Jacobs

Memorandum

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Subject	**Addendum 1 – Project Component Refinements**
Project Name	Regional Brackish Water Reclamation Program Feasibility Study
Date	March 2021

1. Introduction and Purpose

Subsequent to the preparation of the Draft Regional Brackish Water Reclamation Program Feasibility Study Report in 2019, the Water Replenishment District of Southern California (WRD) and other Program Stakeholders identified components of the selected Preferred Projects that required refinement to better reflect updated or recently developed Program-related information.

These refinements included the following:

- Identification of a direct product water pipeline to deliver potable water from the centralized desalter to the Los Angeles Department of Water and Power (LADWP)
- Evaluation of a dedicated wellhead treatment unit to produce potable water for the City of Manhattan Beach
- Consideration of the potential to employ a single-trench conveyance desalter product water, brine waste flows, and advanced treated recycled water for groundwater replenishment

Appendixes 1, 2, and 3 of this addendum include the three technical memorandums that were prepared to address each of the previously noted items.

1.1 Background

WRD is responsible for managing and replenishing both the West Coast and Central groundwater basins. In the West Coast Basin, a significant saline plume of groundwater with elevated total dissolved solids has been trapped in the Gage, Silverado, Lynwood, and Lower San Pedro (equivalent to Sunnyside) aquifers because of historical seawater intrusion and the subsequent implementation of two injection barriers. To more fully utilize the West Coast Basin, WRD has initiated a Program to evaluate ways to use this impaired water supply. Program goals include treating the plume to produce potable water, and to discharge waste streams generated in the treatment process (which consists mostly of high-salinity brine or concentrate).

1.2 Stakeholder-specific Project Refinements

1.2.1 Los Angeles Department of Water and Power Direct Product Water Pipeline

Following completion of the Draft Feasibility Study Report, LADWP expressed interest in a direct product water pipeline to receive potable water from the centralized desalter. In the initial Feasibility Study analysis, it was assumed that LADWP, along with other Program Stakeholders (with the exception of

Manhattan Beach), would receive the desalter product water via interties with the City of Torrance. However, the Torrance distribution pressure at the potential intertie location with LADWP is substantially lower than that required by the LADWP distribution system, necessitating booster pumping prior to connection. A direct product water line could be a more viable option for LADWP.

Appendix 1 of this addendum includes an evaluation of the LADWP product water pipeline, which was a follow-up study to the Draft Feasibility Study Report.

1.2.2 Manhattan Beach Wellhead Treatment Project

During the selection of the Preferred Projects, the Stakeholder Group included an option for 2,000 acre-feet per year of wellhead treatment that could be implemented in addition to the larger, centralized desalter. The portable wellhead treatment equipment could be periodically disassembled and moved to a new location to enable treatment of portions of the saline plume that would not be captured by the primary wellfield that feeds the centralized desalter. Due to the lack of an existing intertie with Torrance and, hence, difficulty in receiving potable water from the centralized desalter, Manhattan Beach is a potential candidate for Program participation through a dedicated, remote wellhead treatment unit.

Appendix 2 of this addendum includes an evaluation of the Manhattan Beach wellhead treatment and blending, which was a follow-up study to the Draft Feasibility Study Report.

1.2.3 Single-trench Opportunities

The LADWP direct product water pipeline extends south from the centralized desalter in the same general corridor as the potential dedicated brine line to the Los Angeles county Sanitation Districts (LACSD) Joint Water Pollution Control Plant, which was considered in the Feasibility Study. In addition, the Regional Recycled Water Program partnership between LACSD and the Metropolitan Water District of Southern California will provide a potential source of advanced treated recycled water for groundwater replenishment to balance the groundwater extraction from the WRD Regional Brackish Water Reclamation Program.

A study was conducted to investigate the potential for all three lines to be constructed at the same time in the same trench, the benefits of which could include a streamlined construction schedule, a potentially lower cost, and less impact and disturbance to the general public.

Appendix 3 of this addendum includes an evaluation of single-trench conveyance opportunities, which was a follow-up study to the Draft Feasibility Study Report.

1.2.4 Project Refinement Impact to Feasibility Study Findings

The Preferred Projects selected by the Stakeholder Group during the Feasibility Study process included incorporation of a wellhead treatment unit and a direct product water pipeline (see Final Feasibility Study Report, Appendix A, Section 8-Potential Project Screening). The project refinements in this addendum examine a direct pipeline to LADWP rather than to the City of Manhattan Beach (as was evaluated during the initial Feasibility Study), and apply the wellhead treatment unit concept to a location in Manhattan Beach that would produce potable water exclusively for that community. Thus, the previous Feasibility Study findings, including those specifically pertaining to treatment technologies, project permitting, environmental review, and project delivery, remain valid and provide for coverage and flexibility of incorporation of the previously noted project refinements. As WRD and the Stakeholder Group move forward in detailed Program development and the evaluation of final project structures and water costs, the results of the Feasibility Study and these follow-up studies will be utilized in concert to inform all final Program decisions.

Appendix 1
Evaluate Los Angeles Department of Water and Power Product Water Pipeline

Jacobs

Technical Memorandum

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Subject	**Subtask 2 - Evaluate Los Angeles Department of Water and Power Product Water Pipeline**	**Project Name**	Regional Brackish Water Reclamation Program
Date	March 2021		

1. Introduction and Purpose

This technical memorandum (TM) presents the findings of a pipeline routing analysis for a treated water pipeline that delivers flow from the Water Replenishment District (WRD) Centralized Treatment Plant Desalter (Desalter) to a connection with the Los Angeles Department of Water and Power (LADWP) Harbor Trunkline (trunkline) near the intersection of Sepulveda Boulevard (Blvd.) and Normandie Avenue (Sepulveda and Normandie). Three feasible alternative routes have been identified that provide the foundation for further analysis and options moving forward for the next phase of the project. The analysis (as part of this study) includes:

- Identification of potential pipeline alignments between the Desalter and the connection to LADWP trunkline upstream of the Sepulveda and Normandie Flow Regulating Station, near the intersection of Sepulveda and Normandie
- Preliminary hydraulic sizing of the pipeline
- Preliminary pipeline material and pressure class recommendations
- Preliminary pipeline corrosion protection recommendations
- Blending of local product water quality (PWQ) specifications with LADWP PWQ requirements
- Preliminary distribution and conveyance system power requirements
- Potential right-of-way (ROW) and easement acquisition requirements and challenges
- Local agency coordination challenges or opportunities
- Identification of Los Angeles County Department of Public Health (DPH) regulatory requirements
- Proposed alternative implementation schedule
- Proposed alternative costs based on American Association of Cost Engineers (AACE) Class 5 estimates

1.1 Background

WRD is responsible for managing and replenishing both the West Coast and Central groundwater basins. In the West Coast Basin, a significant saline plume of groundwater with elevated total dissolved solids has been trapped in the Gage, Silverado, Lynwood, and Lower San Pedro (equivalent to Sunnyside) aquifers because of historical seawater intrusion and the subsequent implementation of two injection barriers. To more fully utilize the West Coast Basin, WRD has initiated a Regional Brackish Water Reclamation Program (Program) to evaluate ways to remediate the trapped saline plume and produce potable water for partnering agencies. LADWP has embarked on reducing imported water by maximizing local groundwater use with the objective of providing a local sustainable water supply and has an agreement with WRD for purchasing potable water produced by the Program.

This TM covers the process and results of the alternative route development for the LADWP potable water pipeline from WRD saline plume Desalter at Old City Yard, located between Elm and Faysmith Avenues in Torrance, California, to the connection point within the LADWP potable water system, located at the intersection of Sepulveda and Normandie.

2. Assumptions

The following assumptions have been made for the purposes of this study:

- A review of pipeline route alternatives has been conducted as a desktop review primarily using Google Earth.
- Site visits have not been performed as part of this review.
- The hydraulic analysis of the pipeline verified the recommended size of the pipeline and did not involve the development of a hydraulic model.
- The maximum and average daily flow used for the analysis were 10,000 acre-feet per year (AFY) and 4,350 AFY, respectively, and were assumed based on the maximum potable water produced and the rate that LADWP can receive, assuming no additional storage would be required as part of the project.
- Per Jacobs Engineering Group Inc. (Jacobs) recommendations, a maximum velocity of 7 feet per second (fps) has been assumed for cement mortar lined (CML) pipe and 10 fps has been assumed for plastic pipe.
- The pipeline will be located entirely within a public ROW and will avoid longitudinal routing within the California Department of Transportation (Caltrans) ROW; however, the pipeline will cross the Caltrans ROW.
- Trenchless construction is assumed to be at locations of rail, highway, freeway, and Caltrans ROW crossings, where the length of construction is assumed to be the width of the crossing plus 100 additional feet (that is, 50 feet on either end).
- No additional storage requirements are needed.

3. Alternatives Analysis

For the purpose of this study, a concept-level alignment for the new LADWP potable water pipeline has been analyzed from the proposed Old City Yard Centralized Desalter location to the LADWP connection on the trunkline upstream of the Sepulveda and Normandie Flow Regulating Station. The following concepts and terminology have been used in the route development process to provide identifiable and distinguishable elements that promote ease of visualization and management of the overall process.

- *Route segments (or segments)* are short, manageable reaches of pipe, often spanning a length as short as a city block, that are combined to create a group of potential alternative routes. The route segments are designated alphanumerically (for example, AA-1, AA-2, AA-3) with the alphabetical identifier representing the street on which the segment is located, and the numerical value representing the identification of a specific segment.
- *Alternative routes (or alternatives)* are the various reasonable combinations of contiguous segments assembled to create an alignment between the beginning and end points of the project.

The alternative route development process consists of the five steps shown in the dark boxes on Figure 1. The next phase of this project (that is, the Alternative Evaluation and Selection Phase) is shown in green and would be completed in the subsequent studies. This section provides descriptions of these phases and how they apply to the pipe routing process.

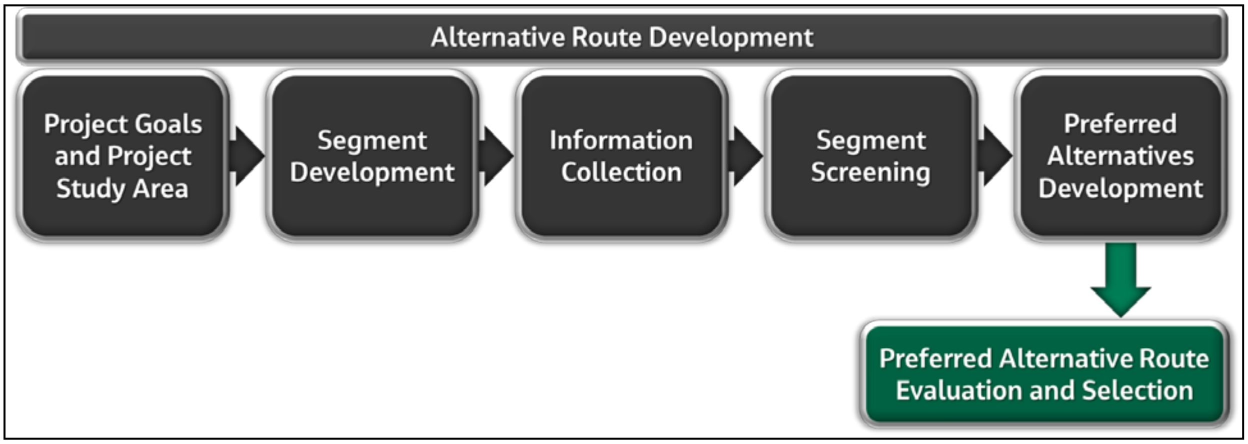

Figure 1. Alternative Route Development, Evaluation, and Selection Process

Sections 3.1 to 3.5 describe the alternative route development process, which consists of the following five steps:

1) Project goals and project study area definition
2) Segment development
3) Information collection
4) Segment screening
5) Preferred alternatives development

3.1 Project Goals and Project Study Area Definition

The overall project goal is to deliver potable water from the WRD Desalter to the LADWP water distribution system. The goal of this route development, evaluation, and selection task is to develop potential pipeline route alternatives to move forward with the next phase of the project for the eventual selection of a preferred alternative.

The project study area has been created by using the project goals to identify a reasonable area in which the pipeline could be installed between the treatment facility and the LADWP connection point on the trunkline, near the intersection of Sepulveda and Normandie. Figure 2 depicts the project study area.

3.2 Segment Development

Within the project study area, segments were placed within the public ROW, with an emphasis on streets with relatively wide drive surfaces that could accommodate a new pipeline of the size anticipated for this project. Figure 2 shows the initial route segments that were developed for this project. Due to the anticipated amount of existing buried utilities in the project area, which are expected to be encountered on practically every street, roadways with a width less than 40 feet have not been included for consideration as these surfaces would more than likely result in minimal room for a new pipeline, as well as less space for construction activities and a higher likelihood of complete road closures.

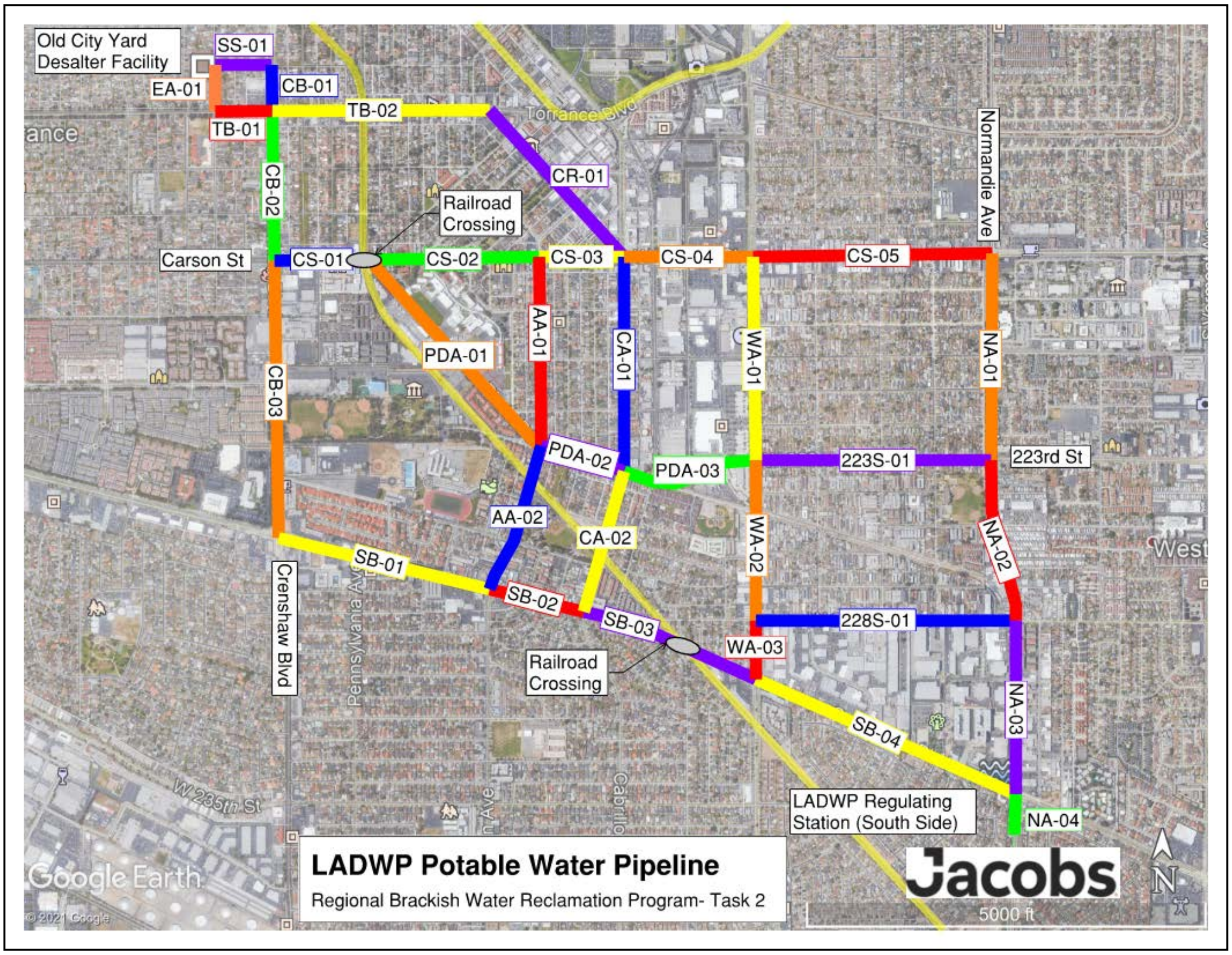

Figure 2. Los Angeles Department of Water and Power Potable Water Pipeline Initial Segments

Note: The LADWP Harbor Trunkline connection point is near the intersection of Sepulveda and Normandie. Its exact location is being further analyzed by the LADWP Water Master Planning Group, and will be finalized during later phases of the project.

3.3 Information Collection

As part of the information collection process, existing underground utility information within the project study area was collected. Previously collected utility information obtained by Jacobs, utility information provided by WRD and LADWP, and publicly available online data, including shapefiles, record drawings, or any readily available information depicting the location and size of utilities, were obtained, including public geographic information system files and other information for the following infrastructure:

- Los Angeles County storm drains
- Metropolitan Water District of Southern California pipelines
- Los Angeles Bureau of Sanitation sewers
- LADWP pipelines and underground electric lines
- WRD recycled water pipelines
- Gas pipelines

To the fullest extent possible, attempts will be made to avoid conflicts with existing utilities. Utilities have been reviewed in Google Earth to identify routes that minimize potential large-diameter utility relocations. In cases where utilities within a segment have diameters equal to or larger than 24 inches, the horizontal clearance between the LADWP pipeline and existing utilities have been reviewed at a high-level using Google Earth to optimally provide a minimum separation of 10 feet.

3.4 Segment Screening

Segment screening consisted of individual segment review and the elimination of less favorable segment choices. The initial segments were screened and evaluated based on various high-level criteria, such as:

- Fatal flaws, such as being located within the Caltrans ROW (not including crossings), and possible major disruptions to the public
- Obstruction of entrances to critical and emergency services, such as fire stations, schools, and hospitals
- Potential major utility interferences
- Residential and business frontage
- Street width

The screening process included the following three sequential steps:

1) **Step 1**: screen and eliminate segments if they are longitudinally located within the Caltrans ROW, or if they contain extra trenchless crossings (such as, crossing a railroad). For example, segments within Western Avenue, which is also California State Route (SR) 213 and maintained by Caltrans, were eliminated.
2) **Step 2**: compare adjacent segments using criteria, such as constructability, street width and length, proximity to emergency service facilities and schools, utility congestion, and relative disturbance to residents and businesses. For example, when comparing adjacent parallel segments along Arlington Avenue and Cabrillo Avenue, the segments along Arlington Avenue would interfere with the access to more residencies when compared with Cabrillo Avenue; therefore, segments in Arlington Avenue were eliminated in Step 2. This process was repeated for situations where segments were parallel or adjacent to one another.
3) **Step 3**: eliminate the residual segments that were previously connected to segments eliminated in Steps 1 and 2 that are now no longer connected to other segments (that is, segments that no longer have continuity). For example, when segment AA-02 was eliminated, segment AA-01 was no longer connected to other segments to contribute to a potential pipeline route; therefore, segment AA-01 was eliminated. This process was repeated for all other disconnected route segments.

Table 1 provides a complete summary of the segments eliminated after the screening process. Refer to Appendix A for a detailed summary of the criteria that led to eliminating segments shown in Table 1.

Table 1. Steps 1, 2, and 3 Eliminated Segments

Roadway Name	Eliminated Segment ID	Segment Screening Criteria				
		Step 1		Step 2		Step 3
		Caltrans ROW	Additional RR Crossing	Constructability: Street Width, Length, and Future Construction	Hospitals, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Torrance Blvd.	TB-02					TB-02
Cravens Avenue	CR-01			•		
Plaza Del Amo	PDA-01 PDA-02				•	PDA-02
228th Street	228S-01			•		
Arlington Avenue	AA-1 AA-02		•			AA-01
Cabrillo Avenue	CA-02		•			
Western Avenue	WA-01 WA-02 WA-03	•				

Notes:

ID = identification

RR = railroad

Figure 3 presents the segments that remained after the elimination of unfavorable segments during the screening process. The number of segments was reduced from 32 to 22, and the remaining segments were used to develop the pipeline route alternatives.

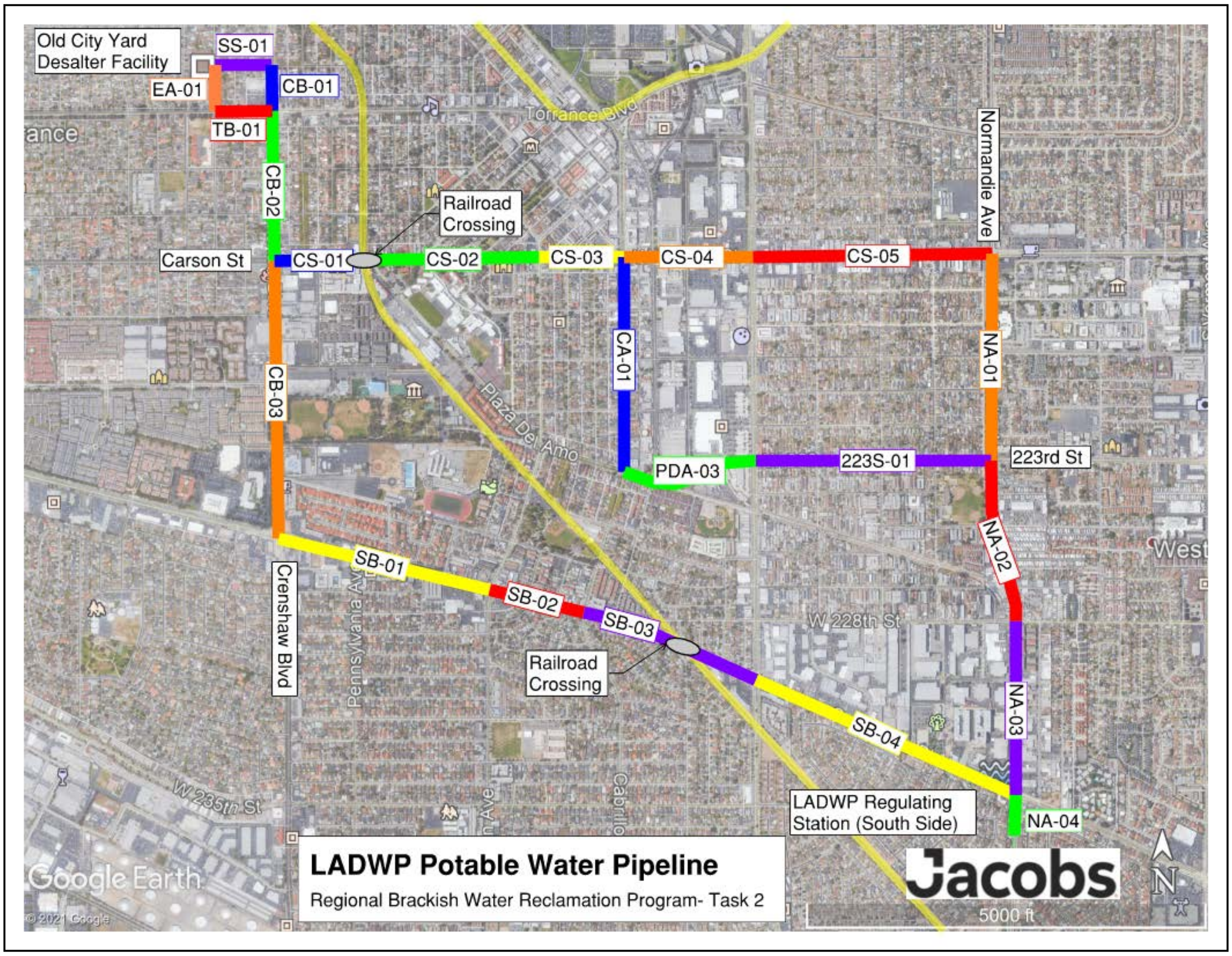

Figure 3. Los Angeles Department of Water and Power Potable Water Pipeline Remaining Segments

Note: The LADWP Harbor Trunkline connection point is near the intersection of Sepulveda and Normandie. Its exact location is being further analyzed by the LADWP Water Master Planning Group, and will be finalized during later phases of the project.

3.5 Preferred Alignment Alternatives Development

Segments that remained after the three-step screening process were used to develop alternative routes for the pipeline between the Desalter and the connection to the trunkline, as shown on Figure 4 Jacobs recommends three alternatives to carry forward for consideration in the next phase of the project.

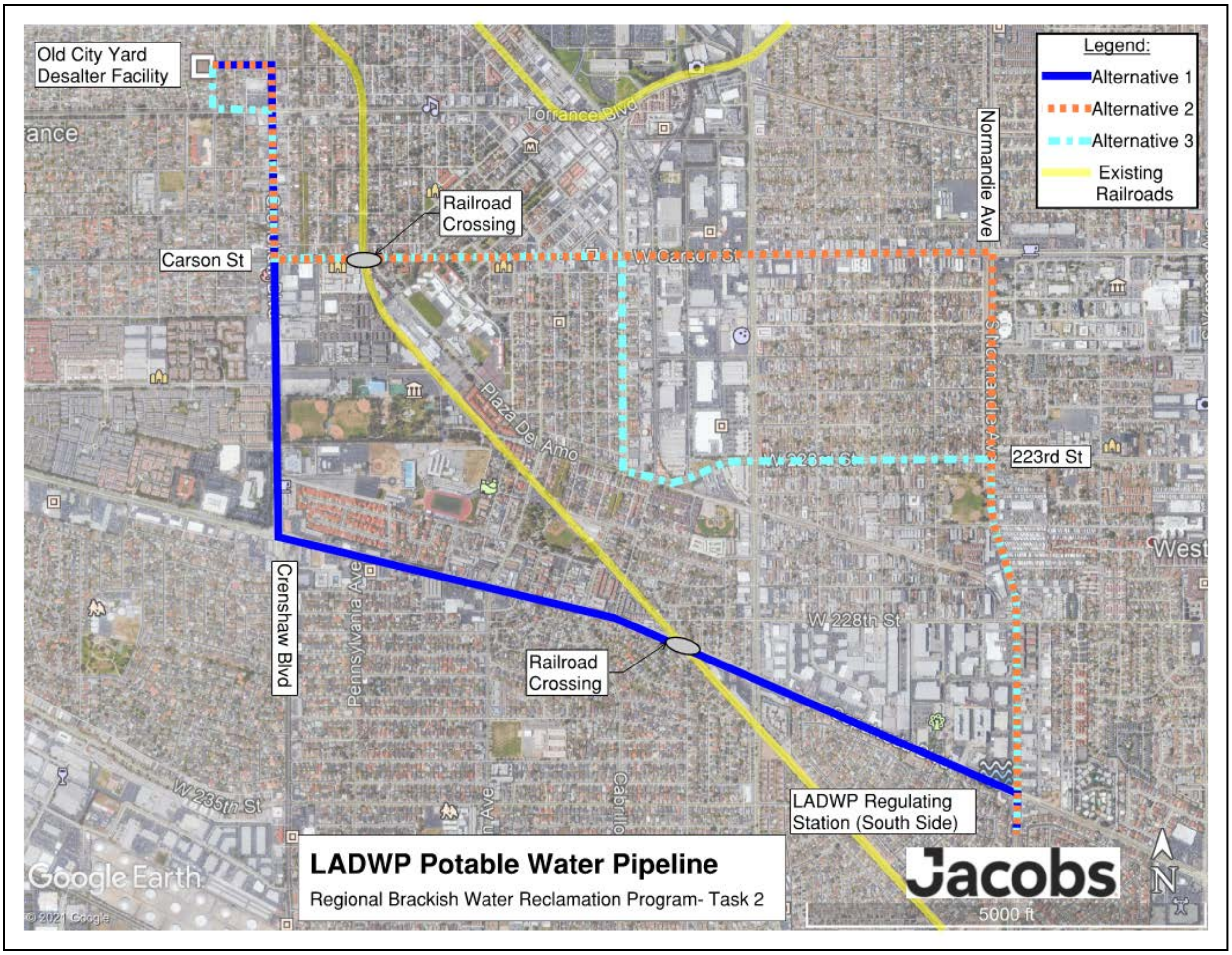

Figure 4. Los Angeles Department of Water and Power Potable Water Pipeline Preferred Alternatives

Note: The LADWP Harbor Trunkline connection point is near the intersection of Sepulveda and Normandie and its exact location is being further analyzed by the LADWP Water Master Planning Group and will be finalized during later phases of the project.

Alternative 1 heads east on Sierra Street from the Desalter, then south on Crenshaw Blvd., and then east on Sepulveda Blvd. Alternative 1 is approximately 3.18 miles long and consists of the flowing segments: SS-01, CB-01, CB-02, CB-03, SB-01, SB-02, SB-03, SB-04, and NA-04.

Alternative 2 heads east on Sierra Street from the Desalter, then south on Crenshaw Blvd., then east on Carson Street, then south on Normandie Avenue. Alternative 2 is approximately 3.64 miles long and consists of the following segments: EA-01, TB-01, CB-02, CS-01, CS-02, CS-03, CA-01, PDA-03, 223S-01, NA-02, NA-03, and NA-04.

Alternative 3 heads south on Elm Avenue, then east on Torrance Blvd., then south on Crenshaw Blvd., then east on Carson Street, then south on Cabrillo Avenue, then east on Plaza Del Amo and 233rd Street, and then south on Normandie Avenue. Alternative 3 is approximately 3.68 miles long and consists of the following segments: SS-01, CB-01, CB-02, CS-01, CS-02, CS-03, CS-04, CS-05, NA-01, NA-02, NA-03, and NA-04.

3.6 Pipe Sizing

The diameter for the pipeline was calculated based on the capacity that LADWP indicated it could accept at the connection with the trunkline: an average of 6 cubic feet per second, or 4,350 AFY. For this preliminary pipe sizing exercise, a maximum flow velocity of 7 fps has been assumed for CML pipe, and 10 fps has been assumed for plastic pipe.

The pipe materials that have been considered at this stage of the project include welded steel pipe (WSP) and earthquake-resistant ductile iron pipe (ERDIP). WSP fabricated with A1018, Grade 36, Type 1 structural steel with a wall thickness of 3/16 inch and cement mortar lining with a thickness of 3/8 inch is assumed for this conceptual stage.

Table 2 shows the inside pipe diameter and resulting velocity for the minimum, average design, and peak flow requirements.

Table 2. Pipeline Material and Corresponding Diameters and Calculated Velocities

Pipe Material	Diameter (inches)		Velocity (fps)			
	Nominal	Actual ID	Low (Q = 1,000 AFY)	Average (Q = 4,350 AFY)	High (Q = 10,000 AFY)	Recommended Maximum
HDPE – DR-11, 200 psi rating	20	17.436	0.83	3.62	8.32	10.0
WSP – 3/16-inch wall with CML	20	18.50	0.74	3.22	7.39	7.0
ERDIP – 0.34-inch wall	18	18.03	0.78	3.39	7.79	7.0

Notes:

HDPE = high-density polyethylene pipe

psi = pound(s) per square inch

The resulting velocities for the anticipated flows for both pipe materials are within an acceptable range, per Jacobs recommendations, that meets the assumed design criteria. Decreasing the pipe diameter in either instance would exceed the recommended maximum velocity for sustained usage should a flow of 10,000 AFY be delivered to LADWP, and as a result, it is not recommended to decrease pipe size at this time.

3.7 Pipe Material and Corrosion Analysis

Pipe materials that have been considered for the new pipeline include:

- ERDIP
- WSP
- HDPE

3.7.1 Earthquake-resistant Ductile Iron Pipe

ERDIP utilizes typical ductile-iron pipe (DIP) dimensions and standards with specialized joint connections that allow for flexibility without breakage in a seismic event. While no known fault lines are crossed in this alignment, liquefaction and lateral spreading may be of concern and should be evaluated during future design phases of the project. ERDIP is fabricated and designed the same as typical DIP in accordance with American Water Works Association (AWWA) *C150-08 Thickness Design of Ductile-Iron Pipe*. Typical DIP joint connections include push-on, mechanical joint, and proprietary restrained joints, all of which are in accordance with AWWA *C111-12 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings* and AWWA *C110-12 Ductile-Iron and Gray-Iron Fittings*. ERDIP joints are specially designed push-on joints that are typically composed with locking rings and spigot projections that allow for 1 percent lateral expansion and 5 degrees of deflection before failure. The ERDIP joints referenced for this design are manufactured by U.S. Pipe.

Corrosion mitigation practice for ERDIP typically includes protective coatings in accordance with AWWA *C151-09 Ductile-Iron Pipe, Centrifugally Cast* and requires the use of polybags (as recommended by the Ductile Iron Pipe Research Association), though polybags are not recommended in areas with high, salty groundwater. Other practices include bonding joints to allow for the monitoring of electrical continuity, additional exterior coating, and cathodic protection systems, such as galvanic anodes.

3.7.2 Welded Steel Pipe

WSP design should be in accordance with AWWA design manual M11, and standards *C200-17 Steel Water Pipe, 6 In. (150 mm) and Larger*, and *C205-18 Cement–Mortar Protective Lining and Coating for Steel Water Pipe – 4 In. (100 mm) and Larger - Shop Applied*.

The relatively small-diameter pipe recommended for this project could present construction difficulties in field welding but should not be considered as a major flaw. WSP is highly subject to corrosion and will require exterior coating and a cathodic protection system, such as an impressed current system or galvanic anodes. The cathodic protection system is to be determined during the final design.

3.7.3 High-density Polyethylene Pipe

HDPE is a flexible plastic pipe that is resistant to chemical and corrosive degradation. For pipe diameters that are 4 to 64 inches, HDPE is fabricated and designed in accordance with AWWA *C906-07*: *Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in. (1,600 mm), for Water Distribution and Transmission*, and the AWWA *M55 PE Pipe - Design and Installation*. Joints for HDPE pipe are typically achieved via thermal heat fusion or electrofusion. The fused joints are restrained, which eliminates the need for further thrust restraint or thrust blocks.

Corrosion concerns are negligible when considering HDPE pipe; however, it is potentially susceptible to degradation when in contact with potable water disinfectants. The severity of this degradation changes based on multiple factors, so further evaluation is recommended in future design phases. For additional information, refer to *Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants: TN-44/2015* (Plastics Pipe Institute 2015).

3.7.4 Preliminary Pipe Material and Class

The pipe material assumed for this project is 18-inch diameter, class 250 psi-rated ERDIP with earthquake-resistant bell- and spigot-gasketed connections. The 250-psi class is the lowest pressure class available for this diameter size, and is rated well above the pressures anticipated for this pipeline. However, it is recommended that further evaluation of WSP should be considered and coordinated with LADWP to discuss the benefits of pipe with a potential lower cost.

3.8 Right-of-way and Easement Acquisition

The conceptual alignments are located entirely within a public ROW to minimize the need to acquire temporary construction or permanent easements. In previous coordination efforts with LADWP, construction within a public ROW and roadways is preferred, and it is unlikely that land acquisition will be required for this project. However, evaluation of land acquisition should be discussed during the next phase of the project, when the route is refined, and more information emerges regarding the finer details of the pipeline.

3.9 Permitting and Approvals

Permits and approvals from regulatory agencies have not been obtained for the project and will require coordination in future phases. This section explores the probable coordination efforts that will be required during the design and construction phases. In addition to construction and regulatory permits, field activities, such as geotechnical and subsurface utility exploration programs, will be required prior to final design.

Table 3. Pipeline Summary of Anticipated Permits and Approvals

Agency	Permit/Approval
Lead agency to be determined	CEQA
Caltrans ▪ Western Avenue (California SR-213) ▪ Caltrans Rail 13	Encroachment permit and traffic control
City of Los Angeles	Includes an encroachment permit, traffic control, discharge, and site development (that is, any municipal local construction permits required for construction in the City of Los Angeles)
City of Torrance	Includes an encroachment permit, traffic control, discharge, and site development (that is, any municipal local construction permits required for construction in the City of Torrance)
DDW State Water Resources Control Board	Approval required for the reduction of utility separation requirements

Notes:

CEQA = California Environmental Quality Act

DDW = Division of Drinking Water

3.9.1 California Department of Transportation

Within the project study area, Caltrans has jurisdiction over California SR-213 (Western Avenue) and Caltrans Rail 13, near the Sepulveda Blvd. and Walnut Street intersection. An encroachment permit is required for all proposed activities under, over, and within the Caltrans ROW. A standard encroachment permit application and supporting documentation includes pipeline designs drawings, traffic management plans, environmental documentation, and a Letter of Authorization. The encroachment permit package is to be submitted to the Caltrans District 7 address listed herein:

Caltrans District 7
100 South Main Street, Suite 100
Los Angeles, California 90012
213.897.3631

The fee for the permit covers the time for Caltrans staff to review and inspect the project area, as well as a deposit with the permit application. The approval process may take up to 60 days.

3.9.2 City of Los Angeles Bureau of Engineering

An encroachment permit and other potential construction-related permits may be required for work conducted in the City of Los Angeles ROW. The segments within the City of Los Angeles boundary include east-west segments CS-05, 223S-01, 228S-01, and SB-04. Encroachment permits, or "B" Permits, require design plans and traffic management plans to be submitted to the City of Los Angeles Bureau of Engineering at the following address:

City of Los Angeles Department of Public Works
Bureau of Engineering
Permit Case Management Office
201 N. Figueroa Street, 2nd Floor Room 200
Los Angeles, California 90012-2601

Permit fees include plan checking deposits, construction inspection deposits, and an application fee.

Other construction-related permits may be required but are typically not required during the design phase of the project and can be deferred to the contractor during construction.

3.9.3 City of Torrance

Portions of the pipeline within the City of Torrance include all segments west of SR-213 and require an encroachment permit issued by the city. The encroachment permit application requires design plans and traffic management plans to be submitted to the City of Torrance Community Development Department at the address listed herein:

City of Torrance, Community Development Department
Attn: Permit Section
3031 Torrance Boulevard
Torrance, California 90503
310.618.589

The City of Torrance Permit Section and City Engineer will review the encroachment permit application package, and once approved, an administrative fee will be required to be paid before the permit can be issued.

3.9.4 Division of Drinking Water Requirements

This project parallels several existing underground utilities, including water and sewer lines. Title 22 of the *California Code of Regulations* establishes the separation criteria between these existing utilities, which are enforced by the DDW. The criteria are as follows:

- 4 feet horizontally and 1 foot vertically from potable and recycled water lines (edge to edge)
- 10 feet horizontally and 1 foot vertically above wastewater (including brine) lines (edge to edge)

If these distances prove to be prohibitive, approval can be obtained from DDW for proposed alternatives that meet at least the "same level of protection to public health" as the previously described minimum distances.

3.9.5 Department of Public Health Regulatory Requirements

The Los Angeles County DPH specifies additional documentation required for new water line construction projects. Receipt of approval must be provided by the Environmental Health Division and requires the project to have a Plan Check Number (PCN) and a legal address before submission of an application. The PCN and legal address are obtained by submission of a construction drawing sent to the Los Angeles County Department of Public Works, Division of Building and Safety, or the City Building Authority. After receipt of the PCN and legal address, the applicant must submit the following documentation to the Environmental Health Division:

- A Service Request Application (with the accompanying fee), which must include the date that plans were received by the Los Angeles County Department of Public Works, Division of Building and Safety, and the PCN
- A will serve letter on water company letterhead, which must state that the project water meets Safe Drinking Water Standards, and include the Public Water System Number assigned by the California DPH

3.9.6 California Environmental Quality Act

The CEQA process requires projects to obtain a biological technical report, a cultural resources report, a noise study, and an air quality study to proceed with construction. These reports can be completed based on the proposed alignments in this TM. Future project work will require the identification of a lead agency to move the CEQA process forward.

3.10 Power Requirements

A pump station will be required to deliver LADWP flows from the Desalter to the proposed connection with the trunkline at Sepulveda and Normandie. A preliminary hydraulic analysis was conducted to establish the approximate power requirements needed by the pump station. The hydraulic analysis assumed the following:

- Average flow: 4,350 AFY
- Discharge water surface elevation at the Desalter: 107 feet
- Sepulveda and Normandie trunkline pressure: 320 feet (139 psi)
- Pipe material: ERDIP
- Pipe ID: 18.03 inches
- Pipe length: 19,120 feet (corresponding to the longest alternative, Alternative 3)
- Pipe absolute roughness coefficient: 0.0015 feet

Based on these assumptions, the pump station will require approximately 260 feet of total dynamic head to deliver a flow of 4,350 AFY. Use of a preliminary motor efficiency of around 93 percent, an electric cost of $0.10 per kilowatt-hour (kWh), and the preliminary pump selection with an efficiency of 82.5 percent results in an estimated total power consumption of 171 kWh and an energy cost of $17.10 per hour by the pumping units. This power consumption is for pumping costs only and does not include ancillary costs for heating, ventilation, and air conditioning, lighting, or any other requirements by the pump station.

4. Implementation and Cost

4.1 Implementation Schedule

The length of the pipeline and the relatively small number of jurisdictions impacted by construction are conducive for the entire pipeline to be packaged as a single contract. However, coordination with LADWP during the design phase will be required to reach a consensus and to determine the design and construction packaging intent.

Construction is anticipated to primarily utilize open-cut and trench methods with a minimum depth of cover between 4 and 5 feet. Trenchless construction would be required at the Caltrans crossings and in any situation where utilities would be difficult to avoid and ground conditions would prohibit or hinder open-trench construction. Based on the size of the pipe and the casing required for trenchless installations, a tunnel boring machine (TBM), jack and bore, auger boring, and horizontal direction drilling are feasible methods that should be evaluated as trenchless construction methods.

Based on the length of the pipeline and the nature of construction within highly urban and developed areas in Los Angeles County, the duration of construction of this pipeline is anticipated to be around 1 year. Construction will span multiple seasons; therefore, project phasing issues, such as local moratoriums and seasonal restrictions, should be considered.

4.2 Opinion of Probable Construction Cost

The assumed total length of the LADWP potable water pipeline is 19,120 feet. Approximately 350 feet is anticipated to be constructed via trenchless installation, with the remainder installed via open-trench construction.

The unit cost for pipe material and installation from the LADWP *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects* (Trunkline Design Manual) indicates that WSP and ERDIP are LADWP's two preferred primary materials (LADWP 2019). (Note: LADWP has indicated that it is currently in the process of updating its unit costs, which have not been reflected in a revised manual as of the issuance of this TM.)

- The ERDIP material cost is estimated from $30 to $35 per diameter-inch per linear foot (dia-in/lf) for pipelines that range in size less than 30 inches in diameter. This material cost assumption by LADWP will provide a basis for a conservative estimate.
- Open-cut pipe installation for ERDIP is estimated by LADWP to range from $15 to $20 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) that ranges from $45 to $55 per dia-in/lf.
- The WSP material cost is estimated from $12 to $15 per dia-in/lf for pipelines that range in size from 30 to 96 inches with CML, cement mortar coating, and a wall thickness of 0.5 inch. In a separate effort, Jacobs obtained a unit cost of $12 per dia-in/lf for steel pipe from a recent price quote from the largest steel pipe supplier in the western United States (U.S.). Since these two sources correlate to similar unit costs, it is assumed for the purposes of this estimate that a cost of $12 per dia-in/lf would suffice since the diameter and wall thickness for the pipeline will be smaller than the assumptions used by LADWP, and as a result, would provide a basis for a conservative estimate.
- Open-cut pipe installation for WSP is estimated by LADWP to range from $20 to $25 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) that ranges from $32 to $37 per dia-in/lf. Typically, conceptual-level unit costs for steel pipe construction in an urban environment can be expected to be $25 per dia-in/lf . This unit cost is based

on recent pricing that Jacobs estimated for a steel pipeline construction project in another urban center within the western U.S. Although the current Engineering News Record (ENR) Construction Cost Index (CCI) for Los Angeles is approximately 5 percent higher than the national ENR CCI, it is not unreasonable to observe a larger increase for pipeline construction in Los Angeles than many other areas in the country. Using a $32 per dia-in/lf unit cost compared with a $25 per dia-in/lf unit cost, which results in a 28 percent increase, seems conservatively reasonable considering that pipe material, labor, equipment costs, and contractor markups would be higher in the greater Los Angeles area than most other places.

- A material unit cost of $1.89 per dia-in/lf for HDPE pipe has been determined based on a pipe material quote for ductile iron pipe size (DIPS), dimension ratio (DR) 11, PE4710 HDPE pipe from one of the largest HDPE pipe suppliers in the U.S., and typical contractor markups expected in Southern California based on recent bids on a cost-per-weight estimate. An installation cost for HDPE pipe has been obtained through recent construction cost estimates and bids for similar HDPE pipe installations in Southern California, resulting in a unit cost (including contractor markups, but excluding pipe material cost and contingency) of $11.03 per dia-in/lf. The total all-in construction cost using HDPE pipe, including a 40 percent contingency, is estimated to be $21.67 per dia-in/lf, when considering 20-inch-diameter pipe.

All unit costs used for this OPCC includes a 40 percent contingency. An additional 3.56 percent due to inflation is also used to bring the unit cost to current 2021 dollars per the ENR CCI. Table 3 presents the OPCC for the project for ERDIP construction in 2021 dollars. The estimate was prepared as a Class 5 cost estimate in accordance with the AACE) International standards of estimation in *AACE International Recommended Practice No. 18R-97*. The specified Class 5 estimate reflects a design level of 0 to 2 percent and suggests that the estimate is in the range of -50 to +100 percent.

An open-face rotary TBM is assumed at this stage of the project for trenchless installations, which more than likely would produce the most conservative estimate. The cost to install a 48-inch-diameter steel casing for an 18-inch-diameter pipeline is $75 per dia-in/lf, based on recent project costs of similar trenchless installations.

Table 3 presents the total pipeline construction cost estimate for ERDIP, WSP, and HDPE.

Table 3. Los Angeles Department of Water and Power Potable Water Pipeline Cost Estimates

Pipeline Cost Estimates		
18-inch ERDIP	**20-inch WSP**	**20-inch HDPE**
$28,178,000	$18,353,000	$8,846,000

Note: The impacts of the COVID-19 pandemic on the construction industry is not known at this time and will likely have some impact on the costs presented.

As a Class 5 estimate, this cost is generally prepared based on limited information and, subsequently, has a wide accuracy range. This level of estimate is typically used for project screening, assessment of initial viability, evaluation of alternate schemes, project location studies, and long-range capital planning (Table 4).

Table 4. Earthquake-resistant Ductile Iron Pipe Estimate Range

Low Range (-50%)	Estimated Cost	High Range (+100%)
$14,089,000	$28,178,000	$56,356,000

Note: The impacts of the COVID-19 pandemic on the construction industry is not known at this time and will likely have some impact on the costs presented.

% = percent

4.3 Recommended Next Steps

Conclusions and recommendations from the LADWP potable water pipeline evaluation include the following:

- A nominal pipeline diameter of 18 inches is appropriate for the LADWP potable water pipeline, when considering ERDIP, and a diameter of 20 inches is appropriate when considering WSP and HDPE.
- Confirmation from LADWP on the maximum anticipated flow rate that they can accept will need to be coordinated and finalized.
- Geotechnical and utility field investigations are required in the preliminary design phase of the project to obtain detailed information that can help determine the most appropriate trenchless construction method and whether additional trenchless installations are warranted.
- Coordination with the various cities and regulatory agencies is required to determine the final requirements necessary for permitting the project.

5. References

Los Angeles Department of Water and Power (LADWP). 2019. *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects*. April.

Plastic Pipe Institute. 2015. *Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants: TN-44/2015."*

Appendix A
Segment Screening

Old City Yard Desalter to the Los Angeles Department of Water and Power Decommissioned Reservoir

1. Sierra Street (SS-01)

- Width: 65 feet; median with mature trees planter; residential street
- Right-of-way (ROW): Public
- Utilities: City of Torrance Utility Request to be purchased
- Segment-specific issues
  - None

2. Elm Avenue (EA-01)

- Width: 33 feet; residential; no medians
- ROW: Public
- Utilities: City of Torrance Utility Request to be purchased
- Segment-specific issues
  - None

3. Torrance Boulevard (Blvd.) (TB-01 to TB-02)

- Width: 75 to 78 feet; three lanes each way (TB-01) to two lanes each way with a turning lane (TB-02)
- ROW: Public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
TB-01	SD	Perpendicular at Crenshaw Blvd	24	RCP
TB-02	SD	South eastbound lane	24- 36	RCP
Notes: SD = Storm Drain utility RCP = Reinforced Concrete Pipe				

- Segment-specific issues:
  - TB-02: railroad (RR) crossing

4. Crenshaw Blvd. (CB-01 to CB-03)

- Width: 77 to 83 feet; median; three lanes each way and a median
- ROW: Public, not maintained by California Department of Transportation (Caltrans)
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CB-01	SD	Perpendicular at El Dorado St	18	Unknown
CB-02	SD	Westside southbound	18- 36	RCB/ RCP
CB-02	SS	Westside southbound	8	VCP
CB-03	SD	Eastside northbound until Jefferson St, then Westside southbound	18- 36	RCP
Notes:				

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
SS = Sanitary Sewer utility RCB = Reinforced Concrete Box VCP = Vitrified Clay Pipe				

- Segment-specific issues:
  - CB-02: Torrance Fire Department, north end

5. Sepulveda Blvd. (SB-01 to SB-04)

- Width: 77 to 83 feet; commercial; three lanes each way and a turning lane
- ROW: Public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
SB-01	SD	South eastbound lane	18- 60	RCP
SB-02	SD	South eastbound lane	27	RCP
SB-03	SD	Perpendicular at RR crossing	15	RCP
SB-04	SD	South eastbound lane	8- 78	RCP
SB-04	SS	North westbound lane	8- 15	VCP
SB-04	PWR	North westbound lane	Not applicable	Not applicable
SB-04	WTR	South eastbound lane and both lanes after Lockness Ave	8- 16	CI, DI, STL
SB-04	WTR	Perpendicular at Normandie Ave	31.4	STL- trunkline
Notes: PWR = Power underground (utility) WTR = Water (utility) CI = Cast Iron pipe DI = Ductile Iron pipe STL = Steel pipe				

- Segment-specific issues:
  - SB-03: RR crossing

6. Cravens Avenue (CR-01)

- Width: 45 feet; commercial; no medians
- ROW: Public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CR-01	SD	Perpendicular at Cabrillo Ave	24	Unknown

- Segment-specific issues:
  - Multiple business buildings

7. West Carson Street (CS-01 to CS-05)

- Width: 58 to 80 feet; commercial and residential; two lanes each way and a turning lane
- ROW: Public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CS-01	SD	Perpendicular at Crenshaw Blvd and Madrird Ave	18- 39	RCP
CS-01	SS	South eastbound lane	10	VCP
CS-02	SD	North westbound lane	15- 42	RCP
CS-03	SD	Center turning lane	18- 39	RCP
CS-04	SD	Center turning lane	18- 36	RCP
CS-05	SD	Perpendicular at Denker Ave	Unknown	Unknown
CS-05	SS	Center turning lane	8- 63	VCP, RCP
CS-05	WTR	South eastbound lane	6- 8	DI, CI,

- Segment-specific issues:
  - CS-01: private Catholic school, east side
  - CS-01: RR crossing

8. Plaza Del Amo (PDA-01 to PDA-03, and 223S-01)

- Width: 38 to 80 feet; PDA-01, one lane each way; PDA-02 median; PDA-03, two lanes each way and a turning lane or median; commercial and residential
- ROW: Public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
PDA-01	SS	South eastbound lane	10	VCP
PDA-01	SD	South eastbound lane	51- 54	RCP
PDA-02	SD	Perpendicular at Arlington Ave	24	Unknown
PDA-03	SD	North westbound lane	18- 36	RCP
223S-01	SD	Perpendicular at Western Ave and Normandie Ave	30-60	Unknown
223S-01	SS	Center turning lane	8	VCP
223S-01	WTR	South eastbound lane	6	CI, AC
Notes: AC = Asbestos-Cement pipe				

- Segment-specific issues:
  - PDA-01 between school parking and buildings - Torrance Tartars, Torrance Unified School District

9. West 228th Street (228S-01)

- Width: 39 feet; no medians; commercial street
- ROW: Public

- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
228S-01	SD	Perpendicular at Normandie Ave	21- 96	RCP
228S-01	SS	Center turning lane	8- 15	VCP
228S-01	WTR	North westbound lane	6- 12	AC, DI

- Segment-specific issues:
  - None

10. Arlington Avenue (AA-01 to AA-02)

- Width: 50 to 60 feet; commercial and residential
- ROW: Public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
AA-01	SD	Westside southbound	15- 54	RCP
AA-02	SD	Westside southbound	15- 24	RCP

- Segment-specific issues:
  - AA-01: Residential Frontage
  - AA-02: RR crossing

11. Cabrillo Avenue (CA-01 to CA-02)

- Width: 54 to 80 feet; commercial to residential; two lanes each way with a turning lane or median
- ROW: Public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CA-01	SD	Center turning lane to 220th S St, then Eastside northbound	15- 69	RCP

- Segment specific issues:
  - CA-02: Private Torrance Montessori school
  - CA-02: RR crossing

12. Western Avenue (WA-01 to WA-03)

- Width: 76 to 81 feet; commercial; two lanes each way and a median; highway
- ROW: Maintained by Caltrans (Highway 213)
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
WA-01	SD	Westside southbound to 223rd S St, then Eastside northbound	15- 51	RCP
WA-01	WTR	Eastside northbound	8	Unknown
WA-02	SD	Eastside northbound	33	RCP
WA-02	WTR	Eastside northbound	8	Unknown

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
WA-03	SS	Center turning lane	15	VCP
WA-03	WTR	Eastside northbound	8	Unknown

- Segment-specific issues:
  - None

13. Normandie Avenue (NA-01 to NA-04)

- Width: 57 to 73 feet; commercial; two lanes each way and a turning lane (next to a very large empty median along segment NA-01)
- ROW: Public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
NA-01	SS	Westside southbound, other side of planter strip	63- 90	RCP
NA-01	WTR	Westside southbound, other side of planter strip	8	Unknown
NA-01	WTR	Eastside northbound	31.4	STL- trunkline
NA-01	SD	Perpendicular at 220th S St	15- 24	RCP
NA-02	SS	Eastside northbound	8- 15	VCP
NA-02	SD	Perpendicular at 228th S St	18- 96	RCP
NA-02	WTR	Eastside northbound	31.4	STL- trunkline
NA-03	WTR	Eastside northbound	31.4	STL- trunkline
NA-04	SD	Westside southbound	78	RCP
NA-04	WTR	Eastside northbound	31.4	STL- trunkline

- Segment-specific issues:
  - NA-01: multiple hospital entrances, north side

		Segment Screening Criteria				
		Step 1		***Step 2***		***Step 3***
Roadway Name	***Segment ID***	Caltrans ROW	Unnecessary RR Crossing	Constructability: Street Width, Length, and Future Construction	Hospitals, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Sierra Street	SS-01					
Elm Avenue	EA-01					
Torrance Boulevard	TB-01— 02					TB-02
Crenshaw Boulevard	CB-01—03					
Sepulveda Boulevard	SB-01—04					
Cravens Avenue	CR-01			•		
Carson Street	CS-01—05					
Plaza Del Amo	PDA-01—03				PDA-01	PDA-02
223rd Street	223S-01					
228th Street	228S-01			•		
Arlington Avenue	AA-01—02		AA-02		AA-01	
Cabrillo Avenue	CA-01—02		CA-02			
Western Avenue	WA-01—03	•				
Normandie Avenue	NA-01—04					

Appendix 2
Evaluate Manhattan Beach Wellhead Treatment and Blending

Jacobs

Technical Memorandum

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Subject	**Subtask 3 - Evaluate Manhattan Beach Wellhead Treatment and Blending**	**Project Name**	Regional Brackish Water Reclamation Program Feasibility Study
Date	March 2021		

1. Introduction and Purpose

This technical memorandum (TM) presents the cost analysis findings for the extraction, conveyance, and treatment of the saline plume water to supplement the City of Manhattan Beach potable water supply by 1,600 acre-feet per year (AFY). Specifically, this remote wellhead treatment project includes well water to be extracted on the grounds of the Meadows Avenue Elementary School (MAES) and routed for treatment and storage at the Peck Reservoir site. This TM also includes the suggested target potable water quality, including required remineralization, and a pipeline route study that has been conducted for the extracted saline well water.

1.1 Background

The Water Replenishment District of Southern California (WRD) is responsible for managing and replenishing both the West Coast and Central groundwater basins. In the West Coast Basin, a significant saline plume of groundwater with elevated total dissolved solids (TDS) has been trapped in the Gage, Silverado, Lynwood, and Lower San Pedro (equivalent to Sunnyside) aquifers because of historical seawater intrusion and the subsequent implementation of two injection barriers. To more fully utilize the West Coast Basin, WRD has initiated a Regional Brackish Water Reclamation Program (Program) to evaluate ways to utilize this impaired water supply. Program goals include treating the plume to produce potable water, and to discharge waste streams generated in the treatment process (which consists mostly of high-salinity brine or concentrate). This TM is part of an effort for the City of Manhattan Beach to receive water from this Program.

2. Water Quality

A Google Earth snapshot of the Manhattan Beach service area is depicted on Figure 1. The image also includes the location of the saline plume, which is color coded to display plume levels of chloride ion with green representing above 3,000 milligrams per liter (mg/L), blue representing above 1,000 to 3,000 mg/L, and purple representing 500 to 1,000 mg/L. MAES has been selected for extraction as it contains public land located above the highest salinity section of the plume.

Figure 1 also displays the location of the Manhattan Beach monitoring well (MBMW). WRD maintains a West Coast Basin database that includes water quality information for both full-scale extraction wells (shown as blue dots) and a set of monitoring wells in the basin. Although MBMW does not extract water from the isolation section of the plume under MAES, this well is the source of high-salinity plume water quality information closest to the MAES extraction location. Information in this TM is based on the water quality information available from MBMW, and Jacobs recommends that information on the water quality of the plume under MAES be developed in the next phase of this project.

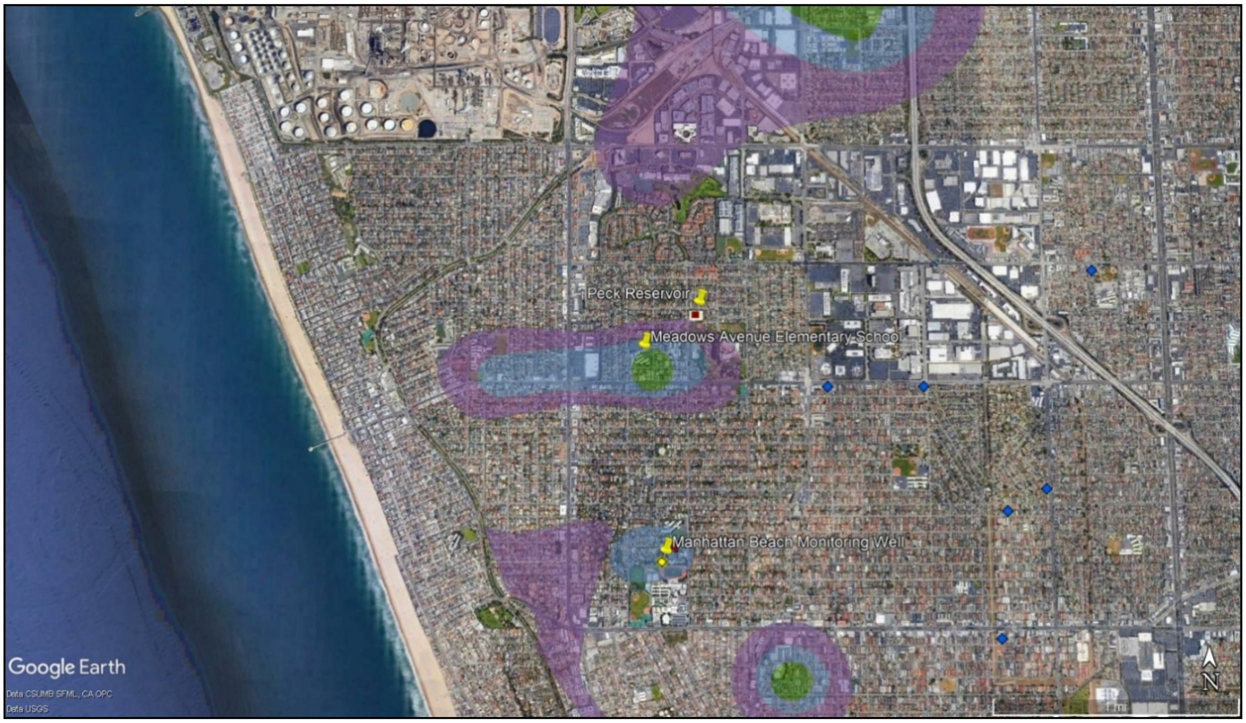


Figure 1. Aerial Image of Saline Plumes and Monitoring Well in the City of Manhattan Beach

MBMW provides water quality at seven different depths (Table 1).

Table 1. Manhattan Beach Monitoring Well Water Quality and Composite Expected Water Quality for Treatment

Extraction Depth (feet below grade) Constituent (mg/L)	1,950 – 1,990	1,570 – 1,590	1,250 – 1,270	865 - 885	640 - 660	320 - 340	180 - 200	Composite of Five Zones Closest to the Surface
Alkalinity	580	440	930	480	130	160	130	366
Apparent color (ACU)	75	150	220	40	100	25	3	78
Barium	0.59	0.18	0.08	0.05	0.2	0.21	0.02	0.1
Boron	16	6.9	3.5	0.41	0.56	0.25	0.18	1.0
Bromide	27	9.6	2.2	0.3	42	14	0.35	11.8
Calcium	49	30	15	28	2,000	960	48	610
Chloride	4,000	1,400	120	33	13,000	4,300	120	3,515
Fluoride	0.75	0.57	0.21	0.21	0.09	0.15	0.32	0.19
Iron	0.51	0.18	0.21	0.1	4.1	1.8	0.02	1.2
pH (no units)	8	8	8.2	8.4	7.5	7.7	8	8
Magnesium	36	12	11	11	980	270	14	257
Manganese	0.06	0.06	0.05	0.07	9.2	1.1	0.07	0.4
Methane	0.4	12	4	10	0.01	0.04	0.003	2.8
Odor (TON)	40	8	8	2	2	2	2	3.2

Extraction Depth (feet below grade) Constituent (mg/L)	1,950 – 1,990	1,570 – 1,590	1,250 – 1,270	865 - 885	640 - 660	320 - 340	180 - 200	Composite of Five Zones Closest to the Surface
Potassium	35	21	26	9.5	170	49	5.5	52
Sodium	2,600	890	400	200	4,700	1,500	150	1,390
Sulfate	< 0.5	< 0.5	0.6	< 0.5	1,600	570	180	470
TDS	7,400	2,700	1,300	600	24,000	8,400	620	6,980
Total organic carbon	17	36	43	5.1	1.6	0.5	1.0	10.2

Notes:

< = less than

ACU = Apparent Color Units

TON = Threshold Odor Number

The two deepest MBMW zones are below the depth of the current injection barrier wells and, compared to the other zones, have elevated levels of boron, odor, and to a lesser extent, TOC and apparent color; therefore, Jacobs Engineering Group Inc. (Jacobs) recommends that the new extraction well extract water from only the five zones closest to the land surface, or down to 1,270 feet. The far right column of Table 1 displays an estimated extracted well water quality from these five zones for treatment.

As part of the Feasibility Study, a team led by Jacobs performed an investigation into the existing potable water quality in the distribution systems of the City of Manhattan Beach and other Program stakeholders. Table 2 summarizes the results of this investigation and represents the treated potable water quality targets for this project. Post-treatment chemicals will be added to the demineralized water to achieve the appropriate chloramine residual, Langelier Saturation Index (LSI), pH, alkalinity, and calcium hardness.

Table 2. Treated Water Quality Targets

Constituent (mg/L)	Target	Notes
Chloramine residual (mg/L)	1.0 mg/L	The existing City of Manhattan Beach water residual contains 0.5 to 1.3 mg/L.
LSI	0.4	The existing City of Manhattan Beach water is 90% purchased Metropolitan Water District surface water with an LSI of 0.2 to 0.62.
pH	8 – 8.5	
TDS (mg/L)	< 500	Secondary Maximum Contaminant Level
Alkalinity (mg/L as $CaCO_3$)	≥ 50	For water stability
Calcium hardness (mg/L as $CaCO_3$)	≥ 40	For water stability

Note:

≥ = greater than or equal to

% = percent

$CaCO_3$ = calcium carbonate

3. Treatment Approach

Table 1 indicates that the extracted water will have an elevated level of TDS, as expected, in addition to elevated levels of methane, TOC, and apparent color. This water will need to be treated prior to introduction into the Peck Reservoir. The methane can be removed efficiently by an air stripper (AS). However, the elevated levels of TOC and color indicate that this water may present a serious fouling risk for the reverse osmosis (RO) process necessary for TDS removal. WRD is experiencing organic fouling issues at the Goldsworthy Desalter in Torrance and has been treating water that is extracted by the Delthorne Park well. Use of the Delthorne Park well water, either alone or when blended with water from the City Yard well, results in rapid Goldsworthy RO pressure increases and frequent RO chemical cleanings.

Pilot, and perhaps bench, testing is recommended to determine the level of organic fouling on the RO for the well water to be extracted at MAES. At this stage, without the benefit of any pilot or bench data, Jacobs would propose the following three treatment scenarios, in order from least to most expensive:

- Best case, water is not a RO fouling problem:
  - Extract groundwater -> RO -> AS -> post-treatment chemical addition
- Intermediate case, water is a fouling problem, but loose nanofiltration will alleviate the problem by removing problematic organic fractions (for example, biopolymers) without concentrating salts like calcium (the combination is often a RO fouling problem):
  - Extract groundwater -> nanofiltration -> RO -> AS -> post-treatment chemical addition
- Worst case, water is a fouling problem and the organics need to be oxidized and bio-assimilated prior to RO:
  - Extract groundwater -> ozonation -> biologically activate granular activated carbon (BAC) -> RO -> AS -> post-treatment chemical addition

The best- and worst-case conditions have been analyzed to develop a range of treated water costs for the project.

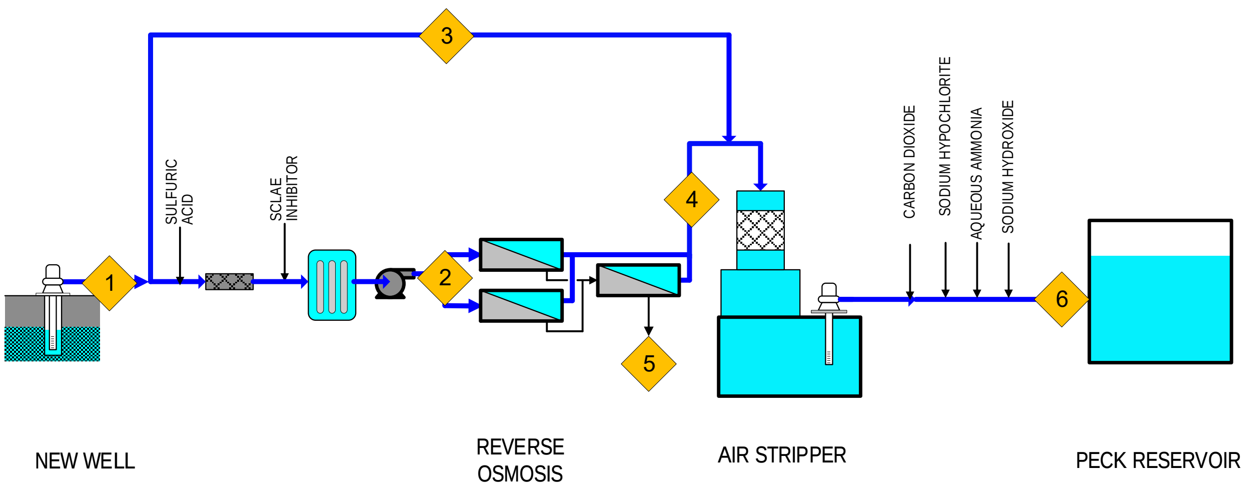
3.1 Best-case Treatment Approach

Per Figure 2, under best-case conditions, the extracted well water could be sent directly to RO following pretreatment with 5-micron cartridge filtration and approximately 80 mg/L sulfuric acid (H_2SO_4) and 3 mg/L antiscalant dosing. The H_2SO_4 is required as the calcium and alkalinity in the extracted MAES well water are high and pH depression is needed to prevent $CaCO_3$ precipitation in the RO process. The antiscalant prevents the scaling of other sparingly soluble salts and works in conjunction with the H_2SO_4 to prevent $CaCO_3$ scaling. The 5-micron cartridge filters will protect the RO from particulate matter that is extracted from the well.

Due to the elevated TDS of the MAES well water, 98.5 percent of the water will be fed to the RO for TDS removal. The 1.5 percent bypass is required to maintain enough calcium in the finished product water to retain 40 mg/L of calcium hardness without adding calcium during post-treatment. The RO feed pressure will initially be on the order of 300 pound(s) per square inch gauge (psig) while the second-stage feed pressure will be boosted to approximately 400 psig, using an energy recovery turbocharger. The RO permeate will have sufficient pressure (approximately 20 psig) to convey to the Peck Reservoir. Over years of treatment, the MAES well water is expected to decrease in salinity as this high TDS water is extracted for treatment and barrier injection water replaces it in the aquifer, and the RO feed pressure may decrease to approximately 180 psig. The RO process will operate at 80 percent recovery; for every 2,000 AFY of well water extracted, roughly 1,600 AFY will be converted to product water. The remaining 400 AFY will contain the salts rejected by the RO process (RO concentrate) and will be directed to the sewer.

The AS is used to reduce the methane and odor in the RO product water; however, the AS will also remove carbon dioxide (CO_2), leaving the water nearly devoid of alkalinity that is required for stabilization, which must be added during post-treatment. Specifically, post-treatment chemical addition will consist of the following:

- Approximately 1.4 mg/L of sodium hypochlorite (NaOCl) and 1 mg/L of ammonium hydroxide (NH_4OH) to produce a chloramine residual
- Approximately 20 mg/L of CO_2 to add alkalinity
- Approximately 22 mg/L of sodium hydroxide (NaOH) for pH adjustment



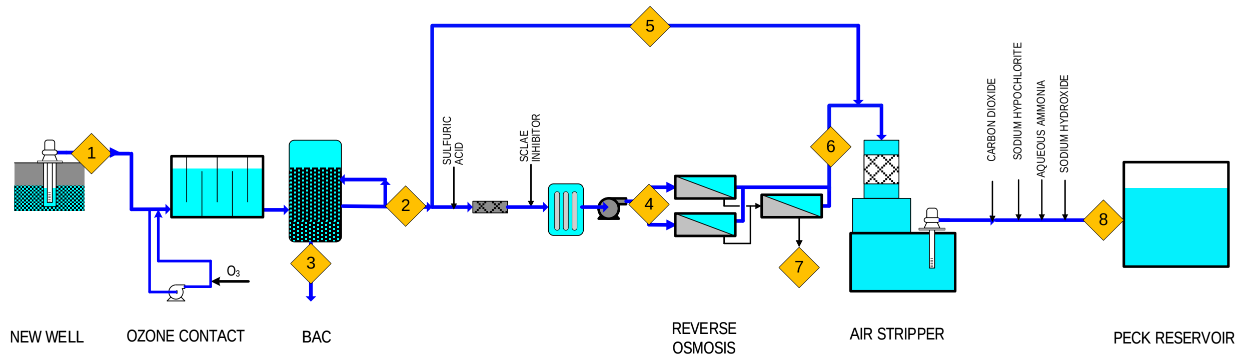
Stream #	1	2	3	4	5	6
Flow, AFY	2000	1970	30	1576	394	1606
Flow, MGD	1.8	1.8	0.0	1.4	0.35	1.4
TDS, mg/L	7000	7000	7000	350	33600	400

Figure 2. Process Flow Diagram of Best-case Treatment

3.2 Worst-case Treatment Approach

If the organics in the MAES cause RO fouling and the fouling impact needs to be mitigated, Jacobs recommends ozonation followed by BAC. The ozone will fracture the larger molecular-weight organics (that is, biopolymers and humic substances), making them biodegradable by bacteria that will inhabit the activated carbon media. An ozone does of 8 mg/L is recommended. The ozone-BAC process will not remove all of the organics, with the intent to reduce the concentration of the organics responsible for RO fouling. The pressurized granular activated carbon filters will require a periodic backwash (to remove accumulated biomass), resulting in a backwash volume of less than 5 percent. As a result, this treatment approach will produce slightly less product water, approximately 1,526 AFY for every 1,800 AFY of well water extracted than the best-case treatment approach.

The process downstream of ozone-BAC includes RO followed by air stripping and post-treatment chemical addition, similar to the description in Section 3.1. A process schematic for the worst-case treatment scenario is shown on Figure 3.



Stream #	1	2	3	4	5	6	7	8
Flow, AFY	2000	1900	100	1870	30	1496	374	1526
Flow, MGD	1.8	1.7	0.1	1.7	0.03	1.3	0.3	1.4
TDS, mg/L	7000	7000	7000	7000	7000	350	33600	400

Figure 3. Process Flow Diagram of Worst-case Treatment

4. Available Footprint for Treatment

The Peck Reservoir is currently undergoing a replacement. Appendix A displays the Civil Yard Piping Plan View of this construction. Although the east side of the Peck Reservoir includes an area of approximately 40 by 220 feet, only about 40 percent of this area (33 by 108 feet) will be available for this project. This area is sufficient only for the best-case treatment approach in Section 3. The additional footprint required for the RO pretreatment of the other treatment approaches will require more area than what is available at this site.

5. Water Cost

The cost-of-water calculation has been prepared as a Class V cost estimate in accordance with the Association for the Advancement of Cost Engineering (AACE) International standards of estimation in AACE International Recommended Practice No. 18R-97. Class V cost estimates of the well, pipeline, and treatment equipment includes accuracies of minus 50 percent to plus 100 percent of actual cost.

5.1 Cost Assumptions

- Well capital cost: from a recent (2016) desalter expansion project in southern San Diego County (that is, Sweetwater Authority Reynolds Plant), the average extraction well cost was $1.4 million for new 1,750-AFY wells. For a 2,000-AFY extraction well, this is roughly equivalent to $2 million; thus, $2 million was used as the new extraction well capital expenditure (CAPEX). This includes protective structures around each well.
- Treatment plant capital cost: the cost includes contractor markups, a 30 percent contingency, and markups for engineering, permitting, and services during construction. Capital costs include electrical infrastructure, but do not include any land purchase or lease costs, if applicable.
- The treatment plant will operate at full capacity for 350 days per year and will be completely shut down for 15 days per year for maintenance activities.

- Brine disposal: the brine is assumed to be sent to the sewer and the existing 8-inch sewer line in 19th Street should be able to accommodate the approximate 300 gallons per minute (gpm) of effluent, which the water treatment plant would produce. This should be verified in the next phase of the project. The Los Angeles County Sanitation Districts has developed a rate structure for the disposal of wastes into their distribution system. The rate structure includes both an initial connection fee and an annual surcharge, as follows:

  Connection fee = R[(X * Flow/260) + (Y * COD/1.22) + (Z* TSS/0.59)]

  Where:

  Flow = Flow of brine (gallons per day)

  R = Cost per capacity unit ($4,015)

  X = Capital cost factor (for an incremental expansion of the sewer system) for flow (0.67)

  Y = Capital cost factor for COD (0.13)

  Z = Capital cost factor for TSS (0.2)

  COD = chemical oxygen demand of the water (in units of 1,000 pounds (lbs) per year)

  TSS = total suspended solids (in units of 1,000 lbs per year)

  For COS and TSS, the following values are assumed:

  - COD of 50 mg/L
  - TSS of 1 mg/L

  Annual surcharge = (Volume * $746) + (COD * $131.90) + (TSS * $372.7) + ([2.5Log(P/Q) * $98.90 * P]

  Where:

  V = Annual volume (in millions of gallons)

  P = Peak flow over 20 minutes (in gallons per minute)

  Q = Average flow (in gallons per minute)

- Labor costs include two additional water treatment operators that will be required to operate the new treatment plant daily during business hours only. Operation during other hours will be monitored, but not staffed. Plant maintenance will be covered by existing maintenance personnel.
- The power cost is $0.105 per kilowatt-hours.
- RO feed pressure is assumed to average 225 pounds per square inch (psi) over the life cycle of the treatment equipment.
- Chemical costs are as follows in dollars per dry tons:
  - Antiscalant - $1,506
  - CO_2 - $168
  - 50 percent NaOH - $530
  - 12.5 percent NaOCl - $1,407
  - 29 percent NH_4OH - $4,266
  - 93 percent H_2SO_4 - $410

5.2 Costs

Table 3 summarizes the costs. The capital cost range is 30 to 63 million dollars, and the annual operating cost range is 1.9 to 2.9 million dollars. The cost of water on a $ per AF basis will need to incorporate details of the larger Program and shall be calculated at a later date.

Table 3. Cost Summary

Capital Costs	Best-case Treatment	Worst-case Treatment
Well	$2 million	$2 million
Pipeline[a]	$937,000	$937,000
Peck Reservoir location retaining wall and dirt removal	$1 million	$1 million
Treatment plant	$22.7 million	$54.5 million
Brine disposal connection fee	$3.7 million	$4.1 million
Total estimated CAPEX	**$30.3 million**	**$62.5 million**
Annual operating costs		
Well energy and maintenance	$0.19 million	$0.19 million
Treatment plant (energy, chemicals, labor, maintenance, and repair)	$1.5 million	$2.5 million
Brine disposal	$0.18 million	$0.18 million
Total estimated annual OPEX	**$1.9 million**	**$2.9 million**

[a] See the pipeline discussion in Section 5.

5.3 Recommended Next Steps for Treatment

The acquisition of water quality information of the plume under MAES is the logical next step for the project. If the water quality indicates that the best-case treatment is suitable, then the sewer capacity of the Peck Reservoir site should be studied to verify that it can handle the approximate 300 gpm effluent that the treatment plant would produce. If the water quality indicates that the additional pretreatment is necessary, another treatment site will need to be identified.

6. Saline Water Pipeline Routing

Three feasible alternative routes have been identified for extracted well water to the Peck Reservoir that provide the foundation for further analysis as options moving forward for the next phase of the project. The analysis (as part of this study) includes:

- Identification of potential pipeline routes between the wellhead treatment site and Peck Reservoir for further consideration and final detailed pipe routing analysis
- Preliminary hydraulic sizing of the well water pipeline
- Preliminary pipeline material and pressure class recommendations
- Preliminary pipeline corrosion protection recommendations
- Potential right-of-way (ROW) and easement acquisition requirements and challenges
- Local agency coordination challenges or opportunities
- Identification of Department of Public Health (DPH) regulatory requirements
- Proposed alternative implementation schedule
- Proposed alternative costs (AACE Class 5 estimate)

6.1 Pipeline Routing Assumptions

The following assumptions have been made for the purposes of the pipeline routing:

1) A review of the pipeline route alternatives has been conducted as a desktop review primarily using Google Earth.
2) Site visits have not been performed as part of this review.
3) The hydraulic analysis of the pipeline verified the recommended size of the pipeline and did not involve the development of a hydraulic model.
4) The average flow used for the analysis was 2,000 AFY with low and high flows of 1,000 AFY and 2,200 AFY, respectively.
5) The maximum velocity of 7 feet per second (fps) has been assumed for the water pipeline.
6) The pipeline will be located entirely within a ROW and will avoid longitudinal routing within the California Department of Transportation (Caltrans) ROW.
7) No trenchless installations will be necessary.
8) The pipeline begins at the east side of MAES and ends at the east side of Peck Reservoir.

6.2 Alternatives Analysis

A concept-level route for the new water pipeline to the Manhattan Beach Peck Reservoir has been analyzed from the extraction well location at MAES by utilizing the following route segment development and screening process. The following concepts and terminology have been used and are defined in this TM to provide identifiable and distinguishable elements that promote ease of visualization and management of the overall process:

- Route segments (or segments) are short, manageable reaches of pipe, often spanning the length of a city block, that are combined to create a group of potential alternative alignments. The route segments are designated alphanumerically (for example, RA-01, RA-02, RA-03) with the alphabetical identifier representing the street on which the segment is located on, and the numerical value representing the identification of a specific segment.
- Alternative routes (or alternatives) are the various reasonable combinations of contiguous segments assembled to create an alignment between the beginning and end points of the project (in this case, between the extraction well at MAES and Peck Reservoir).

The alternative route development process consists of the five steps shown in the dark boxes on Figure 3. The next phase of this project (that is, the Alternative Evaluation and Selection Phase) is shown in green and will be completed in the next phase of work. This section provides descriptions of these phases and how they apply to the pipe routing process.

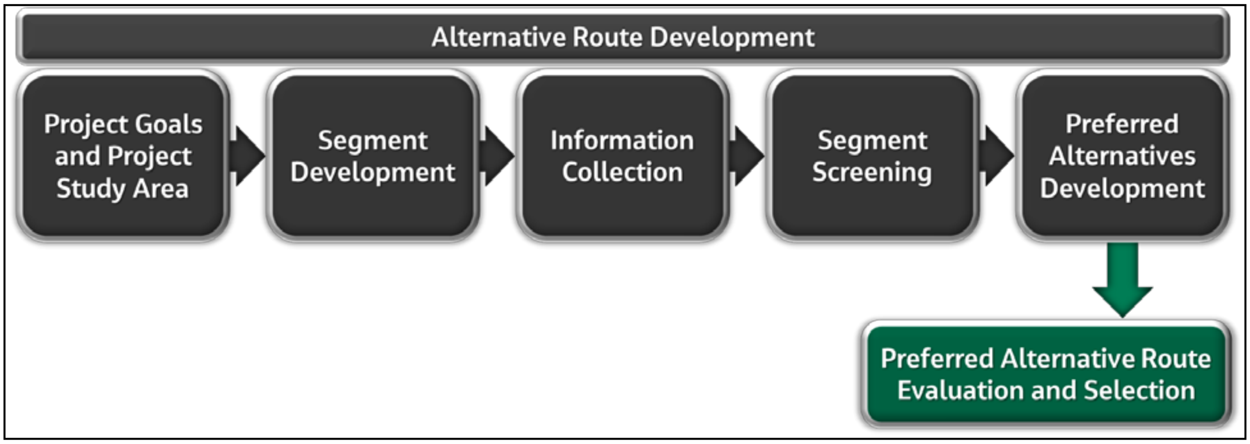


Figure 1. Alternative Route Development, Evaluation, and Selection Process

Sections 5.2.1 to 5.2.5 describe the alternative route development process, which consists of the following steps:

1) Project goals and project study area definition
2) Segment development
3) Information collection
4) Segment screening
5) Preferred alternative development

6.2.1 Project Goals and Project Study Area Definition

The project goal is to convey extracted water from MAES to a treatment facility near the Peck Reservoir, which will serve as a redundant alternative to the City of Manhattan Beach potable water supply. The goal of this route development, evaluation, and selection task is to develop potential pipeline route alternatives to move forward with the next phase of the project for the eventual selection of a preferred alternative.

The project study area has been created by using the project goals to identify a reasonable area in which the pipeline could be installed between the extraction point and Peck Reservoir (near the intersection of Peck Avenue and 19th Street), as shown on Figure 4.

6.2.2 Segment Development

Within the project study area, most streets between the extraction well and the treatment site by Peck Reservoir are reasonably wide enough to accommodate a new pipeline of the size anticipated for this project. Figure 4 shows the initial route segments developed for this analysis.

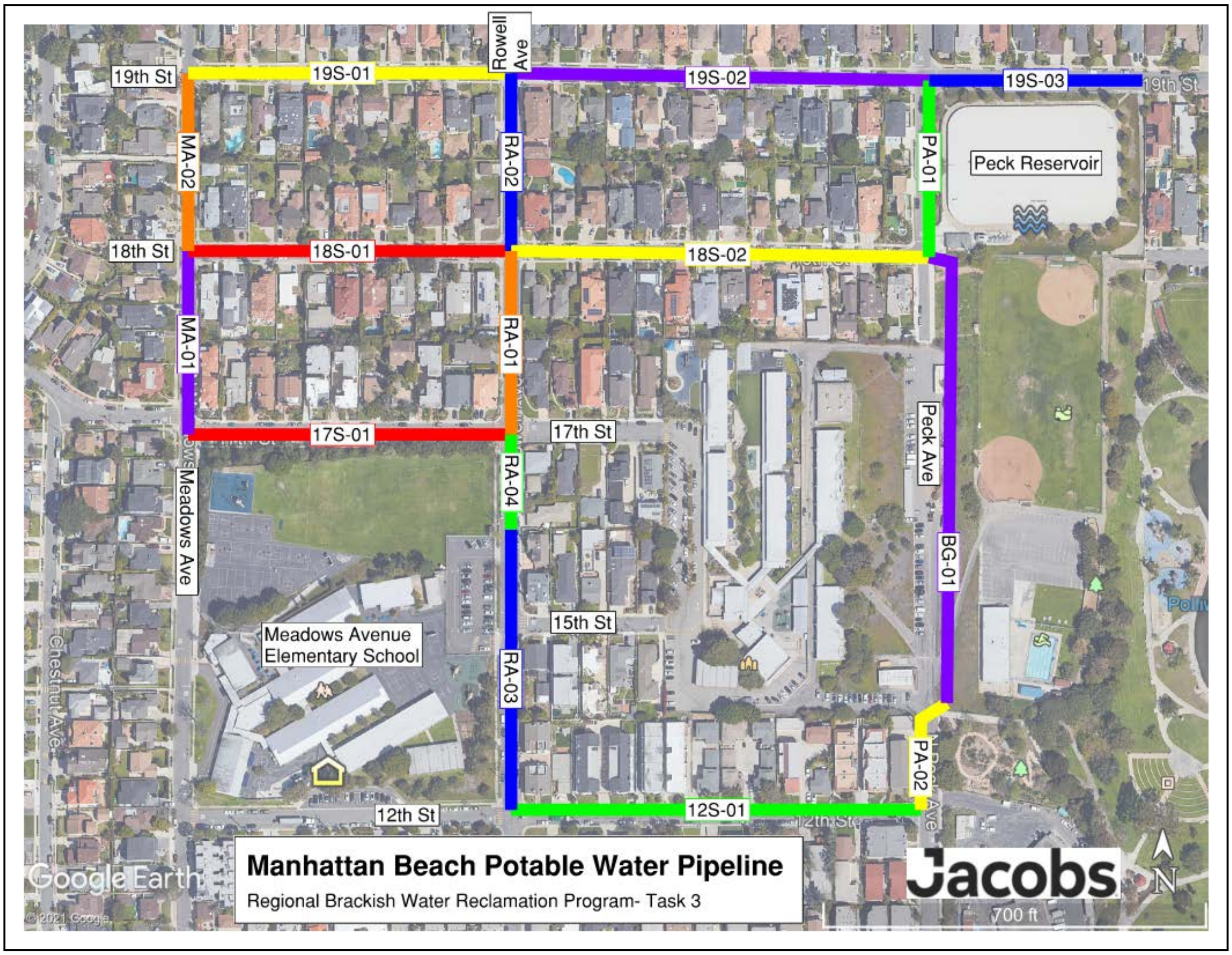


Figure 2 City of Manhattan Beach Potable Water Pipeline Initial Segments

The first step in developing viable alternatives was to designate segments from the east side of MAES to the east side of Peck Reservoir. The inclusion of segments south of MAES allowed for options to avoid busier streets fronting more residences and a potentially higher existing utility concentration north of MAES. In most cases, the segments follow a public roadway and branch to other segments at intersections. Most of the segments are in a road ROW, with one exception on the west side of Begg Park, just south of Peck Reservoir (segment BG-01). The opportunity to install a portion of the pipeline in the park could result in fewer utility conflicts and less disruption to the public.

6.2.3 Information Collection

As part of the information collection process, existing underground utility information was collected within the project study area. Previously collected utility information obtained by Jacobs, utility information provided by WRD, the Los Angeles Department of Water and Power (LADWP), and the City of Manhattan Beach, and publicly available online data, including shapefiles, record drawings, or any readily available information depicting the location and sizes of utilities, were obtained. Information included public GIS files and other information regarding:

- Water utilities
- Sewer utilities
- Storm Drains
- Gas utilities

To the fullest extent possible, attempts will be made to avoid conflicts with existing utilities. Utilities have been reviewed in Google Earth to identify routes that minimize potential large-diameter utility relocations. In cases where utilities within a segment have diameters equal to or larger than 24 inches, the horizontal clearance between the City of Manhattan Beach product water pipeline and existing utilities have been reviewed at a high -level using Google Earth to optimally provide a minimum separation of 10 feet.

6.2.4 Segment Screening

Segment screening consisted of individual segment review and the elimination of less favorable segment choices. The initial segments were screened and evaluated based on various high-level criteria, such as:

- Fatal flaws, such as being within the Caltrans ROW, and possible major disruptions to the public
- Obstruction of entrances to critical and emergency services facilities, such as fire stations, schools, and hospitals
- Potential major utility interferences
- Residential and business frontage
- Street width

The screening process included the following three sequential steps:

1) **Step 1**: screen and eliminate segments if they are located within the Caltrans ROW. For this project study area, there were none.
2) **Step 2**: compare adjacent segments using criteria, such as constructability, street width and length, proximity to emergency service facilities and schools, utility congestion, and relative disturbance to residents and businesses. For example, adjacent segments along Meadows Avenue and Rowell Avenue were compared and the analysis found that Rowell Avenue was less congested with existing utilities and was also more direct to Peck Reservoir, resulting in the elimination of Meadows Avenue.
3) **Step 3:** eliminate any residual segments that were previously connected to segments eliminated in Steps 1 and 2 that are now no longer connected to other segments (that is, segments that no longer have continuity). For example, once Meadows Avenue was eliminated, segments 19S-01 and 18S-01 no longer provided continuity for any route between the extraction wells and Peck Reservoir.

Table 4 provides a complete summary of the segments eliminated after the screening process. Refer to Appendix B for a detailed summary of the criteria that led to eliminating the segments shown in Table 4.

Table 4. Steps 1, 2, and 3 Eliminated Segments

		Segment Screening Criteria				
		Step 1		*Step 2*		*Step 3*
Roadway Name	***Eliminated Segment ID***	**Caltrans ROW**	**Distance from Peck Reservoir and the Desalter**	**Constructability: Street Width, Length, and Future Construction**	**Hospitals, Public Utilities, Schools, and Residential Frontage**	**Resulting Disconnected Segments**
17th South Street	17S-01		•			
Meadows Avenue	MA-01—02		•			MA-02
18th South Street	18S-01					18S-01
19th South Street	19S-01					19S-01

Figure 5 shows the segments that remained after the elimination of unfavorable segments during the screening process. The number of segments was reduced from 16 to 11, and the remaining segments were used to develop the pipeline route alternatives.

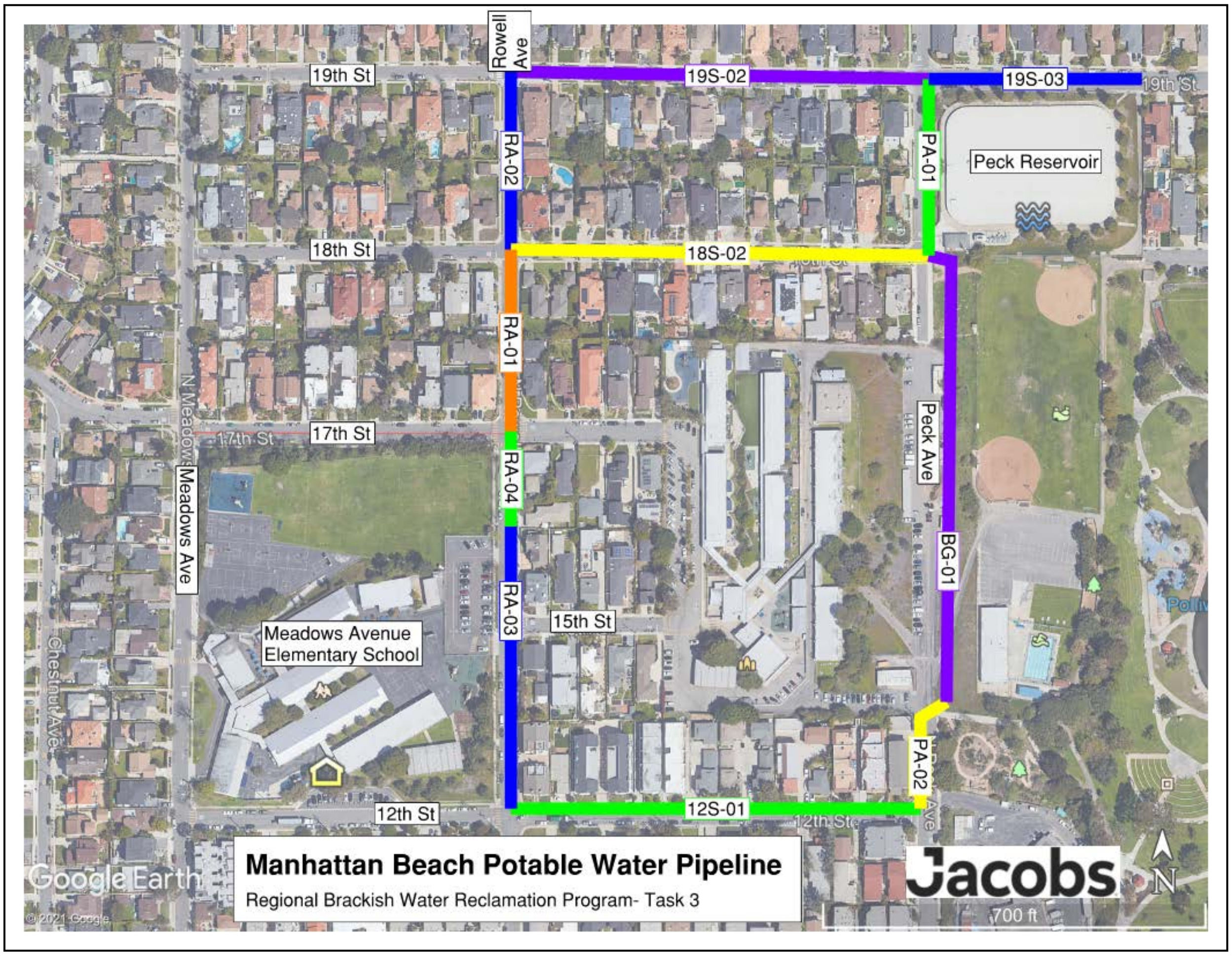


Figure 3. City of Manhattan Beach Potable Water Segments after Screening

6.2.5 Alternative Route Development

Segments that remained after the three-step screening process were used to develop alternative routes between the extraction well and Peck Reservoir, as shown on Figure 6. Jacobs recommends three alternatives to carry forward for consideration in the next phase of the project.

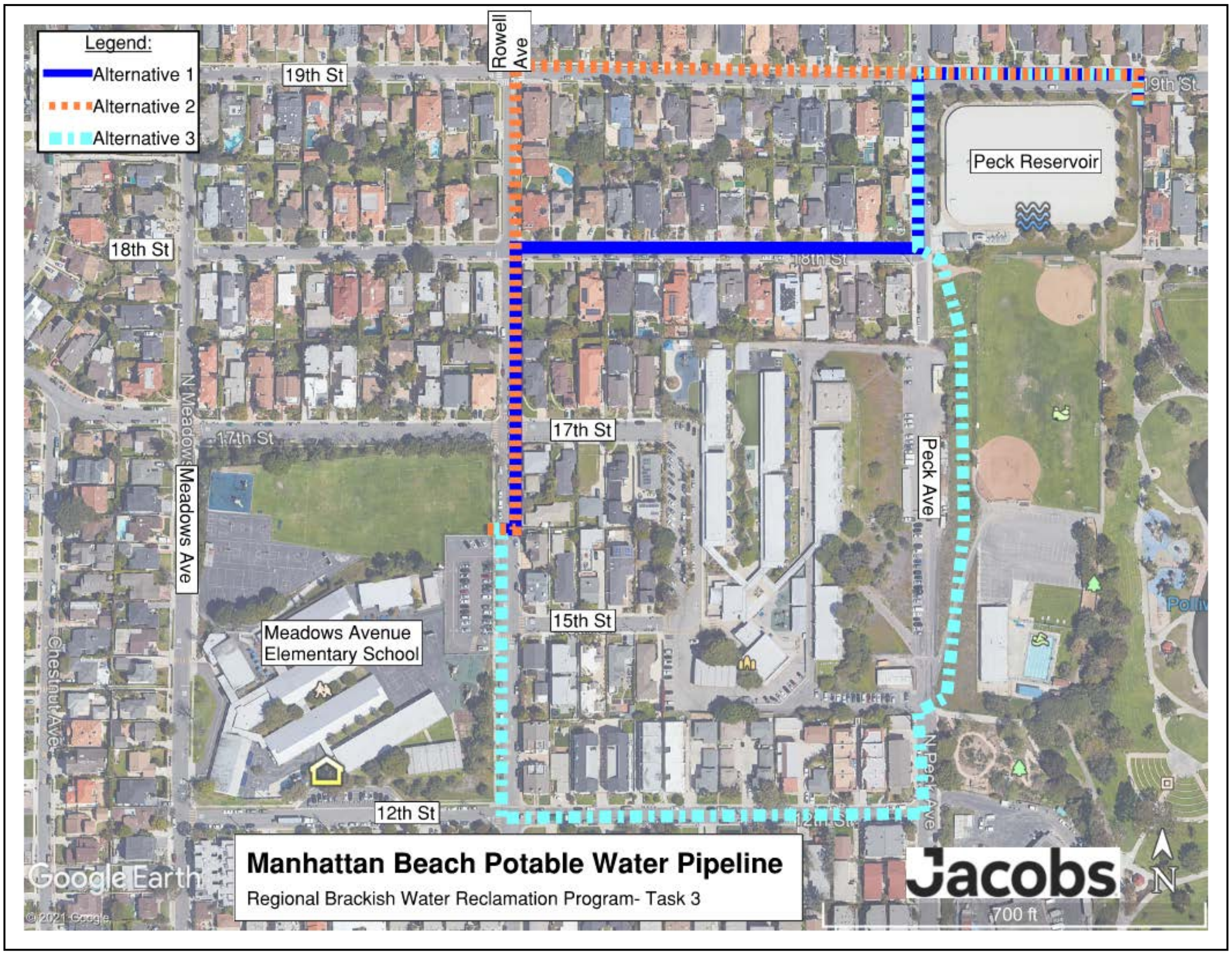


Figure 4. City of Manhattan Beach Potable Water Pipeline Preferred Alternatives

Alternative 1 heads north on Rowell Avenue from the desalter facility, then east on 18th Street toward Peck Reservoir, then north on Peck Avenue, then east on 19th Street to the west side of Peck Reservoir. Alignment 1 is approximately 2,085 feet long and consists of the following segments: RA-04, RA-01, 18S-02, PA-01, and 19S-03.

Alternative 2 heads north on Rowell Avenue from the desalter facility, then east on 19th Street to the west side of Peck Reservoir. Alignment 2 is approximately 2,100 feet long and consists of the following segments: RA-04 RA-01, RA-02, 19S-02, and 19S-03.

Alternative 3 heads south on Rowell Avenue from the desalter facility, then east on 12th Street, then north along Peck Avenue, then crosses Peck Avenue after the conservation park and runs north through Begg Park (which is owned by the nearby school and may be redeveloped in the future, as indicated by the City of Manhattan Beach), then north on Peck Avenue, and then east on 19th Street to the west side of Peck Reservoir. Alignment 3 is approximately 3,208 feet long and consists of the following segments: RA-03, 12S-01, PA-02, BG-01, PA-01, and 19S-03.

6.2.6 Pipe Sizing

The hydraulic analysis resulted in a nominal pipeline diameter of 10 inches as the optimal size to handle an average flow of 2,000 AFY using the previously stated hydraulic assumptions.

Three pipe materials were considered: welded steel pipe (WSP), earthquake-resistant ductile iron pipe (ERDIP), and high-density polyethylene (HDPE) pipe. Existing City of Manhattan Beach water lines in the area have historically been ductile iron pipe (DIP) according to record drawings. For the purposes of this study, it was assumed that ERDIP would be the pipe material of choice. Final pipe material selection will need to be validated during the design phase of the project, and further coordination with the City of Manhattan Beach is recommended to explore potential cost savings with WSP or HDPE pipe. Section 5.4 discusses the cost associated with each pipe material.

Pipe classes were selected based on a 200-psi maximum operating pressure. The pipeline will likely be gravity fed, and experience pressures of roughly 30 psi; however, it is unknown if pumping pressure will be added to the system, so a conservative 200 psi was chosen for the initial conceptual design. The WSP was analyzed using standard-weight steel dimensions, assuming an A1018, grade 36, type 1 structural steel and 3/8 of an inch mortar lining, which are typical requirements for pipelines designed for this criteria. The ERDIP was assumed to be class 350 psi, which is the minimum class for pipe that is 10 inches in diameter, and follows the standards in accordance with American Water Works Association (AWWA) *C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast* for DIP with push-on joints. The HDPE was assumed to have a dimension ratio (DR) of 13.5 with a pressure rating of 160 psi, the next pressure rating that satisfies the assumed maximum operating pressure of 150 psi. Table 5 shows the resulting velocities based on pipe size, pipe material, and various flows.

Table 5. Pipeline Material and Corresponding Diameters and Calculated Velocities

	Diameter (inches)		Velocity (fps)			
Pipe Material	Nominal	Actual ID	Minimum (Q = 1,000 AFY)	Average (Q = 2,000 AFY)	Maximum (Q = 2,200 AFY)	Recommended Maximum
WSP – standard weight .365-inch wall with CML	10	9.27	2.95	5.89	6.48	7.0
ERDIP – 1/4-inch wall with CML	10	9.83	2.62	5.24	6.21	7.0
HDPE – DR-11, 200-psi rating	10	8.96	3.15	6.30	6.93	7.0

Notes:
CML = cement mortar lining (assumed as 3/8 of an inch thick)
ID = identification

The use of a nominal 10-inch-diameter pipeline, regardless of pipe material, provides velocities that are within the acceptable range of typical design standards. Decreasing the pipe diameter would result in increased velocities that would exceed the design criteria and increasing the pipe diameter would increase the cost and result in less than desired low(er) velocities within the pipeline.

6.2.7 Pipe Material and Corrosion Analysis

Pipe materials that have been considered for the new pipeline include:

- WSP
- ERDIP
- HDPE

6.2.7.1 Welded Steel Pipe

WSP is a versatile material that can be supplied with either off-the-shelf or custom-fabricated pipe in a range of diameters, linings, coatings, yield strengths, and wall thicknesses. The pipe is fabricated and designed in accordance with AWWA *C200-17 Steel Water Pipe, 6 In. (150 mm) and Larger* and AWWA design manual M11. WSP joints offer a wide variety of water-tight applications, such as bell and spigot, welded single-lap, double-lap, or butt-welded joints, where thrust restraint, axial loading, or seismic restraint is required. WSP is typically used in high-pressure situations and offers many benefits with its versatility. Typically, welded joints are recommended for WSP due to its reliability and water tightness.

The relatively small-diameter pipe recommended for this project could present construction difficulties in field welding, but it should be considered as a major flaw. WSP is highly subject to corrosion and will require an exterior coating and a cathodic protection system, such as an impressed current system or galvanic anodes.

6.2.7.2 Earthquake Resistant Ductile Iron Pipe

ERDIP utilizes typical DIP dimensions and standards with specialized joint connections that allow for flexibility without breakage in a seismic event. The *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects* (Trunkline Design Manual)(LADWP 2019) suggests that all DIP pipelines in the City of Los Angeles be ERDIP, and for the purposes of this study, it is assumed that ERDIP will be utilized if DIP is procured for the City of Manhattan Beach pipeline. While no known fault lines are crossed in this alignment, liquefaction and lateral spreading may be of concern and should be evaluated during future design phases of the project. ERDIP is fabricated and designed the same as typical DIP in accordance with AWWA *C151-09 Ductile-Iron Pipe, Centrifugally Cast* and AWWA *C150-08 Thickness Design of Ductile-Iron Pipe*. Typical DIP joint connections include push-on, mechanical joint, and proprietary restrained joints, all of which are in accordance with AWWA *C111-12 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings* and AWWA *C110-12 Ductile-Iron and Gray-Iron Fittings*. ERDIP joints are specially designed push-on joints that are typically composed with locking rings and spigot projections that allow for 1 percent lateral expansion and 5 degrees of deflection before failure. The ERDIP joints referenced for this design are manufactured by U.S. Pipe.

Corrosion mitigation practice for ERDIP typically requires the use of polybags (as recommended by the Ductile Iron Pipe Research Association), though polybags are not recommended in areas with high, salty groundwater. Other practices include bonding joints to allow for the monitoring of electrical continuity, additional exterior coating, and implementing cathodic protection systems, such as galvanic anodes.

6.2.7.3 High-Density Polyethylene Pipe

HDPE is a flexible plastic pipe that is highly resistant to chemical and corrosive degradation. For pipe diameters that are between 4 and 64 inches, the pipe is fabricated and designed in accordance with AWWA *C906-07 Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in. (1,600 mm), for Water Distribution and Transmission* and AWWA *Manual M55 PE Pipe-Design and*

Installation. Connections for HDPE pipe consist of thermal heat fusion, electrofusion, and, occasionally, mechanical fittings. The fused joints are considered to be self-restraining, reducing the need for thrust restraints and thrust blocks, and would be the recommended joint for this particular application. HDPE provides a much smoother interior compared to the lining options for WSP or DIP, which lowers friction head losses.

Corrosion is negligible within HDPE pipe; however, it is potentially susceptible to degradation when in contact with potable water disinfectants. The severity of this degradation changes based on multiple factors, so further evaluation is recommended in future design phases. For additional information, refer to *Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants: TN-44* (Plastics Pipe Institute 2015). HDPE is also subject to thermal expansion and contraction, and mitigation measures, such as concrete anchors and specially designed connections to non-HDPE pipe, would be required.

6.2.7.4 Preliminary Pipe Material and Class

The pipe material assumed for this project and for the opinion of probable construction cost (OPCC) is 10-inch, 350-psi rated ERDIP with earthquake-resistant, bell- and spigot-gasketed connections. Further evaluation of HDPE and WSP should be coordinated and examined with the City of Manhattan Beach to discuss the benefits of other pipes, such as a lower cost.

6.2.8 Right-of-Way and Easement Acquisition

The conceptual alternatives (Section 5.2.5) are entirely located within a public ROW to minimize the need for temporary or permanent easement acquisition. The potential exception to this is Alternative 3, which crosses through Begg Park, where discussions with the City of Manhattan Beach are required to determine any land-use requirements associated with installation within the park. Currently, it is considered unlikely that private property will be affected by this project; however, it should be noted that all alignment options will disturb private residence driveway access.

6.2.9 Permitting and Approvals

Permits and approvals from regulatory agencies have not been obtained for the project and will require coordination in future phases. This section explores the probable coordination efforts that will be required during design and construction phases. In addition to construction and regulatory permits, field activities, such as geotechnical and subsurface utility exploration programs, will be required prior to final design.

Table 6. Summary of Anticipated Permits and Approvals

Agency	Permit/Approval
Lead Agency (to be determined)	CEQA approval
City of Manhattan Beach	Includes encroachment and traffic control, discharge, and site development (that is, any municipal local construction permits required for construction in the City of Manhattan Beach)
DDW State Water Resources Control Board DPH	Approval for an alternative to separation requirements
California Occupational Safety and Health Agency	Construction excavation permit

Note: Roadways all appear to be city streets that are not managed by Caltrans.

CEQA = California Environmental Quality Act

DDW = Division of Drinking Water

6.2.9.1 California Environmental Quality Act

The CEQA process requires projects to obtain a biological technical report, a cultural resources report, a noise study, and an air quality study to proceed with construction. These reports can be completed based on the proposed alignments in this TM. Future project work will require the identification of a lead agency to move the CEQA process forward.

6.2.9.2 City of Manhattan Beach

Section 3.3 outlines the route alternatives, which lie entirely within the jurisdiction of the City of Manhattan Beach. All construction within Manhattan Beach streets will require a ROW permit. Applications must be submitted to the City of Manhattan Beach Community Development Department, at this address:

City of Manhattan Beach, Community Development Department
1400 Highland Avenue
Manhattan Beach, California 90266-4795
310.802.5500

The ROW application package requires, at minimum, the following information:

- ROW application
- Plans, including traffic management plans

The received ROW application will be reviewed for approval by the City of Manhattan Beach ROW permitting section and a city engineer. Fees will accrue after approval of the permit, which include a nonrefundable administrative fee and a bond payment.

Additional permits such as groundwater discharge permits, site development approvals, and any construction permits may be required, with coordination typically occurring during the early stages of design.

Additionally, any improvements on school district property (which includes Begg Park) will require easement acquisition, or an agreement or outright purchase plus Division of the State Architect (DSA) approval and permitting.

Any work on Peck Reservoir or park property will require City Building Department approval, which will also require Americans with Disabilities Act (ADA) accessibility improvements. These requirements and coordination will be required during future phases of the project.

6.2.9.3 Division of Drinking Water Requirements

This project parallels several existing underground utilities, including water and sewer lines. Title 22 of the *California Code of Regulations* establishes the separation criteria between these existing utilities, which are enforced by DDW. The criteria are as follows:

- 4 feet horizontally and 1 foot vertically from potable and recycled water lines (edge to edge)
- 10 feet horizontally and 1 foot vertically above wastewater (including brine) lines (edge to edge)

If these distances prove to be prohibitive, approval can be obtained from DDW for proposed alternatives that meet at least the “same level of protection to public health” as the previously described minimum distances.

6.2.9.4 Department of Public Health Regulatory Requirements

The Los Angeles County DPH specifies additional documentation that is required for new water line construction projects. Receipt of approval must be provided by the Environmental Health Division and requires the project to have a Plan Check Number (PCN) and a legal address before submission of an application (LADPH 2010). The PCN and legal address are obtained by submission of a construction drawing set to the Los Angeles County Department of Public Works, Division of Building and Safety, or the City Building Authority. After receipt of the PCN and legal address, the applicant must submit the following documentation to the Environmental Health Division:

- A Service Request Application (with the accompanying fee), which must include the date in which plans were received by the Los Angeles Public Works, Division of Building and Safety, and the PCN.
- A will serve letter on water company letterhead, which must state that the project water meets Safe Drinking Water Standards, and include the Public Water System Number assigned by the California DPH

6.3 Pipeline Implementation and Cost

6.3.1 Implementation Schedule

Since there are relatively few jurisdictions from which permits will be required, it is recommended that the new pipeline be packaged as a single contract, separate from the desalter facility. However, design and construction of the new pipeline should be coordinated with that of the treatment facility.

The new pipeline is anticipated to be constructed primarily by open-cut construction methods with a recommended minimum depth of cover between 4 and 5 feet. Trenchless construction may be used to avoid major utility conflicts; however, based on the preliminary utility assessment within the project area, there appears to be adequate space to construct the new product water pipeline. If trenchless methods are employed, applicable trenchless methods will include traditional jack-and-bore/auger boring and horizontal directional drilling.

For schedule and cost purposes, open-cut construction is assumed for the entire pipeline reach, and based on the length of pipe, construction should be completed within 6 to 8 months of notice to proceed.

6.4 Opinion of Probable Construction Cost

An OPCC has been developed for an average and peak flow of 2,000 and 2,200 AFY, respectively. Alternative 2 (Figure 6) represents the most direct route for the project and has been used for this OPCC, which represents 2,100 linear feet of pipe. This cost estimate has assumed that no trenchless installations would be necessary.

The unit cost for pipe material and installation from the Trunkline Design Manual (LADWP 2019) is as follows:

- The ERDIP material cost is estimated from $30 to $35 per diameter-inch per linear foot (dia-in/lf) for pipelines that range in size less than 30 inches in diameter. This material cost assumption by LADWP will provide a basis for a conservative estimate.
- Open-cut pipe installation for ERDIP is estimated by LADWP to range from $15 to $20 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) that ranges from $45 to $55 per dia-in/lf.

- The WSP material cost is estimated from $12 to $15 per dia-in/lf for pipelines that range in size from 30 to 96 inches with CML, cement mortar coating, and a wall thickness of 0.5 inches. In a separate effort, Jacobs obtained a unit cost of $12 per dia-in/lf for steel pipe from a recent price quote from the largest steel pipe supplier in the western United States (U.S.). Since these two sources correlate to similar unit costs, it is assumed for the purposes of this estimate that a cost of $12 per dia-in/lf would suffice since the diameter and wall thickness for the pipeline will be smaller than the assumptions used by LADWP, and as a result, would provide a basis for a conservative estimate.
- Open-cut pipe installation for WSP is estimated by LADWP range from $20 to $25 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) ranging from $32 to $37 per dia-in/lf. Typically, conceptual level unit costs for steel pipe construction in an urban environment can be expected to be in the $25 per dia-in/lf range. This unit cost is based on recent pricing that Jacobs estimated for a steel pipeline construction project in another urban center within the Western U.S. Although the current Engineering News Record (ENR) Construction Cost Index (CCI) for Los Angeles is approximately 5 percent higher than the national ENR CCI, it is not unreasonable to observe a larger increase for pipeline construction in Los Angeles than many other areas in the country. Using a $32 per dia-in/lf unit cost compared with a $25 per dia-in/lf unit cost, which results in a 28 percent increase, seems conservatively reasonable considering that pipe material, labor, equipment costs, and contractor markups would be higher in the greater Los Angeles area than most other places.
- A material unit cost of $1.89 per dia-in/lf for HDPE pipe has been determined based on a pipe material quote for ductile iron pipe size (DIPS), dimension ratio (DR) 11, PE4710 HDPE pipe from one of the largest HDPE pipe suppliers in the U.S., and typical contractor markups expected in Southern California based on recent bids on a cost-per-weight estimate. An installation cost for HDPE pipe has been obtained through recent construction cost estimates and bids for similar HDPE pipe installations in Southern California, resulting in a unit cost (including contractor markups, but excluding pipe material cost and contingency) of $11.03 per dia-in/lf. The total all-in construction cost using HDPE pipe, including a 40 percent contingency, is estimated to be $18.47 per dia-in/lf, when considering 10-inch-diameter pipe.

The unit costs used for this OPCC includes a 40 percent contingency. An additional 3.56 percent due to inflation is also used to bring the unit cost to current 2021 dollars per the ENR CCI. Table 7 presents the OPCC for the project along Alignment 1 for the three material types in 2021 dollars.

Table 7. Manhattan Beach Cost Estimate Range Based on Pipe Material

Pipe Material	Low Range (-50%)	Estimated Cost	High Range (+100%)
ERDIP	$837,500	$1,675,000	$3,350,000
WSP	$487,000	$975,000	$1,950,000
HDPE	$194,000	$388,000	$776,000

Note: The impacts of the COVID-19 pandemic on the construction industry is not known at this time and will likely have some impact on the costs presented.

6.5 Recommended Next Steps for Pipeline

Conclusions and recommendations from this study include the following:

- A nominal pipeline diameter of 10 inches is recommended for the product water pipeline.
- Additional coordination with the City of Manhattan Beach will be required to determine if other pipe materials, such as HDPE, are acceptable for the product water pipeline.

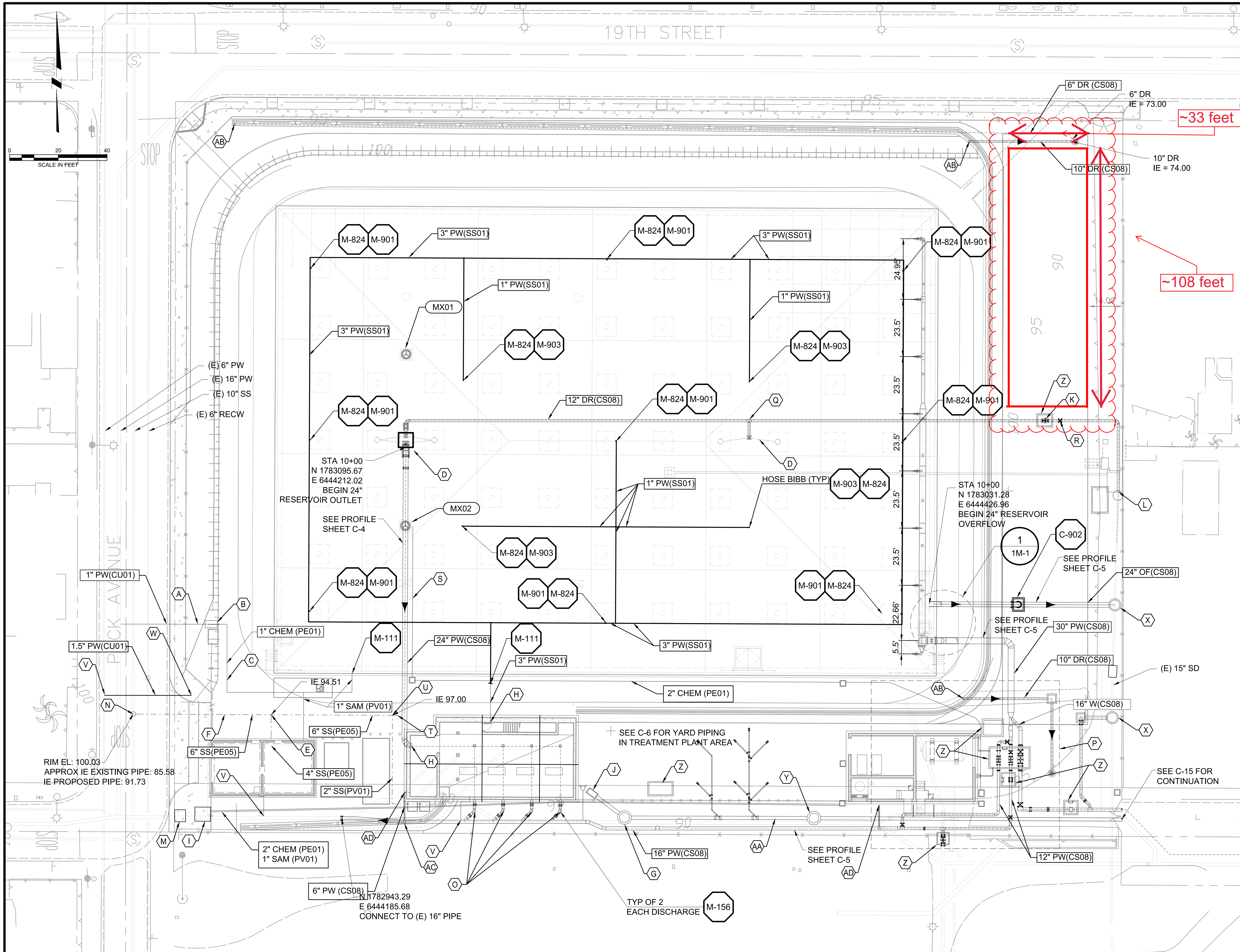
7. References

Los Angeles Department of Water and Power (LADWP). 2019. *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects*. April.

Los Angeles Department of Public Health Environmental Health, Bureau of Environmental Protection Drinking Water Program (LADPH). 2010. *Potable water availability requirements for residential and commercial development.* April.

Plastics Pipe Institute. 2015. Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants: TN-44/2015. Accessed January 2021. https://plasticpipe.org/pdf/tn44.pdf.

Appendix A
Available Area – 8 MG Peck Reservoir Replacement
Project Drawing C3



GENERAL SHEET NOTES

1. LOCATIONS OF EXISTING UTILITIES SHOWN ARE APPROXIMATE, THE CONTRACTOR SHALL FIELD VERIFY LOCATIONS OF ALL UTILITIES.

SHEET KEYNOTES

A. 1" COPPER SAMPLE LINE. TAP TO (E) 16" PER CITY STD DWG ST-15, NO WATER METER OR METER BOX
B. NEMA 3R ENCLOSURE ON PEDESTAL. PENETRATE 1" COPPER SAMPLE LINE INTO ENCLOSURE AND INSTALL 3 CONNECTIONS FOR TOTAL CHLORINE ANALYZER, AMMONIA ANALYZER, AND MANUAL SAMPLE
C. 1" ANALYZER DRAIN LINE
D. RESERVOIR SUMP, SEE STRUCTURAL AND MECHANICAL SHEETS
E. 6" X 4" WYE
F. 6" X 1" WYE
G. MANHOLE PER C-320
H. SEE MECHANICAL DRAWINGS FOR CONTINUATION.
I. EXISTING FLOWMETER VAULT
J. 4' X 2' PRECAST CONCRETE CATCH BASIN
K. 12" CHECK VALVE, SLANTED TYPE WITH SNUBBER
L. 12" RESERVOIR DRAIN, CONNECT TO NEW SDMH PER DETAIL C-923
M. EXISTING INJECTION VAULT
N. INSTALL MANHOLE PER C-320 AND CONNECT TO EXISTING SEWER
O. 16" THRU X 12" BRANCH WYE
P. SEE C-6 FOR TREATMENT PLANT AND RESERVOIR INLET PIPING
Q. SEE C-10 FOR DRAIN AND UNDERDRAIN.
R. 12" BUTTERFLY VALVE
S. ROUTE CHEMICAL LINE TO ABOVE MX02. PENETRATE RESERVOIR WALL PER M-111 AND MOUNT TO RESERVOIR ROOF DECK PER M-101.
T. SEWER CLEANOUT PER P-314
U. 6" X 2" WYE
V. PW CONNECTION PER CITY STD DWG ST-22
W. SEE LANDSCAPE DRAWINGS FOR CONTINUATION
X. INSTALL STORMDRAIN MANHOLE PER C-320 AND CONNECT TO EXISTING STORMDRAIN
Y. 48-INCH MANHOLE WITH INTEGRATED PARSHALL FLUME AS MANUFACTURERED BY OPENCHANNELFLOW OR APPROVED EQUAL. PARSHALL FLUME SHALL BE 9" WIDE AT THE NARROWEST POINT AND SUITABLE FOR A FLOW RANGE OF 40 GPM TO 3,000 GPM.
Z. HS-20 TRAFFIC RATED ACCESS VAULTS
AA. TREATMENT AREA SANITARY SEWER LINE. SEE C-7 TO END OF AA.
AB. DOWN DRAIN PER MANUFACTURER'S RECOMMENDATIONS. SLOPE V-DITCH ALONG MSE WALL TOP TO DRAIN INLET.
AC. 16" X 6" TEE
AD. SEE MECHANICAL DRAWINGS FOR CONTINUATION

REGISTERED PROFESSIONAL ENGINEER CHRISTOPHER STEPHEN MOTE No. C-87384 Exp. 9-30-21 CIVIL STATE OF CALIFORNIA

Thursday, April 2, 2020 8:29:18 AM C:\PWWORKDIR\D0363875\PRR_C-3.DWG SWAIN, CRIS

REV	DATE	BY	DESCRIPTION

SCALE 1" = 20'

WARNING 0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED C SWAIN
DRAWN V HO
CHECKED G TRIEBEL

CONSTRUCTION DOCUMENT PHASE - APRIL 2020

1800 NORTH PECK AVENUE, MANHATTAN BEACH, CA 90266

Hazen

Stantec

8 MG PECK RESERVOIR REPLACEMENT PROJECT
CIVIL
YARD PIPING PLAN

W-625
SHEET
C-3
21 OF 178
224501051

Appendix B
Segment Screening

Manhattan Beach - Meadows Avenue Elementary School to Peck Reservoir Potable Water Pipeline Segments (12-inch Diameter)

1. 17th South Street (17S-01)

- Width: 33 feet; no medians; residential street
- Right-of-way (ROW): public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
17S-01	WTR	North westbound lane	6
17S-01	Gas	North westbound lane	1 1/4
17S-01	SS	North westbound lane	8
17S-01	WTR	South eastbound lane	6
17S-01	WTR	South eastbound lane	4
Notes: SD = Storm Drain utility SS = Sanitary Sewer utility WTR = Water (utility)			

- Pipeline installation is recommended on the south side between the southernmost water line and curb
- Segment-specific issues:
  - Street just north of schoolyard; likely would avoid it by installing pipeline within the schoolyard to either west- or east-connecting streets
  - Elimination of a segment is dependent on the school approving pipeline construction within the schoolyard

2. Rowell Avenue (RA-01 to 04)

- Width: 24 to 29 feet for RA-01 and RA-02, and 34 feet for RA-03 and RA-04; no medians; residential street
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
RA-01	SS	West side southbound	8
RA-01	WTR	West side southbound	6
RA-01	WTR	East side northbound	12
RA-02	WTR	East side northbound	12
RA-03	WTR	East side northbound	16
RA-03	Gas	East side northbound	2
RA-04	WTR	East side northbound	16
RA-04	Gas	East side northbound	2

- Pipeline is recommended to be on the east side for RA-01 and RA-02 and the west side for RA-03

- Segment-specific issues:
  - Residential frontage: RA-01 and RA-02
  - RA-03 would need construction staging because it aligns along the school access and parking lot for staff

3. Meadows Avenue (MA-01 to 02)

- Width: 24 feet; no medians; residential street
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
MA-01	WTR	West side southbound (under sidewalk)	6
MA-01	Gas	West side southbound	4
MA-01	WTR	West side southbound	8
MA-01	SS	East side northbound	8
MA-02	WTR	West side southbound (under sidewalk)	8
MA-02	Gas	West side southbound	3
MA-02	WTR	West side southbound	8
MA-02	SS	East side northbound	8
MA-02	WTR	East side northbound	16
MA-02	WTR	Perpendicular (halfway through segment)	6

- Pipeline installation is recommended on the east side of the easternmost water line
- Segment-specific issues:
  - Residential frontage
  - Utility congestion; low clearance from the sanitary sewer unless it is very deep
  - Puts alignment far from the Peak Reservoir destination

4. 18th South Street (18S-01 to 02)

- Width: 24 feet; no medians; residential street
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
18S-01	WTR	North westbound lane	6
18S-01	WTR	North westbound lane	16
18S-01	SS	South eastbound lane	8
18S-01	Gas	South eastbound lane	2
18S-02	WTR	North westbound lane	6
18S-02	WTR	North westbound lane	18 (to/from Peck Reservoir)
18S-02	SS	South eastbound lane	8
18S-02	Gas	South eastbound lane	2
18S-02	WTR	South eastbound lane	6

- Pipeline installation is recommended on the north westbound lane between the water lines

- Segment-specific issues:
  - Large amount of residential frontage
  - High utility congestion, especially at the 18th South Street and Peck Avenue junction

5. 19th South Street (19S-01 to 03)

- Width: 24 feet; no medians; residential street
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
19S-01	SD	North westbound lane (in sidewalk)	15
19S-01	WTR	North westbound lane	6
19S-01	WTR	North westbound lane	6
19S-01	SS	South eastbound lane	8
19S-01	Gas	South eastbound lane	2
19S-02	WTR	North westbound lane	6
19S-02	WTR	North westbound lane	6
19S-02	SS	South eastbound lane	8
19S-02	Gas	South eastbound lane	2
19S-03	Gas	North westbound lane	3
19S-03	WTR	North westbound lane	6
19S-03	SS	North westbound lane	8
19S-03	WTR	South eastbound lane	16
19S-03	WTR	South eastbound lane	6

- Pipeline installation is recommended on the north lanes for segments 19S-01 and 19S-02, and on the south lane near the water lines for 19S-03
- Segment-specific issues:
  - Residential frontage
  - 19S-03 is north of Peck Reservoir, which may not be helpful in connecting to Peck Reservoir

6. Peck Avenue (PA-01 to 02)

- Width: 28′, no medians, residential street
- ROW: near city park parcel on south side
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
PA-01	WTR	West side southbound	6
PA-01	WTR	West side southbound	16
PA-01	SS	East side northbound	10
PA-01	WTR	East side northbound	6
PA-02	SS	East side northbound	10
PA-02	WTR	East side northbound	6

PA-02	WTR	East side northbound	6
PA-02	SS	Perpendicular (top of segment)	6

- Pipeline installation is recommended on the westside southbound lane for PA-02
- Segment-specific issues:
  - PA-02: near the entry of a large school and a church campus parking lot and entrance
  - PA-01: residential frontage for an apartment building on the west side
  - PA-02: entry to a warehouse with a receiving entrance on the east side

7. 12th South Street (12S-01)

- Width: 28 feet; no medians; residential street
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
12S-01	Gas	North westbound lane	2
12S-01	SS	South eastbound lane	10
12S-01	WTR	South eastbound lane	4
12S-01	WTR	South eastbound lane (under sidewalk)	2

- Pipeline installation is recommended on the north westbound lane
- Segment-specific issues:
  - Residential frontage

8. Begg Park (BG-01)

- Width: open park space to avoid the church parking lot and entries
- ROW: Unknown (the park parcel is likely owned by the City of Manhattan Beach)
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*
BG-01	SS	East side northbound	10
BG-01	WTR	East side northbound	6
BG-01	WTR	East side northbound	6
BG-01	SD	Perpendicular (north side of park)	Unknown

- Pipeline installation is recommended on the westernmost side of park to avoid roads and large trees
- Segment-specific issues:
  - Possibility of a park closure

		Segment Screening Criteria				
		Step 1		***Step 2***		***Step 3***
Roadway Name	***Segment ID***	Caltrans ROW	Distance from Peck Reservoir and Well Site	Constructability: Street Width, Length, and Future Construction	Hospitals, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
17th South Street	17S-01		•			
Rowell Avenue	RA-01—04					
Meadows Avenue	MA-01—02		•			MA-02
18th South Street	18S-01—02					18S-01
19th South Street	19S-01—03					19S-01
Peck Avenue	PA-01—02					
12th South Street	12S-01					
Begg Park	BG-01					

Note:

ID = identification

Appendix 3
Evaluate Single-trench Conveyance Opportunities

Technical Memorandum

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Subject	**Subtask 4 – Evaluate Single Trench Conveyance Opportunities**	**Project Name**	Regional Brackish Water Reclamation Program Feasibility Study
Date	March 2021		

1. Introduction and Purpose

This technical memorandum (TM) presents the findings of a distribution system analysis that evaluates the feasibility of constructing three pipelines in a single trench between the Water Replenishment District (WRD) Centralized Treatment Plant Desalter (Desalter) and the Joint Water Pollution Control Plant (JWPCP), a general location common between all three pipelines, in order to optimize the construction schedule, minimize spatial constraints, and potentially save on cost. The three pipelines include:

1) A brine pipeline originating at the Desalter that conveys reverse osmosis waste flows to the JWPCP for treatment.
2) A potable water pipeline from the Desalter that conveys product water flows for the Los Angeles Department of Water and Power (LADWP). Note: for the purposes of this TM, the LADWP pipeline route will be considered between the Desalter and the JWPCP. However, this pipeline connects prior to reaching the JWPCP, with a final destination at a connection point on the LADWP's Harbor Trunkline, which has been evaluated in the TM for Subtask 2 (Jacobs 2021a).
3) Advanced treated recycled water produced at the JWPCP as part of the Metropolitan Water District of Southern California (MWD) Regional Recycled Water Program (RRWP) to the Desalter.

This TM addresses the following scope items pertaining to the evaluation of the single trench option:

- Identification of potential pipeline routes between the Desalter and the JWPCP for all three pipelines
- Permitting feasibility
- Comparative construction cost per linear foot between a single trench option, and construction of the pipelines in three separate trenches
- Accessibility for pipeline operations and maintenance
- Local agency coordination challenges or opportunities
- Construction timelines and potential schedule challenges
- Initial analysis for the brine and recycled water pipelines pertaining to:
  - Hydraulic sizing of pipelines
  - Potential pipeline alignments
  - Preliminary pipe and material class recommendations
  - Distribution power requirements for pumping

This TM examines the hydraulic requirements of the brine and recycled water pipelines in conjunction with the single trench alignment installation option to provide a basis for design feasibility. A separate TM (for

Subtask 2) has been completed on the hydraulic analysis for the LADWP potable water pipeline. Previously, a high-level analysis of the brine line was completed and reported in Section 5 (Brine Waste Management) of the Conceptual System Design and Program Requirements (CSDPR) in Appendix A of this report. The recommendations for the brine line analysis in that report have been assumed as the baseline condition for the purposes of this TM, while also considering the addition of two pipelines, to develop potential alternative routes for all three lines for future design analysis.

1.1 Background

WRD is responsible for managing and replenishing both the West Coast and Central groundwater basins. In the West Coast Basin, a significant saline plume of groundwater with elevated total dissolved solids has been trapped in the Gage, Silverado, Lynwood, and Lower San Pedro (equivalent to Sunnyside) aquifers because of historical seawater intrusion and the subsequent implementation of two injection barriers. To more fully utilize the West Coast Basin, WRD has initiated a Regional Brackish Water Reclamation Program (Program) to evaluate ways to remediate the trapped saline plume and produce potable water for partnering agencies. In parallel, other local agencies such as MWD and the Los Angeles County Sanitation Districts are embarking on an RRWP that plans to use the JWPCP to produce advanced treated water that can be utilized as recycled water or conveyed for groundwater basin replenishment to injection sites that are assumed, for the purposes of this analysis, to be located near the Old City Yard location. Since the Desalter brine pipeline, product water pipeline to LADWP and MWD advanced treated water pipeline span the same general corridor, this study investigates the potential for all three lines to be constructed at the same time in the same trench, the benefits of which include a streamlined construction schedule, a potentially lower cost, and less impact and disturbance to the general public.

2. Previous Assumption

The following assumptions have been made for the purposes of this study:

- A review of the pipeline routes has been conducted as a desktop review primarily using Google Earth. The original proposed brine pipeline route identified in the CSDPR has served as the baseline alternative.
- A preliminary hydraulic analysis has verified the recommended pipe sizing and did not involve the development of a hydraulic model. Hydraulic analysis for the LADWP potable water line has been completed separately and is presented in the TM for Subtask 2.
- A maximum velocity of 7 feet per second (fps) and 10 fps have been assumed for cement mortar-lined pipes and plastic pipes, respectively.
- The pipelines will be located entirely within a public right-of-way (ROW) and will avoid longitudinal routing within the California Department of Transportation (Caltrans) ROW; however, the pipelines will cross the Caltrans ROW.
- Double containment of the two treated water pipelines is assumed based on typical industry standards, as well as mitigation measures required by MWD for instances when horizontal separation of 10 feet between water and waste pipelines is not achievable. In order for all three pipelines to be constructed in a single trench with a reasonable open-cut trench width within a roadway, this condition would be required as 10 feet of separation would not be feasible. Section 3.8.5 addresses typical separations.
- The project requires no additional storage.
- The pipeline routes begin at the east side of the Desalter and end at the north end of the JWPCP.

3. Alternatives Analysis

This study has examined concept-level routing of all three pipelines if they were to be constructed in a single trench between the Desalter and the JWPCP. The following concepts and terminology have been used in the route development process to provide identifiable and distinguishable elements that promote ease of visualization and management of the overall process:

- *Route segments (or segments)* are short, manageable reaches of pipe, often spanning a length as short as a city block, that are combined to create a group of potential alternative routes. The route segments are designated alphanumerically (for example, AA-1, AA-2, AA-3) with the alphabetical identifier representing the street on which the segment is located on, and the numerical value representing the identification of a specific segment.
- *Alternative routes (or alternatives)* are the various reasonable combinations of contiguous route segments assembled to create an alignment between the beginning and end points of the project.

The alternative route development process consists of the five steps shown in the dark boxes on Figure 1. The next phase of this project (that is, the Alternative Evaluation and Selection Phase) is shown in green and will be completed in the next phase of work. This section provides descriptions of these phases and how they apply to the pipe routing process.

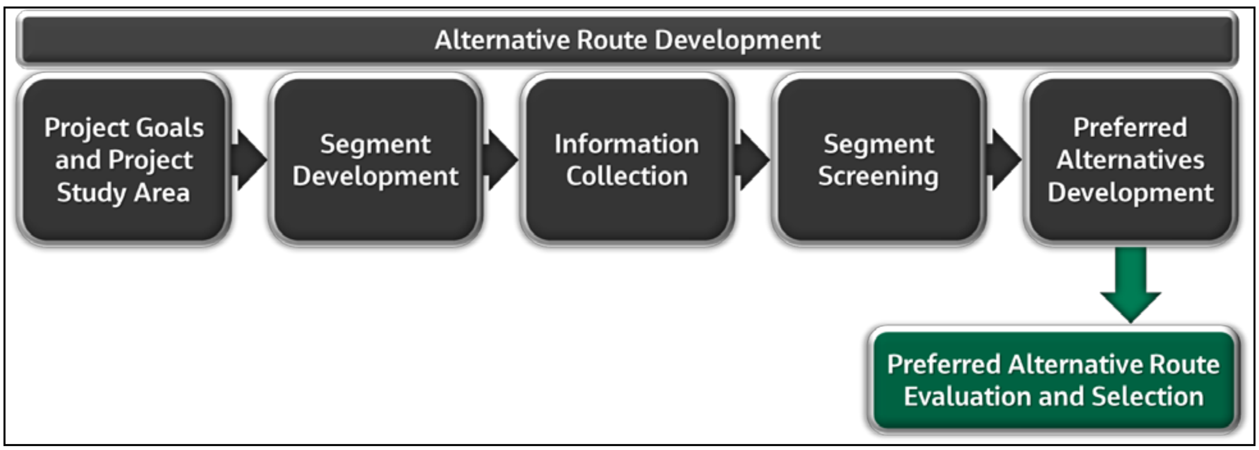

Figure 1. Alternative Route Development, Evaluation, and Selection Process

Sections 3.1 to 3.5 describe the alternative route development process, which consists of the following five steps:

1) Project goals and project study area definition
2) Segment development
3) Information collection
4) Segment screening
5) Preferred alternatives development

3.1 Project Goals and Project Study Area Definition

The goal of this task is to investigate the feasibility of constructing the three pipelines in a single trench between the Desalter and the JWPCP, and to determine potential route alternatives for the pipelines.

The project study area has been established by applying the project goals to identify a reasonable area in which the pipelines could be installed between the Desalter and the JWPCP. Figure 2 depicts the project study area, which is defined by the following:

- The Desalter, located in the City of Torrance, is in proximity to Sierra Street and Elm Avenue, north of Torrance Boulevard (Blvd.).
- The JWPCP is located south of Sepulveda Blvd., between Figueroa Street and Harbor Highway.

3.2 Segment Development

Within the project study area, segments were developed within the public ROW, with an emphasis on streets with relatively wide drive surfaces that could accommodate three new pipelines that range in diameter up to 30 inches within a single trench. Figure 2 shows the initial route segments that were developed for this task, assuming that all three pipelines will be constructed in the same trench and follow the same alignment. Due to the anticipated amount of existing buried utilities in the project area, which are expected to be encountered on every street, roadways with a width of less than 40 feet have been determined to be less desirable from a constructability standpoint as these roads would more than likely result in minimal room for a large trench, less workspace for staging and construction activities, and a higher likelihood of complete road closures.

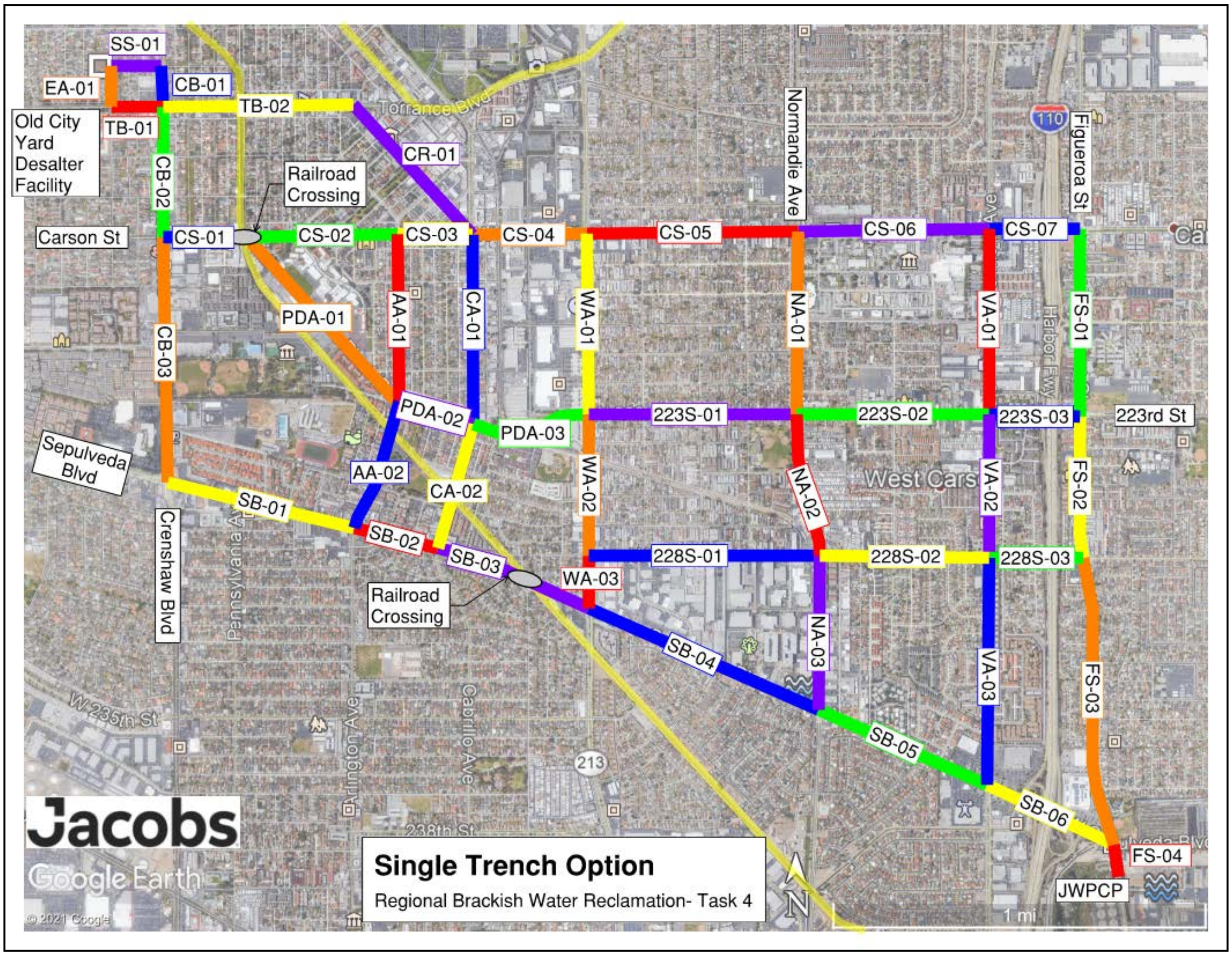

Figure 2. Single Trench Initial Segments

3.3 Information Collection

As part of the information collection process, existing underground utility information within the project study area was collected. Previously collected utility information obtained by Jacobs Engineering Group Inc. (Jacobs), utility information provided by WRD and LADWP, and publicly available online data, including shapefiles, record drawings, or any readily available information depicting location and size of utilities were obtained. Information included public GIS files and other information for the following infrastructure:

- Los Angeles County storm drains
- MWD pipelines
- Los Angeles Bureau of Sanitation sewers
- LADWP pipelines and underground electric lines
- WRD recycled water pipelines

To the fullest extent possible, attempts should be made to avoid conflicts with existing utilities. Utilities have been reviewed in Google Earth to identify routes that minimize potential large-diameter utility relocations. In order for all three pipelines to be constructed within a single trench, the previously described double containment mitigation measure is assumed for the potable and recycled water pipelines. As a result, it may not be necessary to have a clearance of 10 feet between the pipelines associated with this project and other existing pipelines, which provides more flexibility in determining feasible potential routes.

3.4 Segment Screening

Segment screening consisted of individual segment review and elimination of less favorable segment choices. The initial segments were screened and evaluated based on various high-level criteria, such as:

- Fatal flaws, such as longitudinal construction within the Caltrans ROW (not including crossings), and possible major disruptions to the public
- Obstruction of entrances to critical and emergency services, such as fire stations, schools, and hospitals
- Potential major utility interferences
- Residential and business frontage
- Street width

The screening process included the following three sequential steps:

- **Step 1**: screen and eliminate segments if they are longitudinally located within the Caltrans ROW. For example, segments along Western Avenue, which is also California State Route (SR) 213 and maintained by Caltrans, were eliminated.
- **Step 2**: compare adjacent segments using criteria, such as constructability, street width and length, proximity to emergency service facilities and schools, utility congestion, and relative disturbance to residents and businesses. For example, when comparing adjacent segments along Arlington Avenue and Cabrillo Avenue, the segments along Arlington Avenue would interfere with access to more residencies when compared with Cabrillo Avenue; therefore, segments in Arlington Avenue were eliminated in Step 2. This process was repeated for situations where segments were parallel or adjacent to one another.
- **Step 3:** eliminate the residual segments that were previously connected to segments eliminated in Steps 1 and 2 that are no longer connected to other segments (that is, segments that no longer have continuity). For example, when segment AA-02 was eliminated, segment AA-01 no longer connected to other segments to contribute to a potential pipeline route; therefore, segment AA-01 was eliminated. This process was repeated for all other disconnected route segments.

Table 1 provides a summary of the segments eliminated after the screening process. Refer to Appendix A for a detailed summary of the criteria that led to eliminating segments in Table 1.

Table 1. Steps 1, 2, and 3 Eliminated Segments

Roadway Name	Eliminated Segment ID	Segment Screening Criteria				
		Step 1		Step 2		Step 3
		Caltrans ROW	Unnecessary RR Crossing	Constructability: Street Width, Length, and Future Construction	Hospitals, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Torrance Blvd.	TB-02					TB-02
Cravens Avenue	CR-01					
Carson Street	CS-06 and CS-07				CS-06	CS-07
Figueroa Street	FS-01					FS-01, FS-02, and FS-03
Plaza Del Amo	PDA-01 and PDA-02				PDA-01	PDA-02
223rd Street	223S-02 to 223S-03					223S-02 and 223S-03
228th Street	228S-01 to 228S-03					
Arlington Avenue	AA-01 and AA-02		AA-02		AA-01	
Cabrillo Avenue	CA-02		CA-02			
Western Avenue	WA-01 to WA-03					
Vermont Avenue	VA-01 to VA-03					

Note:

ID = identification

Figure 3 presents the segments that remain after elimination of unfavorable segments during the screening process. The number of segments was reduced from 47 to 24, and the remaining segments were used to develop the pipeline route alternatives.

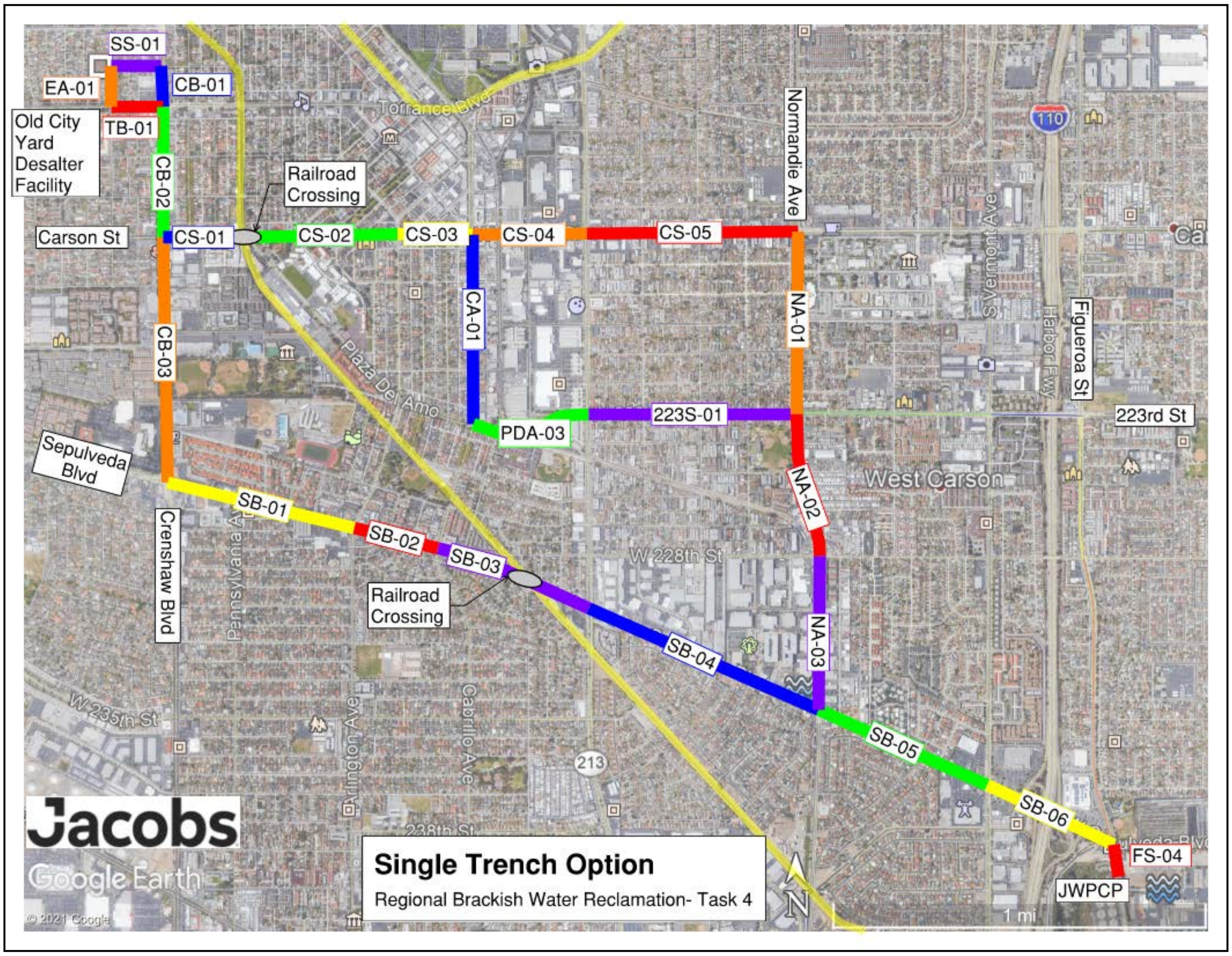

Figure 3. Single Trench Segments After Screening

3.5 Preferred Alignment Alternatives Development

Segments that remain after the three-step screening process were used to develop alternative routes for the pipelines between the Desalter and the JWPCP, as shown on Figure 4. The previous concept-level study in the CSDPR provided the baseline route for the new brine pipeline and is represented as Alternative 1. This route and the segments that comprise it were evaluated as part of the screening process and were determined to be a viable alternative. Two additional alternatives were also evaluated and proposed.

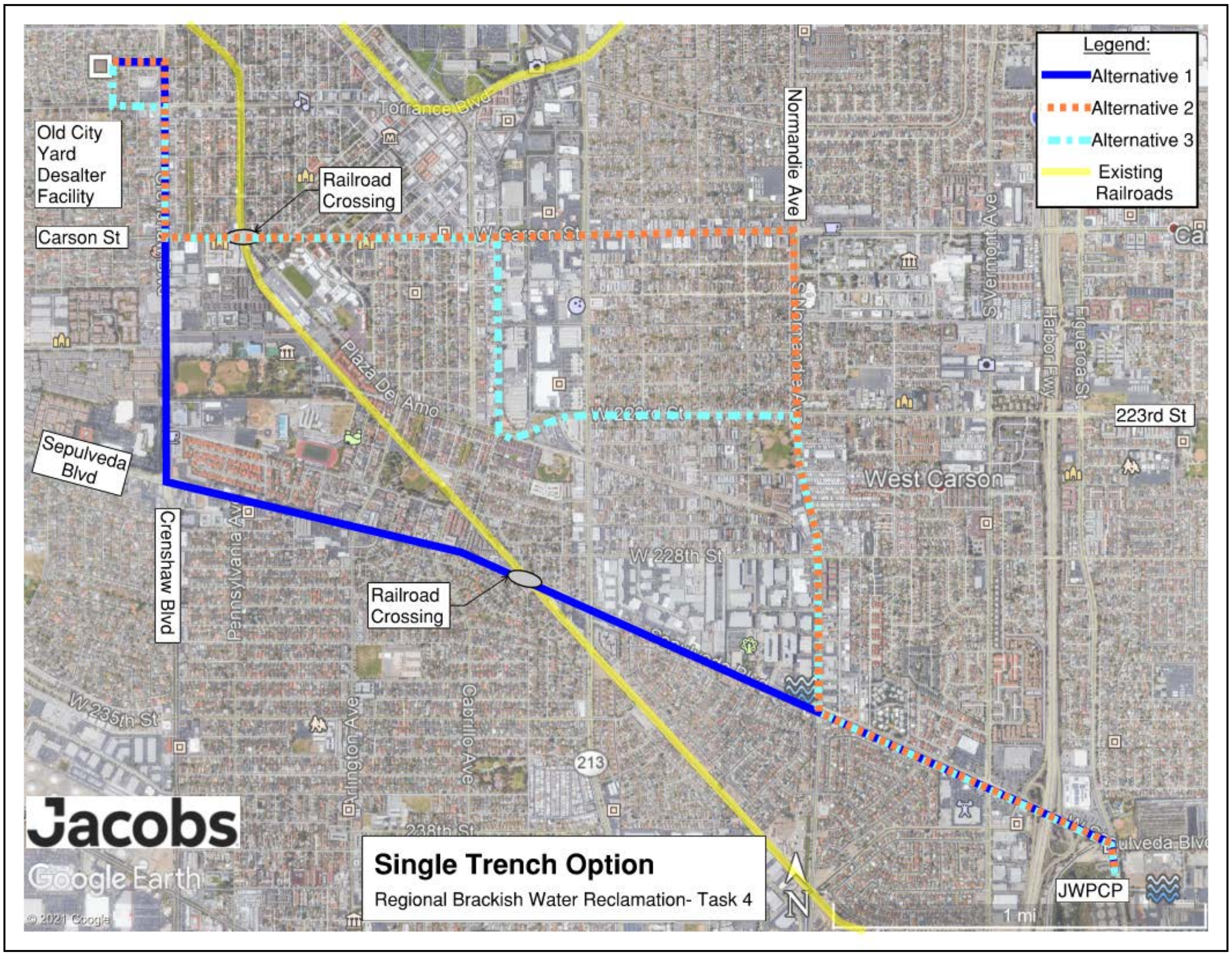

Figure 4. Single Trench Preferred Alternatives

Alternative 1 is approximately 4.1 miles long and heads east on Sierra Street from the Desalter, then south on Crenshaw Blvd., then east on Sepulveda Blvd., then south on Figueroa Street to the JWPCP. The following segments comprise Alternative 1: SS-01, CB-01, CB-02, CB-03, SB-01, SB-02, SB-03, SB-04, SB-05, SB-06, and FS-04.

Alternative 2 is approximately 4.6 miles long and heads east on Sierra Street from the Desalter, then south on Crenshaw Blvd., then east on Carson Street, then south on Normandie Avenue, then east on Sepulveda Blvd., then south on Figueroa Street to the JWPCP. The following segments comprise Alternative 2: SS-01, CB-01, CB-02, CS-01, CS-02, CS-03, CS-04, CS-05, NA-01, NA-02, NA-03, SB-05, SB-06, and FS-04.

Alternative 3 is approximately 4.6 miles long and heads south on Elm Avenue from the Desalter, then east on Torrance Blvd., then south on Crenshaw Blvd., then east on Carson Street, then south on Cabrillo Avenue, then east on Plaza Del Amo Street and continues on to 223rd South Street, then south on Figueroa Street to the JWPCP. The following segments comprise Alternative 3: EA-01, TB-01, CB-02, CS-01, CS-02, CS-03, CA-01, PDA-03, 223S-01, NA-02, NA-03, SB-05, SB-06, and FS-04.

3.6 Pipe Sizing

This single trench analysis considers the alignment for three pipelines with varying flows. The size of the LADWP potable water pipeline has been evaluated as part of TM 2. The recycled water and brine line pipelines have been sized based on preliminary flow information to establish a basis of design for pricing purposes and evaluation for future development.

The brine line will deliver the waste flow stream generated by the Desalter to the JWPCP. The average flow is expected to be 1,175 gallons per minute (gpm) (1,900 acre-feet per year [AFY]) with high and low flows around 2,000 gpm (3,230 AFY) and 1,000 gpm (1,620 AFY), respectively. These high and low flows correspond to the maximum and minimum desalter sizes of 20,000 AFY and 12,500 AFY, respectively. A pipeline diameter of 12 inches is sufficient to meet the previously stated velocity criteria, and the pressure in this pipe is not expected to exceed 150 pounds per square inch (psi). For more details, please refer to the brine line analysis in the CSDPR.

The recycled water pipeline is anticipated to deliver advanced treated water from the JWPCP as part of the MWD RRWP to an injection location near the Desalter. For the purposes of this TM, the average design flow for the replenishment water is assumed to be 16,000 AFY, with a low and high flows corresponding to 12,500 and 20,000 AFY, respectively. Based on these conceptual flow estimates, the recycled water pipeline could be as large as 30 inches in diameter to meet the previously stated flow velocity criteria. It is also assumed that the working pressure in this pipe will not exceed 150 psi. These assumptions will need to be verified by MWD in the next phase of the project to validate future design criteria.

Table 2. Brine Pipeline Material and Corresponding Diameters and Calculated Velocities

Pipe Material	Diameter (inches)		Velocity (fps)			
	Nominal	Actual ID	Low (Q = 1,000 gpm)	Average (Q = 1,175 gpm)	High (Q = 2,000 gpm)	Recommended Maximum
HDPE – DR-11, 200 psi rating	12	10.66	3.60	4.23	7.23	7.0
PVC – SCH 80, 230 psi rating	12	11.38	3.16	3.71	6.31	7.0

Note:

HDPE = high-density polyethylene pipe

Table 3. Recycled Water Pipeline Material and Corresponding Diameters and Calculated Velocities

Pipe Material	Diameter (inches)		Velocity (fps)			
	Nominal	Actual ID	Low (Q = 12,500 AFY)	Average (Q = 16,000 AFY)	High (Q = 20,000 AFY)	Recommended Maximum
WSP – standard weight (.365 inch) wall with CML	30	28.25	3.97	5.08	6.35	7.0

Notes: CML is assumed to be 3/8-inch-thick.

CML = cement mortar lining

WSP = welded steel pipe

3.7 Pipe Material and Corrosion Analysis

The pipe materials considered at this stage of the project include WSP, earthquake-resistant ductile iron pipe (ERDIP), polyvinyl chloride pipe (PVC), and HDPE. The use of HDPE or PVC for the brine line has been discussed in detail in the CSDPR and is recommended for consideration of this pipeline. The use of WSP for the recycled water pipeline is consistent with the MWD design standards, and TM 2 indicates, the use of ERDIP for the LADWP potable water pipeline is the preferred material for this particular pipeline. For this

TM, WSP standard weight dimensions have been assumed with A1018, grade 36, type 1 structural steel and 3/8-inch mortar lining, which are typical industry standards for steel pipe of this size and application. Recommendations for the ERDIP material and sizing are the same as those in TM for Subtask 2.

3.7.1 Polyvinyl Chloride Pipe

PVC is a flexible plastic pipe that is highly resistant to chemical and corrosive degradation. For pipe diameters that are 4 to 60 inches, standard PVC wall thicknesses are designed and manufactured per American Water Works Association (AWWA) C900-07 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100 mm through 300 mm), for Water Transmission and Distribution and the AWWA Manual M23 PVC Pipe-Design and Installation. Typical joints include bell- and spigot-style connections with mechanical-thrust restraint, proprietary interlocking joints, or unrestrained push-on joints with thrust blocks. Watertight fittings for PVC pipe are typically ductile iron pipe (DIP) per AWWA C110-12 Ductile-Iron and Gray-Iron Fittings. However, special proprietary PVC joints with interlocking joints are also available. PVC requires no additional corrosion protection, but if DIP fittings are used, corrosion protection, such as galvanic anodes, will be required.

3.7.2 High-density Polyethylene Pipe

HDPE is a flexible plastic pipe that is highly resistant to chemical and corrosive degradation. For pipe diameters that are 4 to 64 inches, HDPE is fabricated and designed in accordance with AWWA C906-07 Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in. (1,600 mm), for Water Distribution and Transmission and the AWWA Manual M55 PE Pipe-Design and Installation. Joints for HDPE pipe are typically achieved via thermal heat fusion or electrofusion. The fused joints are restrained, which eliminates the need for further thrust restraint or thrust blocks.

Corrosion concerns are negligible when considering HDPE pipe; however, it is potentially susceptible to degradation when in contact with potable water disinfectants. The severity of this degradation changes based on multiple factors, so further evaluation is recommended in future design phases. For additional information, refer to *Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants: TN-44/2015* (Plastics Pipe Institute 2015).

3.7.3 Welded Steel Pipe

WSP is a versatile material that can be custom made to provide a range of diameters, linings, coatings, and wall thicknesses to meet design pressure requirements. The pipe is fabricated and designed in accordance with AWWA C200-17 Steel Water Pipe, 6 in. (150 mm) and Larger and the AWWA Manual M11 Steel Pipe: A Guide for Design and Installation. WSP joints are typically welded as single lap or double lap, or are butt welded, as required by MWD standards. Cement mortar lining and polyethylene tape coating are typical industry practices for the lining and coating of WSP, respectively, and conform to MWD requirements. WSP is highly subject to corrosion and requires cathodic protection via an impressed current system or galvanic anodes. Additional protection using a cement mortar overcoat is also recommended for consideration. All corrosion protection mitigation measures should be coordinated with MWD in the next phase of the project.

3.7.4 Earthquake-resistant Ductile Iron Pipe

In conformance with the LADWP (2019) *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects* (Trunkline Design Manual), the primary material used for pipelines less than 30 inches in diameter is ERDIP. ERDIP utilizes typical DIP dimensions and standards with specialized joint connections that allow for flexibility without breakage in a seismic event. While no known fault lines are crossed in this alignment, liquefaction and lateral spreading may be of concern and should be evaluated during future design phases of the project. ERDIP is fabricated and designed the same as typical DIP, in accordance with AWWA C150-08 Thickness Design of Ductile-Iron Pipe. Typical DIP joint connections include push-on, mechanical joint, and proprietary restrained joints, all of which are in accordance with AWWA C111-12 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings and AWWA C110. ERDIP joints are specially designed push-on joints that are typically composed with locking rings and spigot projections that allow for 1 percent lateral expansion and 5 degrees of deflection before failure. The ERDIP joints referenced for this design are manufactured by U.S. Pipe.

Corrosion mitigation practice for ERDIP typically includes protective coatings in accordance with AWWA C151-09 Ductile-Iron Pipe, Centrifugally Cast and requires the use of polybags (as recommended by the Ductile Iron Pipe Research Association), though polybags are not recommended in areas with high, salty groundwater. Other practices include bonding joints to allow for the monitoring of electrical continuity, additional exterior coating, and cathodic protection systems, such as galvanic anodes.

3.8 Right-of-Way and Easement Acquisition

This TM presents concept-level routes that are located entirely within a public ROW to avoid the need to acquire temporary construction or permanent easements. As the project evolves to the preliminary design phase and a preferred pipeline corridor is selected, determination of land acquisition will need to be made prior to finalizing the final pipe route. Based on previous experience with LADWP and MWD, combined with the nature of the project area, it is anticipated that all pipeline reaches will be constructed within a road ROW.

3.9 Permitting and Approvals

Permits and approvals from regulatory agencies have not been obtained for the project and will require coordination in future phases. This section explores the probable coordination efforts that will be required during the design and construction phases. In addition to construction and regulatory permits, field activities, such as geotechnical and subsurface utility exploration programs, will be required prior to final design.

Table 4. Pipeline Summary of Anticipated Permits and Approvals

Agency	Permit/Approval
Caltrans ▪ Western Avenue (CA SR-213) ▪ I-110 ▪ Rail 13	Encroachment permit and traffic control
City of Carson	Includes an encroachment permit, traffic control, discharge, and site development (that is, any municipal local construction permits required for construction in the City of Carson)
City of Los Angeles	Includes an encroachment permit, traffic control, discharge, and site development (that is, any municipal local construction permits required for construction in the City of Los Angeles)
City of Torrance	Includes an encroachment permit, traffic control, discharge, and site development (that is, any municipal local construction permits required for construction in the City of Torrance)
DDW State Water Resources Control Board	Approval required for the reduction of utility separation requirements

Agency	Permit/Approval
Los Angeles County DPH	Approval required for new water pipelines built in Los Angeles County
Lead agency to be determined	CEQA

Notes:
CEQA = California Environmental Quality Act
DDW = Division of Drinking Water
DPH = Department of Public Health
I = Interstate

3.9.1 California Department of Transportation

Within the project study area, Caltrans has jurisdiction over California SR-213 (Western Avenue), I-110, and Caltrans Rail 13. An encroachment permit is required for all proposed activities under, over, and within the Caltrans ROW. A standard encroachment permit application and supporting documentation includes pipelines designs, traffic management plans, environmental documentation, and a Letter of Authorization. The encroachment permit package needs to be submitted to the Caltrans District 7 address listed herein:

Caltrans District 7
100 South Main Street, Suite 100
Los Angeles, California 90012
213.897.3631

The fee for the permit covers the time for Caltrans staff to review and inspect the project area, as well as a deposit with the permit application. The approval process may take up to 60 days.

3.9.2 City of Carson

The segments within the City of Carson include all segments east of I-110 along Figueroa Street. An encroachment permit is required for all proposed activities within the City of Carson ROW, where a standard permit application, design plans, and traffic control plans are required to be submitted at the address herein:

City of Carson Department of Public Works
701 E. Carson Street
Carson, Caliornia 90745
(310) 952-1700 X1458

An issuance fee, an inspection fee, and a security deposit are required as part of the permit application.

Other construction-related permits may eventually be required but are typically not required during the design phase of the project and can be deferred to the contractor during construction.

3.9.3 City of Los Angeles Bureau of Engineering

An encroachment permit and other potential construction-related permits may be required for work conducted in the City of Los Angeles ROW. The segments within the City of Los Angeles boundary include east-west segments CS-05, 223S-01, 228S-01, and SB-04. Encroachment permits, or B permits, require design plans and traffic management plans to be submitted to the City of Los Angeles Bureau of Engineering at the following address:

City of Los Angeles Department of Public Works
Bureau of Engineering
Permit Case Management Office
201 North Figueroa Street, 2nd Floor Room 200
Los Angeles, California 90012-2601

Permit fees include plan checking deposits, construction inspection deposits, and an application fee.

Other construction-related permits may eventually be required but are typically not required during the design phase of the project and can be deferred to the contractor during construction.

3.9.4 City of Torrance

Portions of the pipeline within the City of Torrance include all segments west of SR-213, and require an encroachment permit issued by the city. The encroachment permit application requires design plans and traffic management plans to be submitted to the City of Torrance Community Development Department at the address listed herein:

City of Torrance, Community Development Department
Attn: Permit Section
3031 Torrance Boulevard
Torrance, California 90503
310.618.589

The City of Torrance Permit Section and City Engineer will review the encroachment permit application package, and once approved, an administrative fee will be required to be paid before the permit can be issued.

Other construction-related permits may eventually be required but are typically not required during the design phase of the project and can be deferred to the contractor during construction.

3.9.5 Division of Drinking Water Requirements

This project is anticipated to parallel several existing underground utilities, including water and sewer lines. Title 22 of the *California Code of Regulations* established the separation criteria between these existing utilities, which are enforced by DDW. The criteria are as follows:

- 4 feet horizontally and 1 foot vertically from potable and recycled water lines (edge to edge)
- 10 feet horizontally and 1 foot vertically above wastewater (including brine) lines (edge to edge)

If these distances prove to be prohibitive, approval can be obtained from DDW for proposed alternatives that meet at least the “same level of protection to public health” as the previously described minimum distances. Constructing all three pipeline in a common trench will require a variance from these requirements, and standard practices (such as, installing a double-containment pipe that includes an exterior-fused joint HDPE protective pipe around the respective carrier pipes that convey water) are accepted by MWD in cases where adequate clearances are not feasible. This variance will need to be coordinated with all agencies, including the utility owners, in future phases of the project prior to design.

3.9.6 Department of Public Health Regulatory Requirements

The Los Angeles County DPH specifies additional documentation required for new water line construction projects. Receipt of approval must be provided by the Environmental Health Division and requires the project to have a Plan Check Number (PCN) and a legal address before submission of an application. The PCN and legal address are obtained by submission of a construction drawing set to the Los Angeles County Department of Public Works, Division of Building and Safety, or the City Building Authority. After receipt of the PCN and legal address, the applicant must submit the following documentation to the Environmental Health Division:

- A Service Request Application (with the accompanying fee), which must include the date that plans were received by the Los Angeles Public Works, Division of Building and Safety, and the PCN
- A will serve letter on water company letterhead, which must state that the project water meets Safe Drinking Water Standards, and include the Public Water System Number assigned by the California DPH

3.9.7 California Environmental Quality Act

The CEQA process requires projects to obtain a biological technical report, a cultural resources report, a noise study, and an air quality study to proceed with construction. These reports can be completed based on the proposed alignments in this TM. Future project work will require the identification of a lead agency to move the CEQA process forward.

4. Implementation and Cost

4.1 Implementation Schedule

Due to the three (brine, potable, recycled water) pipelines each having different owners (possibly WRD, LADWP, and MWD, respectively), an interagency agreement will need to be completed for the pipelines to be constructed within a common trench by a single contractor, resulting in potential construction cost and schedule savings and the streamlining of the entire process, including the obtainment of permits and contractor coordination.

The length of the pipelines and the relatively small number of jurisdictions impacted by construction are conducive for this reach of the project to be packaged as a single contract. However, coordination with all owning agencies during the design phase will be required to reach a consensus on the construction contract language and schedule.

Construction is anticipated to primarily utilize open-cut and trench methods with a minimum depth of cover between 4 and 5 feet. Trenchless construction would be required at the Caltrans ROW crossings and in any situation where utilities would be difficult to avoid and ground conditions would prohibit or hinder open-trench construction. Based on the size of the pipes and the casings required for trenchless installations, a tunnel boring machine, jack and bore, auger boring, and horizontal direction drilling are feasible methods that should be evaluated as trenchless construction methods. Each owner may prefer that their pipe be installed in its own casing with trenchless installation, a detail that will need to be coordinated in the next phase of the project. For the purpose of this TM, it is assumed that all trenchless crossings will require a separate casing installation for each pipeline.

Based on the length of the pipelines and the nature of construction within highly urban and developed areas in Los Angeles County, the duration of construction is anticipated to be 18 to 24 months. Construction will span multiple seasons; therefore, project phasing issues, such as local moratoriums and seasonal restrictions, should be considered.

4.2 Opinion of Probable Construction Cost for Single Trench Alternatives

The unit cost for pipe material and installation from the LADWP (2019) Trunkline Design Manual is assumed, as follows:

- The ERDIP material cost is estimated from $30 to $35 per diameter-inch per linear foot (dia-in/lf) for pipelines that range in size less than 30 inches in diameter. This material cost assumption by LADWP will provide a basis for a conservative estimate.
- Open-cut pipe installation for ERDIP is estimated by LADWP to range from $15 to $20 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) that ranges from $45 to $55 per dia-in/lf. Including a 40 percent contingency to the material and installation unit cost, as well as converting from LADWP April 2019 dollars to January 2021 dollars using escalation from the Engineering News Record (ENR) Construction Cost Index (CCI), results in a total all-in construction cost range from $65.24 to $79.74 per dia-in/lf. For the purposes of this TM, $79.74 per dia-in/lf has been used.
- The WSP material cost is estimated from $12 to $15 per dia-in/lf for pipelines that range in size from 30 to 96 inches with CML, cement mortar coating, and a wall thickness of 0.5 inches. In a separate effort, Jacobs obtained a unit cost of $12 per dia-in/lf for steel pipe from a recent price quote from the largest steel pipe supplier in the western United States (U.S.). Since these two sources correlate to similar unit costs, it is assumed for the purposes of this estimate that a cost of $12 per dia-in/lf would suffice since the diameter and wall thickness for the pipeline will be smaller than the assumptions used by LADWP, and as a result, would provide a basis for a conservative estimate.
- Open-cut pipe installation for WSP is estimated by LADWP to range from $20 to $25 per dia-in/lf. This results in a total construction unit cost (when combined with the pipe material unit cost) that ranges from $32 to $37 per dia-in/lf. Including a 40 percent contingency to the material and installation unit cost, as well as converting from LADWP April 2019 dollars to January 2021 dollars using the ENR CCI, results in a total all-in construction cost range from $46.40 to $57.99 per dia-in/lf. For the purposes of this TM, $57.99 per dia-in/lf has been used.
- A unit cost of $19.11 per dia-in/lf for HDPE pipe has been determined, based on a pipe material quote for DIPS, DR 11, PE4710 HDPE pipe from one of the largest HDPE pipe suppliers in the U.S., and typical contractor markups expected in Southern California, based on a cost-per-weight estimate, where smaller-diameter pipe weighs less than larger-diameter pipe. An installation cost for HDPE pipe has been obtained through recent construction cost estimates for similar HDPE pipe installations in Southern California, resulting in a pipe installation cost (including contractor markups, but excluding pipe material cost and contingency) of $11.03 per dia-in/lf. The total all-in construction cost using HDPE pipe, including a 40 percent contingency and ENR CCI escalation from May 2020 dollars to January 2021 dollars, is estimated at $19.11 per dia-in/lf, when considering 12-inch diameter pipe, which has a different weight than other HDPE pipe diameters.

4.2.1 Opinion of Probable Construction Cost for Separate Trenches

Using the unit costs for the various pipe materials and installation costs in TMs for Subtasks 2 and 3 (Jacobs 2021a, 2021b), the following represent the unit costs for construction of each of the three pipelines installed in separate trenches. Figure 5 depicts a typical single trench section.

- 12-inch brine pipeline (HDPE): $229.32 per linear foot (lf)
- 18-inch LADWP potable water pipeline (ERDIP): $1,435.32 per linear foot
- 30-inch MWD recycled water pipeline (WSP): $1,739.70 per linear foot
- Total unit cost to construct all three pipelines in separate trenches: $3,404 per linear foot

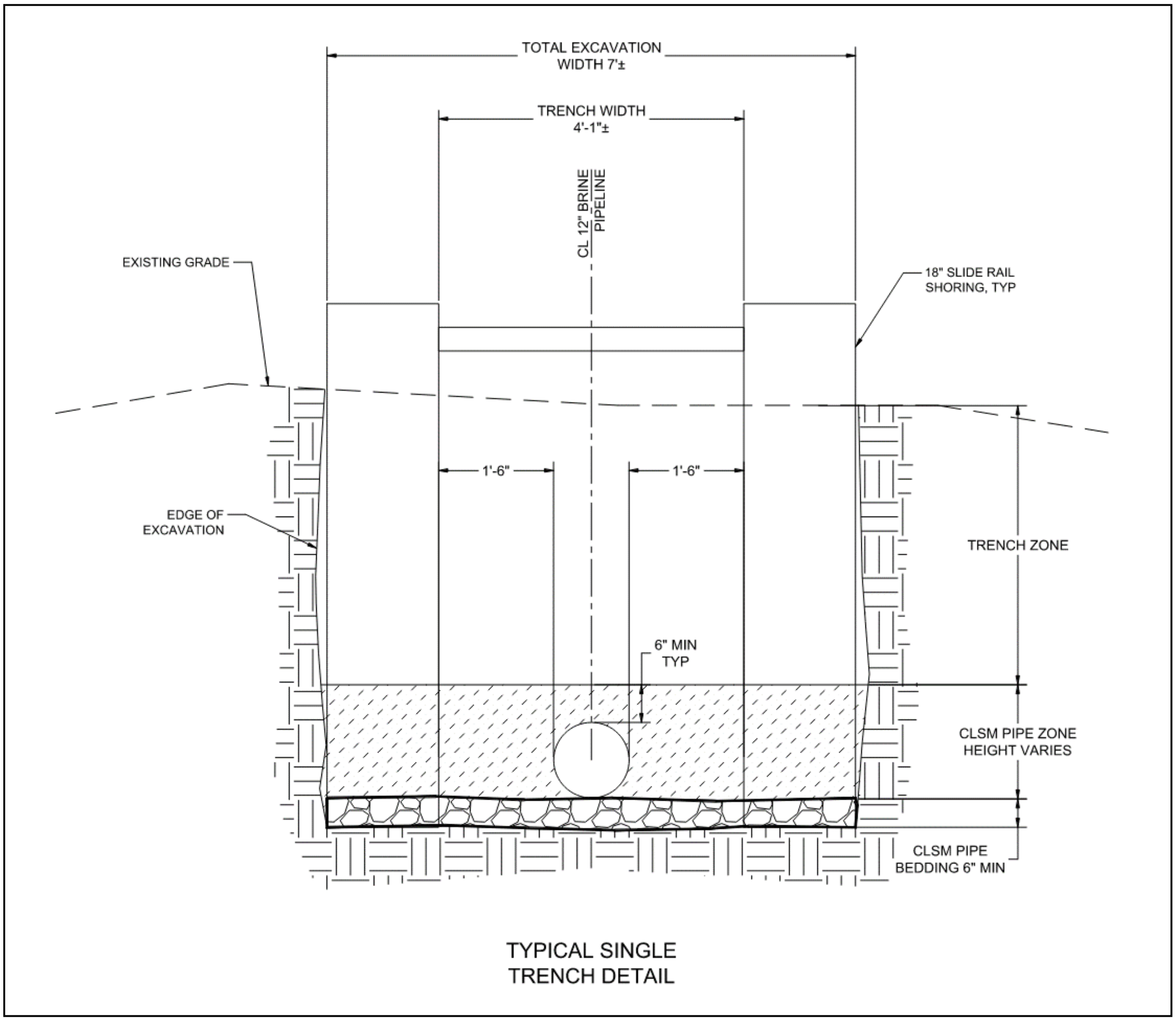

Figure 5. Typical Single Trench Detail

4.2.2 Opinion of Probable Construction Cost for Single Trench

The installation of all three pipelines in a single trench will require double containment on the 18-inch LADWP potable water pipeline and 30-inch MWD recycled water pipeline. A preliminary unit cost for each pipeline has been developed by our professional cost estimators using pricing from previous similar installations where an HDPE containment pipe was required for DIP and WSP carrier pipes. The following are the unit costs to construct both pipes, respectively, with an exterior HDPE containment pipe:

- 18-inch LADWP potable water pipeline: $1,897 per linear foot
- 30-inch MWD recycled water pipeline: $3,162 per linear foot
- 12-inch brine pipeline: $229.32 per linear foot
- Total unit cost to construct all three pipelines in a single trench: $4,495 per linear foot

Combining the cost for the installation of each pipe and applying a cost savings between 10 and 15 percent provides a conservative budgetary estimate for a common trench installation involving multiple pipes, including double containment for two of the three pipelines. This approach has been taken for the purposes of this TM. Installing the pipes in a single trench reduces the amount of excavations, mobilizations, shoring systems, and costs associated with ancillary activities, including staging, multiple traffic control measures, and permits For the purposes of this TM, a 15 percent savings is assumed, which results in a total unit cost of $4,495 per linear foot to construct the pipelines in a single trench. Figure 6 depicts a typical combined trench section. The single trench option for the three pipelines would result in an excavation of roughly 13 feet, assuming that the potable and recycled water pipelines would be double-contained.

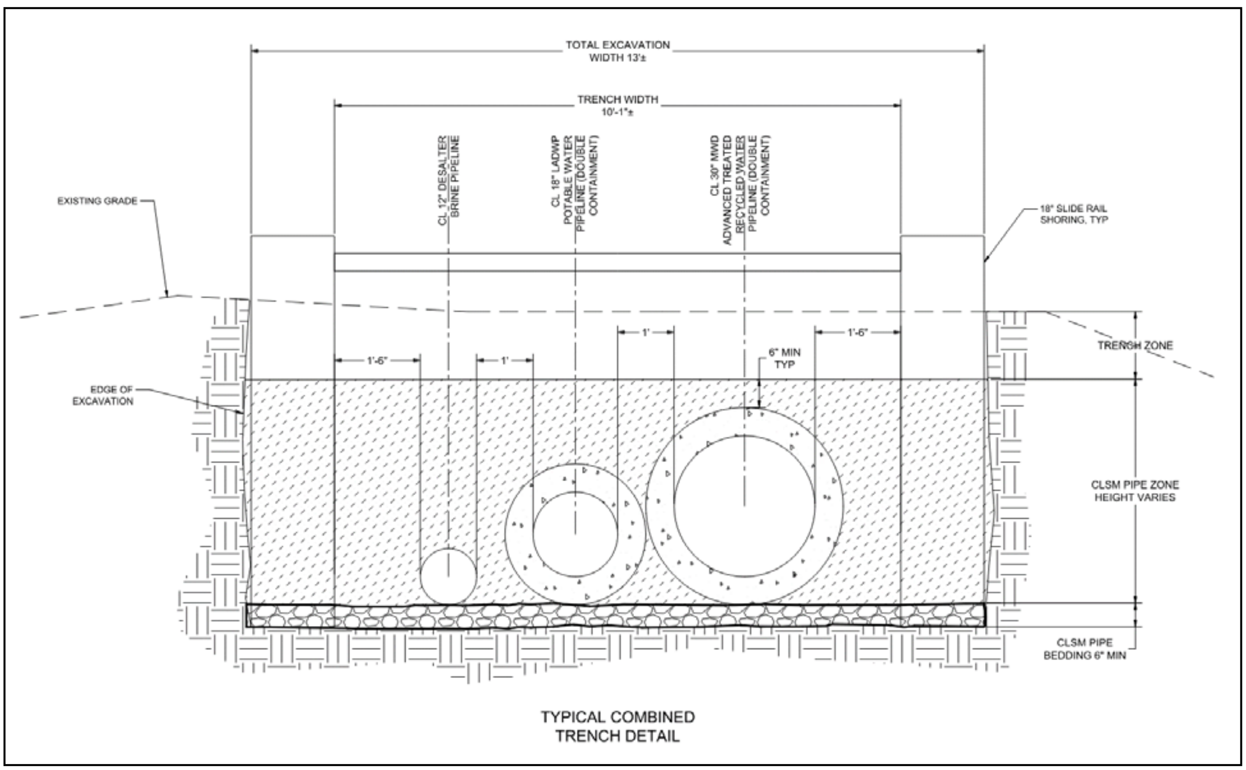

Figure 6. Typical Combined Trench Detail

4.2.3 Cost Comparison

Based on the unit costs in Section 4.2, the cost to construct the three pipelines in separate trenches is around 25 percent lower than the cost to construct them in a single trench. This is primarily due to the double-containment assumed for the two largest pipes (that is, the 18-inch LADWP potable water pipeline and the 30-inch MWD recycled water pipeline) due to horizontal separations less than 10 feet from each other, as well as from the brine pipeline. Installing a carrier pipe in an HDPE casing, which includes additional material for a larger-diameter HDPE pipe, installation costs, labor and equipment, casing spacers, and annular fill, increases the overall cost of construction because it essentially involves installing extra pipelines, in addition to the three carrier pipelines associated with the project. However, there are noncost factors that should be considered when evaluating the feasibility of the common trench approach, including:

- Streamlining the schedule to prevent multiple pipelines constructed in a staggered manner.
- Minimizing disturbances to the public, including traffic impacts, lane closures, utility conflicts, and residential or business access disruption.
- Reducing and consolidating space because installation of the pipelines in a single trench could require an open trench that would be approximately 13 feet wide (Figure 5 provides an example of potential trench width and configuration details). If the three pipelines were constructed separately, a single trench would range in width from 7 feet for the 12-inch brine pipeline to 8.5 feet for the 30-inch recycled water pipeline, with a combined 23 feet required for all three trench excavations (that is, a 77 percent increase in required space when compared with the single trench option). Figure 6 provides an example trench for the 12-inch brine pipeline installation. A 10-foot horizonal clearance would also be required between the 30-inch and 18-inch pipes from the wastewater pipelines. If this clearance space is not available, those pipes would require double containment, which would increase the cost of the separate trench installations more than the single trench option.

4.3 Recommended Next Steps

Conclusions and recommendations from this evaluation include the following:

- An HDPE pipe with a nominal diameter of 12 inches is recommended for the brine pipeline.
- A WSP with a nominal diameter of 30 inches is recommended for the recycled water pipeline. Final pipe material, flow, and sizing will require coordination with MWD and the RRWP prior to the design phase of the project.
- In accordance with TM 2, an ERDIP with a nominal diameter of 18 inches is recommended for the potable water pipeline in conformance with the LADWP (2019) Trunkline Design Manual. Final pipe material, flow, and sizing will require coordination with LADWP prior to the design phase of the project.
- Coordination with LADWP and MWD will be required to determine the allowable clearances between the advanced treated recycled water pipeline, the potable water pipeline, and the brine pipeline and whether double containment will be acceptable. Double containment is the current standard recommended by MWD in cases with horizontal clearances with other utilities less than 10 feet.
- Trenchless crossings will be necessary at the Caltrans crossings.
- Geotechnical, survey, and utility investigations will be necessary prior to the design phase of the project to assess the viability of the alternative routes in this TM.

5. References

Jacobs. 2019. *Regional Brackish Water Reclamation Program Feasibility Study – Dedicated Brine Line Route Analysis Technical Memorandum*. May.

Los Angeles Department of Water and Power (LADWP). 2019. *Trunk Line Design Group Design Manual: A Guide to the Management, Design and Construction Support of Trunk Line Design Projects*. April.

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Appendix A
Segment Screening

Old City Yard Desalter to Joint Water Pollution Control Plant Brine Pipeline Segments

1. Sierra Street (SS-01)

- Width: 65 feet; two lanes with a 20-foot planter strip; residential
- Right-of-way (ROW): public
- Utilities: unknown
- Segment-specific issues:
  - Residential frontage

2. Elm Avenue (EA-01) (Original Brine Line Alignment)

- Width: 33 feet; two lanes; residential
- ROW: public
- Utilities: unknown
- Segment-specific issues:
  - Residential frontage

3. Torrance Boulevard (Blvd.) (TB-01 to 02) (Original Brine Line Alignment TB-01)

- Width: 75 feet; four lanes, a turn lane, and a 10-foot shoulder on each side
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
TB-01	SD	Perpendicular at Crenshaw Blvd.	24	RCP
TB-02	SD	South eastbound lane	24-36	RCP
Notes: SD = Storm Drain utility RCP = Reinforced Concrete Pipe				

- Segment-specific issues:
  - TB-02: railroad (RR) crossing

4. Crenshaw Blvd. (CB-01 to 03) (Original Brine Line Alignment CB-02 to CB-03)

- Width: 77 feet; six lanes and a turn lane
- ROW: public, not maintained by the California Department of Transportation (Caltrans)
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CB-01	SD	Perpendicular at El Dorado Street	18	UNK
CB-02	SD	Westside southbound	18-36	RCB/RCP
CB-02	SS	Westside southbound	8	VCP
CB-03	SD	Eastside northbound until Jefferson Street, then Westside southbound	18-36	RCP
Notes: SS = Sanitary Sewer utility RCB = Reinforced Concrete Box				

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
VCP = Vitrified Clay Pipe				

- Segment-specific issues:
  - CB-03: Torrance Fire Department, north end

5. Sepulveda Blvd. (SB-01 to 06) (Original Brine Line Alignment SB-01 to SB-06)

- Width: 77 feet; six lanes, a turn lane, and periodic medians
- ROW: public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
SB-01	SD	South eastbound lane	18-60	RCP
SB-02	SD	South eastbound lane	27	RCP
SB-03	SD	Perpendicular at RR crossing	15	RCP
SB-04	SD	South eastbound lane	8-78	RCP
SB-04	SS	North westbound lane	8-15	VCP
SB-04	PWR	North westbound lane	--	--
SB-04	WTR	South eastbound lane and both lanes after Lockness Avenue	8-16	CI, DI, and STL
SB-04	WTR	Perpendicular at Normandie Avenue	31.4	STL - trunk
SB-05	SS	South eastbound lane	57?	RCP
SB-05	SD	North westbound lane	18-36	RCP
SB-06	SS	South eastbound lane	12 and 54-83.4	VCP and RCP
SB-06	SD	South eastbound lane	18-79	RCP
Notes: PWR = Power underground (utility) WTR = Water (utility) CI = Cast Iron pipe DI = Ductile Iron pipe STL = Steel pipe				

- Segment-specific issues:
  - SB-03: RR crossing
  - SB-06: crosses under Harbor Freeway

6. Cravens Avenue (CR-01)

- Width: 45 feet; 2 lanes; parking on either side
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CR-01	SD	Perpendicular at Cabrillo Avenue	24	UNK

- Segment-specific issues:
  - Multiple business buildings
  - Compared to other adjacent segments, its 45-foot street width is much less

7. Carson Street (CS-01 to 07)

- Width: 58 to 80 feet; four lanes; occasional shoulders and left-turn lanes
- ROW: public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CS-01	SD	Perpendicular at Crenshaw Blvd. and Madrid Avenue	18-39	RCP
CS-01	SS	South eastbound lane	10	VCP
CS-02	SD	North westbound lane	15-42	RCP
CS-03	SD	Center turning lane	18-39	RCP
CS-04	SD	Center turning lane	18-36	RCP
CS-05	SD	Perpendicular at Denker Avenue		UNK
CS-05	SS	Center turning lane	8-63	VCP, CON, and RCP
CS-05	WTR	South eastbound lane	6-8	DI and CI,
CS-06	SS	North westbound lane	54-57	RCP
CS-06	SD	Perpendicular at Vermont Avenue and hospital north entrance	48	RCB
CS-07	SS	South eastbound lane	12-36	VCP and RCP

- Segment-specific issues:
  - CS-01: private Catholic school, east side
  - CS-01: RR crossing
  - CS-06: hospital with multiple entrances, east side
  - CS-07: crosses over Harbor Freeway

8. Figueroa Street (FS-01 to 04) (Original Brine Line Alignment FS-04)

- Width: 80 feet; two lanes, a left-turn lane, and shoulders
- ROW: public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
FS-01	SD	Perpendicular at 220th South Street		UNK
FS-01	SS	Both lanes of street		UNK
FS-02	SD	Perpendicular at 224th South Place	48	UNK
FS-03	SS	Both lanes of street	12 and 54-78	RCP and VCP
FS-03	SD	Westside southbound	18-79, 85	RCP and RCB
FS-04	SS	Both lanes of street	54-95.7	RCP
FS-04	SD	Westside southbound	15-30	RCP

- Segment-specific issues:
  - FS-01: public middle school, south end

9. Plaza Del Amo (PDA-01 to 03)

- Width: 38-80’ feet; two to four lanes; often a larger planter strip in the median

- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
PDA-01	SS	South eastbound lane	10	VCP
PDA-01	SD	South eastbound lane	51-54	RCP
PDA-02	SD	Perpendicular at Arlington Avenue	24	UNK
PDA-03	SD	North westbound lane	18-36	RCP
Notes: AC = Asbestos-Cement pipe				

- Segment-specific issues:
  – PDA-01: large school (Torrance Tartars, and Torrance Unified School District parking lot entrances)

10. 223rd Street (223S-01 to 03)

- Width: 64 feet; four lanes, a left-turn lane, and 10-foot shoulders
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
223S-01	SD	Perpendicular at Western Avenue and Normandie Avenue	30-60	UNK
223S-01	SS	Center turning lane	8	VCP
223S-01	WTR	South eastbound lane	6	CI, AC
223S-02	SS	Center turning lane	54-90	RCP
223S-02	SD	North westbound lane	15-18 and 48	RCP
223S-03	SS	North westbound lane	48-78	RCP
223S-03	SD	Perpendicular at Harbor Ridge Lane	UNK	UNK

- Segment-specific issues:
  – 223S-02: Meyler Street Elementary School on the north side; does not infringe on entry, but infringes on church entries for two churches
  – 223S-03: crosses over Harbor Freeway
  – Mostly residential frontage

11. 228th Street (228S-01 to 03)

- Width: 40 feet; two lanes; parking on either side
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
228S-01	SD	Perpendicular at Normandie Avenue	21-96	RCP
228S-01	SS	Center turning lane	8-15	VCP
228S-01	WTR	North westbound lane	6-12	AC and DI
228S-02	SD	North westbound lane	18-96	RCP and RCB

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
228S-02	SS	North westbound lane	15-60	VCP and RCP
228S-03	SD	Diagonal from Vermont Avenue to east of Van Deene Avenue	18-60	RCP
228S-03	SS	North westbound lane	60-72	RCP

- Segment-specific issues:
  - 228S-03: crosses over Harbor Freeway
  - Very narrow compared with adjacent segments
  - Mostly residential frontage

12. Arlington Avenue (AA-01 to 02)

- Width: 50 to 60 feet; three lanes; parking on either side
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
AA-01	SD	Westside southbound	15-54	RCP
AA-02	SD	Westside southbound	15-24	RCP

- Segment-specific issues:
  - AA-02: RR crossing
  - AA-01: residential frontage
  - Mostly residential frontage

13. Cabrillo Avenue (CA-01 to 02)

- Width: 54 to 80 feet; four lanes, a median, and parking on either side
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
CA-01	SD	Center turning lane to 220th South Street, then Eastside northbound	15-69	RCP

- Segment-specific issues:
  - CA-02: private Torrance Montessori school
  - CA-02: RR crossing
  - Mostly residential frontage

14. Western Avenue (WA-01 to 03)

- Width: 82 feet; four lanes and a median/left-turn lane
- ROW: maintained by Caltrans (Highway 213)
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
WA-01	SD	Westside southbound to 223rd South Street, then Eastside northbound	15-51	RCP
WA-01	WTR	Eastside northbound	8	UNK

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
WA-02	SD	Eastside northbound	33	RCP
WA-02	WTR	Eastside northbound	8	UNK
WA-03	SS	Center turning lane	15	VCP
WA-03	WTR	Eastside northbound	8	UNK

- Segment-specific issues: not applicable

15. Normandie Avenue (NA-01 to 03)

- Width: 58 to 64 feet; five lanes
- ROW: public, not maintained by Caltrans
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
NA-01	SS	Westside southbound, other side of the planter strip	63-90	RCP
NA-01	WTR	Westside southbound, other side of the planter strip	8	UNK
NA-01	WTR	Eastside northbound	31.4	STL - trunk
NA-01	SD	Perpendicular at 220th South Street	15-24	RCP
NA-02	SS	Eastside northbound	8 and 15	VCP
NA-02	SD	Perpendicular at 228th South Street	18 and 96	RCP
NA-02	WTR	Eastside northbound	31.4	STL - trunk
NA-03	WTR	Eastside northbound	31.4	STL - trunk

- Segment-specific issues:
  – NA-01: multiple hospital entrances, north side

16. Vermont Avenue (VA-01 to 03)

- Width: 85 feet; five lanes, shoulders, bike lanes, and occasional medians
- ROW: public
- Utilities:

Segment	*Utility*	*Run*	*Diameter (inches)*	*Material*
VA-01	SD	Perpendicular at Carson Street	21-27	UNK
VA-01	SS	Both lanes of street	66-78	RCP
VA-02	SS	Both lanes of street	69-78	RCP
VA-02	SD	Perpendicular at 228th South Street	12-30, and 66	RCP and RCB
VA-03	SD	Westside southbound	18-27	RCP
VA-03	SS	Both lanes of street	69-72	RCP

- Segment-specific issues:
  – VA-01: CS-06: hospital with multiple entrances
  – Multiple residential entrances, where connector streets with residencies depend on entry from VA-03, which impacts dozens upon dozens of homes

		Segment Screening Criteria				
		Step 1		***Step 2***		***Step 3***
Roadway Name	***Segment ID***	Caltrans ROW	Unnecessary RR Crossing	Constructability: Street Width, Length, and Future Construction	Hospitals, Public Utilities, Schools, and Residential Frontage	Resulting Disconnected Segments
Sierra Street	SS-01					
Elm Avenue	EA-01					
Torrance Blvd.	TB-01— 02					TB-02
Crenshaw Blvd.	CB-01—03					
Sepulveda Blvd.	SB-01—06					
Cravens Avenue	CR-01			•		
Carson Street	CS-01—07				CS-06	CS-07
Figueroa Street	FS-01—04			•		FS-01, FS-02, FS-03
Plaza Del Amo	PDA-01—03				PDA-01	PDA-02
223rd Street	223S-01—03			•		223S-02, 223S-03
228th Street	228S-01—03			•		
Arlington Avenue	AA-01—02		AA-02		AA-01	
Cabrillo Avenue	CA-01—02		CA-02			
Western Avenue	WA-01—03	•				
Normandie Avenue	NA-01—03					
Vermont Avenue	VA-01—03				•	

Note:

ID = identification