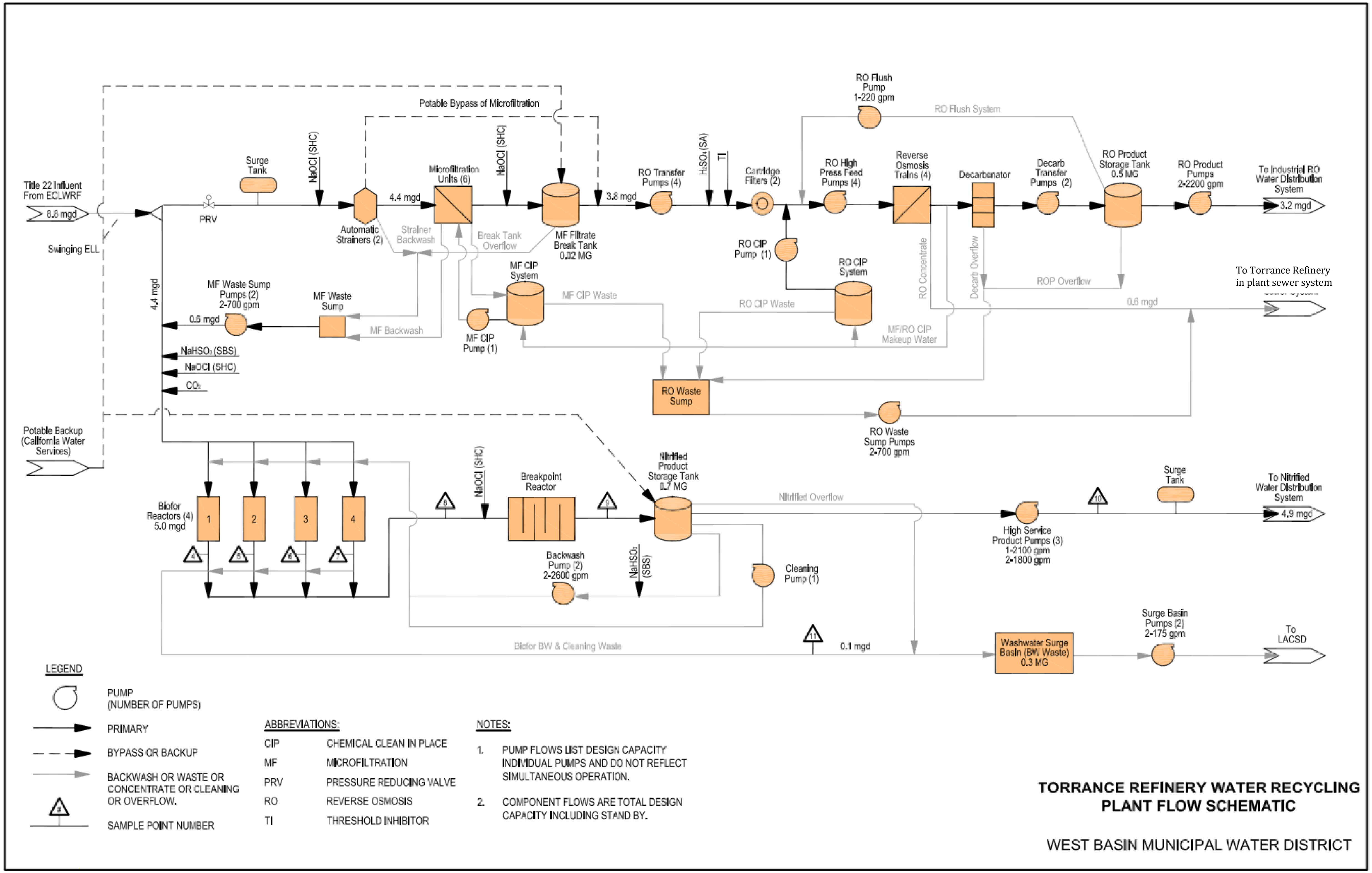
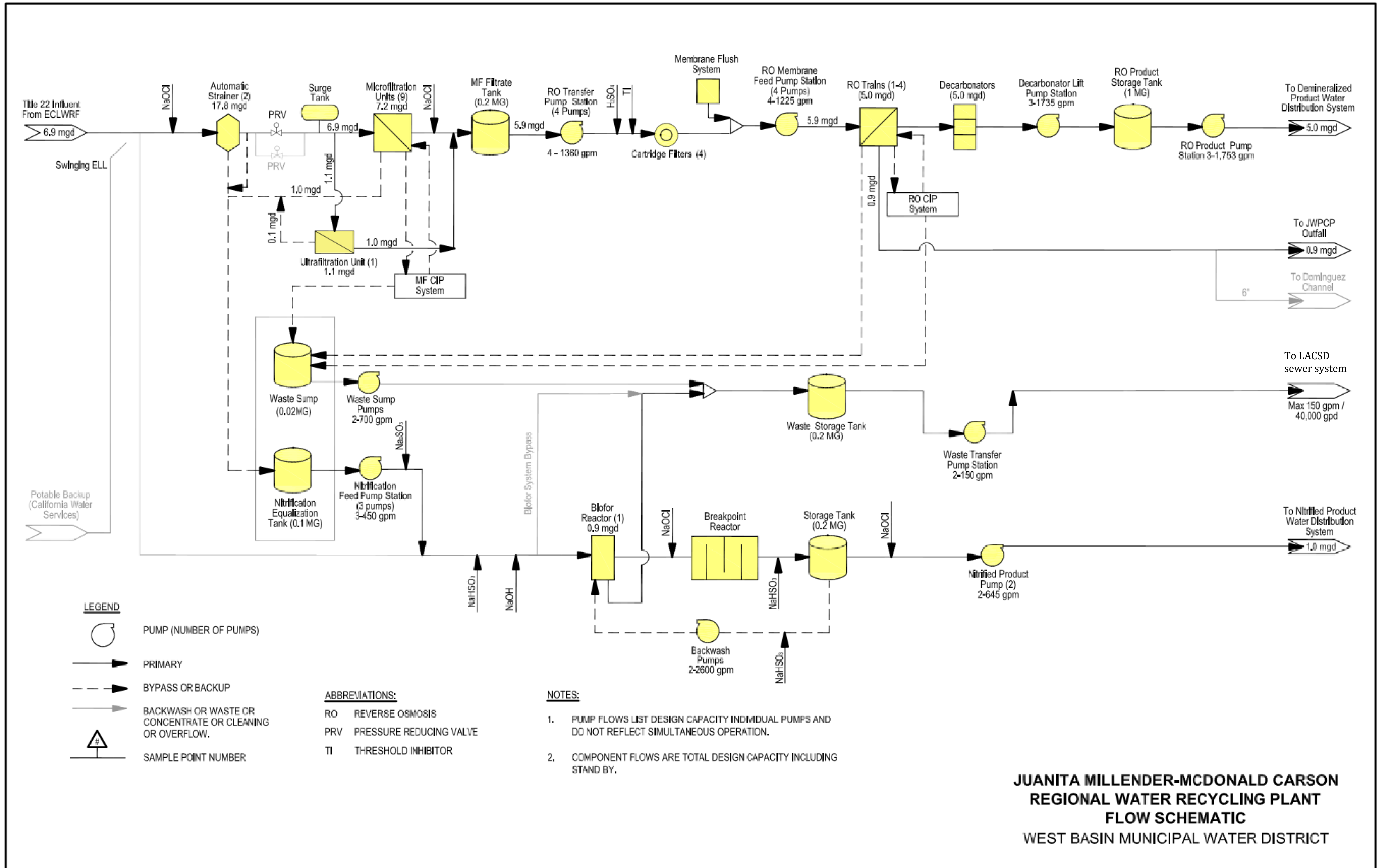


Figure 2-18. JMMCRWRP Process Flow Schematic



2.8.1 JMMCRWRP Pipelines and Pump Stations (Formerly BP)

The JMMCRWRP serves the Carson Refinery, which is located at the southeast corner of Wilmington Ave and E. 223rd Street in the City of Carson. The Carson Refinery receives Single Pass RO and Nitrified water from JMMCRWRP via two separate conveyance pipeline systems for BF and cooling tower applications. Within the Carson Refinery, the Single Pass RO and Nitrified water is blended after delivery to a flow-metering vault. The blended water consists of approximately 83 percent Single Pass RO and the remainder is made up of Nitrified water. The remaining 17 percent of the Single Pass RO water is further treated through an additional RO treatment system located within the refinery for HPBF water applications. Brine from the RO process is discharged from the JMMCRWRP via a dedicated brine line.

JMMCRWRP Brine Line

The RO concentrate collected from JMMCRWRP is discharged to the JMMCRWRP Brine Line, which consists of 14-inch diameter standard dimension ratio (SDR) 11 HDPE and PVC C905 pipe. The brine line extends approximately 28,400 feet (5.38 miles) south and west to LACSD's JWPCP in the City of Carson.

The brine flow in the pipeline is conveyed by the discharge pressure applied at the RO trains at JMMCRWRP. A standpipe is located at the discharge point to the JWPCP outfall to prevent backup of the brine line. A bypass allows diversion flow of brine into the Dominguez Channel midway down the brine line in event of an emergency. The alignment of the brine line is shown in Figure 2-19.

JMMCRWRP Reverse Osmosis Pipeline

The JMMCRWRP RO pipeline consists of 2,710 feet of 30-inch diameter DIP (Class 200 and 300) and 3,270 lineal feet of 24-inch diameter DIP (Class 250) segments. The pipeline is initially sized as 30-inch diameter from JMMCRWRP to the intersection of Carson Street and Wilmington Avenue. Since Wilmington Avenue is heavily congested with oil pipelines and other utilities, the pipeline was reduced to 24-inch diameter from Carson Street to the Carson Refinery. The total length of the pipeline is approximately 1.13 miles from JMMCRWRP to the Carson Refinery on-site blending station. Figure 2-20 shows the pipeline alignment from JMMCRWRP onto the Carson Refinery site.

JMMCRWRP Reverse Osmosis Product Pump Station

The JMMCRWRP Reverse Osmosis Product Pump Station consists of three variable speed, centrifugal pumps. The pump station has a firm capacity of 3,450 gpm. Table 2-13 summarizes the individual pump characteristics.

JMMCRWRP Nitrified Water Pipeline System

The JMMCRWRP Nitrified water pipeline consists of approximately 1.17 miles of 12-inch diameter DIP (Class 350) from JMMCRWRP to the Carson Refinery on-site blending station. Figure 2-21 shows the pipeline alignment from JMMCRWRP to the Carson Refinery.

JMMCRWRP Nitrified Water Product Pump Station

The JMMCRWRP Nitrified Water Product Pump Station consists of two variable speed, centrifugal pumps. The pump station has a firm capacity of 625 gpm. Table 2-14 summarizes the individual pump characteristics.

Figure 2-19. JMMCRWRP Brine Pipeline Alignment

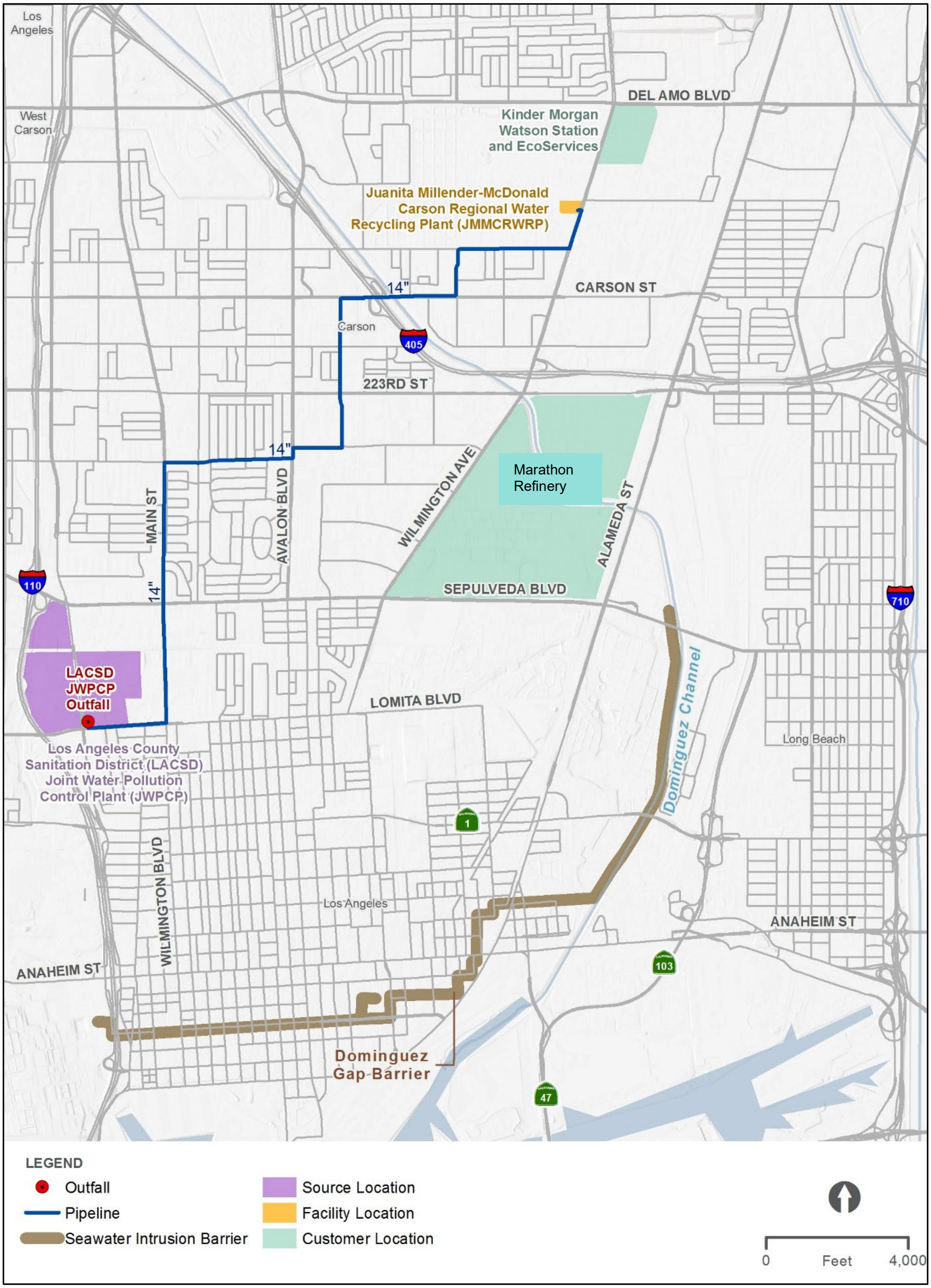


Figure 2-20. JMMCRWRP Reverse Osmosis Water System

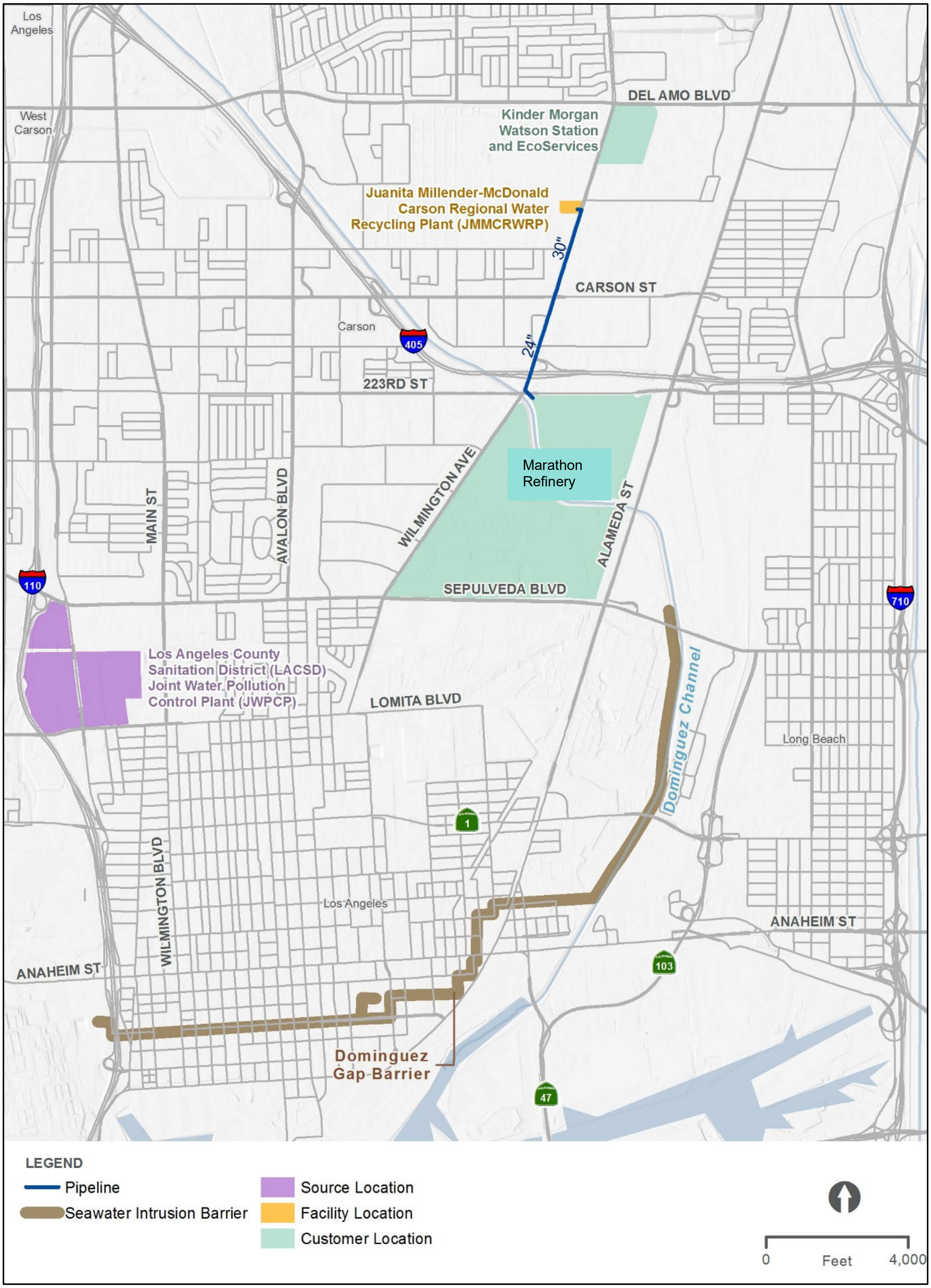


Figure 2-21. JMMCRWRP Nitrified Water System

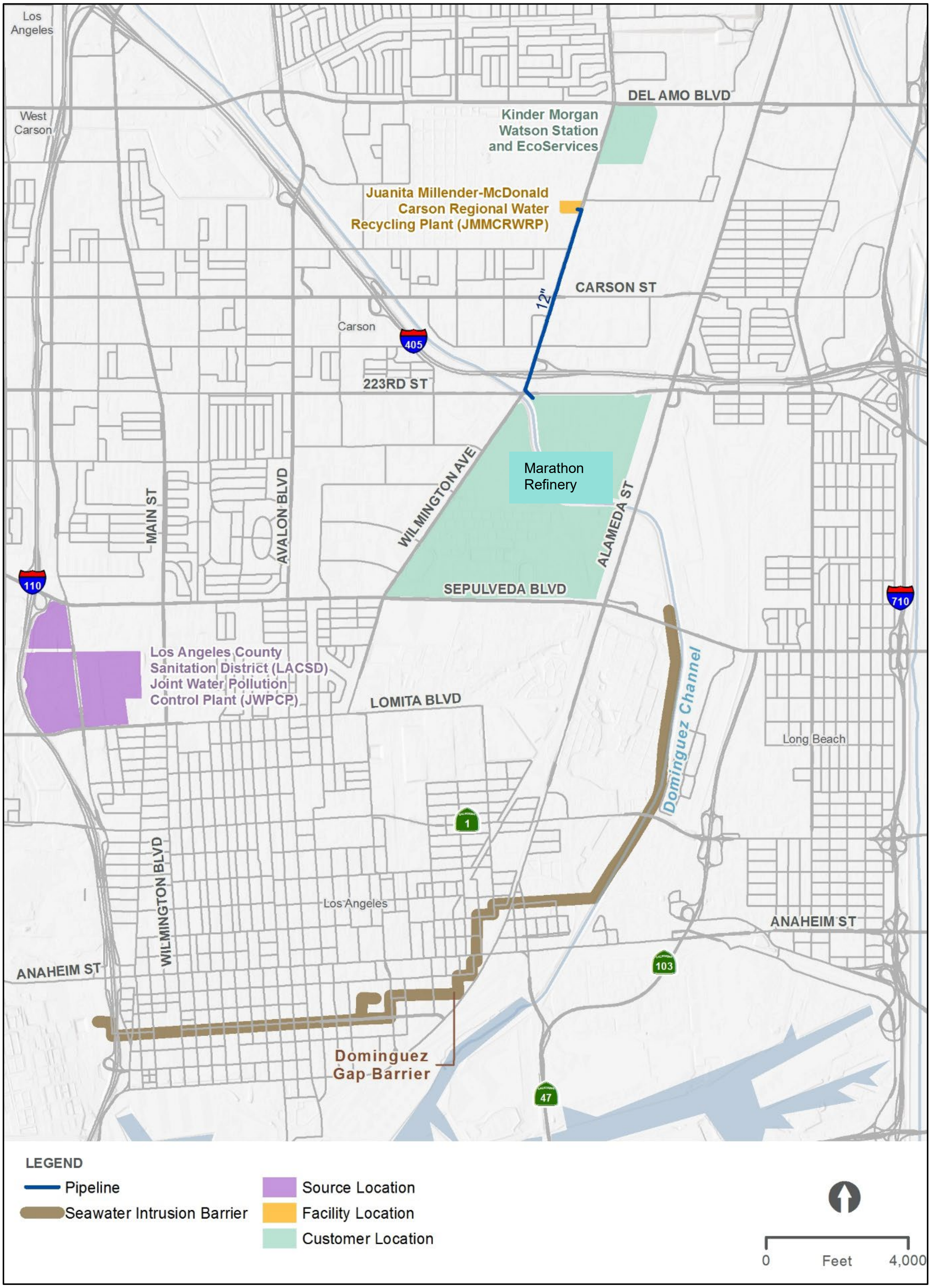


Table 2-13. JMMCRWRP RO Product Pump Station Characteristics

Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Type	Total WR^2 ($lb\text{-}ft^2$)*
1	Goulds	3410	1,725	320	9.5	83	250@3600	Variable	Centrifugal	7.2
2	Goulds	3410	1,725	320	9.5	83	250@3600	Variable	Centrifugal	7.2
3	Goulds	3410	1,725	320	9.5	83	250@3600	Variable	Centrifugal	7.2

* Total WR^2, or moment of inertia, estimated by calculating motor moment of inertia, typically the largest contributor to the pump moment of inertia.

Table 2-14. JMMCRWRP Nitrified Product Pump Station Characteristics

Pump No.	Manufacturer	Model	Design Capacity (gpm)	Design TDH (ft)	Impeller Dia (in)	Efficiency (%)	Power/ Speed (HP @ RPM)	Variable or Constant Speed	Type	Total WR^2 ($lb\text{-}ft^2$)*
1	Goulds	3410	625	345	9.375	75	100@3600	Variable	Centrifugal	1.86
2	Goulds	3410	625	345	9.375	75	100@3600	Variable	Centrifugal	1.86

* Total WR^2, or moment of inertia, estimated by calculating motor moment of inertia, typically the largest contributor to the pump moment of inertia.

2.9 Water Quality Requirements

The following section discusses the water quality criteria and guidelines for the five different types of designer water that West Basin's treatment facilities produce for their customers: Title 22, Nitrified, Barrier, LPBF, and HPBF.

2.9.1 ECLWRF Title 22 Discharge Permit

The ECLWRF Title 22 water is regulated by the California RWQCB Los Angeles Region 4, Order No. 01-043 (File No. 94-062) (Table 2-15).

The California Code of Regulations, Title 22, Division 4, Chapter 3, Recycling Criteria, specifies treatment processes for ensuring proper disinfection of recycled water. It also details requirements for limiting public contact with recycled water to protect public health. Since ECLWRF produces disinfected tertiary recycled water (i.e., Title 22 water), which is a filtered and subsequently disinfected wastewater, it must meet the following criteria:

a) *The filtered wastewater has been disinfected by either:*

   (1) *A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow; or*

   (2) *A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as poliovirus may be used for purposes of the demonstration.*

b) *The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 200 milliliters in more than one sample in a 30 day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.*

Note: MPN is most probable number

According to *Water Reuse: Issues, Technologies, and Applications*, a minimum residual chlorine of 1.0 mg/L is recommended to limit the regrowth of microorganisms within the distribution system.

Table 2-15. Title 22 Permitted Water Quality Requirements

Parameter	Units	Discharge Permit Limit
Turbidity	Nephelometric Turbidity Unit (NTU)	2 (average day) 5 (more than 5% of time over 24 hours) 10 (instantaneous)
Biochemical oxygen demand (BOD_5) at 20°C	mg/L	20
Oil and grease	mg/L	10
Suspended solids (SS)	mg/L	20

Table 2-15. Title 22 Permitted Water Quality Requirements

Parameter	Units	Discharge Permit Limit
Settleable solids	ml/L	0.2
TOC	mg/L	20
TDS	mg/L	800
Chloride	mg/L	250
Sulfate	mg/L	250
Boron	mg/L	1.5
Nitrate + Nitrite (sum as nitrogen)	mg/L	10
pH	s.u.	6.5 to 8.5

[a] Order No. 01-043 (File No. 94-062), RWQCB Los Angeles, Region 4.

2.9.2 Title 22 Irrigation Guidelines

Water quality guidelines for irrigation were developed by the University of California, Committee of Consultants and are shown in Table 2-16. According to Salt-Affected Turfgrass Sites: Assessment and Management, the combination of high nitrogen levels and frequent irrigation has several adverse effects including:

- Excessive growth;
- Reduced heat stress tolerance;
- Reduced cold and drought tolerances;
- Reduced wear-resistant turf;
- Increased opportunity for invasive plant infestation; and
- Increased disease and weed problems.

The successful long-term use of irrigation water depends more on rainfall, leaching, soil drainage, irrigation water management, salt tolerance of plants, and soil management practices than upon water quality itself.

Since salinity problems may eventually develop from the use of any water, the following guidelines are given, should they be needed, to assist water users to better manage salinity in either agricultural or community-based irrigation:

- Irrigate more frequently to maintain an adequate soil water supply.
- Select plants that are tolerant of an existing or potential salinity level.
- Routinely use extra water to satisfy the leaching requirements.
- If possible, direct the spray pattern of sprinklers away from foliage. To reduce foliar absorption, try not to water during periods of high temperature and low humidity or during windy periods. Change time of irrigation to early morning, late afternoon, or night.
- Maintain good downward water percolation by using deep tillage or artificial drainage to prevent the development of a perched water table.

- Salinity may be easier to control under sprinkler and drip irrigation than under surface irrigation. However, sprinkler and drip irrigation may not be adapted to all qualities of water and all conditions of soil, climate, or plants.

Water quality guidelines were identified for drip irrigation in order to avoid or mitigate potential plugging of nozzles (Table 2-17). West Basin self-imposes other limitations on ECLWRF Title 22 effluent to reduce potential issues downstream. For example, Suez staff target a maximum iron concentration of 0.5 mg/L in Title 22 water.

Table 2-16. Title 22 Water Quality Guidelines for Irrigation

Parameter	Units	Established Criteria Degree of Use Restriction[b,c,d]		
		None	Slight to Moderate	Severe
Salinity (affects crop water availability)				
Electrical Conductivity (EC)	dS/m	<0.7	0.7 – 3.0	>3.0
TDS	mg/L	<450	450 – 2,000	>2,000
Infiltration (affects infiltration rate of water into the soil)				
aSAR[e] = 0-3, and EC_w	$(meq/L)^{0.5}$[a]	>0.7	0.7 – 0.2	<0.2
= 3-6, and EC_w		>1.2	1.2 – 0.3	<0.3
= 6-12, and EC_w		>1.9	1.9 – 0.5	<0.5
= 12-20, and EC_w		>2.9	2.9 – 1.3	<1.3
= 20-40, and EC_w		>5.0	5.0 – 2.9	<2.9
Specific ion toxicity (affects sensitive crops)				
Sodium (Na)				
Surface irrigation, SAR	$(meq/L)^{0.5}$	<3	3 – 9	>9
Sprinkler irrigation, Na^+	mg/L	<69	>69	
Chloride (Cl)				
Surface irrigation, Cl^-	mg/L	<142	142 – 355	>355
Sprinkler irrigation, Cl^-	mg/L	<106	>106	
Boron (B)	mg/L	<0.7	0.7 – 3.0	>3.0
Bicarbonate (HCO_3)	mg/L	<92	92 – 518	>518
pH	-	6.5 – 8.4 (normal range)		
Ammonia as N, (NH_3-N)	mg/L	(see combined N values below)		
Nitrate as N, (NO_3-N)	mg/L	(see combined N values below)		
Total Nitrogen (TN)	mg/L	<5	5 – 30	>30

Table 2-16. Title 22 Water Quality Guidelines for Irrigation

Parameter	Units	Established Criteria Degree of Use Restriction[b,c,d]		
		None	Slight to Moderate	Severe

[a] Adapted from University of California Committee of Consultants (1975); Guidelines for interpretation of water quality for irrigation (Ayers and Westcot, 1984).
[b] Method and Timing of Irrigation: Assumes normal surface and sprinkler irrigation methods are used. Water is applied as needed, and the plants utilize a considerable portion of the available stored soil water (50% or more) before the next irrigation. At least 15 percent of the applied water percolates below the root zone (leaching fraction [LF] > 15%).
[c] Site Conditions: Assumes soil texture ranges from sandy loam to clay with good internal drainage with no uncontrolled shallow water table present.
[d] Definitions of "The Degree of Use Restriction" terms:
None = Reclaimed water can be used similar to the best available irrigation water.
Slight = Some additional management will be required above that with the best available irrigation water in terms of leaching salts from the root zone and/or choice of plants.
Moderate = Increased level of management required and choice of plants limited to those which are tolerant of the specific parameters.
Severe = Typically cannot be used due to limitations imposed by the specific parameters.
[e] Permeability is evaluated based on the combination of the adjusted sodium adsorption ratio (aSAR) and electrical conductivity (EC) values.

Table 2-17. Title 22 Water Quality Guidelines for Potential Plugging of Drip Irrigation

Parameter	Units	Degree of Potential Restrictions on Use[a]		
		Little	Slight to Moderate	Severe
Physical				
Suspended solids	mg/L	<50	50 – 100	>100
Chemical				
TDS	mg/L	<500	500 – 2,000	>2,000
Manganese	mg/L	<0.1	0.1 – 1.5	>1.5
Iron	mg/L	<0.1	0.1 – 1.5	>1.5
Hydrogen sulfide	mg/L	<0.5	0.5 – 2.0	>2.0

[a] Adapted from Nakayama, 1982.

2.9.3 Nitrified Water Quality

Nitrified water is produced at the Satellite Plants from ECLWRF Title 22 effluent. The water quality goals for the Nitrified water supplied by CNTP, TRWRP, and JMMCRWRP are shown in Table 2-18.

Table 2-18. Nitrified Water Quality Requirements

Parameter	Units	CNTP[a]	TRWRP	JMMCRWRP
EC	µmho/cm	-	3,000	1,000 (ave)[b] 1,350 (max)
Alkalinity, as $CaCO_3$	mg/L	308	350	-
Sulfate	mg/L	311	600	-
Chloride	mg/L	355	450	-

Table 2-18. Nitrified Water Quality Requirements

Parameter	Units	CNTP[a]	TRWRP	JMMCRWRP
Calcium	mg/L	162.5	80	60 (ave)[b] 100 (max)
Magnesium	mg/L	-	40	24 (ave)[b] 29 (max)
Hardness, as $CaCO_3$	mg/L	306	360	-
Potassium	mg/L	-	20	-
Silica (SiO_2)	mg/L	30	35	22 (ave)[b] 28 (max)
Ammonia, as N	mg/L	0	1.6	0.1 (ave)[b] 0.1 (max)
Nitrate, as N	mg/L	167.5	-	-
Nitrite, as N	mg/L	< 0.1	-	-
Iron	mg/L	-	1.0	-
Total Phosphorus, as P	mg/L	14.6		
Total Dissolved Phosphorus, as P	mg/L	12.8		
Phosphate	mg/L	-	15	-
Total Suspended Solids (TSS)	mg/L	-	5	-
Chemical Oxygen Demand (COD)	mg/L	-	90	-
BOD	mg/L	53	-	-
TOC	mg/L	10	-	-
Total Suspended Solids (TSS)	mg/L	12	-	-

[a] Unit Process Guidelines for the West Basin Nitrification Facility at Chevron, Water quality goals for cooling tower makeup.
[b] For parameters sampled weekly, this is a 12-week rolling average. For parameters sampled continuously, this is a 3-day rolling average.
[c] West Basin Municipal Water District Nitrification and Breakpoint Chlorination Systems Status and Recommendations (Suez, 2011).

2.9.4 Barrier Water

The State of California Los Angeles RWQCB has issued a permit to West Basin and LACDPW jointly for injection of recycled water from the MF, RO, and UV-AOP treatment processes at ECLWRF into the West Coast Basin Barrier. This water has been shown to meet all the requirements (Table 2-19) of the California Drinking Water Primary and Secondary Standards and the Maximum Contaminant Levels (MCLs). However, the permit requires Total Nitrogen (TN) of less than 5 mg/L as total nitrogen or 5 mg/L divided by the maximum average recycled water content, rather than the MCL of less than 10 mg/L for nitrate as nitrogen (NO_3-N). Similarly, the maximum TOC concentrate allowed in the permit is 5 mg/L divided by the maximum average recycled water content using both a 4-week and 20-sample average. It has also been shown that selected pharmaceutically active compounds and other toxic contaminants not included in the drinking water standards are removed or reduced to low levels in the product water.

Table 2-19. Barrier Water Quality Requirements

Parameter	Units	Limit	Title 22 Section
Inactivation/removal of enteric virus / *Giardia* / *Cryptosporidium*	Log-removal	12 / 10 / 10	60320.208
Turbidity			
Not to exceed more than 5% of the time within a 24-hour period	NTU	0.2	60301.320
Not to exceed at any time	NTU	0.5	
Total Nitrogen (TN) average	mg/L	10	60320.210
Total Organic Carbon (TOC) 4-weel and 20-sample average	mg/L	0.5	60320.218
Regulated Contaminants and Physical Characteristics Control	-	-	60320.212
Primary MCLs specified	-	-	60320.201, 212
Priority Toxic Pollutants and Other Priority Constituents and Notification Levels	-	-	60320.220

[a] California Code of Regulations, Title 22, California Statues Related to Recycled Water and the State Board's Division of Drinking Water, January 2019.
[b] State Water Resources Control Board (SWRCB), Title 22, Regulations Related to Recycled Water, October 1, 2018.

2.9.5 LPBF and HPBF Water Quality

The contractual limits for the water quality of each of the LPBF and HPBF water demands supplied by the Chevron LPBF, Chevron HPBF, TRWRP LPBF, and JMMCRWRP LPBF are shown in Table 2-20.

Table 2-20. LPBF and HPBF Water Quality Requirements

Parameter	Units	Chevron LPBF	Chevron HPBF	TRWRP LPBF	JMMCRWRP LPBF
Ammonia as N (NH_3-N)	mg/L	-	-	1.9	4.0 (ave) [a] 5.0 (max)
Calcium (Ca)	mg/L	-	-	-	1.0 (ave) [a] 2.0 (max)
EC	µmho/cm	-	-	50	-
Hardness (as $CaCO_3$)	mg/L	0.3	0.03	-	-
Magnesium (Mg)	mg/L	-	-	-	1.0 (ave) [a] 1.0 (max)
Silica (SiO_2)	mg/L	1.5	0.1	1.0	1.0 (ave) [a] 2.0 (max)
TDS	mg/L	60	5	-	35 (ave)[a] 50 (max)
TOC	mg/L	-	-	0.7	-

[a] For parameters sampled weekly, this is a 12-week rolling average. For parameters sampled continuously, this is a 3-day rolling average.

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Chapter 3 Recycled Water Demands

3.1 Historical Recycled Water Demands

In 2019, West Basin delivered over 38,700 afy of recycled water to over 350 recycled water connections, which are categorized into four usage types: industrial, irrigation, mixed use, and barrier. Mixed use refers to customers that use recycled water for more than one usage type at a site (e.g., irrigation and multi-use/plumbing fixtures). As shown in Figure 3-1, West Basin's recycled water demands equated to an average of 35 mgd from 2014 through 2017 and slightly declined to an average of 33 mgd from 2018 and 2019. As shown in Figure 3-2, on average, 50 percent of the demands are attributed to industrial use, 33 percent to West Coast Basin Barrier injection, 17 percent to irrigation, and less than one percent to mixed use.

Figure 3-1. Historical Recycled Water Sales

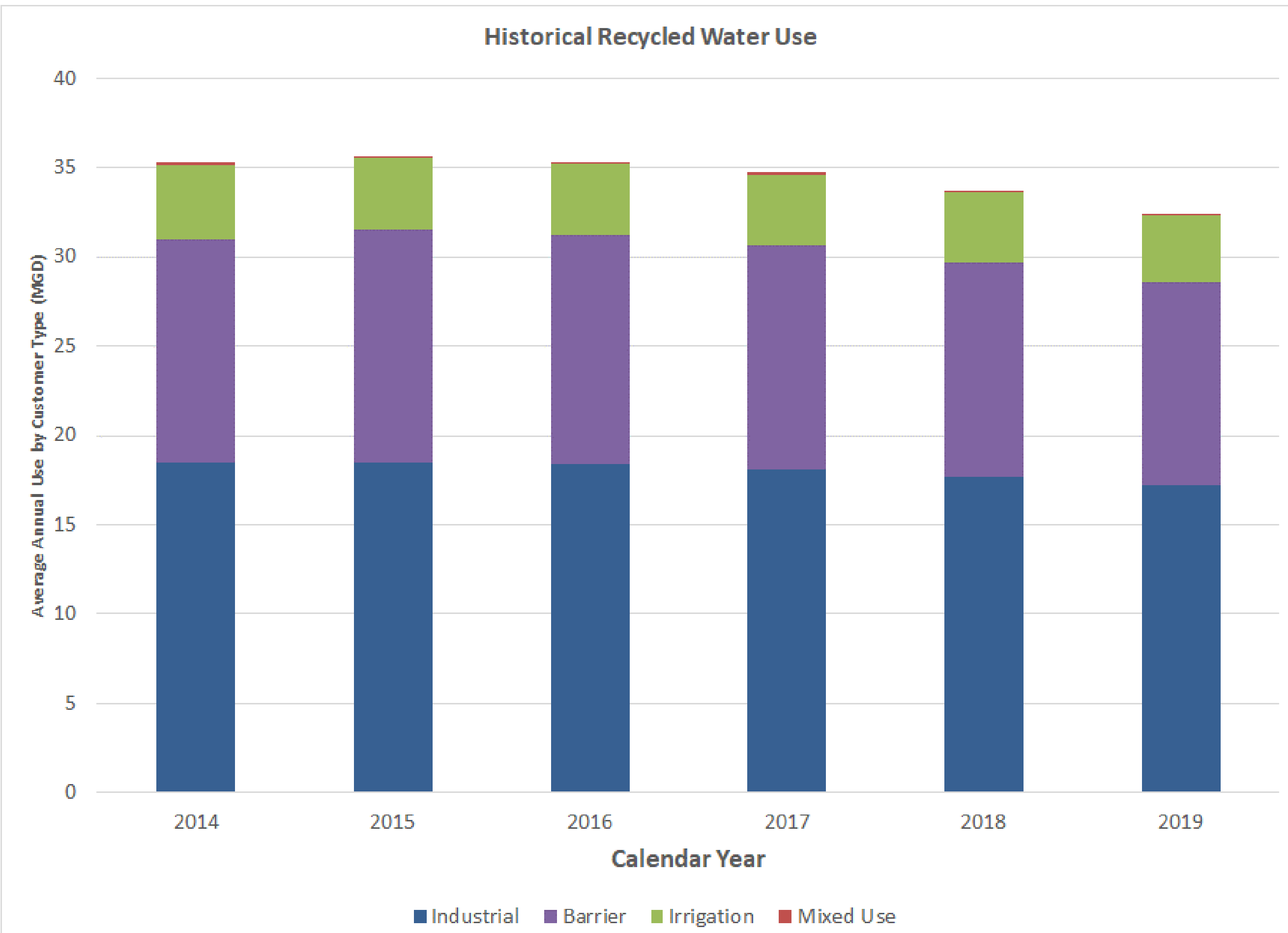
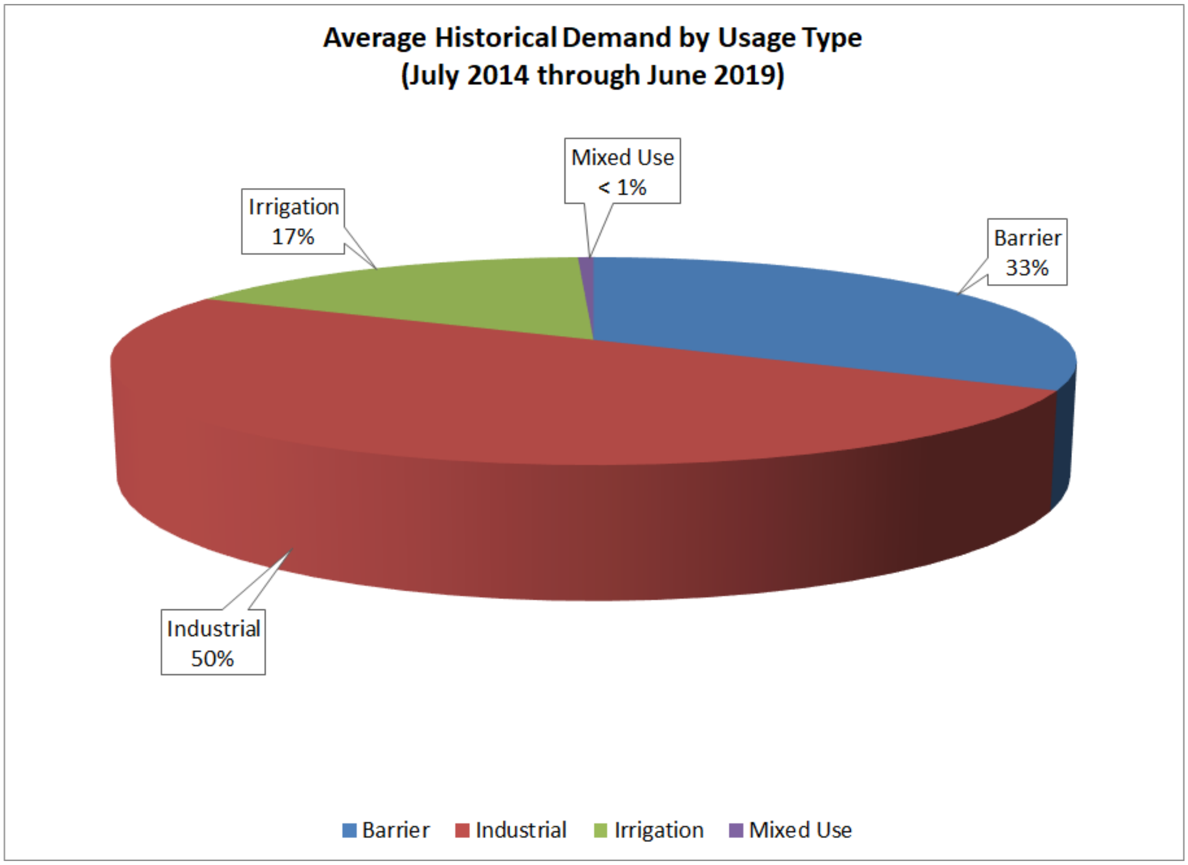


Figure 3-2. Average Historic Demand by Usage Type



West Basin has the potential to increase supply to 70 mgd of secondary effluent, from HWRP and maximize the use of recycled water within the region. The analysis of potential opportunities is described in further detail in this chapter.

3.2 Customer Identification Approach

Recycled water systems for non-potable reuse (NPR) are driven by large users and clusters of customers, who together would be considered a target area based on total demand within small geographical areas. Potable water billing data is typically used to identify customers and areas of high demand. While irrigation customers and some industrial customers can typically use disinfected tertiary recycled water quality, some industrial customers (particularly those with cooling towers) may require higher quality water, such as Nitrified water and reverse osmosis (RO) treated water.

In addition to serving customers through recycled water distribution systems, groundwater augmentation (also referred to as indirect potable reuse [IPR]) and treated water augmentation (also referred to as direct potable reuse [DPR]) are also options for recycled water use. While the State of California is still in process of developing regulations, potable reuse (both IPR and DPR) is considered as an acceptable practice within the planning horizon of this Master Plan.

To initiate the customer development analysis, West Basin's existing database and previous planning studies were reviewed. West Basin's database of potential recycled water customers was used as the baseline list of potential recycled water customers. West Basin staff also identified 23 potential cooling tower sites, which were added to the potential recycled water customer database. To expand the potential recycled water customer database, outreach to purveyors inside and outside West Basin's service area was conducted to obtain potable water billing data. Where billing data was not available, available recycled water master plans or studies were used to identify potential recycled water customers and potable reuse opportunities within the purveyor's service area. United States Geological Information System data depicting locations of green spaces, such as parks, schools, golf courses, and cemeteries, were also used to identify potential irrigation customers. The methodology that was used to determine feasibility of the potential recycled water customers and potable reuse opportunities include the following steps:

1. Develop a list of all potential recycled water customers and potable reuse opportunities.
2. Determine target customers and water quality needs of these customers.
3. Determine potable reuse opportunities.
4. Evaluate future supply and demand balance based on water quality needs of customers and IPR/DPR opportunities.

West Basin conducted stakeholder outreach to obtain information from purveyors within their service area and from other adjacent water agencies. West Basin currently serves recycled water to customers from the following potable water purveyors that overlay West Basin's service area: cities of El Segundo, Inglewood, Lomita, and Manhattan Beach; private utilities California Water Service Company, California American Water Company, and Golden State Water Company; and Los Angeles County Department of Public Works. Agencies outside of West Basin's potable water service area who currently receive recycled water are City of Torrance and LADWP. Other potable water purveyors surrounding West Basin who have indicated interest in receiving recycled water from West Basin include the City of Beverly Hills, Central Basin Municipal Water District (CBMWD), City of Compton, and Long Beach Water Department (LBWD).

For projects including groundwater recharge, West Basin would need to develop an agreement with the Water Replenishment District of Southern California (WRD) who is responsible for recharging groundwater as the Watermaster for the West Coast and Central Basins. However, projects could also be developed with individual purveyors with existing water rights in the groundwater basin. The City of Santa Monica also serves as a potential location for groundwater recharge. Fact sheets presenting additional details from LADWP, MWD, and WRD are included in Appendix D.

3.3 Potential Customers by Water Quality Needs (Step 1)

Using West Basin's potential recycled water customer database composed from previous studies as the foundation, a combination of sources were used to identify potential irrigation customers, commercial customers, industrial customers, parks, and schools. In addition, potable reuse opportunities were evaluated based on discussions with West Basin staff and available public information regarding already planned projects. The potential customers and opportunities were categorized into four main groups:

- Category 1 – Disinfected tertiary recycled water customers (e.g. irrigation, industrial use)
- Category 2 – Nitrified water customers (e.g. cooling towers, refineries)
- Category 3 – RO treated water customers (e.g. refineries, industrial use)
- Category 4 – Advanced purified recycled water opportunities (e.g. potable reuse with groundwater augmentation or treated water augmentation, and barrier injection)

The following sections describe the methodology used to identify potential future recycled water opportunities within West Basin's service area for disinfected tertiary recycled water customers, Nitrified water customers, RO treated water customers, and advanced purified recycled water opportunities.

3.3.1 Methodology and Assumptions

Using West Basin's 2019 potential recycled water customer database as the foundation, a combination of billing data, studies from the various purveyors, customer outreach to potentially large industrial users and refineries, and the Los Angeles County parks and school GIS shapefiles were used to identify additional potential commercial, industrial, park, and school customers.

When available, purveyor's potable water billing data was used to estimate potential recycled water demand for commercial and industrial customers. Assumptions were made to estimate the potential recycled water use by usage type based on typical planning values. These assumptions, which are summarized in Appendix E, assume a percentage of the existing potable water demand is assumed to be used for outdoor use and could be converted to recycled water. If a customer had a specific irrigation account, only the irrigation account was included as the potential recycled water use for disinfected tertiary recycled water.

Similar to large industrial customers, parks and schools can be large recycled water users for irrigation. Los Angeles County parks and land-type GIS files were used to identify schools and parks within the study area that are not currently served recycled water. GIS analyses were conducted to only include green spaces in these shapefiles to more accurately estimate the irrigable areas. Schools or parks not already included from the data provided by the purveyors were added to the list of potential recycled water customers. The potential demand was estimated by multiplying the GIS area with the irrigation requirement of 2.5 afy per acre, which is based on an assumption from the 2009 CIMP.

3.3.2 Category 1 Disinfected Tertiary Recycled Water Potential Customers

The potential disinfected tertiary recycled water customers and estimated demands are summarized by potential end use in Table 3-1 and depicted in Figure 3-3. Customers with a potential recycled water demand of less than 2 afy were eliminated from further consideration unless they are specifically known to have a separate irrigation meter.

In addition, LBWD, in collaboration with the Port of Long Beach (POLB), identified potential disinfected tertiary recycled water customers in their 2020 West Long Beach Advanced Treated Recycled Water Feasibility Study. These customers and their estimated demands are included as West Basin's potential disinfected tertiary recycled water customers.

Table 3-1. Potential Disinfected Tertiary Recycled Water Customers Demand (Step 1)

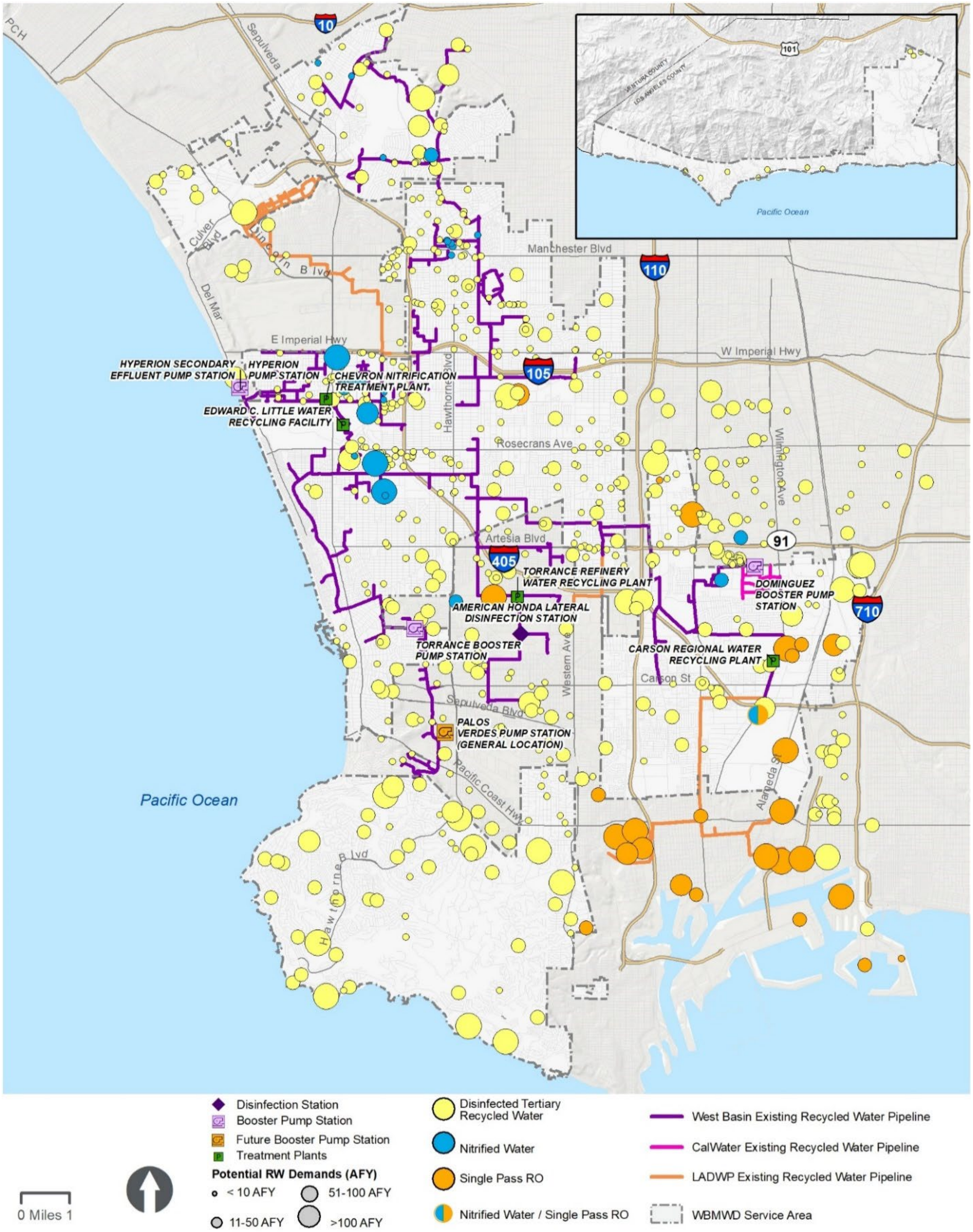
Potential End Use Type	Total Estimated Demand			Percent of Total Annual Demand
	Annual Demand[a] (afy)	Maximum Day Demand[b] (mgd)	Peak Hour Demand[c] (gallons per minute [gpm])	
Irrigation	8,108	14.5	30,163	78.8%
Car Wash	61	<0.1	49	0.6%
Industrial Process	1,731	2.0	1,395	16.8%
Long Beach[d]	387	0.6	1,075	3.8%
Total	**10,287**	**17.2**	**32,682**	**100%**

[a] Annual demand calculated based on billing data and the recycled water conversion assumptions provided in Appendix E.
[b] Maximum Day Demand assumes a peaking factor of 2.0 times the Average Day Demand (ADD) for irrigation and 1.3 times ADD for car wash, industrial process, and cooling tower.
[c] Peak Hour Demand assumes a peaking factor of 3.0 times the MDD for irrigation. All other end use assumed to not have hourly peaks and remain constant during hours of operation.
[d] Long Beach potential disinfected tertiary recycled water customers include 262 afy of irrigation end use and 125 afy of industrial process end use.

As shown in Table 3-1, the total estimated potential disinfected tertiary recycled water demand is approximately 10,287 afy. The end uses include recycled water use for irrigation, car wash, and some industrial processes. As shown in Table 3-1, the largest usage type (78.8 percent of the total potential demand) includes irrigation end use with a potential annual demand of approximately 8,108 afy. The next largest usage type (16.8 percent of the total potential demand) includes industrial process end use.

As shown in Figure 3-3, the potential disinfected tertiary recycled water customers are located throughout the service area with clusters of large users in the eastern and southern portions of the service area. While some users are near existing pipelines, clusters of large users would require an expansion segment to connect to recycled water.

Figure 3-3. All Potential Recycled Water Customers



3.3.3 Category 2 Nitrified Water Potential Customers

Additional treatment may be required in cooling towers at industrial sites and refineries. These Nitrified water customers typically have higher water usage than the disinfected tertiary recycled water customers. Potential cooling tower sites within West Basin's service area were identified by West Basin staff and visually verified on an aerial photograph, or identified by aerial photography. In addition to the list provided by West Basin staff, additional cooling tower sites were identified through aerial images within the study area. The potential demands of these sites were estimated based on discussions with the potential customer or knowledge of these processes.

In addition to the cooling tower sites, three known refineries exist within West Basin's service area. As part of this project, outreach was conducted to identify potential expansions of these refineries.

The Torrance Refinery is an existing West Basin customer and uses Nitrified water for the cooling towers and Single Pass RO, which goes through a second pass of RO on-site, for the HPBF. Based on discussions with Torrance Refinery staff, the ILPBF is currently served partially by purchased water from Metropolitan Water District of Southern California (MWD). This supply can be replaced by recycled water and would equate to approximately 1,000 gpm (or 1,613 afy) of additional recycled water demand.

The Marathon Carson Refinery is an existing West Basin customer. Based on the JMMCRWRP Expansion Feasibility Report – Phase 1, this refinery has the potential to use additional recycled water if the JMMCRWRP were expanded. The Marathon Carson Refinery could use an additional 7,226 afy of Nitrified water for the cooling water and an additional 4,502 afy of single pass RO water.

The Chevron Refinery is an existing West Basin customer. Expansions are not anticipated in the near-term and long-term development is unknown. Thus, no additional demand is anticipated from the Chevron Refinery.

A summary of the potential Nitrified water customers and estimated demands are presented in Table 3-2, while the locations are shown in Figure 3-3.

Table 3-2. Potential Nitrified Water Customers Demand (Step 1)

Potential End Use Type	Total Estimated Demand			Percent of Total Annual Demand
	Annual Demand[a] (afy)	Maximum Day Demand[b] (mgd)	Peak Hour Demand[c] (gpm)	
Cooling Tower	180	0.2	145	2.3%
Industrial Process	375	0.4	302	4.8%
Refineries	7,226	6.5	4,480	92.9%
Total	**7,781**	**7.1**	**4,927**	**100%**

[a] Annual demand calculated based on billing data and the recycled water conversion provided in Appendix E.
[b] Maximum Day Demand assumes a peaking factor of 2.0 times the Average Day Demand (ADD) for irrigation and 1.3 times ADD for car wash, industrial process, and cooling tower. Refineries assumed to have constant seasonal flow.
[c] Peak Hour Demand assumes a peaking factor of 3.0 times the MDD for irrigation. All other end use assumed to not have hourly peaks and remain constant during hours of operation.

As shown in Table 3-2, the total additional potential Nitrified water demand is approximately 7,781 afy. This includes Nitrified water use for cooling towers, industrial processes, and refineries. As shown in Table 3-2, the largest end use type (92.9 percent of the total potential demand) includes refineries with a potential demand of approximately 7,226 afy. As shown in Figure 3-3, the majority of the Nitrified water potential customers are in the northern portion of the system. Since the water for these customers requires additional treatment, it is assumed that these customers would be phased in later and connected once treatment upgrades have been made.

3.3.4 Category 3 RO Treated Water Potential Customers

Higher water quality (RO treated water) can be used in some industrial sites and refineries for BF. In addition, the Los Angeles Harbor area includes portions of LADWP's service area and the LBWD's service area. LADWP's Recycled Water Annual Report 2018-2019 identified several customers that would be served by West Basin's facilities. These customers are included in West Basin's potential single pass RO treated water customers, as the distribution system provides the higher water quality RO treated water to meet the potential customer needs. In addition to the disinfected tertiary recycled water customers, the 2020 West Long Beach Advanced Treated Recycled Water Feasibility Study identified potential advanced treated customers. These customers and their estimated demands are included as West Basin's potential single pass RO treated water customers. A summary of the potential RO treated water customers and estimated demands are presented in Table 3-3, while the locations of the customers are presented in Figure 3-3.

Table 3-3. Potential Single Pass RO Treated Water Customers Demand (Step 1)

Usage Type	Total Estimated Demand			Percent of Total Annual Demand
	Annual Demand[a] (afy)	Maximum Day Demand[b] (mgd)	Peak Hour Demand[c] (gpm)	
Industrial Process	1,299	1.5	1,047	7.0%
Refineries	6,115	5.5	3,792	32.9%
LA Harbor	8,499	10.0	7,957	45.7%
Long Beach	2,675	3.1	2,156	14.4%
Total	**18,588**	**20.1**	**14,952**	**100.0%**

[a] Annual demand calculated based on billing data and the recycled water conversion assumptions provided in Appendix E.
[b] Maximum Day Demand assumes a peaking factor of 2.0 times the Average Day Demand (ADD) for irrigation and 1.3 times ADD for car wash, industrial process, and cooling tower. Refineries assumed to have constant seasonal flow.
[c] Peak Hour Demand assumes a peaking factor of 3.0 times the MDD for irrigation. All other end use assumed to not have hourly peaks and remain constant during hours of operation.

As shown in Table 3-3, the total estimated potential RO treated water demand is approximately 18,588 afy. This category includes single pass RO treated water use for industrial processes, refineries, and customers in the Long Beach and Los Angeles Harbor regions. As shown in Figure 3-3, the majority of the RO customers are in the southern portion of the system. The LA Harbor region contributes to nearly half of the potential RO treated water demand. Since the RO treated water customers require additional treatment, it is assumed that these customers would be phased later and connected once treatment upgrades have been made.

3.3.5 Category 4 Advanced Purified Recycled Water Opportunities

Aside from serving customers through non-potable recycled water distribution systems, potable reuse is another option to fully utilize the 70 mgd available from HWRP. Assuming that LASAN builds the planned MBR treatment system at HWRP, West Basin could receive this MBR-treated wastewater and produce advanced treated water with additional treatment facilities at the ECLWRF, such that meets water quality requirements for groundwater recharge or potable reuse with raw or finished water augmentation.

While West Basin has been involved in the West Coast Basin Barrier Project for decades, there are other IPR opportunities, via groundwater recharge, that have been considered within the region. For the purposes of this demand analysis, the following groundwater injection (or IPR) concepts have been considered:

- Recharge to the West Coast Basin (up to 20,000 afy)
- Expanding recharge to the West Coast Barrier (up to 23,000 afy [CH2M, 2016])
- Expanding recharge to the Dominguez Gap Barrier (up to 7,500 afy [CH2M, 2016])
- Recharging to the Santa Monica Basin (potential range of 1,000 afy to 14,000 afy [Slade, 2018])

Since groundwater recharge is a potentially large demand for West Basin, the feasibility of these concepts merits further investigation. Additional details for these potable reuse concepts are provided in Appendix F.

A more direct potable reuse approach using treated water augmentation is another option for West Basin to consider. As a wholesale water provider, West Basin has customers who could potentially use direct potable reuse product water. While the State of California is still in the process of developing regulations for DPR, these projects are an option for development in the region. In order to serve DPR product water to customers, West Basin will likely need to expand or modify a treatment system serving groundwater augmentation and also construct a transmission network. Blending with other potable water sources may be needed before serving directly to customers. Additional information related to a potential DPR concept is also provided in Appendix F.

3.3.6 Summary of Preliminary Potential Demands

The entire list of potential recycled water customers and a corresponding location map are provided in Appendix G, but due to the confidential nature of the list and map, this information will not be made available as part of the public document. A summary of the total potential demand by water quality need is listed in Table 3-4. These customers will be further evaluated in Chapter 4 to identify target customers.

Table 3-4. Summary of All Potential Demands (Step 1)

Water Quality Need	Total Estimated Demand			Percent of Total Annual Demand
	Annual Demand[a] (afy)	Maximum Day Demand[a] (mgd)	Peak Hour Demand[a] (gpm)	
Disinfected Tertiary Recycled Water	10,287	17.2	32,682	14.4%
Nitrified Water	7,781	7.1	4,927	10.9%
RO Treated Water	18,588	20.1	14,952	26.0%
Advanced Purified Recycled Water Opportunities	34,784	31.1	21,567	48.7%
Total	**71,440**	**75.5**	**74,128**	**100.0%**

[a] See Tables 3-2 through 3-4 for breakdown of demands. Advanced purified recycled water opportunities include groundwater augmentation from Section 3.2.5 and is assumed to not peak seasonally or hourly.

As shown in Table 3-4, the estimated total additional recycled water demand is approximately 71,440 afy. The majority (48.7 percent) of the potential demands are advanced purified recycled water opportunities, which includes groundwater augmentation opportunities. The second largest potential demands (26.0 percent) are RO treated water customers, which include industrial processes, refineries, the Los Angeles Harbor region, and the Long Beach region.

3.4 Determine Target Customers (Steps 2 and 3)

Based on the analysis of all of the potential recycled water customers (Step 1), target customers were identified based on the location to existing pipelines and other potential recycled water customers. Three groups of target customers were identified:

- Tier 1: Disinfected Tertiary Recycled Water customers and Nitrified customers within a quarter mile distance from an existing pipeline.
- Tier 2: Disinfected Tertiary Recycled Water customers and Nitrified customers between a quarter mile and a half mile distance from an existing pipeline.
- Potential Expansion Projects: Clusters of potential customers that may be connected with an expansion pipeline.
- Groundwater Replenishment Projects: Regional projects that may use recycled water provided by West Basin.

A description of each of these target customer groups is described below.

3.4.1 Tier 1 and Tier 2 Target Customers (Step 2)

Customers in close proximity to existing pipelines are likely able to connect at an earlier phase and likely more cost effective as a shorter pipeline is required. Tier 1 includes the customers within a quarter of a mile from an existing pipeline, while Tier 2 includes customers between a quarter of a mile and half of a mile from an existing pipeline. Since disinfected tertiary recycled water customers and nitrified customers can likely be phased earlier, these are included in Tier 1 and Tier 2. Disinfected tertiary recycled water customers do not require additional treatment upgrades at the treatment plants and can be phased earlier. Nitrified customers may require treatment upgrades before connecting and can be phased later. A summary of the Tier 1 and Tier 2 demands by category is listed in Table 3-5. The locations of these customers are shown in Figure 3-4.

Table 3-5. Tier 1 and Tier 2 Target Customers Demand (Step 2)

Tier[a]	Total Estimated Demand by Water Quality Needs (afy)		Total Potential Demand (afy)
	Disinfected Tertiary Recycled Water	Nitrified Water	
Tier 1[b]	1,295	381	1,676
Tier 2[c]	835	123	958
Total	**2,130**	**504**	**2,634**

[a] See Appendix G for detailed list of customers.
[b] Includes customers within ¼ mile from an existing pipeline.
[c] Includes customer between ¼ mile and ½ mile from an existing pipeline.

As shown in Table 3-5, the total estimated potential demand within a quarter mile of an existing pipeline (Tier 1) is approximately 1,676 afy. Expanding the range to a half of a mile from an existing pipeline (Tier 2) increases the potential demand by approximately 958 for a total of 2,634 afy (or 2.4 mgd).

3.4.2 Potential Expansion Projects (Step 2)

In addition to customers in close proximity to existing pipelines, potential expansion projects were identified based on clusters of potential recycled water demands. Three of the projects listed below are existing West Basin projects or recently constructed, but not yet included in the billing data at the time of this master plan development. Based on these clusters, the following potential expansion projects were identified:

- Central Basin
- Harbor City
- Kenneth Hahn – Proposed West Basin Project
- Northeast Carson
- Northeast Carson (RO)
- Palos Verdes Lateral – Proposed West Basin Project
- Palos Verdes North
- Redondo Beach
- Palos Verdes South
- Stadium – Recently connected, but not included in billing data at this time
- Torrance

A summary of the potential recycled water demand of these expansion projects is listed in Table 3-6. The locations of these customers are shown in Figure 3-4. These projects are evaluated in further detail to determine hydraulic capacity needs and financial feasibility.

Figure 3-4. Tier 1 and Tier 2 Customers

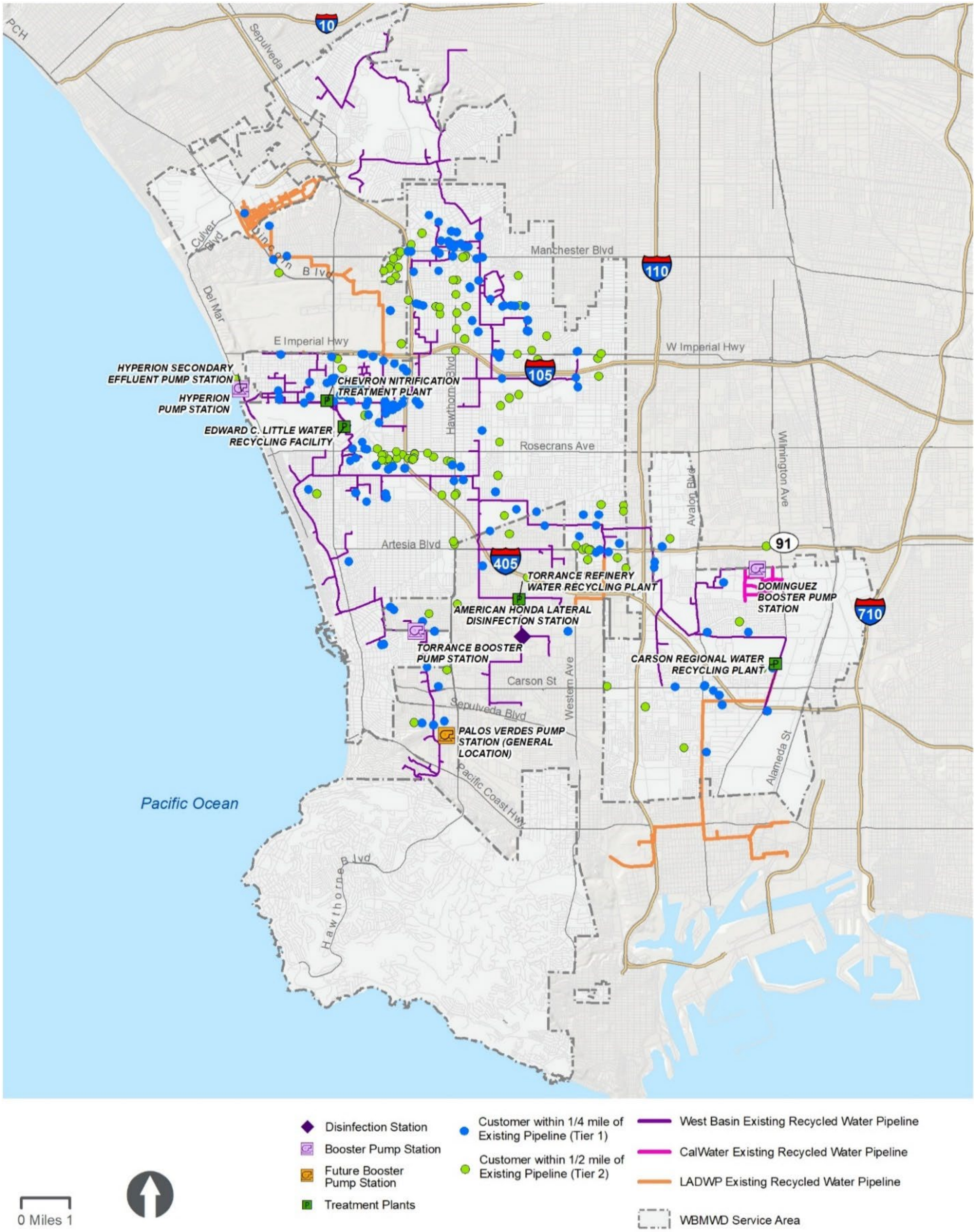


Table 3-6. Potential Recycled Water Expansion Project Demands (Step 2)

Project Name[a]	Number of Potential Customers	Total Estimated Demand by Category (afy)			Total Potential Demand (afy)
		Disinfected Tertiary Recycled Water	Nitrified Water	RO Treated Water	
Central Basin	20	172	0	0	**172**
Harbor City	3	313	0	0	**313**
Kenneth Hahn	36	679	28	0	**707**
Northeast Carson	8	948	0	0	**948**
Northeast Carson AWT	5	0	0	1,036	**1,036**
Palos Verdes Lateral	6	553	0	0	**553**
Palos Verdes North	11	519	0	0	**519**
Redondo Beach	19	150	0	0	**150**
Palos Verdes South	17	1,722	0	0	**1,722**
Stadium	27	82	0	0	**82**
Torrance	50	874	0	0	**874**
Total	**202**	**6,012**	**28**	**1,036**	**7,075**

[a] See Figure 3-5 for locations of projects.

[b] Category 1 includes Disinfected Tertiary Recycled water customers. Category 2 includes Nitrified water customers. Category 3 includes RO treated water customers.

As shown in Table 3-6, the total potential demand from the expansion projects is 7,075 afy. With the exception of the Kenneth Hahn and Northeast Carson RO projects, all of the planned recycled water expansion projects are anticipated to require disinfected tertiary recycled water quality. The Kenneth Hahn lateral is anticipated to have some cooling towers and require Nitrified water. The Northeast Carson RO is anticipated to require RO water quality for industrial processes. Thus, this expansion project would involve a treatment improvement at the JMMCRWRP and would likely be implemented later than the other projects. A description of each project is presented below.

Central Basin Project

The Central Basin Project is located in the cities of Carson and Compton, within the City of Compton and Golden State Water Company service areas. The project includes a total of 20 potential disinfected tertiary recycled water customers with a total estimated potential demand of 172 afy. All of the potential demands are irrigation end uses for cemetery, parks, and separate irrigation meters.

Harbor City Project

The Harbor City Project is located in the City of Los Angeles and West Carson (unincorporated) within the California Water service area. The project includes a total of three potential disinfected tertiary recycled water customers with a total estimated potential demand of 313 afy. The majority (78 percent) of the potential demand is from industrial customers with a total estimated potential demand of 244 afy. The remaining 69 afy of potential demand is from irrigation customers.

Kenneth Hahn Project

The Kenneth Hahn Project is located in the City of Inglewood and Ladera Heights (unincorporated) within the City of Inglewood, California American Water (Baldwin Hills area), LADWP, and Golden State Water Company service areas. The project includes a total of 707 afy of potential recycled water demand consisting of 32 potential disinfected tertiary recycled water customers with a total estimated potential demand of 679 afy and four potential Nitrified water customers with a total estimated potential demand of 28 afy. The majority (86 percent) of the potential demand are irrigation end use with a total potential demand of 611 afy. The remaining demand is for industrial process (86 afy) and cooling tower (10 afy) end use.

Palos Verdes North Project

The Palos Verdes North Project is located in the Cities of Torrance, Rancho Palos Verdes, and Westfield (unincorporated) within the California Water and City of Torrance service areas. The project includes a total of 11 potential disinfected tertiary recycled water customers with a total estimated potential demand of 519 afy for irrigation end use and an industrial site. This project would be served from either the Palos Verdes Lateral Project or the Torrance Project.

Northeast Carson Project

The Northeast Carson Project is located in the Rancho Dominguez (unincorporated) within the California Water service areas. The project includes a total of 8 potential disinfected tertiary recycled water customers with a total estimated potential demand of 948 afy. The majority (98 percent) of the potential demand are industrial process end use with a total potential demand of 934 afy. The remaining 14 afy of potential demand is for irrigation end use.

Northeast Carson RO Project

The Northeast Carson RO Project is located in the City of Carson within the California Water service area. The project includes a total of 5 potential RO customers with a total estimated potential demand of 1,036 afy for industrial process end use.

Palos Verdes Lateral Project

The Palos Verdes Lateral Project is an existing West Basin project located in the Cities of Palos Verdes Estates and Torrance within the California Water and City of Torrance service areas. The project includes a total of 6 potential disinfected tertiary recycled water customers with a total estimated potential demand of 553 afy for irrigation end use at schools, a golf course, and parks. This project will require both a pipeline and a new booster pump station.

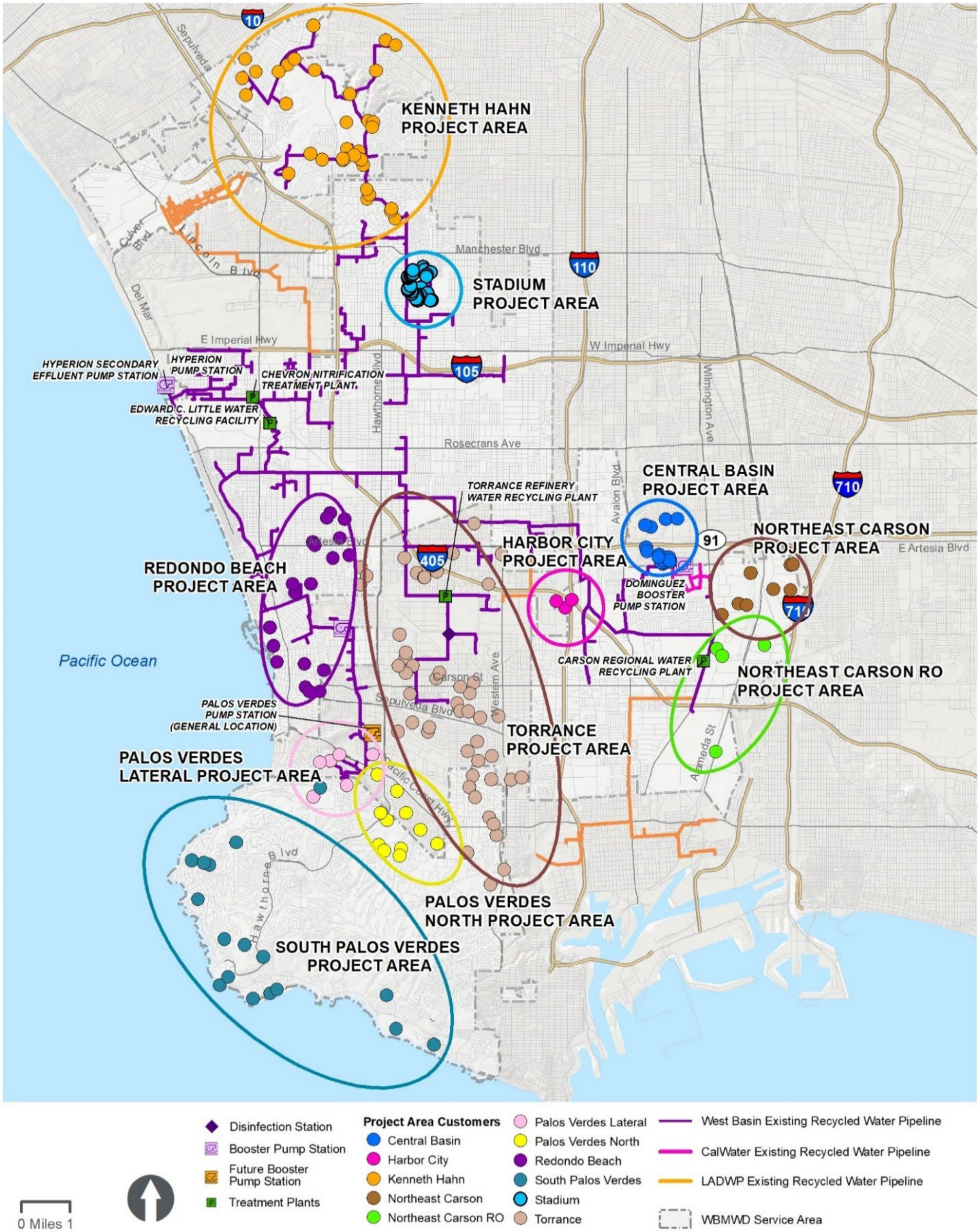
Redondo Beach Project

The Redondo Beach Project is located in the Cities of Redondo Beach and Torrance within the California Water service area. The project includes a total of 19 potential disinfected tertiary recycled water customers with a total estimated potential demand of 150 afy for irrigation end use at schools, parks, and medians.

Palos Verdes South Project

The Palos Verdes South Project is located in the Cities of Palos Verdes Estates and Rancho Palos Verdes within the California Water service area. The project includes a total of 17 potential disinfected tertiary recycled water customers with a total estimated potential demand of 1,722 afy for irrigation end use at schools and parks. This project would be served from the Palos Verdes Lateral Project.

Figure 3-5. Potential Expansion Project Customers



Stadium Project

The Stadium Project is an ongoing West Basin project located at the new SoFi Stadium within the City of Inglewood service area. At the time of this master plan, the stadium has been connected to the recycled water system but has not yet pulled water from the system and is not included in the billing data, so therefore is considered a future demand. The project includes a total of 27 connections with a total estimated potential demand of 82 afy for irrigation end use.

Torrance Project

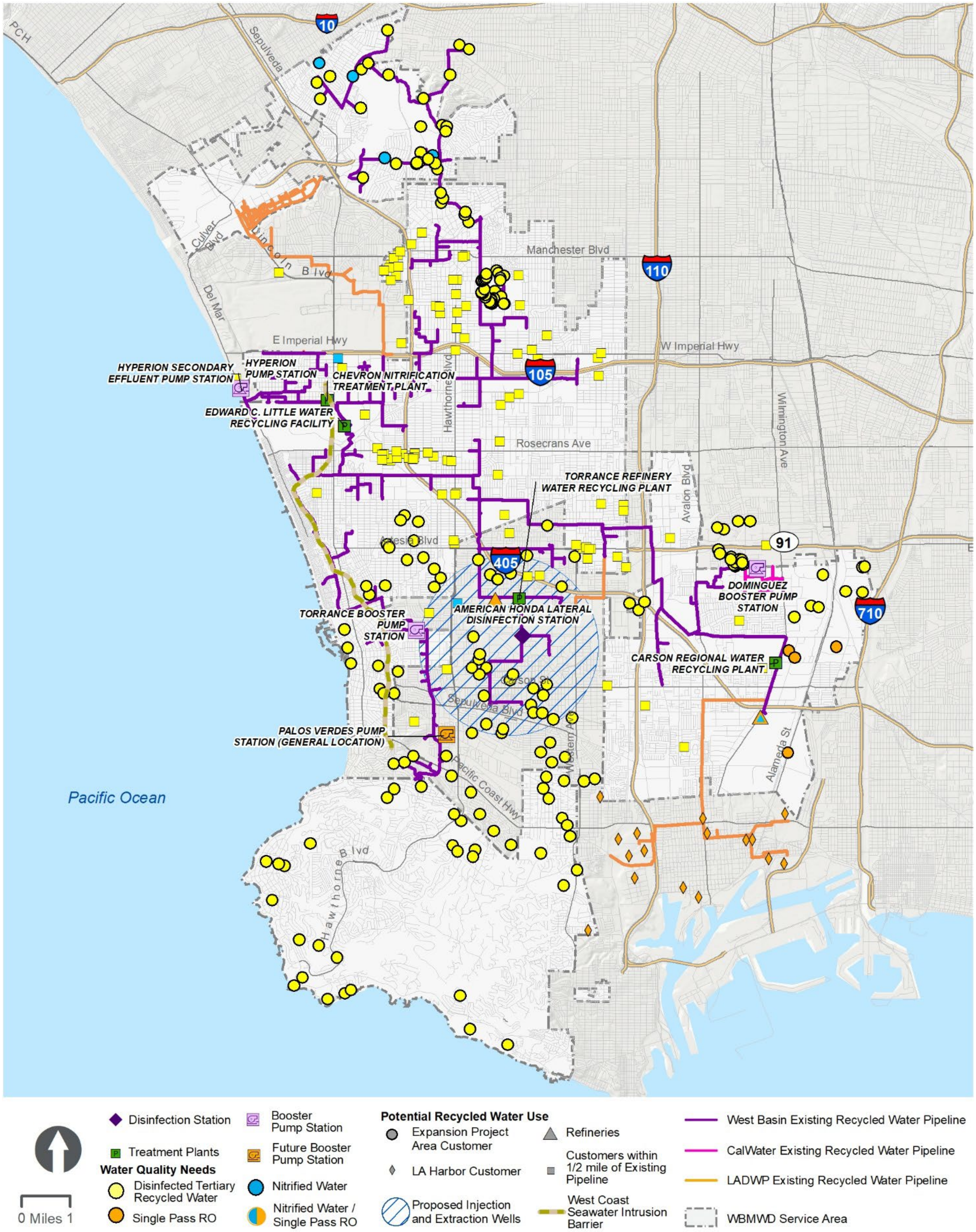
The Torrance Project is located in the Cities of Lomita, Torrance, Rancho Palos Verdes, Los Angeles, and Redondo Beach within the California Water, City of Torrance, LADWP, and City of Lomita service areas. The project includes a total of 50 potential disinfected tertiary recycled water customers with a total estimated potential demand of 874 afy for irrigation end use at schools, parks, golf courses, nurseries, and cemeteries.

3.4.3 Potable Reuse Projects (Step 3)

Based on discussions with other regional water agencies, it appears that the groundwater replenishment project most likely to be supported by the West Basin system is recharge to the West Coast Basin. There is an existing saline plume within the West Coast Basin, and WRD has been pumping the saline groundwater and performing brackish water desalination. WRD, in partnership with LADWP and others such as the City of Torrance, intends to develop a new program to remediate the saline plume and use the water in various potable water systems. Additional injection in the West Coast Barrier and injection via new injection wells would replenish the brackish groundwater and contain the plume. Extraction would occur from other wells and would be treated using desalination, as well as appropriate pretreatment processes as needed. The purpose of this project will be to remove the existing saline groundwater from the West Coast Basin over a 20- to 30-year period. The most likely capacities of this project would be 10,000 or 20,000 afy of injection. Potential sources of water supply for this project could be advanced treated water from West Basin, or from the planned advanced treatment at the JWPCP by LACSD and MWD. The project could be supplied by either one of the two sources, or the supply might be split, depending on price, timing, and availability of the water supply. If West Basin serves this project, it is likely that an advanced treatment facility (RO plus ultraviolet/advanced oxidation process [UV-AOP]) would be installed near the existing TRWRP, with annual recharge ranging from 5,000 to 20,000 afy.

Expanding recharge to the West Coast Barrier is another potential groundwater replenishment demand for West Basin. Increasing this demand is dependent on supply availability, but also based on the condition of the existing barrier injection wells. Currently, West Basin has a contract with WRD to recharge 17,000 afy into the existing West Coast Barrier, but most years, this number is not met. If the wells are rehabilitated as expected, recharge into the West Coast Barrier would meet the 17,000 afy amount, and more water could be recharged if the facilities allow for additional recharge. For purposes of this Master Plan, it is assumed that an additional 5,000 afy beyond the 17,000 afy could be recharged into the West Coast Barrier.

Figure 3-6. Recommended Potential Recycled Water Customers



There is also a possibility of West Basin serving water for recharge to the Santa Monica Subbasin. If this opportunity were to arise, it is recommended that West Basin evaluate the feasibility of doing so. No demands are included for these areas for the purposes of this Master Plan.

It is unlikely that West Basin will be serving water for recharge to the Dominguez Gap Barrier. This barrier is being fed by LASAN's Terminal Island Water Reclamation Plant (TIWRP); West Basin might serve some LADWP industrial customers in the Harbor Area in lieu of this concept as discussed previously in this Chapter.

In the future, there is also the possibility of treated water augmentation (formerly known as direct potable reuse). It is recommended that West Basin monitor the status of regulations associated with treated water augmentation and, if water is available, West Basin evaluate the feasibility of such a project at that time.

3.5 Future Supply and Demand Balance

After reviewing all of the customers in Step 1, the potential customers were further refined using the methodology in Steps 2 and 3. The refined list of potential customers (future demands, not including existing volumes of water already served) are divided into the following groups:

- Tier 1 Customers: Disinfected Tertiary Recycled water and Nitrified water customers that are within a quarter mile of an existing pipeline and require a short pipeline to connect.
- Tier 2 Customers: Disinfected Tertiary Recycled water and Nitrified water customers that are between a quarter mile and half a mile of an existing pipeline and require a short pipeline to connect.
- Potential Expansion Projects: Disinfected Tertiary Recycled water and RO Treated water customers that are clustered and will require an expansion segment to connect.
- Refineries: Expansions at existing refineries that can use additional Nitrified water and/or RO Treated water.
- Los Angeles Harbor Region: The Los Angeles Harbor region would include one system to meet both the irrigation and industrial demands in the area. Since the industrial demands are the majority, RO is anticipated in this area to serve the large users.
- Potable Reuse (Advanced Purified Recycled Water) Opportunities**:** This includes West Coast Basin Barrier and Groundwater Augmentation in the West Coast Basin.

A summary of the estimated potential demands for these groups is listed in Table 3-7.

Chapter 8 describes the future system analysis, which organizes demands into three alternative approaches to reach the future 70 mgd demand target.

Table 3-7. Summary of Potential Demands

Group	Annual Demand by Water Quality Needs (afy)			Total Annual Demand (afy)	Maximum Day Demand by Water Quality Needs (mgd)			Total MDD[d] (mgd)
	Disinfected Tertiary Recycled Water	Nitrified Water	Single Pass RO		Disinfected Tertiary Recycled Water	Nitrified Water	Single Pass RO	
Tier 1[a]	1,295	381	0	1,676	2.2	0.4	0.0	2.7
Tier 2[b]	835	123	0	958	1.5	0.1	0.0	1.6
Potential Expansion Projects[c]	6,012	28	1,036	7,075	9.9	0.0	1.2	11.1
Refineries								
Marathon	0	7,226	4,502	11,728	0.0	6.5	4.0	10.5
Torrance Refinery	0	0	1,613	1,613	0.0	0.0	1.4	1.4
Chevron	0	0	0	0	0.0	0.0	0.0	0.0
Long Beach Region	387	0	2,675	3,062	0.6	0.0	3.1	3.7
Los Angeles Harbor Region	0	0	8,499	8,499	0.0	0.0	10.0	10.0
Advanced Purified Recycled Water Opportunities								
West Coast Basin Seawater Intrusion Barrier	9,784	0	0	9,784	8.7	0.0	0.0	8.7
West Coast Basin GW Replenishment	20,000	0	0	20,000	17.9	0.0	0.0	17.9
Santa Monica Basin GW Replenishment	5,000	0	0	5,000	4.5	0.0	0.0	4.5
Total	**43,313**	**7,758**	**18,325**	**69,395**	**45.3**	**7.0**	**19.7**	**72.1**

[a] Tier 1 includes all customers within a quarter of a mile from an existing pipeline.
[b] Tier 2 includes all customers between a quarter of a mile and half a mile from an existing pipeline.
[c] Potential disinfected tertiary recycled water projects include Central Basin, Harbor City, Kenneth Hahn, Northeast Carson, Palos Verdes Lateral, Palos Verdes North, Redondo Beach, Palos Verdes South, Stadium, and Torrance projects. Nitrified projects include Kenneth Hahn project. RO treated water projects include Northeast Carson RO project.
[d] Maximum Day Demand (MDD) assumes a peaking factor of 2.0 times the Average Day Demand (ADD) for irrigation and 1.3 times ADD for car wash, industrial process, and cooling tower. Refineries, lake supply, and advanced purified recycled water opportunities assumed to have constant seasonal flow.

As shown in Table 3-7, the total potential recycled demand is estimated to be approximately 69,395 afy, while the existing demand in 2019 was 38,700 afy. Hence, the total potential annual recycled water demand if all customers in Table 3-7 would be connected is 108,095 afy or 96.5 mgd. However, the combined MDD is estimated to be 117.1 mgd if the potential recycled water customers are connected. Table 3-8 summarizes the future supply and demand balance if all of the customers from Table 3-7 were connected.

Table 3-8. Future Supply and Demand Balance

Category	Annual Demand (afy)	MDD (mgd)
Existing Demands	38,700	45.0
Potential Future Demands [a]	69,395	72.1
Total Potential Demands	**108,095**	**117.1**
Available HSEPS Capacity [b]	122,100	109.0

[a] Potential future demands from Table 3-7.
[b] Based on firm capacity of the HSEPS. However, HSEPS is currently limited to 72 MGD based on available electrical transformer capacity

As shown in Table 3-8, the estimated available supply in the future is approximately 109 mgd and does not meet all of the potential demands. The potential future demands will be evaluated in further detail to determine the most cost-effective and feasible options within the limited supply.

Chapter 4 Recycled Water Supplies

4.1 Introduction

This chapter characterizes the historical flows, water quality, and treatment performance for each West Basin treatment facility to establish future projections as the basis of planning and to identify potential treatment facility improvements to meet future demands.

Approximately 10 calendar years (2010 to 2019) of historical flow and water quality data were provided by West Basin. All available data were initially plotted and visually inspected to identify overall trends and outliers. Review of record drawings and technical reports as well as West Basin and Suez staff interviews were performed to understand major deviations and trends in data. Based on this data review, periods of analysis are truncated to limit characterization and projections of flows and water quality to periods that reflect normal and long-term operation.

As part of West Basin's Recycled Water Master Plan project, this chapter also summarizes West Basin's current rehabilitation and replacement (R&R) program developed in 2019, and documents updates based on current priorities and site visits. As the master planning for future treatment scenarios develops, these projects will subsequently be reevaluated to determine if they are still necessary for both short-term and long-term treatment performance.

4.2 Historical Flows

For all facilities, West Basin provided daily average feed and product flow data from January 2010 to December 2019. Historical feed and product flow data at West Basin treatment facilities were statistically analyzed to determine flow projections and key peaking factors needed for treatment process design decisions and alternatives evaluation. As part of the flow projection analysis, linear trendlines are developed for each flow. The coefficient of determination (R-squared or R^2) values are statistical measures that indicate the degree of regression fit (where an R^2 value of 1 indicates a perfect fit and an R^2 value of 0 indicates no fit). When applying linear trendlines to the flow data, the R^2 values are low due to the innate variability in the data values. However, the trendline is sufficient to establish an overall qualitative understanding of upwards, downwards, or stagnant trends from 2010 to 2019. The historical flows and key peaking factors discussed in this section impact the flow projections discussed in 4.5 and sizing of future treatment alternatives in Section 2.1. In addition, flow data were provided in 15-minute increments from January 2018 to December 2019 and used to illustrate diurnal patterns.

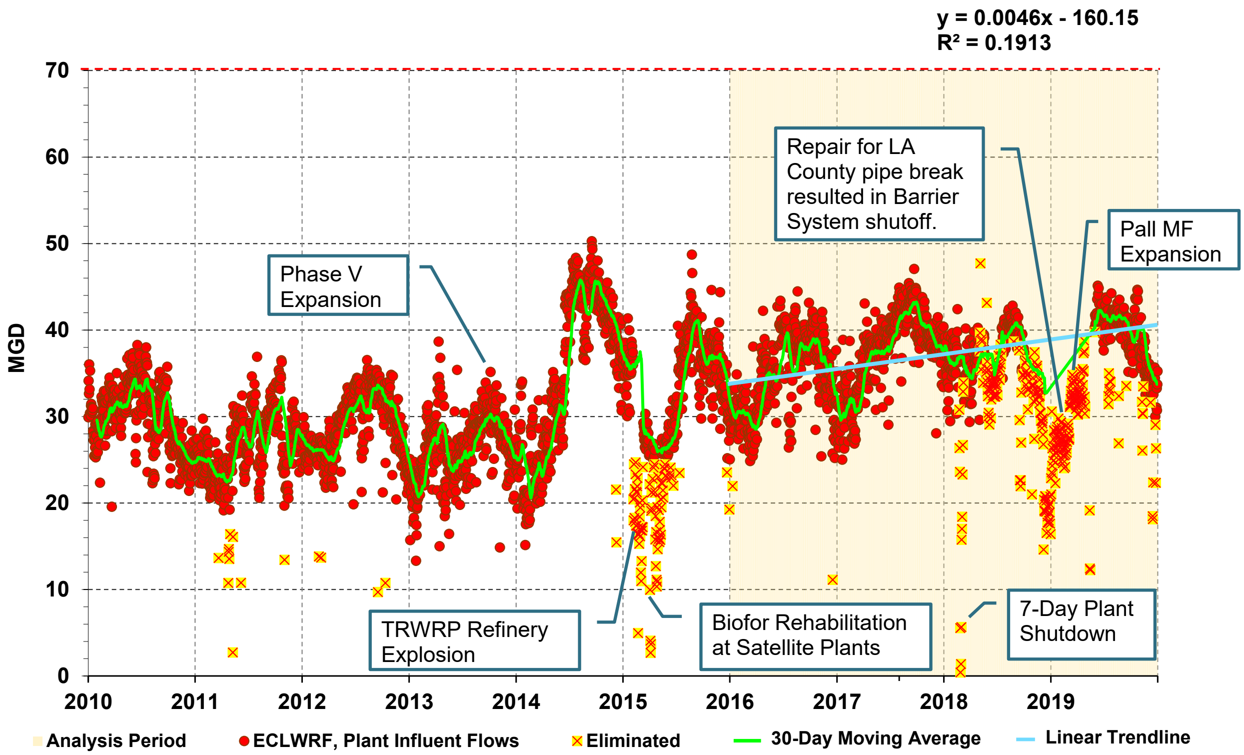
4.2.1 ECLWRF

ECLWRF is comprised of several treatment process trains to treat HWRP secondary effluent and produce four types of designer water: Barrier Water Treatment Train, Title 22 Treatment Train, Chevron LPBF Treatment Train, and Chevron HPBF Treatment Train. These systems produce specific qualities of recycled water for various municipal, commercial, and industrial applications.

ECLWRF Influent

ECLWRF receives secondary effluent from HWRP. Influent flows are primarily dependent upon fluctuating demands of the refineries and Title 22 customers. Figure 4-1 illustrates the historical flows into ECLWRF from 2010 to 2019.

Figure 4-1. ECLWRF Influent Flow (2010 to 2019)



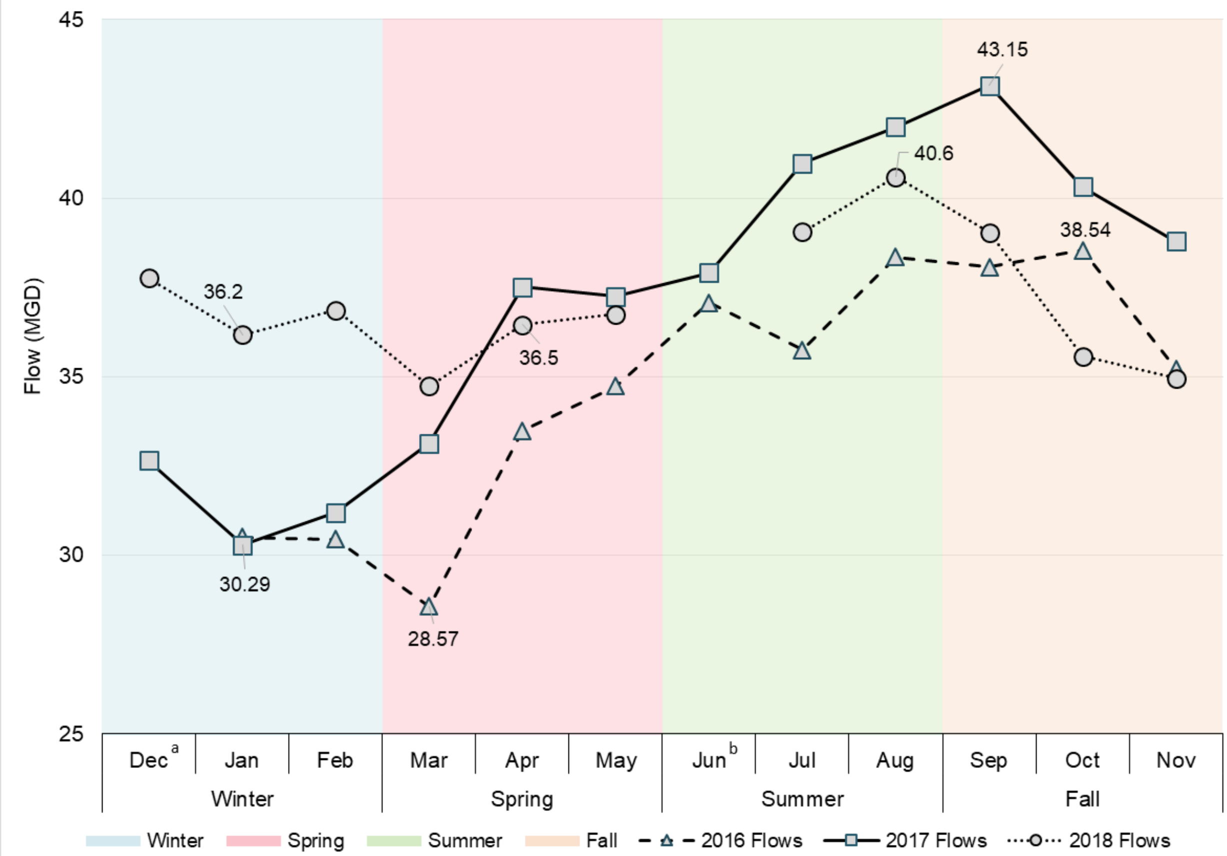
Source: Daily average flow data (2010-2019).

Four calendar years, 2016 to 2019, were selected as typical representative years to serve as the basis of planning for West Basin future projections. These years were selected as the period of analysis for ECLWRF influent because they follow the completion of two significant capital improvement and rehabilitation projects that affect ECLWRF production: 2014 ECLWRF Phase V Expansion and 2015 Biofor rehabilitation work at the Satellite Plants. More recently, the Pall MF Expansion was commissioned in April 2019 with two new MF racks, which helped recover capacity lost due to the older aging MF systems. Phase II MF system was decommissioned in 2018 and Phase III MF system is on standby mode to serve as backup for Chevron boiler feed during emergency situations.

As shown in Figure 4-1, the range of daily average flows during 2016 to 2019 increased to approximately 25 to 45 mgd from 20 to 35 mgd during 2010 to 2015. Upon further inspection of the flows on an annual basis, there appears to be a distinct sinusoidal pattern with peaks occurring toward the latter half of each year. Figure 4-2 displays monthly averages to examine this pattern for potential seasonal variations in demand from three full calendar years, 2016 to 2018. The minimum and maximum monthly average flows are labelled on the figure for each calendar year.

ECLWRF influent appears to peak around late summer to early fall and to dip around winter to early spring, suggesting a correlation between flows and seasons. This pattern is likely driven by demands in Title 22 rather than Barrier water and the boiler feed demands at the refineries. Title 22 customers primarily consist of users that rely on increased water during hotter periods of the year (i.e., irrigation).

Figure 4-2. ECLWRF Influent Monthly Averages and Seasonal Variation



Source: Daily average flow data (2010-2019).

[a] The month of December is represented by the previous calendar year to illustrate in chronological order (i.e., "2016 Flows" uses Year 2015 for December and Year 2016 for January to November to represent monthly average flows).

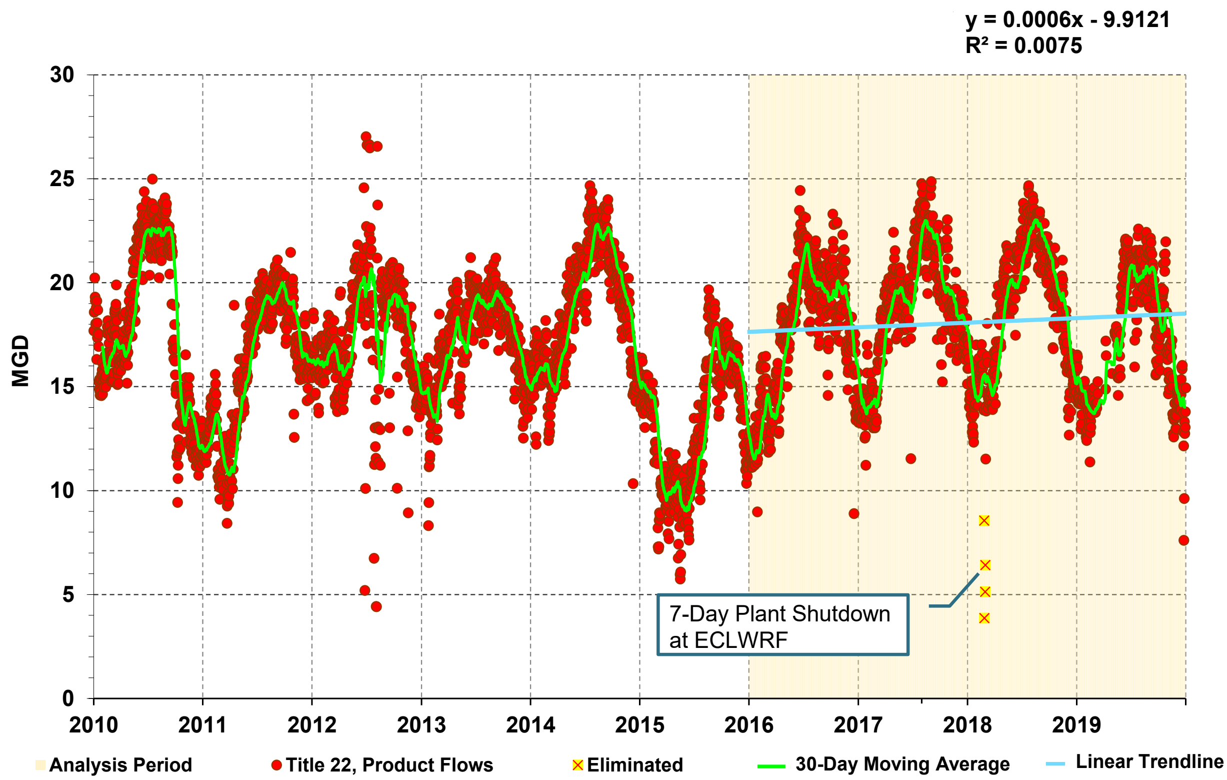
[b] The month of June in Year 2018 is not shown, because water flows were decreased toward end of fiscal year (July-June). The month of June exhibited barrier flows below typical operational range of 10 to 14 mgd, as established by West Basin staff.

Title 22

Title 22 product flows feed into each of the Satellite Plants and serves a wide variety of municipal, commercial, and industrial end users. Figure 4-3 displays the Title 22 product flows from ECLWRF during 2016 to 2019. The period of analysis is selected as 2016 to 2019 following the 2015 Biofor rehabilitation work. Flows are relatively consistent from 2010 to 2019 and range from 12.5 to 25 mgd within the last four calendar years. The sinusoidal pattern aligns with that of the ECLWRF plant influent flows. Figure 4-4 illustrates the seasonal variation using monthly averages from three full calendar years, 2016 to 2018, to match that of ECLWRF.

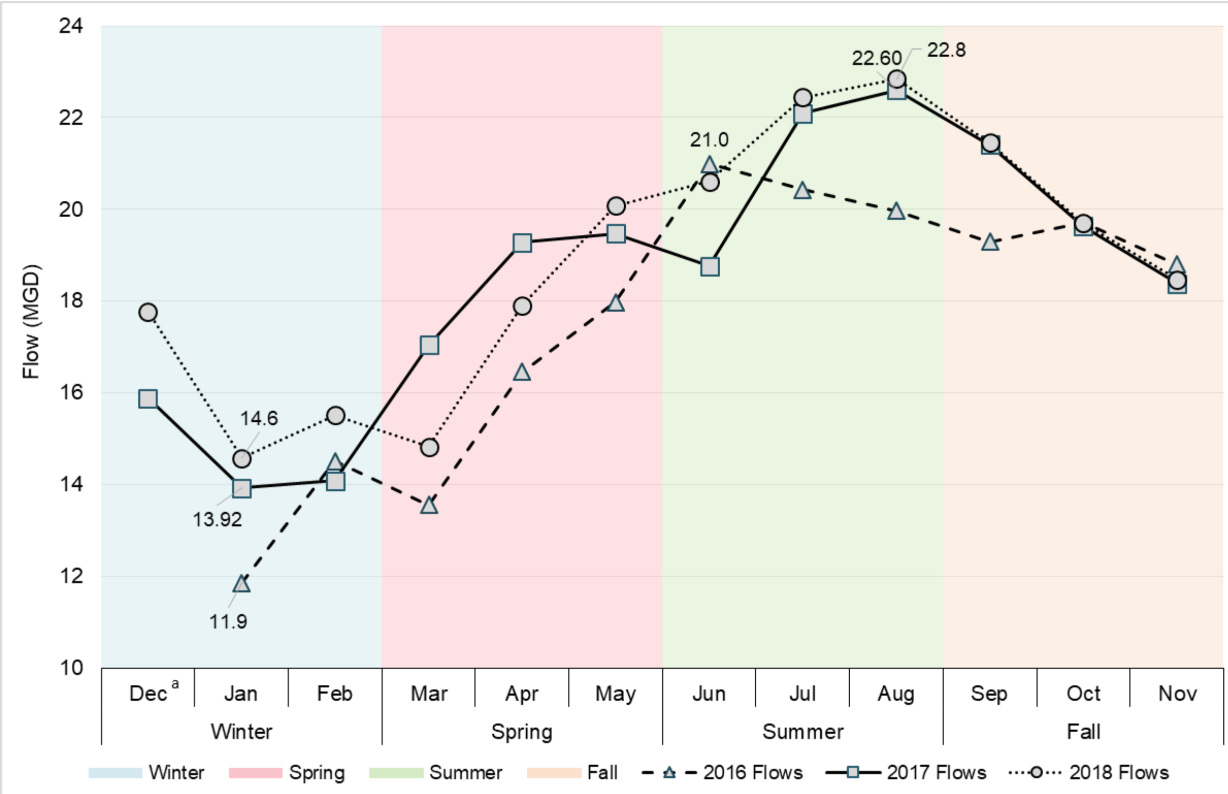
Title 22 product flows distinctly peak during the summer months and dip during the winter months, because irrigation users (i.e., golf courses, parks) utilize more water during hotter months.

Figure 4-3. ECLWRF Title 22 Product Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

Figure 4-4. Title 22 Product Flow from ECLWRF



Source: Daily average flow data (2010-2019).

[a] The month of December is represented by the previous calendar year to illustrate in chronological order (i.e., “2016 Flows” uses Year 2015 for December and Year 2016 for January to November to represent monthly average flows).

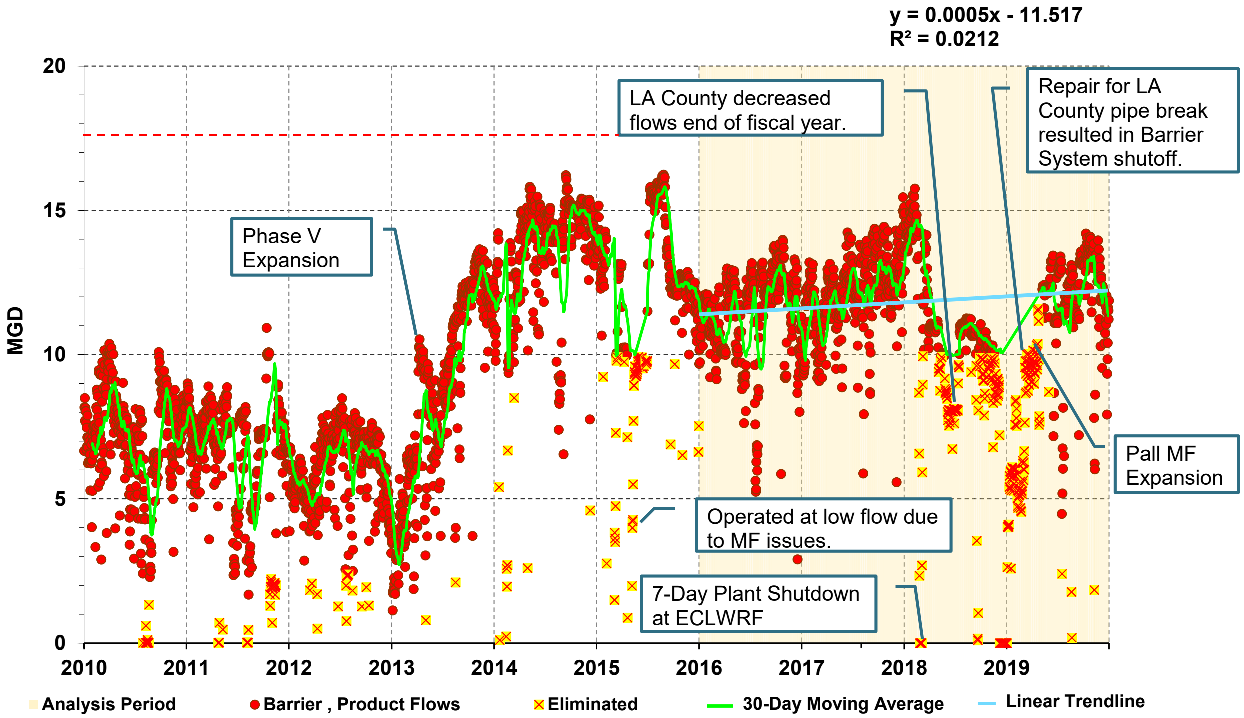
Barrier Water

ECLWRF produces Barrier water for the purpose of injecting it into the West Coast Groundwater Basin to prevent seawater intrusion into the aquifer. Figure 4-5 displays the Barrier water product flows from 2010 to 2019. The horizontal red dashed line in the graph represents the design flow capacity.

Demands for Barrier water do not follow a typical pattern and are based on an injection target that is updated constantly by the Los Angeles County Department of Public Works (County), who owns and operates the West Coast Basin Seawater Barrier. This injection target is dependent upon the chloride and water level within the basin and are being reviewed by the County in a regular basis. It is not uncommon for Barrier water demands to slow and reduced toward the end (April to June) of each fiscal year due to either increase in water level in the spring or the County’s end of fiscal budget constraints.

Historically, Barrier water has been operating below production capacity (17.5 mgd) due to issues with the MF membranes. Currently, the typical operational bandwidth ranges from 10 to 14 mgd and, given the recent upgrades and replacement of the MF membranes, West Basin staff anticipates these flows to be consistent with Barrier water productions in the future. The period of analysis is selected to be 2016 to 2019, to follow the 2013 Phase V Expansion and MF issues in 2015 and include the April 2019 Pall MF Expansion.

Figure 4-5. Barrier Water Product Flow (2010 to 2019)

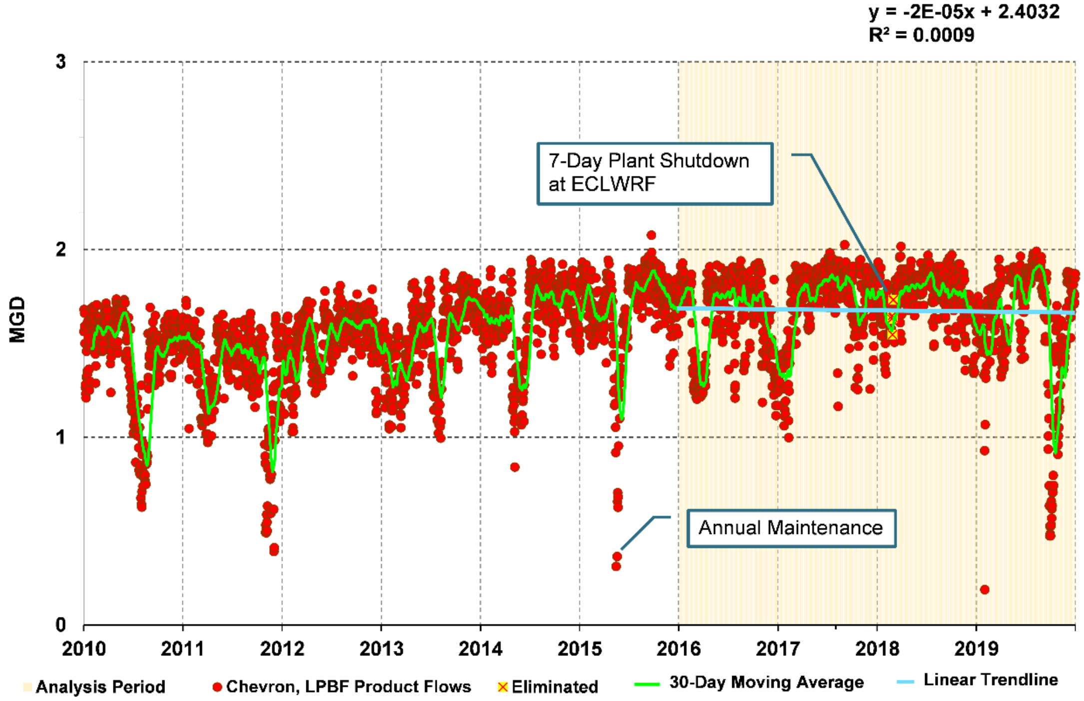


Source: Daily average flow data (2010-2019).

Chevron LPBF and HPBF Treatment Trains

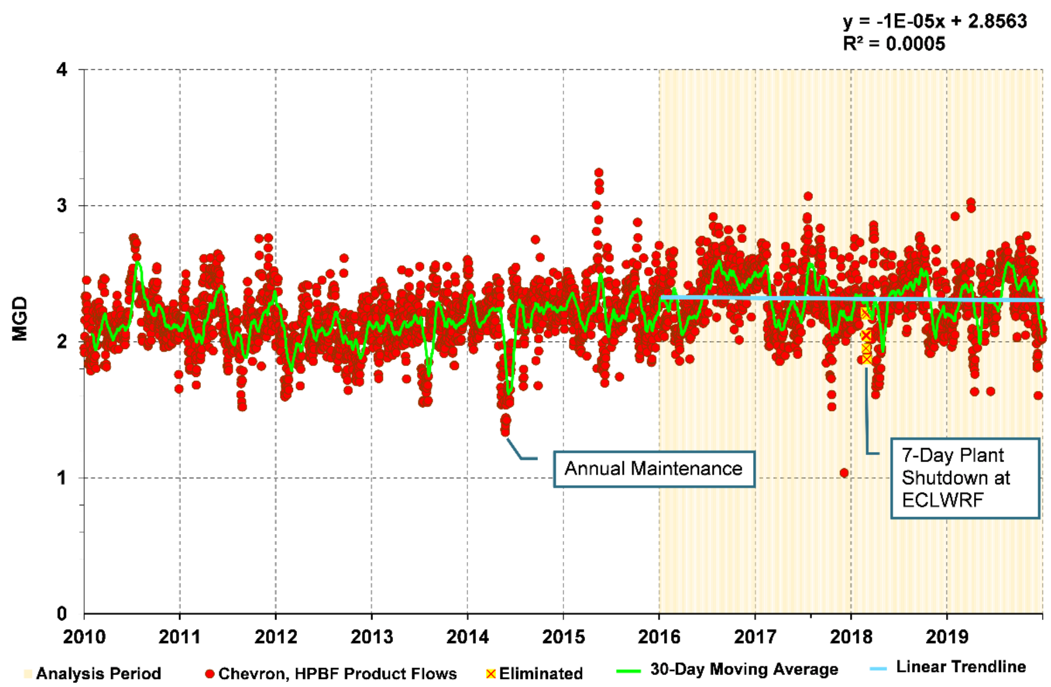
The ECLWRF Chevron LPBF and HPBF treatment trains produce LPBF (Single Pass RO) and HPBF (Double Pass RO) water for boilers at the nearby Chevron Refinery. Figure 4-6 illustrates the LPBF flows, while Figure 4-7 illustrates the HPBF flows, from 2010 to 2019.

Figure 4-6. Chevron LPBF Product Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).
[a] Intermittent supplemental potable water was used to meet LPBF demands during the 7-day plant shutdown at ECLWRF.

Figure 4-7. Chevron HPBF Product Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).
[a] Intermittent supplemental potable water was used to meet HPBF demands during the 7-day plant shutdown at ECLWRF.

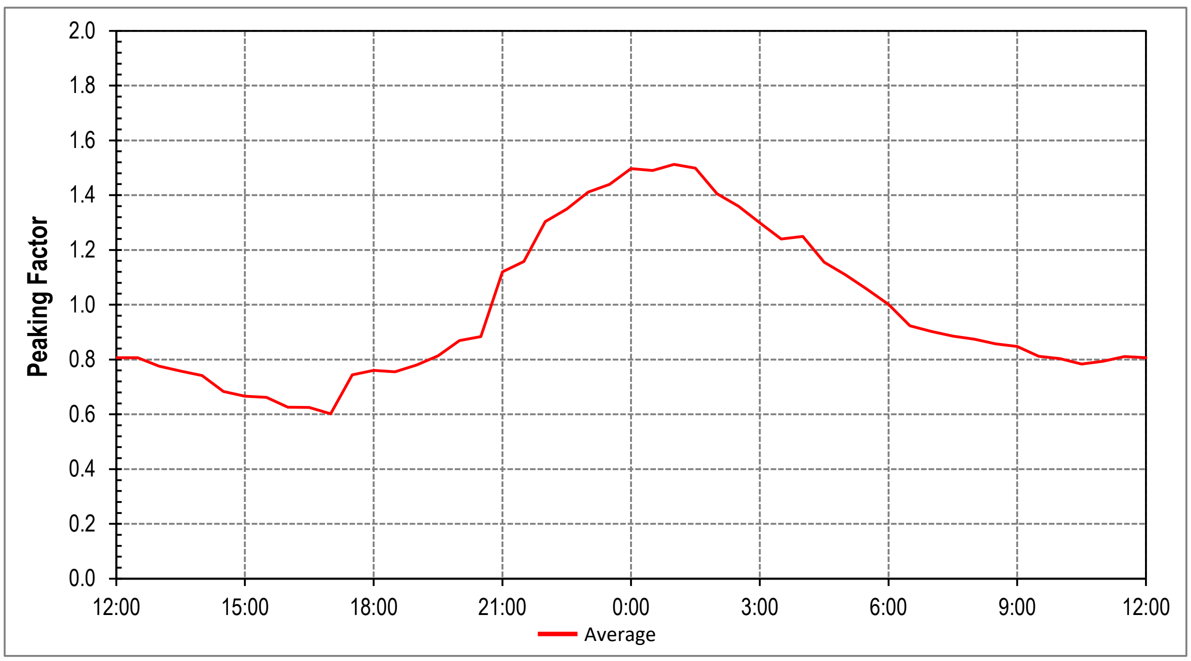
The near-zero slopes suggest flows are generally consistent from 2010 to 2019. Chevron LPBF flows range between 1.5 to 2.0 mgd, while Chevron HPBF flows range between 1.8 to 2.6 mgd, excluding reduced flows due to maintenance events. The period of analysis is selected to be 2016 to 2019 to account for the most recent calendar years and to maintain consistency with all ECLWRF flows. Both BF product flows do not exhibit seasonal variations, because flows depend upon industrial demands at the Chevron Refinery.

Diurnal Curves

Diurnal curves are examined to better understand the typical demands of the customers during a given day. The month of July, typically the driest month, is selected to qualitatively illustrate demand behavior. Year 2019 represents the most recent calendar year available. Figure 4-8 and Figure 4-9 illustrate diurnal curves for Title 22 and Chevron LPBF product flow, respectively.

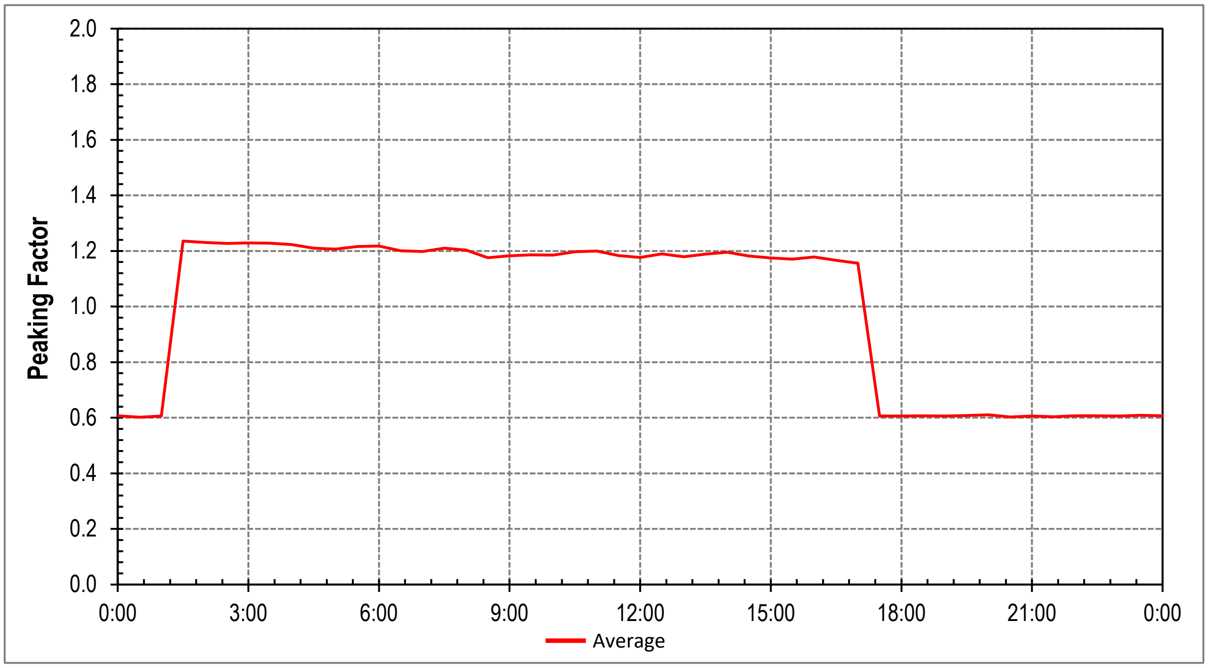
Title 22 product diurnal curve exhibits a typical pattern for irrigation demand for customers who irrigate at night, typically from 9 pm to 5 am (i.e., greenbelt landscaping customers, golf courses, schools, and parks).

Figure 4-8. Title 22 Product Diurnal Curve in July 2019



Source: Flow data in 15-minute intervals from 2018 to 2019.

Figure 4-9. Chevron LPBF Product Diurnal Curve in July 2019



Source: 15-Minute Interval Flow Data 2018-2019.

The Chevron LPBF product follows a typical pattern for industrial demand, where demands are constant during operational hours at refineries. Chevron HPBF product flows, determined by industrial demand, also follow a similar pattern.

Annual Averages

The annual average flows from 2016 to 2019 with respect to system capacities are summarized in Table 4-1. ECLWRF influent, Barrier water, Title 22 product, and Chevron LPBF flows have not been operating historically near full capacity, whereas Chevron HPBF has been operating at about 90 percent of production capacity. The 2009 West Basin RWMP indicated that ECLWRF does not have flow equalization to accommodate daily peaking of influent because supply from HWRP far exceeds existing demands and minimum flow patterns at HWRP also exceed West Basin's firm pumping capacity of 51 mgd at the HSEPS. This is still the case with the 2019 HSEPS improvements to increase firm pumping capacity to 109 mgd, while being contractually limited to 70 mgd.

Table 4-1. Annual Average Flows and Capacities at ECLWRF (2016 to 2019)

Flow	Design Capacity (mgd)	Annual Average (mgd)				
		2016	2017	2018	2019	2016-2019
ECLWRF Influent	**70[a]**	**34.5**	**37.6**	**37.2**	**39.3**	**36.8**
Barrier Water	**17.5[b]**	**11.3**	**12.1**	**11.8**	**12.0**	**11.8**
Title 22 Product	**40[b]**	**17.5**	**18.7**	**18.7**	**17.3**	**18.1**
Title 22 (irrigation)[c]	N/A	-	-	3.8	3.5	3.8[e]
CNTP Influent	5.0[b]	3.9	4.0	3.7	3.8	3.9
TRWRP Influent	8.8[b]	5.4	5.6	6.3	5.5	5.7
JMMCRWRP Influent	6.9[b,d]	-	-	4.9	4.4	4.7[e]
Chevron LPBF	**2.2**	**1.6**	**1.7**	**1.7**	**1.6**	**1.7**
Chevron HPBF	**2.6**	**2.4**	**2.3**	**2.3**	**2.3**	**2.3**

Source: Daily average flow data (2010-2019).

[a] Based on current contractual agreement between West Basin and LASAN to provide up to 70 mgd secondary effluent to West Basin via the HSEPS. HSEPS improvements completed in 2019 increased firm design capacity to 109 mgd. HSEPS capacity is currently limited to 72 MGD based on available electrical transformer capacity

[b] Based on treatment facility process flow schematics (Carollo, 2009) and record drawings (ECLWRF Phase IV and V Expansions).

[c] Annual average Title 22 (irrigation) flow is calculated as the difference between Title 22 Product (from ECLWRF) and sum of the influent for the three satellite facilities.

[d] Based on West Basin and Suez staff interviews and site visits that confirmed PUF offloads MF system but does not increase filtrate production capacity.

[e] Annual average JMMCRWRP influent is calculated as the sum of MF feed flow (includes PUF flows) and the Title 22 bypass flow. Data is not available from 2016 to 2017 for the Title 22 bypass flow due to flow meter reading errors and underground water leaks. Therefore, the annual average analysis period for JMMCRWRP influent, and consequentially that for Title 22 (irrigation), is 2018 to 2019.

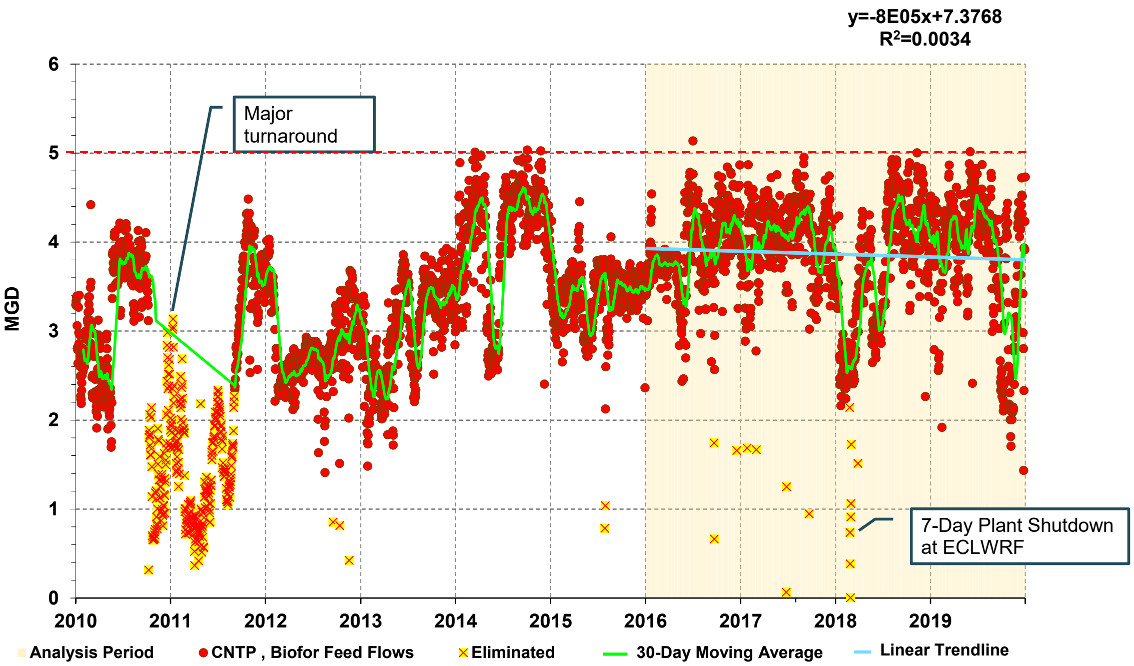
4.2.2 Nitrified Water Production at Satellite Plants

Flows for nitrification treatment processes are influenced by demands of refineries and cooling towers, and therefore, typically do not exhibit seasonal variations. The period of analysis at all Satellite Plants is selected to be 2016 to 2019 to follow the 2015 Biofor rehabilitation work and the explosion at Torrance Refinery in February 2015, which caused TRWRP to operate at lower than normal flows for about a year.

CNTP

Biofor feed and nitrified product flows at CNTP are illustrated in Figure 4-10 and Figure 4-11.

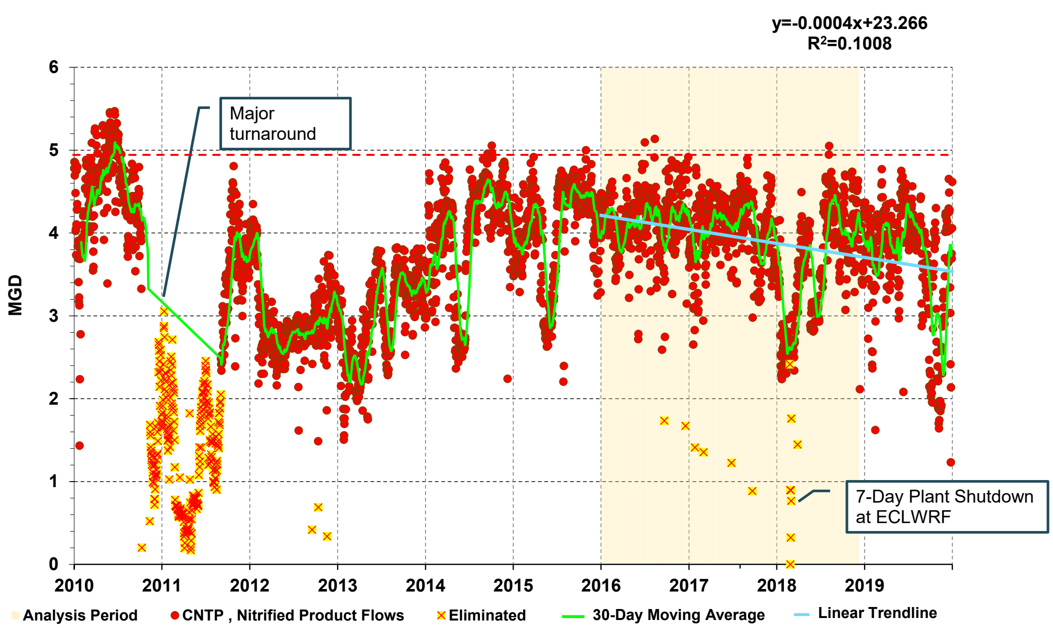
Figure 4-10. CNTP Biofor Feed Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] Biofor feed flows were run at low flow from the Title 22 storage tank at ECLWRF during the 7-day plant shutdown to maintain the biomass and minimize supplemental potable water.

Figure 4-11. CNTP Nitrified Product Flow (2010 to 2019)



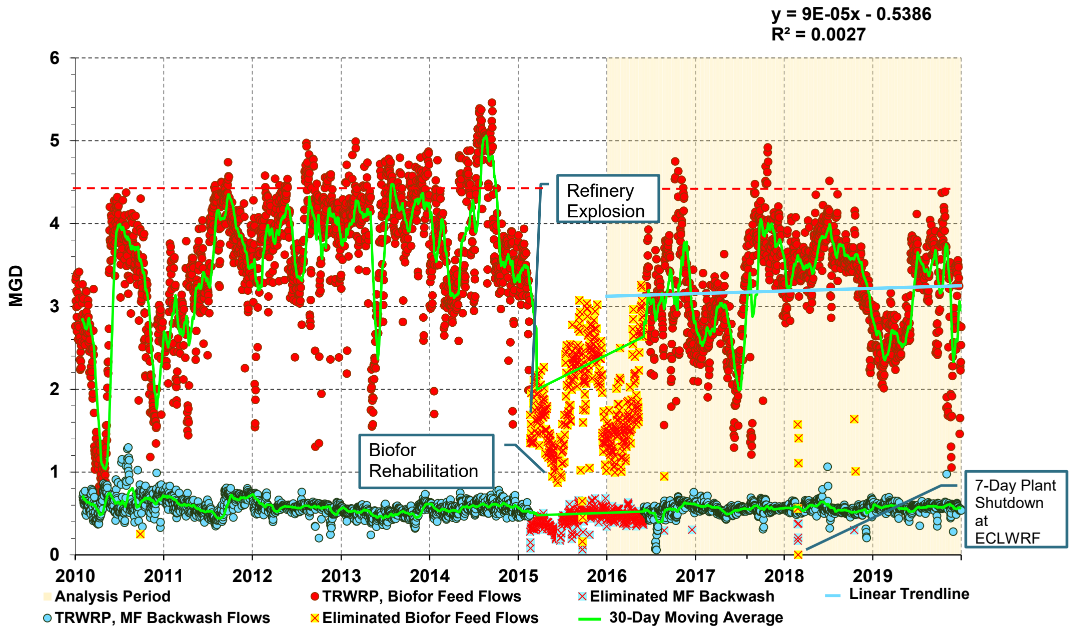
Source: Daily average flow data (2010-2019).

[a] Flows incorporate supplemental potable water to meet demand.

TRWRP

Biofor feed and nitrified product flows at TRWRP are illustrated in Figure 4-12 and Figure 4-13.

Figure 4-12. TRWRP Biofor Feed Flow (2010 to 2019)

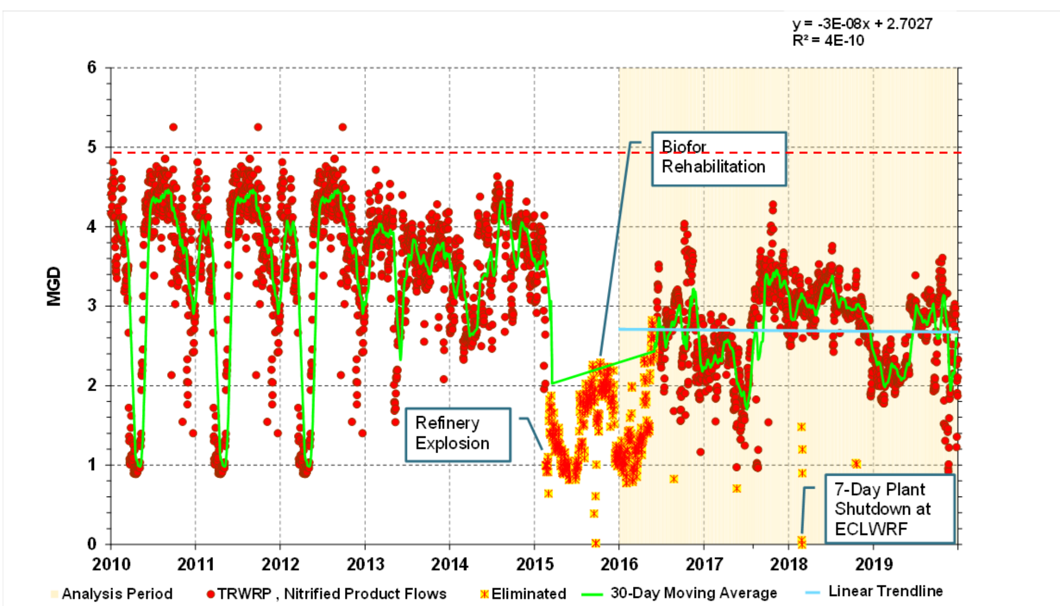


Source: Daily average flow data (2010-2019).

[a] Biofor feed flows incorporate MF backwash feed flow, which accounts for approximately 15% to 20% of the total Biofor feed flow.

[b] Biofor feed flows were run at low flow from the Title 22 storage tank at ECLWRF during the 7-day plant shutdown to maintain the biomass and minimize supplemental potable water.

Figure 4-13. TRWRP Nitrified Product Flow (2010 to 2019)



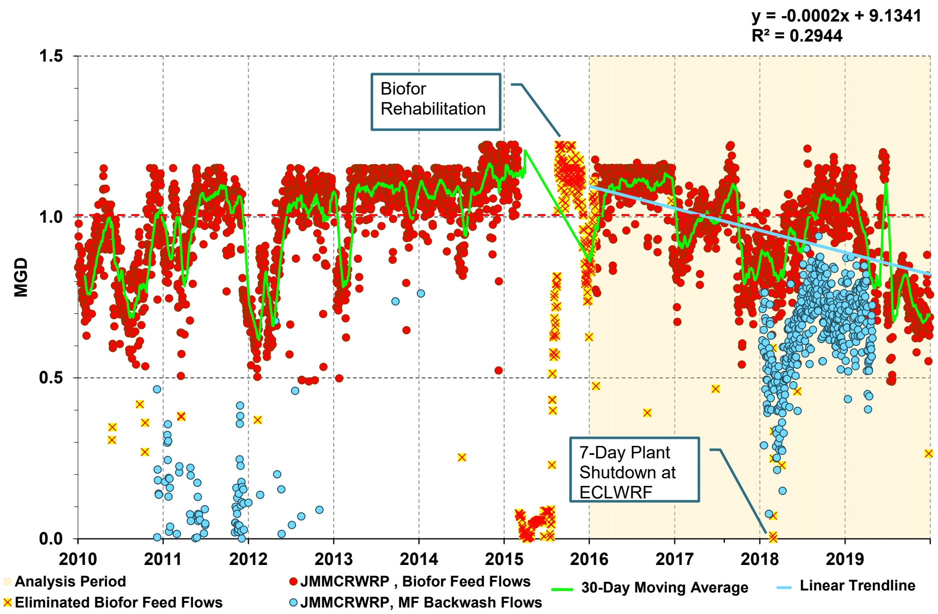
Source: Daily average flow data (2010-2019).

[a] Flows incorporate MF backwash to meet demand.

JMMCRWRP

Biofor feed and nitrified product flows at JMMCRWRP are illustrated in Figure 4-14 and Figure 4-15.

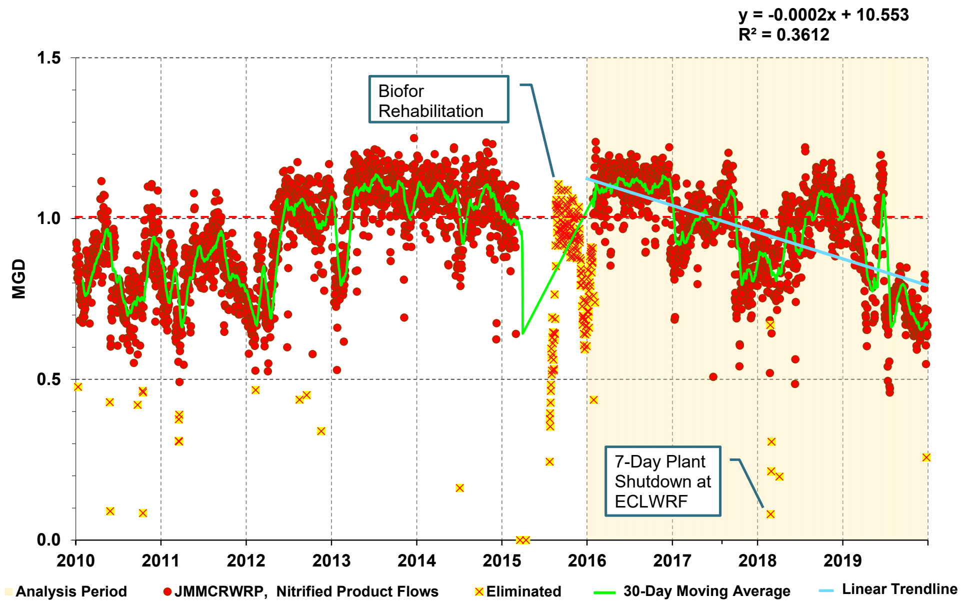
Figure 4-14. JMMCRWRP Biofor Feed Flows (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] Biofor feed flows incorporate MF backwash and Title 22 bypass flow to meet demand. MF backwash accounts for approximately 80% to 85% of total Biofor feed flows. Title 22 bypass flow supplements the Biofor system when ECLWRF plant influent flows are low (approximately 19 to 20 mgd).
[b] MF backwash flows are calculated as the difference between JMMCRWRP Biofor feed flows and Title 22 bypass flow. Title 22 bypass flow data is not available for 2010, November to December 2012, May to December 2015, 2016, and 2017.
[c] Biofor feed flows were run at low flow from the Title 22 storage tank at ECLWRF during the 7-day plant shutdown to maintain the biomass and minimize supplemental potable water.

Figure 4-15. JMMCRWRP Nitrified Product Flows (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] Flows incorporate Title 22 water and MF backwash.

Annual Averages

The annual average flows and capacities for the nitrification treatment processes at the Satellite Plants are summarized in Table 4-2.

Table 4-2. Annual Average Flows and Capacities of Nitrification Treatment Systems (2016 to 2019)

Flow	Capacity (mgd)	Annual Average (mgd)				
		2016	2017	2018	2019	2016-2019
CNTP Biofor Feed	5.0	3.9	4.0	3.7	3.8	3.9
CNTP Nitrified Product	4.9	4.1	4.0	3.6	3.7	3.9
TRWRP Biofor Feed[a]	4.4[a]	3.2	3.1	3.5	3.0	3.2
TRWRP Nitrified Product[a]	4.9	2.7	2.6	3.0	2.5	2.7
JMMCRWRP Biofor Feed[a]	1.1	1.1	1.0	1.0	0.8	1.0
JMMCRWRP Nitrified Product[a,b]	1.0	1.1	1.0	1.0	0.8	1.0

Source: Daily average flow data (2010-2019).

[a] Includes MF backwash.

4.2.3 BF Water Production at Satellite Plants

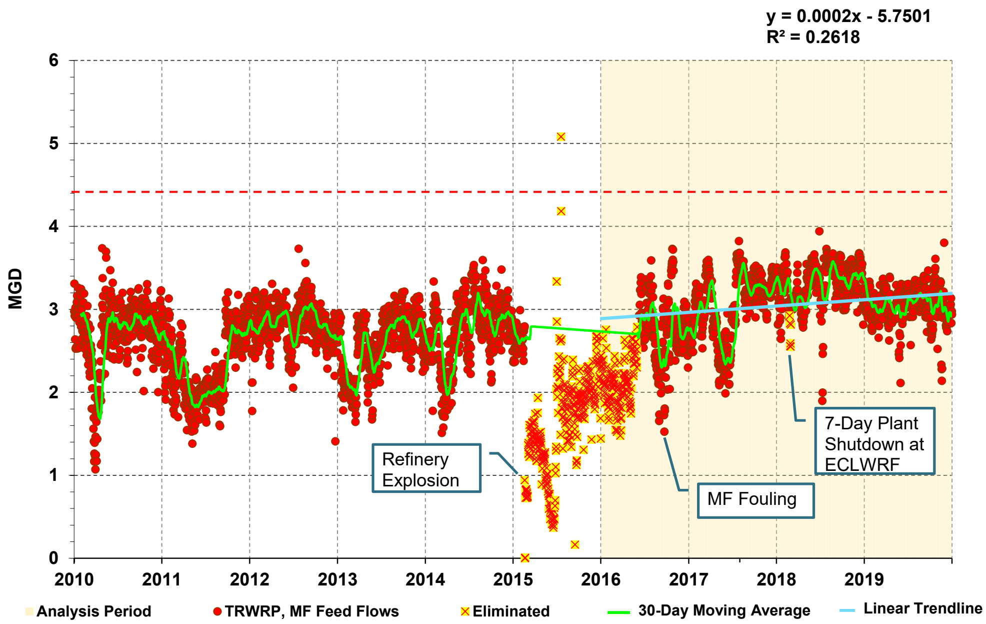
BF product flows at the Satellite Plants are influenced by demands of refineries for BF water and therefore typically do not exhibit seasonal variations. The period of analysis at all Satellite Plants is selected to be 2016 to 2019 to follow the 2015 Biofor rehabilitation work and the explosion at

Torrance Refinery in February 2015. The refineries may rely on their groundwater production wells to meet on-site demands more heavily during wet years or seasons.

TRWRP

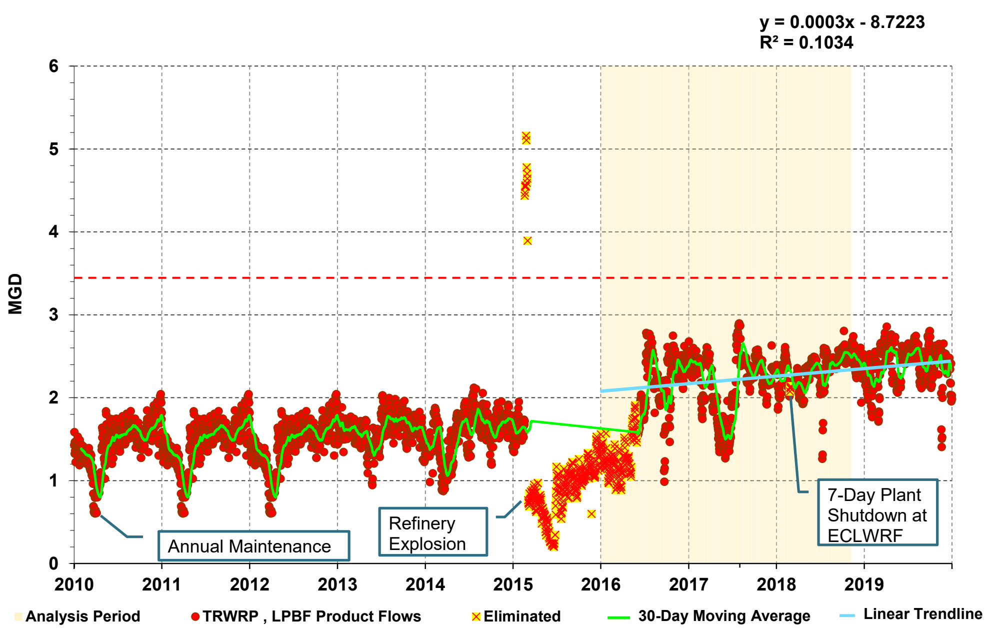
MF feed and BF product flows at TRWRP are illustrated in Figure 4-16 and Figure 4-17.

Figure 4-16. TRWRP MF Feed Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

Figure 4-17. TRWRP LPBF Product Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] Includes supplemental potable water added at the MF filtrate break tank to meet demand.

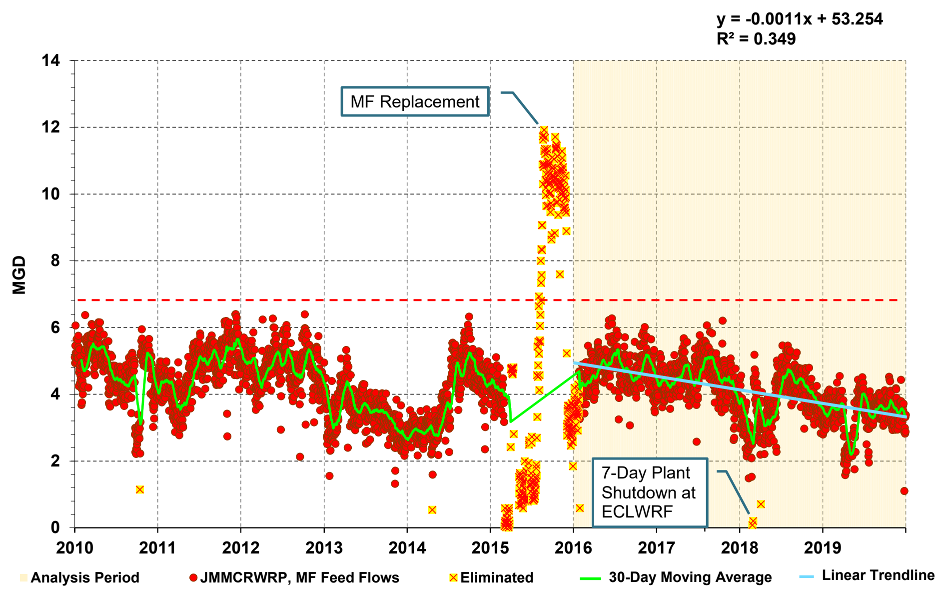
JMMCRWRP

MF feed, PUF feed, and BF product flows at JMMCRWRP are illustrated in Figure 4-18 through Figure 4-20.

The BF product flow at JMMCRWRP experienced a downward trend in flows, because during the past 1.5 years, the end users utilized more groundwater well supply that was available after a rainy season. Increased demands for BF product reflect reduced groundwater well production.

The PUF, which utilizes PVDF fibers, has been in service for approximately 5.5 years prior to being replaced at the end of 2020. Therefore, the period of analysis is five full calendar years from 2015 to 2019. This system is typically operated at maximum capacity, while remaining demand is fulfilled through the MF system. However, Figure 4-19 displays a wide variability in flows frequently deviating from full capacity of 1.1 mgd. Dips in 2016 are a result of water quality issues, while remaining dips are likely due to optimization work on the PUF.

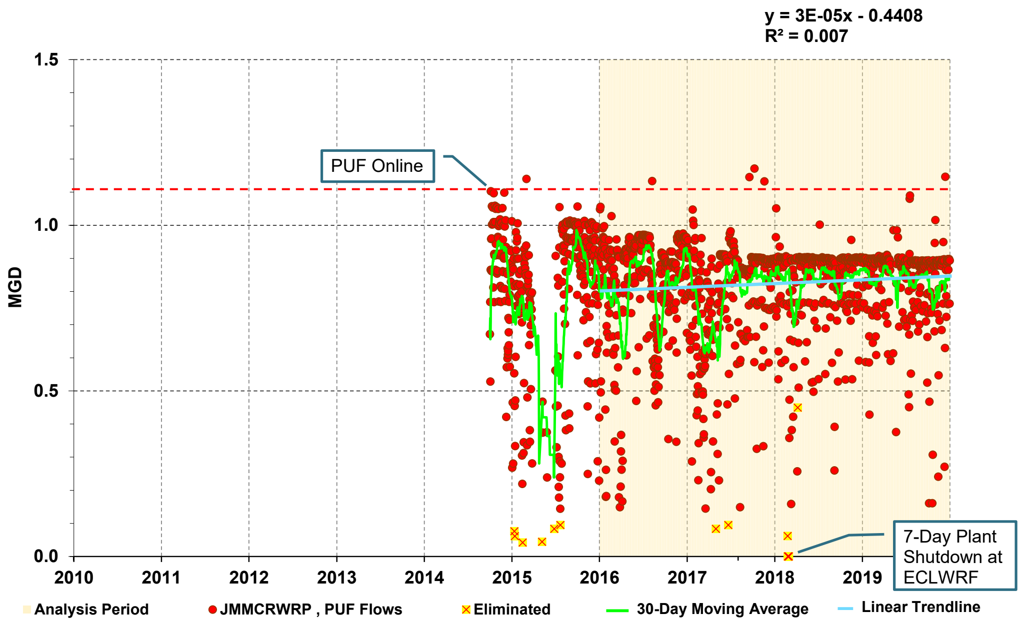
Figure 4-18. JMMCRWRP MF Feed Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] 2012-2015 data includes supplemental potable water added at the influent to JMMCRWRP to meet demand, prior to installation of PUF.

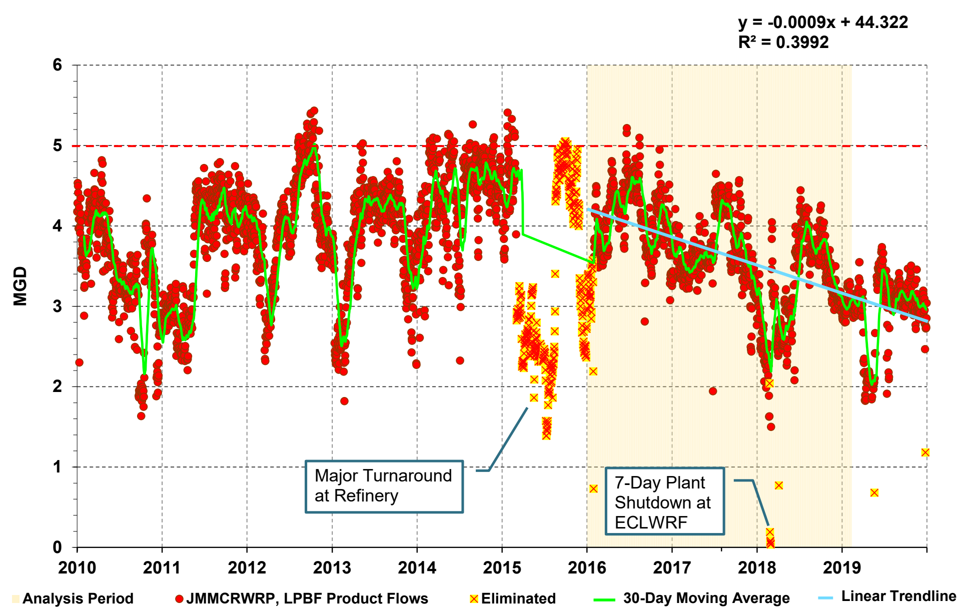
Figure 4-19. JMMCRWRP PUF Feed Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] Includes supplemental potable water added at the influent to JMMCRWRP to meet demand.

Figure 4-20. JMMCRWRP BF Product Flow (2010 to 2019)



Source: Daily average flow data (2010-2019).

[a] Includes supplemental potable water added at the influent to JMMCRWRP to meet demand. Supplemental potable water was consistently used for the Biofor system prior to installation of the PUF in October 2014.

Annual Averages

The annual average flows and capacities for BF treatment systems at the satellite plants are summarized in Table 4-3.

Table 4-3. Annual Average Flows and Capacities for LPBF Systems at Satellite Plants (2016 to 2019)

Flow	Capacity (mgd)	Annual Average (mgd)				
		2016	2017	2018	2019	2016-2019
JMMCRWRP MF Feed	6.9	4.7	4.5	3.8	3.4	4.1
JMMCRWRP PUF Feed	1.1	0.8	0.8	0.8	0.8	0.8
JMMCRWRP BF Product	5.0	4.1	3.7	3.2	3.0	3.5
TRWRP MF Feed	4.4	2.8	3.0	3.3	3.0	3.1
TRWRP BF Product	3.2	2.2	2.2	2.3	2.4	2.3

Source: Daily average flow data (2010-2019).

Peaking Factors

Design of facilities and assessment of permit compliance are typically based on a range of flow conditions including maximum month (MM), maximum week, (MW), and maximum day (MD). This section describes development of peak flow projections for the system.

The key terms to calculate peaking factors are defined as follows:

- **AA flow:** Arithmetic average of all data that occurs in the review period.
- **MM flow:** Maximum 30-day average flow that occurs in the review period. Statistical MM flow for a log-normal distributed data is the 91.7th (11/12th) percentile of the log-normal value.
- **MW flow:** Maximum 7-day average flow that occurs in the review period. Statistical MW flow for a log-normal distributed data is the 98.1st (51/52nd) percentile of the log-normal value.
- **MD flow:** Maximum daily value that occurs in the review period. For log-normal distributed data, the MD is the 99.7th (364/365th) percentile of the log-normal value.

Peaking factor refers to the ratio of the peak flow rate (e.g., MD flow) to the AA. The peaking factors are calculated as follows:

- MM/AA = MM Flow/AA Flow
- MW/AA = MW Flow/AA Flow
- MD/AA = MD Flow/AA Flow

Daily average flows (2016 to 2019) are used to calculate AA, MD, MW, and MM. In general, the flows follow a log-normal curve pattern; therefore, peaking factors are developed using the statistical approach. Peaking factors observed at West Basin treatment facilities are summarized in Table 4-4.

Table 4-4. West Basin Treatment Facility Peaking Factors (2016 to 2019)

Treatment Facility	Flow	MM/AA	MW/AA	MD/AA
ECLWRF	Influent	1.17	1.27	1.38
	Barrier Water	1.20	1.31	1.44
	Title 22 Product	1.25	1.41	1.59
	Chevron LPBF Product	1.20	1.32	1.45
	Chevron HPBF Product	1.15	1.23	1.32
CNTP	Biofor Feed	1.22	1.36	1.50
	Nitrified Product	1.22	1.36	1.51
TRWRP	Biofor Feed	1.28	1.47	1.67
	Nitrified Product	1.29	1.48	1.69
	MF Feed	1.17	1.27	1.37
	LPBF Product	1.19	1.30	1.42
JMMCRWRP	Biofor Feed	1.22	1.36	1.50
	Nitrified Product	1.23	1.37	1.53
	MF Feed	1.29	1.49	1.70
	PUF Feed	1.26	1.42	1.60
	LPBF Product	1.26	1.42	1.59

AA=annual average; MD=max day; MF=microfiltration; MM=max month; MW=max week; PUF=Pall ultrafiltration.
Source: Daily average flow data (2010-2019).

4.3 Water Quality

This section examines the historical water quality data at each West Basin treatment facility to assess existing treatment performance and to identify trends in order to develop projected feedwater quality characteristics for potential improvements.

4.3.1 ECLWRF

Available data provided by West Basin for key constituents at ECLWRF are summarized in Table 4-5.

Table 4-5. Available Data for Water Quality Constituents at ECLWRF

Flow	Constituent	Units	Frequency	Dates
Influent	Ammonia	mg/L	Daily	2010-2020
	EC	μmho/cm	Daily	2010-2020
	Iron	mg/L	Varies, about twice a week	2014-2020
	Ozone	mg/L	Weekly	2013-2017
	TDS	mg/L	Daily	2009-May 2020
	TOC	mg/L	Twice a week, Weekly	2010-2020
	TSS	mg/L	Daily	2010-2020
	Turbidity	NTU	Daily	2009-May 2020

Table 4-5. Available Data for Water Quality Constituents at ECLWRF

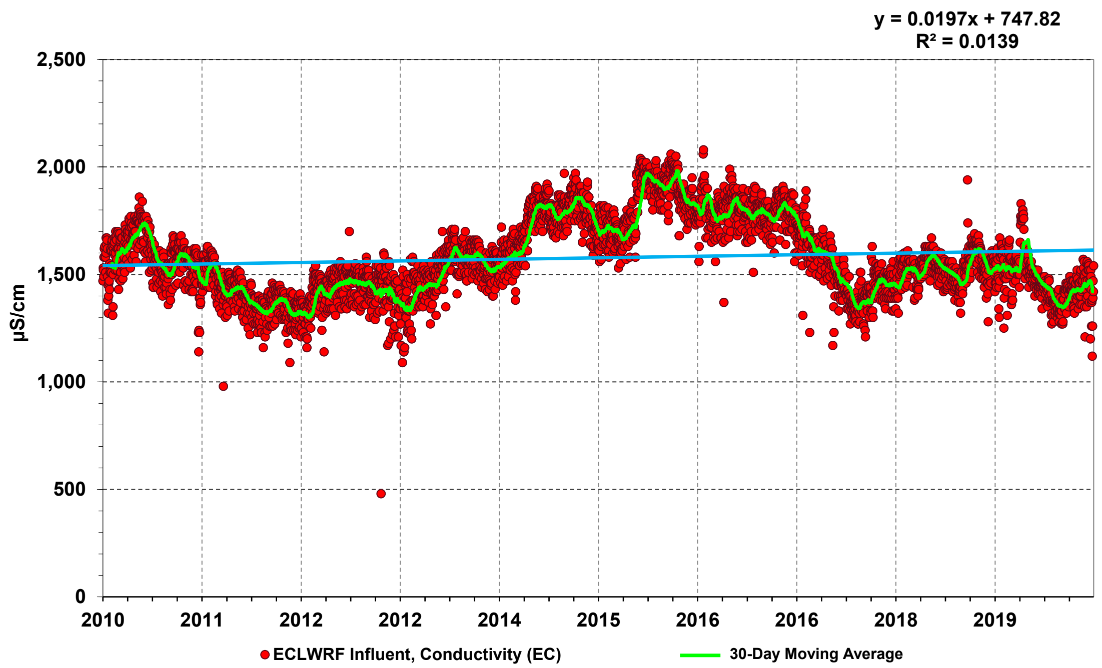
Flow	Constituent	Units	Frequency	Dates
Title 22 Product	Alkalinity	mg/L	Monthly	2014-2019
	Ammonia	mg/L	Monthly	2014-2019
	Boron	mg/L	Monthly	2014-2019
	Chloride	mg/L	Monthly	2014-2019
	EC	mmho/cm	Monthly	2014-2019
	Iron	mg/L	Monthly	2014-2019
	pH	S.U.	Monthly	2014-2019
	TDS	mg/L	Monthly, Composite	2010-2019
	Total Alkalinity	mg/L as $CaCO_3$	Monthly	2014-2019
	TOC	mg/L	Monthly	2014-2019
	TSS	mg/L	Weekly, composite	2010-2019
	Turbidity	NTU	Daily	2010-2019
Barrier Water Product	Ammonia	mg/L	Twice a week	2010-2019
	TDS	mg/L	Quarterly	2010-2019
	Turbidity	NTU	Daily	2010-2019
	NDMA	µg/L, ng/L	Monthly	2010-2019
HPBF Product	TDS	mg/L	Weekly	2013-2019
LPBF Product	TDS	mg/L	Weekly	2013-2019

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

ECLWRF Influent

Key ECLWRF influent water quality constituents from 2010 to 2019 are shown in Figure 4-21 to Figure 4-25.

Figure 4-21. ECLWRF Influent EC from 2014 to 2019

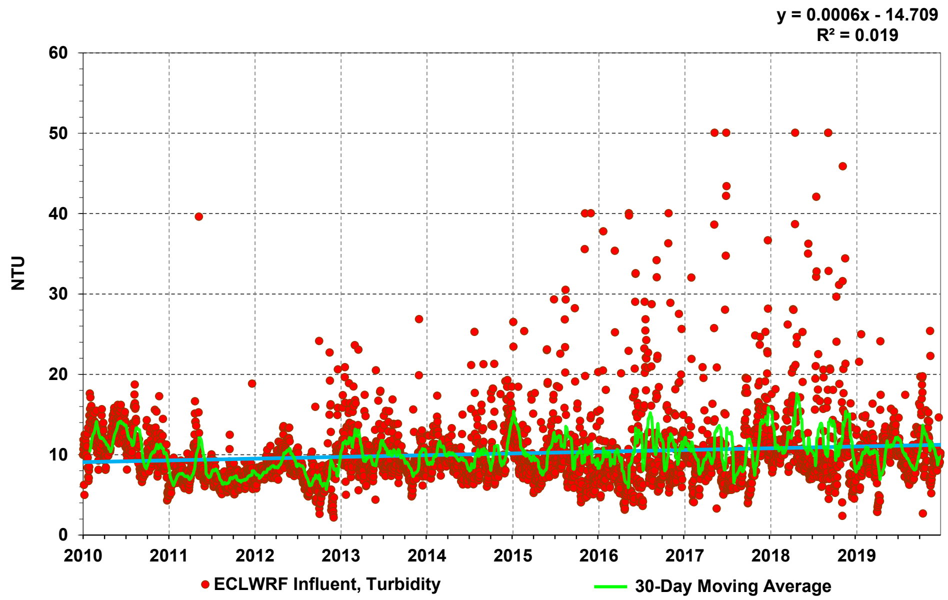


Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Total dissolved solids (TDS) is indirectly measured by electrical conductivity (EC), which is typically estimated by multiplying EC by a factor of 0.6. Concentrations of TDS with sparingly soluble salt ions (i.e., barium, calcium, sulfate, etc.) complicates the recovery performance at BF treatment systems at the satellite plants. Therefore, West Basin imposes a goal to keep TDS below 1,000 mg/L (approximate EC of 1,667 microsiemens per centimeter [µS/cm]) in Title 22 product water. Historical EC ranged from 1,417 to 2,000 µS/cm from 2010 to 2019, which does not hinder the design and operation of nitrification treatment at the satellite plants. Historically, EC consistently peaked over 1,667 µS/cm from 2014 to 2016, eventually tapering off from 2017 and onwards. However, the elevated EC between 2014 and 2017 were likely due to extreme regional drought conditions and increased usage of potable water from the Colorado River Aqueduct (CRA), which has significantly higher TDS levels than the California State Water Project (SWP).

In the event of another extreme drought, it is likely that ECLWRF influent TDS would return to these elevated concentrations (assuming no changes were made upstream). Additionally, levels of TDS are also contingent upon the two sewage sources treated at HWRP: one from costal sewers with high TDS and the second from inland sewers with low TDS. The HSEPS pulls from a common HWRP secondary effluent channel and primarily consists of water from the lower TDS side. Increased flows to ECLWRF may increase the blend of the higher TDS secondary effluent conveyed to West Basin. Projections of TDS potentially requires knowledge of existing and planned secondary effluent management practices and/or regulations by the City of Los Angeles, as well as predictions of future droughts, sea level rises, and agricultural runoff patterns.

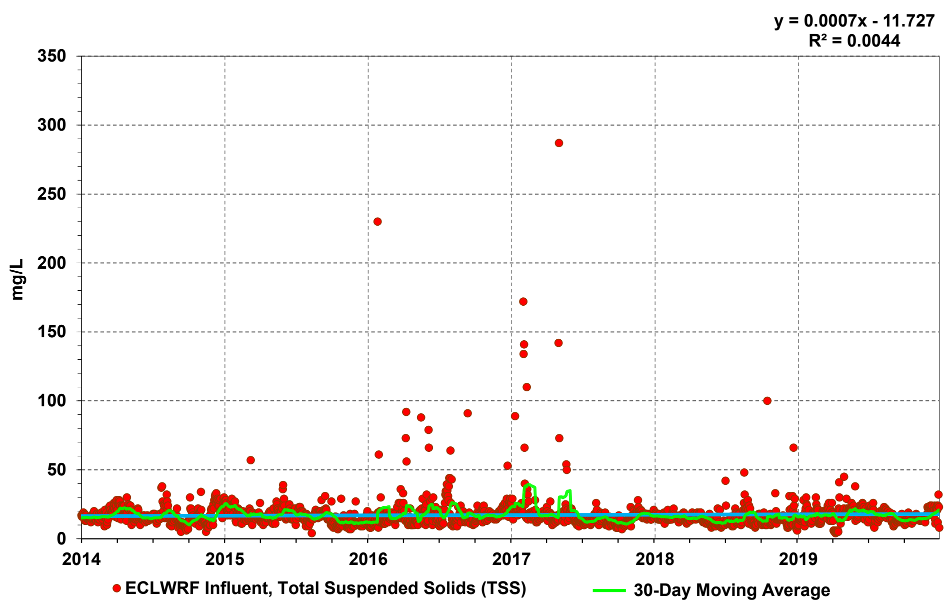
Figure 4-22. ECLWRF Influent Turbidity from 2010 to 2019



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

The linear trendline slope in Figure 4-22 shows that turbidity has gradually increased and generally ranges between 8 and 18 NTU. However, excursions as high as 50 NTU have occurred more frequently in recent years from 2016 to 2019. West Basin staff expect these excursions to continue; therefore, ECLWRF operational procedures were adjusted to anticipate potential influent spikes.

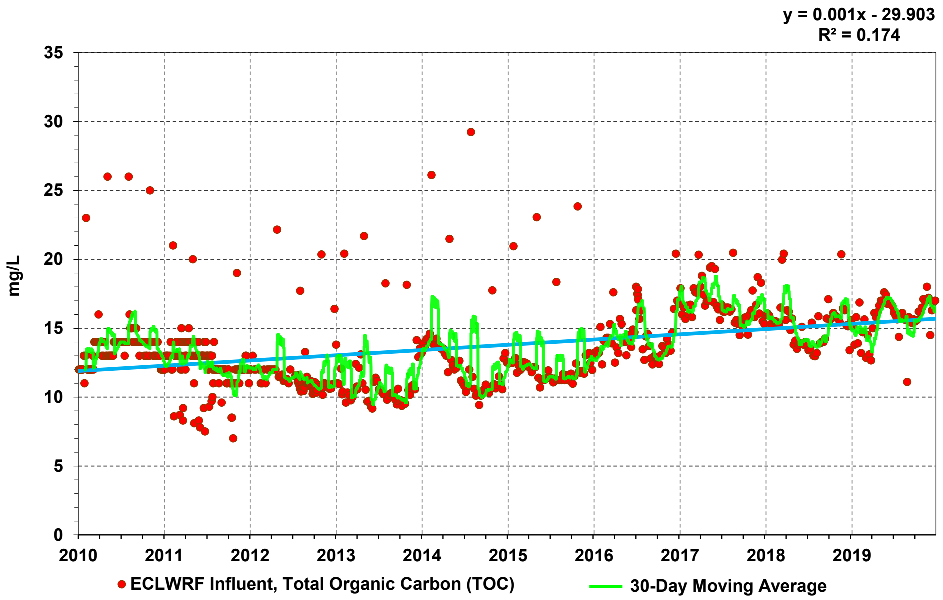
Figure 4-23. ECLWRF Influent TSS from 2010 to 2019



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

According to the linear trendline, TSS has been fairly consistent with a gradual increase. TSS ranges from 12 to 27 mg/L with occasional excursions over 50 mg/L and as high as over 200 mg/L in 2016 and 2017.

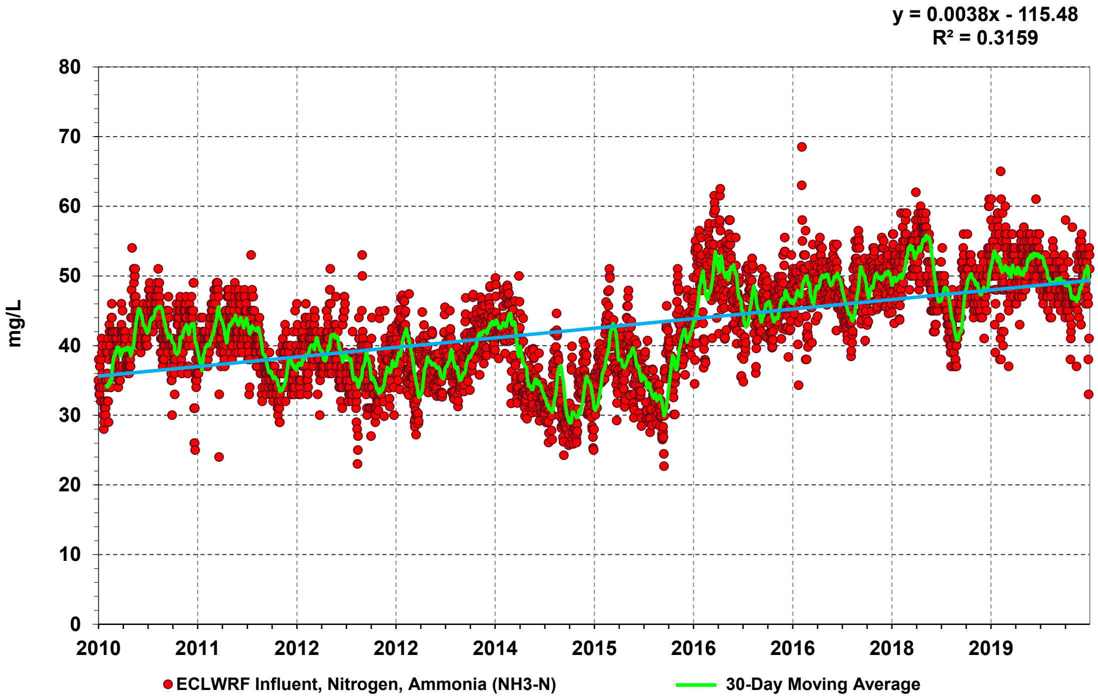
Figure 4-24. ECLWRF Influent TOC from 2010 to 2019



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

According to a study of RO Permeate and Barrier water TOC (West Basin and Suez, 2017), increased ozone dosages increase the formation of TOC byproducts, such as aldehydes and ketones. These byproducts are small molecular weight organics capable of passing through RO membranes, consequentially raising TOC levels in the Double Pass RO permeate and increasing oxidizing demand (i.e., increased chemical and energy dose) in the UV-AOP treatment system for Barrier water. Based on the findings from this study, ozone dose was reduced to 4 mg/L from around 15 mg/L in 2015 to keep TOC below the permit limit of 0.5 mg/L (20-week average limits), as mandated by California Code of Regulations, Title 22, Section 60320.040. However, increases in ECLWF influent TOC, as shown by the upward linear trendline, may also contribute to overall TOC increases in the Barrier product water. TOC ranged from 11 to 15 mg/L in 2010, whereas TOC ranged from 13 to 18 mg/L in 2019.

Figure 4-25. ECLWRF Influent Ammonia from 2010 to 2019



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Currently, the HWRP treatment process does not include ammonia oxidation, or nitrification. Therefore, the nitrification treatment processes at the satellite plants serve to convert ammonia to nitrate, since ammonia adversely impacts the performance of cooling towers. Municipal water usage patterns and wastewater management practices (i.e., water conservation) influence the level of ammonia in HWRP secondary effluent flows. The linear trendline in Figure 4-25 demonstrates a significant increase in ammonia concentrations over the past ten years. Historically, ammonia ranged from 20 to 50 mg/L in 2010, whereas ammonia ranged from 40 to 60 mg/L in 2019. Implications of increased ammonia loading were previously discussed in Section 2.1.

Annual averages of the aforementioned water quality constituents of interest are summarized in Table 4-6. The projected water quality values from the 2010 ECLWRF Phase V Expansion Preliminary Design Report (PDR) are reproduced in Table 4-7 and compared to the historical data in Table 4-8. A comparison of 2020 data for these two tables show that most annual average water quality data are generally in-line with or slightly greater than 2010 projections of annual averages. Historical TSS deviated the most from projections, resulting in higher historical TSS concentrations than anticipated. Ammonia and conductivity projections relatively align, although the percent differences in 2018 and 2020 suggest conductivity may not be continually increasing by 1%. A linear trendline can be used to project future conductivity values instead; however, future blending plans for HWRP secondary effluent should be assessed to determine whether or not TDS is anticipated to increase or decrease in the future.

The statistical analysis between historical water quality data and 2010 PDR projections show the range of concentrations and frequency of variability has historically increased from the 2010 projections, as indicated in a comparison of the maximum and 95th percentiles shown in Table 4-9 and Table 4-10.

Table 4-6. ECLWRF Influent Water Quality Annual Averages

Year	EC (µS/cm)	Turbidity (NTU)	TSS (mg/L)	TOC (mg/L)	Ammonia (mg/L)
2010	1,586	11	15	14	41
2012	1,420	8	22	12	38
2014	1,742	10	17	13	35
2015	1,826	10	16	13	37
2016	1,793	11	19	14	47
2018	1,531	12	15	15	49
2020[a]	1,586	12	20	18	49

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

[a] January to May 2020 daily average turbidity data is available, while January to March 2020 daily average conductivity, TSS, TOC, and ammonia data is available.

Table 4-7. Projected ECLWRF Influent Water Quality from 2010 PDR

Year	EC (µS/cm)[a]	Turbidity (NTU)[b]	TSS (mg/L)[c]	TOC (mg/L)[d]	Ammonia (mg/L))[d]
2009-2010	1,566	9.1	11.7	13.3	38.8
2012	1,598	-	-	-	-
2014	1,630	-	-	-	-
2015	1,646	11	13	14	42
2016	1,662	-	-	-	-
2018	1,696	-	-	-	-
2020	1,730	14	14	14	45

Source: West Basin ECLWRF Phase V Expansion Preliminary Design Report, Volume II – Part 1 of 2 (HDR, 2010).

[a] Based on 1% yearly increase.
[b] Based on linear curve fittings established from 2007 to 2010 annual average data.
[c] Based on linear curve fittings established from 2000 to 2010 annual average data.
[d] Based on linear curve fittings established from 2002 to 2010 annual average data.

Table 4-8. Percent Difference of Average Historical Data to 2010 PDR Projections for ECLWRF Influent

Year	EC (µS/cm)	Turbidity (NTU)	TSS (mg/L)	TOC (mg/L)	Ammonia (mg/L)
2009-2010[a]	+1%	+25%	+26%	+4%	+5%
2012	-11%	-	-	-	-
2014	+7%	-	-	-	-
2015	+11%	+6%	+26%	+10%	-11%
2016	+8%	-	-	-	-
2018	-10%	-	-	-	-
2020[b]	-8%	+17%	+45%	+26%	+9%

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

[a] Only 2010 historical annual average data is used.
[b] January to May 2020 daily average turbidity data is available, while January to March 2020 daily average conductivity, TSS, TOC, and ammonia data is available.

Table 4-9. ECLWRF Influent Water Quality Statistical Analysis (2010 to 2019)

Statistics	EC (µS/cm)	TDS (mg/L)	Turbidity (NTU)	TSS (mg/L)	TOC (mg/L)	Ammonia (mg/L)
Maximum	2,080	1,254	50	287	29	69
95th Percentile	1,890	1,134	18	27	18	54
Average	1,577	947	10	17	13	43
25th Percentile	1,440	864	8	12	12	37
Minimum	480	588	2	4	7	23

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

[a] January to May 2020 daily average turbidity data is available, while January to March 2020 daily average conductivity, TSS, TOC, and ammonia data is available.

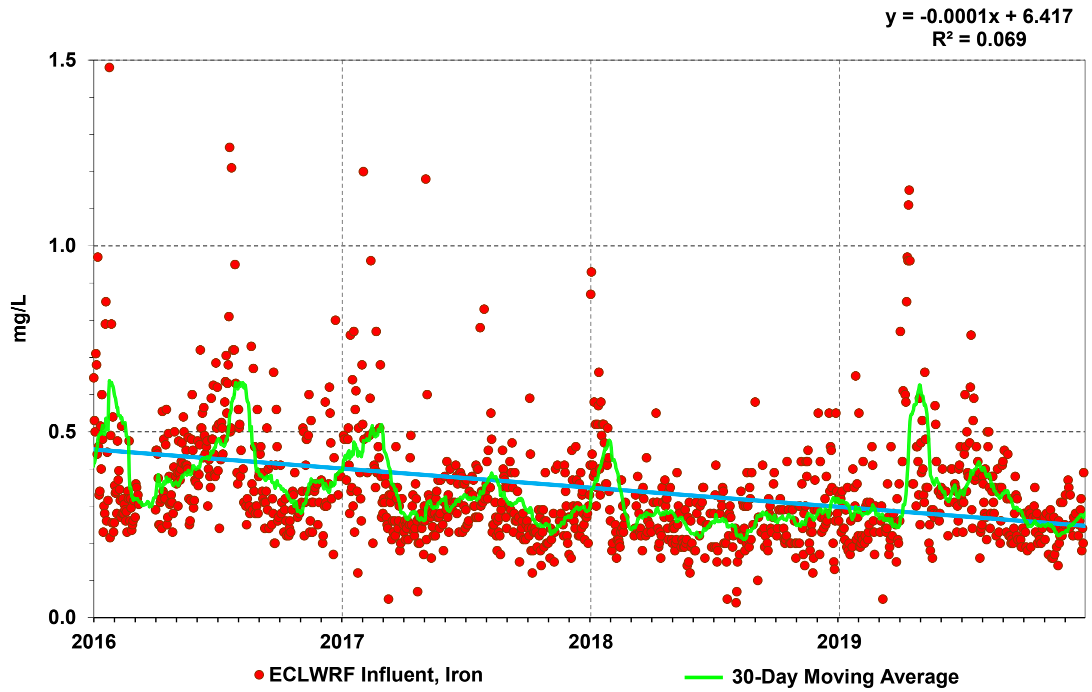
Table 4-10. Projected Year 2020 ECLWRF Influent Water Quality from 2010 PDR

Statistics	EC (µS/cm)	Turbidity (NTU)	TSS (mg/L)	TOC (mg/L)	Ammonia (mg/L)
Maximum	2,386	26	45	25	54
95th Percentile	1,845	25	21	15	50
Average	1,730	12	13	14	41
25th Percentile	-	-	-	-	-
Minimum	1,447	3	3	11	25

Source: West Basin ECLWRF Phase V Expansion Preliminary Design Report, Volume II – Part 1 of 2 (HDR, 2010).

West Basin and Suez Operations staff noted concerns regarding increased ECLWRF influent iron concentrations due to HWRP ferric chloride dosages. The Phase IV MF system is a submerged system with a maximum TMP of 12 psi, whereas the Phase V MF system is a pressurized system with a much higher maximum TMP, typically around 35 psi. ECLWRF tends to have fouling issues on the MF when HWRP secondary effluent iron levels are above 0.3 mg/L, which prompts more frequent cleaning. In addition, West Basin doses ferric chloride prior to the Phase V MF system based on a recommendation by the Pall Corporation. Period of analysis is selected from 2016 to 2019 to eliminate the few excursions over 2 mg/L, which occurred only in year 2015. Although the linear trendline for ECLWRF influent iron from 2016 to 2019 is generally decreasing, Figure 4-26 illustrates that iron concentrations consistently surpass 0.3 mg/L and with high variability.

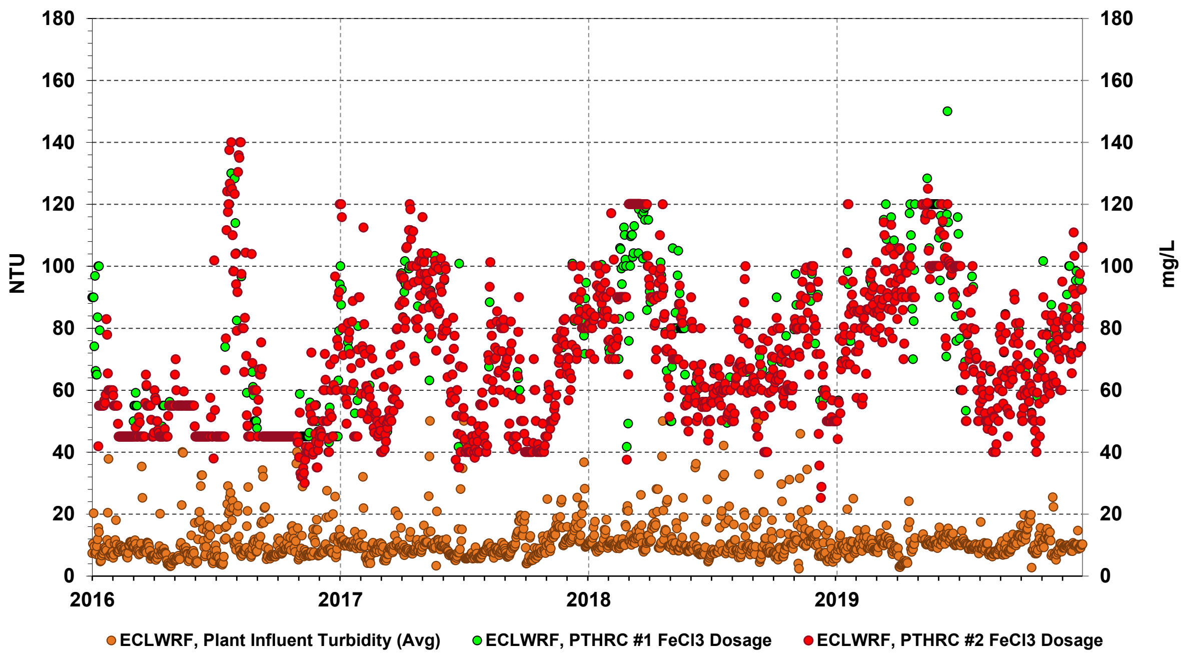
Figure 4-26. ECLWRF Influent Iron from 2016 to 2019



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

In addition, metal salt addition (i.e., ferric chloride coagulant dosing) strips out the phosphate and alkalinity concentrations necessary for biofilm growth at the Biofor systems. In response to the high and variable HWRP secondary effluent turbidity, the ECLWRF Title 22 treatment process correspondingly increases ferric chloride doses at the high-rate clarifiers (pretreatment Densadegs) to reduce turbidity to the filters (Figure 4-27). Unfortunately, some of the iron carries over in the Title 22 product to the satellite plants. The Biofor influent at TRWRP and JMMCRWRP are blended with MF backwash water, which contains 2 or 3 cycles of recycled iron. Iron concentrations are not filtered or removed in the Biofors. Furthermore, West Basin staff indicated that biofilm growth in the Biofor is phosphate-limited. TRWRP and JMMCRWRP recycles and returns phosphorus, but CNTP does not.

Figure 4-27. ECLWRF Influent Ferric Chloride and Turbidity Data (2016 to 2019)



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Barrier Water

A statistical summary of Barrier water quality is provided in Table 4-11.

Table 4-11. Barrier Water Quality Statistical Analysis (2010 to 2019)

Statistics	Ammonia (mg/L)	TDS (mg/L)	NDMA (ng/L)	Turbidity (NTU)
Maximum	6.9	130	58	2.5
95th Percentile	3.7	120	27	2.2
Average	2.5	91	6	1.2
25th Percentile	2.0	82	1	0.9
Minimum	0.4	34	0.3	0.1

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Barrier water is chlorinated; therefore, chloramine forms in the water, because there is about 3 to 5 mg/L ammonia remaining. The NDMA limit is 10 ppt; the 95th percentile and maximum suggests NDMA levels are occasionally exceeded.

Title 22

Constituents of concern for Title 22 irrigation users and for the nitrification facilities are summarized in Table 4-12. In general, ECLWRF Title 22 effluent is in compliance with water quality requirements; however, the high ammonia levels prevent cooling tower use without additional treatment and the TDS and chloride levels may not be conducive for sensitive crop growth.

Table 4-12. Title 22 Water Quality (2014-2019)

Statistics	EC (µS/cm)a	TDS (mg/L)a	TSS (mg/L)b	TOC (mg/L)a	Turbidity (NTU)c	NH3 (mg/L)a	Borona (mg/L)	Chloridea (mg/L)	Irona (mg/L)	Alkalinitya (mg/L as CaCO3)	pHa
Maximum	1,700	1,100	14	15	2.5	56	1.01	394	1.50	335	7.4
95th Percentile	1,700	1,100	4	15	2.1	55	0.75	382	1.05	326	7.0
Average	**1,406**	**894**	**2**	**12**	**1.2**	**45**	**0.48**	**303**	**0.46**	**274**	**7.1**
25th Percentile	1,300	800	2	11	0.8	41	0.40	278	0.28	250	7.0
Minimum	1,000	640	1	9	0.1	23	0	173	0	202	6.8

EC=effluent conductance.

[a] Monthly data.
[b] Weekly data.
[c] Daily data, turbidity station #1.

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

4.3.2 Nitrification Treatment Processes at Satellite Plants

The nitrification systems at the CNTP, TRWRP, and JMMCRWRP remove ammonia-nitrogen from influent Title 22 water for cooling tower application at the refineries. This is critical to prevent failure and damage to piping in the refinery cooling systems, which are sensitive to the presence of ammonia. Overall, the nitrification system converts influent ammonia into two forms that do not harm cooling tower piping:

1. Bacteria in the Biofors convert ammonia to nitrate through nitrification.
2. Chlorine is added to Biofor effluent as it enters the breakpoint reactor to convert residual ammonia-nitrogen into chloramine for nitrified product water distribution.

Relevant parameters for analysis of Biofor performance are as follows:

pH: Reduction in pH increases the risk of ammonia breakthrough. Significant drop in pH below 6.5 retards the nitrification process, whereas decreases in pH below 6.3 halts the nitrification process altogether. Conversely, higher influent pH may result in calcium precipitation, which leads to significant scaling and fouling of the Biolite media within each Biofor filter. To optimize nitrification, the pH of water must be maintained between 6.8 and 7.5.

Alkalinity: The biological oxidation of ammonia through nitrification produces acids that lowers pH; therefore, sodium hydroxide (NaOH or caustic) is added to raise alkalinity and to increase buffering capacity. The increase in alkalinity, and consequentially the increase in pH, causes scaling on the Biofor nozzles. Carbon dioxide (CO_2) is added to form carbonate alkalinity and to reduce scaling. Alkalinity of Nitrified water must be maintained at a minimum of 80 mg/L. Stoichiometrically, 1 mg/L of ammonia consumes 7.14 mg/L as calcium carbonate ($CaCO_3$) of alkalinity; however in practice, 1 mg/L of ammonia consumes about 10 mg/L as $CaCO_3$ of alkalinity.

Chlorine: Chlorine is dosed as 10 ppm per MG of residual ammonia after nitrification, with 30 minute contact time (8.3 to 1 ratio) to complete breakpoint chlorination. This not only incurs additional operational costs but also reduces usable water for cooling towers by adding TDS and chlorides into the effluent water, thus increasing frequency of blowdowns to maintain cooling tower efficiency.

Ammonia: Ammonia levels must be maintained close to 0 mg/L for cooling tower application. Each Biofor unit was originally designed (circa 1994) to handle a daily average ammonia loading of 374 lbs per day based on a flow of 1.25 mgd with an average influent ammonia concentration of 35.90 mg/L (90th percentile).

All nine Biofors at the satellite plants, collectively, were rehabilitated in 2015 after being in service for 14 to 17 years; therefore, the period of analysis examines the three most recent calendar years from 2017 to 2019. Available data of key constituents to evaluate Biofor performance at each satellite plant from 2017 to 2019 are summarized in Table 4-13.

Table 4-13. Available Satellite Plant Water Quality Data for Constituents of Interest

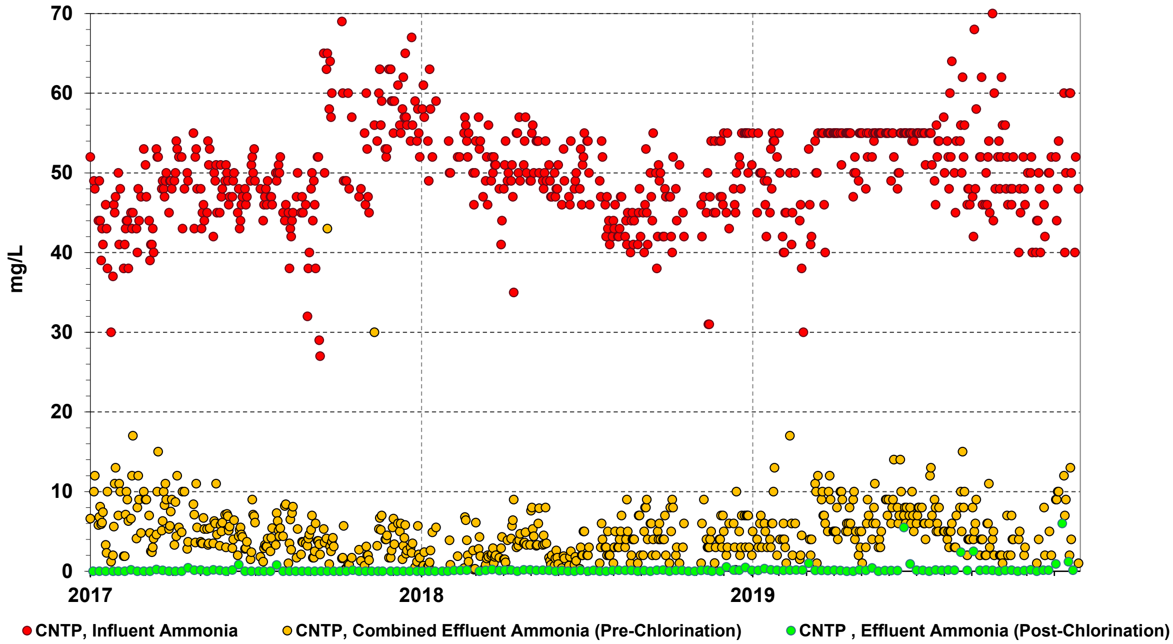
Satellite Plant	Flow	Constituent	Units	Frequency	Dates
CNTP, JMMCRWRP, TRWRP	Biofor Influent and Effluent	Ammonia	mg/L	Weekly	2017-2020
		Alkalinity	mg/L as $CaCO_3$	Weekly	2017-2020
		pH	-	Weekly	2017-2020
CNTP, JMMCRWRP, TRWRP	Biofor Pre-Cl	Ammonia	mg/L	Varies, every few days, grab samples	2014-2020

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

CNTP

Biofor influent and effluent (pre- and post-chlorination) ammonia concentrations at CNTP are illustrated in Figure 4-28, while the performance analysis of ammonia removal is summarized in Table 4-14.

Figure 4-28. CNTP Biofor Ammonia Treatment (2017 to 2019)



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Table 4-14. CNTP Biofor Ammonia Removal Performance

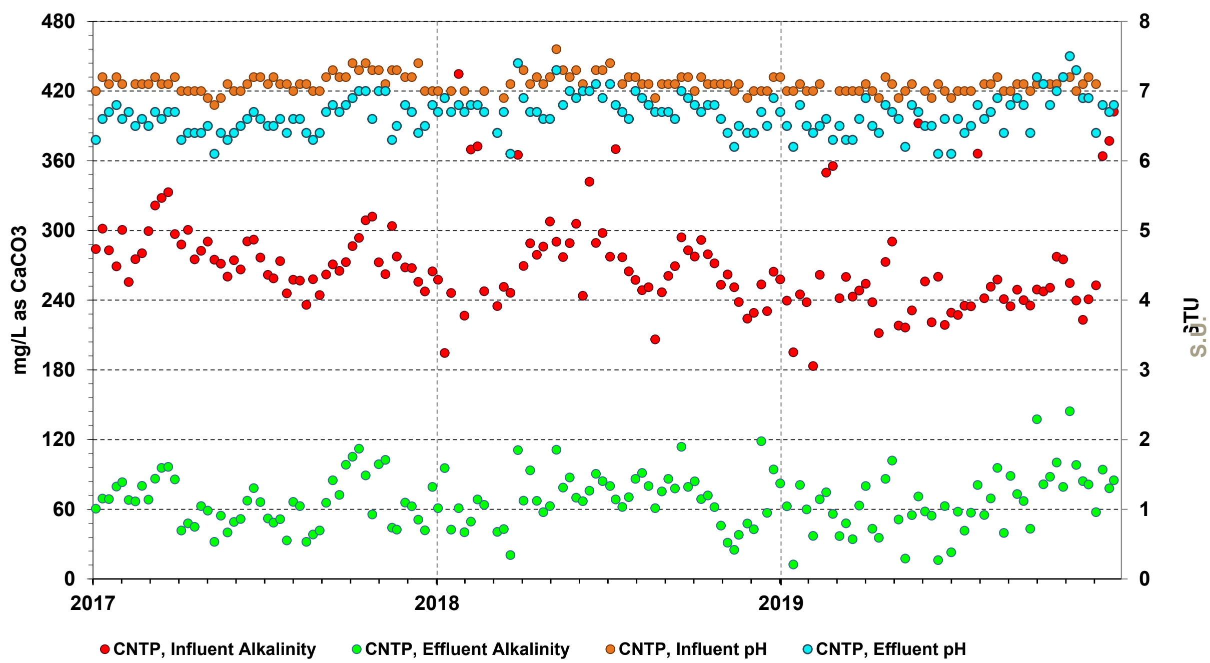
Parameter	Unit	2017	2018	2019
Influent Ammonia (90th Percentile)	mg/L	46	46	47
Total Average Feed Flow	mgd	4.0	3.7	3.8
No. of Biofor	-	4	4	4
Average Feed Flow, Each	mgd	1.0	0.9	1.0
Ammonia Loading/Day, Each	lbs/day	389	355	376
Loading Exceedance, Each [a]	%	4.0%	-5.2%	0.4%
Average Effluent Ammonia (Pre-Chlorination)	mg/L	5.4	3.5	5.4
Total Ammonia Removed (Pre-Chlorination)	lbs/day	344	328	333
Removal Efficiency (Pre-Chlorination)	%	88.4%	92.5%	88.5%
Average Effluent Ammonia (Post-Chlorination)	mg/L	0.3	0.2	0.6
Total Ammonia Removed (Post-Chlorination)	lbs/day	387	353	371
Removal Efficiency (Post-Chlorination)	%	99.4%	99.7%	98.8%
Max Effluent Ammonia (Post-Chlorination)	mg/L	0.8	0.6	6.0
No. of Ammonia Samples (Post-Chlorination)	-	52	51	52

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

[a] Based on designed performance standard for ammonia loading of 374 lbs/day, derived from design average influent ammonia concentration of 35.90 mg/L (90th percentile) and design flow of 1.25 mgd through each Biofor. Negative results indicate extent in which loading is not exceeded.

Although historical annual average flows have operated below the original design capacity of 5.0 mgd, the influent ammonia concentrations exceeded that of the design by about 10 mg/L. In 2017 and 2019, the historical ammonia loading exceeded that of design by approximately 0.4% to 4.0%. Additionally, there were a wide range of ammonia breakthroughs from around 1 to 12 mg/L as shown in Figure 4-28. The CNTP relies on chlorine addition to achieve 99% removal of ammonia by converting any remaining ammonia to chloramines. As a result of almost doubling of the influent ammonia level, even with 99% ammonia removal, the plant experienced excursions ranging from 0.2 to 0.6 mg/L on average. The gradual increase in prechlorine excursions 2017 to 2019, resulted in more frequent cleaning or rehabilitation and increases in operation cost for chlorination and sodium hydroxide. Influent and effluent alkalinity and pH at CNTP are illustrated in Figure 4-29.

Figure 4-29. CNTP Influent Alkalinity and pH (2017 to 2019)



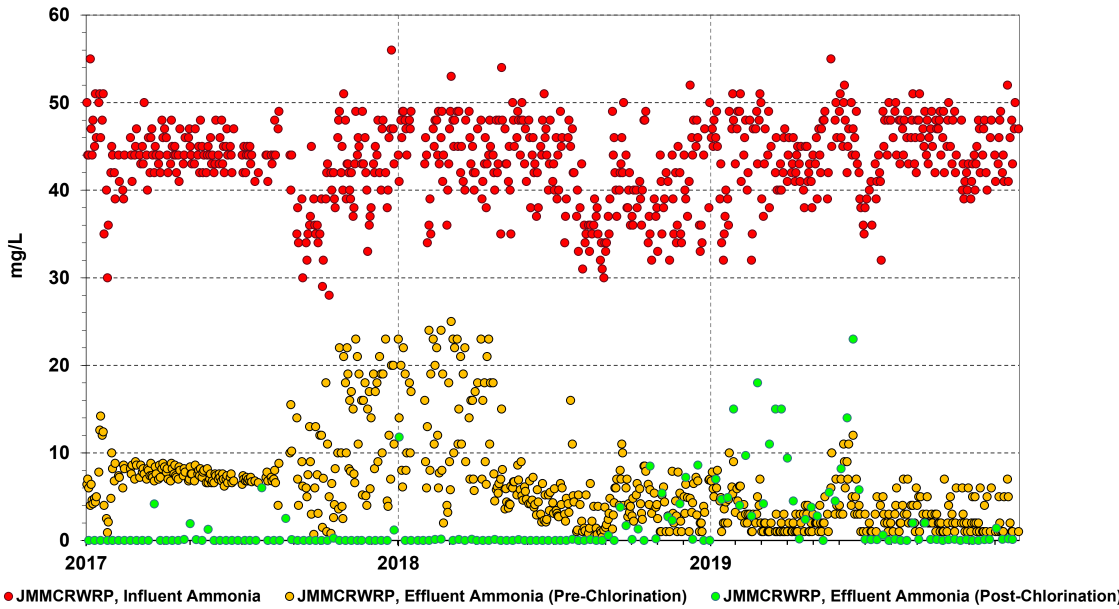
Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Historical influent pH are within optimal range for nitrification; however, that for influent alkalinity are not. Given average ammonia of around 50 mg/L, approximately 500 mg/L as $CaCO_3$ alkalinity is required to nitrify ammonia, which exceeds the average influent alkalinity of 271 mg/L as $CaCO_3$ from 2017 to 2019. Therefore, addition of sodium hydroxide (not shown) is required.

JMMCRWRP

Biofor influent and effluent (pre- and post-chlorination) ammonia concentrations at JMMCRWRP are illustrated in Figure 4-30, while the performance analysis of ammonia removal is summarized in Table 4-15.

Figure 4-30. JMMCRWRP Biofor Ammonia Treatment (2017 to 2019)



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Table 4-15: JMMCRWRP Biofor Ammonia Removal Performance

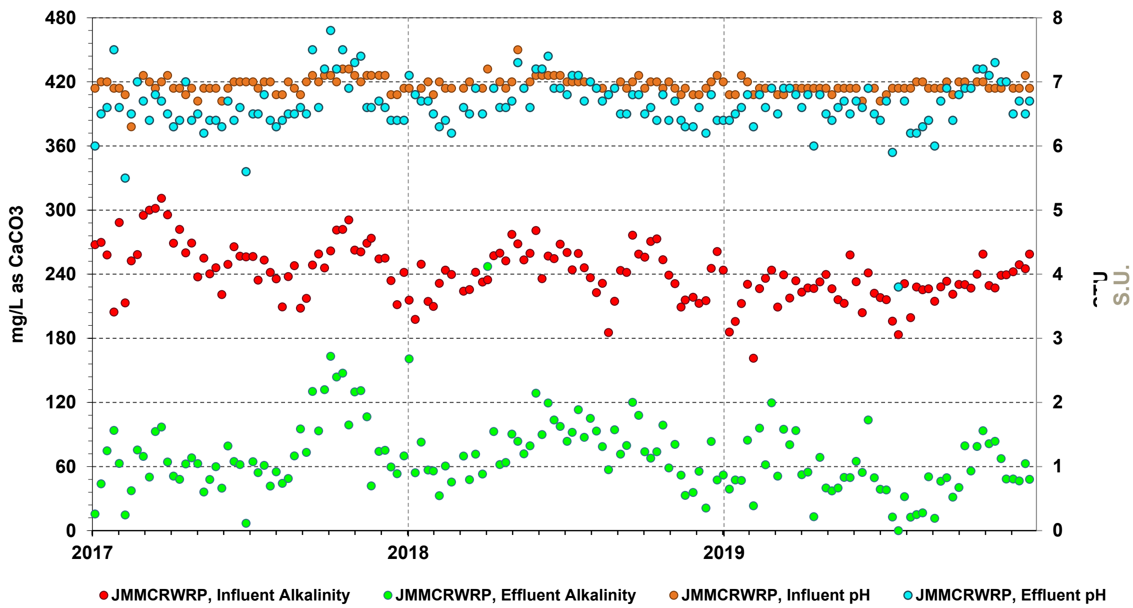
Parameter	Unit	2017	2018	2019
Influent Ammonia (90th Percentile)	mg/L	47	48	48
Total Average Feed Flow	mgd	1.0	1.0	0.8
No. of Biofor	-	1	1	1
Average Feed Flow, Each	mgd	1.0	1.0	0.8
Ammonia Loading/Day, Each	lbs/day	372	385	339
Loading Exceedance, Each [a]	%	-0.5%	2.9%	-9.5%
Average Effluent Ammonia (Pre-Cl)	mg/L	8.7	7.2	3.1
Total Ammonia Removed (Pre-Cl)	lbs/day	303	327	317
Removal Efficiency (Pre-Cl)	%	81.5%	85.0%	93.6%
Average Effluent Ammonia (Post-Cl)	mg/L	1.8	2.6	4.7
Total Ammonia Removed (Post-Cl)	lbs/day	358	364	306
Removal Efficiency (Post-Cl)	%	96.2%	94.6%	90.2%
Max Effluent Ammonia (Post-Cl)	mg/L	6.0	11.8	23.0
No. of Ammonia Samples (Post-Cl)	-	52	51	52

Source: Collection of constituent data spreadsheets ranging from 2009-2020.

[a] Based on designed performance standard for ammonia loading of 374 lbs/day, derived from design average influent ammonia concentration of 35.90 mg/L (90th percentile) and design flow of 1.25 mgd through each Biofor. Negative results indicate extent in which loading is not exceeded.

Although the historical annual average flows from 2017 to 2019 have operated below capacity of 1.25 mgd per Biofor, influent ammonia have exceeded that of design by about 10 mg/L or more, causing loading exceedance in 2018. According to Figure 4-30, there had been significant ammonia breakthrough occurrences, with excursions as high as 20 to 23 mg/L during late 2017 to early 2018. Therefore, the JMMCRWRP relies on chlorine addition to achieve at least 90% removal. In comparison to the nitrifying Biofors at the other two Satellite Plants, JMMCRWRP experiences the lowest removal efficiency post-chlorination with the highest concentrations for ammonia excursions from 2017 to 2019. Aside from having a single Biofor unit versus the four Biofor units at each of the other Satellite Plants, the JMMCRWRP Biofor treats a higher blend of MF backwash waste recycle and utilizes baffles inside a nitrification product tank rather than a breakpoint chlorination reactor. The gradual increase in prechlorine excursions 2017 to 2019, resulted in more frequent cleaning or rehabilitation and increases in operation cost for chlorination and sodium hydroxide. Influent and effluent alkalinity and pH at JMMCRWRP are illustrated in Figure 4-31.

Figure 4-31. JMMCRWRP Influent Alkalinity and pH (2017 to 2019)



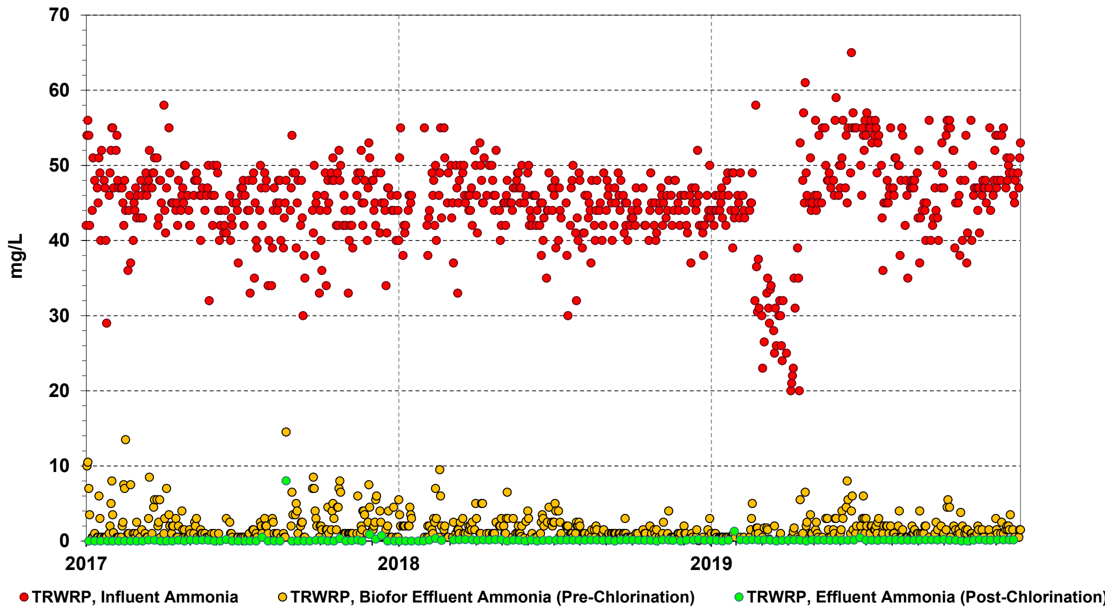
Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Historical influent pH are generally within optimal range for nitrification; however, that for influent alkalinity are not. Given average ammonia of around 43 mg/L from 2017 to 2019, approximately 430 mg/L as $CaCO_3$ alkalinity is required to nitrify ammonia, which exceeds the average influent alkalinity of 241 mg/L as $CaCO_3$ from 2017 to 2019. Therefore, addition of sodium hydroxide is required.

TRWRP

Biofor influent and effluent (pre- and post-chlorination) ammonia concentrations at TRWRP are illustrated in Figure 4-32, while the performance analysis of ammonia removal is summarized in Table 4-16.

Figure 4-32. Ammonia Treatment Through Biofors at TRWRP (2017 to 2019)



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

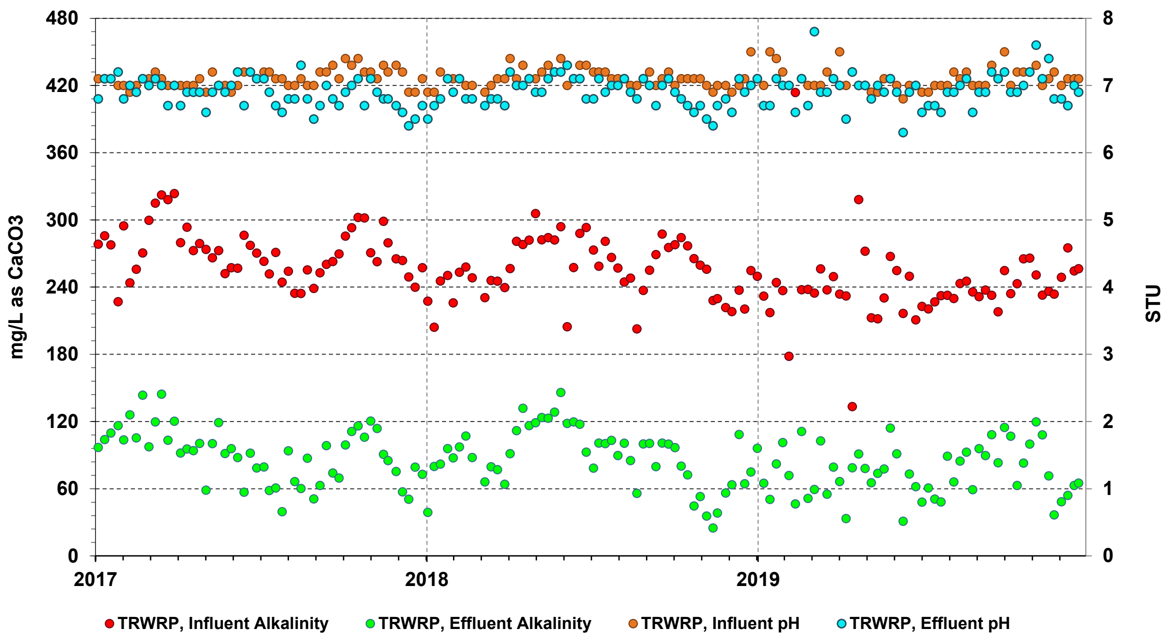
Table 4-16. TRWRP Biofor Ammonia Removal Performance

Parameter	Unit	2017	2018	2019
Influent Ammonia (90th Percentile)	mg/L	49	48	54
Total Average Feed Flow	mgd	3.1	3.5	3.0
No. of Biofor	-	4	4	4
Average Feed Flow, Each	mgd	0.77	0.88	0.75
Ammonia Loading/Day, Each	lbs/day	316	352	338
Loading Exceedance, Each [a]	%	-15.5%	-5.9%	-9.7%
Average Effluent Ammonia (Pre-Cl)	mg/L	2.0	1.4	1.2
Total Ammonia Removed (Pre-Cl)	lbs/day	303	342	330
Removal Efficiency (Pre-Cl)	%	95.9%	97.1%	97.7%
Average Effluent Ammonia (Post-Cl)	mg/L	0.7	0.1	0.2
Total Ammonia Removed (Post-Cl)	lbs/day	312	351	337
Removal Efficiency (Post-Cl)	%	98.6%	99.7%	99.7%
Max Effluent Ammonia (Post-Cl)	mg/L	8.0	0.3	1.3
No. of Ammonia Samples (Post-Cl)	-	52	51	52

Source: Collection of constituent data spreadsheets ranging from 2009-2020.
[a] Based on designed performance standard for ammonia loading of 374 lbs/day, derived from design average influent ammonia concentration of 35.90 mg/L (90th percentile) and design flow of 1.25 mgd through each Biofor. Negative results indicate extent in which loading is not exceeded.

Ammonia loading did not exceed that for design from 2017 to 2019. Since ammonia loading at TRWRP is the least burdensome on the Biofors compared to that at the other Satellite Plants, ammonia breakthrough is the least, averaging at around 1.5 mg/L out of the Biofor. However, chlorination is still necessary for 99% removal. The contractual limit for ammonia is 2.0 mg/L, but the preferred target is 0.1 mg/L. Meeting this target was more difficult due to gradual increases in effluent ammonia between 2017 and 2019 requiring more frequent cleaning or rehabilitation and increases in operation cost for chlorination and sodium hydroxide. Influent and effluent alkalinity and pH at TRWRP are illustrated in Figure 4-33.

Figure 4-33. Alkalinity and pH at TRWRP (2017 to 2019)



Source: Collection of constituent data spreadsheets ranging from 2009-2020.

Historical influent pH are generally within optimal range for nitrification; however, that for influent alkalinity are not. Given average ammonia of around 46 mg/L from 2017 to 2019, approximately 460 mg/L as $CaCO_3$ alkalinity is required to nitrify ammonia, which exceeds the average influent alkalinity of 256 mg/L as $CaCO_3$ from 2017 to 2019. Therefore, addition of sodium hydroxide is required.

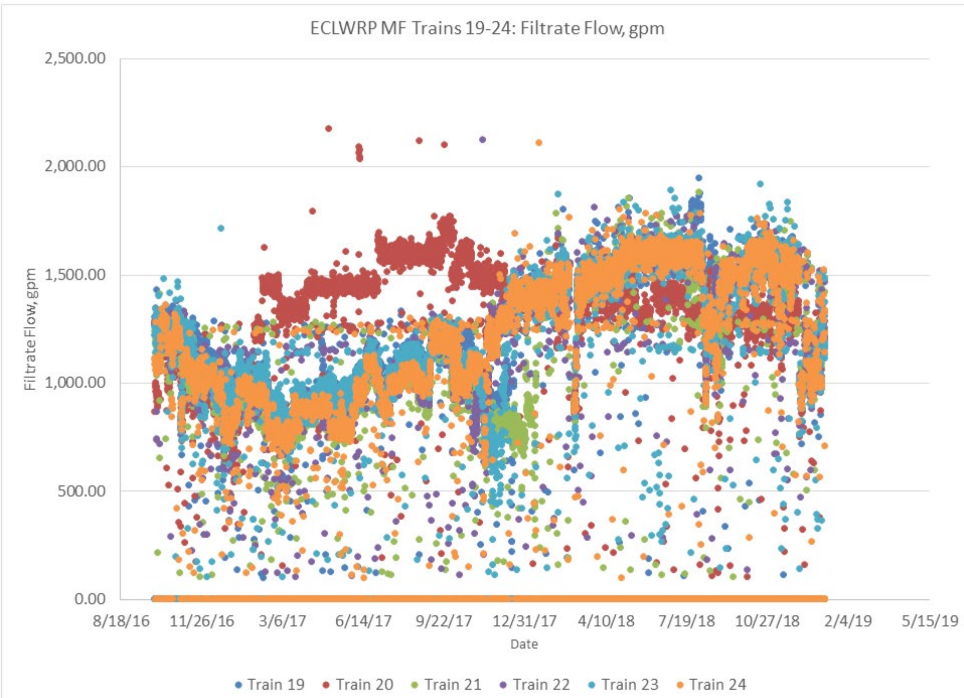
4.3.3 Membrane Treatment Performance

West Basin utilizes MF, UF, and RO membrane systems to treat the Hyperion secondary effluent at ECLWRF and to treat Title 22 product water at the satellite plants. This section presents operating data for the various membrane systems at ECLWRF and the satellite plants. Although exceptions may occur, West Basin generally prefers to maintain a consistent operation and maintenance schedule for each rack or train of membranes for consistent performance among that grouping of membranes. This helps establish a routine to monitor membrane system performance and also to identify whether potential issues represent a consistent trend or pattern or if the issue is an isolated incident.

ECLWRF MF Treatment Process

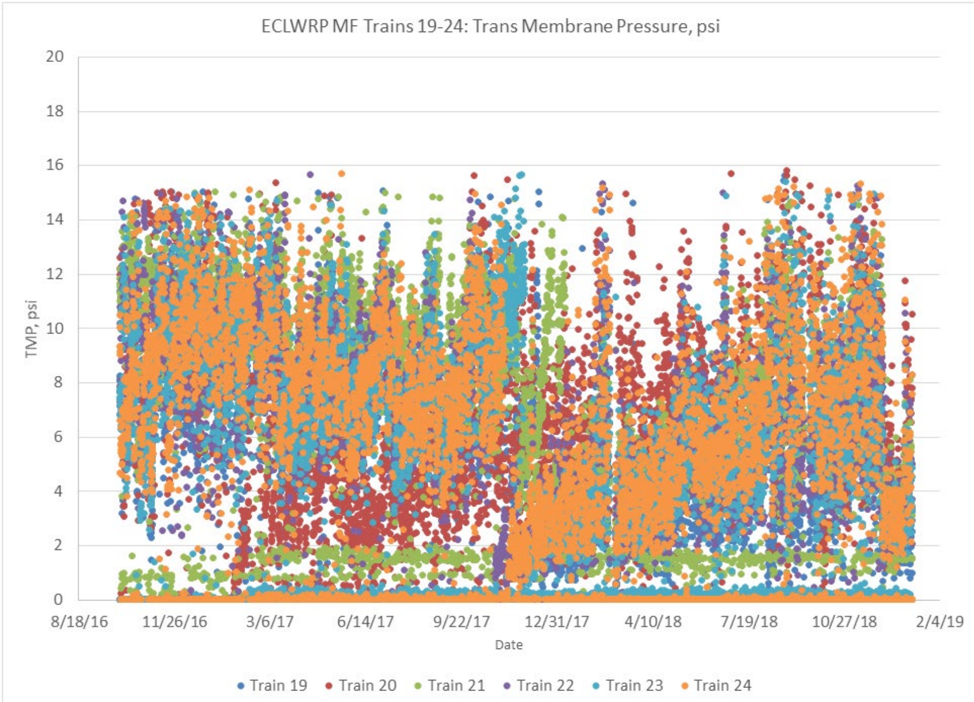
Since 2017-2018, the main MF membrane systems at ECLWRF include submersible MF membranes system (Phase IV Expansion, currently Scinor PVDF membranes), Pall pressurized MF system (Phase V and the Expansion Project, PVDF membranes), and two mobile pressurized MF systems (Trailers 45 and 46, PVDF membranes). The mobile trailers were installed in 2017 and have been operating continuously since early 2018 and the Pall expansion units to Phase V were commissioned in April 2019.The Phase II MF membrane system is not operational due to age and have been decommissioned; while Phase III MF system has been on standby mode since 2018.The Phase IV MF system consists of Units 19-24 and produced an average filtrate flow of 1,500 gpm after installation of Scinor membranes in late 2017 as shown in Figure 4-34. From April 2018 through January 2019, the system maintained a consistent flow rate of 1,500 gpm with a gradual increase of differential transmembrane pressure (TMP) from 2 psi up to 12 psi (Figure 4-35).

Figure 4-34. ECLWRF Phase IV MF Units 19-24 Filtrate Flow



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

Figure 4-35. ECLWRF Phase IV MF Units 19-24 TMP

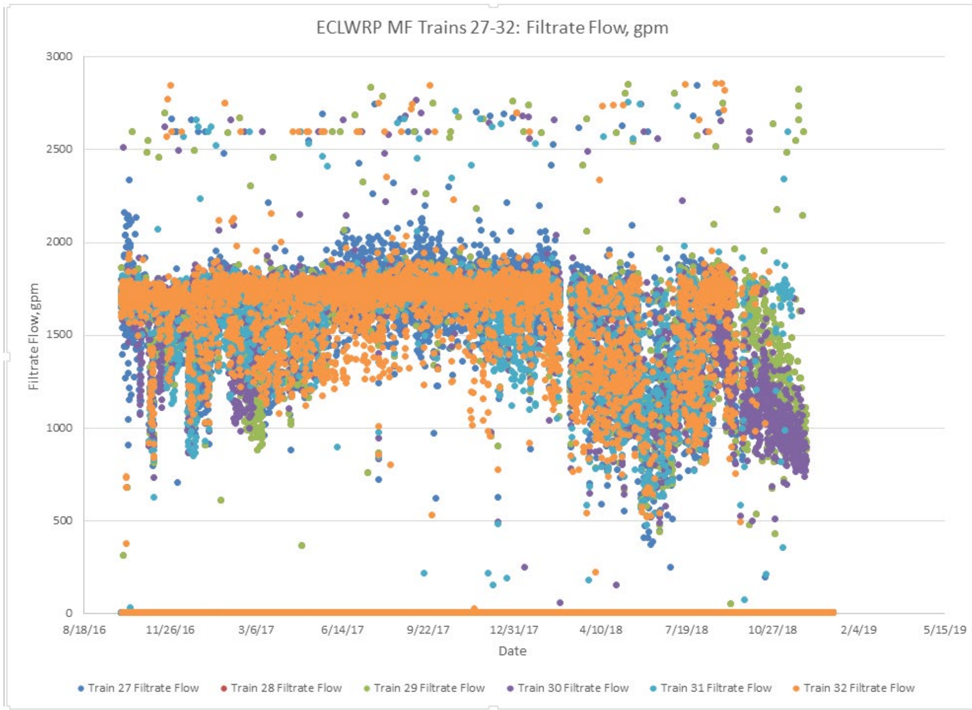


Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

This increase in TMP is typically due to the increase in feed turbidity and high organics in HWRP's secondary effluent water. As the feed water turbidity increases the MF system differential pressure typically increases. With higher turbidity in the feed system the MF system is forced to increase the number of backwash sequences to control fouling. The backwash is complemented with daily maintenance cleans to ensure the system maintains performance throughout the fouling event. In August 2018, there was a dip in filtrate flow to 1,200 gpm, which is a 20% decrease in flow. The Phase IV MF system completed a recovery clean and performance improved since the filtrate flow was back at 1,500 gpm.

The ECLWRF Phase V MF system consists of Units 27-32 with Pall Microza PVDF membranes. This membrane system produced an average filtrate flow of 1,750 gpm for all units as shown in Figure 4-36.

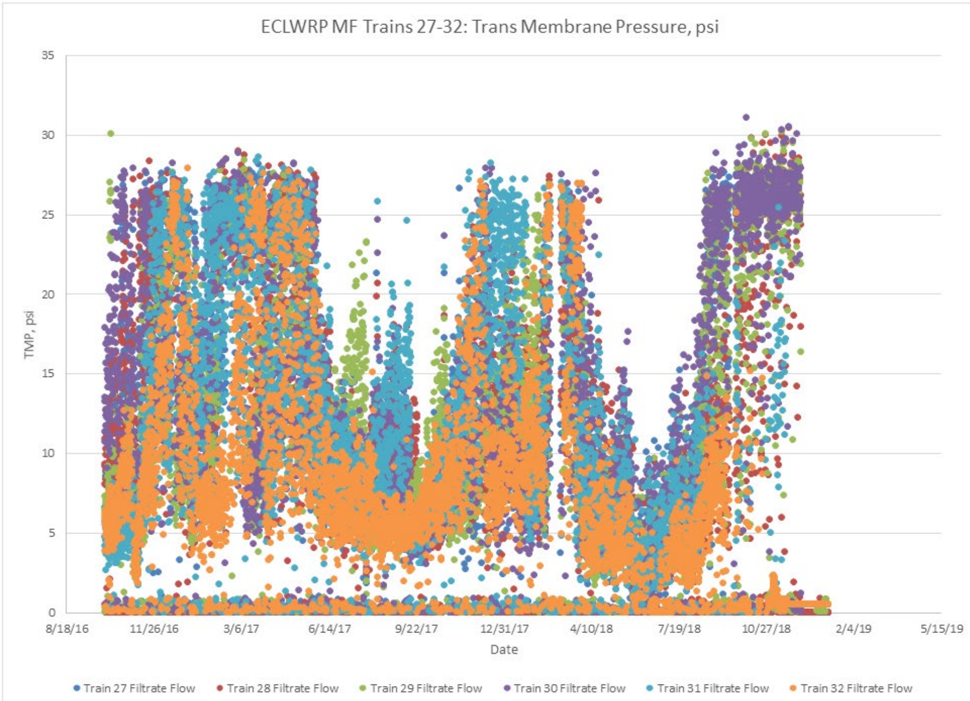
Figure 4-36. ECLWRF Phase V MF Units 27-32 Filtrate Flow



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

From October 2016 through September 2018, the system maintained a constant average flow of 1,750 gpm with an increase in TMP from 5 psi up to 28 psi from the same time span (Figure 4-37). West Basin added Units 33-34 to the Phase V MF system in January 2019 and the Pall MF Expansion Units 33-34 were commissioned in April 2019.

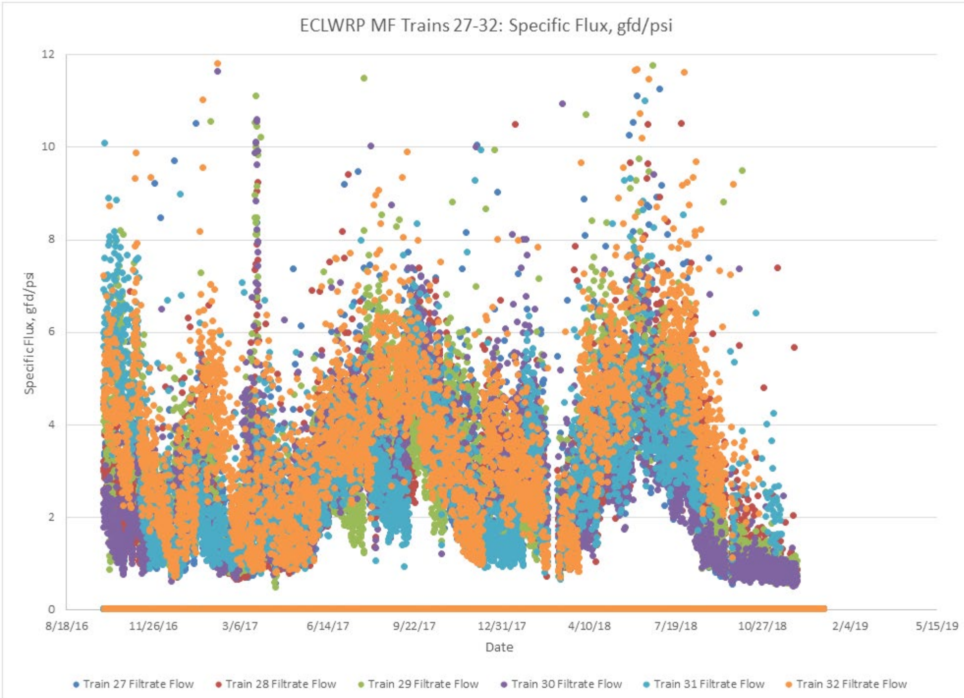
Figure 4-37. ECLWRF Phase V MF Units 27-32 TMP



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

Similar to the submersible MF, the increase in TMP has been due to the increase in feed water turbidity. As the feed water turbidity increases the MF system TMP increases while the specific flux decreases. The specific flux for these systems would operate at a range from 1 to 8 gallons per square foot per day per psi (gfd/psi). The specific flux is affected by the increase in feed turbidity as shown in Figure 4-38.

Figure 4-38. ECLWRF Phase V MF Units 27-32 Specific Flux

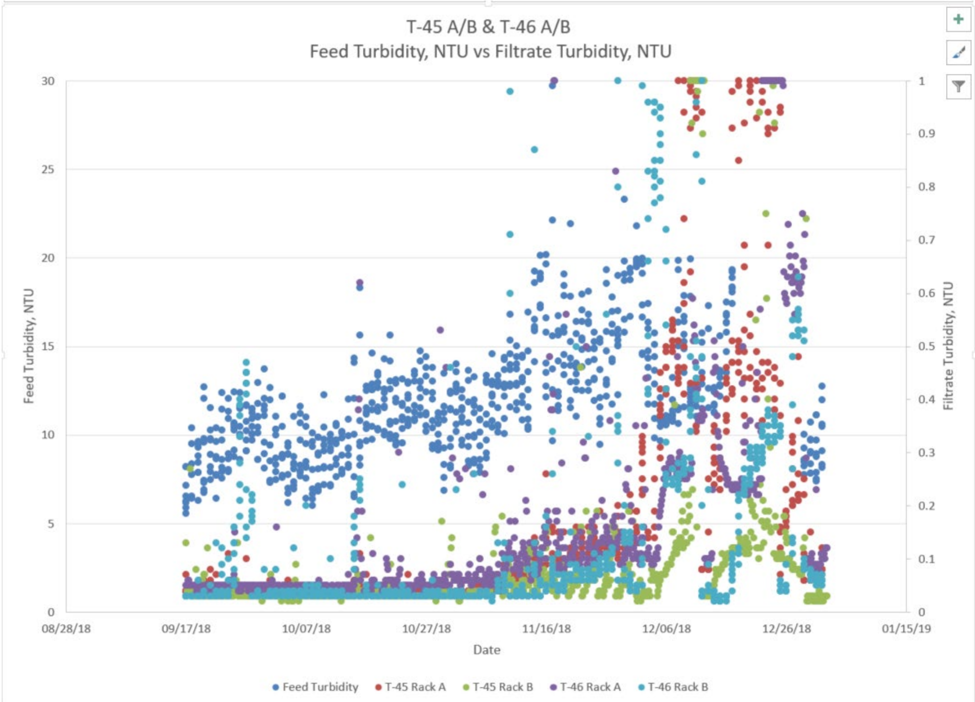


Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

As the feed turbidity would increase from 4 NTU up to 16 NTU, the specific flux performance would decrease from 8 gfd/psi to 1 gfd/psi. This decrease in specific flux across all the MF systems leads to increased backwashes as well as recovery cleans. After the recovery cleans, the specific flux would recover back to 6 to 8 gfd/psi. As operation continued and the feed turbidity would increase the MF performance specific flux would decrease back to 1 gfd/psi and the TMP would increase to 20 psi with increased turbidity. This is noticed with the recovery cleans as the membranes system regain their performance and come close to their baseline. With improved feed water quality at ECLWRF the MF systems would perform at steady specific flux rates and maintenance clean would address gradual increases of TMP and be able to bring system performance back to their baseline. Filtrate quality throughout the membrane life has remained at less than 0.1 NTU.

As a result of declined in performance from the Phase II and Phase III MF systems, West Basin purchased and installed two mobile MF units in 2017 to supplement Chevron BF demands. Each mobile MF units has two racks (Racks A and B) and consists of 40 membranes each. The specific flux of the membranes began operating at 1.5 gfd/psi and gradually trended downward toward 0.5 gfd/psi. This downward trend is related to the increase in feed turbidity into the system. As the system began operating in mid-September, the feed turbidity ranged between 6 to 14 NTU through mid-November 2018 (Figure 4-39).

Figure 4-39. ECLWRF Pall MF Units 45 and 46 Feed and Filtrate Turbidity

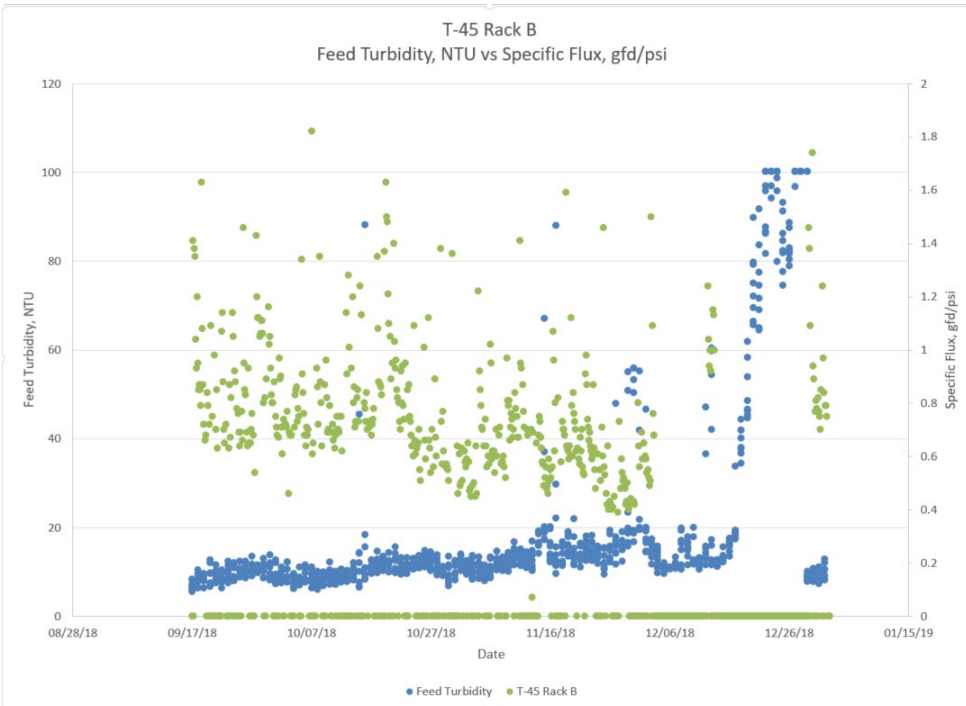


Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

In this period the specific flux was between 0.5 to 1.5 gfd/psi and the TMP increased from 7 to 25 psi. This increase in differential pressure and decrease in specific flux leads to higher rates of backwashes and maintenance cleans. The feed turbidity continued to increase into winter and reached values as high as 20 NTU in late December. Although the feed turbidity kept increasing, the effluent turbidity remained constant at less than 0.2 NTU. In late December, there was an increase to 0.6 NTU for a brief moment, but the system restarted in January 2019 with an effluent quality of 0.1 NTU. The brief increase in effluent turbidity could be a result of the increase in feed turbidity overtime from November through the end of December. Figure 4-40 shows the specific flux on Trailer 45 (T-45) Rack B versus feed turbidity.

The MF units all behave similarly in regard to performance. As feed turbidity increase the MF performance decreases in flow and increases in TMP. This is based on data analyzed. See Appendix H for additional charts for individual MF system performance.

Figure 4-40. ECLWRF Pall MF Unit 45 Rack B Feed Turbidity and Specific Flux



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

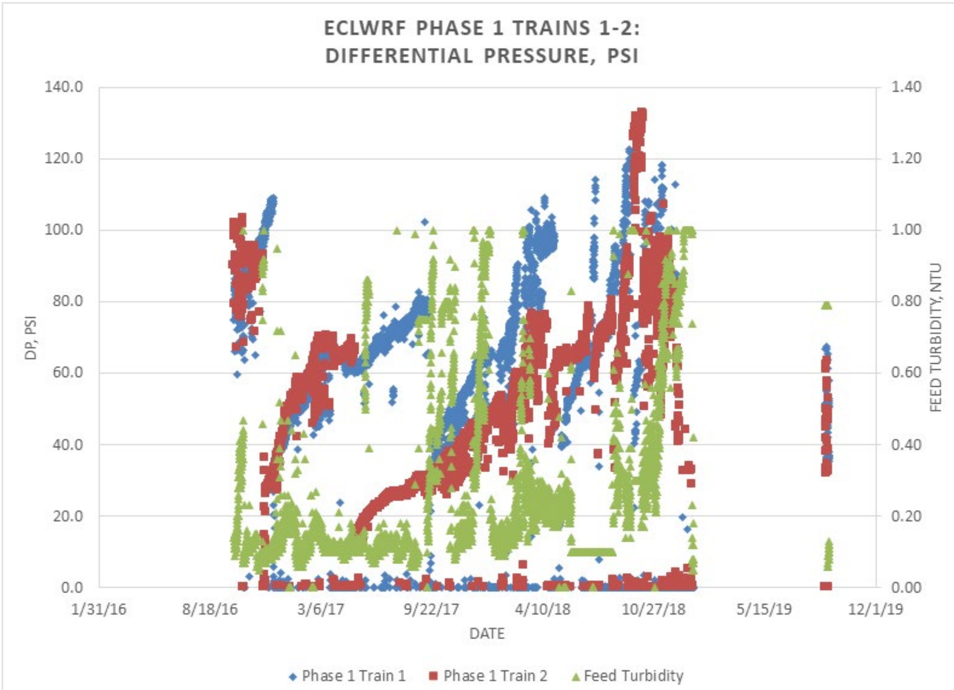
ECLWRF RO Treatment Process

The RO system at ECLWRF consists of 11 trains that were constructed at each capacity construction and expansion, Phase I through Phase V. RO Trains 1 through 5 and Trains 9 through 11 have the same feed water source which is supplied by the MF systems. Trains 6 through 8 are second pass RO trains which are fed from the LPBF well and produce high quality RO treated water to feed the high-pressure boiler system for the Chevron Refinery. In general, West Basin uses the following terminology for the RO Trains:

- Barrier Trains: RO Trains 1, 2, and 9-11; RO Train 3 (swing - Train 3 can serve either the Barrier system or the LPBF system)
- Chevron LPBF Trains: RO Trains 4-5; RO Train 3 (swing)
- Chevron HPBF Trains: RO Trains 6-8

During the analysis period of 2016-2019, the normalized permeate flow (NPF) of the Barrier RO Trains 1 and 2 had a steep decline in performance within 4 to 6 weeks. As a rule of thumb, all membrane manufacturers recommend a recovery clean for their RO membranes when there is a decrease in NPF by 15% or an increase in differential pressure across the membrane of 20%. The RO Train 1 runs at 85% recovery with an average permeate flow of 2,000 gpm. The steep decline in NPF and increase in differential pressure shows how quickly the membranes were being fouled. During this period, the MF filtrate quality was not optimal due to Phase II and III and compromised Phase V MF qualities, which contributed significantly to the quick decline in RO performance The differential pressure from December 2016 through March 2017 shows an increasing trend from 32 psi up to 64 psi. This increase in differential pressure and decrease in NPF is due to the increase in feed water turbidity as shown in Figure 4-41.

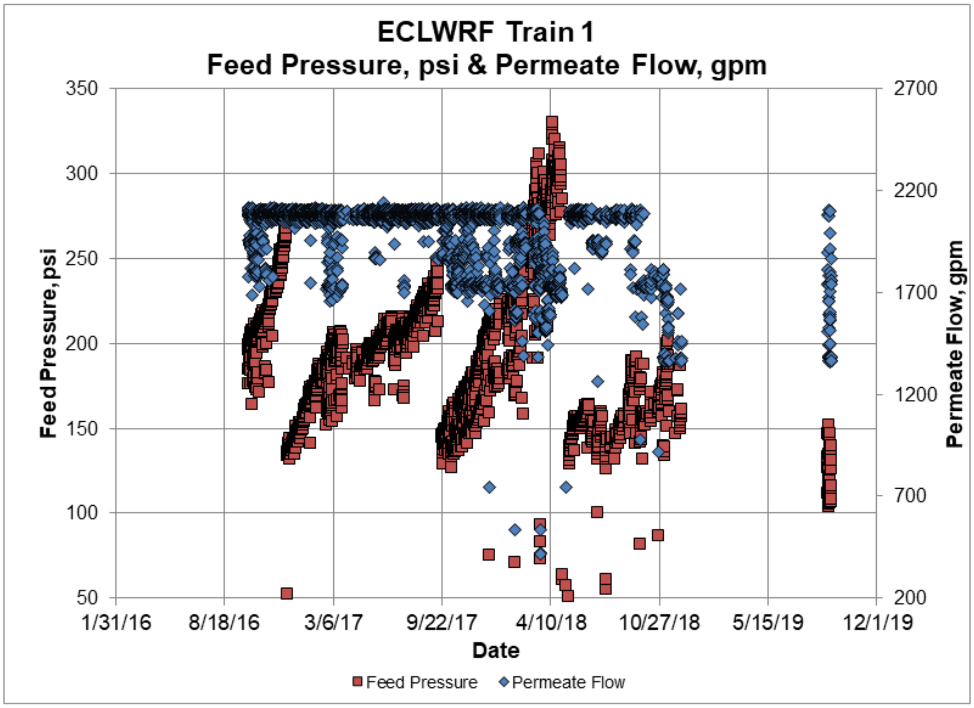
Figure 4-41. ECLWRF Barrier RO Trains 1 and 2 Differential Pressure and Feed Turbidity



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

Increased feed turbidity results in an increase in feed pressure and differential pressure, as well as a decrease in NPF. This leads to increased recovery cleans and energy consumption since the feed pumps will need to supply higher pressures to maintain the same level of permeate production to meet demand. Although there has been a decrease in NPF, the system has maintained a steady normalized salt passage (NSP) producing a permeate quality of less than 150 μS/cm throughout the life of the RO membrane. The feed pressure and actual RO permeate flow of Train 1 are shown in Figure 4-42.

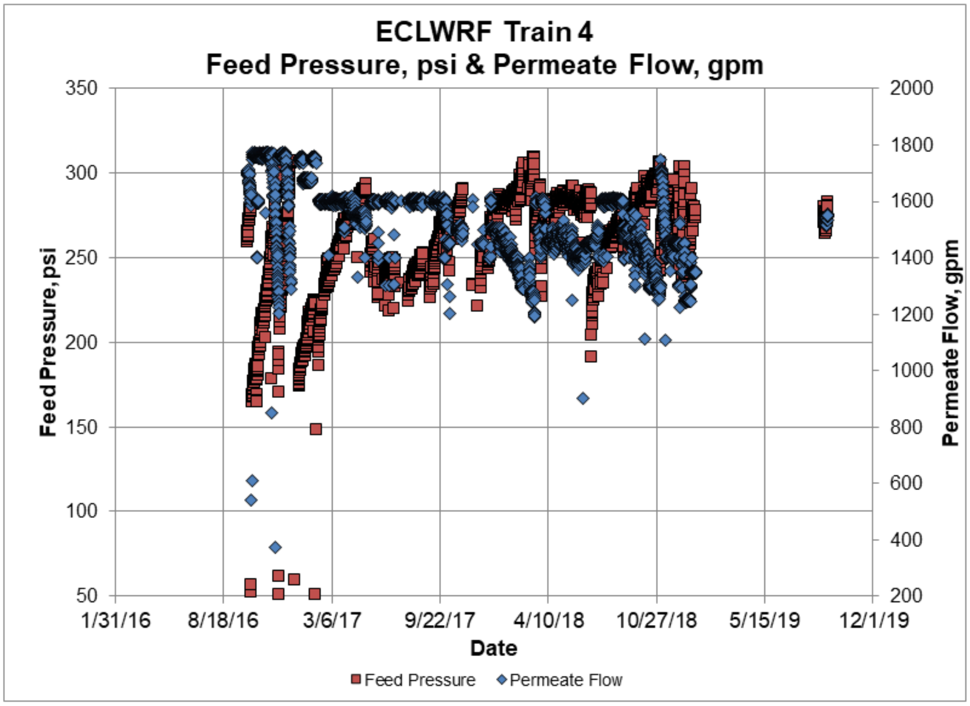
Figure 4-42. ECLWRF Barrier RO Train 1 Feed Pressure and Permeate Flow



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

Chevron LPBF RO trains consist of Trains 3, 4, and 5 and perform similarly to Barrier RO Trains 1 and 2. With increases in feed turbidity, the NPF decreases while the feed and differential pressure across the membranes increase. The membrane performance for RO Trains 4 and 5 have been cyclical, with membrane cleans conducted every 3 months and the performance nearly recovering back to baseline in 2018. Permeate water quality is consistent at less than 100 µS/cm, and the recovery for these trains was consistent at 83%. The feed pressure and permeate flow for Chevron LPBF RO Train 4 is shown in Figure 4-43.

Figure 4-43. ECLWRF Chevron LPBF RO Train 4 Feed Pressure and Permeate Flow

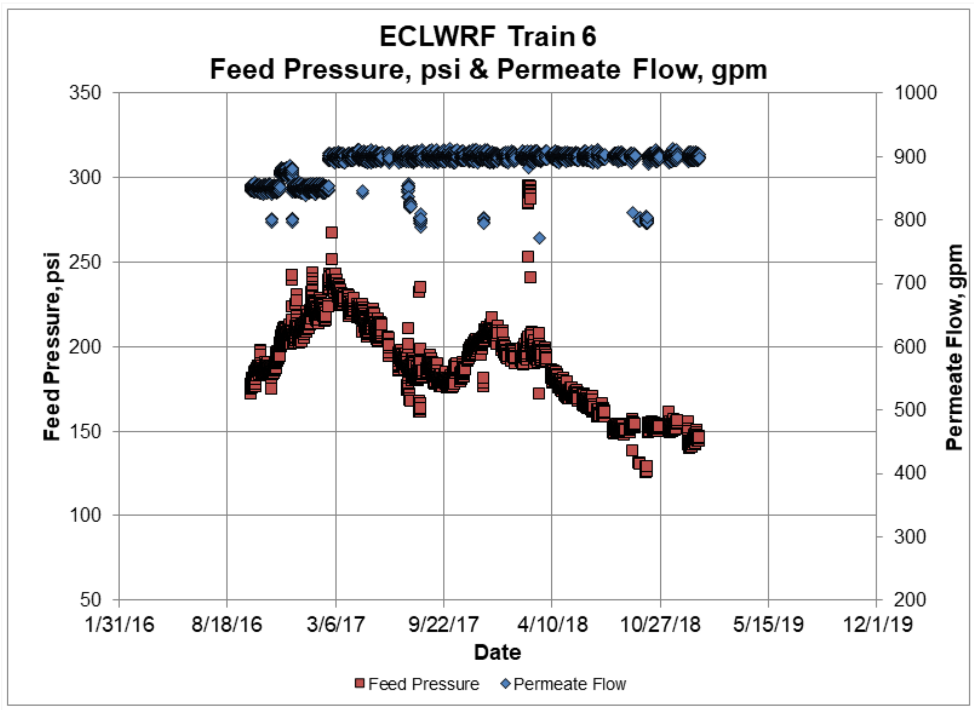


Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

As mentioned previously, RO Trains 6 through 8 produce HPBF water to the Chevron Refinery. The feed water for these RO trains comes from the LPBF well, which is a combined permeate quality of RO Trains 1 through 5 and Trains 9 through 11. This improved RO feed water quality with lower concentrations of organics and foulants extends membrane life and performance.

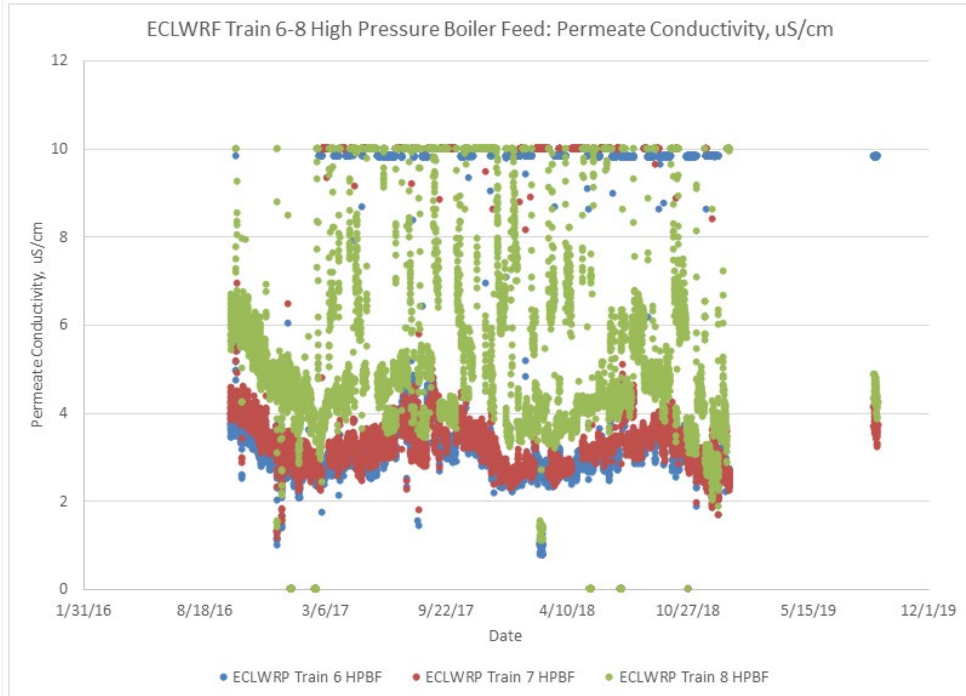
The NPF for Chevron HPBF RO Trains 6 through 8 show that they do not have the high fouling rate compared to the other RO trains. The differential pressure gradually increases by 10 psi in a duration of 8 months. This leads to recovery cleans to be conducted only once a year and the membrane life is extended due to the improved feed quality. The permeate quality for these systems had much lower EC levels at less than 10 µS/cm consistently. The NPF is steady and does not show a rapid decline compared to the other RO trains. The RO Train 6 feed pressure and permeate flow is shown in Figure 4-44, and Figure 4-45 illustrates permeate conductivity for RO Trains 6 through 8.

Figure 4-44. ECLWRF Chevron HPBF RO Train 6 Feed Pressure and Permeate Flow



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

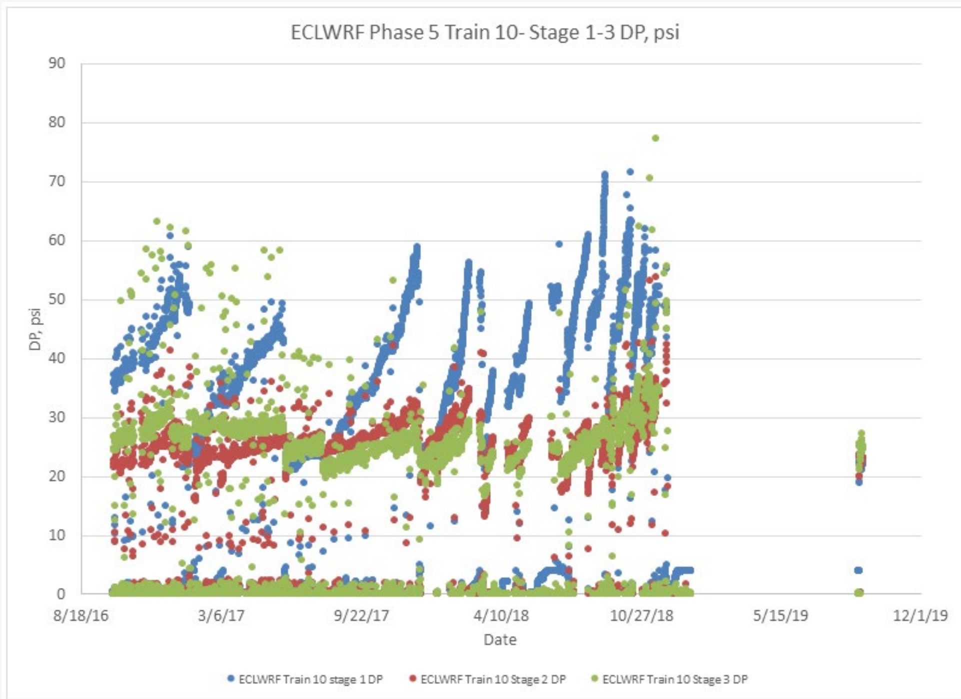
Figure 4-45. ECLWRF Chevron HPBF RO Trains 6 - 8 Permeate Conductivity



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

While Train 9 data was analyzed, flowmeters for the first and second stages were not available to represent system performance and are not included in this evaluation. Barrier RO Trains 10 and 11 consist of three-stage RO systems and were constructed during the Phase V expansion. Similar to other RO trains, the high feed turbidity leads to higher fouling rates and these trains behave similarly. These RO trains have interstage pressure gauges which show the increase in differential pressure between each stage. As shown in Figure 4-46, the first stage of RO Train 10 experienced the greatest increase in differential pressure compared to the second and third RO stages.

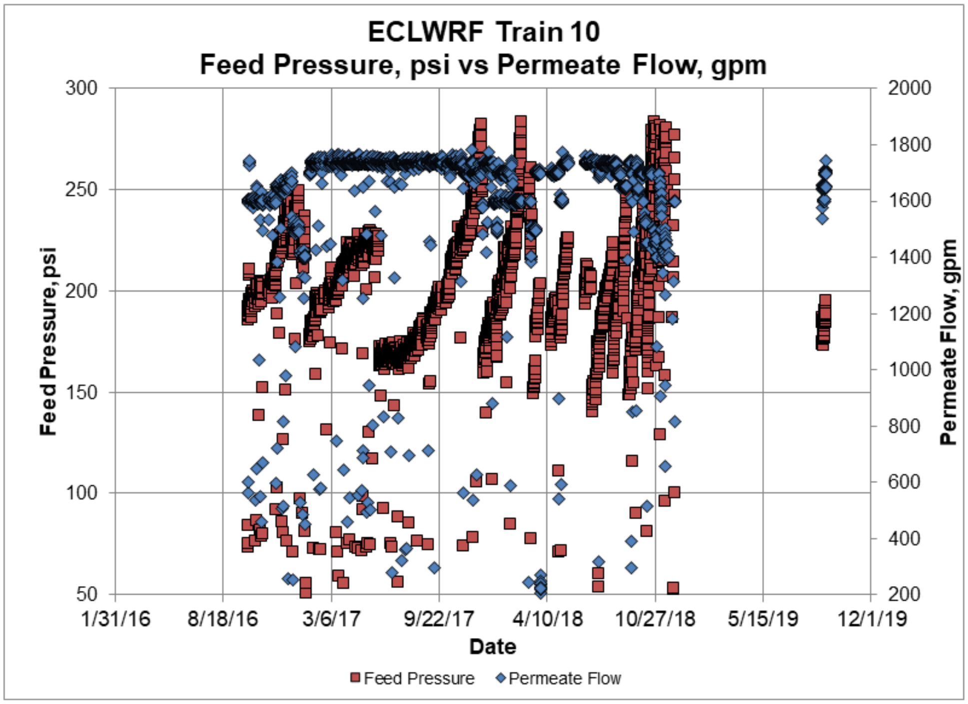
Figure 4-46. ECLWRF Barrier RO Train 10 Inter-stage Differential Pressure



Source: Collection of monthly process data spreadsheets ranging from 2016-2020.

This three-stage configuration leads to a decrease in NPF and an increase in feed pressure throughout each of the interstages for the entire train. The increase in feed pressure and actual permeate flow is shown in Figure 4-47 for RO Train 10. These trends show with a fixed flow of 1,700 gpm the feed pressures increase to maintain the same level of production due to the foulants in the feed water. Recovery cleans are being conducted every two months to maintain low feed pressures. Substandard MF filtrate quality prior to 2019 has contributed to relatively poor RO performance. As mentioned with the other RO trains, as the feed turbidity increases the NPF decreases, feed pressure and differential pressures increase.

Figure 4-47. ECLWRF Barrier RO Train 10 Feed Pressure and Permeate Flow



Source: Raw data provided by West Basin.

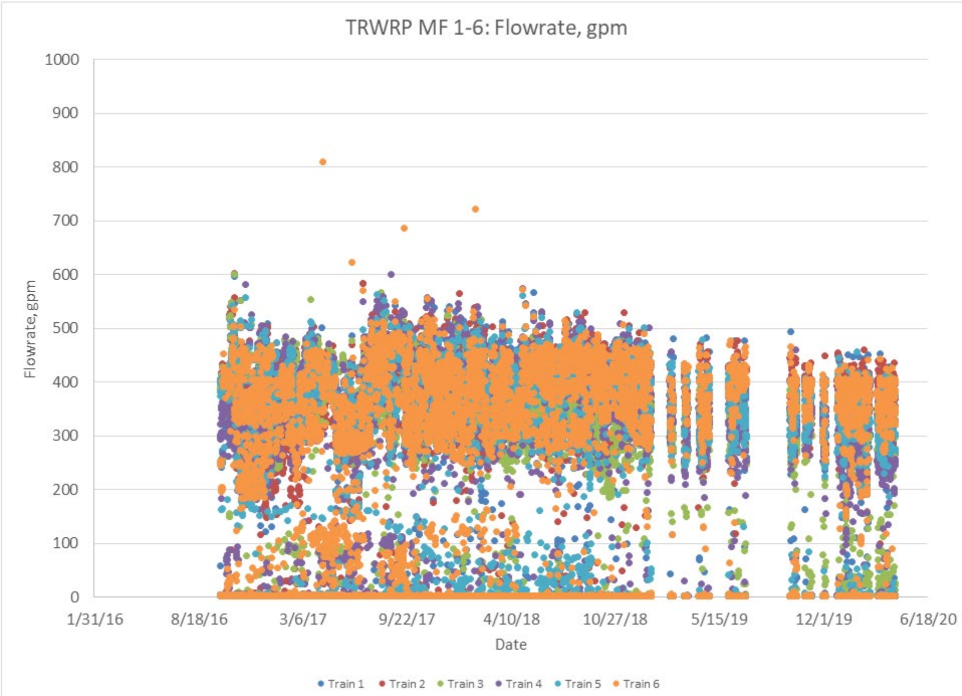
TRWRP MF and RO Treatment Process

The LPBF membrane system at TRWRP includes six MF units. These Evoqua/Filmtec pressurize system are constructed in 1998 and house PP membranes that do not allow the enhanced cleaning protocol. The plastic center tube and the blocks (header) of these MF units have integrity issues similar to the ECLWRF Phase II and III MF units. West Basin and Suez Operations staff cannot perform pressure integrity testing on these older systems due to leakages through cracks.

The feed water comes from the Title 22 distribution system. Feed water quality to the Satellite Plants MF system is better than the feed to the ECLWRF MF membranes since the Title 22 water has been treated by the HRC and tertiary filters. TRWRP MF feed turbidity is an average of 2 NTU but occasionally increases to 4 or 6 NTU, which could be due to sediment from the transmission line due to pressure spikes and start-up/shut-off of the system. As the feed turbidity increases, there is an increase in TMP from 5 to 20 psi, which may be due to higher iron concentrations resulting from water quality issues at the main plant. Each of the MF trains produce a filtrate flow between 300 and 450 gpm with similar performance. Turbid events increase the TMP and decrease filtrate flow, but the membrane system does not have significant performance changes. These events only caused a slight decline in performance. The maintenance cleans and recovery cleans maintain the operating range of filtrate flow since 2016. Figure 4-48, Figure 4-49, and Figure 4-50 show the MF filtrate flow, TMP, and feed turbidity at TRWRP.

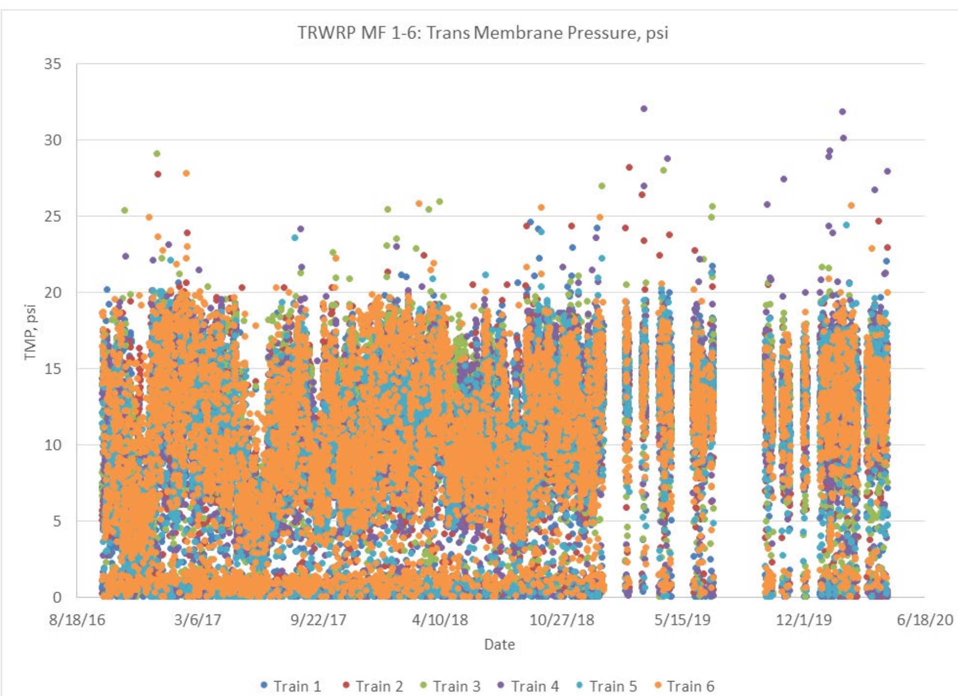
The TRWRP MF system design filtrate capacity is 3.73 mgd (518 gpm per unit) but is only able to produce 86% of design capacity under new conditions due to backwash and cleaning cycles. As membranes age, they are normally operating down to high 50% to 60% of design capacity, and West Basin must supplement production with potable water to meet LPBF demand.

Figure 4-48. TRWRP MF Trains 1 - 6 Filtrate Flow



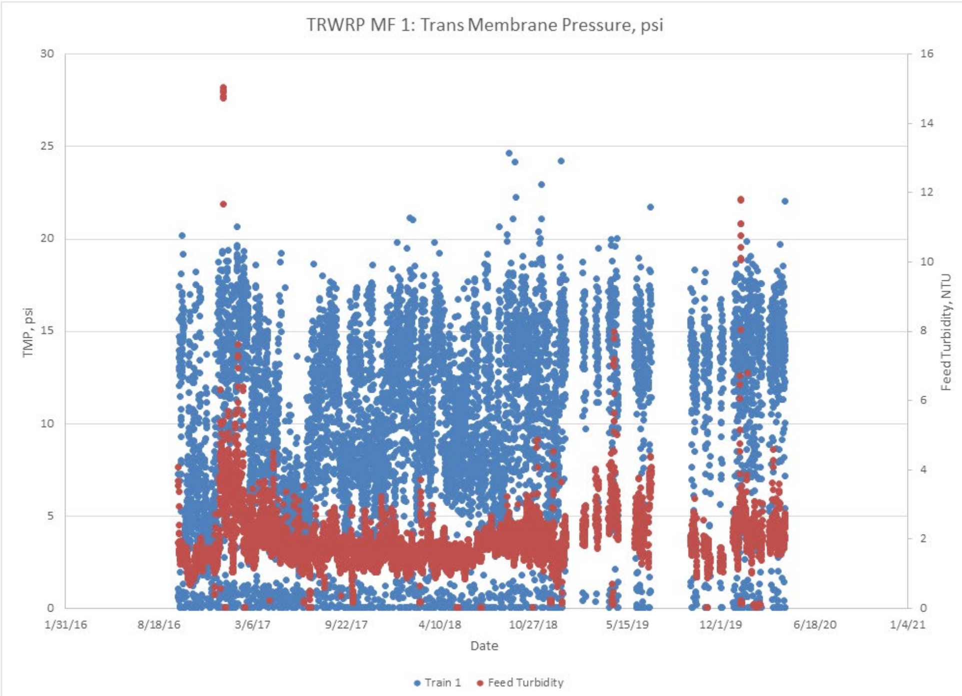
Source: Raw data provided by West Basin.

Figure 4-49. TRWRP MF Trains 1 - 6 TMP



Source: Raw data provided by West Basin.

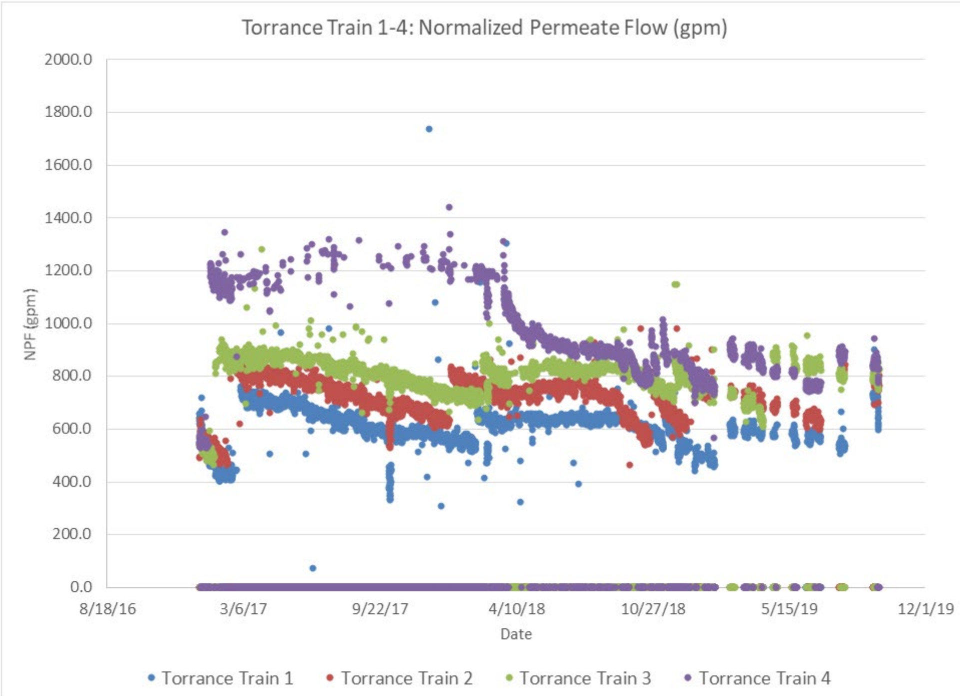
Figure 4-50. TRWRP MF Train 1 TMP and Feed Turbidity



Source: Raw data provided by West Basin.

The TRWRP RO system consists of four identical trains with similar performance. Each RO train operates at a recovery of 85% with a permeate flow of 650 gpm. The RO system exhibited a gradual decrease in performance as seen by the reduced NPF in Figure 4-51.

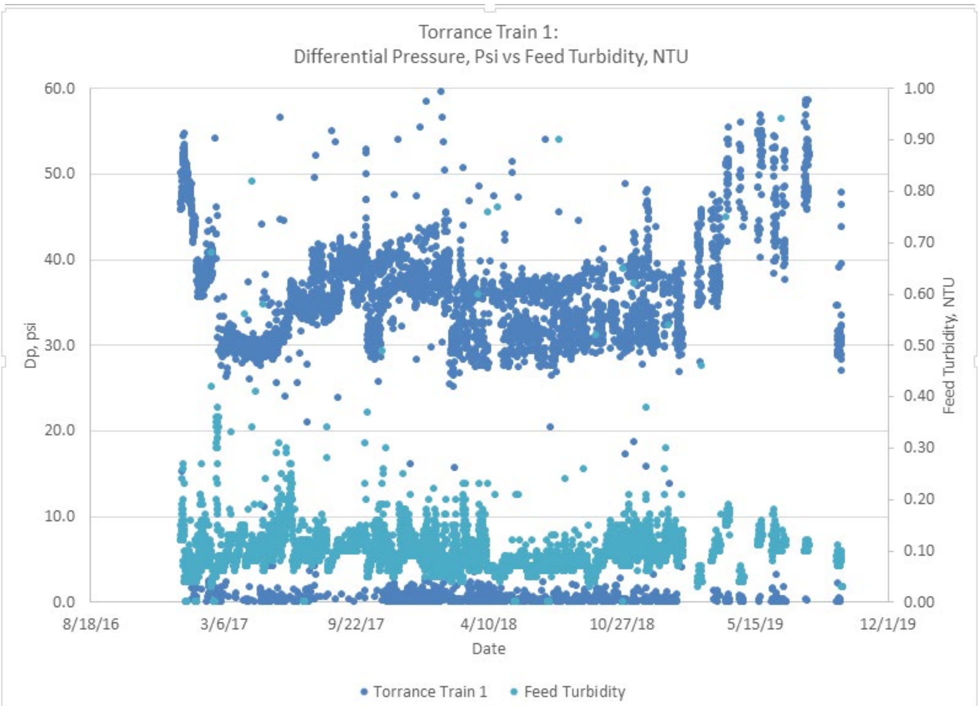
Figure 4-51. TRWRP RO Trains 1 - 4 NPF



Source: Raw data provided by West Basin.

From March 2017 through April 2018, the RO system NPF decreased by 23%. A recovery clean restored the system to near baseline performance. This is seen throughout the performance of all four RO trains. As the feed turbidity increased, the NPF decreased, and the feed and differential pressure increased as shown in Figure 4-52 for RO Train 1.

Figure 4-52. TRWRP RO Train 1 Differential Pressure and Feed Turbidity

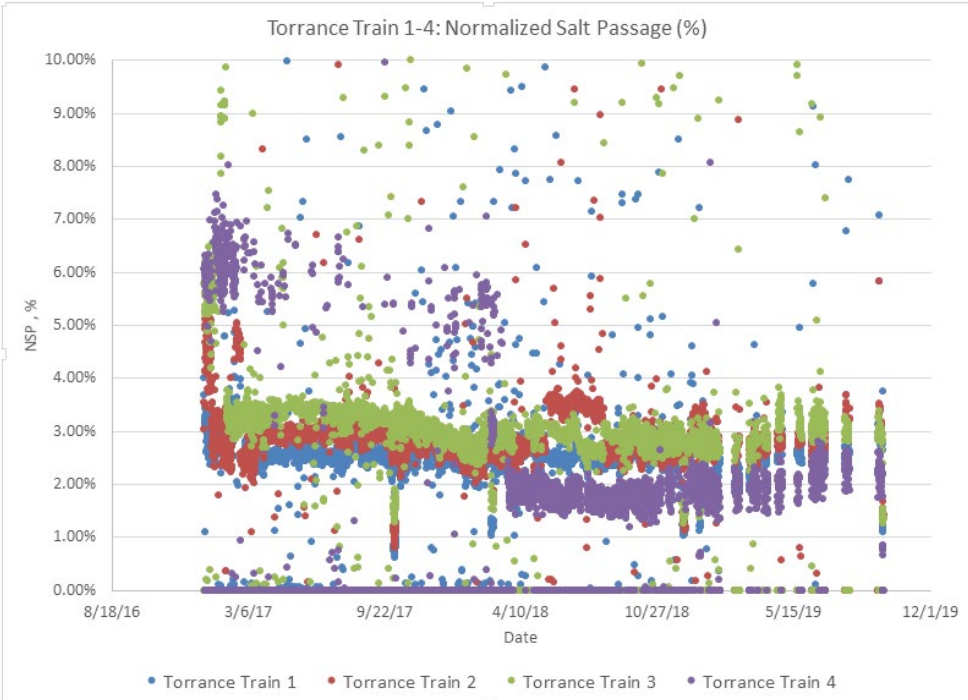


Source: Raw data provided by West Basin.

The NSP remained stable throughout the life of the membranes which is also reflected in the permeate water conductivity being below 100 µS/cm. As seen in Figure 4-53, the NSP for all TRWRP RO systems is stable at 3% or better. The differential pressure gradually increased over time with increased feed turbidity. Overall, the performance of the four RO trains is stable only needing one recovery clean per year. Figure 4-54 shows the differential pressure for TRWRP RO Trains 1 through 4.

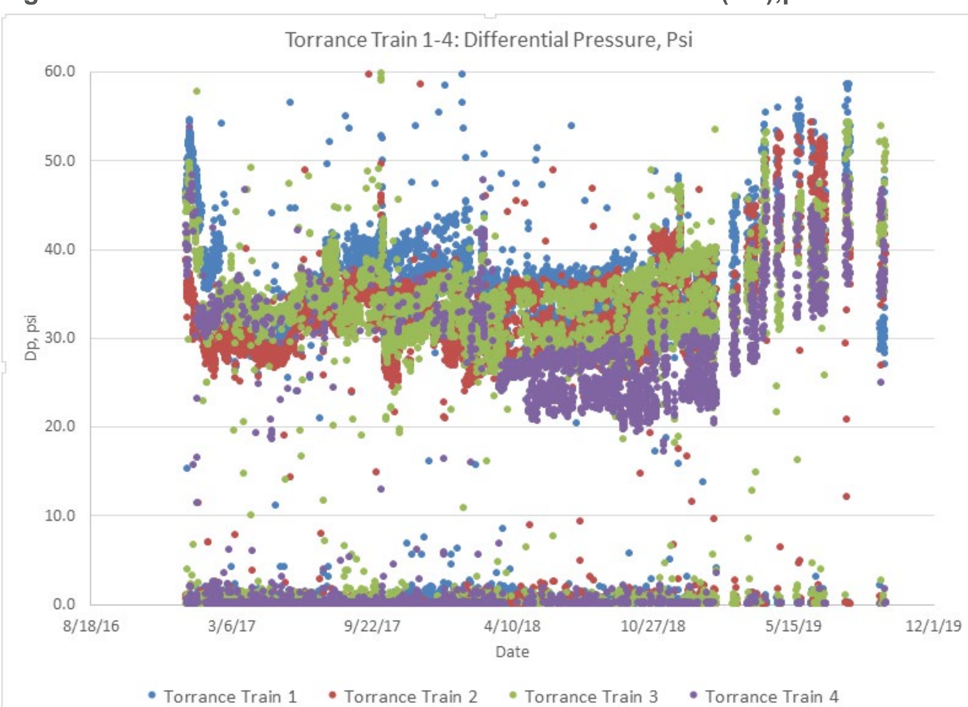
Appendix H includes individual performance graphs for all MF and RO trains from TRWRP.

Figure 4-53. TRWRP RO Trains 1-4: Normalized Salt Passage (NSP), %



Source: Raw data provided by West Basin.

Figure 4-54. TRWRP RO Trains 1-4: Differential Pressure (DP),psi

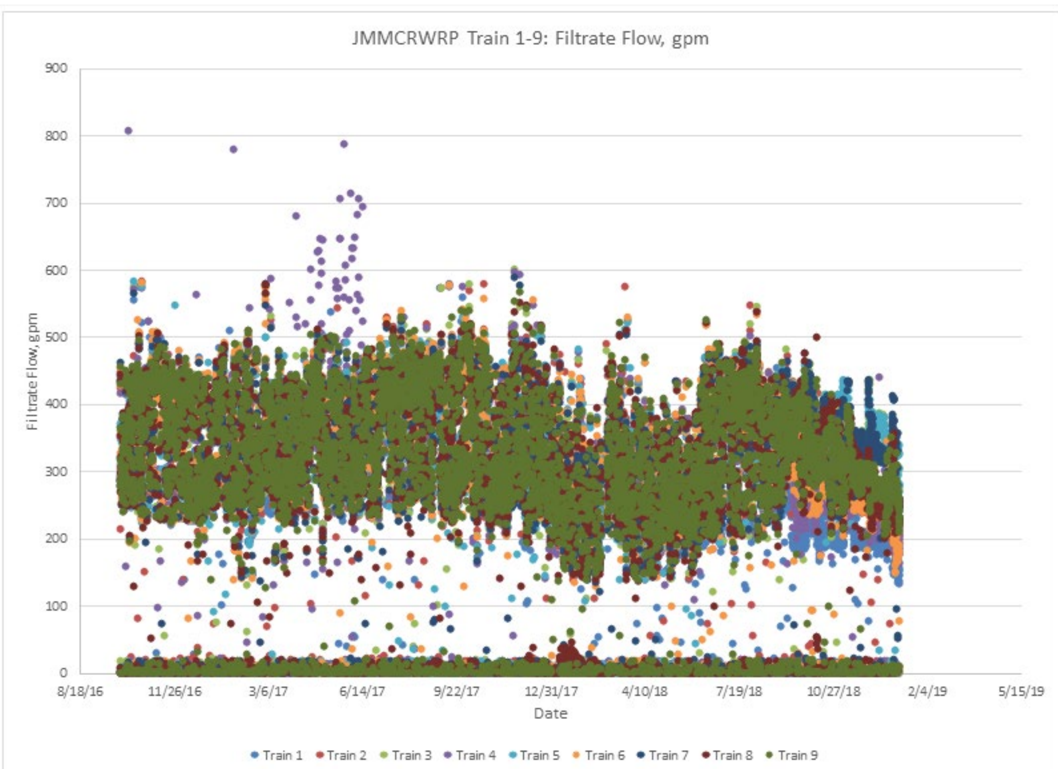


Source: Raw data provided by West Basin.

JMMCRWRP MF/UF and RO Treatment Process

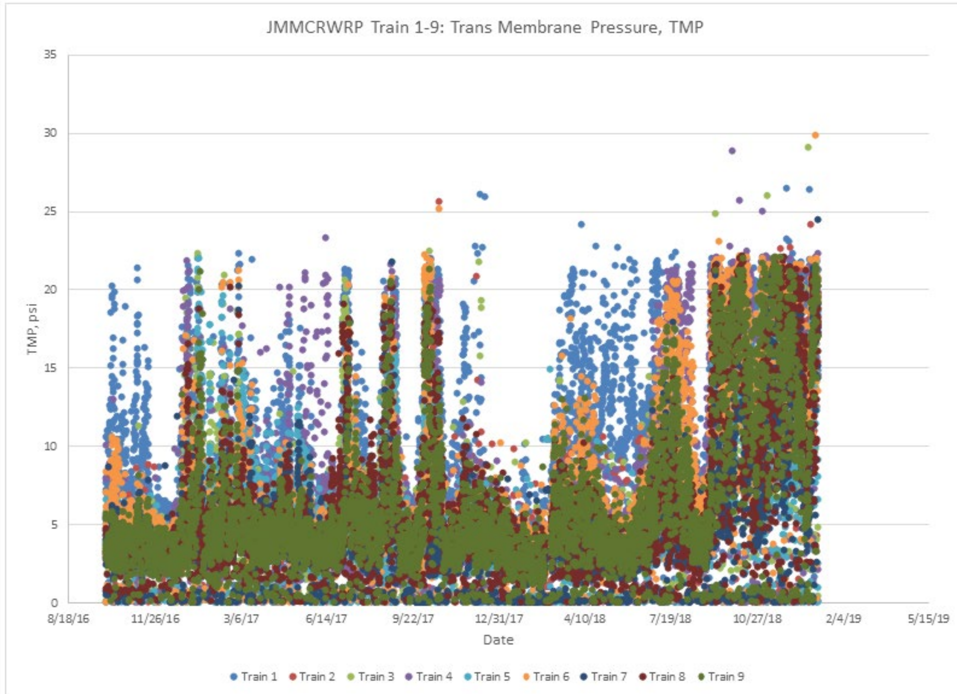
The JMMCRWRP has nine MF membrane units and one potable UF membrane unit. MF and UF feed water comes from the Title 22 distribution system. As previously indicated, the feed water quality to the Satellite Plants MF/UF system is better than the feed to ECLWRF MF membranes since this has been treated by the Title 22 process. JMMCRWRP MF/UF feed turbidity is an average of 2 NTU but occasionally increases to between 4 and 10 NTU. Like the other MF and RO systems, as the feed turbidity increases, the TMP increases. Each of the MF membrane units produce a filtrate flow between 200 and 450 gpm. The minor turbid events do not drastically affect MF membrane performance, and these events only cause a minimal decline in filtrate performance. The maintenance cleans and recovery cleans continue to allow the MF membranes to operate within this flow range since 2016. Figure 4-55, Figure 4-56, and Figure 4-57 illustrate the JMMCRWRP MF filtrate flow, TMP, and feed turbidity over time.

Figure 4-55. JMMCRWRP MF Units 1 - 9 Filtrate Flow



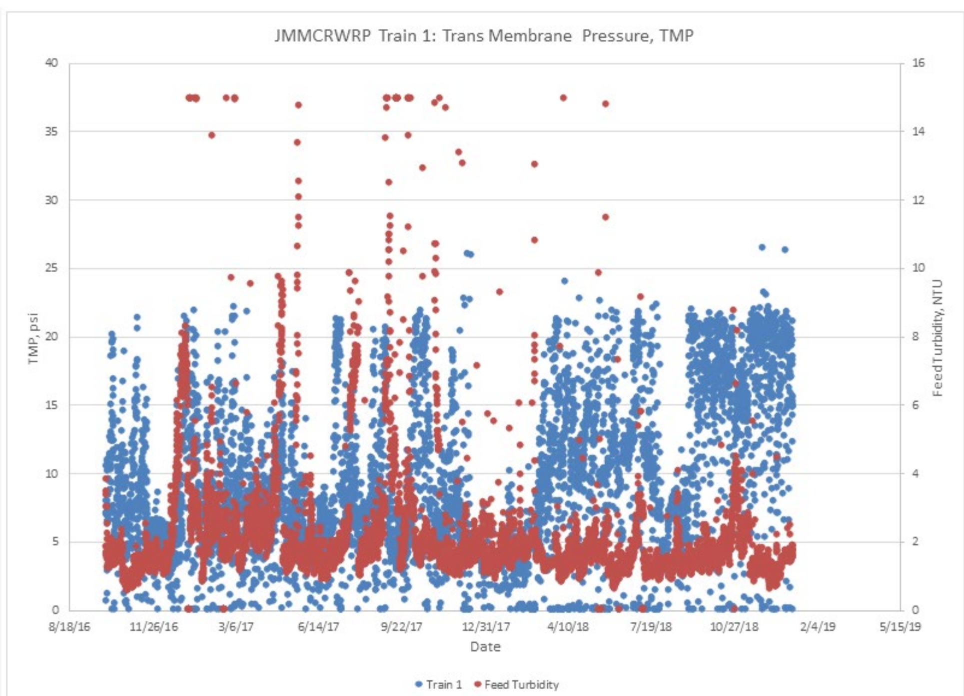
Source: Raw data provided by West Basin.

Figure 4-56. JMMCRWRP MF Units 1 - 9 TMP



Source: Raw data provided by West Basin.

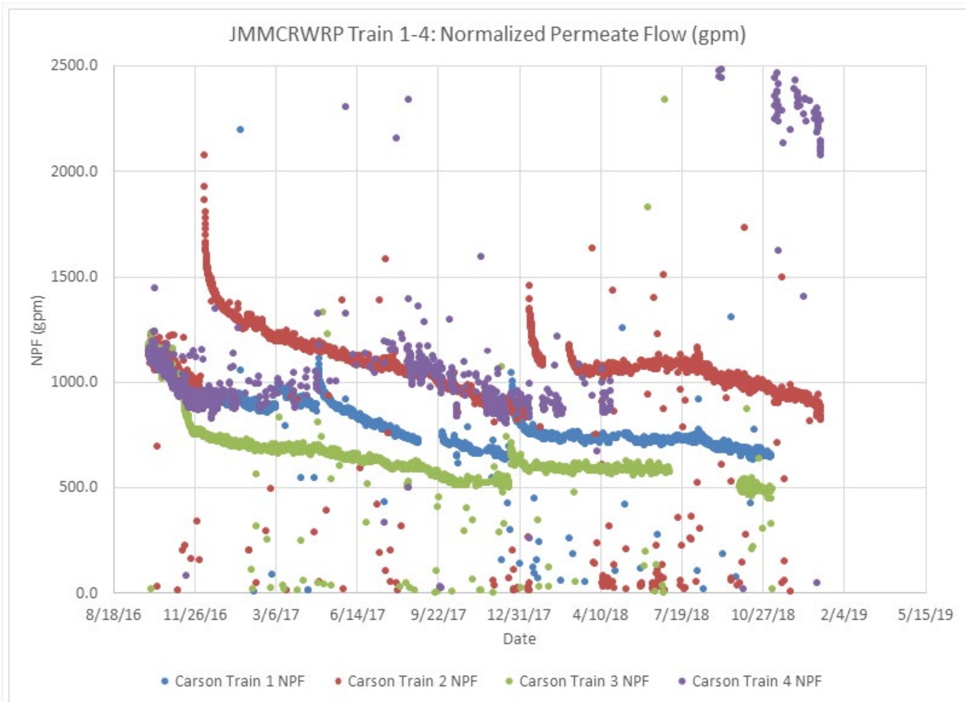
Figure 4-57. JMMCRWRP MF Unit 1 TMP and Feed Turbidity



Source: Raw data provided by West Basin.

The JMMCRWRP RO system consists of four identical trains that perform similarly. The RO trains operate at a recovery of 85% with an average permeate flow of 1,150 gpm. The system has exhibited a gradual decrease in production of NPF (Figure 4-58).

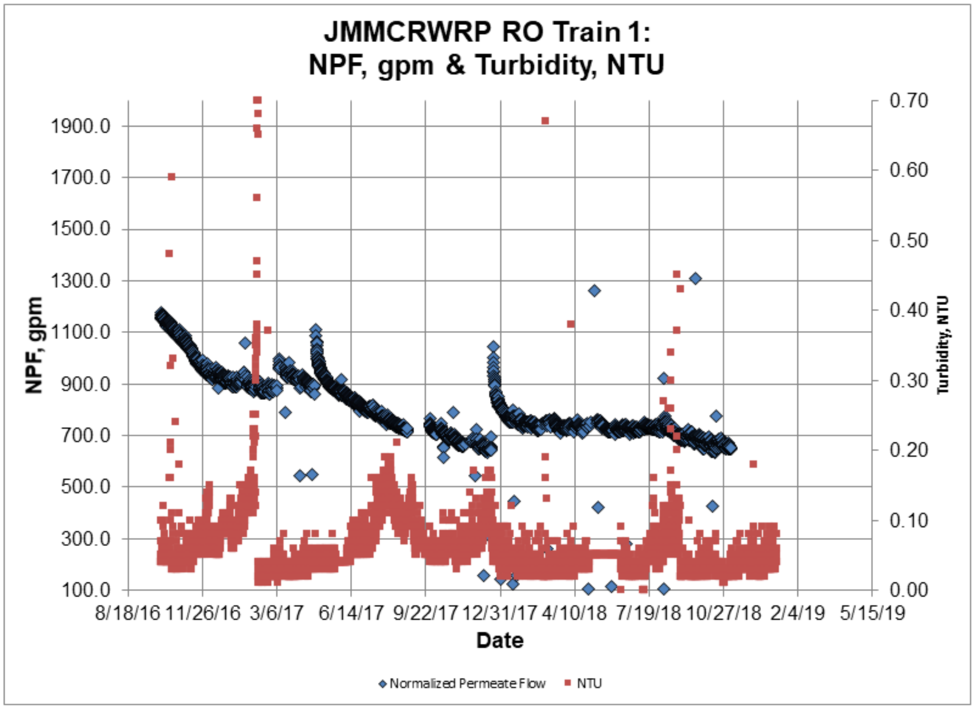
Figure 4-58. JMMCRWRP RO Trains 1 - 4 NPF



Source: Raw data provided by West Basin.

From August 2016 to March 2018, the RO system NPF decreased by 24%, which was reflected in all four RO trains. As the NPF decreases, the feed pressure increases along with the differential pressure. This is due to the increased turbidity in the feed water as shown in Figure 4-59 for RO Train 1.

Figure 4-59. JMMCRWRP RO Train 1 NPF and Feed Turbidity

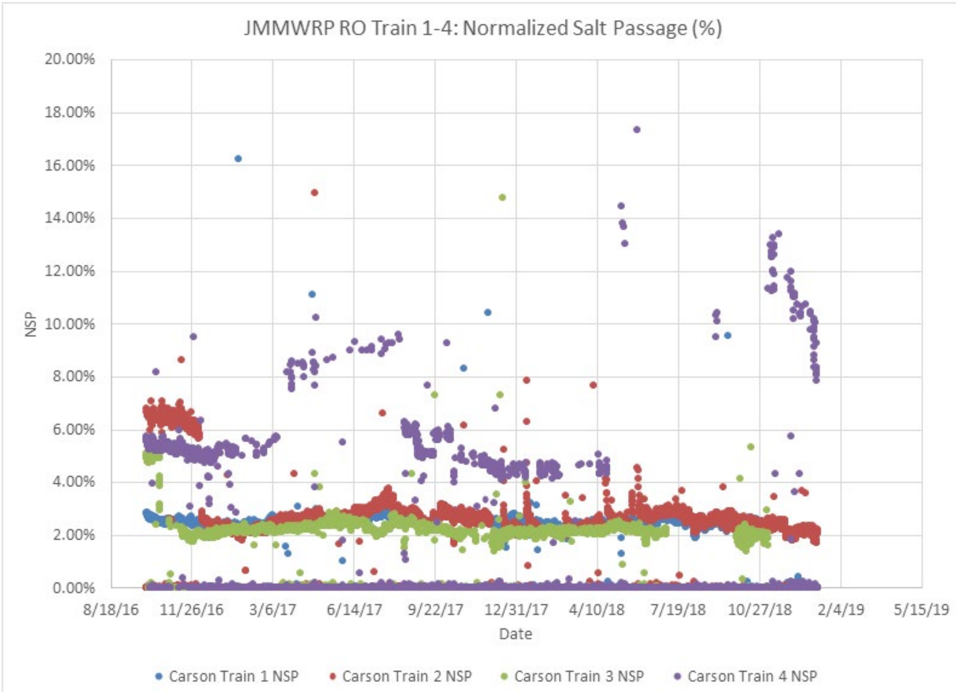


Source: Raw data provided by West Basin.

The normalized salt passage (NSP) remained constant throughout the life of the RO membranes at 2%, which is shown in the permeate water conductivity being below 100 µS/cm. Train 4 had the most issues with permeate water conductivity at times performing at 140 µS/cm. Figure 4-60, Figure 4-61, and Figure 4-62 show the NSP of each RO train, differential pressure, and Train 1 feed pressure and NPF.

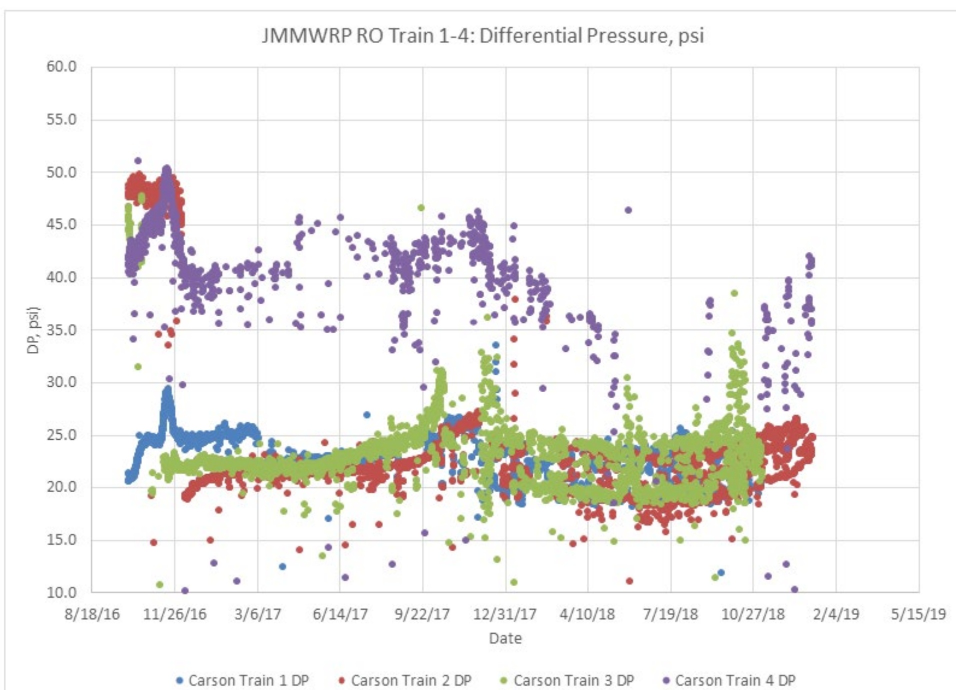
Appendix H includes individual performance graphs for all MF, UF, and RO trains from JMMCRWRP.

Figure 4-60. JMMCRWRP RO Train 1 NSP



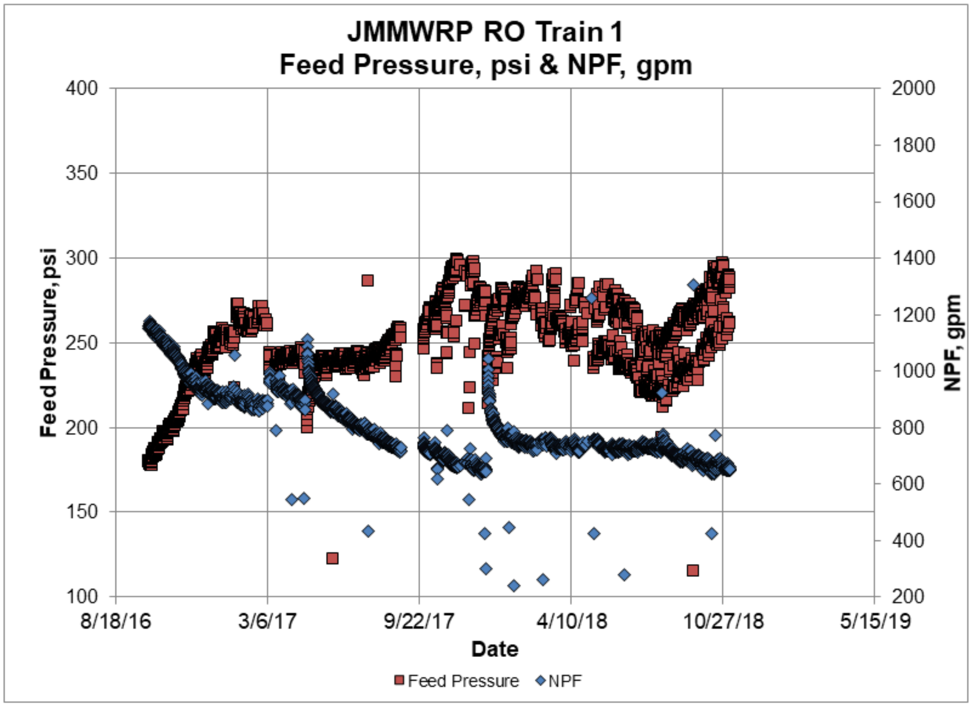
Source: Raw data provided by West Basin.

Figure 4-61. JMMCRWRP RO Trains 1 - 4 Differential Pressure



Source: Raw data provided by West Basin.

Figure 4-62. JMMCRWRP RO Train 1 Feed Pressure and NPF



Source: Raw data provided by West Basin.

4.3.4 Process Optimization Improvements

The following section discusses process optimization improvement suggestions for West Basin treatment facilities. These suggestions are unique to each facility and can improve operations by consuming less energy, improving quality, and reducing chemical consumption. After careful analysis of plant operating data and completing a site walkthrough at each facility, the following process improvements are recommended to begin mitigating some of the current process issues seen at each facility. The details are shown below, while other identified repair and rehabilitation (R&R) projects are documented in a subsequent chapter. West Basin staff indicated that some of these process optimization improvements are currently under consideration. HDR recommends performing research studies, jar testing, or bench-scale tests to determine the feasibility of some of these improvements.

ECLWRF

A. As a test for system performance, take the ozone system out of service for several weeks and monitor performance and operational issues for the MF and RO systems.
   - Confirm impacts to the MF or RO membrane performance.
   - If negligible impact is observed, maintain the ozone system out of service.
   - Monitor reduction in energy usage and liquid oxygen (LOX) consumption during this period to assess impact.

B. Repurpose the ozone system and feed ozone ahead of the pretreatment Densadeg units.

- o Ozone may improve Title 22 water quality by: oxidizing iron, removing color, and breaking down long chain organics.
- o Pre-ozonation may reduce coagulant doses due to micro-flocculation.
- o Perform bench scale ozone and jar tests to determine if ozonation of the feed to the pretreatment Densadeg units improves treatment and/or reduces chemical dosages.
- o There is sufficient ozone generation capacity to feed an ozone dose up to about 8 mg/L to the entire 46 mgd HWRP feed plus recycle to the Densadeg pretreatment units. The ozone flash reactor could be relocated to the Title 22 system feed line and the pipeline could act as an ozone contactor.
- o A foam reduction chamber may need to be installed ahead of the Densadeg units.

C. Provide piping and valves to allow for the Title 22 effluent to be fed to the MF units when HWRP water quality is poor.

- o Install a pipe from Title 22 treated effluent pressurized pipeline to feed the MF membranes. Include a flow meter and mechanical blending system.
- o This will require a control valve and programming to provide the ability to activate the blending system when HWRP secondary effluent water quality is poor.

D. Utilize pressurized Title 22 effluent for backwashing the Title 22 filters and retire the existing poor performing backwash pumps.

- o Install a pipe from main Title 22 pressurized header to backwash the main filters.
- o A pressure reducing valve (PRV) and a flow control valve and flow meter will be required to maintain a constant pressure and controlled flow to have an efficient filter backwash.

E. Install flap gates on the overflow in the intermediate storage basin so it does not overflow into RO feed.

CNTP

A. Perform a study to evaluate the potential to optimize the nitrification (Biofor) treatment process by chemical addition of phosphoric acid to increase biofilm growth and maximize ammonia removal.

TRWRP

A. The needed effort is to begin designing for an MF system replacement as that existing system will not be able to keep operating for another 5 years to produce the needed capacity or water quality without adverse effects to the RO.

JMMCRWRP

A. During periods of anticipated poor water quality to the Satellite Plants, eliminate or reduce MF backwash internal recycle to Biofor feed flow and increase usage of supplemental potable water. However, sending backwash to sewer is cost prohibitive. A life cycle cost analysis will need to be performed to determine the feasibility of this option.

4.4 Rehabilitation and Replacement Program

In developing a proposed list of R&R projects, HDR reviewed and considered several existing sources of information as well as performing a combination of virtual and in-person site visits as part of this Recycled Water Master Plan. Suez performed a study in 2016 that provided some general context on criticality analysis and condition assessment, and the 2019 R&R Program Development Study conducted by Louis Berger identified a number of specific R&R projects which were used as a starting point. HDR conducted two virtual interviews of West Basin and Suez Operations staff and in-person site visits to inform the re-evaluation of these previous studies to confirm, update/modify, or delete the projects from the R&R list. Additional projects were also identified as the result of HDR's staff interviews and site visits.

4.4.1 Existing Rehabilitation and Replacement Program

The 2016 asset Condition Assessment Study conducted by Suez's corporate asset management expert along with Suez operator assistance on West Basin's water recycling treatment facilities including over 1,700 assets at West Basin's Hyperion Secondary Effluent Pump Station (HSEPS) and the four water recycling treatment facilities.The results of that Suez study determined that the CNTP was in need of the most R&R.

In 2016, West Basin retained Louis Berger to prepare an R&R Program Development Study to re-assess and reorganize over 105 projects listed per the study and conversations with Suez Operations staff for rehabilitation or repair that had been deferred for the water recycling treatment facilities. Louis Berger completed the study in 2019 whereby of the 105 projects evaluated, only 11 of these were deemed critical and considered high priority based on West Basin and Suez Operations staff. In examining the non-critical projects as part of this Master Plan, project descriptions/scopes evolved in various ways.

- Some projects were removed because they were no longer necessary or were re-classified as critical CIP projects.
- Projects were consolidated into larger projects to take advantage of planned construction activities on a single site/plant.
- Other projects were consolidated into larger projects to take advantage of similar construction activities or work on similar/identical processes at various sites. It was felt that this type of consolidation may produce the added benefit of standardization of equipment.
- In some cases, as project needs were discussed, projects grew in scope to cover aspects that were identified as necessary by West Basin Engineering or Suez Operations staff.

Ultimately, the list of projects on the initial schedule were consolidated down to 28 projects. Those projects are listed in Table 4-17. Several of the projects are now underway. Four of the critical projects were accelerated into construction:

a. Sodium Hypochlorite Tank Replacement;
b. Phase III Clearwell Rehabilitation (completed at end of 2019);
c. Chlorine Contact Basin Rehabilitation; and
d. Satellite Plants Chemical Containment R&R project.

The three to four letter tag at the beginning of the project name is a naming convention developed by West Basin to facilitate reference to these projects. West Basin and Suez Operations staff identified several projects as having the highest priority.

Table 4-17. 2019 R&R Project List

	Project Title	Status (as of 2019)[a]	High Priority (per Suez)[b]
SHS	ECLWRF Solids Handling System R&R Project	In Progress	
WST	All Sites Welded Steel Storage Tank R&R Project	In Progress	
SUR	Satellite Plant Surge Protection	In Progress	●
HRR	Hyperion Secondary Effluent Pump Station R&R Project	Not Started	
NPPI	CNTP & TRWRP Nitrified Product Water Piping Inspection	Not Started	
SBP	Satellite Plant Breakpoint Reactor R&R Project	Not Started	
SMI	Satellite Plant BIOFOR Mechanical Improvements	Not Started	●
PPV	Satellite Plant VFD R&R Project	Not Started	●
HYD	CNTP Hydrogenerator Removal Project	Not Started	
CRU	Satellite Plant Control Room Upgrade Project	Not Started	
CSTI	All-Sites Chemical Storage Improvements	Not Started	●
TCFS	ECLWRF Title 22 Common Filter Systems Project	In Progress	●
T22F	ECLWRF Title 22 Filter Project	Not Started	●
PWP	ECLWRF VFD R&R Project (Combined with PPV above)	Not Started	
DCS	ECLWRF Distributed Control System Improvement Project	Designer selected, system audit pending	●
TVIP	ECLWRF Title 22 Valve Installation Project	Not Started	
DVPS	ECLWRF Diversion Pump Station R&R Project	Not Started	
EEQP	ECLWRF Equalization Pump Evaluation Project	Not Started	
GBPR	ECLWRF Copper Pipe Replacement (Gravity Belt Thickener)	Not Started	
ASCIP	All-Sites RO CIP Batching System	Not Started	
DSM	TRWRP Disinfection Station Modification	Not Started	
TWS	TRWRP Analyzer and Chemical Waste System Project	Not Started	
PCS	JMMCRWRP Plant-Wide Containment System Project	Not Started	
WDI	TRWRP Waste Discharge Improvements Project	Not Started	
New[c]	Sodium Hypochlorite Tank Replacement	In Progress – Now CIP	
New[c]	Phase III Clearwell Rehabilitation	Completed (end of 2019)	
New[c]	Chlorine Contact Basin Rehabilitation	In Progress – Now CIP	
New[c]	Satellite Plants Chemical Containment R&R project	In Progress – Now CIP	

[a] Status update as of 2019 from the West Basin R&R Program Development Study (Louis Berger, 2019).
[b] "High Priority" designation based on Suez Operations staff (Louis Berger, 2019).
[c] R&R project recently identified during virtual interviews (April 2020) and site walk (May 2020) with West Basin and Suez staff as part of the West Basin Recycled Water Master Plan project that were not previously identified in 2019 Louis Berger study.

4.4.2 Potential Rehabilitation and Replacement Projects

In consideration of those previous studies by Suez and Louis Berger, HDR conducted virtual staff interviews and site visits to West Basin's four water recycling treatment facilities as part of this

Recycled Water Master Plan effort to identify additional R&R projects and provide status updates of R&R projects already identified. HDR conducted virtual interviews with West Basin and Suez staff over two days, April 1-2, 2020, to discuss plant performance. On May 21-22, 2020, in-person site visits were conducted to allow HDR staff to view the treatment facilities and further discuss plant conditions with Suez Operations staff. The R&R projects identified are discussed below. When there was overlap between these projects and projects on the existing R&R List, the existing project tags are shown next to projects.

Edward C. Little Water Recycling Facility

Updates to R&R projects prioritized for the ECLWRF, based on discussions with Suez Operations staff, are listed in Table 4-18, with new projects listed at the end.

Table 4-18. Updated R&R Project List for ECLWRF

	Project Title	Status (as of 2019)[a]	Updated Status (as of 2020)[b]
SHS	ECLWRF Solids Handling System R&R Project	In Progress	Initial Technology Feasibility Study completed; second feasibility study evaluating solids to sewer is almost completed; will be presenting to West Basin team to determine which alternative option
TCFS	ECLWRF Title 22 Common Filter Systems Project	Not Started	Title 22 Filter backwash pumps and piping require rehab/replacement.
T22F	ECLWRF Title 22 Filter Project	Not Started	Rehabilitation of Filters 1-10 and the Converted Title 22 Filters are needed; Immediate attentions are needed for Filter 2 and Converted Filters 1 and 3 (where the underdrains have issues and have been offline for several years).
PWP	ECLWRF VFD R&R Project	Not Started	Title 22 Product water pumps are not energy efficient; reconfiguration of pumping system and potentially selecting a different pump may be required.
TVIP	ECLWRF Title 22 Valve Installation Project	Not Started	Provide isolation valves on the Title 22 Product Water Pump Station discharge piping.
DVPS	ECLWRF Diversion Pump Station R&R Project	Not Started	Replace pumps and VFDs for Diversion Pump Station.
EEQP	ECLWRF Equalization Pump Evaluation Project	Not Started	Study and provide replacement of equalization pumps.
GBPR	ECLWRF Copper Pipe Replacement (Gravity Belt Thickener)	Not Started	GBT's heavy stainless steel covers make it difficult to access and observe operation. The drain pipe is inaccessible for maintenance.
WST[c]	All Sites Welded Steel Storage Tank R&R Project	Not Started	Sludge holding tanks may or may not require rehabilitation pending findings from Solids Handling Study (currently on-going, anticipated completion January 2021).
CSTI	All-Sites Chemical Storage Improvements	Not Started	The Ferric Chloride Bulk Chemical Fill Station requires attention. Bulk storage of NaOCl is currently being replaced as separate work.
New[b]	ECLWRF Phase III Microfiltration (MF) Replacement	-	Phase III MF system is not operable and old. The Phase III MF system (housings, racks, membranes, and appurtenances) is planned to be replaced with a CEMF system.
New[b]	ECLWRF Barrier Water Pump Station and Clearwell R&R	Design RFP issued	Rehabilitate Barrier Water pump station and clearwell.

Table 4-18. Updated R&R Project List for ECLWRF

Project Title		Status (as of 2019)[a]	Updated Status (as of 2020)[b]
New[b]	ECLWRF Replace RO pressure housing rubber supports	-	RO pressure housing.
New[b]	Title 22 Storage Tanks Rehabilitation	-	Inspection was completed in June 2020.

[a] Status update as of 2019 from the West Basin R&R Program Development Study (Louis Berger, 2019).
[b] R&R project recently identified during virtual interviews (April 2020) and site walk (May 2020) with West Basin and Suez staff as part of the West Basin Recycled Water Master Plan project that were not previously identified in 2019 Louis Berger study.
[c] Status update based on discussion with West Basin in September 2020.

During discussions with Suez Operations staff at ECLWRF, the following updates to current R&R projects were provided:

- SHS ECLWRF Solids Handling R&R Project. The ECLWRF solids handling upgrade project includes the replacement of the plate and frame press with a new centrifuge system. Staff is preparing a request for proposal (RFP) for the design following the completion of a Feasibility Study. The new centrifuge will have separate mixing tank for lime addition to raise pH to 12 and increase holding time. The four existing conditioning tanks will not be used. A recent feasibility study was conducted to also look at solids to sewer alternative. A decision is due to enable the design of the SHS to move forward.
- TCFS ECLWRF Title 22 Common Filter Systems Project. The Title 22 Filter backwash pumps and piping require rehab/replacement because there is insufficient lift of the bed to achieve proper backwash. If Title 22 product water is used directly, then the piping still requires rehabilitation since there is significant headloss from the storage tank.
- T22F ECLWRF Title 22 Filters R&R Project. Operations staff reiterated the need for maintenance of the all current and converted Title 22 Filters, where the underdrains have separated from the wall.
- GBPR ECLWRF Copper Pipe Replacement (Gravity Belt Thickener [GBT]). Operations staff stated their concern regarding the GBT's heavy stainless steel covers, which make it difficult to access and observe operation. The drain pipe is inaccessible for maintenance, as noted in the 2019 study. The GBPR project cited the need to replace washwater piping with permanent in-slab piping of appropriate material.
- PWP ECLWRF VFD R&R Project. Operations staff noted that the Title 22 Product water pumps are not energy efficient; reconfiguration of pumping system and potentially selecting a different pump may be required.
- CSTI All-Sites Chemical Storage Improvements. Operations staff noted that the Ferric Chloride Bulk Chemical Fill Station requires attention. In addition, Bulk storage of sodium hypochlorite (NaOCl) is currently being replaced as a separate project that consists of four storage tanks, 2,000-3,000 gallons each.

During discussions with Suez Operations staff at ECLWRF, the following information regarding new issues and potential projects was provided:

- ECLWRF Phase III Microfiltration (MF) Replacement. Operations staff noted that the Phase III membranes are available as an emergency back-up only for the Chevron BF system. The Phase III MF system (housings, racks, membranes, and appurtenances) is planned to be replaced with a CEMF system.
- ECLWRF Barrier Water Pump Station and Clearwell R&R. Operations staff indicated that the pump station and clearwell needs rehabilitation.
- ECLWRF Replace Reverse Osmosis (RO) Pressure Housing Rubber Supports. The RO pressure housing rubber supports are worn out and require replacement.

Chevron Nitrification Treatment Plant

Updates to R&R projects prioritized for the CNTP, based on discussions with Suez Operations staff, are listed in Table 4-19, with new projects listed at the end.

Table 4-19. Updates to R&R Project List at CNTP

Project Title		Status (as of 2019)[a]	Updated Status (as of 2020)[b]
NPPI	Satellite Plants Piping Inspection (formerly the "CNTP & TRWRP Nitrified Product Water Piping Inspection")	Not Started	Piping throughout plant is questionable.
HYD	CNTP Hydrogenerator Removal Project	Not Started	Hydrogenerator is no longer in service.
WST[c]	All Sites Welded Steel Storage Tank R&R Project	In Progress	Rehabilitation of Nitrified Product Storage Tank with the corrugated roof is currently in design.
SBP	Satellite Plant Breakpoint Reactor R&R Project	Not Started	Reactor requires cleaning.
PPV	Satellite Plant VFD R&R Project	Not Started	High service pumps need to be evaluated. Replacement of pump and motor required cutting open roof.
CRU	Satellite Plant Control Room Upgrade Project	Not Started	-
CSTI	All-Sites Chemical Storage Improvements	Not Started	Chemical containment area is common to all chemicals, thus there is a potential for chemical mixing in this area. Significant system improvements are needed.
New[b]	CNTP - Upgrade Plant Electrical System	-	CNTP electrical system is old and has a common grounding wire.

[a] Status update as of 2019 from the West Basin R&R Program Development Study (Louis Berger, 2019).
[b] R&R project recently identified during virtual interviews (April 2020) and site walk (May 2020) with West Basin and Suez staff as part of the West Basin Recycled Water Master Plan project that were not previously identified in 2019 Louis Berger study.
[c] Status update based on discussion with West Basin in September 2020.

During discussions with Suez Operations staff at CNTP, the following updates to current R&R projects were provided:

- WST CNTP Nitrified Product Water Storage Tank. Operations staff recommended that the product storage tank with the corrugated roof, which was once a solid steel roof, be evaluated.

- NPPI Satellite Plants Piping Inspection (formerly the "CNTP TRWRP Nitrified Product Water Piping Inspection"). Operations staff noted that piping throughout the plant is questionable.
- PPV Satellite Plant VFD R&R. Project Operations staff recommended that the condition of high service pumps be evaluated. When one of the pumps was being replaced, the enclosure roof had to be cut out in order to be able to pull the motor and pump out of its location.
- HYD CNTP Hydrogenerator Removal Project. Operations staff noted that the hydrogenerator is no longer in service.
- SBR Satellite Plant Breakpoint Reactor R&R Project. Operations staff noted that the breakpoint reactor, which receives media carry over from Biofor, needs to be cleaned out.
- CSTI All-Sites Chemical Storage Improvements. Operations staff noted that the Chemical containment area is common to all chemicals, thus there is a potential for chemical mixing in this area. Noted a need to isolate acids and bases. They noted a need to upgrade the, chemical pumps, motors, and delivery system. All chemical systems are corroded with extensive leaking throughout the pipes. The panels are worn down and need to be upgraded.

During discussions with Suez Operations staff at CNTP, the following information regarding new issues and potential projects was provided:

- CNTP - Upgrade Plant Electrical System. There is one common grounding wire for the facility, and it is recommended to upgrade this situation.

Torrance Refinery Water Recycling Plant

Updates to R&R projects prioritized for the TRWRP, based on discussions with Suez Operations staff, are listed in Table 4-20, with new projects listed at the end.

Table 4-20. Updates to R&R Project List at TRWRP

Project Title		Status (as of 2019)[a]	Updated Status (as of 2020)[b]
DSM	TRWRP 190th St. Disinfection Station Modification	Not Started	-
TWS	TRWRP Analyzer and Chemical Waste System Project	Not Started	-
WDI	TRWRP Waste Discharge Improvements Project	Not Started	-
WST[c]	All Sites Welded Steel Storage Tank R&R Project	In Progress	Rehabilitation of the Nitrified Product Storage Tank is currently in design. The RO Product Storage Tank needs to be rehabilitated.
SBP	Satellite Plant Breakpoint Reactor R&R Project	Not Started	-
CRU	Satellite Plant Control Room Upgrade Project	Not Started	-
CSTI	All-Sites Chemical Storage Improvements	Not Started	Replacement of the dual-contained chemical piping, the chemical storage tank holding brackets, and the chemical delivery systems are necessary. The concrete chemical containment basins are in the process of being repaired and recoated.

Table 4-20. Updates to R&R Project List at TRWRP

Project Title		Status (as of 2019)[a]	Updated Status (as of 2020)[b]
New[b]	TRWRP MF/RO Replacement and Expansion Project	-	MF/RO system is old and needs to be upgraded with additional membranes to meet increased refinery demand.
New[b]	TRWRP FRP Potable Water Piping Replacement.	-	FRP piping is old and needs to be replaced, potentially with different material.
New[b]	TRWRP Secondary Power Source	-	Single point of power for RO system is a risk due to lack of redundancy.
New[b]	TRWRP New VFDs for RO Pumps 2 and 3	-	Replace VFDs for RO pumps due to age.

[a] Status update as of 2019 from the West Basin R&R Program Development Study (Louis Berger, 2019).
[b] R&R project recently identified during virtual interviews (April 2020) and site walk (May 2020) with West Basin and Suez staff as part of the West Basin Recycled Water Master Plan project that were not previously identified in 2019 Louis Berger study.
[c] Status update based on discussion with West Basin in September 2020.

During discussions with Suez Operations staff at TRWRP, the following updates to current R&R projects were provided:

- WDI TRWRP Waste Discharge Improvements Project. Operations staff stated the need to evaluate waste pump discharge pipeline and determine the reason it is difficult to achieve flow needed to allow backwash of the Biofor units.
- WST All Sites Welded Steel Storage Tank R&R Project. Operations staff noted the poor condition of the Nitrified Product Storage Tank and that replacement is necessary.
- CSTI All Sites Chemical System R&R. Operations staff noted that the replacement of the dual-contained chemical piping, the chemical storage tank holding brackets, and the chemical delivery systems are necessary. The concrete chemical containment basins were damaged by spills and are in the process of being repaired and recoated.
- TWS TRWRP Analyzer and Chemical Waste System Project. The waste pump in chemical holding tank pipeline is broken. Currently, operators need to use a submersible pump with a hose attached to pump to the waste tank.

During discussions with Suez Operations staff at TRWRP, the following information regarding new issues and potential projects was provided:

- TRWRP MF/RO Replacement and Expansion Project. Operations staff noted that the old Memcor MF has reached end of useful life and should be replaced and resized to accommodate refinery flows and to maintain flow during backwash. MF/RO capacity should be increased since refinery could take more MF/RO water. Additional redundancy and some form of standby power is needed because the refinery is heavily reliant on RO water. Autostrainers need to be retrofitted. The existing 500 micron autostrainers need to be reduced down to 200 microns. VFDs for feed pumps 2 and 3 need to be upgraded.
- TRWRP FRP Potable Water Piping Replacement. The fiberglass piping (FRP) which conveys the potable water used as backup when processes are down needs to be replaced.
- TRWRP Secondary Power Source. Provide either a second power feed or a standby generator as backup for critical systems at the plant.

- TRWRP New VFDs for RO Pumps 2 and 3. Replace the old VFDs on RO pumps 2 and 3.

Juanita Millender-McDonald Carson Regional Water Recycling Plant

Updates to R&R projects prioritized for the JMMCRWRP, based on discussions with Suez Operations staff, are listed in Table 4-21, with new projects listed at the end. It was noted that the design for the MBR of the JMMCRWRP expansion was completed but is on hold due to reduced product demand.

Table 4-21. Updated R&R Project List for JMMCRWRP

Project Title		Status (as of 2019)[a]	Updated Status (as of 2020)[b]
PCS	JMMCRWRP Civil Site Improvements (formerly the “Plant-Wide Containment System Project”)	Not Started	Civil site improvements and chemical containment needed; MF Storage Tank foundation requires reinforcement, etc.
CRU	Satellite Plant Control Room Upgrade Project	Not Started	-
CSTI	All-Sites Chemical Storage Improvements	Not Started	-
WST[c]	All Sites Welded Steel Storage Tank R&R Project	In Progress	Rehabilitation of MF Filtrate Tank is under construction. Nitrification and RO Product Water Tanks require inspection.
New[b]	JMMCWRP MF Unit Replacement	In Progress	Under design.
New[b]	JMMCWRP 2-mgd MBR Project	In Progress	Design completed in 2017; project on hold due to reduced refinery demand.
New[b]	JMMCWRP Title 22 Piping Replacement	-	Piping is old and needs replacement.
New[b]	JMMCWRP Critical Asset Standby Power	-	Backup power for critical assets is not available to provide continuous operation in event of power failure.

[a] Status update as of 2019 from the West Basin R&R Program Development Study (Louis Berger, 2019).
[b] R&R project recently identified during virtual interviews (April 2020) and site walk (May 2020) with West Basin and Suez staff as part of the West Basin Recycled Water Master Plan project that were not previously identified in 2019 Louis Berger study.
[c] Status update based on discussion with West Basin in September 2020.

During discussions with Suez Operations staff at JMMCRWRP, the following updates to current R&R projects were provided:

- PCS JMMCRWRP Civil Site Improvements (formerly the “Plant-Wide Containment System”). The existing PCS project addressed improvements for containment of plant spills on-site. There is currently a CIP project to rehab the chemical lines in two phases (i.e., overhead piping, secondary containment.) Phase 1 is from the pumps to the injection point and Phase 2 is from the tanks to the pump. Operations staff reiterated the need to provide civil site improvements, including a new block wall, chemical containment area, back road, and exit gate. Reinforcement of the MF storage tank ring foundation is also necessary as soils at this site are unconsolidated and the existing foundation is not substantial enough. Correct the storm drainage and re-grade site as necessary to provide safety for plant personnel / electrical system and avert pooling of rain water over the electrical vaults.

- WST All Sites Welded Steel Storage Tank R&R Project. Operations staff reiterated the need to inspect the roof of Nitrified Product Storage Tank at the JMMCRWRP ().

During discussions with Suez Operations staff at JMMCRWRP, the following information regarding new issues and potential projects was provided:

- JMMCWRP MF Unit Replacement. Operations staff noted that the replacement of the MF units with new custom engineered MF units is under design. However, if the facility is not installing an MBR system, the current MF membranes should be replaced with a universal membrane system rack with PVDF membranes to provide reliable supply to customers.
- JMMCWRP 2 MGD MBR Project. Operations staff noted that a new 2 MGD MBR has been designed and will run in parallel with the Biofor.
- JMMCWRP Title 22 Piping Replacement. Operations staff recommended the replacement of piping from Title 22 inlet line to existing Biofor.
- JMMCWRP Critical Asset Standby Power. Operations staff noted the need for backup power for critical assets.

Projects Multiple Plant Sites

In discussion with Suez Operations staff, the following updates on issues that impacted more than a single site were provided:

- DCS All Facilities Distributed Control System (DCS) Improvements Project. Operations staff noted that the current system is obsolete and needs updating, as well as adaptation to the functions required of new facilities. The original DCS project was focused on ECLWRF.
- SUR All Facilities Surge Protection. Operations staff noted that the current surge tank controls are obsolete and require updating and redesign.
- SMI Satellite Plant Biofor Mechanical Improvements. Operations staff indicated a need to evaluate current Biofor ancillary equipment and provide new standardized equipment and instrumentation, as well as isolation valves upstream of each of the Biofor units to avoid a plant shutdown in the event an individual Biofor unit is required. Shall include meters, pumps, blowers, compressors, piping, and actuators. As a process improvement, consider a more efficient blower type when replacing the blowers.
- PWP and PPV - All Facilities VFD R&R Project. The projects at ECL and the Satellite Plants were combined.
- CSTI - All-Sites Chemical Storage Improvements. Encompasses chemical storage and pumping systems. Specific issues were noted earlier for CNTP, TRWRP, and ECLWRF.
- NPPI Satellite Plants Piping Inspection (formerly the “CNTP TRWRP Nitrified Product Water Piping Inspection”). Nitrified product water piping is has excessive built up at CNTP. Evaluate pipe condition at CNTP and TRWRP.

4.4.3 Proposed Rehabilitation and Replacement Projects

An updated list of R&R projects is presented below. On-going projects are not included because the purpose of this list is to identify and prioritize future work. Eight projects were identified by Suez as top R&R priority during site visits; however, one of their top priorities has been reclassified as a process improvement project. The remaining seven top priority projects per the site visit are described below, followed by a description of additional future R&R projects. Note that additional prioritization of these R&R projects was conducted later in the Master Plan process, as described in Chapter 9.

Edward C. Little Water Recycling Facility–Title 22 Converted Filters Rehabilitation and Replacement

There are 14 total filters: 1 thru 6 built in 1995; 7 thru 10 built in 1997; and 4 filters converted in 2007 from Barrier filters to Title 22 filters. This project is the first phase of rehabilitating all of the filters and addresses the immediate repairs to converted filters 1 and 3. The remaining filter rehabilitations should be phased to maximize production. This project was a portion of the 2019 Study Project ECLWRF Title 22 Filter R&R Project.

All Facilities–Distributed Control System Improvements Project

The current system is obsolete and needs updating as well as adaptation to the functions required of new facilities. A Consultant has been selected and will be performing an audit of the DCS system, followed by a design. A portion of this project was identified in the 2019 Study as DCS - ECLWRF Distributed Control System Improvements Project.

All Facilities–Surge Tank Control Analysis

The current surge tank controls are obsolete and require updating and redesign. The existing systems need to be reanalyzed in light of current and future flows to determine what modifications are necessary to address those conditions. This was a portion of the 2019 Study Project SUR - Satellite Plant Surge Protection.

Edward C. Little Water Recycling Facility–Title 22 Common Filter Systems Project

This project was identified as the 2019 Study Project TCFS - ECLWRF Title 22 Common Filter Systems Project. It includes common systems such as backwash supply pumps, blowers, valves, piping flow meters, sensors, instrumentation, and controls. This includes Title 22 Filter backwash pumps and piping.

All Facilities–VFD Rehabilitation and Replacement Project

Replace the existing product water pumps and motors and provide VFDs. This project encompasses both the ECLWRF and the Satellite Plant VFD R&R Projects from the 2019 Study.

Satellite Plants–Biofor Mechanical Improvements

A condition assessment is necessary to evaluate current Biofor ancillary equipment and recommend new standardized equipment and instrumentation, as well as isolation valves upstream of each of the Biofor units to avoid a plant shutdown in the event an individual Biofor unit failure. Isolation valves will also facilitate more efficient maintenance activities by allowing a single unit to be serviced without shutting down all Biofor units.

All Facilities–Chemical Storage Improvements

A detailed examination and refurbishment of all chemical storage and pumping facilities is required. This project was identified as the 2019 Study Project CSTI - All-Sites Chemical Storage Improvements.

Future Projects

The projects below are identified as needed but were not selected as one of the top eight projects. Due to a number of uncertain conditions that could affect the priority or criticality of these projects, such as flow quantities, water quality, treatment process additions or modifications, these projects are not prioritized.

- JMMCRWRP – Provide Civil Site Improvements: Construct new block wall, chemical containment area, back road and exit gate.
- JMMCRWRP – Title 22 Piping Replacement: Replace piping from Title 22 inlet line to existing Biofor.
- JMMCRWRP – Critical Asset Standby Power: Provide backup power for critical assets.
- ECLWRF – Phase III MF Replacement: The Phase III membranes are quite old and need to be replaced.
- ECLWRF – Barrier Water Pump Station and Clearwell R&R: Pump station and clearwell needs rehabilitation due to age.
- TRWRP – Chemical Waste System R&R Project: The waste pump in chemical holding tank pipeline is broken. Currently, operators need to use a submersible pump with a hose attached to pump to the waste tank. [TWS]
- HRR – Hyperion Secondary Effluent Pump Station R&R Project: It is our understanding that an interim project was performed by West Basin that addressed critical issues and allowed this more expensive project to be delayed into the future. Thus, this is no longer a critical project.
- NPPI – CNTP Piping Inspection: Piping throughout the plant is questionable. A condition assessment is needed then necessary steps implemented to bring the piping up to reliable standards.
- SBP – Satellite Plant Breakpoint Reactor R&R Project: Assess condition of the structures and recommend repairs at CNTP and TRWRP.
- WST – All Facilities Welded Steel Storage Tank R&R Project: From the site visits and discussions with West Basin and Suez staff, the replacement/rehabilitation of seven tanks were identified:
  - ECLWRF Sludge Holding Tanks (total of 2) may or may not require rehabilitation pending findings from Solids Handling Study (currently on-going).
  - CNTP Nitrified Product Storage Tank with the corrugated roof is under design.
  - TRWRP Nitrified Product Storage Tank is corroded and under design, and the RO Product Storage Tank is planned for R&R.
  - JMMCRWRP MF Filtrate Tank rehabilitation is currently under construction, and the Nitrified Product Storage Tank and RO Product Water Tank are planned for R&R due to significant corrosion.
- HYD – CNTP Hydrogenerator Removal Project: During the visual site visits it was mentioned that the Hydrogenerator for power recovery was no longer in service. This was a low priority

project identified in the 2019 study that could be performed to provide space for new facilities if needed.

- CNTP – Upgrade Plant Electrical System: Perform an evaluation of the existing electrical system with recommendations for improvements.
- CRU – Satellite Plant Control Room Upgrade Project: Replace the structurally unsound control room trailers at CNTP and TRWRP.
- TVIP – ECLWRF Title 22 Valve Installation Project: Install isolation valves on the two Title 22 conveyance pipelines, 42-inch and 48-inch, to allow one of the pipelines to remain operational if the other pipeline requires repair.
- DVPS – ECLWRF Diversion Pump Station R&R Project: Replace the aging pumps that serve as backup for the Product Water Pumps and add a standby VFD for these pumps. The function of the Diversion Pump Station is to convey recycled water directly to the distribution system if a bypass of the Title 22 storage tanks is required for reasons such as maintenance or cleaning.
- EEQP – ECLWRF Equalization Pump Evaluation Project: Evaluate replacement of the Title 22 Backwash Equalization Submersible Sump Pumps which transfer a mix of gravity filter backwash waste, MF backwash waste, and dewatering liquids waste to clarifiers for treatment. Consider that current water quality and hydraulic conditions have changed since the initial pumps were installed in the Phase 1 project.
- ECLWRF – Gravity Belt Thickener (GBT) Modifications: Evaluate 1) replacing or modifying the GBT's heavy stainless steel covers to facilitate access for observing operation, 2) modifications to make the drain pipe more accessible for maintenance, 3) the need to replace washwater piping/hoses with permanent in-slab piping of appropriate material as cited in the 2019 study GBPR – ECLWRF Copper Pipe Replacement project.
- DSM – 190th Street Disinfection Station Modification: Prepare a preliminary design report that describes the issues at the facility and recommended alternative approaches to better maintain water quality in the Title 22 pipeline to the end user (Toyota) point of use, along with a preliminary layout.
- PCS – JMMCRWRP Plant-Wide Containment System Project: Provide a plant-wide system to contain spills and provide regulatory compliance.
- WDI – TRWRP Waste Discharge Improvement Project: Perform a study to identify the factors limiting pump discharge from the wash water tank and making modifications to the system.

Table 4-22 provides a summary of all of the R&R projects. The projects are sorted based on the treatment sites that are involved. The numbers in the left column are purely for reference and are not a prioritization. The reference numbers are used for consistency in Figure 4-63 through Figure 4-66 to illustrate the general locations of the projects on the aerial views of the treatment sites. A refined list of recommended R&R projects, prioritization, and updated budgetary costs are provided in Chapter 9. Additional projects are included in Chapter 9 that incorporate West Basin's latest agreements with their refinery customers to upgrade facilities, including the HSEPS Forcemain.

Table 4-22. R&R Projects Summary

No.	Project Title		Budget Cost [a]
1	DCS	All Facilities - Distributed Control System Improvements Project	$3,600,000
2	SUR	All Facilities - Surge Tank Control Analysis (Study/Design)	$420,000
3	PPV & PWP	All Facilities - VFD R&R Project	$19,700,000
4	CSTI	All Facilities - Chemical Storage Improvements	$13,500,000
5	WST	All Facilities Welded Steel Storage Tank R&R Project	$11,150,000
6	CRU	Satellite Plant Control Room Upgrade Project	$1,500,000
7	SBP	Satellite Plant Breakpoint Reactor R&R Project	$1,600,000
8	SMI	Satellite Plants - Biofor Mechanical Improvements (Study/Design)	$275,000
9	NPPI	Satellite Plants Piping Inspection	$100,000
10	GBPR	ECLWRF Gravity Belt Thickener (GBT) Modifications (Study/Design)	$100,000
11	TCFS	ECLWRF Title 22 Common Filter Systems Project	$4,000,000
12	T22F	ECLWRF - Title 22 Converted Filters R&R	NA
13	New[b]	ECLWRF – Phase III MF Replacement	NA
14	New[b]	ECLWRF Barrier Water Pump Station and Clearwell R&R	NA
15	TVIP	ECLWRF Title 22 Valve Installation Project	$2,000,000
16	DVPS	ECLWRF Diversion Pump Station R&R Project	$4,600,000
17	New[b]	ECLWRF Replace RO Pressure Housing Rubber Supports	
18	EEQP	ECLWRF Equalization Pump Evaluation Project	$830,000
19	DSM	190th Street Disinfection Station Modification (Study/Design)	$65,000
20	TWS	TRWRP – Chemical Waste System R&R Project.	$415,000
21	WDI	TRWRP Waste Discharge Improvement Project (Study/Design)	$80,000
22	New[b]	TRWRP FRP Potable Water Piping Replacement	NA
23	New[b]	TRWRP Secondary Power Source	NA
24	New[b]	TRWRP New VFDs for RO Pumps 2 and 3	NA
25	New[b]	TRWRP MF/RO Replacement and Expansion Project	NA
26	PCS	JMMCRWRP Civil Site Improvements (formerly the “Plant-Wide Containment System Project”) (Study/Design)	$125,000
27	New[b]	JMMCRWRP – Title 22 Piping Replacement	NA
28	New[b]	JMMCRWRP – Critical Asset Standby Power	NA
29	HYD	CNTP Hydrogenerator Removal Project	$67,000
30	New[b]	CNTP Upgrade Plant Electrical System	NA
31	HRR	Hyperion Secondary Effluent Pump Station R&R Project	$9,500,000

[a] Costs derived from West Basin’s Rehabilitation and Replacement Program Development Project (Louis Berger, 2019) and reflect year 2017 costs. Projects with no cost estimates provided by the study were designated as NA.
[b] R&R project recently identified during virtual interviews (April 2020) and site walk (May 2020) with West Basin and Suez staff as part of the West Basin Recycled Water Master Plan project that were not previously identified in 2019 Louis Berger study.

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Figure 4-63. ECLWRF R&R Projects

1	ALL PLANTS - Distributed Control System
2	ALL PLANTS - Surge Tank Control Analysis
3	ALL PLANTS - VFD R&R Project
4	ALL PLANTS - Chemical Storage Improvements
10	ECLWRF Gravity Belt Thickener (GBT) Mods
11	ECLWRF Title 22 Common Filter Systems
12	ECLWRF - Title 22 Converted Filters 1-3 R&R
13	ECLWRF – Phase III MF Replacement.
14	ECLWRF BARRIER WATER Pump Station R&R
15	ECLWRF Title 22 Valve Installation Project
16	ECLWRF Diversion Pump Station R&R Project
17	ECLWRF Replace RO Pressure Housing Rubber Supports
18	ECLWRF Equalization Pump Evaluation Project
31	Hyperion Pump Station R&R Project

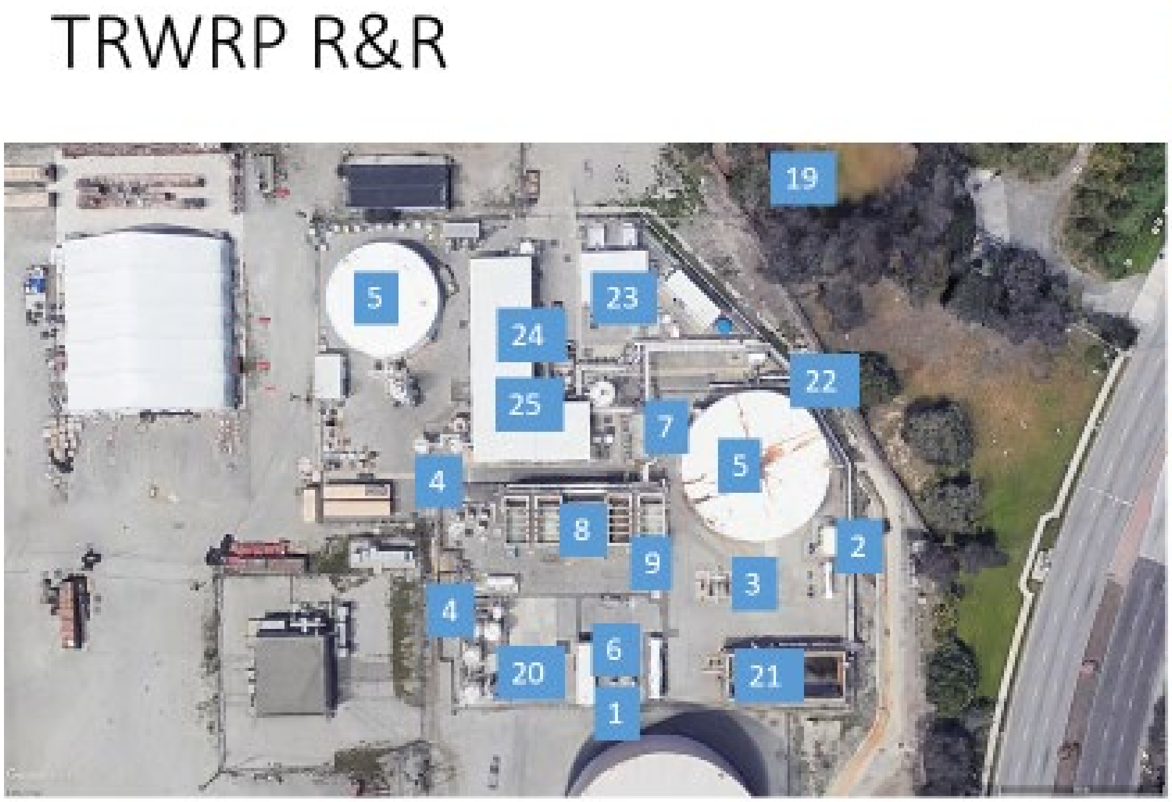
Note: Project 31 is located offsite at HWRP.

Figure 4-64. CNTP R&R Projects

CNTP R&R

1	ALL PLANTS - Distributed Control System
2	ALL PLANTS - Surge Tank Control Analysis
3	ALL PLANTS - VFD R&R Project
4	ALL PLANTS - Chemical Storage Improvements
5	ALL PLANTS Welded Steel Storage Tank R&R
6	Satellite Plant Control Room Upgrade Project
7	Satellite Plant Breakpoint Reactor R&R Project
8	Satellite Plants - Biofor Mechanical Improvements
9	Satellite Plants Piping Inspection
29	CNTP Hydrogenerator Removal
30	CNTP Upgrade Plant Electrical System

Figure 4-65. TRWRP R&R Projects



1	ALL PLANTS - Distributed Control System
2	ALL PLANTS - Surge Tank Control Analysis
3	ALL PLANTS - VFD R&R Project
4	ALL PLANTS - Chemical Storage Improvmnts
5	ALL PLANTS Welded Steel Storage Tank R&R
6	Satellite Plant Control Room Upgrade Project
7	Satellite Plant Breakpoint Reactor R&R
8	Satellite Plants - Biofor Mechanical Improvmts
9	Satellite Plants Piping Inspection
19	190th Street Disinfection Station Modification
20	TRWRP – Chemical Waste System R&R Project.
21	TRWRP Waste Discharge Improvement Project
22	TRWRP FRP Potable Water Piping Replacement
23	TRWRP Secondary Power Source
24	TRWRP New VFDs for RO Pumps 1 and 2
25	TRWRP MF/RO Replacement and Expansion

Figure 4-66. JMMCRWRP R&R Projects

JMMCRWRP R&R

1	ALL PLANTS - Distributed Control System
2	ALL PLANTS - Surge Tank Control Analysis
3	ALL PLANTS - VFD R&R Project
4	ALL PLANTS - Chemical Storage Improvements
5	ALL PLANTS Welded Steel Storage Tank R&R
8	Satellite Plants - Biofor Mechanical Improvements
26	JMMCRWRP – Provide Civil Site Improvements
27	JMMCRWRP – T22 Piping Replacement
28	JMMCRWRP – Critical Asset Standby Power

4.5 Future Supply Requirements and Considerations

As discussed in the previous chapter, the future recycled water demand, including existing customers and potential new customers, can utilize all 70 mgd of HWRP secondary effluent pumped from the HSEPS to ECLWRF. This section discusses the treatment capacity constraints for each treatment process at the plants and water quality requirements for these new potential demands.

4.5.1 Treatment Capacity Constraints

The projected future demand of West Basin's five types of designer water considers their existing customers and potential new customers. However, it is unlikely that all potential new customers identified in the previous chapter will successfully implement conversion to recycled water. Therefore, future demand projections to determine treatment capacity constraints to provide reliable recycled water supply is based on those potential new customers that are likely to convert to recycled water usage and have the largest demands, identified in Chapter 3, that could trigger a capacity increase at the treatment facilities. Based on geographic proximity to the nearest West Basin treatment facility, the likely new customers with the largest additional demands are summarized in Table 4-23. The additional supply capacity at each treatment facility to meet those future demands are also shown in Table 4-23.

Table 4-23: New Potential Demands and Required Supply for West Basin Treatment Facilities

Facility	Existing Production Capacity (mgd)	2016 to 2019 Annual Average (mgd)	New Demand (mgd)	Additional Supply Required (mgd)	Comments
HSEPS	**70.0**	**-**	**-**	**-**	
ECLWRF	**62.4**	**36.8**	**47.3**	**21.7**	
Title 22	40.0	18.1	29.4	7.5	24.0 mgd as Title 22 supply for irrigation and Satellite Plants, and 5.4 mgd for irrigation that needs to account for seasonal peaks.
Barrier	17.5	11.8	17.9	12.2	Groundwater augmentation.
Chevron LPBF	2.2	1.7	-	-	
Chevron HPBF	2.6	2.3	-	-	
CNTP	**4.9**	**3.9**	**2.7**	**1.7**	
Nitrified	4.9	3.9	2.7	1.7	New end user(s) for cooling towers.
TRWRP	**8.1**	**4.4**	**1.0**	**0**	
Nitrified	4.9	2.4	1.0	0	New end user(s) for cooling towers.
LPBF	3.2	2.0	-	-	
JMMCRWRP	**6.0**	**4.3**	**15**	**13.3**	
Nitrified	1.0	0.9	11.25	11.15	Assumed 15 mgd of new demand and 75% of demand is for Nitrified water.
LPBF	5.0	3.4	3.75	2.15	Assumed 15 mgd of new demand and 25% of demand is for Nitrified water.

Source: Daily average flow data (2010-2019).

Chapter 5 Planning and Evaluation Criteria

This chapter summarizes the criteria established for the development of West Basin's hydraulic model and for the analysis of the master plan facilities. The planning and evaluation criteria discussed in this chapter are separated into four subsections, including hydraulic criteria, water quality criteria, facility sizing criteria, and cost estimating criteria.

To better assess opportunities that reflect both current and future regional considerations, a regulatory assessment was performed that summarizes both current and proposed future regulatory requirements. The current requirements include regulations set forth by the State Water Resources Control Board and the State of California RWQCB, which regulate the production, distribution, and use of non-potable and potable water reuse in California based on the California Code of Regulations, Health and Safety Code, and California Water Code, as well as relevant provisions of the Clean Water Act and Safe Drinking Water Act. A detailed description of the current and future regulatory requirements is provided as Appendix I.

5.1 Hydraulic Criteria

The hydraulic criteria described in this section include model simulation requirements, peaking factors, delivery pressure, system losses, and pipeline velocity. While specific analysis criteria for each distribution system will be detailed in Chapter 7, Existing System Analysis, each of these criteria is discussed below in general.

5.1.1 Model Simulation Requirements

The recycled water system was evaluated using hydraulic models that were calibrated for hydraulic parameters measured in the field. These models were developed to conduct 24-hour extended period simulation (EPS) analyses to allow the evaluation of the impact of demand variations on pipeline, pump station, and storage tank performance.

5.1.2 Peaking Factors

Average Day Demands

Annual average day demands (ADD) for existing customers shall be based on historical customer water use data from the past five years, if available. Significant variations in average annual demands will be verified with West Basin staff to identify the reasons. These variations may result from limited usage throughout a year, or very dry and very wet years. The average demands will be determined with consideration of all the available data.

Future average day demands for industrial users and the West Coast Barrier will be based on individual customer requests. Future average day irrigation demands will be based on existing potable water use by the potential customers. For new irrigation customers, water demand factors can be derived from the approach described in Appendix J, Water Demand Factors for Irrigation Customers. The general rule of thumb for irrigation water demand factors is:

= 2.0 to 2.5 afy/acre for irrigating areas with turf

= 1.0 afy/acre for irrigating areas with shrubs

Maximum Month Demands

Maximum month demand (MMD) depends on the type of user. MMD for existing customers shall be based upon the historical seasonal peaking factors for existing system analysis based on available billing data. For future system analysis of existing customers, historical seasonal peaking factors greater than 3.0 will be reduced to 3.0. For future customers, MMD shall generally be based on industry standards for recycled water use, including the following:

Irrigation Customers:	2.5 * ADD
Industrial Use:	1.3 * ADD
Mixed-Use:	1.7 * ADD
Barrier Water Injection:	1.0 * ADD

Diurnal Curves

Hourly fluctuations in the demands are experienced due to variations in seasonal conditions, industry demands, and maintenance operations. As part of the 2009 Master Plan, the peak hourly demand factors for the largest customers were determined individually based on field data. These diurnal curves were then evaluated to develop a set of generic diurnal curves that were applied to all remaining customers based on the water usage types listed in Chapter 3. No changes to the diurnal curves developed for the 2009 Master Plan were determined to be needed, as these curves still sufficiently represent peak demands seen during calibration of the hydraulic model for this Master Plan.

5.1.3 Delivery Pressure

The Title 22 distribution system should typically be designed to provide a minimum service pressure of 65 pounds per square inch (psi). Under special circumstances, higher service pressures may be required. For instance, the Anza Avenue Lateral services, located in the City of Torrance, require a minimum service pressure of 80 psi, because the existing irrigation systems at certain customer sites are old and need a minimum pressure of 75 psi to adequately irrigate.

The pump station control discharge pressures for each of the remaining West Basin recycled water systems are summarized in Table 5.1.

Table 5-1. Control Discharge Pressures

System Description	West Basin Control Discharge Pressure (psi)
Hyperion Secondary Effluent Pumping System	59
Barrier System	73
Chevron LPBF System	34
Chevron HPBF System	34
Chevron Nitrified Water System	100
JMMCRWRP LPBF System	50
JMMCRWRP Nitrified System	50
Title 22 Pump Station at ECLWRF	87

5.1.4 System Frictional Losses

The pressure in the system at any given point for a particular flow is dependent on a number of variables including pipe size, roughness and length. These components all contribute to the magnitude of energy losses in the system and consequently, pressure. The system should be designed and operated to maintain system losses below 10 feet for each 1,000 feet of pipe length under peak hourly demand conditions, subject to satisfying all other criteria.

5.1.5 Pipeline Velocity

The distribution systems should be sized and designed to provide service at adequate pressures with the maximum day demands. To maintain adequate system pressures and prolong the life of the pipe, flow velocities should be limited. The system should be designed to operate at average day demand velocities of 1 to 3 feet per second (fps), with a maximum velocity of 7 fps at intermittent peak flows.

5.2 Water Quality Criteria

The water quality criteria described in this section are separated into irrigation guidelines and disinfection guidelines.

5.2.1 Irrigation Guidelines

Water quality guidelines for irrigation were developed by the University of California Committee Of Consultants. These criteria are presented in Table 5.2. According to *Salt- Affected Turfgrass Sites: Assessment and Management* (Duncan 1998), the combination of high nitrogen levels and frequent irrigation has several adverse effects including:

- Excessive growth and mowing requirements;
- Reduced heat stress tolerance;
- Reduced cold and drought tolerances;
- Reduced wear-resistant turf;
- Increased opportunity for invasive plant infestation (e.g., *Poa annua*); and
- Increased disease and weed problems.

Table 5-2. Irrigation Water Quality Guidelines

Key Irrigation Water Quality Parameter	Units	Established Criteria Degree of Use Restriction (2) (3) (4)		
		None	Slight to Moderate	Severe
Salinity EC	DS/m	<0.7	**0.7-3.0**	>3.0
TDS	mg/L	<450	**450-800**	>2000
Permeability(5)			**EC**	
SAR = 0-3 and EC	—	>0.7	0.7-0.2	<0.2
= 3-6 and EC	—	>1.2	1.2-0.3	<0.3
= 6-12 and EC	—	>1.9	**1.9-0.5**	<0.5
= 12-20 and EC	—	>2.9	2.9-1.3	<1.3
= 20-40 and EC	—	>5.0	5.0-2.9	<2.9
Sodium (Na) Surface Irrigation	mq/L	<3	3-9	>9
Sodium (Na) Sprinkler Irrigation	mg/L	<70	>70	—
Chloride (Cl) Surface Irrigation	mg/L	<140	**140-355**	>355
Chloride (Cl) Sprinkler Irrigation	mg/L	<100	**>100**	—
Boron (B)	mg/L	**<0.7**	0.7-3.0	>3.0
Bicarbonate	mg/L	<90	90-500	>500
pH	—	**6.5-8.4 (normal range)**		
Ammonia (NH_3)	mg/L	(see combined N values below)		
Nitrate (NO_3)	mg/L	(see combined N values below)		
Total Nitrogen (N)	mg/L	<5	5-30	**>30**

(1) Adapted from University of California Committee of Consultants (1974), and Ayers and Westcot (1984).
(2) Method and Timing of Irrigation: Assumes normal surface and sprinkler irrigation methods are used. Water is applied as needed, and the plants utilize a considerable portion of the available stored soil water (50% or more) before the next irrigation. At least 15 percent of the applied water percolates below the root zone (leaching fraction [LF] > 15%).
(3) Site Conditions: Assumes soil texture ranges from sandy loam to clay with good internal drainage with no uncontrolled shallow water table present.
(4) Definitions of "The Degree of Use Restriction" terms:
None = Reclaimed water can be used similar to the best available irrigation water.
Slight = Some additional management will be required above that with the best available irrigation water in terms of leaching salts from the root zone and/or choice of plants.
Moderate = Increased level of management required and choice of plants limited to those which are tolerant of the specific parameters.
Severe = Typically cannot be used due to limitations imposed by the specific parameters.
(5) Permeability is evaluated based on the combination of the adjusted sodium adsorption ratio (aSAR) and electrical conductivity (EC) values.

The successful long-term use of irrigation water depends more on rainfall, leaching, soil drainage, irrigation water management, salt tolerance of plants, and soil management practices than upon water quality itself.

Since salinity problems may eventually develop from the use of any water, the following guidelines are given, should they be needed, to assist water users to better manage salinity in either agricultural or community-based irrigation:

- Irrigate more frequently to maintain an adequate soil water supply.

- Select plants that are tolerant of an existing or potential salinity level.
- Routinely use extra water to satisfy the leaching requirements.
- If possible, direct the spray pattern of sprinklers away from foliage. To reduce foliar absorption, try not to water during periods of high temperature and low humidity or during windy periods. Change time of irrigation to early morning, late afternoon, or night.
- Maintain good downward water percolation by using deep tillage or artificial drainage to prevent the development of a perched water table.

Salinity may be easier to control under sprinkler and drip irrigation than under surface irrigation. However, sprinkler and drip irrigation may not be adapted to all qualities of water and all conditions of soil, climate, or plants.

5.2.2 Disinfection Guidelines

The California Code of Regulations, Title 22, Division 4, Chapter 3, Recycling Criteria, specify treatment processes for ensuring proper disinfection of recycled water. They also specify requirements for limiting public contact with recycled water to protect public health.

Per Article 1. Definitions, Section 60301.230 “Disinfected tertiary recycled water” means a filtered and subsequently disinfected wastewater that meets the following criteria:

- The filtered wastewater has been disinfected by either:
  - A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow; or
  - A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as poliovirus may be used for purposes of the demonstration.
- The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in a 30 day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.

Although there is no regulatory requirement for chlorine residual at the customer point of connection, a range of 0.5 to 2.0 mg/L residual chlorine is recommended to limit the regrowth of microorganisms within the distribution system. The difference between the initial dosing and residual concentration is termed chlorine demand. Factors that increase chlorine demand in recycled water systems include warm weather; presence of ammonia in the water, as well as biofilm and algae. Reducing water age and regularly flushing and cleaning the system can help maintain chlorine residual in the system. If the residual is regularly depleted in long reaches of the system, a chlorine booster station may be needed.

5.2.3 Barrier Water Quality

The State of California RWQCB for the Los Angeles Region has issued a permit, Order No. R4-2006-0069, to West Basin for injection of recycled water from the microfiltration/reverse osmosis/advanced oxidation process (MF/RO/AOP) at ECLWRF into the West Coast Basin Barrier. This water has been shown to meet all the requirements of the California Drinking Water Primary and Secondary Standards and the Maximum Contaminant Levels (MCLs). However, in Table P5 – Recycling Criteria for Groundwater Recharge Reuse the permit requires Total Nitrogen of less than 5 mg/L (as total nitrogen) rather than the MCL of less than 10 mg/L for nitrate. Similarly, the maximum TOC concentrate allowed in the permit is less than 0.5 mg/L. It is of note that the processes being provided have the ability to provide treatment beyond that required by the regulations. For example, the District's AOP study has indicated that selected pharmaceutically active compounds and other toxic contaminants not included in the drinking water standards are removed or reduced to low levels in the product water.

5.2.4 Boiler Feed Water Quality

The contractual limits for the quality of the water supplied by the Chevron LPBF, Chevron HPBF, TRWRP, and JMMCRWRP are shown in Table 5.3.

Table 5-3. Water Quality Criteria RO Products

System	Recycled Water Type	Product Water Quality Limits
Chevron LPBF System	LPBF RO	Hardness <0.3 mg/L
		Silica < 1.5 mg/L
		TDS < 60 mg/L
Chevron HPBF System	HPBF RO	Hardness < 0.03 mg/L
		Silica < 0.1 mg/L
		TDS < 5 mg/L
JMMCRWRP Reverse Osmosis System (JMMCRWRP RO Product Water)	LPBF RO	Calcium 1.0 mg/L
		Magnesium 1.0 mg/L
		Ammonia 4 mg/L
		Silica 1 mg/L
		TDS 35 mg/L
TRWRP RO Product Water	LPBF RO	Conductivity 50 µmho/cm
		TOC 0.7 mg/L
		Ammonia 1.9 mg/L
		Silica 1.0 mg/L

Hardness as mg/L as $CaCO_3$. Individual ions where indicated are as the species.

5.2.5 Nitrified Water Quality

The water quality goals for the Nitrified water supplied by JMMCRWRP and TRWRP are shown in Table 5.4. At the current time there are no water quality goals in place for the Nitrified water supplied by the Chevron Nitrification Facility.

Table 5-4. Water Quality Goals for Nitrification Systems Capital Implementation Master Plan West Basin Municipal Water District

Parameter	TRWRP(1)	JMMCRWRP(2)
Conductivity, µmho/cm	3,000	1,000 (average) 1,350 (max)
Alkalinity, as $CaCO_3$	350	—
Sulfate, mg/L	600	—
Chloride, mg/L	450	—
Calcium, mg/L	80	60 (average) 100 (max)
Magnesium, mg/L	40	24 (average) 29 (max)
Hardness, as $CaCO_3$	360	—
Potassium, mg/L	20	—
Silica, mg/L	35	22 (average) 28 (max)
Ammonia, mg/L as N	1.6	0.1 (average) 0.1 (max)
Iron, mg/L	1.0	—
Phosphate, mg/L	15	—
Total Suspended Solids, mg/L	5	—
COD, mg/L	90	—

(1) Listed limits for TRWRP are maximum concentrations.
(2) JMMCRWRP limits established by Marathon.

5.3 Facility Sizing Criteria

The facility sizing criteria described in this section are separated into pump station sizing and storage requirements.

5.3.1 Pump Station Sizing

All pump stations should have flow meters, suction and discharge pressure gauges, and remote telemetry units. They should be tied to the central DCS system.

Pump stations should be constructed with fireproof materials. Power to the pump stations should be provided through underground service to minimize possibility of damage during fires.

Source of Supply Pump Station

Hyperion Secondary Effluent Pump Station (HSEPS) delivers secondary effluent from the Hyperion Wastewater Treatment Plant (HWRP) to the ECLWRF. HSEPS should have the capability to deliver the peak hour demands via one standby pump in the event the largest pump is out of service. Improvements to the HSEPS were recently completed in 2019 and provided a secondary power supply source for increased reliability.

Booster Pump Stations at ECLWRF

The booster pump stations supplying recycled water from ECLWRF include the Title 22 Pump Station, the Barrier Pump Station, the LPBF Pump Station, and the HPBF Pump Station.

These pumping stations should be sized to deliver the peak hour demands via one standby pump in an event the largest pump is out of service.

The Title 22 Pump Station should be designed to deliver the expected overall peak hour demand with the largest pump out of service, because it pumps into a closed system and there is no storage in the closed system to assist with delivering peak demands. Back-up power should be provided to operate the pump station during commercial power outages.

The Barrier Pump Station should deliver the future maximum day demand with the largest pump out of service. Back-up power is not required because potable water is alternatively available through the Metropolitan Water District of Southern California's West Coast Feeder.

The Chevron LPBF Pump Station should deliver the maximum day demand with the largest pump out of service. Under future maximum day demands, this tank would provide emergency storage for over 9 hours. However, back-up power requirement should be reviewed based upon the future service requirements at the refinery.

The Chevron HPBF Pump Station should have the firm capacity to deliver the maximum day flow. Back-up power is not required because there is approximately 1.2 MG of emergency storage in the on-site storage tank at the Chevron El Segundo Refinery, which provides over 8 hours of storage under future maximum day demands.

Chevron Nitrified Water Pump Station

This pump station should deliver the maximum day demand with the largest pump out of service. Because potable water connection from the City of El Segundo's distribution system is available to supply all the cooling towers, back-up power is not necessary.

Booster Pump Stations in Title 22 Distribution System

The pumping stations in the Title 22 Distribution System should be sized to deliver the peak hour demands with the largest pump out of service (one standby pump). Pump stations should be equipped with portable generator connections and manual transfer switches.

Booster Pump Stations at JMMCRWRP

The RO and Nitrified Water Pump Stations should be designed to deliver the maximum day demands with the largest pump out of service. If this capacity is sufficient for the maximum month demands of the future customers, no additional storage will be necessary. However, either portable power with manual transfer switches, or a secondary source of supply should be provided to operate the pump stations during an outage of the primary power supply.

5.3.2 Storage Requirements

Storage for West Basin's recycled water systems is necessary for:

- Pump station forebay providing operational storage accommodating variations in water production and demand, and retention time for the product water.
- Emergency supply during interruption of treatment or primary supply source.
- Providing break tanks that separate JMMCRWRP and TRWRP from the Title 22 System to minimize the transient pressures (surges) that result from the significant flow changes during the microfiltration backwash cycles.

Forebay storage should be evaluated for each pump station during the preliminary and final design stages.

Emergency storage for each system should accommodate transfer of potable water in the event that recycled water production is interrupted. As required by Title 17 of the California Code of Regulations, Division 1, Chapter 5, Group 4. Drinking Water Supplies, back up potable water should be supplied through an air-gap separation to avoid cross connections. The air-gap separation shall be at least double the diameter of the supply pipe, measured vertically from the flood rim of the receiving vessel to the supply pipe; however, in no case shall this separation be less than one inch.

Break tanks should be sized to accommodate the variations in influent flows and backwash cycles.

5.4 Cost Estimating Criteria

The cost estimates presented in this Master Plan are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and experience on other projects. The costs estimated for each recommended facility are opinions included in the CIP tables developed with this study. The tables are intended to be used to facilitate revisions to West Basin's CIP and ultimately to support determination of the user rates and connection impact fees.

Recommendations for cost criteria of pipelines, pump stations, storage tanks and water treatment are also presented.

5.4.1 Capital Improvement Project Costs

The upgrades and other system capital improvements set the foundation of the District's recycled water distribution system CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and experience on other projects. The costs are based on an *Engineering News Record* Construction Cost Index (ENR CCI) Los Angeles Area of 12,043 (February 2020).

5.4.2 Cost Estimating Accuracy

The cost estimates presented in the Master Plan have been prepared for general master planning purposes and for guidance in project evaluation and implementation. Final costs of a project will depend on actual labor and materials costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate, deemed appropriate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

5.4.3 Construction Unit Costs

The construction costs are representative of water distribution system facilities, sewer collection system facilities, and storm drainage facilities under normal construction conditions and schedules. Costs have been estimated for public works construction.

Pipeline Unit Costs

This section summarizes the unit costs for recycled water distribution system pipelines. All of the unit costs presented in this section include planning level pipeline costs, excavation, and other appurtenances (e.g., valves, manholes)

Water Distribution System Pipelines

Water distribution system pipeline improvements range in size from 4 inches to 16 inches in diameter for this Master Plan. Pipeline unit costs for relevant sized upgrades are shown in Table 5-5. The unit costs are for "typical" field conditions with construction in stable soil and are for PVC pipe material.

Table 5-5. Unit Construction Costs - Recycled Water Pipeline

Pipe Size (inches)	Replacement Unit Construction Cost (1) ($/linear foot)	Capital Cost (2) ($/linear foot)
4	$60	$100
6	$75	$120
8	$81	$140
10	$119	$200
12	$142	$240
14	$159	$265
16	$195	$325
20	$274	$455
24	$346	$575
30	$540	$895
36	$685	$1,140

1 ENR Los Angeles Construction Cost Index for February 2020 is 12,043
2 Capital Markup of 1.658% See section 5.4.4.3

Service Lateral, Meter and Retrofit Costs

On-site retrofit costs for these identified customers may range from $10,000 per site for smaller sites to as much as $75,000 or more, on average per site, for larger sites. On-site retrofit costs may include the service lateral, potable water system backflow prevention upgrades, modifications to the existing irrigation point of connection for use of recycled water, compliance with Title 22 regulations for placing identification signs and tags, and compliance. Materials and installation of the recycled water meter are typically handled by retail agency and is not included in the cost estimate.

Storage Tank, Booster Pump, PRV Station, and Water Treatment Unit Costs

The capital improvement plan includes tank, pump station, pressure reducing valve (PRV) and water treatment improvement projects. The costs for these facilities were developed based on the unit costs shown in Table 5-6, Table 5-7, Table 5-8, and Table 5-9, respectively.

Table 5-6. Unit Construction Costs – Welded Steel Storage Tank

Type (MG)	Unit Construction Cost(1) ($/gallon)	Capital Cost(2) ($/gallon)
<1	$2.75	$4.75
1 to 3	$2.25	$3.75
3 to 5	$2.00	$3.50
5 to 10	$1.75	$3.00

1 ENR Los Angeles Average Construction Cost Index for February 2020 is 12,043
2 Capital Markup of 1.658% See Section 5.4.4.3

Table 5-7. Unit Construction Costs - Pump Stations

Station Size (HP)	Unit Construction Cost(1) ($/Horsepower [HP])	Capital Cost(2) ($/HP)
100 hp and smaller	$12,950	$21,500
100-500 hp	$7,775	$13,000
600-1,000 hp	$6,475	$11,000
1,000 hp and larger	$5,175	$9,000

1 ENR Los Angeles Average Construction Cost Index for February 2020 is 12,043
2 Capital Markup of 1.658% See Section 5.4.4.3

Table 5-8. Unit Construction Costs - Pressure Reducing Valves

Type	Unit Construction Cost(1) ($/PRV)	Capital Cost(2) ($/PRV)
Small (1-2 valves <8")	$103,500	$172,000
Medium (2-3 valves 8" and up)	$207,000	$344,000
Large (3-4 valves 12" and up)	$310,500	$515,000

1 ENR Los Angeles Average Construction Cost Index for February 2020 is 12,043
2 Capital Markup of 1.658% See Section 5.4.4.3

Table 5-9. Unit Construction Costs – Water Treatment

Treatment Category	Unit Construction Cost (1) ($/gpd)	Capital Cost (2) ($/gpd)
From Secondary Effluent to Title 22 (conventional)	$2.50	$4.25
From Secondary Effluent to Title 22 (with MF/RO for TDS reduction)	$7.50	$12.50
From Title 22 to Nitrified Water (Nitrification)	$1.50	$2.50
Single Pass RO (treating T22 water with MF/RO)	$3.00	$5.00
Double Pass RO (treating single pass RO feedwater)	$6.00	$10.00
Barrier (treating Secondary Effluent with MF/RO/UV)	$8.00	$13.50
Potable Reuse (O3/BAF/MF/RO/UV)	$11.00	$18.25

1 ENR Los Angeles Average Construction Cost Index for February 2020 is 12,043
2 Capital Markup of 1.658%; see Section 5.4.4.3

5.4.4 Project Costs and Contingencies

Project cost estimates are calculated based on elements, such as the project location, size, length, and other factors. Allowances for project contingencies consistent with an “Order of Magnitude” estimate are also included in the project costs prepared as part of this master plan, as outlined in this section.

Baseline Construction Cost

Baseline Construction Cost is the total estimated construction cost, in dollars, of the proposed improvements for pipelines, storage tanks, booster pump stations, and PRVs. Baseline Construction Costs were developed using the following criteria:

- **Pipelines:** Calculated by multiplying the estimated length by the unit cost.
- **Storage Tanks:** Calculated by multiplying the tank volume by the unit cost.
- **Booster Pump Stations:** Calculated on a case-by-case basis depending on the type of work that is required.
- **PRV Stations:** Calculated based on the information presented in Table 5-8.
- **Water Treatment:** Calculated by multiplying the estimated capacity by the information presented in Table 5-9.

Estimated Construction Cost

Contingency costs must be reviewed on a case-by-case basis because they will vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Factors such as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in preliminary estimates. To assist the District in making financial decisions for these future construction projects, contingency costs were added to the planning budget as percentages of the total construction cost, divided into two categories: Estimated Construction Cost and Capital Improvement Cost.

Since knowledge about site-specific conditions of each proposed project is limited at this level of project planning, a 30 percent contingency was applied to the Baseline Construction Cost to account for unforeseen events and unknown conditions. A 30 percent contingency was used to account for unknown site conditions such as unforeseen conditions, environmental mitigations, and other unknowns is typical for master planning projects.

Capital Improvement Cost

Other project construction contingency costs include costs associated with project engineering, construction phase professional services, and project administration. Engineering services associated with new facilities include preliminary investigation and reports, Right of Way (ROW) acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling of testing material, and start-up services. Construction phase professional services cover items such as construction management, engineering services, materials testing, and inspection during construction. Finally, there are project administration costs, which cover items such as legal fees, environmental/California Environmental Quality Act (CEQA) compliance requirements, financing expenses, administrative costs, and interest during construction.

The cost of these items can vary, but for the purpose of this study, it is assumed that the other project contingency costs will equal approximately 27.5 percent of the Estimated Construction Cost.

As shown in the following simple calculation (Table 5-10) of the Capital Improvement Cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 65.8 percent of the Baseline Construction Cost. Note that contingencies were not applied to land acquisition costs. Calculation of the 65.8 percent is the overall mark-up on the Baseline Construction Cost to arrive at the Capital Improvement Cost. It is not an additional contingency.

Table 5-10. Capital Improvement Cost Example

Baseline Construction Cost	**$1,000,000**
Construction Contingency (30%)	$300,000
Estimated Construction Cost	**$1,300,000**
Engineering Cost (10%)	$130,000
Construction Management (10%)	$130,000
Project Administration (7.5%)	$97,500
Capital Improvement Cost	**$1,657,500**

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Chapter 6 Model Development

This chapter summarizes the development of a hydraulic model of the West Basin conveyance and distribution systems. The hydraulic model represents the following ten systems:

- Hyperion Secondary Effluent Pumping Station
- Title 22 Distribution System
- West Coat Barrier Water System
- Chevron LPBF System
- Chevron HPBF System
- Chevron Nitrified Water System
- JMMCRWRP LPBF System
- JMMCRWRP Nitrified Water System
- JMMCRWRP Brine Discharge System
- ECLWRF Brine Discharge System

All models with the exception of the ECLWRF Brine Discharge System were created in InfoWater Suite 12.4, Update #5 using ArcGIS Desktop 10.7.1. Due to the open surface flow in the ECLWRF Brine Discharge System, the model for this system was created in InfoSewer Pro Suite 7.6, SP 1, Update #13.

The Title 22 Distribution System model was also updated to include a water quality model representing residual chlorine in the distribution system.

All models were created based on West Basin's geodatabase, updated August 24, 2020. Pipe elevation information was estimated based on a digital elevation map (source). Facility attributes were included in the models based on information provided by West Basin.

6.1 Hydraulic Model Calibration

This section addresses calibration of West Basin's hydraulic models. All models with the exception of the ECLWRF Brine Discharge System were calibrated hydraulically based on SCADA data and, in the case of the Title 22 system model, pressure logger data. The ECLWRF Brine Discharge System was not calibrated. This system experiences free surface flows and calibration for these conditions was outside the scope of this Master Plan.

The Title 22 Distribution system chlorine residual model was also calibrated based on water quality data from ECLWRF and the distribution system.

The objective of the calibration effort was to calibrate the models to within 10 percent of the condition that was field tested, when practicable. The following subsections summarize the model calibration processes and results.

6.1.1 Calibration Methodology

For the 2020 West Basin Recycled Water Master Plan, the existing hydraulic model, built in the Innovyze InfoWater platform, was updated with current GIS information and demand data. Calibration of the model was undertaken to ensure that the model closely approximates actual observed conditions as measured from field data. Field data from West Basin's SCADA system, operated by Suez, and from pressure loggers temporarily installed throughout the distribution systems were used. The information gathered included the following:

- Tank levels
- Pump station flows
- Pump station discharge pressures
- Individual pump on/off settings
- Individual pump speeds
- Pressures at key locations where tanks do not exist
- Flows and pressures for all satellite plants, refineries, and other high-volume water users

The data was recorded in 15-minute intervals over a period of four weeks in the month of August 2020. Demands, tank levels, pump speeds, and pump on/off times were entered to exactly match the recorded SCADA information, where available. Flows and pressures were also verified with the provided SCADA information.

Friction factors used in the hydraulic models developed as part of the 2009 Master Plan were used as starting points for the model calibration. The friction factors for the distribution system were then adjusted until pressures matched.

6.1.2 Field Data Gathering

Field data was gathered over a four-week period from July 31, 2020 through August 28, 2020. The data collected in the field included flows, pressures, tank levels, pump on/off times, and pump speeds for the Title 22 distribution system as well as the satellite systems. West Basin's SCADA system data was utilized as much as possible for accuracy.

Additionally, factory calibrated pressure loggers were installed in the field to obtain specific system pressure information. The time interval selected for the models was 15 minutes to match the field recorded data.

Most of the equipment installed in the field was on the Title 22 distribution system. Pressure loggers were installed at 17 locations in the Title 22 distribution system; however, two of these loggers failed and did not record meaningful data. Pressure loggers were also installed on the Barrier blend station line, the JMMCRWRP Brine Line, the Chevron Nitrification Line, and the JMMCRWRP RO and Nitrified water lines.

6.1.3 Hydraulic Model Calibration Process and Results

Title 22 Distribution System

The Title 22 Distribution System was calibrated over a two week period. The SCADA and pressure logger information used in the calibration process correlates to August 6, 2020 to August 19, 2020. The SCADA and field data collected included the following:

- SCADA Data Sets
  - Edward C. Little Water Recycling Facility (ECLWRF) Tank 1 and Tank 2 levels
  - ECLWRF combined pump station flow
  - ECLWRF combined pump station discharge pressure
  - ECLWRF pump on/off status
  - ECLWRF pump speeds
  - JMMCRWRP influent flow and pressure
  - Chevron Nitrification Facility (CNF) influent flow and pressure
  - Torrance Refinery Water Recycling Plant (TRWRP) influent flow and pressure
- Pressures at 16 locations throughout the distribution system (data loggers installed)

The Title 22 model includes ECLWRF pump station clearwells and pumps. However, to facilitate the calibration process, ECLWRF discharge head was controlled in the model using a fixed head reservoir matching patterns from the SCADA data. Demands for the major Title 22 system users, including JMMCRWRP, CNTP, and TRWRP, were calculated on a 15-minute interval using available SCADA data. Demands for the remaining Title 22 customers were developed by globally adjusting max month demands for each customer to match the balance of Title 22 system demands, as calculated using the SCADA data for each 15-minute time step. This approach was used to represent system flows and associated pressure drops in the system for the purposes of adjusting friction factors as part of the calibration process if needed.

Model calibration started with friction factors that were inherited from the Title 22 hydraulic model developed for the 2008 Master Plan. For pipes that were added to the system since the previous model update and for pipes that were updated based on GIS data, friction factors similar to those used in the 2008 hydraulic model were applied based on material and diameter, including those listed below. Model calibration did not result in adjustments to these friction factors.

- C-factor 125: DIP (6 inch)
- C-factor 130: DIP (12-36 inch), PVC (12 inch), Other (12 inch)
- C-factor 140: DIP (42 inch, 48 inch)

To record data in the field, pressure loggers were installed throughout the system. Pressure logger locations, as well as the water quality sampling sites, are shown in Figure 6-1.

Figure 6-1. Title 22 Distribution System Pressure Logger Locations

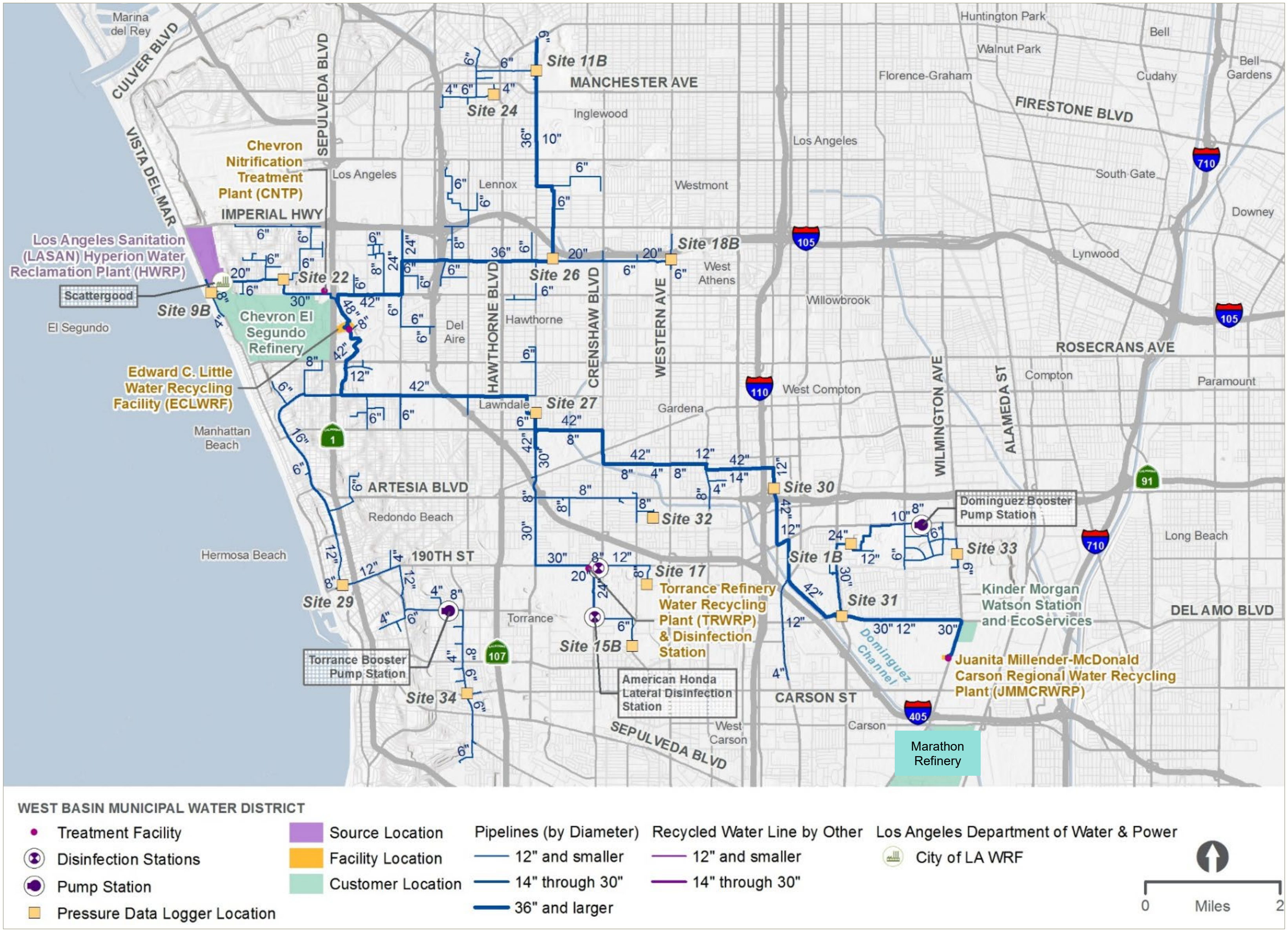


Table 6-1 lists the 16 pressure logger locations distributed throughout the Title 22 distribution system.

Table 6-1. Title 22 Distribution System Pressure Logger Locations

Site Number	Pressure Logger ID	Address
17	Pressure Logger 42	19822 Gramercy Place, Torrance
22	Pressure Logger 43	298 Sierra Street, El Segundo
24	Pressure Logger 46	240 W. Queen Street, Inglewood
26	Pressure Logger 40	11944 Doty Avenue, Hawthorne
27	Pressure Logger HDR 1	4000 154th Street, Lawndale
29	Pressure Logger 39	501 Herondo Street, Redondo Beach
30	Pressure Logger 53	16805 S. Figueroa Street, Gardena
31	Pressure Logger 00	20240 S. Avalon Blvd, Carson
32	Pressure Logger 41	17900 Gramercy Place, Torrance
33	Pressure Logger 47	18701 S. Wilmington Avenue, Carson
34	Pressure Logger 37	4650 Juan Avenue, Torrance
11B	Pressure Logger 44	687 E. Regent Street, Inglewood
15B	Pressure Logger 30	777 Van Ness Avenue, Torrance
18B	Pressure Logger 48	1819 Charlie Sifford Drive, Los Angeles
1B	Pressure Logger 32	Dignity Health Sports - Parking Lot
9B	Pressure Logger 35	12294 Vista Del Mar, Los Angeles

Table 6-2 shows that average model pressures are within ten percent of field data for 15 of the 16 Title 22 Distribution System locations chosen for the model calibration. Pressure comparison graphs are shown in Appendix K, Figure K-1 through K-18.

Pressures did not match at the CNTP because the field model pressure is located along the existing pipe in El Segundo Boulevard upstream of the pressure reducing valve located at the CNTP site. The SCADA data collection point for comparison is located downstream of the pressure reducing valve which is set to maintain a pressure of about 25 psi.

Additionally, data collected by pressure logger 46 shows periodic atmospheric pressure, which is likely due to pressure logger error or an installation issue.

The data sets shown in Table 6-2 represent two different methods of data collection, including averaged pressures and instantaneous pressures. The data set for pressure logger HDR 1 and the SCADA data sets for influent pressures to JMMCRWRP, CNTP, and TRWRP represent recorded field pressures averaged over the 15-minute data collection interval window. Graphing these data sets results in distinguishable pressure trends, shown in Appendix K, Figure K-15 through Figure K-18. Data sets for the other pressure loggers listed in Table 6-2 represent instantaneous field pressures recorded at 15-minute intervals. As a result, data from these pressure loggers, displayed in Appendix K, Figure K-1 through Figure K-14, show considerable scatter, represent instantaneous changes in demands and pump station operations affecting system pressures, and are less representative of diurnal pressure trends.

Model results displayed in Appendix K, Figure K-1 through Figure K-18 show more uniformity and less scatter and appear to more neatly line up with the averaged 15-minute data sources in Appendix K, Figure K-15 through Figure K-18. This is due to the model being set up to with the focus of assessing system capacity by running with a 15-minute calculation time step and including model demands based on hourly diurnal patterns. Therefore, model results represent diurnal demand and pressure trends in the distribution system, rather than instantaneous changes in pressure associated with demand and system operations changes occurring on the sub-15-minute timescale.

Table 6-2. Model Results Comparison with Field Data for Average Pressures

Site Number	Field Data Source	Average Pressure (psi)		
		Field Data	Model Results	Percent Difference
17	Pressure Logger 42	98	101	3%
22	Pressure Logger 43	61	60	-3%
24	Pressure Logger 46	33	79	136%
26	Pressure Logger 40	104	103	-1%
27	Pressure Logger HDR1	106	105	-1%
29	Pressure Logger 39	114	114	0%
30	Pressure Logger 53	113	115	2%
31	Pressure Logger 00	123	118	-5%
32	Pressure Logger 41	Pressure Logger Error, No Data Collected		
33	Pressure Logger 47	60	61	1%
34	Pressure Logger 37	89	93	4%
11B	Pressure Logger 44	59	58	-2%
15B	Pressure Logger 30	88	91	3%
18B	Pressure Logger 48	61	61	0%
1B	Pressure Logger 32	100	100	-1%
9B	Pressure Logger 35	115	113	-1%
NA	JMMCRWRP Influent SCADA Data	114	115	1%
NA	CNTP Influent SCADA Data	27	89	233%
NA	TRWRP Influent SCADA Data	96	98	2%

Barrier Water Conveyance System

The West Coast Barrier Water System was calibrated over a 72-hour period. The SCADA and pressure logger information used in the calibration process correlates to August 25, 2020 to August 28, 2020. The data sets used for the calibration included the following:

- ECLWRF clearwell levels (SCADA data)
- Pump station flows (SCADA data)
- Pump on/off status (SCADA data)
- Pump station discharge pressure upstream of flow control valve (pressure logger data)
- Discharge downstream of flow control valve (pressure setting)

- Blending station influent pressure (pressure logger data)

The pump station flows were used to create a demand pattern and applied to the location in the model representing the blend station. The pump on/off controls were inputted based on time. The clearwell levels were inputted at the tank connected to the suction side of the pump station.

The flow control valve was set to match discharge pressures during the calibration period based on SCADA data, with an average setting of 72.4 psi. The hydraulic model run was performed and the flows and pressures on the discharge side of the pump station were compared to the DCS and field data. Next, the pressures at the blend station were compared to the field data collected. The friction factor within the 30-inch diameter distribution pipeline for Barrier water was inherited from the 2008 Master Plan hydraulic model with a C-factor value of 140. The pressure at the blend station was approximately 72.7 psi during the calibration period based on field pressure logger data.

The average difference in pressures at the blend station between the model and the field data was 2.0 psi, within three percent of the field data. The pressure results are shown in Appendix K, Figure K-19 and Figure K-20.

Hyperion Secondary Effluent Booster Pump and Force Main System

The Hyperion Secondary Effluent Pumping System was calibrated over a 24-hour period. The SCADA information used in the calibration process correlates to July 31, 2020 to August 2, 2020. The SCADA data collected included the following:

- Suction water elevation at the pump station (SCADA data)
- Pump flows to ECLWRF (SCADA data)
- Discharge pressure at the discharge header (SCADA data)
- Pump on/off status (SCADA data)
- Pump speeds (SCADA data)
- ECLWRF influent pressure (SCADA data)

The pump station flows were used to create a demand pattern and applied to the location in the model representing inflows at ECLWRF. Variable pump speeds were controlled based on average discharge pressure during the calibration period based on SCADA data, including 54.5 psi for pumps 1 through 4, and 58 psi for pumps 5 through 7. Initial on/off pump status was input. The wet wells were modeled as reservoirs with levels based on SCADA data.

The hydraulic model run was performed and the flows and pressures on the discharge side of the pump station were compared to the SCADA data. Next, the pressures at ECLWRF were compared to the DCS data. The friction factor within the 60-inch Hyperion Secondary Effluent Force Main was inherited from the 2009 Master Plan hydraulic model with a C-factor of 140.

The average pressure at ECLWRF was approximately 10.7 psi. The average difference in pressures at ECLWRF between the model and the field data was 1.0 psi, within nine percent of field data. The pressure results are shown in Appendix K, Figure K-21 and Figure K-22.

Chevron Low Pressure Boiler Feed System

The Chevron LPBF System was calibrated over a 24-hour period. The SCADA information used in the calibration process correlates to July 31, 2020 to August 2, 2020. The SCADA data collected included the following:

- Clear well levels (SCADA data)
- Pump flows (SCADA data)
- Pump on/off status and pump speeds (SCADA data)
- Pressure at the discharge header (SCADA data)
- Facility influent pressure (SCADA data)

The pump station flows were used to create a demand pattern and applied to the location in the model representing the outlet of the product storage tank. Variable pump speeds were controlled based on average discharge pressure during the calibration period of approximately 45 psi. Initial on/off pump status was also inputted into the hydraulic model. The clearwell levels were inputted at the tank connected to the suction side of the pump station.

The hydraulic model run was performed and the flows and pressures on the discharge side of the pump station were compared to the SCADA data. The friction factor within the 12-inch diameter LPBF distribution pipe was inherited from the 2009 Master Plan hydraulic model with a C-factor value of 120.

The average pressure at the LPBF during the calibration period was approximately 23.9 psi based on SCADA data. The average difference in pressures at ECLWRF between the model and the field data was 1.6 psi, within six percent of field data. The pressure results are shown in Appendix K, Figure K-23 and Figure K-24.

Chevron High Pressure Boiler Feed System

The Chevron HPBF System was calibrated over a 24-hour period. The SCADA information used in the calibration process correlates to July 31, 2020 to August 2, 2020. The SCADA data collected included the following:

- Clear well levels (SCADA data)
- Pump flows (SCADA data)
- Pump on/off status and pump speeds (SCADA data)
- Pressure at the discharge header (SCADA data)
- Facility influent pressure (SCADA data)

The pump station flows were used to create a demand pattern and applied to the location in the model representing the outlet of the product storage tank. Variable pump speeds were controlled based on average discharge pressure during the calibration period of approximately 38 psi. Initial on/off pump status was also inputted into the hydraulic model. The clearwell levels were inputted at the tank connected to the suction side of the pump station.

The hydraulic model run was performed and the flows and pressures on the discharge side of the pump station were compared to the SCADA data. The friction factor within the 16-inch diameter HPBF distribution pipe was inherited from the 2009 Master Plan hydraulic model with a C-factor value of 120.

The average pressure at the HPBF during the calibration period was approximately 23.9 psi based on SCADA data. The average difference in pressures at ECLWRF between the model and the field data was 0.1 psi, within one percent of field data. The pressure results are shown in Appendix K, Figure K-25 and Figure K-26.

Chevron Nitrified Water System

The CNTP System was calibrated over a 24-hour period. The SCADA information used in the calibration process correlates to August 25, 2020 to August 27, 2020. The SCADA data and pressure logger data collected included the following:

- Nitrified water storage tank level (SCADA data)
- Product pump flows (SCADA data)
- Pump on/off status and pump speeds (SCADA data)
- Pressure at the discharge header (SCADA data)
- Pressure near the Chevron gate (pressure logger data)

The pump station flows were used to create demands and a demand pattern which were applied to the location in the model representing the boundary of the Chevron El Segundo Refinery, located south of El Segundo Boulevard at Lomita Street. The pump speeds were inputted for each of the variable speed pumps. Initial on/off pump status was also inputted in the hydraulic model. The product water storage tank levels were input at the tank connected to the suction side of the pump station.

The hydraulic model run was performed and the pressures on the discharge side of the pump station were compared to the SCADA data. The friction factor for the 20-inch CNTP line was inherited from the 2009 Master Plan hydraulic model, with a C-factor value of 140.

The average pressure at the end of the CNTP line during the calibration period was approximately 58.0 psi based on pressure logger data. The average difference in pressures at this location between the model and the field data was 0.1 psi, within one percent of field data. The pressure results are shown in Appendix K, Figure K-27 and Figure K-28.

JMMCRWRP Low Pressure Boiler Feed System

The JMMCRWRP LPBF System was calibrated over a 24-hour period. The SCADA information used in the calibration process correlates to August 22, 2020 to August 24, 2020. The SCADA data and pressure logger data collected included the following:

- Product water storage tank level (SCADA data)
- Product pump flows (SCADA data)
- Pump on/off status and pump speeds (SCADA data)
- Pressure at the discharge header (SCADA data)
- Pressure near refinery facility (pressure logger data)

The pump station flows were used to create demands and a demand pattern which were applied to the location in the model representing the end of the modeled JMMCRWRP LPBF line, located near the adjacent refinery facility. Variable pump speeds were controlled based on average discharge pressure during the calibration period of approximately 52 psi. Initial on/off pump status was also inputted in the hydraulic model. The product water storage tank levels were input at the tank connected to the suction side of the pump station.

The hydraulic model run was performed and the pressures on the discharge side of the pump station were compared to the SCADA data. The friction factor for the 24-inch and 30-inch JMMCRWRP LPBF line was inherited from the 2009 Master Plan hydraulic model, with a C-factor value of 140.

The average pressure at the end of the LPBF line during the calibration period was approximately 52.0 psi based on pressure logger data. The average difference in pressures at this location between the model and the field data was 1.6 psi, within three percent of field data. The pressure results are shown in Appendix K, Figure K-29 and Figure K-30.

JMMCRWRP Nitrified Water System

The JMMCRWRP Nitrified Water System was calibrated over a 24-hour period. The SCADA information used in the calibration process correlates to August 22, 2020 to August 24, 2020. The SCADA data and pressure logger data collected included the following:

- Product water storage tank level (SCADA data)
- Product pump flows (SCADA data)
- Pump on/off status and pump speeds (SCADA data)
- Pressure at the discharge header (SCADA data)
- Pressure near the refinery facility (pressure logger data)

The pump station flows were used to create demands and a demand pattern which were applied to the location in the model representing the end of the modeled JMMCRWRP Nitrified Water System line, located near the adjacent refinery facility. Variable pump speeds were controlled based on average discharge pressure during the calibration period of approximately 58.9 psi. Initial on/off pump status was also inputted in the hydraulic model. The product water storage tank levels were input at the tank connected to the suction side of the pump station.

The hydraulic model run was performed and the pressures on the discharge side of the pump station were compared to the SCADA data. The friction factor for the 12-inch JMMCRWRP Nitrified Water System line was inherited from the 2009 Master Plan hydraulic model, with a C-factor value of 120.

The average pressure at the end of the Nitrified water line during the calibration period was approximately 52.6 psi based on pressure logger data. The average difference in pressures at this location between the model and the field data was 1.0 psi, within two percent of field data. The pressure results are shown in Appendix K, Figure K-31 and Figure K-32.

JMMCRWRP Brine Discharge System

The JMMCRWRP Brine Discharge System was calibrated over a 48-hour period. The SCADA and pressure logger information used in the calibration process correlates to August 22, 2020 to August 24, 2020. The SCADA data collected included the following:

- Brine line flows (SCADA data)
- Pressure on brine line at JMMCRWRP (pressure logger data)
- Pressure on the brine line at end of the brine line in the City of Carson (SCADA data)

SCADA data were used to create demands and a demand pattern which were applied to the location in the model representing the end of the modeled brine line, located at the LACSD's JWPCP in the

City of Carson. Brine line discharge head in the model was controlled using a fixed head reservoir based on patterns from the pressure logger data.

The friction factor for the 14-inch brine line was inherited from the 2009 Master Plan hydraulic model, with a C-factor value of 120.

The hydraulic model run was performed and the flows and pressures at JMMCRWRP were compared to the pressure logger data collected. It is known that the end point is a standpipe with a final elevation of 62.5 feet and a free surface discharge. The elevation of the brine line at JMMCRWRP is approximately 24 feet and is therefore under pressure for its entire length.

The average pressure at the end of the downstream pressure logger location during the calibration period was approximately 13.4 psi based on pressure logger data. The average difference in pressures at this location between the model and the field data was 0.9 psi, within six percent of field data. The pressure results are shown in Appendix K, Figure K-33 and Figure K-34.

Hydraulic Model Calibration Conclusions

The purpose of calibrating the hydraulic models, including the Title 22 Distribution System and the eight dedicated systems, was to develop reliable models for system analysis. The goal of the calibration effort was to demonstrate that the models are reliable based on a comparison of model output with field data.

Table 6-3 summarizes the results of the calibration effort for all modeled systems, including the Title 22 Distribution System and the eight dedicated, single line systems. Model results fall within the ten percent average pressure comparison criteria for all the data sets used, with the exception of two locations on the Title 22 Distribution System. The two locations on the Title 22 system that do not agree with model results include:

- CNTP influent pressure. his discrepancy can be explained by the assumption that the SCADA sensor for this location is downstream of a PRV that is typically set to 25 psi. This same issue was noted in Appendix E of the 2009 Master Plan Model Calibration Results .
- Pressure Logger 46 (Site 24). Pressure logger data indicate periodic atmospheric pressure during the data collection period, a pressure trend which is not reflected by adjacent pressure logger data (Pressure Logger 44, Site 11B) or model results. This is possibly due to pressure logger error or installation issue.

The conclusion of this calibration effort is that the hydraulic models for the Title 22 Distribution System and the eight dedicated systems satisfactorily represent the actual systems within the tolerances indicated in the scope of this project (10 percent) when model results are compared with available field data.

Table 6-3. Calibration Summary All Systems

		Average Pressure (psi)		
System	Field Data Source	Field Data	Model Results	Percent Difference
Title 22 Distribution	Pressure Logger 43	61	60	-3%
Title 22 Distribution	Pressure Logger 00	123	118	-5%
Title 22 Distribution	Pressure Logger 47	60	61	1%
Title 22 Distribution	Pressure Logger 42	98	101	3%

System	Field Data Source	Average Pressure (psi)		
		Field Data	Model Results	Percent Difference
Title 22 Distribution	Pressure Logger 30	88	91	3%
Title 22 Distribution	Pressure Logger 53	113	115	2%
Title 22 Distribution	Pressure Logger 48	61	61	0%
Title 22 Distribution	Pressure Logger 35	115	113	-1%
Title 22 Distribution	Pressure Logger 37	89	93	4%
Title 22 Distribution	Pressure Logger 39	114	114	0%
Title 22 Distribution	Pressure Logger 44	59	58	-2%
Title 22 Distribution	Pressure Logger 46 [1]	33	79	136%
Title 22 Distribution	Pressure Logger 32	100	100	-1%
Title 22 Distribution	Pressure Logger 40	104	103	-1%
Title 22 Distribution	Pressure Logger HDR1	106	105	-1%
Title 22 Distribution	JMMCRWRP Influent	114	115	1%
Title 22 Distribution	CNTP Influent [2]	27	89	233%
Title 22 Distribution	TRWRP Influent	96	98	2%
Barrier Water Conveyance	WB Pressure Logger	73	71	-3%
Hyperion Secondary Effluent	SCADA Data	11	12	9%
Chevron LPBF	SCADA Data	24	26	7%
Chevron HBPF	SCADA Data	21	21	1%
Chevron Nitrified Water	WB Pressure Logger	58	58	0%
JMMCRWRP LPBF	SCADA Data	52	54	3%
JMMCRWRP Nitrified Water	WB Pressure Logger	53	54	2%
JMMCRWRP Brine Discharge	WB Pressure Logger	13	14	7%
Green Cells: Satisfies 10% difference criterion				
Blue Cells: Does not satisfy 10% difference criterion				

[1] Pressure logger data indicates periodic atmospheric pressure. Possibly due to pressure logger error or installation issue.
[2] SCADA system collection point downstream of PRV typically set to around 25 psi.

6.1.4 Title 22 Water Quality Model Calibration

The Title 22 Distribution System model was calibrated for free chlorine residual based on water quality data collected during the calibration period. Water quality model calibration was a two-step process using the following data sources:

1. Clear well chlorine decay test: Used to establish baseline chlorine decay coefficient.
2. Distribution system water quality sampling: Used to calibrate chlorine decay in the distribution system.

Suez performed a chlorine decay test using three ECLWRF clear well water samples. The results of the test are shown in Table 6-4.

Table 6-4. Chlorine Decay Test Results

Time [hours]	Total Chlorine [mg/L]				T [ºC]
	Sample #1	Sample #2	Sample #3	Average	
0	7.2	7.4	7.5	7.4	28.1
1	6.8	6.9	6.8	6.8	27.4
2	6.5	6.6	6.5	6.5	27.1
4	6.2	6.3	6.2	6.2	27.0
22	2.7	2.5	2.6	2.6	28.3
28	2.0	2.0	2.1	2.0	28.1
45	0.99	1.02	1.01	1.0	28.0
72	0.54	0.53	0.56	0.5	28.0

Based on the test results a zero order bulk decay curve formulae was developed to represent baseline chorine decay in the hydraulic model, assuming that chlorine residual in the ECLWRF clear well remains relatively constant. The formulae developed is shown in Equation 1.

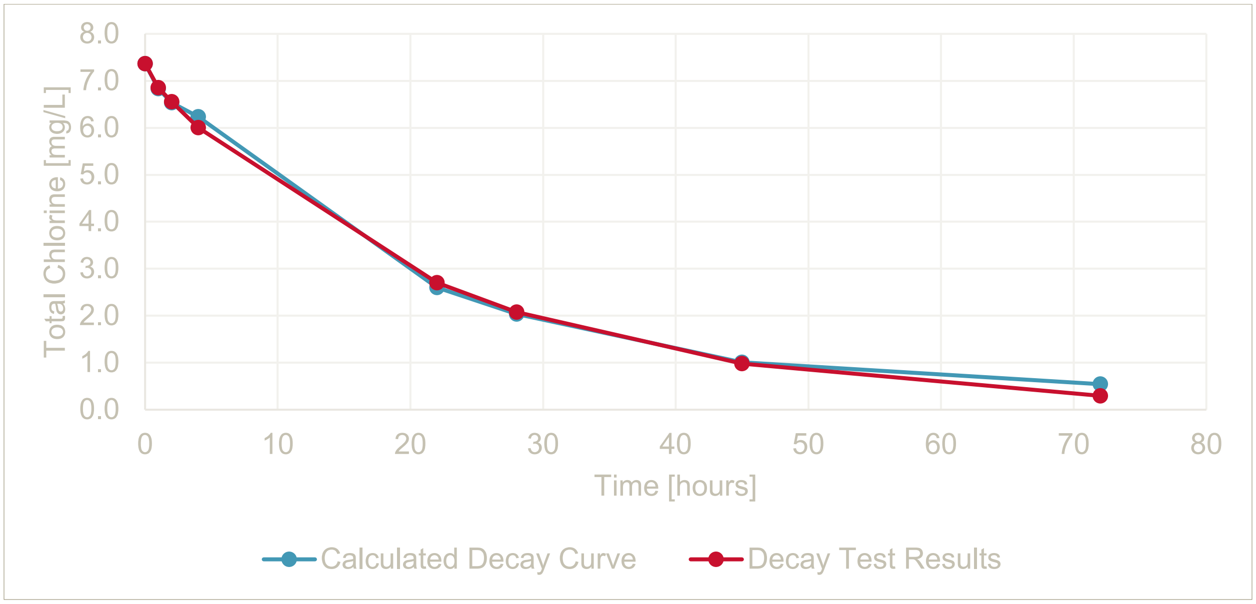
Equation 1. Calculated ECLWRF Chlorine Concentration as a Function of Time

$$C_t = 7.164e^{-1.062\,t}$$

Figure 6-2 shows the chlorine residual based on Equation 1 versus the chlorine decay test results, indicating a good fit between the calculated residual and the lab data. The chlorine decay coefficient was used to establish a baseline water quality model scenario.

The Title 22 Distribution System is reported to experience water quality issues related to nitrification, possibly due to biogrowth in the distribution system, which reduces chlorine residual. Field water quality data indicate reduced or zero chlorine residual in certain areas of the distribution system. Nitrification may not be uniform in the system and can be affected by factors such as water age, temperature, and chlorine residual. Because the distribution system does not include storage, the temperature in the distribution system was assumed to be constant for this analysis.

Figure 6-2. Chlorine Decay Test Results and Calculated Decay Curve



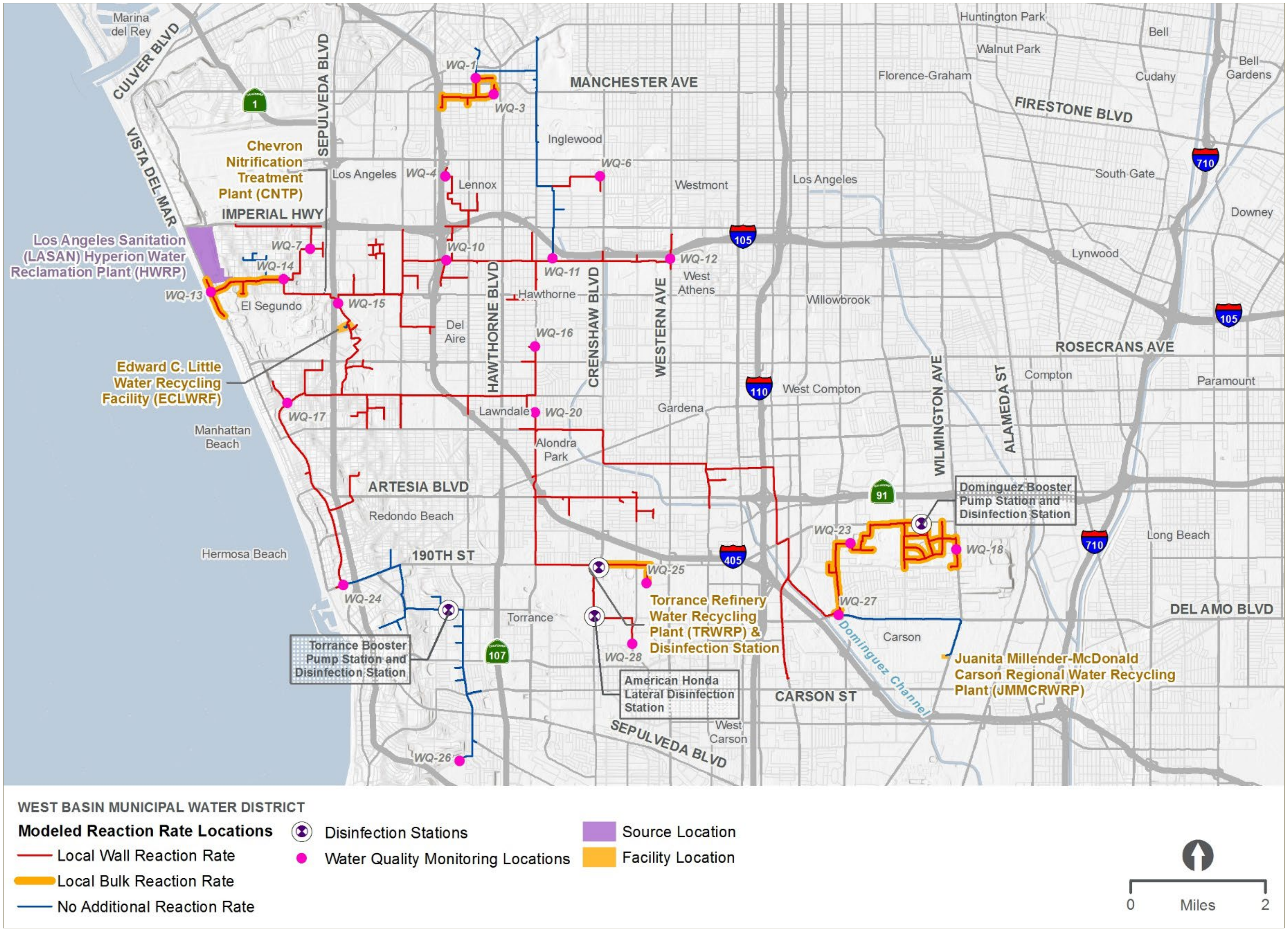
Model calibration was conducted by first applying the calculated chlorine decay rate to the ECLWRF clear well and comparing model results with field data. In order to account for the varying levels of nitrification in the system, wall reaction rates and bulk reaction rates were adjusted in the modeled distribution system as part of the calibration process.

In a two-step process, wall reaction rates were adjusted to represent the effects of biogrowth on chlorine residual. In certain cases, local bulk reaction rates were adjusted when wall reaction rates could not account for the decrease in chlorine residual, typically representing areas of the system with higher water age. Figure 6-3 indicates which areas of the modeled system were updated with local wall and/ or bulk reaction rates as part of the calibration process.

Table 6-5 displays the field data for each monitoring site included in the analysis with the corresponding model results for chlorine residual. Out of the 21 sample sites included in the analysis, model results are within the 10 percent difference of field data calibration criterion for 15 sites. For three of the sites, model results are within 0.1 mg/L of the field data, although the percent difference is greater than 10 percent criterion due to the low level of chlorine residual in the system at these locations. Model results for these locations are considered acceptable.

Model results also exceed the 10 percent criterion at three additional locations. These locations are excluded from the model calibration because field data indicates higher chlorine residual at one or more downstream sample sites. Table 6-5 indicates areas of the system where samples were taken, corresponding with Figure 6-4, which shows the relative locations of sample sites. The Title 22 Distribution System has no loops or storage, so all flow is assumed to be unidirectional away from ECLWRF. It is possible that previously stagnant plugs of older water moving through the system could account for the apparent discrepancies in chlorine residual at these locations since the samples were not taken simultaneously. However, for the purposes of calibrating the model, which represents demands based on repeating diurnal patterns, the water quality data for these locations were excluded from the analysis.

Figure 6-3. Introduced Local Wall and Bulk Rates



Based on the available water quality data, the model is considered calibrated for chlorine residual levels. The increased wall and bulk reaction rates applied to certain areas of the model as part of the calibration process indicate potential biogrowth throughout the system affecting residual chlorine levels. Improved water quality of the ECLWRF Title 22 product water may reduce the amount of biogrowth in the system, limit nitrification, and improve chlorine residual throughout the distribution system. Additional model calibration is recommended if the quality of the ECLWRF product water changes significantly.

Table 6-5. Field Chlorine Residual Values and Model Results

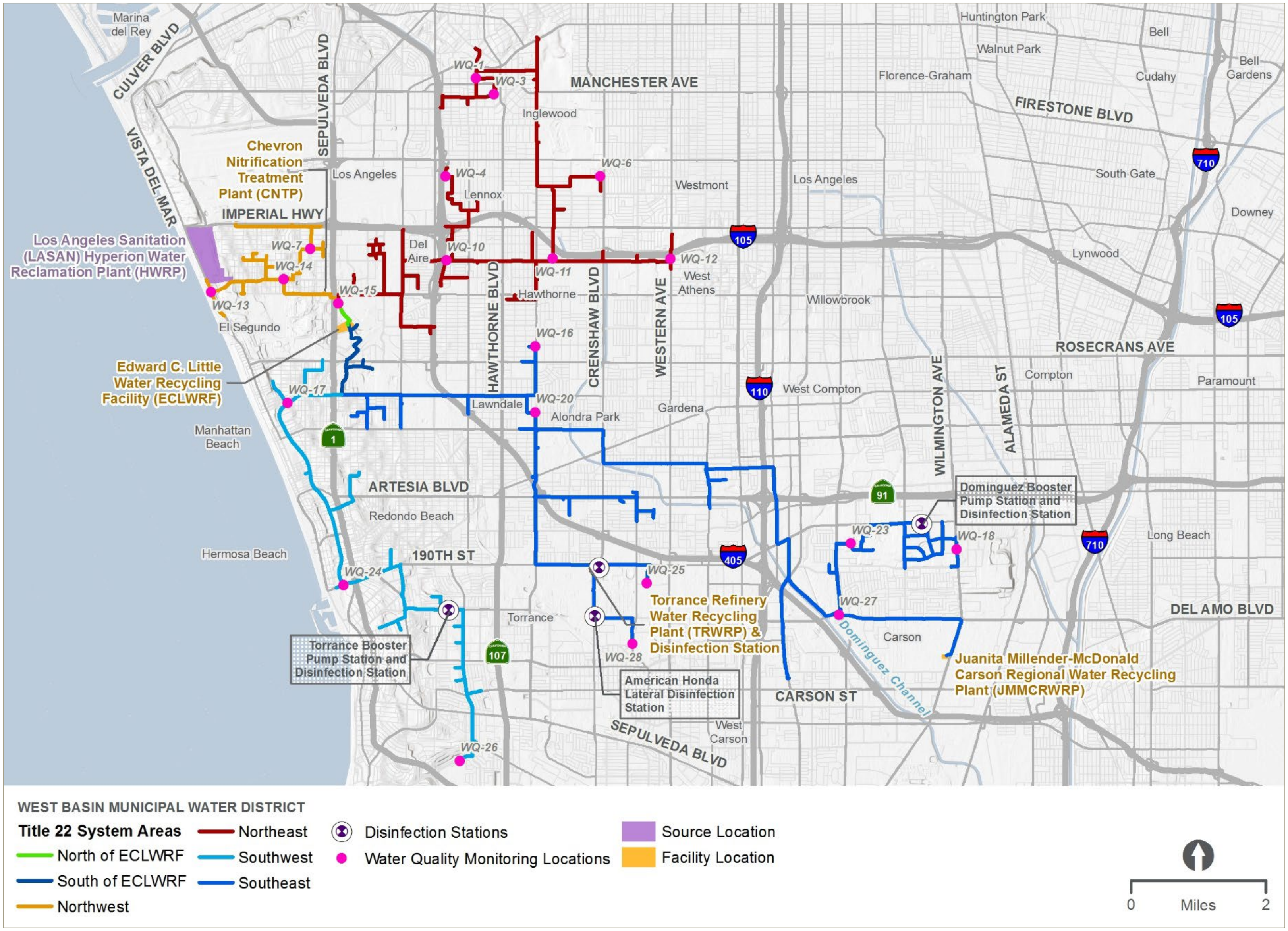
System Area	WQ Site #	Sample Date & Time	Chlorine Residual (mg/L)	Model Residual (mg/L)	Difference (mg/L)	Percent Difference
North of ECLWRF	WQ-15	8/6 13:42	5.08	5.08	0.00	0%
Northwest	WQ-14	8/6 14:14	0.13	3.69	3.56	2736%
	WQ-7	8/6 14:46	2.34	2.28	-0.06	-3%
	WQ-13	8/6 14:29	0.13	0.12	-0.01	-8%
Northeast	WQ-10	8/6 13:00	2.22	2.39	0.17	8%
	WQ-4	8/6 12:43	0.03	0.03	0.00	6%
	WQ-11	8/6 11:29	0.09	2.03	1.94	2158%
	WQ-12	8/6 11:19	0.27	0.25	-0.02	-8%
	WQ-6	8/6 10:20	0.53	0.57	0.04	8%
	WQ-1	8/6 9:18	0.86	0.82	-0.04	-5%
	WQ-3	8/6 9:35	0.00	0.00	0.00	0%
Southwest	WQ-17	8/6 15:20	3.13	3.23	0.10	3%
	WQ-24	8/6 15:43	0.23	0.26	0.03	14%
	WQ-26	8/6 8:37	0.25	0.16	-0.09	-37%
Southeast	WQ-16	8/6 12:02	3.31	3.35	0.04	1%
	WQ-20	8/6 12:17	0.07	4.41	4.34	6205%
	WQ-25	8/6 16:29	0.05	0.05	0.00	-2%
	WQ-28	8/6 16:18	0.38	0.35	-0.03	-7%
	WQ-27	8/6 17:20	0.57	0.55	-0.02	-4%
	WQ-23	8/7 14:35	0.05	0.06	0.01	16%
	WQ-18	8/6 17:50	0.00	0.00	0.00	0%

Green cells: Satisfies 10% difference criterion

Blue Cells: Negligible concentration difference despite percent difference exceeding 10% goal.

Orange Cells: Downstream field chlorine residual higher than residual at this sample location. Water quality sample not included in calibration.

Figure 6-4. Title 22 Distribution System Water Quality Sampling Locations and System Areas



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Chapter 7 Existing System Evaluation

7.1 Distribution System Hydraulic Analyses

This section presents the results of the evaluation of the West Basin existing distribution systems. The hydraulic model was used to analyze the existing distribution systems to determine any deficiencies according to the planning and evaluation criteria and conditions outlined in Chapter 5. Any deficiencies found are discussed and recommendations are made to resolve the deficiencies in Chapter 8.

7.1.1 Hyperion Secondary Effluent Pumping System

Criteria

The general analysis criteria used to evaluate the HSEPS includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Maximum velocity of less than 7 fps in the force main
- Surge pressures that will not cause pumps to operate outside allowable operating range
- Sufficient firm capacity to deliver the maximum demand at the ECLWRF

These criteria were used to evaluate the HSEPS under existing demand conditions.

Analysis Conditions

The HSEPS consists of the booster pump station and the 60-inch diameter PVC-lined reinforced concrete pressure pipe force main that conveys secondary effluent the ECLWRF. The pump station consists of two sets of pumps, including pumps No. 1-4 and pumps No. 5-7. The pump station has three constant speed pumps (No. 1, No. 3, and No. 4), and four variable speed pumps (No. 2 and No. 5-7). Normally, one of the pumps from the original pump station (pump No. 1-4) is operated at constant speed, and one of the pumps from the new pump station (pump No. 5-7) is operated at variable speed to satisfy peak demands. An additional variable speed pump may also be used from either pump station to maintain a constant discharge pressure of 58 psi.

The average annual flow through the pump station and force main is approximately 31 mgd. Minimum month flows are estimated at approximately 19 mgd based on historical SCADA data from 2018 to 2019. During the calibration period of August 2020, the maximum flow from the pump station was recorded as approximately 47 mgd based on 15-minute SCADA data. These flow rates were included in the model analysis. Additionally, the model analysis included flows related to the firm pump station and maximum force main capacities. The firm pump station capacity was based on total design pump flows with the largest capacity pump station offline. Maximum force main capacity was based on flows resulting in 7 fps velocity in the force main per the evaluation criteria.

Table 7-1 shows the pump station flows included in the model analysis.

Table 7-1. Hyperion Secondary Effluent Pumping System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Flow [1]	34,612	30.9	21,458
Maximum Instantaneous Flow (Calibration) [2]	--	46.7	32,431
Minimum Month Demand [3]	--	19.3	13,428
Flow Resulting in 7 fps Pipeline Velocity	--	88.8	61,689
Firm Pump Station Capacity	--	109.0	75,694

[1] Average annual demand from 2018-2019 daily SCADA data.
[2] Instantaneous flow from 15 minute SCADA data recorded August 2020.
[3] Minimum month demand (February 2019) from 2018-2019 daily SCADA data.

Analysis Results

The results from the analyses performed for each of the demand conditions described in Table 7-1 are presented below in Table 7-2. As shown in Table 7-2, the velocities in the pipeline vary from 1.5 fps to 3.7 fps for existing condition scenarios, including annual average, maximum instantaneous (calibration period), and minimum month flows. This range of velocities is well below the maximum desired velocity of 7 fps. The head losses for existing condition scenarios are well within acceptable limits, with average unit headloss ranging from 0.1 feet to 0.5 feet per 1,000 feet of pipe.

For the maximum capacity related scenarios, including flows resulting in 7 fps pipeline velocity and firm pump station capacity, the velocities in the pipeline vary from 7.0 fps to 9.0 fps, at or above the velocity criteria. The head losses for these scenarios are well within acceptable limits, with average unit headloss ranging from 1.6 feet to 2.7 feet per 1,000 feet of pipe.

Table 7-2 shows results for all modeled scenarios.

Table 7-2. Hyperion Secondary Effluent Pumping System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Pump Discharge (psi)		Pressure at ECLWRF (psi)	60-inch Pipe Velocity (fps)	Maximum Travel Time [1] (minutes)
				Pumps 1-4	Pumps 5-7			
Average Annual Demand [2]	21,458	3.7	0.2	55	58	13	2.4	106
Maximum Demand (Calibration) [3]	32,431	8.0	0.5	55	58	11	3.7	70
Minimum Month Demand [2]	13,428	1.6	0.1	55	58	13	1.5	169
Demand Resulting in 7 fps Pipeline Velocity [4]	61,689	26.3	1.6	55	58	3	7.0	37
HSEPS Capacity [5]	75,694	41.9	2.7	51	58	-7	9.0	29

[1] Water age based on length 15,445 feet.
[2] Pump 3 on.
[3] Pump 3 and Pump 7 on.
[4] Pumps 1, 2, 3, 6 and 7 on.
[5] Pumps 1, 2, 3, 5, 6 and 7 on.

Regarding transients in the force main, a study was completed in 2017 analyzing surge pressures in the force main under flow conditions up to 60 mgd (Flow Science, 2017). This study concluded that vapor pressures are not predicted in the force main under current typical operating conditions, specifically for force main flows of 50, 54, and 60 mgd. The study predicts minimum surge pressure head of -22 ft (for a fraction of a second) and maximum surge pressure head of 221 ft. The study recommends that the pipeline designer confirm that the force main is able to withstand these pressures. Additionally, the study recommends controlled venting features be provided for and redundant valves be installed on the vacuum valves predicted by the study to open during a surge event.

Available Capacity

Based on the results of the above analyses, the existing pump station and pipeline have sufficient capacity for the existing demand conditions evaluated. The model results also indicate that the pipeline velocity criterion is the limiting factor in the system capacity.

Based on the velocity criteria, the system has up to 58 mgd (64,893 afy) available capacity, as shown in Table 7-3. Slightly higher velocities in the force main may be allowed given certain conditions and with approval of West Basin staff. Flows based on the firm capacity of the HSEPS at 109 mgd would result in a pipe velocity of 8.6 fps, providing 78 mgd of available system capacity.

It should be noted that the most recent transient analysis performed for the Hyperion force main analyzed flows up to 60 mgd (Flow Science, 2017). Based on this analysis, increased pumping capacity to meet demands will require a revised surge analysis of the HSEPS.

Table 7-3. Available Hyperion System Capacity

Condition	Demand		
	afy	mgd	gpm
Average Annual Flows	34,612	31	21,458
Flows Resulting in 7 fps Pipeline Velocity	99,506	89	61,689
Available Capacity	**64,893**	**58**	**40,231**

7.1.2 ECLWRF Brine Line

Criteria

Analysis criteria for the ECLWRF brine line consists the following:

- Maximum pipeline velocity of 10 fps

Analysis Conditions

The ECLWRF brine line consists of an 18-inch diameter HDPE pipe that extends approximately 3.0 miles north and west from ECLWRF, conveying concentrate from the ECLWRF RO trains to the HWRP in El Segundo. The brine line discharges to the Hyperion Ocean Outfall.

Under existing conditions, the ECLWRF brine line operates off the RO concentrate pressure, which averages approximately 22 psi at the plant. Based on available SCADA data recording weekly flow averages between March 2019 and March 2020, existing average brine flow is approximately 2.8

mgd. The maximum weekly flow rate during this period was 3.3 mgd, with a minimum weekly flow of 2.0 mgd, as shown in Table 7-4.

Table 7-4. ECLWRF Brine Line Flows

Condition	Brine Line Flows [1]		
	afy	mgd	gpm
Average Weekly Flow	3,159	2.8	1,958
Maximum Weekly Flow	--	3.3	2,264
Minimum Weekly Flow	--	2.0	1,382

[1] Flows based on weekly SCADA data collected from March 22, 2019 to March 20, 2020.

The brine line starts as a short section of 12-inch diameter pipeline constructed of HDPE, and increases to 18-inch diameter SDR 17 HDPE (internal diameter 15.88 inches). Below elevation 83 feet, the pipe changes to SDR 15.5 (internal diameter 15.68 inches), and below elevation 58 feet, it changes to SDR 13.5 (internal diameter 15.33 inches). The pipeline has several high and low points along its alignment, which result in the majority of the pipeline flowing with a free surface. The brine line terminates at the Hyperion Ocean Outfall through a manifold with six connections which are at atmospheric pressure. Due to the free surface flow in the brine line, this system was modeled using InfoSewer® by Innovyze® (Pro Suite 7.6, SP 1, Update #13).

Analysis Results

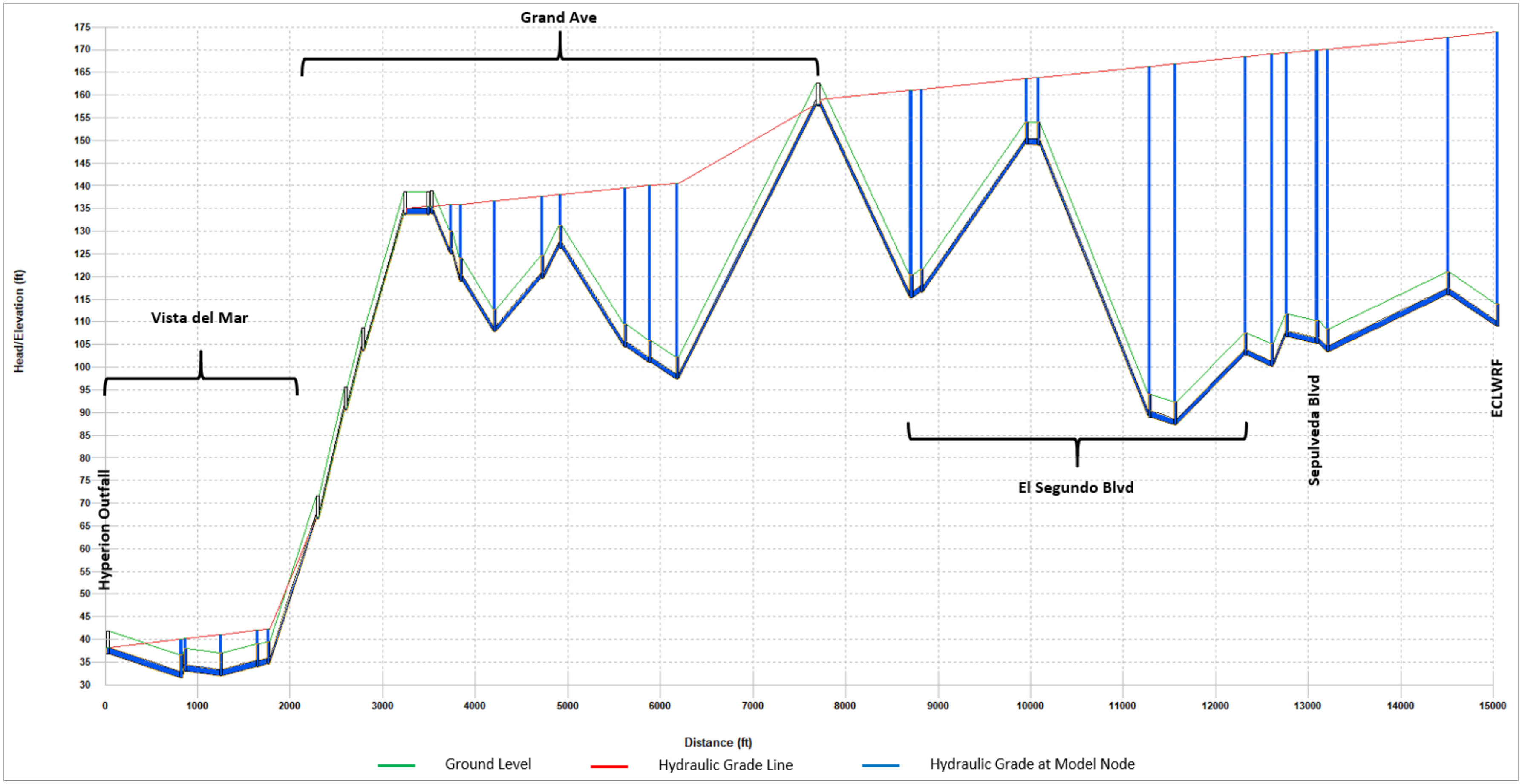
Model results indicated that the average velocity within the sections of the pipe under full flow is approximately 3.2 fps, below the maximum desired velocity of 7 fps. However, the low velocities in this pipeline may lead to build-up of materials and is cause for concern for occurrence of scaling.

Figure 7-1 shows a hydraulic profile of the brine pipeline under average annual flow conditions. Due to the steep slopes within the brine line (up to 9.2 percent on Grand Avenue), model results indicated velocities reach as high as 15 fps, exceeding the maximum desired velocity of 10 fps. While the high-density polyethylene pipe manufacturer catalogues indicate resistance to abrasion with velocities up to 25 fps, the pipe should be inspected periodically to assess its condition.

The record documents do not show any access ports for pipe inspection. The brine line is an essential element of the overall recycled water system. In case of its failure, West Basin and its customers will have to convert to the use of potable water supplies. In the 2009 Master Plan, it was recommended that West Basin design and install inspection ports on the brine line so that its condition can be assessed, and corrective actions can be taken proactively. For conservative planning purposes, 12 access ports were included in the CIP. To date, none of those recommended improvements have been made.

To mitigate the high velocities, it is recommended that the downstream pressure near the Hyperion Ocean Outfall be increased. This would require installing a series of pinch valves or pipe restrictions to reduce the pressure gradually prior to discharge to the Outfall. A detailed study of this system should be conducted to develop the most cost-effective approach.

Figure 7-1. Hydraulic Grade Line Profile of ECLWRF Brine Pipeline Average Annual Flow Conditions



Available Capacity

The minimum inner diameter of the brine line is 15.33 inches in the SDR 13.5 HDPE portion of the pipe. The limiting velocity criterion of 10 fps for this portion of the brine line results in a maximum available flow of 5,753 gpm, assuming the brine line is pressurized. Based on the current average weekly flows of 1,958 gpm, the brine line would have an available remaining capacity of 3,795 gpm (5.5 mgd) if the line were operated as a pressurized line. However, the brine line currently experiences open surface flow conditions in some portions of the line resulting in velocities that exceed the 10 fps criteria.

7.1.3 Title 22 Distribution System

Criteria

The general analysis criteria used to evaluate the existing Title 22 Distribution System include the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps. A minimum velocity of 1 fps is desired under average annual demands
- Minimum pressure of 65 psi at customer meter connections
- Surge pressures within 10 percent of the operating pressures. (It should be noted that West Basin staff indicated surge tanks connected to the system are designed for a 10 psi deviation from the operating pressure, which may or may not be less than 10 percent, depending on the operating pressure)
- Minimum chlorine residual of 1.0 mg/L

Analysis criteria specific to the Title 22 Distribution System includes:

- Ability to deliver the peak hour flow of 44.4 mgd (as detailed in Chapter 2) with the largest pump out of service

These criteria were used to evaluate the Title 22 distribution system under existing demand conditions.

Analysis Conditions

The primary Title 22 Distribution System consists of two 5-MG storage tanks (Tank 1 and 2), a pump station with two constant speed and two variable speed pumps each on tank, and the distribution system consisting of approximately 85 miles of pipe varying from 4 inches to 48 inches in diameter. Additionally, approximately 2,400 feet of pipe, ranging from 30 to 60 inches in diameter, is located within the treatment plant perimeter connecting the effluent pump stations to the distribution system. Currently, a combination of variable speed and constant speed pumps are operated at each tank to meet the varying demands. During the calibration period during August 2020, one constant speed pump was operated at Tank 1 and a combination of variable and constant speed pumps were operated at Tank 2. During the lower demand periods, the variable speed pumps are capable of supplying the entire system demands. The controls are set to maintain a pressure of 85 psi at the discharge pipe near Tank 1, with a desired variation of ± 5 psi.

The existing peak hour demand is estimated at 30,860 gpm or 44.4 mgd. The existing pump station has ample capacity (approximately 63 mgd) to meet this demand, even with one of the large capacity pumps out of service.

The analyses were conducted with the maximum month demands, including the peak hour period. The current maximum month demand is estimated at 29 mgd based on billing records from fiscal year (FY) 2014/15 through FY 2018/19.

Table 7-5 shows the average annual demands, as well as the maximum month and associated peak hour demands.

Table 7-5. Title 22 Distribution System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand [1]	19,874	17.7	12,321
Maximum Month Demand [2]	--	29.1	20,241
Maximum Month, Peak Hour Demand [3]	--	44.4	30,860

[1] Average annual demand from FY 2014/15 through FY 2018/19.
[2] Maximum month demand from FY 2014/15 through FY 2018/19.
[3] Determined from maximum month demand and the diurnal curves used in this study.

Analysis Results

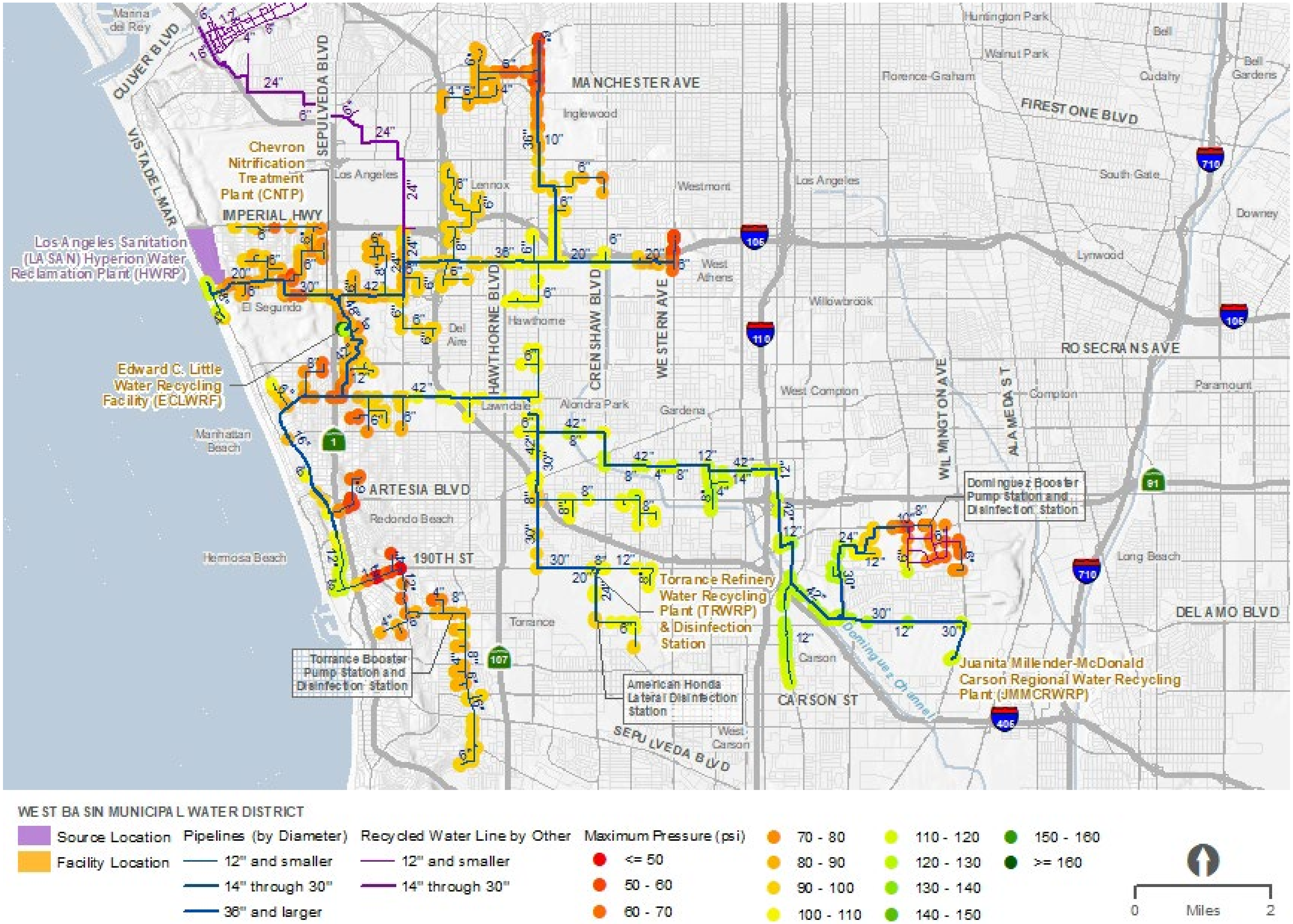
System Capacity

The Title 22 recycled water distribution system is able to provide the peak hour demands to most existing customers with adequate pressures. Figure 7-2 illustrates modeled pressures in the system under peak hour demand conditions.

The model indicates a few low pressures generally at higher elevations where the distribution system piping is small. With the Title 22 pump station discharge pressure maintained at 85 psi, the areas identified with pressures less than 65 psi during maximum month, peak hour conditions are shown in Figure 7-2.

Velocities in the distribution system are all within the 7 fps criteria for maximum flows under maximum day demand, peak hour conditions.

Figure 7-2. Title 22 Peak Hour Demand Pressures



Title 22 Pump Station Operation

The Title 22 pump station includes two 5-MG product water storage tanks. Currently, each Title 22 product water storage tank has four pumps. Two of these pumps are variable frequency drive operated with rated capacities of 4,500 to 6,000 gpm. The other two pumps are constant speed equipment with rated capacities of 8,000 gpm and similar total dynamic head as the variable frequency drive pumps. According to the record information, the shut-off head of the constant speed pumps (458 feet) are significantly greater than that of the variable speed pumps (387 feet).

Review of the SCADA data during the calibration period indicated one constant speed pump operating with one variable speed pump at each tank nearly the entire time period of August 2020, indicating typical operation. During this time, it was observed that the variable speed pumps quite often operate to the left of the preferred operating range, sometimes near the shut-off conditions. This will likely result in frequent physical pump failure.

The operation of the Title 22 pumping system should be studied in detail based upon the annual, seasonal, and daily variation in demands, following the formulation of a solution to the surge problem. The study should develop an efficient pumping system that allows operation of the pumps within the preferred operating ranges.

Pressure Surges

Surge pressures are experienced throughout the system and throughout the day. The surge pressures occur due to sudden changes in flows at JMMCRWRP and the TRWRP during the microfiltration (MF) backwash cycles. The 2009 Master Plan includes a comprehensive discussion of the causes of the surge pressures in the distribution system. Field pressure measurements at 5-minute increments indicated pressure variations of over 70 psi throughout the day. While these may be acceptable for ductile iron and steel pipe, the system includes a significant amount of PVC pipe, which is likely to experience fatigue failure due to frequent pressure variations. Therefore, it is essential that a proper method of surge control be implemented.

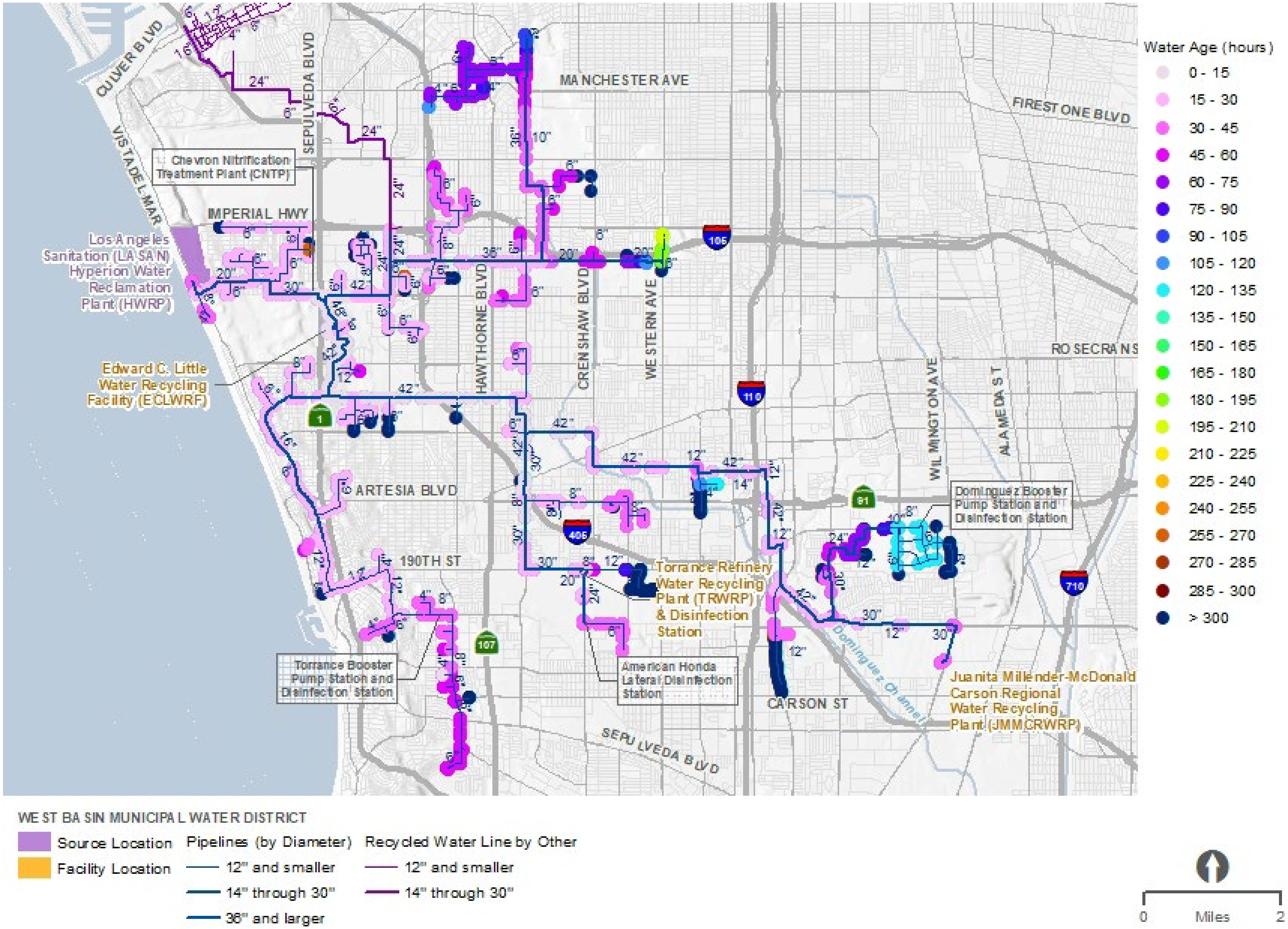
Water Quality

The hydraulic model was used to simulate water quality in the distribution system under average day demand conditions. Analysis included modeling water age and chlorine residual in the distribution system.

Modeled water age results indicate potential high water age in the extents of the system. Notably downstream of the Dominguez Hills BPS, Torrance BPS, near the American Honda Lateral, and to the area of the system north of SoFi Stadium. Water age results are shown in Figure 7-3. Areas in Figure 7-3 showing water age in excess of 450 hours represent smaller diameter dead end lines with smaller demands. Mitigating water quality in these dead end pipelines would be based on individual customer needs.

During calibration of the hydraulic model, chlorine residuals were satisfactory downstream of the disinfection stations. However, a need for additional disinfection stations in the northern part of the system (north of Manchester Avenue) and the northeastern part of the system (west of Crenshaw Blvd near West Athens) was evident, which corresponds with the water age results shown in Figure 7-3.

Figure 7-3. Title 22 Modeled Water Age Results



Available Capacity

System capacity was estimated by comparing modeled flows with the estimated available capacity of each pipe in the system. Pipe capacity was based on the velocity and headloss criteria for the system dependent on material, diameter, age, and the resulting Hazen-Williams roughness factor for each pipe in the system.

Model results indicate sufficient existing capacity in all major transmission lines of the system based on the velocity criteria. Figure 7-4 shows estimated available capacity in larger diameter Title 22 distribution system transmission lines under average annual demand conditions. Figure 7-5 shows estimated available capacity under peak hour demand conditions.

Capacity in the reach of the system leading to the Torrance BPS and downstream of the Torrance BPS is limited by the diameter in the system at these locations.

Figure 7-4. Title 22 Transmission Line Available Capacity Existing Average Annual Demand Conditions

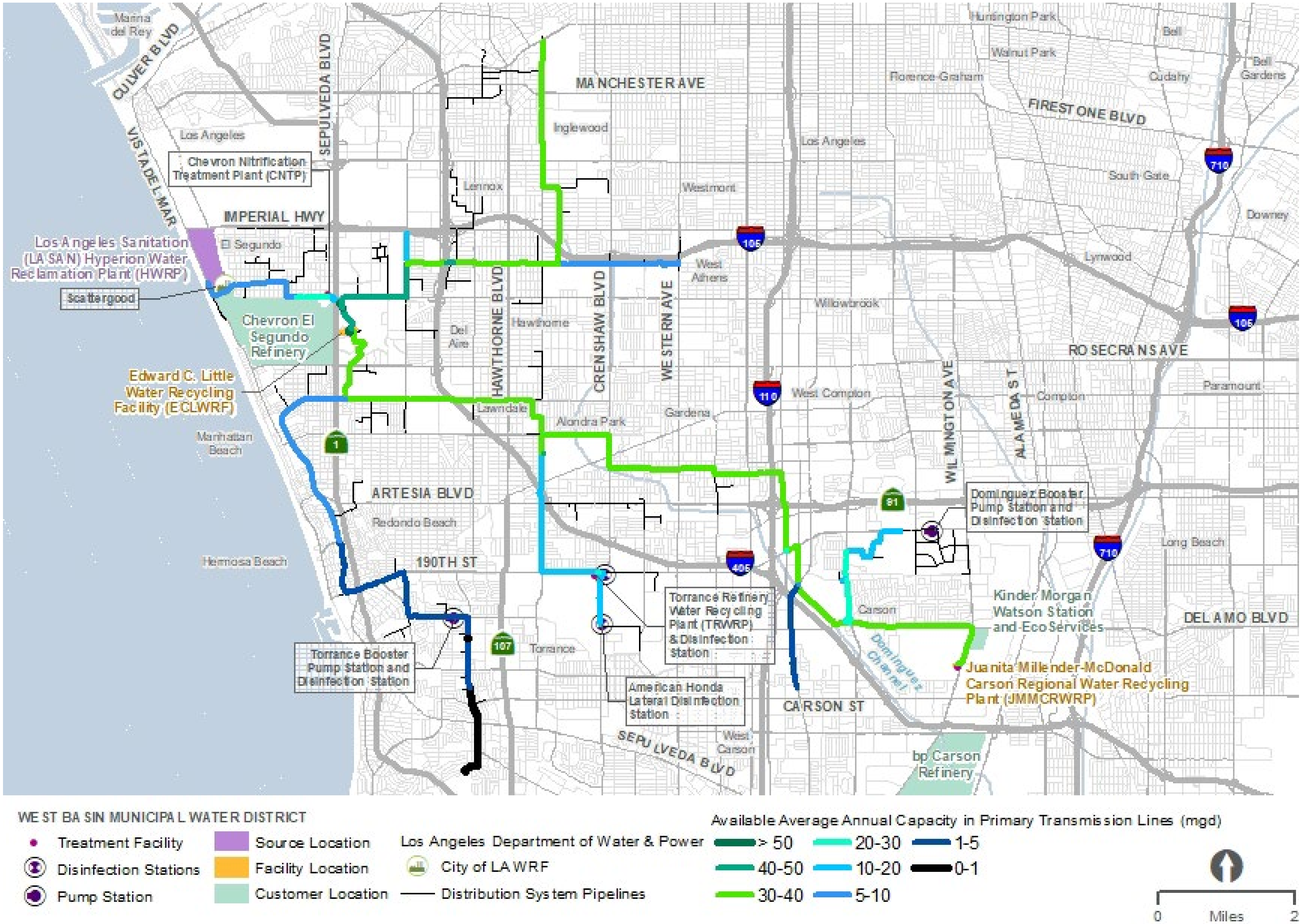
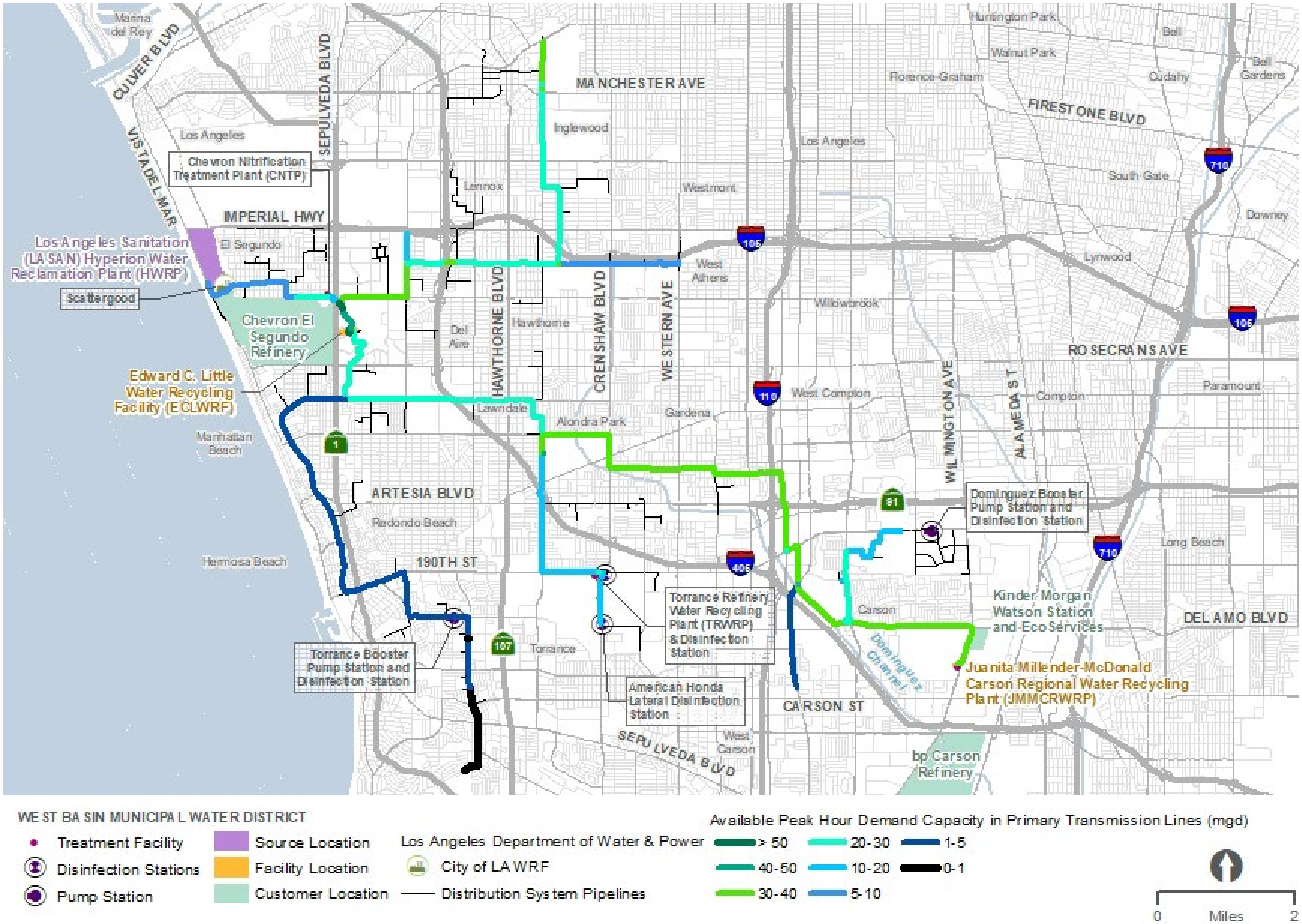


Figure 7-5. Title 22 Transmission Line Available Capacity Existing Peak Hour Demand Conditions



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7.1.4 West Coast Barrier System

Criteria

The general analysis criteria used to evaluate the West Coast Barrier Water System includes the following:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Maximum velocity of 7 fps

Analysis criteria specific to the West Coast Barrier Water System includes:

- Adequate pressure at the Blend Station, approximately 78 psi
- Ability to deliver the maximum daily flow of 20.2 mgd with firm pumping capacity
- Ability to deliver potable MWD water from the Blend Station to the RO Trains when the Barrier Treatment System is out of service, and to the DT22 Distribution System during an outage of the DT22 Treatment System

These criteria were used to evaluate the existing West Coast Barrier Water System under existing demand conditions.

Analysis Conditions

The West Coast Barrier Water System consists of the Barrier Product Water Pump Station and the 30-inch diameter CMLC transmission main that conveys Barrier water from ECLWRF to the Barrier Blend Station, located north of the treatment facility on El Segundo Boulevard, west of Nash Street in the City of El Segundo.

The transmission main is approximately 4,720 feet in length.

The Barrier Product Water Pump Station includes six pumps (with 14,000 gpm of firm capacity) to deliver up to 20.2 mgd of Barrier water. Between FY 2014/15 and FY 2018/19, West Basin delivered an average of 12,344 afy of Barrier water for injection into the West Coast Barrier based on billing records. Currently, a control valve on the discharge pipe of the pump station maintains an approximate pressure of 80 psi on the downstream side of the valve. The existing system analysis was conducted with various pump flows, including the existing firm pump station capacity of and maximum flows meeting the velocity criteria, at this valve setting.

Table 7-6 shows the average annual, maximum month, minimum month, and design demands. Maximum and minimum month demands were based on billing records for FY 2014/15 through FY 2018/19.

Table 7-6. West Coast Barrier System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	12,344	11.0	7,653
Maximum Month Demand		15.8	10,979
Minimum Month Demand		1.7	1,146
Firm Pump Station Capacity		20.2	14,000

Analysis Results

The results from the analyses performed for each of the demand conditions described in Table 7-6 are presented in Table 7-7.

Table 7-7. West Coast Barrier System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Blend Station (psi)	Velocity (fps)	Maximum Travel Time [1] (minutes)
Average Annual Demand [2]	7,653	5.2	1.1	78	3.5	23
Maximum Month Demand [3]	10,979	10.2	2.2	76	5.0	16
Minimum Month Demand [4]	1,146	0.2	< 0.1	80	0.5	151
Firm Pump Station Capacity [5]	14,000	15.9	3.4	74	6.4	12

[1] Water age based on length 4,720 feet.
[2] Pump 3 and Pump 4 on.
[3] Pumps 3, 4, and 5 on.
[4] Pump 1 on.
[5] Pumps 2, 3, 4, 5, and 6 on.

As shown in Table 7-7, the velocities in the pipeline vary from 0.5 fps with the minimum month flows to 6.4 fps with the current design flows. These are below the maximum desired velocity of 7 fps. The head losses are well within acceptable limits with the average unit head loss ranging from less than 0.1 to 3.4 feet per 1,000 feet of pipe.

The existing pump station has the firm capacity (20.2 mgd) to deliver the maximum month demand of 15.8 mgd to the West Coast Barrier System with a pump station discharge pressure of 93 psi. However, there is a significant loss of pressure at the control valve, where the pump station discharge pressure is reduced from approximately 98 psi to 80 psi. Model results indicate resulting maximum month demand pressure at the Blend Station under these conditions is approximately 76 psi, 2 psi below the criteria. Increasing pressure at the Blend Station to the minimum pressure criteria would mean increasing pressure at the control valve to 82 psi. Similarly, pressure would need to be increased at the control valve to 84 psi to meet criteria under firm pump station capacity flows. Pressure would need to be increased at the control valve to 86 psi to meet the pressure criteria at flows resulting in the maximum allowable pipeline velocity of 7 fps.

It is recommended that the operational condition of the pump station be evaluated to avoid the headloss due to pumping through the control valve. This may consist of replacing the existing pumps with lower head pumps, adding variable frequency drives to the existing pumps, or replacing the existing pumps with lower head pumps and adding VFDs.

In 2020, Suez and West Basin prepared an Energy Optimization Plan (Suez, 2020) to identify strategies to utilize energy more efficiently at West Basin facilities. The 2020 performance test for the Barrier Pumps revealed that Pumps 2 and 3 were performing at lower than optimal efficiencies (74 to 79%), and planning for their replacement was recommended.

Available Capacity

Model results for the firm pump station flow rate of 20.2 mgd indicate velocities approaching the 7 fps criteria. Model results do not indicate significant pipeline headloss issues at firm capacity flow rates. Comparing the pump station firm capacity with the current average annual Barrier water deliveries of 11 mgd, model results indicate that the existing pump station has an existing available capacity of approximately 9.2 mgd, as shown in Table 7-8.

Table 7-8. West Coast Barrier System Available Capacity

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	12,344	11.0	7,653
Firm Pump Station Capacity	22,582	20.2	14,000
Available Capacity	10,238	9.2	6,347

7.1.5 Chevron High Pressure Boiler Feed System

Criteria

Analysis criteria for the Chevron HPBF System includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps
- Firm capacity at HPBF pump station should meet peak demands

Analysis Conditions

The Chevron HPBF System consists of the booster pump station and the 12-inch diameter HDPE and 16-inch diameter PVC transmission main that conveys Double Pass RO water to the Chevron El Segundo Refinery on-site HPBF Storage Tank. The transmission main is approximately 2 miles, or 10,030 feet in length.

The booster pump station includes two pumps rated at 1,800 gpm, resulting in a firm capacity of approximately 2.6 mgd.

Under existing conditions, the Chevron HPBF system supplies 2.3 mgd of Double Pass RO water to the Chevron El Segundo Refinery on an average annual basis. This average annual demand was established from historical billing records from FY 2014/15 to FY 2018/19. Maximum and minimum month demands were also based on historical billing records and included in the analysis. The analysis demands are summarized in Table 7-9.

Table 7-9. Chevron High Pressure Boiler Feed System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	2,567	2.3	1,592
Maximum Month Demand		2.6	1,943
Minimum Month Demand		1.9	1,350

Analysis Results

As shown in Table 7-10, the average unit headloss per 1,000 feet of pipe ranged from 1.8 feet to 3.6 feet for existing conditions, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 3.8 fps to 5.5 fps in the 12-inch section of the pipeline. Although the velocities are slightly higher than 3 fps under the demand conditions analyzed, the velocities are not extreme and no recommendations are made at this time for increasing pipeline sizes.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the HPBF pump station, which is currently maintained at 41 psi. With one pump on stand-by, the firm capacity of the pump station is 1,800 gpm or 2.59 mgd, which is the design capacity of one pump. Although this firm capacity is less than the maximum demand of 2.6 mgd, analysis of the pump curve indicates that the pump can still provide this demand within its normal operating range. The difference between the existing maximum day demand and maximum month demand can be made up from storage at the Chevron El Segundo Refinery.

Table 7-10. Chevron High Pressure Boiler Feed System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Delivery Point (psi)	Velocity (fps)		Maximum Travel Time [1] (minutes)
					12-inch Pipe	16-inch Pipe	
Average Annual Demand [2]	1,592	26.0	2.0	50	4.5	2.5	67
Maximum Month Demand [3]	1,943	37.6	3.6	40	5.5	3.1	54
Minimum Month Demand [2]	1,350	19.2	1.8	25	3.8	2.2	76

[1] Water age based on length 10,030 feet.
[2] Pump 1 on.
[3] Pump 1 and Pump 2 on.

Available Capacity

Based on the above analyses, it is shown that the existing pipeline and pump station has sufficient capacity for the existing demand conditions evaluated. Based on the average annual demand of 2.3 mgd, compared with the firm capacity of the pump station, the system currently has additional average capacity of approximately 0.3 mgd, as shown in Table 7-11. However, based on the criteria related to firm pump capacity and pipeline velocity, the existing system can be considered at or slightly above capacity for current maximum month demand conditions.

Table 7-11. Chevron High Pressure Boiler Feed System Available Capacity

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	2,567	2.3	1,592
Pump Station Firm Capacity	2,903	2.6	1,800
Available Capacity	336	0.3	208

7.1.6 Chevron Low Pressure Boiler System

Criteria

Analysis criteria for the Chevron LPBF System includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps
- Firm capacity at LPBF pump station should meet peak demands

Analysis Conditions

The Chevron LPBF System consists of the booster pump station and the 12-inch diameter PVC transmission main that conveys Pure RO water to the Chevron El Segundo Refinery on-site LPBF Storage Tank. The transmission main is approximately 2 miles, or 10,400 feet in length.

The booster pump station includes three pumps each rated at 600 gpm, resulting in a firm capacity of approximately 1.73 mgd.

Under existing conditions, the Chevron LPBF system supplies 1.7 mgd of Single Pass RO water to the Chevron El Segundo Refinery on an average annual basis. This average annual demand was established from historical billing records from FY 2014/15 to FY 2018/19. Maximum and minimum month demands were also based on historical billing records and included in the analysis. The analysis demands are summarized in Table 7-12.

Table 7-12. Chevron Low Pressure Boiler Feed System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	1,868	1.7	1,157
Maximum Month Demand		1.8	1,285
Minimum Month Demand		1.0	710

Analysis Results

As shown in Table 7-13, the average unit headloss per 1,000 feet of pipe ranged from 2.2 feet to 5.7 feet for existing conditions, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 2.0 fps to 3.7 fps in the pipeline. Although the maximum month demand velocities are slightly higher than 3 fps, the velocities are not extreme and no recommendations are made at this time for increasing pipeline sizes.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the LPBF pump station, which is currently maintained at 45 psi. With one pump on stand-by, the firm capacity of the pump station is 1,200 gpm or 1.7 mgd. Model results indicate that all three pumps need to be operating at some speed to maintain the 45 psi discharge pressure under average and maximum month demand conditions.

Table 7-13. Chevron Low Pressure Boiler Feed System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Delivery Point (psi)	Velocity (fps)	Maximum Travel Time [1] (minutes)
					12-inch Pipe	
Average Annual Demand [2]	1,157	55	5.4	16	3.3	54
Maximum Month Demand [2]	1,285	67	5.7	11	3.7	48
Minimum Month Demand [3]	710	22	2.2	30	2.0	86

[1] Water age based on length 10,400 feet.
[2] Pumps 1, 2, and 3 on.
[3] Pumps 1 and 2 on.

Available Capacity

Based on the above analyses, it is shown that the existing pipeline is at or exceeds capacity for the existing demand conditions evaluated based on the velocity criteria. Additionally, based on the criteria related to firm pump capacity, the existing pump station can be considered under capacity. A pump station upgrade and either a parallel pipeline or increased diameter pipeline is recommended to accommodate current flow rates.

7.1.7 Chevron Nitrified Water System

Criteria

Analysis criteria for the Chevron Nitrified Water System includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps
- Pump station discharge pressure of at least 80 psi to serve the Chevron Refinery cooling towers
- Sufficient firm pumping capacity to deliver the existing maximum demands

Analysis Conditions

The Chevron Nitrified Water System consists of the following:

- An 80-foot diameter, 24-foot high, product water storage tank operated between a high level of 17.5 feet and a low level of 2 feet
- Nitrified Water Pump Station
- A surge tank on the discharge side of the pump station
- Approximately 2,970 feet of 20-inch diameter discharge pipe that extends to the Chevron El Segundo Refinery (El Segundo Boulevard and Lomita Street), supplying water to the cooling towers.
- Estimated delivery point elevation of 143 feet

The pump station includes one variable speed pump (design capacity of 2,100 gpm) and two constant speed pumps, which are referred to as the High Service Pumps (design capacity of 1,800 gpm each). This results in a firm capacity of approximately 5.2 mgd.

Under existing conditions, the Chevron Nitrified Water System supplies 3.8 mgd of Nitrified water to cooling towers at the Chevron El Segundo Refinery on an average annual basis. This average annual demand was established from historical billing records from FY 2014/15 to FY 2018/19. Maximum and minimum month demands were also based on historical billing records and included in the analysis. The analysis demands are summarized in Table 7-14.

Table 7-14. Chevron Nitrified Water System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	4,243	3.8	2,628
Maximum Month Demand		4.5	3,145
Minimum Month Demand		2.3	1,592

Analysis Results

As shown in Table 7-15, the average unit headloss per 1,000 feet of pipe ranged from 0.5 feet to 1.8 feet for existing conditions, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 1.6 fps to 3.2 fps. Although the maximum month demand velocities are slightly higher than 3 fps, the velocities are not extreme and no recommendations are made at this time for increasing pipeline sizes.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the pump station, which is currently maintained at 80 psi. With one pump on stand-by, the firm capacity of the pump station is 3,600 gpm or 5.2 mgd. Model results indicate that only two pumps need to be operating to maintain the 80 psi discharge pressure under average and maximum month demand conditions.

Table 7-15. Chevron Nitrified Water System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Delivery Point (psi)	Velocity (fps)	Maximum Travel Time [1] (minutes)
Average Annual Demand [2]	2,628	3.7	1.3	59	2.7	18
Maximum Month Demand [3]	3,145	5.1	1.8	58	3.2	15
Minimum Month Demand [3]	1,592	1.5	0.5	60	1.6	30

[1] Water age based on length 2,910 feet.
[2] Pump 2 and Pump 3 on.
[3] Pump 2 on.

Available Capacity

Based on the above analyses, it is shown that the existing pipeline and pump station have sufficient capacity for the existing demand conditions evaluated. The limiting factor in estimating available system capacity is the velocity criteria for the pipeline. Based on the velocity resulting from the average annual demands, the system has approximately 0.4 mgd remaining capacity, as shown in Table 7-16.

Table 7-16. Chevron Nitrified Water System Available Capacity

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	4,240	3.8	2,628
Demand Resulting in 3 fps Pipeline Velocity	4,739	4.2	2,938
Available Capacity	499	0.4	310

7.1.8 JMMCRWRP Low Pressure Boiler Feed System

Criteria

Analysis criteria for the JMMCRWRP LPBF System includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps
- Capacity should be met with at least one booster pump kept in reserve

Analysis Conditions

The JMMCRWRP LPBF System consists of the booster pump station and the 30-inch diameter DIP and 24-inch diameter DIP transmission main that conveys Single Pass RO water to the adjacent refinery. The transmission main is approximately 1.1 miles, or 5,980 feet in length.

The pump station includes three variable speed pumps each with a design capacity of 1,725 gpm, resulting in a firm capacity of approximately 5.0 mgd.

Under existing conditions, the JMMCRWRP LPBF System supplies 3.6 mgd of recycled RO water to the adjacent refinery facility on an average annual basis. This average annual demand was established from historical billing records from FY 2014/15 to FY 2018/19. Maximum and minimum month demands were also based on historical billing records and included in the analysis. The analysis demands are summarized in Table 7-17.

Table 7-17. JMMCRWRP Low Pressure Boiler Feed System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	4,006	3.6	2,482
Maximum Month Demand		4.5	3,145
Minimum Month Demand		2.3	1,592

Analysis Results

As shown in Table 7-18, the average unit headloss per 1,000 feet of pipe ranged from 0.1 feet to 0.3 feet for existing conditions, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 0.7 fps to 2.2 fps, also below the analysis criteria of 3 fps.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the pump station, which is currently maintained at 52 psi. With one pump on stand-by, the firm capacity of the pump station is 3,450 gpm or 5 mgd. Model results indicate that only two pumps need to be operating to maintain the 52 psi discharge pressure under average and maximum month demand conditions.

Table 7-18. JMMCRWRP Low Pressure Boiler Feed System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Delivery Point (psi)	Velocity (fps)		Maximum Travel Time [1]
					24 inch Pipe	30 inch Pipe	(minutes)
Average Annual Demand [2]	2,482	1.3	0.2	53	1.8	1.1	66
Maximum Month Demand [2]	3,145	2.1	0.3	53	2.2	1.4	52
Minimum Month Demand [3]	1,592	0.6	0.1	54	1.1	0.7	103

[1] Water age based on length 5,200 feet.
[2] Pump 1 and Pump 2 on.
[3] Pump 1 on.

Available Capacity

Model results indicate that the existing JMMCRWRP LPBF System has adequate capacity to convey current flows.

Remaining capacity in the pump station is estimated at approximately 1.4 mgd based on the firm capacity criteria and current average annual demand, as shown in Table 7-19.

Table 7-19. JMMCRWRP Low Pressure Boiler Feed System Available Pump Station Capacity

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	4,003	3.6	2,482
Existing Pump Station Firm Capacity	5,565	5.0	3,450
Available Capacity	1,562	1.4	968

7.1.9 JMMCRWRP Nitrified Water System

Criteria

Analysis criteria for the JMMCRWRP Nitrification System includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps
- Capacity should be met with at least one booster pump kept in reserve

Analysis Conditions

The JMMCRWRP Nitrified Water System consists of the booster pump station and the 12-inch diameter DIP transmission main that conveys Nitrified water to the Marathon Refinery. The transmission main is approximately 1.2 miles, or 6,110 feet.

The pump station includes two variable speed pumps each with a design capacity of 625 gpm, resulting in a firm capacity of approximately 0.9 mgd.

Under existing conditions, the JMMCRWRP Nitrified Water System supplies 1.0 mgd of Nitrified water to the adjacent refinery facility on an average annual basis. This average annual demand was established from historical billing records from FY 2014/15 to FY 2018/19. Maximum and minimum month demands were also based on historical billing records and included in the analysis. The analysis demands are summarized in Table 7-20.

Table 7-20. JMMCRWRP Nitrified Water System Demands

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	1,125	1.0	697
Maximum Month Demand		1.5	1,021
Minimum Month Demand		0.1	61

Analysis Results

As shown in Table 7-21, the average unit headloss per 1,000 feet of pipe ranged from 0.02 feet to 3.1 feet for existing conditions, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 0.2 fps to 2.9 fps, slightly below the analysis criteria of 3 fps.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the pump station, which is currently maintained at 57 psi. With one pump on stand-by, the firm capacity of the pump station is 625 gpm or 0.9 mgd. Although maximum month demands exceed the individual design point for each of the variable speed pumps, model results indicate that only one pump needs to be operating to maintain the 57 psi discharge pressure under maximum month demand conditions with a relative speed factor of 91 percent.

Table 7-21. JMMCRWRP Nitrified Water System Model Results

Condition	Demand (gpm)	Total Headloss (ft)	Average Headloss Rate (ft/kft)	Pressure at Delivery Point (psi)	Velocity (fps)	Maximum Travel Time [1] (minutes)
Average Annual Demand [2]	697	7.8	1.5	54	2.0	44
Maximum Month Demand [2]	1,021	15.8	3.1	50	2.9	30
Minimum Month Demand [2]	61	0.1	0.02	57	0.2	510

[1] Water age based on length 5,200 feet.
[2] Pump 1 on.

Available Capacity

Based on the above analyses, the existing pipeline and pump station have sufficient capacity for the existing demand conditions evaluated. Based on the criteria related to pipeline velocity and firm pump station capacity, the existing system can be considered at capacity for current maximum month demand conditions. The limiting system criteria is the pipeline capacity based on the 3 fps velocity criteria. Remaining system capacity under average annual demand conditions is approximately 310 gpm based on available pipeline capacity, as shown in Table 7-22.

Table 7-22. Remaining System Capacity under Average Annual Demand Conditions

Condition	Demand		
	afy	mgd	gpm
Average Annual Demand	4,240	3.8	2,628
Demand Resulting in 3 fps Pipeline Velocity	4,739	4.2	2,938
Available Capacity	499	0.4	310

7.1.10 JMMCRWRP Brine Line

Criteria

Analysis criteria for the JMMCRWRP brine line includes the following general criteria:

- Maximum headloss of 10 feet for each 1,000 feet of pipe length
- Velocities of 1 to 3 fps under normal operations, with maximum velocities of 7 fps

Analysis criteria specific to the JMMCRWRP brine line includes:

- Positive pressure at the LACSD JWPCP standpipe corresponding to 8.0 psi at the standpipe sampling point
- Maximum daily flow of 0.9 mgd (regulated by discharge permit)

These criteria were used to evaluate the existing JMMCRWRP brine line system under existing demand conditions.

Analysis Conditions

The JMMCRWRP brine line consists of:

- 28,190 lineal feet of 14-inch diameter AWWA C905 PVC pipe that runs from the RO concentrate discharge system at JMMCRWRP to Lomita Street, south of the JWPCP
- 216 lineal feet of 14-inch outer diameter (OD) SDR-11 HDPE pipe that runs from north of Lomita Boulevard to the LACSD's Outfall Surge Tower

Under existing conditions, the JMMCRWRP Brine Line supplies 0.64 mgd of RO concentrate to the LACSD surge tower on an average annual basis. This average annual demand was established based on daily SCADA data collected in 2019. Minimum day flows of 0.05 mgd were also indicated using the daily SCADA data records. Maximum instantaneous flows are estimated at 0.87 mgd based on SCADA data from the calibration period of August 2020, which was collected with a 15-minute sampling interval. The analysis demands are summarized in Table 7-23.

Table 7-23. JMMCRWRP Brine Line Demands

Condition	Brine Line Flow Rate		
	afy	mgd	gpm
Average Annual Flow [1]	711	0.64	441
Maximum Instantaneous Flow [2]		0.87	603
Minimum Day Flow [3]		0.05	36

[1] Average annual flow from 2019 historical SCADA data.
[2] Maximum flow observed during August 2020 calibration period, 15-minute sampling interval.
[3] Minimum daily flow observed from 2019 historical SCADA data.

Analysis Results

As shown in Table 7-24, the average unit headloss per 1,000 feet of pipe ranged from 0.02 feet to 3.1 feet for existing conditions, well below the analysis criteria of 10 feet per 1,000 feet. The maximum velocity ranged from 0.2 fps to 2.9 fps, slightly below the analysis criteria of 3 fps.

Pressure at the point of delivery is dictated by the pressure at the discharge side of the pump station, which is currently maintained at 57 psi. With one pump on stand-by, the firm capacity of the pump station is 625 gpm or 0.9 mgd. Although maximum month demands exceed the individual design point for each of the variable speed pumps, model results indicate that only one pump needs to be operating to maintain the 57 psi discharge pressure under maximum month demand conditions with a relative speed factor of 91 percent.

Table 7-24. JMMCRWRP Brine Line Model Results

Condition	Flow (gpm)	Average Headloss Rate (ft/kft)	Conditions at Standpipe		Velocity (fps)	Maximum Travel Time [1] (hours)
			Pressure (psi)	Hydraulic Grade (feet)		
Average Annual Flow	441	0.3	14	76	0.9	8.6
Maximum Instantaneous Flow	603	0.5	12	69	1.3	6.3
Minimum Day Flow	36	<0.01	18	85	0.1	99

[1] Water age based on length 28,400 feet.

Available Capacity

Based on the model results, the brine line meets the velocity and pressure criteria for the existing demand conditions analyzed.

The limiting hydraulic factor in the brine line capacity is maintaining 8 psi pressure at the LACSD Outfall Surge Tower. Iterative model runs indicate a maximum brine line flow of approximately 730 gpm (1.1 mgd) would satisfy the pressure criteria at the surge tower, approximately twenty percent more flow than the maximum instantaneous flow observed during the calibration period in August 2020. Therefore, based on annual average flows observed in 2019, the brine line has a remaining available capacity of approximately 0.42 mgd. Based on the maximum instantaneous flows observed during the calibration period, the brine line has a remaining instantaneous flow capacity of approximately 0.18 mgd.

7.2 Hydraulic Model Analysis Summary

The results of the hydraulic model analysis of the ten modeled systems is summarized below in Table 7-25. The model results indicate that two of the systems exceed the evaluation criteria under existing average operational conditions. These systems include the ECLWRF Brine Pipeline, which exceeds velocity criteria due to free surface gravity flows, and the Chevron LPBF System, which exceeds the velocity and pump station capacity criteria under average annual demand conditions.

Three systems are either near capacity or slightly exceed one evaluation criterion under maximum month demand conditions but have sufficient capacity to satisfy average annual demands. These systems include the Chevron HPBF System, the Chevron Nitrified Water System, and the JMMCRWRP Nitrified Water System.

Model results indicate that the remaining systems have sufficient capacity to satisfy demands under average annual and maximum month conditions.

Table 7-25 also includes calculated remaining available capacity based on a comparison of annual average demands and the limiting criteria for each system currently capable of satisfying annual average flows.

Recommended improvements to address the deficiencies identified during the hydraulic model analysis are also listed in Table 7-25. Recommended improvements for the ECLWRF brine line include installing a series of pinch valves or pipe restrictions on the pipeline designed to pressurize the pipeline and to reduce the pressure gradually prior to discharge to the Hyperion Ocean Outfall. Pressurized flow in the pipeline would mitigate high velocity free surface gravity flows.

Model results indicate the Chevron LPBF System currently exceeds both pipeline and pump station capacities. A pump station upgrade and either a parallel pipeline or increased diameter pipeline is recommended to accommodate current flow rates.

Model results indicate that the HSEPS and force main have sufficient capacity to convey current flows. However, a 2017 Flow Science study performed a surge pressure analysis and recommended that controlled venting features be provided for and redundant valves be installed on the vacuum valves expected to open during a surge event. Additionally, it is recommended that isolation valves be installed on the force main so that sections of the pipeline can be isolated for maintenance and in the case of breaks.

As noted in Chapter 4, West Basin has previously identified the need to install isolation valves on the two Title 22 conveyance pipelines, 42-inch and 48-inch, to allow one of the pipelines to remain operational if the other pipeline requires repair. This project is referenced as TVIP – ECLWRF Title 22 Valve Installation Project.

In addition, the DVPS – ECLWRF Diversion Pump Station R&R Project includes the replacement of the aging pumps that serve as backup for the Product Water Pumps and the addition of a standby VFD for these pumps. The function of the Diversion Pump Station is to convey recycled water directly to the distribution system if a bypass of the Title 22 storage tanks is required for reasons such as maintenance or cleaning.

Table 7-25. Summary of Available System Capacities

System	Status Under Current Demand Conditions		Available Capacity Under Average Annual Demand Conditions
	Annual Average	Maximum Month	
Hyperion Secondary Effluent Pumping System	Sufficient Capacity		Approximately 58 mgd of remaining available capacity based on current average annual flow rate and force main velocity criteria.
ECLWRF Brine Line	Exceeds Velocity Criteria due to Free Surface Flow		Currently experiencing velocities exceeding the 10 fps criteria due to free surface gravity flows. Recommended that the downstream pressure near the Hyperion Ocean Outfall be increased by installing a series of pinch valves or pipe restrictions to reduce the pressure gradually prior to discharge to the outfall.
Title 22 Distribution System	Sufficient Capacity		Sufficient capacity in all major reaches of the system. Limited capacity in the Torrance BPS reach of the system due to existing pipe capacity.
West Coast Barrier System	Sufficient Capacity		Approximately 9.2 mgd of remaining available capacity based on current average annual flow rates compared with current firm pump station capacity. Replacement of Pumps 2 and 3 is recommended, as they are reaching end of useful life and efficiencies are lagging.
Chevron HBPF System	Sufficient Capacity	Slightly Exceeds Velocity Criteria	Approximately 0.30 mgd of remaining available capacity based on current average annual flow rates compared with current firm pump station capacity.
Chevron LPBF System	Exceeds Velocity and Pump Capacity Criteria		Currently experiencing velocities exceeding 3 fps under average annual demand conditions. Additionally, annual average demands exceed the firm capacity of the pump station.
Chevron Nitrified Water System	Sufficient Capacity	Slightly Exceeds Velocity Criteria	Approximately 0.45 mgd of remaining available capacity based on current average annual flow rates compared with pipeline flow resulting in 3 fps velocity.
JMMCRWRP LPBF System	Sufficient Capacity		Approximately 1.4 mgd of remaining available capacity based on current average annual flow rates compared with current firm pump station capacity.
JMMCRWRP Nitrified Water System	Sufficient Capacity	At Capacity	Approximately 0.47 mgd of remaining available capacity based on current average annual flow rates compared with pipeline flow resulting in 3 fps velocity.
JMMCRWRP Brine Line	Sufficient Capacity for both Average Annual and Maximum Instantaneous Flows		Approximately 0.42 mgd of available capacity for average annual flows and 0.18 mgd of available capacity for instantaneous flows based on required minimum pressure criteria at the LACSD Outfall Surge Tower.

As part of the Suez West Basin Energy Optimization Plan (Suez, 2020) a number of energy conservation measures (ECMs) were identified. Pump performance analyses were recommended for all West Basin pumping facilities through a pump performance monitoring plan, as well as an analysis of current pressure setpoints to meet production demands. The assessments will be based on operational data, including flow, suction and discharge pressure, temperature and electric current, and includes pump testing information from Southern California Edison. Expected performance is based on design point and manufacturer data, such as pump head-flow and efficiency curves.

Suez's plan for ongoing ECMs will include reviewing available information for each pump and pump station, evaluation of design specifications compared to operational needs, installing monitoring equipment, a pilot effort to test other pumps with higher criticality, and development of a long-term pump replacement program. Information will be utilized to prioritize and make recommendations for pressure setpoint changes, operational guidelines, and lead-lag pump configurations for all of West Basin's facilities. Suez plans to widen the scope of this program to include the Title 22 Product Pumps at ECLWRF next, then the nitrified product pumps for CNTP and TRWRP.

7.3 Risk and Criticality Assessment

A risk and criticality assessment for West Basin's recycled water main pipelines, valves and booster pump stations for the Title 22 system was conducted to fulfill Master Plan Task 9.3: Criticality Analysis and Risk Prioritization of System Assets. West Basin manages approximately 85 miles of recycled water main pipeline infrastructure and two BPSs. As the system continues to age and deteriorate, West Basin will continue to identify and prioritize pipeline and BPS condition assessment and replacement projects for the purpose of cost effectively sustaining desired service levels to ratepayers. This technical memorandum documents the methodology and results for prioritizing pipelines through a Pipe Risk Score (PRS) in this section and also documents specific condition assessment and remediation recommendations in Section 7.3.2. Recommendations for integration of the risk model into West Basin systems is included in Section 7.3.3. Nitrified, Barrier, RO, and HPBF pipelines and valves are not included in the scope of work for this analysis.

7.3.1 Pipeline Risk Assessment

The foundation of West Basin's recycled water main pipeline risk model combines the consequence of failure (CoF) and the likelihood of failure (LoF) to produce a Pipe Risk Score (PRS). This section describes the methodology for calculating the PRS and presents the results of this methodology when applied to West Basin's recycled water mains. The PRS should be updated regularly to account for new data such as break history and aging infrastructure. As the program continues to mature, it is anticipated that the PRS calculation methodology will adapt to changing drivers, experiences, and readily available information.

Basis of Pipe Risk Score (PRS)

Recycled water pipes are accounted for in segments: pipes are split into individual pipe segments at diameter changes, material changes, install date changes, valves, tees/crosses, bends, and other attributes in GIS. The PRS is calculated for each pipe segment owned by West Basin as shown in GIS.

PRS Calculation Methodology

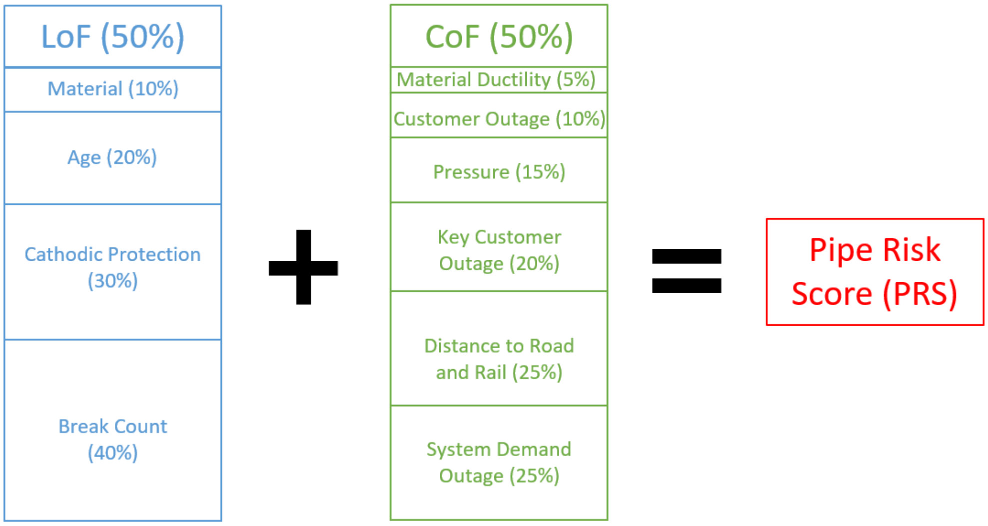
The PRS quantifies relative risk on a scale of zero (lowest risk) to one hundred (highest risk). Figure 7-6 summarizes the PRS calculation methodology. A one to 100 scale is selected to provide a broader range of potential scores which provide more flexibility when setting trigger thresholds for renewal or condition assessment decision making. Risk scores that range from 1-5 or 1-25 may require setting a risk score decision making trigger that does not align with available budget and resources. Risk scores that range from 1-100 provide a significant number of potential values for risk score decision making triggers. In addition, risk scores that range from 1-100 provide additional flexibility when weighting CoF and LoF.

The PRS is calculated as a weighted summation of the LoF and CoF. This weighted summation method is one of two methods commonly used in the industry to assess risk (the other being multiplication). Historically, utilities[2] have attempted to use multiplication to assess risk, but they have found that this method places too much emphasis on high CoF lines that rarely fail. Replacement of these pipes does not mitigate risk because the new pipe also has a high CoF. An example of this is a pipe replacement adjacent to freeway. The new pipe will be in excellent condition, but the pipe will still receive a high CoF score due to its proximity to a freeway. Meanwhile, in the multiplication approach, low CoF pipes in poor condition are not recommended for replacement and will continue to fail and repeatedly put the same customers out of service. Utilities have also found that multiplication limits flexibility to adequately add secondary risk factors in the future that support effective decision making such as the number of inoperable valves on a pipe, the performance of services that will be replaced at the same time as the pipe, and water quality limitations. The weighted summation method is selected to enable future integration of secondary factors as well as to allow for additional flexibility when weighting LoF and CoF to ensure the ratepayer realizes the greatest return on their investment.

The LoF weighting typically ranges from 50 to 80 percent depending on the quality of LoF data available and the quantity of failures. For West Basin’s system, both the LoF and CoF weighting were set to 50 percent. Because the PRS is on a scale of zero to one hundred, LoF can contribute up to 50 points and the CoF can contribute up to 50 points. Figure 7-6 presents the Pipe Risk Score calculation including the weights for LoF, CoF and for each LoF and CoF factor.

[2] Amarillo Texas, Carlsbad California, Contra Costa Water District, Des Moines Iowa, Los Angeles Bureau of Sanitation, Fallbrook Public Utilities, Huntington Beach California, Johnson County Kansas, San Antonio Water Systems, Lee’s Summit Missouri, Mesa Water District, Padre Dam Municipal Water District, Phoenix Arizona, Rainbow Municipal Water District, Richardson Texas, Rochester Minnesota, Seattle Public Utilities, Santa Cruz California, Vista Irrigation District, City of Vista California, Winston Salem North Carolina, Bellevue Washington, Boulder Colorado, Buena Park California, City and County of Honolulu Hawaii, Las Vegas Nevada, Eugene Oregon, Hopewell Virginia, Joint Base Elmendorf Richardson, Lincoln Nebraska, Loudon Virginia, Missoula Montana, Olathe Kansas, Soldotna Alaska, San Juan Capistrano California, West Basin Municipal Water District, Westminster Colorado.

Figure 7-6. Pipe Risk Score Calculation



Each of the PRS LoF and CoF are made up of different factors. For example, Distance to Roadway and Rail is a CoF factor because a failure under a freeway or railroad line is often more consequential than a failure under a minor street. Each factor was scored on a zero to ten scale (Factor Score) where zero represents the lowest risk and ten represents the highest risk. A scale of zero to ten is used so the risk model is compatible with common off-the shelf risk model software such as InfoAsset Planner by Innovyze. Each factor contributes to the PRS based on the following equations:

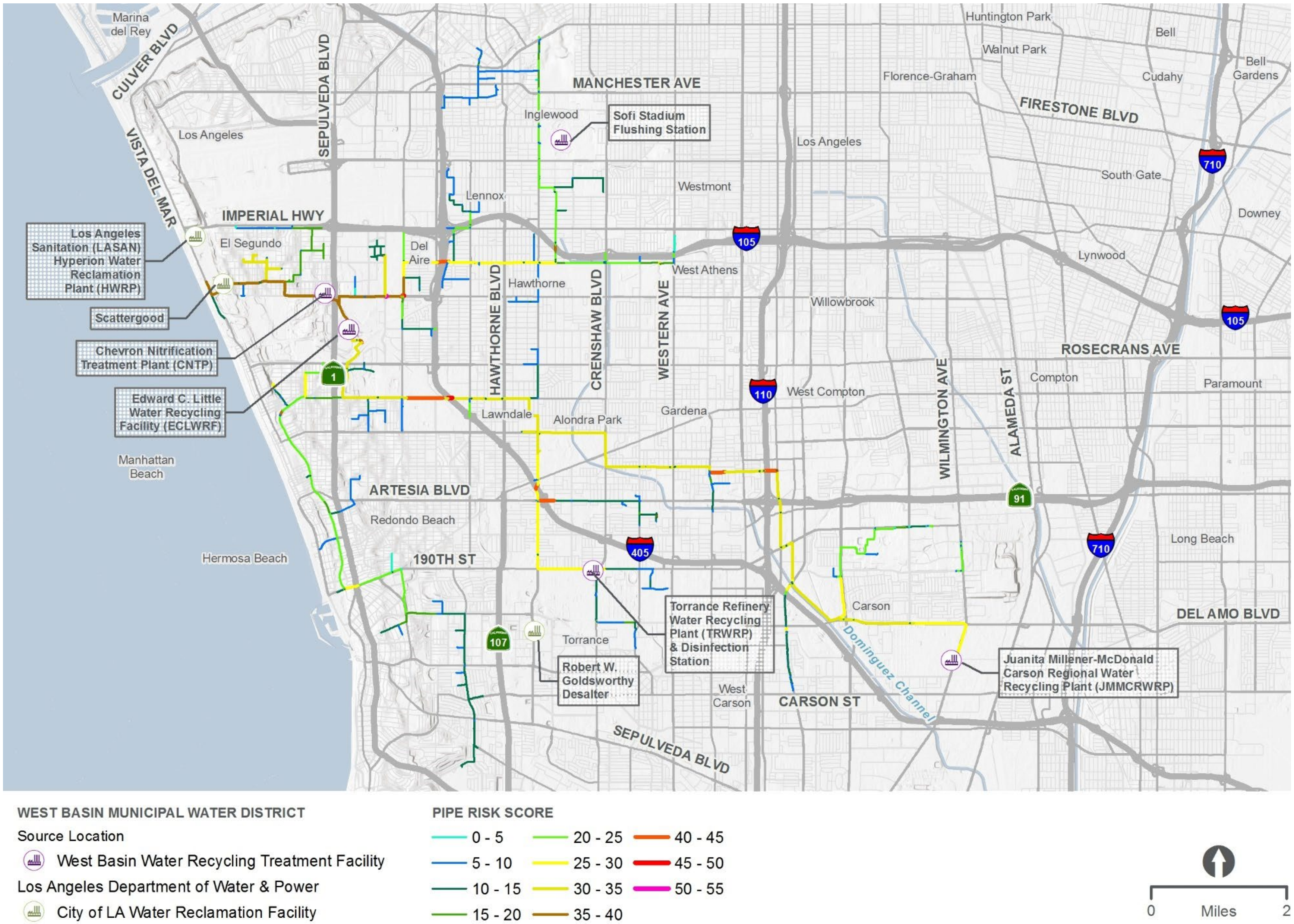
PRS = Σ Factor Score * 10 * Factor Weight * COF / LOF Weight

For example, if a pipe is installed under a Freeway, the pipe gets the highest Roadway and Rail factor score of 10, a Roadway and Rail Factor Weight of 25 percent, and the CoF weight of 50 percent. Therefore, a pipe under a freeway will contribute 12.5 points to the total PRS:

Freeway contribution to PRS = 10 * 10 * 25% * 50% = 12.5

The following subsections describe the method for quantifying each LoF and CoF factor. Each factor of CoF and LoF has a summary table which includes the scoring criteria for that factor, and the corresponding miles of pipe that fits the criteria, the corresponding factor score, and the contribution to the overall PRS. The summation of all PRS contribution scores provides the overall PRS for each pipe. The PRS is mapped for each pipe in GIS in Figure 7-7.

Figure 7-7. West Basin Risk Model - Pipe Risk Score



Likelihood of Failure

Based on the analysis of available West Basin data, industry experience and workshops with West Basin staff, the following LoF factors and weighting were used to calculate the LoF portion of the PRS:

- Break Count (40 percent)
- Pipe Characteristics (60 percent)
    - Cathodic Protection Potential Data (30 percent)
    - Pipe Age (20 percent)
    - Pipe Material (10 percent)

Each factor listed above is further broken down into subcategories (i.e., ductile iron is a subcategory of the pipe material LoF factor). This section includes an explanation of the reasoning and subcategories relating to each factor listed above, as well as the number of miles of pipe falling into each subcategory. The LoF for each pipe is mapped in Figure 7-8.

Break Count

Break counts are a strong indicator of condition related failure and a pipe that has broken is more likely to break again. No pipes had more than one break for West Basin's system, so the only subcategories that apply are 0 breaks and 1 break. Table 7-26 summarizes the factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS. West Basin's break data is used for this factor. Break data was reviewed and breaks caused by water main condition related failure are included. Other breaks such as those caused by contractor hits and service line failures were excluded.

Table 7-26: Break Count Factor Scoring

Break Count	Miles	Factor Score	Pipe Risk Score
0	77.82	0	0
1	0.61	9	18
> 1	0	10	20

Pipe Characteristics

Age

Although age alone is not necessarily a good predictor of pipe condition, it does have an influence on deterioration. West Basin's recycled water mains vary in age and range from 1-30 years. Table 7-27 summarizes the subcategory scoring of the pipe age LoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory. There are approximately 0.4 miles of pipe without information. These pipes are assumed to have an age of 21-30 years because the majority of the pipes are this age. West Basin's GIS data is used for this factor.

Table 7-27. Age Factor Scoring

Age	Miles	Factor Score	Pipe Risk Score
Unknown	0.4	2	2
1-10	4.5	0	0
11-20	15.8	1	1
21-30	57.7	2	2
31-40	0.0	3	3
41-50	0.0	5	5
51-60	0.0	7	7

Material

The material factor accounts for different material performance of pipes since some materials are more likely to fail than others. Table 7-28 summarizes the subcategory scoring of the pipe material LoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory. This scoring is based on industry experience. There are too few breaks to determine these scores based on West Basin data. There are approximately 2.8 miles of pipe with unknown material. These pipes are assumed to receive a factor score of 10 to be conservative. West Basin's GIS data is used for this factor.

Table 7-28. Material Factor Scoring

Material	Miles	Factor Score	Pipe Risk Score
Cement Mortar Line and Coated Steel	1.3	10	5
Cement Mortar Line and Tape Wrapped	0.9	10	5
Ductile Iron	21.2	10	5
Polyvinyl Chloride	37.3	0	0
Steel	0.01	10	5
Unknown	2.8	10	5
Welded Steel	14.9	10	5

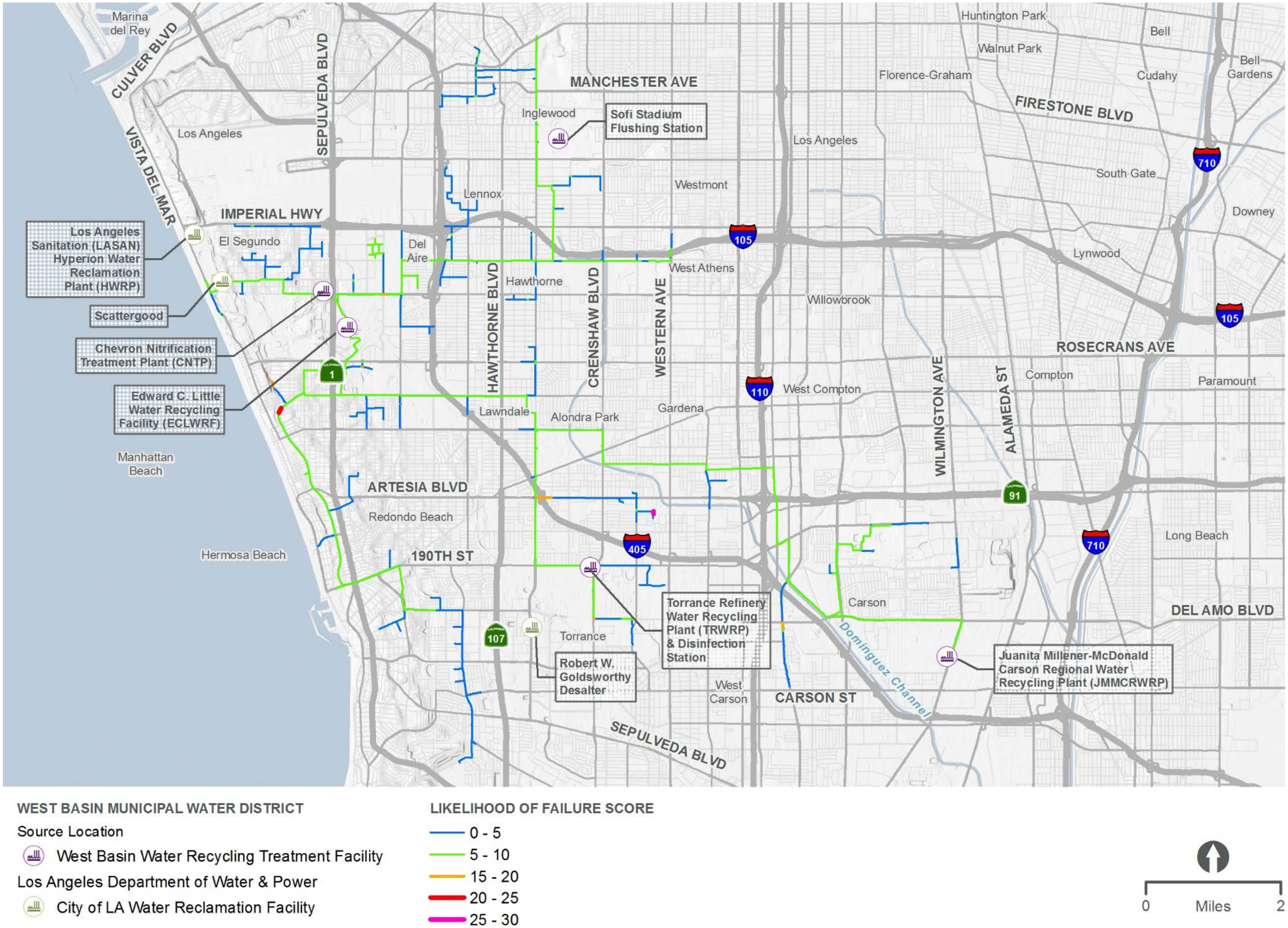
Cathodic Protection

Spatial data regarding cathodic protection were compared to the physical location of West Basin's pipes to identify the pipes that were proactively protected against corrosion. Factor scores were derived based on cathodic protection and the material of the pipe. Table 7-29 summarizes the subcategory scoring of the cathodic protection LoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory. A total of 4.1 miles of metallic pipelines were identified without cathodic protection. However, these pipelines are smaller diameter and lower risk. The pipelines assessed in the Cathodic Protection Testing Study in 2018 have been identified by West Basin for cathodic protection improvements to extend pipeline useful life and reduce risk. Subsequent cathodic protection surveys will identify condition based risk for these pipelines. This factor should be updated after completion of these cathodic protection surveys.

Table 7-29. Cathodic Protection Factor Scoring

Cathodic Protection Category	Miles	Factor Score	Pipe Risk Score
Non-metallic	37.3	0	0
Metallic and assessed in the Cathodic Protection Testing Study 2018	37.1	0	0
Metallic – No Cathodic Protection	4.1	2	3

Figure 7-8. West Basin Risk Model – Likelihood of Failure Score



Consequence of Failure

The CoF analysis focuses on the impact the failure would have on the service provided to customers, the risk for financial expenditures West Basin would incur due to the failure, and impacts to the community and environment. The following CoF criteria are considered in the risk assessment:

- Customer Impacts (55 percent)
    - System Demand Outage (25 percent)
    - Critical Customer Outage (20 percent)
    - Customer Outage (10 percent)
- Community and Environment Impacts (45 percent)
    - Roadway and Rail (25 percent)
    - Pressure (15 percent)
    - Material ductility (5 percent)

Each factor listed above is further broken down into subcategories (i.e., pressure range 0 – 60 psi is a subcategory of the pressure CoF factor). This section includes an explanation of the reasoning and subcategories relating to each factor listed above, as well as the number of miles of pipe falling into each subcategory. The map of CoF is presented in Figure 7-9.

Customer Impacts

An analysis of West Basin's hydraulic model was used to measure CoF factors by evaluating the impacts of each pipe failure. The hydraulic model is used to simulate the impacts of pipe failure for each pipe in the system. This is done by closing each pipe in the model and quantifying the system demand shortage and customers (including key customers) without access to water due to that specific break.

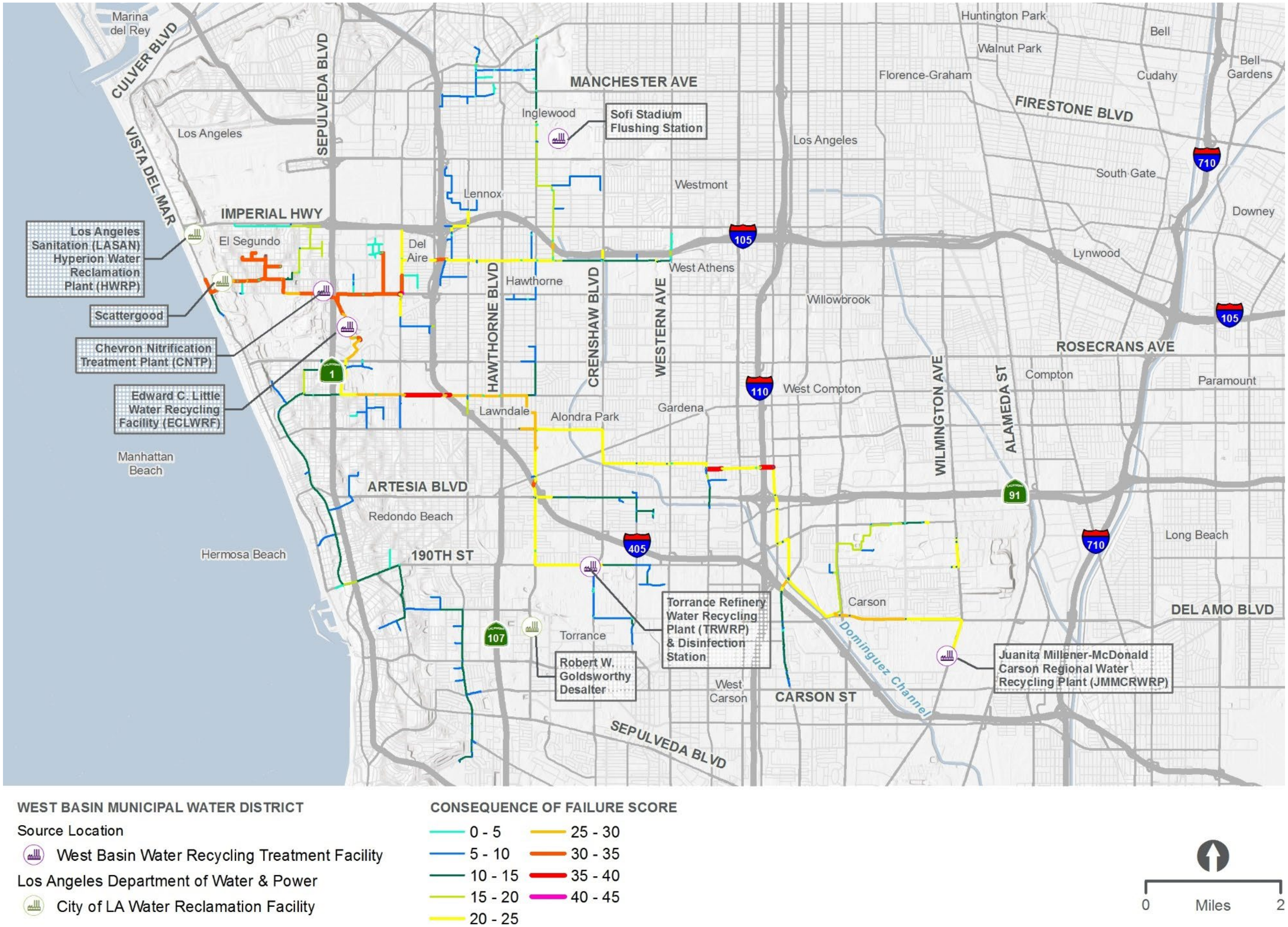
System Demand Outage

A pipe taken out of service can cause other customers in the system to be isolated from any source of water. For each pipe, the hydraulic model analysis reports the percentage of the system demand that is not delivered due to that pipe's failure. Embedded in this analysis is also the accounting of the consequence of failure of the pipes to the water supply of larger customers. Table 7-30 summarizes the subcategory scoring of the system demand outage CoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory.

Table 7-30. System Demand Outage Factor Scoring

System Demand Outage (%)	Miles	Factor Score	Pipe Risk Score
< 0.1	10.3	0	0
0.1 - 1	25.2	2	2.5
1 to 5%	16.9	6	7.5
5 to 10	2.6	9	11.25
>10%	23.4	10	12.5

Figure 7-9. West Basin Risk Model – Consequence of Failure Score



Customer Outage

The customer outage factor identifies the number of customers that would be out of service if each pipeline were to fail. Table 7-31 summarizes the subcategory scoring of the customer outage CoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory.

Table 7-31. Customer Outage Factor Scoring

Customer Outage Count	Miles	Factor Score	Pipe Risk Score
0	7.90	0	0
1-20	53.82	2	1
20-80	10.70	5	2.5
>80	6.01	10	5

Key Customer Outage

Key customers for the pipeline risk analysis include users with the largest recycled water demands that exceed 1 percent of system demand. The key customer outage factor identifies the number of key customers that would be out of service if a pipe fails. Table 7-32 summarizes the subcategory scoring of the key customer outage CoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory.

Table 7-32. Key Customer Outage Factor Scoring

Key Customer Outage Count	Miles	Factor Score	Pipe Risk Score
0	43.61	0	0
1	13.38	4	4
2	1.57	5	5
3	0.72	5	5
4	8.14	6	6
5	4.99	7	7
11	6.01	10	10

Community and Environment Factors

The Community and Environment factors represent conditions that could impact the environment or community in terms of health and safety, public disruption, damage and West Basin's reputation.

Roadway and Rail

Breaks on pipes crossing significant roadways and railways can result in significant impacts to the community. California State Geoportal provides the spatial data from the National Highway System and California Rail Network that is free to download from https://gis.data.ca.gov/. ArcGIS was used to calculate the distance between West Basin's pipelines and both freeways and railroads to properly score these CoF factors for the analysis. The corresponding CoF score of each pipeline is based on the distance between that pipeline and the corresponding transportation infrastructure. Table 7-33 and Table 7-34 summarizes the subcategory scoring of the roadway and rail factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory.

Table 7-33. Freeway Distance Factor Scoring

Distance to Freeway (feet)	Miles	Factor Score	Pipe Risk Score
< 0.1	1.83	10	12.5
0.1 - 50	0.13	10	12.5
> 50	76.46	0	0

Table 7-34. Rail Factor Scoring

Distance to Railroad (feet)	Miles	Factor Score	Pipe Risk Score
< 0.1	1.41	10	12.5
0.1 - 50	0.40	5	6.25
> 50	76.61	0	0

Material Ductility

A brittle pipe that fractures generally damages more property and is more difficult to repair than an equally-sized ductile pipe that merely "leaks." For example, PVC pipe often fractures during failure and steel is more likely to leak. Table 7-35 summarizes the subcategory scoring of the material ductility factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory. There are approximately 2.8 miles of pipe with unknown material ductility. These pipes are assumed to receive a factor score of 10 to be conservative. West Basin's GIS is used for this factor.

Table 7-35. Material Ductility Factor Scoring

Ductility (Based on Material)	Miles	Factor Score	Pipe Risk Score
Cement Mortar Lined and Coated Steel	1.3	0	0.0
Cement Mortar Lined and Tape Wrapped	0.9	0	0.0
Ductile Iron	21.2	2	0.5
Polyvinyl Chloride	37.3	10	2.5
Steel	0.013	0	0.0
Unknown	2.8	10	2.5

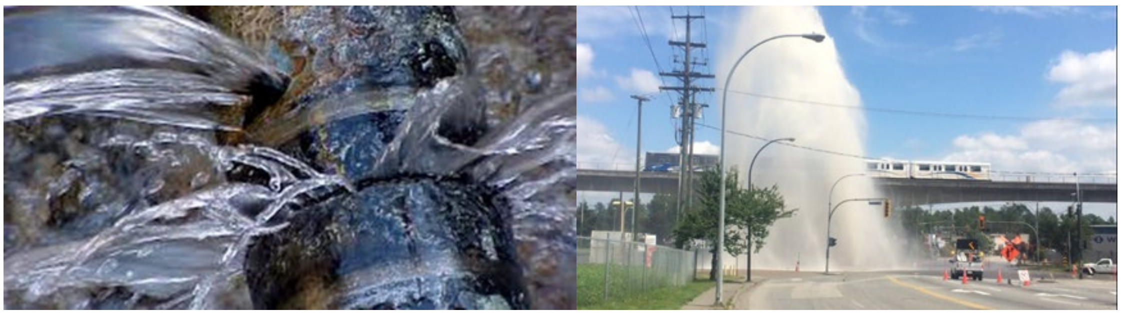
Table 7-35. Material Ductility Factor Scoring

Ductility (Based on Material)	Miles	Factor Score	Pipe Risk Score
Welded Steel	14.9	0	0.0

Pressure

High pressure breaks can result in much greater impacts to health and safety, economics, and disruptions than low pressure breaks. Figure 7-10 shows examples of breaks at different pressures. The image on the left shows a pipe with a low pressure and the water trickling out, which is typically a low CoF. The image on the right's break has occurred on a pipe with significant high pressure, resulting in a more violent break and a higher CoF.

Figure 7-10. Pipe Breaks with Low Pressure (Left) and High Pressure (Right)



Maximum system pressure data was obtained from each hydraulic model junction and applied to the pipes in the hydraulic model. The pressure assigned to each pipe correspond to the maximum pressure of that modeled pipe's adjoining junctions during the maximum daily demand scenario. Each recycled water pipe in GIS was associated with either the corresponding FacilityID in the hydraulic model or the closest physical model pipe when no FacilityID match existed. Table 7-36 summarizes the subcategory scoring of the pressure CoF factor by miles of pipe, the factor score, and the contribution of this factor to the overall PRS fitting that subcategory. The hydraulic model maximum pressure data at each node is used for this factor.

Table 7-36. High Pressure Factor Scoring

Pressure (psi)	Miles	Factor Score	Pipe Risk Score
0 - 60	2.67	0	0.00
60.1 - 80	9.57	2	1.5
80.1 - 100	33.27	4	3.0
100.1 - 120	26.91	6	4.5
120 - 140	4.12	8	6.0
140 - 160	1.88	10	7.5

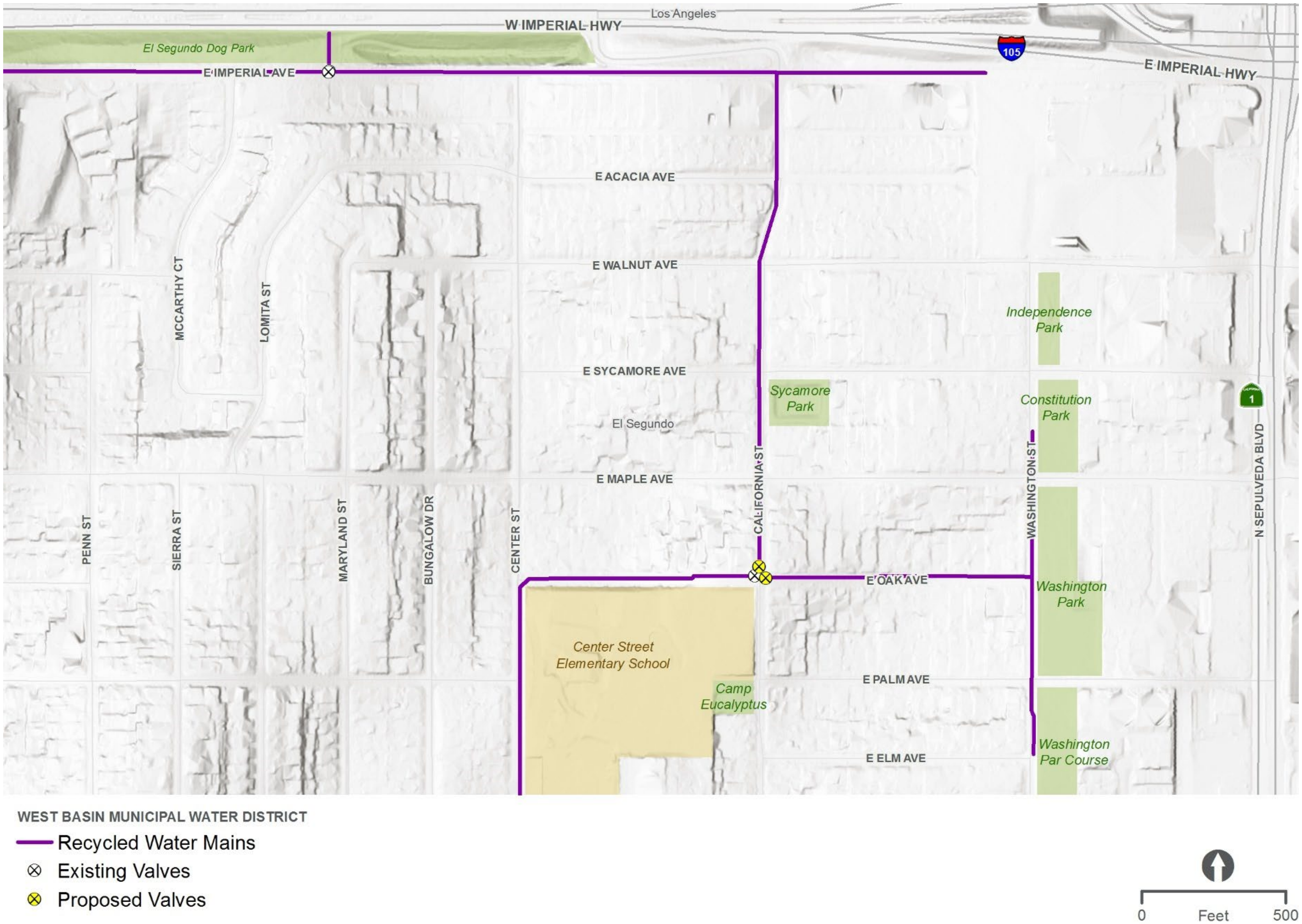
7.3.2 Risk Mitigation Recommendations

The results of the risk model were used to identify risk mitigation recommendations including installing new valves and corrosion assessment. HDR recommends West Basin perform annual cathodic protection surveys for corrosion assessment and use the results to identify condition assessment needs, repairs and update the risk model. The mains are relatively new and significant condition assessment is not anticipated at this time. West Basin's mains will deteriorate over time and West Basin should consider developing a budget for condition assessment in the future.

The results of the CoF analysis were used to identify low cost and high value valve installations that will significantly improve reliability and reduce the risk associated with a failure on smaller diameter mains. This resulted in the identification of two (2) new 6-inch valves and recommended refinements to West Basin's valve placement standards to maximize the value of each valve installed in the future. A description of the location and impact of each of those improvement is described below.

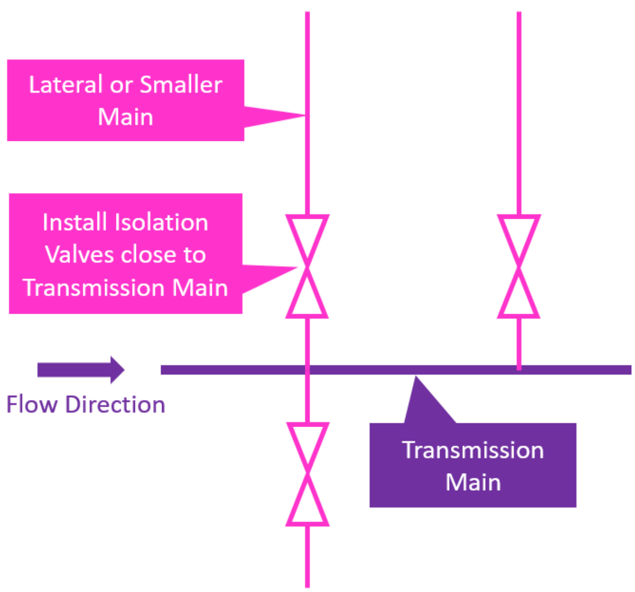
In Figure 7-11, two new 6-inch valves on the northern and eastern side of the tee at the intersection of California Street and East Oak Avenue would ensure a break or shutdown on the teal pipe would not isolate the entire service area (1.8% of system demand, 9 customers, 1 critical customer).

Figure 7-11. Reliability Enhancement #4 – Two New 6-inch Valves



In the future, whenever feasible, valves isolating mains or laterals from transmission mains should be located as close as possible to the transmission main tees and crosses to limit the likelihood that a distribution main failure requires a transmission main shutdown which will impact many more customers. An example of this is shown in Figure 7-12 and described below. While the impacts of a failure are high in the following example, the length protected by a new valve is relatively short and the level of effort to install a new valve may be high. West Basin should review this location to determine whether a valve is warranted. This will be dependent on operational parameters such as the surface conditions and the difference in impact between a planned and unplanned shutdown in each of these areas.

Figure 7-12. Valve Placement



7.3.3 Booster Pump Station Risk

West Basin owns and operates the Dominguez Hills BPS and Torrance BPS which are described in detail in Section 2.4.4. The following section documents the criticality analysis including a summary of key characteristics and findings. The Dominguez Hills BPS capacity is 600 gpm. The purpose of the Dominguez Hills BPS was to provide recycled water to new users within the City of Carson and currently serves the Dominguez Technology Center. The BPS was installed in 2012 and the pipeline CoF analysis identifies one critical customer utilizing 1 percent or more of system demand that is served by the BPS.

The Torrance BPS capacity is 1,425 gpm. West Basin anticipates this pump station meeting the needs associated with future system expansion and the addition of demands downstream of the pump station. The GIS identifies the BPS install year in 2012 and the pipeline CoF analysis identifies no critical customers served by the BPS.

The two BPS do not warrant a calculated risk score methodology like the model developed for pipelines. There are not enough BPS to justify the effort. The qualitative and quantitative information evaluated identifies the Dominguez Hills BPS to be higher criticality than the Torrance BPS. The Dominguez Hills BPS is currently in operation.

BPS replacement is typically managed through condition assessment and evaluations based on equipment age. These BPS were installed recently and a detailed condition assessment is not likely necessary for another 5 to 10 years based on the data evaluated. Preventative operations and maintenance should continue to be performed on the Dominguez Hills BPS. Non-operation and maintenance measures should be considered for the Torrance BPS to prolong asset life while the BPS is in use.

7.3.4 Risk Model Integration Recommendations

This section documents the recommended steps to integrate the risk model into West Basin's production environment and the data translations performed to develop the risk model.

The current risk model is built in Microsoft Excel software and the risk model results and data are mapped by joining the Microsoft Excel spreadsheet to the recycled water main GIS feature using unique pipe asset IDs. There are several approaches West Basin could take to integrate this risk model into West Basin's production environment. These approaches include the following:

- Approach 1 – Utilize existing Microsoft Excel spreadsheet for updates and join to GIS.
- Approach 2 – Build the data translations and risk model into ESRI ArcModel Builder software.
- Approach 3 – Utilize "Off-the-shelf" software such as InfoAsset Planner by Innovyze to build the risk model.

Approach 1 is the recommended approach for West Basin. Approach 1 provides the most flexibility for updates because the Microsoft Excel software requires less specialized skills for making updates. There are also no additional costs to West Basin associated with Approach 1. One risk associated with Approach 1 is that Microsoft Excel files may be corrupted easily through user entry errors because there are limited version controls available through this software. This risk may be mitigated by regular archiving of files and limiting access to the Microsoft Excel file. In the future, as West Basin updates the risk model over time, it may be cost effective to migrate the risk model to ESRI ArcModel Builder software (Approach 2) or InfoAsset Planner by Innovyze (Approach 3).

The following four steps are recommended for integration of the risk model using Approach 1 with West Basin's production environment:

1. Archive a copy of the risk model Microsoft Excel spreadsheet on the appropriate West Basin server or file management system.
2. Store a working version of the risk model Microsoft Excel spreadsheet on West Basin server or file management system.
3. Mapping – incorporate current risk model shapefiles into West Basin GIS. For future updates:
    a. Import the "For GIS" tab of the Microsoft Excel spreadsheet into ESRI ArcGIS geodatabase or SQL server as a table.
    b. Join this new table to West Basin's recycled water mains GIS feature.
    c. Update the recycled water mains GIS feature symbology per this technical memorandum and save as a new pipe risk GIS feature.
4. Provide access and read/write privileges to this new pipe risk GIS feature to appropriate staff.

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Chapter 8 Future System Analysis

8.1 Introduction

This chapter presents the results of the evaluation of the West Basin distribution systems and treatment facilities under the projected future demand conditions.

The premise for planning for the future of West Basin's recycled water facilities is primarily based on the opportunity to take up to 70 mgd of secondary effluent from the City of Los Angeles's HWRP, which treats an average of 275 mgd. Approximately 71,000 afy, or 63 mgd, of new opportunities were identified for expansion of the recycled water system customer base. As noted in Chapter 2, West Basin currently takes an average of 34 mgd of secondary effluent from the HWRP.

As described in Chapter 2, HWRP is currently the sole source of supply for West Basin's water recycling treatment facilities and recycled water distribution systems. West Basin owns and operates the HSEPS located at HWRP which conveys secondary effluent for further treatment at West Basin's water recycling facilities.

West Basin owns and operates one large water recycling treatment facility, the ECLWRF in El Segundo, and three smaller treatment facilities which are generally referred to as the Satellite Plants: the CNTP in El Segundo, the TRWRP in Torrance and the JMMCRWRP) in Carson.

The ECLWRF is the only treatment facility that receives secondary effluent directly from the HWRP via a 60-inch diameter force main from the HSEPS and produces disinfected tertiary water (or Title 22) for industrial and irrigation applications, as well as BF water for the Chevron Refinery. The Satellite Plants further treat Title 22 recycled water produced at ECLWRF for specific refinery customers for cooling towers and BF applications. As noted in Chapter 2, the ECLWRF and Satellite Plants allow West Basin to produce five types of designer water to meet end user water quality needs:

1. Disinfected tertiary water for recycled water irrigation (Title 22)
2. Nitrified water for cooling towers (Nitrified)
3. Advanced purified recycled water for groundwater barrier injection and protection from seawater intrusion (Barrier)
4. Single Pass RO water for LPBF
5. Double Pass RO water for HPBF

This chapter addresses the opportunities for improvement and expansion of West Basin's treatment facilities to accommodate near term operational improvements as well as future scenarios for system expansion.

Section 8.2 addresses the big picture, alternative approaches for using up to 70 mgd of secondary effluent flow from HWRP, based on new opportunities identified in 2.9. Three demand scenarios are presented, each with a phased implementation plan that allows West Basin to reach 70 mgd by 2040.

In order to meet the proposed increase in demand, improvements to West Basin's treatment and distribution systems are required. In addition to increased capacity, water quality improvements were also considered. Currently HWRP secondary effluent quality can fluctuate, making it challenging to produce a consistent recycled water quality for West Basin customers.

In August 2012, the Los Angeles Bureau of Sanitation (LASAN) prepared a TM that provided a basis for the evaluation of the HWRP Secondary Treatment System (Carollo, 2012). That TM acknowledged that:

> *Even though the HWRP meets all of its secondary effluent discharge permit requirements, the quality of the secondary effluent that is pumped to West Basin has changed since the original West Basin treatment facilities were built. These changes, which include elevated levels of ammonia, turbidity, large-chain soluble organics, and total dissolved solids (TDS) in the HWRP secondary effluent, resulted in adverse impacts to the West Basin recycled water treatment facilities. For some of the West Basin treatment facilities, these impacts have led to increased treatment costs and decreased treatment capacity for various facilities.*

In addition, the TM further acknowledged that the diurnal nature of HWRP influent flows is at odds with the 24-hour continuous demand for secondary effluent by West Basin. Because of the combined impacts of HWRP diurnal pattern low plant influent flows, the corresponding constant flow of high ammonia centrate associated with the HWRP treatment process and constant pumping from West Basin, there is concern that ammonia levels for West Basin will be higher during plant influent low flow periods.

As a result of these water quality concerns and a desire to reach a city-wide goal of 100% recycled wastewater, LASAN, in a joint effort with Los Angeles Department of Water and Power (LADWP) and West Basin, has initiated the Hyperion Membrane Bioreactor Pilot Facility. The $19.5 million facility is anticipated to be operational by 2022. The Hyperion MBR Pilot Facility will test new methods for improving recycled water quality and doubling the recycled water sent from HWRP to West Basin's ECLWRF (WaterWorld, July 2020). Pending the result of this pilot project, LASAN may move forward with converting their entire HWRP process to MBRs. As this proposed MBR conversion may take a decade or more to implement, availability of improved water quality for delivery to West Basin is not anticipated until 2030.

From West Basin's perspective, there are two potential opportunities to improve recycled water quality at ECLWRF: continue to support LASAN's plans to install membrane bioreactors (MBRs) at the HWRP or install tertiary membrane bioreactors (tMBRs) at ECLWRF.

Therefore, Section 8.3 provides a description of alternative treatment processes available to expand treatment to accommodate increased flows from the HWRP under the Scenarios proposed in Section 8.2, and to improve product water quality. Although moving forward with tMBRs at ECLWRF in the near term may result in better water quality sooner than 2030, that investment would be sunk cost once the HWRP is fully converted to MBR treatment. However, if the HWRP MBR conversion is deferred or cancelled, West Basin's investment in tMBRs would allow the District's customers to continue to have access to better quality recycled water. Although the comparative cost to West Basin for participating in the HWRP MBR conversion project is currently unknown, the potential lifecycle costs of fully converting to tMBRs at ECLWRF, as well as non-economic decision factors, are presented in Section 8.4, to inform future discussions with LASAN.

Section 8.4 provides a lifecycle cost evaluation of the alternative treatment processes proposed in Section 8.3, as well as non-economic advantages and disadvantages for each alternative.

Section 8.5 provides a summary of capital and operations and maintenance (O&M) costs for each Scenario, as well as a proposed implementation plan in the form of a decision tree, to help West Basin leaders to identify key trigger events and decision points, as both regional and internal plans evolve.

8.2 Future System Analysis Approach

West Basin anticipates doubling the existing average day demand (ADD) of 34 mgd to 70 mgd, with a maximum day demand in the range of 80 to 85 mgd, by Year 2040. Based on the findings of 2.9, approximately 70,000 afy (63 mgd) in new recycled water opportunities were identified. The individual ADD and maximum day demand (MDD) conditions associated with each group of potential customers are presented in Table 8-1.

Table 8-1. West Basin Recycled Water Existing Demands and Opportunities

Existing Demands and Opportunities	Total Demand (afy)	ADD (mgd)	Peaking Factor	MDD (mgd)
EXISTING DEMANDS [a]				
Title 22 (Distribution and Satellite Plants)	16,071	18.0	1.2	22.0
West Coast Basin Barrier Feed	10,714	12.0	1.3	16.0
Chevron LPBF	1,518	1.7	1.2	2.0
Chevron HPBF	2,054	2.3	1.3	3.0
Existing Demands Subtotal	30,357	34.0	-	43.0
NEW OPPORTUNITIES [b]				
Reserve Capacity for CNTP	1,120	1.0	1.3	1.3
Tier 1 Category 1 (Title 22) only - 75%	1,089	1.0	2.0	1.9
Tier 2 Category 1 (Title 22) only - 50%	429	0.4	2.0	0.8
JMMCRWRP Phase 2 Expansion	2,890	2.5	1.3	3.3
Increase Flows to West Coast Basin Barrier [c]	5,600	5.0	NA	1.5
Groundwater Augmentation Phase 1	10,000	8.9	1.0	8.9
Central Basin Expansion	195	0.2	2.0	0.3
Kenneth Hahn Expansion	773	0.7	2.0	1.4
Harbor City Expansion	313	0.3	2.0	0.6

Table 8-1. West Basin Recycled Water Existing Demands and Opportunities

Existing Demands and Opportunities	Total Demand (afy)	ADD (mgd)	Peaking Factor	MDD (mgd)
NE Carson Expansion	1,121	1.0	2.0	2.0
NE Carson Expansion [Single Pass RO]	245	0.2	1.3	0.3
Palos Verdes North Expansion	519	0.5	2.0	0.9
Palos Verdes South Expansion	1,722	1.5	2.0	3.1
Redondo Beach Expansion	150	0.1	2.0	0.3
So Fi Stadium Expansion [d]	82	0.1	2.0	0.1
Torrance Expansion	871	0.8	2.0	1.6
West Coast Basin Barrier Feed Expansion	5,600	5.0	1.0	5.0
Groundwater Augmentation Phase 2	10,000	8.9	1.0	8.9
Marathon (Carson) Refinery Expansion Nitrified	4,336	3.9	1.3	5.0
Marathon (Carson) Refinery Expansion Single Pass RO	4,502	4.0	1.3	5.2
Torrance Refinery Expansion Single Pass RO	1,613	1.4	1.3	1.9
LA Harbor (Single Pass RO)	8,909	8.0	1.3	10.3
Long Beach (Single Pass RO)	2,240	2.0	1.3	2.6
Santa Monica Groundwater Replenishment	5,000	4.5	1.0	4.5
Additional Tier 1 and 2 Title 22 Customers	1,065	1.0	2.0	1.9
New Opportunities Subtotal	70,111	62.9	--	73.7
Total Existing Demand and New Opportunities [e]	**100,468**	**96.8**	**--**	**116.7**

[a] Existing Demands are based on West Basin 2019 billing data for recycled water customers.
[b] New Opportunities are based on the findings of 2.9, Demand Analysis, from Table 3-3: Potential Single Pass RO Treated Water Customers Demand (Step 1), Table 3-5: Tier 1 and Tier 2 Target Customers Demand, Table 3-6: Potential Recycled Water Expansion Project Demands, and Table 3-7: Summary of Potential Demands.
[c] This opportunity includes expanding the existing West Basin Barrier flows by an average of 5 mgd. However, the MDD would increase by only 1.5 mgd to use the maximum capacity of the existing facilities of 17.5 mgd.
[d] The So Fi Stadium was constructed and became operational in 2020. For purposes of this Master Plan, this is considered a new opportunity, as existing demands were based on 2019 billing data, before the Stadium project was operational.
[e] Note that the volume of existing demands plus new opportunities is greater than the anticipated future capacity of the system, as the systemwide ADD target is 70 mgd and the maximum day capacity target is 85 mgd.

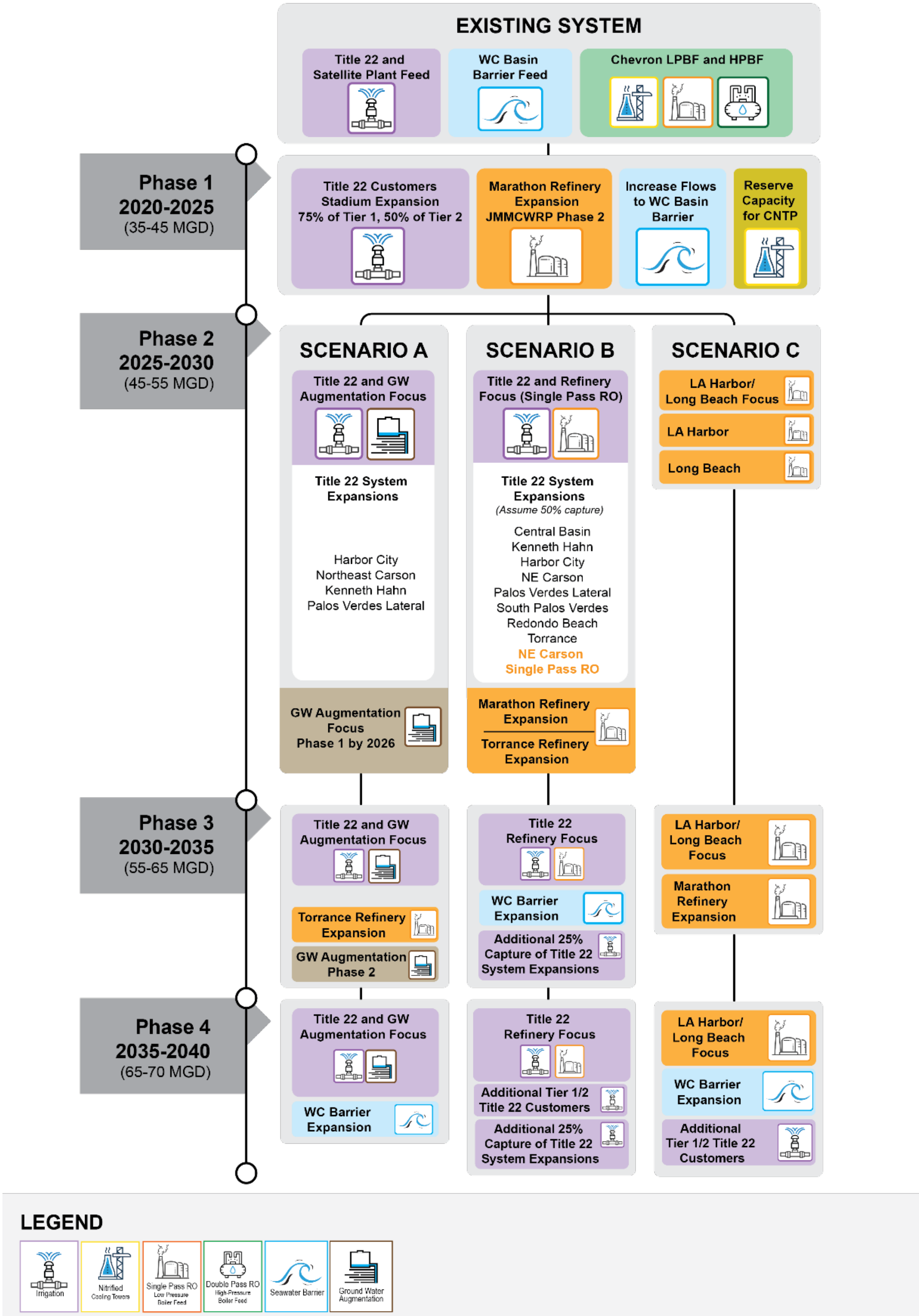
This future system analysis is organized into three alternative approaches to reaching the future 70 mgd demand target. These approaches are focused on the following themes:

- Scenario A – Title 22 and Groundwater Augmentation Focus
- Scenario B – Title 22 and Refinery Focus
- Scenario C – LA Harbor/Long Beach Focus

Each scenario is divided into four phases that delineate an approximate timeframe for implementation and generally occur in 5-year increments. Phase 1 is anticipated to occur from 2020 to 2024, while Phases 2, 3, and 4 are anticipated to occur from 2025 to 2029, 2030 to 2034, and 2035 to 2040, respectively. Phase 1 incorporates near-term improvements and is common to each scenario.

The phased expansion scenarios are illustrated in Figure 8-1 and are further described in subsequent sections. Note that the Santa Monica groundwater expansion project, listed in Table 8-1, was not forwarded as a project in the proposed scenarios presented in Figure 8-1, as there are more cost effective opportunities within West Basin's service area. However, if in the future West Basin desires to serve Santa Monica with Title 22 water, an increase in infrastructure capacity within the Kenneth Hahn expansion project would be required, as well as a 1.5-mile pipeline extension to the Santa Monica service area.

Figure 8-1. Proposed Phased Expansion Scenarios



8.2.1 Phase 1

Phase 1 is the common element amongst all three proposed scenarios.

This Phase 1 expansion would require an increase in treated recycled water from ECLWRF from an average day production of 34 mgd to 44 mgd to provide service to the following new customers:

- New SoFi Stadium, which became operational in 2020.
- 75 percent of the identified Tier 1 customers, which lie within 0.25 miles from the existing recycled water system.
- 50 percent of the identified Tier 2 customers, which lie between 0.25 and 0.50 miles from the existing recycled water system.
- An additional 1 mgd is reserved for expansion of the CNTP.

This phase also increases flow into the West Coast Barrier System by an average of 5 mgd; however, the MDD would increase by only 1.5 mgd to use the maximum capacity of the existing facilities of 17.5 mgd. This phase also expands the capacity for the JMMCRWRP (increase capacity by 2.5 mgd) to serve future demands at the adjacent refinery.

8.2.2 Scenario A – Title 22 and Groundwater Augmentation Focus

As shown in Figure 8-1, Scenario A focuses on expanding Title 22 customers and developing a new groundwater augmentation opportunity associated with the West Coast Basin groundwater system. It is anticipated that this project would take place in two phases at 10,000 afy each. WRD, in partnership with LADWP and others such as the City of Torrance, intends to develop a new program to remediate the West Coast Basin saline plume and use the water in the various potable water systems.

The purpose of this groundwater augmentation project is to remove the existing saline groundwater from the West Coast Basin over a 20- to 30-year period. The most likely sizes of this project would be 5,000, 10,000, or 20,000 afy of injection. Potential sources of water supply for this project could be advanced treated water from West Basin or from the planned advanced treatment at the JWPCP by the Los Angeles County Waterworks District and MWD. The project could be supplied by either one of the two sources or the supply might be split depending on price, timing, and availability of the water supply. If West Basin serves this project, it is likely that a new IPR advanced treatment facility (RO plus ultraviolet/advanced oxidation process [UV-AOP]) would be installed near the existing TRWRP. Phase 1 of this groundwater augmentation project would likely be accomplished by 2026.

Scenario A, Phase 2 also includes expansion of West Basin's Title 22 recycled water system in five areas: Central Basin, Harbor City, Kenneth Hahn, Northeast Carson, and Palos Verdes North. For this alternative, it was assumed that only 50 percent of the identified customers within these expansion areas would be captured. This phase increases recycled water production at ECLWRF to approximately 55 mgd and an MDD of 59 mgd.

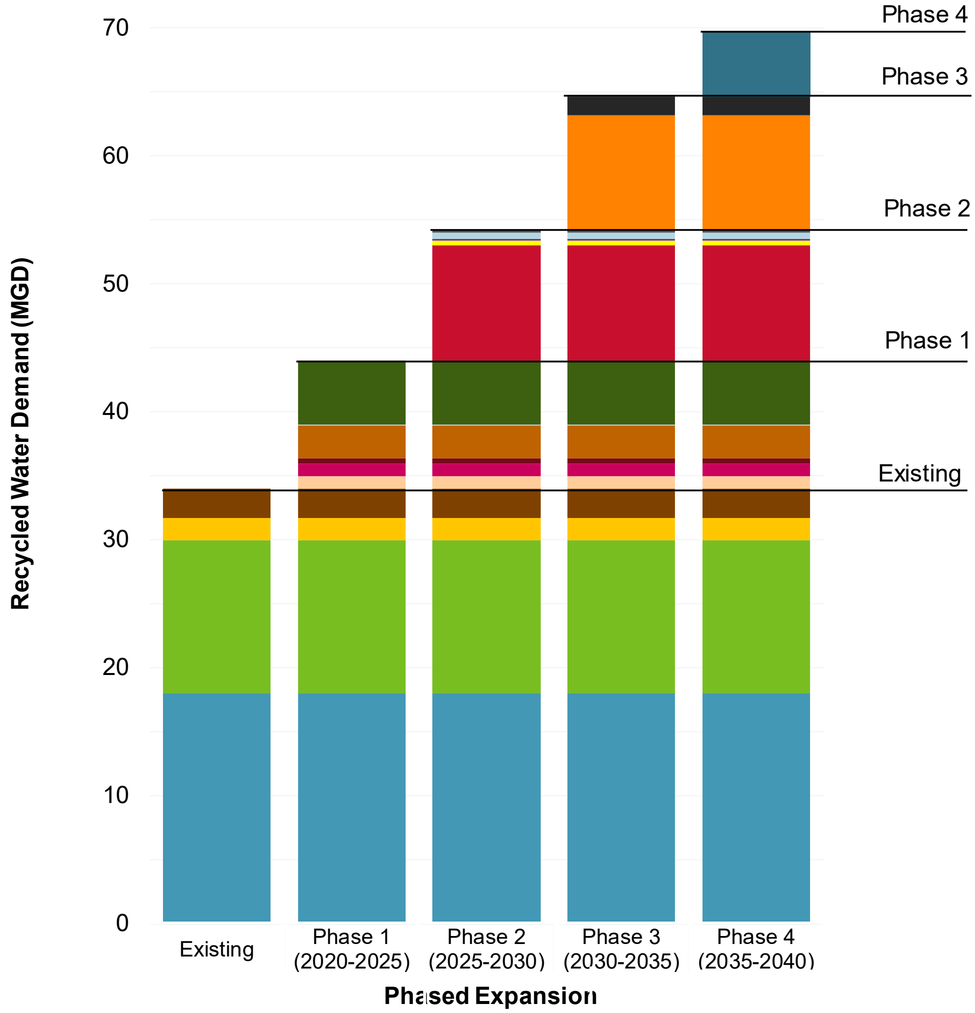
Scenario A, Phase 3 would include the delivery of an additional 10,000 afy for groundwater augmentation of the West Coast Basin and a 1.4 mgd expansion of the TRWRP single pass RO system. This phase increases recycled water production at ECLWRF to approximately 64 mgd and a maximum day demand of 74 mgd.

Scenario A, Phase 4 would add an additional average day demand of 5 mgd and an additional maximum day demand of 1.5 mgd to the West Coast Basin Barrier system to maximize the pipeline capacity of 22.5 mgd. This would require additional injection wells along the Barrier system or improvement of existing injection wells. This phase increases recycled water production at ECLWRF to approximately 70 mgd and supplies a maximum day demand of 79 mgd.

Figure 8-2 illustrates the increasing demands for the proposed phases of Scenario A. Figure 8-3 illustrates the overall flow system of Scenario A during Phase 4, as well as the anticipated maximum day volume of flows to the Title 22 distribution system and the Satellite Plants to accommodate the new customers proposed under Scenario A by 2040. The new facilities, indicated by the red line at TRWRP, include the construction of a new IPR system at the TRWRP site with a capacity of 17.9 mgd.

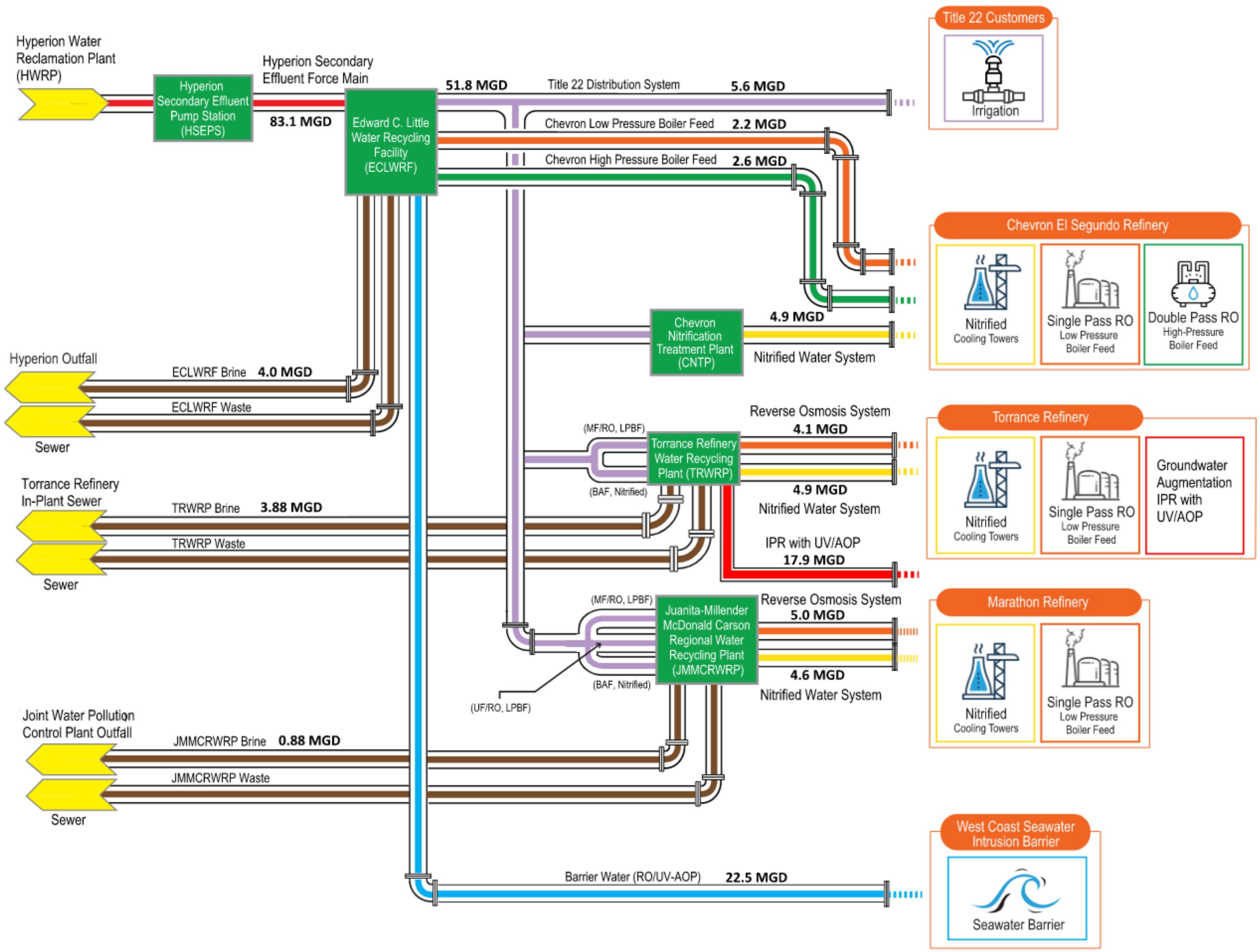
Table 8-2 presents the proposed average and maximum day capacities required for each treatment facility by phase. Proposed Increases in capacity, beyond existing production capacity, are indicated in red text.

Figure 8-2. Scenario A Average Day Demands



	Existing	Phase 1 (2020-2025)	Phase 2 (2025-2030)	Phase 3 (2030-2035)	Phase 4 (2035-2040)
WC Basin Barrier Feed Expansion					5.0
Torrance Refinery Expansion Single pass RO				1.4	1.4
Groundwater Augmentation Phase II				8.9	8.9
Palos Verdes North Expansion			0.2	0.2	0.2
NE Carson Expansion			0.5	0.5	0.5
Harbor City Expansion			0.1	0.1	0.1
Kenneth Hahn Expansion			0.3	0.3	0.3
Central Basin Expansion			0.1	0.1	0.1
Groundwater Augmentation Phase I			8.9	8.9	8.9
Increase Flows to WC Basin Barrier		5.0	5.0	5.0	5.0
Stadium Expansion		0.1	0.1	0.1	0.1
Marathon (JMMCWRP Phase 2 Expansion)		2.6	2.6	2.6	2.6
Tier 2 Cat 1 (Title 22) only - 50%		0.4	0.4	0.4	0.4
Tier 1 Cat 1 (Title 22) only - 75%		1.0	1.0	1.0	1.0
Reserve Capacity for CNTP		1.0	1.0	1.0	1.0
Chevron HPBF (Existing)	2.3	2.3	2.3	2.3	2.3
Chevron LPBF (Existing)	1.7	1.7	1.7	1.7	1.7
WC Basin Barrier Feed (Existing)	12.0	12.0	12.0	12.0	12.0
Title 22 and Satellite Plants (Existing)	18.0	18.0	18.0	18.0	18.0

Figure 8-3. West Basin Flow Schematic – Scenario A with Maximum Day Demands in 2040



[a] RO recovery is assumed 85%.
[b] Waste flow is assumed negligible at less than 0.1% of influent flow.

Table 8-2. Scenario A Treatment Facility Expansion Average and Max Day Production Capacity

Scenario A	Existing Production Capacity (mgd)		Phase 1 Production Capacity (mgd)		Phase 2 Production Capacity (mgd)		Phase 3 Production Capacity (mgd)		Phase 4 Production Capacity (mgd)	
Treatment Facility	**ADD**	**MDD[a]**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**
ECLWRF	34.0	62.4	44.0	52.0	54.2	63.3	64.6	74.3	69.5	79.1
Title 22 System	18.0	40.0	23.0	29.5	33.1	41.0	43.6	51.8	43.6	51.8
Barrier System	12.0	17.5	17.5	17.5	17.5	17.5	17.5	17.5	22.5	22.5
Chevron LPBF System	1.7	2.2	1.7	2.2	1.7	2.2	1.7	2.2	1.7	2.2
Chevron HPBF System	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6
CNTP Nitrified System	3.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
JMMCRWRP Nitrified System	1.0	1.3	3.5	4.6	3.5	4.6	3.5	4.6	3.5	4.6
JMMCRWRP Single Pass RO	3.4	5.0	3.4	5.0	3.4	5.0	3.4	5.0	3.4	5.0
Torrance Single Pass RO	2.2	3.2	2.2	3.2	2.2	3.2	3.6	4.1	3.6	4.1
Torrance IPR	NA	NA	NA	NA	8.9	8.9	17.9	17.9	17.9	17.9

[a] MDD Design Capacity based on information presented in Chapter 2.
[b] Red values indicate production capacity expansion beyond current production capacity.

8.2.3 Scenario B – Title 22 and Refinery Focus

As shown in Figure 8-1, Scenario B focuses on maximizing Title 22 customer opportunities and expanding service to the existing refineries within the West Basin service area.

In Phase 2, Scenario B includes expansion of West Basin's Title 22 recycled water system in nine areas: Central Basin, Harbor City, Kenneth Hahn, Northeast Carson, Palos Verdes North, Palos Verdes Lateral, Palos Verdes South, Redondo Beach and Torrance. For this phase, it was assumed that only 50 percent of the identified customers within these expansion areas would be captured.

Expansion of the demands for Nitrified water and single pass RO water at the adjacent refinery is anticipated to be 3.9 mgd and 4.0 mgd, respectively. Expansion of single pass RO demand at the Torrance Refinery is anticipated to be 1.4 mgd.

Scenario B, Phase 2 increases recycled water production at ECLWRF to approximately 56 mgd, and a maximum day demand of 70 mgd.

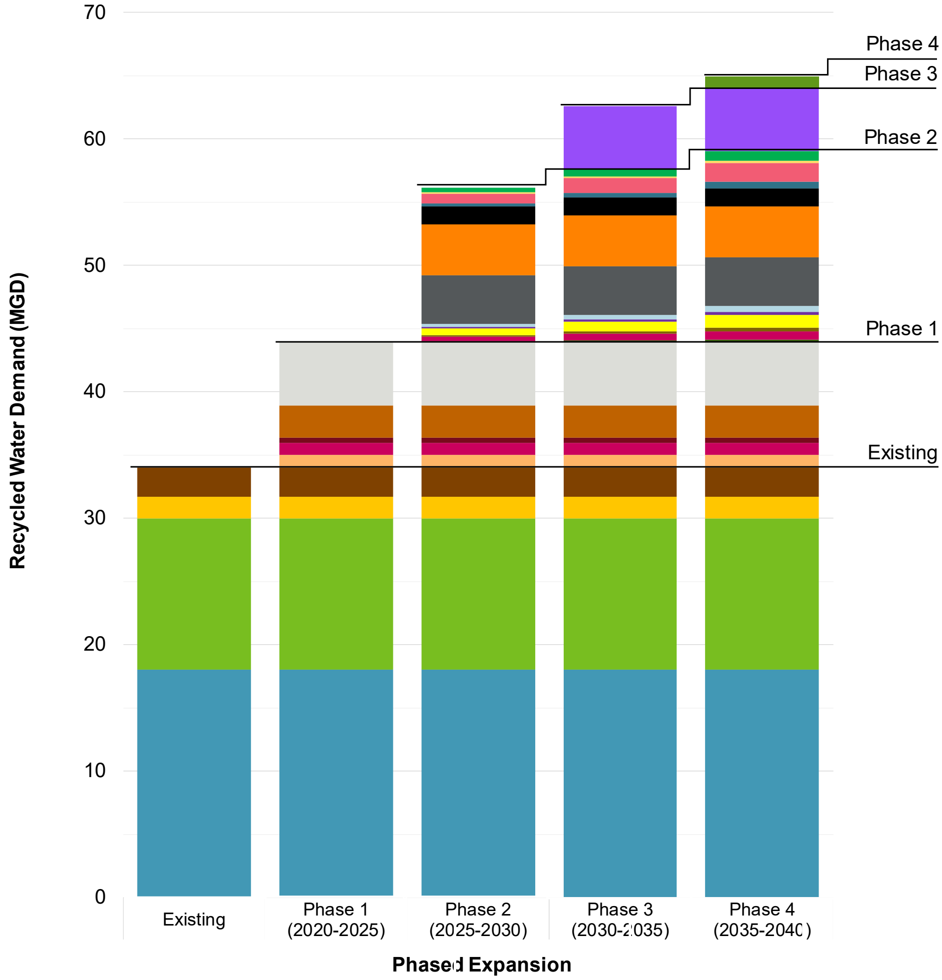
Scenario B, Phase 3 includes an additional 25 percent of the demand of the Title 22 system expansion is anticipated as well as an additional 5 mgd to the West Coast Basin Barrier system – to maximize the pipeline capacity of 22.5 mgd. This phase increases recycled water production at ECLWRF to approximately 63 mgd, and a maximum day demand of 78 mgd.

Scenario B, Phase 4 includes the remaining 25 percent of the demand of the Title 22 system expansion is anticipated as well as the balance of the Tier 1 and Tier 2 customers. This phase increases recycled water production at ECLWRF to approximately 65 mgd and supplies a maximum day demand of 82 mgd.

Figure 8-4 illustrates the increasing demands for the proposed phases of Scenario B. Figure 8-5 illustrates the overall flow system of Scenario A during Phase 4, as well as the anticipated maximum day volume of flows to the Title 22 distribution system and the Satellite Plants to accommodate the new customers proposed under Scenario B by 2040. The new facilities include the expansion of the single pass RO system at JMMCRWRP.

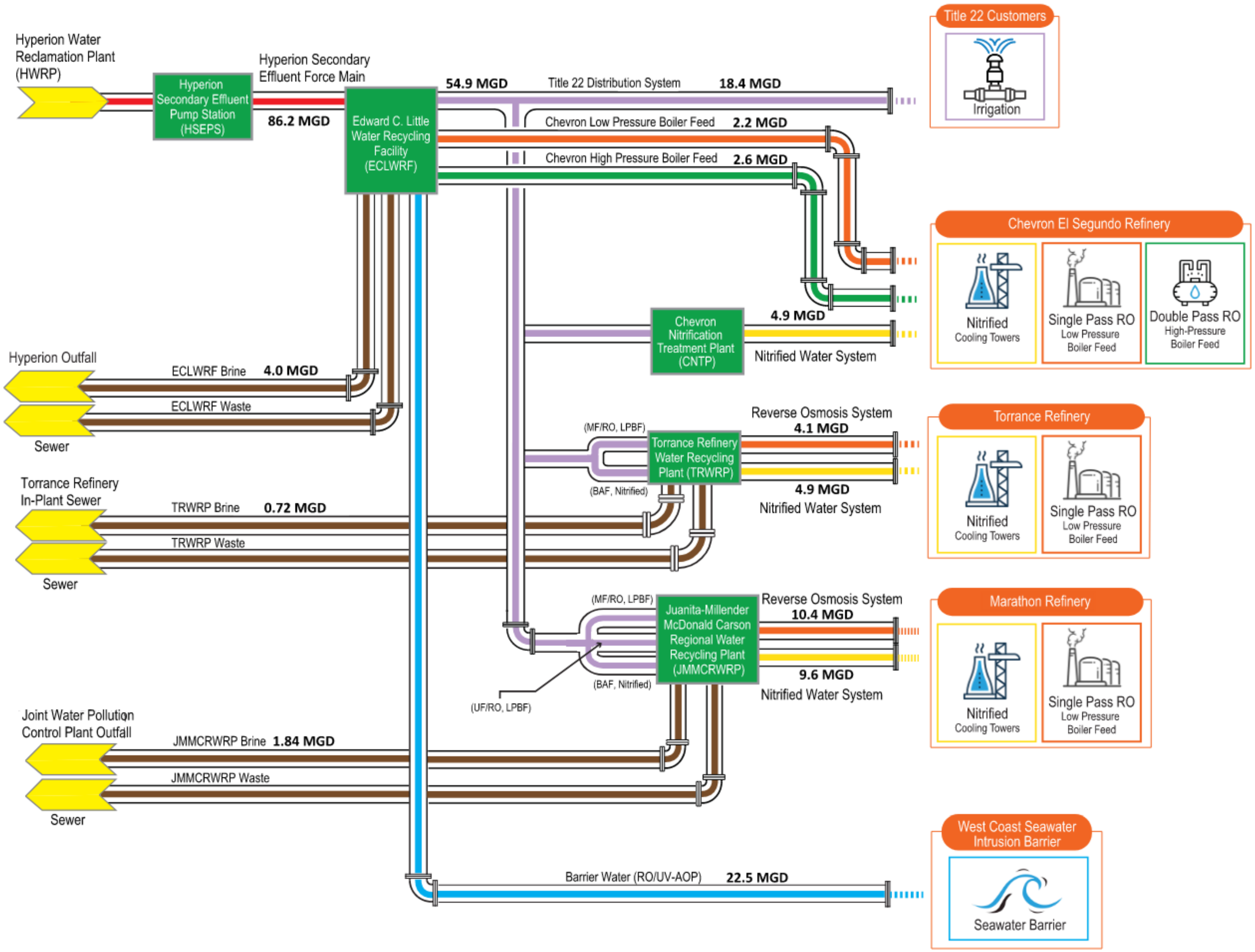
Table 8-3 presents the proposed average and maximum day capacities required for each treatment facility by phase. Proposed increases in capacity, beyond existing production capacity, are indicated in red text.

Figure 8-4. Scenario B Average Day Demands



	Existing	Phase 1 (2020-2025)	Phase 2 (2025-2030)	Phase 3 (2030-2035)	Phase 4 (2035-2040)
Additional Tier 1 and 2 Title 22 Customers					1.0
WC Basin Barrier Feed Expansion				5.0	5.0
Torrance Expansion			0.4	0.6	0.8
Redondo Beach Expansion			0.1	0.1	0.1
South Palos Verdes Expansion			0.8	1.2	1.5
Palos Verdes Lateral Expansion			0.2	0.4	0.5
Torrance Refinery Expansion Single pass RO			1.4	1.4	1.4
Marathon (Carson) Refinery Expansion Single pass RO			4.0	4.0	4.0
Marathon (Carson) Refinery Expansion Nitrified			3.9	3.9	3.9
Palos Verdes North Expansion			0.2	0.3	0.5
NE Carson Expansion (single pass RO)			0.1	0.2	0.2
NE Carson Expansion			0.5	0.8	1.0
Harbor City Expansion			0.1	0.2	0.3
Kenneth Hahn Expansion			0.3	0.5	0.7
Central Basin Expansion			0.1	0.1	0.2
Increase Flows to WC Basin Barrier		5.0	5.0	5.0	5.0
Marathon (JMMCWRP Phase 2 Expansion)		2.6	2.6	2.6	2.6
Tier 2 Cat 1 (Title 22) only - 50%		0.4	0.4	0.4	0.4
Tier 1 Cat 1 (Title 22) only - 75%		1.0	1.0	1.0	1.0
Reserve Capacity for CNTP		1.0	1.0	1.0	1.0
Chevron HPBF (Existing)	2.3	2.3	2.3	2.3	2.3
Chevron LPBF (Existing)	1.7	1.7	1.7	1.7	1.7
WC Basin Barrier Feed (Existing)	12.0	12.0	12.0	12.0	12.0
Title 22 and Satellite Plants (Existing)	18.0	18.0	18.0	18.0	18.0

Figure 8-5. West Basin Flow Schematic - Scenario B with Maximum Day Demands in 2040



[a] RO recovery is assumed 85%.
[b] Waste flow is assumed negligible at less than 0.1% of influent flow.

Table 8-3. Scenario B Treatment Facility Expansions Average and Max Day Production Capacity

Scenario B	Existing Production Capacity (mgd)		Phase 1 Production Capacity (mgd)		Phase 2 Production Capacity (mgd)		Phase 3 Production Capacity (mgd)		Phase 4 Production Capacity (mgd)	
Treatment Facility	**ADD**	**MDD[a]**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**
ECLWRF	34.0	62.4	44.0	52.0	56.2	69.8	62.7	77.7	65.1	82.4
Title 22 System	18.0	40.0	23.0	29.5	35.3	47.3	36.7	50.2	39.1	54.9
Barrier System	12.0	17.5	17.5	17.5	17.5	17.5	22.5	22.5	22.5	22.5
Chevron LPBF System	1.7	2.2	1.7	2.2	1.7	2.2	1.7	2.2	1.7	2.2
Chevron HPBF System	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6
CNTP Nitrified System	3.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
JMMCRWRP Nitrified System	1.0	1.3	3.5	4.6	7.4	9.6	7.4	9.6	7.4	9.6
JMMCRWRP Single Pass RO	3.4	5.0	3.4	5.0	7.5	10.4	7.6	10.4	7.6	10.4
Torrance Single Pass RO	2.2	3.2	2.2	3.2	3.6	4.1	3.6	4.1	3.6	4.1
Torrance IPR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] MDD Design Capacity based on information presented in Chapter 2.
[b] Red values indicate production capacity expansion from that of existing.

8.2.4 Scenario C – Title 22 and LA Harbor/Long Beach Focus

As shown in Figure 8-1, Scenario C focuses on capturing Tier 1 and Tier 2 Title 22 customer opportunities and serving advanced treated water (single pass RO) to industrial customers in the Los Angeles (LA) Harbor and Long Beach area via the JMMCRWRP.

Scenario C, Phase 2 sends 10 mgd of single pass RO water to the LA Harbor and Long Beach area via a pipeline connection to the LADWP system, south of the JMMCRWRP. This phase increases recycled water production at ECLWRF to approximately 54 mgd, and a maximum day demand of 64 mgd and expansion of the JMMCRWRP single pass RO treatment system.

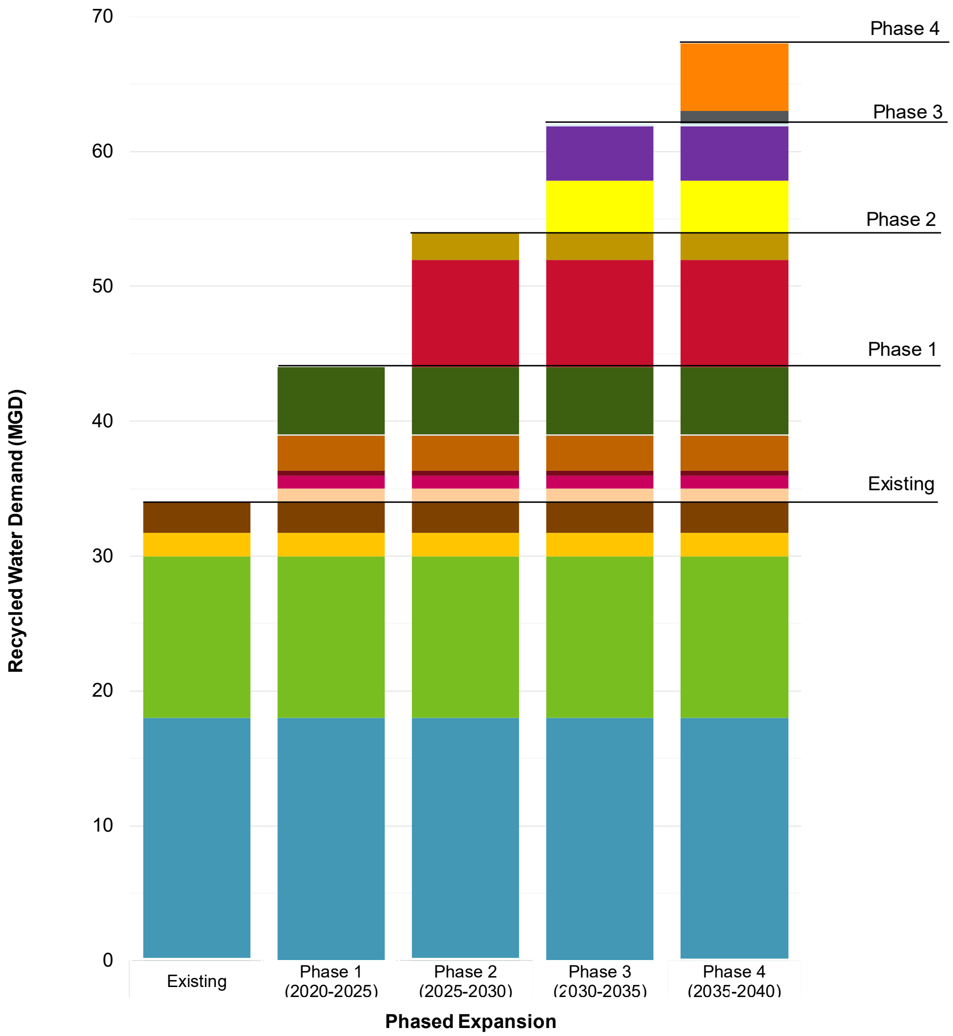
Scenario C, Phase 3 includes expansion of the demands for Nitrified water and single pass RO water at the Marathon Refinery is anticipated to be 3.9 mgd and 4.0 mgd, respectively. Expansion of single pass RO demand at the Torrance Refinery is anticipated to be 1.4 mgd. This phase increases recycled water production at ECLWRF to approximately 62 mgd, and a maximum day demand of 75 mgd.

Scenario C, Phase 4 includes an additional 5 mgd to the West Coast Basin Barrier system, to maximize the pipeline capacity of 22.5 mgd, as well as the balance of the Tier 1 and Tier 2 customers. This phase increases recycled water production at ECLWRF to approximately 68 mgd and supplies a maximum day demand of 82 mgd.

Figure 8-6 illustrates the increasing demands for the proposed phases of Scenario C. Figure 8-7 illustrates the overall flow system of Scenario C during Phase 4, as well as the anticipated maximum day volume of flows to the Title 22 distribution system and the Satellite Plants to accommodate the new customers proposed under Scenario C by 2040.

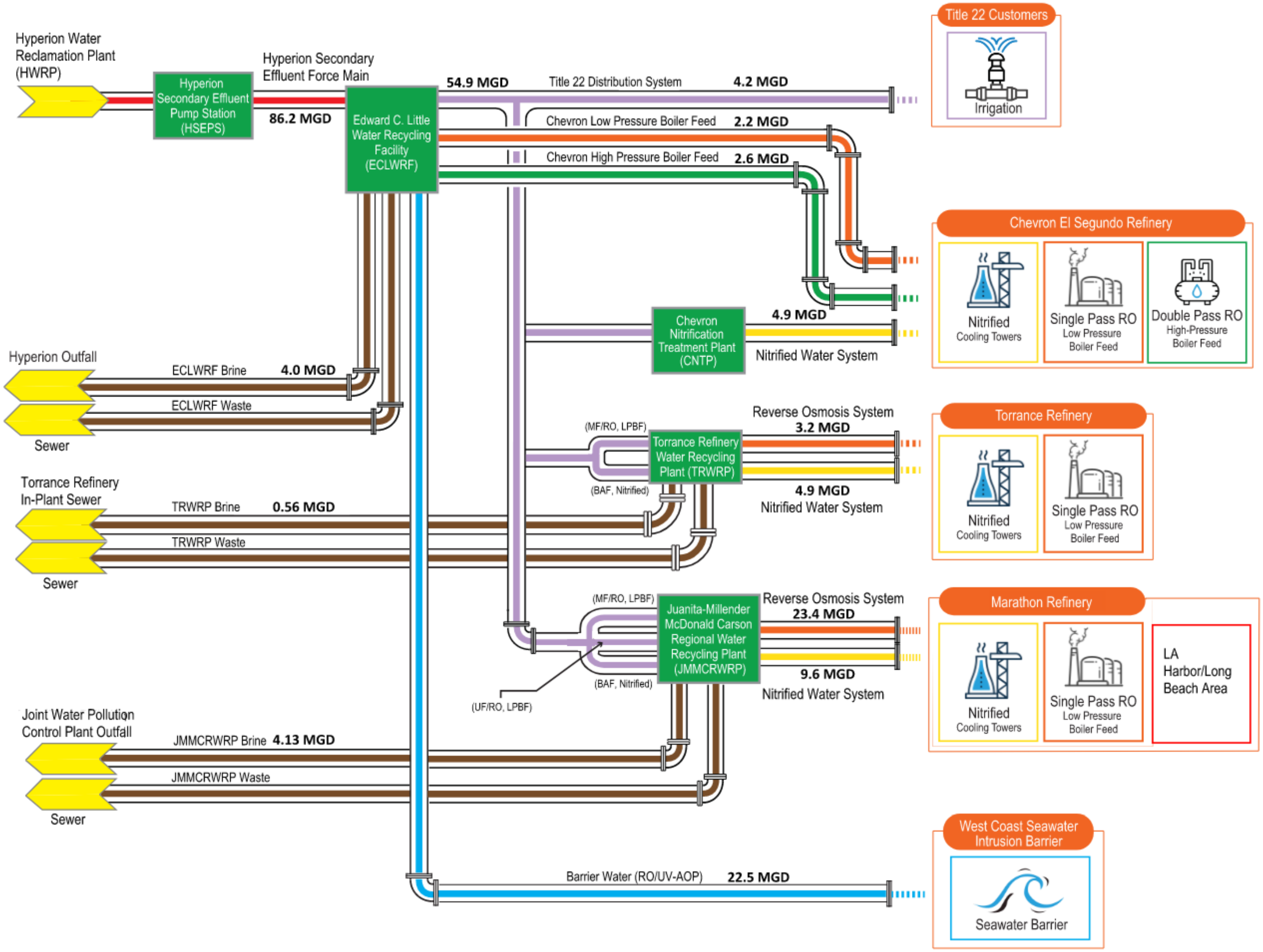
Table 8-4 presents the proposed average and maximum day capacities required for each treatment facility by phase. Proposed Increases in capacity, beyond existing production capacity, are indicated in red text.

Figure 8-6. Scenario C Average Day Demands



	Existing	Phase 1 (2020-2025)	Phase 2 (2025-2030)	Phase 3 (2030-2035)	Phase 4 (2035-2040)
WC Basin Barrier Feed Expansion					5.0
Additional Tier 1 and 2 Title 22 Customers					1.0
NE Carson Expansion (single pass RO)				0.2	0.2
Marathon (Carson) Refinery Expansion Single pass RO				4.0	4.0
Marathon (Carson) Refinery Expansion Nitrified				3.9	3.9
Long Beach (single pass RO)			2.0	2.0	2.0
LA Harbor (single pass RO)			8.0	8.0	8.0
Increase Flows to WC Basin Barrier		5.0	5.0	5.0	5.0
Stadium Expansion		0.1	0.1	0.1	0.1
Marathon (JMMCWRP Phase 2 Expansion)		2.6	2.6	2.6	2.6
Tier 2 Cat 1 (Title 22) only - 50%		0.4	0.4	0.4	0.4
Tier 1 Cat 1 (Title 22) only - 75%		1.0	1.0	1.0	1.0
Reserve Capacity for CNTP		1.0	1.0	1.0	1.0
Chevron HPBF (Existing)	2.3	2.3	2.3	2.3	2.3
Chevron LPBF (Existing)	1.7	1.7	1.7	1.7	1.7
WC Basin Barrier Feed (Existing)	12.0	12.0	12.0	12.0	12.0
Title 22 and Satellite Plants (Existing)	18.0	18.0	18.0	18.0	18.0

Figure 8-7. West Basin Flow Schematic - Scenario C with Maximum Day Demands in 2040



[a] RO recovery is assumed 85%.
[b] Waste flow is assumed negligible at less than 0.1% of influent flow.

Table 8-4. Scenario C Treatment Facility Expansions Average and Max Day Production Capacity

Scenario C	Existing Production Capacity (mgd)		Phase 1 Production Capacity (mgd)		Phase 2 Production Capacity (mgd)		Phase 3 Production Capacity (mgd)		Phase 4 Production Capacity (mgd)	
Treatment Facility	**ADD**	**MDD[a]**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**	**ADD**	**MDD**
ECLWRF	34.0	62.4	44.0	52.0	54.0	65.0	61.9	75.4	68.0	82.4
Title 22 System	18.0	40.0	23.0	29.5	33.0	42.5	41.0	52.9	42.0	54.9
Barrier System	12.0	17.5	17.5	17.5	17.5	17.5	17.5	17.5	22.5	22.5
Chevron LPBF System	1.7	2.2	1.7	2.2	1.7	2.2	1.7	2.2	1.7	2.2
Chevron HPBF System	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6	2.3	2.6
CNTP Nitrified System	3.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
JMMCRWRP Nitrified System	1.0	1.3	3.5	4.6	3.5	4.6	7.4	9.6	7.4	9.6
JMMCRWRP Single Pass RO	3.4	5.0	3.4	5.0	13.4	17.9	17.5	23.4	17.6	23.4
Torrance Single Pass RO	2.2	3.2	2.2	3.2	2.2	3.2	2.2	3.2	2.2	3.2
Torrance IPR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] MDD Design Capacity based on information presented in Chapter 2.
[b] Red values indicate production capacity expansion from that of existing.

8.3 Future Treatment Process Alternatives

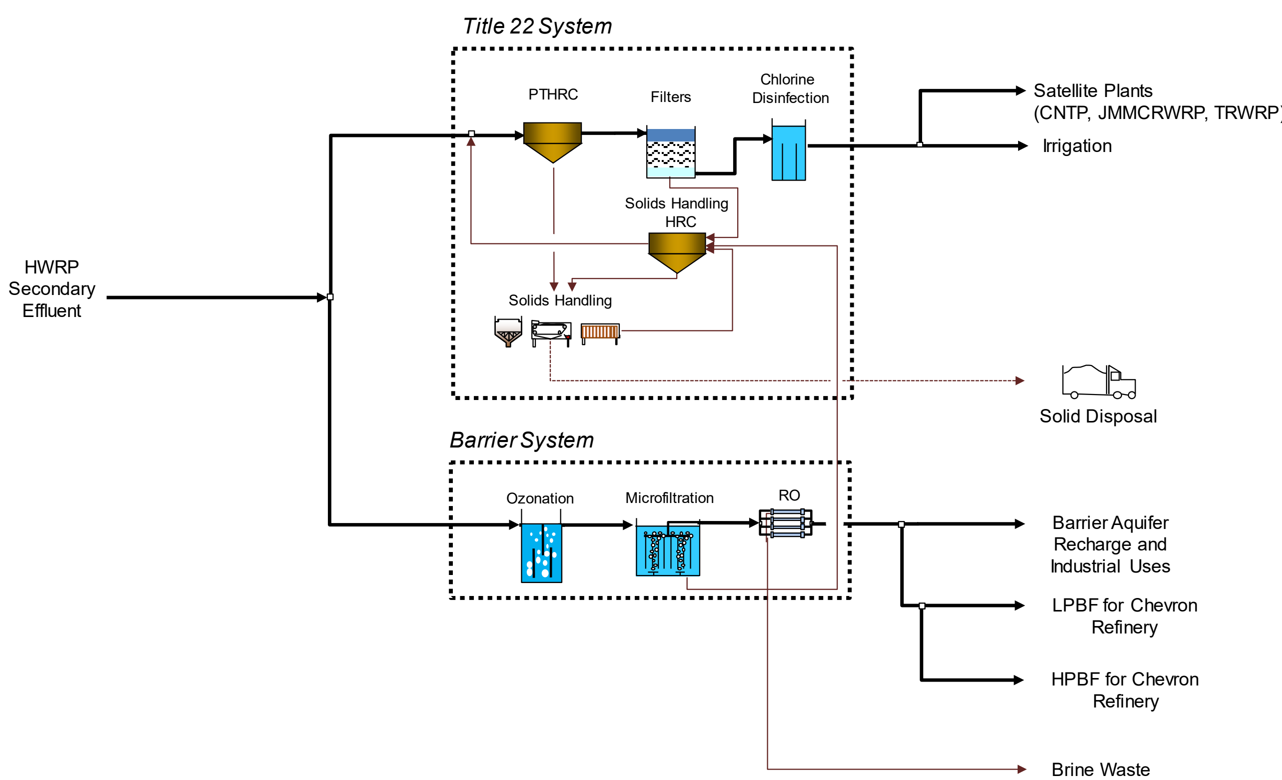
This section discusses the future treatment process alternatives identified for each facility to improve operations or to fulfill demands under the scenarios described in Section 8.2. ECLWRF Title 22 System, ECLWRF Barrier System, and JMMCRWRP Nitrification System require expansion. The CNTP, Chevron HPBF and Chevron LPBF systems remain at existing capacities. The alternatives discussed in this section are compared and evaluated in Section 8.4.

Details describing the existing treatment processes at each facility are described in Chapter 2. Operational improvements and Rehabilitation & Replacement Program (R&R) improvements, identified in Chapter 4, based on site visits to JMMCRWRP, CNTP and TRWRP, are not reiterated in this chapter.

8.3.1 ECLWRF Process Optimization Options

Process optimization options are analyzed to determine the extent in which improvements to the Title 22 and Barrier System processes at ECLWRF would yield water quality improvement and/or cost savings. For comparison to the proposed options, the existing Title 22 and Barrier System process flow diagram at ECLWRF is illustrated in Figure 8-8.

Figure 8-8. ECLWRF Existing System – Title 22 and Barrier System Diagram



Three process optimization options at ECLWRF are discussed as follows:

1. Convey Title 22 Product Water to Barrier System
2. Move Pre-Ozonation Ahead of Title 22 System
3. Send Solids to Sewer

The operational optimization improvements presented in this section derive from recommendations summarized in Chapter 4, after identifying process concerns during a site visit in June 2020. To simplify this analysis, expansion is not considered, and the proposed improvements are not carried over to ECLWRF expansion alternatives in Section 8.3.2 nor Section 8.3.3. In addition, these alternatives are not exclusive to one another; therefore, the improvements are considered “options”. Improvements can either be implemented near term (5 to 10 years) or long-term (20 years). The duration is dependent upon the potential implementation of tMBR at HWRP and the extent of water quality improvement into ECLWRF.

Optimization Option 1 – Convey Title 22 Product Water to Barrier System

Historically, occasional spikes in total suspended solids and total organic carbon within the HWRP secondary effluent have caused issues at the MF units. Small dissolved organics are consumed by long chain molecules, in which the long chain molecules irreversibly foul the MF membranes. In addition, the water becomes cloudy and unattractive to use as recycled water.

To mitigate this issue, Optimization Option 1 reroutes the product flow from Title 22 System through a constructed 36-inch diameter pipeline to ahead of the MF strainer. This takes advantage of the pressure in the Title 22 pipeline to drive flow through the strainers. Furthermore, this reduces the solids loading to the MF units, consequentially reducing the frequency of MF membrane cleaning and O&M costs and increasing the MF membrane efficiency. Ozonation ahead of the MF system is eliminated, since it is intended to reduce fouling in the MF membrane.

Currently, ECLWRF conducts clean-in-place maintenance about once every three weeks and recovery clean in place about three times a year on each MF rack. The reduced number of clean in place from implementing this option is compared to that at the Satellite Plants, which also receive Title 22 Distribution System product water. At the Satellite Plants, the number of maintenance clean in place is about once every four weeks, and recovery CIP is about once a year. Therefore, maintenance clean in place is estimated to reduce from around 17 routines per rack a year down to 13 per rack a year, while recovery clean in place is estimated to be reduced from around three routines a year per rack down to one routine a year per rack.

Depending on the demands on the Title 22 system, the MF membranes could receive either 100% Title 22 effluent or a blend of Title 22 and HWRP effluents. A conceptual layout showing the proposed piping change is presented in Figure 8-9, and the process flow diagram is illustrated in Figure 8-10.

Figure 8-9. Optimization Option 1 – Conceptual Layout of Piping Addition

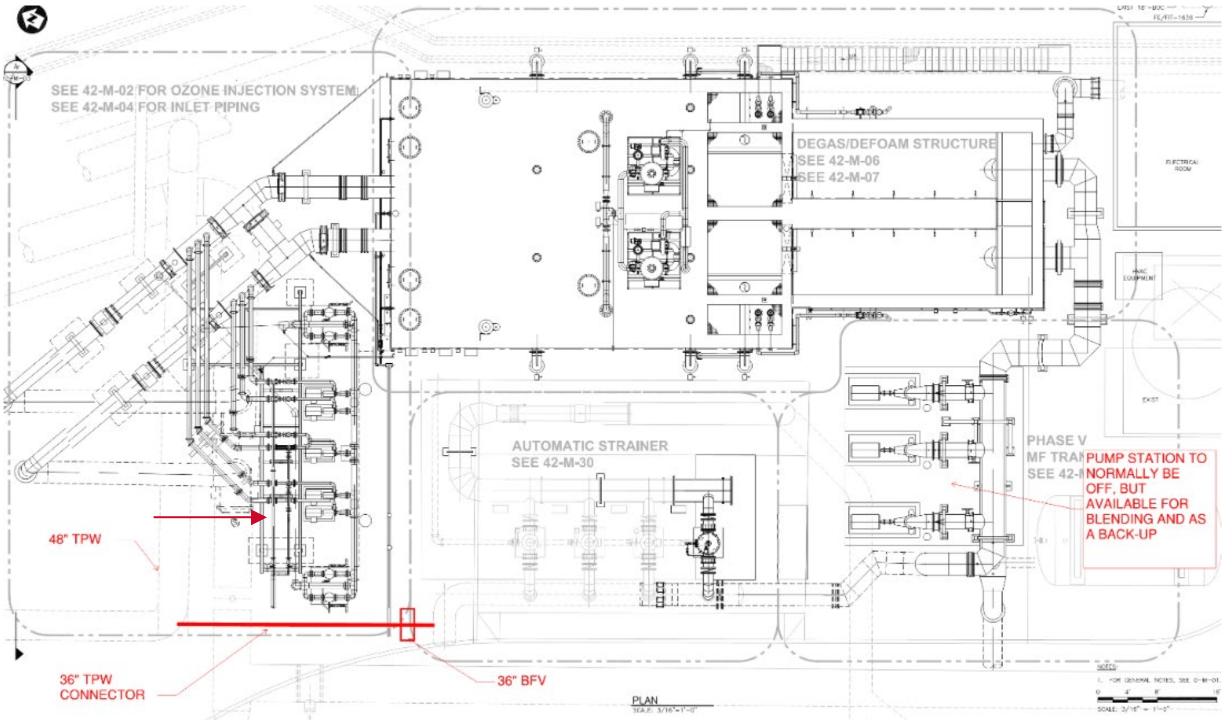
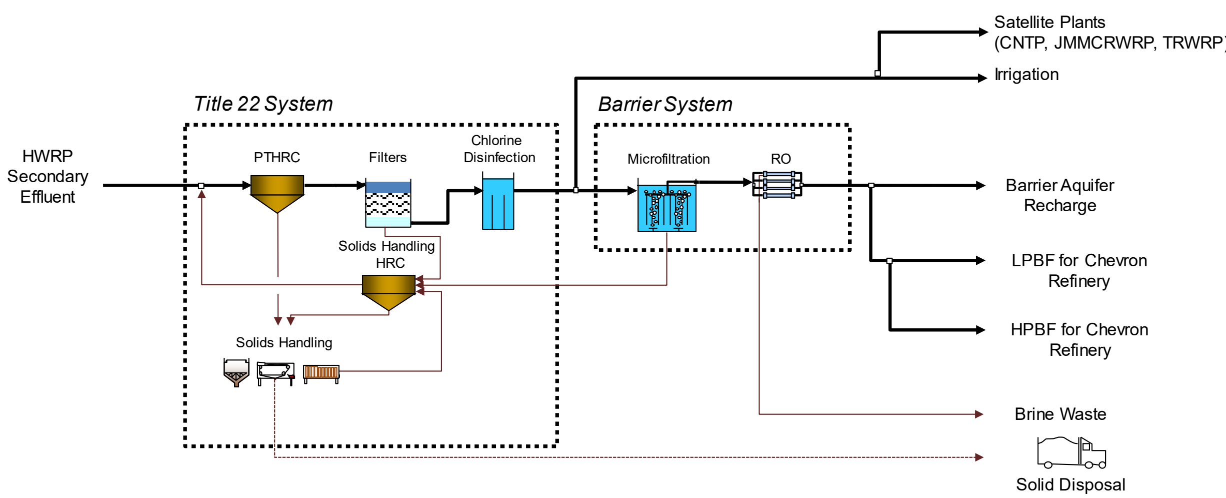


Figure 8-10. Optimization Option 1 – Process Flow Diagram



Optimization Option 2 – Move Ozonation from MF to Ahead of Title 22 System

From operating ozone over five years, West Basin determined that higher ozone doses increased breakthrough of TOC, which caused TOC excursions in RO permeate for the Barrier System and increased formation of N-Nitrosodimethylamine. To control this issue, ozone doses are currently maintained around 4 mg/L. During the two years when higher ozone dose was use, there were inconclusive data that supports improvement in membrane performance and reduction in membrane cleanings for PP membranes. Since conversion to the PVDF MF membranes, no apparent benefit of preozonation has been observed. West Basin will be conducting study in the coming year to determine whether the current MF systems, which are all fitted with PVDF MF modules, will have any impacts to operations of both the Barrier and Chevron boiler feed systems. This alternative reroutes current ozonation process ahead of the MF membranes to ozonate ahead of the Title 22 pretreatment system. Ozonation ahead of the Title 22 System potentially reduces the required coagulant dose, removes additional TOC, and reduces color by biodegradation in the media filters (biological filtration). Chlorine would be fed downstream of biological filtration to not interfere with the biological process.

A 36-inch bypass pipeline connects the existing ozone flash reactors at the Barrier System to an isolation butterfly valve on the existing 60-inch secondary effluent line downstream. The existing 60-inch secondary effluent pipeline serves as an ozone pipe contactor prior to the existing Pretreatment High Rate Clarifiers (PTHRC) Densadeg units. A second 36-inch bypass line would be constructed to convey non-ozonated HWRP secondary effluent to the MF feed pump station. A conceptual layout of the proposed piping change is presented in Figure 8-11, and the process flow diagram illustrated in Figure 8-12.

Bench scale and/or pilot testing is recommended to confirm the required ozone dose and likely reduction of coagulant dose. The proposed operating strategy will be to add ozone as needed to satisfy the demand and decay in the pipe contactor and to have a zero ozone residual at the PTHRC Densadegs.

Figure 8-11. Optimization Option 2 – Conceptual Layout of Piping Changes for Ozonation Ahead of Title 22 Pretreatment System

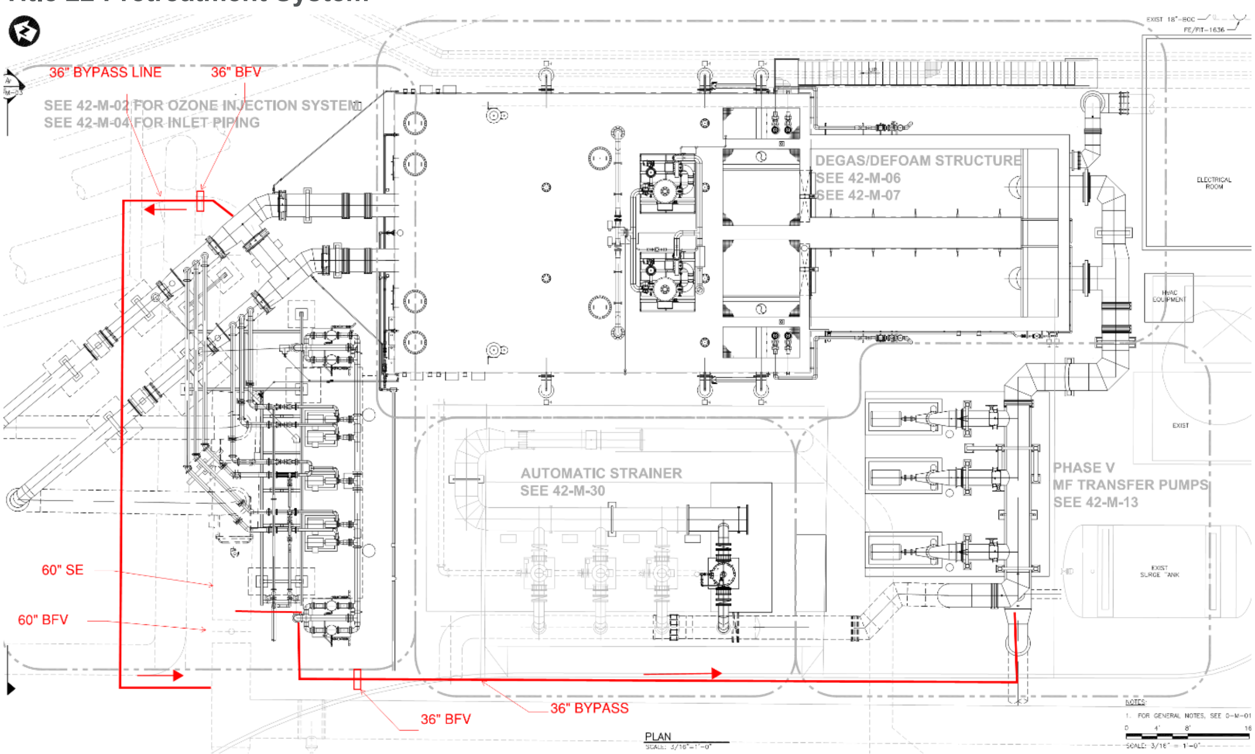
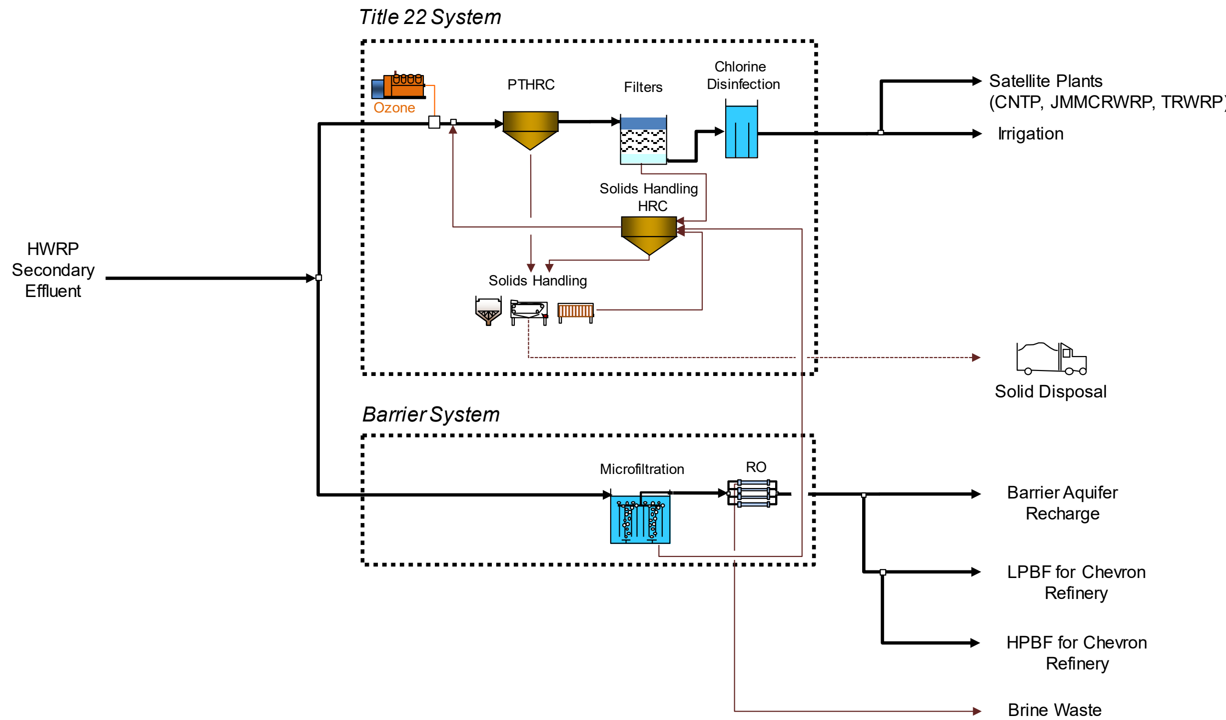


Figure 8-12. Optimization Option 2 – Process Flow Diagram



Optimization Option 3 – Send Solids from Gravity Belt Thickeners to Sewer

This optimization option discontinues operating the mechanical dewatering systems and discharges the solids from the gravity belt thickeners to the sewer. Benefits include repurposing or demolishing the existing solids handling building to free up space at ECLWRF for future expansions.

West Basin is currently performing a Solids Handling Improvement Feasibility Study to evaluate industrial waste discharge alternatives for recycling water solids at ECLWRF. One alternative investigates the potential of adding the solids waste stream to ECLWRF's existing industrial waste discharge permit with the LACSD's Joint Water Pollution Control Plant. The existing industrial waste discharge permit is utilized for the discharge of clean in place wastes from membrane cleanings associated with the MF and RO processes at the ECLWRF. The other alternative evaluates the discharge of the concentrated solids waste stream from the Gravity Belt Thickeners, which consolidates solids to approximately 6% solids, into the sewer with the MF and RO clean in place waste streams. Depending on the results of the Solids Handling Improvement Feasibility Study, West Basin may replace the existing plate and frame filter press system that is antiquated and at the end of its useful life with centrifuges for dewatering or stop thickening and handling of solids altogether at ECLWRF.

For these waste streams to be acceptable to the LACSD, which collects waste streams from HWRP, the various waste streams must be tested and characterized for various water quality parameters. West Basin is working with a consultant to develop a sampling and analysis plan. A technical report summarizing the data and determining the suitability for discharge to the LACSD sewer collection system is anticipated to be completed in spring of 2021 and submitted to LACSD for review.

8.3.2 ECLWRF Barrier System Expansion

Based on the Barrier System MDD values for Scenario A, B, and C from Table 8-2, Table 8-3, and Table 8-4, respectively, Scenarios A and C require 5 mgd expansion for both MF (PVDF) and RO in Phase 4, while that for Scenario B requires expansion in Phase 3. The MF expansion applies for ECLWRF Title 22 System Alternatives 1 to 3, while the RO expansion applies for all ECLWRF Title 22 System alternatives in Section 8.3.3. MF membranes are proposed to be installed at the location. These new MF membranes are proposed to be installed at the location of the existing Phase 2 and 3 MF building, where equipment is currently idle. New RO membrane trains are proposed to be installed in the available space along the east side of the property. New feed transfer pumps, cartridge filters, and high-pressure feed pumps would also be installed. The proposed layout of the new facilities is shown in Figure 8-13. The existing 18-inch RO concentrate pipeline appears to have sufficient capacity for the anticipated increased brine flows.

Figure 8-13. ECLWRF Barrier Expansion Proposed Site Layout

8.3.3 ECLWRF Title 22 System Expansion Alternatives

Given the existing maximum day Title 22 production capacity is rated 40 mgd, and based on ECLWRF Title 22 System MDD values for Scenario A, B, and C from Table 8-2, Table 8-3, and Table 8-4, respectively, Scenario A requires an overall expansion of 11.8 mgd, while Scenario B and C requires an overall expansion of 14.9 mgd.

At ECLWRF, four expansion process improvement alternatives for the Title 22 System are discussed as follows:

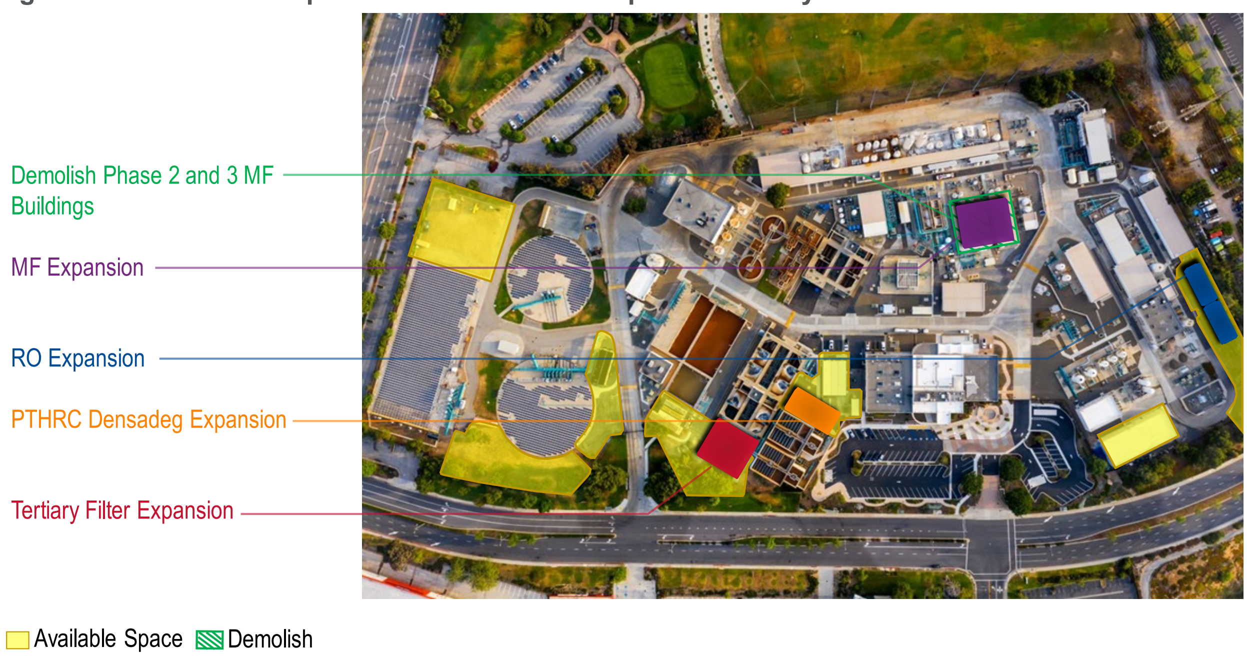
a. Expand with PTHRC Densadeg and Filter
b. Expand with tMBR
c. Expand and Replace with tMBR
d. Expand and Replace Title 22 and MF with tMBR

Refer to Appendix L for an overview on tMBR design and Appendix M for process flow balance schematics.

Expansion Alternative 1 – Expand with PTHRC Densadeg and Filter

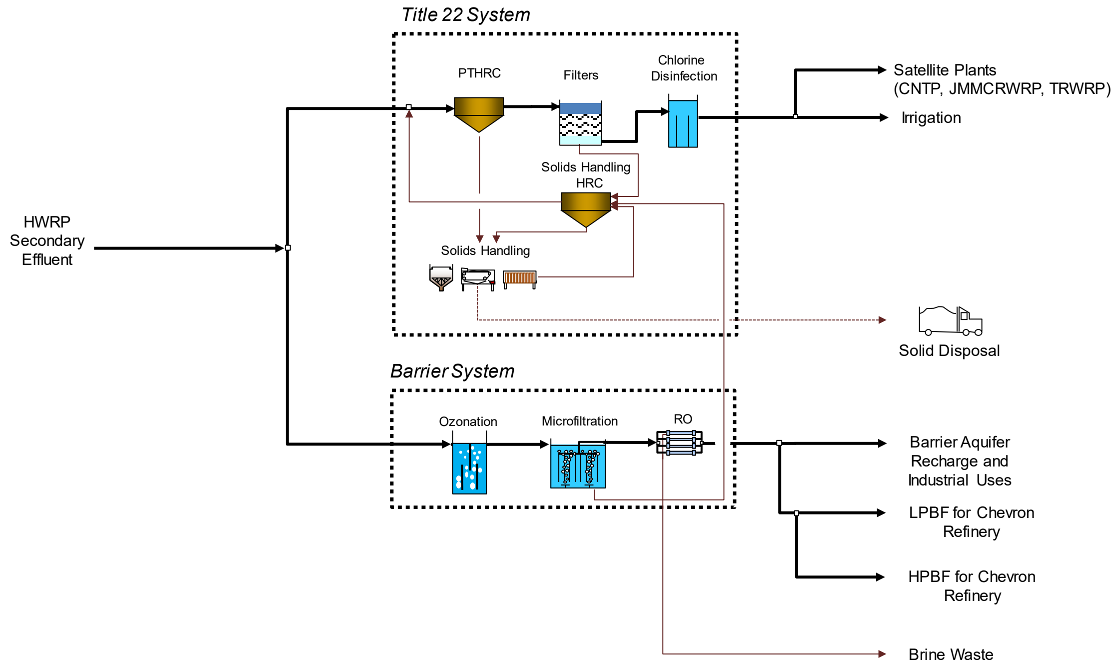
This alternative expands the Title 22 System with filters and PTHRC Densadeg, which are two process units currently operated at ECLWRF. For planning purposes, it is assumed that the Title 22 System will be expanded with the installation of a third 20 mgd PTHRC Densadeg unit and additional mono-media anthracite filters in 5 mgd increments to achieve a capacity of 55 mgd. For Scenario A and C, 5 mgd of filter and 20 mgd PTHRC Densadeg are constructed during Phase 3, while 10 mgd of filter capacity is constructed during Phase 3. For Scenario B, 10 mgd of filter capacity and 20 mgd PTHRC Densadeg is constructed in Phase 2, while 5 mgd of filter capacity is constructed in Phase 3. The proposed site layout of the new facilities is shown in Figure 8-14, and the process flow diagram is illustrated in Figure 8-15.

Figure 8-14. ECLWRF Expansion Alternative 1 Proposed Site Layout



Note:
[a] MF and RO expansion, described in Section 8.3.2, are also illustrated.

Figure 8-15. Expansion Alternative 1 – Process Flow Diagram



Note:
[a] The process flow diagram is similar to that of the existing, as shown in Figure 8-8. The difference is expansion of filters and one additional PTHRC Densadeg at ECLWRF.

Expansion Alternative 2 – Expand with tMBR

This alternative expands the Title 22 System with 5 mgd tMBR modules to improve quality of Title 22 Product by reducing the ammonia, TOC, and turbidity levels. Furthermore, tMBR can handle BOD and turbidity spikes from HWRP secondary effluent better than PTHRC Densadeg and can reduce coagulation addition, which results in net reduction in solids generation.

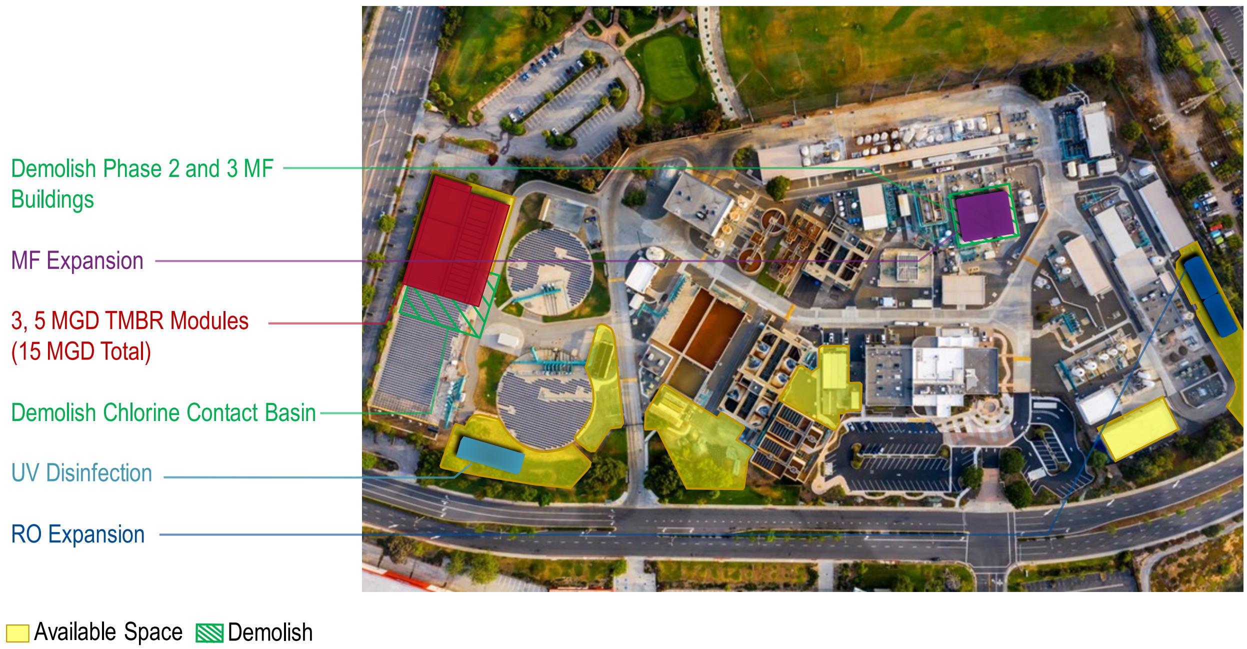
For Scenario A and C, one 5 mgd tMBR module is constructed during Phase 3, while two 5 mgd tMBR modules are constructed during Phase 3 for a total of 15 mgd tMBR. For Scenario B, two 5 mgd tMBR modules are constructed in Phase 2, while one 5 mgd tMBR module is constructed in Phase 3. The proposed site layout of the new facilities is shown in Figure 8-16, and the process flow diagram is illustrated in Figure 8-17.

To make space for the tMBR trains and to provide added disinfection capacity, this alternative first demolishes most of the existing chlorine contact basin and repurposes the remaining portion to install an in-channel ultraviolet (UV) disinfection system. Besides freeing up space on the site, the UV system has the added benefit of reducing the required chlorine dosage from around 25 mg/L to 5 mg/L. The existing solar panels on the chlorine contact basin will need to be relocated to another roof space in the plant.

The proposed layout of the new UV facility included a total of 3 channels that are 6 feet wide by 60 feet long and 7.5 feet deep, as shown in Figure 8-18. The UV system will fit in the southern 30 feet of the existing chlorine contact basin. Additional space is available, should further expansion of the UV system be needed. The remaining portion of the chlorine contact basin, not used for tMBRs, can continue to be used for chlorine contact. A budget proposal and brochure for the proposed in-channel UV equipment are presented in Appendix N.

The quantity of solids generated by the tMBRs will be less than that from the PTHRC Densadeg. The tMBR wastes solids as mixed liquor with a solids concentration in the range of 0.35 to 0.5% TSS. For this alternative, it is estimated that 15 mgd tMBR generates approximately 0.1 mgd of solids, whereas PTHRC Densadeg would generate approximately 1.25% of the Title 22 Product flow, or 0.55 mgd of solids in Year 2040. The flow from the equivalent 15 mgd Densadeg capacity would be 1.25% of 15 mgd, or 0.19 mgd. The solids handling system is designed for 60 mgd of Densadeg capacity. Therefore, no changes to the solids handling system are required.

Figure 8-16. ECLWRF Expansion Alternative 2 Proposed Site Layout



Notes:
[a] MF and RO expansion, described in Section 8.3.2, are also illustrated.

Figure 8-17. ECLWRF Expansion Alternative 2 – Process Flow Diagram

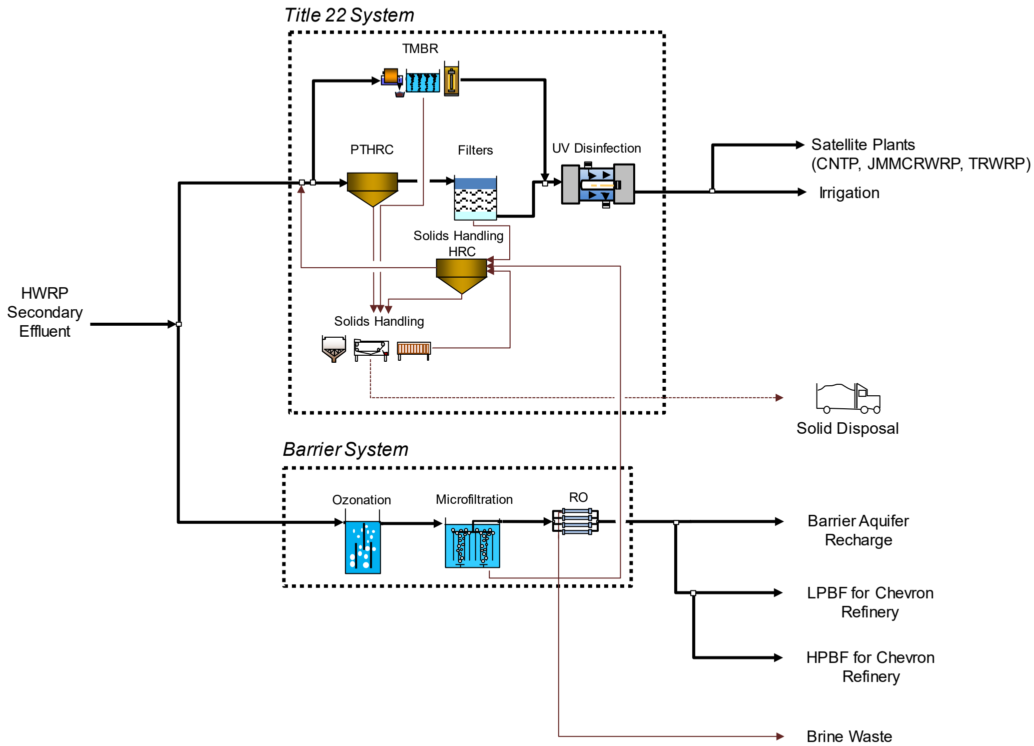
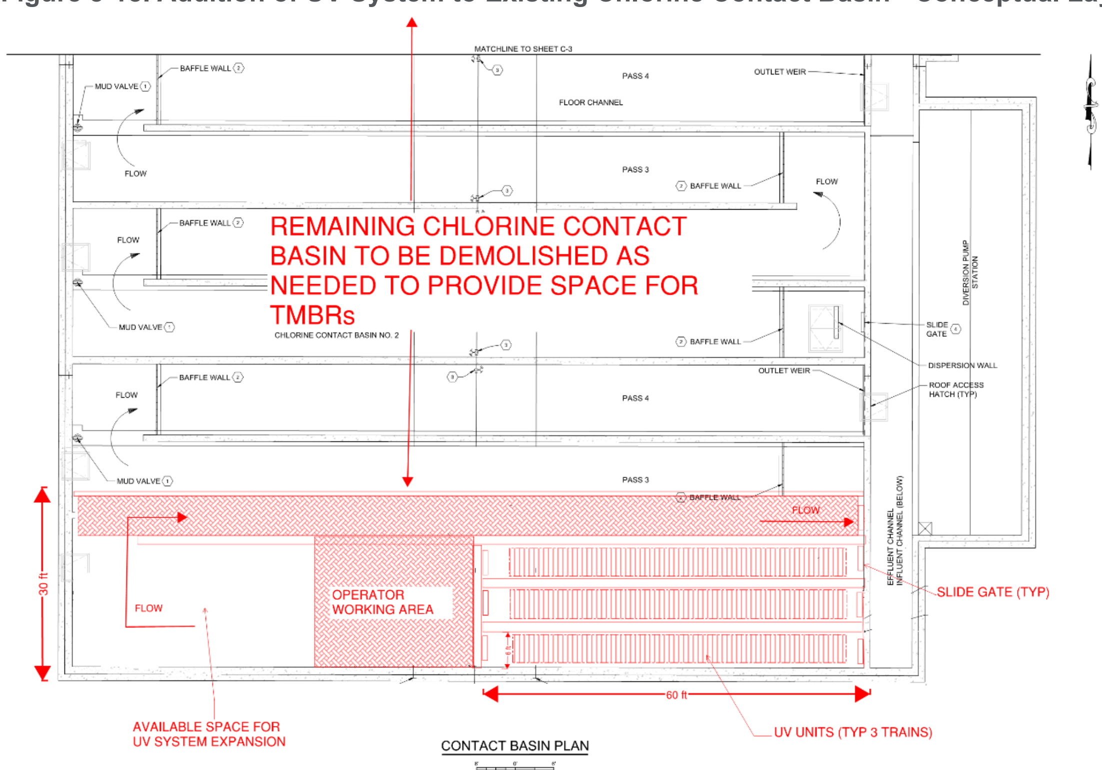


Figure 8-18. Addition of UV System to Existing Chlorine Contact Basin - Conceptual Layout



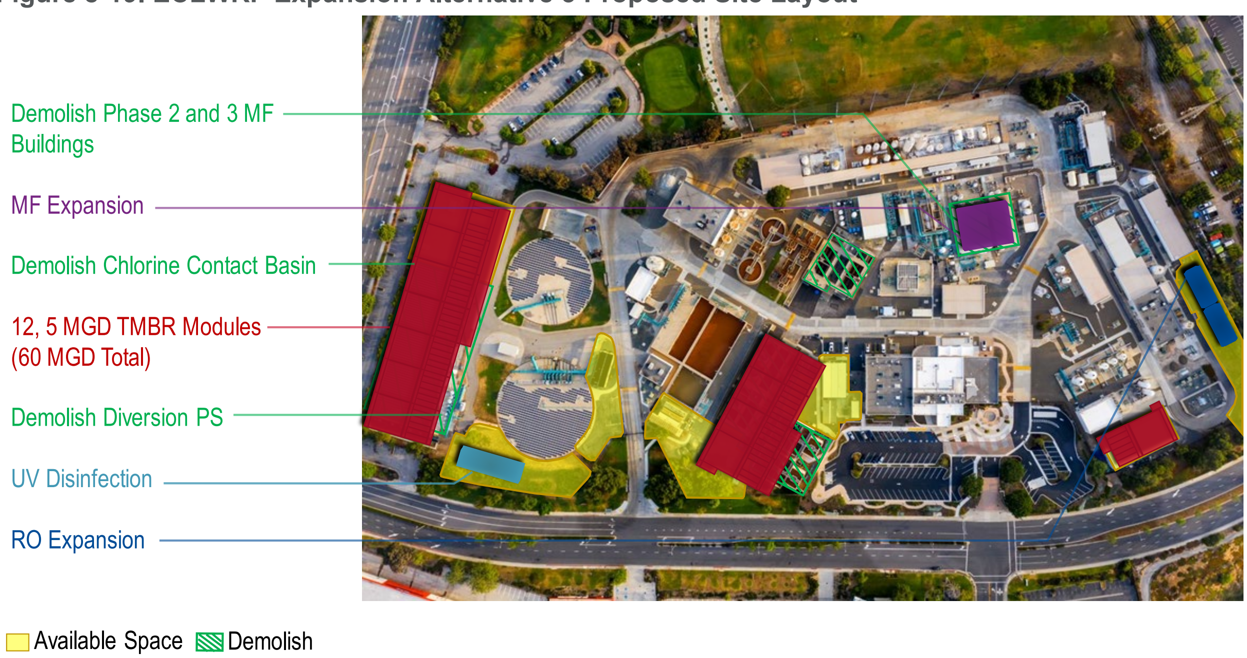
Expansion Alternative 3 – Expand and Replace with tMBR

This alternative replaces the entire Title 22 system with tMBRs and builds additional tMBRs for future expansion. UV system for disinfection is first installed at the end of the existing chlorine contact basin, and the chlorine contact basin is demolished to allocate space for 35 mgd of tMBR. The design for the UV system is the same as that described for Alternative 2 in Section 0. Waste activated sludge from the tMBR are disposed through the existing solids handling system.

The total capacity of proposed tMBR is 60 mgd. The tMBRs are constructed in increments of 20 mgd. During phasing, the tMBR treats the Title 22 backwash and the solids dewatering recycle from the Title 22 pretreatment system, in addition to the MF backwash. Once 40 mgd of tMBR are constructed, the Title 22 pretreatment systems can be demolished to allocate space for the remaining 20 mgd of tMBR.

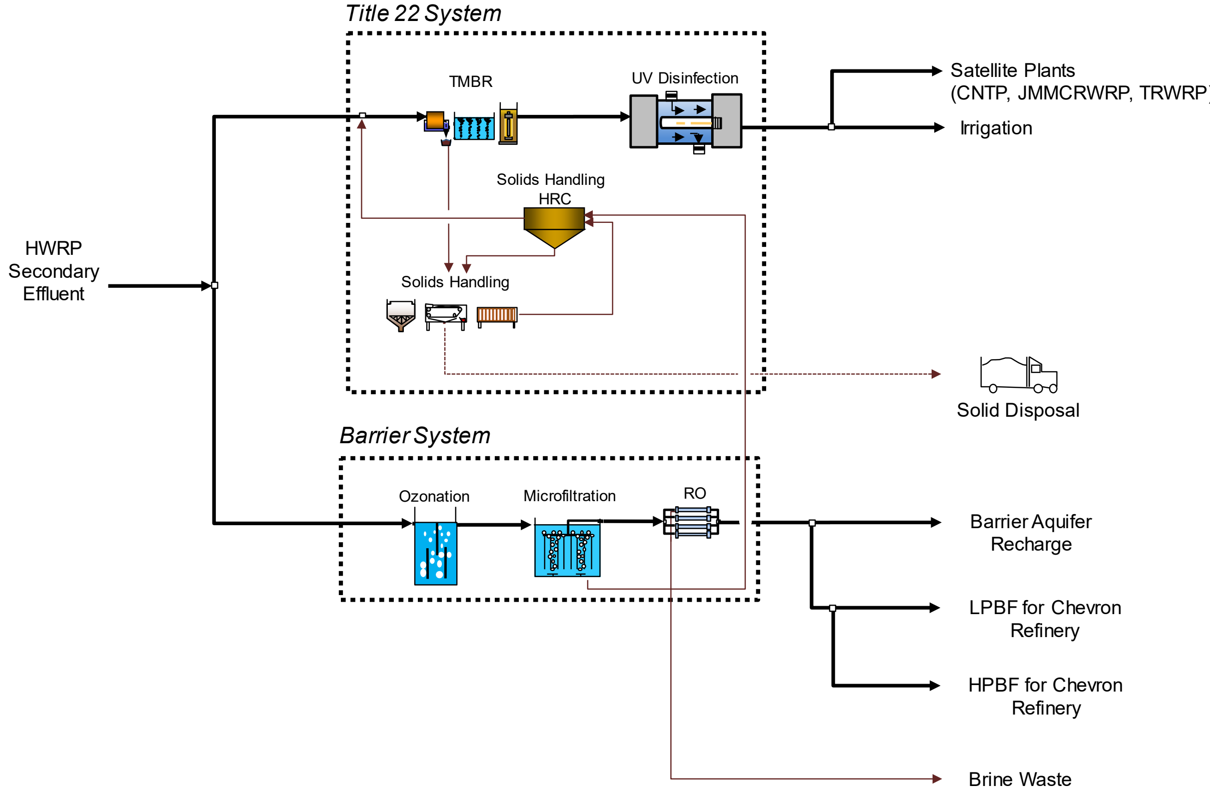
Once the entire Title 22 system is replaced with tMBRs, the existing MF and ultrafiltration treatment systems at the satellite plants can be taken out of service. The tMBR conversion will be timed with retirement of MF systems at the Satellite plants. In addition, the tMBR effluent can go straight to the equalization basin that feeds the RO membranes at ECLWRF and the satellite plants. The proposed site layout of the new facilities is illustrated in Figure 8-19, and the process flow diagram is illustrated in Figure 8-20.

Figure 8-19. ECLWRF Expansion Alternative 3 Proposed Site Layout



Notes:
[a] MF and RO expansion, described in Section 8.3.2, are also illustrated.

Figure 8-20. Expansion Alternative 3 – Process Flow Diagram



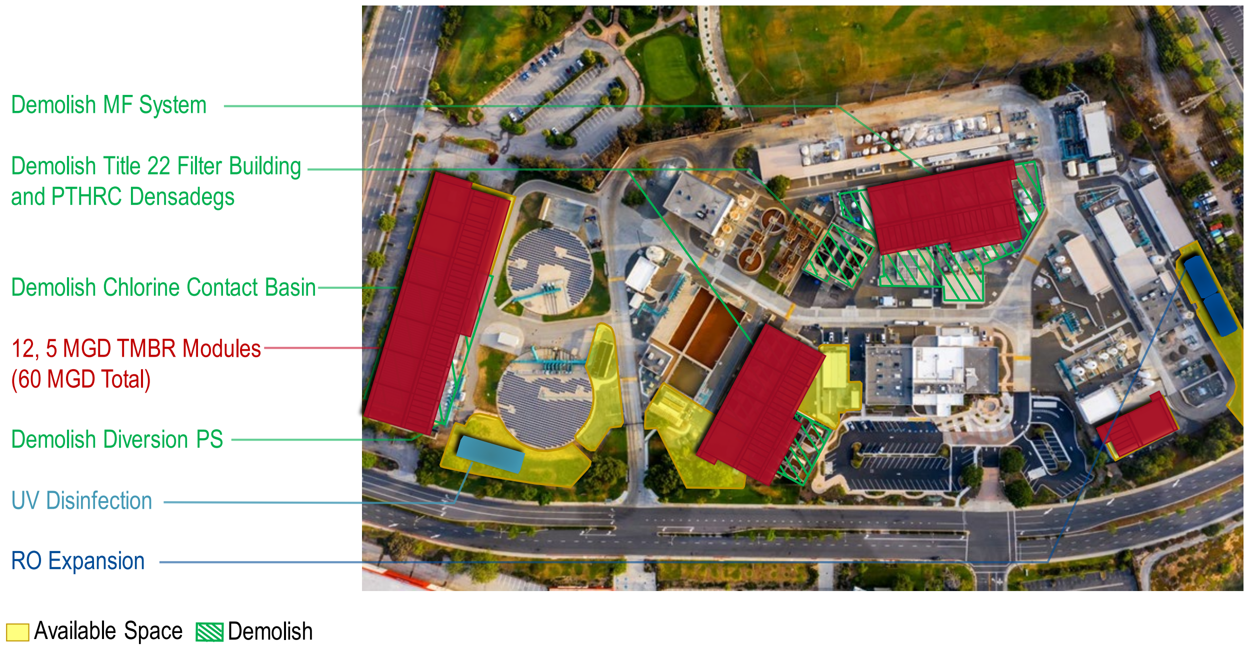
Expansion Alternative 4 – Expand and Replace Title 22 and MF with tMBR

This alternative replaces the existing Title 22 System PTHRC Densadeg and filters and MF membranes with tMBRs and builds additional tMBRs for future expansion. Preozonation to the MF is also eliminated. Similar to Alternative 3 in Section 0, the UV system for disinfection is first installed at the end of the existing chlorine contact basin, and the chlorine contact basin is demolished to allocate space for 30 mgd of tMBR. The design for the UV system is the same as that described for Alternative 2 in Section 0. Waste activated sludge from the tMBR are disposed through the existing solids handling system.

The total capacity of proposed tMBR is 80 mgd. Also similar to Alternative 3 in Section 0, tMBRs are initially constructed in increments of 20 mgd. During phasing, the tMBR treats the Title 22 backwash and the solids dewatering recycle from the Title 22 pretreatment system, in addition to the MF backwash. Once 40 mgd of tMBR are constructed, the Title 22 pretreatment system can be demolished to allocate space for another 20 mgd of tMBR. Once the entire Title 22 system is replaced with tMBRs, the existing MF and ultrafiltration treatment systems at the satellite plants can be taken out of service. In addition, tMBR effluent can go straight to the equalization basin that feeds the RO membranes at ECLWRF and the satellite plants. The remaining 20 mgd of tMBR are constructed in 10 mgd increments and in two phases. The Phase 2 and Phase 3 MF buildings, with idle equipment, are demolished to allocate space for 10 mgd of tMBR. Once tMBR capacity reaches 70 mgd to handle all Title 22 System demands and partial Barrier System demands, the MF are taken offline, and the Phase 5 MF building is demolished to allocate space for the remaining 10 mgd of tMBR. The proposed site layout for the new tMBR expansion at the ECLWRF is shown in Figure 8-21, and the process flow diagram is illustrated in Figure 8-22.

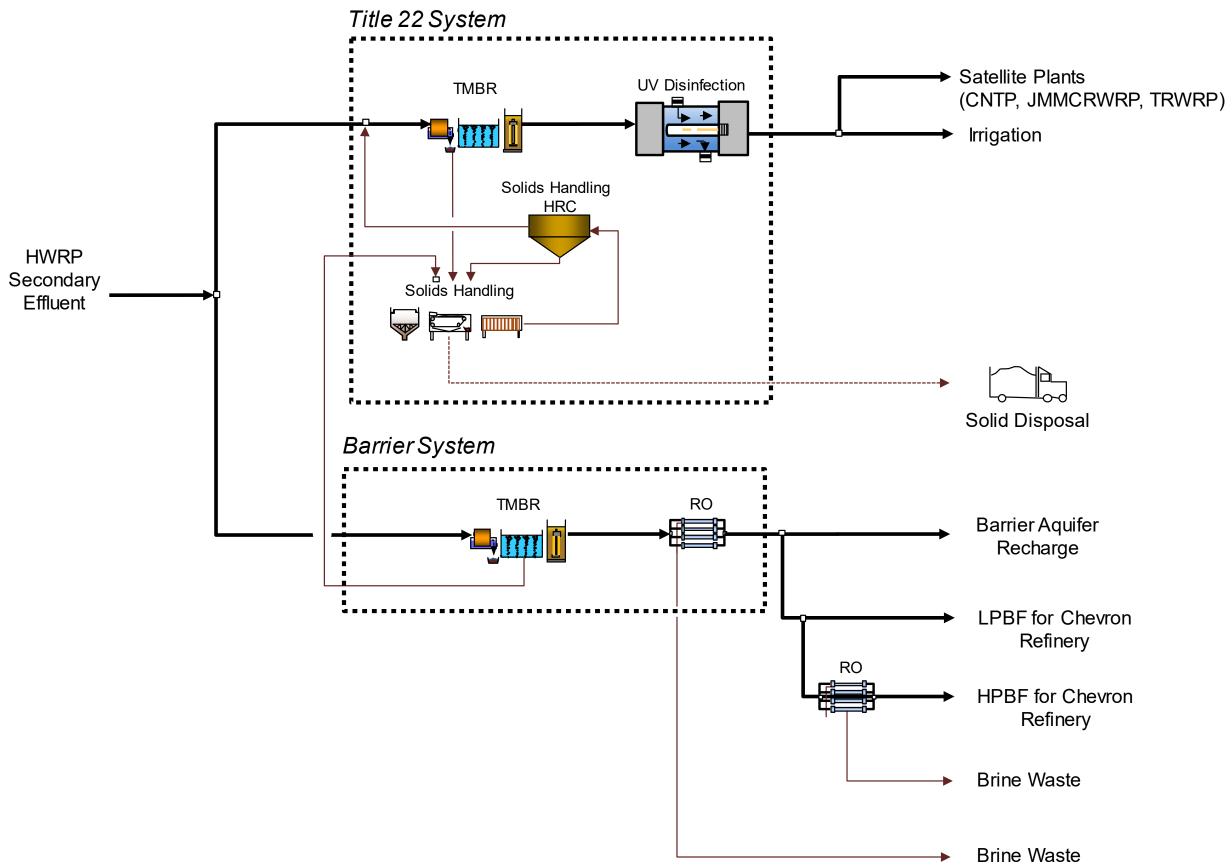
The solids handling system is designed for a total ECLWRF Title 22 flow of 60 mgd at the maximum coagulant dose along with 30 mgd of Barrier System and Chevron LBPF and HPBF operation. Although the capacity of the tMBR system will exceed 60 mgd, it does not require coagulant addition and the total waste activated sludge solids production will be within the capacity of the existing system.

Figure 8-21. ECLWRF Expansion Alternative 4 Proposed Site Layout



Notes:
[a]. Barrier System RO expansion, described in Section 8.3.2, are also illustrated.

Figure 8-22. ECLWRF Expansion Alternative 4 – Process Flow Diagram



8.3.4 JMMCRWRP Nitrification System Expansion Alternatives

Based on JMMCRWRP Nitrified System MDD values for Scenario A, B, and C from Table 8-2, Table 8-3, and Table 8-4, respectively, the expansion of JMMCRWRP under Scenario A requires 3.3 mgd expansion during Phase 1. Scenario B requires 3.3 mgd expansion during Phase 1 and 5 mgd expansion during Phase 2, and Scenario C requires 3.3 mgd expansion during Phase 1 and 5 mgd expansion during Phase 3. Either Biofors or tMBRs are considered to meet future demands. Biofor units are expanded in units of 1.25 mgd, while tMBRs are expanded in units of 5 mgd. West Basin has already designed a 2.5 mgd tMBR plant for the Phase 1 expansion of JMMCRWRP, indicated as “Marathon (JMMCRWRP Phase 2 Expansion)” from Table 8-1, but construction has been put on hold.

Under Scenario A, three alternatives for achieving at least 3.3 mgd expansion are developed as follows:

1. Full Biofor (3.75 mgd)
2. Full tMBR (5 mgd)
3. Biofor and tMBR (3.75 mgd)

Under Scenarios B and C, two alternatives for achieving at least 8.3 mgd expansion are developed as follows:

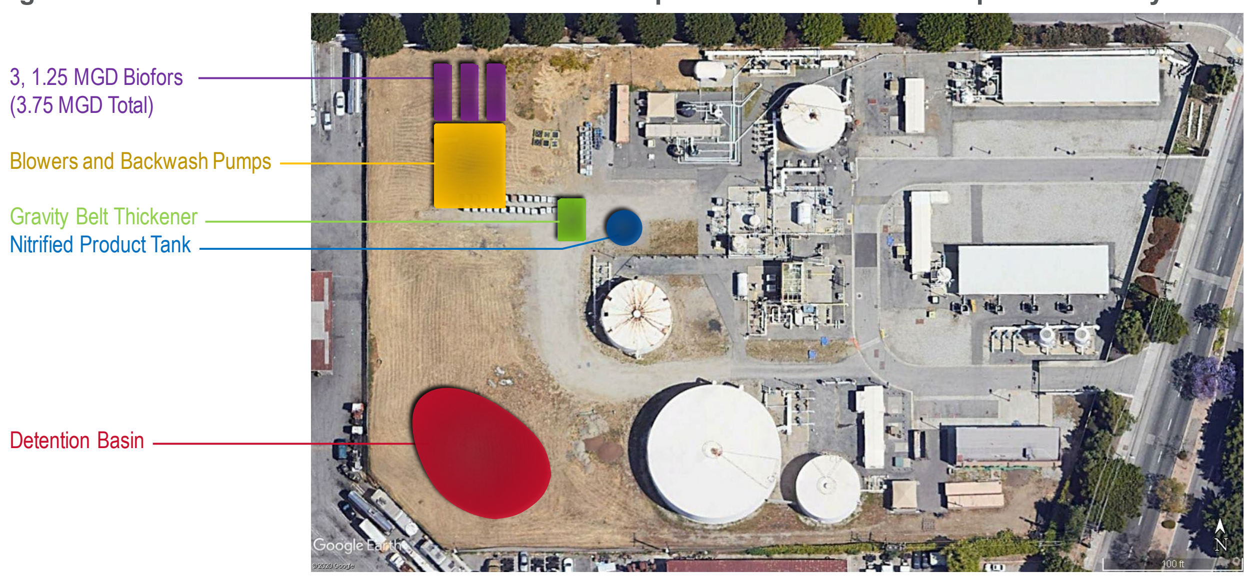
1. Full Biofor (8.75 mgd)
2. Full tMBR (10 mgd)

Implementation of tMBRs at HWRP or ECLWRF would improve Title 22 water quality and could potentially eliminate the need for additional tMBRs or Biofors at JMMCRWRP. Subsequent sections describe each of the nitrification expansion alternatives under the assumption that tMBR is not built at HWRP nor at ECLWRF.

Scenario A Expansion Alternative 1 – Full Biofor

This alternative expands the existing Biofor units that are currently used at this site by installing three new 1.25 mgd Biofor units (total 3.75 mgd) in Scenario A. All new Biofors are sized for the current ammonia loading. The proposed layout of the new facilities is shown in Figure 8-23.

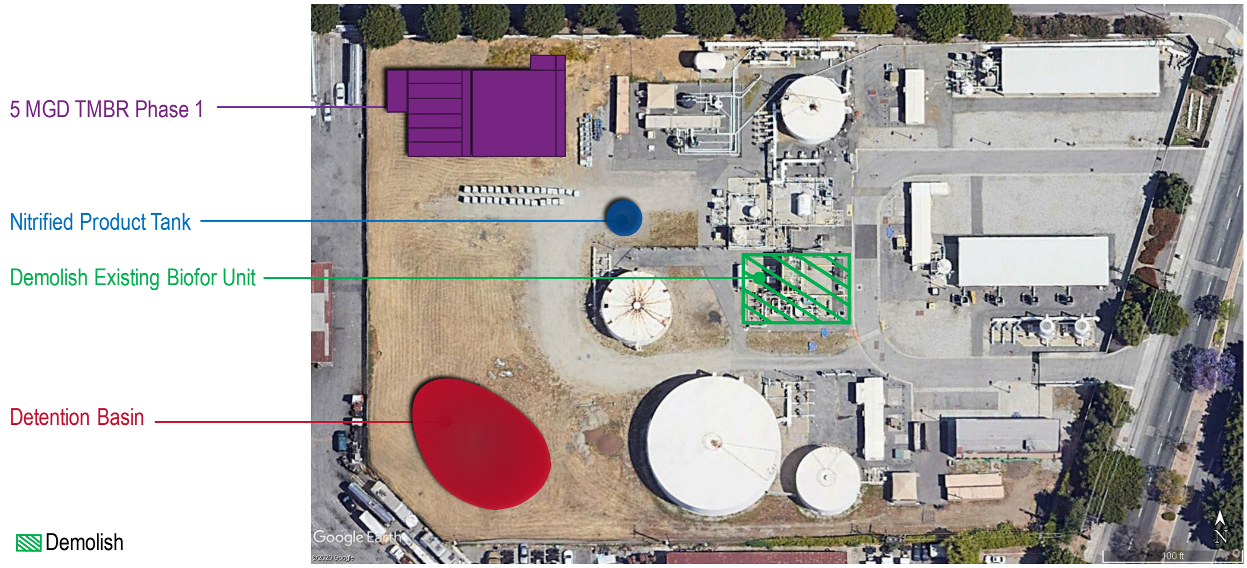
Figure 8-23. JMMCRWRP Nitrification Scenario A Expansion Alternative 1 Proposed Site Layout



Scenario A Expansion Alternative 2 – Full tMBR

This alternative demolishes the existing Biofor and installs a 5 mgd tMBR system for Scenario A. The proposed layout of the new facilities is shown in Figure 8-24.

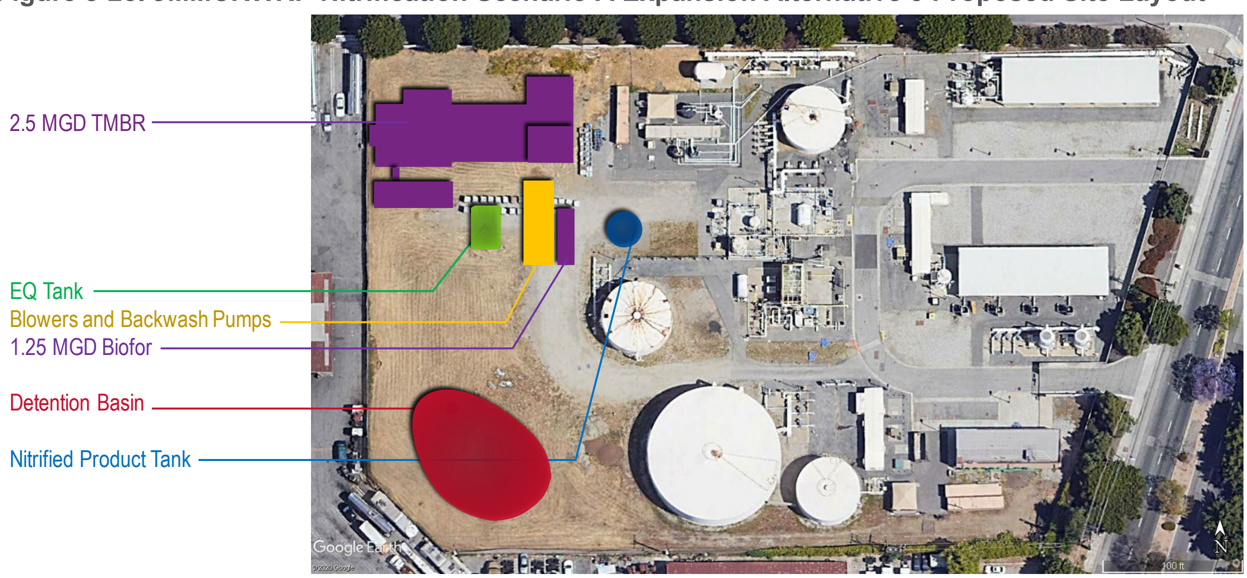
Figure 8-24. JMMCRWRP Nitrification Scenario A Expansion Alternative 2 Proposed Site Layout



Scenario A Expansion Alternative 3 – Biofor and tMBR

This hybrid alternative installs an additional 1.25 mgd Biofor unit sized for current ammonia loading and a 2.5 mgd tMBR system to increase the nitrified capacity to 5 mgd. This alternative only applies to Scenario A, because West Basin has already designed a 2.5 mgd tMBR plant for the Phase 1 expansion of JMMCRWRP, but construction has been put on hold. The proposed layout of the new facilities is shown in Figure 8-25 for Scenario A.

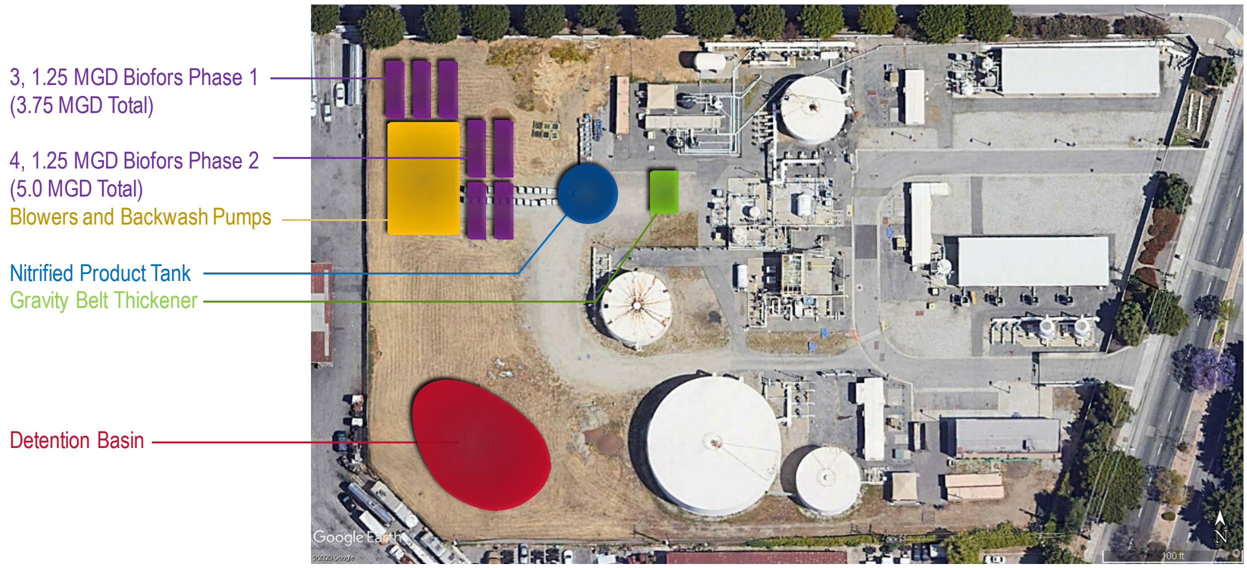
Figure 8-25. JMMCRWRP Nitrification Scenario A Expansion Alternative 3 Proposed Site Layout



Scenario B and C Alternative 1 – Full Biofor

This alternative expands the existing Biofor units that are currently used at this site by 3.75 mgd during Phase 1 and 5.0 mgd during Phase 2. All new Biofors are sized for the current ammonia loading. The proposed layout of the new facilities is shown in Figure 8-26 for Scenarios B and C.

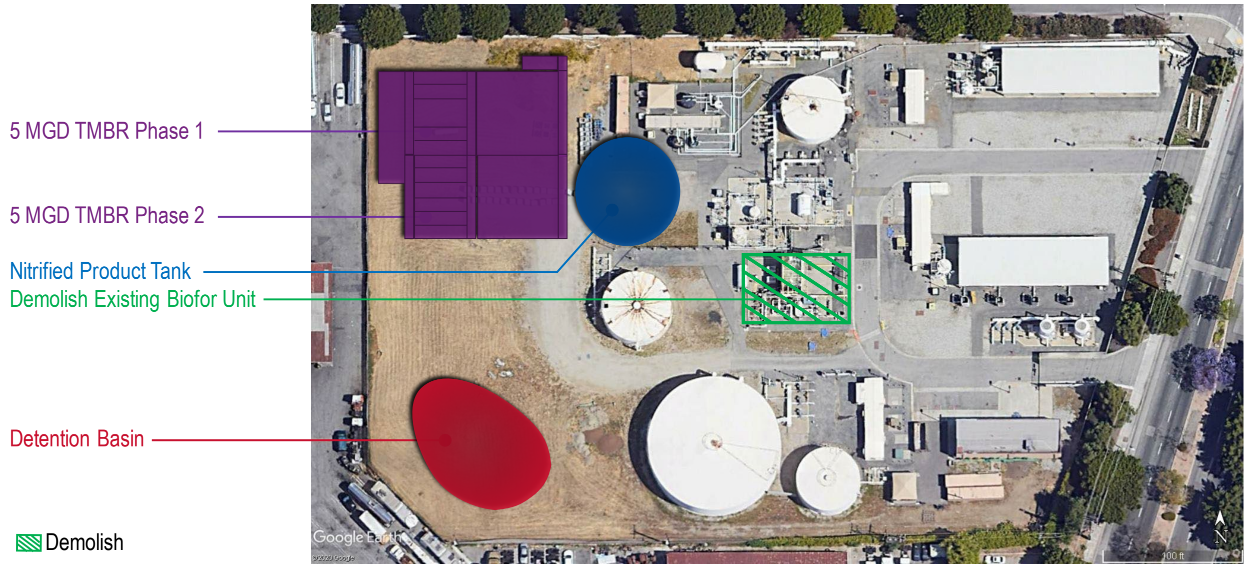
Figure 8-26. JMMCRWRP Nitrification Scenario B and C Expansion Alternative 1 Proposed Site Layout



Scenario B and C Alternative 2 – Full tMBR

This alternative replaces the existing Biofors with 5 mgd tMBR during Phase 1 and an additional 5 mgd tMBR during Phase 2. The proposed layout of the new facilities is shown in Figure 8-27 for Scenarios B and C.

Figure 8-27. JMMCRWRP Nitrification Scenario B and C Expansion Alternative 2 Proposed Site Layout



8.3.5 JMMCRWRP Single Pass RO System Expansion

Based on the single pass RO MDD values for Scenario A, B, and C from Table 8-2, Table 8-3, and Table 8-4, respectively, Scenario A does not require any RO expansion, Scenario B requires 5.4 mgd expansion during Phase 2, and Scenario C requires 12.9 mgd expansion during Phase 2 and 5.5 mgd expansion during Phase 3. The proposed layout of the new MF and single pass RO system is shown in Figure 8-28 for Scenario C at buildout.

Figure 8-28. JMMCRWRP Single Pass RO Expansion – Scenario C Proposed Site Layout

8.3.6 TRWRP IPR System Addition

For Scenario A, a new MF/RO ultraviolet-advanced oxidation process (UV-AOP) system to produce IPR quality water will be constructed at TRWRP to provide groundwater augmentation for the West Coast Barrier. Based on Torrance Groundwater Augmentation Capacity MDD values for Scenario A from Table 8-2, construction occurs in two phases; Phase 2 constructs 8.9 mgd, and Phase 3 constructs 9.0 mgd. Additional property will need to be leased from the Torrance Refinery to provide space for these facilities. These facilities will include the following major components:

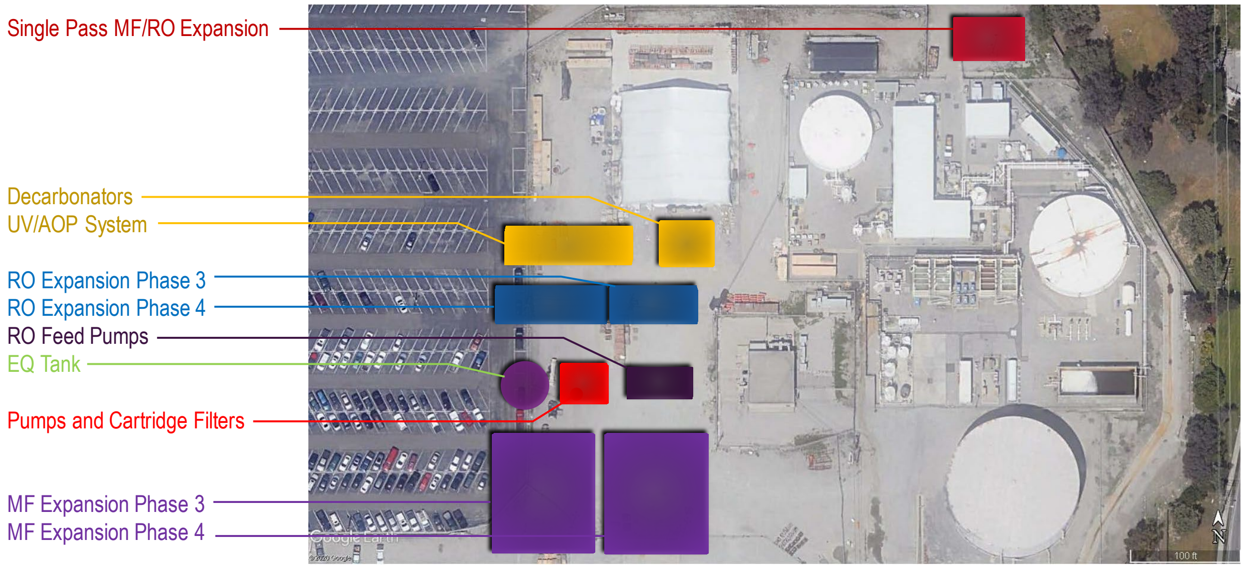
- 200-micron strainers
- Microfiltration membranes installed beneath a canopy
- MF clean-in-place system
- MF effluent equalization tanks, transfer pump station, and cartridge filters
- High pressure RO feed pumps
- RO membrane system installed beneath a canopy
- UV-AOP system
- Decarbonators
- Chemicals systems, including acid and lime or caustic for stabilizing permeate, to reduce its corrosivity

Brine from TRWRP is currently disposed to the local sewer; however, a separate brine line will likely be required for this IPR project. As the need for this facility has not been determined, a new brine line is not included in the cost opinion for this project.

8.3.7 TRWRP Single Pass RO System Expansion

Based on the single pass RO MDD values for Scenario A, B, and C from Table 8-2, Table 8-3, and Table 8-4, respectively, Scenario A requires 0.9 mgd expansion in Phase 3, Scenario B requires 0.9 mgd expansion during Phase 2, and Scenario C does not require expansion. The MF and single pass RO system will include the same major components as that for the IPR addition, with the exception of the UV-AOP system. The proposed layout for both the IPR addition and Single Pass RO expansion is shown in Figure 8-29. Cost of land purchase or leasing is excluded.

Figure 8-29. TRWRP IPR Addition and RO Expansion – Scenario A Proposed Site Layout



8.4 Evaluation of Future Treatment Process Alternatives

This section compares the process optimization and expansion alternatives discussed in Section 8.3 with an economic and non-economic evaluation. Processes that did not have alternatives and were assumed to be expanded in kind, such as the single pass RO expansions, were not evaluated in this section. The economic evaluation compares each alternative based on a 20-year life cycle cost, while the non-economic evaluation compares the advantages and disadvantages of the proposed alternative process.

Recommendations for process selection are included in this section and those costs are then used in Section 8.5 to develop the cost summaries for all of the recommended expansion improvements identified under Scenarios A, B and C, as described in Section 0.

8.4.1 Economic Evaluation Approach

The economic factors for the proposed treatment system improvements were estimated using a variety of tools and estimating techniques, summarized below.

- HDR's costSPACE Estimating Software Tool
- Historical data from West Basin

- Vendor cost estimates
- Estimates from previous planning documents

Planning level cost estimate tables for each alternative and references are included in Appendix O. Cost assumptions for all alternatives are summarized in Table 8-5 below.

Table 8-5. Cost Model Assumptions

Parameter	Value	Unit	Description
General			
Base Year	2020	-	Beginning year of analysis period
Term (years)	20	-	Duration of analysis period
Annual inflation rate	3.0	%	
Discount Rate	4.0	%	

8.4.2 ECLWRF Process Optimization Options

Three optimization options were presented in Section 3.1. However, only two options are evaluated in this Master Plan, as the third option regarding solids handling is currently being evaluated in a separate study.

Economic Evaluation

The 20-year lifecycle cost comparisons of the proposed ECLWRF operational improvements are presented in Table 8-6. The baseline existing system operational lifecycle costs are provided for comparison. From a cost perspective, the cost to implement Option 1 increases the baseline costs by $44.8M over 20 years. The cost to implement Option 2 results in a cost savings of $8.7M over 20 years.

Table 8-6. Comparison of ECLWRF Optimization Options Life Cycle Costs

Option[1]	Description	Capital Cost ($M)	20-Year Net Present Value O&M Costs ($M)						Life Cycle Costs Total ($M)
			Ozone	Coagulant	Solids Handling	Clean-in-Place	Barrier Pump Energy to	Total	
Baseline	Existing System	$0.0	$8.6	$28.3	$20.4	$10.2	$1.8	$69.3	$69.3
1	Convey Title 22 Product Water to Barrier System	$0.4	$0.0	$61.4	$44.2	$6.3	$1.8	$113.6	$114.1
2	Move Ozonation from MF to Ahead of Title 22 System	$0.9	$12.9	$21.3	$15.3	$10.2	$0.0	$59.7	$60.6

Table 8-6. Comparison of ECLWRF Optimization Options Life Cycle Costs

Option[1]	Description	Capital Cost ($M)	20-Year Net Present Value O&M Costs ($M)						Life Cycle Costs Total ($M)
			Ozone	Coagulant	Solids Handling	Clean-in-Place	Barrier Pump Energy to	Total	

[1] This captures energy cost required to pump from ozone degas system to the MF system relative to Option 2, which does not require this process.

Non-Economic Evaluation

The non-economic advantages and disadvantages of the proposed optimization options are presented in Table 8-7.

Table 8-7. Advantages and Disadvantages of ECLWRF Optimization Options

Option	Advantages	Disadvantages
1. Convey Title 22 Product Water to Barrier System	• Reduces TOC and total suspended solids loading to the MF units. This will reduce clean in place frequency • Eliminates spikes that disrupt the operation • Improves water quality to RO system, reducing membrane cleaning frequency • Reduces cost for treating MF backwash water	• Treating more HWRP effluent through Title 22 system will significantly increase coagulant usage and solids generation
2. Move Ozonation from MF to Ahead of Title 22 System	• Reduces ferric chloride dose to PTHRC Densadeg units and subsequently reduces solids generation • Reduces TOC and color in Title 22 effluent	• Increases ozone feed production with associated costs
3. Send solids from Gravity Belt Thickeners to Sewer	• Frees-up space on site for expansion facilities • Reduces operator time now devoted to plate and frame press	• Facility could be subject to future sewer rate increases • Conveyance through the El Segundo trunk sewer may not be acceptable to LACSD due to capacity and/or quality constraints

Optimization Options Evaluation Conclusions

Based on the economic and non-economic factors, the following conclusions are made:

1. Convey Title 22 Product Water to Barrier System – This option is not recommended because the added cost of treating water through the Title 22 system is greater than the estimated savings in the MF system operation.
2. Move Ozonation from MF to Ahead of Title 22 System - This option has the potential to reduce 20-year lifecycle costs by $8.7M by improving the feed water quality to the Title 22 PTHRC Densadeg units, which reduces the amount of ferric chloride addition. Prior to implementing this alterative, either bench scale testing or full pilot test is recommended to assess the actual benefits of this ozonation.
3. Send Solids from Gravity Belt Thickeners to Sewer - A decision on whether to send solids to the sewer is pending until January 2021, when the ongoing solids system evaluation will be completed.

8.4.3 ECLWRF Expansion Alternatives

Four alternatives for expansion of ECLWRF to meet future demands are considered in Section 8.3.3. The first two options consider whether to expand the Title 22 system with PTHRC Densadeg units or tMBR units to meet the projected future demands associated with the scenarios presented in Section 8.2. The third alternative considers the long-term impact of replacing all of the existing PTHRC Densadeg units with tMBR. The fourth alternative expands on the third alternative by also adding tMBR for the MF System. These final two alternatives can be used to inform discussions with LASAN regarding the cost of implementing MBR treatment at HWRP versus installing tMBRs at ECLWRF.

Economic Evaluation

For the Title 22 expansion alternatives, a comparison of 20-year life-cycle costs are presented in Table 8-8. As a conservative estimate, the capital costs assume that the expansions occur based on Scenario B, while the O&M costs assume that the expansions would occur based on Scenario A.

Table 8-8. Comparison of ECLWRF Title 22 System Expansion Alternatives Life Cycle Costs

Alternative No.	Description	Capital Cost ($M)	Net Present Value O&M Cost ($M)					Life Cycle Costs Total ($M)
			Title 22 Filter & PTHRC Densadeg	MBR	Disinfection	MF	Total	
1	Expand with PTHRC Densadeg and Filter	$44.9	$90.8	$0.0	$33.3	$109.9	$234.0	$278.9
2	Expand with tMBR	$183.8	$65.8	$34.3	$19.3	$109.9	$229.3	$413.2

Table 8-8. Comparison of ECLWRF Title 22 System Expansion Alternatives Life Cycle Costs

Alternative No.	Description	Capital Cost ($M)	Net Present Value O&M Cost ($M)					Life Cycle Costs Total ($M)
			Title 22 Filter & PTHRC Densadeg	MBR	Disinfection	MF	Total	
3	Expand and Replace Title 22 System with tMBR	$656.8	$23.0	$88.2	$19.3	$109.9	$240.4	$897.1
4	Expand and Replace Title 22 and MF system with tMBR	$845.2	$22.8	$89.4	$19.3	$101.7	$233.2	$1,078.4

[a] Barrier RO Expansion is common to all ECLWRF alternatives; therefore, it is excluded from this life cycle cost comparison.

Non-Economic Evaluation

Advantages and disadvantages of the Title 22 expansion alternatives are presented in Table 8-9.

Table 8-9. Advantages and Disadvantages of Title 22 Expansion Alternatives

Alternative	Advantages	Disadvantages
1. Expand with PTHRC Densadeg and filter	• Operators are familiar with existing PTHRC Densadeg system • Takes up less space than tMBRs	• Effluent water quality is inferior compared to tMBRs • Requires high coagulant dose and generates solids as a result of coagulant addition
2. Expand with tMBR	• tMBRs will reduce ammonia levels and reduce loading on Biofors	• Plant will have to operate two separate processes
3. Expand and Replace with tMBR	• tMBR effluent will improve water quality • Allows for removing Biofors and MF units at Satellite Plants	• Will become a large sunk cost, if MBRs installed at HWRP
4. Expand and Replace Title 22 and MF with tMBR	• tMBR effluent will improve water quality • Allows for removing Biofors and MF units at Satellite Plants and at ECLWRF	• Uses nearly all available space at ECLWRF

Conclusions

Alternative 1 has a significantly lower 20-year lifecycle cost compared to any of the tMBR alternatives and is recommended.

Alternative 4 presents the costs for completely converting the Title 22 and MF System to tMBRs. This cost can be used as a baseline cost to inform discussions with LASAN regarding proposed tMBR improvements at HWRP.

The conversion of HWRP to tMBRs is anticipated by the year 2035. In the event the tMBR conversion is delayed, ECLWRF and the Satellite Plants would continue current operation or with tMBRs, if installed. The advantages of receiving nitrified tMBR water from the HWRP include:

- Decommissioning of many processes at the ECLWRF and the Satellite Plants including MF/ultrafiltration systems, Title 22 pretreatment, and filters from receiving higher quality water.
- More customers (particularly cooling towers) willing to purchase Title 22 water with the reduction of ammonia.
- Reduction in solids production.

Disadvantages of receiving HWRP tMBR effluent include:

- The ability for West Basin to continue to scalp water from the secondary effluent outfall pipeline will be limited based on diurnal variations, since LASAN will also be using HWRP MBR effluent for reuse. An equalization facility will likely be required at the HWRP site, increasing the costs of the overall system.
- West Basin giving up control of a significant component of the recycled water operating costs.
- Relying on HWRP to meet water quality commitments and the possible need to maintain. back-up treatment facilities, should exceedances occur.

8.4.4 JMMCRWRP Expansion Alternatives

Alternatives for expansion of JMMCRWRP to meet future demands are considered in Section 8.3.4. For lifecycle cost comparison, two evaluations are completed. The first evaluation analyzes three alternatives for achieving 3.3 mgd expansion under Scenario A. The second analysis analyzes two alternatives for achieving at least a total maximum day capacity of 9.6 under Scenarios B and C.

Economic Evaluation

A comparison of life-cycle costs for Scenario A are presented in Table 8-10. Although the 2.5 mgd tMBR facility is already designed, expanding the current Biofor processes with three 1.25 mgd units to reach 4.6 mgd in Alternative 1 is less costly than converting to 5 mgd of tMBR. The lifecycle costs savings over 20 years between the two is approximately $12.4M. Alternative 3 takes advantage of the previously designed 2.5 mgd tMBR facility and develops a hybrid process with the addition of a single Biofor unit to meet the projected 4.6 mgd demand. This saves approximately $2M from not building an additional 2.5 mgd of tMBR, which would result in excess capacity.

Table 8-10. Comparison of JMMCRWRP Nitrification Expansion Alternatives Scenario A Life Cycle Costs

Alt. No.	Description	Capital Cost ($M)			20-Year Net Present O&M Cost ($M)			Life Cycle Costs Total ($M)
		tMBR	Biofor	Total	tMBR	Biofor	Total	
1	Full Biofor (3.75 mgd)	$0.0	$22.1	$22.1	$0.0	$33.4	$33.4	$55.5
2	Full tMBR (5 mgd)	$54.1	$0.0	$54.1	$13.1	$0.8	$13.9	$67.9
3	Biofor (1.25 mgd) and tMBR (2.5 mgd)	$33.5	$7.4	$40.9	$7.2	$17.9	$25.0	$65.9

Both Scenarios B and C reach a maximum day capacity of 9.6 mgd by Year 2040. Two alternatives are evaluated: full Biofor or full tMBR. As a conservative estimate to compare the two alternatives, the capital and O&M costs assume that the expansions occur based on Scenario B, since expansion occurs earlier for Scenario B compared to Scenario C. A comparison of life-cycle costs for Scenario B are presented in Table 8-11. Over a 20-year lifecycle, Biofors are anticipated to cost less than tMBRs by $16.8M.

Table 8-11. Comparison of JMMCRWRP Nitrification Expansion Alternatives Scenario B Life Cycle Costs

Alt. No.	Description	Capital Cost ($M)			20-Year Net Present O&M Cost ($M)			LCC Total ($M)
		tMBR	Biofor	Total	tMBR	Biofor	Total	
1	Full Biofor (8.75 mgd)	$0.0	$50.4	$50.4	$0.0	$62.2	$62.2	$112.6
2	Full tMBR (10 mgd)	$106.5	$0.0	$106.5	$22.1	$0.8	$22.9	$129.4

Non-Economic Evaluation

Non-economic advantages and disadvantages of the JMMCRWRP Nitrification system expansion alternatives for Scenario A are presented in Table 8-12 and for Scenarios B and C in Table 8-13.

Table 8-12. Advantages and Disadvantages of JMMCRWRP Nitrification System Scenario A Expansion Alternatives

Alternative	Advantages	Disadvantages
1. Full Biofor (3.75 mgd)	• Operators familiar with the system • Produces acceptable quality water • Smaller footprint	• May have to continue occasional breakpoint chlorination
2. Full tMBR (5 mgd)	• Produces superior quality water • Effluent can also be sent to RO system	• Will become sunk cost, if MBRs installed at HWRP or tMBRs installed at ECLWRF
3. Biofor (1.25 mgd) and tMBR (2.5 mgd)	• The tMBR system is already designed • Produces superior quality water • tMBR Effluent can also be sent to RO system	• Need to operate two different systems • Will become sunk cost, if MBRs installed at HWRP or tMBRs installed at ECLWRF

Table 8-13. Advantages and Disadvantages of JMMCRWRP Nitrification System Scenario B and C Expansion Alternatives

Alternative	Advantages	Disadvantages
1. Full Biofor (8.75 mgd)	• Operators familiar with the system • Produces acceptable quality water • Smaller footprint	• Cannot send treated water to the RO system
2. Full tMBR (10 mgd)	• Produces superior quality water • Allows for operation of just one system • Effluent can be sent directly to RO system	• Will become large sunk cost, if MBRs installed at HWRP or tMBRs installed at ECLWRF

Conclusions

Scenario A

Based on the life cycle cost evaluation, Alternative 1 with full Biofor is $12.4M lower in 20-year lifecycle cost compared to Alternative 2 with full tMBR. The 2012 CH2MHILL report indicated tMBRs had a slightly lower lifecycle cost. However, HDR's recent experience with tMBRs is that the actual costs have overrun planning budgets by about 50 to 100%. In addition, Alternative 3 is not recommended due to the disadvantage of operating two different systems. Therefore, the Biofor system is recommended for the nitrification system expansion for Scenario A.

Scenarios B and C

Based on the life cycle cost evaluation, Alternative 1 with full Biofor is $16.8M lower in 20-year life cycle cost compared to Alternative 2 with full tMBR. Based on the above, the Biofor system is recommended for the nitrification system expansion for Scenarios B and C.

8.4.5 Recommendations

Table 8-14 provides a summary of the recommended alternatives from Section 8.4 that are brought forward to Section 5 for capital and O&M cost summaries. The ‘X’ symbol represents the corresponding scenario and phase in which the alternative project occurs.

Table 8-14. Alternative Recommendations

Scenario	Phase	ECLWRF					JMMCRWRP				TRWRP	
		Title 22 System				Barrier System						
		Alt 1	Alt 2	Alt 3	Alt 4		Alt 1	Alt 2	Alt 3	-	-	-
		Expand with PTHRC Densadeg and Filter	Expand with tMBR	Expand and Replace with tMBR	Expand and Replace Title 22 and MF with tMBR	Expand MFand RO	Full Biofor	Full tMBR	Biofor and tMBR	Expand Single Pass MF/RO	Expand Single Pass MF/ RO	New IPR System (MF/ RO/UV-AOP)
A	1						X	X	X			
	2	X	X	X	X							X
	3	X	X	X	X						X	X
	4			X	X	X						
B	1						X	X	X			
	2	X	X	X	X		X	X	X	X	X	
	3	X	X	X	X							
	4			X	X	X						
C	1						X	X	X			
	2	X	X	X	X					X		
	3	X	X	X	X		X	X	X	X		
	4			X	X	X						

[a] Green columns indicate recommended alternatives.

8.5 Recommended Treatment Facility Costs and Implementation Plan

This section presents the costs and implementation strategies for the recommended treatment facility optimization option and expansion alternatives. Details of cost estimate approach are provided in Appendix O.

8.5.1 Capital Costs

The capital costs for the recommended optimization option are summarized in Table 8-15.

Table 8-15. Recommended Optimization Option 2 Capital Cost Summary

Facility	Improvement or Expansion	Capital Cost ($M)
ECLWRF	Move Ozonation from MF to Ahead of Title 22 System	$0.9

The capital costs for the recommended expansion alternatives are summarized in Table 8-16.

Table 8-16. Recommended Expansion Alternatives Capital Cost Summary

Facility	Process	Expansion or Addition	Capital Cost ($M, 2020 Dollars)				
			Phase 1 (2020-2024)	Phase 2 (2025-2029)	Phase 3 (2030-2034)	Phase 4 (2035-2040)	Total (2020-2040)
Scenario A							
ECLWRF	Title 22 System	15.0 mgd filter and 20 mgd PTHRC	-	$14.8	$17.3	-	$73.9
	Barrier System	5.0 mgd MF	-	-	-	$12.8	
	Barrier System	5.0 mgd RO	-	-	-	$29.0	
JMMCRWRP	Nitrification System	3.8 mgd Biofors	$22.1	-	-	-	$22.1
	Single Pass RO	No change	-	-	-	-	
TRWRP	IPR System	17.9 mgd	-	$79.8	$76.7	-	$164.5
	Single Pass RO	0.9 mgd	-	-	$8.0	-	
		Total Scenario A	**$22.1**	**$94.6**	**$102.0**	**$41.8**	**$260.5**

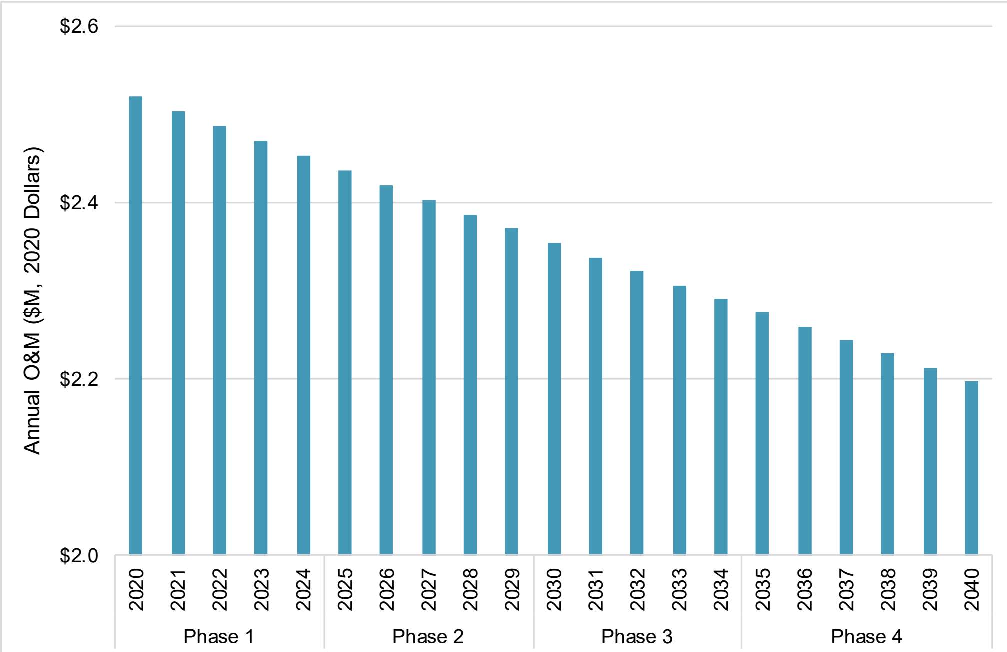
Table 8-16. Recommended Expansion Alternatives Capital Cost Summary

Facility	Process	Expansion or Addition	Capital Cost ($M, 2020 Dollars)				
			Phase 1 (2020-2024)	Phase 2 (2025-2029)	Phase 3 (2030-2034)	Phase 4 (2035-2040)	Total (2020-2040)
Scenario B							
ECLWRF	Title 22 System	15.0 mgd filter and 20 mgd PTHRC	-	$23.9	$8.6	-	$76.3
	Barrier System	5.0 mgd MF	-	-	$13.4	-	
	Barrier System	5.0 mgd RO	-	-	$30.4	-	
JMMCRWRP	Nitrification System	8.75 mgd Biofors	$22.1	$28.3	-	-	$84.3
	Single Pass RO	5.4 mgd	-	$33.9	-	-	
TRWRP	IPR System	NA	-	-	-	-	$8.4
	Single Pass RO	0.9 mgd	-	$8.4	-	-	
		Total Scenario B	**$22.1**	**$94.5**	**$52.4**	**$0.0**	**$169.0**
Scenario C							
ECLWRF	Title 22 System	15.0 mgd filter and 20 mgd PTHRC	-	$14.8	$17.3	-	$73.9
	Barrier System	5.0 mgd MF	-	-	-	$12.8	
	Barrier System	5.0 mgd RO	-	-	-	$29.0	
JMMCRWRP	Nitrification System	8.75 mgd Biofors	$22.1	-	$27.0	-	$147.7
	Single Pass RO	18.5 mgd	-	$66.2	$32.4	-	
TRWRP	IPR System	NA	-	-	-	-	$0.0
	Single Pass RO	No change	-	-	-	-	
		Total Scenario C	**$22.1**	**$81.0**	**$76.7**	**$41.8**	**$221.6**

8.5.2 Annual O&M Costs

Annual O&M costs for the recommended ECLWRF Optimization Option 2 are summarized in Figure 8-30.

Figure 8-30. Recommended ECLWRF Optimization Option 2 Annual O&M Cost Summary



Annual O&M costs for each scenario for the recommended ECLWRF, JMMCRWRP, and TRWRP expansion alternatives, single pass RO expansions, and IPR addition are shown in Figure 8-31 through Figure 8-35.

Figure 8-31. Recommended ECLWRF Expansion Alternative 1 Annual O&M Cost Summary

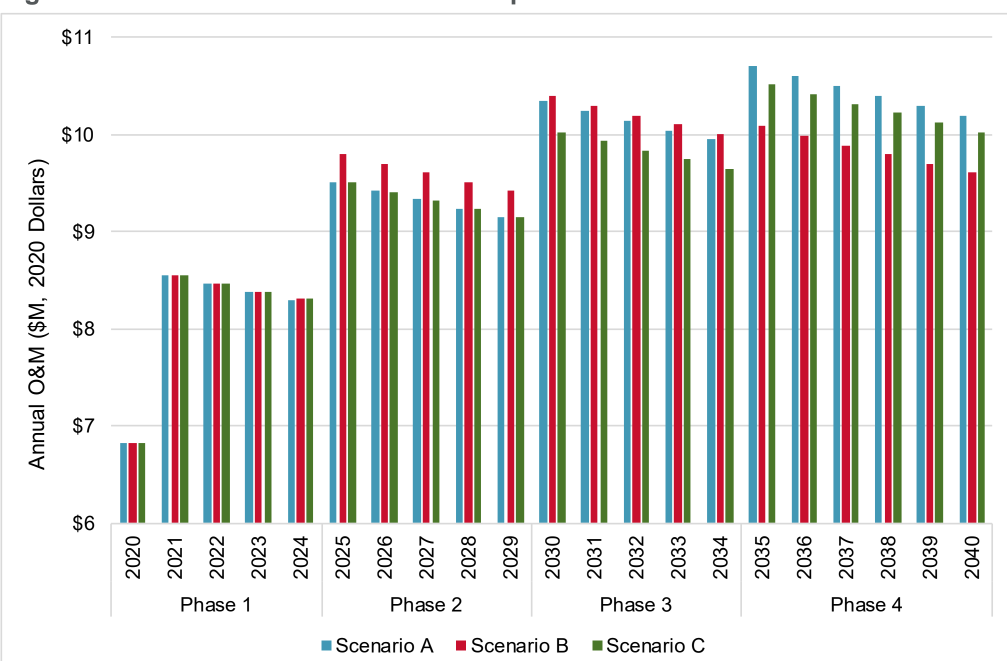


Figure 8-32. Recommended JMMCRWRP Nitrified Expansion Alternative 1 Annual O&M Cost Summary

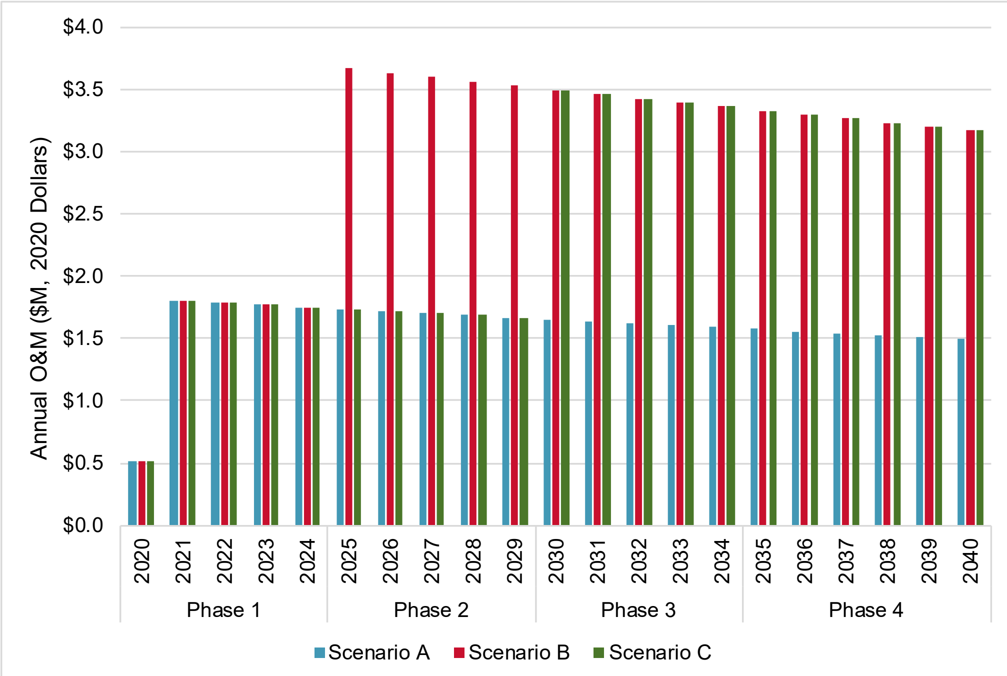


Figure 8-33. JMMCRWRP Single Pass RO Annual O&M Cost Summary

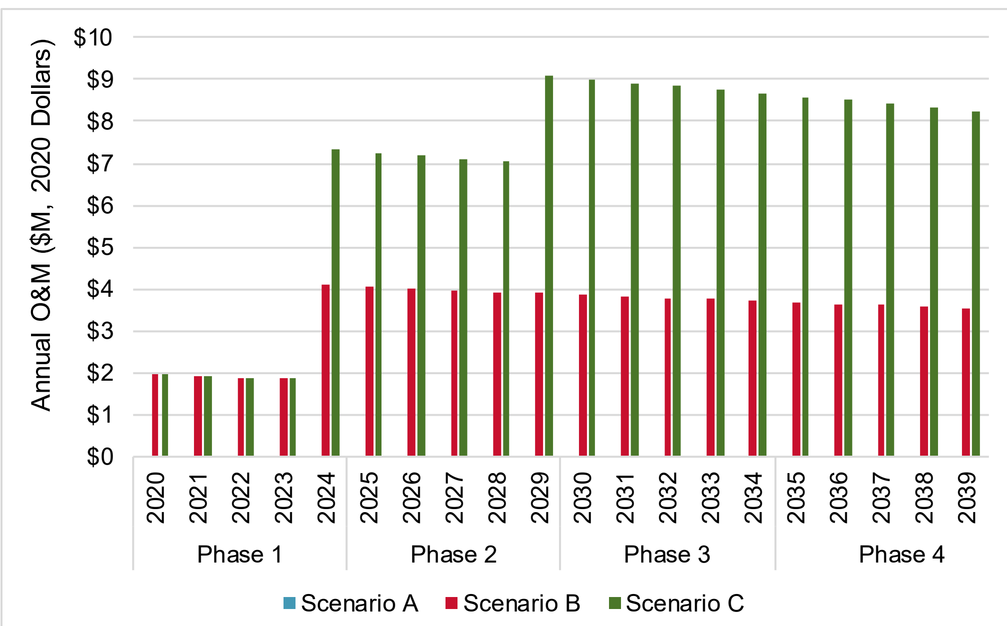


Figure 8-34. TRWRP Single Pass RO Expansion Annual O&M Cost Summary

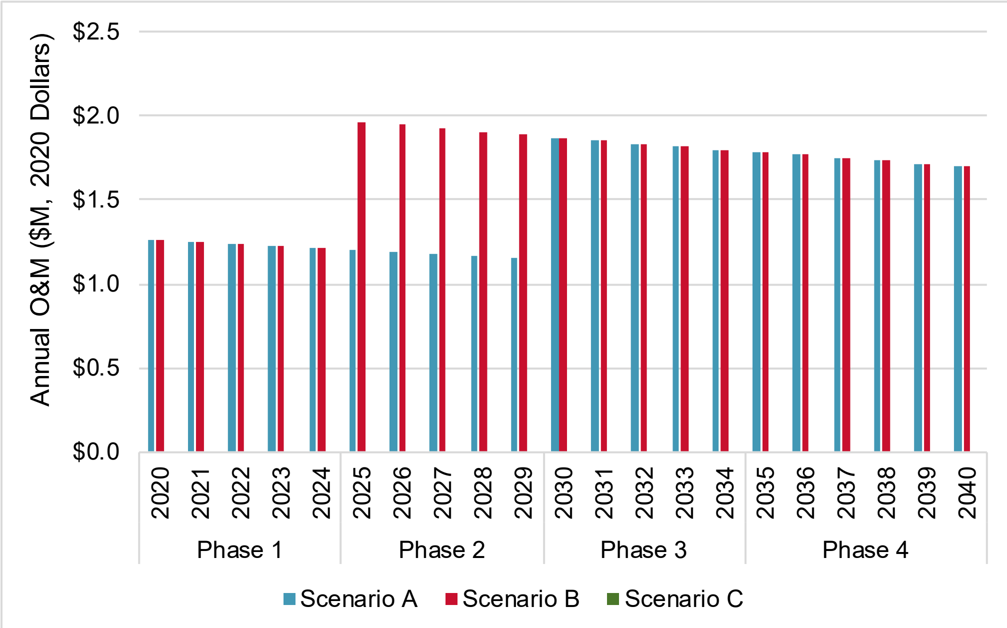
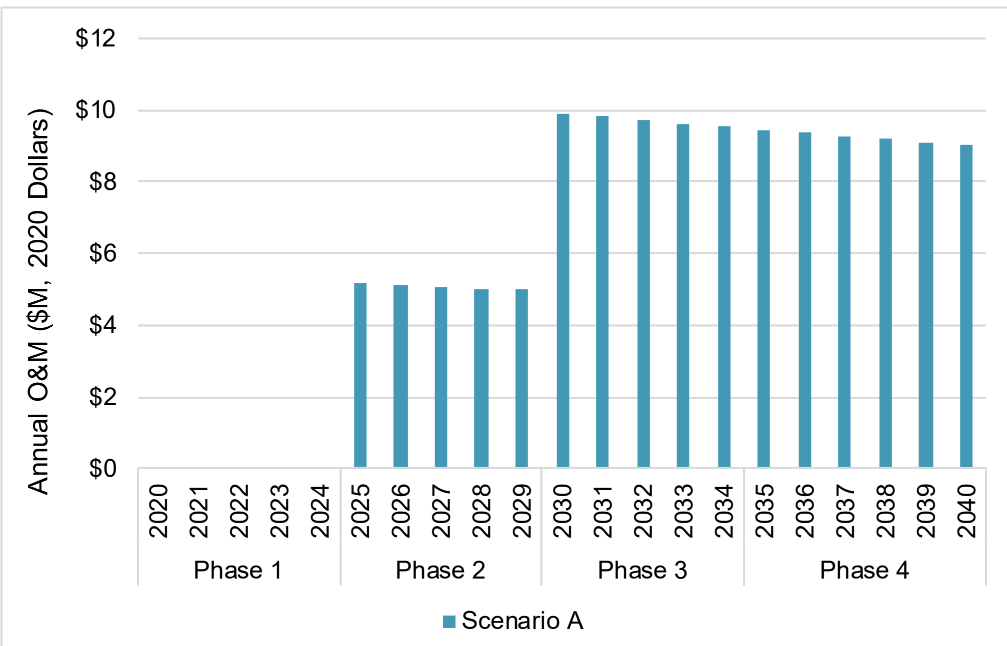


Figure 8-35. TRWRP IPR Addition Annual O&M Cost Summary



8.5.3 Scenario Implementation

This Master Plan has presented two alternatives for system optimization and three scenarios that allow West Basin to reach its goal to expand to approximately 70 mgd of recycled water production capacity.

Two of the expansion scenarios are dependent on West Basin's ability to negotiate favorable terms for the sale of recycled water to neighboring agencies for either groundwater augmentation (Scenario A) or industrial uses (Scenario C). Triggers for going down one path or another may be based on the timing of neighboring agency programs and decisions that lie outside of the District's control.

This section describes the issues at hand and a proposed implementation strategy for long term improvements and expansion. Figure 8-36 provides a graphical representation of the recommended implementation strategy. Regardless of which scenario is selected, system process optimization improvements are recommended to be implemented in Phase 1 because of overall reduced life cycle costs.

This Master Plan presents information on what it would cost for West Basin to convert to full tMBR facilities. It is anticipated that this information will be used to assess the District's option for partnering with LASAN to make MBR improvements at HWRP for improved secondary effluent quality or to invest in tMBR facilities at ECLWRF to accomplish that same goal. It is anticipated that this decision would be made within the next 5 years. These decisions also impact the need for use of tMBRs at the Satellite Plants to improve water quality.

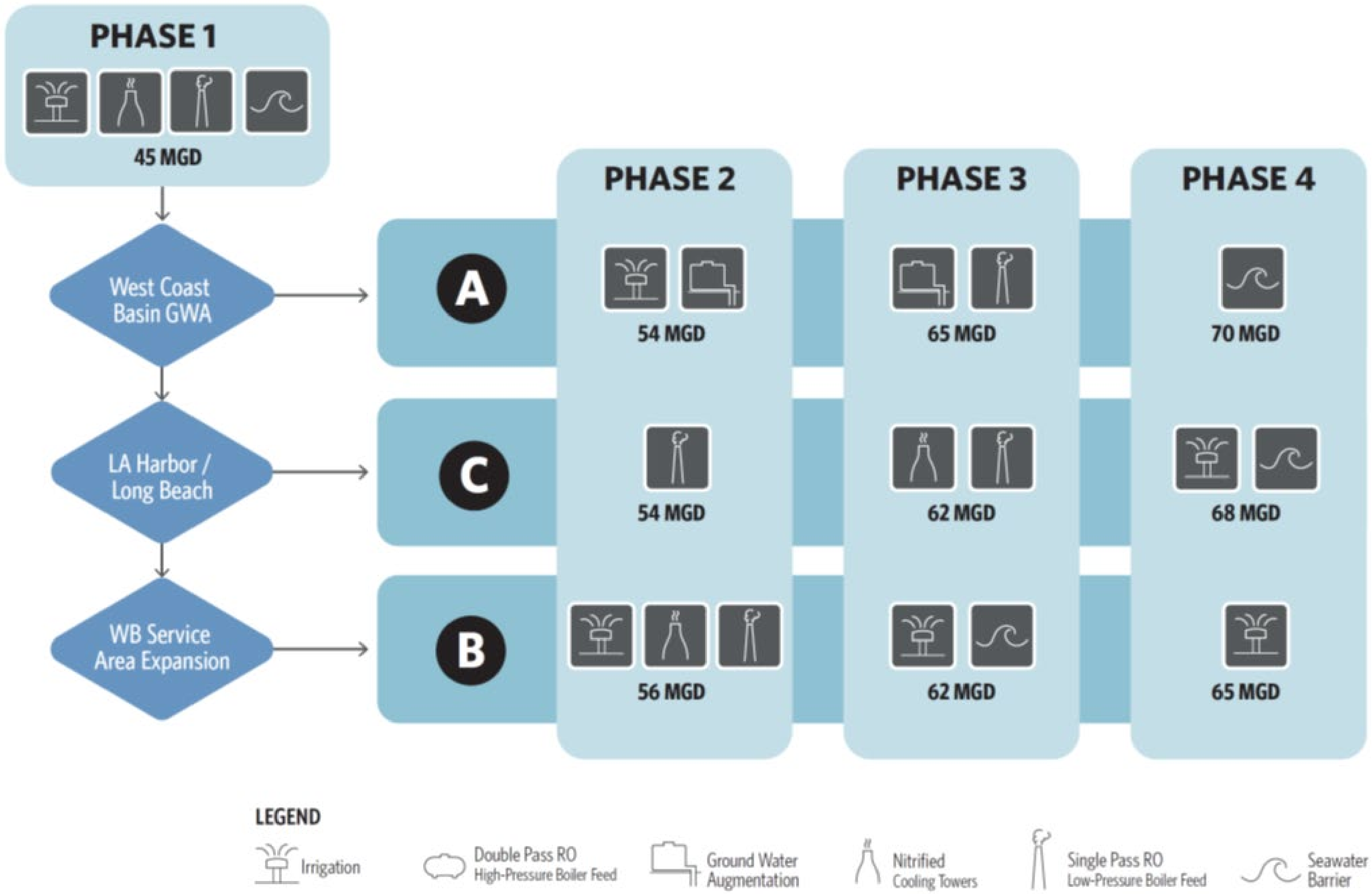
In addition, under Phase 1, West Basin has the opportunity to maximize use of existing facilities to ECLWRF to capture Tier 1 and 2 customers, located along existing Title 22 distribution pipelines and implement the planned expansion of the JMMCRWRP.

For Scenario A, it is anticipated that by 2026, a decision will be made by the City of Los Angeles and WRD on where to obtain source water for expansion of groundwater augmentation in the West Coast groundwater basin. With expansion of the ECLWRF, West Basin is in a position to ultimately deliver up to 20,000 afy for groundwater augmentation. This scenario requires the least amount of facility improvements, both for treatment and distribution, and should be considered a priority for implementation. In conjunction with the groundwater augmentation project, West Basin would continue to advance recycled water expansion projects within the District boundary.

If an agreement for groundwater augmentation is not obtainable by 2026, West Basin may then consider delivering single pass RO water via the JMMCRWRP to LADWP to serve industrial facilities in the LA Harbor and the City of Long Beach. There is sufficient demand in this area such that West Basin would not need to advance non potable water expansion projects within its District boundary but could still expand delivery of recycled water for expansion of the West Coast Barrier System.

Should West Basin not come to an agreement with neighboring agencies under Scenarios A or C, the District does have opportunities within its boundaries to expand recycled water use to offset irrigation and potential future industrial demands to support refinery expansions under Scenario B.

Figure 8-36.Trigger-Based Implementation Strategy for Long Term Improvements and Expansion



8.6 Proposed Future Distribution System Scenarios

This section recommends distribution system improvements based on the phased expansion scenarios discussed in Section 8.2, including Scenarios A, B, and C. As outlined in Figure 8-1, each of these scenarios includes a combination of distribution service area expansion and increased capacity at various treatment facilities

The expansion recommendations made in Section 8.2 are based in part on available capacity in the District's distribution systems, including the Title 22 system and the dedicated satellite systems. Therefore, most recommended distribution system improvements in this section are related to service area expansion, and limited improvements are recommended for the District's existing distribution and conveyance system facilities.

Additionally, Phase 1 assumptions are shared by all the expansion scenarios, and some service area expansion projects are shared between scenarios. This section includes recommended improvements for the following:

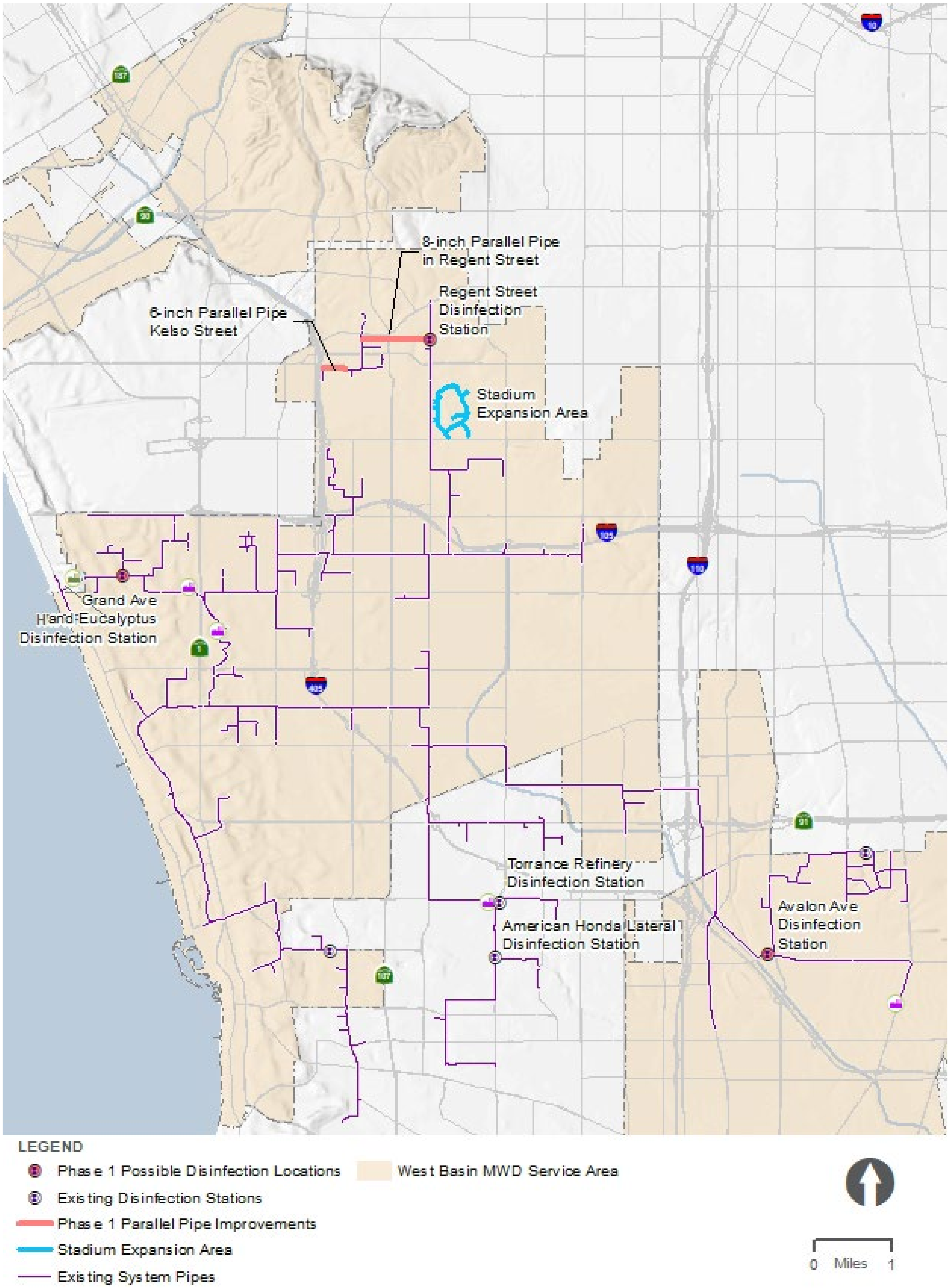
- Phase 1 Recommended Improvements
- Title 22 Distribution System Expansion
- Carson RO Distribution System Expansion
- Satellite System and Dedicated Conveyance System Upgrades

8.6.1 Phase 1 Recommended Improvements

Phase 1 demand loading requires capacity improvements for the existing distribution system. Phase 1 capacity improvements are related to local issues and are recommended for all phased expansion scenarios. These capacity related improvements include installing pipes parallel to existing system pipes at two locations shown in Figure 8-37. These locations are in the northern most area of the existing distribution system owned by the District and include a parallel 8-inch pipe in Regent Street and a parallel 6-inch pipe in Kelso Street.

Phase 1 water quality improvement recommendations include installing additional disinfection stations based on existing system water quality. Three possible locations are shown in Figure 8-37 based on existing system water quality. However, it is anticipated that implementing the Phased System Expansion options will improve distribution system water quality due to increased system demand (decreasing water age) and improved ECLWRF effluent water quality (reducing nutrients). Following the treatment plant improvements and increased system demands, the dynamic effects of improved water quality and decreased water age on biofilm growth in the distribution system will need to be validated by water quality sampling in the distribution system to determine the need for additional disinfection stations.

Figure 8-37. Phase 1 Recommended Title 22 Distribution System Improvements



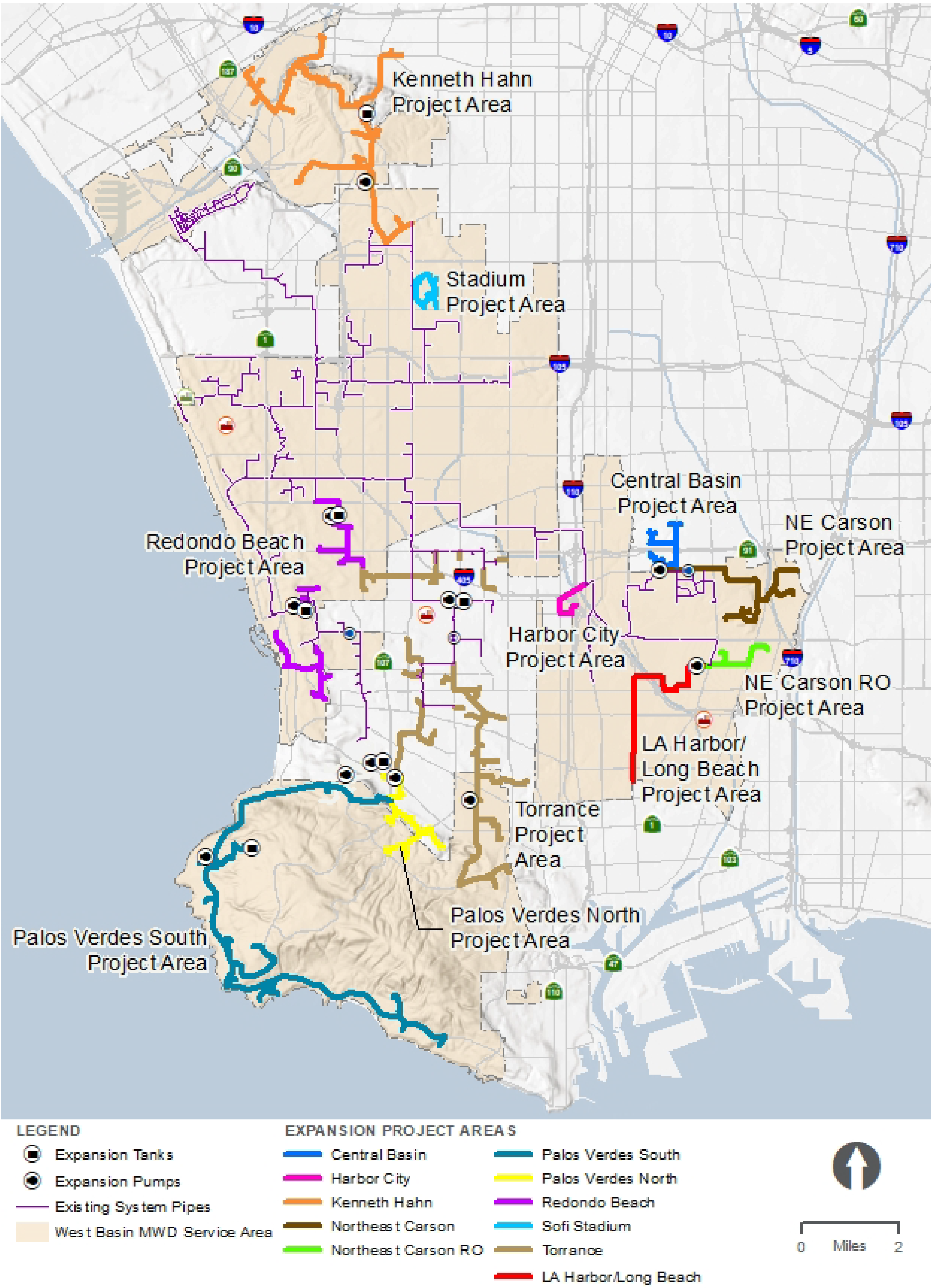
8.6.2 System Expansion Areas

Phased Expansion Scenarios A, B, and C include proposed system expansion projects to serve areas both inside and outside of West Basin's current service area. This section discusses the proposed facility expansion, including proposed distribution networks and facilities. The expansion areas can be categorized as Title 22 system expansion areas and JMMCWRP Single Pass RO distribution expansion areas, including:

- Title 22 System Expansion Areas
  - Kenneth Hahn
  - Harbor City
  - Redondo Beach
  - Torrance
  - Palos Verdes North
  - Palos Verdes South
  - Central Basin
  - Northeast Carson
- JMMCWRP Single Pass RO Distribution System Expansion Areas
  - Northeast Carson RO
  - Los Angeles Harbor/ Long Beach Connection

Proposed facilities to serve the system expansion areas are displayed in Figure 8-38 and detailed in the following sections.

Figure 8-38. System Expansion Areas



Title 22 System Expansion Areas

Phased Expansion Scenarios A and B include ten proposed Title 22 distribution system expansion areas, including the already planned Stadium and Palos Verdes Lateral areas. Proposed system expansion to these areas is discussed in the following subsections. Potential customer numbers are shown in the figures for the individual expansion areas. These numbers correspond with the object identifier numbers in the potential customer GIS files prepared for this Master Plan, which are also included as Appendix Q.

Kenneth Hahn Expansion Area

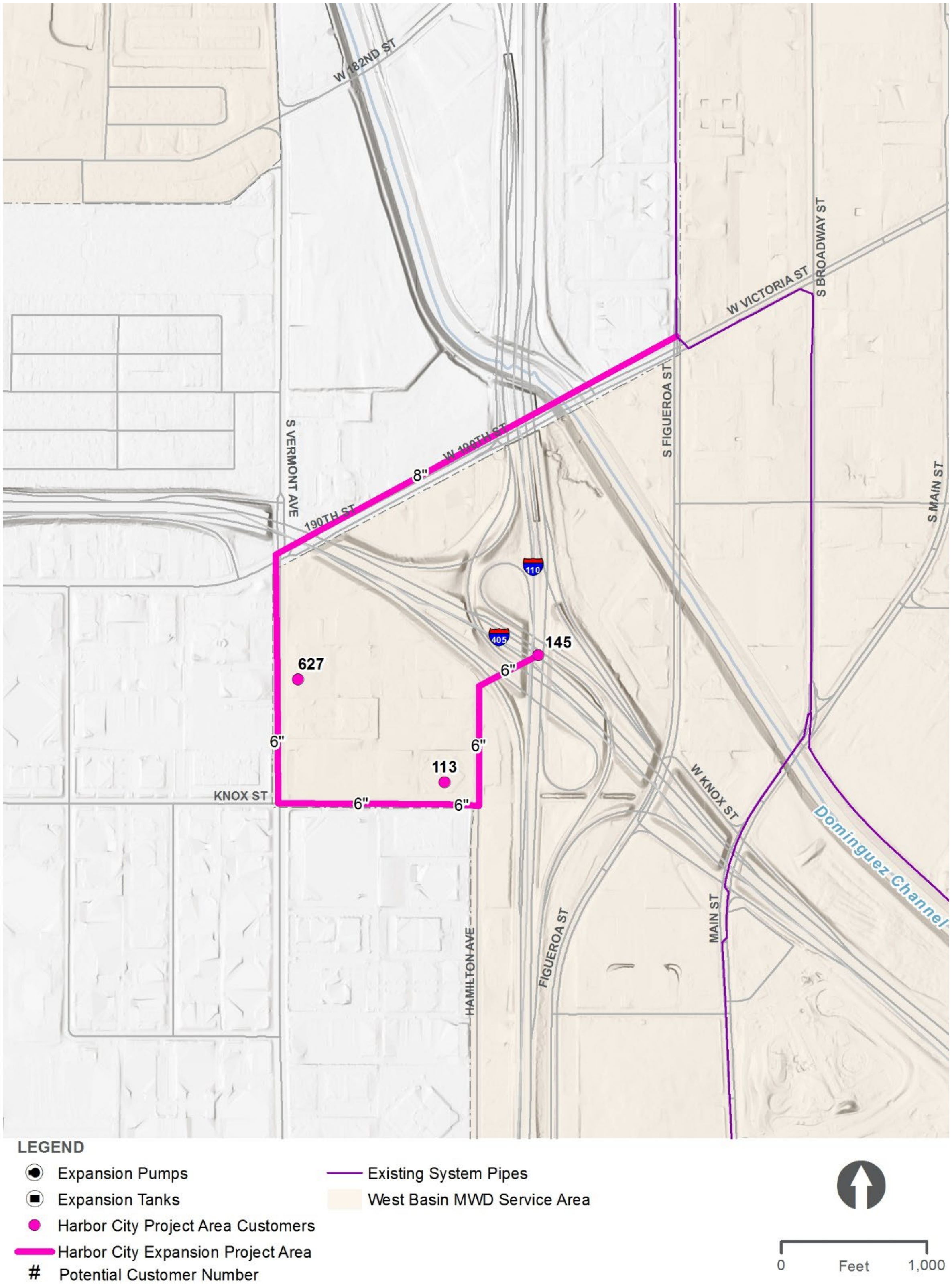
The Kenneth Hahn expansion project extends the existing Title 22 system at Florence Avenue and Prairie Avenue, as shown in Figure 8-39. The project includes approximately 17 miles of pipe, a booster pump station, and a 1.3 MG reservoir with disinfection station. For planning purposes, the project is divided into three phases, the first of which includes the BPS and reservoir. This project is projected to deliver up to 707 afy to new customers.

Harbor City Expansion Area

The Harbor City expansion project connects to the existing Title 22 distribution system at Victoria Street and Figueroa Street, as shown in Figure 8-40. The expansion includes a single pipeline crossing under the I-110 and I-405 freeways via underpasses. This project is projected to deliver up to 313 afy to new customers.

Figure 8-39. Kenneth Hahn Expansion Area

Figure 8-40. Harbor City Expansion Area



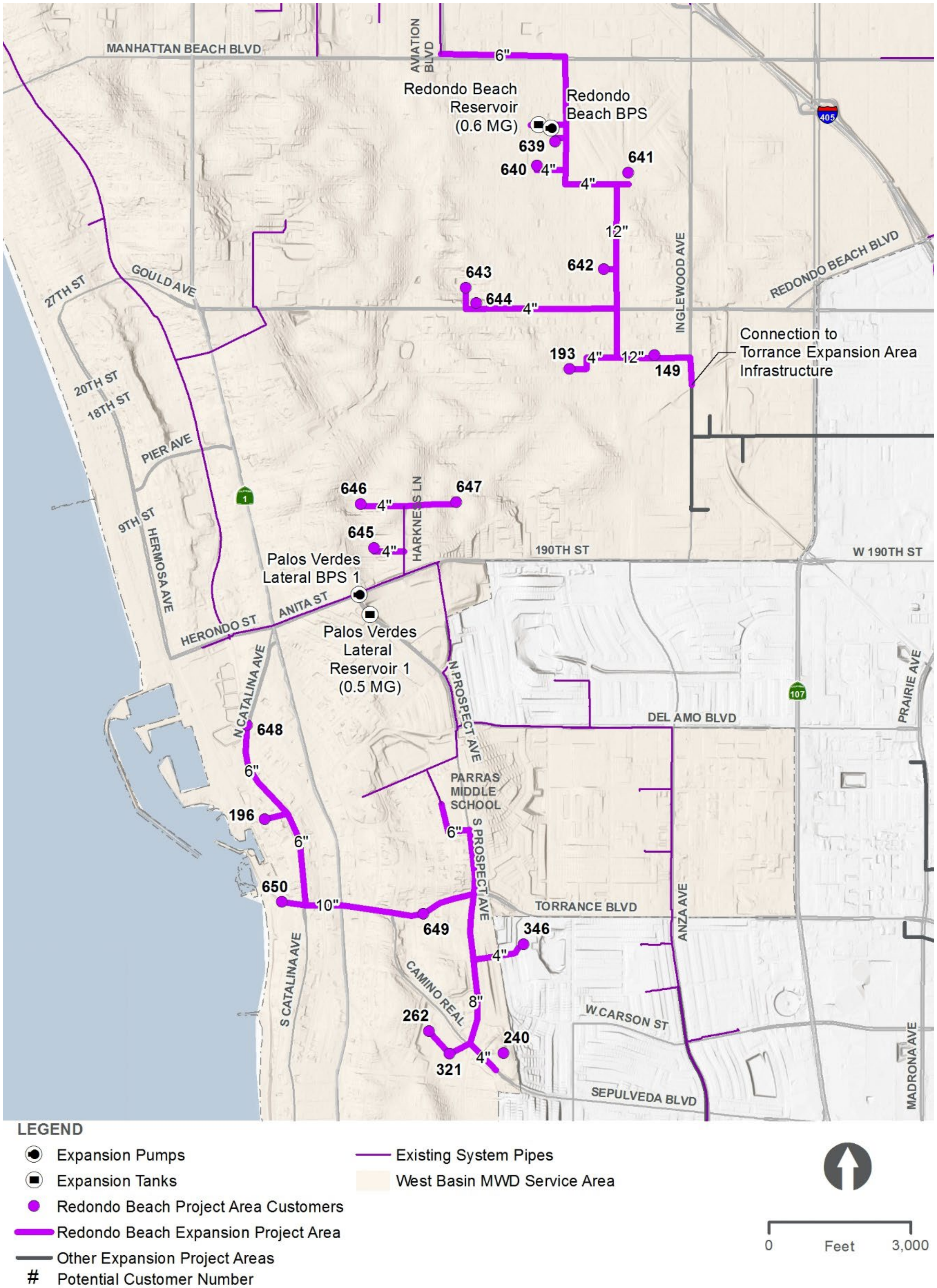
Redondo Beach Expansion Area

Redondo Beach expansion area projects include expansion off the existing Title 22 distribution system at four locations, as shown in Figure 8-41. This project is projected to deliver up to 150 afy to new customers.

The southernmost expansion area connects to the existing system at Parras Middle School. North of this location are two more connection points to the existing system on Harkness Lane. These three connection locations would be influenced by the Palos Verdes Lateral BPS 1 located on Anita Street. The Palos Verdes Lateral Reservoir 1 is sized to minimize peak flows from the existing distribution system for these Redondo Beach demand locations, and the BPS will provide additional head needed for the higher elevations in system expansion area.

The northernmost expansion area connects to the existing system at Manhattan Beach Boulevard and Aviation Boulevard. This expansion area includes the proposed Redondo Beach Reservoir, a 0.6 MG reservoir to minimize the peak flows required from the existing distribution system, and the Redondo Beach BPS to provide increased head for the higher elevations of proposed customers. The Redondo Beach BPS would also provide flow and head to a portion of the proposed Torrance expansion area, discussed in the Torrance subsection.

Figure 8-41. Redondo Beach Expansion Area



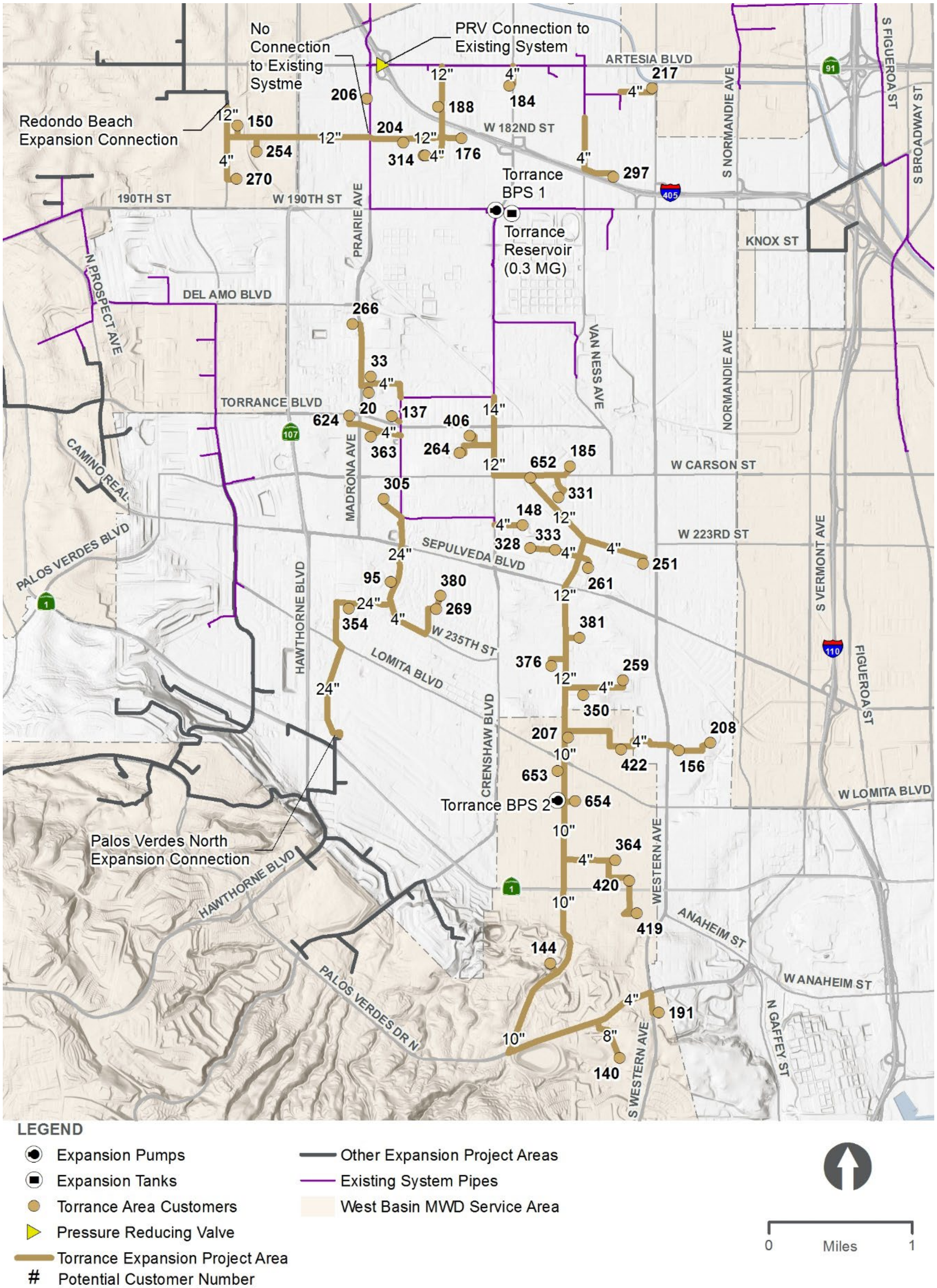
Torrance Expansion Area

The Torrance expansion area projects expand the existing Title 22 distribution system as shown in Figure 8-42. This project is projected to deliver up to 874 afy to new customers.

Proposed system expansion occurs in two general areas. The northernmost expansion location is proposed to connect to the Redondo Beach expansion area on Inglewood Avenue. This area of the Torrance expanded system would be supplied by the proposed Redondo Beach BPS, and the proposed Redondo Beach Reservoir would limit the flows from the existing distribution system required to meet the peak expansion area demands. The expanded distribution system would cross the existing transmission line in Prairie Avenue and connect to the existing distribution system in Artesia Boulevard with the Redondo Beach BPS providing additional head to this area of the distribution system. A pressure reducing valve is recommended at Artesia Boulevard and Prairie Avenue for a redundant connection to the existing system. No additional pipe is needed for this connection since the system is currently looped at this intersection.

The southern Torrance expansion area would connect to the existing system downstream of the Torrance Refinery and expand the system south to Palos Verdes Drive. A new 0.3 MG reservoir and BPS, referred to as the Torrance Reservoir and Torrance BPS 1, would minimize existing system flows required to meet peak demands in the expansion area and provide additional head to meet pressure criteria. The proposed expanded system in this area would include two branches. The southeast branch would connect to the existing system in Crenshaw Boulevard and expand south to Palos Verdes Drive and include an additional BPS south of Lomita Boulevard to serve the higher elevations of the expanded system. The southwest branch would connect to the existing system north of Sepulveda Boulevard and extend south to near the Pacific Coast Highway where it would connect with the proposed Palos Verdes North expansion area, as discussed in the Palos Verdes North subsection.

Figure 8-42. Torrance Expansion Area



Palos Verdes North Expansion Area

The Palos Verdes North expansion area project includes expanding the distribution system off the proposed Torrance expansion area distribution system south of the Pacific Coast Highway, as shown in Figure 8-43. Therefore, flows to the Palos Verdes North expansion area would be conveyed by Torrance BPS 1 and a portion of the proposed Torrance expansion system. This project is projected to deliver up to 519 afy to new customers.

The Palos Verdes North system would connect to the Torrance system at Madison Street and Airport Drive via the Palos Verdes North BPS, required to provide increased head to the higher elevation customers in the expansion area. The Palos Verdes North system would also connect to the Palos Verdes South system, as shown in Figure 8-43, and convey flows to that expansion area. Therefore, the Palos Verdes North BPS was sized to also supply Palos Verdes South expansion area demands, as discussed in the Palos Verdes South subsection.

Palos Verdes South Expansion Area

The Palos Verdes South expansion area project includes expanding the distribution system off the proposed Palos Verdes South expansion area, as shown in Figure 8-44. This project is projected to deliver up to 1,722 afy to new customers.

The system would connect at Via Valmonte and Hawthorne Boulevard and extend east to Palos Verdes Drive, circling most of the Palos Verdes Peninsula via this thoroughfare. Due to the proposed configuration of the expansion area networks, flows to the Palos Verdes South expansion area would be conveyed via the Torrance BPS 1 and the Palos Verdes North BPS and portions of the Torrance and Palos Verdes North distribution networks.

The Palos Verdes South expansion system would include a combination reservoir and BPS to minimize the flows required from the upstream distribution system needed to satisfy peak flows in the expansion area and to provide required head to the system. The Palos Verdes South BPS would pump to the 3.5 MG Palos Verdes South Reservoir, located off Via Zurita near George Allen Field at an elevation of approximately 700 feet. The head provided by a reservoir at this elevation is anticipated to provide required pressure to most of the proposed downstream system, although some proposed customers at higher elevations may require local BPS, as shown in Figure 8-44.

Central Basin Expansion Area

The Central Basin expansion area project includes expanding the existing Title 22 distribution system north of Victoria Street near Central Avenue as shown in Figure 8-45. This project is projected to deliver up to 172 afy to new customers.

This expansion project includes a BPS that could be shared with the Northeast Carson expansion area. The Central Basin/ Northeast Carson BPS would connect to the existing 24-inch pipe in Victoria Street upstream of the existing transition to a 10-inch pipe leading to the Dominguez BPS. The proposed Central Basin expansion system would extend the service area north of California State Route 91 via the existing Central Avenue overpass.

Figure 8-43. Palos Verdes North Expansion Area

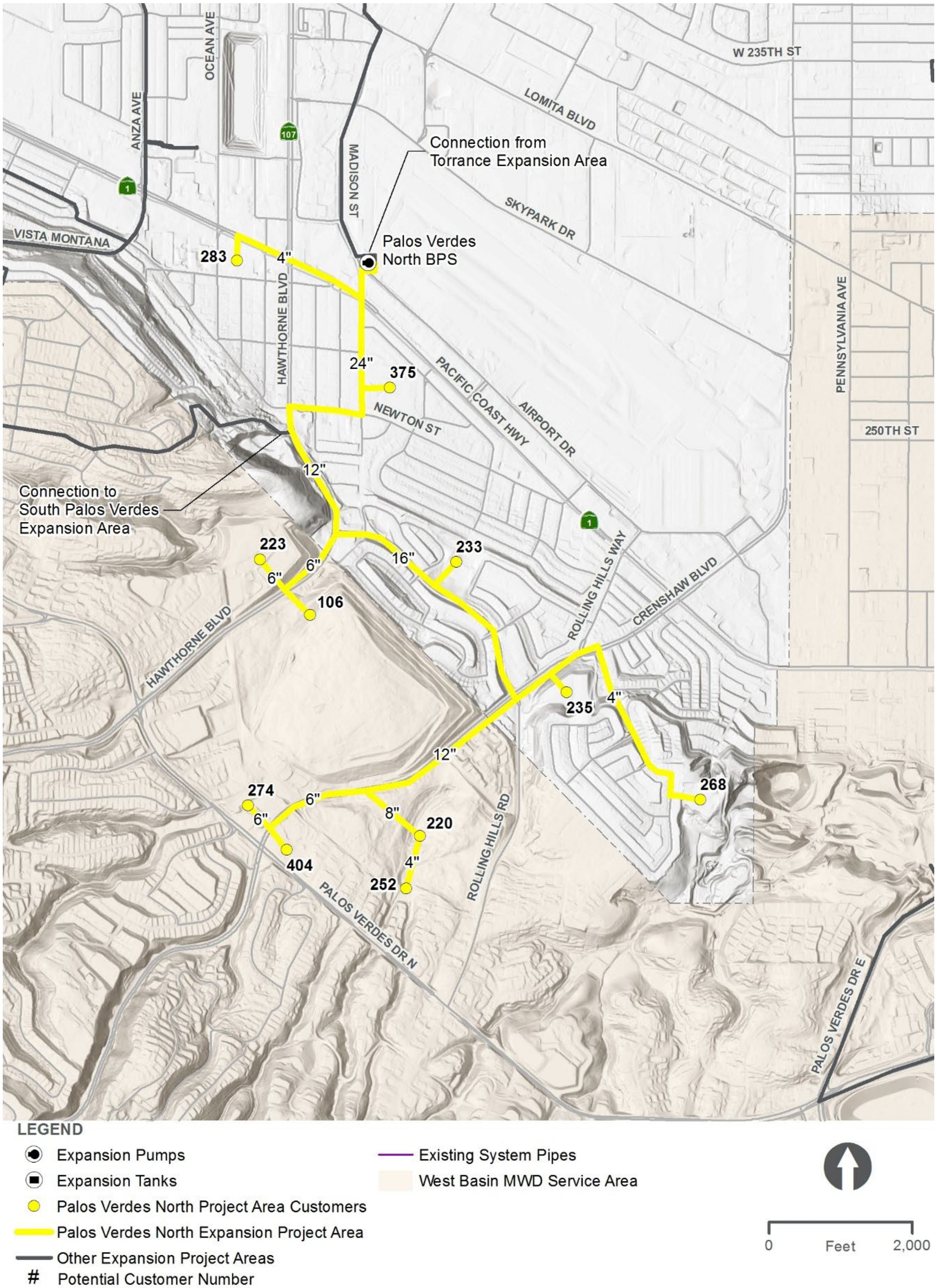
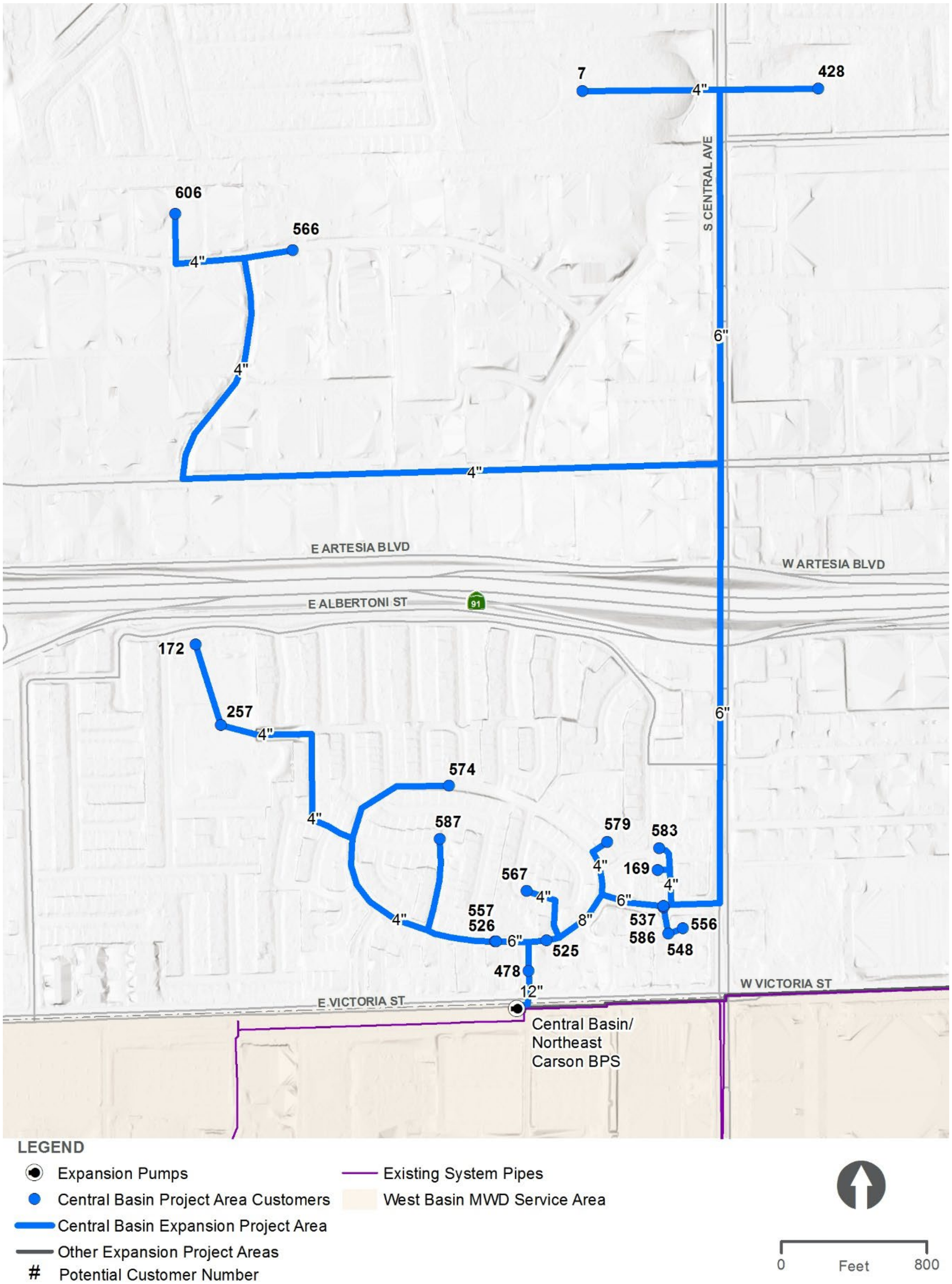


Figure 8-44. Palos Verdes South Expansion Area

Figure 8-45. Central Basin Expansion Area



Northeast Carson Expansion Area

The Northeast Carson expansion area project includes expanding the existing Title 22 distribution system east of the existing Dominguez Hills area as shown in Figure 8-46. This project is projected to deliver up to 948 afy to new customers.

This expansion project includes a BPS that could be shared with the Northeast Carson expansion area, as discussed in the previous subsection. From the Central Basin/ Northeast Carson BPS, the system would be expanded west on Victoria Street via a dedicated pipeline bypassing the existing Dominguez BPS to the expansion area. The expansion system includes two rail crossings near Alameda Street.

JMMCWRP Single Pass RO Distribution System Expansion Areas

Phased Expansion Scenarios B and C each include a proposed system expansion downstream of the JMMCWRP for the purposes of delivering advanced treated RO quality water. Proposed system expansion to these areas is discussed in the following subsections.

Northeast Carson RO Expansion Area

The Northeast Carson RO expansion area project includes expanding the distribution system west of the JMMCWRP as shown in Figure 8-47. This project is projected to deliver up to 1,055 afy to new customers.

This expansion project includes adding a dedicated pump station at JMMCWRP and installing approximately two miles of pipe, primarily along Dominguez Street and Alameda Street, to convey RO quality water to customers in the expansion area.

Los Angeles Harbor/ Long Beach Connection

The LA Harbor/ Long Beach Connection system expansion project includes installing a 4.4 mile 30-inch transmission line from the JMMCWRP to the Los Angeles Department of Water and Power distribution system at Avalon Boulevard and Bonds Street. This project is projected to deliver up to 10,600 afy to new customers.

The alignment shown in Figure 8-48 includes a crossing of Interstate 405 via an existing underpass. Additionally, a pump station would need to be installed at the JMMCWRP to provide enough head to meet the estimated 150 psi system pressure at the connection point.

Figure 8-46. Northeast Carson

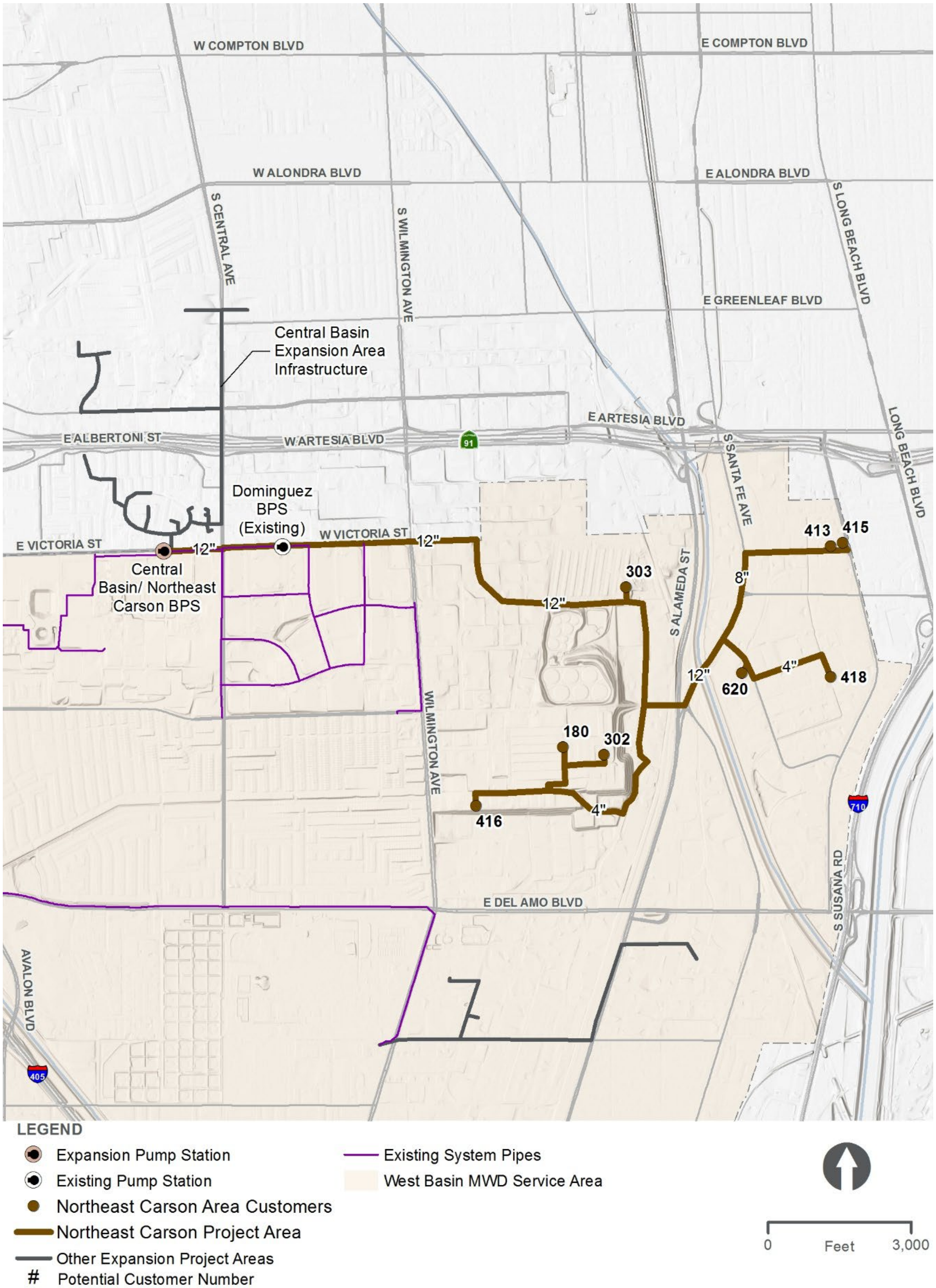


Figure 8-47. Northeast Carson RO

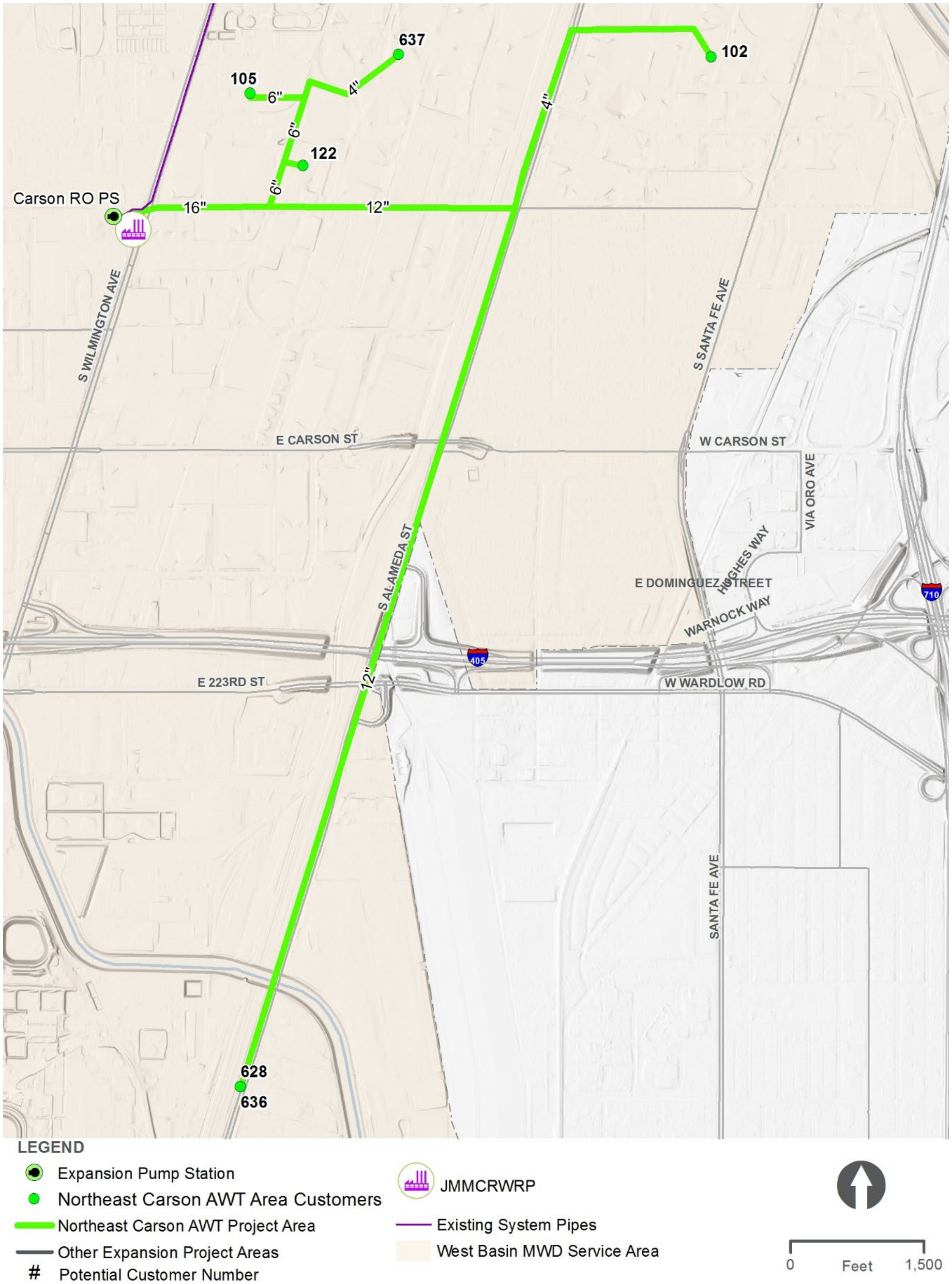
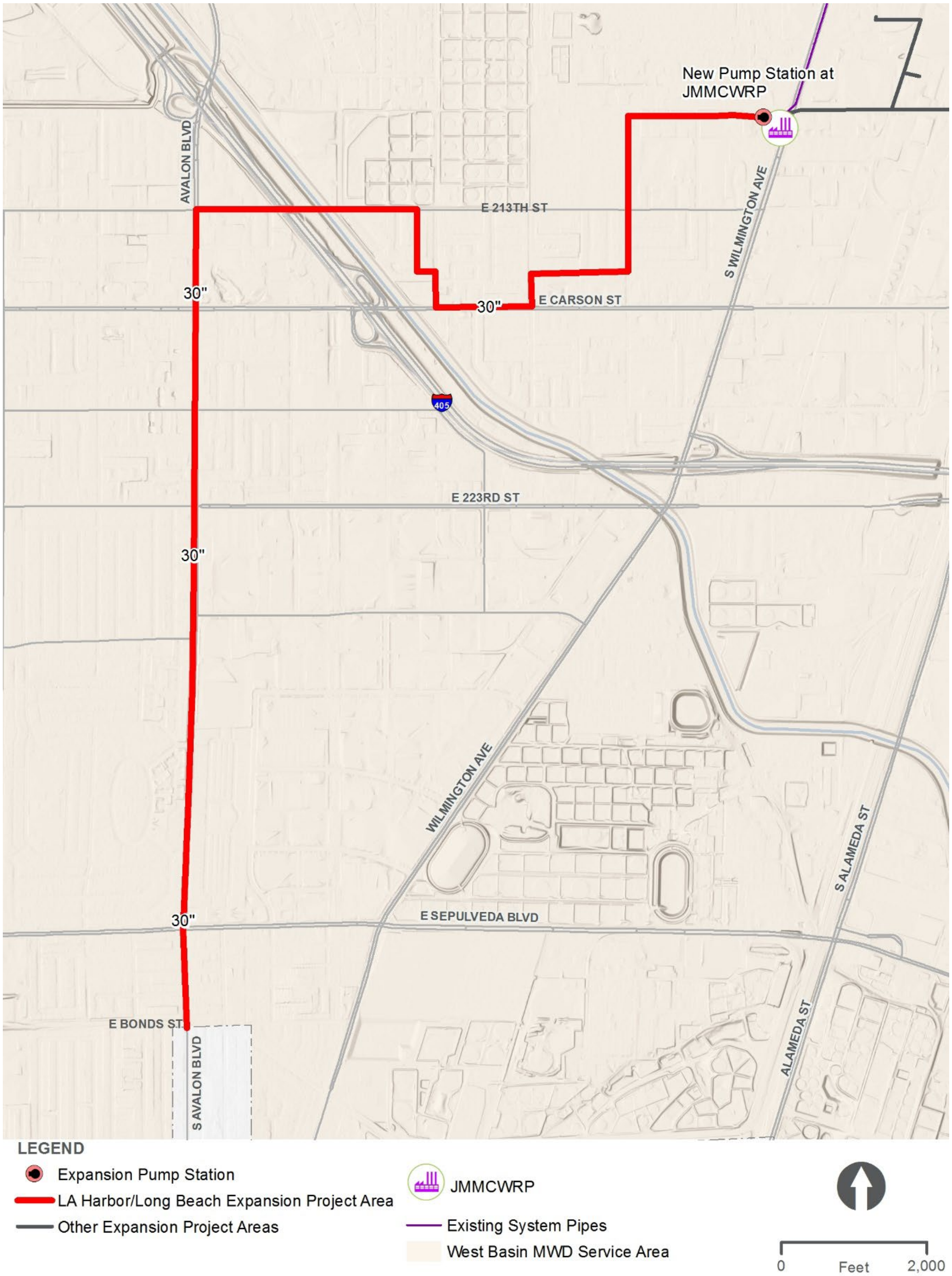


Figure 8-48. Los Angeles Harbor/Long Beach Connection



8.6.3 Satellite and Dedicated Conveyance System Upgrades Improvements

Scenarios A, B, and C include increased capacities in existing satellite and/ or dedicated conveyance systems. Capacities were assessed based on existing system estimated capacities (discussed in Chapter 7). Table 8-17 summarizes required improvements for each scenario, indicating four systems that would require upgrades to accommodate increased capacities for the expansion scenario projects. Table 8-18 indicates that the four systems listed have sufficient capacity for all three scenarios.

Table 8-19 through Table 8-22 indicate which improvements are required for each expansion project scenario and an estimated capital cost. Detailed cost estimates for these conveyance system improvements are provided in Appendix P.

Table 8-17. Satellite and Dedicated Conveyance System Improvements Required per Scenario

System	Required Improvement		
	Scenario A	**Scenario B**	**Scenario C**
Chevron LPBF	PS (600 gpm)	PS (600 gpm)	PS (600 gpm)
Marathon/ Carson LPBF	-	PS (5,175 gpm)	PS (13,800 gpm) Pipeline (24" x 1.0 mile)
Marathon/ Carson Nitrified	PS (3,125 gpm) Pipeline (8" x 1.0 mile)	PS (6,250 gpm) Pipeline (16" x 1.0 mile)	PS (6,250 gpm) Pipeline (16" x 1.0 mile)
JMMCRWRP Brine Line	-	Pipeline (16" x 5.4 miles)	Pipeline (24" x 5.4 miles)
Hyperion Force Main	No improvements required		
ECLWRF Brine Line	No improvements required		
Chevron HPBF	No improvements required		
Chevron Nitrified Treatment Plant	No improvements required		

Table 8-18. Systems with Sufficient Capacity

System	Existing System Capacity [1]	Required Flow per Scenario [1]		
		Scenario A	**Scenario B**	**Scenario C**
Hyperion Force Main	89	83.1	86.2	86.2
ECLWRF Brine Line [2]	5.8	4.0	4.0	4.0
Chevron HPBF	2.6	2.6	2.6	2.6
Chevron Nitrified Treatment Plant	5.2	4.9	4.9	4.9

[1] Source: Chapter 7.
[2] Capacity if operated as a pressurized system, see Chapter 7 for recommendations.

Table 8-19. Chevron Low Pressure Boiler Feed Improvements

Parameter		Scenario A	Scenario B	Scenario C
Required Flow (mgd)		2.2	2.2	2.2
Existing Firm PS Capacity (mgd)		1.7	1.7	1.7
Required PS Capacity (mgd) (adding additional Afton pump at 600 gpm)	Flow Needed (mgd)	0.5	0.5	0.5
	Flow Needed (gpm)	326	326	326
	Pumps Added	1	1	1
	Capacity Added (gpm)	600	600	600
	Pump Head (ft)	186	186	186
	Additional hp	20	20	20
Estimated Capital Cost		**$214,646**	**$214,646**	**$214,646**

Table 8-20. JMMCRWRP Refinery Boiler Feed (RO) Improvements

Parameter		Scenario A	Scenario B	Scenario C
Required Flow (mgd)		5.0	10.4	23.4
Existing Pipeline Capacity (mgd)		14.0	14.0	14.0
Required Additional Pipeline Capacity (mgd)				9.4
Parallel Pipe Diameter (at 7 fps)				24"
Existing PS Capacity (mgd)		5.0	5.0	5.0
Required Additional PS Capacity (adding additional Goulds pumps at 1,725 gpm each)	Flow Needed (mgd)		5.4	18.4
	Flow Needed (gpm)		3,750	12,778
	Pumps Added		3	8
	Capacity Added (gpm)		5,175	13,800
	Pump Head (ft)		320	320
	Additional hp		380	1,293
Estimated Capital Cost			**$4,078,279**	**$14,063,786**

Table 8-21. JMMCRWRP Nitrified Water System

Parameter		Scenario A	Scenario B	Scenario C
Required Flow (mgd)		4.6	9.6	9.6
Existing Pipeline Capacity (mgd)		3.6	3.6	3.6
Required Additional Pipeline Capacity (mgd)		1.0	6.0	6.0
Parallel Pipe Diameter (at 7 fps)		8"	16"	16"
Existing PS Capacity (mgd)		0.9	0.9	0.9
Required Additional PS Capacity (adding additional Goulds pumps at 625 gpm each)	Flow Needed (mgd)	3.7	8.7	8.7
	Flow Needed (gpm)	2,569	6,042	6,042
	Pumps Added	5	10	10
	Capacity Added (gpm)	3,125	6,250	6,250
	Pump Head (ft)	345	345	345
	Additional hp	281	682	682
Estimated Capital Cost		**$3,711,771**	**$8,994,971**	**$8,994,971**

Table 8-22. Carson Brine Line

Parameter	Scenario A	Scenario B	Scenario C
Required Flow (mgd)	0.88	1.84	4.13
Existing Pipeline Capacity (mgd)	1.1	1.1	1.1
Required Additional Pipeline Capacity (mgd)		0.74	3.03
Parallel Pipe Diameter (maintaining 8 psi at standpipe)		16"	24"
Estimated Capital Cost		**$9,180,528**	**$16,289,552**

8.6.4 Distribution System Improvements Cost Estimate

Table 8-23 through Table 8-25 provide cost summaries for distribution expansion and improvement projects, satellite system improvement projects, and a summary cost of estimated distribution system improvement costs, in 2020 dollars, for each Scenario A, B, and C. Detailed cost estimates for these conveyance system improvements are provided in Appendix P. Although Tier 1 and 2 laterals are listed as Phase 1, in reality these individual projects to add nearby customers will likely extend throughout the planning period. For the Capital Improvement Program, it has been assumed that $22 million will be expended by 2030 to capture these customers, and the program would be revisited at that point to reassess the viability of the remaining Tier 1 and 2 customers on the list.

Table 8-23. Distribution System Expansion Project Summary

Phase	Project	Pipe (miles)	Reservoirs (MG)	Pump Stations	Disinfection Stations	Annual Demand (afy)	Capital Cost ($m)
Phase 1	Tier 1 & 2 Laterals and existing system Capacity improvements	70.6	0	0	2-3 (to address existing water quality issues)	1,634	37.6
Scenario A & B	Northeast Carson	5.6	0	0.5 (w/ Central Basin)	0.5 (w/ Central Basin)	948	6.7
	Harbor City	1.3	0	0	0	313	1.2
	Kenneth Hahn	16.2	1 (1.3 MG)	1	1	707	19.9
Scenario B	Central Basin	3.4	0	0.5 (w/ NE Carson)	0.5 (w/ NE Carson)	172	2.5
	Redondo Beach	7.5	1 (0.6 MG)	1	1	150	8.2
	Torrance	20.4	1 (0.25 MG)	2	1	874	27.7
	Palos Verdes North	4.8	0	1	1	519	11
	Palos Verdes South	13.1	1 (3.5 MG)	1	1	1,722	35.4
	Northeast Carson RO	2	0	1	0	1,055	7.3
Scenario C	LA Harbor/ Long Beach	4.5	0	1	0	10,600	33.7

Table 8-24. Satellite and Dedicated Conveyance System Improvements

Project	Chevron LPBF ($m)	Carson/ Marathon RO ($m)	Carson/ Marathon Nitrified ($m)	Carson Brine Line ($m)	Total Estimated Cost ($m)
Scenario A	$0.21		$3.71		$3.93
Scenario B	$0.21	$4.08	$8.99	$9.18	$22.47
Scenario C	$0.21	$14.06	$8.99	$16.29	$39.56

Table 8-25. Satellite and System Expansion Distribution Cost Summary

Scenario	System Expansion Projects ($m)	Satellite System Improvements ($m)	Total Estimated Cost ($m)
Scenario A	$41.38	$3.93	$45.31
Scenario B	$115.8	$22.47	$138.27
Scenario C	$35.4	$39.56	$74.96

Chapter 9 Capital Improvement Program

9.1 Introduction

As a part of the Recycled Water Master Plan, a Capital Improvement Planning tool was developed to support the District in making long-term capital planning decisions. This tool was used to evaluate the costs and sequencing of projects in different expansion scenarios, in addition to the needed reinvestment into the system for rehabilitation and replacement (R&R) projects. This tool is based in Microsoft Excel, and includes the following key functionality:

- Create treatment and distribution expansion scenarios
- Prioritize R&R projects
- Sequence R&R projects within a specified time and annual budget goal
- Adjust capital budgeting as implementation of the plan progresses

This chapter presents three different expansion scenarios in four phases (or time-periods) (Scenarios A, B, and C). It does not recommend a particular combination of these scenarios across phases; however, it does assume that the District will begin with Scenario A and proceed until external or internal decisions change the strategic direction for the District.

This chapter also presents a recommended implementation plan for R&R projects that focuses on completing these projects within 5 years and generally with respect to priority order. Ultimately the capital expenditure plan in this Master Plan will need to be flexible, and as described in Chapter 8, will allow the District to progress along different scenarios until an approach or market is deemed infeasible. The tool can easily be updated with new or additional projects and scenarios in the future.

9.2 Approach to Capital Improvement Planning Tool

The Capital Improvement Planning tool developed for West Basin is controlled by a central dashboard that allows the user to define the specific treatment and conveyance expansion projects within each scenario. Developed in fiscal year 2020-2021, this Master Plan defines three scenarios for future expansion of the recycled water system: A, B, and C. Each scenario is divided into four phases that represent 5 year time blocks. Phase 1 is 2020 through 2025, Phase 2 is 2025 through 2030, Phase 3 is 2030 through 2035 and Phase 4 is 2035 through 2040. The tool allows the user to select projects to create new scenarios and the phases in which those projects would be constructed. This provides flexibility in future planning, allowing the District to evaluate projects and proceed with the scenarios and phasing that fits their future goals. For instance, the District may decide to proceed with Scenario A to begin with, it may switch to Scenario B or C, or a new scenario, based on future conditions. The tool supports the District in maintaining a flexible, dynamic CIP that is reflective of the current drivers of the external and internal influences of local supply development for the West Basin service area.

9.2.1 Project Input

Projects are input on the “Projects” sheet. This sheet includes all relevant fields including project number, description, predecessor relationship, scenario and phase numbers, duration and costs. Durations and costs are input for planning, design, and construction for each project. Costs input into the Capital Improvement Planning tool are all in 2020 dollars. Although the tool allows for escalation to account for inflation, no escalation was included in this model.

Projects are categorized by expansion scenarios A, B, and C, and Phases 1, 2, 3, and 4. Additionally, the Capital Improvement Planning tool includes a second category of projects focused on the District's identified Rehabilitation and Replacement (R&R) projects. All relevant fields, particularly costs, cost curve modeling selections, and project durations are input into the tool

9.2.2 Budget Input

Inputting a budget is a key constraint for the tool when developing the R&R implementation schedule. The tool's automated schedule development feature requires a constraint in order for the process to work. This process is more thoroughly described under the "Prioritization" section of this chapter. The budget is input on the "Finance Input" sheet, where R&R budget is designated. This must be input each year that there will be R&R projects scheduled. The dollar number put in these cells will serve as the upper limit constraint in the scheduling of projects.

9.2.3 Staff Resource Input

An optional feature of the tool is to input staff resources, in terms of full-time equivalents (FTEs). There are several categories of staff that can be input, however the most common is project manager. An overall staff resource constraint may be entered as well as the time required for each individual project. If both of these data are included, an option is to constrain the scheduling algorithm, described in detail below.

No staffing resource data was incorporated into the Capital Improvement Planning tool for this Master Plan update.

9.3 Expansion Scenarios

As described in Chapter 8, three scenarios of expansion projects and corresponding market delivery for recycled were developed to maximize West Basin's use of recycled water. Figure 8-1 describes the timing of each phase, and how these phases were developed.

For the purposes of implementation planning, planning level costs for design and construction of the individual projects that were identified in each scenario. It is assumed that 10% of the total costs for each individual project was allocated for design and 90% for construction. Construction services cover items such as construction management, engineering services, materials testing, and inspection during construction. The Capital Improvement Planning tool added an additional 5% of the to account for District planning costs.

Another key feature of the Capital Improvement Planning tool is to describe the generally timing to complete capital projects. For future CIP projects, the general assumption used is projects under $7M are expected to have durations of 1 year for planning, 1 year for design, and 1 year for construction. Larger projects, those greater than $7M, have longer construction periods of 1 years. A small number of projects have 2-year planning, design, and construction periods. The Capital Improvement Planning tool includes each of these durations for each project. For R&R projects, anticipated costs were entered manually, to coincide with West Basin's current CIP planning models.

For future CIP projects, project cost curves were modeled in the tool using these durations, planning level cost estimates, and s-curves. An s-curve aims to represent the utilization of resources over the proposed time of the project. So rather than a straight line distribution of costs over the duration of a project, the S curve assumptions allow project costs to ramp up and down at the beginning and end of the project, such that, graphically, expenditures are shown in the shape of an S. S curves are applied individually to planning, design, and construction. Based on duration, the total cost curve is in then developed by the tool for each project.

The Capital Improvement Planning tool can develop any combination of scenarios across the four phases that the user wishes to model (Figure 9-1). Multiple scenarios can be compared by saving individual model runs. The user can design a new combination of scenarios on the dashboard using the controls below:

Figure 9-1. Dashboard Controls for Expansion Scenario Development

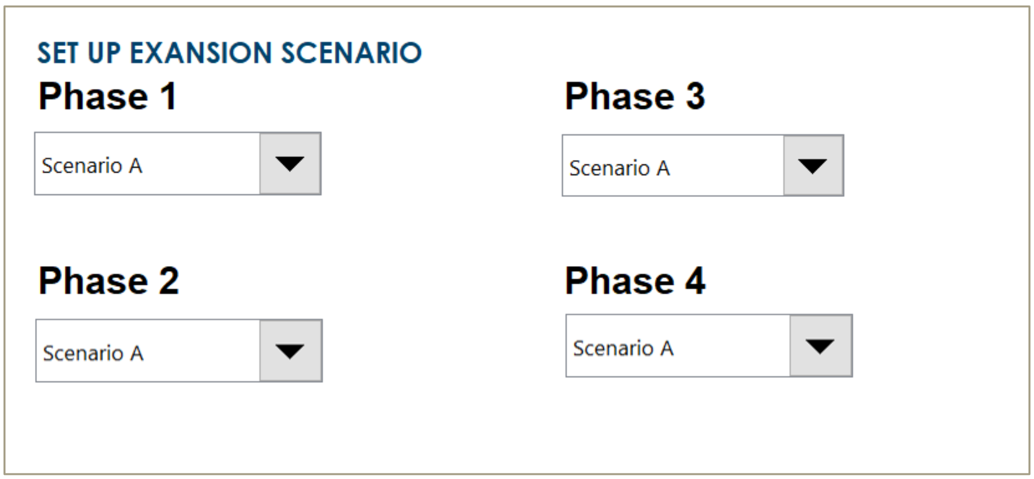


Table 9-1 provides a summary of the proposed expansion scenario costs by phase, as developed from treatment and conveyance costs established in Chapter 8 for each scenario. Figure 9-2 through Figure 9-4 show the annual capital investment for Scenarios A, B, and C. These costs are detailed in Table 9-2 through Table 9-4.

Table 9-1. Expansion Project Costs by Scenario and Phase

Scenario		Phase 1	Phase 2	Phase 3	Phase 4	Total
Scenario A	Treatment	$48,256,000	$103,297,000	$116,778,000	$52,720,000	
	Conveyance	$49,757,000	$21,450,000	$3,808,000	$0	
	Total	$98,013,000	$124,747,000	$120,586,000	$52,720,000	**$396,066,000**
Scenario B	Treatment	$32,850,000	$128,177,000	$27,774,000	$34,828,000	
	Conveyance	$49,757,000	$44,523,000	$47,452,000	$44,206,000	
	Total	$82,607,000	$172,700,000	$75,226,000	$79,034,000	**$409,567,000**
Scenario C	Treatment	$43,964,000	$85,668,000	$88,187,000	$52,720,000	
	Conveyance	$31,670,000	$0	$24,720,000	$7,000,000	
	Total	$75,634,000	$85,668,000	$112,907,000	$59,720,000	**$333,929,000**

Note: Costs are in 2020 dollars and rounded to nearest thousandth.

In Scenario A, increased capacity at ECLWRF and the JMMCRWRP, along with a new advanced treatment facility at the TRWRP, are proposed to be constructed over the next 10 years. Conveyance projects that are proposed in this Master Plan for the first 5 years (Phase 1) could be deferred to later years to balance annual budgets.

In Scenario B, increased capacity at ECLWRF, JMMCRWRP and TRWRP, are proposed to be constructed over the next 10 years. Similar to Scenario A, conveyance projects that are proposed in this Master Plan for the first 5 years, could be deferred to later years to balance annual budgets.

For Scenario C, increased capacity at both ECLWRF and the JMMCRWRP to serve industrial customers in LA Harbor/Long Beach area are proposed to be constructed over the next 10 years. Conveyance projects are minimal, as the focus of this Scenario is to serve industrial customers to the south and not expand recycled water use within the West Basin service area.

All scenarios include expansion improvements at ECLWRF for increased Barrier production by 5 mgd between 2030 and 2040.

Figure 9-2. Scenario A — Estimated Annual Capital Expenditures

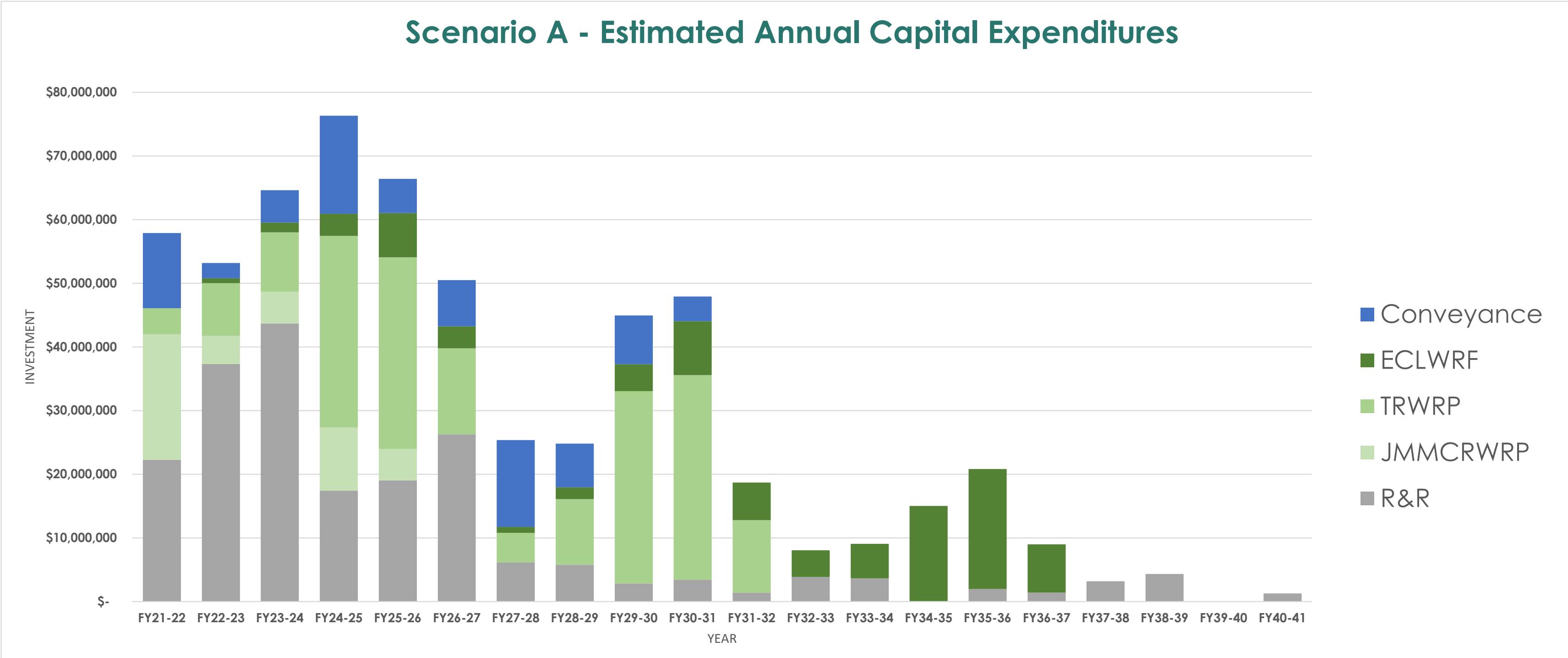


Figure 9-3. Scenario B — Estimated Annual Capital Expenditures

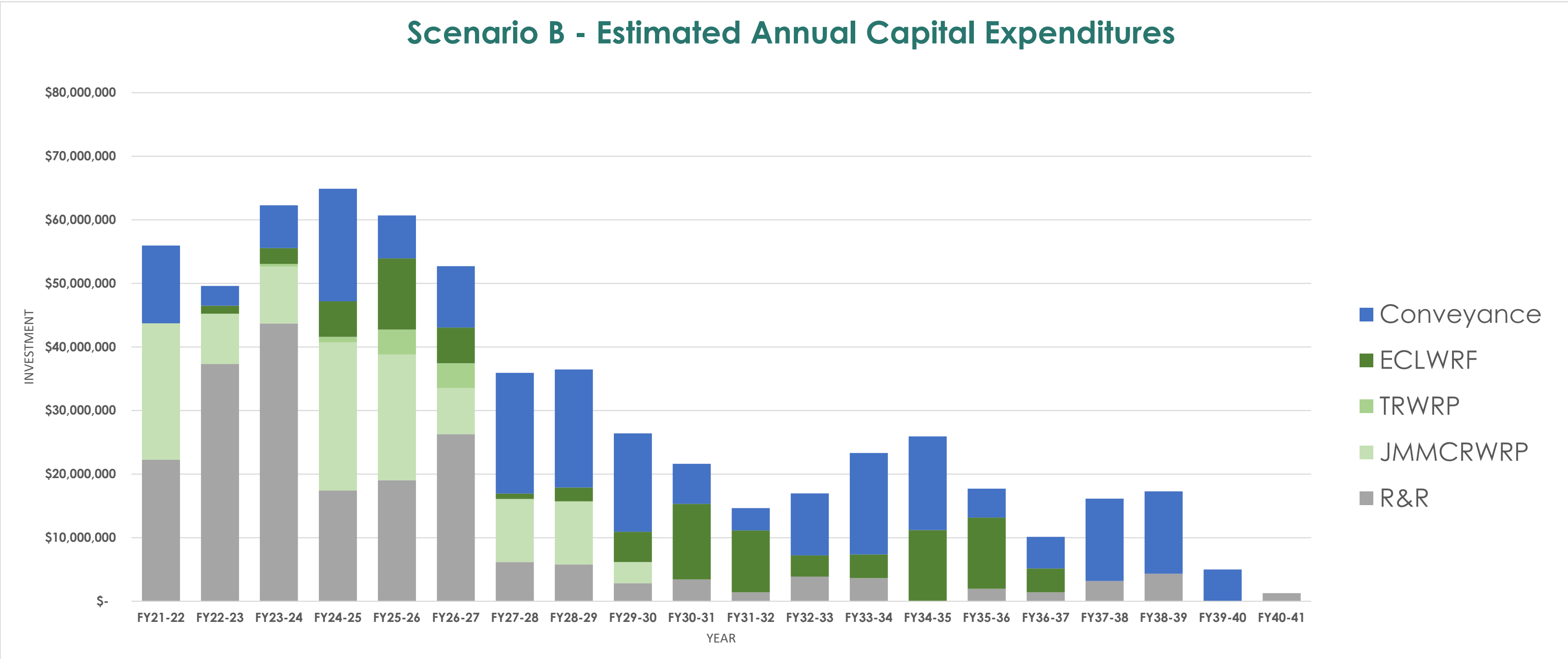


Figure 9-4. Scenario C — Estimated Annual Capital Expenditures

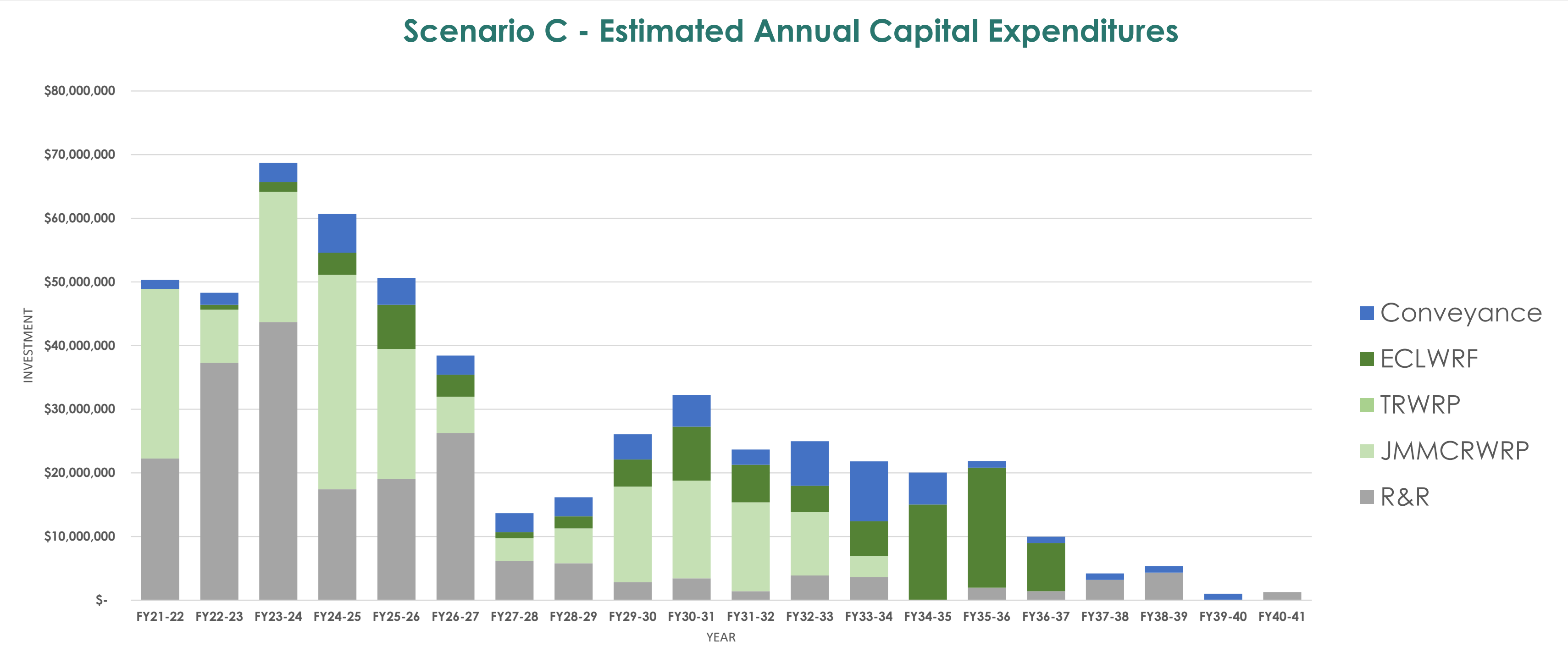


Table 9-2. Scenario A Estimated Annual Capital Expenditures

Project Name	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Scenario A - Tier 1 and 2 Customers - Phase 1	$1,000,000	$1,000,000	$1,000,000	$2,000,000	$2,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$-	$-	$-	$-	$-	$-
Scenario A - Chevron LPBF Improvements - Phase 1	$-	$-	$10,732	$21,465	$193,181	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - Palos Verdes Lateral Project	$9,300,515	$835,863	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - Marathon-Carson Refinery Nitrified Water System - Phase 1	$-	$193,650	$387,300	$1,742,850	$1,742,850	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - Kenneth Hahn Ph 1 Expansion - Phase 1	$1,494,180	$376,011	$3,696,743	$11,623,314	$429,943	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - JMMCRWRP - Nitrification - Biofor - Phase 1	$1,103,823	$2,207,645	$4,967,202	$9,934,404	$4,967,202	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - JMMCRWRP Phase II Expansion - CEMF	$18,586,000	$2,198,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - Kenneth Hahn Ph 2 Expansion - Phase 2	$-	$-	$-	$-	$677,362	$3,528,294	$9,005,204	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - Harbor City Expansion - Phase 2	$-	$-	$-	$-	$-	$55,989	$111,977	$503,898	$503,898	$-	$-	$-	$-	$-	$-	$-
Scenario A - Northeast Carson Expansion - Phase 2	$-	$-	$-	$-	$336,373	$672,746	$1,513,678	$3,027,355	$1,513,678	$-	$-	$-	$-	$-	$-	$-
Scenario A - ECLWRF - Title 22 Expansion - Phase 2	$-	$771,329	$1,542,657	$3,470,979	$6,941,958	$3,470,979	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - TRWRP - IPR - Phase 2	$4,147,586	$8,295,172	$9,332,068	$27,996,204	$27,996,204	$9,332,068	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario A - Kenneth Hahn Ph 3 Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$306,614	$2,626,185	$874,789	$-	$-	$-	$-	$-	$-
Scenario A - ECLWRF - Title 22 Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$941,174	$1,882,348	$4,235,283	$8,470,567	$4,235,283	$-	$-	$-	$-	$-
Scenario A - TRWRP - IPR - Phase 3	$-	$-	$-	$2,092,174	$2,092,174	$4,184,348	$4,184,348	$9,414,783	$28,244,348	$28,244,348	$9,414,783	$-	$-	$-	$-	$-
Scenario A - TRWRP - Single Pass RO - Phase 3	$-	$-	$-	$-	$-	$-	$435,328	$870,655	$1,958,974	$3,917,949	$1,958,974	$-	$-	$-	$-	$-
Scenario A - ECLWRF - Barrier MF Expansion - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$852,003	$1,704,005	$3,834,011	$7,668,023	$3,834,011
Scenario A - ECLWRF - Barrier RO Expansion - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,658,455	$3,316,910	$3,731,524	$11,194,572	$11,194,572	$3,731,524
Total	**$35,632,103**	**$15,877,669**	**$20,936,702**	**$58,881,389**	**$47,377,247**	**$24,244,423**	**$19,191,708**	**$19,005,653**	**$42,082,366**	**$44,507,652**	**$17,267,496**	**$4,168,913**	**$5,435,529**	**$15,028,583**	**$18,862,595**	**$7,565,535**

Note: All capital expenditures are displayed in 2020 dollars.

Table 9-3. Scenario B Estimated Annual Capital Expenditures

Project Name	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Scenario B - Tier 1 and 2 Customers - Phase 1	$1,000,000	$1,000,000	$1,000,000	$2,000,000	$2,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Chevron LPBF Improvements - Phase 1	$-	$-	$10,732	$21,465	$193,181	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Palos Verdes Lateral Project	$9,300,515	$835,863	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Marathon-Carson Refinery Nitrified Water System - Phase 1	$449,750	$899,500	$2,023,875	$4,047,750	$2,023,875	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Kenneth Hahn Ph 1 Expansion - Phase 1	$1,494,180	$376,011	$3,696,743	$11,623,314	$429,943	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - JMMCRWRP - Nitrification - Biofor - Phase 1	$1,103,823	$2,207,645	$4,967,202	$9,934,404	$4,967,202	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - JMMCRWRP - Nitrification - Biofor - Phase 2	$-	$-	$-	$1,471,764	$2,943,527	$3,311,468	$9,934,404	$9,934,404	$3,311,468	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - JMMCRWRP Phase II Expansion - CEMF	$18,586,000	$2,198,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Carson Brine Line- Phase 2	$-	$-	$-	$-	$548,350	$1,096,700	$2,467,575	$4,935,150	$2,467,575	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Kenneth Hahn Ph 2 Expansion - Phase 2	$-	$-	$-	$-	$677,362	$3,528,294	$9,005,204	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Harbor City Expansion - Phase 2	$-	$-	$-	$-	$-	$55,989	$111,977	$503,898	$503,898	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Palos Verdes North Expansion - Phase 2	$-	$-	$-	$-	$550,342	$1,100,684	$2,476,540	$4,953,079	$2,476,540	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Marathon- Carson Refinery BF (RO)- Phase 2	$-	$-	$-	$-	$-	$203,900	$407,800	$1,835,100	$1,835,100	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Northeast Carson Expansion - Phase 2	$-	$-	$-	$-	$336,373	$672,746	$1,513,678	$3,027,355	$1,513,678	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - ECLWRF - Title 22 Expansion - Phase 2	$-	$1,241,916	$2,483,831	$5,588,621	$11,177,241	$5,588,621	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - JMMCRWRP - Single Pass RO - Phase 2	$1,761,060	$3,522,121	$3,962,386	$11,887,158	$11,887,158	$3,962,386	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - TRWRP - Single Pass RO - Phase 2	$-	$-	$435,328	$870,655	$3,917,949	$3,917,949	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Torrance North Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$-	$344,373	$688,746	$1,549,677	$3,099,355	$1,549,677	$-	$-	$-	$-	$-
Scenario B - Torrance Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$1,039,111	$2,078,222	$2,338,000	$7,013,999	$7,013,999	$2,338,000	$-	$-	$-	$-	$-
Scenario B - Kenneth Hahn Ph 3 Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$306,614	$2,626,185	$874,789	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Redondo Beach North Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$212,392	$424,783	$1,911,524	$1,911,524	$-	$-	$-	$-	$-
Scenario B - Central Basin Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$119,795	$239,589	$2,156,305	$-	$-	$-	$-	$-
Scenario B - Redondo Beach Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$82,615	$165,230	$1,487,073	$-	$-	$-	$-	$-
Scenario B - NE Carson RO Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$280,000	$560,000	$2,520,000	$2,520,000	$-	$-	$-	$-	$-
Scenario B - ECLWRF - Barrier MF Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$852,003	$1,704,005	$3,834,011	$7,668,023	$3,834,011	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - ECLWRF - Title 22 Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$-	$470,587	$941,174	$4,235,283	$4,235,283	$-	$-	$-	$-	$-	$-	$-	$-
Scenario B - Tier 1 and 2 Customers - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Scenario B - Palos Verdes South Expansion - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,771,736	$3,543,472	$3,986,405	$11,959,216	$11,959,216	$3,986,405
Scenario B - ECLWRF - Barrier RO Expansion - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,658,455	$3,316,910	$3,731,524	$11,194,572	$11,194,572	$3,731,524	$-	$-	$-
Total	**$33,695,328**	**$12,281,056**	**$18,580,097**	**$47,445,130**	**$41,652,503**	**$26,438,736**	**$29,769,179**	**$30,670,192**	**$23,548,739**	**$18,200,690**	**$13,246,887**	**$13,067,779**	**$19,681,221**	**$25,928,885**	**$15,738,043**	**$8,717,929**	**$12,959,216**	**$12,959,216**	**$4,986,405**

Note: All capital expenditures are displayed in 2020 dollars.

Table 9-4. Scenario C Estimated Annual Capital Expenditures

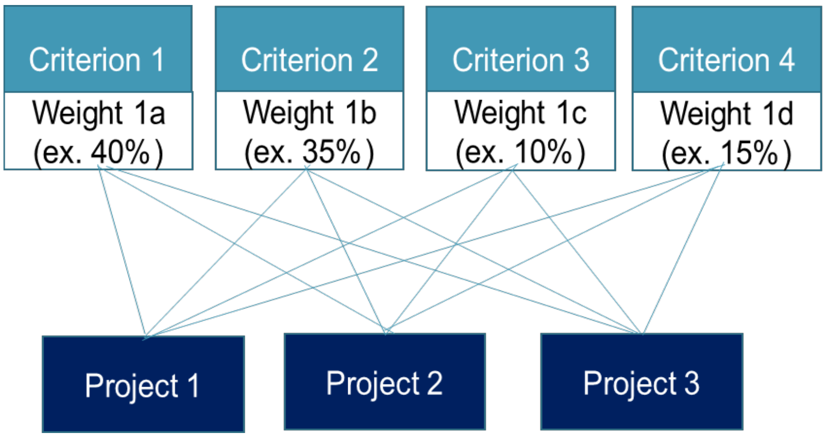
Project Name	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Scenario C - Tier 1 and 2 Customers - Phase 1	$1,000,000	$1,000,000	$1,000,000	$2,000,000	$2,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - Marathon-Carson Refinery Nitrified Water System - Phase 1	$449,750	$899,500	$2,023,875	$4,047,750	$2,023,875	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - Chevron LPBF Improvements - Phase 1	$-	$-	$10,732	$21,465	$193,181	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - JMMCRWRP - Nitrification - Biofor - Phase 1	$1,103,823	$2,207,645	$4,967,202	$9,934,404	$4,967,202	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - JMMCRWRP Phase II Expansion - CEMF	$18,586,000	$2,198,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - ECLWRF - Title 22 Expansion - Phase 2	$-	$771,329	$1,542,657	$3,470,979	$6,941,958	$3,470,979	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - JMMCRWRP - Single Pass RO - Phase 2	$6,946,997	$3,907,686	$15,474,435	$23,758,728	$15,474,435	$3,907,686	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - Marathon- Carson Refinery BF (RO)- Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$203,900	$407,800	$1,835,100	$1,835,100	$-	$-	$-	$-	$-
Scenario C- Carson Brine Line - Phase 3	$-	$-	$-	$-	$-	$-	$-	$-	$973,250	$1,946,500	$2,189,813	$6,569,438	$6,569,438	$2,189,813	$-	$-	$-	$-	$-
Scenario C - ECLWRF - Title 22 Expansion - Phase 3	$-	$-	$-	$-	$-	$-	$941,174	$1,882,348	$4,235,283	$8,470,567	$4,235,283	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - JMMCRWRP - Single Pass RO - Phase 3	$-	$-	$-	$-	$-	$1,786,447	$3,572,893	$4,019,505	$12,058,514	$12,058,514	$4,019,505	$-	$-	$-	$-	$-	$-	$-	$-
Scenario C - JMMCRWRP - Nitrification - Biofor - Phase 3	$-	$-	$-	$-	$-	$-	$-	$1,471,764	$2,943,527	$3,311,468	$9,934,404	$9,934,404	$3,311,468	$-	$-	$-	$-	$-	$-
Scenario C - Tier 1 and 2 Customers - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Scenario C - ECLWRF - Barrier MF Expansion - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$852,003	$1,704,005	$3,834,011	$7,668,023	$3,834,011	$-	$-	$-
Scenario C - ECLWRF - Barrier RO Expansion - Phase 4	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,658,455	$3,316,910	$3,731,524	$11,194,572	$11,194,572	$3,731,524	$-	$-	$-
Total	**$28,086,569**	**$10,984,160**	**$25,018,901**	**$43,233,326**	**$31,600,651**	**$12,165,111**	**$7,514,067**	**$10,373,616**	**$23,210,574**	**$28,787,049**	**$22,241,359**	**$21,080,554**	**$18,151,534**	**$20,053,496**	**$19,862,595**	**$8,565,535**	**$1,000,000**	**$1,000,000**	**$1,000,000**

Note: All capital expenditures are displayed in 2020 dollars.

9.4 R&R Project Prioritization

Prioritization in the tool is used for R&R projects only. The approach follows a multi-criteria decision analysis approach to prioritizing projects. Figure 9-5 describes the general approach for prioritizing projects using this method.

Figure 9-5. Multi-Criteria Prioritization Process



Several criteria were selected by District staff to prioritize R&R projects. Those criteria are defined in Table 9-5:

Once these criteria were developed, District staff allocated 100 points between each of the criteria. These points were averaged across participants for each criterion, which then became the criteria weight. The weights are represented in Table 9-5. Projects were then scored on a scale of 1 to 5 for each criterion, with 1 representing the lowest possible benefit towards the criteria and 5 representing the highest possible benefit towards the criteria. Individual criterion scores multiplied by weights are then summed for each project. These final total scores are used to rank the projects.

Table 9-5. R&R Project Prioritization Criteria

Criteria	Definition	Weight
Safety	• Reduces immediate, identifiable safety risk to the public and employees • Mitigates likelihood or consequence of safety risk that could result in injury, disability, or death of an employee or member of the public	30%
Customer Experience	• Improves water quality for customer • Improves delivery of recycled water to customer (pressure, storage, surge control, etc.)	10%
Reliability	• Increases reliability by replacing equipment that is at the end of its useful life • Increases reliability in meeting permitting requirements • Reduces potential for system outages or reduction in production capacity	20%

Criteria	Definition	Weight
Compliance and Stewardship	• Contributes to meeting regulatory compliance requirements • Supports achieving conservation goals or other mandated requirements • Contributes to meeting environmental stewardship objectives (e.g., spill containment, air pollution)	20%
Schedule	• Requires significant lead time to order equipment/parts • Impacts other R&R or expansion project schedules	5%
Cost Savings	• Increases generation of revenue through improved efficiency or availability • Contributes to cost savings associated with RW production	15%

9.4.1 Automated Scheduling Process

One of the Capital Improvement Planning tool's key features is its automated scheduling process. This should be treated as a first draft of the schedule, which the user may refine further as desired. The tool's automated scheduling process works by testing to see if projects are "affordable" within the input budget constraint. This process goes in ranked priority order, as developed in the prioritization described in the section above. Table 9-6 shows the proposed R&R project implementation schedule. The prioritization scores (out of a total of 500 possible points) for the top projects are listed. Appendix R includes detailed project worksheets for all the R&R projects listed in the table.

Table 9-6. R&R Projects Estimated Annual Capital Expenditures

Project #	Priority Score	Project Name	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2040
RR1	445.00	TRWRP MF Replacement Project	$10,318	$1,366,595	$5,137,599	$7,485,489	$-	$-	$-	$-	$-	$-	
RR2	432.50	Hyperion FM R&R Project	$324,325	$1,325,675	$-	$-	$-	$-	$-	$-	$-	$-	
RR3	420.00	Chevron HP & LP Boiler Feed Tanks R&R	$181,055	$518,945	$3,264,002	$685,998	$-	$-	$-	$-	$-	$-	
RR4	415.00	ECLWRF Distributed Control System	$643,485	$2,839,375	$648,284	$106	$-	$-	$-	$-	$-	$-	
RR5	415.00	ECLWRF Phase II & III MF Replacement	$684,042	$1,861,423	$7,450,542	$3,993	$-	$-	$-	$-	$-	$-	
RR6	406.67	Chemical Containment R&R Project (All Satellite Sites)	$2,418,780	$686,220	$-	$-	$-	$-	$-	$-	$-	$-	
RR7	401.67	Chevron Nitrification Tank	$2,817,648	$497,553	$-	$-	$-	$-	$-	$-	$-	$-	
RR8	400.00	ECLWRF Title 22 Common Filter Systems - Ancillary Facilities	$-	$246,000	$3,784,000	$-	$-	$-	$-	$-	$-	$-	
RR9	397.50	ECLWRF Solids Handling Improvement	$1,030,010	$9,323,683	$2,346,307	$-	$-	$-	$-	$-	$-	$-	
RR10	397.50	ECLWRF Title 22 Filter R&R	$561,155	$2,927,143	$-	$-	$-	$-	$-	$-	$-	$-	
RR11	395.00	All Sites Chemical Storage Improvements	$606,890	$2,211,113	$7,318,812	$1,292,119	$-	$-	$-	$-	$-	$-	
RR12	390.00	ECLWRF VFD R&R	$500,000	$750,000	$1,000,000	$1,650,200	$1,650,200	$1,650,200	$1,650,200	$1,650,200	$1,650,200	$1,650,200	
RR13	388.33	TRWRP Nitrification Tank R&R	$60,783	$2,044,742	$-	$-	$-	$-	$-	$-	$-	$-	
RR14	383.33	JMMCRWRP Waste Storage Tank R&R	$-	$-	$-	$1,643,480	$1,856,520	$-	$-	$-	$-	$-	
RR15	375.00	ECLWRF BF RO Treatment System R&R	$-	$-	$299,299	$1,400,701	$-	$-	$-	$-	$-	$-	
RR16	370.00	Chevron HP-LP VFD & Pump R&R	$-	$-	$-	$218,893	$362,730	$1,417,617	$760	$-	$-	$-	
RR17	370.00	ECLWRF RO Post treatment and Distribution System R&R	$-	$-	$-	$128,522	$601,478	$-	$-	$-	$-	$-	
RR18	354.00	ECLWRF Barrier Basin & PS R&R	$866,537	$123,668	$-	$-	$-	$-	$-	$-	$-	$-	
RR19	354.00	TRWRP VFD R&R	$-	$-	$-	$123,848	$1,392,288	$70,865	$-	$-	$-	$-	
RR20	355.00	TRWRP Waste Discharge Improvements	$66,106	$670,574	$63,320	$-	$-	$-	$-	$-	$-	$-	
RR21	352.50	JMMCRWRP Title 22 Piping Replacement	$-	$-	$-	$264,087	$1,235,913	$-	$-	$-	$-	$-	
RR22	350.00	ECLWRF Instrument Air System Improvements for Phase IV MF	$-	$-	$130,283	$609,717	$-	$-	$-	$-	$-	$-	
RR23	347.50	Torrance Potable Water Pipe Replacement	$584,590	$-	$-	$-	$-	$-	$-	$-	$-	$-	
RR24		CNTP Nitrified Product Water Piping Improvements	$-	$-	$-	$240,000	$2,735,632	$-	$-	$-	$-	$-	
RR25		Torrance RO Product Water Tank	$-	$-	$-	$204,267	$1,755,733	$-	$-	$-	$-	$-	
RR26		HSEPS R&R Project	$382,031	$5,821,094	$3,196,875	$-	$-	$-	$-	$-	$-	$-	
RR27		All Sites RO CIP Batching System	$-	$-	$-	$662,571	$17,880	$-	$-	$-	$-	$-	
RR28		TRWRP Analyzer and Chemical Waste System	$-	$-	$-	$-	$73,064	$341,936	$-	$-	$-	$-	
RR29		Satellite Plant Breakpoint Reactor R&R	$-	$-	$-	$100,000	$1,525,000	$-	$-	$-	$-	$-	
RR30		JMMCRWRP Plant-wide Containment System	$-	$-	$-	$-	$155,661	$1,064,339	$-	$-	$-	$-	
RR31		Satellite Plant Surge Protection System	$-	$-	$-	$-	$480,000	$6,420,000	$-	$-	$-	$-	
RR32		CNTP Nitrified Process Water Piping Rehab	$-	$-	$-	$-	$264,087	$1,235,913	$-	$-	$-	$-	
RR33		Title 22 Valve Installation Project	$-	$-	$-	$-	$162,910	$1,831,090	$-	$-	$-	$-	
RR34		ECLWRF Copper Pipe Replacement	$-	$-	$-	$-	$82,800	$531,200	$-	$-	$-	$-	
RR35		Satellite Plant Control Room Upgrade	$-	$-	$-	$-	$94,000	$1,438,000	$-	$-	$-	$-	
RR36		Satellite Plant Biofor Mechanical Improvements	$-	$274,000	$4,212,000	$-	$-	$-	$-	$-	$-	$-	
RR37		ECLWRF EQ Pump Replacement	$-	$-	$-	$-	$93,268	$735,732	$-	$-	$-	$-	
RR38		ECLWRF Relocate Ozone Feed Ahead of T22 System	$-	$-	$-	$-	$158,452	$741,548	$-	$-	$-	$-	
RR39		ECLWRF Diversion Pump Station	$-	$-	$-	$-	$419,462	$4,314,871	$-	$-	$-	$-	

Project #	Priority Score	Project Name	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2040
RR40		190th Street Disinfection Station Modification	$-	$-	$-	$-	$77,163	$447,837	$-	$-	$-	$-	
RR41		TRWRP Secondary Power Source	$-	$-	$-	$-	$-	$176,058	$823,942	$-	$-	$-	
RR42		Miscellaneous Facility R&R	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	$500,000	
RR43		Barrier RO Membrane Replacement	$685,000	$-	$1,163,000	$-	$-	$685,000	$-	$1,163,000	$-	$-	
RR44		Chevron BF RO Membrane Replacement	$-	$-	$695,000	$-	$-	$695,000	$-	$-	$695,000	$-	
RR45		JMMCWRF BF RO Membrane Replacement	$724,000	$-	$-	$-	$-	$724,000	$-	$-	$-	$-	
RR46		TRWRP BF RO Membrane Replacement	$-	$-	$390,000	$-	$-	$-	$-	$390,000	$-	$-	
RR47		Barrier Phase IV and V MF Membrane Replacement	$-	$2,870,000	$2,085,000	$-	$-	$-	$2,870,000	$2,085,000	$-	$-	
RR48		Chevron BF Pall Trailer MF Membrane Replacement	$-	$316,000	$-	$-	$-	$-	$316,000	$-	$-	$-	
RR49		JMMCWRF BF MF Membrane Replacement	$-	$-	$-	$-	$749,000	$-	$-	$-	$-	$749,000	
RR50		TRWRP BF MF Membrane Replacement	$-	$-	$-	$-	$512,000	$-	$-	$-	$-	$512,000	
RR51		ECLWRF MF-RO Waste Improvements	$352,231	$-	$-	$-	$-	$-	$-	$-	$-	$-	
RR52		RW Distribution System Cathodic Protection	$6,675,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	
RR53		CNTP VFD R&R Project	$-	$-	$-	$123,848	$1,392,288	$-	$-	$-	$-	$-	
RR54		TRWRP Nitrified Process Water Piping Rehab	$-	$-	$-	$-	$264,087	$1,235,913	$-	$-	$-	$-	
RR55		Barrier RO Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$3,696,000
RR56		Chevron BF RO Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$2,085,000
RR57		JMMCWRF BF RO Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,448,000
RR58		TRWRP BF RO Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$780,000
RR59		Barrier Phase IV and V MF Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$9,910,000
RR60		Chevron BF Pall Trailer MF Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$632,000
RR61		JMMCWRF BF MF Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,498,000
RR62		TRWRP BF MF Membrane Replacement	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$1,024,000
		Total R&R	**$20,673,986**	**$37,173,803**	**$43,684,323**	**$17,337,839**	**$18,611,616**	**$26,257,119**	**$6,160,902**	**$5,788,200**	**$2,845,200**	**$3,411,200**	**$21,073,000**

Note: All capital expenditures are displayed in 2020 dollars.