FINAL DRAFT

Task 7: Morena Pump Station, WW Force Main, and Brine Conveyance Predesign (NC01)

10% Engineering Design Report

Prepared For:

City of San Diego

Public Utilities Department

San Diego, California

March 25, 2016

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Brown and Caldwell

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ACRONYM	DEFINITION
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
AACE	Association for the Advancement of Cost Engineering International
AADF	annual average daily flow
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
ADT	average daily trip
AISC	American Institute of Steel Construction
AQMD	Air Quality Management District
ASCE	American Society of Civil Engineers
AV/AR	air vacuum/air release
AWPF	advanced water purification facility
BC	Brown and Caldwell
bgs	below ground surface
BMP	best management practice
BOD	biochemical oxygen demand
BOV	blowoff valve
CAAWPF	Central Area Advanced Water Purification Facility
Caltrans	California Department of Transportation
$Ca(NO_3)_2$	calcium nitrate
CBC	California Building Code
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CDPH	California Department of Public Health
CEC	California Electrical Code
CEPT	chemically enhanced primary treatment
CFC	California Fire Code
cfs	cubic foot/feet per second
CIP	capital improvement project
City	City of San Diego
CML&C	cement mortar lined and coated pipe
CMU	concrete masonry init
County	San Diego County
dBA	decibel(s)
DCS	distributed control system
DDW	Division of Drinking Water
DIPS	ductile iron pipe size
DR	dimension ratio
EDR	Engineering Design Report
ELBE	emerging local business enterprise

ACRONYM	DEFINITION
EMBTS	East Mission Bay Trunk Sewer
EQ	equalization
ESA	Environmental Site Assessment
ESDC	Engineering services during construction?
$FeCl_2$	ferrous chloride
FEMA	Federal Emergency Management Agency
FeS	ferrous sulfite
fps	foot/feet per second
ft^2	square foot/feet
FTE	full-time equivalent
GAC	granular activated carbon
GBR	geotechnical baseline report
GIS	geographic information system
gpm	gallon(s) per minute
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
HCL	hydrochloric acide
HDPE	high-density polyethylene
HGL	hydraulic grade line
hp	horsepower
HPO	high-purity oxygen
HVAC	heating, ventilation, and air conditioning
IPS	influent pump station
I-5	Interstate 5 (San Diego Freeway)
I-805	Interstate 805 (Jacob Dekema Freeway)
kW	kilowatt(s)
kWh	kilowatt-hour(s)
lb/d	pound(s) per day
$lb\text{-}ft^2$	pound foot squared
lb/gal	pound(s) per gallon
LF	linear foot/feet
MBI	Morena Boulevard Interceptor
MBTS	Morena Boulevard Trunk Sewer
MCAS	Marine Corps Air Station
MCC	motor control center
MCCTP	Mid-Coast Corridor Transit Project
mgd	million gallons per day
mg/L	milligram(s) per liter
MHPA	Multi-Habitat Planning Area
MPS	Morena Pump Station
MR	Miramar Reservoir
MS4	municipal separated storm sewer system
MSCP	Multiple Species Conservation Program

ACRONYM	DEFINITION
MTS	(San Diego) Metropolitan Transit System
MWH	MWH Americas, Inc.
NCAWPF	North City Advanced Water Purification Facility
NCTD	North County Transit Department
NCWRP	North City Water Reclamation Plant
NFPA	National Fire Protection Association
NMI	North Metro Interceptor
NMVI	North Mission Valley Interceptor
NPDES	National Pollutant Discharge Elimination System
NPR	non-potable reuse
NPSH	net positive suction head
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
PLC	programmable logic controller
PLWTP	Point Loma Wastewater Treatment Plant
PLRCP	polyvinyl chloride/plastic-lined reinforced concrete pipe
PRI-SC	peroxide-regenerated iron for sulfide control
Project	Task 7: Morena Pump Station, Wastewater Force Main, and Brine Conveyance (NC01) Project
Program	Pure Water San Diego Program
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
PUD	(City of San Diego) Public Utilities Department
RCP	reinforced concrete pipe
RCRA	Resource Conservation and Recovery Act
READ	(City of San Diego) Real Estate Acquisition Department
RO	reverse osmosis
ROI	return on investment
rpm	revolution(s) per minute
RS	raw sewage
RW	recycled water
RWQCB	Regional Water Quality Control Board
SANDAG	San Diego Association of Governments
SBAWPF	South Bay Advanced Water Purification Facility
SBWRP	South Bay Water Reclamation Plant
SDG&E	San Diego Gas & Electric
SDRDT	San Diego River Bridge Double Track
SLBE	small local business enterprise
SPCA	Society for the Prevention of Cruelty to Animals
SR 52	State Route 52 (San Clemente Canyon Freeway/Mt. Soledad Freeway)
SVR	San Vicente Reservoir
SWRCB	State Water Resources Control Board
TCE	Temporary Construction Easement
TDS	total dissolved solids

ACRONYM	DEFINITION
TO	task order
TRC	Technical Review Committee
TT	Trussell Technologies
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UTC	University Towne Centre
V	volt(s)
VCP	vitrified clay pipe
VFD	variable-frequency drive
WATCH	Work Area Traffic Control Handbook
WRP	water reclamation plant
WTP	water treatment plant
WW	wastewater

1 Executive Summary

The Morena Pump Station (MPS), Wastewater (WW) Force Main, and Brine Conveyance (NC01) Project (Project) conveys 32 million gallons per day (mgd) (average annual daily flow [AADF]) of raw wastewater to the North City Water Reclamation Plant (NCWRP). NC01 (Task 7) completes planning-level engineering and technical investigations to develop a 10% design of the Project.

The Project connects North Mission Valley Interceptor (NMVI) #1, NMVI #2, Morena Boulevard Interceptor (MBI), Morena Boulevard Trunk Sewer (MBTS), and East Mission Bay Trunk Sewer (EMBTS). Wastewater will be conveyed to the MPS site and screened to remove larger solids prior to being conveyed to MPS. MPS will consist of five two-stage vertical-turbine, nonclog pumps operating in series sequence in a four active plus one standby (4+1) configuration. The site will also include new facilities to supply ferrous chloride ($FeCl_2$) for odor control in the force main, and a passive odor control system to remove fouled air from the screening facility and MPS wetwell.

Wastewater will be conveyed from MPS via a new 48-inch-diameter force main approximately 10.4 miles north to NCWRP, and connect to NCWRP's 60-inch-diameter raw sewage (RS) line from the influent pump station (IPS) to the headworks. A new 24-inch-diameter brine pipeline parallel to the force main will convey 6 mgd of brine (generated from the North City Advanced Water Purification Facility [NCAWPF]) south to the NMVI (by way of MPS), before flowing south for treatment at the Point Loma Wastewater Treatment Plant (PLWTP). Pressure-reducing stations will be constructed at two locations because of the high pressures from the grade changes between NCAWPF and Friars Road, and an energy dissipation structure will be constructed at the MPS site.

The following section summarizes each of the Project facilities.

1.1 Project Need

The City of San Diego (City) has limited local water supply sources and relies on importing 85% of its water from the Colorado River and Northern California. The reliability of the City's water supply is threatened by ongoing drought, rising imported water costs, and increased water demand due to population growth. In November 2014, the San Diego City Council unanimously approved the advancement of the Pure Water San Diego Program (Program), which included application to the United States Environmental Protection Agency (USEPA) to renew PLWTP's modified National Pollutant Discharge Elimination System (NPDES) permit. Without the modified permit, the City would need to invest $1.8 billion and overcome extreme space constraints to upgrade PLWTP to secondary treatment requirements. Further, these costly upgrades would not produce a new water supply.

Investing in the Program and seeking federal legislation to allow the City to meet modified secondary standards will eliminate the need for the costly upgrades at PLWTP, enable the City to divert more water for recycling, and reduce ocean discharges. Increasing NCWRP's design flow rate to 54 mgd is the first step to meeting Program requirements.

NCWRP upgrades are also being designed to meet the requirements of the new NCAWPF, which will deliver 30 mgd of advanced treated recycled water (RW) to be stored in local surface water bodies. The MPS and force main will divert wastewater from existing sanitary sewers and convey it to NCWRP to help meet the 54 mgd design capacity. Currently existing pumps stations which deliver wastewater to NCWRP are not able to consistently deliver the 54 mgd design capacity during average dry weather conditions. In order to provide a supply of wastewater for the NCWPR the Program is advancing the MPS design. The MPS will take wastewater from the area near the intersection or Friars Road and Morena Boulevard and pump it north to the NCWRP. This will allow the NCWRP to consistently operate at the 54 mgd design capacity.

The MPS is being designed to deliver a flow rate from as low as 4,000 gallons per minute (gpm) to as high as 26,180 gpm. This variation in flow rate is a function of the diurnal variation in wastewater availability and maximum allowable flow rate to NCWRP based on the equalization (EQ) strategy developed under other tasks. The Distributed Control System (DCS) will select a flow rate for the MPS based on deviation from the targeted equalization volume and direct the MPS to pump at this rate.

Figure 1-1 shows the relative location (illustrated by the blue line) of the proposed conveyance system relative to San Diego County's (County) major thoroughfare and landmarks. The preliminary design of the conveyance system is discussed in greater detail throughout this Engineering Design Report (EDR).

1.2 Force Main

The 48-inch-diameter discharge line will provide a maximum flow rate of 26,180 gpm (37.7 mgd) and requires a significant amount of hydraulic head to convey raw wastewater from MPS to NCWRP; there is up to 104 feet of dynamic losses and 460 feet of static losses over the approximately 10.4-mile distance.

To meet anticipated high pressures, the first 3 miles of pipeline (from the outlet of MPS to Iroquois Avenue) will be constructed of a 48-inch-diameter cement-mortar lined and coated (CML&C) steel pipe. Near the intersection of Iroquois Avenue and Clairemont Drive, the pipeline will transition to a high-density polyethylene (HDPE) pipe—specifically a resin PE 4710 ductile iron pipe size (DIPS) HDPE pipe. The force main will connect to the existing NCWRP IPS discharge line, an existing 60-inch-diameter pipeline connecting to the headworks building. Figure 1-1 depicts the force main's anticipated alignment.

There is significant grade change along the pipeline alignment, as indicated by the large static head losses. Figure 1-2 depicts the ground surface profile and hydraulic grade of this force main. The ground surface profile is depicted by the black line, the proposed hydraulic grade line (HGL) at peak flow is depicted by the red line, the proposed HGL at low flow is depicted by the blue line. The HGL remains above the surface profile, therefore a positive pressure is maintained for the entire force main length.

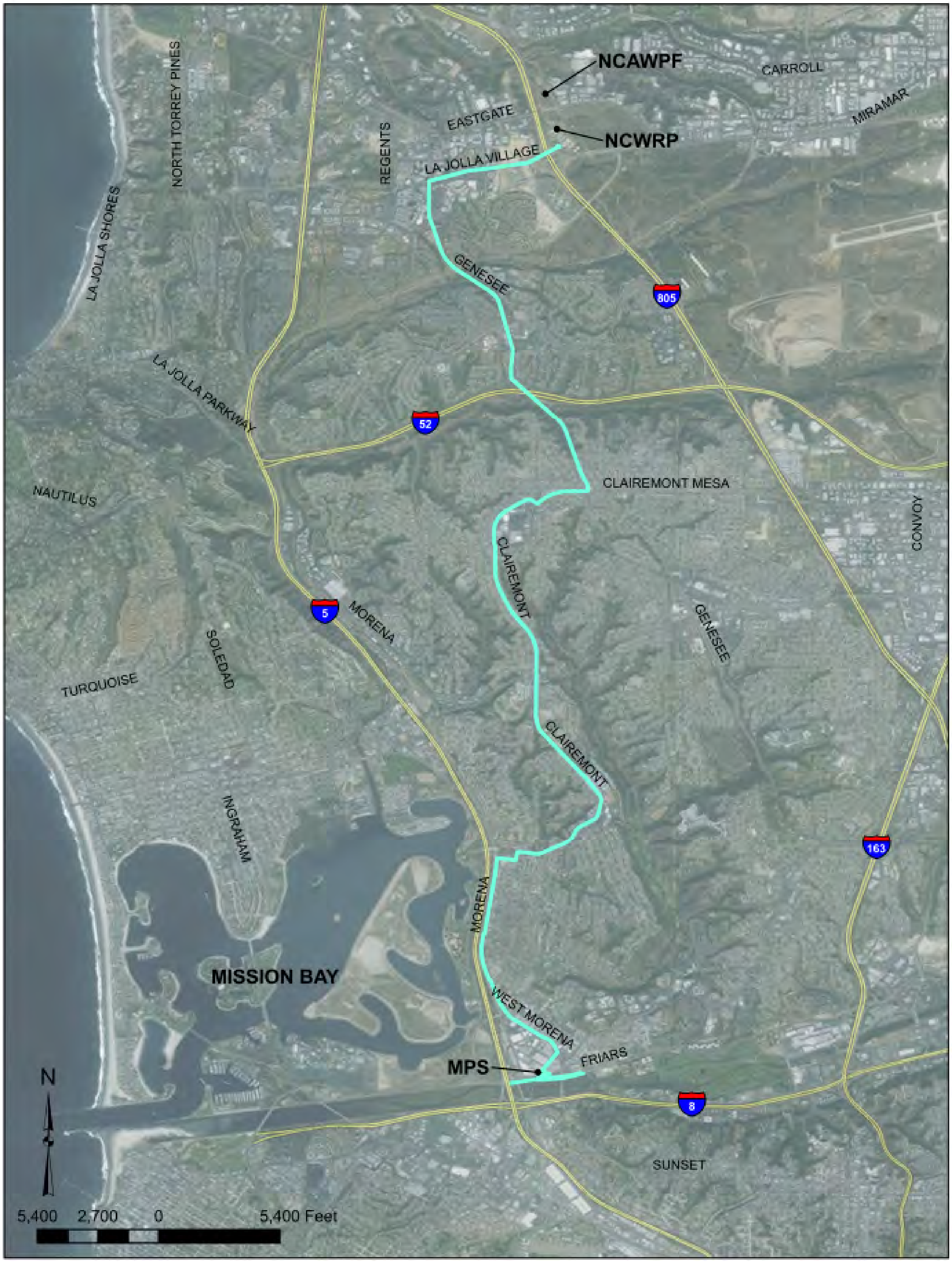


Figure 1-1: NC01 (Task 7) Facilities

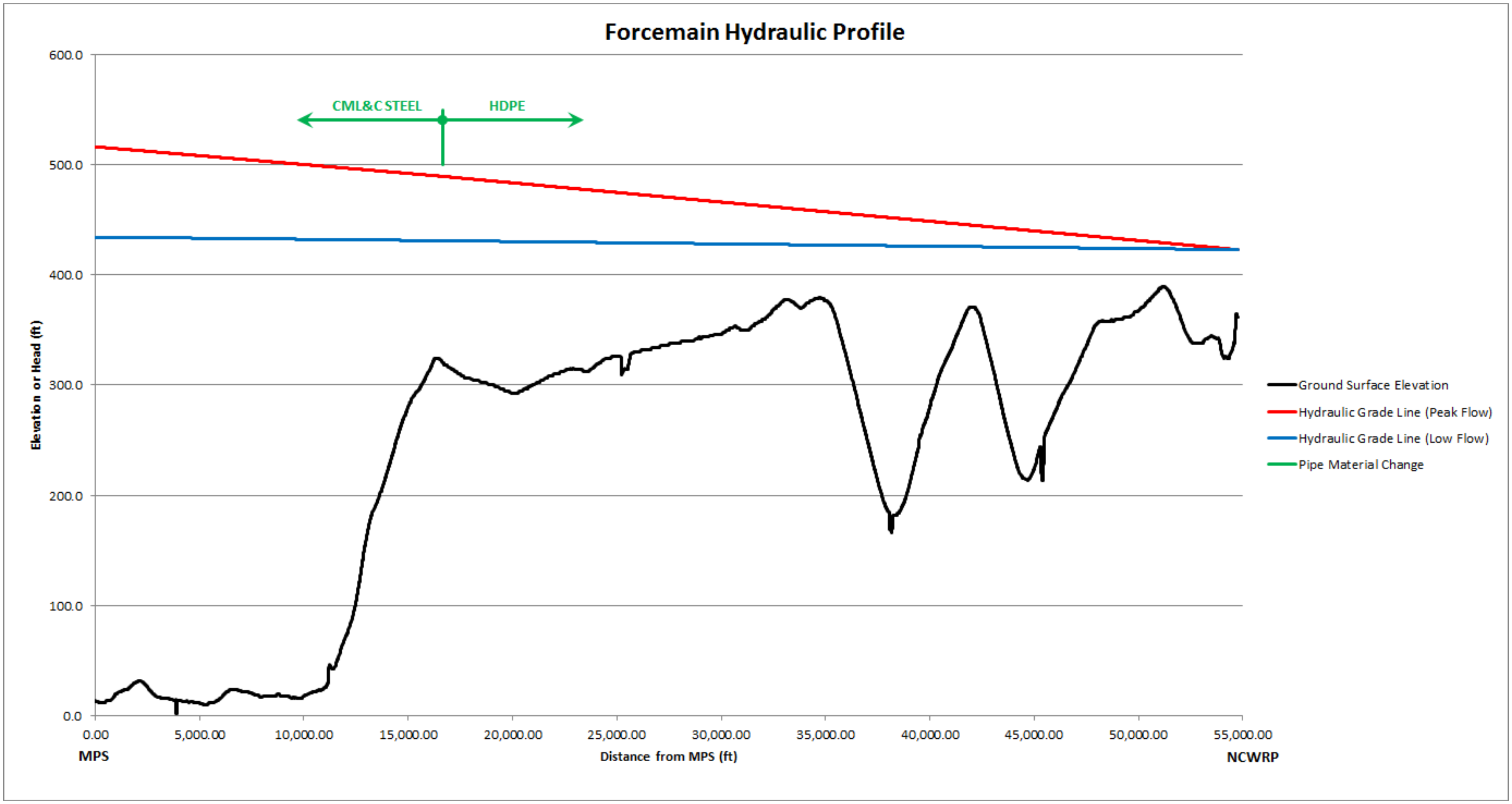


Figure 1-2: Hydraulic Grade Line

1.3 Brine Conveyance

A new advanced water purification facility (AWPF) will be designed and constructed north of the existing NCWRP to produce recycled water from the effluent generated by NCWRP. The new AWPF will consist of a series of reverse osmosis (RO) trains that discharge brine as a treatment process by-product. The brine solution will be conveyed from the new NCAWPF to MPS via a 24-inch-diameter HDPE pipeline in a common trench with the MPS force main. Brine arriving at the MPS site will be discharged into the NMVI (at Friars Road), downstream of the point where wastewater is withdrawn, and flow to PLWTP. By withdrawing the wastewater upstream of the brine discharge point recirculation of the brine to NCWPR is prevented. The brine pipeline will follow the same alignment as the force main shown in Figure 1-1.

Brine pipeline pressure could range between 80 and 50 pounds per square inch (psi). Initial residual pressure of 80 psi at the RO system will provide approximately 540 feet of head available to convey the brine to the discharge location. If NCAWPF chooses to implement an energy recovery system, the hydraulic head available for brine conveyance would be reduced. As shown in , the minimum energy residual pressure required at the RO system to maintain brine conveyance operations is 50 psi. With a residual pressure between 50 and 80 psi to convey the brine, the HGL must be dropped along the pipeline. Pressure will be dropped at two locations along the pipeline alignment by using plunger valves and at MPS with a jet flow valve. Figure **1-3** illustrates the pipeline's proposed hydraulic profile including pressure control facilities. This hydraulic profile runs opposite of the force main profile shown above, with the profile beginning at NCAWPF and ending at MPS.

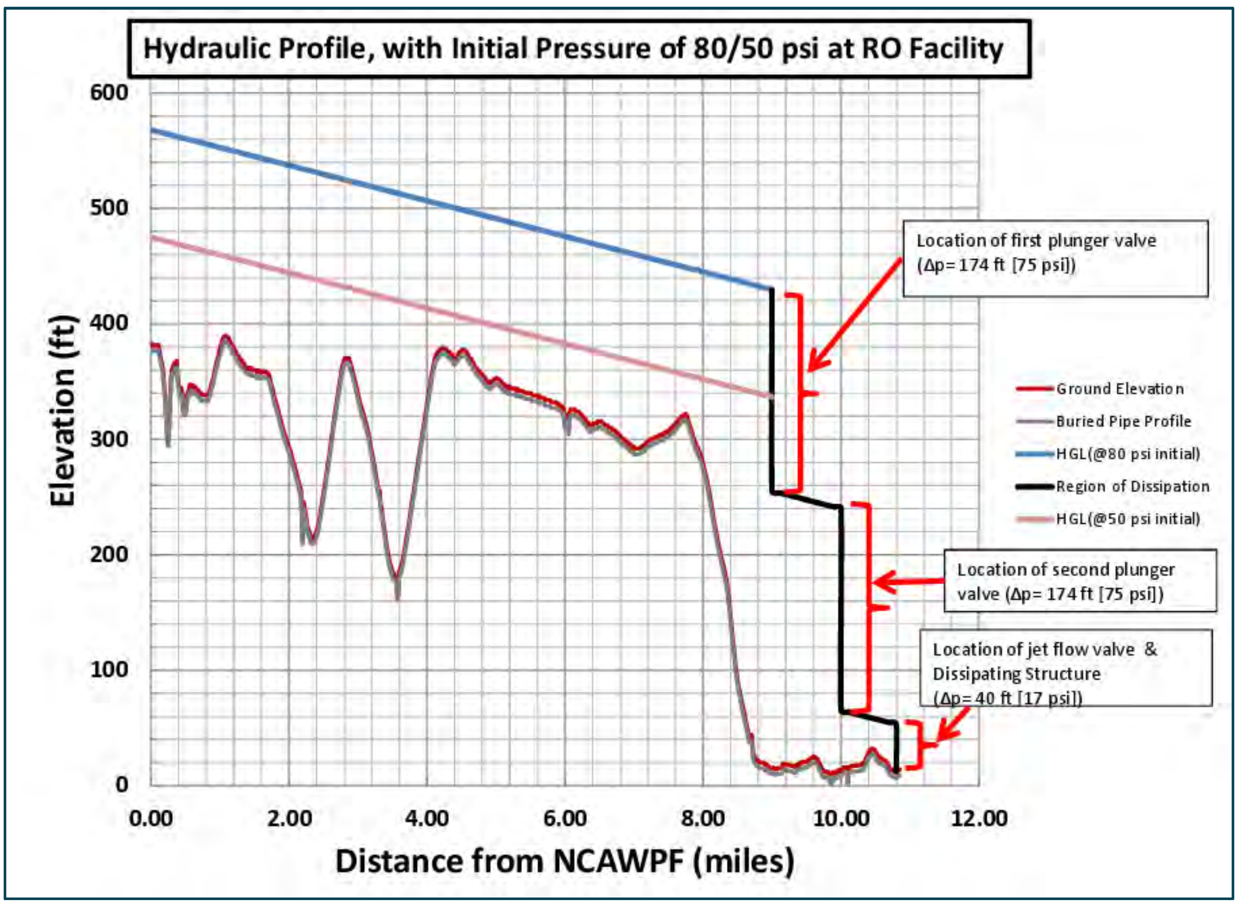


Figure 1-3: Brine Pipeline Hydraulic Profile

1.4 Pump Station

The MPS's proposed location is a land parcel currently owned by the San Diego Humane Society and Society for the Prevention of Cruelty to Animals (SPCA), an approximately 1-acre site located near the intersection of Sherman and Custer streets. The new facilities are anticipated to include the following:

- Intake screening facility (flow separator and screening structures) *
- Pump station building
- Odor control and chemical storage *
- Energy dissipation for the 24-inch-diameter brine pipeline
- Transformer
- Electrical and motor control center (MCC) building

** Indicates facilities to be coordinated with the City during the final design phase and added to the Project if recommended.*

Figure 1-4 illustrates the Project's proposed facilities.

Yard piping is anticipated to consist of wet and dry underground piping and duct banks. Wet piping includes large-diameter pipelines such as the existing 66-inch-diameter sanitary sewer (abandoned), new 84-inch-diameter polyvinyl chloride/plastic-lined reinforced concrete pipe (PLRCP) main diversion pipeline (MPS influent pipeline), 48-inch-diameter pumped discharge, 48-inch-diameter MPS gravity overflow (offsite), 24-inch-diameter brine pipeline, storm drains, and other miscellaneous small piping less than 18 inches in diameter. This includes potable water, chemical, irrigation, and drain piping. Dry piping includes foul air odor control, gas, electrical, and communication duct banks.

Influent flows are conveyed through a new 84-inch-diameter PLRCP diversion pipeline to the flow separator structure near the west parcel corner before entering the intake screening building. Influent is conveyed to the pump station building through another 72-inch-diameter reinforced concrete pipe (RCP) downstream of the intake screening building.

The MPS is anticipated to consist of a below-grade facility with five sets of two-stage vertical-turbine, non-clog pumps operating in a four active plus one set standby (4+1) configuration. Figure 1-5 shows hydraulic analysis for MPS; pumps depicted in the pump and system curves are based on the Fairbanks 14-inch 5743 XL. The need for variable-frequency drives (VFDs) and number of pumps allows the pumps to deliver the required range of flow and head conditions. Other pump manufactures manufacture an equivalent type and size of pumps that can meet the operational hydraulic conditions. The final designer shall validate the pump selection design presented in this report and select additional pump manufacturers to provide "an or equal" to the Fairbanks Morse pump units Additionally, the final designer shall select the pumps so that the best efficiency point is optimized to intersect or as near as possible to the flow and head that the pump station is expected to operate most of the time.

MPS will be an approximately 91-foot-long by 65-foot-wide, reinforced, cast-in-place concrete structure. The finished floor of the pump room and wetwell will be located approximately 43 feet and 45 feet (respectively) below finished grade. The top slab will extend above the finished grade by approximately 1 foot 6 inches at the ridge and taper to 1 foot 3 inches at the edges. Cast-in-place walls are anticipated to be approximately 3.5 feet thick and include external buttresses; wall thickness and buttresses are required because of seismic design requirements.

It is anticipated that MPS will be controlled via level a pumping setpoint received from the DCS. The pumping setpoint will be based on water level in the equalization basins at the NCWRP. The number of active pumps and speed of the pumps will be selected based on the target pumping rate in order to maximize efficiency. At the current time it is anticipated that low flow condition will be 4,000 GPM and the high flow condition will be 26,500 gpm. The distributed control system (DCS) will prevent an increase in flow rate beyond 26,180 gpm with excess flow overflowing into a pipeline and flowing to NMVI on Friars Road. Similarly it is anticipated that flow rates below 4,000 gpm will be locked out.

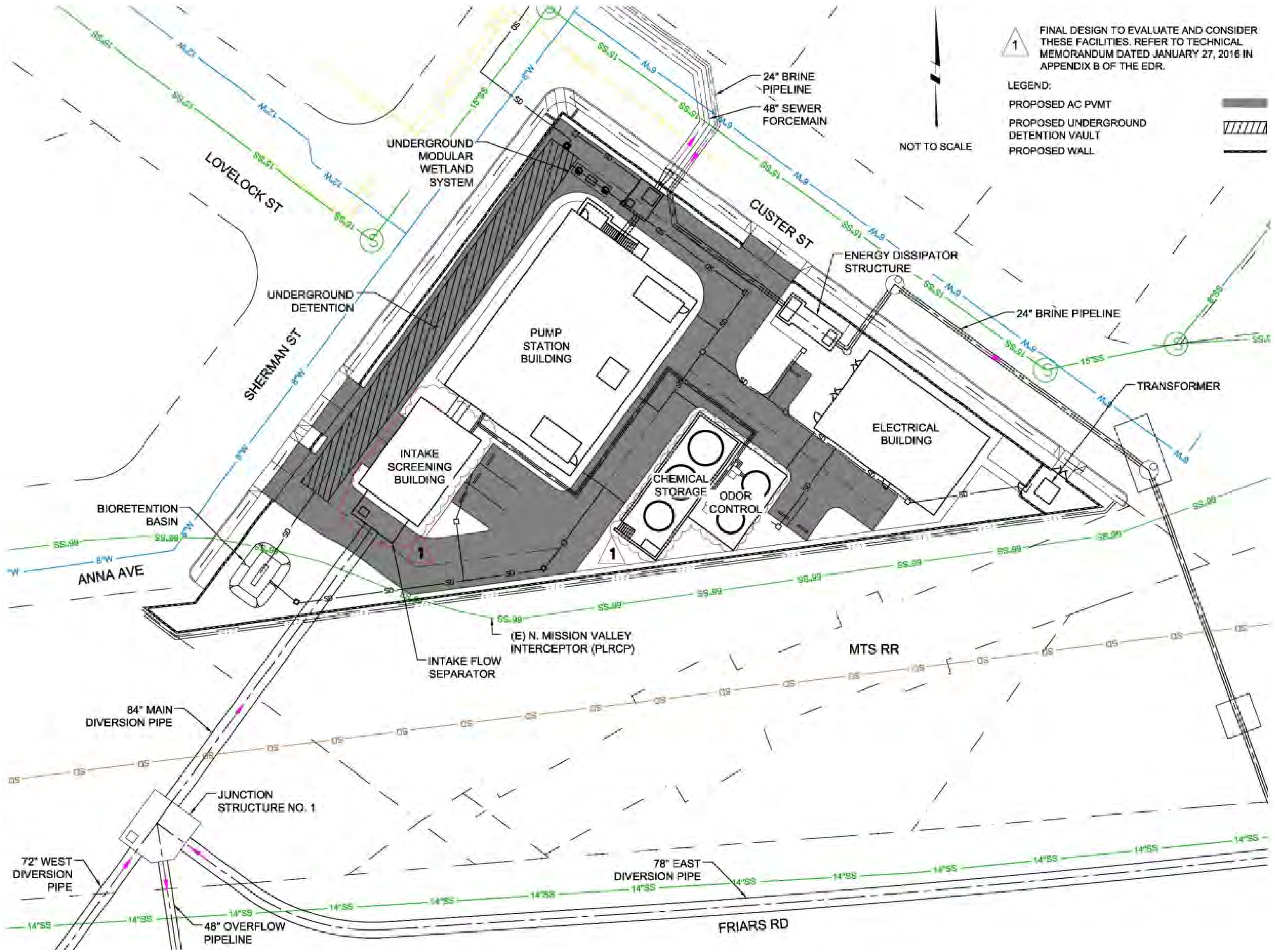


Figure 1-4: MPS Site

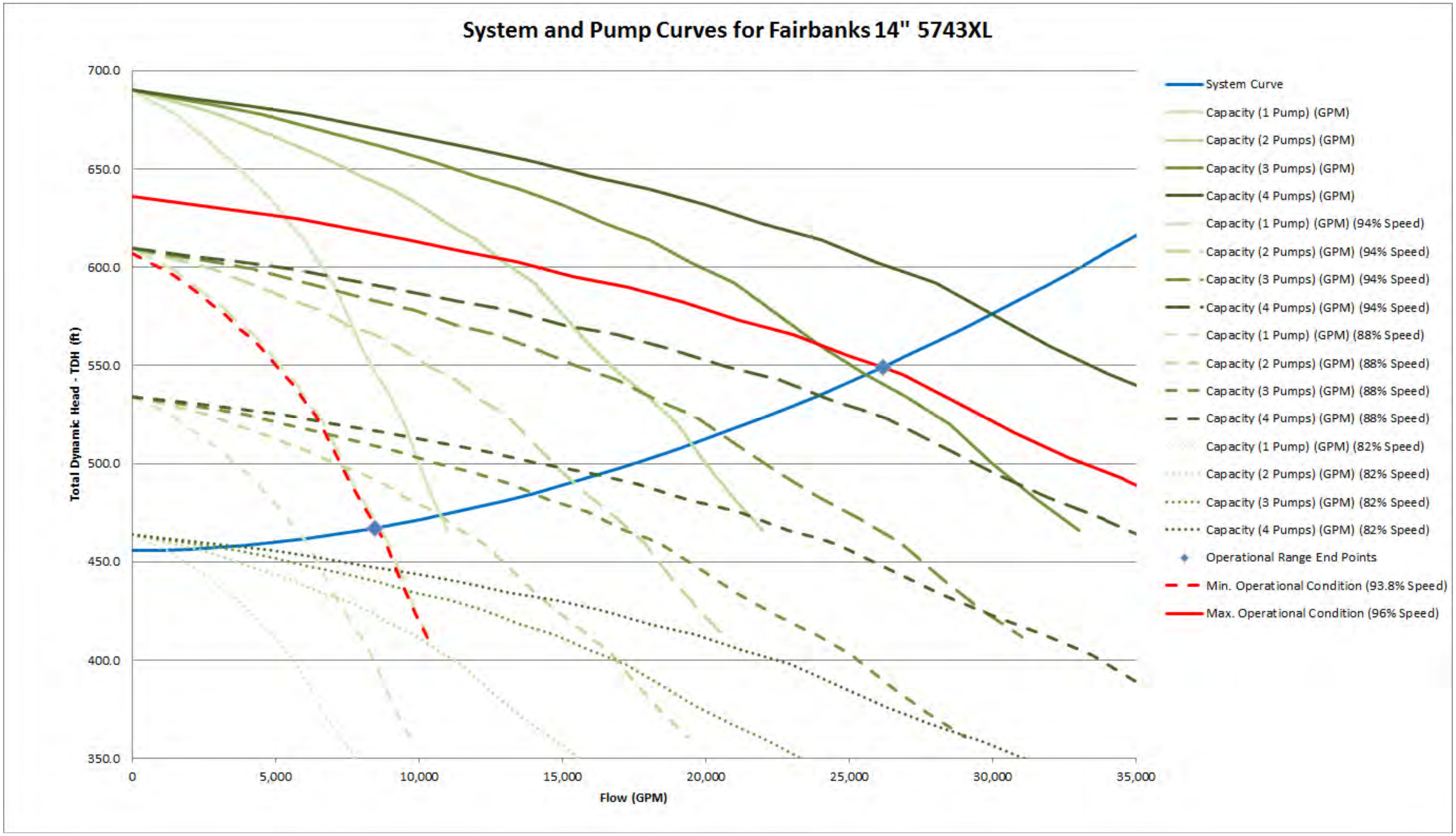


Figure 1-5: MPS Pump and System Curves

1.5 Schedule

Pursuant to the Pure Water Program's current cooperative agreement, delivery of purified water to the reservoir(s) must begin by December 31, 2023. However, the Pure Water Program schedule identifies several opportunities to accelerate this schedule, and shows completion of the Project by approximately October 7, 2021. This Pure Water Program summary schedule is provided in Figure 1-6, which depicts the overall program schedule with the MPS Project highlighted. As is demonstrated in this figure, many concurrent projects will be ongoing with the MPS Project. Project work must be coordinated with other North City projects including NC02 NCWRP Expansion and AWPF Influent Conveyance, and NC03A/B NCAWPF.

1.6 Cost Estimate

This EDR includes an opinion of probable construction cost (OPCC) for the Project, summarized in Section 8 and below in Table 1-1. In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, a Class 4 estimate has been prepared as part of this EDR. A Class 4 estimate is typically based on a design where engineering is between 1% and 15% complete. The expected accuracy for a Class 4 estimate is between -30% and +50%, depending on the technological complexity of the Project.

The complete cost estimate report is included in Appendix A and is based on the 10% design drawings in Exhibit A.

Operations and maintenance (O&M) cost information is described in Section 8.2 of the EDR.

Table 1-1: Project Cost Summary

Construction Cost Breakdown	
Mobilization and demobilization	$2,315,826
Demolition at Pump Station	$1,066,624
Site works at Pump Station	$1,125,753
Energy Dissipation Structure	$1,236,463
Electrical Building	$847,499
Morena Blvd. Pump Station	$20,553,792
48" Force Main and 24" Brine Line	$66,936,363
East Diversion Pipeline	$5,453,416
Main Diversion Pipeline	$791,008
West Diversion Pipeline	$2,417,877
Overflow Pipeline	$4,829,643
Pressure Reducing Stations	$582,576
Fiber Optic Line	$1,313,119
Subtotal construction cost	**$109,469,958**
Contingency (30%)	$32,840,987
Total construction cost	**$142,310,945**

Table 1-1: Project Cost Summary	
Delivery costs [a]	
Predesign [b]	$2,510,000
Detailed design (7.1%)	$10,104,077
ESDC (1.4%)	$1,992,353
Construction management: bid phase (0.4%)	$569,244
Construction management: construction phase (6.8%)	$9,677,144
Environmental: review and permitting (1.4%)	$1,992,353
Environmental: construction compliance (2.1%)	$2,988,530
Project management: City Project management (3.6%)	$5,123,194
Project management: other City departments (1.4%)	$1,992,353
Subtotal delivery costs	**$36,949,249**
Other costs [a]	
Land acquisition	$3,200,000
Environmental mitigation (2.1%)	$2,988,530
Subtotal other costs	**$6,188,530**
Total Project cost	**185,448,724**

a. *Delivery and other costs based on total construction cost.*

b. *Fixed costs are per baseline budget or current Pure Water Program directive.*

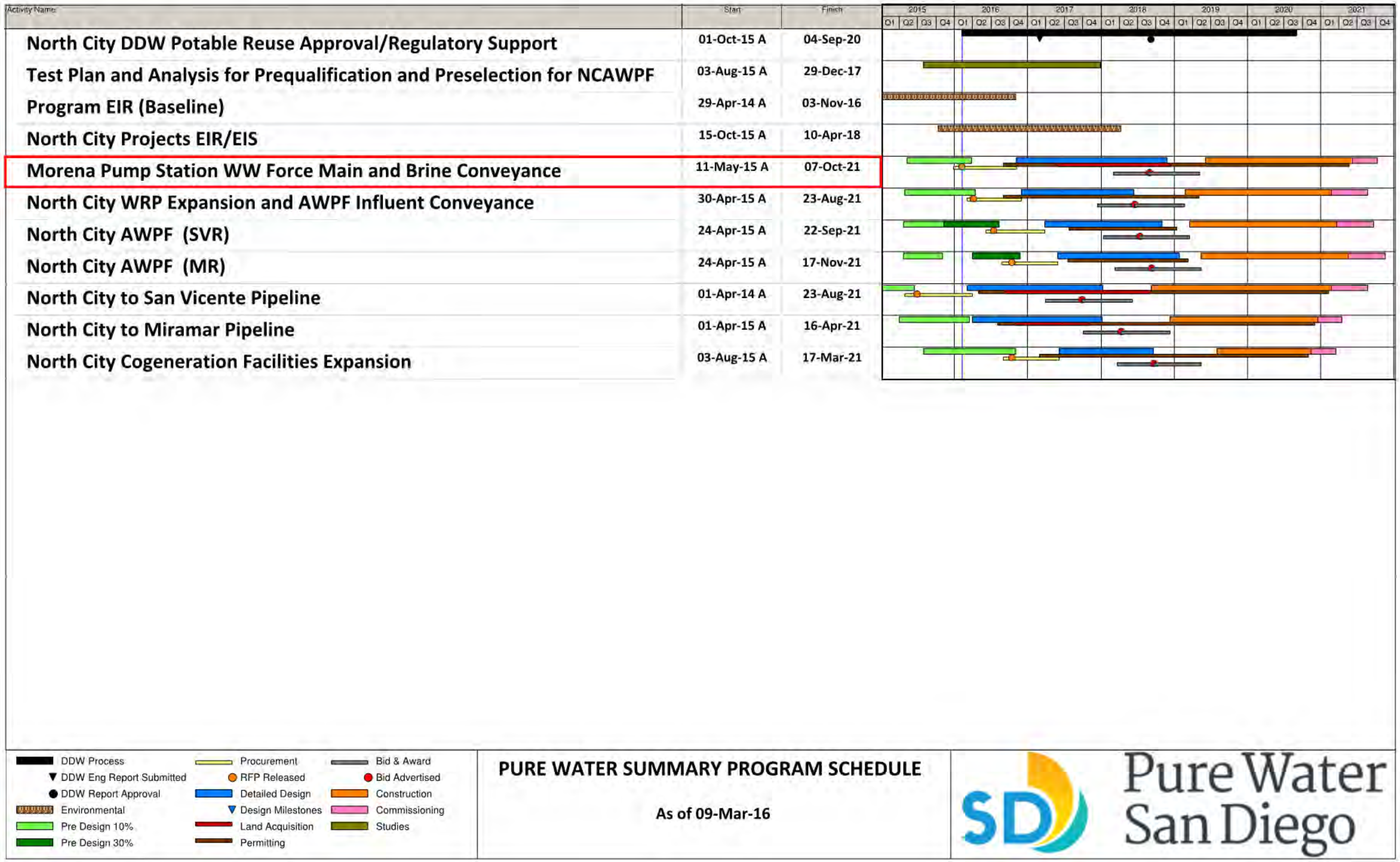


Figure 1-6: Summary Program Schedule

1.7 Summary

The MPS, force main, and brine conveyance pipeline involves many engineering disciplines, construction trades, and stakeholders. It is strongly recommended that this entire 10% Engineering Design Report (EDR) including appendices be read for a more detailed Project understanding.

Each Project element strongly influences other elements and design criteria are interconnected, including downstream facilities such as NCWRP, NCAWPF, and others. Before any element is amended, it is recommended that a detailed analysis be conducted to determine impacts to other North City upgrades.

1.8 Notes to Final Designer

Recommended action items for the final designer to address are listed below. During preparation of the 10% design, key elements essential to the successful design, construction, and future operation of the MPS, force main, and brine pipeline were identified. The list below identifies items requiring the final designer's special and timely attention to mitigate risk and negative schedule impacts anticipated during final design:

- Early coordination with the City's Real Estate Acquisition Department (READ) to obtain permanent and temporary construction easements, and acquire the MPS site.
- Early coordination with the California Department of Transportation (Caltrans) to permit the Interstate 805 (I-805) and State Route 52 (SR 52) crossings.
- Early coordination with the San Diego Metropolitan Transit System (MTS) to permit the presented encroachment crossings.
- Early coordination with the San Diego Association of Governments (SANDAG) on the ongoing San Diego River Bridge Double Track (SDRDT) Project and Mid-Coast Corridor Transit Project (MCCTP) on Friars Road, West Morena Boulevard, and Genesee Avenue.
- Early coordination with the City's Public Utilities Department (PUD) on the Morena Pipeline Project.
- Early coordination with the City's PUD to verify MPS incoming flows from existing sewer facilities and diversion pipeline sizes.
- Evaluation of CEQA requirements, including historical districts and greenhouse gas emissions.
- Evaluation of the necessity of screening facilities and odor control system at MPS to potentially provide operational reliability, ease of maintenance and overall cost savings to the City.
- Validation with the City on the number and type of pumps to be used at MPS.
- Consideration of the presented alternate alignment along Nobel Drive/Towne Centre Drive/Executive Drive to avoid the MCCTP station on Genesee Avenue.
- Design of communication and control systems between MPS and critical points along the pipeline and at NCWRP and NCAWPF.
- Coordination of the brine pipeline origination with NCAWPF's (Tasks 2 and 3) 10% design and the brine pipeline's routing with NCWRP's (Tasks 5 and 6) 10% design.

- Coordination of the force main terminus with NCWRP's (Tasks 5 and 6) 10% design.
- Coordination of MPS hydraulic design and instrumentation and controls with NCWRP (Tasks 5 and 6) 10% design.
- Coordination of the Project schedule with pavement moratoriums and planned capital improvement projects (CIPs) in the corridor.
- Coordination and performance of higher-level subsurface utility engineering investigations to confirm existing utility locations and finalize alignment.
- Analysis of the consequences of pipeline failure relating to pipeline pressures and pipe material to ensure that risk is minimized.
- Analysis of flooding potential at the MPS site due to sewer surcharging, brine flow, and force main back flow.
- Submittal of plans to the California Department of Public Health (CDPH) for approval of all areas of the alignment with less than 10 feet of horizontal separation from water pipelines.Early completion of a full geotechnical investigation, including soil borings and potholing, and geotechnical baseline reports (GBRs) to fully evaluate the MPS site, develop a comprehensive dewatering plan, evaluate trenchless methods, and design cathodic protection for the pipeline, among other reasons.
- Consideration of removing isolation valves, if needed, to provide a cost-saving opportunity for the City.
- Meet with San Diego Transportation and Storm Water Department to detail the resurfacing and Americans with Disabilities Act (ADA) requirements that apply specifically to this Project (i.e., bring non-standard ramps to code, resurface roadway curb-to-curb, etc.)
- Consider advising the City on pump pre-purchasing options to reduce potential long-lead-time-related impacts to the schedule and future maintenance.
- Attain additional survey mapping for revised gravity pipeline alignments on Friars Road from Interstate 5 (I-5) to Napa Street. See Appendix R for Task 7 aerial survey data including geo-referenced aerial imageries for final design use.
- On account of late revisions of the diversion pipeline alignments on Friars Road, some subsidiary documents in the appendices were not updated in a timely manner to reflect the plans. These include the Desktop Geotechnical Report (Appendix L), Environmental Assessments (Appendix M), Traffic Control Assessments (Appendix O), and Permit and Key Considerations Preliminary Assessment (Appendix P).

2 Introduction

The City of San Diego (City) has limited local water supply sources and relies on importing 85% of its water from the Colorado River and Northern California. San Diego's water reliability is threatened by ongoing drought, rising imported water costs, and increased water demand due to population growth. In November 2014, the San Diego City Council unanimously approved advancement of the Pure Water San Diego Program (Program). For the Program to proceed, the City must renew its modified National Pollutant Discharge Elimination System (NPDES) permit for the Point Loma Wastewater Treatment Plant (PLWTP) with the United States Environmental Protection Agency (USEPA). Without the permit, the City would need to invest $1.8 billion and overcome extreme space constraints to upgrade PLWTP to secondary treatment—upgrades that would not produce new water supply.

Investing in the Program and seeking federal legislation allowing the City to meet modified secondary standards will eliminate the need for the costly upgrades at PLWTP, enable the City to divert more water for recycling, and reduce ocean discharges. For these reasons, the City is moving forward with the Program to purify recycled water (RW) (final effluent) from water reclamation plants (WRPs) to drinking-water quality, providing a third of San Diego's water supply needs by 2035 with a projected capacity of 83 mgd.

Approximately 100 million gallons per day (mgd) of feed flow would be required to reduce PLWTP's discharge to the ocean by the same amount. Figure 2-1 shows the typical water cycle after Program implementation.

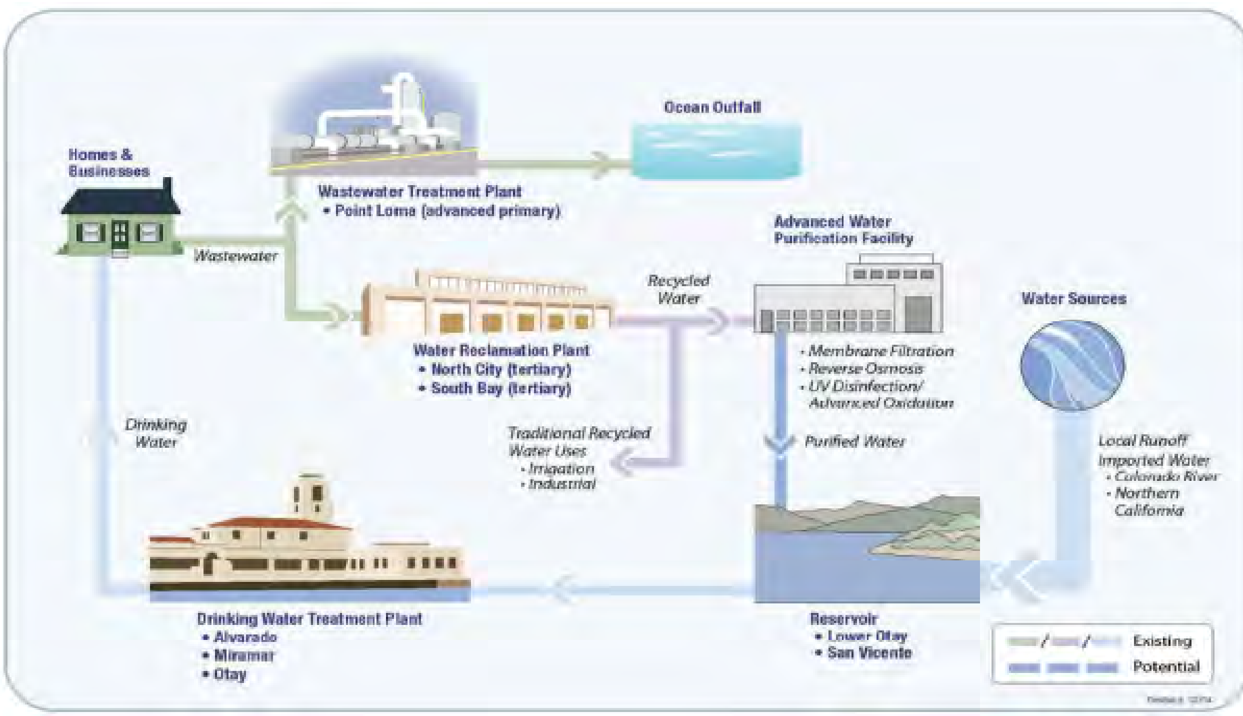


Figure 2-1: Water Cycle after Program Implementation

The Program will implement proven technology to purify RW through a triple-barrier treatment process consisting of membrane filtration, reverse osmosis (RO), and advanced oxidation with ultraviolet (UV) light and an oxidant (sodium hypochlorite or hydrogen peroxide [H_2O_2]). The City has established a demonstration project, still in operation at NCWRP, to confirm the viability and safety of the new advanced water treatment process. More than 1 million gallons of water have been purified every day at the City's demonstration facility. Rigorous daily monitoring has confirmed that no contaminants are present in the product water and RW can be purified and safely added to a reservoir. The California Department of Public Health (CDPH) (now the State Water Resources Control Board [SWRCB] Division of Drinking Water [DDW] Programs) and San Diego Regional Water Quality Control Board (RWQCB) approved the water purification process and confirmed that the purified water meets all federal and state drinking water standards.

Potable reuse is the addition of purified water to raw water supplies. Purified water is added to an environmental buffer, such as a reservoir, before being treated again at a standard drinking water treatment plant (WTP). Figure 2-2 shows major components of the typical potable reuse treatment process planned to be implemented as part of the Program.

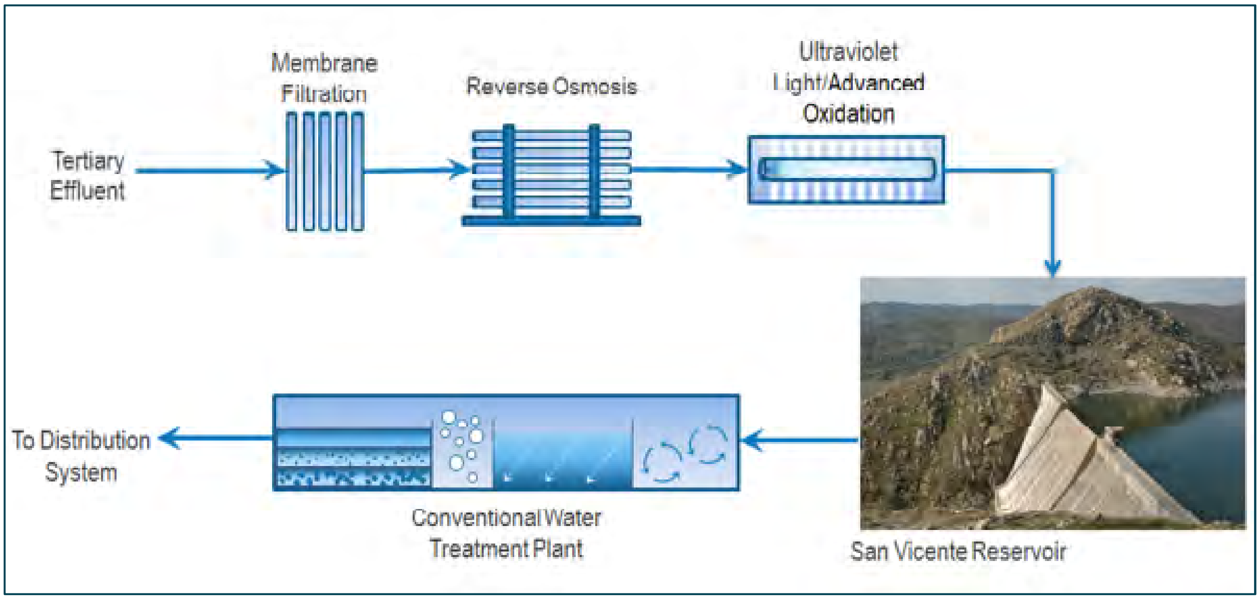


Figure 2-2: Potable Reuse Treatment Process

Program facilities are planned to be developed in phases at three different locations:

- **North City Advanced Water Purification Facility** (NCAWPF) will draw tertiary effluent from the existing North City Water Reclamation Plant (NCWRP) with a capacity of 30 mgd, planned to be operational by 2021
- **South Bay Advanced Water Purification Facility** (SBAWPF) will draw effluent from the existing South Bay Water Reclamation Plant (SBWRP) with a capacity of 15 mgd
- **Central Area Advanced Water Purification Facility** (CAAWPF) will draw effluent from a new WRP (to be built in the future) and generate the final 38 mgd

Figure 2-3 shows the relative locations of the three facilities and related conveyance systems planned under the Program.

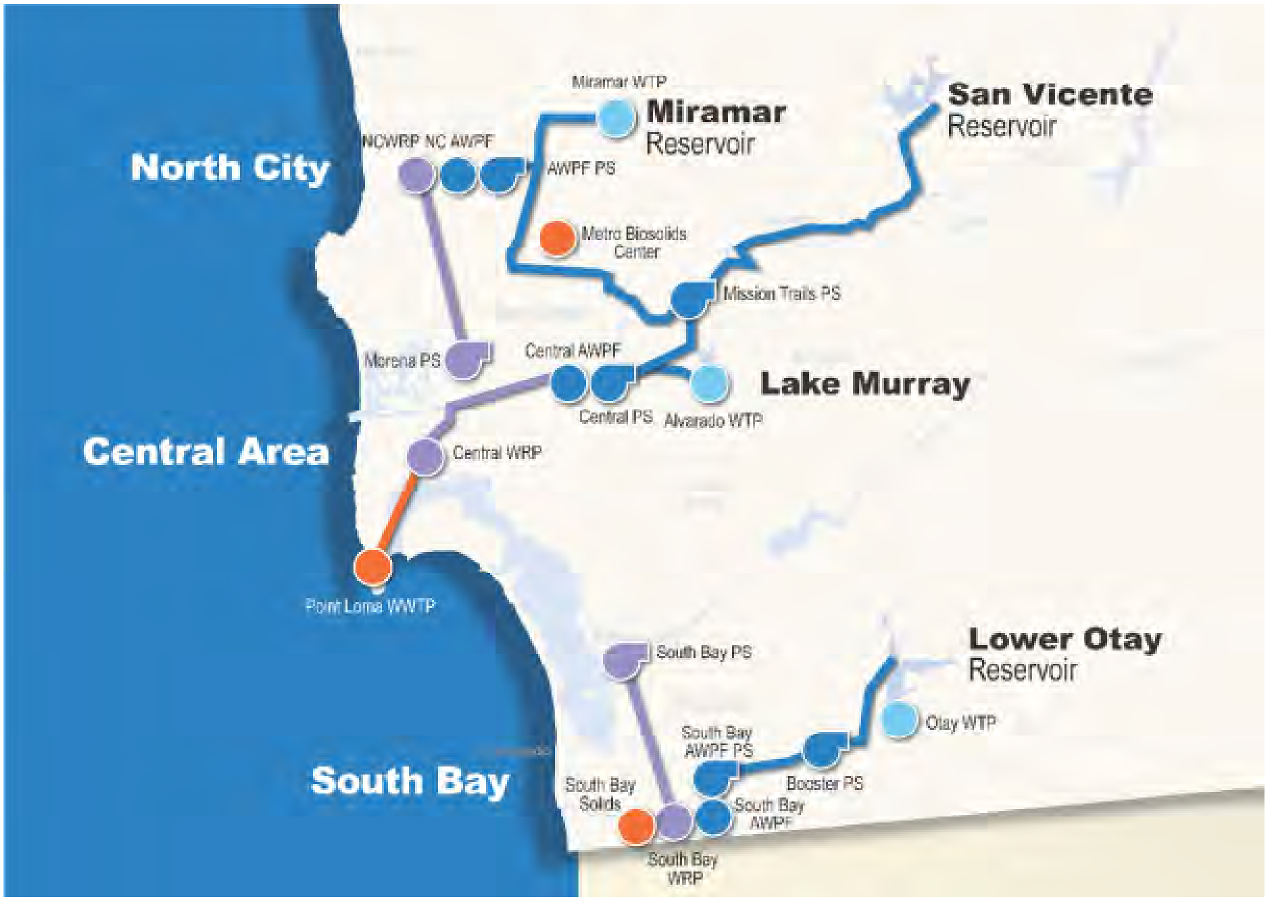


Figure 2-3: Proposed Program Facilities

NCAWPF's conveyance system, including the Morena Pump Station (MPS), wastewater (WW) force main, and brine pipeline, will deliver 37.7 mgd of raw wastewater to NCWRP. Wastewater will be conveyed to MPS by connections with four existing sanitary sewer trunk sewers. At MPS, wastewater will likely be screened (the necessity of the screening facility is anticipated to be validated by the final designer during the final design phase) and pumped approximately 10.4 miles through a new 48-inch-diameter wastewater force main for final discharge into the existing NCWRP force main. NCAWPF's final product water will be discharged to the San Vicente Reservoir (SVR) or Miramar Reservoir (MR). A new 24-inch-diameter brine pipeline constructed parallel to the wastewater force main will deliver brine by gravity flow from NCAWPF to MPS, where brine will flow through an energy dissipator before discharge into the North Mission Valley Interceptor (NMVI). Once in NMVI, the brine will ultimately flow to PLWTP, preventing recirculation back to NCWRP.

Figure 2-4 shows the relative location (illustrated by the blue line) of the proposed conveyance system relative to San Diego County's (County) major thoroughfares and landmarks. The preliminary design of the conveyance system is discussed in greater detail throughout this Engineering Design Report (EDR).

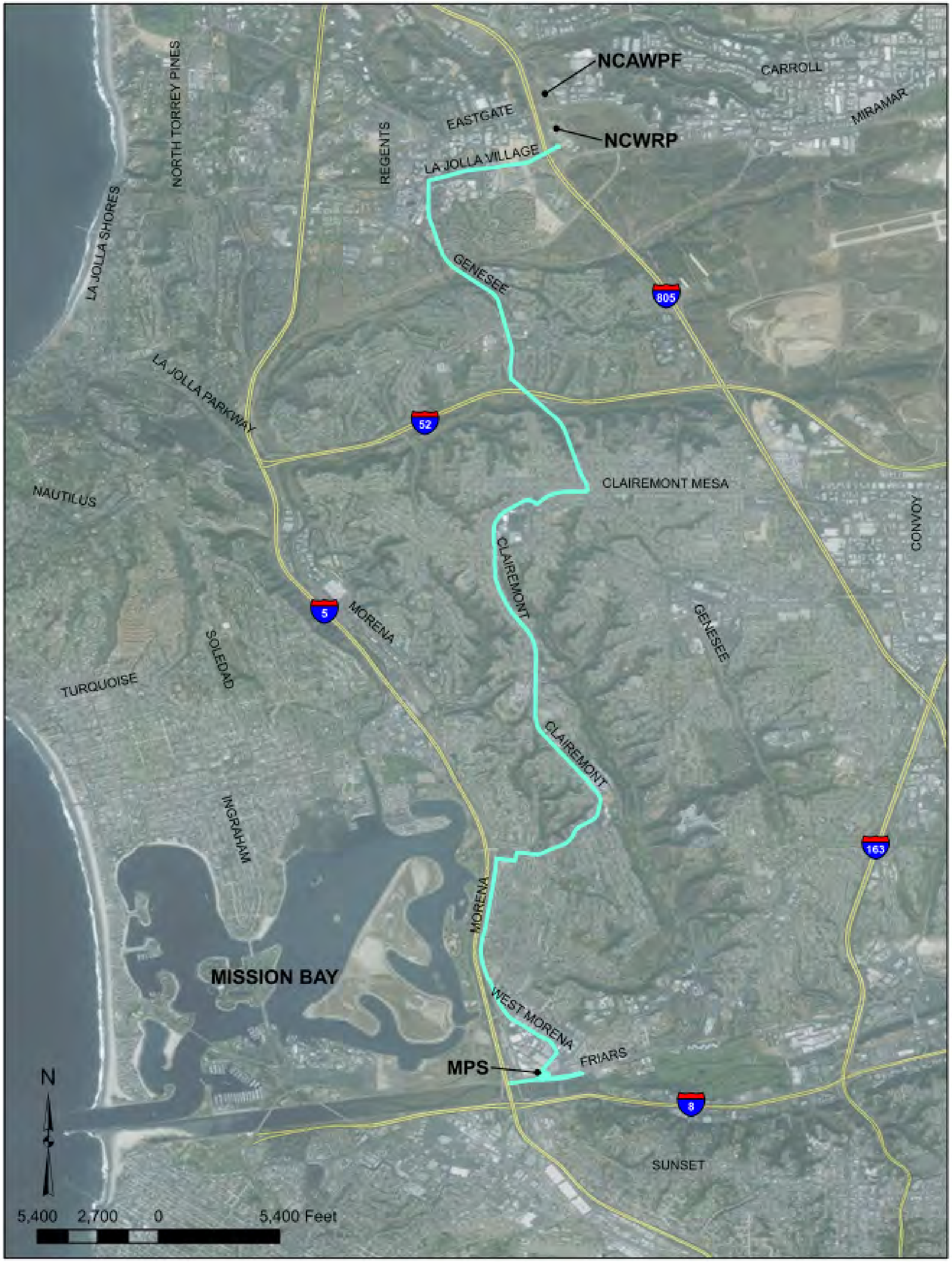


Figure 2-4: NC01 (Task 7) Facilities

3 Project Objective

This section describes past work related to the MPS, WW Force Main, and Brine Conveyance (NC01) Project (Project); its objectives; and coordination with other projects.

3.1 Past Work

In 2010, USEPA issued a modification to its NPDES permit allowing the City to continue to operate PLWTP as a chemically enhanced primary treatment (CEPT) facility until permit renewal in 2015. The 2015 renewed permit outlines potable reuse implementation goals for the City to meet, such as diverting wastewater from PLWTP's ocean outfall to produce 15 mgd of purified water by 2023 and 30 mgd of purified water by 2027.

NCAWPF and the associated conveyance system with MPS represent an important part of that diversion strategy. The facilities described under NC01 (Task 7) will collect, pump, and convey a portion of flow currently being sent to PLWTP and supplement other sources of flow to NCWRP. NC01 (Task 7) also includes a brine pipeline to convey brine generated at NCAWPF south to sewers flowing to PLWTP.

The City has completed several studies related to reusing existing water sources. Major water reuse studies conducted include the following:

- **Water Reuse Study** (2004–06) identified water purification via reservoir augmentation as San Diego's preferred water reuse strategy.
- **Recycled Water Study** (2009–12) developed and presented water reuse alternatives for San Diego's future.
- **Demonstration Project** (2009–13) confirmed that the City can produce purified water meeting all federal and state drinking water standards.

The Project's design of the MPS, wastewater force main, and brine pipeline will build upon recommendations in these three studies. The studies can be found online at http://www.sandiego.gov/water/purewater/purewatersd/.

3.2 Project Objective

In May 2015, the City contracted MWH Americas, Inc. (MWH), Brown and Caldwell (BC), and Trussell Technologies, Inc. (TT) to complete planning-level engineering and technical investigations to support a 10% design of the Project. This EDR presents the findings and conclusions of the Project's preliminary technical investigations, methodology, analyses, calculations, and design development. The EDR also includes comprehensive recommendations to be used as the basis for the next phase of design.

The Project's main objective is to transmit 32 mgd (average annual daily flow [AADF]) of raw wastewater to NCWRP. To accomplish this, connections to NMVI, Morena Boulevard Interceptor (MBI), Morena Boulevard Trunk Sewer (MBTS), and East Mission Bay Trunk Sewer (EMBTS) must be constructed. Wastewater will be conveyed to the MPS site and screened to remove larger solids prior to conveyance to MPS, which will consist of five two-stage vertical-turbine, nonclog pumps operating in a series sequence with four active and one standby (4+1) configuration. The MPS site will also include new facilities to supply ferrous chloride ($FeCl_2$) for odor control in the force main, and a passive odor control system to remove fouled air from the screening facility and MPS wetwell.

Wastewater will be conveyed via a new 48-inch-diameter force main located approximately 10.4 miles north of NCWRP and connect to the 60-inch-diameter raw sewage (RS) line from the influent pump station (IPS) to the headworks. A new 24-inch-diameter brine pipeline will be constructed parallel to the force main. The brine pipeline will convey brine (generated from NCAWPF) south to NMVI (by way of MPS), where it will flow south for treatment at PLWTP. Because of grade changes between NCAWPF and Friars Road, construction of pressure-reducing stations at two locations and an energy dissipation structure at the MPS site will be necessary.

3.3 Coordination with Other North City Projects

North City upgrade projects include numerous task orders (TOs), each consisting of various tasks. Table 3-1 summarizes task orders, task descriptions, and how each TO and its tasks relate to TO 2, Task 7 (NC01).

Table 3-1: Task Order and Task Summary

Task Order No.	Task No.	CIP No.	Task Description	Coordination with Task 7 Remarks
2	1		TO 2 project management	Project management and Task 3 controls
	2	NC03A	NCAWPF design for potable reuse to SVR	Brine pipeline connection to microfiltration and RO facilities at NCAWPF
	3	NC03B	NCAWPF design for potable reuse to MR	Brine pipeline connection to microfiltration and RO facilities at NCAWPF
	4		Not used	
	5	NC02	NCAWPF IPS and pipeline	Wastewater force main connection to NCAWPF IPS
	6		NCWRP improvements to augment feed water to NCAWPF	Brine pipeline routing to NCWRP
	7	NC01	MPS, wastewater force main, and brine conveyance	
	8	NC04B	NCPS pump station to MR	None
3	-	-	MR modeling	None
4	-	-	Impact of Pure Water on WTP and reservoir operations	None
5	-	-	Program management services	None
6	-	-	Full-scale stress test	None
7	-	NC05	North City cogeneration	Location of new facilities with brine pipeline
8	-	-	SVR tunneling alternative	None
9	-	-	Prequalification testing	None
10	-	-	TRC review	Presentation of proposed design
11	-	-	Impact of brine on PLWTP	None
12	-	-	Regulatory support	Design information required
13	-	-	Impact of centrate on NCWRP	None

Table 3-1: Task Order and Task Summary				
Task Order No.	**Task No.**	**CIP No.**	**Task Description**	**Coordination with Task 7 Remarks**
14	-	-	ELBE/SLBE fair	None
15	-	-	MBC upgrades due to NCWRP Expansion	Potential relocation of pipeline facilities to include coordination with MBC
16	-	-	Centrate study	Potential reduction of flows from MPS
17	-	-	Program extension of COMNET	System-wide control strategy determining MPS operations based on demands at NCWRP and NCAWPF
18	-	-	Impacts of Program solids on MBC	No direct impact

3.4 Coordination with Other Area Projects

In addition to North City upgrade projects, coordination with several other ongoing area projects will be necessary. Table 3-2 lists projects known at the time of EDR publication.

Table 3-2: Other Area Projects			
Project Name	**Agency**	**Project Description**	**Coordination with NC01 (Task 7) Remarks**
Mid-Coast Corridor Transit Project	MTS, SANDAG	Light-rail corridor, train stations, and utility relocation	• New light-rail stations on Morena Boulevard and Genesee Avenue • Utility relocations from the western side of Morena Boulevard • New parking lot at the corner of Morena Boulevard and Mission Bay Drive • Diversion pipeline crosses tracks at Anna Avenue for the Alternative Offsite Infrastructure (Refer to Section 4.8.1)
San Diego River Bridge Double Track Project	MTS, SANDAG	Heavy rail corridor, utility relocation	Expansion of existing single track to double track at Anna Avenue crossing, including utility relocations
Morena Pipeline Project	San Diego Public Utilities Department (PUD)	New 18-inch-diameter pipeline on northbound lanes of Morena Boulevard, new 36-inch-diameter pipeline along Friars Road and Morena Boulevard (refer to the City PUD's "Alvarado 2nd Extension and Morena Pipeline" Planning Study)	Location of pipelines along Morena Boulevard and crossing of supply lines for MPS

4 Project Description

This section describes the design criteria and design details of the Project.

4.1 Introduction

New facilities will be constructed to divert wastewater flow from the existing 66-inch-diameter NMVI #2, 72-inch-diameter NMVI #1, 33-inch-diameter MBTS, and 60-inch-diameter EMBTS toward the new MPS site. Wastewater will be collected in a trench type wet well in the new MPS. New vertical solids handling centrifugal pumps will draw wastewater from the wet well and pump it through a new 48-inch-diameter discharge force main to the existing NCWRP. At NCWRP, the force main will connect to the existing 60-inch-diameter RS line (refer to As Built Plan 26982-75-D Drawing N01-CY-14 included in Appendix E) prior to entering the existing headworks building.

Brine from the new NCAWPF (to be located directly north of the existing NCWRP) will be conveyed via a 24-inch-diameter brine pipeline to an energy dissipation structure located at the MPS site. The brine discharge will flow by gravity from NCAWPF to the MPS site, with the 48-inch-diameter force main and brine pipeline residing in a common pipe trench. The MPS energy dissipation structure will reduce flow velocity and pressure before the brine is discharged into the manhole of the new MPS overflow pipeline on Friars Road.

Optional work items consist of two traveling bar screens sized, a manual bar screen, a screening building, and a liquid phase odor control system. The wastewater will be screened prior to entering MPS via one or both traveling screens or through a bypass manual bar rack, refer to Sections 4.6.2 for further details on this element. Ferrous chloride is also an optional element which consists of on-site ferrous chloride storage tanks and metering pumps. The ferrous chloride will be metered into the raw wastewater being pumped from the MPS to bind with hydrogen sulfide to decrease odors emanating from the air-vacuum/air-release valves, refer to section 4.7 for further details.

A system schematic of the Project is depicted on Drawing G-006 in Exhibit A.

4.2 Pipeline Alignment Alternative Analysis

The initial alignment for the wastewater force main and brine pipeline was based on the Plant Siting and Pipe Alignment Study (February 2, 2015), prepared by BC and Black & Veatch. This alignment was based on a proposed MPS site in the vicinity of the intersection of Morena Boulevard and Balboa Avenue. The proposed corridor ran east from MPS along Balboa Avenue, north along Genesee Avenue, east along Governor Drive, and north along the San Diego Gas & Electric (SDG&E) utility corridor (requiring an easement), crossing Miramar Road to NCWRP and NCAWPF. Figure 4-1 shows the initial pipeline alignment.

After further coordination with the City during the Preliminary Engineering and Technical Investigations phase of the Project, the proposed MPS location was moved to the vicinity of the Friars Road and Morena Boulevard intersection to capture additional wastewater flows needed to produce 30 mgd of purified water plus 11.8 mgd required for non-potable reuse (NPR). The initial alignment was extended south along Morena Boulevard and Sherman Street to connect to MPS at its newly proposed location; this alignment was considered the baseline alignment at the start of the Project and labeled Alternative Alignment 1. Two alternative alignments were developed to evaluate cost savings potential.

Figure 4-1: Baseline Alignment

(from Plant Siting and Pipe Alignment Study, 2015)

4.2.1 Alternative Alignment 1

Alternative Alignment 1 consists of 11.5 miles of open-trench construction with seven tunnel sections. The alignment extends from MPS along Morena Boulevard, north to Balboa Avenue, and proceeds to Genesee Avenue before following Genesee Avenue north to Governor Drive and east along Governor Drive toward Jacob Dekema Freeway (Interstate 805 [I-805]). The pipeline crosses under I-805 and is tunneled approximately 7,200 feet through the SDG&E right-of-way to the north side of Miramar Road. The pipeline then follows the southern and western perimeter fence and connects to the IPS discharge pipeline (RS pipeline). Tunnel crossings include Tecolote Road bridge and Tecolote Creek, Clairemont Drive bridge, SDG&E utility corridor (two tunnel locations), San Clemente Canyon Freeway/Mt. Soledad Freeway (State Route [SR] 52), I-805, and within the SDG&E right-of-way. The combined length of tunnel sections measures approximately 10,700 feet. Figure 4-2 shows Alternative Alignment 1.

Major items of consideration for this alignment include the following:

- SDG&E requires any utilities within its right-of-way to be tunneled a minimum depth of 80 feet below grade. Approximately 7,200 feet of this alignment is within the SDG&E right-of-way.
- This alignment requires a lease agreement with the federal government to establish an easement for encroachment within the San Diego National Wildlife Refuge and Marine Corps Air Station (MCAS) Miramar properties east of I-805.
- The easement area includes three endangered species and additional coordination and time should be anticipated.
- The alignment's profile includes many high and low points.
- Some of the alignment's low points are within environmentally sensitive areas.
- The new 36-inch-diameter Morena Water Main Pipeline project parallels this alignment, and will require coordination with the City's Public Works Department.
- Most of this alignment is within public street right-of-way and will cause traffic impacts for the community. A traffic control plan will be required.
- The new light-rail trolley line and Clairemont Drive Station of the Mid-Coast Corridor Transit Project (MCCTP) parallels the pipeline along Morena Boulevard. Coordination with the San Diego Association of Governments (SANDAG) will be required.

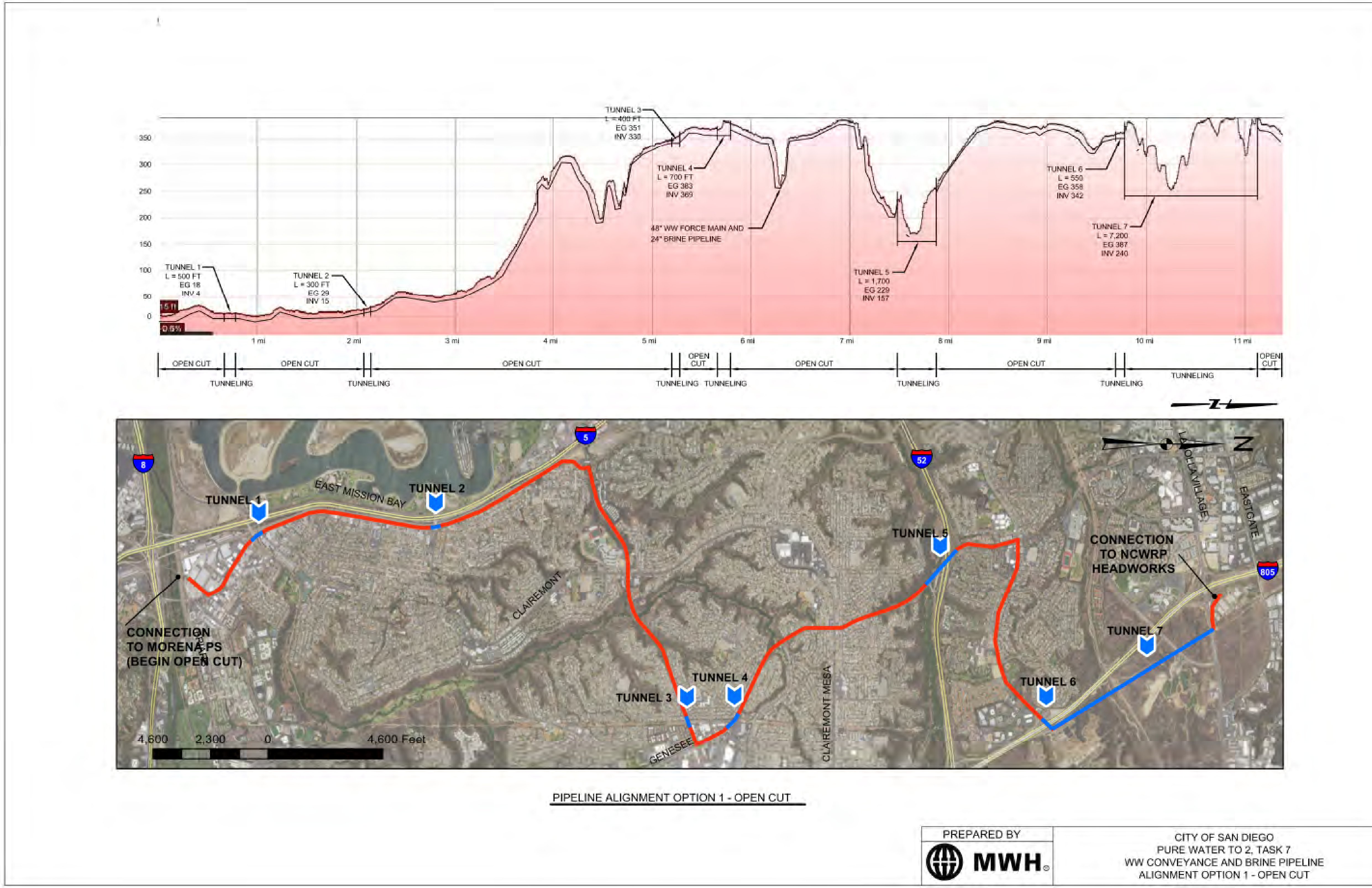


Figure 4-2: Alternative Alignment 1: Profile and Alignment

4.2.2 Alternative Alignment 2

Alternative Alignment 2 follows the SDG&E utility corridor from Linda Vista Road near MPS to Miramar Road. This alignment consists of approximately 8.9 miles of mostly tunnel construction, except for a small portion along Sherman Street and Linda Vista Road requiring open-trench construction. Within the SDG&E-owned right-of-way, the alignment would be constructed as a 102- to 112-inch-diameter tunnel, as deep as 80 to 100 feet because of low points and deep foundations of the SDG&E transmission towers. This alignment, though shorter, would require major permitting and coordination work with SDG&E and impact sensitive environmental areas and locations of tunneling shafts.

This alignment requires six tunnel portals placed at low points of its profile. The combined length of tunnel sections measures approximately 37,900 feet. Figure 4-3 shows Alternative Alignment 2.

Major items of consideration for this alignment include the following:

- The alignment provides a significant savings in pipeline length and pumping requirements, and significantly reduces traffic impacts to the community.
- Permitting for the easement within the SDG&E right-of-way and future approval will require extensive coordination and is not guaranteed.
- A lease agreement with the federal government is required to establish an easement for encroachment within the San Diego National Wildlife Refuge and MCAS Miramar properties east of I-805.
- The tunnel will be affected by high groundwater levels.
- The tunnel alignment crosses seismic faults.
- Shaft depth will pose construction difficulties and will make access and maintenance more difficult.
- Tunneling could cause surface settlement, which could damage existing power transmission towers above.
- Unknown soil conditions could create schedule risks that may slow or halt tunneling.
- A comprehensive geotechnical baseline report (GBR) is required.
- The alignment runs through environmentally sensitive areas and requires additional permitting.

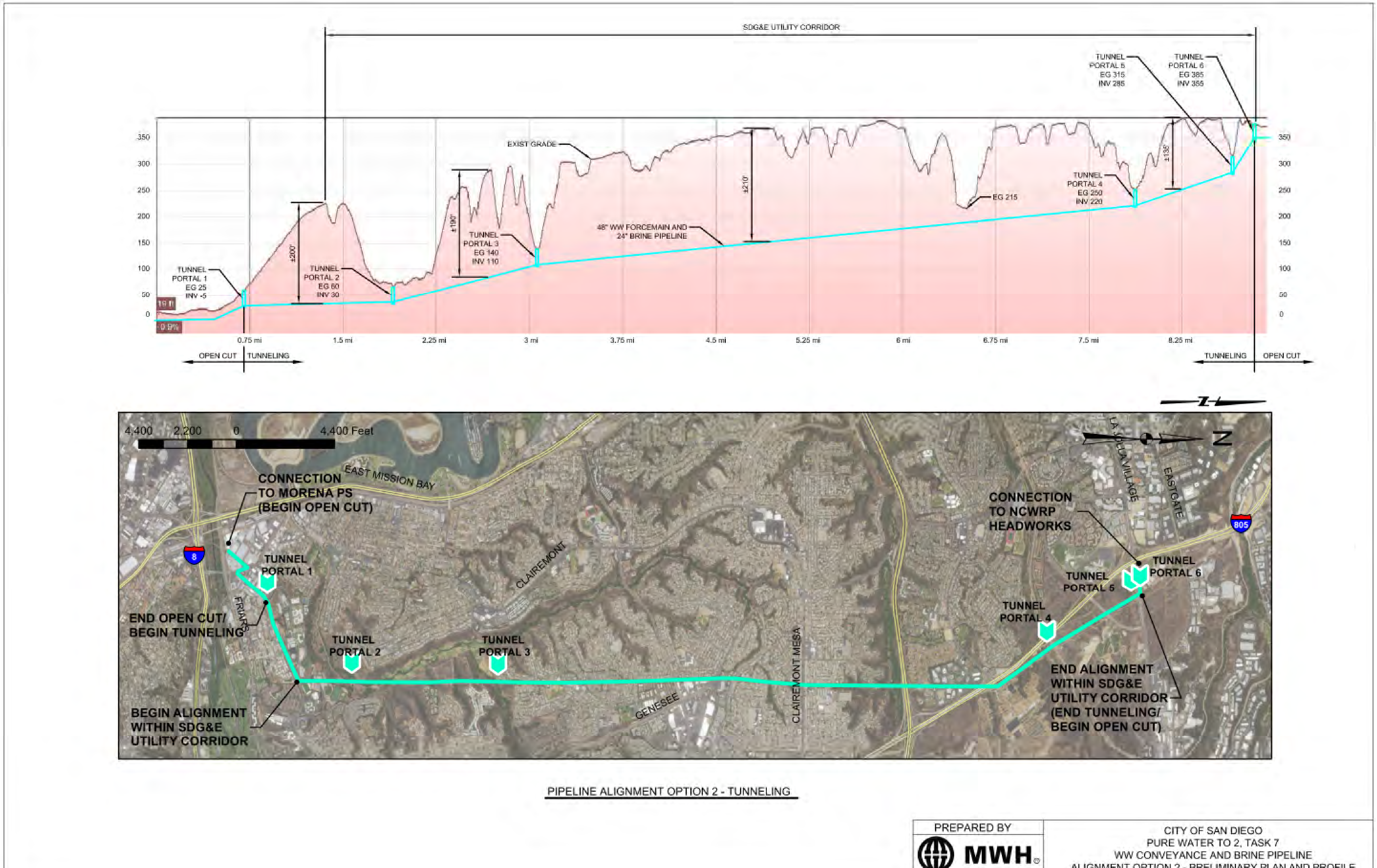


Figure 4-3: Alternative Alignment 2: Profile and Alignment

4.2.3 Alternative Alignment 3

Alternative Alignment 3 was developed to offer a more efficient hydraulic profile, reduce overall tunnel length, and avoid the SDG&E utility corridor and associated permitting requirements and regulations. The proposed alignment matches portions of Alternative Alignment 1 along Morena Boulevard and Genesee Avenue, starting at MPS, running north along Sherman Street and Morena Boulevard, and east on Clairemont Drive. It then turns and runs north, east on Clairemont Mesa Boulevard, north on Genesee Avenue, east on Miramar Road, crosses under I-805, and connects to NCWRP's IPS RS pipeline. The alignment consists of approximately 10.4 miles of open-trench construction with tunnels at crossings, including Tecolote Road bridge and Tecolote Creek, SR 52, and I-805. The combined length of tunnel sections measures approximately 3,400 feet. Figure 4-4 shows Alternative Alignment 3.

Major items of consideration for this alignment include the following:

- The alignment does not encroach on the SDG&E right-of-way and will not require associated easements and permitting.
- The alignment does not encroach on the San Diego National Wildlife Refuge and MCAS Miramar properties east of I-805 and will not require lease agreements with the federal government.
- The alignment has a smoother elevation profile than Alternative Alignment 1.
- The alignment parallels the 36-inch-diameter Morena Water Main Pipeline project and requires coordination with the City's Public Works Department.
- Most of the alignment is within public street right-of-way, and will cause traffic impacts for the community. A traffic control plan will be required.
- The alignment parallels the new light-rail trolley line and stations (Clairemont Drive Station and University Towne Centre [UTC] Station) of the MCCTP along Morena Boulevard and a portion of Genesee Avenue. Coordination with SANDAG will be required.

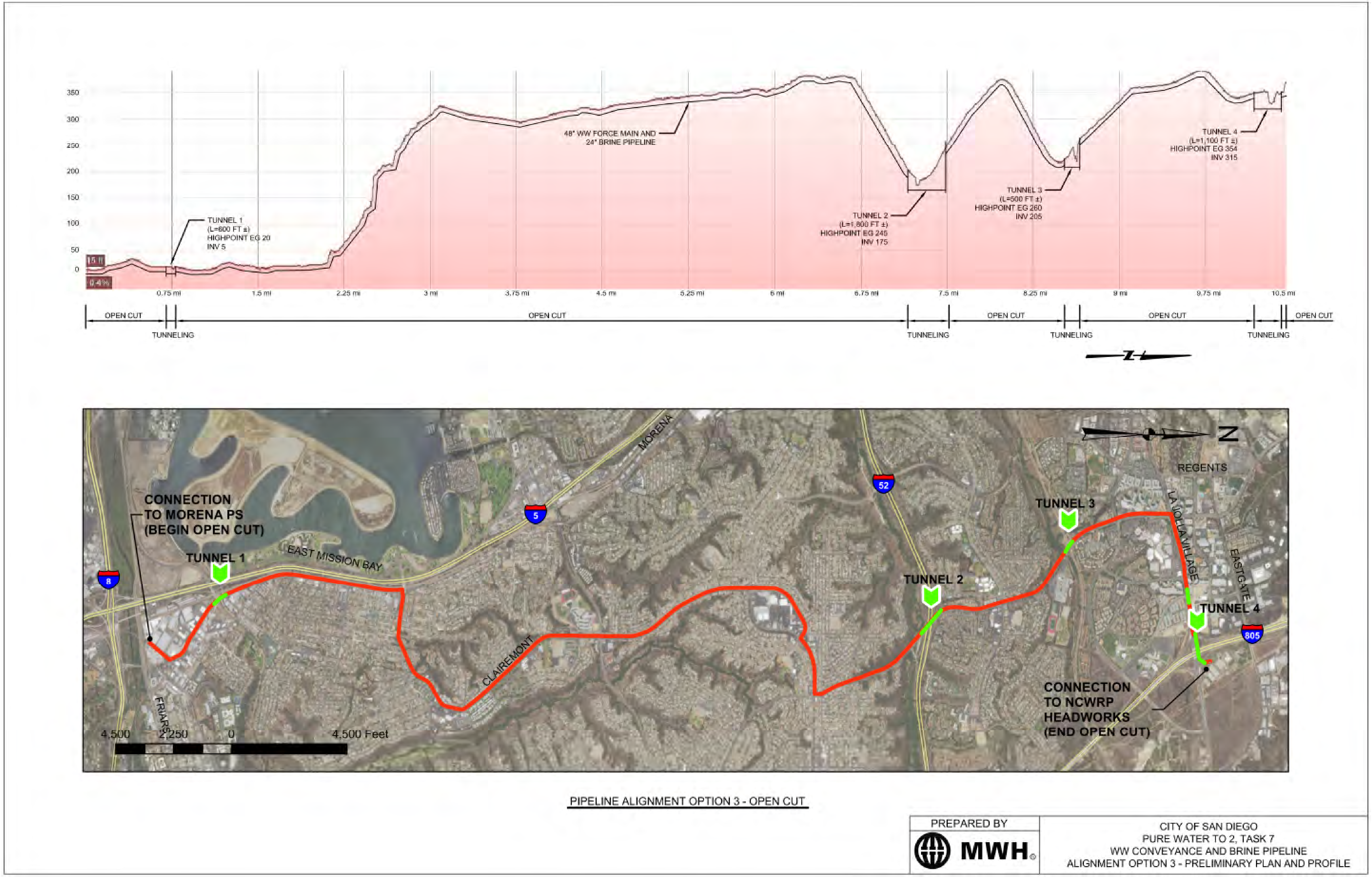


Figure 4-4: Alternative Alignment 3: Profile and Alignment

4.3 Selected Alignment

An Alternatives Analysis Report (Appendix F) was developed to determine the most feasible alignment alternative. Based on the Alternatives Analysis Report's Pipeline Alternative Evaluations Matrix, Alternative Alignment 3 is the recommended alternative and was selected by the City as its preferred pipeline alignment. This section discusses the 10% predesign of Alternative Alignment 3, including the 48-inch-diameter force main and 24-inch-diameter brine pipeline, which will be installed parallel within the same open-trench and tunnel sections.

Numerous design changes to the alignment were incorporated after the alternative alignment selection process to avoid conflicts with existing utilities and the ongoing MCCTP, which impacts alignment portions along West Morena Boulevard and Genesee Avenue. The alignment was revised at the Morena Boulevard and Clairemont Drive intersection to avoid the MCCTP Clairemont Drive light-rail station and associated parking facility. The latest alignment and corresponding stations are located as follows:

- **Station 9+53±:** begin alignment as an open-trench section near the north corner of the MPS site, enter the public street right-of-way on Custer Street, turn left, and head northwest
- **Station 11+00**: turn right on Sherman Street and head northeast
- **Station 20+50**: turn left on Morena Boulevard and head north
- **Station 27+00**: continue on West Morena Boulevard
- **Station 46+80**: end open-trench section and begin tunnel section to cross Tecolote Road bridge and Tecolote Creek
- **Station 50+75**: end tunnel section and begin open-trench section
- **Station 118+50**: turn right on Ingulf Street and head east
- **Station 125+50**: turn left on Denver Street and head north
- **Station 129+30**: turn right on Clairemont Drive and head east, then follow the road north
- **Station 329+50**: turn left on Clairemont Mesa Boulevard and head east
- **Station 350+00**: turn left on Genesee Avenue and head north
- **Station 390+15**: end open-trench section and begin tunnel section to cross bridge at San Clemente Canyon near the SR 52 on-ramp
- **Station 395+25**: end tunnel section and begin open-trench section

- **Station 398+95**: end open-trench section and begin tunnel section to cross SR 52
- **Station 414+05**: end tunnel section and begin open-trench section
- **Station 464+75**: end open-trench section and begin tunnel section to cross railroad tracks owned by San Diego Metropolitan Transit System (MTS)
- **Station 467+75**: end tunnel section and begin open-trench section
- **Station 508+00**: turn right on La Jolla Village Drive and head east
- **Station 534+70**: end open-trench section and begin tunnel section to cross grade separation at Judicial Drive intersection
- **Station 537+60**: end tunnel section and begin open-trench section
- **Station 548+95**: end open-trench section and begin tunnel section to cross I-805
- **Station 559+95**: end tunnel section and end alignment

The alignment's design avoids existing utilities where possible, the MCCTP rail alignment, and train stations. Existing utilities were identified using the SanGIS database; utilities with diameters equal to and greater than 8 inches and high-pressure gas lines were included in plan and profile sheets. Based on the CDPH, Zone B "Special Pipe" requirement, a minimum 6 feet of horizontal clearance and 1 foot of vertical clearance will be provided between the alignment and all potable water lines. The alignment will also be placed at least 1 foot below adjacent water lines.

4.3.1 Open-Trench Sections

Approximately 50,935 linear feet (LF) (93%) of the total alignment is installed with open-trench construction method. The open-trench section for the combined 48-inch-diameter force main and 24-inch-diameter brine pipeline will be approximately 10 feet wide within the street right-of-way. Vertical wall trenching and trench shoring will be provided for the full length of the open- trench sections to reduce roadway width affected by construction. The pipelines will be placed 5 feet apart, from center to center. As an industry standard, a minimum of approximately 6 feet of clear cover will be provided (verified during final design) and shall be in compliance with CDPH Title 22 requirements. Bedding and backfill criteria will be determined once geotechnical analysis is finalized. Figure 4-5 shows a typical open-trench section.

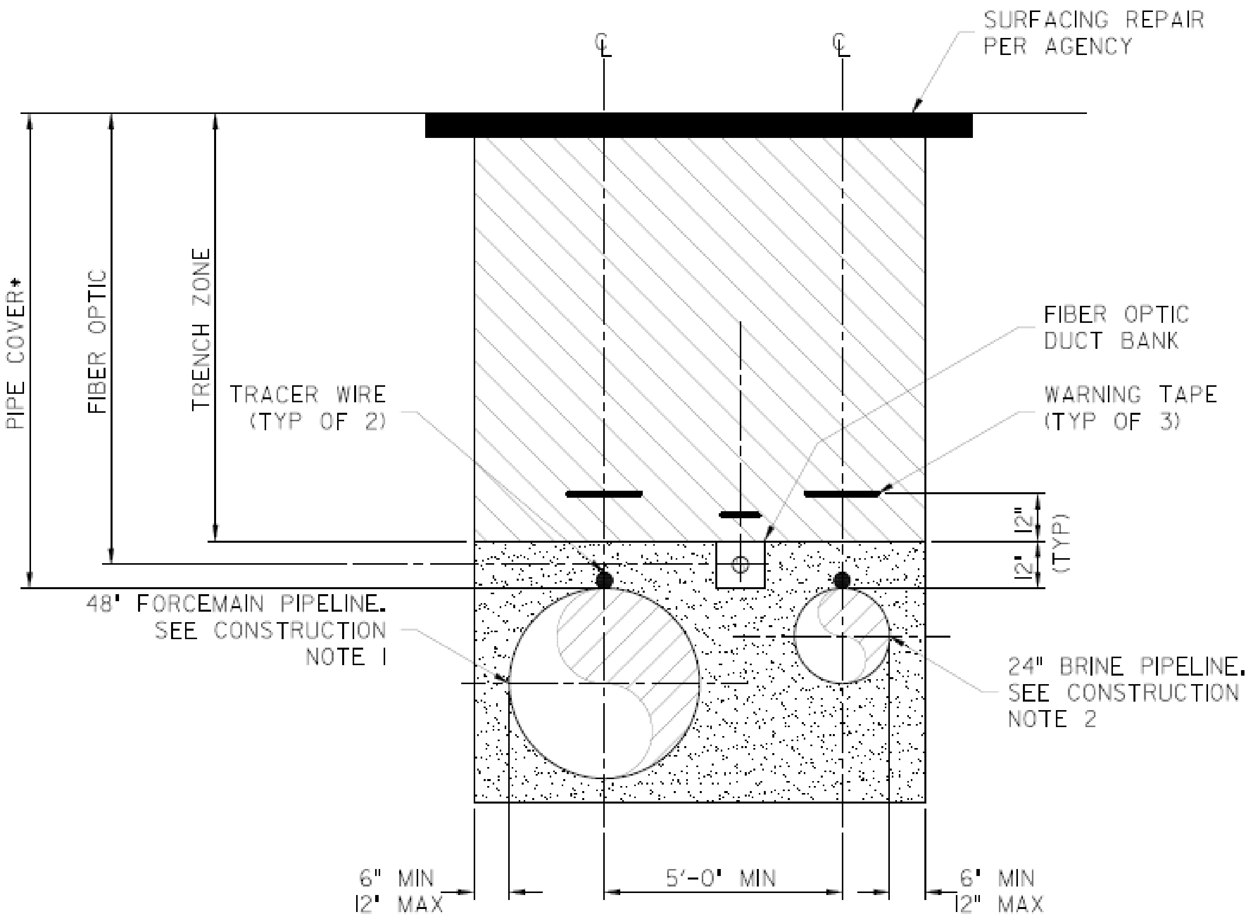


Figure 4-5: Typical Open-Trench Section

4.3.2 Trenchless Crossing Sections

Approximately 4,105 LF (7%) of the total alignment is installed with trenchless construction. Six tunnel sections are proposed for the following crossings:

- Tecolote Road bridge and Tecolote Creek (395 LF)
- The bridge at San Clemente Canyon near the SR 52 on-ramp (510 LF)
- SR 52 (1,510 LF)
- Railroad right-of-way owned by MTS and operated by North County Transit Department (NCTD) (300 LF)
- Grade separation at Judicial Drive intersection (290 LF)
- I-805 (1,100 LF)

Exhibit A contains 10% preliminary design plans and profiles for the trenchless sections of the force main alignments.

4.4 Force Main

This section discusses the 10% predesign of the selected alignment's 48-inch-diameter force main.

4.4.1 Pipeline

The 48-inch-diameter discharge line shall provide a maximum flow rate of 26,180 gallons per minute (gpm) (37.7 mgd) and requires significant hydraulic head to convey wastewater from MPS to NCWRP. Over that distance, there is up to 104 feet of dynamic losses and 446 feet of static losses, requiring careful calculations for pump and pipeline design. Because of high pressures, the first 3 miles of pipeline (from the outlet of MPS to Iroquois Avenue) will be constructed of a 48-inch-diameter cement mortar lined and coated pipe (CML&C) steel pipe. Near the intersection of Iroquois Avenue and Clairemont Drive, the pipeline will transition to a high-density polyethylene (HDPE) pipe (specifically resin PE 4710 ductile iron pipe size [DIPS] HDPE pipe) with a nominal diameter of 48 inches, outer diameter of 50.80 inches, minimum wall thickness of 3.277 inches, and average inner diameter of 43.85 inches. The pipe's dimension ratio (DR) is 15.5 (value of the outside diameter divided by minimum wall thickness), providing a pressure rating of 139 pounds per square inch (psi) and a sufficient safety factor for transient flow conditions.

The force main will connect to the existing 60-inch-diameter RS IPS discharge force main prior to entering the existing headworks building (refer to As Built Plan 26982-75-D Drawing N01-CY-14 in Appendix E). Results of MPS's hydraulic analysis (presented in Section 4.6) supported development of a hydraulic grade line (HGL) and determination of pressure as a function of distance along the pipeline alignment. Hydraulic analysis of the force main used a C-value of 120 for steel pipeline and 140 for the HDPE pipeline. Figure 4-6 presents the anticipated HGL for peak and low flow conditions, showing the HGL considerably higher than ground surface elevation and decreasing slowly over the length of the pipeline. Additionally, a difference of approximately 60 feet between NCWRP's ground surface elevation and the HGL correlates to approximately 26.6 psi of pressure in the IPS discharge pipeline (IPS line pressure was determined in conjunction with the NC02 (Task 5) team and BLP Engineers). Maintaining this additional pressure at the connection point allows the IPS and MPS to function together properly, and the additional head dissipated through dynamic head loss. In the event that the IPS operates higher or lower than this pressure, MPS provides sufficient capability to adjust pump operating speed to accommodate this change. Section 4.6 provides more detail about MPS's operations and flexibility.

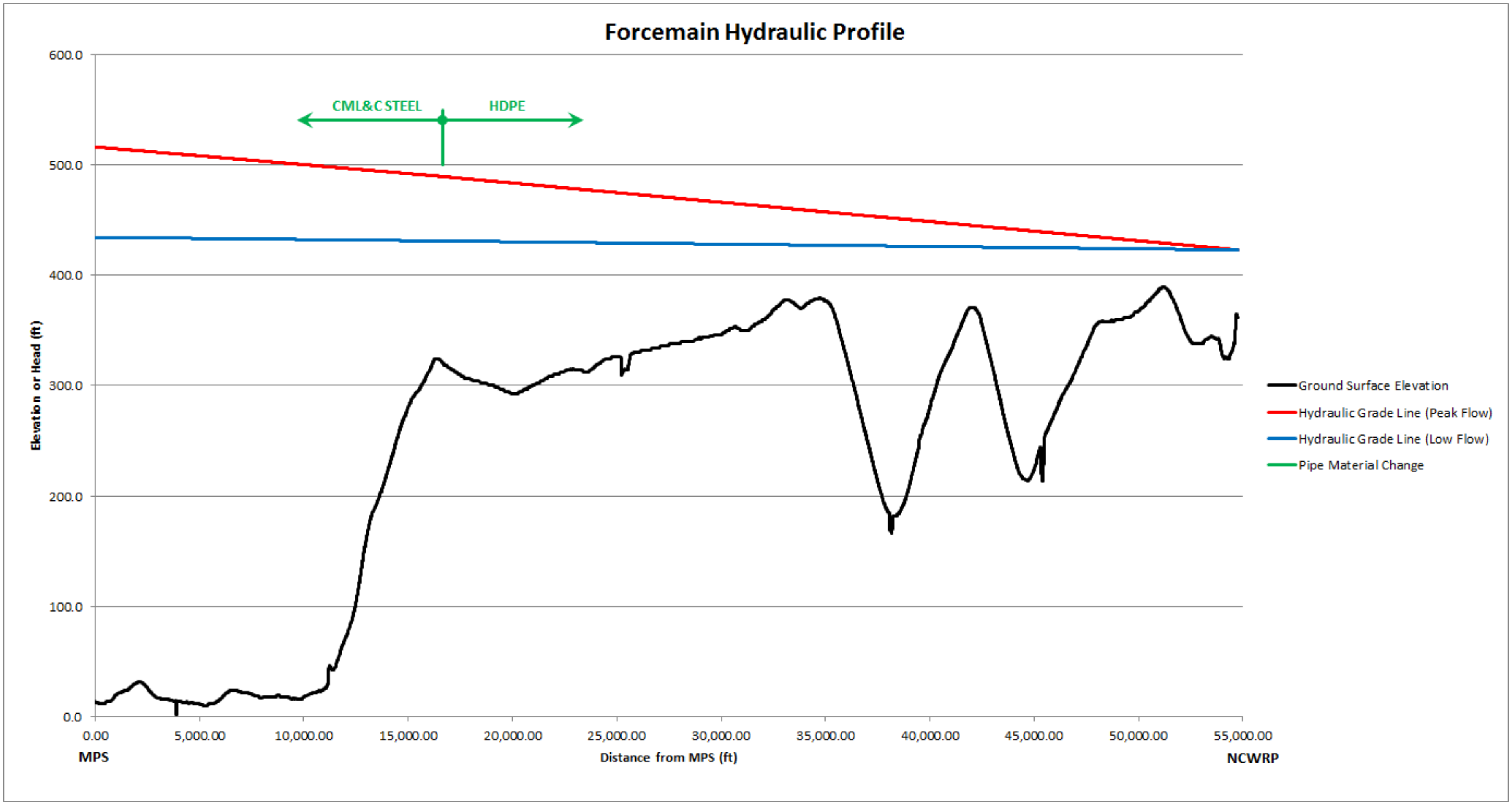


Figure 4-6: HGL at Peak Flow

Pipeline pressure is a function of the pipeline's elevation and distance from MPS. Figure 4-7 presents ground surface elevation (as the black line) and pressure at peak and low flow scenarios. As the figure shows, ground surface elevation generally increases along the pipeline's length with two large dips corresponding to crossing SR 52 approximately at Station 380+00 and a railroad approximately at Station 440+00. Smaller dips occur along Morena Boulevard approximately at Station 200+00 and crossing I-805 approximately at Station 540+00. Consequently, each dip corresponds to a location with an increase in pipeline pressure because of the difference between the HGL and pipeline elevation.

The final EDR should include a detailed analysis of pressure along the pipeline alignment. The final designer should review pipeline materials and amend selections if necessary, and include a consequence of pipeline failure analysis to ensure that all risks are properly addressed.

Figure 4-7 shows that the pipeline's operating pressure varies between just under 220 psi at MPS and 16 psi at the high point west of the NCWRP connection to the 60-inch-diameter RS pipeline. Because of the pressure limitations of HDPE pipe, the first 3 miles will be CML&C welded-steel pipe rated for a pressure of 250 psi. Alternatively, this pipe section could be epoxy-coated welded-steel pipe; the final designer will determine material after the transient analysis has been updated during final design.

HDPE pipe nominally rated for 139 psi will be used after the first 3 miles. The pipeline will be close to the HDPE pipe's pressure rating where it crosses SR 52. Fortunately, this location corresponds to a trenchless crossing location where steel casing will be required. The final designer may need to select the casing pipe to be filled with concrete slurry for this location.

The force main pipeline must be designed to meet the operating conditions described in this section and transient conditions described in Section 4.4.2. To provide an appropriate level of safety for facility operation, recommended pipelines are designed for full vacuum conditions (-14.7 psi) and for peak pressures to be experienced with a 50% factor of safety.

4.4.2 Transient Flow

A loss of power when running four pumps at the peak flow rate is the worst-case transient condition. When this occurs, the pumps and motors (without the flywheel) immediately start slowing down at a deceleration rate based on their rotational moment of inertia of approximately 1,250 lb-ft^2. The wastewater being pumped uphill toward the high point near Iroquois Street will reach a speed of zero, then flow backward until MPS's check valves close. Flow farther along the alignment will continue to flow toward NCWRP, creating a vacuum condition at the pipeline's high points. Initial modeling shows this as a full vacuum condition (-14.7 pounds per square inch gauge [psig]) near the Iroquois Street high point that flows back toward MPS.

A water hammer condition will also form during this condition, however it has no adverse impacts on pipeline or valves. The water hammer forms when the water column stops moving and rebounds off the MPS check valves, then reverberates through the system until it dissipates.

To address vacuum conditions, it will be necessary to increase the rotational moment of inertia by attaching flywheels on the pump/motor trains to approximately 4,000 lb-ft^2 and allow additional air into the pipeline. A 1,000-pound, 20-inch-diameter flywheel on each pump and motor combination is proposed, and a 10-inch air vacuum/air release (AV/AR) assembly on the MPS discharge header and near Station 160+00. Additional 6-inch AV/AR assemblies are recommended at Stations 20+00, 125+00, 130+00, 140+00, 150+00, 230+00, 258+00, 290+00, 310+00, 330+00, 345+00, 420+00, 480+00, 505+00, and 510+00; these are in addition to the AV/AR assemblies necessary for proper pump station operation. The final designer should confirm these locations with updated transient analysis during final design.

It is recommended that the final designer update the transient analysis after a more detailed hydraulic analysis has been conducted. It is further recommended that the final designer give a target rotational moment of inertia for the pumps and allow the pump manufacturers to compete.

4.4.3 Force Main Appurtenances

Maintenance access manways are recommended every 1,700 LF along the pipeline alignment and isolation valves placed at approximately 3,500 LF along the alignment. Access manway and isolation valve spacing should be coordinated between the final designer and the City. Manways will consist of a 24-inch-diameter pipe opening with blind flanges placed above the force main and an access manhole situated directly above. Isolation valves will be plug valves with an actuator (manual) and maintenance hole for access to the force main.

Blowoff valves (BOVs) are designed to be located at local low points and AV/AR assemblies located at local high points. The typical AV/AR facility is a buried precast vault with access hatch and ladder, inline AV/AR assembly, charcoal canister to mitigate foul odor, drain line, and sump. Drain lines from the BOVs should drain to the nearest sanitary sewer. Exhibit A includes the 10% predesign plan and profiles for locations of force main appurtenances. AV/AR and blowoff assembly details will be included in the final design.

4.5 Brine Conveyance

This section summarizes the decision-making process to determine brine conveyance design components and major system elements.

4.5.1 Background

As part of the overall objective to produce potable reuse water from NCWRP-generated effluent, NCAWPF will be designed and constructed north of the existing NCWRP. As shown in Figure 4-8, the AWPF will consist of several advanced treatment processes including RO membrane filtration, UV disinfection, and RO.

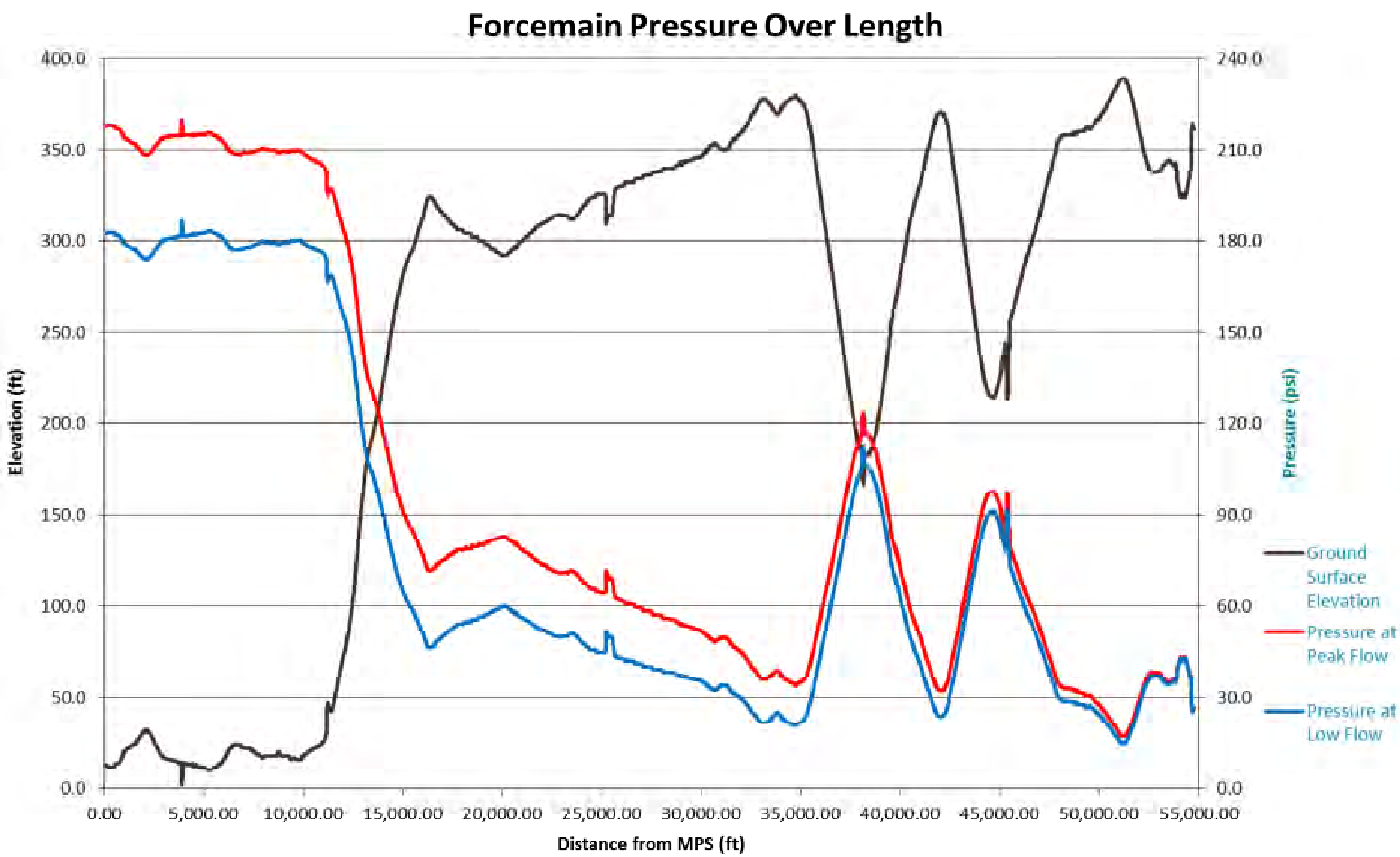


Figure 4-7: Pressure along Pipeline Length

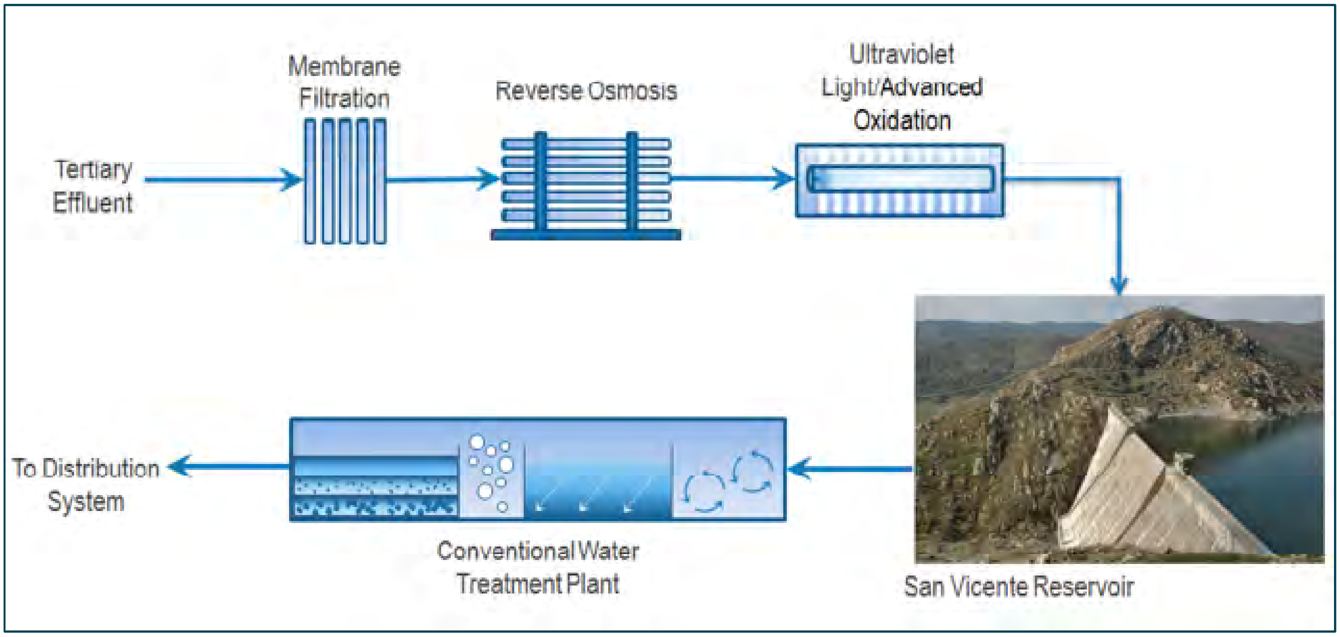


Figure 4-8: AWPF and Treatment

The RO unit process consists of a series of RO trains that discharge brine as a treatment process by-product. The brine solution will be conveyed from the new AWPF to MPS via a 24-inch-diameter HDPE pipeline in a common trench with the MPS force main. From MPS, the brine will be discharged into NMVI located in Friars Road and flow to PLWTP, preventing brine from being recirculated in the wastewater pumped to NCWRP. The detailed brine pipeline route is included in the design drawings found in Exhibit A.

Brine generated during the normal treatment process will be conveyed to NMVI and sized for 6 mgd of constant flow. The brine flow is not expected to have peaks or minimums and should be constant because of NCAWPF's treatment strategies. This predesign evaluation of the brine conveyance design has investigated feasible alternatives for discharging the brine to NMVI; this analysis is presented in the following sections.

4.5.2 Design Criteria for Brine Conveyance

Table 4-1 presents brine conveyance alternatives based on the evaluated criteria.

Table 4-1: Brine Conveyance Design Criteria

Description	Value
Flow rate (max)	6 mgd
Residual pressure available	50–80 psi [a]
Pipe discharge length	Approximately 10.4 miles
Total dissolved solids (TDS) content	4,425 mg/L
pH of brine solution	7.4
Temperature	77 °F

a. This value could drop to 40 psi should energy recovery be used at the AWPF.

Data are based on the AWPF's predesign being executed under Tasks 2 and 3, and the recommended pipe alignment discussed elsewhere in this EDR.

4.5.3 Alternatives for Brine Conveyance

This section discusses brine conveyance alternatives. Pump and gravity conveyance were evaluated, and gravity conveyance was ultimately recommended. The decision-making process used to make this recommendation is described in the following section.

4.5.3.1 Alternative 1: Pumping

Alternative 1 would convey by gravity brine generated from the RO process to a holding tank for equalization (EQ). The tank would also serve as a forebay for MPS before being pumped downstream for discharge near MPS. The RO treatment process generates high residual pressure; however, this residual pressure would drop downstream to atmospheric because of the air gap between the RO process and EQ tank.

The brine conveyance pump station would need to be located at the NCWRP site because of site space constraints, and potential locations would need to be coordinated with the NCWRP Expansion (NC02) project. The north side of NCWRP adjacent to Eastgate Mall Road was considered, as this part of NCWRP has no buildings in its immediate vicinity and its proximity to Eastgate Mall would allow easy access for installation and removal of pumps and associated appurtenances.

Brine generated during the RO process will be mixed with anti-scalant solution to reduce potential for brine precipitation during conveyance to the discharge manhole. The pipe’s assumed bury depth is 5 feet below grade.

4.5.3.2 Alternative 2: Gravity Conveyance

Alternative 2 would convey brine generated by the RO process to the discharge sewer by using available residual energy from the RO process, coupled with energy gained from the significant elevation drop between the AWPF and final discharge location. The difference in residual energy available from the RO process is discussed in the last paragraph of this section. This alternative also assumes an average burial depth of 5 feet below grade, and that a portion of this brine pipeline would be routed within the NCWRP. The terrain undulates throughout this route, as shown in Figure 4-9.

The undulating terrain of the brine discharge pipe route alters the difference between the HGL and crown elevation of the pipe throughout the route: the higher the terrain is, the closer the discharge pipe’s crown gets to the HGL. Similarly, in portions of the pipe route where the grade drops, the difference between the HGL and crown elevation increases. The HGL consistently remains above the pipe crown throughout the pipeline route, ensuring that flow will be conveyed from the RO process trains to the discharge location and providing sufficient energy to convey the brine solution to the discharge location by gravity. Figure 4-9 illustrates the different starting residual pressures at the AWPF RO units.

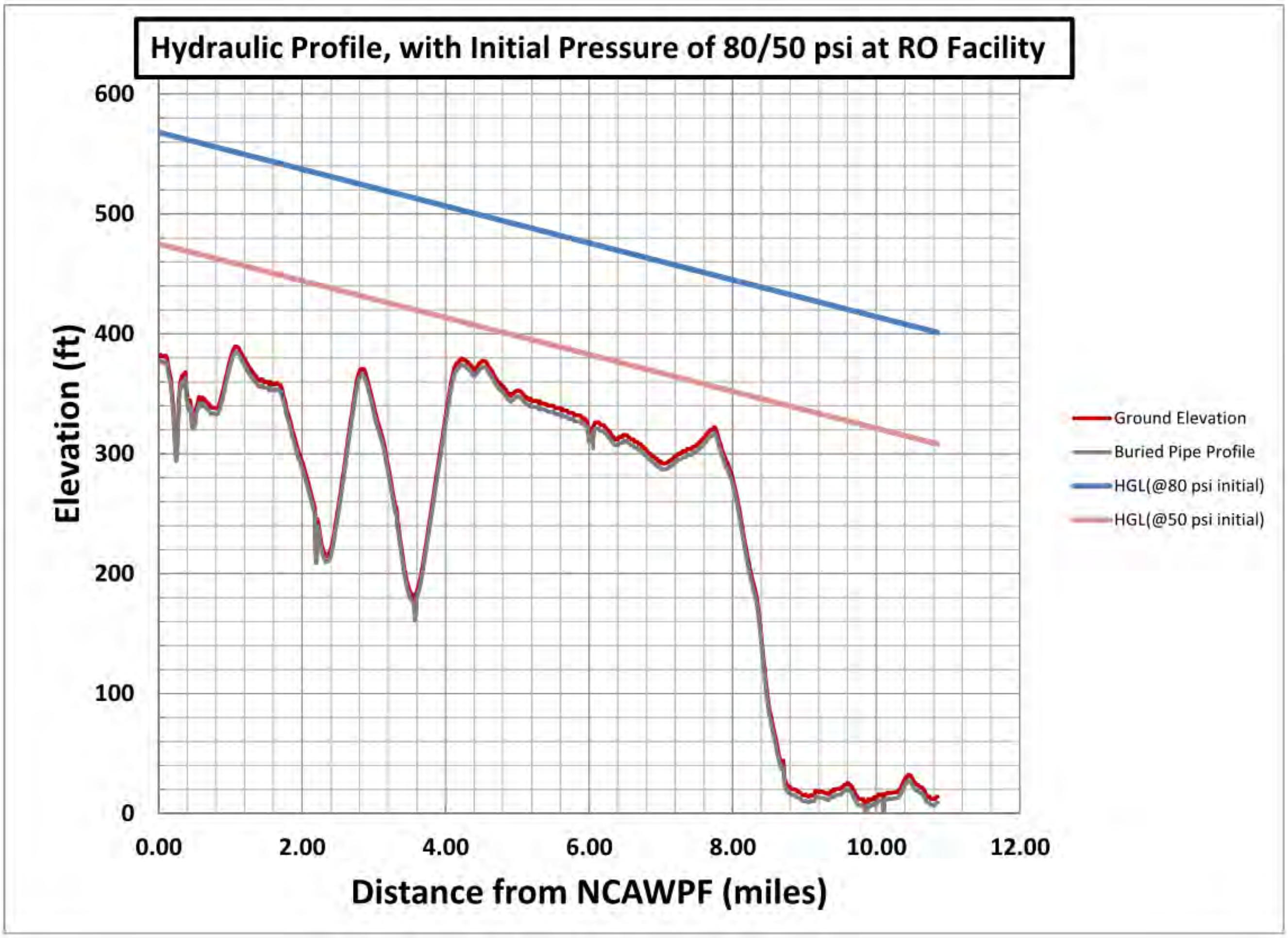


Figure 4-9: Brine Pipeline Route and HGL

The amount of energy available from the brine conveyance process exceeds the amount required to convey brine from the AWPF to the discharge manhole, because of the significant drop in net elevation between these two locations. To prevent this excess energy from causing overflow conditions at the discharge location, Alternative 2 requires installation of energy dissipating valves along the pipeline and an energy dissipation structure at the MPS site. Energy recovery along the brine route has also been considered as a means of using this excess energy; this approach is discussed in more detail in later sections of this EDR.

Energy recovery may also be considered at the AWPF; if implemented, residual pressure available for brine conveyance will be less. Figure 4-9 illustrates the energy interval between which brine conveyance by gravity is feasible. With an initial residual pressure of 80 psi at the RO system, approximately 540 feet of head is available to convey brine to the discharge location. An energy recovery system would reduce available hydraulic head for brine conveyance. The minimum energy residual pressure required to maintain brine conveyance operations at the RO system is 50 psi, also shown in Figure 4-9. Residual pressures lower than this would place the HGL below the crown of the brine discharge line, resulting in cavitation.

4.5.3.3 Recommended Alternative

The evaluation performed by the Project team demonstrates that, while hydraulically viable, pumping brine to the discharge location is not the most economical alternative. This is because residual pressure from the brine process, and a net elevation drop of 300 feet between the AWPF and final discharge location, supplies sufficient motive force for brine conveyance. Available energy from the RO process can be used to send the brine to the final discharge location directly rather than breaking available energy in the brine and expending a comparable amount of energy with a new pump station. Using available hydraulic head for the brine conveyance process is cheaper than using electricity to pump brine to the discharge location.

In addition to being more operationally feasible, it is expected that the gravity conveyance alternative will have lower capital costs compared to the pump conveyance option. The gravity alternative involves less equipment, and therefore requires a smaller footprint for installation. Design details for the brine pipeline conveyance system are presented in subsequent sections of this EDR.

4.5.4 Brine Pipeline Size and Material

Previous project experience indicates a relatively high total dissolved solids (TDS) concentration of 4,425 milligrams per liter (mg/L), as shown in Table 4-2. Brine solutions at these concentrations can be very corrosive, particularly on ferrous material; therefore, the selected pipe material is HDPE to minimize long-term pipe degradation. Low pipe velocities—preferably below 5 feet per second (fps)—are recommended because of the potential for scouring in the pipe at high velocities. Therefore, 24-inch-diameter DIPS is the selected pipe size. This pipe will have a DR7.3 (254 psi) rating because of the high pressures required for brine conveyance. Table 4-2 presents the brine pipeline characteristics.

Table 4-2: Brine Pipeline Characteristics

Description	Value
Flow rate (max)	6 mgd
Maximum pipe velocity	5 fps
Pipe size	24-inch, DIPS
Inner diameter	19.723 inches
Pipe material	HDPE
Pressure rating	DR7.3 Pressure Class (254 psi pressure rating)

4.5.5 Control Valves and Appurtenances

As described previously, excess energy generated during the brine conveyance process must be dissipated to avoid surcharging the discharge sewer manhole. A number of valves were evaluated to assess their ability to achieve this objective in light of the mechanical restrictions associated with their construction and quality of the brine solution. The full evaluation matrix is presented in Appendix H1 and discusses the following:

- Plug valves
- Cla-Val valves
- Cone valves

- Sleeve valves
- Plunger valves

The valves provide a two-step drop in the HGL along the pipe route prior to discharging the brine to an energy dissipation structure (discussed below), and finally into the sewer manhole. The plunger valve best met the evaluation metrics, as described on the following pages.

4.5.5.1 Plunger Valves

Figure 4-10 shows a plunger valve, considered to be resilient and long-lasting. These valves consist of a flanged, short conical section with an internal cone to divert flow into an annular body chamber. This annular section can be reduced or enlarged to modulate flow through the valve. Plunger valves can also handle large flow ranges without cavitating, and can be outfitted with an air admission device to allow intake of air to further limit risk of cavitation. These valves' main advantage versus sleeve valves is that the interior body can be rubber-lined, making them less susceptible to long-term degradation from brine exposure. These valves also cost slightly less than sleeve valves. This valve is the most viable of all considered alternatives and therefore the recommended valve selection.

Figure 4-10: Plunger Valve

Figure 4-11 shows the plunger valve installation in a vault along the pipe route. Redundant valves are provided at each of the two energy dissipation locations, shown in Exhibit A. A detailed discussion on energy dissipating valves and evaluation matrix is presented in Appendix H1.

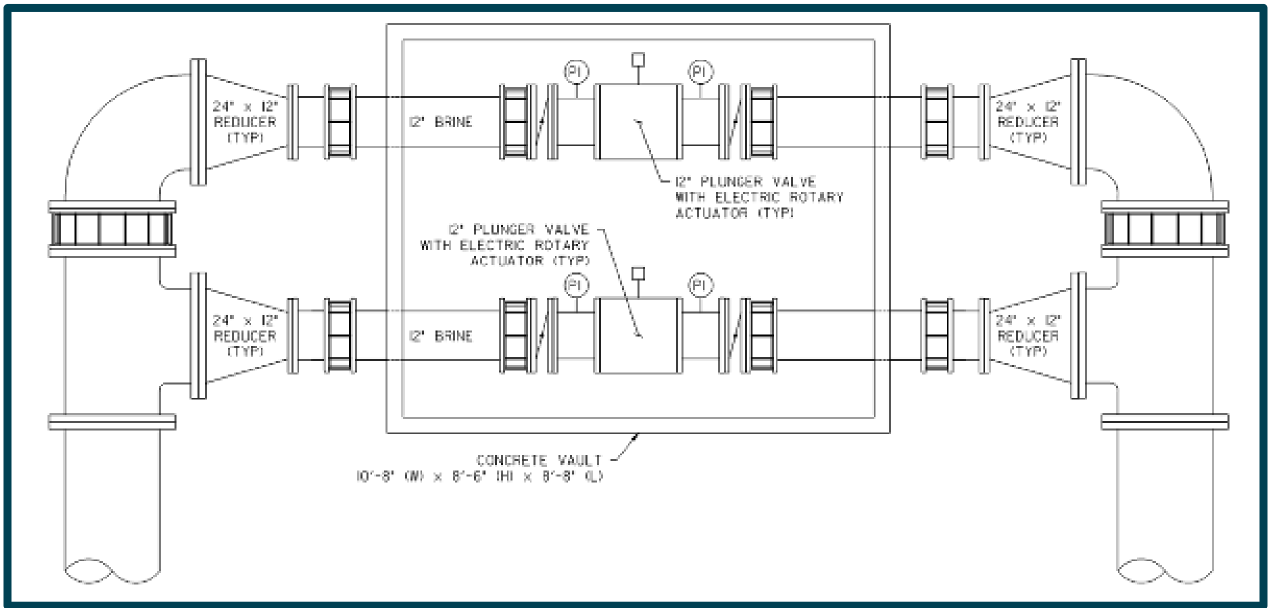


Figure 4-11: Example Plunger Valve Application

4.5.5.2 Jet Flow Valves

As previously discussed, most of the excess energy generated during the brine conveyance process will be dissipated with the control valves. However, there will be residual pressure downstream of these dissipating valves. This pressure is required to ensure that the HGL does not drop below the pipe crown and result in cavitation. Figure 4-9 shows this hydraulic profile.

The remaining pressure will be dissipated with a jet flow valve and energy dissipation structure located at the MPS site. Figure 4-12 shows a cross-section of the jet flow valve, which is designed for free discharge. Jet flow valves have a tapered seat ring to prevent cavitation, and an orifice port to allow sufficient airflow during operation. Wetted valve components would be made of Monel to resist the abrasive effects of the brine solution. This jet flow valve would be installed in-line with the 24-inch-diameter brine discharge pipe immediately upstream of the energy dissipation structure, as described in the following section.

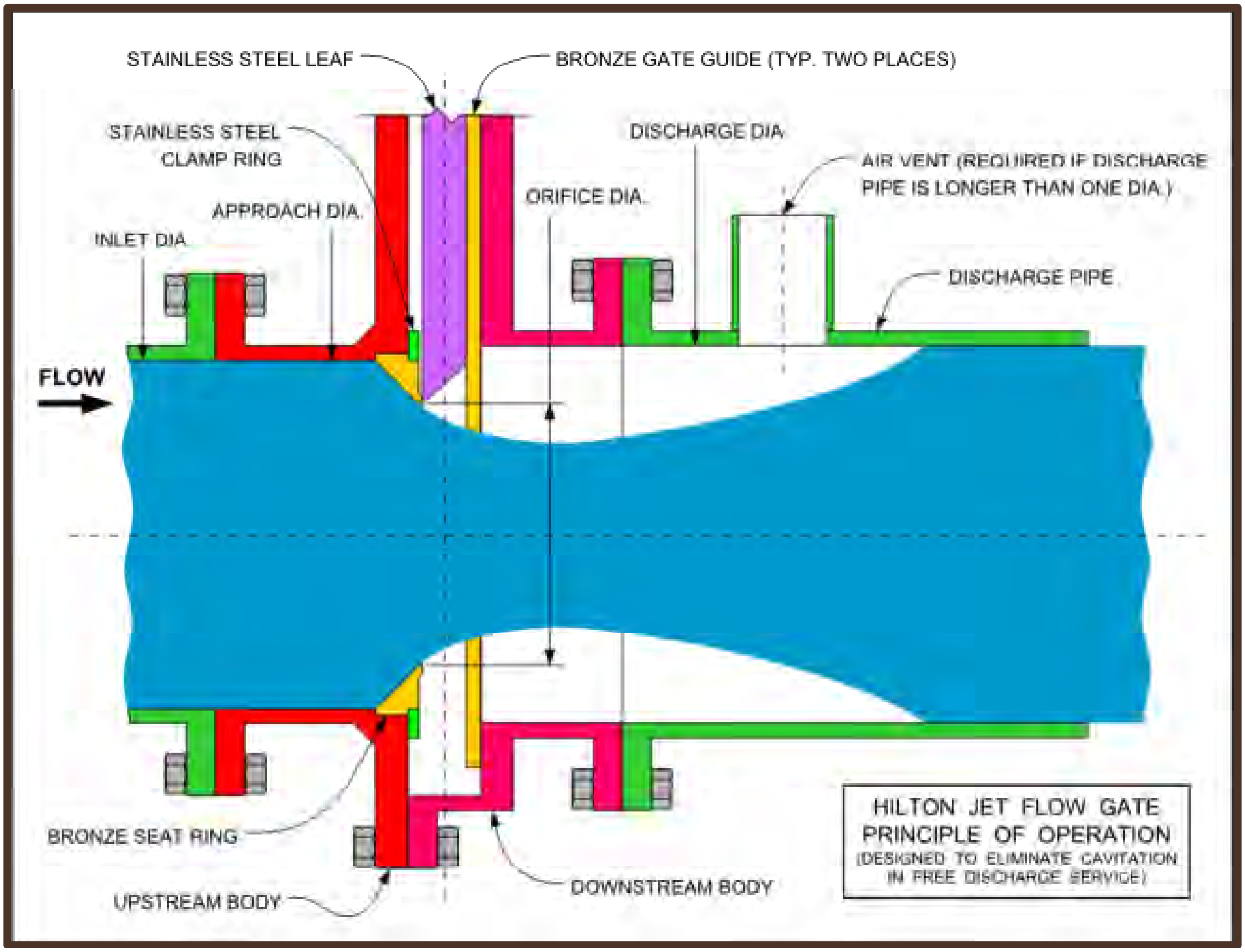


Figure 4-12: Cross-Section of a Jet Flow Valve for Energy Dissipation

4.5.6 Energy Dissipation Structure

The energy dissipation structure aims to reduce the HGL of the brine system to zero (atmospheric conditions). It is constructed of concrete, located in the same property as MPS, and located mostly below grade. Drawings S-401 through S-403 in Exhibit A show the energy dissipation structure layout.

Brine is discharged into the structure through the jet flow valve, made to impinge an internal wall within it. The impact of the brine on the existing concrete wall will bring the horizontal velocity of the brine solution to zero, and water will subsequently flow by gravity down the wall to the floor under nearly laminar conditions. The energy dissipation structure will be connected to the sewer discharge location with a gravity pipe, enabling the gradual discharge of brine into the discharge sewer and preventing overflow conditions at the downstream manhole.

The structure's size is based on previous projects and a report prepared by the Federal Emergency Management Agency (FEMA) on energy dissipators presenting best practices for design and construction of these hydraulic devices. The sizing methodology presented is based on empirical equations developed from evaluation of the hydraulic performance of energy dissipation structures of different sizes.

Brine conveyance flows are on the low end of the interval evaluated in the study. Additionally, the footprint allotted during this predesign phase is conservative, based on the recommendations published in this FEMA report. Therefore, the structure's allotted footprint can be reduced during the Project's final design phase should other equipment be required at MPS.

Brine has the potential to corrode concrete over time. It is recommended that the energy dissipating valves be protected with an epoxy-based product and a liner provided to inner portion of concrete structures to prevent corrosion.

4.5.7 Brine Conveyance Control Strategy

Brine created from the RO process will be conveyed at a constant flow rate under normal operation. This flow rate will be typically at the maximum value of 6 mgd, but may vary depending on the number of RO process trains in operation. A pressure control valve immediately downstream of the RO process train will maintain residual RO pressure at 70 to 90 psi (without energy recovery at NCAWPF) or 40 psi (if energy recovery is installed at NCAWPF). Plunger valves will be selected and operated to allow the full flow rate from NCAWPF, maintain a constant downstream pressure, and modulate open or closed to maintain these two elements. As a result, upstream pressure can vary based on NCAWPF's needs, maximizing operational flexibility and preventing facilities from combatting each other. Plunger valve modulation is anticipated to be relatively slow to prevent fast changes in the brine pipeline from creating a water hammer.

Figure 4-13 shows the hydraulic profile of the brine pipeline with energy dissipation. The jet flow valve will be set to discharge 6 mgd of brine to the energy dissipation structure before passively conducting flow to the discharge sewer manhole. A process flow diagram of the brine conveyance system is shown in Figure 4-14:.

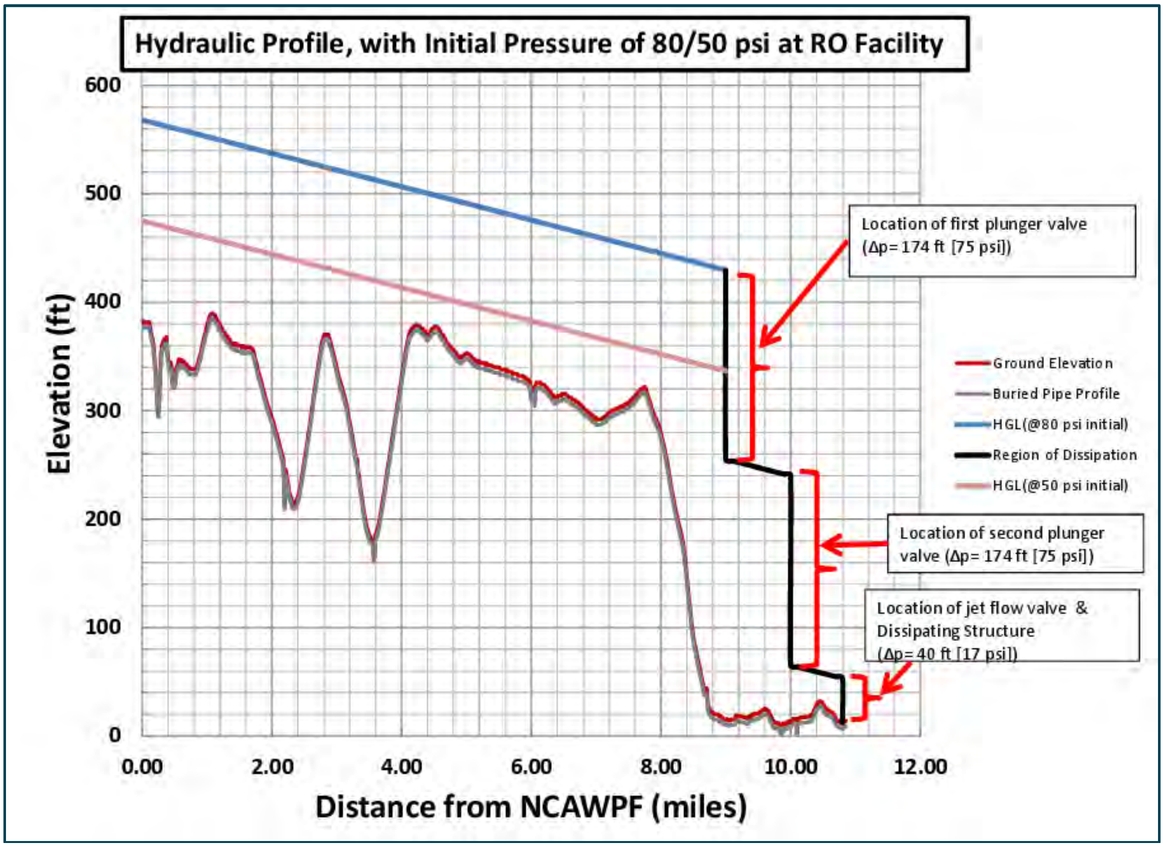


Figure 4-13: Modified Hydraulic Profile (with Energy Dissipation)

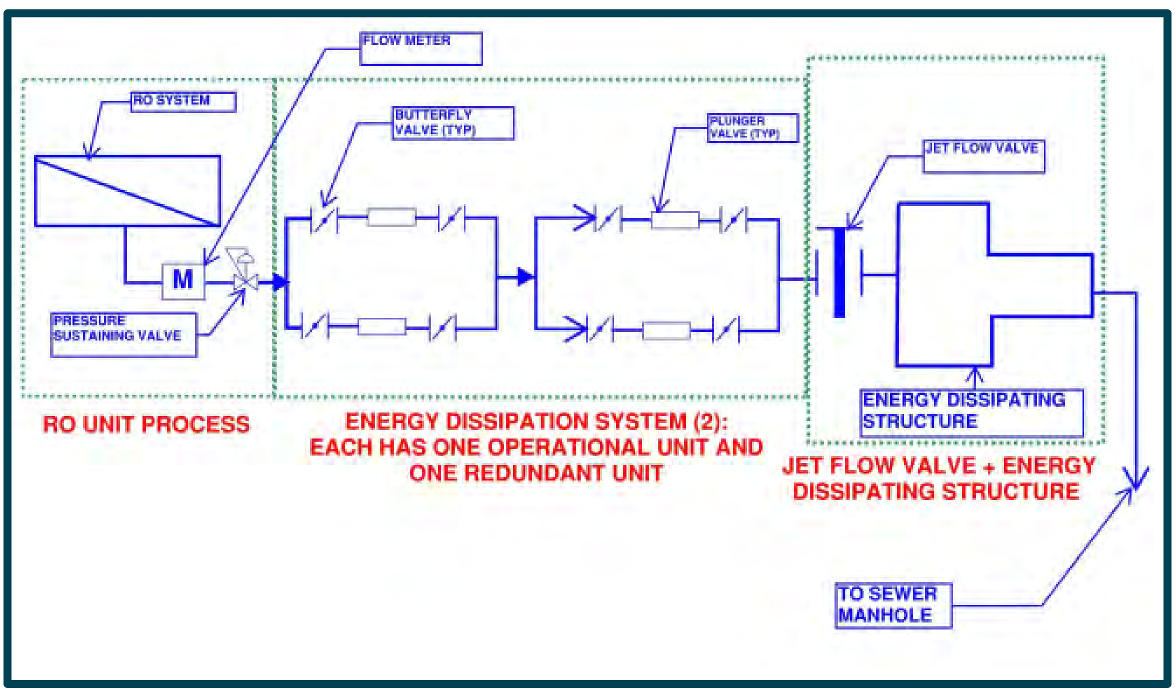


Figure 4-14: Simplified Process Flow Diagram for Energy Dissipation

4.5.8 Energy Recovery System

Energy recovery was evaluated as an alternative to dissipating excess energy associated with the brine conveyance design via control valves. This investigation aimed to determine if energy recovered from the brine conveyance process in the form of hydroelectric power would generate enough revenue to offset the investment associated with the system's design, construction, and operation. The following section provides the results of this evaluation.

4.5.8.1 System Description

Several examples exist of energy recovery systems using clean or raw water (with low TDS). However, energy recovery systems using brine systems are not as common. The Project team contacted numerous hydro-turbine vendors, considering the need for specialized material to handle equipment abrasion because of the brine solution.

DTL Hydro® was contacted to provide a proposal for energy recovery options. This firm has experience in providing energy recovery units for brine solution, and recommended a two-nozzle Turgo unit for this application. This hydroelectric power unit would convert most of the excess energy available along the HGL into hydroelectric power, generating an output of 217 kilowatts (kW) at 1,200 revolutions per minute (rpm). The Turgo unit would be installed at MPS, immediately upstream of the energy dissipation structure previously discussed.

Electricity generated by the turbine would be conveyed to the City's grid system with a horizontal-induction, 3-phase generator and associated switchgear. The energy dissipator described above would still be required for periods when the hydroelectric unit will be out of service because of required routine maintenance operations.

4.5.8.2 Life-Cycle Costs

A preliminary cost evaluation was developed to determine the return on investment (ROI) for an energy recovery device, should the City decide to proceed with installation for this Project. The main components of this evaluation included:

- Capital and installation costs (from vendor quote)
- Service entrance fees (for integration of new system with the City's grid)
- Operations and maintenance (O&M) costs (estimated at 4% of capital costs)
- Estimated revenue from hydroelectric power generation ($0.0756 per kilowatt-hour [kWh], per past City projects)
- Contingency (35% of capital costs)

This analysis assumed a multi-year operation of the energy recovery system, inflation rate of 2.5%, and loan discount rate of 4.0%. Table 4-3 shows estimated first-year costs for its installation and operation. Table 4-4 summarizes the ROI evaluation, showing that the energy recovery unit would have to be in operation for 21 years before generated revenue pays for its initial capital investment. This estimate assumes that the energy recovery system will not require replacement in this period. The City does not consider an ROI of 21 years to be feasible; therefore, energy recovery is not recommended at this predesign stage.

Table 4-3: Energy Recovery System Costs: First Year		
Description	**Value**	**Comment**
Total energy drop	337 feet (145 psi)	Reference hydraulic profile
Maximum capacity of turbine	6 mgd	Per vendor
Capital costs (for turbines)	$400,000	Per vendor
Additions	$400,000	Estimated for control building and appurtenances
Engineering and bypass valves	$200,000	Estimated (dissipating valves still required)
Service entrance fees	$100,000	Estimated
Subtotal	$1,100,000	From above
Contingency (35%)	$385,000	Estimated
Capital costs	**$1,485,000**	**Subtotal + capital costs**
Estimated revenue (best case scenario)	$144,000	1,900,000 kWh @ $0.0756/kWh
O&M costs (estimated)	$60,000	Assumed 4% of capital costs

Table 4-4: Energy Recovery System Costs: ROI Period		
Description	**Value**	**Comment**
Capital costs	$1,485,000	From above
Expected revenue	$144,000	
Annual O&M costs	$60,000	
Assumed inflation rate	2.5%	From previous life-cycle costs prepared for the City
Assumed discount rate	4.0%	
ROI period	21 years	Estimated

4.5.8.3 Alternative Energy Recovery Evaluation

The Project team also contacted NLine Energy, an in-conduit hydropower corporation specializing in hydroelectric power solutions in California, to assess (provided as a free preliminary service) the feasibility of energy recovery for the Project. The complete report is included in Appendix H4. NLine considers energy recovery economically feasible within an 8- to 12-year period; however, key differences between the Project team's and NLine's evaluations are important to consider:

- Estimated O&M costs were based on potable water used for operation, and not the more aggressive brine solution that is being considered for the Project. Therefore, actual O&M costs are expected to be higher than those in NLine Energy's estimates.
- NLine Energy's evaluation does not consider the time value of money, and expected future dollars are more than what would be actually realized in present-day dollars. Therefore, the expected ROI is expected to be longer than that in NLine Energy's estimate.

Subsequent discussions with NLine Energy also determined that the energy recovery system's installation is a multi-step process that could last 19 to 24 months (as shown in the schedule presented in Appendix H4) and could impact the Project's overall schedule. In addition, federal regulations require that energy recovery systems be equipped with a means of bypass in the event that shutdown for maintenance is required. Considering this, plus the lengthy implementation schedule and differences in the evaluation assumptions presented above, has led the Project team to not recommend energy recovery at this Project stage.

Energy recovery may be feasible at a future date. After construction of the brine conveyance system and MPS, only the turbine's capital costs would need to be factored into the ROI analysis, as the energy dissipator would already be installed. The City may elect to reconsider energy recovery at that time.

4.6 Pump Station Facility

The proposed MPS will be located in the parcel to the south of the T-intersection of Sherman Street and Custer Street. The approximately 1-acre site and existing buildings are currently owned by the San Diego Humane Society and Society for the Prevention of Cruelty to Animals (SPCA). The parcel's triangular shape is bounded by Sherman Street to the west, Custer Street to the east, and Friars Road and a portion of an MTS railroad bridge to the south. Pre-construction activities include demolition of all existing onsite buildings and infrastructure.

New onsite construction will consist of the following infrastructure:

- Intake screening facility (including flow separator and screening structures)
- Pump station building
- Odor control and chemical storage
- Energy dissipator for the 24-inch-diameter brine pipeline
- Transformer
- Electrical and motor control center (MCC) building

The MPS and intake screening facility will extend approximately 50 feet below grade and require extensive excavations. A comprehensive dewatering strategy shall be prepared during final design, as the site is located in an area with a high water table.

4.6.1 Civil

This section presents civil engineering design for the Project, including site layout, grading and drainage, yard piping, and landscaping.

4.6.1.1 Site Layout

Figure 4-15 provides a site plan, showing that the proposed MPS site will be encompassed by 8-foot-high masonry perimeter walls and three entrances equipped with 26-foot-wide sliding access gates. Two adjacent entrances are sited on Sherman Street and one on Custer Street; this configuration of multiple and opposite points of access provides oversized vehicles with driving maneuverability in one continuous direction without requiring a roundabout or hammerhead turnaround within the yard's limited area. The MPS facility ground surface improvements, inside and outside of the parcel, will mostly consist of hardscape (asphaltic concrete and Portland cement concrete pavement) and softscape (landscape and gravel pavement). Section 4.6.1.4 describes landscaping details.

Facility access roads have three widths: 18, 22, and 26 feet. The main access road will connect the Custer Street entrance directly with the south entrance on Sherman Street, and serve as MPS's main access point. The main access road measures 22 feet wide after narrowing from 26 feet at the entrances, and is designed to accommodate the turning radius of vehicles such as a WB-50 intermediate semitrailer (50 feet long), chemical delivery trucks, and pumper fire trucks.

The site layout is grouped into three main areas. The first area consists of intake screening facilities at the west parcel corner and pump station building and meter valve at the north parcel corner in respective order of incoming and discharge flows. The proposed layout configuration minimizes the amount of piping required to convey incoming gravity sewage flow to MPS and for pump discharge. The north entrance on Sherman Street provides access for the solids dumpster truck to the intake screening structure. A narrower auxiliary 18-foot-wide access road, running parallel to Sherman Street and Custer Street and along the street side of the intake screening facilities and pump station building, will serve smaller vehicles up to the single unit truck size (assumed to be single axle and 30 feet long).

The second area is near the parcel center and includes the foul odor control facilities and chemical storage. Because of the importance of these facilities to the intake screening facilities and pump station building, they are best situated as close as possible to these wet structures. The west parcel corner was originally considered a potential location for odor control; however, its limited available space would require removal of existing large-diameter trees. Therefore, odor control and chemical storage are sited adjacent to the parcel center, with chemical storage along the main access road for easy delivery accessibility.

The third area is the east parcel corner, consisting of an energy dissipation structure for the 24-inch-diameter brine pipeline, electrical and MCC building, and transformer. Among this group of facilities only the energy dissipator is a wet structure; it will be located close to the center of the MPS facility and to Custer Street to reduce the required length of the brine pipeline extension. The electrical and MCC building is located adjacent to the energy dissipator, followed by the transformer. The transformer will be placed in the area's east corner to maximize available site usage and because the transformer will not be owned and maintained by the City. The transformer area will be enclosed with a perimeter wall matching the overall site perimeter wall, and will allow access from inside and outside the yard facility; transformer service and maintenance by non-City personnel will be performed from Custer Street through a double-leaf gate. Gravel pavement will surround the transformer concrete pad inside the enclosed transformer area.

A second auxiliary access road connects to the main access road near the Custer Street entrance, running between the foul odor control facilities (second main area) and energy dissipator and electrical building (third main area). The auxiliary access road provides access to these areas, with parking and turnaround capabilities for smaller vehicles.

Six parking stalls are provided on site. Each stall is 10 feet wide by 20 feet long and sized for full-sized pickup trucks. Two parking stalls are located near the odor control facilities and electrical building, and three parking stalls are located at the intake screening structure.

4.6.1.2 Grading and Drainage

The MPS site is currently developed and consists of buildings, access driveways, paved parking lot, and landscaping. Site topography is relatively flat (between 0% and 5% slopes), with a high point in the back of the site sloping downward toward the intersection of Sherman and Custer streets. Stormwater runoff generated from existing conditions flows northerly toward Sherman and Custer streets, before traveling northeast along Sherman Street via curb-and-gutter into an existing public curb inlet approximately 200 feet from the Project site. Drawing C-201 in Exhibit A shows the stormwater plan.

Runoff from the proposed developed site will flow primarily the same as under existing conditions, with site drainage splitting into two portions. Stormwater runoff from the site's western portion will be diverted by catch basins and private storm drains to a bioretention basin located in the site's western corner; the runoff is then treated and routed to the proposed detention vault. Stormwater runoff from the site's eastern portion will be gathered by catch basins and roof drains, and conveyed via private storm drains to the site's northern corner for treatment by an underground modular wetland system and storage in the detention vault.

The proposed underground detention vault fulfills the hydromodification requirements of the City Storm Water Standards Best Management Practices (BMP) design handbook. The vault is sized to accommodate the default range of flow when a stream susceptibility study has not been prepared, defined as 10% of the 2-year storm event and up to the 10-year storm event. Stormwater discharge from the detention vault will require construction of a force main, connected to the existing curb inlet located within Sherman Street. A control system will also be installed to account for larger storm events and various discharge rates. Because of the topography at the southern property line, the proposed wall will require a swale to divert stormwater runoff away from and around the proposed wall. Appendix I includes the Preliminary Drainage Analysis, with more detailed descriptions of site grading and drainage and preliminary hydrology calculations.

Total site runoff for the 100-year storm event was calculated to be 2.72 cubic feet per second (cfs). Redevelopment should not increase the amount of runoff leaving the site as the site is fully developed. Therefore, there is no increase in risk of onsite flooding and downstream from storm events. However, more detailed downstream analysis is needed to determine if offsite improvements are required to provide a safe and less impactful route to convey post-developed runoff from storm events up to the 100-year storm per City requirements. The site does not reflect potential flooding risk from the San Diego River based upon the FEMA Flood Map exhibit; see Appendix I for reference. The final designer shall assess potential flooding at the MPS site because of sewer surcharging, brine overflow, or force main backflow.

4.6.1.3 Yard Piping

MPS facility yard piping consists of wet and dry underground piping and duct banks. Wet piping includes large-diameter pipelines such as the existing 66-inch-diameter sanitary sewer (abandoned), new 84-inch-diameter polyvinyl chloride/plastic lined reinforced concrete pipe (PLRCP) diversion pipeline (MPS influent pipeline), 48-inch-diameter pumped discharge, 48-inch-diameter MPS gravity overflow (offsite), 24-inch-diameter brine pipeline, storm drains, and other miscellaneous smaller piping of less than 18 inches in diameter. Potable water, chemical, irrigation, and drain piping is included. Dry piping includes foul air odor control, gas, electrical, and communication duct banks. Depth of conduit piping varies by content type, beginning with the influent set deepest because of its existing depth.

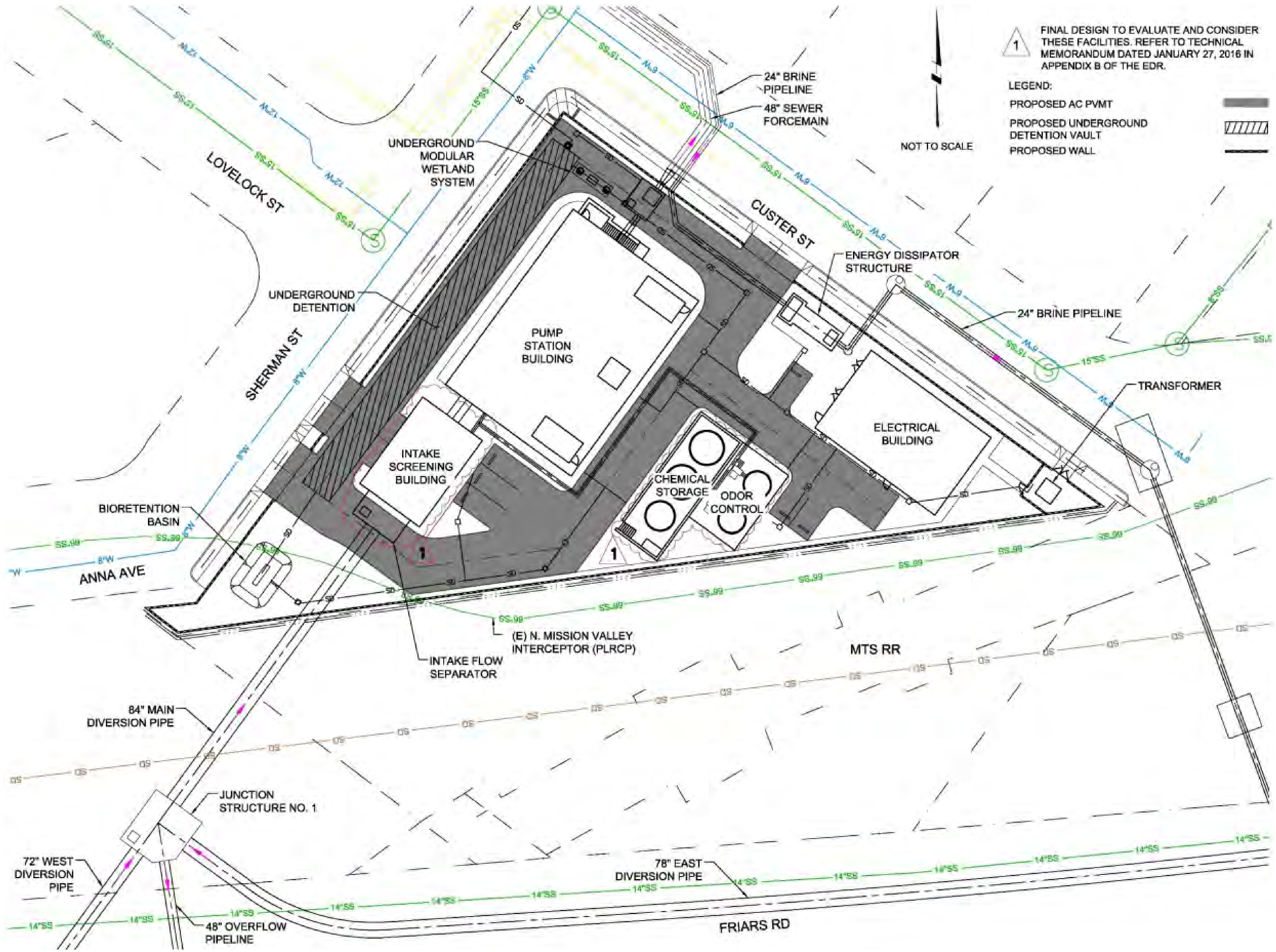


Figure 4-15: MPS Site

Influent flows are conveyed through a new 84-inch-diameter PLRCP main diversion pipeline from a new offsite junction structure (Junction Structure No. 1) to the flow separator structure near the west parcel corner, then dispatching into the intake screening building. Downstream of the intake screening building, the influent is sent to the pump station building through another 72-inch-diameter reinforced concrete pipe (RCP). Section 4.4 describes how wastewater is discharged with a 48-inch-diameter welded-steel pipe to the north corner of the site, continuing within street right-of-way to the NCWRP.

A 48-inch-diameter RCP overflow pipe is provided at Junction Structure No. 1 upstream of the influent pipeline (offsite), functioning as a pump station bypass system. As discussed in Section 4.5, the 24-inch-diameter HDPE gravity brine pipeline entering the site parallel to the 48-inch-diameter force main on Custer Street from NCWRP is under hydraulic static pressure. It enters the energy dissipation structure to lower the pressure and exits to the overflow line. This brine pipeline segment material is RCP.

Section 4.8 further discusses the offsite continuation of the new 84-inch-diameter influent pipeline (main diversion pipeline) to Junction Structure No. 1, as well as the contributing diversion pipelines into the junction structure, 48-inch-diameter overflow pipeline, and 24-inch-diameter brine pipeline from the energy dissipator to the 48-inch-diameter overflow pipeline.

4.6.1.4 Landscaping

Drawing L-101 in Exhibit A shows the proposed landscaping plan. The existing site has been in use for various purposes for more than 100 years and includes more than 12 mature trees. Most of the trees are clustered in one general area and appear to be part of the landscape design for the 1952 Humane Society Building on the site's southwest corner. One considerably older large palm tree is located north toward the center of the site; the palm likely dates to the site's use as a milk plant facility that supported Mission Valley's early dairy industry.

Existing specimen trees include the following:

- One Phoenix canariensis "Canary Island date palm," a specimen tree more than 40 feet tall and 90 to 100 years old
- One Eucalyptus lehmanii "Bushy Yate," a rare specimen tree with roughly 50 feet of canopy, located on the southwest corner

These two specimen trees are in good health and have low supplemental water requirements. These trees provide a significant presence in the neighborhood by their size and history, and effort should be taken to include them in the design. In addition to its visual value as a specimen, the bushy yate will provide immediate screening of the facility from the south.

The remaining existing trees include:

- Two pine trees with canopies of 40 and 30 feet, respectively. Overall, the trees appear to be in good health.
- Three evergreen pear trees with matched calipers, each with an approximately 15-foot spread. They are struggling because of drought and are poor specimens.
- Several eucalyptus trees located on the south edge of the property providing site screening. Each is more than 40 feet tall with an approximately 30-foot canopy. They are in poor health because of drought and are poor specimens.

- Two or three smaller trees located within the facility. The Project team was unable to photograph or identify the trees due to existing structures surrounding the site.

The two pine trees are located in a row with the bushy yate on the southwest property line. Their age is consistent with the date of the Humane Society construction of 1952. The smaller pine tree is crowded with a poor form and should be removed. The larger pine tree provides value as an existing screen, but individually has poor form and relocation is not recommended. The pear, pine, and eucalyptus trees would be removed during the demolition process.

The MPS site will be protected by an 8-foot-high masonry wall extending along the full width of the property excluding vehicular and pedestrian access points. One tree every 30 feet is proposed along Sherman Street and on Custer Street, located within a 4-foot minimum wide parkway between the curb and sidewalk. Vines are proposed, planted in pockets in the concrete sidewalk on the outside of the wall to deter graffiti. A 6-foot-wide sidewalk is recommended adjacent to the wall, with 12-inch-deep by 24-inch-wide vine pockets evenly spaced at 12- to 15-foot intervals at the wall base. The proposed parkway surfacing is stabilized decomposed granite.

Two specimen trees will be retained within MPS. The bushy yate will be protected in place as a specimen tree and provide immediate screening for the facility. The Canary Island date palm will also be protected; a certified arborist and contractor with proven experience in successful palm relocation advises that it be relocated on site.

New landscaping is proposed within the facility, including small-scale shade trees, large-scale accent tree, and vertical cylindrical accent trees in narrow planters to screen structures and provide visual interest. Plant material that is attractive and provides interest, shade, and light facility screening will be selected; use of shrubs and groundcover will be minimal. Overall, maintenance can be reduced by selecting low-maintenance plant material with low water requirements that are resistant to disease and require minimal pruning.

The bio-retention basin will be planted with container stock tolerant of fast-draining moist soil. Areas adjacent to the inlet will be planted with container stock tolerant of up to 72 hours of inundation.

Landscape surface material will include inorganic rock such as 3/8-inch gravel and larger cobble chosen to complement building colors and architecture. Cobble will be used to provide visual interest as a 24- to 36-inch-wide edge to planting areas along walkways and pedestrian areas. A 3-inch-thick layer of gravel will be used within planting areas to maintain moisture for trees and vines. A 4-inch-thick layer of stabilized decomposed granite will be used as surfacing outside of the facility and within the pump station, where it can be used as service access for light foot traffic.

Criteria for plant material selection will include that they be noninvasive species established after 2 to 5 years to limit the need for weekly or monthly landscape maintenance service within MPS after the establishment of plant material.

4.6.2 Intake Flow Separator, and Intake Screening Building

The intake flow separator structure, located on the southwest side of the screening structure, splits the flow into three channels entering the screening structure before flowing to MPS.

The screening building (44 feet long by 30 feet wide) receives three channels of flow from the intake flow separator at an elevation of -14.75 feet. Two channels pass through traveling bar screens; the other is a bypass channel with a manual screen. Intake bar screens convey screenings over 28 feet in elevation to the second level of the building, where screenings are emptied into a dumpster. All three channels converge at the structure’s northeast side and into an inflow pipeline to MPS. Truck access from Sherman Street with a 26-foot-wide driveway and sliding gate allows for dumpster removal.

A traveling bar screen (similar to a Parkson AquaGuard) will provide preliminary screening of RS from the interceptor before entering MPS. The screens should be constructed from stainless-steel, perforated-plate media to provide a large contact area for solids capture. Screen assembly will consist of a series of parallel shafts on a moving belt, combining bar and fine screen technologies for increased efficiency of downstream pumps. As solids are collected on the screen assembly, they are conveyed upward for discharge and removal toward the back of the screening building. A lack of submerged bushing or bearings within the assembly offers ease of maintenance. The screens are designed for minimal head loss but a high capture rate suitable for flows up to 100 mgd. Mechanically self-cleaning with brush units require low power consumption (2 horsepower [hp] or less) and low operating costs. The third channel operates only when both traveling bar screens are out of commission, and contains a bar rack requiring manual cleaning. The screening building is depicted on plan sheet M-201.

A final decision has not yet been made regarding inclusion of the screening building and intake flow separator in the final design. The final designer will need to conduct an analysis to determine if screening will be required and whether its benefit justifies its cost.

4.6.2.1 Screening Disposal

Screening will be collected in two roll-off dumpsters, each sized to accommodate 1 week of solids collection during a high solids period (1 cubic yard of solids per day). Screens will operate alternately to collect solids for 1 week, then allow 1 week for the collected solids to dewater. Water will drain from the solids through the bottom of the dumpster and drop through a trench drain to the third channel. Once per week, a dumpster will be removed from the screening building and transported to a local landfill for disposal. If necessary, a third dumpster can be kept on site to allow further dewatering.

4.6.2.2 Mechanical

The traveling screens are the screening building’s primary piece of mechanical equipment. Each screen contains a 2 hp motor to actuate the screens, and will be activated intermittently when head loss through the screens is sufficient to raise the channel level beyond an acceptable set point. The screen will convey collected materials into the roll-off dumpster.

4.6.2.3 Structural

The intake flow separator and screen structure will be an approximately 57-foot 4-inch long, 21-foot 4-inch wide, reinforced, cast-in-place concrete structure. The intake screen structure will consist of three 3-foot-wide channels extending approximately 28 feet below finished grade. Slide gates and stop blocks will control flow. The structures will be accessed by stainless-steel access hatches.

The top slab of the intake screen structure will be at finished grade. A concrete masonry unit (CMU) intake screen room, measuring approximately 45 feet 4 inches long by 31 feet 4 inches wide, will provide an enclosed space for the traveling screens and bar screen. The intake screen room walls will be 12-inch CMUs with a maximum height of 24 feet. The roof will be steel-framed, and primary roof framing members will have a 180-foot radius to match other site structures. Appropriate protective coatings will be provided for all steel-framed structural members because of the highly corrosive environment. Two operable or removable skylights will be located over the traveling screens to facilitate maintenance and removal when required. Two 12-foot-wide by 12-foot-tall roll-up doors will provide access to the room and dumpsters. Plan set drawings S-201 through S-205 show the preliminary structural design of the structures.

4.6.2.4 Electrical and Instrumentation

Each screen's 2 hp motor requires 480-volt (V) 3-phase power; the building lights and rolling overhead doors each require 110 V 1-phase power. Power will be provided from the electrical building and carried to the screening building via underground conduits.

4.6.2.5 Heating, Ventilation, and Air Conditioning (HVAC)

An onsite odor control system will pull negative pressure from the building and pass it through granular activated carbon (GAC) canisters. The screening building is not anticipated to be permanently staffed; air conditioning and heating will not be provided.

4.6.3 Pump Station

MPS receives screened wastewater through a 72-inch-diameter inflow pipeline into the wetwell (70 feet by 14 feet). Suction pipes (24-inch diameter) carry wastewater from the wetwell to five vertical solids-handling centrifugal, two-stage pumps, each capable of pumping up to 6,550 gpm (9.4 mgd) of flow. The pumps each discharge into 20-inch-diameter discharge pipes connecting to a common 48-inch discharge header. The 48-inch discharge header connects to the 48-inch-diameter force main connected to NCWRP. These pumps were sized to provide sufficient hydraulic head to convey wastewater to NCWRP.

Two 10-by-10-foot pump room access structures are located on top of either side of MPS, along with stairway access to the wetwell. A 10-by-10-foot equipment hatch is also included for easy maintenance access to the pumps.

4.6.3.1 Mechanical

A preliminary hydraulic analysis was prepared for the 48-inch-diameter wastewater force main conveying water from MPS to NCWRP. Analysis determined that to meet the total daily volumetric requirements for NCWRP during average dry weather conditions, all flow arriving at MPS must be pumped up to a maximum flow rate of 26,180 gpm (37.7 mgd). Additional flow beyond 26,180 gpm will not be pumped to NCWRP; this additional flow will be allowed to overflow through the passive overflow as described later in this EDR. Figure 4-16 depicts the flow arriving at MPS during average dry weather conditions, and flow pumped from MPS.

Based on the diurnal variation in flows during average dry weather conditions and flow requirements at NCWRP, all flow arriving at MPS is anticipated to be pumped except between 9 a.m. and 3 p.m. and between 7 p.m. and 11 p.m.; during these periods, the flow exceeds the anticipated maximum pumping rate. During these times, flow will be allowed to reach the high water level in the wetwell and back up to the overflow pipeline. Excess flow will be conveyed into NMVI and to PLWTP for treatment and disposal. The overflow pipeline is anticipated to be connected to Junction Structure No. 1 upstream of the 84-inch-diameter influent main diversion pipeline. This pipeline is shown on plan sheet C-103 and discussed further in Section 4.8. The flow rate from MPS is based on an assumption of flow rates and there will be variations in actual conditions. In order to accommodate this variation, a control strategy based on a combination of level in the NCWRP EQ basins, time of day, and level in the wetwell has been developed. This control strategy is described later in this document.

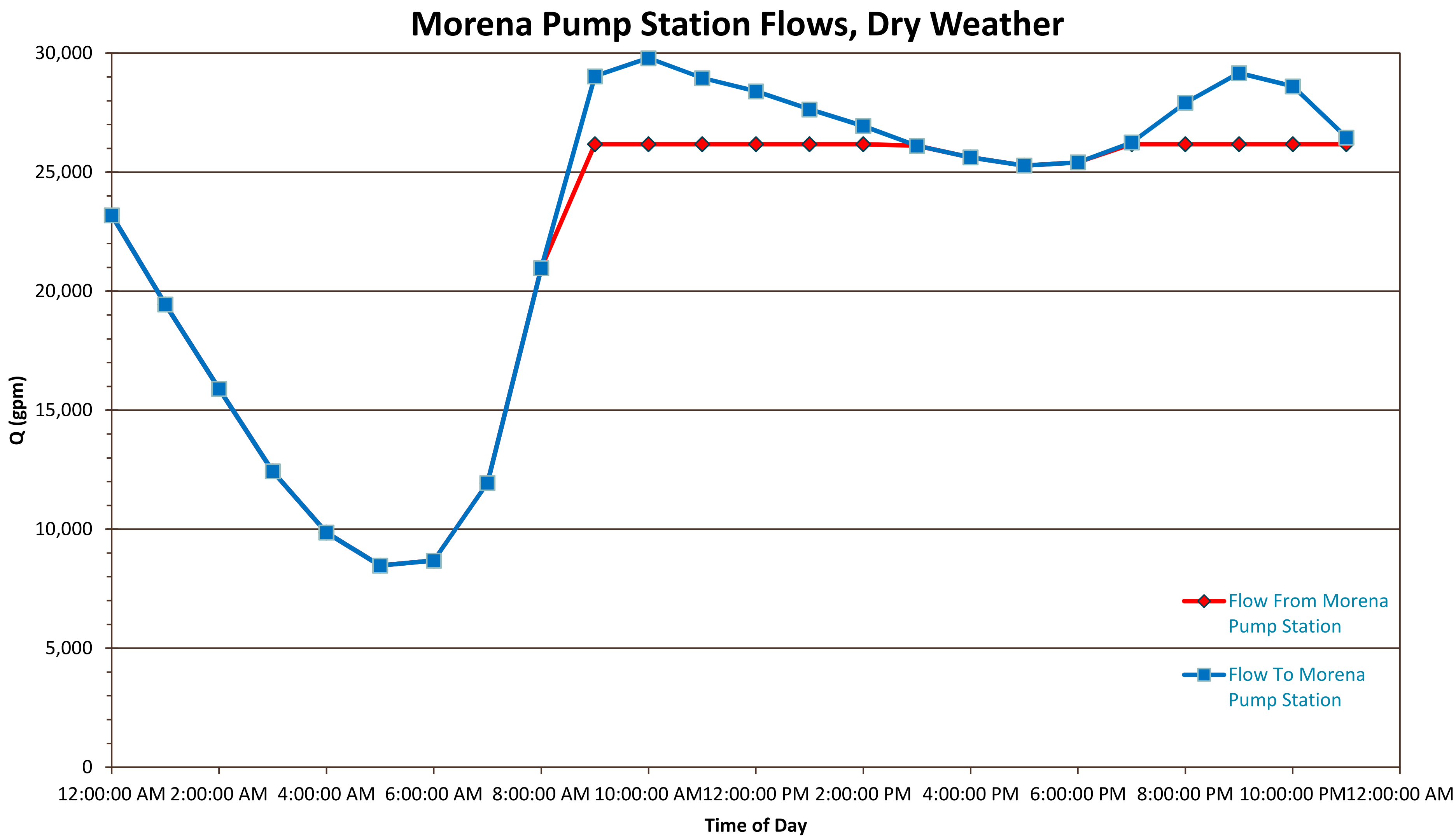


Figure 4-16: MPS Flows, Dry Weather

During wet weather conditions more wastewater will be available in the northern service areas; this means it will not be necessary to pump as much wastewater from MPS during these conditions. Also during wet weather conditions more flow will be available to MPS. During wet weather conditions it is anticipated that flow from MPS will vary between a minimum of 4,000 gpm and a maximum of 7,900 gpm. Figure **4-17** depicts the flow arriving at MPS during wet weather conditions and flow pumped from MPS. When low-flow conditions occur, the gates in the diversion structures will start to be modulated, diverting flow back into the local sanitary sewers and away from MPS.

The selected pumps must be capable of delivering the low-flow condition of 4,000 gpm (5.8 mgd) and peak-flow condition of 26,180 gpm (37.7 mgd). Several pumps are able to meet this condition, but the Fairbanks 14-inch 5743 XL appears to best meet operational conditions. Installing 10 pumps designed to operate in a two-series 4+1 configuration will allow MPS to meet all anticipated pumping conditions.

Figure 4-18 shows the pumping curves for the 5743 XL pumps. These pumps are identical in performance; however, the 5743 XL is the close-coupled version and the 5713 XL is the extended-shaft version.

Figure 4-19 illustrates the result of importing these curves into the hydraulic analysis and applying the affinity law to determine pumping operations at lower speeds. This figure shows how varying the number of operating pumps and speeds between 100% and 82% provides complete coverage for all MPS operational conditions. This strategy also provides some redundant capacity if the City decides to increase the flow rates to NCWRP. In situations when flow rates are lower than anticipated, the City can decrease the flow rate. The maximum operational condition is anticipated to be four pumps running at 96% speed, which matches the maximum flow condition in the flow EQ strategy anticipated by other tasks. The minimum operational condition is one pump operating at 93.8% speed. Additional information on efficiencies at variable operating speeds and pumps in operation was also prepared, and is depicted in Figure **4-20** through Figure **4-23** on the following pages.

As shown in the figures, the pumps can be operated near efficiency points ranging from 75% to 81% for all dry weather flow conditions. During wet weather conditions the pumps will operate at efficiencies from 60% to 80%. Net positive suction head (NPSH) requirements for anticipated pumping rates vary from 25 to 32 feet; NPSH available, considering the anticipated operating level and atmospheric pressure, is approximately 41 feet. The current conceptual design exceeds the Hydraulic Institute’s standard of providing 20% to 30% additional NPSH for pumps of this size. The final designer should carefully consider the pumps’ NPSH requirements during final design.

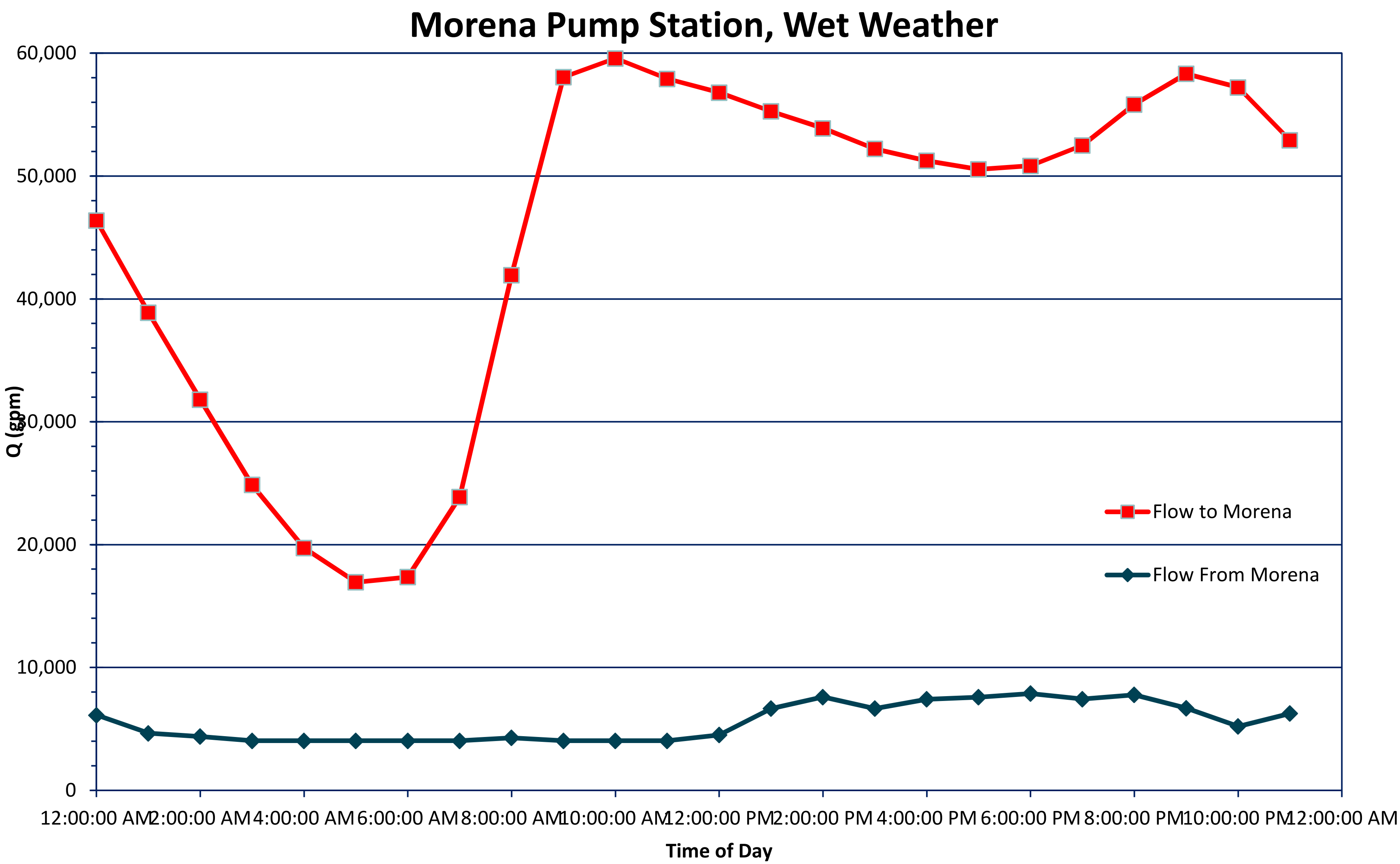


Figure 4-17: MPS Flows, Wet Weather

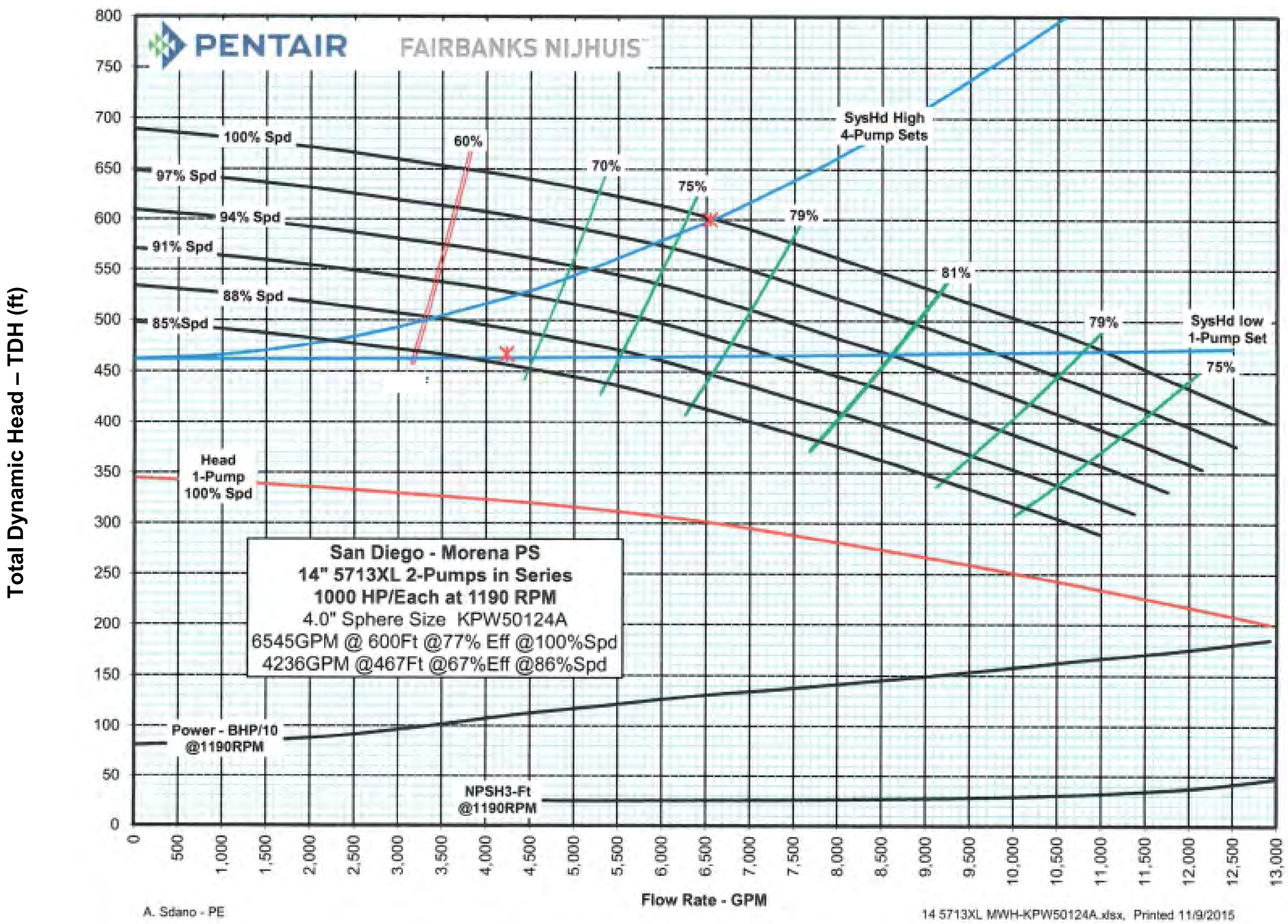


Figure 4-18: Pumping Curves for Fairbanks 14-inch 5713 XL and 5743 XL

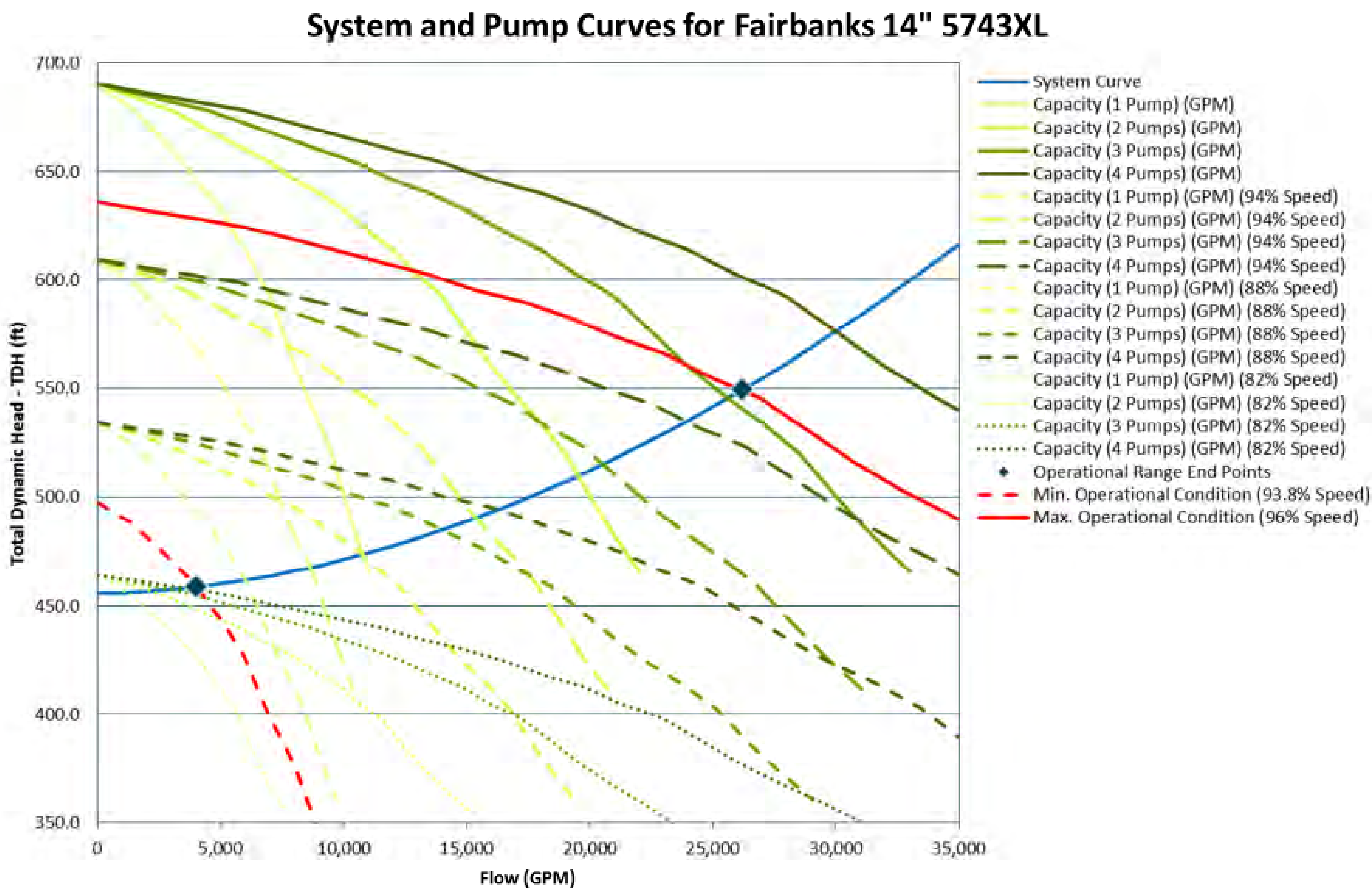


Figure 4-19: Hydraulic Analysis and Pump Curves for Fairbanks 14-inch 5743 XL

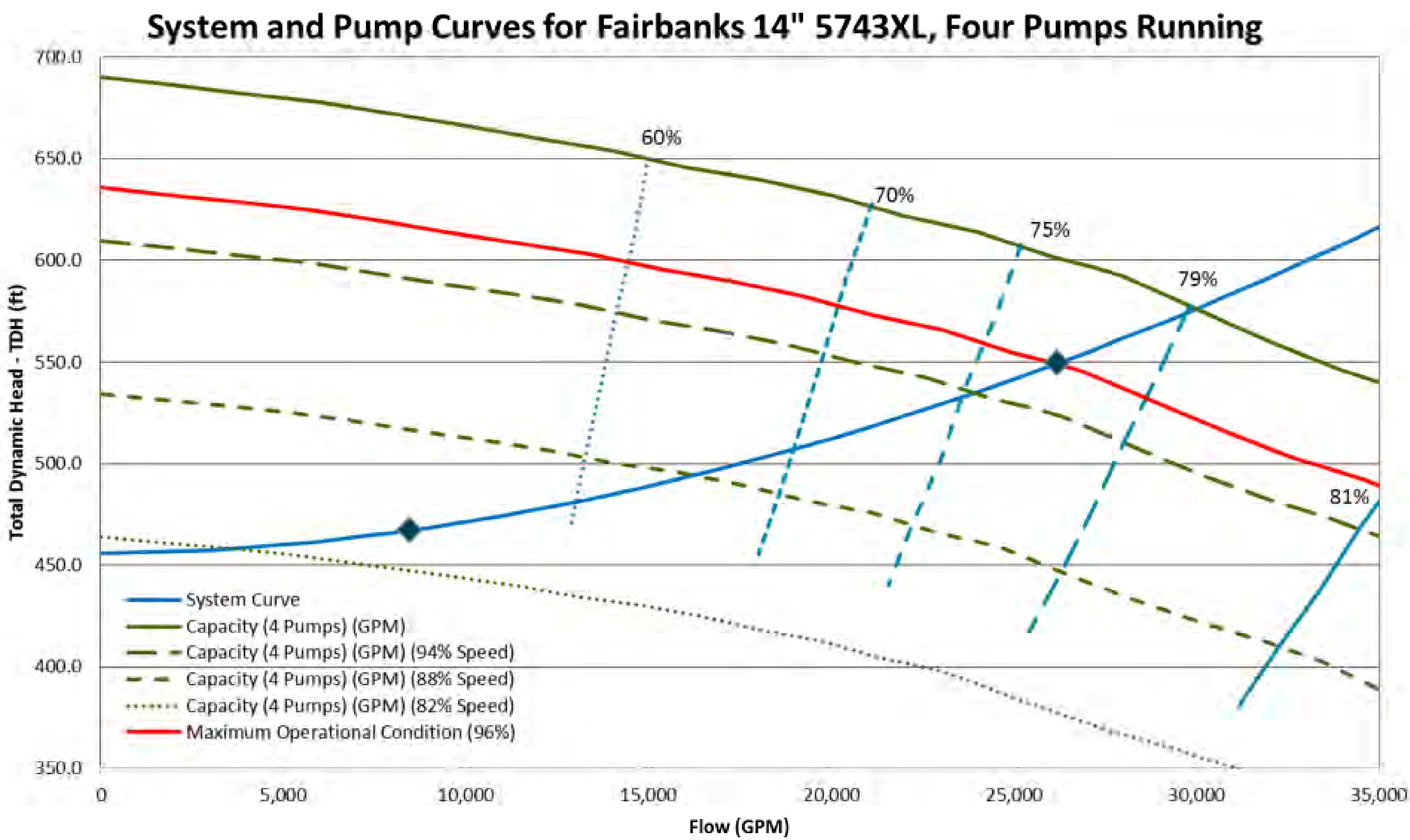


Figure 4-20: Hydraulic Analysis and Pump Curves for Fairbanks 14-inch 5743 XL, Four Pumps

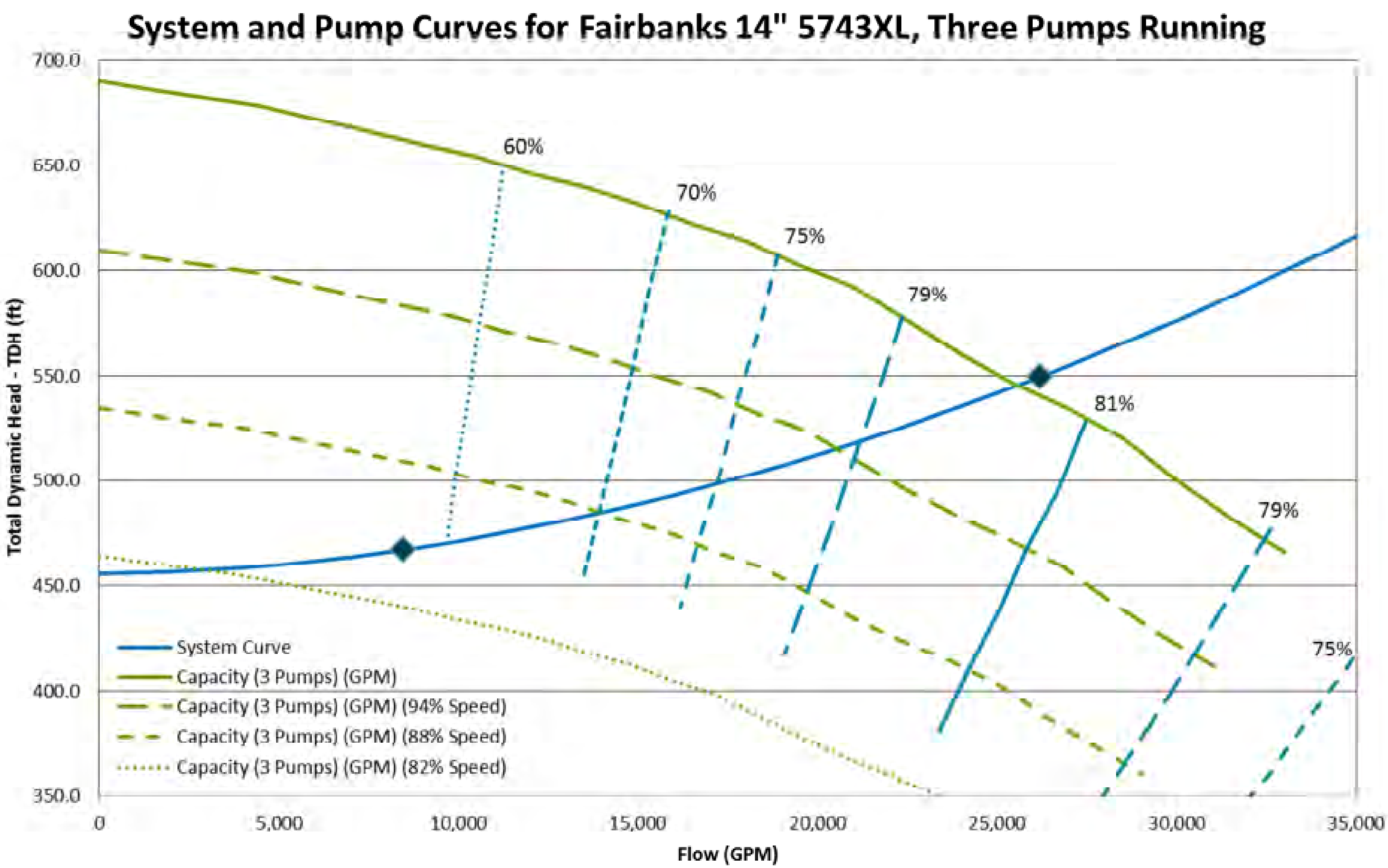


Figure 4-21: Hydraulic Analysis and Pump Curves for Fairbanks 14-inch 5743 XL, Three Pumps

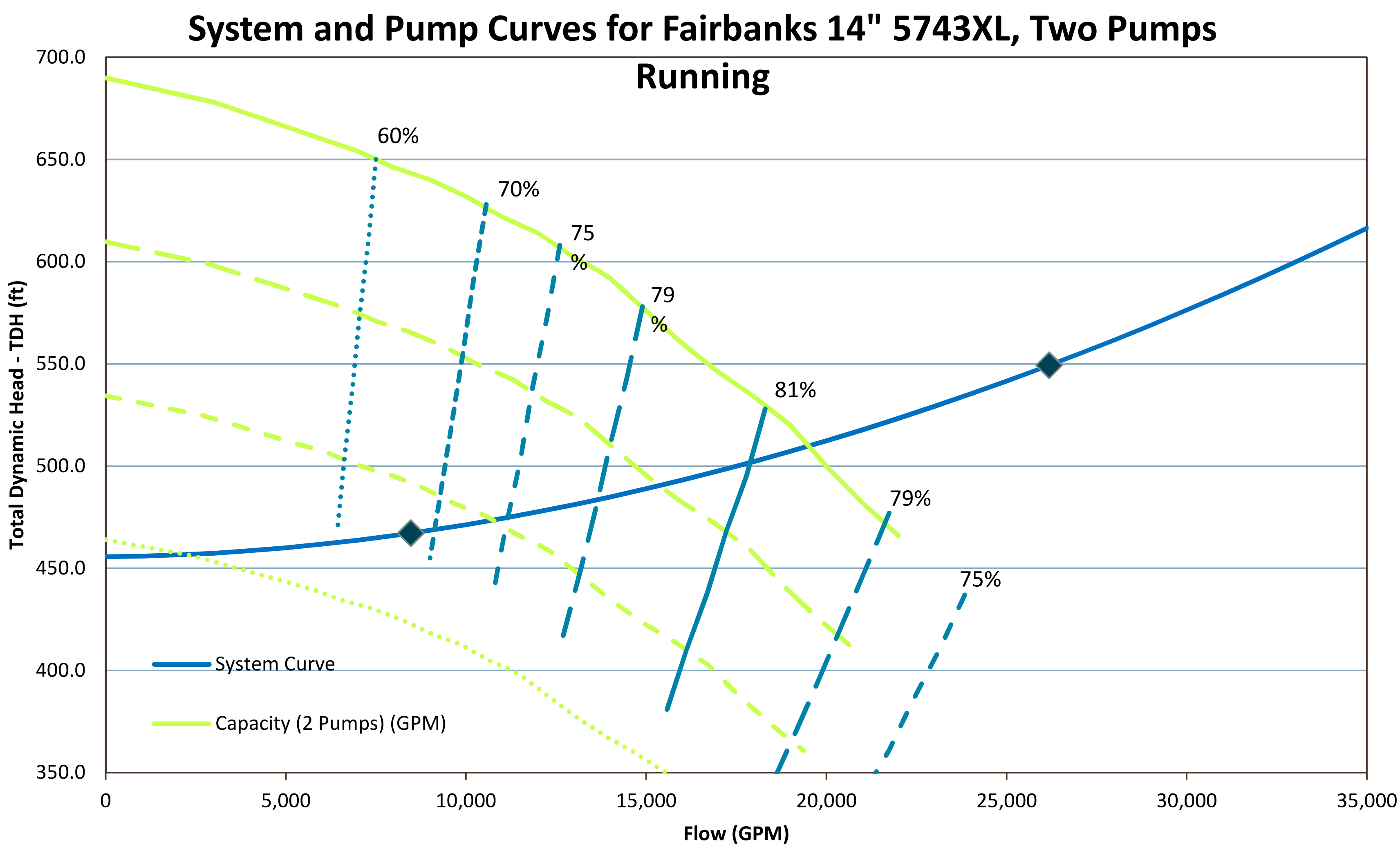


Figure 4-22: Hydraulic Analysis and Pump Curves for Fairbanks 14-inch 5743 XL, Two Pumps

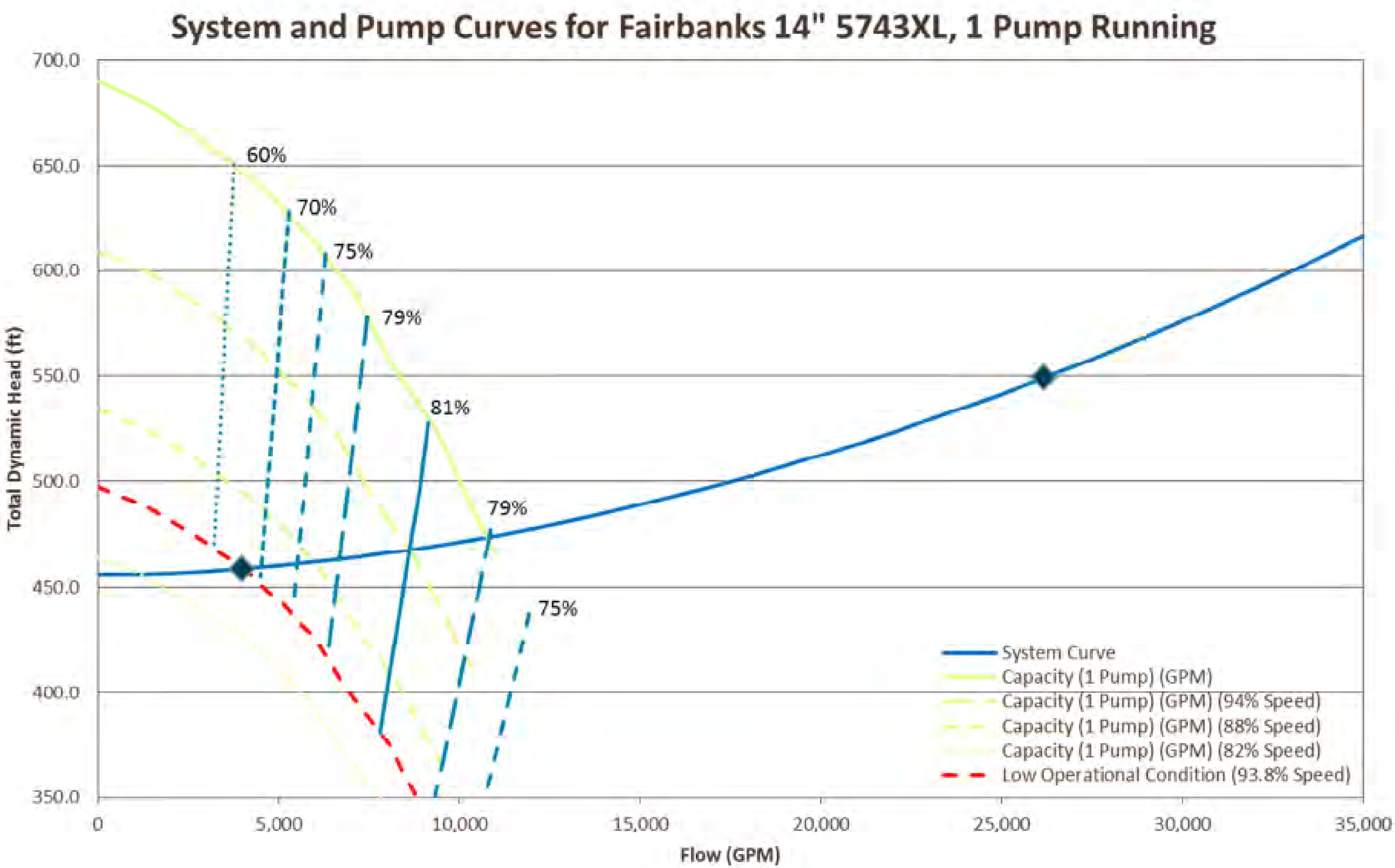


Figure 4-23: Hydraulic Analysis and Pump Curves for Fairbanks 14-inch 5743 XL, One Pump

It is recommended that MPS be provided a target pumping rate every hour based on the level in the EQ basins at NCWRP. Based on the target flow rate the distributed control system (DCS) will select the number of active pumps and speed. This full coverage allows the final designer to select the most efficient operational conditions to minimize electrical power costs. Figure 4-24 shows the results of applying these conditions to the anticipated flow rates over a daily period. The slide gates in the nearby diversion structures will be modulated to be either fully open or fully closed based on a continually increasing or decreasing water level in the wetwell. Where water level continues to increase beyond the high water level, the slide gates within Diversion Structure No. 1 will be modulated to allow flow to continue south through the existing EMBTS #4 to Point Loma and block flow to MPS. If water level continues to rise afterward, the slide gates in Diversion Structure No. 3 will be modulated similarly to allow flow from NMVI # 2 to continue south through the existing NMI to Point Loma and block flow to MPS. If water level continues to rise again, the slide gates in Diversion Structure No. 2 will be modulated similarly to allow flow from MBI 14 and MBTS #11 to continue south to Point Loma and block flow to MPS. During this time, the wet well will be pumped down and the pump station will be locked out of operation until a higher set point is selected by the DCS. Refer to Figure 4-15 for site plan showing the diversion structures.

As shown in Figure 4-24, it is anticipated that three pumps will operate from 12 to 1 a.m., two pumps from 1 to 3:30 a.m., one pump from 3 to 6:30 a.m., two pumps from 6:30 to 7:45 a.m., three pumps from 7:45 to 9 a.m., and four pumps from 9 to 12:00 a.m. The anticipated number of pumps in operation, flow ranges, and operational speed are shown in Table 4-5.

Table 4-5: Pump Station Operational Conditions

Pump Trains Operating	Upper Flow Rate (gpm)	Upper Speed (%)	Lower Flow Rate (gpm)	Lower Speed (%)
1	10,800	100	4,000	86
2	19,500	100	10,800	88
3	24,500	99	19,500	93
4	26,180	96	24,500	95

4.6.3.2 Structural

MPS will be an approximately 91-foot-long, 65-foot-wide, reinforced, cast-in-place concrete structure. The finished floor elevation of the pump room and wetwell will be approximately -27.12 feet and -29.0 feet, respectively. The top slab will extend above the finished grade by approximately 1.5 feet at the ridge and taper to 1.25 feet at the edges. Cast-in-place walls are anticipated to be approximately 3.5 feet thick and include external buttresses. The wall thickness and buttresses are required because of the location's assigned seismic design site classification of E.

Exterior cast-in-place concrete stairs at the northeast end of the structure provide wetwell access. The stairs terminate onto a maintenance platform located approximately 11 feet below grade and 18 feet above the invert of the wetwell; this platform allows personnel to access the wetwell for cleaning, inspection, and maintenance without shutting down the entire MPS.

Two 19-foot 8-inch by 10-foot 4-inch concrete masonry structures on the top slab provide access to galvanized steel framed stairs to the pump room. A 10-by-10-foot steel access hatch in the top slab allows for piping, pump, and equipment maintenance and removal.

Drawings S-101 through S-106 show MPS's preliminary structural design. Section 4.6.7 illustrates the general structural requirements.

4.6.3.3 Electrical and Instrumentation

The control system was previously described in Section 4.6.3.1, the pumps will be sped up, slowed down, brought into service, and brought out of service based on a setpoint provided by the DCS. Sensors for pump vibration, discharge pressure, motor temperature, and availability of each phase of power will also be provided. Information from these sensors will be relayed to a programmable logic controller (PLC) in the control room of the electrical building and imported into the DCS for relay back to NCWRP.

Electrical power will be provided from the electrical building to the pump station building. Each of the 10 motors will be 1,000 hp and require 4,160 V 3-phase power. The building will also require 110 V 1-phase power for lighting. Section 4.6.4 describes the electrical building in more detail.

4.6.3.4 HVAC

MPS is not anticipated to be permanently staffed; heating and cooling will not be provided. A negative pressure will be pulled from MPS and the air will be treated through a GAC filter to remove odors. In coordination with City staff, it was determined that MPS will not need a wet scrubber and instead a passive system will be used. The final designer should analyze and update the GAC system during final design. The HVAC system should be designed in accordance with National Fire Protection Association (NFPA) 820.

MPS is recommended to have 12 air changes per hour in the pump room and 20 air changes per hour in the wetwell. This is based on the pump room being a Class 1 Division 2 environment and the wetwell being a Class 1 Division 1 environment. It is important to consider that flow of wastewater into the wetwell will also draw in air that must be disposed of through the HVAC system. This air is anticipated to be part of the 20 air changes per hour and the sizing of the HVAC system should take this air into account.

4.6.4 Electrical Building and Transformers

The electrical building houses all electrical equipment required at the site, such as VFDs, meters, and transmitters. One transformer is contained just outside the electrical building. This transformer will step down mainline power to 480 V 3-phase, and step down again via a smaller transformer inside the building to 110 V 1-phase power.

4.6.4.1 Electrical and Instrumentation

The electrical building will contain ten 1,000 hp VFDs, one for each pump motor. The VFDs will accept mainline power and step power down to 4,160 V 3-phase power suitable for use in the pump motors. Drawings E-101 through E-104 show the proposed MPS single-line diagrams.

4.6.4.2 Structural

The electrical building will be an approximately 63-foot-long, 40-foot 8-inch-wide, CMU structure with a maximum height of 17 feet 4 inches and steel-framed roof. The primary roof-framing members will have a 180-foot radius to match other site structures. The walls will be 12-inch CMUs, and the foundation system will be reinforced concrete to accommodate potential hazards because of differential soil settlement and liquefaction. Cast-in-place concrete housekeeping pads will be provided below electrical equipment. Drawings S-301 through S-303 show the preliminary structural design of the electrical building.

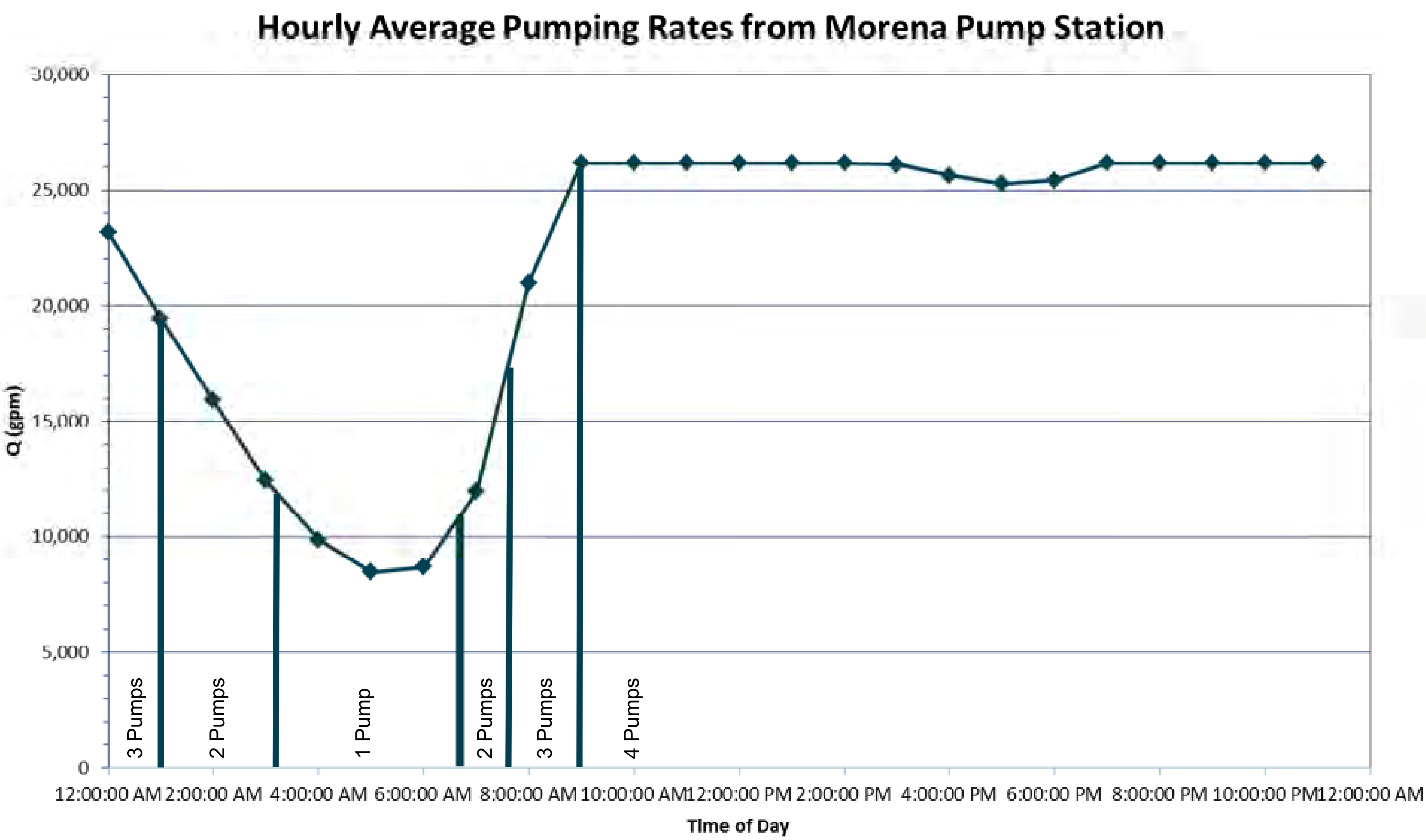


Figure 4-24: Hydraulic Analysis and Pump Curves for Fairbanks 14-inch 5743 XL, One Pump

4.6.4.3 HVAC

The electrical building requires an HVAC system as the VFDs, switchgear cabinet, and other MCC equipment will generate a significant amount of heat. The ambient temperature should be kept between 65 and 80 degrees Fahrenheit (°F) for the VFDs to operate properly.

It is anticipated that a roof-mounted HVAC system will be suitable to meet the electrical building's HVAC requirements. At the 10% level of design, the total heat load generated by the equipment has not been calculated and the final designer should conduct these calculations during the next phase of the work.

4.6.5 Odor Control and Chemical Storage

MPS's odor control system uses negative pressure to change the air in the screening and pump station buildings 20 times per hour. This process ensures that the air surrounding the wetwell at MPS and the air in the screening building remains as clean as possible for the workers at the site and for the surrounding community. This air will be conveyed to the odor control building at the same site where two GAC canisters will be used to remove odors from the air. This is a passive treatment system with limited active elements. After passing through the GAC canisters the air will be released into the atmosphere. Plan sheet M-601 depicts the anticipated odor control system.

4.6.5.1 Mechanical

The odor control system will require two blowers pulling a negative pressure on the screening and pump station buildings, and the blowers' size should comply with the air handling requirements listed in this section. It is recommended that this system be handled as a package unit to confirm equipment consistency and operational compatibility.

4.6.5.2 Electrical and Instrumentation

The blowers should each be sized to use 480 V 3-phase power. No other power requirements are anticipated.

Instrumentation should consist of pressure-indicating transmitters on the downstream side of the blowers. In the event there is a blockage in the pipe or damage to the GAC canisters, the transmitters will indicate that the blowers are operating outside the design parameters. In this case, an alarm will be activated and one or both blowers will be shut down and locked out of operation. It is recommended that final design accommodate a temporary system in case of this alarm condition. The health and safety plan to be prepared for the facility should incorporate Air Quality Management District (AQMD) and Occupational Safety and Health Administration (OSHA) requirements.

4.6.6 Architectural

MPS's architectural design features consist of the perimeter site walls and walls and roofs of the pump station building and electrical building. Architectural renderings are included in Appendix J.

4.6.6.1 Reference Criteria

The architectural design must comply with the following design criteria:

- 2016 California Building Code (CBC) with local amendments
- 2013 California Fire Code (CFC) with local amendments
- 2013 California Electrical Code (CEC) with local amendments

- San Diego Sprinkler Policies
- San Diego Municipal Codes
- NFPA Standard 13 (Installation of Sprinkler Systems), 2010 Edition
- NFPA 70 (National Electrical Code), 2011 Edition
- NFPA 72 (National Fire Alarm Code), 2010 Edition

4.6.6.2 Building Envelope, Exterior Facade, and Roof

The proposed buildings and structures shall conform to the 2013 CBC. The exterior walls will be a combination of split-faced and standard CMU; this combination of types of CMU and colors will give the buildings character and break the monotony of a single wall finish. The roof will be metal standing-seam with a brighter color to match the surrounding roof color. This modern, neutral color scheme will match the existing adjacent buildings along the two streets' frontage.

For security, the site will be surrounded by CMU walls interrupted by vertical columns. The roofs will curve in various directions to provide interesting views from different viewpoints.

4.6.6.3 Egress Systems

Egress systems will be provided in accordance with requirements of 2013 CFC Chapter 10 with local amendments.

4.6.6.4 Accessibility Compliance

It is anticipated that the buildings will be exempt from Americans with Disabilities Act (ADA) regulations as facility work requires able-bodied personnel only.

4.6.7 General Structural

A Risk Category III and Importance Factor of 1.0 for wind loads and 1.25 for seismic loads were assumed for this level of structural design. The following relevant design codes were used at the MPS site:

- CBC and all subsequent amendments, which adopts in whole or in part the following documents by reference:
    - American Society of Civil Engineers (ASCE) 7-10, "Minimum Design Loads for Buildings and Other Structures"
    - American Concrete Institute (ACI) 318-11, "Building Code Requirements for Structural Concrete"
    - ACI 350-06, "Code Requirements for Environmental Engineering Concrete Structures and Commentary"
    - ACI 350.3-06, "Seismic Design of Liquid-Containing Concrete Structures and Commentary"
    - ACI 530-11, "Building Code Requirements and Specification for Masonry Structures and Related Commentaries"
    - American Institute of Steel Construction (AISC) 360-10, "Specification for Structural Steel Buildings"

Preliminary soil design parameters were provided by Allied Geotechnical Engineers in Section 5.2 of its "Draft Geotechnical Desktop Study Report, Pure Water Program Task 7: MPS, WW Force Main and Brine Conveyance Pre-Design (NC05)," (November 24, 2015). These parameters were used with the relevant design codes to determine preliminary wall and base slab thicknesses. The design forces on the MPS walls are very significant because of MPS's significant size and depth, high groundwater level, and proximity to several active and potentially active faults. In an effort to minimize wall thicknesses, buttresses have been provided to reduce the horizontal wall spans. Other appropriate methods may be considered during final design to minimize the wall thicknesses.

MPS's preliminary structural design was developed using limited "desktop" geotechnical design parameters. Further geotechnical study should be performed to determine appropriate soil design parameters and assess the effects of potential seismic hazards including but not limited to soil liquefaction, differential seismic-induced settlement, fault ground rupture, and ground lurching.

4.7 Liquid-Phase Odor Control

MPS will convey waste streams from a nearby sewer interceptor to NCWRP for treatment. Gas-phase odor control treatment is provided for MPS to reduce hydrogen sulfide (H_2S) gas concentrations; however, a significant portion of H_2S will remain dissolved in the solution pumped in the force main to NCWRP; this dissolved H_2S also needs treatment to reduce odor generation. Treating this additional dissolved H_2S load requires new and/or additional odor control equipment at NCWRP's already limited site. As a result, other locations for a new odor control facility were evaluated.

Appendix K1 details the analysis of potential odor control options and facility locations. Prior to this evaluation, the dissolved H_2S content was estimated using the Pomeroy equation and water quality information available for MPS source water; Appendix K2 presents this calculation. Table 4-6 summarizes the water quality information and odor control results.

Table 4-6: Odor Control Design Criteria

Description	Value	Comment
Average flow rate from MPS	32 mgd	Estimated from modeling
Peak-day flow rate from MPS	37.7 mgd	
5-day BOD of wastewater	270 mg/L	From water quality measurements
pH of wastewater	7.3	
Wastewater temperature	25°C	
Estimated pipe length	10.4 miles	Estimated from design
Estimated liquid sulfide in pipe	7.60 mg/L	From the Pomeroy equation
Quantity of dissolved H_2S	2,001 lb/d	Assumed average flow concentration of 8.34

4.7.1 Odor Control Alternatives

Odor control alternatives were evaluated based on discussions with vendors and City staff, and results of pilot and full-scale testing conducted for previous projects. The alternatives considered include the following:

- Calcium nitrate: $Ca(NO_3)_2$ (trade name: BIOXIDE)
- Peroxide-regenerated iron for sulfide control (PRI-SC): consisting of ferrous chloride ($FeCl_2$) and hydrogen peroxide (H_2O_2)
- High-purity oxygen (HPO)
- $FeCl_2$

In addition to capital costs, this evaluation examined how each method could affect NCWRP performance and O&M risks associated with each option. A weighted matrix evaluation was developed to rank the alternatives and help make a final recommendation for MPS force main odor control. The matrix identified **ferrous chloride ($FeCl_2$)** as the best option.

A full discussion of the odor control alternatives and the complete evaluation matrix are included in Appendix K1.

4.7.1.1 Ferrous Chloride Addition

The $FeCl_2$ process is a one-stage process during which $FeCl_2$ is the only chemical used to provide odor control; the equation for this alternative is presented below. More $FeCl_2$ is used in this alternative than in the PRI-SC alternative because the target dissolved sulfide concentration is 0.1 mg/L versus 0.5 mg/L with the PRI-SC alternative.

Equation: Ferrous Chloride Addition

$$\underset{\text{Ferrous chloride diss.}}{FeCl_2} + \underset{\text{Sulfide}}{H_2S} \rightarrow \underset{\text{Ferrous sulfite}}{FeS} + \underset{\text{Hydrochloric acid}}{HCL}$$

Past pilot-scale testing indicates that the ratio of $FeCl_2$ to dissolved sulfide concentration required for adequate treatment is 11:1. The City typically purchases $FeCl_2$ at 33%, equivalent to 3.9 pounds per gallon (lb/gal).

4.7.2 Preliminary Site Evaluation

The original $FeCl_2$ chemical treatment system consisted of pumps, chemical feed tanks, and other associated appurtenances. The facility would have required access by City staff to replace the chemicals as needed; $FeCl_2$ would be injected directly into the MPS force main, fabricated of steel for the first 3 miles of pipe and HDPE for the remainder, as discussed in other sections. However, $FeCl_2$ is highly acidic and generally incompatible with cement-lined mortar pipe at high concentrations. As a result, potential locations for the chemical facility along the HDPE portion of the MPS force main were evaluated. These potential sites included:

- Location 1: property near Clairemont High School
- Location 2: abandoned gas station at Clairemont Drive and Balboa Avenue
- Location 3: City-owned property near railroad

These sites were evaluated by three metrics: site conditions, site preparation, and schedule and costs. Appendix K1 describes each location in detail. The matrix identified Location 1: property near Clairemont High School as the best option.

However, further discussions with City staff concluded that this option was not viable because of its proximity to Clairemont High School. The elimination of Location 1 as a viable site led to considering the feasibility of installing the odor control facility at MPS. This option is discussed in the following sections.

4.7.3 Alternative Location for Ferrous Chloride System

Installing a chemical feed system within MPS presents a set of unique challenges, which have been evaluated and are discussed below.

4.7.3.1 Ferrous Chloride Addition into the Force Main

$FeCl_2$ is deemed incompatible with cement mortar lined steel pipe material because of its acidic nature; the low pH is known to degrade the pipe material's inner lining over time. Lining the inner walls with a more compatible plastic product, such as polyurethane or HDPE, is one method for reducing the abrasive effects of $FeCl_2$ on steel pipe. However, lining the inner walls of the steel pipe with plastic material is expensive and not a common industry practice. Additionally, the City has noted that pipes lined with polyurethane on past projects have short useful lives.

Based on these concerns, a jar test was conducted to determine the effect of $FeCl_2$ on the pH of the MPS feed water. This experiment aimed to determine if adding $FeCl_2$ to the waste stream would lower the pH to a level below neutral (<7) and, if so, investigate how operating procedures could mitigate this outcome.

4.7.3.2 pH Testing

The jar testing process involved the following steps:

1. A composite sample consisting of the expected wastewater flow contributions to MPS was prepared. The pH of this composite sample was measured.
2. Known concentrations of $FeCl_2$ were added to this sample and completely mixed. After every $FeCl_2$ spike, the composite sample's resulting pH was measured.
3. The composite sample was spiked with $FeCl_2$ several times; the final $FeCl_2$-to-wastewater ratio exceeded results expected under normal operations.

The experiment was designed to make a reasonable inference of the expected pH of the composite sample during actual treatment. The experiment showed that the pH of the grab sample remained above neutral even after the $FeCl_2$-to-wastewater ratio exceeded the value expected under normal conditions. Figure 4-25 illustrates this experiment and its results. Appendix K4 includes a detailed description of the test protocol.

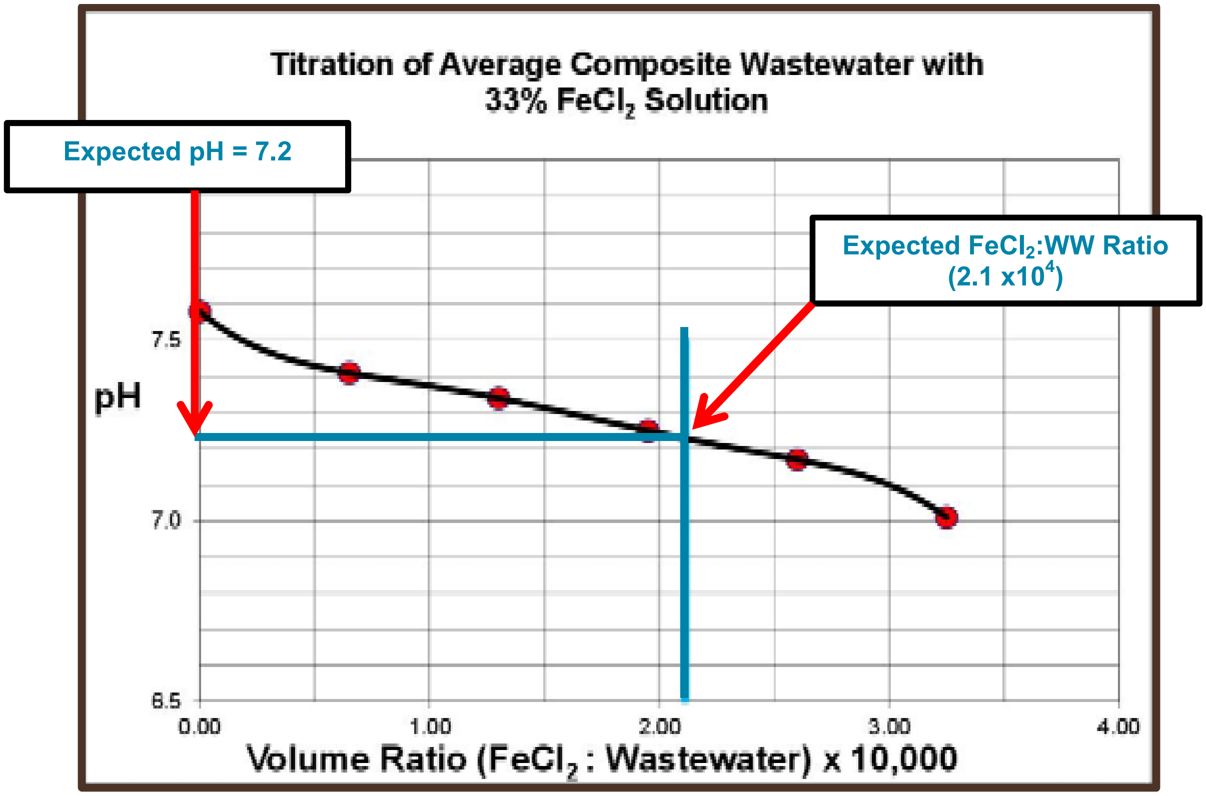


Figure 4-25: pH Change in MPS Feed Water Source from Ferrous Chloride Addition

4.7.3.3 Integration with MPS Force Main Design

The results of this experiment indicate that the wastewater stream provides sufficient buffering capacity (alkalinity) to reduce the acidifying effect of $FeCl_2$ addition. This finding suggests that lining the steel MPS force main with cement mortar is a viable option, provided that the $FeCl_2$ is completely mixed in the waste stream. This can be rapidly achieved by installing a mechanical mixing devices in-line with the MPS force main. Table 4-7 presents design criteria for the metering pumps, and Figure 4-26 shows a vendor cut sheet for the proposed $FeCl_2$ metering pumps.

Table 4-7: Odor Control Chemical Feed System

Description	Value
Pumped fluid	$FeCl_2$
Pump type	Peristaltic metering pump
Flow rate	4 gpm
Operating pressure	~20 psi [a]
Chemical storage volume	41,000 gallons [b]

a. Estimated based on preliminary pipe layout.

b. Estimated based on 1 weeks' worth of storage.

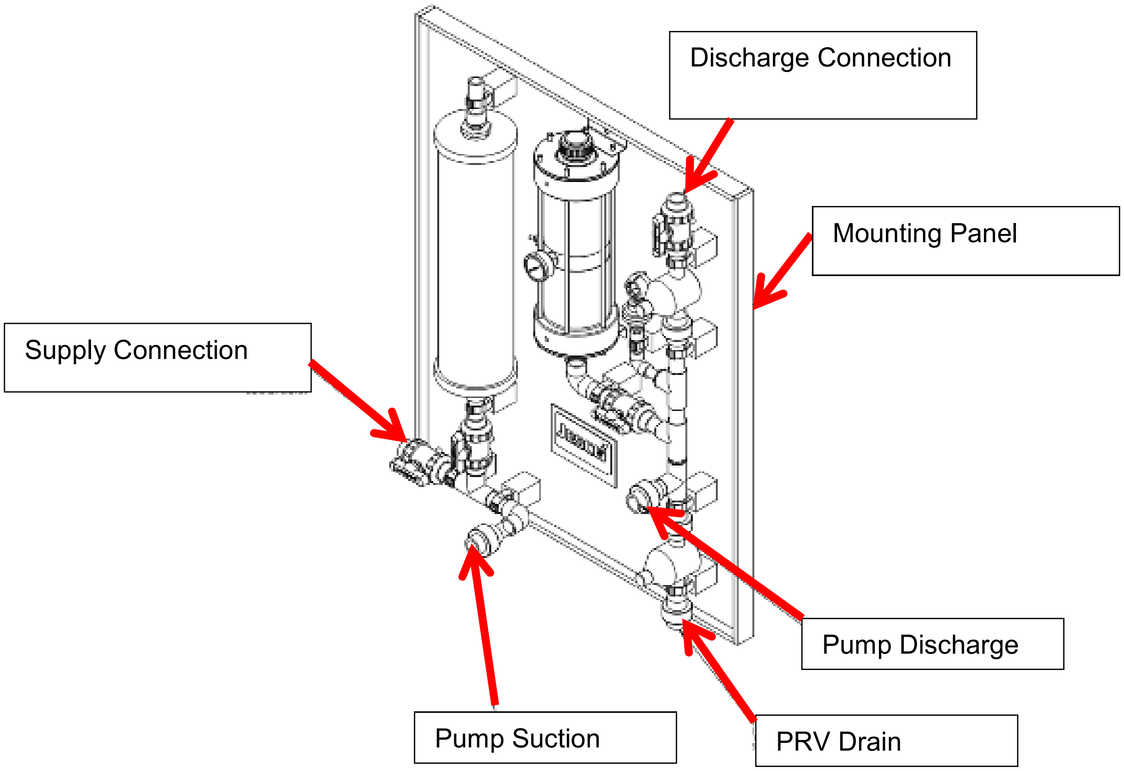


Figure 4-26: Ferrous Chloride Metering Pump

The rapid mixing is expected to produce a homogeneous $FeCl_2$/wastewater mixture; however, based on empirical equations in fluid mechanics, fully developed flow conditions (where frictional effects of the pipe walls are no longer significant) are not expected to occur until approximately 200 feet downstream of the point of $FeCl_2$ injection. As a precautionary measure, the Project team proposes to line the first 500 feet of steel pipe with HDPE, as this is the area most susceptible to long-term degradation. However, as discussed above, this is likely not to occur, as the waste stream's pH is expected to be above 7 under normal operations.

4.8 Offsite Infrastructure

MPS's offsite infrastructure (excluding the 48-inch-diameter force main and 24-inch-diameter brine pipeline upstream of the energy dissipator discussed in Sections 4.4 and 4.5 respectively, and storm drainage line discussed in Section 4.6) consists of the MPS inflow piping and overflow piping, and associated subgrade diversion structures and junction structures as well as the brine pipeline downstream of the energy dissipator. Figure 4-27 depicts a system schematic of the MPS, including incoming diversion flows, force main to NCWRP and brine line from AWTF. Figure 4-28 depicts an offsite infrastructure plan view, including a profile of inflow piping modification. Figure 4-29 depicts an alternative offsite infrastructure plan view, with Junction Structure No. 1 on the MPS site and west diversion pipeline along Anna Avenue.

4.8.1 Pump Station Inflow Piping

Two main pipelines will convey wastewater to MPS. Wastewater will be collected at Junction Structure No. 1, and flow through an 84-inch-diameter PLRP pipeline (main diversion pipeline) to the influent flow separator structure as described in Section 4.6. Junction Structure No. 1 is approximately 20 feet by 22 feet in size and is located on the north side of Friars Road.

The first pipeline is the new PLRCP west diversion pipeline, which will intercept and convey raw wastewater from the 60-inch-diameter EMBTS and 72-inch-diameter NMVI #1. The west diversion pipeline is located on the north side of Friars Road and connects to Junction Structure No. 1. The west diversion pipeline originates as a 60-inch-diameter PLRCP, which matches the size of the existing EMBTS, approximately 1,200 feet to the west of the MPS facility. A new diversion structure (Diversion Structure No. 1) will be constructed at the intersection with the existing EMBTS within the Friars Road right-of-way just east of the Interstate 5 (I-5) freeway. Diversion Structure No. 1 is anticipated to be a 12-by-14-foot below-grade cast-in-place concrete vault. From Diversion Structure No. 1, the west diversion pipeline will convey wastewater approximately 51 feet to a second diversion structure (Diversion Structure No. 2), also located within the Friars Road right-of-way. Diversion Structure No. 2 is anticipated to be a 14-by-14-foot below-grade cast-in-place vault. Diversion Structure No. 2 will intercept wastewater from the 33-inch-diameter vitrified clay pipe (VCP) MBTS #11, 72-inch-diameter PLRCP MBI #14, and 15-inch-diameter VCP North Metro Interceptor (NMI) #1A from the north via the existing NMVI #1. From Diversion Structure No. 2 the west diversion pipeline will increase in size to a 72-inch-diameter PLRCP and continue for approximately 987 feet to Junction Structure No. 1. The two diversion structures will channelize wastewater eastward to MPS during normal conditions. When MPS is not operating or during some wet weather conditions, wastewater will be conveyed southward to its original discharge point. Figure 4-30 refers to the new diversion structures and junction structures.

The west diversion pipeline will be constructed via open-trench methods within the Friars Road right-of-way, crossing Pacific Highway and MTS railroad bridges. Two separate rail design projects, San Diego River Bridge Double Track (SDRDT) and MCCTP, adjacent to this project and just north of Friars Road, are currently in design by SANDAG.

The second pipeline is the new PLRCP east diversion pipeline that will intercept and convey wastewater from the new Diversion Structure No. 3. Diversion Structure No. 3 will be constructed at the intersection with the existing 108-inch-diameter PLRCP NMI and replace existing facilities depicted in As-Built Plan 27152-15-D within Appendix E. The east diversion pipeline continues west 1,750 feet to Junction Structure No. 1. Diversion Structure No. 3 is anticipated to be a 16-by-20-foot below-grade cast-in-place vault within the Friars Road right-of-way. The east diversion pipeline crosses under both Morena Boulevard and an MTS rail line.

The main diversion pipeline will collect raw wastewater flows from the west diversion pipeline and east diversion pipeline at Junction Structure No. 1, located between Friars Road and the MPS site, and carry the wastewater approximately 144 feet north to the MPS site. If the screening facilities are included in the Project, the wastewater will connect to the screening facility first before discharging into MPS.

Wastewater volumetric flow rates, existing sewer facilities sizing, and facility depths should be verified during final design. The size of diversion and overflow pipelines shall also be verified and if necessary revised based on this updated information.

The diversion and junction structures are located within the coastal zone. A comprehensive dewatering strategy shall be prepared during final design, as the site is located in an area with a high water table.

SYSTEM SCHEMATIC

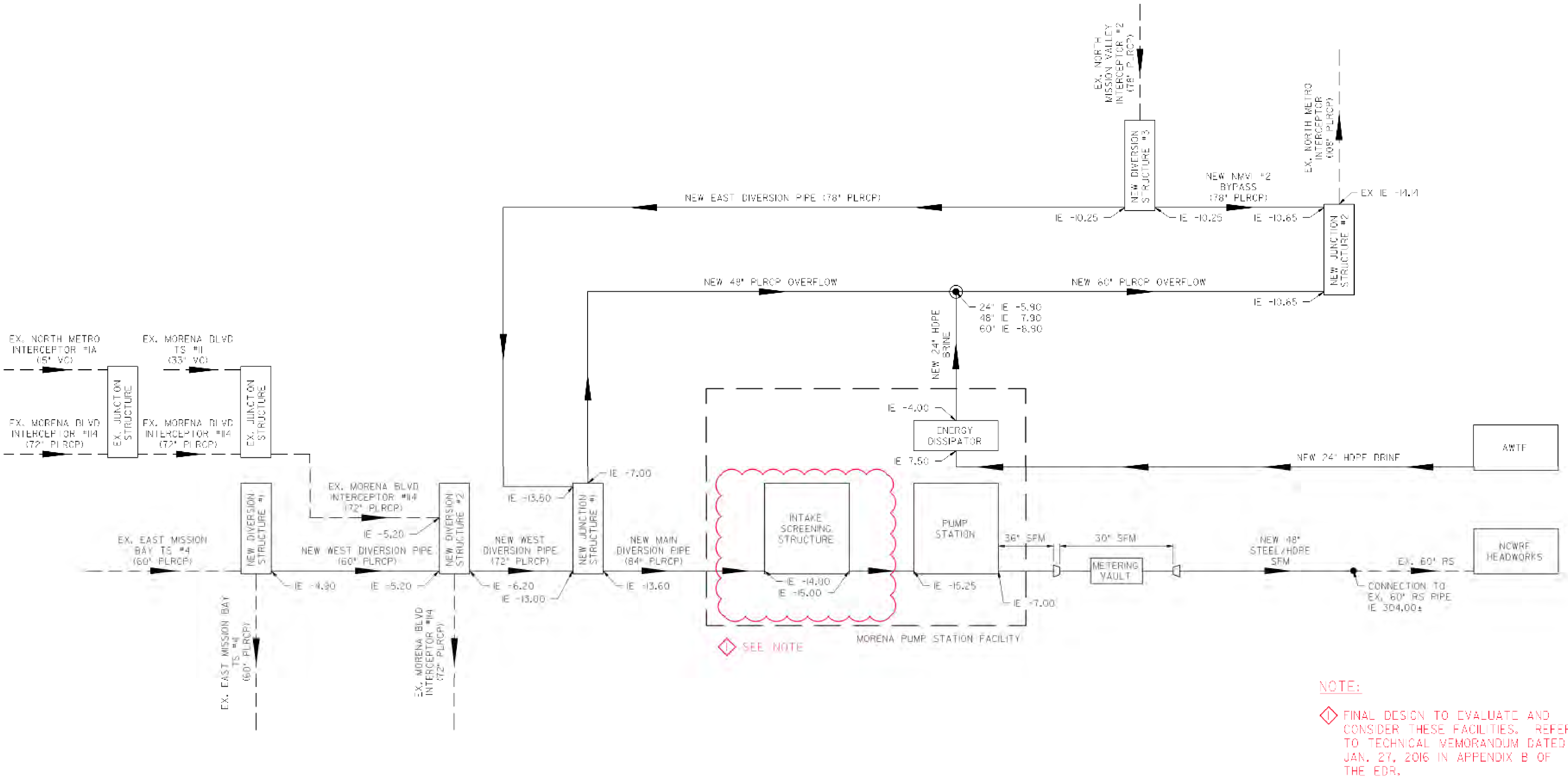


Figure 4-27: System Schematic Diagram

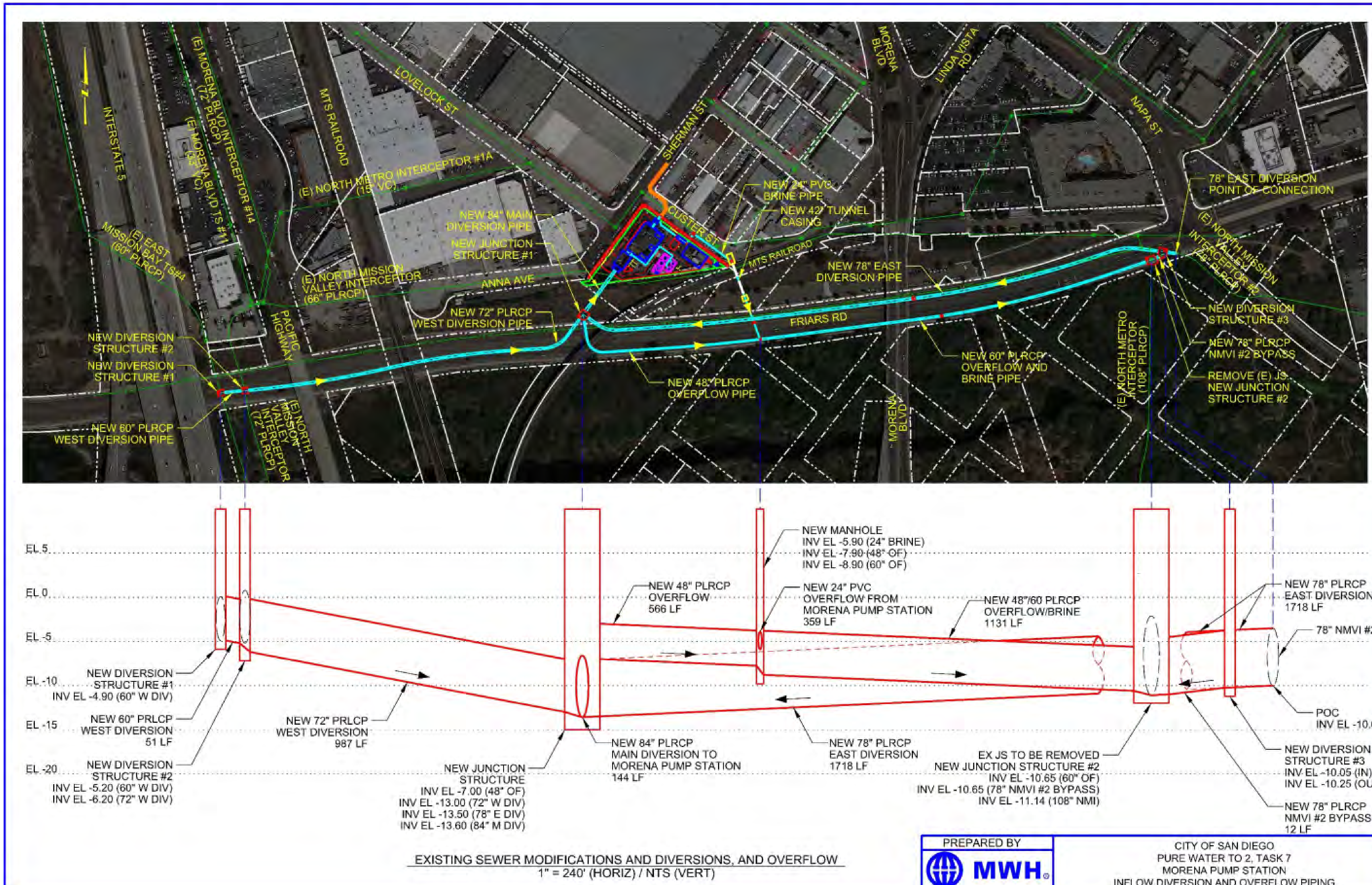


Figure 4-28: Offsite Infrastructure

ALTERNATIVE EXISTING SEWER MODIFICATIONS AND DIVERSIONS, AND OVERFLOW
1" = 240' (HORIZ)

PREPARED BY	CITY OF SAN DIEGO PURE WATER TO 2, TASK 7 MORENA PUMP STATION ALTERNATIVE INFLOW DIVERSION AND OVERFLOW PIPING
MWH	

Figure 4-29: Alternative Offsite Infrastructure

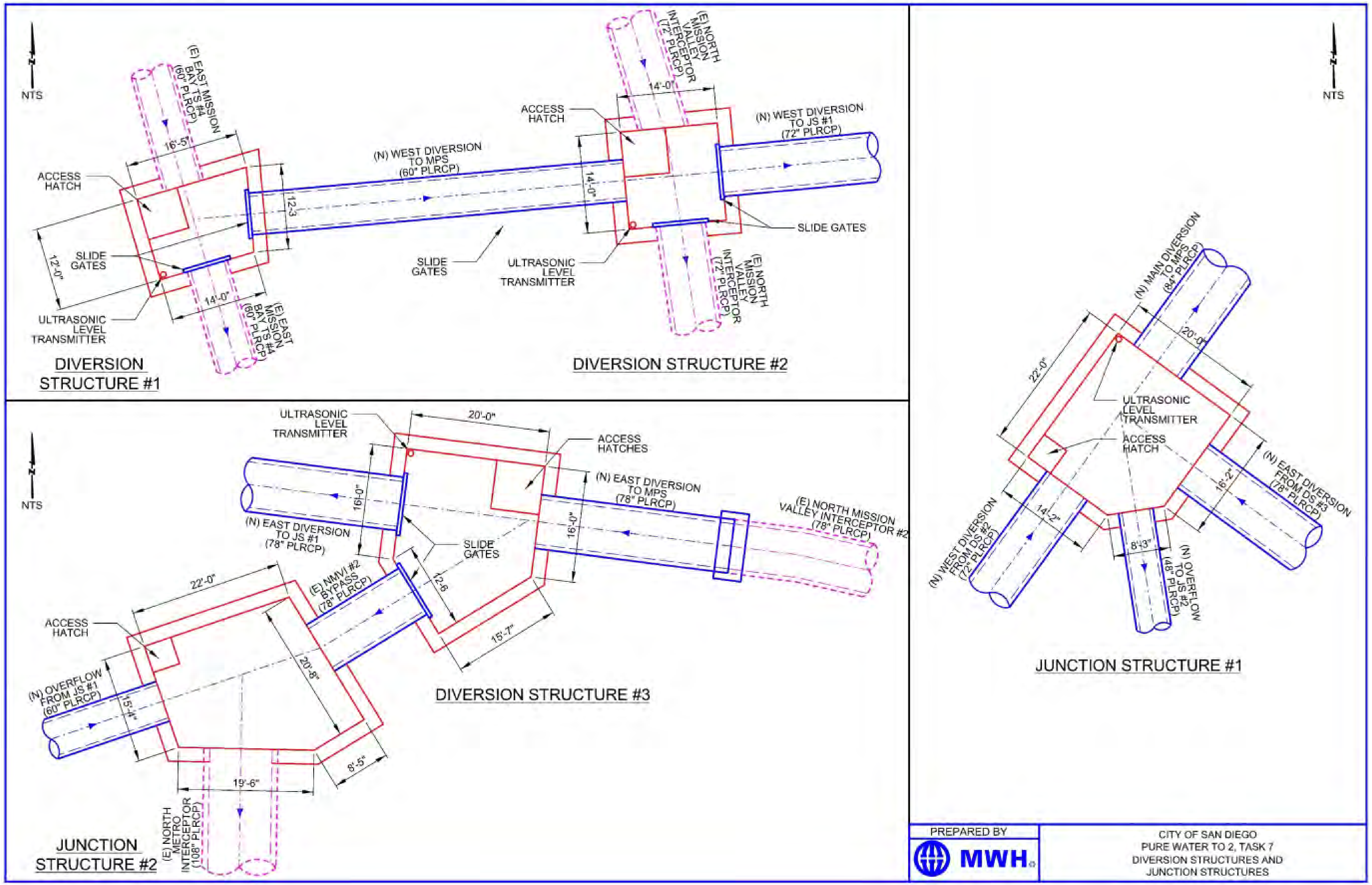


Figure 4-30: Diversion Structures and Junction Structures

4.8.2 Pump Station Overflow Piping

The overflow channel conveys excess wastewater flowing into MPS to the existing 108-inch-diameter NMI on Friars Road. As a gravity pipeline, it will begin with a 48-inch-diameter PLRCP at Junction Structure No. 1 heading south into the Friars Road right-of-way before running east along Friars Road in open-trench construction. At approximately 566 feet downstream from Junction Structure No. 1, the overflow pipe will connect to the 24-inch-diameter brine pipeline from the north (refer to Section 4.8.3 for a description of continuation of the brine pipeline). Combined flow of the overflow and brine is then conveyed by the 60-inch-diameter PLRCP overflow pipe for approximately 1,131 feet toward its final discharge destination at a new junction structure (Junction Structure No. 2), approximately 22 feet by 22 feet, which will channelize flows from the overflow pipeline to the existing 108-inch-diameter NMI. The new junction structure will be placed in the same location as the existing Junction Structure No. 3 mentioned in the previous section. The existing Junction Structure No. 3 will be demolished. The gravity-fed overflow piping will be equipped with maintenance holes at all horizontal angle points and spaced no farther than 800 feet apart.

4.8.3 Brine Pipeline Downstream of Energy Dissipator

The 24-inch-diameter gravity-fed brine pipeline will exit the energy dissipation structure at the MPS and head northeast into the Custer Street right-of-way before running southeast toward the end of the cul-de-sac of Custer Street in open-trench construction. In the cul-de-sac of Custer Street, the brine pipeline inside its 42-inch-diameter casing will cross under the existing raised MTS railroads with approximately 24 feet of cover. Supported by MSE retaining walls on both sides, the existing rail section was raised higher than Custer Street level. The tunnel, measured about 100 feet in length, will exit the opposite MTS right-of-way in a publicly owned parking lot between the fill slope embankment to the north and Friars Road to the south. The brine pipeline will continue in open-trench construction in its same orientation to Friars Road. It will cross the new 78-inch-diameter east diversion pipeline prior to connecting to a manhole of the new overflow pipe running easterly along Friars Road. The brine pipeline downstream of the energy dissipator is approximately 259 feet of open construction and 100 feet of tunnel.

4.9 Preliminary Specifications Outline

Table 4-8 presents a preliminary outline of specifications.

Table 4-8: Preliminary Specifications Outline	
Division 1	**General Requirements**
1025	Measurement and Payment
1300	Contractor Submittals
1400	Quality Control
1510	Temporary Utilities
1660	Facility Start-Up and Operator Training
1680	Physical Checkout; Shop, Field, and Functional Testing
1700	Contract Closeout
1730	Operation and Maintenance Information
1750	Spare Parts and Maintenance Materials
Division 2	**Sitework**

Table 4-8: Preliminary Specifications Outline	
2050	Demolition
2100	Site Preparation
2140	Dewatering
2200	Earthwork
2510	Asphalt Concrete Pavement and Base
2620	Subdrainage
2644	PVC Nonpressure Pipe
2645	PVC Pressure Pipe (4 in. and Smaller)
2650	Steel Pipe, Lined and Coated
2651	HDPE Pressure Pipe
2666	Water Pipeline Testing and Inspection
2810	Landscape Irrigation System
2831	Chain Link Fence and Gates
2900	Landscaping
Division 3	**Concrete**
3100	Concrete Formwork
3200	Reinforcement Steel
3280	Joints in Site Work Concrete
3290	Joints in Concrete Structures
3300	Cast-in-Place Concrete
3310	Cast-in-Place Site Work Concrete
3315	Grout
3400	Precast Concrete
Division 4	**Masonry**
4232	Reinforced Concrete Block Masonry
4815	Glass Unit Masonry Assemblies
Division 5	**Metals**
5120	Structural Steel
5220	Concrete Bolts
5310	Steel Deck and Wall Panels
5500	Miscellaneous Metals
Division 6	**Miscellaneous Carpentry**
6105	Miscellaneous Carpentry
Division 7	**Thermal and Moisture Protection**

Table 4-8: Preliminary Specifications Outline	
7100	Waterproofing
7210	Building Insulation
7321	Concrete Roof Tiles
7600	Flashing and Sheet Metal
7720	Roof Accessories
7920	Sealants and Caulking
Division 8	**Doors and Windows**
8110	Steel Doors and Frames
8347	Sound Control Door Assemblies
8620	Unit Skylights
8710	Finish Hardware
8800	Glazing
Division 9	**Finishes**
9511	Acoustical Panel Ceilings
9800	Protective Coating
9900	Architectural Paint Finishes
Division 10	**Specialties**
10210	Outside Noise Barrier
10400	Identifying Devices
10520	Fire Extinguishers
Division 11	**Equipment**
11000	Equipment General Provisions
11033	Variable Frequency Drives
11175	Pumps General
11214	Vertical Turbine Pumps
11346	Submersible Sump Pumps
Division 13	**Special Construction**
13110	Galvanic Anode Cathodic Protection
13300	Instrumentation and Control
13301	Instrumentation and Control Descriptions
13314	In-Line Flow Measuring Systems
13316	Security Surveillance and Access Control System
13325	Level Detection Switches
13334	Pressure Measuring Systems

Table 4-8: Preliminary Specifications Outline	
13335	Pressure Detection Switches
13344	Temperature Measuring Systems
13370	Control Panels
13374	Control Panel Instrumentation
13400	Communications
13825	Automatic Gate Operator
Division 14	**Conveying Systems**
14600	Hoist and Cranes, General
14605	Electric Monorail Systems
Division 15	**Mechanical**
15000	Piping Components
15020	Pipe Supports
15030	Pipe Identification Systems
15050	Vibration Isolation
15100	Valves, General
15101	Valve and Gate Operators
15102	Gate Valves
15104	Butterfly Valves
15113	Air Release and Vacuum Valves
15114	Pressure Regulating Valves
15117	Pump Control Valves
15118	Spring-Loaded Swing Check Valves
15250	Pipe and Equipment Insulation
15990	Testing, Adjusting and Balancing
Division 16	**Electrical**
16040	Electric Motors
16050	Basic Electrical Materials and Methods
16200	Engine Generator
16290	Power Monitor
16400	Low Voltage Electrical Service and Distribution
16421	Surge Arrestor
16431	Short Circuit Study Protective Device Coordination and Arc Flash Analysis Report
16480	Motor Control Center
16485	Local Control Panels

Table 4-8: Preliminary Specifications Outline	
16500	Lighting
16926	Automatic Transfer Switches
16950	Electrical Tests

5 Special Considerations

The following section discusses special considerations as part of the Project design.

5.1 Preliminary Geotechnical Conditions

A desktop geotechnical report, *Geotechnical Desktop Study Pure Water Program Task 7 Morena Pump Station, WW Force Main and Brine Conveyance Pre-Design (NC05) City of San Diego* (December 14, 2015) was prepared for the Project. The study aimed to evaluate potential major geologic and geotechnical issues and constraints potentially impacting the Project's pipeline alignment, and included an in-depth information review, site reconnaissance, and data evaluation and reporting. The report details geologic site conditions, potential geologic hazards, and construction considerations.

Most of the Project's pipeline will be installed using conventional open-trench construction methods; however, trenchless technology will be used in multiple locations. The geological landscape at each of these locations are described in the report. The six proposed trenchless excavation sites are:

- Trenchless Crossing A: Miramar Road/La Jolla Village Drive Crossing at I-805
- Trenchless Crossing B: La Jolla Village Drive crossing at Judicial Drive
- Trenchless Crossing C: Genesee Avenue crossing at SDMTA railroad tracks in Rose Canyon
- Trenchless Crossing D: Genesee Avenue crossing SR 52 and San Clemente Canyon
- Trenchless Crossing E: Morena Boulevard crossing Tecolote Creek
- Trenchless Crossing F: Custer Street crossing MTS railroad tracks

During final design, additional geotechnical investigation must be performed along the proposed alignment and GBRs considered where trenchless methods are proposed. The complete Geotechnical Desktop Study is included in Appendix L.

5.2 Preliminary Environmental Constraints

Potential environmental impacts generated by the Project were evaluated and documented in two reports: (1) a Preliminary Environmental Assessment by the City, and (2) a Phase I Environmental Site Assessment (ESA) by Allied Geotechnical. The Preliminary Environmental Assessment provided a desktop assessment of environmental constraints associated with the Project, identified potential environmental resources present, and recommended avoidance or mitigation measures. Pertinent information in the Preliminary Environmental Assessment is summarized in Sections 5.2.1 through 5.2.4; the complete report is included in Appendix M1.

The Phase I ESA reviewed past and present land use practices and site operations to evaluate the potential presence of environmental conditions within 1,000 feet on either side of the proposed pipeline alignment. Visual site reconnaissance along the alignment was performed and pertinent records/files maintained by various local regulatory agencies were reviewed. The high-impact sites are detailed in Section 5.2.5; the complete Phase I ESA is included in Appendix M2.

5.2.1 Impacts on Biological Resources

The proposed pipeline alignment is located within developed street right-of-way, disturbed/developed lands, and ornamental vegetation. However, pipeline segments are located adjacent to sensitive habitats, and work in these areas will be restricted according to the City's Land Use Adjacency Guidelines. Field surveys will be conducted along the alignment to identify exact locations of resources during subsequent environmental work to support the Project.

Habitat for sensitive species may be under moratorium for disturbance during nesting season, from February 1 through September 15. Sensitive species known to occur in the alignment's immediate vicinity include the California gnatcatcher, which uses Diegan coastal sage scrub habitat for nesting and foraging. Clearing, grubbing, or grading is restricted from March 1 through August 15 for the California gnatcatcher.

Noise from construction operations can also impact nesting bird species, and construction activities should occur outside of nesting season in areas where nesting birds are present. If construction activities must occur during nesting season, a qualified biologist will conduct appropriate surveys to ensure that construction noise will not impact nesting birds. Noise reduction measures such as noise walls, noise blankets, exhaust mufflers, low idling of equipment, and reduction of work hours could be required to maintain compliance.

The Project should also incorporate construction BMPs to prevent release of toxins, sediment, or other pollutants. Implementation of BMPs such as sediment and erosion control, fugitive dust suppression, spill prevention, and delineation of Project limits will prevent significant indirect effects from construction activities.

The Project is located within the San Diego Multiple Species Conservation Program (MSCP) Planning area, which outlines preserve areas called the Multi-Habitat Planning Area (MHPA). MHPA areas restrict development and focus preservation in areas supporting the highest-quality biological resources. Figure 4 in the Preliminary Environmental Assessment (Appendix M1) shows these preserve areas relative to the pipeline alignment.

5.2.2 Impacts on Jurisdictional Resources

Waterways and wetlands in the Project area are regulated by the City of San Diego, United States Army Corps of Engineers (USACE), RWQCB, and California Department of Fish and Wildlife (CDFW). Three locations along the pipeline cross or intersect with documented waterways and wetland that include riparian habitat. Project activities potentially impacting these jurisdictional resources will require regulatory permits; a complete list of permits required for the Project is included in Appendix M1. Work within wetland buffers must also address land use adjacency issues such as drainage, noise, lighting, exotic species, and human activity.

5.2.3 Impacts on Cultural Resources

Most of the alignment is located in developed areas with disturbed soils not expected to contain cultural resources requiring protection. Field investigations should be performed as part of the final design in locations where the alignment enters undeveloped areas or undisturbed soils to ensure that cultural resources are not present in the proposed corridor.

Excavation in moderate or high sensitivity formations introduces potential for paleontological resources to be found. Monitoring would be required where construction is proposed to excavate more than 10 feet deep into native soils.

5.2.4 Community Impacts

Pipeline construction will result in noise impacts. Construction noise limits are regulated by the City's municipal code, and short-term construction noise at or beyond the property lines is limited to an average sound level less than 75 decibels (dBA) from 7 a.m. to 7 p.m.

5.2.5 Findings from the Phase I ESA

The Phase I ESA categorized the evaluated sites as follows:

1. Sites with **no** impact to the pipeline alignment
2. Sites with **minimal** potential impact to the pipeline alignment
3. Sites with **high** potential impact to the pipeline alignment

Thirteen sites were categorized as having high potential impact to the pipeline alignment, as listed below:

- **Intersection of Governor Drive and Genesee Avenue:**
  - United Oil Service Station (formerly Chevron): 3860 Governor Drive
  - World Oil Service Station (formerly Exxon): 3918 Governor Drive
  - Mobil Service Station: 3861 Governor Drive
- **Intersection of Clairemont Mesa Boulevard and Clairemont Drive:**
  - MIC Gas Station: 4592 Clairemont Mesa Boulevard
- **Intersection of Clairemont Drive and Balboa Avenue:**
  - Shell Oil Service Station (currently abandoned): 3901 Clairemont Drive
  - Tune Craft 2 (formerly ARCO): 3901 Clairemont Drive
- **Clairemont Drive between the intersections of Erie Street and Morena Boulevard:**
  - Bay View Plaza: 2565 Clairemont Drive
  - Unocal Service Station: 2576 Clairemont Drive
  - Shell Service Station: 2606 Clairemont Drive

- **Morena Boulevard at the intersections of Jellet Street, Cushman Avenue, and between the Intersection of Napa Street and Linda Vista Road:**
    - USA Service Station (formerly Prestige Station): 2505 Morena Boulevard
    - Valera Service Station (formerly Ultramar): 1083 Morena Boulevard
    - Carl's Junior (formerly Texaco): 845 Morena Boulevard
- **Morena Pump Station Site:**
    - Lloyd Pest Control: 935 Sherman Street

Figure 5-1 maps the general location of each listed site, and each site is described in detail in Section 5.0 of the Phase I ESA (Appendix M2). A Phase II subsurface investigation is recommended for the areas of high potential impact listed above and shown in Figure 5-1.

5.3 Land Use Interagency Coordination

Section 6 of this EDR lists known stakeholders in the NC01 (Task 7) Project area. Coordination with the County, SANDAG, California Coastal Commission (CCC), and California DDW is anticipated to be required to construct MPS. Each of these agencies has approval authority on this Project.

Several non-governmental stakeholders should be informed of Project impacts in their areas of interest. These stakeholders do not have approval authority on the Project, but should be engaged in the interest of community acceptance. These stakeholders are listed in Section 7.1.

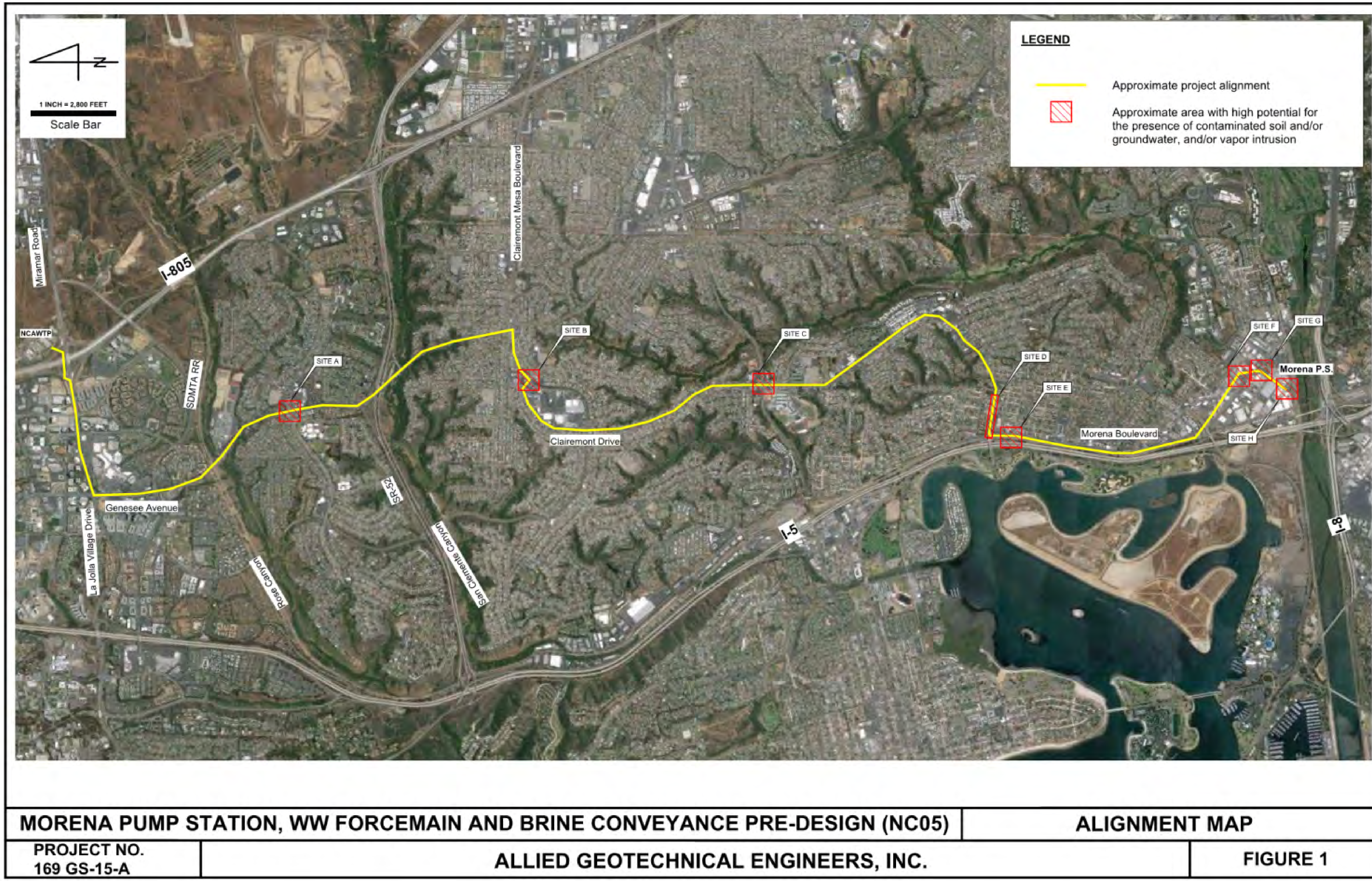


Figure 5-1: High-Impact Sites Identified in Phase I ESAs

5.4 Land, Easement, and Right-of-Way Acquisitions

The Project area was evaluated for necessary easements and acquisitions for the MPS site, diversion pipeline, and brine overflow pipeline. Figure 5-2 depicts all land acquisitions and easements described in this section. Figures of each individual parcel and detailed costs are included in Appendix N1.

5.4.1 Cost Estimate

Table 5-1 shows a Level 4 budget estimate for the proposed easements and acquisitions. Assumptions used to develop these costs are listed in the full table in Appendix N1. Each parcel is described in more detail in subsequent sections.

Table 5-1: Permanent and Temporary Easement Costs

ID*	APN	Owner	Type of Acquisition	Area of Acquisition (ft^2)	Estimate of Cost
A1	436-510-600	San Diego Humane Society and SPCA	Full take	43,600	$3,200,000
E1	436-451-10-00	San Diego Metropolitan Transit District	Easement	210	--
			TCE	600	--
E2	--	Caltrans: SR 52 Crossing	TCE	46,600	--
E3	348-010-61-00	San Diego Metropolitan Transit District	TCE	4,400	--
E4	--	Caltrans: I-805 Crossing	TCE	35,600	--

5.4.2 Acquisition 1: Morena Pump Station Site

The Humane Society operates this site as a wildlife sanctuary. Because a full property acquisition is expected, the animals would have to be relocated to other facilities. This property is currently on the market with no sale pending, and the City should consider advance acquisition of the entire site.

5.4.3 Easement 1: Brine Overflow—Railroad Crossing

MTS indicated a preference to speak directly with the City's project manager versus with the City's consulting team regarding the process for obtaining rights within the MTS right-of-way.

5.4.4 Easement 2: Genesee Avenue—State Route 52 Crossing

The process varies for permit, easement, or acquisition. The City would need to prepare a letter describing the Project and what is needed (easement, encroachment permit, etc.), prepare exhibits in a format acceptable to the California Department of Transportation (Caltrans), and submit this information with the processing fee. A minimum of 12 months should be anticipated to complete this process.

5.4.5 Easement 3: Genesee Avenue—MTS Crossing

MTS indicated a preference to speak directly with the City's project manager versus the City's consulting team regarding the process for obtaining rights within MTS right-of-way.

5.4.6 Easement 4: Miramar Road—I-805 Crossing

The process varies for permit, easement, or acquisition. The City would need to prepare a letter describing the Project and what is needed (easement, encroachment permit, etc.), prepare exhibits in a format acceptable to Caltrans, and submit this information with the processing fee. A minimum of 12 months should be anticipated to complete this process.

5.5 Traffic Impacts

A formal traffic study was conducted for the construction of the pipeline alignments, and is included in Appendix O1. The study assumed a trench width ranging from 10 to 12 feet and a depth ranging from 10 to 12 feet. Figure 2 in the Traffic Control Study shows minimum work zone requirements to construct the pipelines. The City of San Diego Public Works Department requires “D” Sheet Traffic Control Plans for streets averaging over 10,000 average daily trips (ADTs); all streets discussed in this section have greater than 10,000 ADTs and will require a “D” Sheet Traffic Control Plan except for Sherman Street, Ingulf Street, and Denver Street.

The study details specific traffic control for areas along the pipeline, including:

- Sherman Street
- Morena Boulevard
- West Morena Boulevard
- Ingulf Street
- Denver Street
- Clairemont Drive
- Clairemont Mesa Boulevard
- Genesee Avenue
- La Jolla Village Drive

The preliminary traffic control detailed in the study requires coordination with UTC, local businesses, Caltrans, railroads, NCTD, and MTS. The complete traffic study is included in Appendix O1.

5.6 Potable and Non-Potable Water Demand of the MPS Facility

MPS will have small requirements for potable and non-potable water use for infrequent cleaning of the screens and wetwell. This supply can be provided by a hydrant located on site or on the sidewalk.

Because of anticipated high pressures, seal water or recirculation pumps will be required for each of the five two-stage pumps. Three possible seal water sources include sanitary sewage from the wetwell, non-potable water, or potable water. Sanitary sewage will create potential odor issues in the pump room and may have clogging issues; these issues can be addressed with screens and proper odor control. Potable or non-potable water will require a day tank for recirculation water and a piped connection from the requisite pipeline.

Sanitary sewage is recommended for use as seal water, as used at other City facilities. Seal water pumps are expected to be 2 hp, 480 V, 3-phase power.

Map ID	Description	APN	Public/ Private	Owner	Total Parcel Area (ac)	Size Req'd (WxL)	Type
ACQUISITIONS							
A1	Morena PS site	4364510600	Private	San Diego Humane Society & SPCA	1.00	1 acre	Land Acquisition
EASEMENTS							
E1	Brine Overflow - Railroad crossing	4364511000	Public	San Diego Metropolitan Transit Development Board	N/A	84" x 50' tunnel	Right-of-Entry Permit
E2	Genesee - 52 crossing	--	Public	Caltrans	N/A	120" x 1,100' + 120" x 600' tunnels	Encroachment Permit
E3	Genesee - Railroad crossing	3480106100	Public	San Diego Metropolitan Transit Development Board	N/A	120" x 200' tunnel	Right-of-Entry Permit
E4	Miramar Rd - 805 crossing	--	Public	Caltrans	N/A	120" x 1,200' tunnel	Encroachment Permit

This map has been designed to print size 11" by 17".

Figure 5-2: Overall Land Acquisition Map

6 Project Permitting and Agency Coordination Requirements

A preliminary assessment of permit requirements and key considerations for the Project was conducted; the complete assessment is included in Appendix P. Three major agency types were analyzed: transportation, resource, and miscellaneous (agencies outside of transportation and resource). Each permit requirement and key consideration was given an impact score based on importance and schedule impact. Impact scores range from 0 to 5 and are summarized below.

- 5: presents a fatal flaw to the Project or requires an alternative alignment
- 4: presents a permit that may cause significant Project delays
- 3: presents a key consideration that may cause significant Project delays
- 2: presents a permit that may cause minor Project delays
- 1: presents a key consideration that may cause minor Project delays
- 0: presents a permit of key consideration that will not cause Project delays

A detailed assessment of each permit and its key considerations is provided in the permitting report included in Appendix P. Table 6-1 summarizes the permits and key considerations required as the design progresses. Figure 6-1 presents permits and key considerations on a map.

Table 6-1: Summary of Permits and Key Considerations

Reviewing Agency	Permit/Consideration ID	Description	Impact Score
Caltrans (District 11)	Permit: P01	SR 52 encroachment permit	4
	Permit: P02	I-805 encroachment permit	4
San Diego MTS	Permit: P03	Mid-Coast right-of-entry permit	4
	Permit: P04	MTS NTCD dual right-of-entry permit	4
	Permit: P05	MPS right-of-entry permit	4
	Permit: P06	No longer needed	4
	Permit: P07	Custer St. right-of-entry permit	4
	Consideration: C01	Temporary bus service interruptions	1
North County Transit District (NCTD)	Consideration: C02	Temporary bus service interruptions	1
City of San Diego Transportation and Storm Water Department	Consideration: C03	Street resurfacing	1
	Consideration: C04	ADA compliance	1
	Permit: P08 Consideration: C05	Traffic control permit	2

Table 6-1: Summary of Permits and Key Considerations

USACE	Permit: P09	404 Clean Water Act	4
U.S. Fish and Wildlife Service	Permit: P10	Endangered Species Act: take permit	4
Regional Water Quality Control Board	Permit: P11	401 Clean Water Act	4
Regional Water Quality Control Board	Permit: P12	Construction general permit	2
California Coastal Commission	Permit: P13	California coastal permit	4
City of San Diego PUD	Permit: P14	Groundwater discharge permit	4
Naval Supply System Command	Consideration: C06	Jet fuel line	3
Other utilities	Consideration: C07	Miscellaneous utilities	3

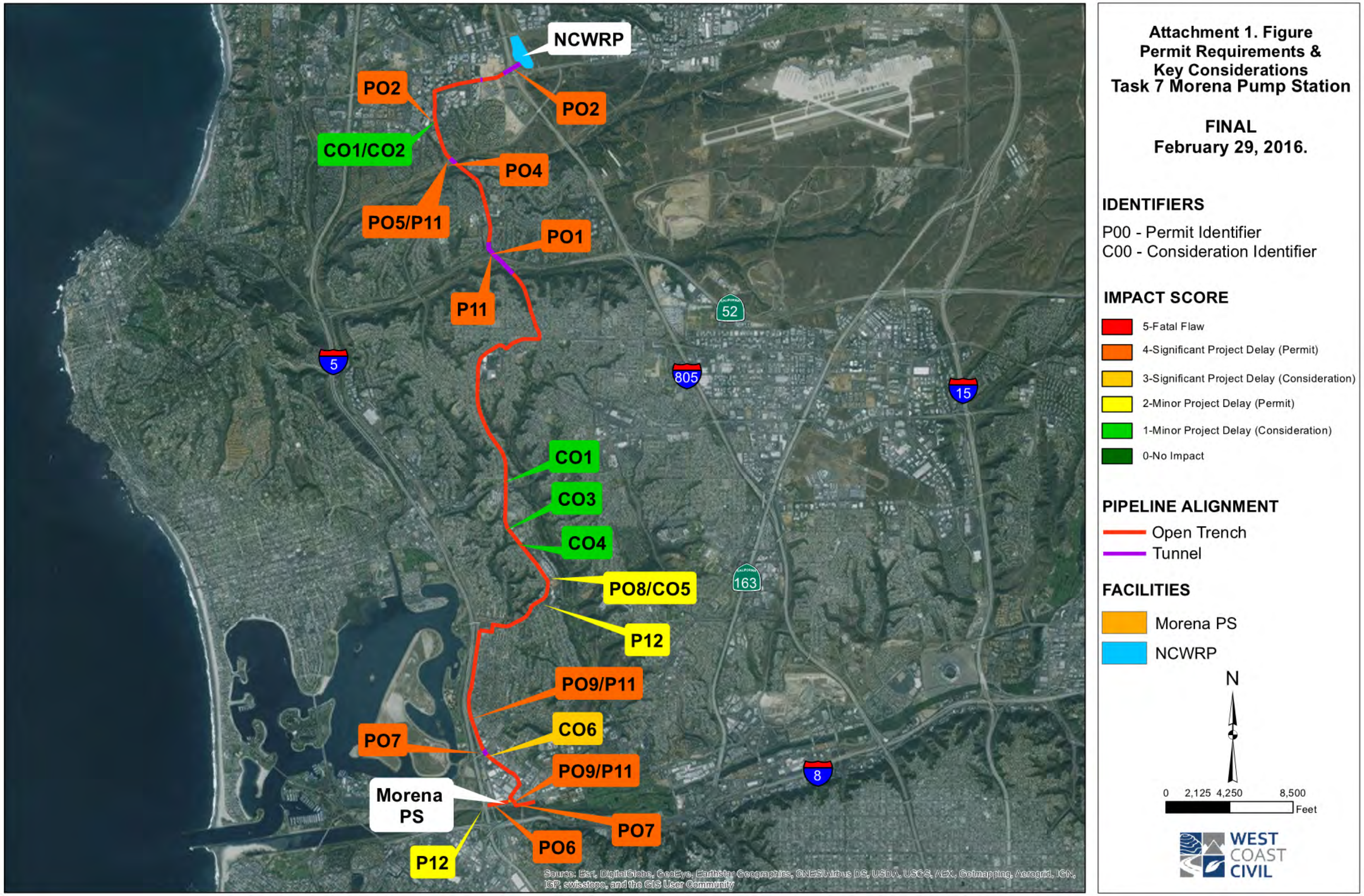


Figure 6-1: Summary Permitting Map

7 Construction Methods/Sequencing/Commissioning/ Schedule

The Project requires coordination with City, County, and State agencies to receive input on design requirements and approval of construction locations and methods. This section identifies stakeholders, lists anticipated construction methods, provides a Project schedule, and explains work-element sequencing.

7.1 Stakeholders

Stakeholders that must be consulted during the design and construction of this Project are listed in the following sections.

7.1.1 Municipal Stakeholders

Involved City governmental bodies and agencies are anticipated to be as follows:

- Council District 2
- Council District 3
- Council District 6
- Council District 7
- City Police Department
- City Fire-Rescue Department
- San Diego Unified School District
- Clairemont Community Planning Group
- City of San Diego

7.1.2 County Stakeholders

Involved County governmental agencies are anticipated to be as follows:

- San Diego Association of Governments

7.1.3 State Stakeholders

Involved State of California agencies are anticipated to be as follows:

- California Coastal Commission
- California Division of Drinking Water
- California Department of Fish and Wildlife

7.1.4 Non-Governmental Stakeholders

Involved local non-governmental stakeholders are anticipated to be as follows:

- Clairemont Chamber of Commerce
- Clairemont Town Council
- Linda Vista Community Development Corporation
- Linda Vista Town Council
- University City Community Association
- University City Planning Group
- Westfield UTC
- Friends of Rose Canyon

7.2 Construction Methods

The MPS, pipeline, and associated facilities can be constructed by standard methods. The following sections describe the Project's anticipated construction methods.

7.2.1 Pipeline Construction Methods

Most of the 48-inch-diameter force main (approximately 50,935 feet) and 24-inch-diameter brine pipeline is anticipated to be constructed by open-trench methods. The remaining length of pipe (approximately 4,105 feet) will be constructed by tunneling. These methods are described in greater detail below.

7.2.1.1 Open-Trench Construction

The first step of open-trench construction will identify the location within the street where pipelines will be installed. The selected contractor will use survey information provided in the drawings to place stakes along the length of the pipeline alignment. Stakes will identify stationing at important intervals and locations, and offsets from the stakes for important locations. Important locations are anticipated to consist of points of horizontal inflection, points of vertical inflection, locations of special fittings, locations of valves, locations of BOVs, and locations of AV/AR assemblies.

After the pipeline location is determined, the contractor will conduct supplemental utility potholing. This process will identify locations where existing utilities may interfere with new pipelines or where insufficient information exists to determine the location of existing utilities. The contractor will excavate at these locations, compare findings with the contract drawings, and supply the results to the City and final designer. Some revisions to pipeline depths may be required after completion of supplemental utility potholing; these potential revisions must be coordinated among the contractor, City, and final designer.

The contractor will prepare a shoring plan to be signed and stamped by a California-licensed structural engineer. The shoring plan will be based on the geotechnical report prepared during the design phase by the final designer. Because of the proximity of nearby homes, businesses, environmental resources, and necessary transit corridors, it is anticipated that laying back the trench at a stable slope will not be permissible. Instead, the contractor must use sheeting and shoring to stabilize the trench at a 90-degree angle from vertical. Figure 7-1 depicts the anticipated trench section.

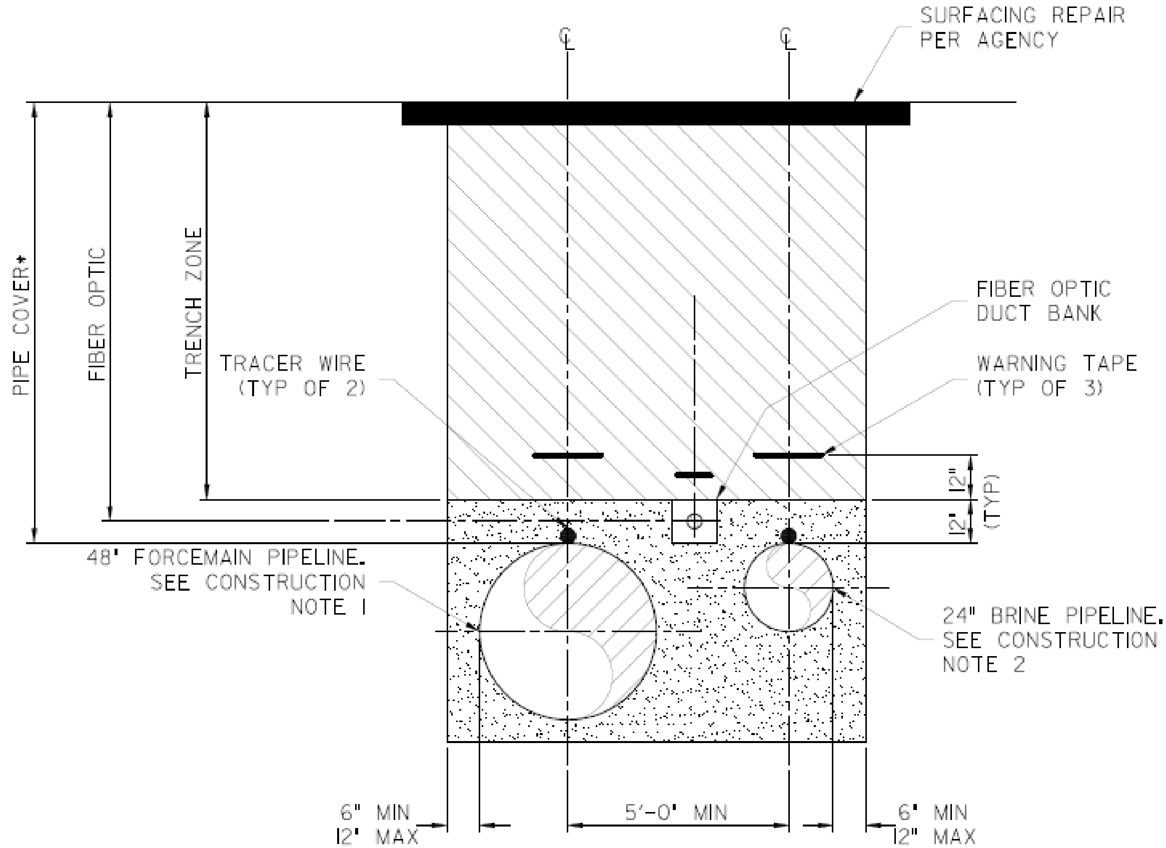


Figure 7-1: Anticipated Trench Cross-Section for Open-Trench Construction

In parallel to preparing the shoring plan, the contractor will prepare traffic-control drawings complying with the traffic-control drawings, technical requirements, general conditions, and supplemental general conditions of the contract documents. The traffic-control drawings will be prepared based on the requirements of the Work Area Traffic Control Handbook (WATCH). The contractor must maintain access to businesses, cross streets, bus stops, rail stations, and schools during the Project. The contractor may be given permission to restrict access to homes (for 1 to 2 days) provided that the contractor coordinates with homeowners and makes provisions for parking, home access, and mail delivery.

The contractor will begin laying out pipeline along the Project route after supplemental utility potholing and development of shoring and traffic control plans. Because of the busy and congested nature of the Project area, it is anticipated that approximately 1,000 feet of pipe can be laid out in preparation for upcoming construction at any one time. The contractor will saw-cut the edges of the trench's width along the length expected to be constructed over the following 2 days.

The contractor will remove 100 to 500 feet of pavement between saw-cuts; the length removed will depend on area congestion and anticipated amount of work to be conducted over the following 2 days. The pavement will be transported to an aggregate processing facility for reprocessing into aggregate for asphalt or crushed miscellaneous base.

Next, the contractor will excavate a trench to the bottom of pipe for that location, plus 6 inches to accommodate crushed rock bedding. As the trench is excavated to the desired depth, shoring will be installed to protect the excavation. The shoring will be affixed in place to protect workers entering the trench when the desired depth is reached.

The contractor will mechanically compact native soils in the trench at the optimum water content. Six inches of crushed rock will be placed at the bottom of the trench to provide stable bedding for the pipe. There are two potential means by which the HDPE pipe can be fused and installed.

1. Sections of pipe will be lowered into the trench and HDPE pipe fused in place by butt-fusion welding. The trench will be backfilled (in 6-inch lifts) with suitable pipe zone backfill material (sand or crushed rock) to a depth of 12 inches over the top of the pipes.

2. Section of HDPE pipe will be fused on the surface by butt-fusion welding. The pipe will then be placed into the trench in sections as the pipe fusion is completed. The trench will be backfilled (in 6-inch lifts) with suitable pipe zone backfill material (sand or crushed rock) to a depth of 12 inches over the top of the pipes.

After the pipe zone backfill is placed, trench zone material will be placed; native soil, screened to remove rocks greater than 2 inches in diameter, is anticipated to be suitable material for this use. Temporary pavement (consisting of a base asphalt course to the pavement elevation plus 1/2 inch) will be installed over the length of the trench width plus 6 inches, allowing asphalt to settle in preparation for permanent pavement. Near the conclusion of construction, the temporary pavement's surface will be ground off and removed. A permanent cap of surface course asphalt (approximately 1 inch thick) will be placed along the pipeline trench's length.

Green-colored, magnetically detectable warning tape will be located 2 feet above the top of each pipe. The tape will be labeled "Sanitary Sewer" to warn people working in the area in the future of nearby pipelines.

Some groundwater may be encountered (as described in Appendix L), impacting the Project's design and construction in several ways. First, migration of groundwater or stormwater to unanticipated areas can have a deleterious effect on the bedding by washing fines downstream. The final designer may need to specify trench plugs to prevent groundwater or stormwater from migrating along the length of the trench in areas with a steep gradient. Typically, trench plug spacing is determined by dividing soil overburden height by surface gradient, providing a safety factor of approximately 2.0; however, this spacing should be specified by a geotechnical engineer. Additionally, it may be necessary for the pipelines to be periodically weighted down with externally applied slurry or concrete weights to prevent flotation. Finally, groundwater will need to be periodically removed from the Project area, treated, and discharged into local sewers, and the contractor will need to make appropriate allowances for dewatering.

7.2.1.2 Tunneling

The Project will create six major trenchless crossings with a combined length of approximately 4,105 feet. Two trenchless construction methods may be used: jack-and-bore and directional drilling. The method selected depends upon pipe material, crossing location, and utility or feature to be crossed.

Jack-and-bore is suitable for HDPE or steel pipe installation and is typically installed in locations where additional structural stability is required. Jack-and-bore tunneling involves excavation of a boring pit and receiving pit on opposite sides of the feature or utility to be crossed; the pits will be excavated to a depth below the invert of the pipeline to be installed. A boring head is installed on the boring driver, used to progressively push segments of steel casing pipe through a tunnel prepared by the boring head. The tunnel will be bored from the boring pit to the receiving pit. The casing pipe will be of a sufficient diameter to install the 48-inch-diameter force main and 24-inch-diameter brine pipeline. Figure 7-2 shows a standard jack-and-bore tunneling pit and casing pipe installation equipment.

Figure 7-2: Jack-and-Bore Tunneling Operation

The 48-inch-diameter force main and 24-inch-diameter brine pipeline will be pulled through the casing pipe after casing pipe installation. Casing spacers will be periodically installed on the pipelines to place the pipes off the bottom of the casing. An end plate with openings for the pipes will be welded on one side of the casing to prevent leakage of annular space filler. The annular space of the casing will be filled with sand or grout, depending upon the requirements of the utility to be crossed. Railroads and roads typically require sand to allow pipeline removal; environmental resources typically require grout filling. A second end plate will be welded on the other end of the casing and pits will be backfilled in accordance with requirements previously described.

The directional drilling method of tunneling can also be used, but only for HDPE pipe installation; it is not a suitable method for steel pipe because of steel's inflexibility. Directional drilling is typically used in locations where additional structural support is not necessary. Similar to jack-and-boring, a drilling pit and a receiving pit will be excavated. A drilling rig will be positioned at the drilling pit and used to push a cutting head on the end of a drilling rod to the receiving pit; location and progress of the cutting head will be tracked by personnel with a locator, and pressure exerted on the cutting head will be carefully monitored at the drilling rig. A quick increase in pressure typically indicates presence of a utility or rock and in these cases, pressure should be decreased and drilling adjusted. The cutting head will be guided to the receiving pit by the drilling team.

Once the receiving pit is reached, the cutting head will be removed and a reamer, shroud, and HDPE pipe will be installed on the end of the drilling rod. The drilling rod, reamer, shroud, and pipe will be pulled through the tunnel and back toward the drilling rig. After the pipe has been pulled completely through the tunnel, the pipe will be joined with adjacent pipes via butt-fusion welding. Figure 7-3 depicts the typical directional drilling process.

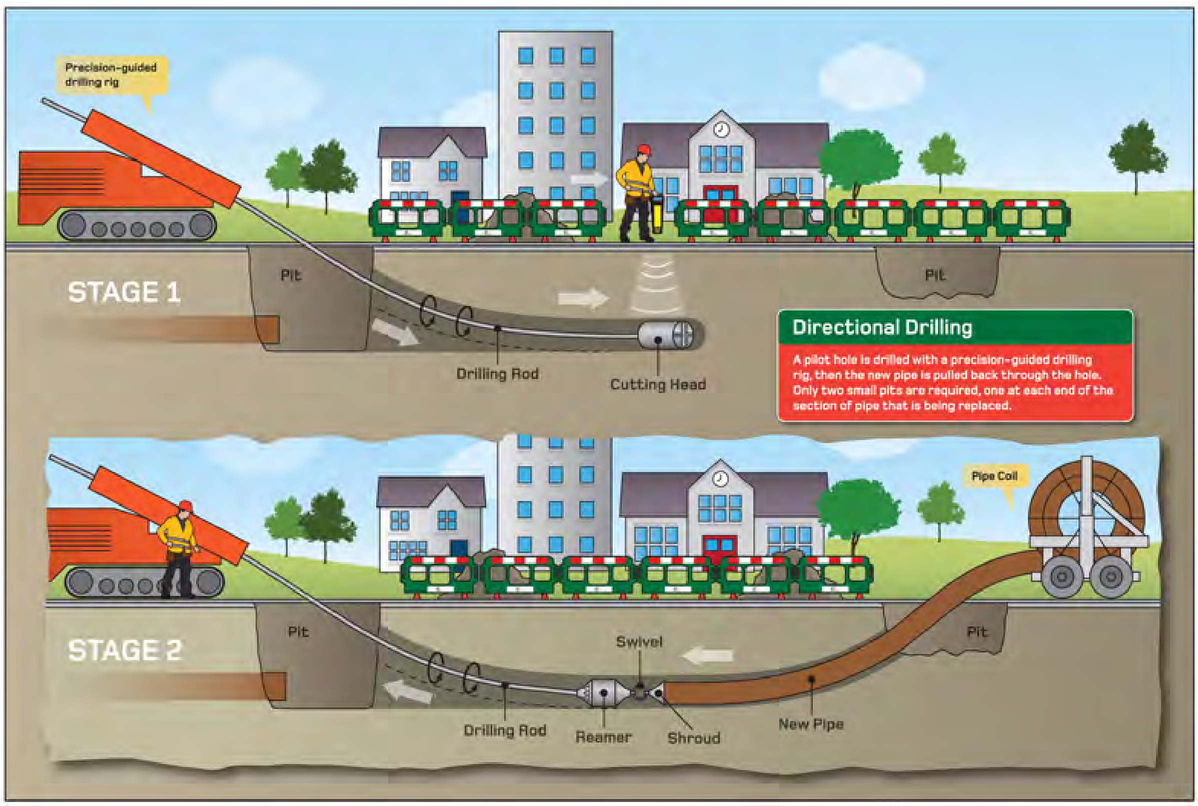


Figure 7-3: Horizontal Directional Drilling Operation Schematic

7.2.2 Pump Station Construction Methods

The lowest finished floor of the MPS is anticipated to be approximately 45 feet below grade, with total excavation of approximately 50 feet below grade; this depth is required to accommodate pumping requirements and the elevation of pipelines bringing flow to the MPS.. Ground surface at MPS is approximately 16 feet above mean sea level. The contractor will prepare a site-specific shoring plan based on the results of the geotechnical investigation, which may include sheet piles or steel plating. Because of the size and depth of MPS, supporting the walls of the excavation with beams braced against the sheet piles or steel plating will be necessary.

The excavation will reach a depth of approximately 34 feet below mean sea level. This additional over-excavation depth is required to place a stable and solid soil base per the geotechnical engineer's recommendations. After locating the soil base, the contractor will place rebar for the building footings and slab. The slab's anticipated thickness (approximately 3 feet 6 inches thick) is based on desktop geotechnical analysis conducted during the 10% design phase; it is recommended that the final designer conduct a geotechnical investigation, including soil borings, to determine final design requirements.

A dewatering system will likely be necessary because of MPS's depth and location. Groundwater will be collected in the excavation area and pumped to a treatment system to remove excess silts and solids. Treatment systems of this type are typically portable tanks and a sump. Staff periodically tests the water prior to discharge into a local sanitary sewer to determine if it meets discharge requirements. Upon Project completion, there will likely be additional sediment for disposal; because of the ocean's proximity, this sediment may be high in TDS and could require disposal in a Resource Conservation and Recovery Act (RCRA) landfill.

Crushed aggregate base will be placed in 6-inch lifts at the bottom of the excavation to provide a firm and unyielding base, hydrated to achieve optimum moisture content, and compacted to at least 95% compaction.

The contractor will begin laying out rebar for the foundation and footings after the excavation, shoring, and dewatering system is in place. The rebar will be welded together to meet the spacing and layout required by the final designer shown in the structural drawings. Rebar will likely be placed on dobies or concrete blocks to meet separation requirements from the bottom of the excavation. Wooden forms, corresponding to the size of designed footings and foundations, will be installed. Concrete will be poured into the forms to create footings and foundations; a 4,000 psi concrete mix with admixtures suitable for water-bearing structures is expected to be used. The footings and foundations are anticipated to be too large to pour monolithically; at least one and possibly two construction joints will be required to prevent cracking.

Rebar for interior and exterior walls will be installed after pouring footings and foundations. Similar to the previously installed rebar, it will be welded together before placement of wooden forms. The walls will also require construction joints to prevent cracking. Opposite walls can be poured simultaneously with vertical construction joints placed at the boundaries or using an alternate method proposed by the selected contractor and approved by the final designer. After the walls are poured, the roof forms will be set up and constructed similarly to the other MPS elements, plus the forms necessary to contain the concrete underneath the roof. Connections to the sanitary sewer and discharge headers will be stubbed out beyond the radius at which later excavations would impact the building structure.

After the pump station is poured and concrete has properly set, the area surrounding MPS will be backfilled in 6-inch lifts. Each lift will be watered to achieve optimum moisture content and compacted to at least 95% compaction.

Ingress and egress elements consisting of doors, stairs, and hatches will be installed after completion of the MPS structure. These elements will facilitate movement of personnel, tools, materials, and equipment into and out of the facility. Equipment mounting locations will be finished internally and set up for eventual equipment mounting. Cast-in-place anchor bolts previously installed with the rebar or adhesive anchor bolts will be installed based on the requirements of the final designer. Equipment will be moved into MPS and attached; it is anticipated that equipment will include piping, pumps, HVAC ductwork, control panels, instrumentation, and other items incorporated into the final design. Equipment will be connected to the anchor bolts and mountings and checked for compliance with the manufacturer's requirements for mounting and vibration.

Installation of pumps, motors, and piping inside MPS is the most important element of equipment installation. Each pump will be factory-tested for compliance with the design requirements developed by the final designer during final design prior to delivery to MPS. Testing will be conducted to establish pump curves for each pump, confirm that the pump and motor combination work properly together, and confirm that temperature monitoring instrumentation is functioning properly. After the pump testing is completed and approved by the final designer, the equipment will be shipped to the MPS site for installation, commissioning, and testing.

7.2.3 Other Elements of Construction

Several facilities will be constructed as part of the Project in addition to the pipelines and pump station. An electrical building will be required, anticipated to be a CMU block structure with a light metal-framed roof. It will be excavated as described previously in Section 7.2.2, but with shallower footings and foundations. After the electrical building footings and foundation are placed, rebar will be welded to stub-ups placed in the foundation. CMU blocks installed in a running bond pattern will provide walls for the new structure, with horizontal rebar placed at spacing identified by the final designer. Mortar will be placed between layers of CMU blocks; after the wall has been installed to the height determined by the final designer, the annular space of each block will be filled with grout. After the grout has been allowed to set, the light metal-frame roof will be installed, doors hung, and louvers placed in the walls. Adhesive anchor bolts will be installed into the foundation and electrical equipment pads will be installed in the buildings. MCC sections, VFDs, switchgear, lighting panels, and other equipment will be moved into the building and installed on proper equipment pads. Each piece of electrical equipment will be tested and verified prior to connection to the electrical grid.

A screening building may be needed; during final design it will be determined, in coordination with the City, whether it will be required. If installed, the screening building's footings and foundation will be constructed similarly to those of MPS. It is anticipated to be a CMU block building with a light metal-framed roof, installed with the same methods as the electrical building. The screening building's only major equipment is anticipated to be traveling bar screens; the design is currently based on AquaGuard traveling bar screens, a model similar to other equipment of this type, and the design criteria should not be significantly different if another model of equipment is the basis of the final design or provided during construction. Each traveling screen must have a roof hatch/skylight located to allow the screens to be removed for maintenance and repair.

The Project also requires several below-grade structures, such as diversion structures and vaults for the pipelines. These structures are anticipated to be cast-in-place concrete structures (which should be designed in the same manner as the MPS footings, foundations, and walls) or pre-cast structures (placed on top of cast-in-place footings and foundations). This design element will be determined by the final designer.

7.3 Schedule

The Project involves work over many years to reach completion and/or approval by many governmental agencies, consultants, contractors, and non-governmental organizations. The City anticipates the following important milestones:

- **Advertise for consultants to bid:** February 5, 2016
- **Design notice to proceed:** November 7, 2016
- **City approval of and completion of final design:** August 29, 2018
- **Completion of permitting:** May 21, 2021
- **Advertise for contractors to bid:** August 29, 2018
- **Construction notice to proceed:** June 6, 2019
- **Completion of construction:** June 7, 2021
- **Project completion:** October 7, 2021

Figure 7-4 on the following page depicts the overall program schedule with the MPS Project highlighted. As is demonstrated in this figure, many concurrent projects will be ongoing with the MPS Project. Figure 7-5 depicts a summary of the MPS schedule. Major schedule elements and milestones are indicated on this schedule. Appendix Q1 contains a five-page detailed schedule of the MPS schedule. Specific work items, milestones, and schedule details are depicted in this figure.

7.4 Sequencing

The Project has many separate construction elements, each requiring multiple construction trades. Most work can be conducted concurrently, and it may be advisable for the contractor to use two to four different crews: one crew constructing MPS, one crew conducting tunneling work, and two crews installing the pipelines. The construction contractor will determine the appropriate number of construction crews.

We recommend that constructing the diversion pipeline (depicted on plan sheet C-102) be the first work element. This gravity pipeline will supply a significant amount of source water to MPS, and its slope and elevation will impact the depth of MPS and associated facilities. Constructing this pipeline first will determine if unknown utilities require this pipeline, and consequently MPS, to be constructed at a lower elevation.

We also recommend that MPS construction be started prior to construction of the overflow pipeline (depicted on plan sheet C-103). Specifically the footings, foundations, walls, and roof should be formed and finished prior to starting overflow pipeline construction. The elevation of the tie-in point on Friars Road is set and cannot be adjusted; similarly, the existing railroad south of the MPS site will have minimum clearance requirements that must be met. If MPS needs to be constructed at a lower elevation, the slope and/or size of this pipeline may need to be amended.

The force main and brine pipeline will operate under pressure, allowing for field fitting of both pipelines to be conducted by the contractor if existing utilities or structures are found to interfere. We advise that pressure pipelines be constructed in a generally uphill direction, allowing for joints to settle into the adjacent pipe versus being pulled apart by gravity. The seven tunneling sections for the force main and brine pipeline are generally located at low points and provide excellent locations from which to build uphill.

Overall, the Project provides excellent opportunities for concurrent work activities, with only the items listed in the preceding paragraphs requiring sequential work activities.

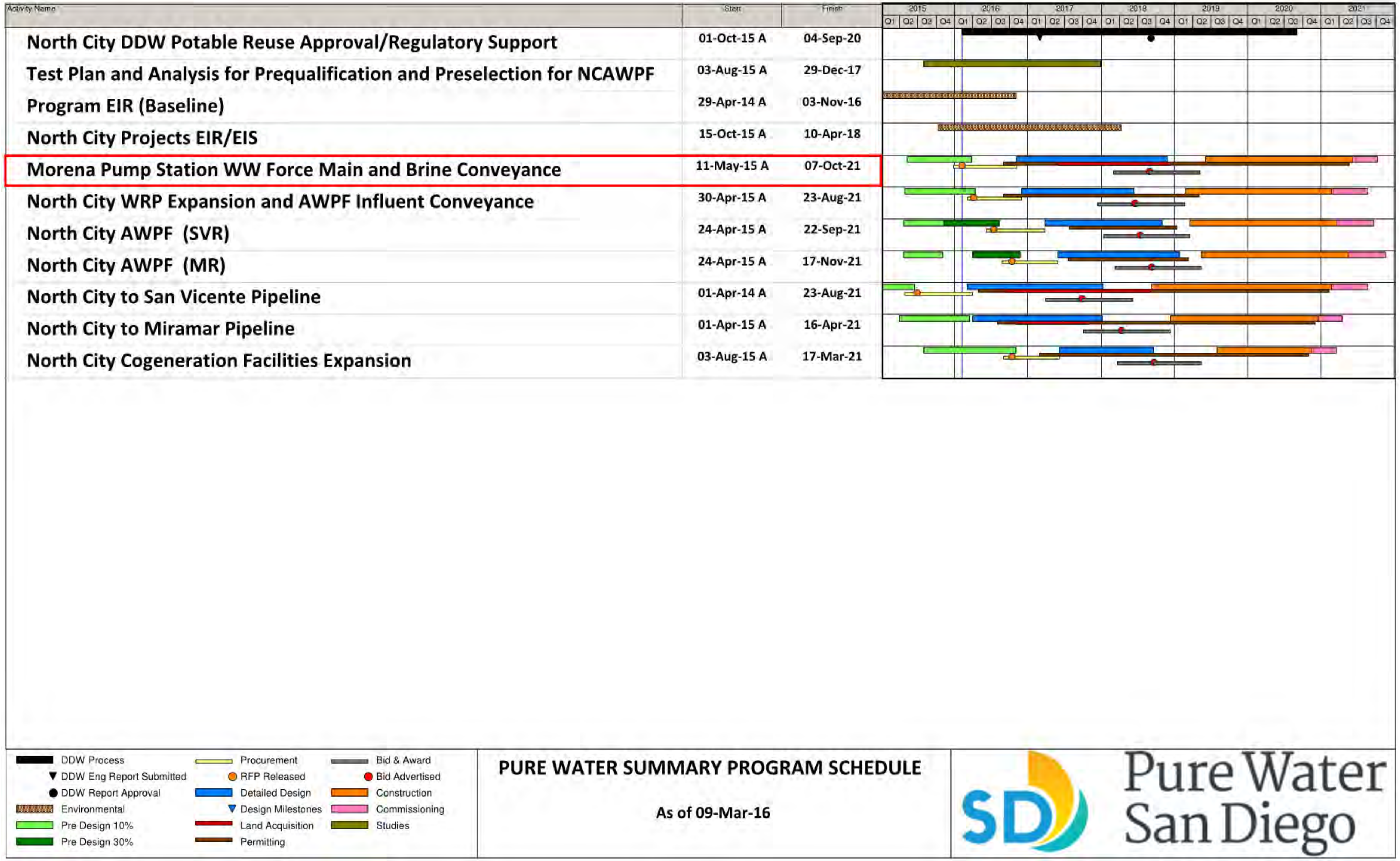
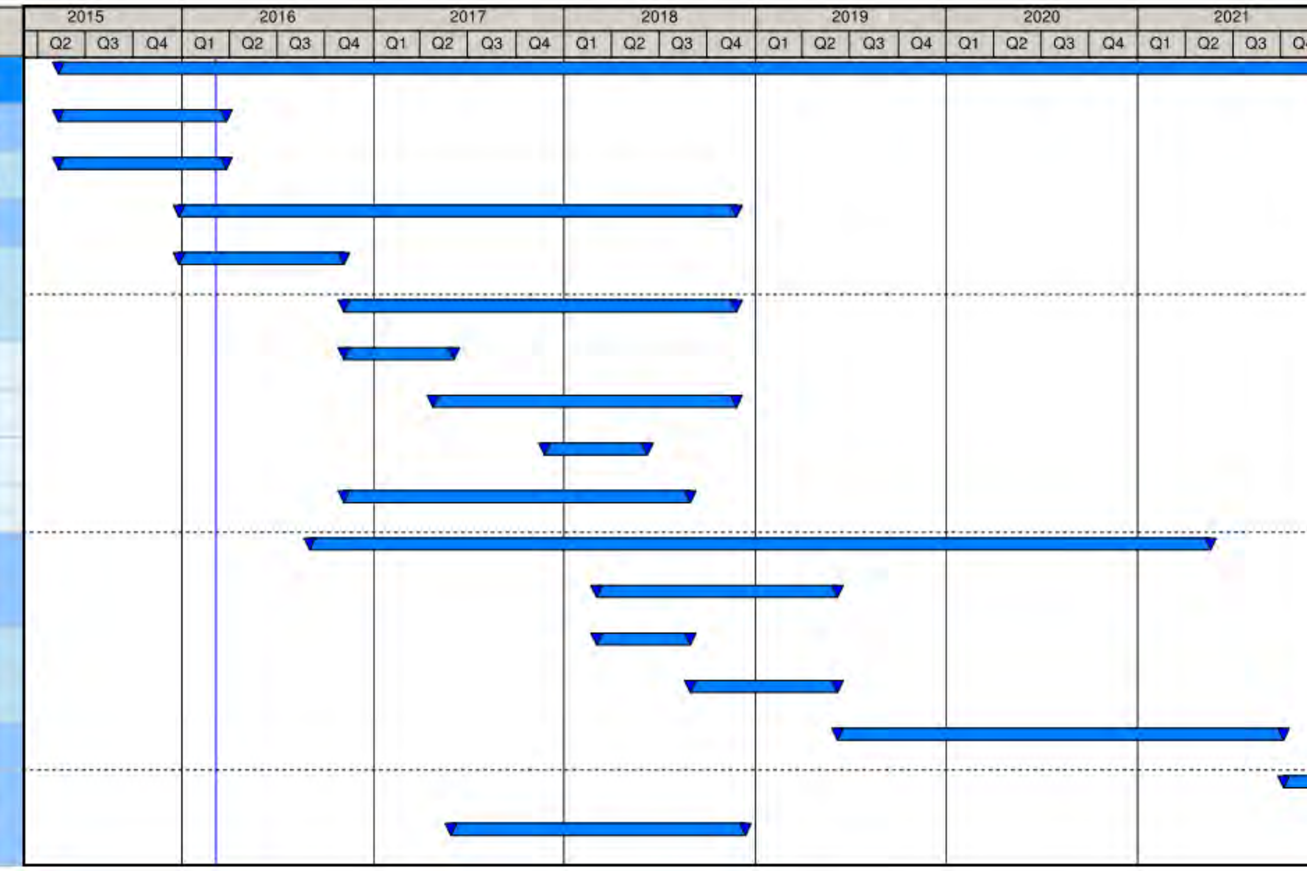


Figure 7-4: Pure Water Summary Program Schedule

Activity ID	Activity Name	Start	Finish
	Morena Pump Station WW Force Main and Brine Conveyance	11-May-15 A	07-Jan-22
	Planning	11-May-15 A	25-Mar-16
	Pre-Design	11-May-15 A	25-Mar-16
	Procurement & Design	28-Dec-15 A	26-Nov-18
	Designer Procurement	28-Dec-15 A	07-Nov-16
	Detailed Design	07-Nov-16	26-Nov-18
	30% Design	07-Nov-16	05-Jun-17
	60% Design	24-Apr-17	26-Nov-18
	90% Design	24-Nov-17	07-Jun-18
	Final Design	07-Nov-16	29-Aug-18
	Permitting	01-Sep-16	21-May-21
	Bid/Award	05-Mar-18	06-Jun-19
	Advertise/Bid	05-Mar-18	29-Aug-18
	Award	30-Aug-18	06-Jun-19
	Construction & Commissioning	06-Jun-19	07-Oct-21
	Post-Construction	07-Oct-21	07-Jan-22
	Land Acquisition	30-May-17	14-Dec-18



Summary

Morena Pump Station WW Force Main and Brine Conveyance

As Of 09-Mar-16

Figure 7-5: Summary Project Schedule

8 Cost Estimate

The following section summarizes total Project costs. Appendix A includes the Basis of Estimate and detailed cost estimate reports.

8.1 Construction Cost

Table 8-1 summarizes the Project cost estimate.

Table 8-1: Project Cost Summary	
Construction Cost Breakdown	
Mobilization and demobilization	$2,315,826
Demolition at Pump Station	$1,066,624
Site works at Pump Station	$1,125,753
Energy Dissipation Structure	$1,236,463
Electrical Building	$847,499
Morena Blvd. Pump Station	$20,553,792
48” Force Main and 24” Brine Line	$66,936,363
East Diversion Pipeline	$5,453,416
Main Diversion Pipeline	$791,008
West Diversion Pipeline	$2,417,877
Overflow Pipeline	$4,829,643
Pressure Reducing Stations	$582,576
Fiber Optic Line	$1,313,119
Subtotal construction cost	**$109,469,958**
Contingency (30%)	$32,840,987
Total construction cost	**$142,310,945**
Delivery costs [a]	
Predesign [b]	$2,510,000
Detailed design (7.1%)	$10,104,077
ESDC (1.4%)	$1,992,353
Construction management: bid phase (0.4%)	$569,244
Construction management: construction phase (6.8%)	$9,677,144
Environmental: review and permitting (1.4%)	$1,992,353
Environmental: construction compliance (2.1%)	$2,988,530
Project management: City Project management (3.6%)	$5,123,194

Table 8-1: Project Cost Summary	
Project management: other City departments (1.4%)	$1,992,353
Subtotal delivery costs	**$36,949,249**
Other costs [a]	
Land acquisition	$3,200,000
Environmental mitigation (2.1%)	$2,988,530
Subtotal other costs	**$6,188,530**
Total Project cost	**185,448,724**

a. *Delivery and other costs based on total construction cost.*

b. *Fixed costs are per baseline budget or current Pure Water Program directive.*

8.1.1 Estimate Class

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, this is a Class 4 estimate, which is defined as a planning-level or design technical feasibility estimate. Typically, engineering is from 1% to 15% complete. Class 4 estimates are used to prepare planning-level cost scopes or to evaluate alternatives in design conditions and form the base work for the Class 3 Project budget or funding estimate.

Expected accuracy for Class 4 estimates typically ranges from -30% to +50%, depending on the technological complexity of the Project, appropriate reference information, and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

8.1.2 Construction Cost Breakdown

The construction cost breakdown represents the estimated cost of construction based on the current design documentation available for development of the cost estimate. These costs include direct costs as well as contractor overhead, insurance, bond cost, and profit markups. Further explanations of these cost components are included in the cost estimate reports in Appendix A.

8.1.3 Contingency

The AACE recommended practice 10S-90 defines contingency as: An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Contingency is typically estimated using statistical analysis or judgment based on past asset or project experience.

Contingency usually excludes (1) major scope changes such as changes in end product specification, capacities, building sizes, and location of the asset or project; (2) extraordinary events such as major strikes and natural disasters; (3) management reserves; and (4) escalation and currency effects.

Some of the items, conditions, or events for which the state, occurrence, and/or effect is uncertain include, but are not limited to, planning and estimating errors and omissions, minor price fluctuations (other than general escalation), design developments and changes within the scope, and variations in market and environmental conditions. Contingency is generally included in most estimates, and is expected to be expended.

8.1.4 Delivery and Other Costs

Delivery and other costs include estimates of costs for non-construction activities required to plan, design, and fully deliver the Project to completion. The costs are estimated as an expected percentage of the total construction cost. Where actual costs are known based on awarded service contracts, or more definitive costs are established at the time of EDR preparation, those fixed costs are included in the delivery and other cost breakdown.

The opinion of probable construction cost (OPCC) is based on documents received on November 23, 2015, and subsequent updates. These documents are described as 10% complete based on the current Project progression, additional or updated scope and/or quantities, and ongoing discussions with the Project team. Further information can be found in the detailed estimate reports included in Appendix A.

8.2 O&M Cost

This section summarizes the estimated O&M costs for this task.

8.2.1 Pump Station O&M Costs

The primary operational cost for MPS will be the electrical cost for operating the wastewater pumps. The other electrical costs for the screens (optional item), lights, chemical pumps, HVAC, and other ancillary equipment can be considered within the margin of error of the pump operations costs. Based on the operational scenario presented in Section 4 of this EDR, an anticipated operational cost on a daily basis has been developed. Table 8-2 presents this information.

Table 8-2: Estimated Pump Station O&M Costs

Time of Day	Flow to MPS (gpm)	Flow from MPS (gpm)	TDH	Pumps	Efficiency	kW	Operational Cost ($0.10/ kWh)
12 a.m.	23,194	23,194	543	3	80%	2,968	$297
1 a.m.	19,444	19,444	523	3	78%	2,454	$245
2 a.m.	15,903	15,903	506	2	80%	1,894	$189
3 a.m.	12,431	12,431	492	2	77%	1,497	$150
4 a.m.	9,861	9,861	484	1	81%	1,110	$111
5 a.m.	8,472	8,472	480	1	81%	946	$95
6 a.m.	8,681	8,681	481	1	81%	970	$97
7 a.m.	11,944	11,944	491	2	76%	1,452	$145
8 a.m.	20,972	20,972	531	3	78%	2,688	$269
9 a.m.	29,028	26,180	562	4	77%	3,602	$360
10 a.m.	29,792	26,180	562	4	77%	3,602	$360
11 a.m.	28,958	26,180	562	4	77%	3,602	$360
12 p.m.	28,403	26,180	562	4	77%	3,602	$360
1 p.m.	27,639	26,180	562	4	77%	3,602	$360

Table 8-2: Estimated Pump Station O&M Costs							
2 p.m.	26,944	26,180	562	4	77%	3,602	$360
3 p.m.	26,111	26,111	562	4	77%	3,589	$359
4 p.m.	25,625	25,625	559	4	77%	3,502	$350
5 p.m.	25,278	25,278	556	4	77%	3,441	$344
6 p.m.	25,417	25,417	557	4	77%	3,465	$347
7 p.m.	26,250	26,180	562	4	77%	3,602	$360
8 p.m.	27,917	26,180	562	4	77%	3,602	$360
9 p.m.	29,167	26,180	562	4	77%	3,602	$360
10 p.m.	28,611	26,180	562	4	77%	3,602	$360
11 p.m.	26,458	26,180	562	4	77%	3,602	$360
						TOTAL	**$6,959**

Based on the calculations above it is estimated that the power draw on an average day will cost approximately $6,960. This cost is based on an assumed power cost of $0.10/kWh. It is possible that the City can agree to a power plan with SDG&E with lower costs during portions of the day. However, this information is not currently available and it is recommended that the final designer and the City discuss a power plan during the design phase of the work. Assuming 365 days of average operations conditions, the anticipated electrical cost for operating MPS will be approximately $2,540,000 annually.

Maintenance costs for MPS are anticipated to be approximately 2% of the capital cost per year. It is anticipated that this cost will be approximately $350,000 annually. This cost will be inclusive of equipment, materials, and labor.

O&M costs are based on the assumption of continuous equipment use, and have been estimated on an annual basis. These costs may change over time, depending on equipment use and the cost of replacing and/or replenishing various components of the system. Table 8-3 and Table 8-4 present the O&M costs for brine conveyance and odor control.

8.2.2 Brine Conveyance Costs

O&M costs for brine conveyance are presented in Table 8-3 below.

Table 8-3: Brine Conveyance O&M Costs

Description	Cost	Comment
Labor costs	$34,000	0.25 FTE * $75,000 * 1.8
Power costs	$2,000	Estimate of power costs for operating valves
Total O&M costs (brine conveyance)	**$36,000**	**From above**

FTE = full-time equivalent; number is multiplied by 1.8 to account for associated benefits.

8.2.3 Odor Control O&M Costs

O&M costs for odor control are presented in Table 8-4 below.

Table 8-4: Odor Control O&M Costs

Description	Cost	Comment
Estimated chemical costs	$3,662,000	Estimated based on previous projects, and the estimated chemical requirements to achieve odor control objectives
Labor costs	$68,000	0.5 FTE * $75,000 * 1.8
Estimated electrical costs	$7,000	Assume 5 hp pump, $0.20/kWh * 365 days per year
Total O&M costs (odor control)	**$3,737,000**	**From above**

8.2.4 Pipeline O&M Costs

The force main and brine pipeline will have costs for repair and maintenance of coatings, valves, O&M costs of plunger valves, maintenance and inspection costs for pipelines, and O&M costs for AV/AR assemblies and carbon canisters. A general pipeline O&M cost is approximately 2% of capital costs per year. Based on the capital costs for the pipelines it is estimated that the O&M costs for the pipelines will be approximately $1.2 million per year. This is inclusive of equipment, materials, and labor.

8.2.5 Total O&M Costs

Table 8-5 provides the total annual O&M costs for this task.

Table 8-5: Total O&M Costs

Description	Annual Cost	Comment
Estimated MPS power cost	$2,540,000	Daily power costs * 365
Estimated MPS maintenance cost	$350,000	Assume to be 2% of capital costs
Brine conveyance cost	$36,000	See Table 8-3 for breakdown
Total odor control O&M costs	$3,737,000	See Table 8-4 for breakdown
Conveyance pipeline costs	$1,200,000	Assume to be 2% of capital costs
Total annual O&M costs	**$7,863,000**	**Total from above**

9 10% Design Drawings

This section describes the preliminary technical design drawings developed for the Project, listed in Table 9-1. Drawings are prepared at 10% level of detail design, sized at 22 inches by 34 inches, and consist of various scales depending on level of detail.

Typical civil drawings are scaled at 1 inch = 80 feet for pipeline and 1 inch = 20 feet for the MPS site plan, and use aerial photography and existing subsurface utility data from a geographical information system (GIS) for background display. Wet subsurface structure data were provided by the City; dry utility data, such as gas, were obtained through DigAlert. Civil pipeline drawings depict the Project's proposed pipeline alignment consisting of the 48-inch-diameter wastewater force main and 24-inch-diameter brine pipelines, special crossings, separation requirements, manway and valve locations, and connections with existing pipe.

Exhibit A includes the 10% design drawings.

Table 9-1: Drawing Index

Sheet	Drawing Number	Drawing Name
General		
1	G-001	TITLE SHEET
2	G-002	SHEET INDEX
3	G-003	SYMBOLS, ABBREVIATIONS AND NOTES
4	G-004	KEY MAP
5	G-005	HGL AND SYSTEM CURVES
6	G-006	SYSTEM SCHEMATIC
Civil		
7	C-101	MORENA PUMP STATION SITE PLAN
8	C-102	WEST & MAIN DIVERSION PIPELINE PLAN & PROFILE - STA 796+00 TO 813+00
9	C-103	OVERFLOW PIPELINE PLAN & PROFILE - STA 899+00 TO 919+00
10	C-104	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 9+32 TO 18+00
11	C-105	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 18+00 TO 36+00
12	C-106	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 36+00 TO 54+00
13	C-107	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 54+00 TO 72+00
14	C-108	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 72+00 TO 90+00
15	C-109	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 90+00 TO 108+00
16	C-110	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 108+00 TO 126+00

Table 9-1: Drawing Index		
17	C-111	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 126+00 TO 144+00
18	C-112	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 144+00 TO 162+00
19	C-113	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 162+00 TO 180+00
20	C-114	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 180+00 TO 198+00
21	C-115	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 198+00 TO 216+00
22	C-116	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 216+00 TO 234+00
23	C-117	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 234+00 TO 252+00
24	C-118	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 252+00 TO 270+00
25	C-119	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 270+00 TO 288+00
26	C-120	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 288+00 TO 306+00
27	C-121	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 306+00 TO 324+00
28	C-122	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 324+00 TO 342+00
29	C-123	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 342+00 TO 360+00
30	C-124	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 360+00 TO 378+00
31	C-125	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 378+00 TO 396+00
32	C-126	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 396+00 TO 414+00
33	C-127	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 414+00 TO 432+00
34	C-128	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 432+00 TO 450+00
35	C-129	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 450+00 TO 469+00
36	C-130	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 469+00 TO 486+00

Table 9-1: Drawing Index		
37	C-131	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 486+00 TO 504+00
38	C-132	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 504+00 TO 522+00
39	C-133	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 522+00 TO 540+00
40	C-134	FORCEMAIN AND BRINE PIPELINE PLAN & PROFILE - STA 540+00 TO 561+00
41	C-135	BRINE PIPELINE PLAN & PROFILE - STA 2+00 TO 12+00
42	C-136	BRINE PIPELINE PLAN & PROFILE - STA 560+00 TO 578+00
43	C-137	EAST DIVERSION PIPELINE PLAN AND PROFILE - STA 699+00 TO 719+00
44	C-138	PIPELINE CROSS SECTION - 1
45	C-139	PIPELINE CROSS SECTION - 2
46	C-140	PIPELINE CROSS SECTION - 3
47	C-141	CIVIL DETAIL - 1
48	C-142	CIVIL DETAIL - 2
49	C-201	MORENA PUMP STATION STORM WATER PLAN
Civil Alternative		
50	C-131A	ALT. ALIGNMENT FORCEMAIN AND BRINE PIPELINE - STA 486+00 TO 504+00
51	C-132A	ALT. ALIGNMENT FORCEMAIN AND BRINE PIPELINE - STA 504+00 TO 522+00
52	C-133A	ALT. ALIGNMENT FORCEMAIN AND BRINE PIPELINE - STA 522+00 TO 540+00
53	C-134A	ALT. ALIGNMENT FORCEMAIN AND BRINE PIPELINE - STA 540+00 TO 558+00
54	C-135A	ALT. ALIGNMENT FORCEMAIN AND BRINE PIPELINE - STA 558+00 TO 576+14
Structural		
55	S-101	PUMP STATION FOUNDATION PLAN
56	S-102	PUMP STATION TOP SLAB PLAN
57	S-103	PUMP STATION ACCESS STRUCTURE PLANS
58	S-104	PUMP STATION SECTION - A
59	S-105	PUMP STATION SECTION - B
60	S-106	PUMP STATION SECTION - C
61	S-201	INTAKE SCREEN STRUCTURE FOUNDATION PLAN

Table 9-1: Drawing Index		
62	S-202	INTAKE SCREEN STRUCTURE TOP SLAB PLAN
63	S-203	INTAKE SCREEN STRUCTURE ROOF FRAMING PLAN
64	S-204	INTAKE SCREEN STRUCTURE SECTIONS - A
65	S-205	INTAKE SCREEN STRUCTURE SECTION - B
66	S-301	ELECTRICAL BUILDING FOUNDATION PLAN
67	S-302	ELECTRICAL BUILDING ROOF FRAMING PLAN
68	S-303	ELECTRICAL BUILDING SECTIONS
69	S-401	ENERGY DISSIPATION STRUCTURE FOUNDATION PLAN
70	S-402	ENERGY DISSIPATION STRUCTURE TOP SLAB PLAN
71	S-403	ENERGY DISSIPATION STRUCTURE SECTION - A
Mechanical		
72	M-101	PUMP STATION PUMP ROOM AND WETWELL PLAN
73	M-102	PUMP STATION SECTION A
74	M-103	PUMP STATION SECTION B
75	M-104	PUMP STATION SECTION C
76	M-201	INTAKE SCREEN STRUCTURE PLAN & SECTION A
77	M-202	INTAKE SCREEN STRUCTURE SECTION B
78	M-401	ENERGY DISSIPATION STRUCTURE PLAN & SECTION
79	M-501	CHEMICAL STORAGE STRUCTURE PLAN & SECTION
80	M-601	ODOR CONTROL PLAN & SECTION
Mechanical Alternative		
81	M-102A	ALTERNATIVE PUMP STATION SECTION A
82	M-104A	ALTERNATIVE PUMP STATION SECTION C
Electrical		
83	E-101	SINGLE LINE DIAGRAM - 1
84	E-102	SINGLE LINE DIAGRAM - 2
85	E-103	SINGLE LINE DIAGRAM - 3
86	E-104	SINGLE LINE DIAGRAM - 4
87	E-105	EQUIPMENT ELEVATION - 1
88	E-106	EQUIPMENT ELEVATION - 2
89	E-107	ELECTRICAL ROOM PLAN
Instrumentation		

Table 9-1: Drawing Index

90	I-101	NETWORK BLOCK DIAGRAM
91	I-102	DIVERSION, JUNCTION AND INTAKE SCREENING STRUCTURES P&ID
92	I-103	TYPICAL PUMP CONFIGURATION P&ID
93	I-104	CHEMICAL FEED AND ODOR CONTROL P&ID
94	I-105	PRESSURE REDUCING STATION P&ID
Landscaping		
95	L-101	MORENA PUMP STATION LANDSCAPE PLAN

Task 7

Morena Pump Station, WW Forcemain and Brine Conveyance Pipeline

WW Pipeline Alignment Alternative Analysis

Prepared For:

City of San Diego

Public Utilities Department

San Diego, California

October 16, 2015

Table of Contents

List of Tables

List of Acronyms & Abbreviations

ACRONYM	DEFINITION
AWPF	Advanced Water Purification Facility
City	City of San Diego
CALTRANS	California Department of Transportation
IN	Inch
FWY	Freeway
MGD	million gallons per day
MPS	Morena Pump Station
MR	Miramar Reservoir
NCWRP	North City Water Reclamation Plant
O&M	Operation and Maintenance
ROW	Right-Of-Way
RS	Raw Sewage
SDG&E	San Diego Gas & Electric
SVR	San Vicente Reservoir
WW	Wastewater

A. Executive Summary

The Task 7 Morena Pump Station (MPS), WW Forcemain, and Brine Conveyance pipeline includes the construction of a 48-inch diameter forcemain and a 24-inch diameter brine pipeline constructed within the same open-cut trench or tunnel. The 48-inch forcemain pipeline will be designed to convey a peak flow of 37.3 MGD, a minimum flow of 12.2 MGD, and an average flow of 31.3 MGD. Pipeline information is listed below:

48-Inch Diameter WW Pipeline: For the first four miles of the pipeline from MPS, the pipe material will be welded steel pipe with cement mortar lining and coating. This is required due to higher internal pressure in order to achieve the desired head at NCWRP. Past the first four miles, where the internal pressure drops lower, the pipe material will change to HDPE for the ease of installation and resistance to corrosion.

24-inch Diameter Brine Pipeline: The proposed brine pipeline will be designed to convey 5 to 6 MGD of flow from the NCWRP south to an area near the MPS and discharge into one of the existing sewer interceptors. This discharge point will be located downstream from the MPS. The WW pipeline and the brine pipeline will be constructed within the same common trench. The 24-inch brine line will also include an energy dissipation system. Options for energy recovery will also be investigated.

The City provided a Pipeline Alignment No. 1 for the Task 7 Team's consideration. While conducting the preliminary design work for Task 7, two additional alternative alignments were also considered and are presented as alignments 2 and 3.

Alignments 1, 2, and 3 are presented in the **Figure 1** (Appendix A) attached to this report (Appendix A). Below is a description of each alignment alternative.

Alternative Alignment No. 1:

Alternative Alignment No. 1 (Baseline Alignment) was originally provided by the City. It is approximately 11.5 miles long. This alignment extends from Morena Pump Station to Morena Bivd., north to Balboa Blvd. and proceeds to Genesee Avenue. The alignment then follows Genesee North to Governor Drive and follows Governor Drive east towards the 805 Fwy. The pipeline crosses under the 805 freeway. From there, an approximately 7,200 feet of tunnel through the SDG&E right-of-way to the North side of Miramar Road. The pipeline will then follow the southern and western the perimeter fence and connect to the Influent Pump Station (IPS) discharge pipeline (RS pipeline). This alignment also includes other tunnels consisting of:

1. A crossing under Tecolote Rd.
2. A crossing under Clairemont Dr.
3. Two crossing under the SDG&E ROW
4. A crossing under the Caltrans ROW for State Highway 52
5. A crossing under the 805 Fwy, SDG&E to Miramar Road

This alignment has already been reviewed and approved by the city. This alignment also crosses several sensitive environmental areas. A plan and profile of this alignment is presented in **Figure 2** (Appendix A).

Alternative Alignment No. 2:

Alternative Alignment No. 2 was developed by the Task 7 Team to present an alternative that would possibly decrease the environmental and community impacts of the project. Alternative Alignment No. 2 has attractive features such as a shorter pipeline length and would eliminate construction within busy streets thus reducing traffic impacts. This alignment is approximately 9 miles long and would be located within the SDG&E owned ROW by means of tunneling. Approximately 90% of the entire length of this alignment from Linda Vista Road to NCWRP will be constructed in a 102 to 112 inch diameter tunnel and will be as deep as 80 to 100 feet. This depth is required due to low points within the alignment and deep foundations of the SDG&E transmission towers within the alignment ROW. This alignment even though shorter, would require major permitting and coordination work with SDG&E and also involves impacting sensitive environmental areas. It should also be noted that there are several risks associated with deep tunnels such as:

1. High Groundwater Levels/Shaft Construction Difficulties
2. Surface Settlement Damaging Nearby Structures (Power Transmission Towers, etc.)
3. Soils That Slow Down or Halt Tunneling Machines Can Pose Schedule Risks
4. Seismic Fault(s) Crossing the Tunnel Alignment
5. Environmental Impacts Due to Shaft Construction at Low Points
6. Permitting Process Can Cause Schedule Delays

A plan and profile of this alignment is presented in **Figure 3** (Appendix A).

Alternative Alignment No. 3:

Alternative Alignment No. 3 was developed by the Task 7 Team to present an alternative that could decrease the environmental impacts of the project and is more hydraulically favorable. Alternative Alignment No. 3 (Open Cut Alignment) has a preferential hydraulic profile because it crosses fewer canyons and thus contains fewer low points and crosses fewer environmental sensitive areas. This alignment will allow for the entire length to be accessed for cleaning and maintenance. This alignment is approximately 10.4 miles long and extends from the Morena Pump Station north along Morena Blvd. to Clairemont Drive. Then follows Clairemont drive east and north to Clairemont Mesa Boulevard and then east to Genesee Avenue. From there, the alignment follows Genesee north to La Jolla Village Drive and follows this road to the 805 Fwy. This alignment crosses under the Caltrans 805 Fwy then connects to the Influent Pump Station (IPS) discharge pipeline (RS pipeline) at NCWRP. This alignment has five tunnels consisting of:

1. A crossing under Tecolote Rd.
2. A crossing under the Caltrans ROW for State Highway 52

3. A crossing under a railroad at Genesee Avenue
4. A crossing under La Jolla Village Dr. and Judicial Dr.
5. A crossing under the Caltrans ROW for 805 Freeway

A plan and profile of this alignment is presented in **Figure 4** (Appendix A).

Description of Evaluation:

Once the alternatives were established, an evaluation matrix was developed and specifically tailored for this project. The matrix accounts for the various risks associated with constructing each alternative in relation to its anticipated cost and constructability. The objective was to quantitatively compare the alternatives side-by-side in a manner that would highlight the alternative with the best risk-to-cost balance. To achieve this objective, the evaluation matrix uses a numerical ranking system to compare the alignments across a variety of project specific criteria. These criteria assess the risks and costs relative five major categories, which include; 1) Alignment Characteristics; 2) Schedule and Coordination; 3) Operation and Maintenance; 4) Constructability; and 5) Cost. Each category produces a score, which ultimately highlights the preferred alignment via "the lowest score wins" method. Table 1 on the following pages provides a summary of the ranking results across the above five major categories, as well as the total scores for each alignment.

The results of the evaluation matrix ultimately identified **Alternative '3' – The Hybrid Alignment** as the preferred alternative with the lowest score of 22. For more detail relative to the ranking of each criterion, see the following pages for the detailed evaluation matrix and Appendix A, B, and C for supporting materials.

Following review and acceptance by the City of San Diego (City), the above mentioned alignment (Alternative 3) will be further developed to a 10-percent design level, which will then be submitted to the City in a 10-percent Engineering Design Report for distribution to the final pipeline designer.

Scoring and Evaluation of Alternatives

In order to objectively evaluate each alternative, various criteria were developed to assess the various risks to the project's constructability, schedule, O&M and costs. To best account for all associated risks and costs, the criteria were organized into five major categories, which include: 1) Alignment Characteristics; 2) Schedule and Coordination; 3) O&M; 4) Constructability; and 5) Cost. To provide more objectivity to the evaluation, the alignments were ranked 1 to 3 for each individual criterion. The logic used in assigning rankings was as follows:

1. First Choice = Alternative is more preferred with respect to criterion
2. Second Choice = Alternative is less preferred with respect to criterion
3. Third Choice = Alternative is least preferred with respect to criterion

Once a ranking was assigned for each criterion, all ranking values were tallied and a total score was assigned. The lowest score would be identified as the alignment alternative which best balanced risk and cost. A summary of the evaluation ranking results, including the preferred alignment highlighted in green, are provided below in Table 1 on the next page.

A workshop meeting with the City was held on September 9, 2015 and the three alternatives were reviewed. The City then decided that **Alternative '3' – The Hybrid Alignment was the preferred alignment.** For more details pertaining ranking of each criterion see the Alternatives Evaluation Matrix and Appendix A, B, and C for supporting materials. More details pertaining to the estimated construction costs, annual O&M, and 50-year life cycle costs are included in Appendix B.

Table 1, Alternative Evaluation

		Alternative 1	Alternative 2	Alternative 3
Criteria	Parameter/Condition	Score	Score	Score
1. ALIGNMENT SUMMARY	1a. Approximate Alignment Length (LF)	3	1	2
	1b. Static Hydraulic Profile	3	1	2
	1c. Discharge Location	2	3	1
	1d. Estimated Construction Duration	1	3	2
2. SCHEDULE& COORDINATION	2.a Coordination Requirements:	3	1	2
	2.b Real Property Acquisition for Permanent Easement/ROW	2	3	1
	2.c Local Communities/Schedule Impacts	2	1	3
	2.d Environmental Permitting	3	1	2
	2.e Risk	2	3	1
3. PIPELINE OPERATION & MAINTENANCE	3a. O&M Considerations	2	3	1
	3b. O&M Risk	2	3	1
	3c. Operating Permit Requirements	2	3	1
4. CONSTRUCTABILITY	4a. Environmental / Environmental Permitting	3	1	2
	4b. Geotechnical	2	3	1
	4c. Traffic Control	3	1	2
	4.d Construction Methods	2	3	1
	4.e Utility Coordination & Conflicts	3	1	2
5. COST	5a. Total Construction Cost (Midpoint) / Present Cost / Present Cost (w/o soft costs)	2	3	1
	5b. Total Annual O&M Cost	3	2	1
	TOTAL SCORE	**36**	**32**	**22**
	FINAL RANKING	**3**	**2**	**1**

Evaluation Matrix

The evaluation matrix is provided on the following page.

	Parameter/Condition	Criteria Definintion	Alternative 1: Baseline Alignment		Alternative 2: SDG&E Alignment		Alternative 3: Open Cut Alignment	
			Rank	Description	Rank	Description	Rank	Description
1. ALIGNMENT SUMMARY	**1a. Approximate Alignment Length (LF)** Morena Pump Station to NCWRP (miles) Length of Open-Cut Trench (FT) Length of Tunnel (FT)		3	11.48 49,900 10,700	1	8.84 8,800 37,900	2	10.72 53,200 3,400
	1b. Static Hydraulic Profile **Elevation at Morena Pump Station - Discharge** **Elevation at NCWRP (FT)** **High Point Elev (Static head); (FT)** **Total Dynamic Head (TDH)** **Pumping pressures & operating ranges** Installed motor HP		3	-10 378 384 520 Low End: 8,700 GPM @ 424 ft High End: 22,200 GPM @ 520 ft	1	-10 378 384 494 Low End: 8,700 GPM @ 420 ft High End: 22,200 GPM @ 494 ft	2	-10 378 389 518 Low End: 8,700 GPM @ 423 ft High End: 22,200 GPM @ 513 ft
	1c. Discharge Location		2	NCWRP 60" RS LINE	3	NCWRP 60" RS LINE	1	NCWRP 60" RS LINE
	1d. Estimated Construction Duration	**Assumes:** **60 LF/day per crew (open cut)** **40 LF/day per crew (tunneling)** **2 Crews per shift (open cut)** **2 Crews per shift (tunneling)** **1 Shift per day** **8 working hours per shift**	1	23 Months	3	26 Months	2	24 Months

	Parameter/Condition	Criteria Definintion	Alternative 1: Baseline Alignment		Alternative 2: SDG&E Alignment		Alternative 3: Open Cut Alignment	
			Rank	Description	Rank	Description	Rank	Description
2. SCHEDULE& COORDINATION	**2.a Coordination Requirements:**	**Rank =**	**3**		**1**		**2**	
		Total Score =	10		4		8	
	i) ROW Permitting and Temporary Construction Easements (ROW Width Range)	- Accessibility short- & long-term - Permits requirements - Permits which could impact the schedule	3	Most of the pipeline will be constructed in existing ROW. Some segments will require easement acquisition.	1	Some portions of the pipe will be constructed in the ROW. Two easements will be required. SDG&E has been very positive about the easement	2	All pipe will be constructed in existing ROW
	ii) Caltrans Crossings	- Available space for pits - Impact to ramps - Risk of tunneling operations	3	Two Caltrans crossing via shallow tunnels	1	Two Caltrans crossings via deep tunnels	3	Two Caltrans crossing via shallow tunnels
	iii) Railroad Crossings	- Existing MOU - Need to obtain new MOU.	1	One railroad crossing utilizing railroad standards	1	One railroad crossing utilizing railroad standards	1	One railroad crossing utilizing railroad standards
	iv) Existing Utilities and Access	- Easement access - Conflicting utilities	3	Access via City streets. Significant potential utility conflicts with both parallel and transverse crossings. Parallel to high pressure gas line and US Navy fuel line.	1	Access via SDG&E easements. Some cross utilities from streets and parallel gas utilities.	2	Access via City Streets. Significant potential utility conflicts with both parallel and transverse crossings.
	2.b Real Property Acquisition for Permanent Easement/ROW	- Public vs private property availability - Establish easements - Purchase Property - Legal risks that may impact schedule	2	Easement Required from Federal Government	3	Easement required from SDG&E and Federal Government.	1	No easement required.
	2.c Local Communities/Schedule Impacts	- Disruption to community - Disruption to businesses - Home owner group coordination	2	The community will be inconvenienced due to the movement of construction materials through the construction area. The community community will be impacted by the construction and traffic control requirements.	1	The community will be inconvenienced due to the movement of construction materials through the construction area.	3	The community will be inconvenienced due to the movement of construction materials through the construction area. The community community will be impacted by the construction and traffic control requirements.
	2.d Environmental Permitting	- Timeframe to obtain permit(s)	3	Total of 12 tunnel portals for 7 tunnels to cross: ~Under Tecolote Road ~Under Clariremont Drive ~Under SDG&E easement twice ~State Highway 52 ~Miramar Drive south to 805. ~Under railroad, environmentally sensitive area, and Miramar Road. Greenhouse gas emissions from construction equipment and delivery trucks. Nuisance dust from open cut pipeline installation. Environmental permitting will take approximately 9 months.	1	Total of 6 tunnel portals for 5 tunnels to cross: ~From Marian Way to Tecolote Canyon Portal 1 ~Tecolote Canyon Portal 1 to Tecolote Canyon Portal 2 ~Tecolote Canyon Portal 2 to 805 and Railroad Portal ~805 and Railroad Portal to Miramar Portal ~Miramar Portal to North City Portal Greenhouse gas emissions from tunneling equipment and delivery trucks. Environmental permitting will take approximately 6 months.	2	Total of 8 tunnel portals for 4 tunnels to cross: ~Under Tecolote Road ~State Highway 52 ~Under Railroad ~Under the 805 Greenhouse gas emissions from construction equipment and delivery trucks. Nuisance dust from open cut pipeline installation. Environmental permitting will take approximately 8 months.
	2.e Risk	-Risk to Schedule -Risk to Existing Facilities/Structures	2	There is a low schedule risk. Open cut installation is a very commoditized type of construction. Unknown geotechnical conditions may slow the tunneling portions of the work. There is a very low risk to existing facilities. The preponderance of the tunneling is under open areas or areas where settlement and vibration would have very few impacts.	3	There is a schedule risk associated with the tunneling. Unknown geotechnical conditions may slow the work. There is a risk to existing facilities due to settlement or vibration from the tunneling work.	1	There is a very low schedule risk. Open cut installation is a very commoditized type of construction. There is a very low risk to existing facilities and structures. The trench will be opened carefully subsequent to

	Parameter/Condition	Criteria Definintion	Alternative 1: Baseline Alignment		Alternative 2: SDG&E Alignment		Alternative 3: Open Cut Alignment	
			Rank	Description	Rank	Description	Rank	Description
3. PIPELINE OPERATION & MAINTENANCE	**3a. O&M Considerations**	- Access to pipeline for O&M - Emergency identification, location, and repair - Ability to drain pipeline	**2**	There will be ample access points for O&M. The pipeline locations will be easily identifiable from valve locations, access points, and identification wire. Isolation and drainage of the existing pipeline will be possible with valves and blow-offs. Tunnel locations will be more difficult to access due to the depths. Nearby sanitary sewers will allow for disposal of the wastewater.	**3**	Access will be difficult due to tunnel depths. It will be possible to isolate and drain the pipe. But the low points are in environmentally sensitive areas. The pipe will be able to be drained but a pump will be required in order to pump it to a sanitary sewer.	**1**	There will be ample access points for O&M. The pipeline locations will be easily identifiable from valve locations, access points, and identification wire. Isolation and drainage of the existing pipeline will be possible with valves and blow-offs. Nearby sanitary sewers will allow for disposal of the wastewater.
	3b. O&M Risk	- Limited access - Difficult to repair	2	There is a low O&M risk associated with access to the pipe. The pipe will be easily accessible in the open cut sections	3	There is an O&M risk associated with lesser access to the pipe. Due to the depth of the pipeline access repairs will be difficult.	1	There is a very low O&M risk associated with access to the pipe. The pipe will be easily accessible.
	3c. Operating Permit Requirements	- Identify permits required - Flag long lead permit items	2	~City of San Diego Encroachment Permit ~City of San Diego Traffic Control Permit	3	~City of San Diego Encroachment Permit ~City of San Diego Traffic Control Permit ~Operating and Access Agreement with SDG&E	1	~City of San Diego Encroachment Permit ~City of San Diego Traffic Control Permit

	Parameter/Condition	Criteria Definintion	Alternative 1: Baseline Alignment		Alternative 2: SDG&E Alignment		Alternative 3: Open Cut Alignment	
			Rank	Description	Rank	Description	Rank	Description
4. CONSTRUCTABILITY	**4a. Environmental / Environmental Permitting**	- ESLs - Archeological - Paleontological - Known HAZMAT - Known areas of potential contamination	3	EIR based on MND ~Low probability of archaelogical resources. ~Low probability of palentological resources ~Very low probably of hazardous materials ~No known areas of contamination	1	EIR based on MND ~Very low probability of archaelogical resources. ~Very low probability of palentological resources ~Very low probably of hazardous materials ~No known areas of contamination	2	EIR based on MND ~Low probability of archaelogical resources. ~Low probability of palentological resources ~Very low probably of hazardous materials ~No known areas of contamination
	4b. Geotechnical	- Poor and loose materials - Suitable for backfill material - Corrosive soils - Seismic activity - Cobbles and boulders	2	Suitable geotechnical conditions for pipeline installation. The soil should be either screened native soils or fill. Some tunnels may encounter cobbles or rocks especially the deeper tunnels.	3	Cobbles, rocks, and boulders will be encountered. The tunnel would need to be	1	Suitable geotechnical conditions for pipeline installation. The soil should be either screened native soils or fill. Some tunnels may encounter cobbles or rocks.
	4c. Traffic Control	- Impacts to community - Traffic control difficulty	3	Considerable impacts to the community from open cut segments. The design will need to accommodate a progressive traffic control plan that moves forward with the installation of the pipe.	1	Very low impacts to community Very simple traffic control required.	2	Considerable impacts to the community from open cut segments. The design will need to accommodate a progressive traffic control plan that moves forward with the installation of the pipe.
	4.d Construction Methods	- Feasibility to construct - Required relocation (long/short lead)	2	Constructability is almost assured for the open cut segments. Open cut construction has been extremely comoditized. Tunneling will require a more detailed geotechnical investigation. Some utility relocation is anticipated.	3	Tunneling will require a more detailed geotechnical investigation. But could be impacted by geotechnical conditions. Some utility relocation is anticipated.	1	Constructability is almost assured. Open cut construction has been extremely comoditized. Some utility relocation is anticipated.
	Trenchless methods are based on general knowledge of the area and a desktop geotechnical investigation (no borings or evaluations have been conducted.) Trenchless methods will be confirmed during design (not pre-design) and after borings and more detailed geotechnical information is obtained. Methods with sufficient line and grade control such as Mircotunneling assumed.							
	4.e Utility Coordination & Conflicts	- Number of conflicts - Size and severtiy of conflicts - Health and saftely risks - Deflect alignment or relocate utility	3	Significant potential utility conflicts with both parallel and transverse crossings. Parallel to high pressure gas line and US Navy fuel line.	1	Some cross utilities from streets and parallel gas utilities.	2	Significant potential utility conflicts with both parallel and transverse crossings.

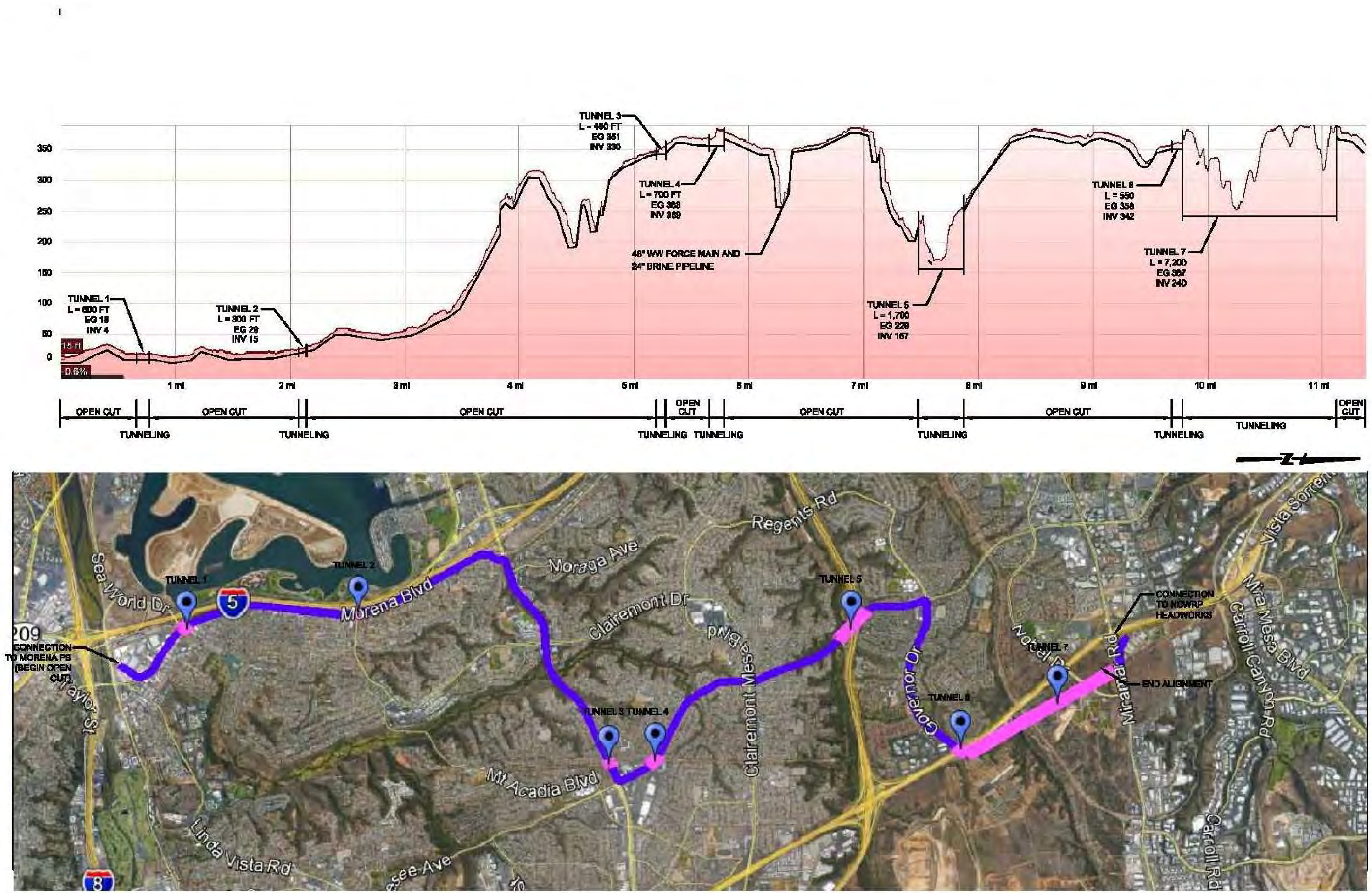
	Parameter/Condition	Criteria Definintion	Alternative 1: Baseline Alignment		Alternative 2: SDG&E Alignment		Alternative 3: Open Cut Alignment	
			Rank	Description	Rank	Description	Rank	Description
5. COST	**5a. Total Construction Cost (Midpoint) / Present Cost / Present Cost (w/o soft costs)**	**i. Construction Cost ii. Delivery Cost iii. Other Costs**		i. $82,177,063 ii. $36,979,678	3	i. $89,000,000 ii. $40,000,000	1	i. $58,898,285 ii. $26,504,229
	Construction dollars (Year 2019), escalated at 4%/yr.		2	$139,396,533	3	$150,911,754	1	$99,908,861
	5b. Total Annual O&M Cost	- Electrical Cost - Routine Maintenance - Repair and replacement	**3**	- $2,974,000 - $81,000	2	- $2,870,000 - $108,000	1	- $2,900,000 - $60,000
	These cost estimates were developed as a Class 4 Cost Estimate with a -30%/+50% accuracy according to the Association of Cost Engineering (AACE) International cost estimate classification system.							

	Alternative 1	Alternative 2	Alternative 3
TOTAL =	*36*	*32*	*22*
FINAL RANK =	**3**	**2**	**1**

Appendix A: Supporting Figures

Figure 1 Pipeline 1, 2, and 3 Alignments

Figure 2 Alternative No. 1 Alignment Plan and Profile



PIPELINE ALIGNMENT OPTION 1 - OPEN CUT

PREPARED BY	CITY OF SAN DIEGO PURE WATER TO 2, TASK 7 WW CONVEYANCE AND BRINE PIPELINE ALIGNMENT OPTION 1 - OPEN CUT
MWH.	

Figure 3 Alternative No. 2 Alignment Plan and Profile

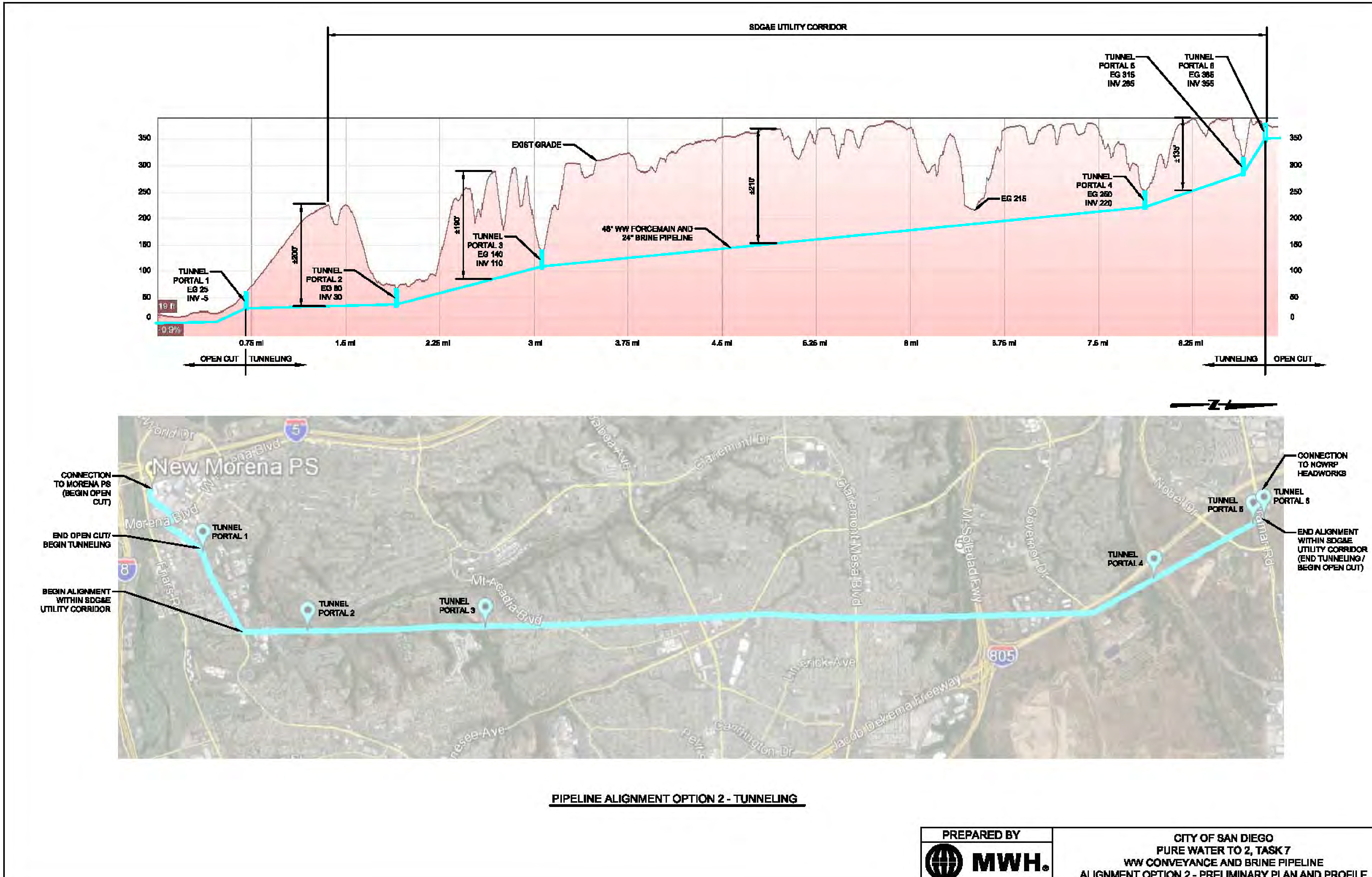
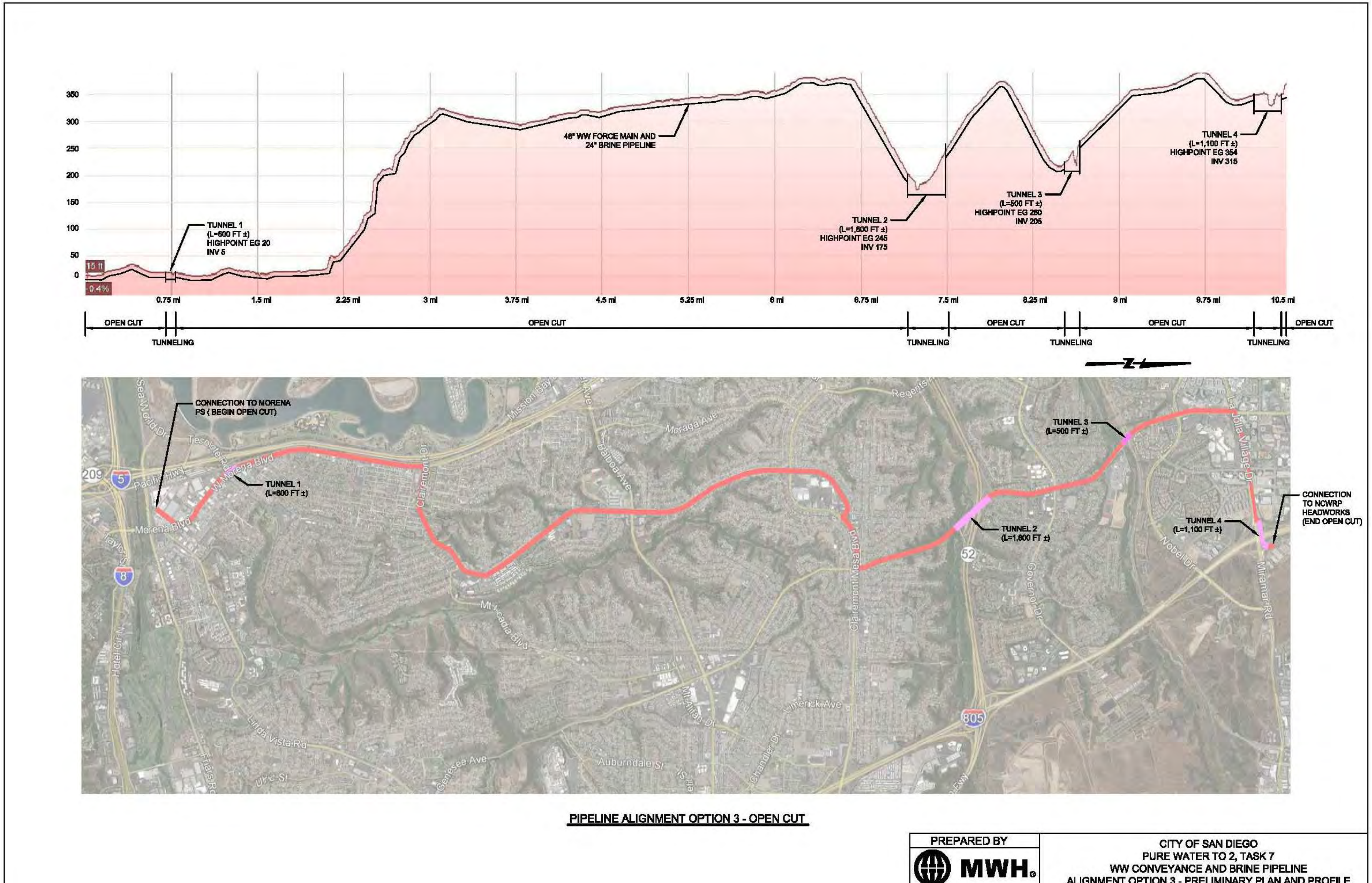


Figure 4 Alternative No. 3 Alignment Plan and Profile



Appendix B: Conceptual Cost Estimates

B1 Alternative 1: Baseline Alignment No. 1

B3 Alternative 3: Hybrid alignment No. 3

MWH

PURE WATER PROGRAM- CITY OF SAN DIEGO - CLASS 5 COST ESTIMATE (L-20 to -50% & H+30 to +100%)

CPM CONSTRUCTION INC

TASK 7 - MORENA PS, WW FORCE MAIN & BRINE LINE (Alignment 1, 59,945 incl. tunnels)

909 598-9898

Percent	Amount	Category	Hours	Job Cost Phase
14.97 %	8,645,299	Labor	200,470.4	
60.39 %	34,864,673	Material		
14.41 %	8,317,500	Subcontractor		
10.23 %	5,905,507	Equipment	73,015.3	
	57,732,980	Net Costs		
32.50 %	**2,809,722**	**Labor Burden**		
8.50 %	**2,963,497**	**Material Tax - San Diego**		
2.00 %	**166,350**	**Sub Contractor Bond**		
9.60 %	**829,949**	**San Diego - Labor Adjustment**		
0.50 %	**203,851**	**San Diego - Mat & Equip Adjustment**		
	64,706,349	Subtotal		
15.00 %	9,705,952	GENERAL CONDITIONS		
2.00 %	1,294,127	GENERAL LIABILITY		
10.00 %	6,470,635	PROFIT		
	82,177,063	Subtotal Cost		
15.00 %	12,326,559	ESTIMATE CONTINGENCY 15%		
30.00 %	24,653,119	SCOPE CONTINGENCY 30%		
		LAND ACQUISITION @ 4%		
		ENGG, PERMITTING, LEGAL & ADMIN. 25%		
		CONSTRUCTION MANAGEMENT 10%		
		PROJECT MANAGEMENT 5%		
	119,156,741	Subtotal Grand		
		2015 COST : ENR @ 10037 - ESCALATION		
	119,156,741	Total Estimate		

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
	TASK 7 - NORTH CITY											
	TASK 7 - MORENA PUMP STATION, WW FORCE MAIN & BRINE CONVEYANCE											
	1 PIPE (48" Dia Steel CML&C)											
	1 EARTHWORKS											
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	70,400.0	B.C.Y.	2,343.84	194,304			4.01	281,984		7	476,288
	1 EARTHWORKS Total	1.0	LS	2,343.84	194,304			281,984.36	281,984		476,288	476,288
	1 PILING & SHORING / 10% Length											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	50,688.0	SF	1,191.72	283,853	5.70	288,922	6.85	347,213		18	919,987
	1 PILING & SHORING / 10% Length Total	1.0	LS	1,191.72	283,853	288,921.60	288,922	347,212.80	347,213		919,987	919,987
	2 PIPELINE											
02510760	Pipe Steel 48" dia - First four miles 5,280x4=21,120'	21,120.0	LF	7,180.80	1,544,949	375.00	7,920,000	22.10	466,752		470	9,931,701
	2 PIPELINE Total	1.0	LS	7,180.80	1,544,949	7,920,000.00	7,920,000	466,752.00	466,752		9,931,701	9,931,701
	3 HAULING OPERATIONS											
02315492	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 25 MPH, excludes loading equipment	18,312.0	L.C.Y.	1,110.13	39,188			4.43	81,122		7	120,310
02315492	Hauling Dump Charges?		L.C.Y.					4.43			7	
	3 HAULING OPERATIONS Total	1.0	LS	1,110.13	39,188			81,122.16	81,122		120,310	120,310
	4 BACKFILL											
02315110	Trench Zone Backfill, 12" layers, compaction in layers, roller compaction with operator walking	32,267.0	E.C.Y.	1,721.58	110,353			1.14	36,784		5	147,138
02315640	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	5,867.0	L.C.Y.	312.78	38,722	25.50	149,609	2.43	14,257		35	202,588
02315510	Pipe Zone - Fill by borrow and utility bedding, borrow, select fill for shoulders and embankments, spread fill, with front-end loader	13,954.0	L.C.Y.	108.89	13,954	21.00	293,034	2.31	32,234		24	339,222
	4 BACKFILL Total	1.0	LS	2,143.25	163,029	442,642.50	442,643	83,274.93	83,275		688,947	688,947
	5 ASPHALT WORK											
02740310	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	17,600.0	SY	34.07	15,488	15.25	268,400	0.66	11,616		17	295,504
02720200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 12" deep	17,600.0	SY	33.46	7,744	9.20	161,920	1.00	17,600		11	187,264
	5 ASPHALT WORK Total	1.0	LS	67.53	23,232	430,320.00	430,320	29,216.00	29,216		482,768	482,768
	1 PIPE (48" Dia Steel CML&C) Total	1.0	LS	14,037.27	2,248,555	9,081,884.10	9,081,884	1,289,562.25	1,289,562		12,620,001	12,620,001
	2 PIPE (48" Dia HDPE)											
	1 EARTHWORKS											
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	92,450.0	B.C.Y.	3,077.95	255,162			4.01	370,305		7	625,467
	1 EARTHWORKS Total	1.0	LS	3,077.95	255,162			370,304.75	370,305		625,467	625,467
	1 PILING & SHORING / 10% Length											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	66,564.0	SF	1,564.98	372,758	5.70	379,415	6.85	455,963		18	1,208,137
	1 PILING & SHORING / 10% Length Total	1.0	LS	1,564.98	372,758	379,414.80	379,415	455,963.40	455,963		1,208,137	1,208,137
	2 PIPELINE											
02510760	Pipe HDPE 48" dia; Minus steel pipe 21,120' & tunnels=27,735'	27,735.0	LF	4,437.60	954,750	228.00	6,323,580	22.10	612,944		285	7,891,273
	2 PIPELINE Total	1.0	LS	4,437.60	954,750	6,323,580.00	6,323,580	612,943.50	612,944		7,891,273	7,891,273
	3 HAULING OPERATIONS											

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
02315492	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 25 MPH, excludes loading equipment	24,048.0	L.C.Y.	1,457.87	51,463			4.43	106,533		7	157,995
02315492	Hauling Dump Charges?		L.C.Y.					4.43			7	
	3 HAULING OPERATIONS Total	1.0	LS	1,457.87	51,463			106,532.64	106,533		157,995	157,995
	4 BACKFILL											
02315110	Trench Zone Backfill, 12" layers, compaction in layers, roller compaction with operator walking	42,373.0	E.C.Y.	2,260.77	144,916			1.14	48,305		5	193,221
02315640	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	7,704.0	L.C.Y.	410.71	50,846	25.50	196,452	2.43	18,721		35	266,019
02315510	Pipe Zone - Fill by borrow and utility bedding, borrow, select fill for shoulders and embankments, spread fill, with front-end loader	18,325.0	L.C.Y.	143.00	18,325	21.00	384,825	2.31	42,331		24	445,481
	4 BACKFILL Total	1.0	LS	2,814.49	214,087	581,277.00	581,277	109,356.69	109,357		904,721	904,721
	5 ASPHALT WORK											
02740310	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	23,113.0	SY	44.74	20,339	15.25	352,473	0.66	15,255		17	388,067
02720200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 12" deep	23,113.0	SY	43.94	10,170	9.20	212,640	1.00	23,113		11	245,922
	5 ASPHALT WORK Total	1.0	LS	88.68	30,509	565,112.85	565,113	38,367.58	38,368		633,990	633,990
	2 PIPE (48" Dia HDPE) Total	1.0	LS	13,441.57	1,878,729	7,849,384.65	7,849,385	1,693,468.56	1,693,469		11,421,582	11,421,582
	2a PIPE COMBINE TRENCH (24" Dia HDPE)											
	1 EARTHWORKS											
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	65,864.0	B.C.Y.	2,192.82	181,785			4.01	263,816		7	445,600
	1 EARTHWORKS Total	1.0	LS	2,192.82	181,785			263,815.60	263,816		445,600	445,600
	2 PIPELINE											
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	48,855.0	LF	3,905.68	840,306	59.00	2,882,445	11.05	539,848		87	4,262,599
	2 PIPELINE Total	1.0	LS	3,905.68	840,306	2,882,445.00	2,882,445	539,847.75	539,848		4,262,599	4,262,599
	3 HAULING OPERATIONS											
02315492	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 25 MPH, excludes loading equipment	13,229.0	L.C.Y.	801.98	28,310			4.43	58,604		7	86,915
02315492	Hauling Dump Charges?		L.C.Y.					4.43			7	
	3 HAULING OPERATIONS Total	1.0	LS	801.98	28,310			58,604.47	58,604		86,915	86,915
	4 BACKFILL											
02315110	Trench Zone Backfill, 12" layers, compaction in layers, roller compaction with operator walking	42,080.0	E.C.Y.	2,245.14	143,914			1.14	47,971		5	191,885
02315640	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	5,489.0	L.C.Y.	292.63	36,227	25.50	139,970	2.43	13,338		35	189,535
02315510	Pipe Zone - Fill by borrow and utility bedding, borrow, select fill for shoulders and embankments, spread fill, with front-end loader	5,066.0	L.C.Y.	39.53	5,066	21.00	106,386	2.31	11,702		24	123,154
	4 BACKFILL Total	1.0	LS	2,577.30	185,207	246,355.50	246,356	73,011.93	73,012		504,574	504,574
	5 ASPHALT WORK											
02740310	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	16,466.0	SY	31.87	14,490	15.25	251,107	0.66	10,868		17	276,464
02720200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 12" deep	16,466.0	SY	31.30	7,245	9.20	151,487	1.00	16,466		11	175,198

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
	5 ASPHALT WORK Total	1.0	LS	63.18	21,735	402,593.70	402,594	27,333.56	27,334		451,662	451,662
	2a PIPE COMBINE TRENCH (24" Dia HDPE) Total	1.0	LS	9,540.96	1,257,343	3,531,394.20	3,531,394	962,613.31	962,613		5,751,350	5,751,350
	3 TUNNEL - TECOLOTE ROAD											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total	1.0	LS	229.85	25,673	17,100.00	17,100	32,411.71	32,412		75,185	75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.5	L.C.Y.	28.98	1,161			7.20	2,502		11	3,663
	RECEIVING PIT 15'x20'x25'D Total	1.0	LS	94.18	12,755	9,975.00	9,975	15,935.58	15,936		38,666	38,666
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	540.0	LF	183.60	39,502	375.00	202,500	22.10	11,934		470	253,936
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	540.0	LF	459.00	98,754	850.00	459,000	117.42	63,405	750.00	1,900	1,026,159
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	540.0	LF	43.17	9,288	59.00	31,860	11.05	5,967		87	47,115
	TUNNEL Total	1.0	LS	685.77	147,543	693,360.00	693,360	81,306.11	81,306	405,000.00	1,327,210	1,327,210
	3 TUNNEL - TECOLOTE ROAD Total	1.0	LS	1,009.80	185,972	720,435.00	720,435	129,653.40	129,653	405,000.00	1,441,060	1,441,060
	4 TUNNEL - SDG&E EASEMENT											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total	1.0	LS	229.85	25,673	17,100.00	17,100	32,411.71	32,412		75,185	75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.5	L.C.Y.	28.98	1,161			7.20	2,502		11	3,663
	RECEIVING PIT 15'x20'x25'D Total	1.0	LS	94.18	12,755	9,975.00	9,975	15,935.58	15,936		38,666	38,666
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	400.0	LF	136.00	29,260	375.00	150,000	22.10	8,840		470	188,100
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	400.0	LF	340.00	73,151	850.00	340,000	117.42	46,967	750.00	1,900	760,118
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	400.0	LF	31.98	6,880	59.00	23,600	11.05	4,420		87	34,900
	TUNNEL Total	1.0	LS	507.98	109,291	513,600.00	513,600	60,226.75	60,227	300,000.00	983,118	983,118
	4 TUNNEL - SDG&E EASEMENT Total	1.0	LS	832.01	147,720	540,675.00	540,675	108,574.04	108,574	300,000.00	1,096,969	1,096,969
	5 TUNNEL - SDG&E EASEMENT											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total	1.0	LS	229.85	25,673	17,100.00	17,100	32,411.71	32,412		75,185	75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.3	L.C.Y.	28.96	1,160			7.20	2,500		11	3,660
	RECEIVING PIT 15'x20'x25'D Total	1.0	LS	94.16	12,754	9,975.00	9,975	15,933.78	15,934		38,663	38,663
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	700.0	LF	238.00	51,206	375.00	262,500	22.10	15,470		470	329,176
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	700.0	LF	595.00	128,014	850.00	595,000	117.42	82,192	750.00	1,900	1,330,206
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	700.0	LF	55.96	12,040	59.00	41,300	11.05	7,735		87	61,075
	TUNNEL Total	1.0	LS	888.96	191,260	898,800.00	898,800	105,396.81	105,397	525,000.00	1,720,457	1,720,457
	5 TUNNEL - SDG&E EASEMENT Total	1.0	LS	1,212.97	229,688	925,875.00	925,875	153,742.30	153,742	525,000.00	1,834,305	1,834,305
	6 TUNNEL - STATE HIGHWAY 52											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total	1.0	LS	229.85	25,673	17,100.00	17,100	32,411.71	32,412		75,185	75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.3	L.C.Y.	28.96	1,160			7.20	2,500		11	3,660
	RECEIVING PIT 15'x20'x25'D Total	1.0	LS	94.16	12,754	9,975.00	9,975	15,933.78	15,934		38,663	38,663
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	1,700.0	LF	578.00	124,357	375.00	637,500	22.10	37,570		470	799,427
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	1,700.0	LF	1,445.00	310,892	850.00	1,445,000	117.42	199,609	750.00	1,900	3,230,500
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	1,700.0	LF	135.91	29,240	59.00	100,300	11.05	18,785		87	148,325
	TUNNEL Total	1.0	LS	2,158.91	464,488	2,182,800.00	2,182,800	255,963.69	255,964	1,275,000.00	4,178,252	4,178,252
	6 TUNNEL - STATE HIGHWAY 52 Total	1.0	LS	2,482.92	502,916	2,209,875.00	2,209,875	304,309.17	304,309	1,275,000.00	4,292,100	4,292,100
	7 TUNNEL - UNDER 805											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total	1.0	LS	229.85	25,673	17,100.00	17,100	32,411.71	32,412		75,185	75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.3	L.C.Y.	28.96	1,160			7.20	2,500		11	3,660
	RECEIVING PIT 15'x20'x25'D Total	1.0	LS	94.16	12,754	9,975.00	9,975	15,933.78	15,934		38,663	38,663
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	550.0	LF	187.00	40,233	375.00	206,250	22.10	12,155		470	258,638
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	550.0	LF	467.50	100,583	850.00	467,500	117.42	64,579	750.00	1,900	1,045,162
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	550.0	LF	43.97	9,460	59.00	32,450	11.05	6,078		87	47,988

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
	TUNNEL Total	1.0	LS	698.47	150,276	706,200.00	706,200	82,811.78	82,812	412,500.00	1,351,787	1,351,787
	7 TUNNEL - UNDER 805 Total	1.0	LS	1,022.48	188,703	733,275.00	733,275	131,157.27	131,157	412,500.00	1,465,636	1,465,636
	8 TUNNELS - MIRAMAR DRIVE SOUTH TO 805											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total	1.0	LS	229.85	25,673	17,100.00	17,100	32,411.71	32,412		75,185	75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.3	L.C.Y.	28.96	1,160			7.20	2,500		11	3,660
	RECEIVING PIT 15'x20'x25'D Total	1.0	LS	94.16	12,754	9,975.00	9,975	15,933.78	15,934		38,663	38,663
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	7,200.0	LF	2,448.00	526,687	375.00	2,700,000	22.10	159,120		470	3,385,807
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	7,200.0	LF	6,120.00	1,316,718	850.00	6,120,000	117.42	845,401	750.00	1,900	13,682,120
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	7,200.0	LF	575.60	123,840	59.00	424,800	11.05	79,560		87	628,200
	TUNNEL Total	1.0	LS	9,143.60	1,967,245	9,244,800.00	9,244,800	1,084,081.50	1,084,082	5,400,000.00	17,696,127	17,696,127
	8 TUNNELS - MIRAMAR DRIVE SOUTH TO 805 Total	1.0	LS	9,467.61	2,005,673	9,271,875.00	9,271,875	1,132,426.99	1,132,427	5,400,000.00	17,809,975	17,809,975
	TASK 7 - MORENA PUMP STATION, WW FORCE MAIN & BRINE CONVEYANCE Total	1.0	LS	53,047.60	8,645,299	34,864,672.95	34,864,673	5,905,507.28	5,905,507	8,317,500.00	57,732,980	57,732,980
	TASK 7 - NORTH CITY Total	1.0	LS	53,047.60	8,645,299	34,864,672.95	34,864,673	5,905,507.28	5,905,507	8,317,500.00	57,732,980	57,732,980
	Grand Total		LS	53,047.60	8,645,299		34,864,673		5,905,507			57,732,980

MWH

PURE WATER PROGRAM- CITY OF SAN DIEGO - CLASS 5 COST ESTIMATE (L-20 to -50% & H+30 to +100%)

CPM CONSTRUCTION INC

TASK 7 - MORENA PS, WW FORCE MAIN & BRINE LINE (Alignment 3, 55,100 incl. tunnels)

909 598-9898

Percent	Amount	Category	Hours	Job Cost Phase
16.69 %	6,847,485	Labor	158,786.2	
64.52 %	26,472,647	Material		
6.71 %	2,752,500	Subcontractor		
12.09 %	4,958,797	Equipment	59,255.8	
	41,031,429	Net Costs		
32.50 %	**2,225,433**	**Labor Burden**		
8.50 %	**2,250,175**	**Material Tax - San Diego**		
2.00 %	**55,050**	**Sub Contractor Bond**		
9.60 %	**657,359**	**San Diego - Labor Adjustment**		
0.50 %	**157,157**	**San Diego - Mat & Equip Adjustment**		
	46,376,602	Subtotal		
15.00 %	6,956,490	GENERAL CONDITIONS		
2.00 %	927,532	GENERAL LIABILITY		
10.00 %	4,637,660	PROFIT		
	58,898,285	Subtotal Cost		
15.00 %	8,834,743	ESTIMATE CONTINGENCY 15%		
30.00 %	17,669,486	SCOPE CONTINGENCY 30%		
		LAND ACQUISITION @ 4%		
		ENGG, PERMITTING, LEGAL & ADMIN. 25%		
		CONSTRUCTION MANAGEMENT 10%		
		PROJECT MANAGEMENT 5%		
	85,402,513	Subtotal Grand		
		2015 COST : ENR @ 10037 - ESCALATION		
	85,402,513	Total Estimate		

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
	TASK 7 - NORTH CITY											
	TASK 7 - MORENA PUMP STATION, WW FORCE MAIN & BRINE CONVEYANCE											
	1 PIPE (48" Dia Steel CML&C)											
	1 EARTHWORKS											
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	70,400.0	B.C.Y.	2,343.84	194,304			4.01	281,984		7	476,288
	1 EARTHWORKS Total	1.0	LS	2,343.84	194,304			281,984.36	281,984		476,288	476,288
	1 PILING & SHORING / 10% Length											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	50,688.0	SF	1,191.72	283,853	5.70	288,922	6.85	347,213		18	919,987
	1 PILING & SHORING / 10% Length Total	1.0	LS	1,191.72	283,853	288,921.60	288,922	347,212.80	347,213		919,987	919,987
	2 PIPELINE											
02510760	Pipe Steel 48" dia - First four miles 5,280x4=21,120'	21,120.0	LF	7,180.80	1,544,949	375.00	7,920,000	22.10	466,752		470	9,931,701
	2 PIPELINE Total	1.0	LS	7,180.80	1,544,949	7,920,000.00	7,920,000	466,752.00	466,752		9,931,701	9,931,701
	3 HAULING OPERATIONS											
02315492	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 25 MPH, excludes loading equipment	18,312.0	L.C.Y.	1,110.13	39,188			4.43	81,122		7	120,310
02315492	Hauling Dump Charges?		L.C.Y.					4.43			7	
	3 HAULING OPERATIONS Total	1.0	LS	1,110.13	39,188			81,122.16	81,122		120,310	120,310
	4 BACKFILL											
02315110	Trench Zone Backfill, 12" layers, compaction in layers, roller compaction with operator walking	32,267.0	E.C.Y.	1,721.58	110,353			1.14	36,784		5	147,138
02315640	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	5,867.0	L.C.Y.	312.78	38,722	25.50	149,609	2.43	14,257		35	202,588
02315510	Pipe Zone - Fill by borrow and utility bedding, borrow, select fill for shoulders and embankments, spread fill, with front-end loader	13,954.0	L.C.Y.	108.89	13,954	21.00	293,034	2.31	32,234		24	339,222
	4 BACKFILL Total	1.0	LS	2,143.25	163,029	442,642.50	442,643	83,274.93	83,275		688,947	688,947
	5 ASPHALT WORK											
02740310	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	17,600.0	SY	34.07	15,488	15.25	268,400	0.66	11,616		17	295,504
02720200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 12" deep	17,600.0	SY	33.46	7,744	9.20	161,920	1.00	17,600		11	187,264
	5 ASPHALT WORK Total	1.0	LS	67.53	23,232	430,320.00	430,320	29,216.00	29,216		482,768	482,768
	1 PIPE (48" Dia Steel CML&C) Total	1.0	LS	14,037.27	2,248,555	9,081,884.10	9,081,884	1,289,562.25	1,289,562		12,620,001	12,620,001
	2 PIPE (48" Dia HDPE)											
	1 EARTHWORKS											
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	104,267.0	B.C.Y.	3,471.37	287,777			4.01	417,637		7	705,414
	1 EARTHWORKS Total	1.0	LS	3,471.37	287,777			417,637.27	417,637		705,414	705,414
	1 PILING & SHORING / 10% Length											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	75,072.0	SF	1,765.01	420,403	5.70	427,910	6.85	514,243		18	1,362,557
	1 PILING & SHORING / 10% Length Total	1.0	LS	1,765.01	420,403	427,910.40	427,910	514,243.20	514,243		1,362,557	1,362,557
	2 PIPELINE											
02510760	Pipe HDPE 48" dia; Minus steel pipe 21,120' & tunnels=31,280'	31,280.0	LF	5,004.80	1,076,783	228.00	7,131,840	22.10	691,288		285	8,899,911
	2 PIPELINE Total	1.0	LS	5,004.80	1,076,783	7,131,840.00	7,131,840	691,288.00	691,288		8,899,911	8,899,911
	3 HAULING OPERATIONS											

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
02315492	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 25 MPH, excludes loading equipment	27,122.0	L.C.Y.	1,644.22	58,041			4.43	120,150		7	178,192
02315492	Hauling Dump Charges?		L.C.Y.					4.43			7	
	3 HAULING OPERATIONS Total	1.0	LS	1,644.22	58,041			120,150.46	120,150		178,192	178,192
	4 BACKFILL											
02315110	Trench Zone Backfill, 12" layers, compaction in layers, roller compaction with operator walking	47,787.0	E.C.Y.	2,549.63	163,432			1.14	54,477		5	217,909
02315640	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	8,689.0	L.C.Y.	463.23	57,347	25.50	221,570	2.43	21,114		35	300,031
02315510	Pipe Zone - Fill by borrow and utility bedding, borrow, select fill for shoulders and embankments, spread fill, with front-end loader	20,667.0	L.C.Y.	161.28	20,667	21.00	434,007	2.31	47,741		24	502,415
	4 BACKFILL Total	1.0	LS	3,174.14	241,446	655,576.50	655,577	123,332.22	123,332		1,020,355	1,020,355
	5 ASPHALT WORK											
02740310	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	26,067.0	SY	50.46	22,939	15.25	397,522	0.66	17,204		17	437,665
02720200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 12" deep	26,067.0	SY	49.55	11,469	9.20	239,816	1.00	26,067		11	277,353
	5 ASPHALT WORK Total	1.0	LS	100.01	34,408	637,338.15	637,338	43,271.22	43,271		715,018	715,018
	2 PIPE (48" Dia HDPE) Total	1.0	LS	15,159.56	2,118,858	8,852,665.05	8,852,665	1,909,922.37	1,909,922		12,881,446	12,881,446
	2a PIPE COMBINE TRENCH (24" Dia HDPE)											
	1 EARTHWORKS											
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	69,335.0	B.C.Y.	2,308.38	191,365			4.01	277,719		7	469,083
	1 EARTHWORKS Total	1.0	LS	2,308.38	191,365			277,718.55	277,719		469,083	469,083
	2 PIPELINE											
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	51,430.0	LF	4,111.53	884,596	59.00	3,034,370	11.05	568,302		87	4,487,268
	2 PIPELINE Total	1.0	LS	4,111.53	884,596	3,034,370.00	3,034,370	568,301.50	568,302		4,487,268	4,487,268
	3 HAULING OPERATIONS											
02315492	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 25 MPH, excludes loading equipment	13,926.0	L.C.Y.	844.24	29,802			4.43	61,692		7	91,494
02315492	Hauling Dump Charges?		L.C.Y.					4.43			7	
	3 HAULING OPERATIONS Total	1.0	LS	844.24	29,802			61,692.18	61,692		91,494	91,494
	4 BACKFILL											
02315110	Trench Zone Backfill, 12" layers, compaction in layers, roller compaction with operator walking	44,298.0	E.C.Y.	2,363.48	151,499			1.14	50,500		5	201,999
02315640	Fill by borrow and utility bedding, for pipe and conduit, crushed or screened bank run gravel, excludes compaction	5,778.0	L.C.Y.	308.04	38,135	25.50	147,339	2.43	14,041		35	199,514
02315510	Pipe Zone - Fill by borrow and utility bedding, borrow, select fill for shoulders and embankments, spread fill, with front-end loader	5,333.0	L.C.Y.	41.62	5,333	21.00	111,993	2.31	12,319		24	129,645
	4 BACKFILL Total	1.0	LS	2,713.13	194,967	259,332.00	259,332	76,859.49	76,859		531,158	531,158
	5 ASPHALT WORK											
02740310	Plant-mix asphalt paving, for highways and large paved areas, binder course, 4" thick, no hauling included	17,334.0	SY	33.55	15,254	15.25	264,344	0.66	11,440		17	291,038
02720200	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 12" deep	17,334.0	SY	32.95	7,627	9.20	159,473	1.00	17,334		11	184,434

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
	5 ASPHALT WORK Total	1.0	LS	66.51	22,881	423,816.30	423,816	28,774.44	28,774		475,472	475,472
	2a PIPE COMBINE TRENCH (24" Dia HDPE) Total	1.0	LS	10,043.79	1,323,610	3,717,518.30	3,717,518	1,013,346.16	1,013,346		6,054,475	6,054,475
	3 TUNNEL - TECOLOTE ROAD											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total		LS	229.85	25,673		17,100		32,412			75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.5	L.C.Y.	28.98	1,161			7.20	2,502		11	3,663
	RECEIVING PIT 15'x20'x25'D Total		LS	94.18	12,755		9,975		15,936			38,666
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	540.0	LF	183.60	39,502	375.00	202,500	22.10	11,934		470	253,936
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	540.0	LF	459.00	98,754	850.00	459,000	117.42	63,405	750.00	1,900	1,026,159
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	540.0	LF	43.17	9,288	59.00	31,860	11.05	5,967		87	47,115
	TUNNEL Total		LS	685.77	147,543		693,360		81,306			1,327,210
	3 TUNNEL - TECOLOTE ROAD Total	1.0	LS	1,009.80	185,972	720,435.00	720,435	129,653.40	129,653	405,000.00	1,441,060	1,441,060
	4 TUNNEL - UNDER RAILROAD											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total		LS	229.85	25,673		17,100		32,412			75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.5	L.C.Y.	28.98	1,161			7.20	2,502		11	3,663
	RECEIVING PIT 15'x20'x25'D Total		LS	94.18	12,755		9,975		15,936			38,666
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	580.0	LF	197.20	42,428	375.00	217,500	22.10	12,818		470	272,746
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	580.0	LF	493.00	106,069	850.00	493,000	117.42	68,102	750.00	1,900	1,102,171
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	580.0	LF	46.37	9,976	59.00	34,220	11.05	6,409		87	50,605
	TUNNEL Total		LS	736.57	158,473		744,720		87,329			1,425,521
	4 TUNNEL - UNDER RAILROAD Total	1.0	LS	1,060.60	196,901	771,795.00	771,795	135,676.07	135,676	435,000.00	1,539,372	1,539,372
	6 TUNNEL - STATE HIGHWAY 52											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total		LS	229.85	25,673		17,100		32,412			75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.3	L.C.Y.	28.96	1,160			7.20	2,500		11	3,660
	RECEIVING PIT 15'x20'x25'D Total		LS	94.16	12,754		9,975		15,934			38,663
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	1,700.0	LF	578.00	124,357	375.00	637,500	22.10	37,570		470	799,427
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	1,700.0	LF	1,445.00	310,892	850.00	1,445,000	117.42	199,609	750.00	1,900	3,230,500
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	1,700.0	LF	135.91	29,240	59.00	100,300	11.05	18,785		87	148,325
	TUNNEL Total		LS	2,158.91	464,488		2,182,800		255,964			4,178,252
	6 TUNNEL - STATE HIGHWAY 52 Total	1.0	LS	2,482.92	502,916	2,209,875.00	2,209,875	304,309.17	304,309	1,275,000.00	4,292,100	4,292,100
	8 TUNNELS - MIRAMAR DRIVE SOUTH TO 805											
	LUNCHING PIT 30'x30'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	3,000.0	SF	70.53	16,800	5.70	17,100	6.85	20,550		18	54,450
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	833.3	B.C.Y.	27.74	2,300			4.01	3,338		7	5,638
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	833.3	E.C.Y.	44.43	3,083			1.20	1,000		5	4,083

CSI	Item Description	Qty	Unit	Labor Hours	Labor $Total	Mat Unit Price	Material $ Total	Equip Unit Price	Equip $ Total	Subs Unit Price	Total Unit Price	Total
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	1,045.0	L.C.Y.	87.15	3,490			7.20	7,524		11	11,014
	LUNCHING PIT 30'x30'x25'D Total		LS	229.85	25,673		17,100		32,412			75,185
	RECEIVING PIT 15'x20'x25'D											
02250400	Sheet piling, steel, 22 psf, 15' excavation, per S.F., drive, extract and salvage, excludes wales	1,750.0	SF	41.14	9,800	5.70	9,975	6.85	11,988		18	31,763
02315424	Excavating, bulk bank measure, 1/2 C.Y. = 30 C.Y./hour, hydraulic excavator, truck mounted, excluding truck loading	277.8	B.C.Y.	9.25	767			4.01	1,113		7	1,879
02315110	Backfill and compact, by hand, 12" layers, compaction in layers, roller compaction with operator walking, add to above	277.8	E.C.Y.	14.81	1,028			1.20	333		5	1,361
02315492	Cycle hauling(wait, load, travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 12 C.Y. truck, cycle 10 miles, 15 MPH, excludes loading equipment	347.3	L.C.Y.	28.96	1,160			7.20	2,500		11	3,660
	RECEIVING PIT 15'x20'x25'D Total		LS	94.16	12,754		9,975		15,934			38,663
	TUNNEL											
02510760	Pipe Steel 48" dia CML&C	850.0	LF	289.00	62,178	375.00	318,750	22.10	18,785		470	399,713
02510760	Pipe Steel 108" dia - Casing Pipe 0.5" thick	850.0	LF	722.50	155,446	850.00	722,500	117.42	99,804	750.00	1,900	1,615,250
02510760	Piping HDPE, butt fusion joints, 40' lengths, 24" diameter, DR 17	850.0	LF	67.95	14,620	59.00	50,150	11.05	9,393		87	74,163
	TUNNEL Total		LS	1,079.45	232,244		1,091,400		127,982			2,089,126
	8 TUNNELS - MIRAMAR DRIVE SOUTH TO 805 Total	1.0	LS	1,403.47	270,672	1,118,475.00	1,118,475	176,327.33	176,327	637,500.00	2,202,974	2,202,974
	TASK 7 - MORENA PUMP STATION, WW FORCE MAIN & BRINE CONVEYANCE Total	1.0	LS	45,197.42	6,847,485	26,472,647.45	26,472,647	4,958,796.76	4,958,797	2,752,500.00	41,031,429	41,031,429
	TASK 7 - NORTH CITY Total	1.0	LS	45,197.42	6,847,485	26,472,647.45	26,472,647	4,958,796.76	4,958,797	2,752,500.00	41,031,429	41,031,429
	Grand Total		LS	45,197.42	6,847,485		26,472,647		4,958,797			41,031,429

Appendix C: Meeting Minutes

Task 7 –MORENA PUMP STATION (MPS), WASTEWATER AND BRINE PIPELINE

ALTERNATIVES ALIGNMENT ANALYSIS WORKSHOP Meeting Minutes

Meeting Information

Date: September 3, 2015

Location: Pure Water Program Office - MOC2 Conference Room 2F

Start/End Time: 8:00 am/9:00 am

Meeting Participants

Victor Occiano (B&C)	Paige Russell (MWH)	Gary Webb (City)
Chris Mote (MWH)	Lubna Arikat (City)	John Helminski (City)
Miko Aivazian (MWH)	Anthony Van (City)	Richard Snow (City)
Peggy Umphres (MWH)	Amer Barhoumi (City)	

Meeting Purpose/Objectives

Purpose: Alternatives Analysis Workshop

Objectives:

1. Review and discuss the 48-inch WW Forcemain and 24-inch Brine Line alternatives and evaluation matrix.
2. Obtain the City's concurrence on a preferred alternative.
3. Move forward with 10% design development.

8:00 am **Welcome & Agenda/Objective Overview**

8:05 am **48-inch Forcemain Alternatives**

- Alternative #1 has a rough elevation profile with many high and low points. The multiple low points along the alignment would require tunneling.
- Alternative #2 is the alignment that follows the SDG&E easement and would require tunneling the entire length. It also has a rough surface profile, with more high and low points. These extreme low points would require very deep tunnel shafts. There could be many risks involved in tunneling for this length.
    - Receiving approval from SDG&E to tunnel beneath their easement could be lengthy, and future approval is not guaranteed.
    - The deep tunnel shafts make access and maintenance more difficult.
    - This alignment would require a comprehensive Geotechnical baseline report.
    - The alignment runs through environmentally sensitive areas, requiring additional permitting.
- Alternative #3 has a much smoother elevation profile. There is a reduced amount of low points along this alignment, requiring only about 4 tunneling sections. This profile is much more accommodating for installation of a forcemain.

8:15 am **Evaluation Matrix**

- The costs shown on the matrix are only for the pipelines, with both the wastewater forcemain and the brine line included. The pump station, odor control, etc. would be the same for all three alternatives so it was not included in this analysis.
- The matrix shows that Alternative #3 has the lowest cost, and is also the #1 choice in the evaluation matrix. This alternative has several advantages over the other two alignments.

8:25 am **Alternative Alignment Selection**

- Question: Are there any issues with Alternative #3, even though it is the "best" alignment?

  Answer: No. This option has the best profile, the lowest costs, and no deep tunnels. However, a utility study needs to be performed to make sure the pipeline will fit within Morena Blvd. The addition of the new 36-inch water main may also include several challenges.

DECISION: City agreed upon Alternative #3 for the Task 7 alignment.

8:30 am **Next Steps**

8:30am **Alvarado 2nd Extension and Morena Pipeline PDR**

- A portion of the new 36" Morena water main pipeline parallel's Task 7's alignment, starting near the Morena Pump Station site.
  - o The new Morena water main extends north on Morena Blvd, past Clairemont Dr, which is outside of Task 7's preliminary design report limits.
  - o The length of the 36-inch water main pipe that resides in Task 7's project limits is approximately 2 miles.
- The Alvarado extension pipeline is outside of Task 7's project limits and should be designed and constructed as a separate project.
- The 16" replacement pipeline will be located approximately 3-5 feet from the surface.
- The new 36" water main will be located approximately 5 feet from the surface.

▪ Question: Would we include the 36" North-South water main with the Task 7 scope?

Answer: Discussions with Public Works will be necessary in order to determine if some or all of the new water main would be incorporated into Task 7.

ACTION: John Helminski will discuss with Public Works regarding incorporating the water line(s) into Task 7.

▪ Question: In the areas of high conflict along Morena Blvd, could side streets be looked at as alternative routes?

Answer: The scope of Task 7 would need to be expanded, including a wider survey that would include the surrounding nearby streets.

8:50 am **Question & Answer**

▪ Question: Have we coordinated with the new light-rail trolley going down Morena Blvd?

Answer: Not yet.

ACTION: City to provide the 65% design drawings for the trolley.

▪ Question: How long is the area of conflict with the trolley?

Answer: About 1 ¼ mile.

▪ Comment: Permitting parallel to easements is very difficult. Short tunnel sections may be required in the section of alignment adjacent to the trolley line.

- Comment: There was major construction done recently in the center median along Morena Blvd. It was not a City project; the City has been researching what it was.

  ACTION: City to continue researching recent construction along Morena Blvd.

- Question: Who does the MWH/BC team coordinate with about the Trolley Project?

  Answer: Luis Shar. There are weekly meetings for the trolley that we should try to get involved in and present the Task 7 project.

- Question: Are there any widening projects planned along the Morena Blvd?

  Answer: No.

9:00 am **Adjourn**

Action Items

- City – John Helminski will discuss with Public Works regarding incorporating the water line(s) into Task 7.
- City – Provide 65% design drawings for the trolley line running along Morena Blvd.
- City – Continue researching recent construction along Morena Blvd.

Pure Water SAN DIEGO

Task Order No. 2
Task 7 Predesign

Morena Pump Station WW Forcemain Alignments

Alternatives Analysis Workshop

September 3, 2015

Meeting Agenda

1. Meeting Objectives
2. 48-inch Forcemain Alternatives
3. Evaluation Matrix
4. Alternative Alignment Selection
5. Next Steps

Meeting Objectives

- Review and discuss the 48-inch WW Forcemain and 24-inch Brine Line alternatives and evaluation matrix.
- Obtain the City's concurrence on a preferred alternative.
- Move forward with 10% design development

NOTE: All sketches are preliminary

Morena Pump Station WW Forcemain Alternatives

Alignments Considered

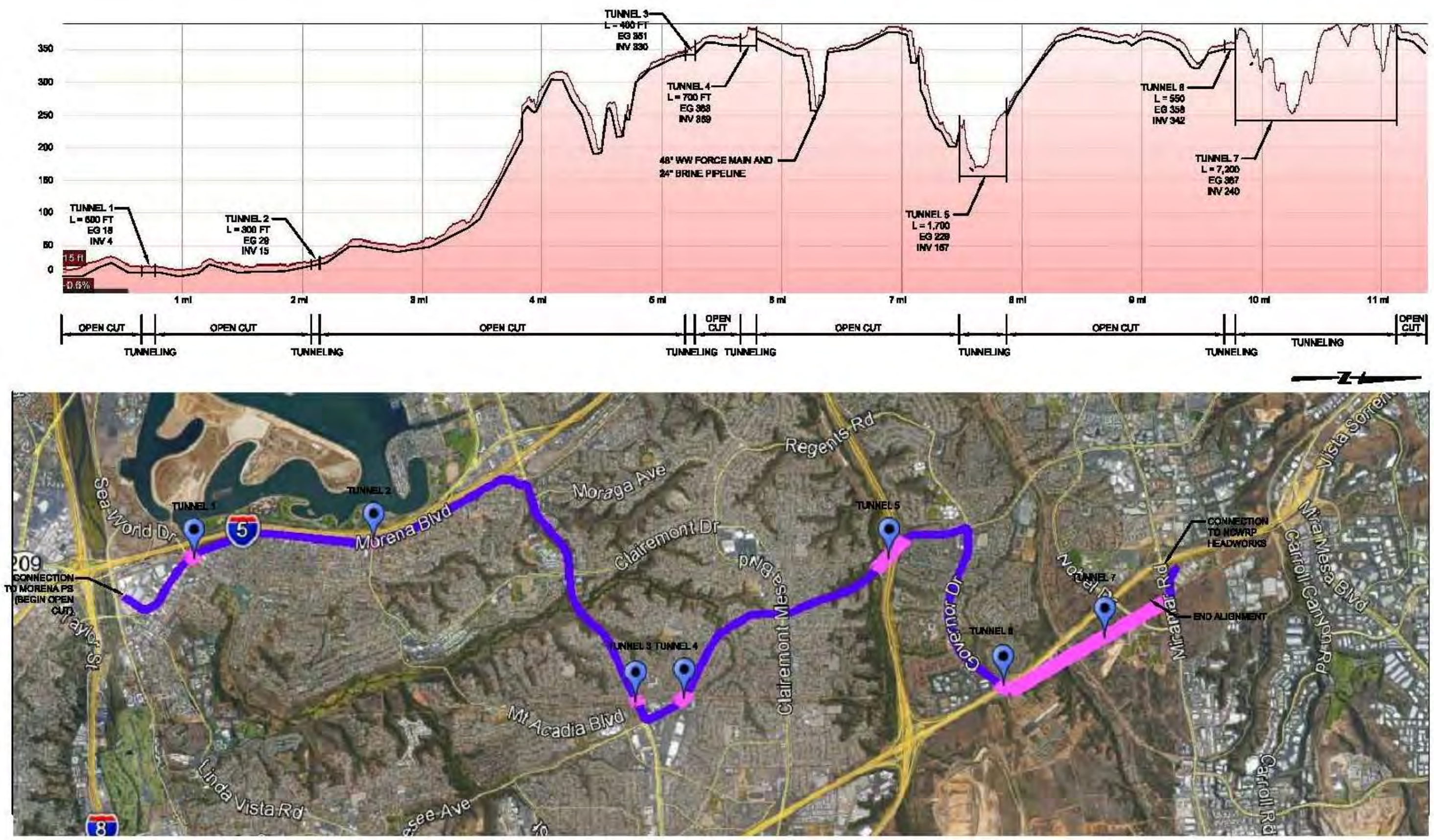
- Alignment No 1: Baseline Alignment (Open-cut trench)
- Alignment No 2: SDG&E (Tunnel)
- Alignment No. 3: Hybrid Alignment (Open-cut trench)

Alignments Summary

	Parameter/Condition	Criteria Definintion	Alternative 1: Baseline Alignment – Rank	Alternative 1: Baseline Alignment – Description	Alternative 2: SDG&E Alignment – Rank	Alternative 2: SDG&E Alignment – Description	Alternative 3: Open Cut Alignment – Rank	Alternative 3: Open Cut Alignment – Description
1. ALIGNMENT SUMMARY	**1a. Approximate Alignment Length (LF)**		3		1		2	
	Morena Pump Station to NCWRP (miles)			11.48		8.84		10.72
	Length of Open-Cut Trench (FT)			49,900		8,800		53,200
	Length of Tunnel (FT)			10,700		37,900		3,400
	1b. Static Hydraulic Profile		3		1		2	
	Elevation at Morena Pump Station - Discharge			-10		-10		-10
	Elevation at NCWRP (FT)			378		378		378
	High Point Elev (Static head); (FT)			384		384		389
	Total Dynamic Head (TDH)			520		494		518
	Pumping pressures & operating ranges			Low End: 8,700 GPM @ 424 ft High End: 22,200 GPM @ 520 ft		Low End: 8,700 GPM @ 420 ft High End: 22,200 GPM @ 494 ft		Low End: 8,700 GPM @ 423 ft High End: 22,200 GPM @ 513 ft
	Installed motor HP							
	1c. Discharge Location		2	NCWRP 60" RS LINE	3	NCWRP 60" RS LINE	1	NCWRP 60" RS LINE
	1d. Estimated Construction Duration	**Assumes:** **60 LF/day per crew (open cut)** **40 LF/day per crew (tunneling)** **2 Crews per shift (open cut)** **2 Crews per shift (tunneling)** **1 Shift per day** **8 working hours per shift**	1	23 Months	3	26 Months	2	24 Months

Alignments Considered

Alignment No. 1

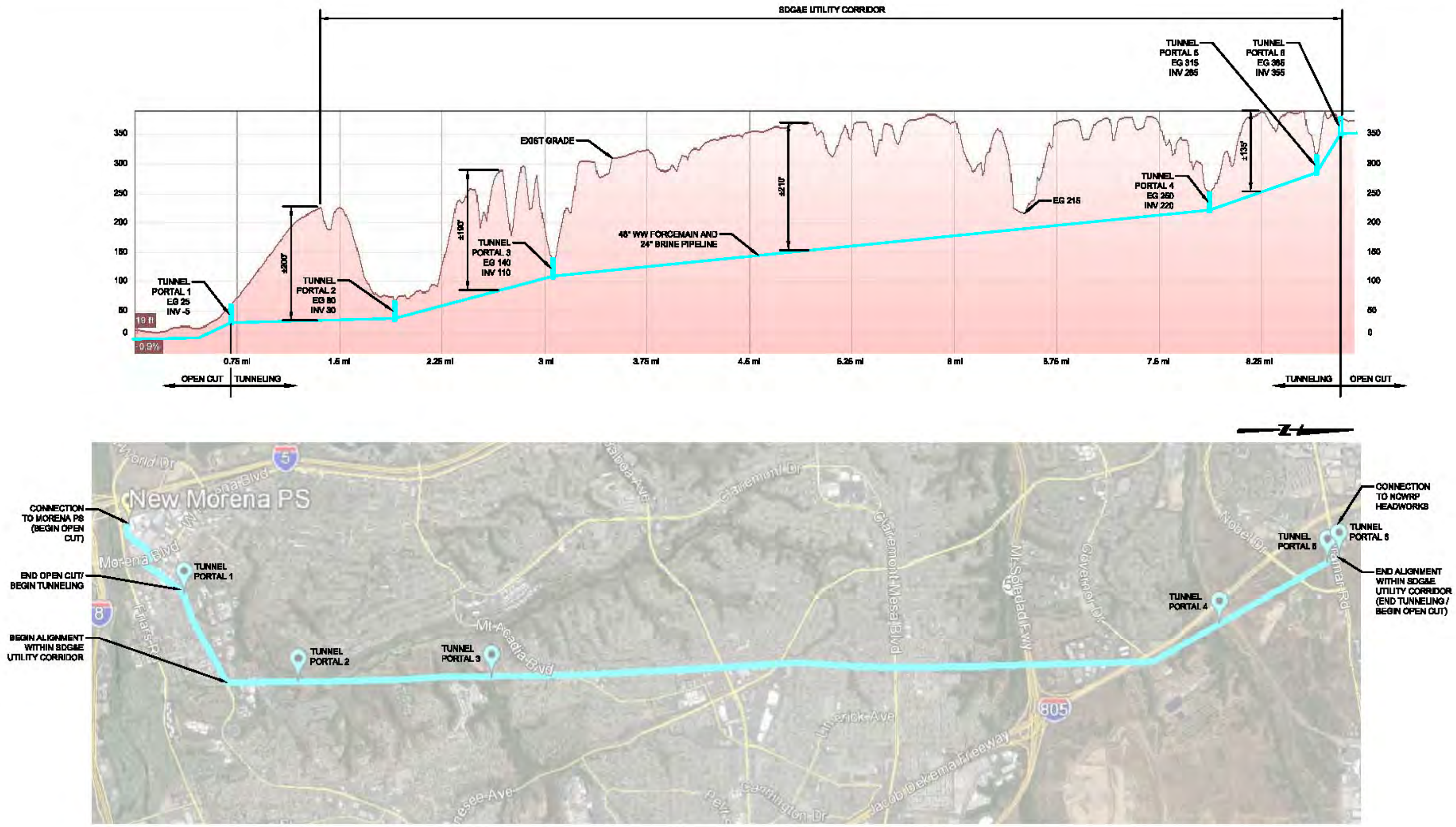


PIPELINE ALIGNMENT OPTION 1 - OPEN CUT

PREPARED BY MWH.

CITY OF SAN DIEGO
PURE WATER TO 2, TASK 7
WW CONVEYANCE AND BRINE PIPELINE
ALIGNMENT OPTION 1 - OPEN CUT

Alignment No. 2



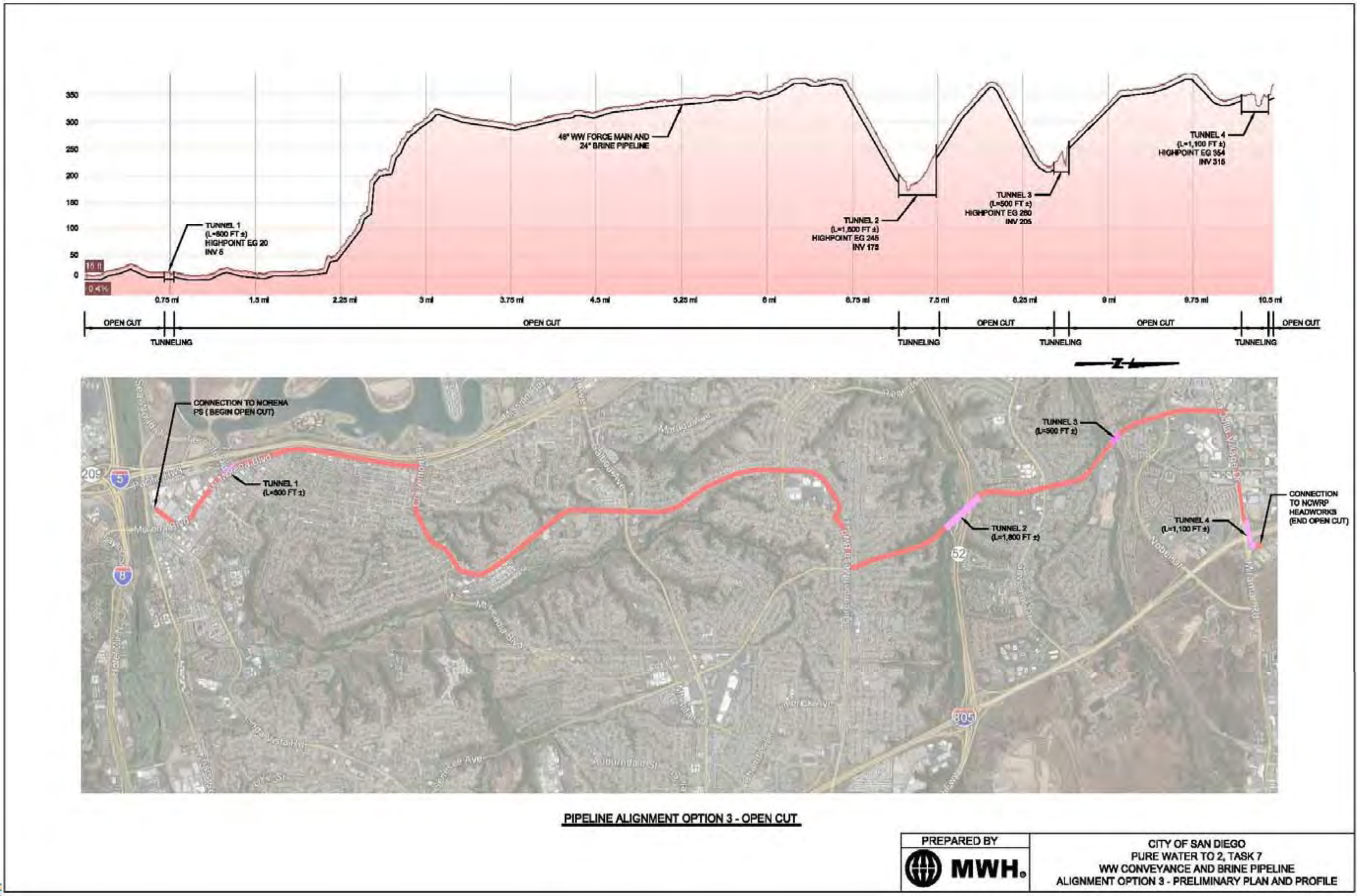
PIPELINE ALIGNMENT OPTION 2 - TUNNELING

PREPARED BY MWH	CITY OF SAN DIEGO PURE WATER TO 2, TASK 7 WW CONVEYANCE AND BRINE PIPELINE ALIGNMENT OPTION 2 - PRELIMINARY PLAN AND PROFILE

Risks Associated with Tunneling

- High GW Levels/Shaft Construction Difficulties
- Surface Settlement Damaging Structures Above (Power transmission towers, etc.)
- Soils that Slow Down or Halt Tunneling Machine Can Pose Schedule Risks
- Seismic Fault(s) Crossing the Tunnel Alignment
- Environmental Impacts During Construction
- Permitting Process Can Cause Schedule Delays
- Requires a Comprehensive Geotechnical Baseline Report

Alignment No. 3



Considerations for Alternatives Development

- Environmental Impacts
- Traffic Impacts
- Access to utilities for Operation and Maintenance
- Schedule
- Risk
- Constructability
- Construction Cost
- O&M Costs

Evaluation Matrix Summary

Table 1, Alternative Evaluation				
		Alternative 1	Alternative 2	Alternative 3
Criteria	Parameter/Condition	Score	Score	Score
1. ALIGNMENT SUMMARY	1a. Approximate Alignment Length (LF)	3	1	2
	1b. Static Hydraulic Profile	3	1	2
	1c. Discharge Location	2	3	1
	1d. Estimated Construction Duration	1	3	2
2. SCHEDULE& COORDINATION	2.a Coordination Requirements:	3	1	2
	2.b Real Property Acquisition for Permanent Easement/ROW	2	3	1
	2.c Local Communities/Schedule Impacts	2	1	3
	2.d Environmental Permitting	3	1	2
	2.e Risk	2	3	1
3. PIPELINE OPERATION & MAINTENANCE	3a. O&M Considerations	2	3	1
	3b. O&M Risk	2	3	1
	3c. Operating Permit Requirements	2	3	1
4. CONSTRUCTABILITY	4a. Environmental / Environmental Permitting	3	1	2
	4b. Geotechnical	2	3	1
	4c. Traffic Control	3	1	2
	4.d Construction Methods	2	3	1
	4.e Utility Coordination & Conflicts	3	1	2
5. COST	5a. Total Construction Cost (Midpoint) / Present Cost / Present Cost (w/o soft costs)	2	3	1
	5b. Total Annual O&M Cost	3	2	1
	TOTAL SCORE	**36**	**32**	**22**
	FINAL RANKING	**3**	**2**	**1**

Preliminary Construction Cost Estimates

COST	**5a. Total Construction Cost (Midpoint) / Present Cost / Present Cost (w/o soft costs)**	**i. Construction Cost** **ii. Contingency**	**2**	i. $82,177,063 ii. $36,979,678	3	i. $89,000,000 ii. $40,000,000	1	i. $58,898,285 ii. $26,504,229
	Construction dollars (Year 20xx), escalated at 4%/yr.		2	$139,396,533	3	$150,911,754	1	$99,908,861
	5b. Total Annual O&M Cost	- Electrical Cost - Routine Maintenance - Repair and replacement	**3**	- $2,974,000 - $81,000	2	- $2,870,000 - $108,000	1	- $2,900,000 - $60,000
	These cost estimates were developed as a Class 4 Cost Estimate with a -30%/+50% accuracy according to the Association of Cost Engineering (AACE) International cost estimate classification system.							

Preliminary Cost Estimate – Major Assumptions

- No rock formations will be encountered.
- No dewatering required.
- Will be able to support existing utilities.
- Costs do not include utility relocations that may be required at NCWRP.
- Costs do not include the odor control, and Morena Pump Station and other facilities

Recommended Alternative
Alternative No. 3 (Open-Cut)

WW Pipeline Alignment Alternative Evaluation - TASK 7

The following table provides a comparison of three alignment alternatives evaluated to deliver Wastewater from Morena Pump Station to NCWRP.

	Parameter/Condition	Criteria Definintion	Alternative 3: Open Cut Alignment Rank	 Description
ALIGNMENT SUMMARY	**1a. Approximate Alignment Length (LF)** Morena Pump Station to NCWRP (miles) Length of Open-Cut Trench (FT) Length of Tunnel (FT)		2	10.72 53,200 3,400
	1b. Static Hydraulic Profile **Elevation at Morena Pump Station - Discharge** **Elevation at NCWRP (FT)** **High Point Elev (Static head); (FT)** **Total Dynamic Head (TDH)** **Pumping pressures & operating ranges** Installed motor HP		2	-10 378 389 518 Low End: 8,700 GPM @ 423 ft High End: 22,200 GPM @ 513 ft
	1c. Discharge Location		1	NCWRP 60" RS LINE
	1d. Estimated Construction Duration	**Assumes:** **60 LF/day per crew (open cut)** **40 LF/day per crew (tunneling)** **2 Crews per shift (open cut)** **2 Crews per shift (tunneling)** **1 Shift per day** **8 working hours per shift**	2	24 Months
COST	**5a. Total Construction Cost (Midpoint) / Present Cost / Present Cost (w/o soft costs)**	**i. Construction Cost** **ii. Contingency**	1	i. $58,898,285 ii. $26,504,229
	Construction dollars (Year 20xx), escalated at 4%/yr.		1	$99,908,861
	5b. Total Annual O&M Cost	- Electrical Cost - Routine Maintenance - Repair and replacement	1	- $2,900,000 - $60,000
	These cost estimates were developed as a Class 4 Cost Estimate with a -30%/+50% accuracy according to the Association of Cost Engineering (AACE) International cost estimate classification system.			
		TOTAL =	*22*	
		FINAL RANK =	**1**	

Task 7 Next Steps

- City to select preferred confirm/select alternative.
- Finalize alignment for 48-inch Morena Pump Station 48-inch WW Forcemain
- Refine Morena Pump Station Discharge and Diversion
- Engage Subconsultants such as surveying, permitting, etc.
- Begin 10% predesign - initiate architectural, structural, electrical and I&C coordination for AWPF influent pumping system.
- Develop 10% design for the brine pipeline and the Morena Pump Station

Questions?

Pure Water SAN DIEGO

Sign-in Sheet

Meeting Information

Meeting/Workshop Name: PW2-TO7_Alternatives Analysis

Time and Date: 8:00 AM, September 3, 2015

Location: MOC, Conference Room 2F

Name	Title, Firm
Richard Snow	Senior Civil Eng, WWTD, CSD
Lubna Arikat	PUD / Pure Water
Anthony Van	PUD / Pure Water
Amer Barhoumi	PUD / Pure Water
John Helminski	PUD / Pure Water
Peggy Humphres	MWH
Gary Webb	PUD
Chris Mote	MWH
Miko Aivazian	MWH
Paige Russell	MWH
Victor Occiano	B+C