METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

FINAL

REGIONAL RECYCLED WATER PROGRAM

Backbone Conveyance System | Feasibility Level Design Report

Volume II of III

June 2020

Black & Veatch
Project No. 191628

BLACK & VEATCH

IN ASSOCIATION WITH CDM Smith

FINAL

REGIONAL RECYCLED WATER PROGRAM

Backbone Conveyance System

Feasibility-Level Design Report

Volume 2 - Appendices A-K

BLACK & VEATCH PROJECT NO. 191628

PREPARED FOR

Metropolitan Water District of Southern California

30 JUNE 2020

In association with

Regional Recycled Water Program
Black & Veatch Project 191628

Backbone Conveyance System Feasibility-Level Design Report
June 2020

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ACRONYM AND ABBREVIATIONS LIST

The following abbreviations or acronyms are used in this document.

AACE	Association for the Advancement of Cost Engineering
ARVV	air-release and vacuum valve
AWT	advanced water treatment
Black & Veatch	Black & Veatch Corporation
BEP	best-efficiency point
CalOSHA	California Occupational Safety and Health Administration
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
cf	cubic feet
CGS	California Geologic Survey
CM	construction method
CNDDB	California Natural Diversity Database
DPR	direct potable reuse
EPBM	earth pressure balance tunnel boring machine
FEWWTP	F.E. Weymouth Water Treatment Plant
ft	feet
FLDR	Feasibility-Level Design Report
fps	feet per second
GAC	granular activated carbon
GeoPentech	GeoPentech Inc
GIS	geographic information system
gpm	gallons per minute
HDD	horizontal directional drilling
HGL	hydraulic grade line
HI	Hydraulic Institute
HP	horsepower
ID	inside diameter
in	inches
IPR	indirect potable reuse
IRRP	Indirect Reuse Replenishment Project
IPR	indirect potable reuse
JWPCP	Joint Water Pollution Control Plant
kWh	kilowatt hour
LA	Los Angeles
LACDPW	Los Angeles County Department of Public Works

LACFCD	Los Angeles County Flood Control District
LACSD	Sanitation Districts of Los Angeles County
LADWP	Los Angeles Department of Water and Power
LUFT	leaking underground storage tank
MCAA	Mechanical Contractors Association of America
MCCs	motor control centers
Metropolitan	Metropolitan Water District of Southern California
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
Minagar	Minagar & Associates, Inc.
MJA	McMillan Jacobs Associates
MT	microtunneling
M_W	moment magnitude scale
NECA	National Electrical Contractors Association
OC	Orange County
OC Reach	optional branch to the Orange County Spreading Grounds
OCSD	Orange County Sanitation District
OCWD	Orange County Water District
OD	outside diameter
O&M	operations and maintenance
OPCC	opinion of probable construction cost
Project	design of the conveyance facilities of the Regional Recycled Water Program
PS	pump station
PS-1	Pump Station 1
PS-2	Pump Station 2
PS-3	Pump Station 3
RPM	revolutions per minute
RRWP	Regional Recycled Water Program
RVs	recreational vehicles
SCE	Southern California Edison
SFSG	Santa Fe Spreading Grounds
SG	San Gabriel
SWRCB	State Water Resources Control Board
TBM	tunnel boring machine
TCE	trichloroethylene
USGMWD	Upper San Gabriel Municipal Water District
VFD	variable frequency drive

WBS	work breakdown structures
WRD	Water Replenishment District of Southern California
WSE	water surface elevation

Appendix A. Field Investigation Notes

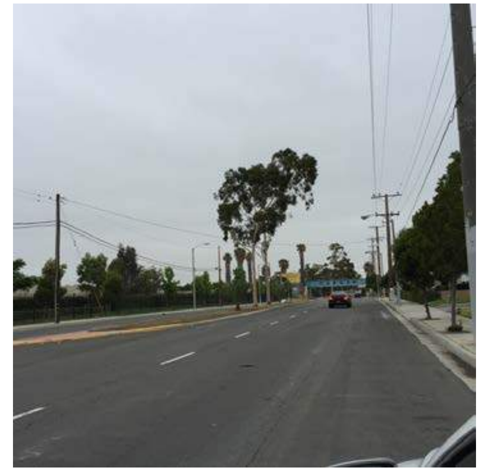
SEGMENT 1

<u>MWD Alignment</u>

- Locate within Right-of-Way of Main Street and Sepulveda Blvd
- Approx. 80 ft curb to curb width available in Main Street and Sepulveda Blvd

<u>B&V Alignment</u>

- Same location
- Located approx. on east side of Main Street and south side of Sepulveda Blvd
- Main Street and Sepulveda Blvd. are very congested with U/G utilities
- Traffic does not seem to be an issue



1. Looking North on Main Street

SEGMENT 1 – Sepulveda Blvd Crossing Railroad and Alameda St.

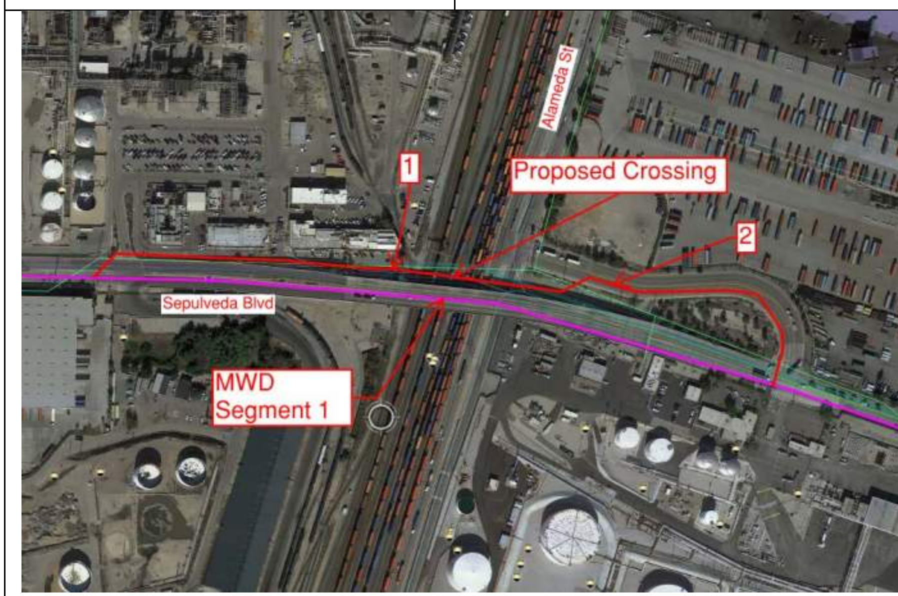
<u>MWD Alignment</u>

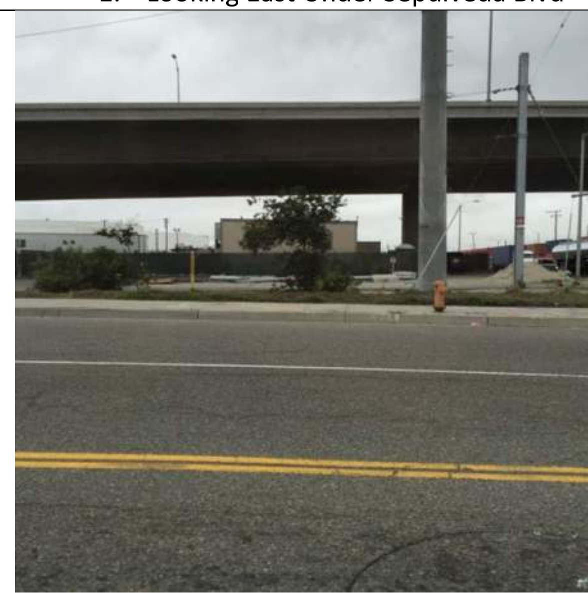
- Locate within Right-of-Way of Sepulveda Blvd
- Approx. 80 ft curb to curb width available in Sepulveda Blvd.
- Sepulveda Blvd. crosses as a raised bridge

<u>B&V Alignment</u>

- Tunnel across north of Sepulveda in private parking lot

1. Looking East Under Sepulveda Blvd





2. Looking South Under Sepulveda Blvd

SEGMENT 1 – Sepulveda Blvd Crossing 710 Fwy and LA River

<u>MWD Alignment</u>

- Locate within Right-of-Way of Sepulveda Blvd
- Approx. 80 ft curb to curb width available in Sepulveda Blvd
- Sepulveda Blvd. crosses as a raised bridge over 710 Fwy and LA River, back-to-back

<u>B&V Alignment</u>

- Tunnel across south of Sepulveda in private parking lot and open space

1. Looking East on Sepulveda Blvd at 710 Fwy and Open Lot

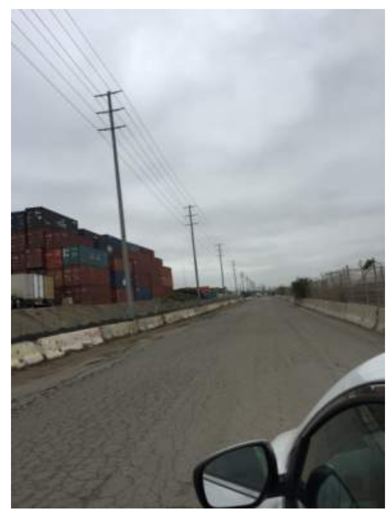
2. Looking East on Sepulveda Blvd

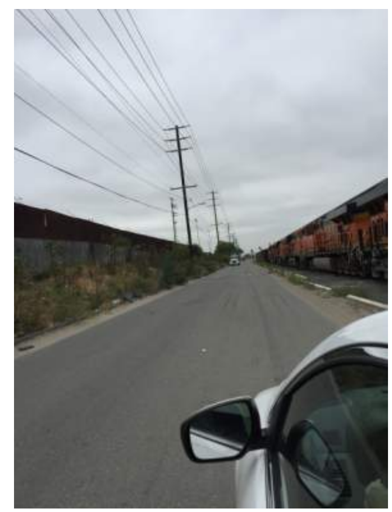
SEGMENT 1 Alternative – Lomita Blvd.

MWD Alignment
- N/A

B&V Alignment
- Head south on Main Street from the JWPCP and east on Lomita Blvd. Tunnel under railroad into Alameda. Head north on Alameda to reconnect to MWD Segment 1.
- Lomita has several large diameter utilities, including a 90-inch tunnel.
- Parallels railroad along Lomita
- Challenging crossing at Lomita and Alameda

1. Lomita Blvd. at Railroad Crossing (looking east)





2. Lomita Blvd. (looking west)

SEGMENT 1 Alternative – Avalon Blvd. to Del Amo Blvd.

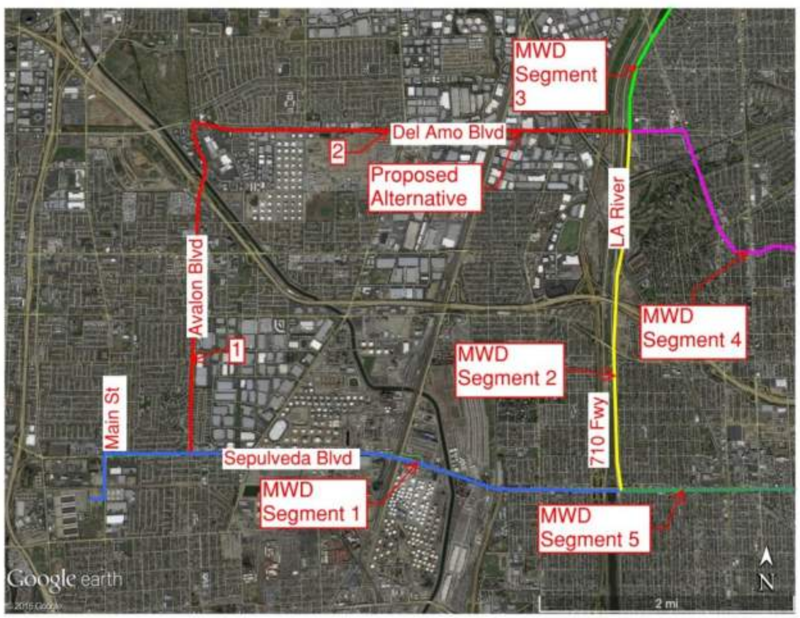
MWD Alignment

- N/A

B&V Alignment

- Head north on Avalon Blvd to Del Amo Blvd.
- Locate within Right-of-Way of Avalon Blvd and Del Amo Blvd
- Approx. 80 ft curb to curb width available in Avalon Blvd and 85 ft. curb to curb width in Del Amo Blvd.
- Avalon Blvd. crosses underneath 405 Fwy and Del Amo Blvd. crosses underneath 710 Fwy.
- Extra channel crossing on Del Amo Blvd. compared to Sepulveda Blvd.

1. Avalon Blvd. looking North



2. Del Amo Blvd. looking East

SEGMENT 1 Alternative – Main St. to Avalon Blvd. to Del Amo Blvd.

MWD Alignment

- N/A

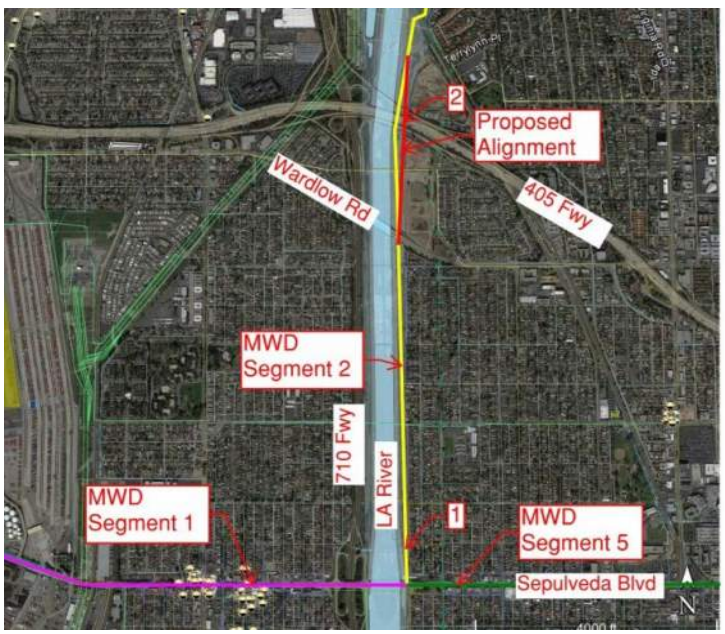
B&V Alignment

- Head north on Main St to 223rd to Avalon Blvd to Del Amo Blvd.
- Main St has many known underground utilities, including oil and gas pipelines.
- Carson High School located at Main St and 223rd
- Approx. 80 ft curb to curb width available in Main St, 80 ft curb to curb width available in Avalon Blvd, and 85 ft. curb to curb width in Del Amo Blvd.

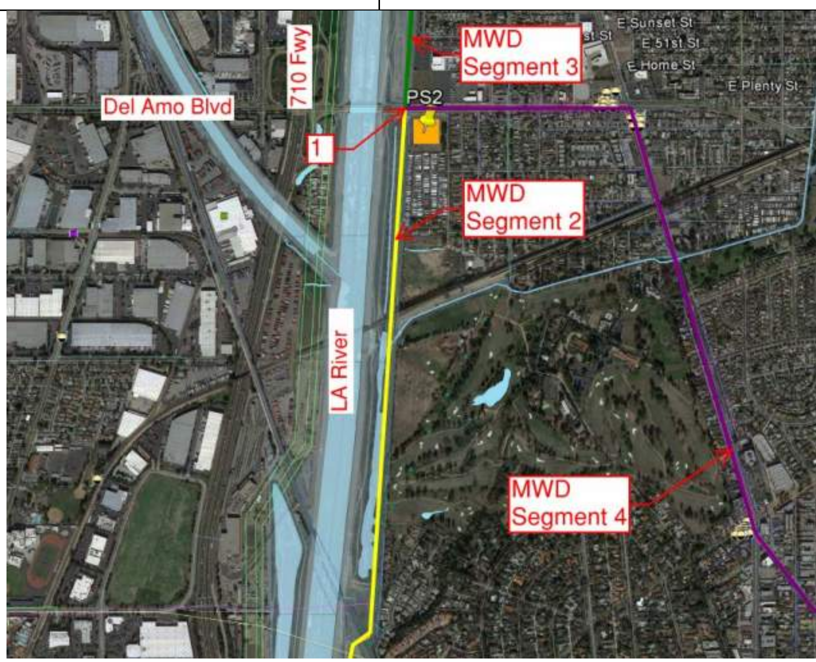
1. Lomita Blvd. at Railroad Crossing (looking east)

SEGMENT 2 – LA River at 405 Fwy Crossing

MWD Alignment	B&V Alignment	
• Locate within LACFCD easement • Built outside of rivers levee • Open cut and shored excavation as needed	• Approximately same location • Could use Deforest Ave when U/G space is available to avoid impacting too many trees • Use space between equestrian areas and levee as required • Cross Wardlow Rd and 405 Fwy using open cut or shored excavation methods • Cross RR using trenchless methods	 1. Looking Northwest on Deforest Ave at LACFCD easement



2. Looking North Under 405 Fwy

SEGMENT 2 – LA River at Del Amo Blvd		
<u>MWD Alignment</u> • Locate within LACFCD easement • Built outside of rivers levee • Passes through some constructed wetlands • Open cut and shored excavation as needed	<u>B&V Alignment</u> • Approximately same location • Use access road on top of west bank of constructed wetlands to minimize impact. • Approx. 40’ from power poles to edge of constructed wetland fence • Cross RR and Del Amo Blvd using trenchless methods	 1. Looking South from Del Amo Blvd
		

<table>
<tr><th colspan="3">SEGMENT 3 – De Forest Ave Proposed Alignment</th></tr>
<tr>
<td><u>MWD Alignment</u>
• Locate within LACFCD easement
• Built outside of rivers levee
• Passes through constructed wetlands
• Open cut and shored excavation as needed</td>
<td><u>B&V Alignment</u>
• Approximately same location
• Use access road on top of west bank of constructed wetlands to minimize impact
• Approx. 40'-60' from LACFCD easement edge to shoulder of slope to constructed wetlands
• Crosses 180" LACFCD Market Street Drain
• Potential to cross Long Beach Blvd using open cut methods.
• Use DeForest Ave to avoid DeForest Park, large wetlands, and LACSD pipes</td>
<td>
1. Looking North at Long Beach Blvd</td>
</tr>
<tr>
<td colspan="2">
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<td>
2. Looking North on DeForest Ave</td>
</tr>
</table>

SEGMENT 3 – MWD Tunneling

<u>MWD Alignment</u>

- Locate mostly within LACFCD easement
- Tunnel from Ginger Dr. to 1360' south of Somerset Blvd

<u>B&V Alignment</u>

- Approximately same location
- Open cut or shored excavation from Artesia Blvd to north of 91 Fwy
- Begin tunneling again north of 91 Fwy
- Stay as close to the LACSD pipe corridor and river levee as possible to provide space from crowded facilities areas. May not be possible (see alternative for two tunnel portions)
- Crosses through a former municipal solid waste landfill

1. Looking North at 91 Fwy

2. Looking North at Crowded Alignment from Equestrian Area

SEGMENT 3 – MWD Tunneling

MWD Alignment

- Locate mostly within LACFCD easement
- Tunnel from Rosecrans Ave to after 105 Fwy
- Built outside of rivers levee
- Open cut and shored excavation outside of tunneled portions

B&V Alignment

- Approximately same location
- Stay as close to the LACSD pipe corridor and river levee as possible to provide space from crowded facilities areas (see B&V alternative for two tunnel portions)
- Alignment goes through golf course and Ralph C. Dills Park and hiking trails
- Tunneled portion is very congested with buildings
- Open cut in Compton Par 3 goes through former Compton City Landfill

1. Looking Northwest on Deforest Ave at LACFCD easement

SEGMENT 3 – Intersection of Rio Hondo and LA River

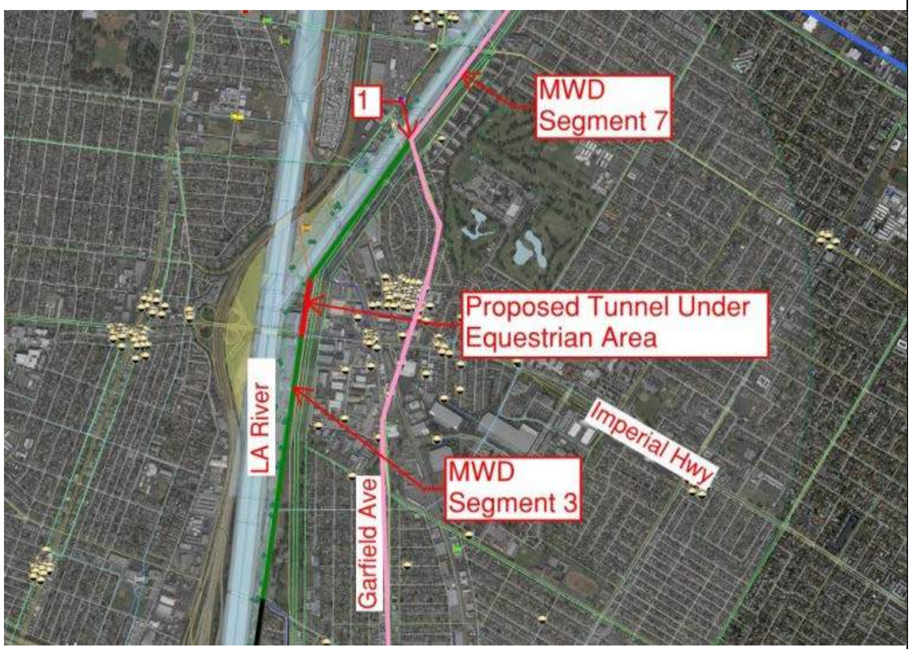
MWD Alignment

- Locate mostly within LACFCD easement and SCE easement
- Built outside of rivers levee
- Open cut and shored excavation outside of tunneled portions

B&V Alignment

- Approximately same location
- Stay as close to the LACSD pipe corridor and MWD Middle Feeder as possible to provide space from crowded facilities areas (see B&V alternative)
- Alignment goes through park, row crops, and equestrian areas.
- Proposed tunnel under equestrian area

1. Looking south at SCE easement



SEGMENT 3 - Alternative to Tunneling

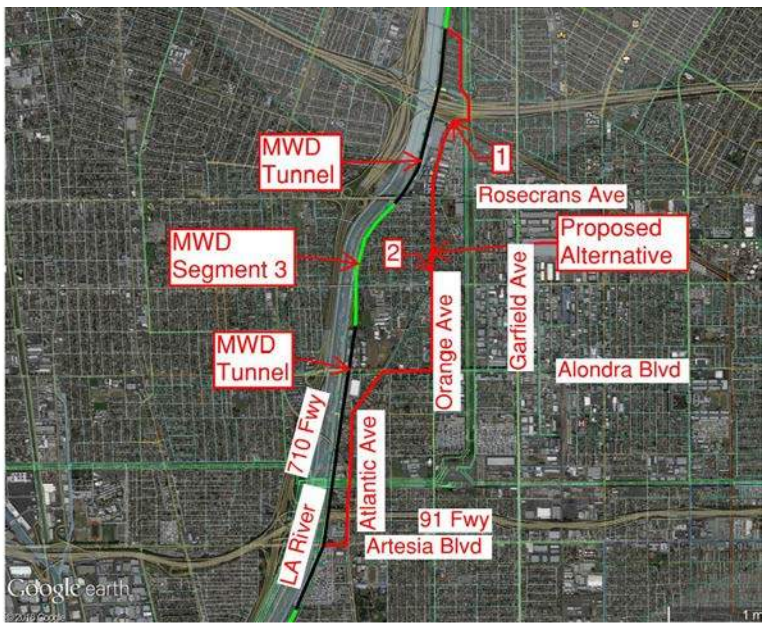
<u>MWD Alignment</u>

- N/A

<u>B&V Alignment</u>

- To avoid 6,800 feet of MWD Tunnel 1 and all of MWD Tunnel 2, locate alignment on Artesia Blvd to Atlantic Ave to Hunsaker Ave to Alondra Blvd to Orange Ave to Century Blvd back to the MWD alignment
- Shored excavation on streets, trenchless crossing of 105 Fwy and major intersections
- Orange Ave is narrow with residential driveways on both sides of street from Alondra Blvd to Rosecrans Ave; another alternative is to continue east on Alondra Blvd to MWD Segment 7 on Garfield Ave rather than using Orange Ave

1. Looking South on Orange Ave



2. Looking North on Orange Ave

SEGMENT 5

MWD Alignment

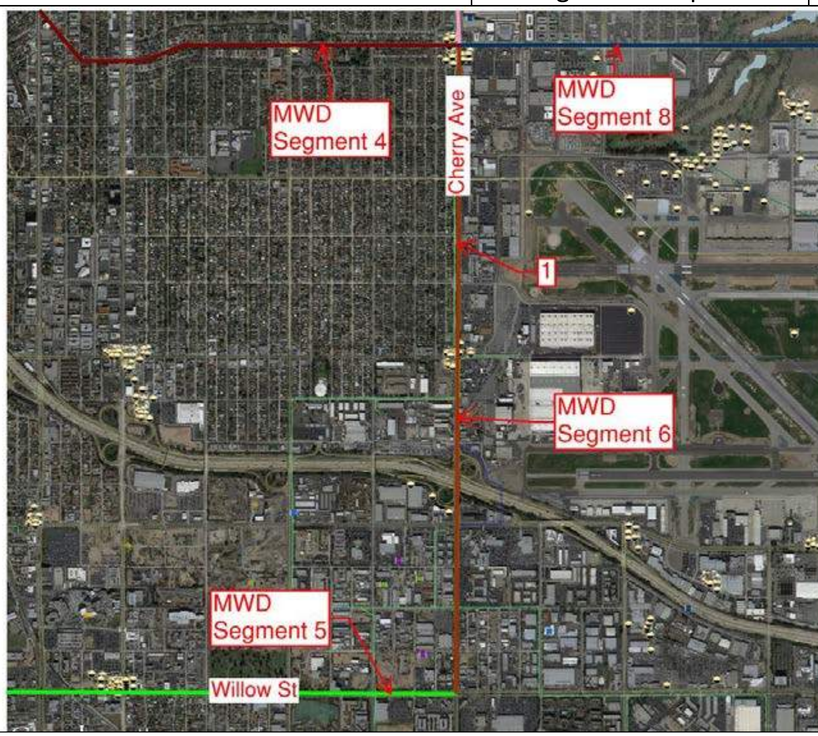
- Locate within Right-of-Way of Willow St
- Approx. 80 ft curb to curb width available in Willow St
- Improved center median with trees

B&V Alignment

- Same location
- Located approx. on south side of Willow St
- Willow St. is very congested with U/G utilities.
- Lots of commercial driveway access on Willow St

1. Looking east on Willow St

SEGMENT 6		
<u>MWD Alignment</u> • Locate within Right-of-Way of Cherry Ave • Approx. 80 ft curb to curb width available in Cherry Ave • Improved center median for a portion	<u>B&V Alignment</u> • Same location • Located approx. on west side of Cherry Ave • Cherry Ave. is very congested with U/G utilities • Lots of commercial driveway access on Cherry Ave • Difficult crossing of 405 Fwy • Long Beach Airport	 1. Looking north on Cherry Ave



SEGMENT 6 – Cherry Ave and 405 Fwy

MWD Alignment	B&V Alignment	
• Locate within Right-of-Way of Cherry Ave • Approx. 80 ft curb to curb width available in Cherry Ave	• Proposed crossing of 405 Fwy uses Spring Street to a vacant parking lot on the southeast corner of the intersection. This lot can be used to cross the 405 Fwy using trenchless technologies to the corner of the Long Beach Airport on the north side of the 405 Fwy. The alignment then follows the edge of the Long Beach Airport and a parking lot to return to Cherry Ave.	 1. Looking North at Vacant Lot

2. Looking Northeast at Long Beach Airport

SEGMENT 7 – Cherry Ave/Garfield Ave

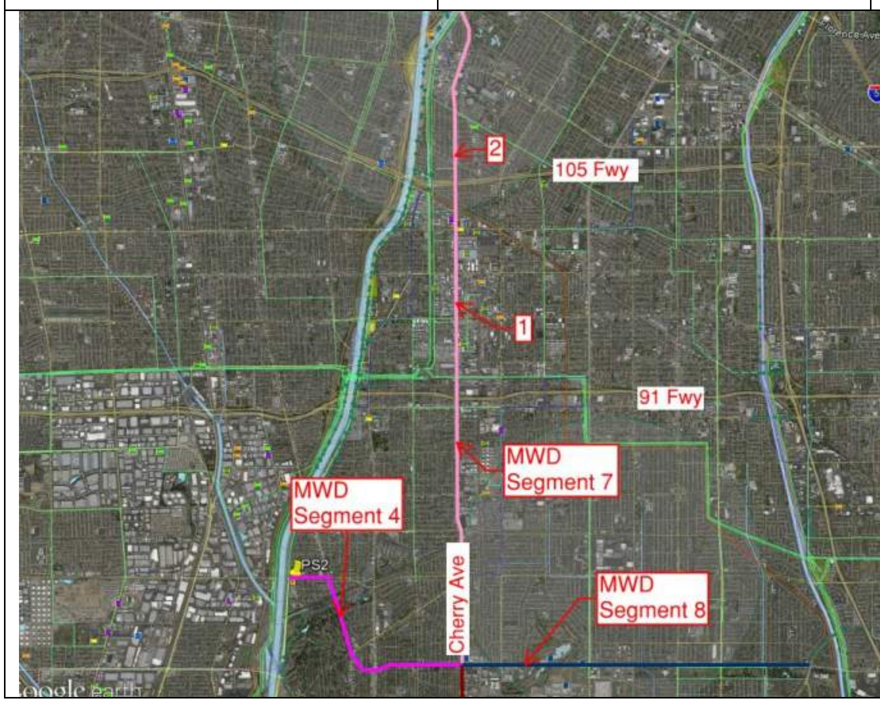
<u>MWD Alignment</u>

- Locate within Right-of-Way of Cherry Ave/Garfield Ave
- Approx. 80 ft curb to curb width available in Cherry Ave/Garfield Ave
- Mostly painted center median

<u>B&V Alignment</u>

- Same location
- Located approx. on east side of Cherry Ave/Garfield Ave
- Cherry Ave. is very congested with U/G utilities near Carson St
- Lots of commercial driveway access on Cherry Ave/Garfield Ave
- Difficult crossing of 105 Fwy
- Parallels MWD's West Coast Feeder on Garfield Ave

1. Looking North on Garfield Ave



2. Looking North on Garfield Ave

SEGMENT 7 – SCE Easement

<table>
<tr>
<td><u>MWD Alignment</u>
• Locate within SCE easement
• Approx. 325 ft width of easement</td>
<td><u>B&V Alignment</u>
• Use SCE and LACFCD easements
• Parallel West Coast Feeder in SCE easement initially and then run between transmission towers north of Southern Ave
• SCE easement goes through a trailer and storage parking lot
• Difficult crossing of 105 Fwy
• Parallels MWD's West Coast Feeder on Garfield Ave</td>
<td>
1. Looking South on Firestone Blvd</td>
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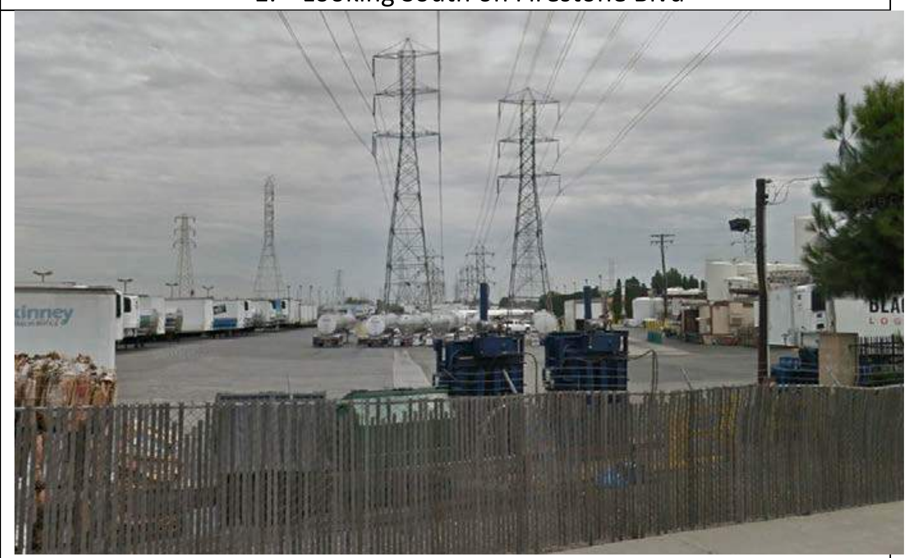
<td>
2. Looking North on SCE Easement</td>
</tr>
</table>

SEGMENT 7 – Garfield Ave and 105 Fwy

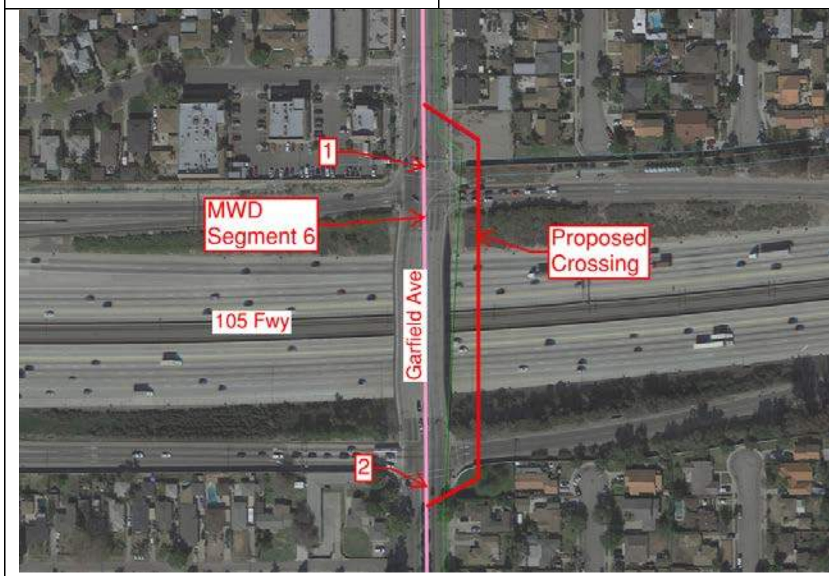
<u>MWD Alignment</u>

- Locate within Right-of-Way of Garfieldn Ave
- Approx. 80 ft curb to curb width available in Cherry Ave

<u>B&V Alignment</u>

- Proposed crossing of 105 Fwy uses a vacant lot behind a sound wall on the southeast corner of the intersection and another vacant lot on the northeast corner of the intersection. These can be used to cross the 105 Fwy using trenchless technologies.

1. Looking Northeast at Vacant Lot



2. Looking East at Vacant Lot Behind Sound Wall

SEGMENT 19 – Lakewood Blvd

MWD Alignment

- Locate within Right-of-Way of Lakewood Blvd
- Approx. 90 ft curb to curb width available in Lakewood Blvd
- Improved center median starting north of Alondra Blvd and in front of the Lakewood Center

B&V Alignment

- Same location
- Located approx. on east side of Lakewood Blvd
- North of the Lakewood Center, Lakewood Blvd has large stretches without residential driveways and most residential areas use frontage streets
- Difficult crossing of 105 Fwy

1. Looking North on Lakewood Blvd at Lakewood Center

2. Looking Northeast on Garfield Ave

SEGMENT 19 – Lakewood Blvd and 105 Fwy (Alternative A)

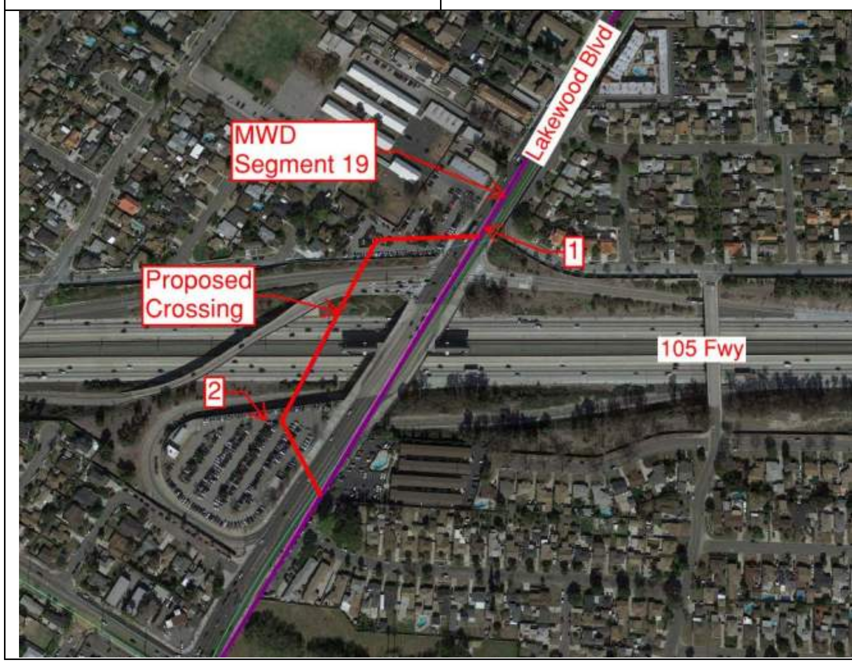
<u>MWD Alignment</u>

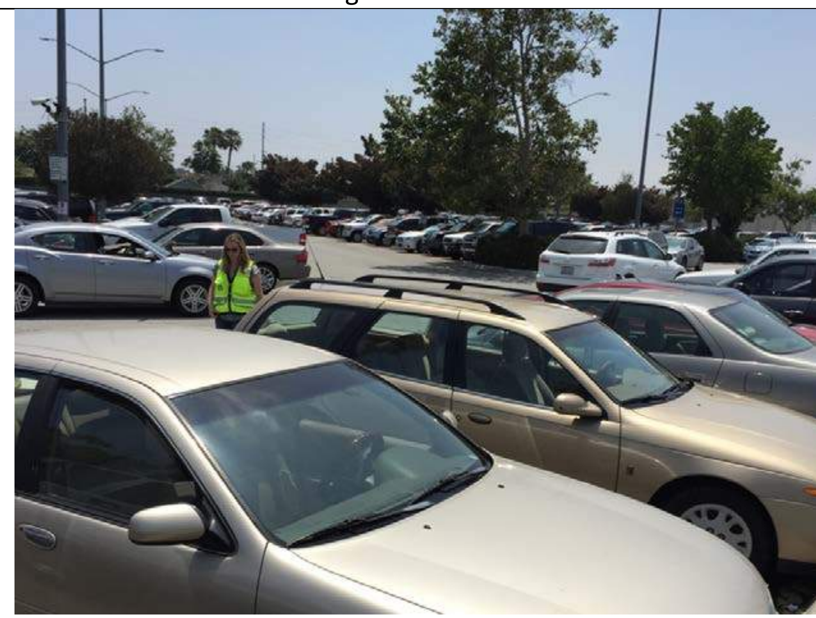
- Locate within Right-of-Way of Lakewood Blvd
- Approx. 90 ft curb to curb width available in Lakewood Blvd

<u>B&V Alignment</u>

- Proposed crossing of 105 Fwy uses a Park and Ride Lot on the northwest corner of the intersection and a Train Station Parking Lot on the South West Corner. These can be used to cross the 105 Fwy using trenchless technologies. However, these parking lots were completely full with commuters during the site visit.

1. Looking West at Park and Ride Lot





2. Looking Southwest at Parking Lot

SEGMENT 19 – Lakewood Blvd and 105 Fwy (Alternative B – Rosecrans to Clark Ave/Columbia Way)

<u>MWD Alignment</u>

- Locate within Right-of-Way of Lakewood Blvd
- Approx. 90 ft curb to curb width available in Lakewood Blvd

<u>B&V Alignment</u>

- Proposed crossing of 105 Fwy uses a Park and Ride Lot on the northwest corner of the intersection and a Train Station Parking Lot on the South West Corner. These can be used to cross the 105 Fwy using trenchless technologies. However, these parking lots were completely full with commuters during the site visit.

1. Looking Northwest at Vacant Lot

2. Looking East at ISD Parking Lot

SEGMENT 20 – San Gabriel River (Liberty Park)

<u>MWD Alignment</u>

- Locate within SCE Easement
- Passes through Liberty Park, parking lot, park bathrooms, and pavilion
- Built outside of rivers levee
- Open cut and shored excavation as needed

<u>B&V Alignment</u>

- Same location
- Located as far west as possible except to avoid park bathroom and pavilion
- Major disruption of park activities
- Trenchless crossing of South Street
- Due to congestion in park, Segment 20.1 Alternative was considered to avoid disruption of facilities

1. Looking North at Restroom and Pavilion

2. Looking South at Park Parking Lot

SEGMENT 20 Alternative – San Gabriel River (Liberty Park)

MWD Alignment

- N/A

B&V Alignment

- Use Studebaker Rd as alternative route to avoid congestion in Liberty Park
- Locate on west side of Studebaker Rd within Right-of-Way
- Approx. 75 ft curb to curb width available in Studebaker Rd
- Use baseball field to cross back into SCE easement on north end of Liberty Park
- 4 lanes with parking on either side of street

1. Looking North on Studebaker Rd

2. Looking West at Baseball Field to SCE Easement

SEGMENT 20 – San Gabriel River (Cerritos Auto Square)

MWD Alignment

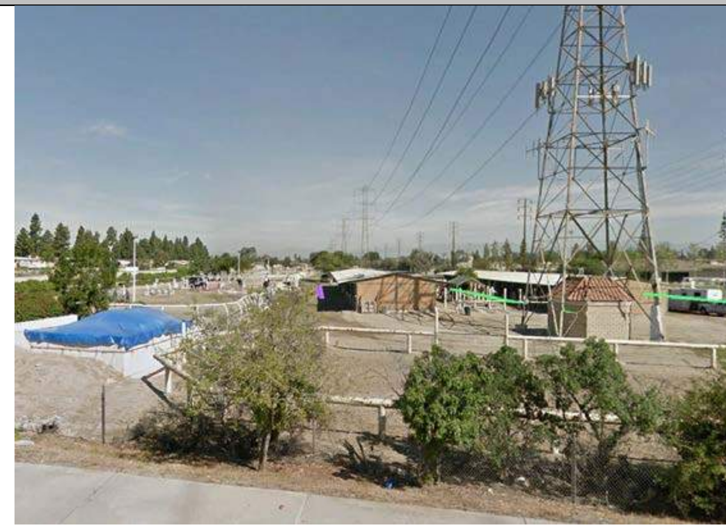
- Locate within SCE Easement
- Passes through Cerritos Auto Square parking lot
- Built outside of rivers levee
- Open cut and shored excavation as needed

B&V Alignment

- Same location
- Located as far west as possible
- Trenchless crossing of Allington Street
- Major disruption of Cerritos Auto Square car storage

1. Looking North at Cerritos Auto Square

SEGMENT 20 – San Gabriel River (Equestrian Area North of 183rd St)

MWD Alignment	B&V Alignment	
• Locate within SCE Easement • Passes through equestrian areas • Built outside of rivers levee • Open cut and shored excavation as needed	• Same location • Located in between equestrian facilities as much as possible • Major disruption of equestrian facility activities • Trenchless crossing of Artesia Blvd • Could be necessary to tunnel from 183rd St to north of 91 Fwy (or even Iron Wood Golf Course)	 1. Looking North at Equestrian Area

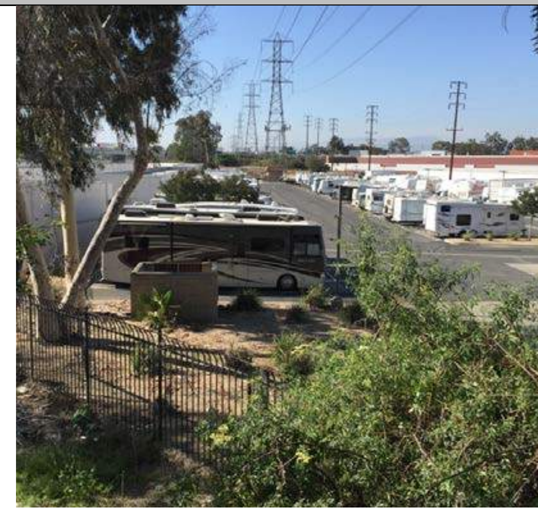
SEGMENT 20 – San Gabriel River (RV Parking and Iron Wood Golf Course)

<u>MWD Alignment</u>

- Locate within SCE Easement
- Passes through storage yard and Iron Wood Golf Course
- Built outside of rivers levee
- Open cut and shored excavation as needed

<u>B&V Alignment</u>

- Same location
- Located between storage buildings and transmission line towers (approx. 65') through RV parking
- North of the 91 Fwy the pipeline will be located as far west as possible while remaining outside of the river levee
- Trenchless crossing of RR and 91 Fwy
- Will be difficult to find portal/pit locations for trenchless crossings of RR and 91 Fwy
- Could be necessary to tunnel from 183rd St to north of 91 Fwy (or even Iron Wood Golf Course)



1. Looking North at Storage Units and RV Parking

2. Looking South at Park Parking Lot

SEGMENT 20 – San Gabriel River (RV Parking and LA River Crossing)

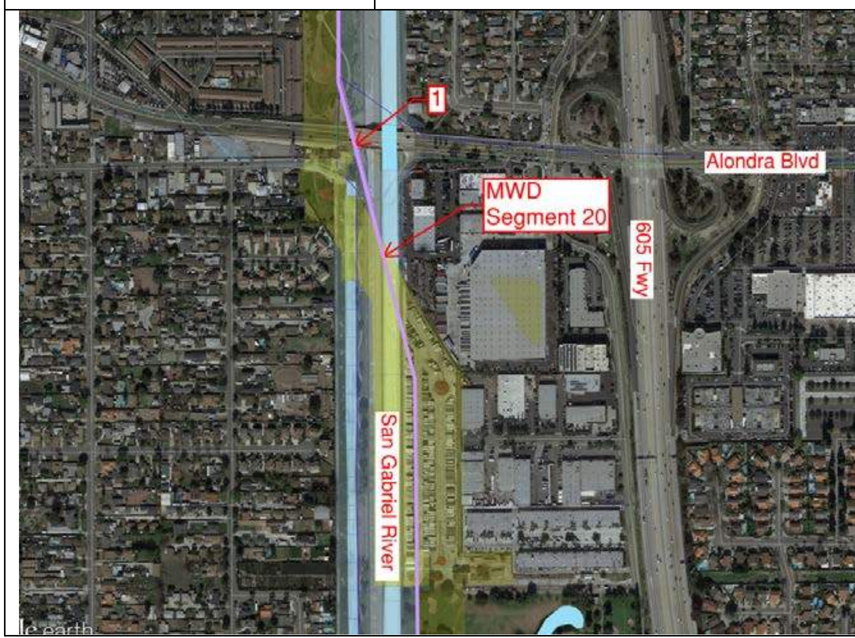
MWD Alignment

- Locate within SCE Easement
- Passes through RV parking and LA River
- Built outside of rivers levee except to cross the river
- Open cut and shored excavation as needed

B&V Alignment

- Same location
- Located as far west as possible while remaining outside of the river levee
- Cross the LA River at an angle that allows crossing under Alondra Blvd

1. Looking South at LA River Crossing



<table>
<tr><td colspan="3">SEGMENT 20 – San Gabriel River (SCE Easement – Alondra Blvd to Rosecrans Ave)</td></tr>
<tr><td><u>MWD Alignment</u>
• Locate within SCE Easement
• Passes through longitudinal park and beside trailer homes
• Built outside of rivers levee
• Open cut and shored excavation as needed</td><td><u>B&V Alignment</u>
• Same location
• Located as far east as possible in SCE easement - may need to use LACFCD easement for construction activities
• Trenchless crossing of South Rosecrans Ave</td><td>
1. Looking North at SCE Easement</td></tr>
<tr><td colspan="2">
</td><td>
2. Looking South at SCE Easement</td></tr>
</table>

SEGMENT 20 – San Gabriel River (Storage Yard North of Rosecrans Ave)

<table>
<tr><td>

MWD Alignment

- Locate within Storage Unit and RV parking drive (possibly LACFCD easement)
- Passes down the middle of storage unit yard access road
- Built outside of rivers levee
- Open cut and shored excavation as needed

</td><td>

B&V Alignment

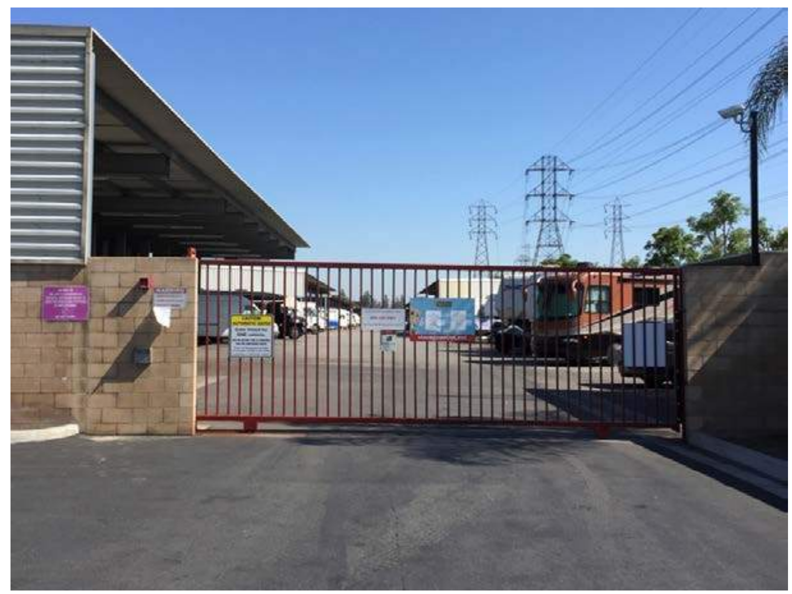
- Same location
- Located down the middle of storage units and covered RV parking - approximately 30' alley between storage units
- Drive is only access to larger RV parking in adjacent SCE easement

</td><td>

1. Looking North at Storage Units and Drive

</td></tr>
<tr><td colspan="2">

</td><td>



2. Looking South at RV Parking and Storage Units

</td></tr>
</table>

SEGMENT 20 – San Gabriel River (Foster Rd to Imperial Hwy)

MWD Alignment
- Locate within vacant lot south of 105 Fwy (possibly LACFCD easement)
- North of 105 Fwy, locate within RV parking lot in LACFCD easement
- Built outside of rivers levee
- Open cut and shored excavation as needed

B&V Alignment
- Same location
- Located down the middle of RV parking
- Crossing of 105 Fwy can potentially be done with open cut or shored excavation
- Enter San Gabriel River Channel prior to Imperial Hwy

1. Looking South at RV Parking

2. Looking North at Vacant Lot (Possibly LACFCD Easement)

SEGMENT 20 – San Gabriel River (River Bed)

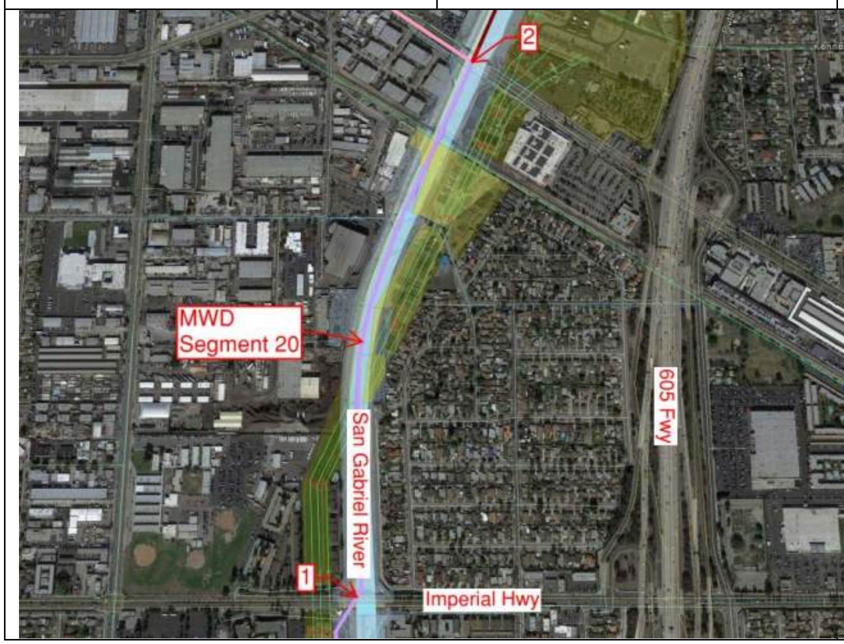
MWD Alignment

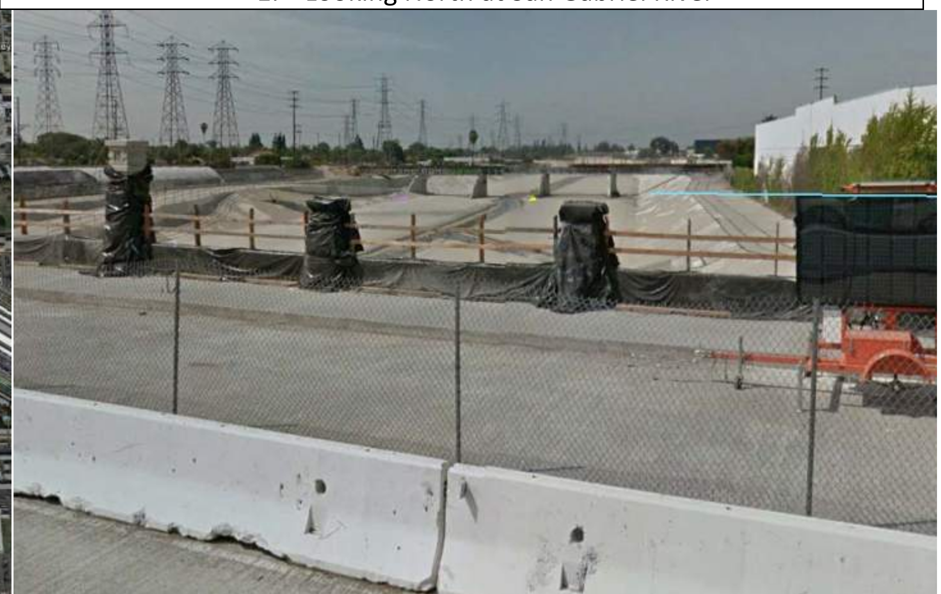
- Locate within San Gabriel River bed
- Open cut and shored excavation as needed

B&V Alignment

- Same location
- Located down the middle of RV parking
- Crossing of 105 Fwy can potentially be done with open cut or shored excavation.
- Enter San Gabrial River Channel prior to Imperial Hwy

1. Looking North at San Gabriel River

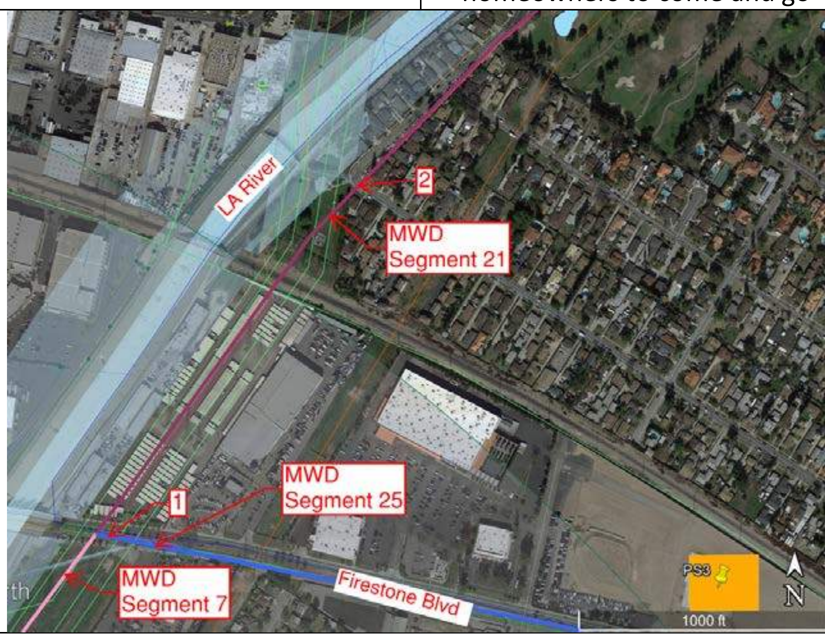




2. Looking South at San Gabriel River

SEGMENT 21 – LA River (From Firestone Blvd to Rio Hondo Golf Course)

MWD Alignment	B&V Alignment	
• Locate within SCE easement through storage facility then down Rio Hondo Dr north of Crawford Park • Open cut and shored excavation as needed • Built outside of rivers levee	• Same location • Potentially enough space located down the middle of storage units and transmission towers • Trenchless methods used to cross railroad into Crawford Park. • Rio Hondo Dr. is 40 ft. from curb to curb with residential driveways located on both sides of the road • Located within a neighborhood • No alternative routes for homeowners to come and go	 1. Looking North at a Storage Facility



2. Looking North at Rio Hondo Drive

SEGMENT 21 – LA River (From Rio Hondo Golf Course LA River Crossing)

<u>MWD Alignment</u>

- Locate within LADWP easement from the Rio Hondo Golf Course to LA River Crossing
- Open cut and shored excavation as needed
- Built outside of rivers levee

<u>B&V Alignment</u>

- Same location
- Alignment will impact a minimum of 4 holes through the Rio Hondo Golf Course including greens and tee boxes
- North of Rio Hondo Golf Course there is adequate space in the LADWP easement
- Trenchless crossing of Florence Ave and (potentially) the LA River

1. Looking North at a Rio Hondo Golf Course

2. Looking North at SCE Easement

SEGMENT 21 – LA River (Rio Hondo Channel)

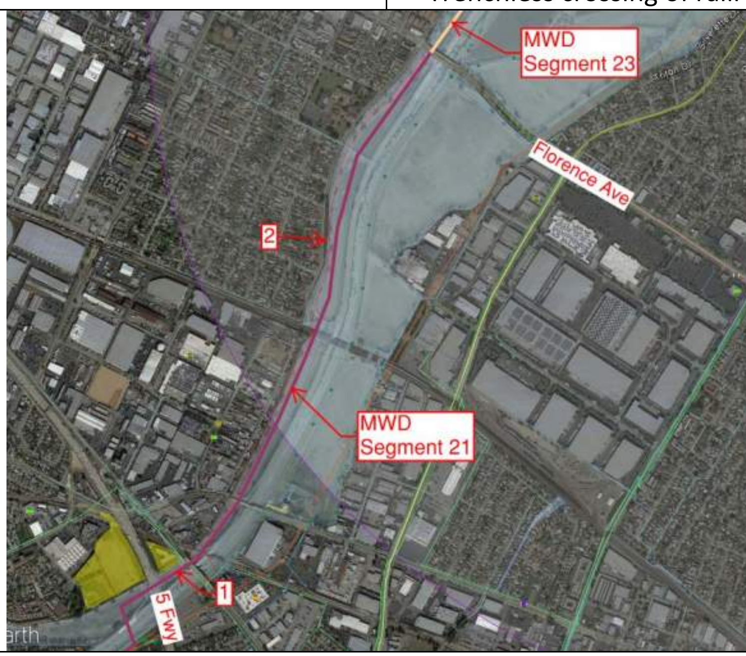
MWD Alignment

- Locate within Rio Hondo Channel west of LA River
- Open cut and shored excavation as needed
- Built outside of rivers levee
- Rio Hondo Channel is a designated wetland area and environmental impact mitigation requirements will need to be assumed

B&V Alignment

- Same location
- Locate as far west as possible on the Rio Hondo Channel to minimize impact to designated wetlands
- Potentially locate on access road/multiuse trail on west side of channel since another trail exists on the eastern bank as well
- North of Rio Hondo Golf Course there is adequate space in the LADWP easement
- Trenchless crossing of railroad

1. Looking South at 5 Fwy Crossing



2. Looking North at Rio Hondo Channel West of LA River

SEGMENT 21 Alternative A– LA River Bottom

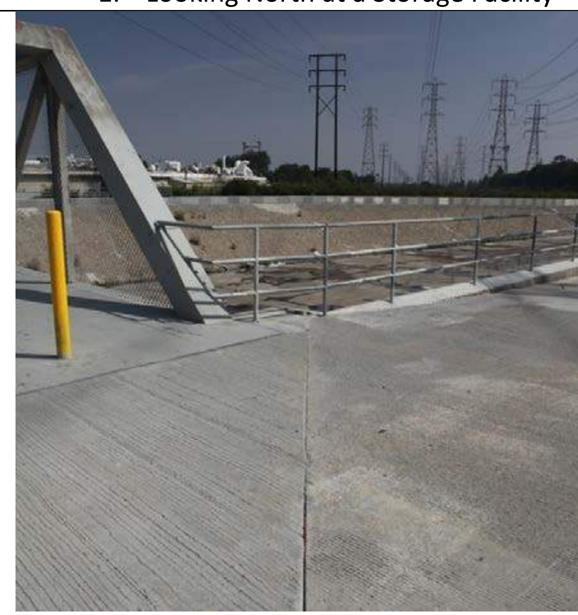
<u>MWD Alignment</u>

- N/A

<u>B&V Alignment</u>

- Use LA River bed to avoid congested storage facility, railroad crossing, narrow residential street, and the Rio Hondo Golf Course
- Enter LA River using saw cut methods similar those used by LACSD in the area for their sewer laterals as can be seen in Picture 2

1. Looking North at a Storage Facility



2. LACSD Saw Cut Pavement and New Bridge on Left of Picture

SEGMENT 21 Alternative B - Roadway

<u>MWD Alignment</u>

- N/A

<u>B&V Alignment</u>

- Use Firestone Blvd to Old River School Rd to Florence Ave to avoid congested storage facility, railroad crossing, narrow residential street, and the Rio Hondo Golf Course
- Shored excavation on streets, trenchless
- Old River School Rd is the narrowest street with 65 feet curb to curb and no center median
- Little residential driveway access

1. Looking North on Old River School Rd

2. Looking Northwest on Florence Ave

SEGMENT 22 – LA River (San Gabriel River Bed)

<u>MWD Alignment</u>

- Locate within San Gabriel River bed
- Open cut and shored excavation as needed
- Built outside of rivers levee
- San Gabriel River Bed is a designated wetland area for the entire 19,791 feet and environmental impact mitigation requirements will need to be assumed
- Length – 19,791 feet

<u>B&V Alignment</u>

- Same location
- Locate on the east edge of the San Gabriel River bed due to less discharges using that bank
- Trenchless crossing of railroad
- Crosses 4 of LADWP's rubber dams that will need to be crossed using trenchless methods
- Rubber dam just south of Washington Blvd is inflated and water is ponded north of it for approx. 400 feet of alignment until it leaves the river bed

1. Looking South at Rubber Dam and San Gabriel River

2. Looking South at San Gabriel River

SEGMENT 24 – Washington Blvd to Rio Hondo Spreading Grounds

<u>MWD Alignment</u>

- Locate within Washington Blvd Right-of-Way until discharge to Rio Hondo Spreading Grounds
- Approx. 85 ft curb to curb width available in Washington Blvd
- Shored excavation
- Length – 700 feet

<u>B&V Alignment</u>

- Same location
- Discharge to Rio Hondo Spreading Grounds north of Washington Blvd in the southeast corner of spreading basin
- Locate on north side of road to avoid storm drain

1. Looking Northwest on Washington Blvd

2. Looking Northeast into Rio Hondo Spreading Grounds

SEGMENT 25

<u>MWD Alignment</u>

- Locate within Firestone Blvd Right-of-Way
- Approx. 80 ft curb to curb width available in Firestone Blvd
- Shored excavation
- Length – 7,650 feet

<u>B&V Alignment</u>

- Same location
- Locate on south side of road to avoid LACFCD storm drain
- Trenchless crossing of railroad
- Center medians with trees
- No residential driveway access
- Strip malls along most the segment

1. Looking Northwest on Firestone Blvd

2. Looking East on Firestone Blvd

SEGMENT 26

MWD Alignment	B&V Alignment	
• Locate within Washington Blvd Right-of-Way • Approx. 88 ft curb to curb width available in Washington Blvd • Shored excavation • Length – 2,920 feet	• Same location • Locate on north side of road to avoid LACFCD storm drain and entrances to Pico Revera Towne Center • Center medians with trees • No residential driveway access • Pico Revera Towne Center (shopping center) entrances are located on Washington Blvd • Traffic impact concerns along this route	 1. Looking East on Washington Blvd

2. Looking West on Washington Blvd

SEGMENT 27

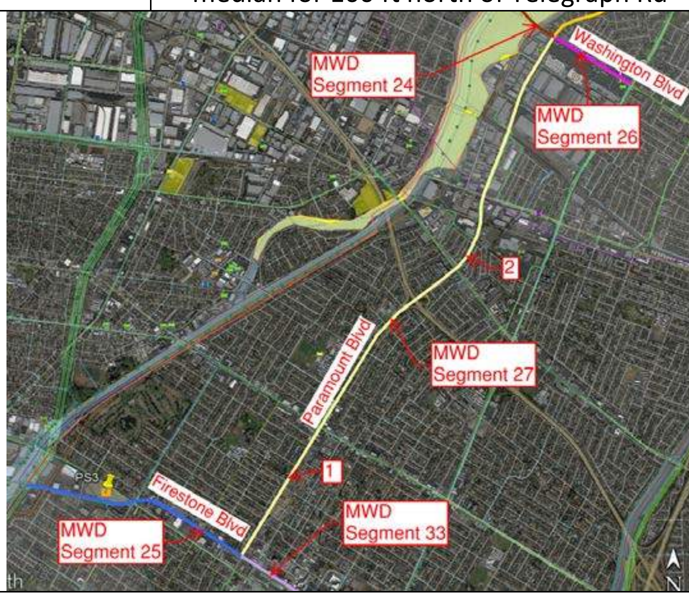
MWD Alignment

- Locate within Paramount Blvd Right-of-Way
- Between 60 - 80 ft curb to curb width available in Paramount Blvd
- Shored excavation
- Length – 19,500 feet

B&V Alignment

- Locate on primarily on west side of road to avoid major U/G utilites and entrances to Pico Revera Towne Center, major 5 Fwy on and off ramps, and school entrances
- Center medians with trees from Florence Ave to the 5 Fwy and from Telegraph Rd to Washington Blvd
- Mostly residential areas but no driveway access onto street
- Pico Revera Towne Center (shopping center) entrances are located on Paramount Blvd
- Trenchless crossing of railroad
- Potential to cross 5 Fwy using shored excavation methods
- Road shrinks to 60 ft wide with no center median for 100 ft north of Telegraph Rd

1. Looking Northeast on Paramount Blvd



2. Looking Northeast on Paramount Blvd

SEGMENT 28

<u>MWD Alignment</u>

- Locate within Washington Blvd Right-of-Way
- Approx. 75 ft curb to curb width available in Washington Blvd
- Shored excavation
- Length – 5,000 feet

<u>B&V Alignment</u>

- Locate on north side of road
- No residential driveway access
- Frontage roads for residential portion
- Center medians with trees east of Passons Blvd

1. Looking Northwest on Washington Blvd

2. Looking Northwest on Washington Blvd

SEGMENT 30

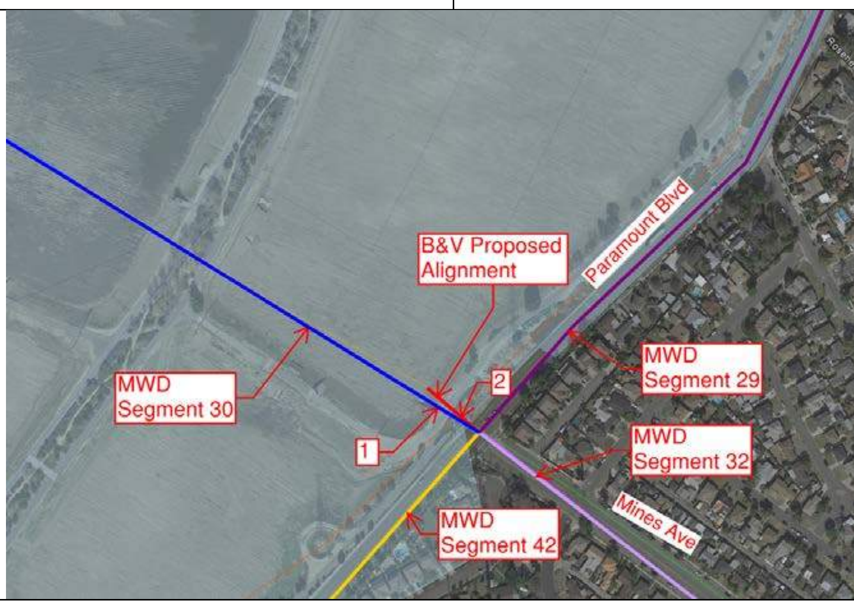
<u>MWD Alignment</u>

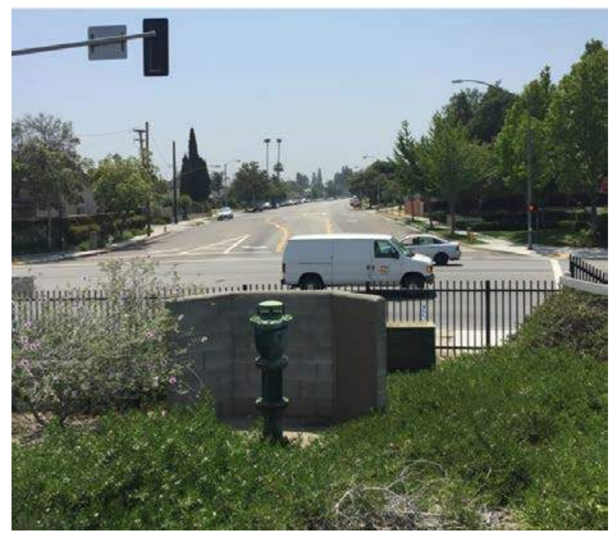
- Starts at the intersection of Mine Ave and Paramount Blvd and discharges into the Rio Hondo Spreading Grounds
- Shored excavation in Mines Ave and open cut once outside of the street
- Length – 1,640 feet

<u>B&V Alignment</u>

- Stop segment after 175 ft and discharge into the spreading grounds adjacent to existing discharge

1. Looking Northwest at Spreading Grounds





2. Looking Southeast on Mines Ave

SEGMENT 32

MWD Alignment
- Locate within Mines Ave Right-of-Way
- Approx. 80 ft curb to curb width available in Mines Ave
- Open cut (space permitting), Shored excavation
- Length – 1,850 feet

B&V Alignment
- Locate on north side of road
- Through a residential neighborhood but no residential driveway access
- Painted turn median

1. Looking Southeast on Mines Ave

SEGMENT 33

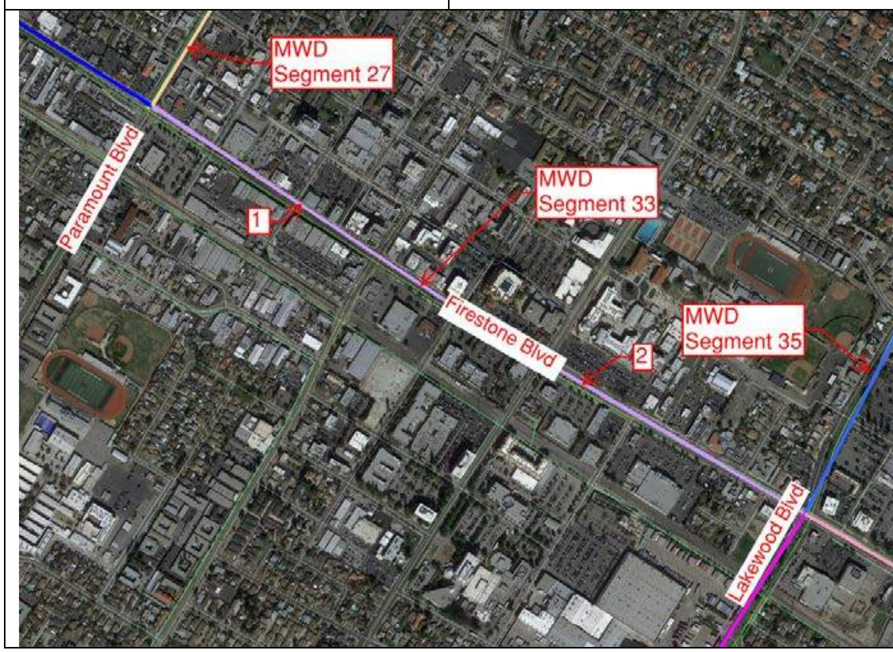
MWD Alignment

- Locate within Firestone Blvd Right-of-Way
- Approx. 75 ft curb to curb width available in Firestone Blvd
- Shored excavation
- Length – 4,970 feet

B&V Alignment

- Locate on south side of road
- Through a commercial area
- Commercial driveway access on both sides of street
- Center medians with trees

1. Looking Southeast on Firestone Blvd



2. Looking Northwest on Firestone Blvd

SEGMENT 34

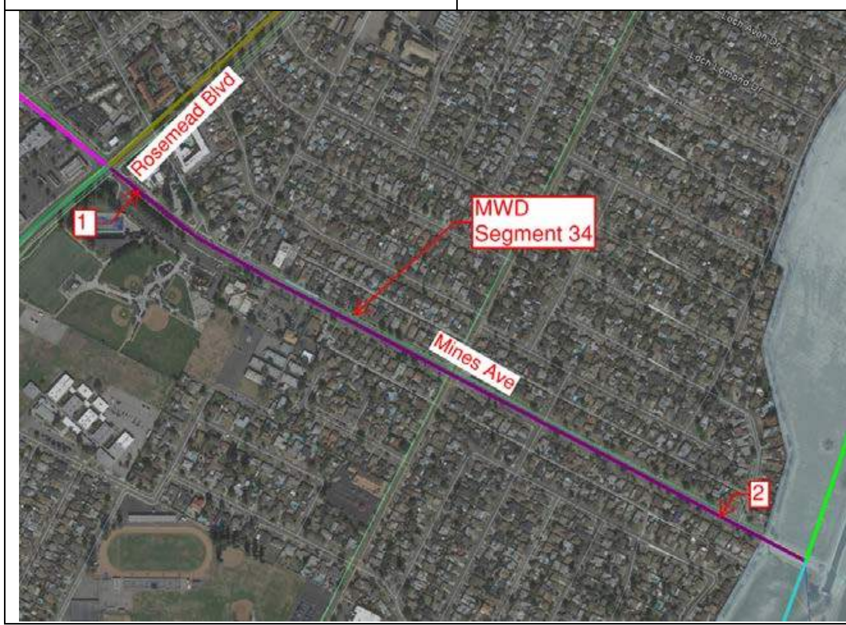
<u>MWD Alignment</u>

- Locate within Mines Ave Right-of-Way
- Approx. 75 ft curb to curb width available in Mines Ave
- Shored excavation
- Length – 4,775 feet

<u>B&V Alignment</u>

- Locate on north side of road
- Through a residential neighborhood but little to no residential driveway access
- Painted turn median

1. Looking Southeast on Mines Ave



2. Looking Northwest on Mines Ave

SEGMENT 35

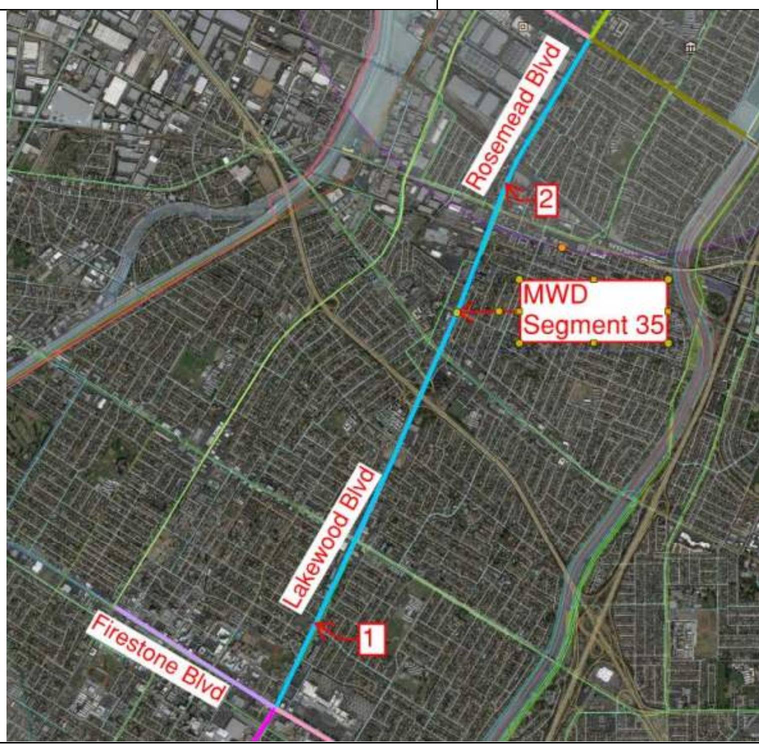
MWD Alignment

- Locate within Lakewood Blvd/Rosemead Blvd Right-of-Way
- Approx. 65-75 ft curb to curb width available in Lakewood Blvd/Rosemead Blvd
- Shored excavation
- Length – 18,150 feet

B&V Alignment

- Locate on east side of road
- Through residential and commercial areas
- Frontage roads for most residential areas
- Center medians with trees

1. Looking North on Lakewood Blvd



2. Looking North on Rosemead Blvd

SEGMENT 36

MWD Alignment	B&V Alignment	
• Locate down the middle of San Gabriel River Constructed Wetlands • Open cut excavation; Shoring if necessary • Length – 4,250 feet • Through a designated wetland	• Locate as close to, or on top of, one of the wetland banks to minimize impact to wetland area • Prefer west bank of wetlands to avoid encroaching on river levee • Multi use trails or access roads on top of wetland banks	 1. Looking South at Wetland
		 2. Looking North on West Edge of Wetland

SEGMENT 40

MWD Alignment

- Locate within Lakewood Blvd/Rosemead Blvd Right-of-Way
- Approx. 75 ft curb to curb width available in Lakewood Blvd/Rosemead Blvd
- Shored excavation
- Length – 3,925 feet

B&V Alignment

- Locate on west side of road to maximize use of frontage streets and avoid school entrances
- Through residential and commercial areas
- No direct residential driveway access on street, utilize frontage roads
- Center medians with trees
- School crossing has an overhead (not at grade) walkway to cross Rosemead Blvd

1. Looking North on Rosemead Blvd

2. Looking North on Rosemead Blvd

SEGMENT 42

MWD Alignment

- Locate within Paramount Blvd Right-of-Way
- Approx. 60 ft curb to curb width available in Paramount Blvd
- Shored excavation
- Length – 4,325 feet

B&V Alignment

- Locate on west side of road to avoid LACSD sewer laterals on east side of road
- Through a residential area
- Direct residential driveway access on street from Silverette Dr to Maris Ave
- Painted center median

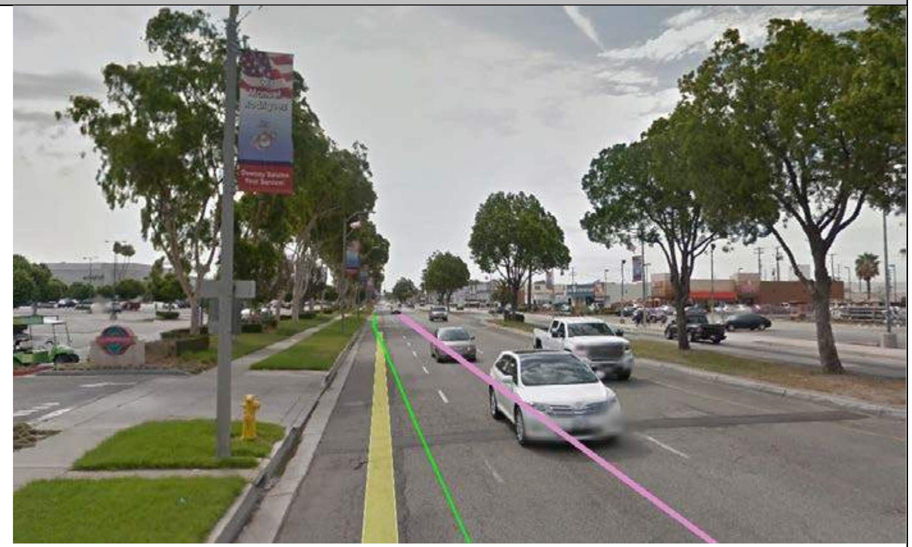
1. Looking North on Paramount Blvd

2. Looking North on Paramount Blvd

SEGMENT 57

MWD Alignment
- Locate within Firestone Blvd Right-of-Way
- Approx. 80-90 ft curb to curb width available in Firestone Blvd
- Shored excavation
- Length – 4,325 feet

B&V Alignment
- Locate on north side of road
- Stonewood Center at intersection with Lakewood Blvd
- Landscaped center median



1. Looking East on Firestone Blvd

2. Looking East on Firestone Blvd

Base Case Alternative – Los Coyotes Diagonal

MWD Alignment

- N/A

B&V Alignment

- Head west on Willow St to Los Coyotes Diagonal.
- Good potential launching and receiving pit locations for San Gabriel River crossing.
- Carson High School located at Main St and 223rd
- Approx. 85-90 ft curb to curb width available in Willow St and 75-85 ft. curb to curb width in Los Coyotes Diagonal.
- No residential driveway access.
- No center median on Los Coyotes Diagonal

1. Looking East on Willow St

2. Looking Northeast on Los Coyotes Diagonal

SEGMENT 4

<u>MWD Alignment</u>

- Wetland area adjacent to LA River.
- Intersection of San Antonio, Long Beach Blvd and Carson will be difficult to navigate

<u>B&V Alignment</u>

- Adjusted location of proposed pipeline according to utility information. On Del Amo to south side of street, Carson to north side.
- Del Amo past Long Beach looks to be a good alternative.

1. Facing South on Del Amo and LA River

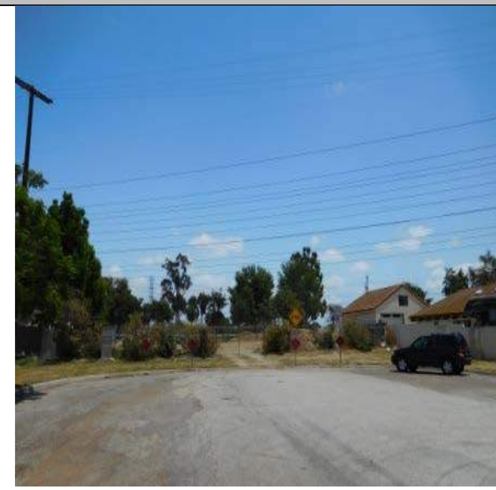
2. Facing South on Long Beach Blvd at San Antonio and Carson

<table>
<tr><th colspan="3">SEGMENT 8</th></tr>
<tr>
<td><u>MWD Alignment</u>
• Carson St – approx. 75ft ROW. Leads to SCE easement.
• From initial PS 2 location on Del Amo and LA River, you head south to Carson and then back up north on SCE easement.</td>
<td><u>B&V Alignment</u>
• Approx 60 ROW on Palo Verde, (residential), low traffic street, avoids SCE easements, meets alterative crossing of I-605 at 195th St.
• Approx 75ft ROW on Del Amo, comparable street to Carson. Del Amo was a straight shot from initial PS 2 location to Orangethorpe.</td>
<td>
1. Del Amo Facing East</td>
</tr>
<tr>
<td colspan="2">
</td>
<td>
2. Palo Verde Facing North</td>
</tr>
</table>

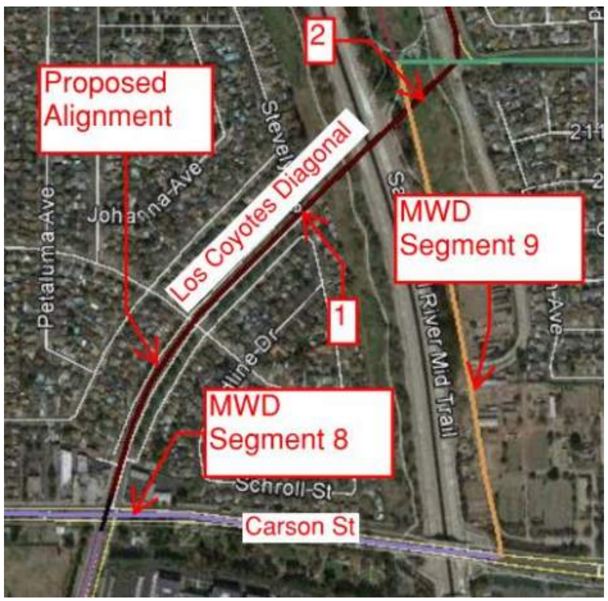
SEGMENT 10 – Los Coyotes Diagonal Crossing

MWD Alignment
- N/A

B&V Alignment
- Tunnel across San Gabriel River from Los Coyotes Diagonal empty lot.
- Avoid SCE corridor and disturbing parks



1. Looking NE Los Coyotes Diagonal



2. Looking South on SCE Corridor

SEGMENT 10 – Studebaker Rd

MWD Alignment

- Located within SCE Easement
- Approx. 70 ft width available between towers in park.
- Transfer station very congested with high voltage towers.

B&V Alignment

- Avoid SCE Easement and drainage channel
- Avoids SCE Transfer Station
- Accommodates new PS 2 location

1. SCE Corridor looking North (parallel to Studebaker Rd

2. At SCE Transfer Station looking East

SEGMENT 11 & 16

<u>MWD Alignment</u>

- Located within SCE Easement
- Width varies on north side of towers. Approx. 30-40 ft width available between north tower and the wall from homes.
- Given SCE guidelines the clearances cannot be met for this alignment, alternatives were identified.

<u>B&V Alignment</u>

- Located within SCE Easement
- Per Construction sections the needed clearances cannot be met.
- Approx. 40th width available between high voltage tower and south line.
- Between Valley View and Knotts a second set of power lines enters the SCE easement so the alignment moves to the north side of the easement for this stretch.

1. Facing West on SCE at Walker

2. Facing East on SCE at Valley View

SEGMENT 12

<u>MWD Alignment & Notes</u>

- Centralia St, Approx 60ft ROW.
- 1,500ft long tunnel for I-605 crossing
- Alt for SCE Easement

<u>B&V Alignment & Notes</u>

- Didn't observe better location for tunnel pits to shorten length of tunnel on either side of I-605 bridge.

1. Centralia facing west, east of I-605

2. Centralia facing west, west of I-605

SEGMENT 11 Alternative - San Gabriel River Crossing at 195TH St

MWD Alignment & Notes

- N/A

B&V Alignment & Notes

- Open lot at 195th St and San Gabriel River would serve as pit location for the crossing.
- 195th St – approx. 60ft ROW, low traffic.

1. San Gabriel River and 195th St Facing West

1. San Gabriel River and 195th St facing east

COYOTE CREEK X-ING ALTERNATIVE

MWD Alignment & Notes

- N/A

B&V Alignment & Notes

- Orangethorpe Ave, 100ft ROW, South St 80ft ROW, narrows at Coyote creek crossing but tunneling pits can be set up at each end.

1. Orangethorpe and Coyote Creek, facing west

2. South St at Coyote Creek, facing East

SEGMENT 23

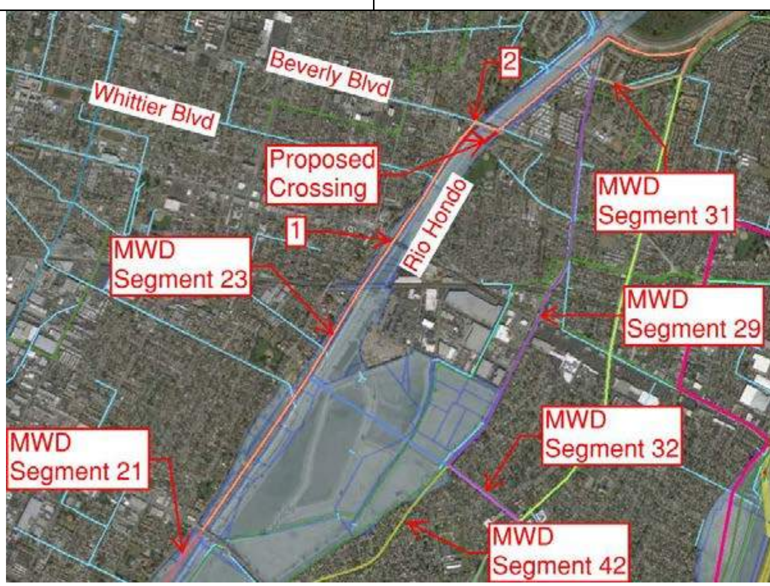
MWD Alignment

- Locate within LAFCD Easement along earthen spreading basin east of Rio Hondo Channel
- Approx 45 to 290 ft toe to toe width available in the earthen spreading basin
- Length - 15,280 ft.

B&V Alignment

- Cross Rio Hondo just South of Beverly Blvd

1. Looking North up earthen spreading basin at Whittier Blvd.



2. Looking South down earthen spreading basin at Beverly Blvd.

SEGMENT 29

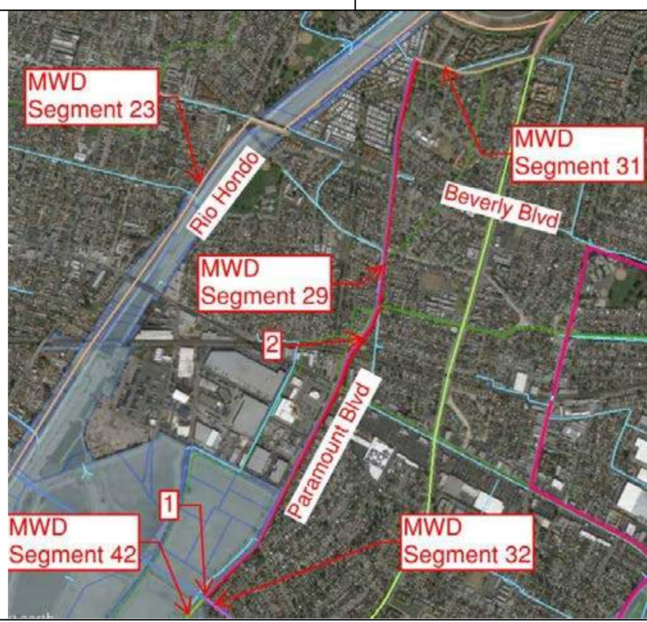
MWD Alignment

- Locate within ROW of Paramount Blvd.
- Approx. 58 ft curb to curb width available on Paramount between Mines and Whitter Blvd.
- Approx 80 to 92 ft curb to curb width available on Paramount between Whittier Blvd and Gallatin Rd.
- Impacts single family residential/light commercial
- Length - 8,665 ft.

B&V Alignment

- Runs along East side of Paramount to avoid sewers

1. Looking North on Paramount Blvd at Mines Ave



2. Looking North on Paramount Blvd.

SEGMENT 31

<u>MWD Alignment</u>

- Locate within ROW of Gallatin Rd.
- Approx. 60 ft curb to curb width available.
- Impacts single family residential
- Length - 1,905 ft.

<u>B&V Alignment</u>

- Runs along South side of Gallatin Rd. West of Bolker Way to avoid storm drain.
- Runs along North side of Gallatin Rd. East of Bolker Way to avoid sewers.

1. Looking East on Gallatin Road

SEGMENT 37

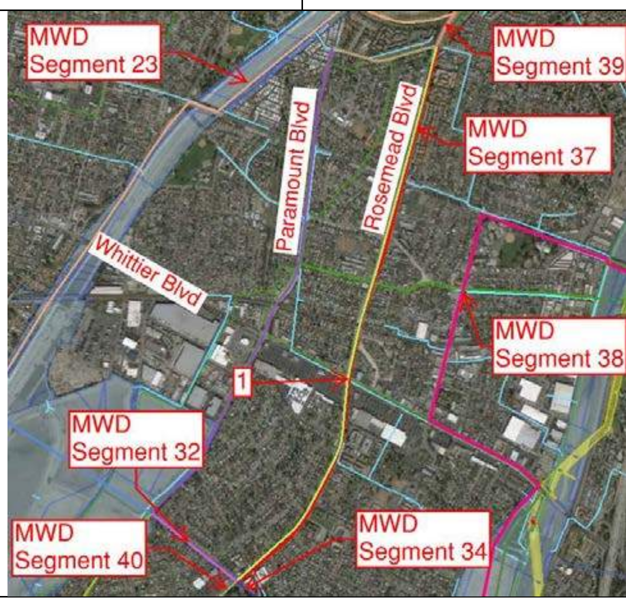
MWD Alignment

- Locate within ROW of Rosemead Blvd.
- Approx. 80 ft curb to curb width available
- Impacts residential/light commercial
- Length - 9,915 ft.

B&V Alignment

- Runs along East side of Rosemead Blvd.

1. Looking South on Rosemead Blvd. at Whittier Blvd.



SEGMENT 38

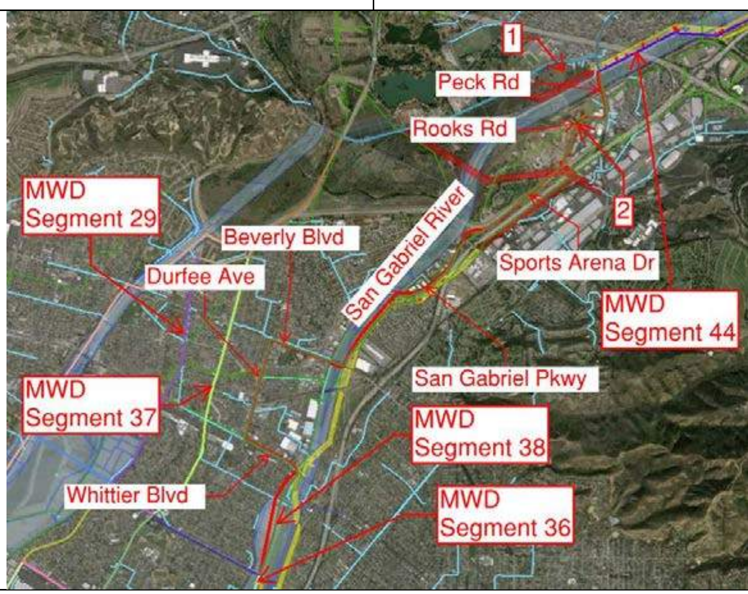
<u>MWD Alignment</u>

- Locate within ROW of Whittier Blvd, Durfee Ave, and Beverly Blvd.
- Approx. 76 ft curb to curb width available in Whitter and Beverly Blvd
- Approx 36 to 50 ft curb to curb width available in Durfee Ave.
- Impacts single family residential/light commercial
- Limits access to North Park Middle School
- Length - 8,665 ft.

<u>B&V Alignment</u>

- Same location

1. Looking South at San River Coastal Spreading Grounds



2. Looking South on Rooks Rd

SEGMENT 38 Alternative A – San Gabriel River Trail

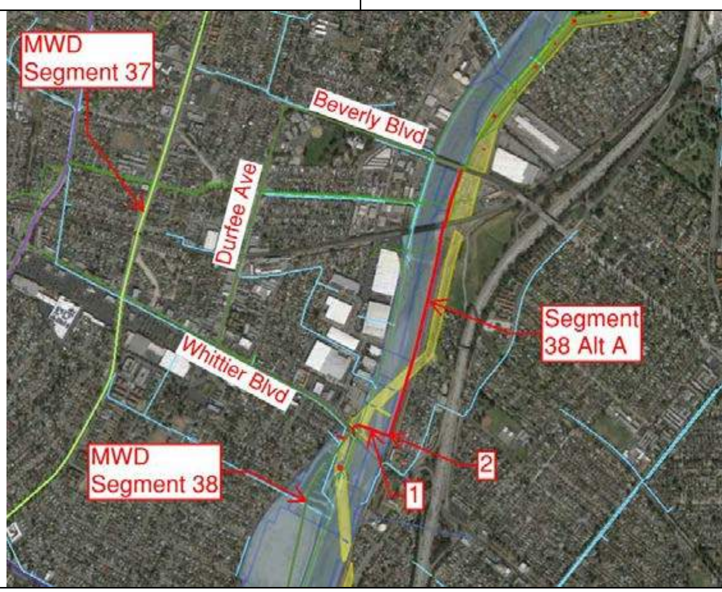
<u>MWD Alignment</u>

- Locate within ROW of Whittier Blvd, Durfee Ave, and Beverly Blvd.
- Approx. 76 ft curb to curb width available in Whitter and Beverly Blvd
- Approx 36 to 50 ft curb to curb width available in Durfee Ave.
- Impacts single family residential/light commercial
- Limits access to North Park Middle School
- Length - 8,665 ft.

<u>B&V Alignment</u>

- Locate within LAFCD Easement along San Gabriel River Trail on East side of San Gabriel River.
- Approx. 75 to 160 ft from edge of easement to edge of trail.
- No impact to commercial or residential property.
- No impact to North Park Middle School
- Length - 4535 ft.

3. Looking North up the San Gabriel River



4. Looking North up LAFCD Easement

SEGMENT 38 Alternative B – San Gabriel River Parkway

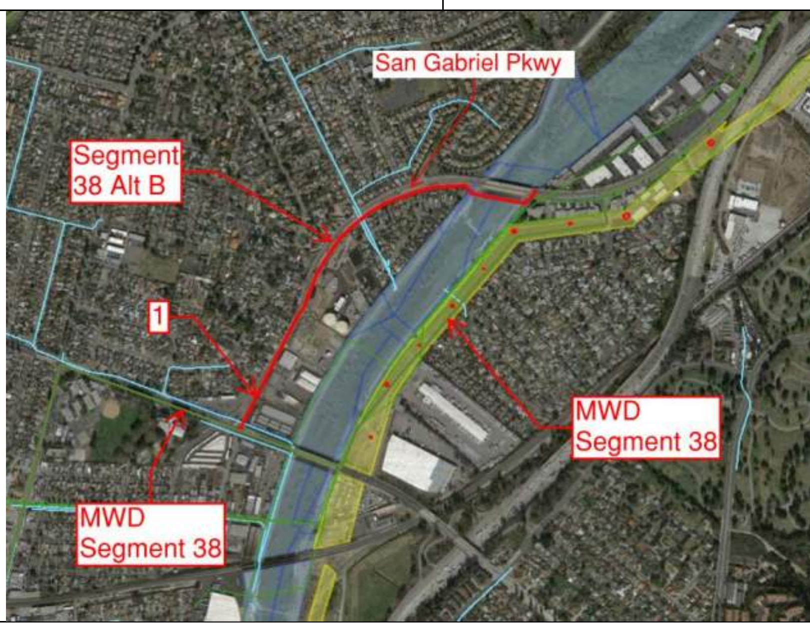
<u>MWD Alignment</u>

- Locate within SCE Easement
- Easement width varies between 160 and 290 ft.
- Limited space due to SCE towers.

<u>B&V Alignment</u>

- Locate within ROW of San Gabriel River Parkway
- Approx. 50 – 95 ft curb to curb width available in San Gabriel River Parkway
- Backup option if SCE easement not available.

1. San Gabriel River Parkway Looking North



SEGMENT 39

<table>
<tr><td><u>MWD Alignment</u>
• Locate within ROW of Rosemead Blvd.
• Approx. 80 ft curb to curb width available
• Length - 650 ft.</td><td><u>B&V Alignment</u>
• Runs along East side of Rosemead Blvd.</td><td>
1. Looking North on Rosemead Blvd.</td></tr>
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</table>

SEGMENT 41

<u>MWD Alignment</u>

- Locate within ROW of Rosemead Blvd.
- Crosses bridge at wetland/critical habitat
- Approx 83 ft curb to curb width available on Rosemead Blvd.
- Impacts a critical habitat/wetland
- Length - 4,860 ft.

<u>B&V Alignment</u>

- Runs along South/East side of Rosemead Blvd.
- At the bridge, alignment steps out into land parallel to Rosemead Blvd and remains there until Durfee Ave.

1. Looking North on Rosemead Blvd near bridge

2. Proposed step out location

SEGMENT 41 Alternative A

MWD Alignment

- Locate within ROW of Rosemead Blvd.
- Crosses bridge at wetland/critical habitat
- Approx 83 ft curb to curb width available on Rosemead Blvd.
- Impacts a critical habitat/wetland
- Length - 4,870 ft.

B&V Alignment

- Runs along South/East side of Rosemead Blvd.
- At the bridge, alignment steps out into land parallel to Rosemead Blvd for approx 1,110 ft
- Alignment merges back onto Rosemead Blvd ROW until Durfee Ave

3. Looking North on Rosemead Blvd near bridge

4. Proposed step out location

SEGMENT 43

MWD Alignment

- Locate within ROW of Durfee Ave.
- Approx 63 ft curb to curb width available on 4-lane portions of Durfee Ave.
- Approx 38 ft width available including shoulders on 2-lane portion of Durfee Ave.
- Impacts light residential/commercial
- Length - 9,675 ft.

B&V Alignment

- Runs along South side of Durfee Ave to avoid impacting school, Whittier Narrows Recreation Area, and overhead power lines

1. Looking East on 2-lane stretch of Durfee Ave

2. Looking East on 4-lane stretch of Durfee Ave

SEGMENT 44

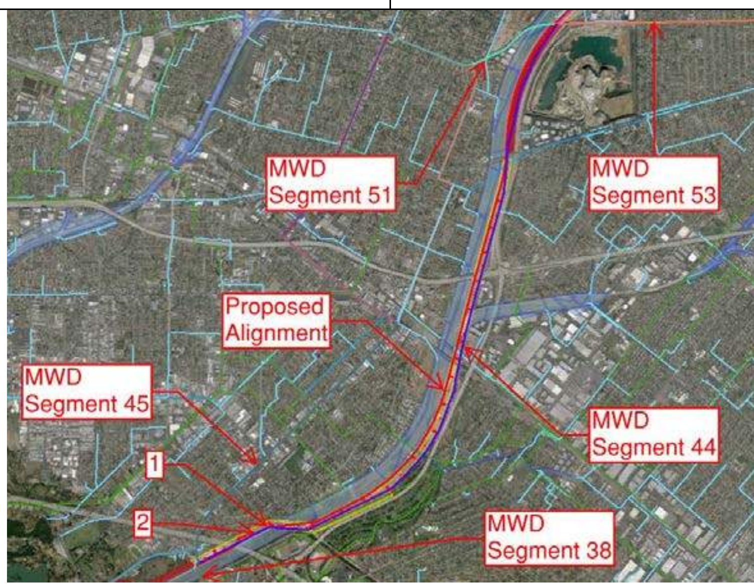
MWD Alignment

- Two river crossings over San Gabriel River
- Within SCE Easement

B&V Alignment

- Same location

1. San Gabriel River Trail Looking East



2. San Gabrial River Trail Looking Southwest

SEGMENT 44 Alternative A – Southside of San Gabriel River

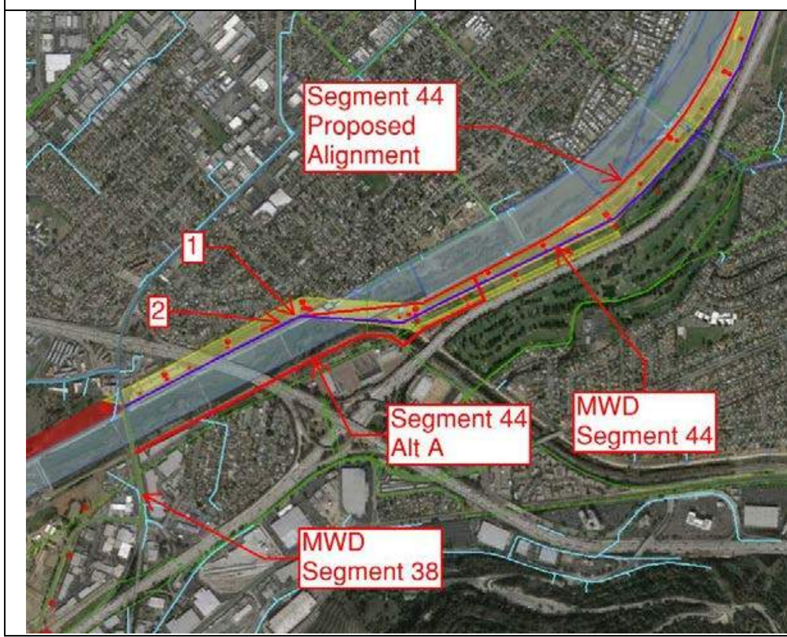
<u>MWD Alignment</u>

- Two river crossings over San Gabriel River
- Within SCE Easement

<u>B&V Alignment</u>

- One short river crossing
- Pipe Bridge over San Jose Creek.

1. San Gabriel River Trail Looking East



2. San Gabrial River Trail Looking Southwest

SEGMENT 45

MWD Alignment
- Locate within ROW of Durfee Ave.
- Approx 75 to 80 ft curb to curb width available on Durfee Ave.
- Impacts residential/commercial (with majority having back access)
- Length - 11,480 ft.

B&V Alignment
- Runs along South side of Durfee Ave South of Rush St to avoid water and storm drain lines
- Runs along North side of Durfee Ave North of Rush St to avoid storm drain lines

1. Looking North on Durfee Ave at Peck Road

2. Looking North at 60 freeway on-ramp

SEGMENT 45 Alternative A – Peck Road

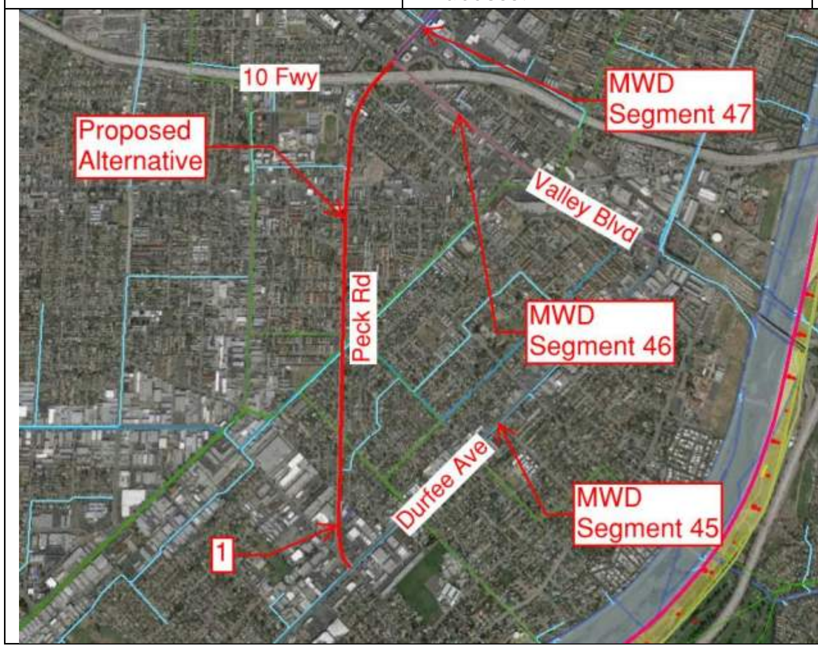
MWD Alignment

- Locate within ROW of Durfee Avenue and Valley Blvd.
- Approx 70 to 76 ft curb to curb width available in Durfee Avenue and Valley Blvd.
- Median on Valley Blvd
- Length - 12,630 ft

B&V Alignment

- Locate within ROW of Peck Road.
- Approx 76 ft curb to curb width available in Peck Road.
- Median on Peck near I-10 intersection.
- Length - 8720 ft
- Impacts industrial, light commercial, and residential.
- Most residences and businesses have alternative access.

1. Looking North on Peck Road



SEGMENT 46

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MWD Alignment

- Locate within ROW of Valley Blvd.
- Approx 75 to 80 ft curb to curb width available on Valley Blvd.
- Impacts light commercial
- Length - 5,575 ft.

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B&V Alignment

- Runs along South side of Valley Blvd to avoid MWD Middle Feeder line

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1. Looking West on Valley Blvd at Durfee Ave

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SEGMENT 47

<u>MWD Alignment</u>

- Locate within ROW of N Peck Rd.
- Approx 80 ft curb to curb width available on N Peck Rd
- Impacts light residential/commercial
- Length - 9,100 ft.

<u>B&V Alignment</u>

- Runs along North side of N Peck Rd to avoid storm drain lines

1. Looking South on N Peck Rd

2. Looking North on N Peck Rd

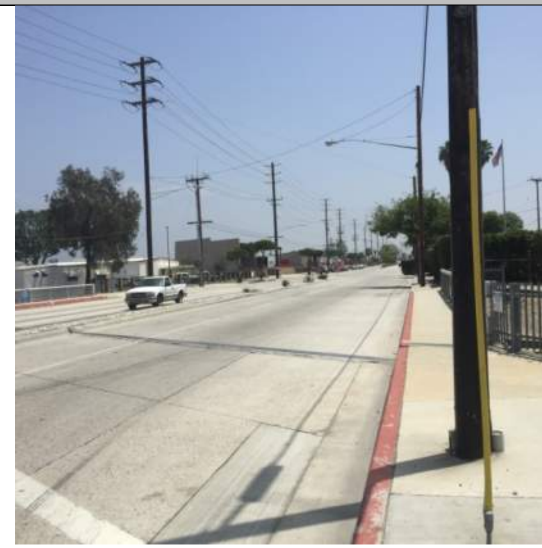
SEGMENT 47 Alternative A – Peck Road and Live Oak Avenue

<u>MWD Alignment</u>

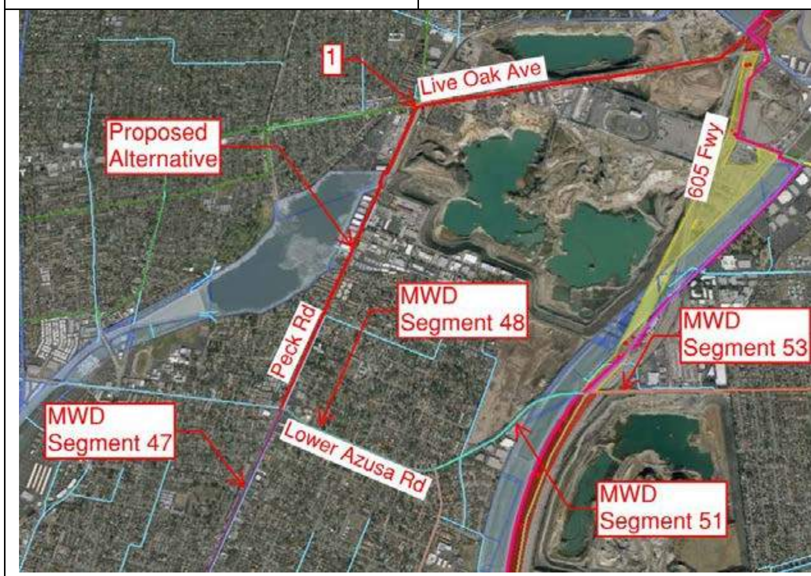
- N/A

<u>B&V Alignment</u>

- Locate within Right-of-Way of North Peck Road, East Live Oak Ave/Arrow Highway, Avendia Barbosa, and Buena Vista Street.
- Approx. 76 ft curb to curb width available in North Peck Road, East Life Oak Ave/Arrow Highway, Avenida Barbosa, and Buena Vista Street
- Avoids crossing 605 freeway



2. Looking South on Peck Road



SEGMENT 48

<u>MWD Alignment</u>

- Locate within ROW of Lower Azusa Rd.
- Approx 62 ft curb to curb width available on Lower Azusa Rd
- Impacts light residential/commercial
- Length - 3,530 ft.

<u>B&V Alignment</u>

- Runs along South side of Lower Azusa Rd

1. Looking South on N Peck Rd

SEGMENT 51

MWD Alignment	B&V Alignment	
• Locate within ROW of Lower Azusa Rd. • Approx 62 ft curb to curb width available on Lower Azusa Rd • Impacts light residential/commercial • Length - 3,675 ft.	• Runs along North side of Lower Azusa Rd to reduce impacts on residential and commercial areas	 1. Looking East Lower Azusa Rd at Durfee Ave
 		 2. Looking East Lower Azusa Rd at San Gabriel River Bridge

SEGMENT 52 – San Gabriel River or SCE Easement

<u>MWD Alignment</u>

- Locate within SCE Easement
- Limited space due to SCE towers.
- Conflicts with businesses on Rivergrade Road.

<u>B&V Alignment</u>

- Locate within LACFD Easement at bottom of San Gabriel River
- Require permitting with USACE

1. Lower Azusa Road Looking North towards SCE Easement

SEGMENT 52 Alternative A – San Gabriel River Option 1

<table>
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MWD Alignment

- Passes through land that is an active construction site.
- Locate within ROW of Rivergrade Rd
- Approx 33 ft curb to curb width in Rivergade Rd South of Olive St
- Approx 60 ft curb to curb width in Rivergade Rd North of Olive St

</td><td>

B&V Alignment

- Runs in river bed in location where Rivergrade Rd is narrow
- Avoids closure of Rivergrade Rd
- Locate within dry riverbed to minimize impacts to commercial centers at intersection of Rivergrade Rd and Live Oak Ave.
- Requires easements in private property

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SEGMENT 52 Alternative B – San Gabriel River Option 2		
MWD Alignment • Passes through land that is an active construction site. • Locate within ROW of Rivergrade Rd • Approx 33 ft curb to curb width in Rivergade Rd South of Olive St • Approx 60 ft curb to curb width in Rivergrade Rd North of Olive St	B&V Alignment • Avoids closure of Rivergrade Rd • Locate within dry riverbed to minimize impacts to commercial centers at intersection of Rivergrade Rd and Live Oak Ave. • Requires easements in private property	 1. Looking South at San Gabriel River
		

SEGMENT 52 Alternative C – San Gabriel River Option 3

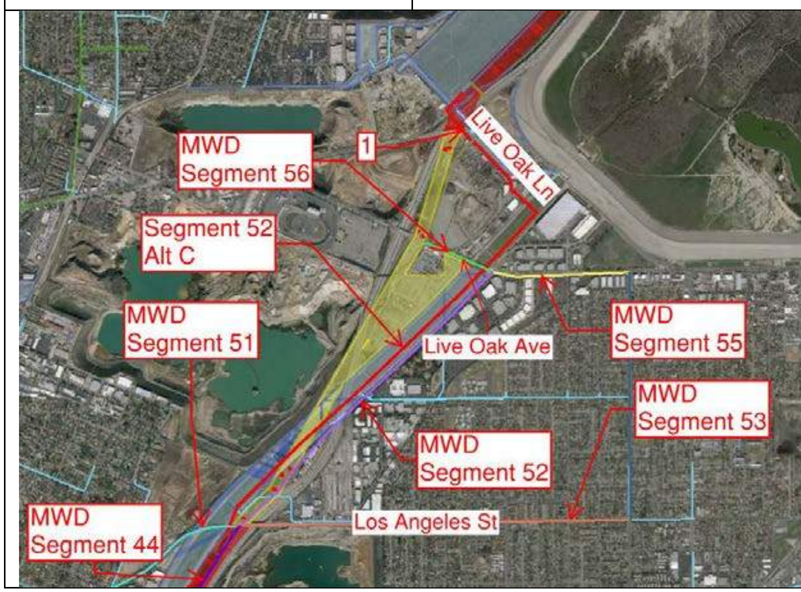
<u>MWD Alignment</u>

- Passes through land that is an active construction site.
- Locate within ROW of Rivergrade Rd
- Approx 33 ft curb to curb width in Rivergade Rd South of Olive St
- Approx 60 ft curb to curb width in Rivergade Rd North of Olive St

<u>B&V Alignment</u>

- Avoids closure of Rivergrade Rd
- Locate within dry riverbed to minimize impacts to commercial centers at intersection of Rivergrade Rd and Live Oak Ave.
- Eliminates Segment 56
- Connects to Segment 58 via Live Oak Ln (industrial road)
- Requires easements in private property

1. Looking East on Live Oak Ln



SEGMENT 53

MWD Alignment

- Locate within ROW of Los Angeles St.
- Approx 60 ft curb to curb width available on Los Angeles St.
- Impacts light residential/commercial
- Length - 8,450 ft.

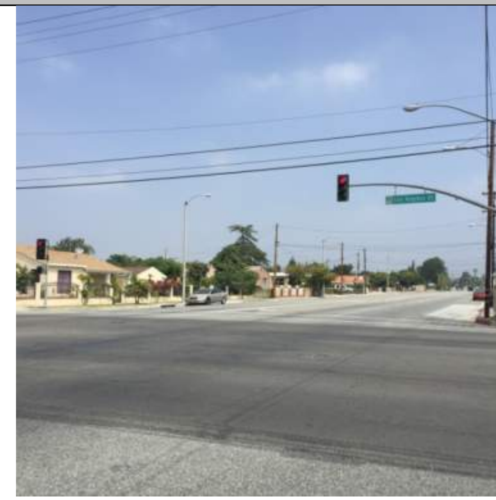
B&V Alignment

- Runs along North side of Los Angeles St. to avoid storm drain lines

1. Looking East on Los Angeles Street at 605 Bridge

2. Looking West on Los Angeles St. at Baldwin Park Blvd.

SEGMENT 54

MWD Alignment	B&V Alignment	
• Locate within ROW of Baldwin Park Blvd. • Approx 72 ft curb to curb width available on N Peck Rd • Impacts light residential/commercial • Impacts Jerry D. Holland Middle School and Santa Fe Elementary School • Passes Valley County Water District storage tanks • Length - 5,215 ft.	• Runs along West side of Baldwin Park Blvd. to minimize impact with schools and Valley County Water District operations.	 1. Looking North on Baldwin Park Blvd
		 2. Valley County Water District Tank

SEGMENT 54 Alternative A

MWD Alignment & Notes	B&V Alignment & Notes	
• Not Applicable	• Locate within Right-of-Way of Merced Ave., Olive St., and Stewart Ave. • Approx. 56 ft curb to curb width available in Merced Ave. and Olive St. • Approx 36 ft curb to curb width available in Stewart Ave.	 1. Merced Ave. Looking North

SEGMENT 55

MWD Alignment

- Locate within ROW of Live Oak Ave.
- Approx 80 to 85 ft curb to curb width available on Live Oak Ave.
- Impacts to commercial/industrial
- Length - 2,955 ft.

B&V Alignment

- Runs along South side of Live Oak Ave

1. Looking West on Live Oak Ave.

2. Looking East on Live Oak Ave. at Rivergrade Rd.

SEGMENT 56

<u>MWD Alignment</u>

- Locate within ROW of Live Oak Ave
- Approx 84 ft curb to curb width available on Live Oak Ave
- Impacts commercial/industrial
- Length – 1,580 ft

<u>B&V Alignment</u>

- Same location
- Begins after San Gabriel River Crossing
- Runs on North side of Live Oak Ave to connect to Segment 52 without crossing Live Oak Ave
- Length – 1,100 ft

1. Looking West on Live Oak Ave

SEGMENT 58

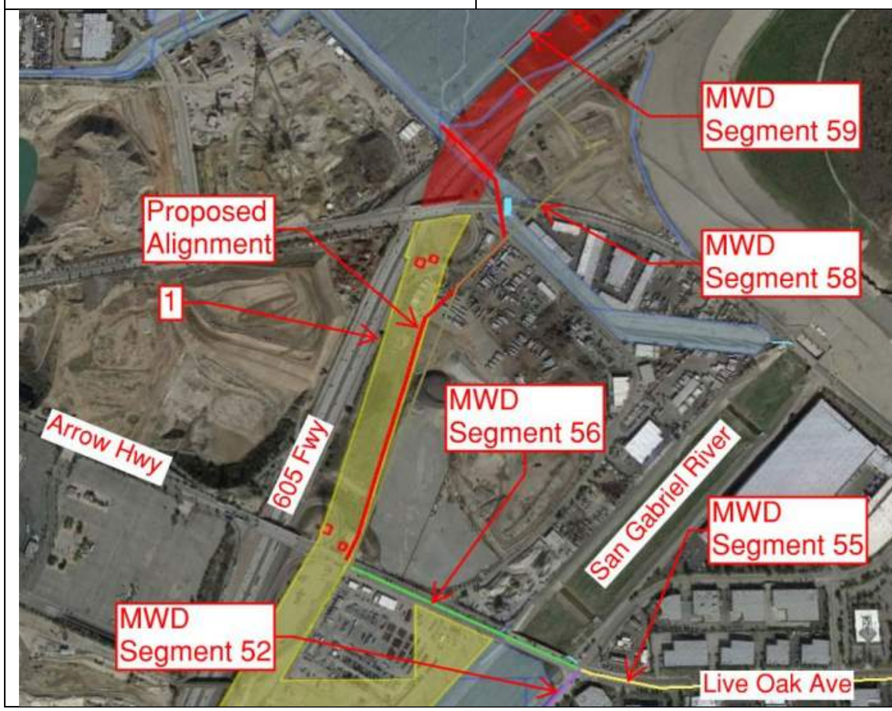
<u>MWD Alignment</u>

- Cross through private property and an unknown easement
- Length – 4,125 ft

<u>B&V Alignment</u>

- Adjusted to locate within SCE Easement on initial portion of Segment
- Approx. 63 ft width available from edge of transmission tower to edge of the SCE Easement
- Length – 3,340 ft

1. Looking East at SCE Easement



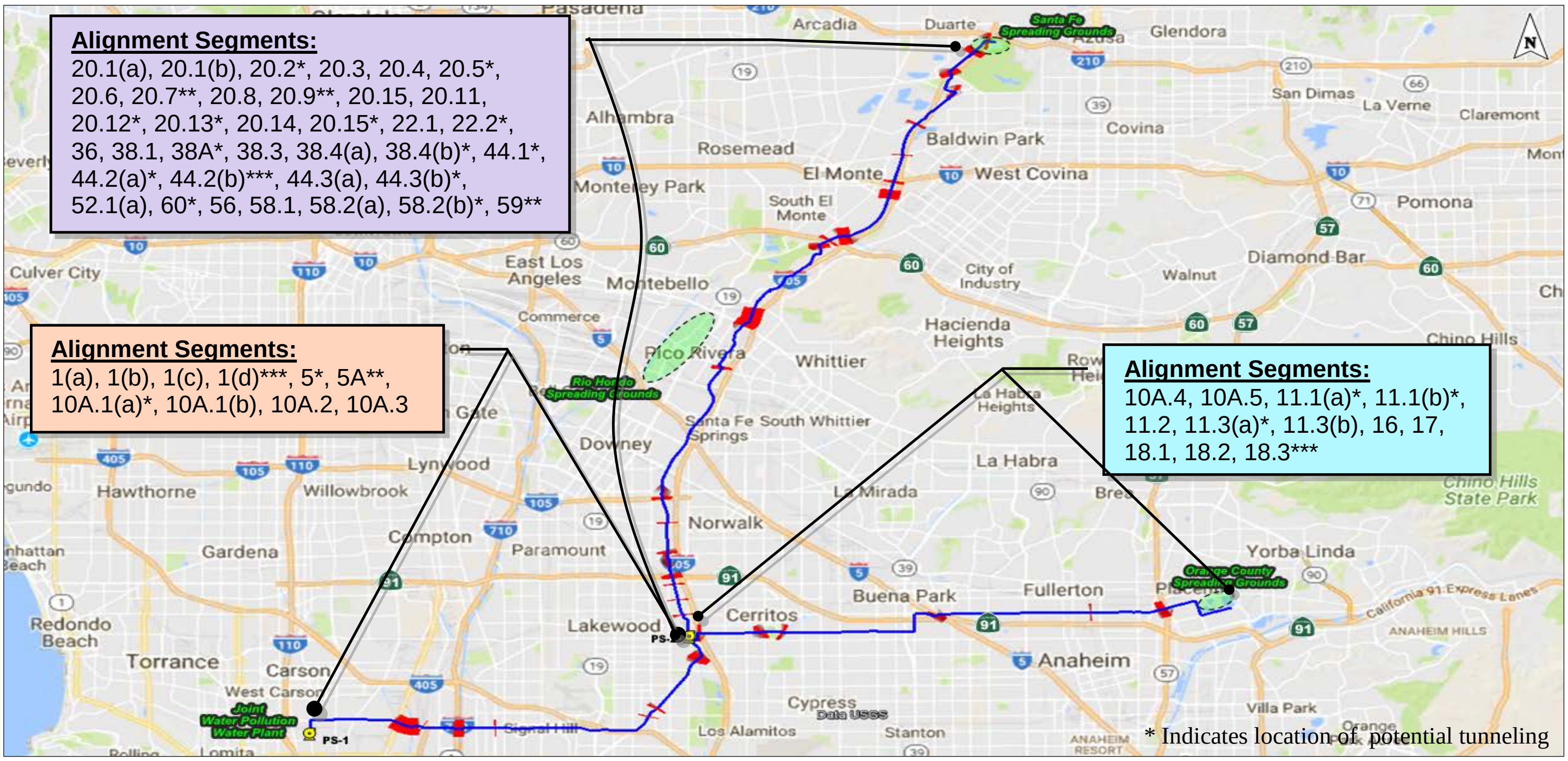
SEGMENT 59		
MWD Alignment • Locate within side slope of channel in LAFCD Easement • Length - 8,590 ft.	B&V Alignment • Refined location to be within river bank for easier construction • Length – 9,245 ft	 1. Santa Fe Spreading Grounds
 		

Appendix B. Preliminary Traffic Control Assessment for The Metropolitan Water District of Southern California's Potential Regional Recycled Water Supply Program Feasibilities Studies

Final Traffic Control Assessment

for the

Metropolitan Water District of Southern California's
Regional Recycled Water Supply Program (RRWSP) Feasibilities Studies



PRESENTED TO:

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
700 North Alameda Street
Los Angeles, CA 90012-2944

PREPARED FOR:

Black & Veatch
5 Peters Canyon Road
Irvine, CA 92606

PREPARED BY:

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25 Years of Excellence

August 25, 2018

1 GENERAL

1A **Overview**. The Metropolitan Water District of Southern California (MWD), in collaboration with the Los Angeles County Sanitation District (LACSD), is developing a new regional water supply program to deliver recharge water of groundwater basins for conservation, desalination, recycling and potable reuse purposes, and to improve and diversify storage and delivery capabilities and water supply throughout the region. MWD is contemplating a long-term phased approach, with an initial demonstration phase requiring the completion of several feasibility studies. An important part of the feasibility studies pertains to satisfying the comprehensive and multi-jurisdictional set of traffic control requirements, and managing the impacts of project construction on the surface transportation system. The proposed RRWSP pipeline alignment will traverse the following local jurisdictions in Los Angeles and Orange Counties:

Los Angeles County	
City of Arcadia	City of Lakwood
City of Baldwin Park	City of Long Beach
City of Bell Gardens	City of Los Angeles
City of Bellflower	City of Montebello
City of Carson	City of Norwalk
City of Cerritos	City of Paramount
City of Commerce	City of Pico Rivera
City of Compton	City of Santa Fe Springs
City of Downey	City of Signal Hill
City of El Monte	City of South El Monte
City of Hawaiian Gardens	City of South Gate
City of Industry	Unincorporated
City of Irwindale	L.A. County

Orange County
City of La Palma
City of Cypress
City of Buena Park
City of Fullerton
City of Placentia
City of Anaheim

The project design contractor, Black & Veatch, has requested Minagar & Associates, Inc. to provide a preliminary, top-level assessment of the temporary traffic control and work zone-related construction impacts and associated costs involved with constructing the subject Preferred Alignment for MWD's Potential Regional Recycled Water Supply Program (RRWSP). The following discussions include a general overview of the expected procedures, impacts and costs associated with temporary traffic control/work zone set-ups for the various Project alignments.

While there are a number of Potential RRWSP route alternatives that are located off-road, or only cross relatively short widths through city streets which would not require any significant traffic control set-ups within the public right-of-way, most of the alignments are located on public highways and would require MWD to implement proper traffic control methods to ensure construction worker and public safety. Boring/tunneling methods are undetectable to the public and would not interfere with traffic, with the exception of bore pits required at excavation exit and entry points.

1B **General Requirements.** The nature of the project construction involves a moving operation both on and off of the public right-of-way to sawcut and excavate pavement;

load and haul soils to the laydown area; install trench shoring; install, weld, inspect and test pipeline and valve appurtenances; grade, compact and backfill the site; and conduct other site restoration/cleanup on an ongoing basis. Daily construction will operate as a "rolling work zone" that is approximately 600 feet in length along any given alignment, and 36 feet wide. The typical construction method for use in all roadway-street locations requires a 10-foot lateral clearance from the trench or boring pit centerline to the nearside work zone edge, and 26 feet to the far-side work zone edge. Metropolitan estimates that daily trench-based work will be completed at a rate of 40 feet of pipeline construction per day within public roadways, and 200 feet per day within off-street easements. Trenchless-based construction between contiguous boring pits along the alignment is estimated to be completed at a rate ranging between 35 and 60 feet per day, depending on the soil conditions and trenchless method.

1C Specific/Special Requirements.

1C.1 Meeting Minutes. MWD has conducted a preliminary agency outreach effort with several local jurisdictions through which the project alignment will be constructed. MWD prepared a minutes summary of these meetings for the following agencies:

- City of Anaheim
- City of Buena Park
- City of Carson
- City of Cypress
- City of Fullerton
- City of La Palma
- City of Long Beach
- Los Angeles County Department of Public Works (LACDPW)
- Southern California Edison (SCE)

For each meeting, the following questions/concerns were raised:

- Traffic management and detour requirements;
- Need to obtain the width of public right-of-way for streets affected by the potential alignment;
- Encroachment permit process/timeframe;
- Utility relocation and median issues, where applicable;
- Upcoming projects or street improvements along the potential alignment?;
- Specification of City ordinances regarding pipeline construction (repaving/backfill requirements, etc.);
- Environmentally sensitive and restricted areas;
- Knowledge of any hazardous materials, contaminated soils, or chemical facilities in the vicinity of the project;
- Availability of electronic files (e.g., Microstation, AutoCad, GIS or PDF utility maps);
- Points of contact for Traffic, Environmental, Permits, Property Access and Street Parking Impacts, Other
- For corridor alignments:

- Need City contact for permanent easement and temporary construction easement process/timeframe;
- Need City contact for coordination of any park closures/impacts during construction

1C.2 Municipal Regulations, local concerns and potential nighttime work.

The following includes the traffic control related concerns and feedback provided from each local agency during the outreach meetings:

City of Carson

- The city had concerns that 223rd Street is busy, might want to stay out. Avalon (or Main) to Del Amo could be an option.
- Avoid Wilmington because it's a busy street with a lot of utilities.
- Construction Means and Methods: Maintain at least one lane of traffic in each direction. If you're at an intersection, maintain the left turn open. For trenching, you would need to reroute one block at a time.
- Working hours: 9am to 3pm weekdays. Times may change depending on the project. The City had a previous project with a starting time at 7am.
- We would need a detour plan which would serve as guidance to the contractors
- Sepulveda is busy with a lot of pipes/utilities, traffic is not as much of an issue
- Streets to stay away from:
  - Intersection of Wilmington/223rd. There's an ongoing construction project.
  - Carson from 405 to Figueroa

City of Long Beach

- Major streets will need to maintain one (1) lane of traffic in each direction at all times. The City does not want to detour any streets completely, but may approve flagging for minor streets on a case by case basis.
- Working hours are restricted to 8:30am to 3:30pm. A special permit request will need to be submitted to work outside of these hours. The City does not allow work on Sundays, however, Saturday work may be allowed with a special permit. Any requests are considered on a case by case basis. Refer to the City's noise ordinance for more information or contact the City's Noise Ordinance Officer to discuss further.

City of Cypress

- A traffic control plan will be required along with advance notification to residents and businesses.
- Working hours in the City are 8:30am to 3:30pm for cone traffic. If k-rails are installed, the working hours can be extended.
- With k-rail installed, there are no restrictions on the length of the open trench. If k-rail is not installed, the trench will need to be covered daily (back filled or covered with traffic bearing plates).
- The subdivisions to the east of Coyote Creek, on the north and south side of Crescent Avenue (Carob Street and Acacia Street), have only one point of access. Coordinate construction to accommodate these residents.

- A comment was made that Moody Street or Bloomfield Avenue may be better choice for the north/south alignment over Walker Street. All three of these options are within the City of La Palma. Kamran also mentioned that Holder Street in Buena Park is a quiet street. Valley View Street and Knott Avenue are busy north/south streets in Buena Park.
- Crescent Avenue is the best east/west option in the City of Cypress as there would be minimal traffic impacts in this area relative to the other east/west streets in the City.
- The intersection of Walker Street and Crescent Avenue is busy.
- Forest Lawn Cemetery has an access gate onto Crescent Avenue (adjacent to Moody Creek) that is used frequently. Prior to construction, MWD should meet with Forest Lawn to discuss any impacts to this access point and the cemetery. The main entrance to the cemetery is off of Lincoln Avenue.

City of Fullerton

- The City would like for MWD to establish guidelines related to traffic and detour management.
- Working daytime hours in the City are 7am to 4pm.
- Will need to do nighttime work through major intersections (i.e., Harbor & Orangethorpe). The Harbor intersection will be the biggest issue for this alignment.
- The City can give us as-built drawings of Orangethorpe as well as Orange County pipeline drawings. Contact Brian K.

L.A. County

- MWD should try to stay away from using bicycle and other multi-use trails. The public may protest our use of these trails.

City of La Palma

- The City uses MUTCD standards for traffic control. Generally one lane must remain open in each direction. A preliminary traffic control plan should be submitted with MWD's construction plans.
- There is no paving currently planned for Walker Street or Crescent Avenue. They will start slurry seal in 2 years. La Palma Avenue will have grind/overlay completed this summer.
- There are no specific City ordinances regarding pipeline construction.
- Walker Street has less traffic than Moody Street. It operates as a collector street and has less traffic than streets to the east as well (i.e., Valley View Street and Knott Avenue).

2 ROADWAYS AND INTERSECTIONS

2A Roadways

2A.1 Roadway Designation and Definitions. All public streets and highways are sorted within three general classes, or functional classifications, established by the Federal Highway Administration (FHWA) and the American Association of State Highway Transportation Officials (AASHTO). They are as follows:

- *Arterials*. Provide the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.
- *Collectors*. Provide a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials.
- *Local roads*. Consist of all streets not defined as arterials or collectors; primarily provides access to land with the least amount of mobility (lower travel speeds, narrower streets, fewer lanes, more driveways, etc.).

The roadway functional classifications are based on the character of traffic service that they are intended to provide and the degree of land access that they allow. Therefore, the degree to which a project roadway segment will be limited or closed off to public use during construction will largely depend on its functional classification, since this represents how the roadway is currently being used and whether or not lane closures are feasible or will be acceptable to the local governing agency.

Due to the diverse combinations of land use patterns, street access, local roadway standards, and individual public interests, local municipalities in Southern California often use functional classifications in their General Plans which do not align verbatim with the FHWA's above three-tiered system. Oftentimes, roadway type designations may not even correlate over jurisdictional boundaries. Generally speaking, however, the FHWA's functional classes are consistent with the urban context of Los Angeles and Orange Counties where the project will be constructed, and can be represented as:

- ***Arterials***
  - ***Principal Arterials*** (Interstates, Freeways, Expressways, and major conventional highways) carry the large majority of through movements wishing to bypass the central city of an urban area. Although there are no Principal Arterials along which the project will be constructed, there are several base and alternative alignments which would cross underneath Principal Arterials at a handful of locations, including across Interstates (I-) 5, 10, 105, and 605, and State Routes (SR-) 91 and 57.
  - In the local context of Los Angeles and Orange Counties, FHWA's ***Minor Arterials*** classification is represented by what many cities separate into individual categories termed "Major Arterials" and "Primary Arterials". These facilities serve as multi-lane divided highways providing cars, trucks and buses with a high degree of intercity travel, as well as direct access to Principal Arterial facilities. In fully developed areas minor arterials are usually spaced at about 1 mile apart; however, they may be spaced more closely within central business districts and further apart (up to 2-3 miles) in suburban fringes.

- ***Collector Streets*** in the project area are represented by local jurisdictions by the "Collector" and "Secondary Arterial" (intermediary roadways between collectors and major arterials) functional classifications, and are most often found to be two-lane divided highways or four-lane highways both divided and undivided, providing a mix of intercity and intracity travel with simultaneous access to adjacent land uses.

- ***Local Streets*** are comprised of all other functionally unclassified roadways which provide direct access to abutting land and access to the above higher service facilities. Within the project limits these are generally undivided, two-lane streets in residential neighborhoods, often with curbside width for on-street parking. Service to through-traffic movements is usually deliberately discouraged, and bus routes are usually not located on local streets.

From a temporary traffic control standpoint, in terms of mobility impacts and costs, local agencies will generally not permit Principal or Minor Arterials to be fully closed at any time. With proper mitigation and traffic detours, cities may possibly grant the full closure of certain collector roads and local streets during their off-peak usage periods, with seasonal/day-of-week/time-of-day factors considered. However, this will require that MWD address the long-term impacts associated with the affected residents and businesses for whom direct vehicular access from the public right-of-way would be restricted during construction.

2A.2 Roadway Map and List. A map of the RRWSP Preferred Alignment is shown on ***Figure 1.*** A list of the project segments located on public roadways where temporary traffic control will be required is provided under ***Attachment 1A***. A truncated list of project segments composed of the current preferred alternative project routing is provided under ***Attachment 1B***.

2A.3 Roadway Traffic Control Types and Descriptions. Minagar & Associates, Inc. developed four basic traffic control configurations which might be used for pipeline construction along open roadway segments. Traffic control set-ups along the roadway would fall under one of the following basic conditions along the highway:

- **TC Configuration #1 (two-way traffic, both sides of work zone)**
  - Interior lanes closure for all roadways ≥ 60' wide
  - Pipeline along center of the street, or offset from street centerline with at least 12' available on both sides of the work zone.

- **TC Configuration #2 (two-way traffic, one side of work zone)**
  - Closure of one side for all roadways ≥ 60' wide
  - Pipeline offset from street centerline with ≥ 24' available on one side of the work zone.

- **TC Configuration #3 (one traffic lane alongside the work zone)**
  - Closure of one side for all roadways 48-60' wide
  - Pipeline offset from street centerline with < 24' available on one side of the work zone.

- Depending on the needs and requirements of the local agency, the traffic control configuration may include: (1) two-way traffic alternating back and forth on one lane with the use of flagmen; (2) temporary restriction of the segment to one-way traffic with the implementation of detour routes for the closed direction; or (3) a combination of flagmen and/or detouring during designated hours of the day.
- Depending on the traffic volume and capacity of the street in question, the implementation of one-way restrictions with detours or the use flagmen to manage two-way traffic on one travel lane would be feasible on all streets; however, the configuration will likely be limited to Collectors and Local Streets. In the case of collector roads, many local agencies will typically not allow peak traffic flows (e.g., 7:00-9:00AM and 4:00-6:00PM) to be obstructed in this way, and thus may be more amenable to nighttime work where one open lane of traffic is desirable.

- **TC Configuration #4 (closed to through traffic)**—full street closure for local roads and city-approved collector streets
  - Available lane width for through traffic outside of the work zone < 12' on both side of the construction area.

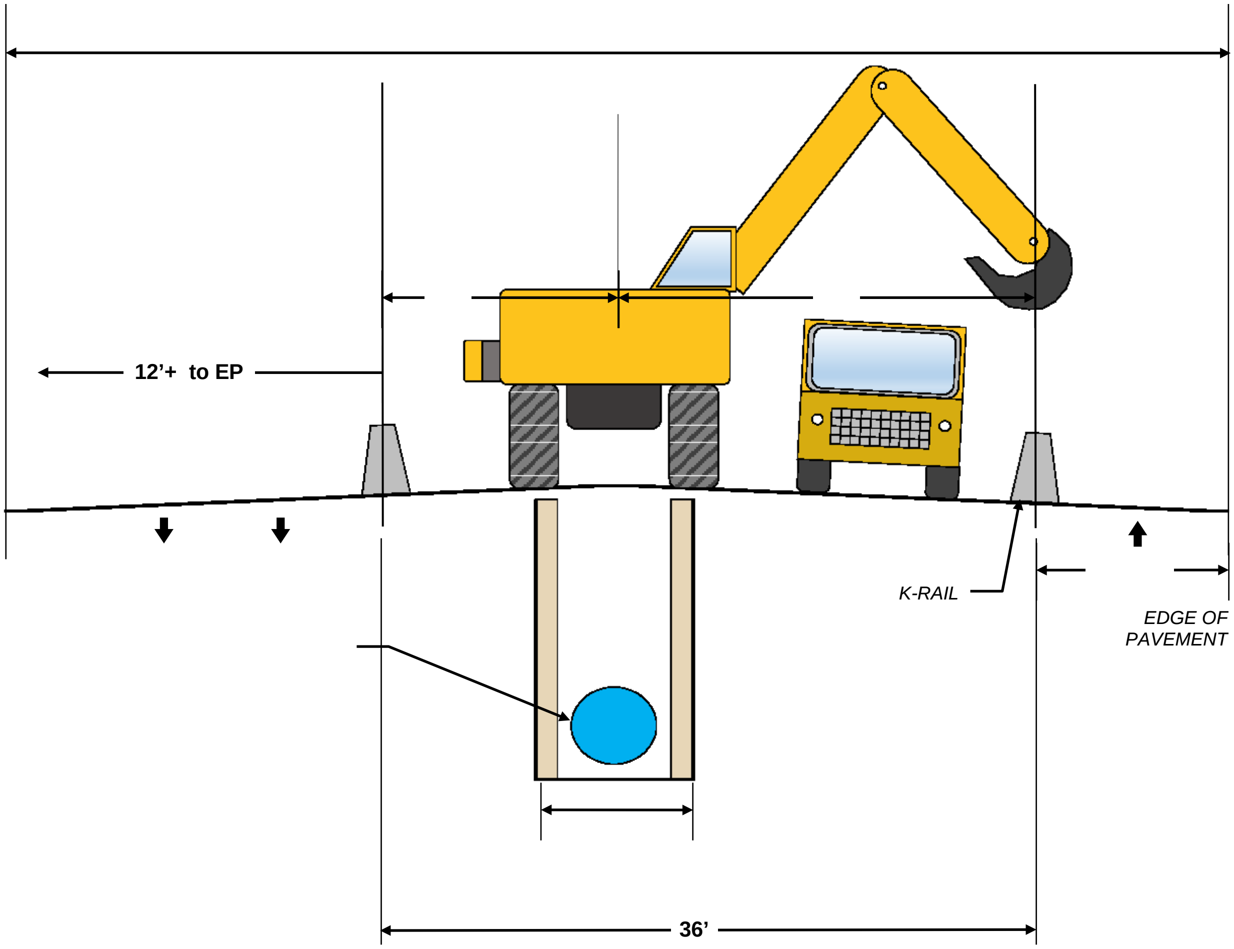
Conceptual layouts of the above generalized traffic control patterns are shown in the diagrams below. Where the project alignment crosses a freeway, at-grade railroad or storm water/flood control channel, the construction method will be trenchless with launching/receiving pits located 25 feet from the controlling jurisdiction's right-of-way line.

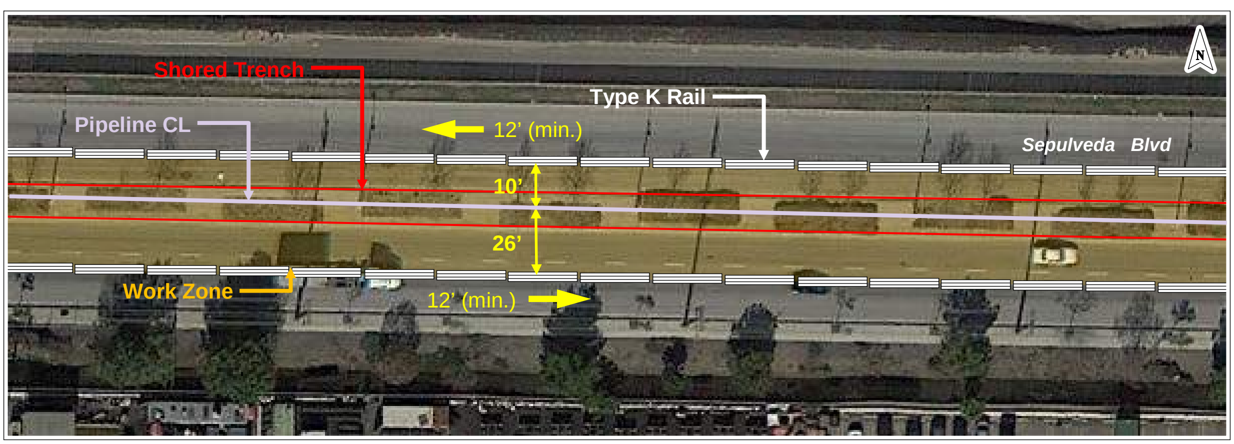
Based on Minagar & Associates, Inc.'s assessment of the Preferred Alignment, there is one (1) roadway segment which would potentially require full-roadway closure (TC Configuration #4) and detour-based temporary traffic control while construction is underway. The segment is described as follows:

- <u>52 – Rivergrade Road between Lower Azusa and Brooks (0.41-mile segment)</u>
  - Cities of Irwindale and Baldwin Park – *Local Street*
  - 32-foot wide, 2-lane street, no median
  - Adjacent land use: Industrial (auto and boating service centers)

Traffic Control Configuration #1 (two-way traffic, both sides)

Interior lanes closure for arterials ≥ 60' wide. Pipeline alignment is located along the center of the street, or is offset from the street centerline with ≥ 12 feet available on both sides of the work zone.



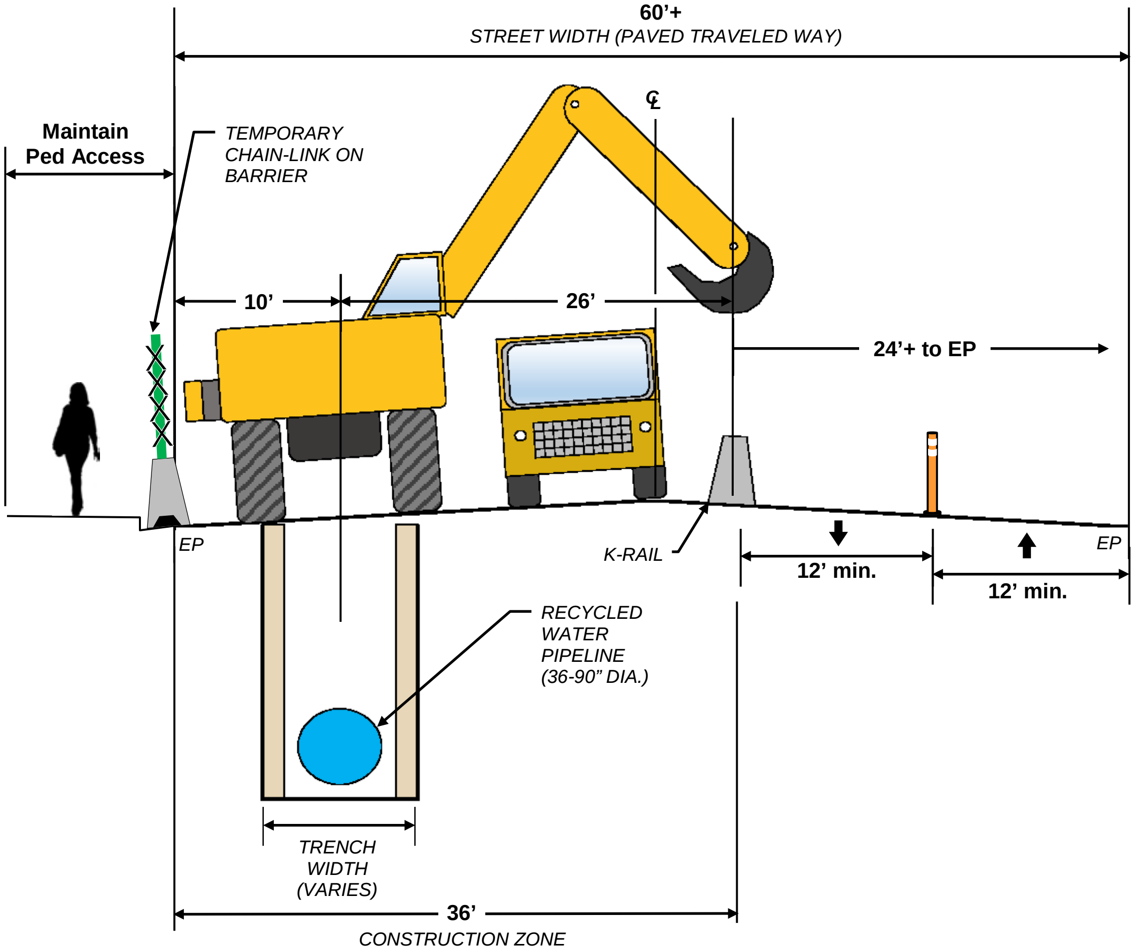


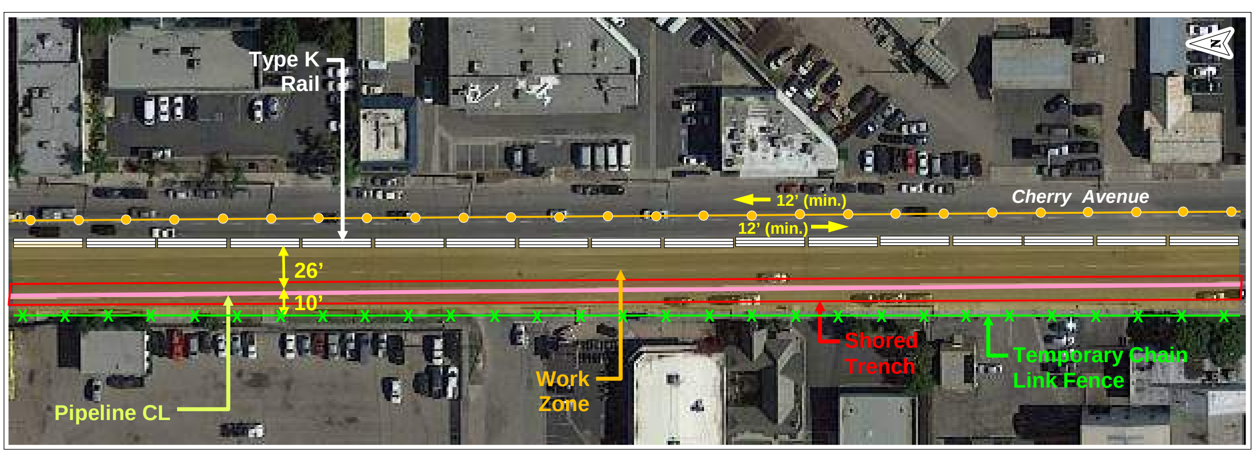
Traffic Control Configuration #1 (Plan View) **– Two-way traffic, both sides of work zone**

Traffic Control Configuration #2 (two-way traffic, one side)

Closure of one side for all roadways ≥ 60' wide

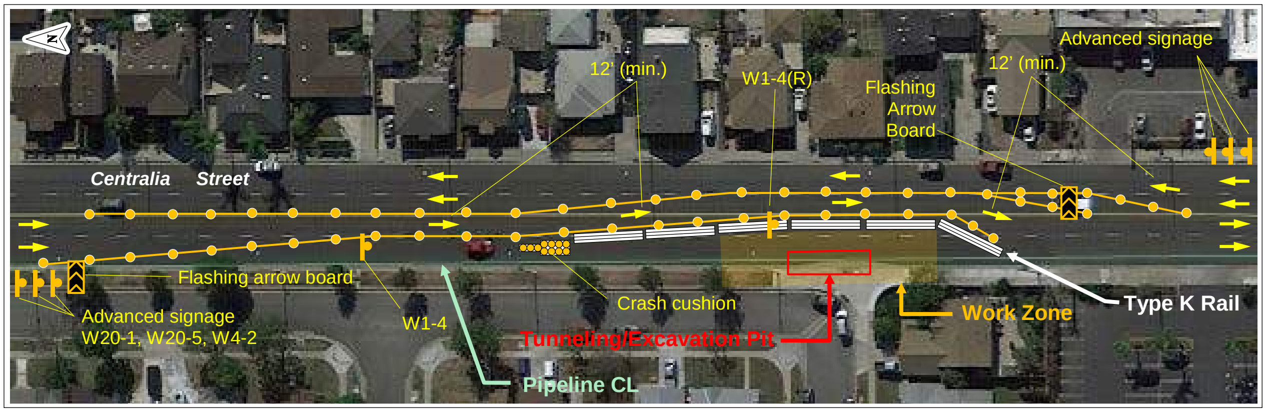
Pipeline offset from street centerline with ≥ 24' available on one side of the work zone





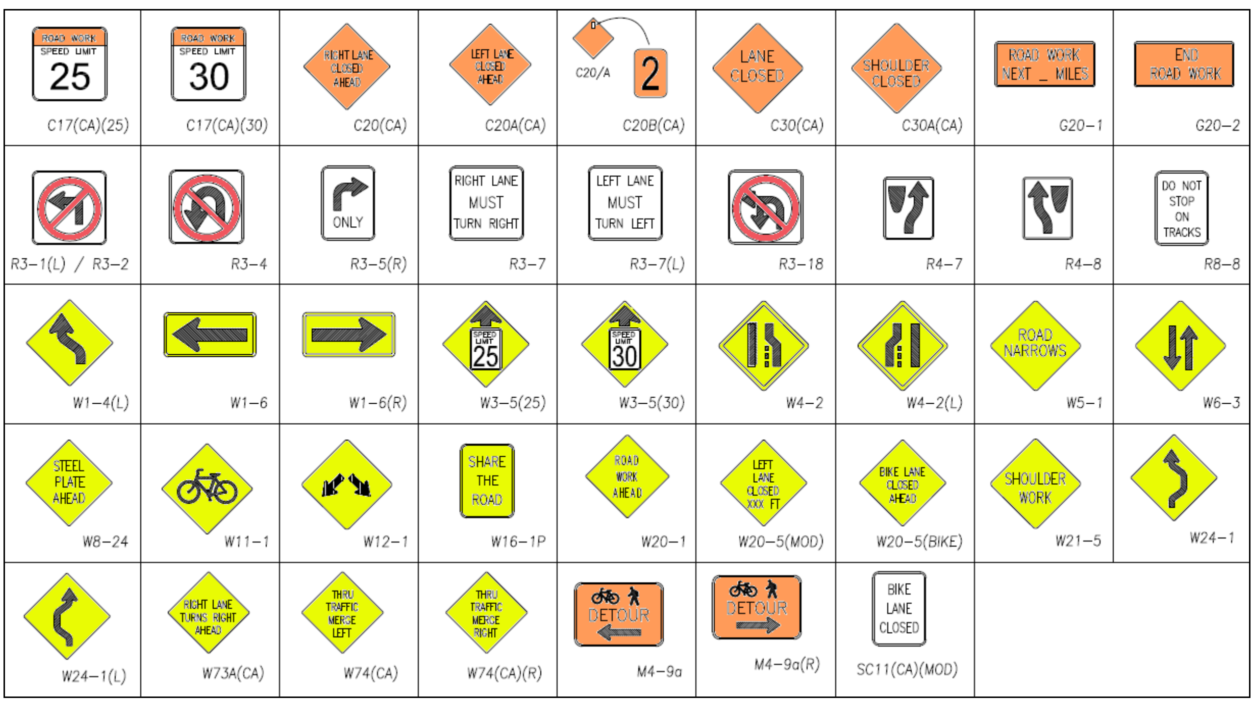
Traffic Control Configuration #2 (Plan View)

Two-way traffic, one side of work zone



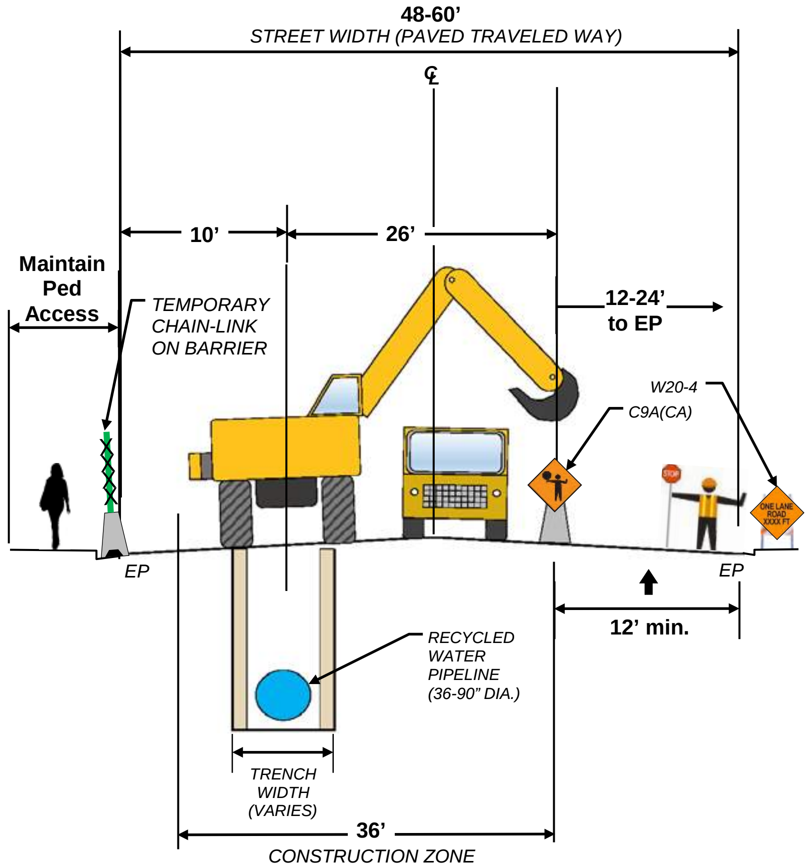
Traffic Control Configuration #2 (Alternative Pattern)
Transition to half roadway closure with lane merge

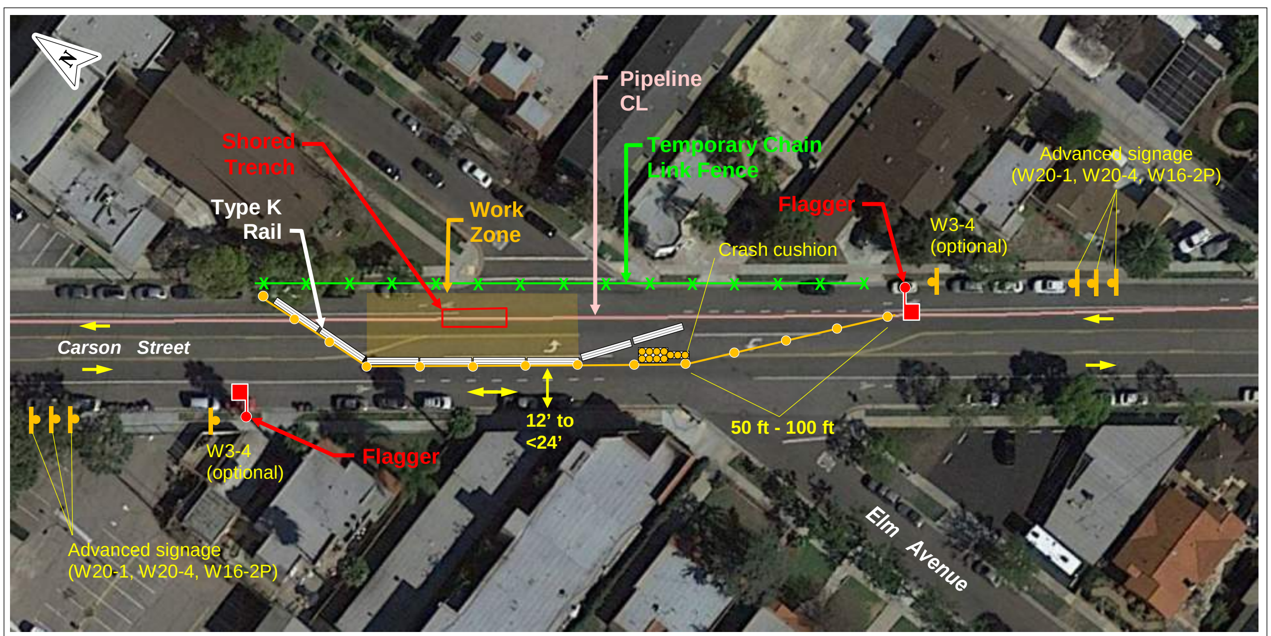
The sign chart below is based on the latest California MUTCD and depicts the typical temporary traffic control/work zone signage which would be used for the proposed project construction along both roadway segments and at intersections.



Traffic Control Configuration #3 (one-way traffic alongside work work)

Closure of one side for all roadways 48-60' wide. Pipeline offset from street centerline with < 24' available on one side of the work zone. Implement one-way closure with detour or two-way flagger station (shown below)

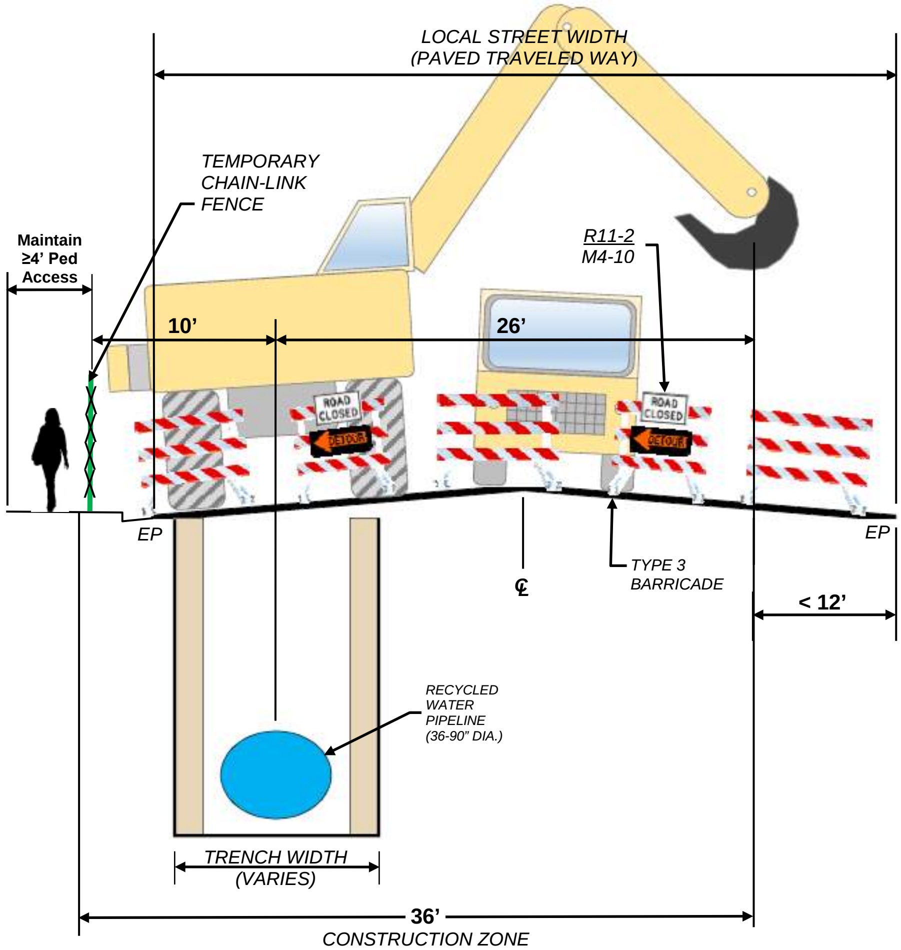




Traffic Control Configuration #4 (closed to through traffic)

Full street closure for local roads and city-approved collector streets.

Available lane width for through traffic outside of the work zone < 12' on both sides of the construction area



2A.4 Roadway Traffic Control Cost Estimate. Minagar & Associates, Inc. developed four basic temporary traffic control cost estimates to correspond to each of the above four configurations. Cost estimates were developed using a method-based specification based on the types of devices which might to be used (signs, barricades, channelizing devices, etc.), their locations and quantities in advance of and through the work zone construction area.

TC Configuration #1 Cost Estimate (two-way traffic, both sides of work zone):

- 600' work zone @ 25 mph reduced speed
  - Direction 1 Transition: 125' Right Merge
  - Assumed 750' two-way TTC transition zone (not including advanced signage)
- Traffic Control Quantities:
  - K-Rail, Direction 1: (600 LF) / (20 ft per railing) = 30 ct Type K Rail
  - K-Rail, Direction 2: (600 LF) / (20 ft per railing) = 30 ct Type K Rail

- Construction Signs: 10 ct (approx..)
- Temporary Crash Cushions (unidirectional): 2 ct
- Flashing Arrow Boards: 2 ct
- If far-side lane width ≥ 24 ft, add: 1,000 LF remove lane striping and install temporary lane markings

- TTC Cost Estimate:
  - **$64,100 per 750 ft. "rolling work zone"**
    + $8/LF temporary lane marking removals/installations (2-way)

TC Configuration #2 Cost Estimate (two-way traffic, one side of work zone):

- 600' work zone @ 25 mph reduced speed
  - Direction 1 Transition: 125' Merge + 100' Tangent + 63' Shift + 100' Tangent + 63' Shift = 451'
  - Direction 2 Transition: 125' Right Merge
  - Assumed 1,200' two-way TTC transition zone (not including advanced signage)
- Traffic Control Quantities:
  - K-Rail, Direction 1: (600 LF) / (20' ft per railing) = 30 ct Type K Rail
  - Install temporary chain link fence: 600 LF
  - Construction Signs: 10 ct (approx..)
  - Temporary Crash Cushions (unidirectional): 1 ct
  - Flashing Arrow Boards: 2 ct
  - Remove lane striping: 1,000 LF
  - Install delineators: [(1,000 LF)/(20 ft spacing)] x 2 rows = 100 delineators
- TTC Cost Estimate:
  - **$63,800 per 1,200 ft. "rolling work zone"**
    + $8/LF temporary lane marking removals/installations (2-way)

TC Configuration #3 (one traffic lane alongside the work zone)

- 600' work zone @ 25 mph reduced speed
  - Direction 1 Transition: 125' Merge
  - Direction 2 Transition: 63' Shift
  - Assumed 800' two-way TTC transition zone (not including advanced signage)
- Traffic Control Quantities:
  - K-Rail, Direction 1: (600 LF) / (20' ft per railing) = 30 ct Type K Rail
  - Install temporary chain link fence: 600 LF
  - Construction Signs: 10 ct (approx..)
  - Temporary Crash Cushions (unidirectional): 1 ct
  - Remove lane striping: 1,000 LF
  - Flagger: 2 ct
- TTC Cost Estimate:
  - **$65,380 per 800 ft. "rolling work zone"**

TC Configuration #4 (closed to through traffic)

- Traffic Control Quantities:
  - Install temporary chain link fence: (Length of segment, LF)

  - Type III Barricade (4-8'): 20 ct
  - Construction Signs: 20 ct (approx..)
  - Detour Signs: 10 ct (approx..)
  - Traffic Signal Modification: (Varies)
  - Modify lane striping at signal: (Varies)
- TTC Cost Estimate:
  - **$1,200 per street closure +**
    + $4/LF temporary chain link fence
    + traffic signal modification (if needed, per Attachment 2)

Per-segment cost estimates are provided in Attachments 1A and 1B. It should be noted that the temporary traffic control costs are independent from one another and should not be considered cumulatively. All segments will not be under construction simultaneously, nor are they expected to be completed by the same contractor; thus, traffic control cost estimates will be affected by lump sum bids and varying mobilization costs, depending on the scope of each contract.

2B Intersections

2B.1 Intersection Designation and Definitions. Minagar & Associates, Inc. has identified, listed and described all of the signalized intersections through which the proposed pipeline alignments, segments and alternatives, would cross. The proposed construction method for each signalized intersection (either Open Trench or Tunnel) was considered by weighing the degree to which local and sub-regional traffic would be affected with other factors such as jurisdictional requirements and the potential for various underground and/or overhead utilities within the intersection. With open trenching methods, the crossing street perpendicular to the project alignment would be closed to through traffic at the intersection since the work zone would continue through the intersection in both directions upstream and downstream.

In general, where the project alignment crosses a multi-lane arterial highway or major collector roadway at an intersection, and/or provides protected left-turn signal phasing on all four intersection approaches, is a designated regional truck route, or serves multiple municipal fixed bus routes, Minagar & Associates, Inc. has considered the intersection to be a "Major Intersection". Conversely, where the project alignment intersects a cross street at a signalized intersection that operates on a two-phase signal, is not a designated truck route, or does not serve local bus routes, Minagar has considered the intersection to be a "Minor Intersection".

For the majority of major signalized intersections, it is recommended that standard trenching methods be used in the absence of any known jurisdictional requirements prohibiting it (e.g., railroad tracks, rivers, bridges, Caltrans facilities). Open trenching construction would likely occur at a much slower rate across these intersections and more significantly impact vehicle traffic and mobility. For all minor signalized intersections listed, shored trenching methods would be allowed with the concurrence of the local agency, to permit closing of the intersection to through traffic on the crossing street while the intersection is under construction.

2B.2 Intersection List. A list of the signalized intersections through which project alignment will traverse, and require temporary traffic control, is provided under ***Attachment 2A***. The list of Perferred Alignment signalized intersections also includes a probable cost to implement the proposed traffic control method. A truncated list of impacted signalized intersections along the current preferred alternative project routing is provided under ***Attachment 2B***.

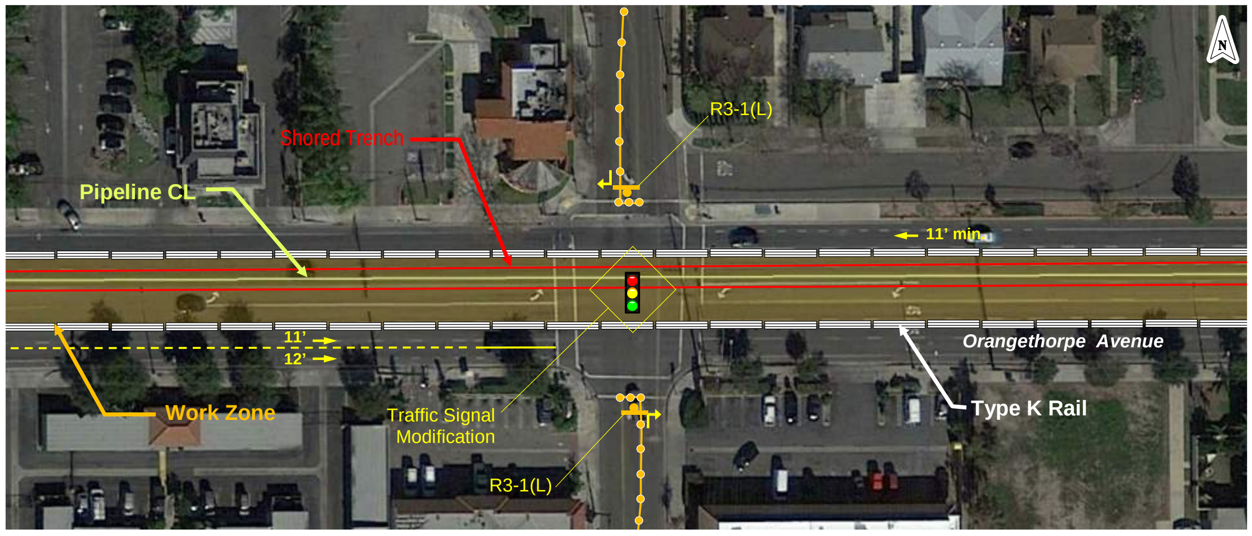
2B.3 Intersection Traffic Control Types and Descriptions. At roadway intersections, the traffic control configuration would be set-up as one of two general variations:

- For tunneling, at major intersections (**TC Configuration #5**)
- For intersection half-closure set-up (**TC Configuration #6**)

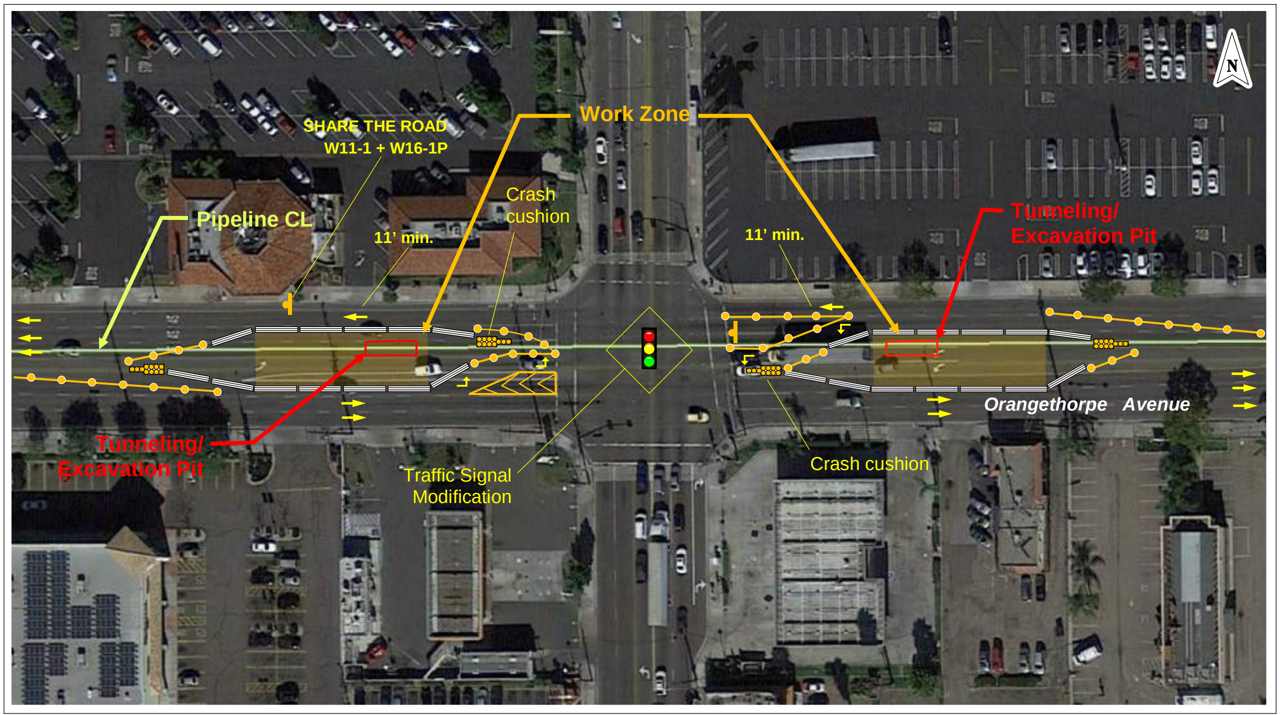
Conceptual layouts of the above generalized traffic control patterns are shown in the figures below. For shored trench methods, jersey barriers of K-Rail (Caltrans type) would be used along both sides of the work zone in parallel with the pipeline alignment through the intersection. Traffic movements approaching the construction site from side streets at the intersection would be prohibited from crossing the street or turning left.

Such movements would be directed to make Right Turns Only with appropriate detour signage installed as needed downstream from the intersection. In addition, manual traffic signal timing and/or detector setting modifications would be implemented at each signalized intersection to ensure that proper signal operations are maintained during the construction period.

For trenchless (tunneling) construction methods, the intersection would be kept clear for traffic to pass in each direction. On the primary street where the pipeline is being constructed, the work zone width would taper off on one side as it approaches the crosswalk or limit line at each signalized intersection to provide the needed space for left turns onto the crossing street. On streets where there are marked bike lanes which must be narrowed or temporarily overtaken for the use of vehicle traffic, the traffic control plan will include appropriate warning signage notifying vehicles to share the roadway space with bicyclists.

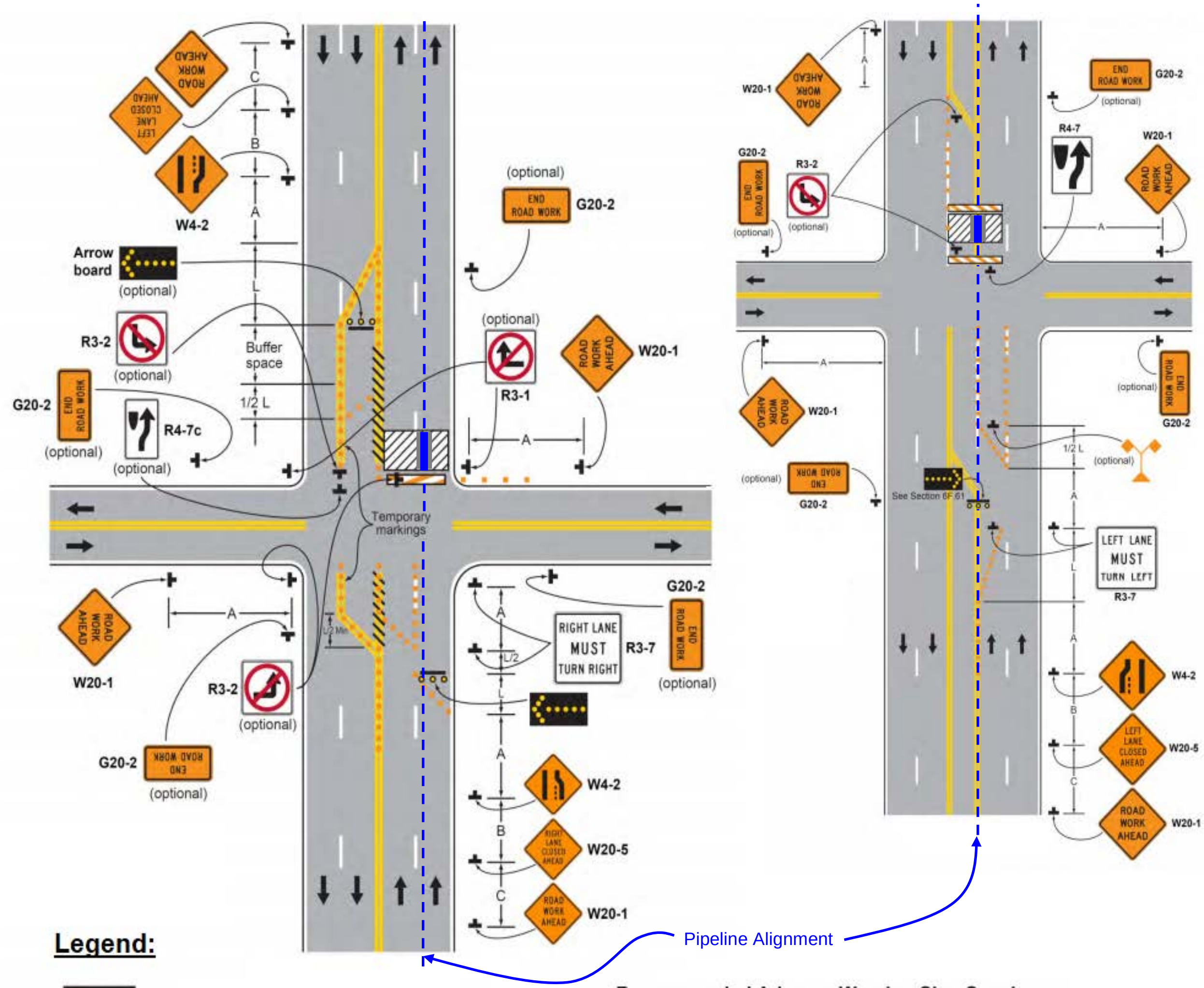


Traffic Control Configuration #5 – **Half Signalized Intersection Closure (Open Trench Construction)**



Traffic Control Configuration #6 – **Interior Lanes Closure at Signalized Intersection (Trenchless Construction)**

Typical Applications for Trenching at Major Intersections
Multiple Lane Closures at an Intersection (Left) &
Half Road Closure, Far Side of the Intersection (Right)



Legend:

Recommended Advance Warning Sign Spacing

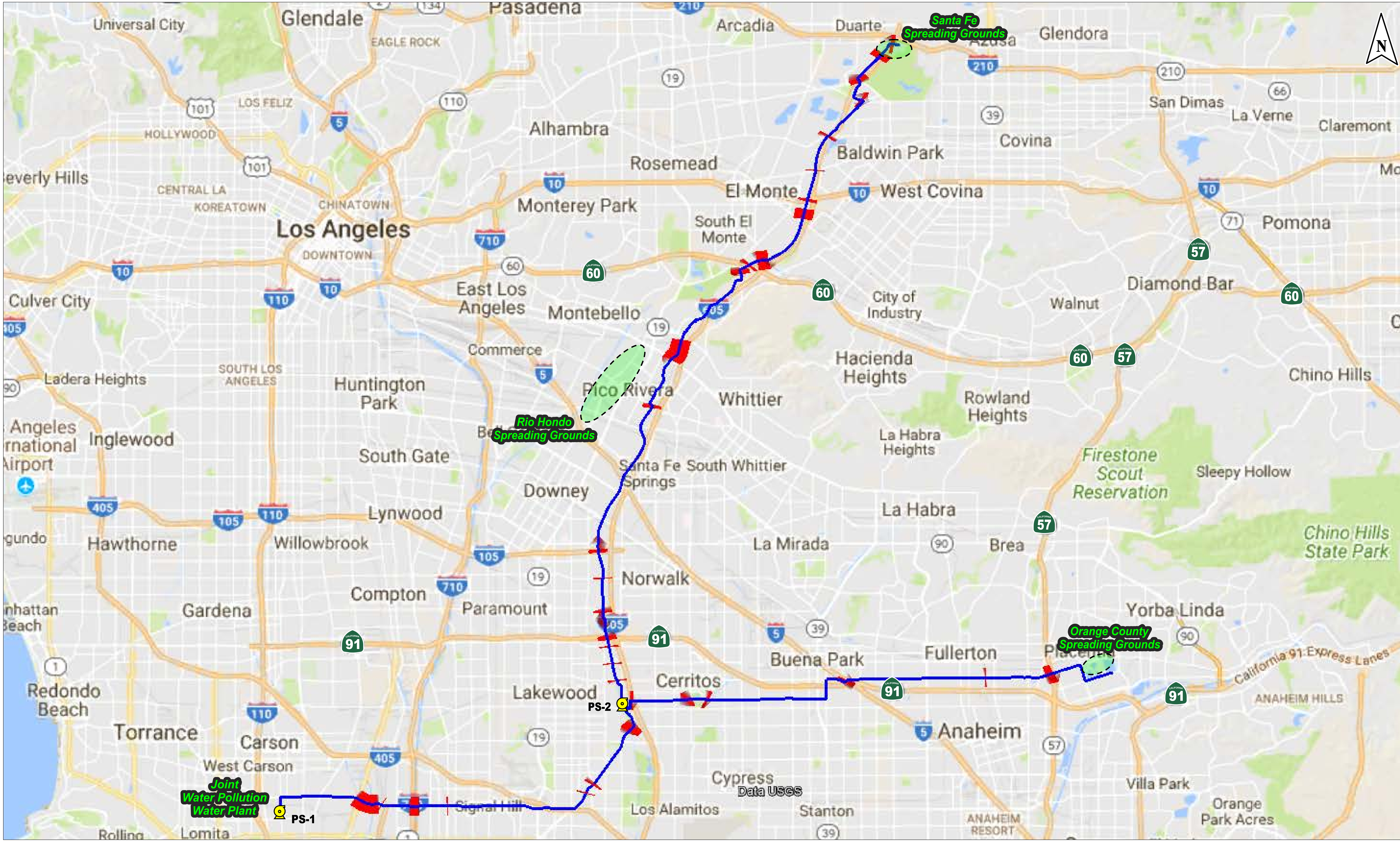
Road Type	Distance Between Signs**		
	A	B	C
Urban 25 mph or less***	100 feet	100 feet	100 feet
Urban - more than 25 mph to 40 mph***	250 feet	250 feet	250 feet
Urban - more than 40 mph***	350 feet	350 feet	350 feet
Rural	500 feet	500 feet	500 feet
Expressway / Freeway	1,000 feet	1,500 feet	2,640 feet

*** Posted speed limit, off-peak 85th-percentile speed prior to work starting, or other anticipated operating speed in mph.

Taper Length

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$

Where: L = taper length in feet
W = width of offset in feet
S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph


N
Santa Fe
Spreading Grounds
Rio Hondo
Spreading Grounds
Orange County
Spreading Grounds
Joint
Water Pollution
Water Plant
PS-1
PS-2
Data USGS

Preliminary Traffic Control Assessment for the Metropolitan Water District of Southern California's Potential Regional Recycled Water Supply Program (RRWSP) Feasibility Studies

ATTACHMENT 1B. Traffic Control Assessment for Public Highway Segments Along Preferred Alignment - as of 8/10/18

Key:	Roadway Segment				
Alignmt No.	Length (miles)			Length (feet)	
	N Lanes	RM	W	Pipe CL	LW_{AVAIL}

RM: Width of existing raised/curbed center median (value=0 if no raised median exists, or is flush with the pavement)
W: Width of the traveled way (between edge of pavements)
PIPE CL: Offset of proposed RRWSP pipeline centerline with respect to the nearest edge-of-pavement
LW_{AVAIL}: Roadway width available o/s of work zone for 2-way traffic (near-side curb || far-side curb), including any raised median

Color key:
- Recommend minor alignment modification to allow for two (2), 12-foot traffic lanes.
- Sufficient space for no more than one (1) 12-foot traffic lane.
- Candidate roadway for full street closure.

Alignmt No.	Roadway Segment	TC Config.	Cost Est	Length (miles)	Length (feet)	N Lanes	RM	W	Pipe CL	LW_{AVAIL} (near-side)	LW_{AVAIL} (far-side)
1	**Main St.**	TC-1	$75,000	0.327 miles	1,727 feet	N= 4	RM: 14'	W= 78'	26' off E.	16'	26'
1	**Sepulveda Blvd./Willow St.**	TC-2	$91,000	0.648 miles	3,421 feet	N= 4	RM: 16'	W= 80'	10' off S	0'	44'
5	**Willow St.**	TC-2	$152,000	2.09 miles	11,035 feet	N= 6	RM: 15'	W= 75'	17' off S.	7'	32'
5A	**Willow St.**	TC-2	$172,000	2.56 miles	13,517 feet	N= 6	RM: 18'	W= 89'	18' off S.	8'	45'
5A	**Los Coyotes Dia.**	TC-2	$169,000	2.5 miles	13,200 feet	N= 4	RM: 0'	W= 62'	8' off W.	-2'	28'
10A	**Los Coyotes Dia.**	TC-2	$108,000	1.04 miles	5,491 feet	N= 3	RM: 0'	W= 74'	20' off E.	10'	28'
10A	**Off-street** (under San Gabriel River)	-	-	0.133 miles	702 feet	Tunnel under SG River					
10A	**Off-street** (at Rynerson Park)	-	-	0.204 miles	1,077 feet	Trench through Rynerson Park					
10A	**Studebaker Rd.**	TC-2	$85,000	0.496 miles	2,619 feet	N= 4	RM: 0'	W= 75'	13' off E.	3'	36'
10A	**Studebaker Rd.** (off-street)	-	-	0.089 miles	470 feet	Trench through SCE easement					
10A	**Del Amo Blvd.**	TC-2	$67,000	0.082 miles	433 feet	N= 4	RM: 16'	W= 76'	13' off N.	3'	37'
10A	**State Rd.** (off-street)	-	-	0.173 miles	913 feet	Trench through Edison property					
10A	**State Rd.** (off-street)	-	-	0.051 miles	269 feet	Trench through Edison property					
17	**Stanton Ave.**	TC-3	$65,000	0.596 miles	3,147 feet	N= 4	RM: 0'	W= 60'	11' off W.	1'	23'
18	**Orangethorpe Ave.** (Stanton-Kass/I-5 Fwy.)	TC-2	$76,000	0.3 miles	1,584 feet	N= 4	RM: 0'	W= 81'	15' off S.	5'	40'
18	**(off-street)**	-	-	0.251 miles	1,325 feet	Trench between Kass Dr./I-5 Fwy.					
18	**Orangethorpe Ave.** (under I-5 Fwy.)	-	-	0.109 miles	576 feet	Tunnel under Caltrans R/W					
18	**Orangethorpe Ave.** (e/o I-5 Fwy.-Magnolia)	-	-	0.361 miles	1,906 feet	Trench through Rideshare Parking Lot					
18	**Orangethorpe Ave.** (Magnolia-57 Fwy.)	TC-1	$298,000	5.6 miles	29,568 feet	N= 6	RM: 0'	W= 77'	25' off S.	15'	26'
18	**Orangethorpe Ave.** (under SR-57 Fwy.)	-	-	0.14 miles	739 feet	Tunnel under Caltrans R/W					
18	**Orangethorpe Ave.** (57 Fwy.-Kraemer)	TC-2	$99,000	0.826 miles	4,361 feet	N= 4	RM: 0'	W= 61'	11' off S.	1'	24'
18	**Kraemer Blvd.**	TC-2	$85,000	0.5 miles	2,640 feet	N= 4	RM: 0'	W= 82'	20' off W.	10'	36'
18	**Miraloma Ave.**	TC-3	$65,000	0.844 miles	4,456 feet	N= 4	RM: 0'	W= 60'	16' off S.	6'	18'
20	**Studebaker Rd.** (Del Amo-195th)	TC-2	$85,000	0.493 miles	2,603 feet	N= 4	RM: 14'	W= 77'	19' off W.	9'	32'
20	**Studebaker Rd.** (195th-1,100' n'ly)	TC-2	$102,000	0.9 miles	4,752 feet	N= 4	RM: 15'	W= 76'	9' off W.	-1'	41'
20	**SG River** (Liberty Park - Firestone Blvd.)	-	-	5.517 miles	29,130 feet	*Segments 20.2-20.9, 20.15 and 20.11-20.14*					
38	**Whittier Blvd.**	TC-2	$81,000	0.417 miles	2,202 feet	N= 6	RM: 17'	W= 80'	14' off N.	4'	40'
38	**Durfee Ave.**	TC-4	$16,000	0.682 miles	3,601 feet	N= 2	RM: 0'	W= 35'	9' off W.	-1'	0'
38	**Beverly Blvd.** (Durfee-SG River Pkwy.)	TC-2	$78,000	0.335 miles	1,769 feet	N= 6	RM: 16'	W= 74'	4' off S.	-6'	44'
38	**Beverly Blvd.** (SGR Pkwy.-E. side SG River)	TC-3	$65,000	0.095 miles	502 feet	N= 4	RM: 0'	W= 48'	5' off S.	-5'	17'
38	**SG River Pkwy.**	TC-1	$86,000	0.572 miles	3,020 feet	N= 4	RM: 16'	W= 96'	8' off W.	-2'	62'
38	**Shepard St.**	TC-4	$2,000	0.061 miles	322 feet	N= 2	RM: 0'	W= 32'	7' off E.	-3'	-1'
38	**Rose Hills Rd.**	TC-3	$65,000	0.413 miles	2,181 feet	N= 4	RM: 0'	W= 56'	16' off W.	6'	14'
38	**Workman Mill Rd./Peck Rd.**	TC-2	$107,000	1.027 miles	5,423 feet	N= 4	RM: 15'	W= 80'	18' off E.	8'	36'
38	**Pellissier Pl/Workman Mill Rd.**	TC-2	$121,000	1.345 miles	7,102 feet	N= 4	RM: 0'	W= 55'	8' off E.	-2'	21'
38	**Workman Mill Rd.**	TC-1	$130,000	1.622 miles	8,564 feet	N= 4	RM: 14'	W= 82'	24' off S.	14'	32'
38	**Puente Ave.**	TC-2	$167,000	2.439 miles	12,878 feet	N= 4	RM: 16'	W= 76'	18' off E.	8'	32'
38	**Merced Ave.**	TC-2	$136,000	1.709 miles	9,024 feet	N= 4	RM: 0'	W= 56'	9' off E.	-1'	21'

ATTACHMENT 1B. Traffic Control Assessment for Public Highway Segments Along Preferred Alignment - as of 8/10/18

Key:	Roadway Segment				
Alignmt No.	Length (miles)			Length (feet)	
	N Lanes	RM	W	Pipe CL	LW_{AVAIL}

RM: Width of existing raised/curbed center median (value=0 if no raised median exists, or is flush with the pavement)
W: Width of the traveled way (between edge of pavements)
PIPE CL: Offset of proposed RRWSP pipeline centerline with respect to the nearest edge-of-pavement
LW_{AVAIL}: Roadway width available o/s of work zone for 2-way traffic (near-side curb || far-side curb), including any raised median

Color key:
- Recommend minor alignment modification to allow for two (2), 12-foot traffic lanes.
- Sufficient space for no more than one (1) 12-foot traffic lane.
- Candidate roadway for full street closure.

Alignmt No.	Segment					
38A	**E. side SG River**					
	TC Config.	-	Cost Est	-		
	0.861 miles		4,546 feet			
	Tunnel under SG River					

Alignmt No.	Rivergrade Rd. (Lower Azusa-Brooks)						Rivergrade Rd. (Brooks-Live Oak)						Across SG River			
52/60	TC Config.	**TC-4**		Cost Est	$15,000		TC Config.	**TC-3**		Cost Est	$65,000		TC Config.	-	Cost Est	-
	0.67 miles			**3,538 feet**			0.746 miles			**3,939 feet**			0.114 miles		**602 feet**	
	N= 2	RM: 0'	W= 32'	4' off W.	**-6'**	**2'**	N= 4	RM: 0'	W= 60'	15' off E.	**5'**	**19'**	Tunnel underneath SG River			

Alignmt No.	Live Oak Ave.					
56	TC Config.	**TC-2**		Cost Est	$72,000	
	0.205 miles			**1,082 feet**		
	N= 4	RM: 15'	W= 73'	11' off N.	**1'**	**36'**

ATTACHMENT 2B. Traffic Control Cost Estimation at Signalized Intersections Along Preferred Alignment - as of 8/10/18

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)		
1	25,064	4.75	**Main Street**	S	1,650' s/o Sepulveda	N	Sepulveda Blvd.	Carson	Los Angeles	Long Beach
			Sepulveda Bl./Willow St.	W	Main St.	E	E. side L.A. River			

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Prop. Constr. Method: Open Trench	Prop. Constr. Method: Tunnel	Probable TTC Cost
Rdwy Seg	Main - 1,650' s/o Sepulveda to Sepulveda	84' (34'/dir) Major Highway	2 lanes/direction + raised median	No	No	CMP- No			
Intersection	Sepulveda Blvd. @ Main St. (alignment turn)	4 Protected LT Signals; TT Bus Stops @ WNW, **SSW** & **ESE** Corners					1		$78,500
Rdwy Seg	Sepulveda/Willow - Main to L.A. River	84' (32-34'/dir) Maj. Hwy (CAR)/Boulevard(LB)	2 lanes/direction + raised median	Yes	No	CMP-No Truck-Yes			
Intersection	Sepulveda Blvd. @ Dolores St.	2 Protected-Permissive LT Signals; TT Bus Stop @ **ESE** Corner					1		$78,500
Intersection	Sepulveda Blvd. @ Marbella Ave.	T-Intersection; Protected LT Phase on Sepulveda					1		$78,500
Intersection	Sepulveda Blvd. @ Panama Ave.	2-Phase Signal; TT Bus Stops @ **WNW** & ESE Corners					1		$78,500
Intersection	Sepulveda Blvd. @ Avalon Blvd.	4 Protected LT Signals; MTA Bus Stop @ NNW Corner; TT Bus Stop @ **WSW** Corner					1		$78,500
Intersection	Sepulveda Blvd. @ Banning Blvd.	2-Phase Signal					1		$78,500
Intersection	Sepulveda Blvd. @ Wilmington Ave.	4 Protected LT Signals					1		$78,500
Intersection	Sepulveda Blvd. @ Tesoro/Phillips 66	2-Phase Signal					1		$78,500
Intersection	Sepulveda Blvd. @ Alameda Connector	2 Protected LT Signals on Sepulveda; Split phasing on Alameda St. connector					1		$78,500
Intersection	Sepulveda Blvd. @ Intermodal Wy.	2 Protected LT Signals					1		$78,500
Intersection	Sepulveda Blvd. @ R/R Xing	R/R Signal					1		$78,500
Intersection	Sepulveda Blvd. @ ICTF	4 Protected LT Signals						1	$12,500
Intersection	Sepulveda Blvd. @ Middle Rd.	2 Protected LT Signals					1		$78,500
Intersection	Sepulveda Blvd. @ CA-103 terminus	Freeway On/Off-Ramp; 3 Protected LT Signals and RT Overlaps					1		$78,500
Intersection	Sepulveda Blvd. @ Regway Ave.	2-Phase Signal					1		$78,500
Intersection	Sepulveda Blvd. @ Santa Fe Ave.	4 Protected LT Signals; LBT Bus Stops @ SSW & NNE Corners					1		$78,500
Intersection	Sepulveda Blvd. @ Easy Ave.	2-Phase Signal; LBT Bus Stops @ NNE, **WNW**, **ESE** & SSW Corners					1		$78,500
						TOTALS:	16	1	$1,268,500

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)	
5	11,010	2.09	**Willow Street**	W	E. side L.A. River	E	Cherry Ave.	Long Beach	Signal Hill

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Prop. Constr. Method: Open Trench	Prop. Constr. Method: Tunnel	Probable TTC Cost
Rdwy Seg	Willow - L.A. River to Cherry Ave.	76-80' (32-36'/dir) Boulevard	4-6 lanes/direction + raised median	No	No	CMP-No Truck-Yes			
Intersection	Willow @ Golden Ave.	2-Phase Signal; LBT Bus Stop east of **ENE** Corner					1		$78,500
Intersection	Willow @ Magnolia Ave.	1 Protected LT Signal; LBT Bus Stop @ NNE Corner					1		$78,500
Intersection	Willow @ Pacific Ave.	2 Protected LT Signals; LBT Bus Stop @ NNE & **ESE** Corners					1		$78,500
Intersection	Willow @ Earl Ave.	2 Protected LT Signals					1		$78,500
Intersection	Willow @ Long Beach Blvd.	4 Protected LT Signals; MTA Blue Line runs N/S through the intersection; LBT Bus Stop @ NNE, **WNW** & WSW Corners						1	$12,500
Intersection	Willow @ Atlantic Ave.	4 Protected LT Signals; LBT Bus Stops @ **WNW**, SSW & NNE Corners					1		$78,500
Intersection	Willow @ California Ave.	2-Phase Signal; LBT Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Willow @ Orange Ave.	4 Protected LT Signals; LBT Bus Stops @ **WNW** & **WSW** Corners					1		$78,500
Intersection	Willow @ Walnut Ave.	2 Protected LT Signals; LBT Bus Stops @ **WNW** Corner					1		$78,500
Intersection	Willow @ Town Center	2 Protected LT Signals; LBT Bus Stop @ **WSW** Corner					1		$78,500
Intersection	Willow @ Cherry Ave. (alignment turn)	4 Protected LT Signals; LBT Bus Stops @ **WNW**, NNE and ESE Corners						1	$12,500
						TOTALS:	9	2	$731,500

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)		
5A	26,728	5.06	**E. Willow Street**	W	Cherry Ave.	E	Los Coyotes Diagonal	Signal Hill	Long Beach	Lakewood
			Los Coyotes Diagonal	S	E. Willow St.	N	Carson St.			

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Prop. Constr. Method: Open Trench	Prop. Constr. Method: Tunnel	Probable TTC Cost
Rdwy Seg	E. Willow - Cherry Ave. to Los Coyotes Diagonal	98' (36'/dir)	3/direction + raised median	No	No				
Intersection	E. Willow @ Cherry Ave. — ***continued from 5***	4 Protected LT Signals; LBT Bus Stops @ WNW, **NNE** and **ESE** Corners					1		$78,500
Intersection	E. Willow @ Dawson Ave. / Town Center E.	2 Protected LT Signals on Willow					1		$78,500
Intersection	E. Willow @ Junipero Avenue	2 Protected LT Signals on Willow; LBT Bus Stops @ **WNW** and **ESE** Corners					1		$78,500
Intersection	E. Willow @ Temple Avenue	2-phase Signal; LBT Bus Stops @ **WNW** and **ESE** Corners					1		$78,500
Intersection	E. Willow @ Redondo Avenue	4 Protected LT Signals; LBT Bus Stops @ NNE, **ENE** and **ESE** Corners					1		$78,500
Intersection	E. Willow @ Grand Avenue	2 Protected LT Signals on Willow; LBT Bus Stop @ **WNW** Corner					1		$78,500
Intersection	E. Willow @ Lakewood Boulevard	4 Protected LT Signals; LBT Bus Stops @ NNE, **WNW**, **ESE** and SSW Corners					1		$78,500
Intersection	E. Willow @ Clark Avenue	4 Protected LT Signals; LBT Bus Stop @ NNE Corner					1		$78,500
Intersection	E. Willow @ Bellflower Boulevard	4 Protected LT Signals					1		$78,500
Intersection	E. Willow @ N. Los Coyotes Diagonal (alignment turn)	2 Protected LT Signals on Willow; LBT Bus Stop @ ENE Corner					1		$78,500
Rdwy Seg	Los Coyotes Dia. - E. Willow to Carson	74-88' (32-36'/dir.)	2 lanes/dir + TWLTL	Spring-P.Verde	Yes				
Intersection	Los Coyotes Dia. @ Spring St.	2 Protected LT Signals on Los Coyotes; LBT Bus Stop @ ENE Corner					1		$78,500
Intersection	Los Coyotes Dia. @ Woodruff Ave.	2 Protected LT Signals on Los Coyotes; LBT bus stop @ WNW Corner					1		$78,500

ATTACHMENT 2B. Traffic Control Cost Estimation at Signalized Intersections Along Preferred Alignment - as of 8/10/18

Facility	Location	Roadway or Intersection Description	Open Trench	Tunnel	Probable TTC Cost
Intersection	Los Coyotes Dia. @ Wardlow Rd.	2-phase Signal	1		$78,500
Intersection	Los Coyotes Dia. @ Palo Verde Ave.	2-phase Signal; LBT Bus Stops @ NNE and SSW Corners (on Palo Verde)	1		$78,500
Intersection	Los Coyotes Dia. @ Studebaker Rd. / Parkcrest St.	Combined signal at "Y" Junction; LBT Bus Stop @ **NE** Corner	1		$78,500
Intersection	Los Coyotes Dia. @ Carson St. — ***continues to 10A.1(a)***	2 Protected LT Signals on Carson; LBT Bus Stops @ ESE Corner	1		$78,500
		TOTALS:	**16**	**0**	**$1,256,000**

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)	
10A	13,111	2.48	**10A.1(a) - Los Coyotes Dia.**	S	Carson St.	N	E. of San Gabriel River	Lakewood	Cerritos
			10A.1(b) - Studebaker Rd.	S	E. of San Gabriel River	N	SCE easement		
			10A.2 - Studebaker *(off-street)*	S	SCE easement	N	Del Amo Blvd.		
			10A.3 - Del Amo Blvd.	W	Studebaker Rd.	E	350' w/o State Rd.		
			10A.4 - State Rd. *(off-street)*	S	150' n/o Del Amo Blvd.	N	150' n/o cul-de-sac		
			10A.5 - State Rd. *(off-street)*	S	150' n/o cul-de-sac	N	350' n/o cul-de-sac		

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	CMP or Truck Rte?	Open Trench	Tunnel	Probable TTC Cost
Seg 10A.1(a)	Los Coyotes - Carson to E. side of SG River	116' (36'/dir.)	2 lanes/direction + striped median	Yes	No				
Intersection	Los Coyotes Diagonal @ Carson — ***continued from 5A***	2 Protected LT Signals; LBT Bus Stops @ ESE Corner					1		$78,500
Seg 10A.1(b)	Studebaker Rd. - Centralia St. to 350' s/o Del Amo Blvd.	80' (32'/dir.)	2 lanes/direction + striped median	No	No				
Seg 10A.2	Studebaker Rd. (off-street) - Del Amo Blvd. from 350' s'ly	80' (32'/dir.)	2 lanes/direction + raised median	No	Yes				
Intersection	Studebaker @ Del Amo — ***continued from 10A.1(b)***	4 Protected LT Signals					1		$78,500
Seg 10A.3	Del Amo - Studebaker to 350' w/o State Rd.	80' (32'/dir.)	2 lanes/direction + striped median	No	No				
Seg 10A.4	State Road (off-street) - 150' n/o Del Amo to 150' n/o cul-de-sac	-	-	-	-	-			
Seg 10A.5	150' n/o State Rd. cul-de-sac to 350' n/o cul-de-sac	-	-	-	-	-			
						TOTALS:	**2**	**0**	**$157,000**

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)	
11	17,497	3.31	**Pub. Utility Easement - 11.1(a), 11.1(b), 11.2, 11.3(a), 11.3(b)**	W	I-605 Freeway	E	Valley View St.	La Palma	Buena Park

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable Cost
Not located on public roadway.							n/a	n/a	
						TOTALS:	**n/a**	**n/a**	**$0**

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)	
16	13,375	2.53	**Pub. Utility Easement**	W	Walker St.	E	Stanton Ave.	La Palma	Buena Park

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable Cost
Not located on public roadway. 1,150' segment through Movieland/Raddison Hotel Parking Lots west and east of Beach Boulevard							n/a	n/a	
						TOTALS:	**n/a**	**n/a**	**$0**

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)
17	3,149	0.60	**Stanton Avenue**	S	Pub. Utility Easement	N	Orangethorpe Ave.	Buena Park

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Rdwy Seg	Orangethorpe - 1,400' n/o La Palma Ave. to Orangethorpe Ave.	64' (26'/dir) Secondary Highway	2 lanes/direction + TWLTL	No	No	CMP- No			
Intersection	Orangethorpe @ Page St.	4 Protected-Permissive/Shared-Protected Only LT Signals					1		$78,500
						TOTALS:	**1**	**0**	**$78,500**

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)			
18	47,453	8.99	**Orangethorpe Avenue**	W	Stanton Ave.	E	Kraemer Blvd.	Buena Park	Fullerton	Anaheim	Placentia
			Kraemer Boulevard	N	Orangethorpe Ave.	S	Miraloma Ave.				
			Miraloma Avenue	W	Kraemer Blvd.	E	4,000' e/o Kraemer				

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Rdwy Seg	Orangethorpe - Stanton Ave. to Kraemer Ave.	64-80' (26-34'/dir) Sec. Hwy. (BP), Maj. Arterial (F,P)	2-3 lanes/direction + TWLTL	No	Yes	CMP Route			
Intersection	Orangethorpe @ Auto Center Dr.	2 Shared Protected-Only LT Signals (side street); OCTA Bus Stops @ **ENE** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Magnolia Ave.	4 Protected LT Signals; OCTA Bus Stops @ NNW & **ESE** Corner; OCTA/Metro Bus Stop @ **WSW** Corner					1		$78,500
Intersection	Orangethorpe @ Gilbert Street	2-Phase Signal; OCTA Bus Stops @ **ESE** & **ENE** Corners					1		$78,500
Intersection	Orangethorpe @ Brookhurst St.	4 Protected/Protected-Permissive LT Signals; OCTA Bus Stops @ NNW, **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Pacific Dr.	2-Phase Signal					1		$78,500

ATTACHMENT 2B. Traffic Control Cost Estimation at Signalized Intersections Along Preferred Alignment - as of 8/10/18

Facility	Location	Street Classification and Width / Description	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Intersection	Orangethorpe @ Basque Ave.	2 Protected-Permissive LT Signals; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Euclid St.	4 Protected/Protected-Permissive LT Signals; OCTA Bus Stops @ **WNW**, SSE, SSE & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Woods Ave.	2-Phase Signal; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Richman Ave.	2-Phase Signal; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Highland Ave.	2 Protected-Permissive LT Signals; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Harbor Blvd.	CMP Intersection— 4 Protected LT Signals; OCTA Bus Stops @ NNE, SSW, **ESE** & **ENE** Corners					1		$78,500
Intersection	Orangethorpe @ Orangefaire Marketplace	2-Phase Signal					1		$78,500
Intersection	Orangethorpe @ Lemon St.	4 Protected/Protected-Permissive LT Signals; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Cypress Via	2-Phase Signal					1		$78,500
Intersection	Orangethorpe @ R/R Xing	R/R Signal					1		$78,500
Intersection	Orangethorpe @ Raymond Ave.	4 Protected/Protected-Permissive LT Signals; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Acacia Ave.	2-Phase Signal; OCTA Bus Stops @ **WNW** & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ State College Blvd.	CMP Intersection— 4 Protected-Permissive LT Signals; OCTA Bus Stops @ **WNW**, SSW, SSE & **ESE** Corners					1		$78,500
Intersection	Orangethorpe @ Placentia Ave.	4 Protected LT Signals; OCTA Bus Stops @ **WNW**, **ESE** & NNE Corners					1		$78,500
Intersection	Orangethorpe @ SR-57 SB On-Off/Iowa Pl.	2 Protected LT Signals; N/S split phase; OCTA Bus Stop @ **WNW** Corner						1	$12,500
Intersection	Orangethorpe @ SR-57 NB On/Off-Ramps	3-Phase Signal; 1 Protected LT Signal; N/S legs one-way NB						1	$12,500
Intersection	Orangethorpe @ Melrose St.	4 Protected LT Signals; OCTA Bus Stops @ SSW, **ESE** & **ENE** Corners					1		$78,500
Intersection	Orangethorpe @ Kraemer Blvd. (alignment turn)	4 Protected LT Signals; OCTA Bus Stops @ **WNW**, SSW & NNE Corners					1		$78,500
Rdwy Seg	Kraemer - Orangethorpe Ave. to Miraloma Ave.	86' (36'/dir) Primary Arterial	2 lanes/direction + TWLTL	Yes	No	CMP- No			
Intersection	Kraemer @ La Jolla St.	2 Protected-Permissive LT Signals; OCTA Bus Stops @ **NNE** & **SSW** Corners					1		$12,500
Intersection	Kraemer @ Miraloma Ave.	4 Protected/Protected-Permissive LT Signals; OCTA Bus Stops @ **NNE** & SSW Corners					1		$12,500
Rdwy Seg	Mira Loma - Kraemer St. to MWD	86' (36'/dir) Primary Arterial	2 lanes/direction + TWLTL	Yes	No	CMP- No			
Intersection	Mira Loma @ Miller St.	2-Phase Signal; OCTA Bus Stops @ **WSW** & **ESE** Corners					1		$78,500
						TOTALS:	24	2	$1,777,000

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)			
20	36,466	6.91	**20.1(a) - Studebaker Rd.**	S	200' n/o Del Amo Blvd.	N	195th St.	Cerritos	Bellflower	Downey	Norwalk
			20.1(b) - Studebaker Rd.	S	195th St.	N	1,100' n'ly				
			San Gabriel River	S	Pub. Utility Easement	N	Firestone Blvd. OC				

Facility	Location	Street Classification and Width / Description	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Seg 20.1(a)	Studebaker - 200' n/o Del Amo to 195th Street								
Intersection	Studebaker @ 195th Street	2 Protected-Permissive LT Signals on Studebaker; CoW Bus Stop @ NNE Corner					1		$78,500
Seg 20.1(b)	Studebaker - 200' n/o Del Amo to 195th Street								
Segments 20.2 through 20.15 located off-street; Tunneling w/o traffic control required across South Street (20.2), 183rd Street (20.5), Artesia Blvd. and SR-91 Fwy. (20.7), Alondra Blvd. (20.9), I-105 (20.12), Imperial Hwy. and Firestone Blvd. (20.14) and Rosecrans Ave. (20.15). 5,000' segment north and south of Rosecrans Avenue located along alleyways through Riverview Parking residential community and an industrial park in the City of Bellflower. 2,600' segment traverses the Cerritos Auto Square between South Street and Allington Street.							n/a	n/a	
						TOTALS:	1	0	$78,500

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)	
22	19,969	3.78	**22.1 - San Gabriel River**	S	Firestone Blvd. OC	N	1,200' n'ly	Downey	Pico Rivera
			22.2 - San Gabriel River	S	1,200' n/o Firestone Blvd.OC	N	Washington Blvd. OC		

Facility	Location	Street Classification and Width / Description	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Seg 22.1	SG River - Firestone OC to 1,200' n'ly	No signalized intersection crossings.							
Seg 22.2	SG River - 1,200' n/o Firestone OC to Washington OC	No signalized intersection crossings.							
						TOTALS:	0	0	$0

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)
36	4,265	0.81	**W. side of San Gabriel River**	S	65' north of Washington Blvd.	N	Mines Ave.	Pico Rivera

Facility	Location	Street Classification and Width / Description	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Rdwy Seg	W. side of SG River - 65' north of Washington to Mines	No signalized intersection crossings.							
						TOTALS:	0	0	$0

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)
			38.1 - W. side of SG River	S	Mines Ave.	N	Whittier Blvd.	
			38.2(a) - Whittier Blvd.	E	E. side of San Gabriel River	W	Durfee Ave.	

ATTACHMENT 2B. Traffic Control Cost Estimation at Signalized Intersections Along Preferred Alignment - as of 8/10/18

Alignment ID No.	LF	mi.	Roadway/Route		end/from		end/to	Jurisdiction(s)			
38 (modified)	27,870	5.28	**- Durfee Ave.**	S	Whittier Blvd.	N	Beverly Blvd.	Pico Rivera	Industry	L.A. County	Baldwin Park
			- Beverly Blvd.	W	Durfee Ave.	E	SG River Pkwy. / Manning Rd.				
			38.2(b) - Beverly Blvd.	W	SG River Pkwy. / Manning Rd.	E	E. side of San Gabriel River				
			38.3 - E. side of SG River	S	Beverly Blvd.	N	San Gabriel River Pkwy.				
			38.4(a) - SG River Pkwy	S	E. side of San Gabriel River	N	300' south of I-605 SB On-Ramp				
			38.5 - Sheperd St.	S	300' south of I-605 NB Off-Ramp	N	Rose Hills Rd.				
			38.6 - Rose Hills Rd.	W	Sheperd St.	E	Workman Mill Rd.				
			38.7 - Workman Mill Rd./Peck Rd.	S	Rose Hills Rd.	N	Pellissier Pl				
			38.8 - Pellissier Pl.	W	Peck Rd.	E	SR-60 UC / Workman Mill Rd.				
			38.9 - Workman Mill Rd.	W	SR-60 UC / Pellissier Pl.	E	Future UC/Grade Sep. @ Valley				
			38.10 - Puente Ave.	W	Future UC/Grade Sep. @ Valley	E	Merced Ave.				
			38.11 - Merced Ave.	S	Puente Ave.	N	Palm Ave.				

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	CMP or Truck Rte?	Open Trench	Tunnel	Probable TTC Cost
Seg 38.1	W. side of SG River - Mines to Whittier	No signalized intersection crossings. Tunneling w/o TTC potentially required at N. end of segment under Whittier Blvd.							
Seg 38.3	E. side of SG River - Beverly Blvd. to San Gabriel River	No signalized intersection crossings.							
Seg 38.4	SG River Pkwy - E. side of SG River to 300' south of I-605 SB On-Ramp	No signalized intersection crossings.							
						TOTALS:	0	0	$0

Alignment ID No.	LF	mi.	Roadway/Route		end/from		end/to	Jurisdiction(s)
38A	4,545	0.86	**E. side of San Gabriel River**	S	Whittier Blvd.	N	Beverly Blvd.	Pico Rivera

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Rdwy Seg	E. side of SG River - Whittier to Beverly	No signalized intersection crossings. Tunneling w/o TTC potentially required under Beverly Blvd., Whittier Blvd. and UPRR Railway							
						TOTALS:	0	0	$0

Alignment ID No.	LF	mi.	Roadway/Route		end/from		end/to	Jurisdiction(s)				
44	28,891	5.47	**44.1 - San Gabriel River Trl.**	S	Peck Rd.	N	N. side of SR-60 Fwy.	L.A. County	South El Monte	Industry	Baldwin Park	Irwindale
			44.2(a) - W/E of SG River	S	N. side of SR-60 Fwy.	N	1,500' n/o SG River-SJ Crk Jct.					
			44.2(b) - E. side of SG River	S	1,500' n/o SG River-SJ Crk Jct.	N	Ramona Blvd.					
			44.3(a) - E. side of SG River	S	Ramona Blvd.	N	Lower Azusa Rd.					
			44.3(b) - E. side of SG River	S	Lower Azusa Rd.	N	Rivergrade Rd.					

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	CMP or Truck Rte?	Open Trench	Tunnel	Probable TTC Cost
Seg 44.1	SG River Trl. - Peck to N. side of SR-60 Fwy.	No signalized intersection crossings. Tunneling w/o TTC potentially required under Peck Rd. and SR-60 Fwy.							
Seg 44.2(a)	W/E of SG River - N. of 60 Fwy. to 1,500' n/o SG River-SJ Crk Jct.	No signalized intersection crossings.							
Seg 44.2(b)	E. side of SG River - 1,500' n/o SGR-SJ Crk Jct. to Ramona	No signalized intersection crossings. Tunneling w/o TTC potentially required under Valley Blvd., Ramona Blvd. and I-10 Fwy.							
Seg 44.3(a)	E. side of SG River - Ramona to Lower Azusa	No signalized intersection crossings.							
Seg 44.3(b)	E. side of SG River - Lower Azusa to Rivergrade	No signalized intersection crossings. Tunneling w/o TTC potentially required under Los Angeles St.							
						TOTALS:	0	0	$0

Alignment ID No.	LF	mi.	Roadway/Route		end/from		end/to	Jurisdiction(s)	
52	2,604	0.49	**52.1(a) - Rivergrade Rd.**	S	0.25 mi. n/o Lower Azusa Rd.	N	125' s/o Brooks Dr.	Irwindale	Baldwin Park

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	CMP or Truck Rte?	Open Trench	Tunnel	Probable TTC Cost
Seg 52.1(a)	Rivergrade - 0.25 mi. n/o Lower Azusa to 125' s/o Brooks Dr.	No signalized intersection crossings. Tunneling w/o TTC potentially required under I-605							
						TOTALS:	0	0	$0

Alignment ID No.	LF	mi.	Roadway/Route		end/from		end/to	Jurisdiction(s)
56	1,080	0.20	**Live Oak Ave.**	E	W. side of San Gabriel River	W	Graham Rd.	Irwindale

Facility	Location	Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Open Trench	Tunnel	Probable TTC Cost
Rdwy Seg	Live Oak - W. side of SG River to Graham								
Intersection	Live Oak @ Graham		T-intersection; 2-Phase Signal				1		$78,500
						TOTALS:	1	0	$78,500

Alignment ID No.	LF	mi.	Roadway/Route		end/from		end/to	Jurisdiction(s)
58	3,350	0.63	**58.1 - (off st) n/o Live Oak Ave.**	S	Graham Rd.	N	E. Side of I-605 (1,700' n'ly)	Irwindale
			58.2(a) - (off street)	S	Live Oak @ 220' s/o Arrow Hwy.	N	650' n/o I-605/Arrow IC	
			58.2(b) - (off street)	W	700' SW of Live Oak Ln.	E	Live Oak Ln.	

ATTACHMENT 2B. Traffic Control Cost Estimation at Signalized Intersections Along Preferred Alignment - as of 8/10/18

Facility	Location	Roadway or Intersection Description: Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Prop. Constr. Method: Open Trench	Tunnel	Probable TTC Cost
Seg 58.1	(off st) n/o Live Oak - Graham to E. Side of I-605 (1,700' n'ly)	No signalized intersection crossings. Tunneling w/o TTC potentially required at the south end of segment under Live Oak Ave.							
Seg 58.2(a)	(off street) - Live Oak @ 220' s/o Arrow to 650' n/o I-605/Arrow IC	No signalized intersection crossings. Tunneling w/o TTC potentially required under Arrow Hwy., Live Oak Ln. and I-605 n/o Arrow.							
Seg 58.2(b)	(off street) - 700' SW of Live Oak to Live Oak	No signalized intersection crossings.							
						TOTALS:	0	0	$0

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)
59	9,246	1.75	59 - W. side of I-605	S	650' n/o I-605/Arrow IC		1,450' SW of I-605/I-210 IC	Irwindale

Facility	Location	Roadway or Intersection Description: Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	Special Route?	Prop. Constr. Method: Open Trench	Tunnel	Probable TTC Cost
Rdwy Seg	W. side of I-605 - 650' n/o I-605/Arrow IC to 1,450' SW of I-605/I-210 IC	No signalized intersection crossings. Tunneling w/o TTC potentially required at north end of segment under I-605 s/o I-210							
						TOTALS:	0	0	$0

Alignment ID No.	Length LF	Length mi.	Roadway/Route	Limits end/from		Limits end/to		Jurisdiction(s)
60	4,875	0.92	52.1(a) - Rivergrade Rd.	S	150' s/o Brooks Dr.	N	150' n/o Live Oak Ave.	Irwindale

Facility	Location	Roadway or Intersection Description: Street Classification and Width	Travel Lanes, Center Division	On-Street Pkg.?	Bike lanes?	CMP or Truck Rte?	Prop. Constr. Method: Open Trench	Tunnel	Probable TTC Cost
Seg 60	Rivergrade - 150' s/o Brooks Dr. to 150' n/o Live Oak Ave.								
Intersection	Rivergrade @ Brooks Dr.	T-intersection; 2-Phase Signal					1		$78,500
Seg 52.4(b)	Rivergrade - 400' n/o Brooks to Live Oak Ave.								
Intersection	Rivergrade @ Live Oak Ave.	4 Protected LT Signal					1		$78,500
Seg 52.2	Across SG River - Rivergrade to SG River Trail								
						TOTALS:	2	0	$157,000

Notes:

Bus stop locations shown in **bold** indicate bus stop is located on the street of the project route.

Appendix C. Preliminary Geotechnical/Geologic Evaluation, Proposed Regional Recycled Water Supply Program

DRAFT

Preliminary Geotechnical/Geologic Evaluation
Proposed Regional Recycled Water Supply Program
Metropolitan Water District of Southern California

Prepared for
Black and Veatch
800 Wilshire Bouldevard, Suite 600
Los Angeles, CA 90017

September 6, 2018

Prepared by
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September 6, 2018
Project No.: 16001A

Mr. Andrew Stanton, PE
Black and Veatch Corp.
800 Wilshire Ave., Suite 600
Los Angeles, CA 90017

Subject: **Draft Preliminary Geotechnical/Geologic Evaluation Report**
Proposed Regional Recycled Water Supply Program
Metropolitan Water District of Southern California

Dear Mr. Stanton:

In general accordance with the provisions of our agreement for professional services, we are presenting our draft preliminary geotechnical/geologic evaluation report for the subject project for your review. The report provides preliminary geologic conditions and geotechnical recommendations for design and construction of the project in accordance with the information that has been provided to us. The report provides tables and figures that summarize the findings of our “desk-top” study. Site specific field investigations will be necessary as the project advances beyond this current preliminary phase of work.

Thank you for providing GeoPentech the opportunity to participate on this project. If you have any questions or require additional information, please call.

Very truly yours,
GeoPentech, Inc.

Eric Fordham, PG, CEG, CHg
Principal

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1.0 INTRODUCTION

This report presents the results of a preliminary desktop geologic and geotechnical evaluation of Metropolitan Water District of Southern California's (Metropolitan's) conveyance alignment alternatives for the proposed Regional Recycled Water Supply Program (RRWSP conveyance project). This desktop evaluation, as shown on Figure 1, focuses on the "Preferred" alignment along with recommended pipe diameters. Figure 1 also shows the Alignment Alternatives that were considered as part of the RRWSP conveyance project. Steel pipe ranging from 4.5 feet to 7 feet in diameter is recommended for the three main segments of the RRWSP conveyance project.

1.1 Purpose and Scope of Study

The purpose of this study is to assess the general geotechnical/geological conditions along Metropolitan's proposed conveyance alignment alternatives for the RRWSP conveyance project with a focus on the Preferred Alignment (Figure 1). A description of the conveyance project features are provided by Black and Veatch Corporation's (B&V) engineering report for which this report provides supporting geological and geotechnical information. The geological and geotechnical conditions presented in this report are based on a desktop-type evaluation that is preliminary and high-level.

The information gathered and used in the evaluation is from published literature, government agency websites and in-house records. Specifically, this report summarizes the mapped surficial geologic units, soil types reported for borings up to 100 feet in depth, shallowest historic depths to groundwater, location of oil and gas fields, seismic hazards, earthquake fault zones, and Quaternary faults mapped along the alternative alignments. We understand that the gathered geotechnical and geologic information and our geotechnical evaluation of these data will be used by B&V and Metropolitan as input for project planning including conceptual design and cost estimating, and California Environmental Quality Act (CEQA) documentation in support of the proposed program. As the program progresses beyond this conceptual design level, collection of site specific geologic and geotechnical data along the Preferred Alignment will be needed.

1.2 Documents Reviewed

B&V provided GeoPentech with the proposed conveyance segment and alignment alternatives for the RRWSP as shown on Figure 1 along with possible trenchless/tunnel undercrossing locations. The alignment data were provided in tabular and geographic information systems (GIS) format. The available technical documents and maps that cover the RRWSP conveyance project area reviewed for this study include the following:

- Geologic units from geologic maps of Long Beach and Los Angeles, California produced by the California Geologic Survey (CGS) and of Orange County from the Santa Ana – San Bernardino map produced by the United States Geological Survey (USGS).

- CGS Seismic Hazard Zones Maps and Evaluation Reports for the following 7.5-minute quadrangles: Yorba Linda, Anaheim, Orange, Los Alamitos, Torrance, Long Beach, Inglewood, Los Angeles, Hollywood, Southgate, Whittier, El Monte, Baldwin Park and Azusa.
- Faults from the USGS Quaternary Fault and Fold Database (2006) as well as from the third Uniform California Earthquake Rupture Forecast (UCERF3; USGS, CGS and Southern California Earthquake Center) are plotted on the maps in this report for identification of Quaternary to Recent age faults.
- Depth-to-groundwater data was reviewed from several sources, including USGS National Water Information System (NWIS), the State of California Water Resources Control Board's GeoTracker GAMA program (Groundwater Ambient Monitoring & Assessment Program), the CGS Borehole database, and the CGS Seismic Hazards Evaluation reports and maps. The GAMA groundwater data is the most recent shallow groundwater data of all the sources. The USGS data is primarily from production wells, and mostly represents groundwater levels in groundwater aquifers that are generally deeper than 200 feet below ground surface. The CGS groundwater contour maps provide a broad coverage of the highest historic groundwater that is perched or semi-perched within shallow alluvial sediments across the conveyance project area.
- Soil type was compiled from the CGS borehole database, summarized and plotted spatially along the conveyance alignment alternatives for evaluation.

1.3 Data Summary Organization

The data collected and reviewed for this study are summarized on figures and tables for the conveyance project area. Regional-scale maps combine like information from various sources showing the following information:

- Geology and Quaternary Faults (Figure 2; Table 1a, b)
- Seismic Hazards (Figure 3)
- Alquist-Priolo Earthquake Fault Zones (Figure 4)
- Groundwater Depth (Figure 5)
- Oil and Gas Fields (Figure 6)
- Soil Characteristics less than 20 feet below ground surface representative of pipeline trenching conditions (Figure 7a), and
- Soil Characteristics greater than 20 feet below ground surface representative of trenchless/tunnel pipeline placement conditions (Figure 7b).

Ground conditions relevant to cut and cover pipeline and undercrossing (trenchless/tunnel excavation) construction for the RRWSP conveyance alignment alternatives are summarized in Tables 2 and 3. Geotechnical conditions for cut and cover trenching and trenchless/tunnel undercrossing pipeline construction are summarized on Figures 8A and 8B, respectively, and discussed following the data review. Potential right-of-way issues associated with cut and cover trenching and trenchless/tunnel undercrossing pipeline construction from a geotechnical perspective, are discussed in Section 3.1.

2.0 SUMMARY OF DATA REVIEW

The following sections summarize our review of the available data for the RRWSP conveyance alignment alternatives. The data presented include regional geology and Quaternary faults, seismic hazards, earthquake fault zones designated for special studies, depth-to-groundwater, oil and gas fields crossed by the conveyance alignment alternatives, and the distribution of soil types within the depths of planned excavation for pipelines and undercrossings.

2.1 Regional Geology

The RRWSP conveyance alignment alternatives traverse portions of the Los Angeles, San Gabriel and Orange County basins. Figure 2 shows a compilation of geology maps produced by the CGS and USGS that cover the conveyance project area (Figure 2A provides an explanation of the geologic units shown on Figure 2). The majority of the conveyance alignment alternatives are located within Quaternary-age alluvial and fluvial sediments that were deposited in the basins from the foot of the San Gabriel and San Bernardino mountains to the Pacific Ocean along the Los Angeles, San Gabriel, Rio Hondo and Santa Ana rivers and their associated tributaries. The Quaternary-age alluvial and fluvial sediments mapped along the alignment are composed mainly of sand, gravel and cobble at the northern end of the alignment with fine-grained sediments present at depth less than about 20 feet; sand, silty sand and silt in the central and eastern alignment areas; and silty sand, silt and clay in the south and southwestern portion of the conveyance project area.

Outcrops of Pleistocene-age and older bedrock units occur in the Puente, Montebello and Signal hills through which the alignment passes. Bedrock units in the Puente and Montebello hills are composed of shale, siltstone, sandstone, pebbly sandstone, and conglomerate of the Sespe, Topanga, Puente and Fernando formations. Bedrock units exposed in the Signal Hill area are composed of sandy silt, sandstone and pebbly sandstone of the Lakewood Formation, Palos Verdes Sand and San Pedro Formation. Within the Los Angeles coastal plain, shallow groundwater less than 50 feet below the ground surface occurs perched on fine-grained alluvial deposits that range in depth from about 60 to 100 feet.

2.2 Quaternary Faults

Figure 2 shows that the conveyance alignment alternatives cross the Newport-Inglewood Fault Zone, the Los Alamitos Fault and possibly, though not shown, a buried fault trace that connects the Whittier and East Montebello faults. The Newport-Inglewood and Los Alamitos faults have experienced surface rupture in the late Quaternary (<130,000 years before present) as defined in the USGS Quaternary Fault and Fold Database. Tables 1a and 1b provide a summary of fault geometry and deformation characteristics for those faults shown on Figure 2 that occur within the RRWSP conveyance alignment alternatives area.

The alternative alignments cross the Newport-Inglewood Fault from about the intersection of the 405 and 710 freeways to the intersection of Cherry Avenue and the 405 freeway. The Newport-Inglewood Fault Zone is Holocene active as evidenced by many geotechnical studies as well as the M_W 6.3 Long Beach Earthquake of 1933. This fault is estimated to have probable earthquake magnitudes in the range of M_W 6.0 to 7.4 with surface rupture likely to occur above M_W 6.0. The Newport-Inglewood Fault has right-lateral displacement with a best estimate of 2 meters (6.5 feet) average displacement.

The Los Alamitos Fault crosses the alignment, near the intersection of Wardlow Road and Los Coyotes Diagonal. The Los Alamitos Fault is not known to be active in the Holocene (<11,700 years before present) although this fault is considered to have last ruptured the surface in the Late Quaternary (less than 700,000 years before present; Southern California Earthquake Data Center). The Los Alamitos Fault is theorized to deform with movement on the larger Compton Blind Thrust fault system (Leon, et al., 2009) Southern California Earthquake Data Center, 2016).

In the Puente Hills southeast of the alignment, the Whittier Fault is Holocene active as corroborated by many geotechnical studies in the surrounding hills. This fault is estimated to have probable earthquake magnitudes in the range of M_W 6.0 to 7.2 with surface rupture likely to occur above M_W 6.0. The Whittier Fault has right-lateral displacement with a best estimate of 1.9 meters (6 feet) average displacement.

Within the Whittier Narrows between Beverly Boulevard and the 60 Freeway, the alignment crosses the projection of the Whittier Fault and East Montebello Fault. Although the projection of the Whittier Fault through the Narrows is speculative due to the lack of clear geomorphic features (e.g. Yerkes, 1972; Smith, 1977), Holocene-aged sediments in the Narrows have likely been significantly reworked by the San Gabriel River removing any fault related features that may have existed. At depth beneath the Narrows, the fault has been shown to offset Miocene/Pliocene and older sedimentary deposits (Yerkes, 1972). While direct evidence of Holocene fault rupture within the Whittier Narrows does not exist, there may be potential for fault offset in this area to occur as a result of a large magnitude earthquake (i.e. M_W 7 or greater) on the Whittier Fault.

There are no other late Quaternary or Holocene active faults currently mapped at the surface along other portions of the proposed conveyance alignment alternatives considered for this study. Although, at least four blind thrust faults exist beneath the alignment area that have recent seismic activity. These are the Compton, Puente Hills and Peralta Hills blind thrust systems.

It was generally considered that M_W 6.0 is the approximate lower limit of earthquakes capable of producing fault surface displacements. However, experience gained through recent analyses by the Jet Propulsion Laboratory in Pasadena of ground surface fault displacements that occurred during the March 28, 2014 M_W 5.1 La Habra Earthquake, whose epicenter was about 2 miles north of the eastern portion of the proposed alignment, will likely shift this surface fault rupture lower limit down to ≈ M_W 5.0. Although the surface fault displacements observed following this event were reported to be generally in the millimeter/centimeter range, if larger earthquakes (M_W 6) are generated by the thrust faults underlying the proposed alignment alternatives, surface displacement in the range of centimeters to tens of centimeters may occur.

The subsurface geometry of the blind thrust system is uncertain, and demonstrating Holocene activity on blind thrusts is often difficult; however, Leon et al. (2007, 2009) report evidence for Holocene-aged sediments folded by coseismic slip on the Puente Hills and Compton blind thrust systems. Furthermore, the 1987 M_W 6.0 Whittier Narrows earthquake has been attributed to slip on the central section of the Puente Hills blind thrust fault (Leon et al., 2007). Large earthquakes on the Puente Hills and Compton blind thrust systems are not known to rupture the surface, but distributed coseismic deformation is possible, with potential for differential uplift spanning a few centimeters to tens of centimeters across a broad area (tens of square kilometers).

2.3 Seismic Hazards

The California Seismic Hazard Zonation program is a state regulatory program that produces maps delineating areas where investigation is required to assess potential impacts of liquefaction or seismically induced landsliding. Detailed geotechnical/geologic investigations are required for projects that are proposed in these zones to identify the extent and potential consequences of these hazards for the proposed work. The implementation of the requirement is left to local jurisdictions, although CGS Special Publication 117 (2008) is typically used for guidance.

Figure 3 shows that the majority of the conveyance alignment alternatives cross over several Liquefaction Hazard Zones that have been defined by the CGS. The alternative alignments as they are currently proposed do not pass through Earthquake-Induced Landslide Hazard Zones, but are within 1 mile of these zones in the Montebello/Pico Rivera area.

2.4 Earthquake Fault Zone (AP Zone)

In response to the 1971 San Fernando Earthquake, the Alquist-Priolo Act was signed into law in 1972. The act established a program to produce maps of Earthquake Fault Zones that delineate the surface trace of active faults as well as buffer zones where special studies are required to ensure structures for human occupancy do not cross the fault. It should be noted that the act does not directly address structures without human occupancy or infrastructure facilities such as pipelines or tunnels. However, this information is included here for reference purposes.

As shown on Figure 4, the proposed conveyance alignment alternatives cross the Newport-Inglewood Earthquake Fault Zone as defined by the CGS, approximately between about the intersection of the 710 and 405 freeways and the intersection of Cherry Avenue and the 405 Freeway. Other identified Alquist-Priolo (A-P) Earthquake Fault Zones that are near the proposed conveyance alignment alternatives include the Whittier-Elsinore Fault Zone and East Montebello Fault near the center of the alignments, and the Sierra Madre Fault Zone just north of the alignments in the San Gabriel Valley. The other fault that is crossed by the alternative conveyance alignments is the Los Alamitos Fault, though this fault has not been identified by the CGS as a possible Holocene-active fault and, therefore, is not designated as an A-P Earthquake Zone.

2.5 Groundwater Occurrence

The depth to shallowest historic groundwater contours (as produced in the CGS seismic hazard evaluation maps) were digitized and are provided on Figure 5. These levels represent perched or semi-perched groundwater within the uppermost alluvial deposits of the San Gabriel Valley and Los Angeles Coastal Plain. The CGS depths to shallowest historic groundwater contours are reasonably consistent with the more recent GAMA depth to groundwater measurements and CGS Borehole database values. The GeoTracker GAMA depths to groundwater values that were reviewed represent the shallowest depth to groundwater measurement from each GeoTracker site. GeoTracker sites are soil and groundwater monitoring sites, often associated with hazardous waste contamination and where many monitoring wells have been installed at each site. The advantage of the GeoTracker, GAMA and CGS Borehole database groundwater elevations is that they are often a good representation of first-encountered or shallow groundwater, which can be beneficial in assessing the need to dewater excavations for pipeline trenches and undercrossings. Regional groundwater levels provided by water agencies such as the Water Replenishment District of Southern California, generally represent the piezometric level within deep aquifers of the Los Angeles basin, which have little bearing on the shallow sediments where dewatering is a concern.

As shown on Figure 5, shallow groundwater with depths of 20 feet or less is found primarily within alluvial sediments throughout most the conveyance project area with exceptions including Signal Hill, the area east of the intersection of the 91 and 5 freeways in Orange County and north of Ramona Boulevard in the San Gabriel Valley. The shallow groundwater generally coincides with CGS mapped Liquefaction Hazard Zones. Based on review of compiled groundwater levels and local experience, shallow groundwater that occurs within the uppermost alluvial deposits may vary up to 10 feet between dry and wet years and several feet seasonally. Also, areas influenced by tides (e.g. near Los Angeles Harbor and Los Angeles River south of Willow

Street), or short term changes in river stage due to rainfall (e.g. Dominguez Channel, San Gabriel River from Santa Fe Dam south to about Downey, and near the Santa Ana River) may also be influenced by changes in groundwater on the order of several feet.

2.6 Oil and Gas Fields

As shown on Figure 6, the proposed conveyance alignment alternatives overlie oil and gas fields in the cities of Wilmington, Long Beach, Signal Hill, Industry, Montebello, Whittier, Santa Fe Springs, Buena Park and Placentia. Issues associated with pipeline and undercrossing tunnel construction in areas overlying oil and gas fields include the potential accumulation of hazardous gasses, including methane and hydrogen sulfide in underground excavations and tunnels, oil residuals in soil, legacy contamination associated with oil and gas production activities and encountering abandoned well casings.

2.7 Soil Characteristics

The distribution of soil types along the proposed conveyance alignment alternatives is shown for depths less than 20 feet below ground surface in Figure 7A, which relates to the anticipated depth of excavation for pipeline construction and greater than 20 feet in Figure 7B, which relates to depths of trenchless/tunneling excavation methods to cross under existing infrastructure. The figures show the locations of borings compiled from the CGS Borehole database along with the prevalent soil type for the shallow (less than 20 feet) and deep (greater than 20 feet) intervals. In general, shallow soils throughout the conveyance project area are composed of sand silt and clay while the deeper soils tend to be coarse grained (sand, gravel, cobbles and boulders) in the northern portion of the alignment and finer grained to the south consistent with alluvial and fluvial deposition that is sourced from the mountains north of the project. Deep soils within the eastern portion of the proposed conveyance project area (i.e. within Orange County) tend to be predominantly sand with some fine-grained silts and clays in the shallow zone.

3.0 GEOTECHNICAL CONSIDERATIONS

Table 2 provides key geotechnical conditions that are considered for the cut and cover and undercrossing pipeline construction elements of the proposed RRWSP conveyance alignment alternatives. In addition, the following geotechnical issues that will likely be a consideration of future pipeline and trenchless/tunnel alignment designs are discussed in more detail. For reference, Figures 8A and 8B provide a summary of shallow (less than 20 feet) and deep (greater than 20 feet) ground conditions interpreted throughout the proposed conveyance project area.

3.1 Cut and Cover Pipeline and Undercrossing Pit Excavations

1) ***Temporary Shoring***

Temporary shoring will likely be necessary for most pipeline and pit excavations due to the fact that the alignment is along existing public rights-of-way such as roads and highways. Where the pipeline is located in areas with adequate space that can accommodate open-cut trenching to access the existing structure, the trench excavation can be sloped back. Typically, excavations in clayey material are anticipated to stand steeper than in sandy material. In addition, areas where the groundwater level is high, open-cut trenching and pit excavation may be difficult without adequate dewatering.

Temporary shoring such as speed-shores, slide rails, trench boxes, cantilever sheet piles, soldier piles with lagging, and internal bracing could be used throughout the alignment combined with adequate dewatering where necessary. An exception is that the use of cantilever sheet piles would likely not be appropriate in areas where outcropping rock occurs such as in the areas near Signal Hill where bedrock is outcropping or is close to the ground surface as the necessary embedment may be difficult to achieve. Non-interlocking shoring is not appropriate in areas where shallow groundwater and sandy materials are not adequately dewatered ahead of the excavation as windows between shoring may allow soil and groundwater intrusion into the excavation, potentially destabilizing the excavation walls.

2) Excavation and Soil Reuse

In general, excavation of the alluvial or fluvial materials that are present along the majority of the proposed alternative alignments should not require special equipment. Where the alignment enters the Signal Hill area where outcropping bedrock is present heavy ripping equipment, such as a Caterpillar D-9 or D-10 dozer equipped with a ripper shank may be necessary. Based on our experience, blasting would not be necessary for excavation sites in this area.

Reuse of excavated material for backfill should be evaluated on a case by case basis depending on the soil type present at the proposed excavation sites and the possible occurrence of contamination/hazardous substances, specifically in the areas near oil and gas fields. Generally, non-contaminated alluvial or fluvial materials should be acceptable for reuse provided that oversize material is removed and the material is appropriately moisture conditioned and compacted.

Note that the requirements for backfill material will depend on the anticipated use of the site and any conditions imposed by the design or the local jurisdiction. As general guidance material with a liquid limit less than 40 and a plastic limit less than 12, or alternatively, with a sand equivalent less than 30 would likely be acceptable. Generally, this excludes clays with moderate to high plasticity, but may allow reuse of some low plasticity clays and silts. Actual requirements would depend on the soil properties, design criteria, and local jurisdictional restrictions.

Note that in some portions of the proposed conveyance project area, soil boring logs reviewed identified some material that would not likely be acceptable for reuse. This included particular references to material characterized as "Gumbo silt" which was noted in logs from specification No. 722 for Metropolitan's Second Lower Feeder Project in the Los Alamitos area. It is not clear whether this material was only present locally and therefore was not noted in other logs, or if the particular description is a unique expression from the person(s) who documented these boreholes. Our experience at other projects in this area suggests that fine-grained sediments would be appropriate for reuse. However, it does appear that "Gumbo silt" would not be reusable based on the textural descriptions in the logs. Increased cost for imported backfill material should be included in cost estimates for areas where "Gumbo silt" or contaminated material has been identified.

3) ***Dewatering***

Most of the proposed conveyance alignment alternatives appear to have relatively shallow groundwater with depths ranging from about 8 feet to 20 feet below ground surface. Groundwater that is less than 20 feet below ground surface will likely require dewatering for pipeline trench construction. This is shown by the hatched stippled pattern on Figure 8A. Groundwater that is less than 50 feet below ground surface will require dewatering or watertight support of excavation with sump pumping for undercrossing pit construction. This is shown by the stippled pattern on Figure 8B.

Dewatering is a viable means for controlling groundwater flow into open excavations for most of the alignment; however a specific assessment of seepage rates into excavations is beyond the scope of this study. Groundwater inflow is dependent on local soil conditions as more clayey soils in the zone of the excavation would expect to have less flow compared to sandy soils that would have higher flow. Also, the use of interlocking sheet piles for shoring may be helpful in reducing groundwater flow into excavations and should be considered for undercrossing pits where appropriate. In general, the sandy to cobbley deposits that occur at the northern end of the conveyance project area and the sands on the eastern end will require higher pumping rates than the finer grained deposits that occur in the south and southwestern areas of the proposed alternative alignments. Where dewatering is required, right of way will need to be acquired for dewatering wells, associated conveyance piping, and effluent treatment and discharge.

4) ***Bearing Capacity for Pipe Jacking Equipment***

The use of pipe jacking for pipe installation by jack and bore or microtunneling may be required to cross under existing infrastructure. This process will require winching or jacking equipment whose size depends on the length and diameter of the undercrossing. Pipe jacking equipment will likely bear on either native soils or on prepared temporary foundation elements that in turn bear on the native soils. In general, the portions of the alignment near outcropping rock such as within Signal Hill will likely have relatively high bearing capacities. The remainder of the proposed conveyance project area is situated in relatively softer alluvial and fluvial deposits that may not have sufficient bearing capacities unless modified through ground treatment.

Ground preparation for areas with softer soils could include using engineered fill, rat/mud slabs, or stabilization using crushed rock or geotextiles in order to provide a more stable base. The requirements will depend on the size of the equipment needed and the soil conditions encountered.

5) ***Liquefaction***

As described previously, a significant portion of the proposed conveyance project area is located within mapped liquefaction hazard zones. Due to the deeper depth of groundwater in the portions of the conveyance alignment alternatives in Signal Hill, north of Arrow Highway in the San Gabriel Valley and between Euclid Street and Kraemer Boulevard in Orange County, liquefaction hazards in these sections are considered relatively low and not likely. However, liquefaction hazards are moderate to high on a regional basis for the remaining portions of the proposed conveyance alignment alternatives. Sections that pass through mapped liquefaction hazard zones should be prioritized for evaluation and the remaining areas should be screened to establish whether there is relatively high groundwater present and potentially susceptible soils (i.e. loose granular soils with low plasticity). Areas where these hazards are known to exist should be evaluated to estimate potential settlements or deformation for design or whether flotation of the pipeline could be a risk.

6) ***Seismically Induced Landsliding***

Most of the proposed alternative alignments cross relatively flat terrain through the Los Angeles, San Gabriel and Orange County basins and are not near areas where seismically induced landslide zones are mapped.

7) ***Fault Offset***

The pipeline crosses three known Quaternary-age faults, the Newport-Inglewood Fault, the Los Alamitos Fault, and the projection of the Whittier Fault as well as three blind thrust fault systems, the Compton, Puente Hills and Peralta Hills. The portion of the pipeline that crosses the Newport-Inglewood Fault is in a mapped Alquist-Priolo Zone. While this may not require a special fault study on the basis that the pipeline is not a human occupancy structure, these fault crossings should be recognized during the design of the project. Table 1b provides a summary of estimated average displacement and relative motion for the faults crossed by the proposed alternative alignments. Due to the likely consequences of pipeline failure given a fault offset at any of these identified locations, evaluation of pipeline resiliency for a given seismic event should be considered for future pipeline design.

8) ***Oil and Gas Fields***

The proposed conveyance alignment alternatives cross known oil and gas fields in Wilmington, Long Beach, Signal Hill, City of Industry, Montebello, Whittier, Santa Fe Springs, Buena Park and Placentia (Figure 6). In these areas where occurrences of explosive and hazardous gases are possible, positive ventilation along with intrinsically safe and explosion-proof equipment should be used. In addition, pre-design hazardous chemical assessments should be completed to identify if legacy soil contamination exists in the project area. A review of California's Division of Oil and Gas records should be completed in these areas to identify the possible presence of abandoned well casings, and prior to construction geophysical means should be used to clear the planned extent of excavations of buried objects. For the purpose of this study, all alignment segments crossing Oil and Gas Fields should be considered gassy and will require utilization of specialized explosion-proof equipment.

3.2 Pipeline Undercrossing Excavation

Table 3 provides a summary of undercrossings along the "Preferred" conveyance alignment for alternatives that extend from Harbor City into Orange County and the San Gabriel Basin. The locations of the undercrossings are shown on Figure 8B by their ID number. The table provides the pipe diameter of the undercrossing along with its likely length and minimum depth of cover. Inferred ground conditions at the identified undercrossings shown on the table are based on soil type at nearby borings from the CGS Borehole Database, mapped geologic units, potential for fault and seismic hazards, oil and gas field occurrence, and need for dewatering based on depth to groundwater.

Based on our understanding of the undercrossing design and inferred ground conditions, excavation methods including Jack and Bore, Microtunneling, Conventional Tunneling and Horizontal Directional Drilling (HDD) are considered. Table 3 presents methods that are considered feasible based on the information presented. Methods that are not applicable for a specific reach may have been excluded due to limitations in meeting pipe diameter, length requirements, bending radii, separation distance required from undercrossing obstacle, elevation difference between entrance and exit locations, or the methods ability to control the inferred ground conditions at the undercrossing location.

The geotechnical criteria used to evaluate the feasibility of the alternative excavation methods consider the following:

- Pipeline design (i.e. diameter, depth and length) and applicability considering engineering constraints,
- Construction access such as launching and receiving pits,
- Anticipated soil conditions along undercrossing such as mixed face with cobbles and boulders and potential running ground,
- Ability to control groundwater along undercrossing.

General capabilities and limitations of the four considered excavation methods for the undercrossings include the following:

Jack and Bore: Pipe diameters up to 48 to 72 inches are most common but diameters up to 120 inches are possible. Drive length is generally less than 1,000 ft and typically limited to short undercrossings such as beneath roadways, intersections, or railroads. Jack and bore is best suited for stable ground conditions. This method can accommodate excavation in clays, silts, sands and fine gravels, cobbles and boulders. Although cobbles and boulders are challenging, jack and bore is one of the most favorable trenchless methods for cobbles and boulders as access to the face of the excavation can be provided to remove obstructions. In general, jack and bore is feasible where boulders are less than about one-third the size of the bore diameter. Where excavation is below the groundwater table, dewatering or watertight support of excavation may be required for launching and receiving pits. Also, dewatering would be required along the length of the excavation if high groundwater inflows are expected or if groundwater is expected to destabilize the ground. For undercrossings in transmissive soils such as sands and gravels, access for dewatering wells along the alignment are necessary to control groundwater inflows and to limit the potential for running or flowing ground from entering the excavation. For freeway undercrossings beneath the water table in transmissive soils, dewatering and ground control may be challenging for this method. Jack and bore is generally not suitable for river undercrossings.

Microtunneling: Pipe diameters up to 120 inches and lengths between jacking pits of 1,500 to 2,000 ft with total drive lengths over 10,000 feet are feasible. A more sophisticated trenchless method than jack and bore, microtunneling can accommodate excavation in clays, silts, sands, gravels, cobbles and boulders, though cobbles and boulders may be challenging. Unlike jack and bore, access to the face of the excavation is not readily available in diameters less than 72 inches. Where excavation is below the groundwater table, dewatering or watertight support of excavation may be required for launching and receiving pits. Bentonite and/or polymer slurry at the face of the Microtunneling machine is typically used to control the ground and groundwater along the length of the excavation and reduce the friction along the advancing jacking pipe. This method is ideal for long undercrossings such as for freeways and rivers and is well suited where excavation is beneath the water table in transmissive soils.

Conventional Tunnel Excavation: Best suited for large diameter and long drive lengths, conventional tunneling is capable of installing pipelines as small as 60 inch diameter although smaller diameter pipe can be installed within a larger excavation if necessary. Due to equipment constraints conventional tunneling is not considered for short lengths, such as beneath intersections, where jack and bore or microtunneling is more suitable. Where excavation is beneath the water table, groundwater control or watertight support of excavation may be required for entrance and exit shafts.

Along the tunnel, ground and groundwater control can be provided through a number of methods. The equipment utilized in conventional tunneling can provide proactive or reactive ground and groundwater support. Excavation with an earth pressure balance machine (EPBM) or slurry machine can provide proactive ground and groundwater support. Excavation with an open style tunnel boring machine (TBM) does not provide proactive support but can support the ground behind the excavation with an initial support system. Excavations classified as gassy will require proper ventilation and intrinsically safe equipment.

Horizontal Directional Drilling (HDD): This method of undercrossing excavation can accommodate pipe diameters up to 60 inches with lengths over 10,000 feet feasible between access points. This method can accommodate excavation in clays, silts, sands, gravels, cobbles and boulders, though gravel, cobbles, and boulders are challenging. Consistency in the geology along the excavation is critical to success as crossing between disparate geologic units while maintaining alignment and grade with HDD can be challenging. Launching and receiving pits, such as are required for other tunneling methods, are not required for this method, negating the need to dewater. Bentonite and/or polymer slurry is used to stabilize the ground and reduce friction for drill pipe, backreaming and to pull the pipe into place. This method is ideal for long undercrossings such as for freeways and rivers and is well suited where excavation is beneath the water table in transmissive soils. The HDD method requires enough area to lay down and weld the finished pipe prior to pulling the pipe back through the reamed HDD hole. Considering that for the RRWSP conveyance project, steel pipe with diameters from 4.5 to 7 feet are required, undercrossings less than about 1,800 ft are generally not considered for HDD due to equipment constraints related to the angle of approach and required bending radii.

4.0 GENERAL CONDITIONS

The conclusions and recommendations presented in this report are based upon our review of the documents provided to us and our relevant previous experience. No field exploration, laboratory testing, or analyses were performed as part of this review. In addition, we have relied on data such as boring logs or groundwater levels collected by others. As such, the findings summarized in this report are preliminary and subject to change when additional information or further investigations become available.

The information presented in this report is intended to be used for project planning purposes only. This information is subject to change once the specific details or features of the proposed project are identified and/or undergo changes.

Professional judgments presented in this report are based on an evaluation of the technical information gathered and GeoPentech's general experience in the fields of geotechnical engineering and geology. GeoPentech does not guarantee the performance of the project in any respect, only that the engineering work and judgment rendered meet the standard of care of the geotechnical profession at this time.

5.0 REFERENCES

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TABLE 1a
FAULT CHARACTERISTICS - GEOMETRY
Regional Recycled Water Supply Program

	Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*	*Column 6*	*Column 7*
Fault	Style	M_{char} (M_w)	Length (km)	Dip, Dir. (deg, -)	TOR (km)	BOR (km)	Total Area (sq km)
Whittier-Elsinore Whittier Segment Only	OBL	7.0	46	75 NE	0	13.0	623
Newport-Inglewood	SS	7.4	157	85, NE	0	15.0	2,359
Compton	OBL	6.9	65	28, NE	5.0	10.0	613
Puente Hills (unsegmented)	OBL	7.3	44	27, NE	3.0	17.0	1,357
Puente Hills (Alternate #2) Coyote Hills Segment Only	OBL	6.7	17	27, NE	3.0	17.0	537
Peralta Hills	RV	6.4	14	50, N	0.3	14.0	249

Key To Fault Parameters

Column 1	Style of faulting: SS = Strike-slip; RV = Reverse; OBL = Oblique.
Column 2	Best-estimate moment magnitude (Mw) characteristic earthquake generated by fault; based on literature review of peer-reviewed journal publications and discussions with academic experts.
Column 3	Fault length; based on WGCEP (2013a,b), literature review of peer-reviewed journal publications, and discussions with academic experts.
Column 4	Fault dip and dip direction; based on WGCEP (2013a,b), literature review of peer-reviewed journal publications, and discussions with academic experts.
Column 5	Depth to top of rupture (non-zero values indicate blind fault); based on WGCEP (2013a,b), literature review of peer-reviewed journal publications, and discussions with academic experts.
Column 6	Depth to bottom of rupture; based on WGCEP (2013a,b), literature review of peer-reviewed journal publications, and discussions with academic experts.
Column 7	Area of fault plane, based on geometry in Columns 3 through 6.

References: Akciz et al., 2014; Brankman and Shaw, 2009; Brothers et al., 2015; Dolan et al., 2001; Freeman et al., 1992; Fumal et al., 2002; Grant-Ludwig et al., 2015; Grant et al., 1997; Gurrola and Rockwell, 1996; Leon et al., 2009; Leon et al., 2007; Leonard, 2010; McNeilan et al., 1996; Rockwell, pers. comm., 2015; Rockwell et al., 2012; Sahakian et al., 2015; Shaw, 2009; Shaw and Suppe, 1996; Weldon et al., 1996; WGCEP, 2008, 2013; Yule and Sieh, 2001.

TABLE 1b
FAULT CHARACTERISTICS - DEFORMATIONS AND RATES
Regional Recycled Water Supply Program

	Column 1	*Column 2*	*Column 3*	*Column 4*
Fault	Best-Estimate Avg. Disp. (m)	Best-Estimate Slip Rate (mm/yr)	MRE (cal. yrs)	Best-Estimate RI (yrs)
Whittier-Elsinore Whittier Segment Only	right-lateral: 1.9	2 to 3	200 BC to 600 AD	1,400
Newport-Inglewood	right-lateral: 2.0	1.8	1933 (no surf. rupt.) M_{char} since 2300 BC	2,000 to 3,000
Compton	uplift: 1.0 along-plane: 2.2	1.2	250 AD to 1300 AD	2,200
Puente Hills (unsegmented)	uplift: 1.6 along-plane: 3.5	0.9 to 1.6 (Santa Fe Springs Segment)	since 2200 BC (Santa Fe Springs Seg.)	3100 (Santa Fe Springs Seg.)
Puente Hills (Alternate #2) Coyote Hills Segment Only	uplift: 0.5 along-plane: 1.1	0.9 to 1.6	since 2200 BC	3,100
Peralta Hills	uplift: 0.4 along-plane: 0.9	0.4	within last ~14,000 yrs	6,000 to 7,000

Key To Fault Parameters

Column 1	Best-estimate average coseismic displacement for characteristic earthquake in Column 2; based on literature review of peer-reviewed journal publications and discussions with academic experts.
Column 2	Best-estimate average fault slip rate; based on literature review of peer-reviewed journal publications and discussions with academic experts.
Column 3	Most recent surface-rupturing earthquake (MRE) in calendar years; based on literature review of peer-reviewed journal publications and discussions with academic experts.
Column 4	Best-estimate average recurrence interval for characteristic earthquake in Column 3; based on literature review of peer-reviewed journal publications and discussions with academic experts.

References: Akciz et al., 2014; Brankman and Shaw, 2009; Brothers et al., 2015; Dolan et al., 2001; Freeman et al., 1992; Fumal et al., 2002; Grant-Ludwig et al., 2015; Grant et al., 1997; Gurrola and Rockwell, 1996; Leon et al., 2009; Leon et al., 2007; Leonard, 2010; McNeilan et al., 1996; Rockwell, pers. comm., 2015; Rockwell et al., 2012; Sahakian et al., 2015; Shaw, 2009; Shaw and Suppe, 1996; Weldon et al., 1996; WGCEP, 2008, 2013; Yule and Sieh, 2001.

TABLE 2

Geotechnical Conditions for Cut and Cover and Undercrossing Pipeline Sections

Ground Condition	Cut and Cover Pipeline	Undercrossing Pipeline
Depth to Groundwater	Areas with depth to water less than 20 feet as shown on the Ground Conditions map (Figure 8A) will likely require dewatering; this includes approximately 80% of the alignment.	Areas with depth to water less than 50 feet as shown by the stippled area on the Ground Conditions map (Figure 8B) will likely require dewatering for jack and bore and conventional tunneling methods; this includes 29 of the 35 proposed undercrossings for the “Preferred” alignment.
Running or Flowing Ground	Areas with groundwater less than 20 feet and sandy soil with little or no silt as shown on the Ground Conditions map as “Sand-Gravel-Cobbles-Boulders,” “Sand,” and “Sand with Silt” (Figure 8A) have the potential to run where unconsolidated in open excavations; shoring or cut slopes and dewatering will be required in these areas.	Areas with groundwater less than 50 feet as shown by the stippled area on the Ground Conditions map and with sandy soil with little or no silt as identified as “Sand-Gravel-Cobbles-Boulders,” “Sand,” and “Sand with Silt” (Figure 8B) have the potential to run where unconsolidated in an unsupported tunnel face. Tunneling method that counteracts running ground conditions will be required for these ground types.
High Permeability	Areas with groundwater less than 20 feet and sandy soil with little or no silt as shown on the Ground Conditions map as “Sand-Gravel-Cobbles-Boulders,” “Sand,” and “Sand with Silt” (Figure 8A) are likely highly permeable and may yield high volumes of groundwater during dewatering (e.g. greater than 500 gpm combined pump rates with close density of extractions wells along excavation may be needed).	Areas with groundwater less than 50 feet as shown by the stippled area on the Ground Conditions map and with sandy soil with little or no silt as identified as “Sand-Gravel-Cobbles-Boulders,” “Sand,” and “Sand with Silt” (Figure 8B) are likely highly permeable and may yield high inflows of groundwater during tunneling. Dewatering in advance of jack and bore or conventional tunnel excavation, or other means of groundwater control will be required in these areas.

TABLE 2

Geotechnical Conditions for Cut and Cover and Undercrossing Pipeline Sections

Ground Condition	Cut and Cover Pipeline	Undercrossing Pipeline
Organic/Soft Soils	Organic and or soft soil conditions may be present where "Sand-Silt-Clay" soils are shown on the Ground Conditions map (Figure 8A). Ground preparation and or treatment will be likely in these areas.	Organic and or soft soil conditions may be present where "Sand-Silt-Clay" soils are shown on the Ground Conditions map (Figure 8B). Undercrossing excavation method used will require guidance system to maintain line and grade control. Soil modification will be necessary to stabilize the ground to improve bearing capacity for launching/receiving pits.
Gassy Conditions & Oil Fields	The Ground Conditions Map (Figure 8A) shows the extent of known Oil and Gas fields in the project alignment area; gassy ground conditions, abandoned well casings and legacy soil contamination may be present within these areas of the proposed pipeline alignments.	The Ground Conditions Map shows the extent of known Oil and Gas fields in the project alignment area (Figure 8B); gassy ground conditions, abandoned well casings and legacy soil contamination may be present within these areas of the proposed pipeline alignments.
Corrosive Soil	Corrosive soils are known to exist within the planned pipeline alignments though they currently have not been mapped.	Corrosive soils are known to exist within the planned tunnel alignments though they currently have not been mapped.
Liquefaction	Areas with groundwater less than 50 feet as shown by the stippled area on the Ground Conditions map and with sandy soil with little or no silt identified as "Sand-Gravel-Cobbles-Boulders," "Sand," and "Sand with Silt" (Figure 8A) have the potential to liquefy where not dense. Pipeline design should take into account potential ground deformations in these areas.	Areas with groundwater less than 50 feet as shown by the stippled area on the Ground Conditions map and with sandy soil with little or no silt as identified as "Sand-Gravel-Cobbles-Boulders," "Sand," and "Sand with Silt" (Figure 8B) have the potential to liquefy where not dense. Undercrossing design should take into account potential ground deformations in these areas.

TABLE 2

Geotechnical Conditions for Cut and Cover and Undercrossing Pipeline Sections

Ground Condition	Cut and Cover Pipeline	Undercrossing Pipeline
Faults	The proposed pipeline alignments cross the Newport Inglewood Fault Zone, The Los Alamitos Fault, Whittier Fault, and possibly the East Montebello Fault (Figure 8A); though not mapped, the alignment also overlies the Puente Hills, Peralta Hills and Compton blind thrust system. Ground deformation and possibly displacement should be considered in the pipeline design for these areas.	The proposed undercrossing tunnel sections cross the Newport Inglewood Fault Zone, The Los Alamitos Fault, and Whittier Fault (Figure 8B); though not mapped, undercrossing tunnel alignments also overlie the Puente Hills, Peralta Hills and Compton blind thrust system. Ground deformation and possibly displacement should be considered in the pipeline undercrossing design for these areas.
Mixed Face Conditions	Ground with cobbles and boulders are common in the Upper San Gabriel Valley and, although not shown on the Ground Conditions Map (Figure 8A), these sized clasts may be encountered during pipeline excavation.	Ground with cobbles and boulders as identified on the Ground Conditions map as "Sand-Gravel-Cobbles-Boulders" (Figure 8B) are common in the Upper San Gabriel Valley and may be encountered during tunnel excavation. Tunneling means and methods must be able to accommodate these mixed face conditions.

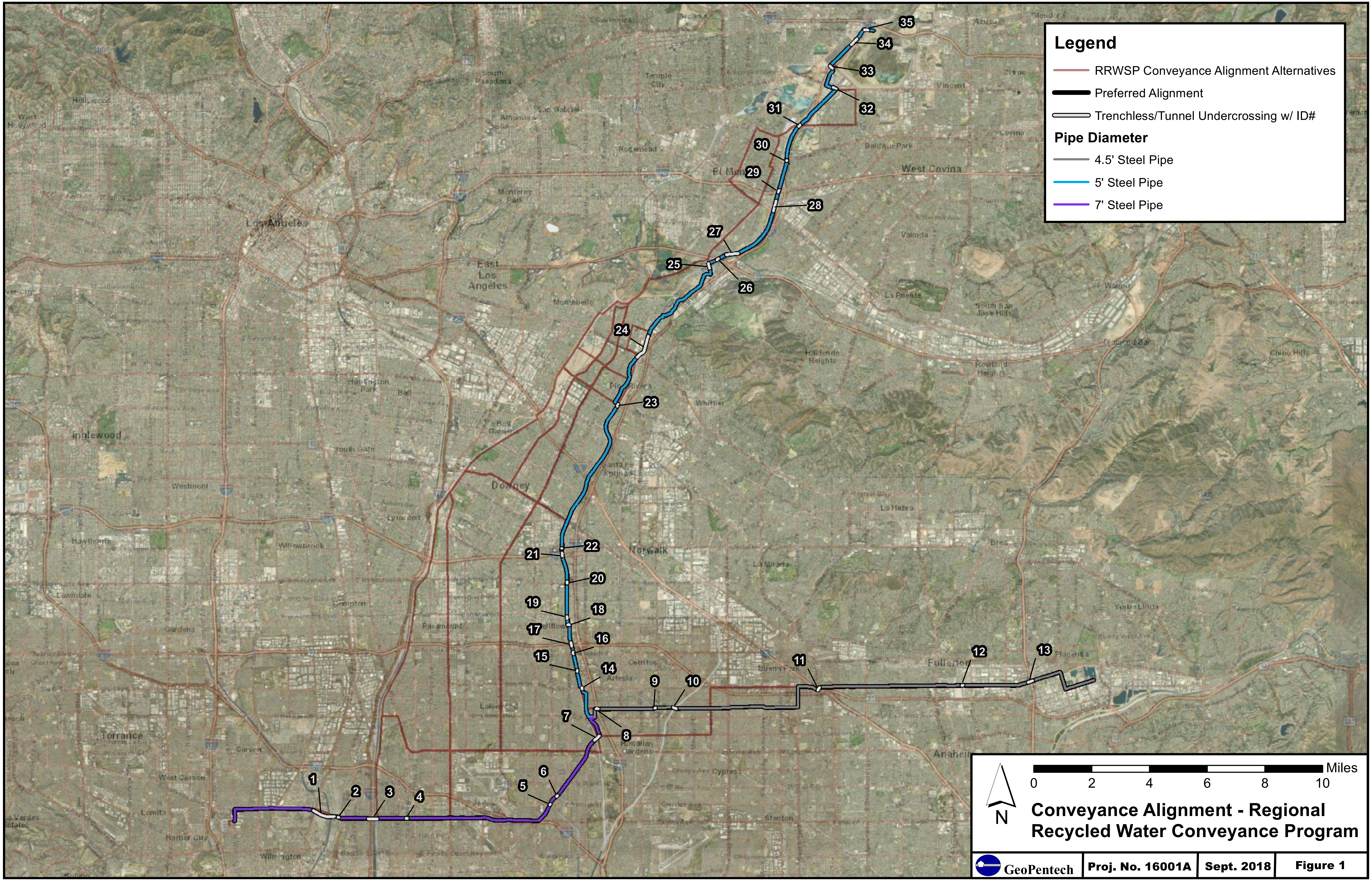
Table 3
Undercrossing Summary and Alternative Excavation Methods

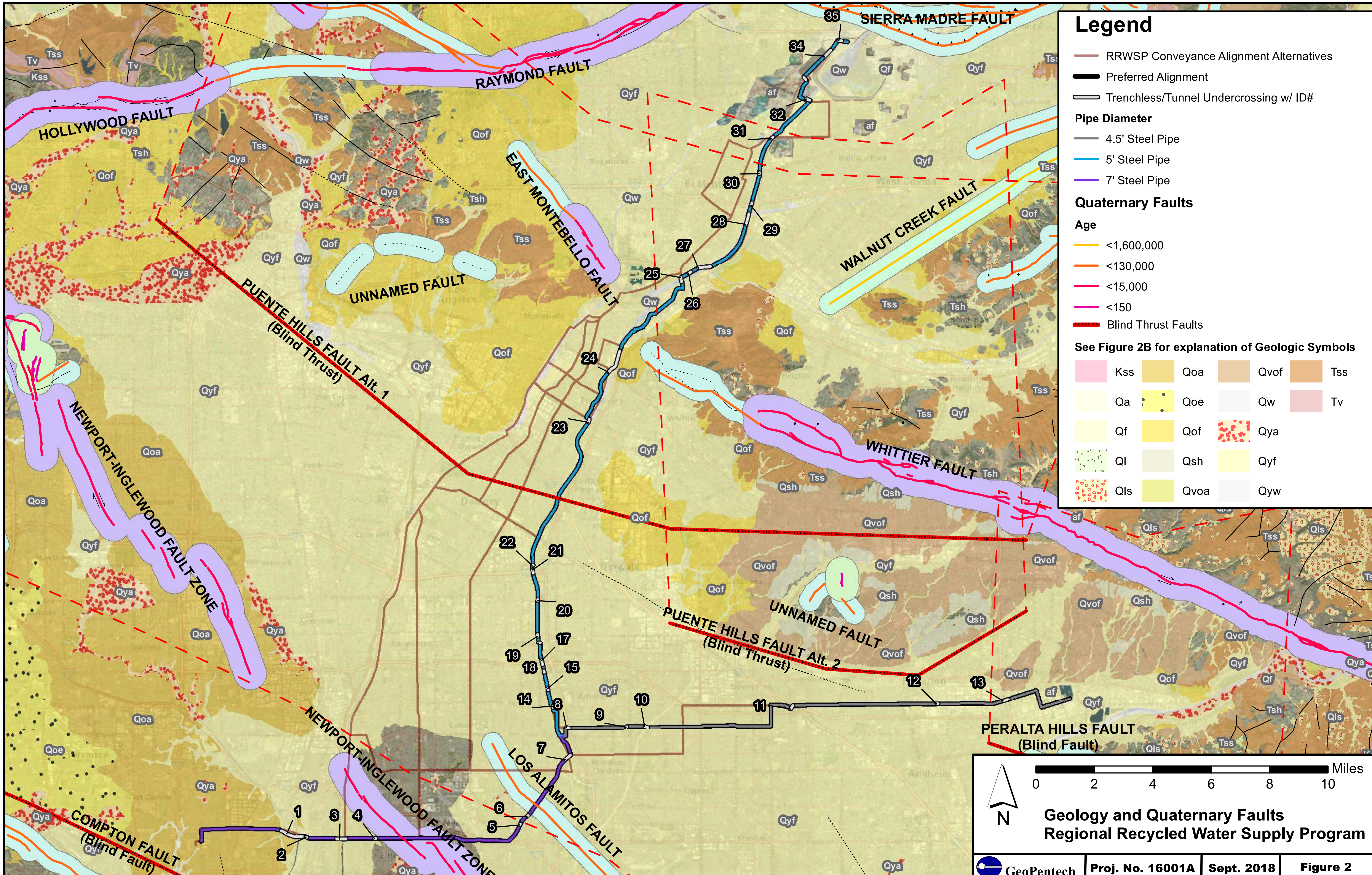
Undercrossing Conceptual Layout					Ground Conditions within Undercrossing	GW Level Above Tunnel	Alternative Excavation Method[3]			
Tunnel ID	**Length (ft)**	**Undercrossing Description**	**Diameter (ft)**	**Minimum Cover (ft)[2]**			**A - Jack & Bore**	**B - Micro-Tunneling**	**C - Traditional**	**D - Horizontal Directional Drilling (HDD)**
1	3,442	Intersection/ railroad/river	7	31	**Alluvium:** Sand (SP), Silty Sand (SM) with trace gravel and clay, Clay (CL) and Clayey Sand (SC)	Yes	Not Applicable	Applicable	Applicable	Not Applicable
2	88	Railroad	7	21	**Alluvium:** Sand (SP), Silty Sand (SM) with trace gravel and clay, Clay (CL) and Clayey Sand (SC)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
3	1,418	River	7	21	**Alluvium:** Loose Sand (SP), Silty Sand (SM) and Sandy Silt (ML)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
4	222	Intersection/ railroad	7	21	**Alluvium, San Pedro Fm. and Palos Verdes Sand:** Clayey Silt (ML), dense Sand (SP), dense Silty Sand (SM); **Long Beach Oil & Gas Field**	Yes	Applicable	Applicable	Not Applicable	Not Applicable
5	166	River	7	21	**Alluvium:** Silty Sand (SM), Silty Clay (CL), Clayey Silt (ML) with fine sand, Clayey Sand (SC) with silt	Yes	Applicable	Applicable	Not Applicable	Not Applicable
6	200	River	7	21	**Alluvium:** Silty Sand (SM), Silty Clay (CL), Clayey Silt (ML) with fine sand, Clayey Sand (SC) with silt	Yes	Applicable	Applicable	Not Applicable	Not Applicable
7	1,006	River	7	21	**Alluvium:** compact Sand (SP), loose to compact Silty Sand (SM), soft Silt (ML)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
8	351	Freeway	4.5	13.5	**Alluvium:** fine Sandy Silt (ML), compact Sand (SP), dense Silty Sand (SM), Clayey Silt (ML), loose Silty Sand (SM)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
9	134	River	4.5	27.5	**Alluvium:** fine Sand (SP), Silt (ML), Silty Clay (CL), loose fine Sand (SP), soft Silty Clay (CL) with sand, loose fine Sand (SP)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
10	478	River	4.5	29.5	**Alluvium:** fine Sand (SP), Silt (ML), Silty Clay (CL), loose fine Sand (SP), soft Silty Clay (CL) with sand, loose fine Sand (SP)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
11	518	Freeway	4.5	13.5	**Alluvium:** Sand (SP), Silt (ML); **Buena Park East Oil & Gas Field**	Yes	Applicable	Applicable	Not Applicable	Not Applicable
12	201	Railroad	4.5	13.5	**Alluvium:** Sand (SP), Silt (ML)	No	Applicable	Applicable	Not Applicable	Not Applicable
13	1,050	Freeway	4.5	13.5	**Alluvium:** Sand (SP), Silt (ML); **Richfield Oil & Gas Field**	No	Not Applicable	Applicable	Not Applicable	Not Applicable
14	206	Intersection	5	15	**Alluvium:** Clayey Silt (ML), Silty Clay (CL), Silty Sand (SM), interbedded Sand (SP) and Clay (CL)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
15	169	Intersection	5	15	**Alluvium:** Clayey Silt (ML), loose to dense Silty Sand (SM), Silt (ML) with some fine sand	Yes	Applicable	Applicable	Not Applicable	Not Applicable
16	249	Intersection	5	15	**Alluvium:** compact Silty Sand (SM), soft Clayey Silt (ML)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
17	585	Freeway	5	15	**Alluvium:** compact Silty Sand (SM), soft Clayey Silt (ML), fine to medium Sand (SP), fine Silty Sand (SM)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
18	275	River	5	15	**Alluvium:** very fine to fine Silty Sand (SM), medium to coarse Sand (SP), fine to medium Sand (SP), interbedded Silt (ML) and fine Silty Sand (SM), compact interbedded fine Sand (SP) and fine Silty Sand (SM)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
19	280	Intersection	5	15	**Alluvium:** very fine to fine Silty Sand (SM), medium to coarse Sand (SP), fine to medium Sand (SP), interbedded Silt (ML) and fine Silty Sand (SM), compact interbedded fine Sand (SP) and fine Silty Sand (SM)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
20	205	Intersection	5	15	**Alluvium:** compact to dense fine to medium Sand (SP), compact Silty fine Sand (SM), medium to coarse Sand (SP), stiff Sandy Clay (CL)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
21	472	Freeway	5	15	**Alluvium:** compact to dense fine to medium Sand (SP), compact Silty fine Sand (SM), medium to coarse Sand (SP), stiff Sandy Clay (CL)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
22	102	Dam	5	15	**Alluvium:** compact to dense fine to medium Sand (SP), compact Silty fine Sand (SM), medium to coarse Sand (SP), stiff Sandy Clay (CL)	Yes	Applicable	Applicable	Not Applicable	Not Applicable

Table 3 (continued)
Undercrossing Summary and Alternative Excavation Methods

Undercrossing Conceptual Layout					Ground Conditions within Undercrossing	GW Level Above Tunnel	Alternative Excavation Method[3]			
Tunnel ID	Length (ft)	Undercrossing Description	Diameter (ft)	Minimum Cover (ft)[2]			A - Jack & Bore	B - Micro-Tunneling	C - Traditional	D - Horizontal Directional Drilling (HDD)
23	422	River	5	15	**Alluvium:** medium to coarse Sand (SP) with lenses of gravel grading to very fine Silty Sand (SM), fine to very coarse Sand (SW) with occasional gravel, fine to coarse Sand (SW), Sandy Silt (ML)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
24	3,779	River/Railroad	5	31	**Alluvium:** fine to medium Sand (SP), fine to coarse Sand (SW); **Whittier Oil & Gas Field**	Yes	Not Applicable	Applicable	Applicable	Applicable
25	666	River	5	15	**Alluvium:** compact interbedded very fine Silty Sand (SM) and soft very fine Sandy Silt (ML), dense Sand (SP) and Sandy Gravel (GP) interbedded with compact very fine Silty Sand (SM) and very fine Sand (SP), compact Gravelly Sand (SP) and Sandy Gravel (GP), stiff Silty Clay (CL), dense to very dense coarse Sand (SP) with scattered gravel, well graded Sand (SW); **Lapworth Oil & Gas Field**	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
26	336	Freeway	5	15	**Alluvium:** compact interbedded very fine Silty Sand (SM) and soft very fine Sandy Silt (ML), loose to dense Sand (SP) and Sandy Gravel (GP) interbedded with compact very fine Silty Sand (SM), compact Gravelly Sand (SP) and Sandy Gravel (GP), stiff Silty Clay (CL), interbedded Silt (ML) and fine sand (SP)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
27	1,826	River	5	15	**Alluvium:** compact interbedded very fine Silty Sand (SM) and soft very fine Sandy Silt (ML), loose to dense Sand (SP) and Sandy Gravel (GP) interbedded with compact very fine Silty Sand (SM), compact Gravelly Sand (SP) and Sandy Gravel (GP), stiff Silty Clay (CL), interbedded Silt (ML) and fine sand (SP)	Yes	Not Applicable	Applicable	Not Applicable	Applicable
28	1,629	River	5	15	**Alluvium:** gravelly sand (SW), poorly sorted fine sand with trace coarse sand (SW), fine to medium silty sand w/ interbedded fine to coarse gravelly sand beds (SM), fine to medium sand (SP), compact silty fine sand (SM) with interbedded clean sand and gravel layer, compact to dense clean medium to coarse sand and interbedded very fine to fine sand (SP), slightly compact clean medium to coarse sand and scattered cobbles (SP)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
29	325	Freeway	5	15	**Alluvium:** gravelly sand (SW), poorly sorted fine sand with trace coarse sand (SW), fine to medium silty sand w/ interbedded fine to coarse gravelly sand beds (SM), fine to medium sand (SP), compact silty fine sand (SM) with interbedded clean sand and gravel layer, compact to dense clean medium to coarse sand and interbedded very fine to fine sand (SP), slightly compact clean medium to coarse sand and scattered cobbles (SP)	Yes	Not Applicable	Applicable	Not Applicable	Not Applicable
30	130	Intersection	5	15	**Alluvium:** dense to very dense Sand (SP) and coarse Gravel (GP), Gravelly Sand (SW)	Yes	Applicable	Applicable	Not Applicable	Not Applicable
31	287	Intersection	5	15	**Alluvium:** very dense coarse Gravel (GP) with scattered cobbles, dense to very dense Sand (SP), dense to very dense gravelly Silty Sand (ML) with cobbles and boulders	No	Applicable	Applicable	Not Applicable	Not Applicable
32	530	River	5	15	**Alluvium:** very dense Sandy Gravel (GW) with cobbles and boulders	No	Not Applicable	Applicable	Not Applicable	Not Applicable
33	517	Freeway	5	15	**Alluvium:** very dense Sandy Gravel (GW) with cobbles and boulders	No	Not Applicable	Applicable	Not Applicable	Not Applicable
34	1,215	Dam	5	15	**Alluvium:** dense to very dense Sand (SP) and Gravel (GP) with cobbles and scattered boulders, dense to very dense fine to medium Sand (SP) with scattered gravel	No	Not Applicable	Applicable	Not Applicable	Not Applicable
35	508	Freeway	5	15	**Alluvium:** dense to very dense Sand (SP) and Gravel (GP) with cobbles and boulders, dense to very dense fine to medium Sand (SP) with scattered gravel and cobbles	No	Not Applicable	Applicable	Not Applicable	Not Applicable

Notes:
1. Tunnel ID number correspond with undercrossing number on Figures 1, 7B and 8B.
2. Depth below ground surface or river channel thalweg to top of pipe or crown of tunnel; generally equal to 3 pipe diameters.
3. Applicability of excavation method based on inferred ground conditions.


Legend
RRWSP Conveyance Alignment Alternatives
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Miles
0 2 4 6 8 10
N
Conveyance Alignment - Regional Recycled Water Conveyance Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 1


Legend
RRWSP Conveyance Alignment Alternatives
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Quaternary Faults
Age
<1,600,000
<130,000
<15,000
<150
Blind Thrust Faults
See Figure 2B for explanation of Geologic Symbols
Kss
Qoa
Qvof
Tss
Qa
Qoe
Qw
Tv
Qf
Qof
Qya
Ql
Qsh
Qyf
Qls
Qvoa
Qyw
SIERRA MADRE FAULT
RAYMOND FAULT
HOLLYWOOD FAULT
EAST MONTEBELLO FAULT
UNNAMED FAULT
WALNUT CREEK FAULT
PUENTE HILLS FAULT Alt. 1
(Blind Thrust)
NEWPORT-INGLEWOOD FAULT ZONE
WHITTIER FAULT
UNNAMED FAULT
PUENTE HILLS FAULT Alt. 2
(Blind Thrust)
PERALTA HILLS FAULT
(Blind Fault)
LOS ALAMITOS FAULT
NEWPORT-INGLEWOOD FAULT ZONE
COMPTON FAULT
(Blind Fault)
Miles
0
2
4
6
8
10
N
Geology and Quaternary Faults
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 2

Geologic Units

Kss - Coarse-grained Cretaceous age formations of sedimentary origin

Qa - Quaternary age Alluvial Valley Deposits

Qb - Quaternary age Beach Deposits

Qe - Quaternary age Eolian and Dune Deposits

Qf - Quaternary age Alluvial Fan Deposits

Ql - Quaternary age Lacustrine, Playa and Estuarine (Paralic) Deposits

Qls - Quaternary age Landslide Deposits; may include debris flows and older landslides

Qoa - Quaternary age Old Alluvial Valley Deposits

Qoe - Quaternary age Old Eolian and Dune Deposits

Qof - Quaternary age Old Alluvial Fan Deposits

Qsh - Fine-grained formations of Quaternary age; includes fine-grained sandstone, siltstone, mudstone, shale, siliceous and calcareous sediments

Qvoa - Quaternary age Very Old Alluvial Valley Deposits

Qvof - Quaternary age Very Old Alluvial Fan Deposits

Qw - Quaternary age Alluvial Wash Deposits

Qya - Quaternary age Young Alluvial Valley Deposits

Qyf - Quaternary age Young Alluvial Fan Deposits

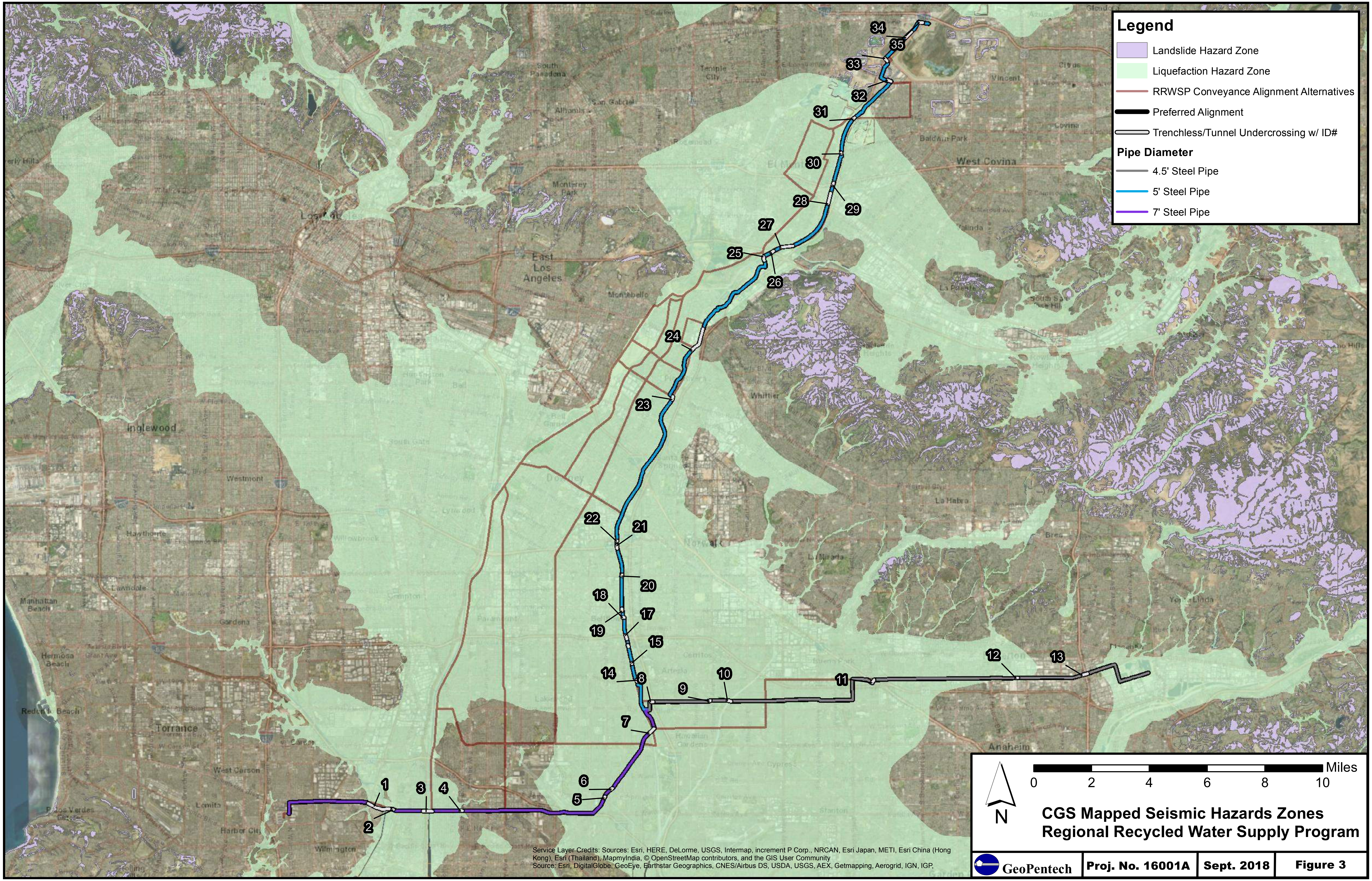
Qyw - Quaternary age Young Alluvial Wash Deposits

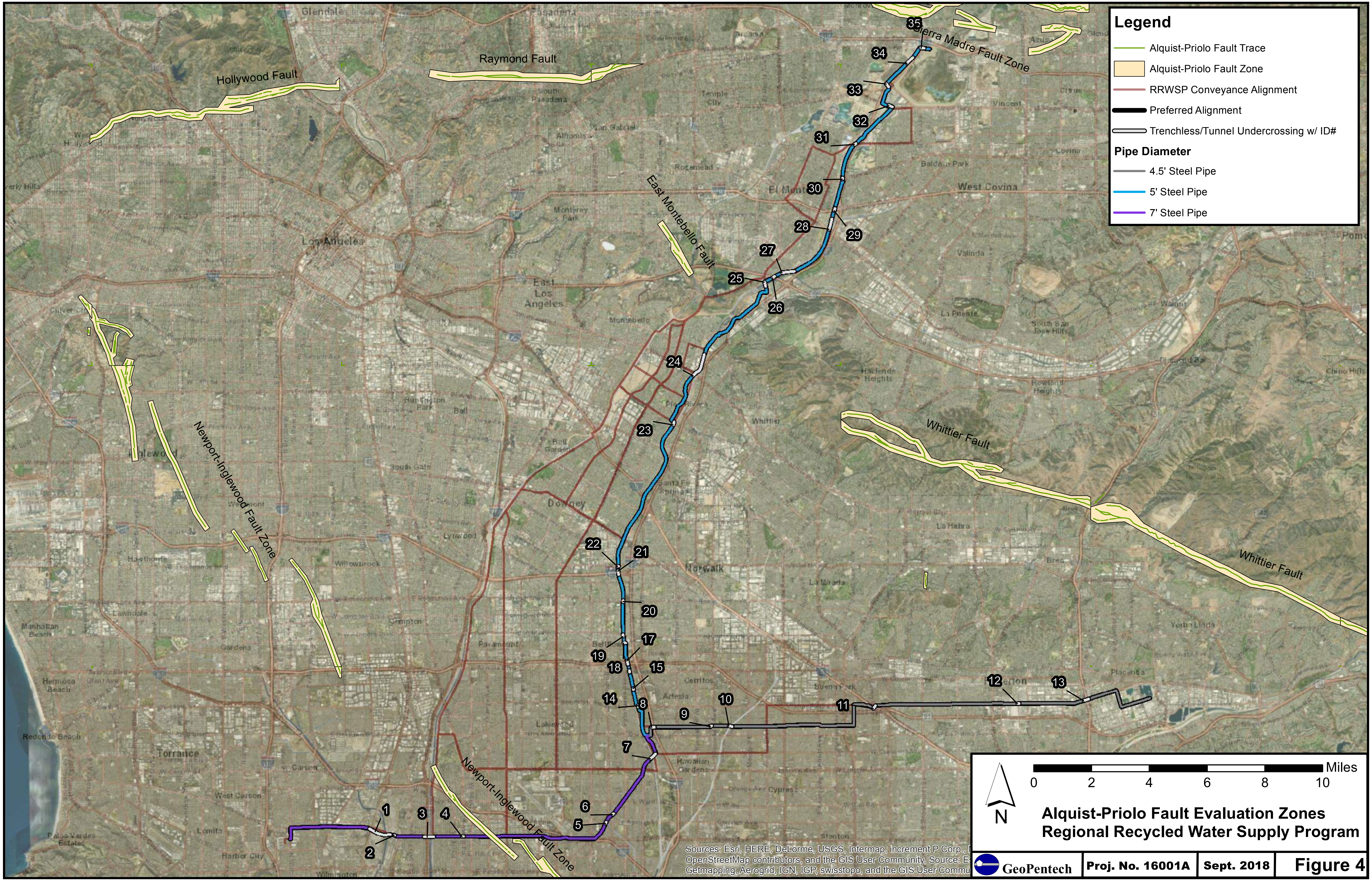
Tss - Coarse-grained Tertiary age formations of sedimentary origin

Tv - Tertiary age formations of volcanic origin

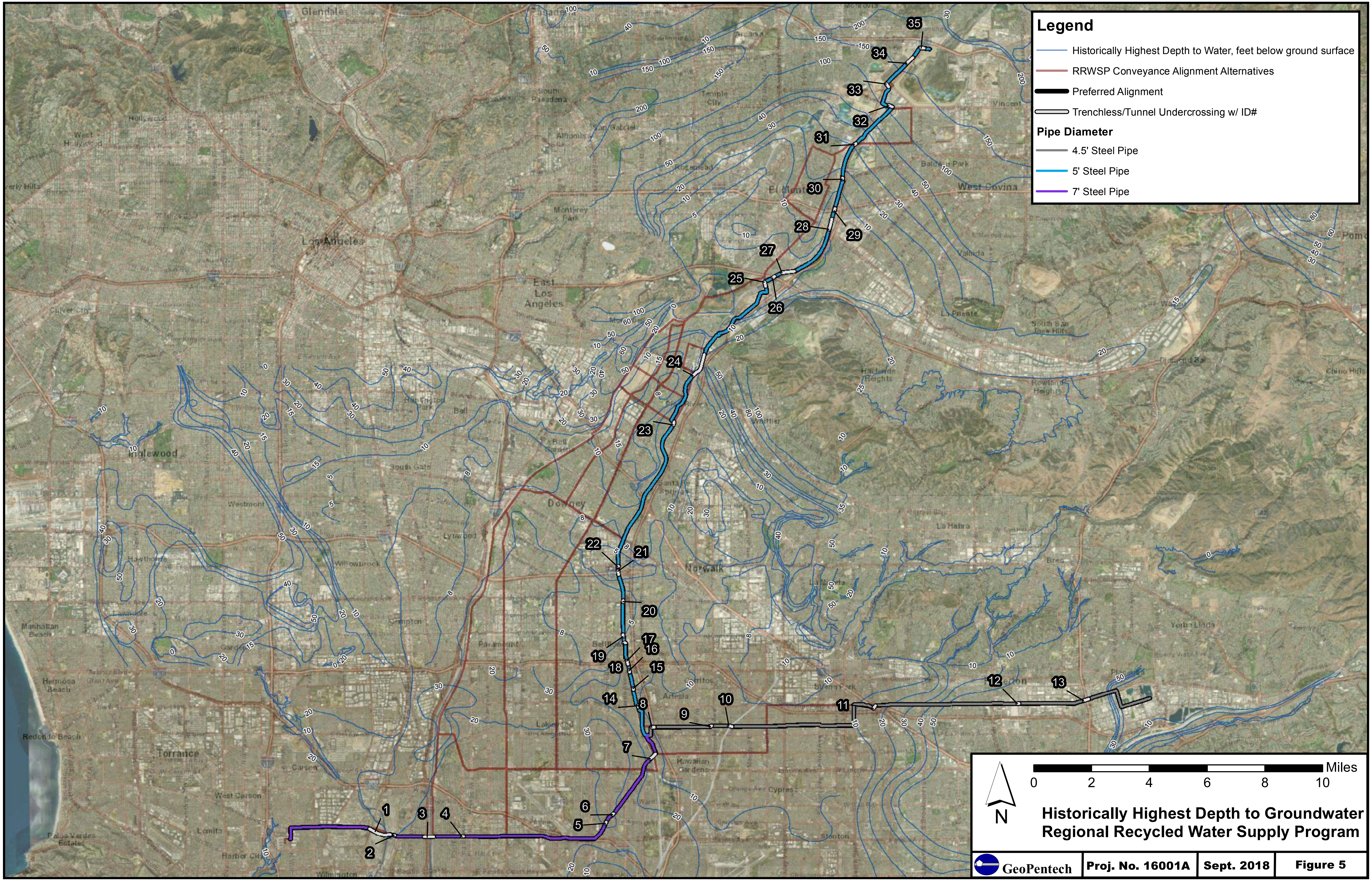
GEOLOGY KEY

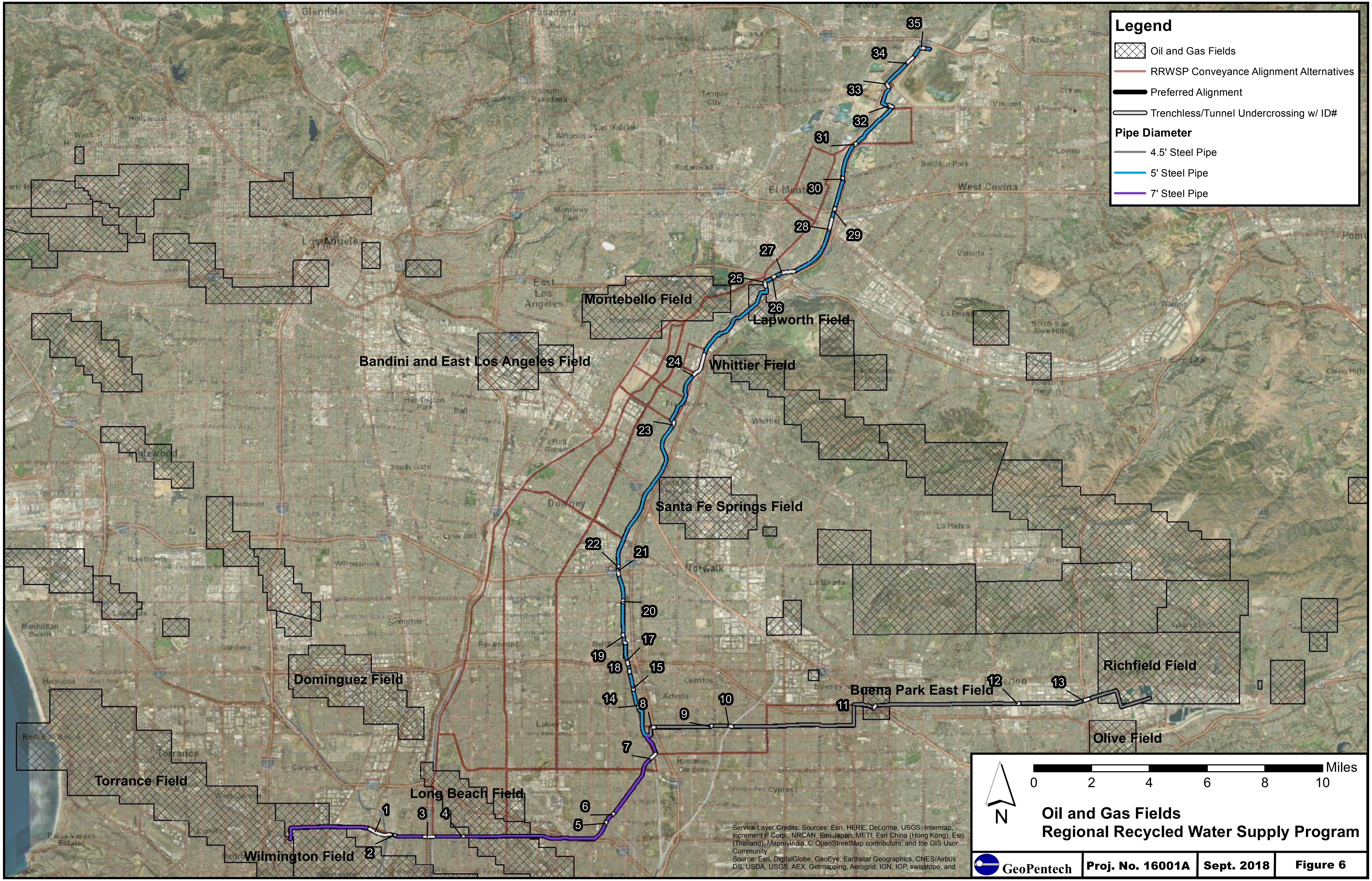
GeoPentech	Proj. No. 16001A	Oct 2017	Figure 2a

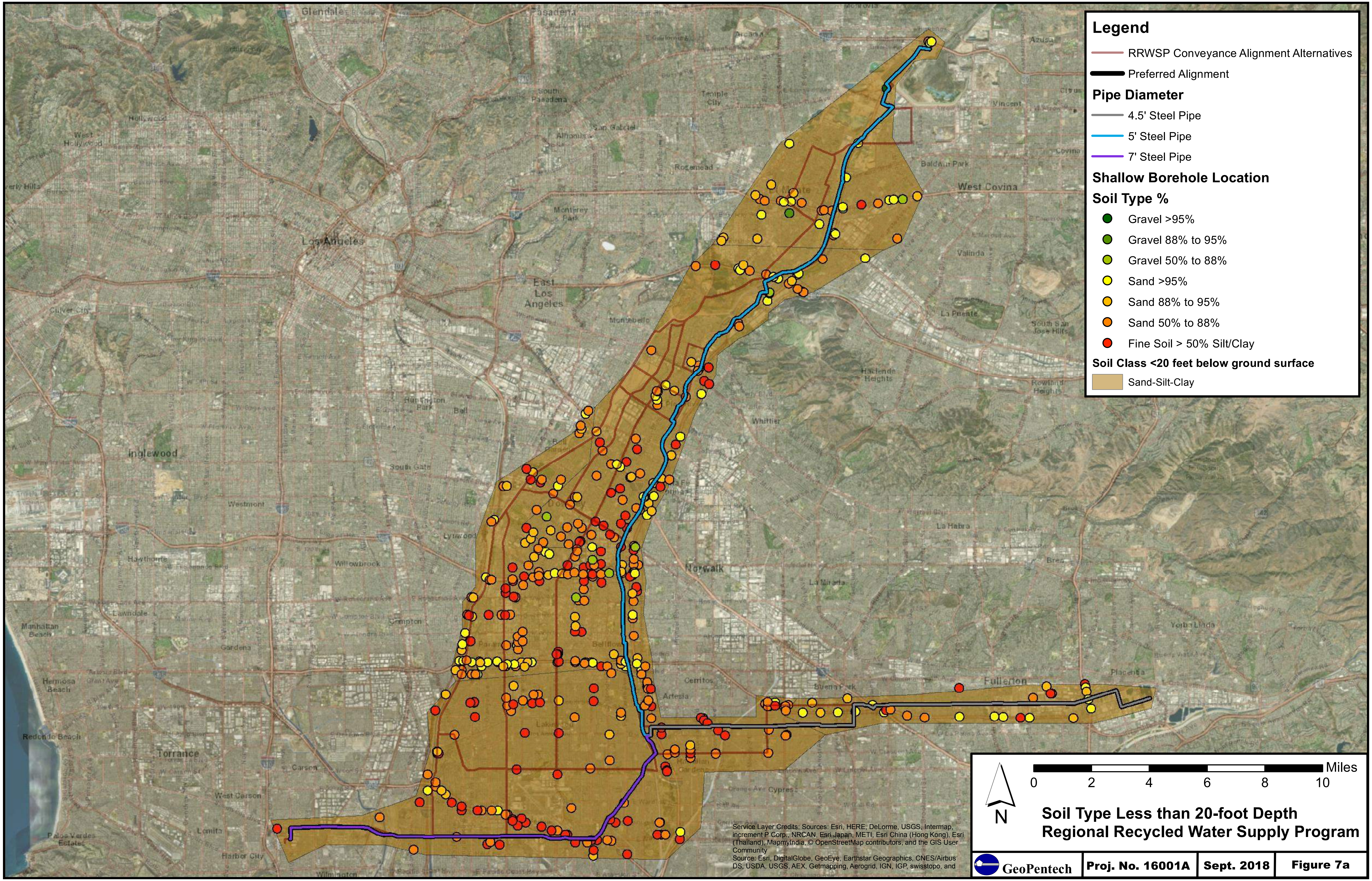

Legend
Landslide Hazard Zone
Liquefaction Hazard Zone
RRWSP Conveyance Alignment Alternatives
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Miles
0 2 4 6 8 10
N
CGS Mapped Seismic Hazards Zones
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 3
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP,
East Los Angeles
Inglewood
Torrance
West Covina
Whittier
La Habra
Anaheim
Hawthorne
Manhattan Beach
Hermosa Beach
Redondo Beach
Gardena
Westmont
Lawndale
West Carson
Lomita
Harbor City
Wilmington
Montebello
Monterey Park
Alhambra
San Gabriel
Temple City
South Pasadena
Baldwin Park
Covina
La Mirada
Norwalk
Downey
Lynwood
Paramount
Compton
Willowbrook
Cerritos
Artesia
Lakewood
Hawaiian Gardens
Cypress
Stanton
Yorba Linda
La Puente
Vincent
Walnut
Hacienda Heights



Legend
Alquist-Priolo Fault Trace
Alquist-Priolo Fault Zone
RRWSP Conveyance Alignment
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Raymond Fault
Hollywood Fault
Sierra Madre Fault Zone
East Montebello Fault
Newport-Inglewood Fault Zone
Whittier Fault
Los Angeles
East Los Angeles
Downey
Norwalk
Torrance
Miles
0 2 4 6 8 10
N
Alquist-Priolo Fault Evaluation Zones
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 4
Sources: Esri, HERE, DeLorme, USGS, Intermap, Increment P Corp., OpenStreetMap contributors, and the GIS User Community, Source: Es... Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Commu...

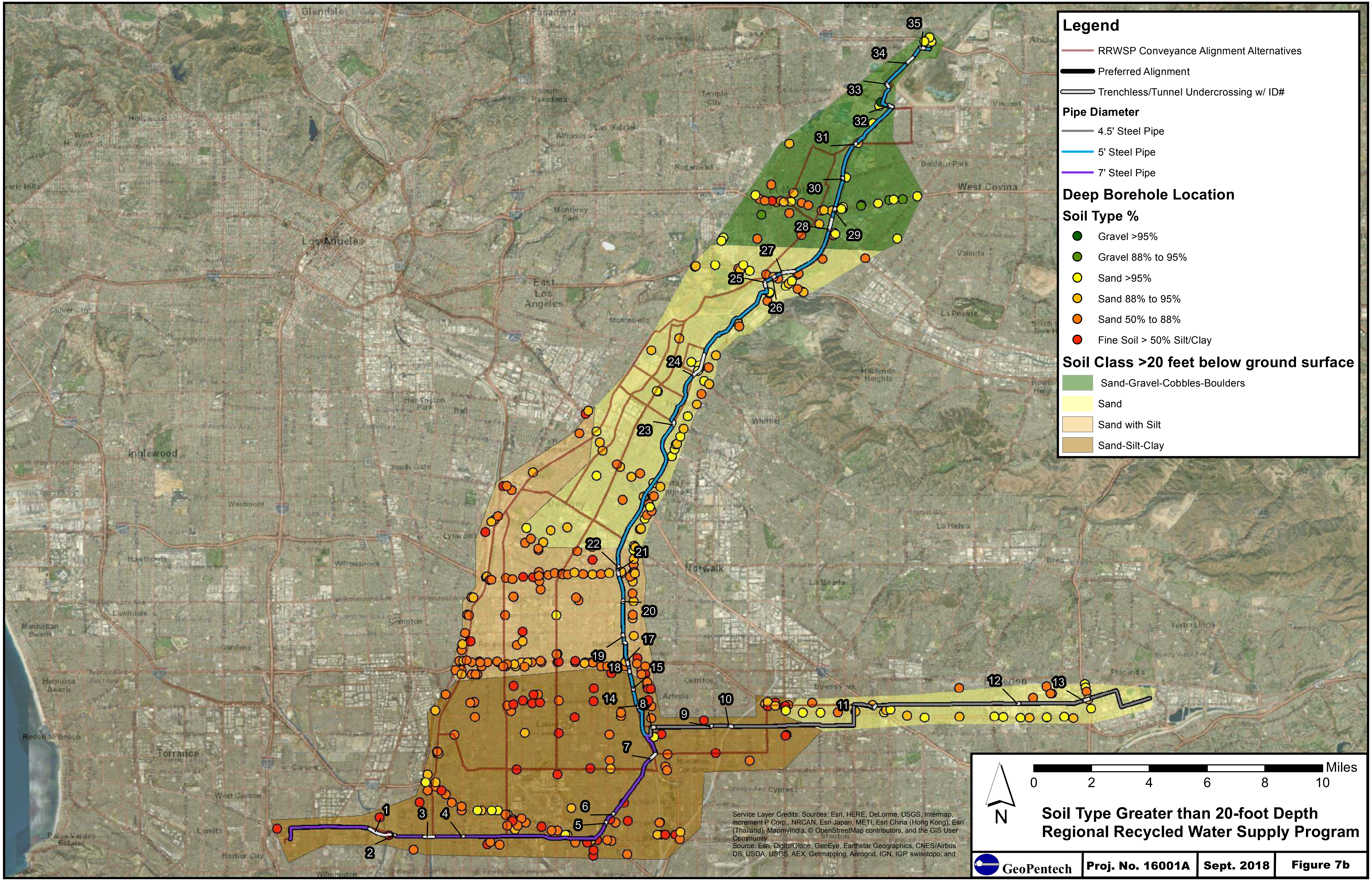

Legend
Historically Highest Depth to Water, feet below ground surface
RRWSP Conveyance Alignment Alternatives
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
0 2 4 6 8 10 Miles
N
Historically Highest Depth to Groundwater
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 5


Legend
Oil and Gas Fields
RRWSP Conveyance Alignment Alternatives
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Montebello Field
Lapworth Field
Bandini and East Los Angeles Field
Whittier Field
Santa Fe Springs Field
Richfield Field
Buena Park East Field
Olive Field
Dominguez Field
Torrance Field
Long Beach Field
Wilmington Field
Miles
0 2 4 6 8 10
N
Oil and Gas Fields
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 6

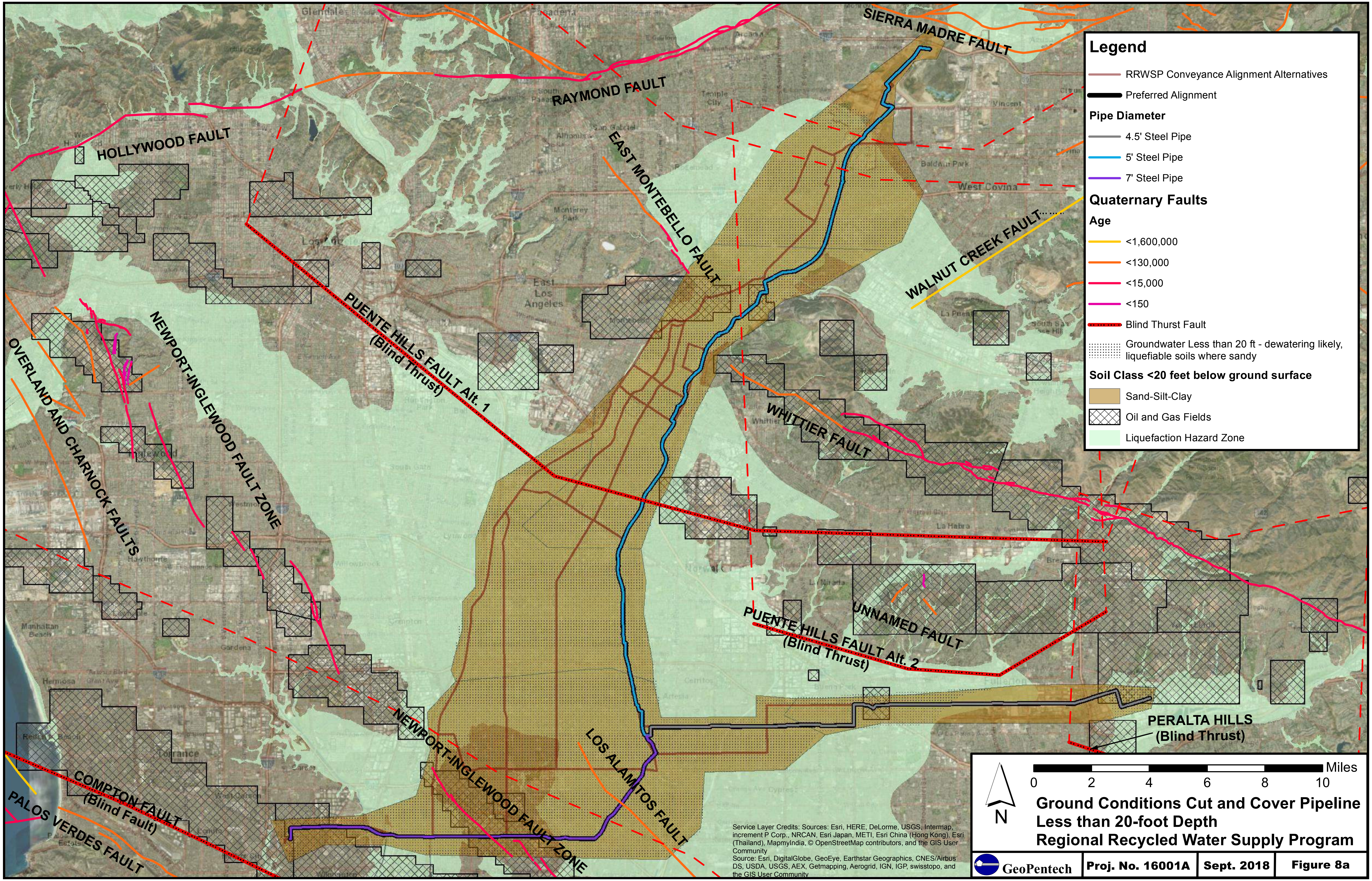


Soil Type Less than 20-foot Depth
Regional Recycled Water Supply Program

GeoPentech | Proj. No. 16001A | Sept. 2018 | Figure 7a

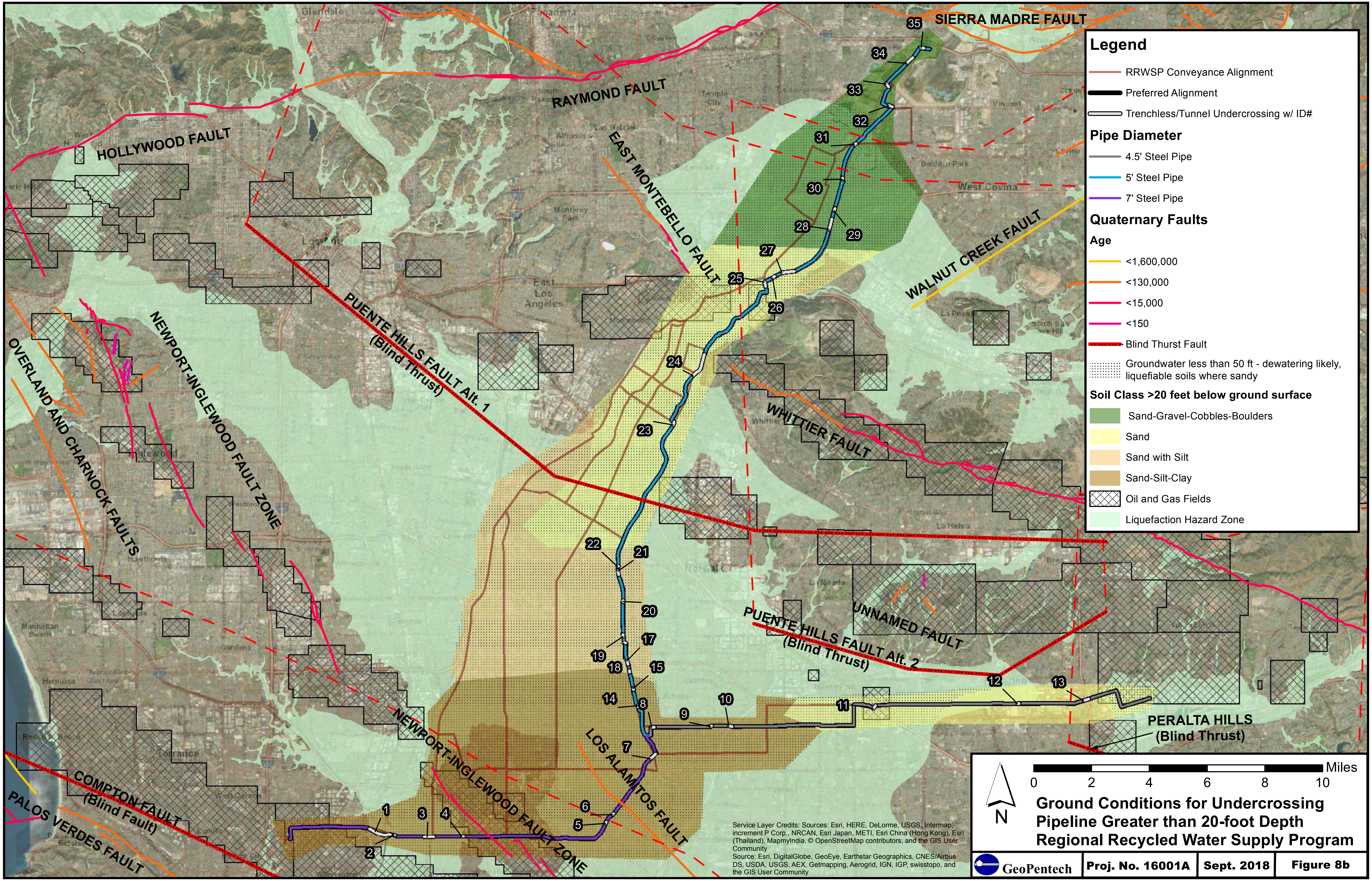


Legend
RRWSP Conveyance Alignment Alternatives
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Deep Borehole Location
Soil Type %
Gravel >95%
Gravel 88% to 95%
Sand >95%
Sand 88% to 95%
Sand 50% to 88%
Fine Soil > 50% Silt/Clay
Soil Class >20 feet below ground surface
Sand-Gravel-Cobbles-Boulders
Sand
Sand with Silt
Sand-Silt-Clay
Miles
0 2 4 6 8 10
N
Soil Type Greater than 20-foot Depth
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 7b
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and



Ground Conditions Cut and Cover Pipeline Less than 20-foot Depth
Regional Recycled Water Supply Program

GeoPentech	Proj. No. 16001A	Sept. 2018	Figure 8a



Legend
RRWSP Conveyance Alignment
Preferred Alignment
Trenchless/Tunnel Undercrossing w/ ID#
Pipe Diameter
4.5' Steel Pipe
5' Steel Pipe
7' Steel Pipe
Quaternary Faults
Age
<1,600,000
<130,000
<15,000
<150
Blind Thrust Fault
Groundwater less than 50 ft - dewatering likely, liquefiable soils where sandy
Soil Class >20 feet below ground surface
Sand-Gravel-Cobbles-Boulders
Sand
Sand with Silt
Sand-Silt-Clay
Oil and Gas Fields
Liquefaction Hazard Zone
SIERRA MADRE FAULT
RAYMOND FAULT
HOLLYWOOD FAULT
EAST MONTEBELLO FAULT
WALNUT CREEK FAULT
PUENTE HILLS FAULT Alt. 1 (Blind Thrust)
NEWPORT-INGLEWOOD FAULT ZONE
OVERLAND AND CHARNOCK FAULTS
WHITTIER FAULT
UNNAMED FAULT
PUENTE HILLS FAULT Alt. 2 (Blind Thrust)
PERALTA HILLS (Blind Thrust)
LOS ALAMITOS FAULT
NEWPORT-INGLEWOOD FAULT ZONE
COMPTON FAULT (Blind Fault)
PALOS VERDES FAULT
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
Miles
0 2 4 6 8 10
N
Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Ground Conditions for Undercrossing Pipeline Greater than 20-foot Depth
Regional Recycled Water Supply Program
GeoPentech
Proj. No. 16001A
Sept. 2018
Figure 8b

Appendix D. Raw Data Tables of Segments and Subsegments

Regional Recycled Water Supply System - Conveyance Feasibility Study

Evaluation Criteria and Data for Pipeline Segments and Sub-Segments

Alignment No	Alignment Sub-Segment	Diameter	Pipe Length	Trenchless Construction	Trenched Construction	Major Utilities	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Street	Lanes of Traffic	Road Category & Traffic Impact	Median Improvements	Major Intersections	Residential/ Minor Commercial	Property Description	Waters of the US and State	Critical Habitats and Listed Species	Cost
		in	ft	ft	ft	ea	ft	Y/N	# Hits		length	length	ea	length	# of lanes		lf	ea	length		length	Y/N	$ mil
1	1(a)	84	3,106	82	3,024	13	11	N	0	Roadway			1	3023.6	4	Collector	1675	1	0	Roadway			$6.04
1	1(b)	84	3,407		3,407	3	13	N	1	Roadway			1	3407	4	Collector	3340		1192	Roadway			$6.25
1	1(c)	84	9,263	926	8,337	60	17	N	7	Roadway				8337	4	Collector	7490	2	7456	Roadway			$20.24
1	1(d)	84	9,559	2,025	7,535	48	19	N	5	Roadway				7535	4	Collector	3700	2	5997	Roadway	655		$24.74
10	10	84	3,372	248	3,124	-	15	N	0	SCE		3123.9		0	0	Easement		1		SCE			$5.29
10A	10A.1(a)	84	2,529	674	1,855	3	19	N	0	Roadway				1855	4	Collector			177	Roadway			$6.18
10A	10A.1(b)	84	2,984	359	2,625	2	14	N	0	Roadway				2625	4	Collector			0	Roadway			$6.29
10A	10A.1(a)OC	54	2,529	674	1,855	3	19	N	0	Roadway				1855	4	Collector			177	Roadway			$5.25
10A	10A.1(b)OC	54	2,984	359	2,625	2	14	N	0	Roadway				2625	4	Collector			0	Roadway			$4.99
10A	10A.2	84	468	83	384	-	15	N	0	Private					0	Easement		1	0	Private			$0.97
10A	10A.3	84	435		435	1	14	N	0	Roadway				435	4	Collector	375		0	Roadway			$0.80
10A	10A.2OC	54	468	83	384	-	15	N	0	Private					0	Easement			0	Private			$0.78
10A	10A.3OC	54	435		435	1	14	N	0	Roadway				435	4	Collector	375		0	Roadway			$0.58
10A	10A.4	54	911		911	-	11	N	0	SCE					0	Easement			0	SCE			$0.70
10A	10A.5	54	271		271	-	11	N	0	SCE					0	Easement			0	SCE			$0.21
11	11.1(a)	54	9,733	1,402	8,332	8	10	N	0	SCE		3851	2		0	Easement			0	SCE	175		$13.21
11	11.1(b)	54	2,039		2,039	-	10	N	0	SCE		2039.2			0	Easement			0	SCE			$1.56
11	11.2	54	501		501	1	10	N	0	LAFCD					0	Easement			0	LAFCD	215		$0.75
11	11.3(a)	54	2,689	149	2,541	1	10	N	0	SCE		2540.6			0	Easement			0	SCE			$2.82
11	11.3(b)	54	2,534		2,534	-	10	N	0	SCE		2534.2			0	Easement			0	SCE			$1.94
11A	11A(a)	84	2,544	421	2,123	-	17	N	0	Roadway				2123	2	Local			0	Roadway	154		$6.28
11A	11A(a)OC	54	2,544	421	2,123	-	17	N	0	Roadway				2123	2	Local			0	Roadway	154		$4.37
11A	11A(b)	54	5,243	2,004	3,239	6	10	N	0	Roadway				3239	Closure	Closure	2500		0	Roadway			$10.69
11A	11A(c)	54	3,015	185	2,830	3	10	N	0	Roadway			1	2830	4	Collector	2040	1	139	Roadway			$4.52
11A	11A(d)	54	2,636	162	2,474	4	10	N	0	Roadway			1	2474	4	Collector	1860	1	1190	Roadway	159		$3.95
11B	11B(a)	54	3,001	169	2,832	4	10	N	1	Roadway			1	2832	4	Collector	1820	1	2338	Roadway			$4.46
11B	11B(b)	54	2,601	200	2,401	3	10	N	2	Roadway			2	2401	4	Collector	1490	1	1210	Roadway			$3.94
11B	11B(c)	54	7,961	1,965	5,996	3	10	N	4	Roadway			1	5996	4	Collector	5135	3	1909	Roadway			$15.22
12	12(a)	54	9,211	2,662	6,549	12	10	N	2	Roadway				6549	2	Local		3	3341	Roadway	17		$18.44
12	12(b)	54	5,287	524	4,763	3	10	N	0	Roadway				4763	2	Local			913	Roadway	309		$8.28
12	12(c)	54	2,779	251	2,528	1	10	N	2	Roadway				2528	2	Local		1	842	Roadway			$4.29
13	13	54	4,135		4,135	2	10	N	1	Roadway			4	4135	4	Collector			2225	Roadway	70		$5.53
13A	13A	54	4,166	388	3,779	3	10	N	0	Roadway				3779	4	Collector	3500	1	566	Roadway	131		$6.52
13C	13C	54	4,122	457	3,665	3	10	N	1	Roadway				3665	4	Collector	2330	2	440	Roadway	84		$6.70
14	14	54	3,121		3,121	-	10	N	2	Roadway				3121	4	Collector	500	0	614	Roadway			$4.18
14A	14A	54	1,932	235	1,697	-	10	N	1	Roadway			2	1697	4	Collector	920	2	999	Roadway			$3.20
14B	14B	54	1,868	176	1,692	3	10	N	1	Roadway				1692	4	Collector	160	2	1400	Roadway	121		$2.96
14C	14C	54	1,879	209	1,669	2	10	N	0	Roadway				1669	4	Collector	1670	2	987	Roadway			$3.06
15	15	54	13,257	2,055	11,202	5	10	N	6	Roadway			3	11202	6	Arterial	2790	4	9299	Roadway	26		$22.46
16	16	54	13,375	990	12,385	5	10	N	0	SCE		2529	4		0	Easement			1146	SCE			$12.44
17	17	54	3,148	117	3,032	-	10	N	0	Roadway			1	3032	4	Collector			689	Roadway			$4.62
18	18.1	54	1,629		1,629	-	11	N	0	Roadway				1629	4	Collector	520		635	Roadway			$2.18
18	18.2	54	1,894	564	1,329	2	14	N	0	SCE					0	Easement			0	SCE			$3.07
18	18.3	54	43,931	2,366	41,565	4	39	N	12	Roadway			2	41565	6	Arterial	2090	10	25869	Roadway	56		$64.12
19	19.1(a)	84	5,538	261	5,277	4	21	N	0	Roadway				5277	4	Collector	4550	1	775	Roadway	16		$11.16
19	19.1(b)	60	10,058	519	9,538	8	25	N	1	Roadway			2	9538	4	Collector	7725	3	2961	Roadway			$15.54
19	19.1(c)	60	1,689		1,689	4	19	N	2	Roadway				1689	4	Collector	1175		588	Roadway			$2.33
19	19.1(d)	60	8,865	174	8,691	7	11	N	8	Roadway			1	8691	4	Collector	4685	2	6262	Roadway			$12.79
19	19.1(e)	60	7,409	993	6,416	11	8	N	2	Roadway				6416	6	Arterial	5382	1	2040	Roadway			$12.95
19	19.1(f)	60	6,044	365	5,679	4	8	N	1	Roadway			1	5679	6	Arterial	4700	1	988	Roadway			$9.39
19A	19A(a)	60	12,604	412	12,192	20	23	N	6	Roadway				12192	4	Collector	4200	3	5061	Roadway			$16.81
19A	19A(b)	60	2,783	307	2,476	7	24	N	1	Roadway				2476	4	Collector		2	2231	Roadway			$3.41
19B	19B.1	60	1,765	531	1,234	9	26	N	0	Roadway				1234	4	Collector		1	750	Roadway			$3.92
19B	19B.2	60	2,643	113	2,530	2	22	N	1	SCE				0	0	Easement		1	0	SCE			$2.54
19C	19C	60	9,190	1,274	7,916	10	8	N	0	Roadway			2	7916	Closure	Closure		3.5	8136	Roadway			$16.28
1A	1A	84	9,731	462	9,269	18	14	N	0	Roadway			2	9269	4	Collector	6070	3	2803	Roadway			$19.74
1B	1B(a)	84	5,964	358	5,606	11	15	N	2	Roadway				5606	4	Collector	5500	2	1364	Roadway			$12.40
1B	1B(b)	84	8,572	1,548	7,024	16	15	N	5	Roadway			4	7024	6	Arterial	6850	3	3232	Roadway	146		$21.79
1B	1B(c)	84	19,384	1,860	17,524	36	20	N	6	Roadway			2	17524	6	Arterial	17000	6	3756	Roadway	418		$42.91

Regional Recycled Water Supply System - Conveyance Feasibility Study

Evaluation Criteria and Data for Pipeline Segments and Sub-Segments

Alignment No	Alignment Sub-Segment	Diameter	Pipe Length	Trenchless Construction	Trenched Construction	Major Utilities	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Street	Lanes of Traffic	Road Category & Traffic Impact	Median Improvements	Major Intersections	Residential/ Minor Commercial	Property Description	Waters of the US and State	Critical Habitats and Listed Species	Cost
		in	ft	ft	ft	ea	ft	Y/N	# Hits		length	length	ea	length	# of lanes		lf	ea	length		length	Y/N	$ mil
1C	1C	84	16,200	1,286	14,914	74	14	N	7	Roadway			1	14914	4	Collector	4700	2	7067	Roadway			$34.82
2	2(a)	84	8,276	211	8,065	18	30	Y	0	LAFCD				0	0	Easement			0	LAFCD			$11.11
2	2(b)	84	7,405	5,393	2,013	12	30	Y	0	LAFCD				0	0	Easement			0	LAFCD			$29.23
20	20.1(a)	60	3,572		3,572	3	14	N	0	Roadway				3572	4	Collector	2500		0	Roadway			$4.93
20	20.1(b)	60	1,125		1,125	-	12	N	0	Roadway				1125	4	Collector	1050		0	Roadway			$1.55
20	20.11	60	2,752		2,752	-	5	N	0	Roadway				2752	0	Easement			2687	Roadway			$3.80
20	20.12	60	1,741	422	1,318	1	5	N	0	LAFCD				0	0	Easement			766	LAFCD			$2.75
20	20.13	60	867		867	-	5	N	0	Roadway				867	0	Easement			0	Roadway			$1.20
20	20.14	60	4,211	164	4,047	1	6	N	0	River				0	0	Easement			0	LAFCD	1,160		$5.66
20	20.15	60	5,118	261	4,858	2	5	N	0	SCE		3040		0	0	Easement			0	SCE			$4.93
20	20.2	60	1,192	191	1,001	1	12	N	0	SCE	395	606		0	0	Easement			0	SCE			$1.68
20	20.3	60	636		636	1	12	N	0	Roadway			1	636	0	Easement			0	Roadway			$0.88
20	20.4	60	1,199		1,199	-	12	N	0	SCE			1	0	0	Easement			0	SCE			$0.96
20	20.5	60	934	169	766	1	13	N	0	Roadway			1	766	0	Easement			0	Roadway			$1.83
20	20.6	60	2,180		2,180	-	15	N	0	Private					0	Easement			0	Private			$1.74
20	20.7	60	2,055	1,133	922	2	17	N	0	SCE					0	Easement			0	SCE			$5.31
20	20.8	60	1,781		1,781	5	14	N	0	SCE		1780.8			0	Easement			0	SCE	3		$1.42
20	20.9	60	2,402	1,211	1,192	7	8	N	0	SCE					0	Easement			0	SCE	281		$5.84
20A	20A	60	8,655	1,176	7,480	13	14	N	0	River				0	0	Easement			0	LAFCD	8,250		$16.70
20B	20B	60	12,168	1,270	10,898	18	9	N	4	Roadway			5	10898	4	Collector	10890	3	5074	Roadway	87		$20.59
21	21.1	60	1,550	378	1,172	-	8	N	0	SCE		415			0	Easement			0	SCE			$2.46
21	21.2	60	939		939	-	8	N	0	Roadway				939	Closure	Closure			1135	Roadway			$1.29
21	21.3(a)	60	2,748		2,748	-	8	N	0	SCE		2747.7			0	Easement			2477	SCE			$2.20
21	21.3(b)	60	1,495	298	1,197	1	8	N	0	SCE					0	Easement			0	SCE			$2.16
21	21.4	60	7,180	683	6,497	3	9	N	0	SCE					0	Easement			0	SCE	149		$7.95
21	21.5	60	4,964	1,110	3,854	4	17	N	0	LAFCD					0	Easement			0	LAFCD	1,599		$7.61
21	21.6	60	3,900	158	3,741	-	32	N	0	LAFCD					0	Easement			0	LAFCD			$3.69
21A	21A	60	5,773	248	5,525	6	8	N	0	River					0	Easement			0	LAFCD	5,339		$9.69
21B	21B	60	6,176	372	5,803	4	8	N	1	Roadway				5803	4	Collector	210	2	3344	Roadway			$9.58
22	22.1	60	1,219		1,219	-	8	N	0	River					0	Easement			0	LAFCD	1,219		$1.92
22	22.2	60	18,750	1,001	17,749	5	10	N	0	River					0	Easement			0	LAFCD	18,005		$25.61
23	23.1	60	9,872		9,872	2	20	N	0	LAFCD					0	Easement			0	LAFCD	8,168		$11.68
23	23.2	60	224		224	-	5	N	0	LAFCD					0	Easement			0	LAFCD	86		$0.35
23	23.3	60	5,364	408	4,956	1	3	N	0	LAFCD					0	Easement			0	LAFCD			$7.62
24	24.1	60	515		515	1	12	N	0	Roadway				515	6	Arterial	500		250	Roadway			$0.71
24	24.2	60	139		139	-	12	N	0	LAFCD					0	Easement			0	LAFCD	22		$0.11
25	25(a)	60	3,447		3,447	2	8	N	0	Roadway				3447	6	Arterial	1300		1800	Roadway			$4.75
25	25(b)	60	3,849	254	3,595	2	8	N	0	Roadway				3595	6	Arterial	3500	2	3471	Roadway			$5.98
26	26	60	3,100	372	2,728	4	14	N	0	Roadway			1	2728	6	Arterial	2700	2	1791	Roadway			$5.47
27	27	60	19,619	1,384	18,235	14	11	N	1	Roadway			3	18235	4	Collector	10600	6	8177	Roadway			$31.21
28	28.1	60	4,700		4,700	2	13	N	1	Roadway			1	4700	6	Arterial	560		1547	Roadway			$6.48
28	28.2	60	63		63	1	10	N	0	LAFCD					0	Easement			0	LAFCD			$0.05
29	29	60	8,719	367	8,352	9	11	N	0	Roadway			1	8352	4	Collector	5000	2	1737	Roadway			$13.20
2A	2A	84	5,595	4,774	821	6	30	Y	0	LAFCD				0	0	Easement			0	LAFCD			$24.57
3	3.1	60	4,632		4,632	4	30	N	0	LAFCD				0	0	Easement			0	LAFCD			$3.66
3	3.2	60	4,329		4,329	10	29	N	0	Roadway				4329	2	Local			0	Roadway	18		$5.97
3	3.3(a)	60	2,195	2,126	69	-	17	N	0	LAFCD					0	Easement			0	LAFCD			$7.55
3	3.3(b)	60	16,575	11,543	5,032	24	9	N	3	LAFCD	4130				0	Easement			0	LAFCD			$44.88
3	3.4(a)	60	4,696		4,696	10	8	N	0	SCE		2150			0	Easement			0	SCE			$3.75
3	3.4(b)	60	1,087		1,087	-	8	N	0	SCE					0	Easement			0	SCE			$0.87
3	3.4(c)	60	2,689	371	2,318	1	8	N	0	SCE		570			0	Easement			0	SCE			$3.44
30	30	60	125		125	1	15	N	0	LAFCD					0	Easement			0	LAFCD	42		$0.10
31	31	60	1,834	150	1,684	1	2	N	0	Roadway				1684	4	Collector		1	0	Roadway			$3.01
32	32	60	1,890	176	1,715	3	10	N	0	Roadway				1715	2	Local		1	390	Roadway			$3.17
33	33	60	4,950	497	4,454	1	8	N	1	Roadway			1	4454	6	Arterial	3325	4	3498	Roadway			$8.42
34	34.1	60	4,063		4,063	-	10	N	0	Roadway				4063	2	Local		1	438	Roadway			$5.60
34	34.2	60	263		263	-	10	N	0	LAFCD					0	Easement			0	LAFCD	64		$0.21
35	35	60	19,187	1,828	17,359	9	13	N	4	Roadway			2	17359	6	Arterial	17300	7	7019	Roadway			$31.81
36	36	60	4,265		4,265	-	10	N	0	LAFCD			0		0	Easement			0	LAFCD	2,670		$3.37

Regional Recycled Water Supply System - Conveyance Feasibility Study
Evaluation Criteria and Data for Pipeline Segments and Sub-Segments

Alignment No	Alignment Sub-Segment	Diameter	Pipe Length	Trenchless Construction	Trenched Construction	Major Utilities	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Street	Lanes of Traffic	Road Category & Traffic Impact	Median Improvements	Major Intersections	Residential/ Minor Commercial	Property Description	Waters of the US and State	Critical Habitats and Listed Species	Cost
		in	ft	ft	ft	ea	ft	Y/N	# Hits		length	length	ea	length	# of lanes		lf	ea	length		length	Y/N	$ mil
37	37	60	9,977	154	9,822	7	10	N	4	Roadway			4	9822	4	Collector	9000	1	4316	Roadway			$14.25
38	38.1	60	4,032		4,032	5	11	N	0	LAFCD					0	Easement			0	LAFCD	2,713		$3.19
38	38.2(a)	60	7,549	68	7,480	6	13	N	1	Roadway			2	7480	Closure	Closure	3735	1	5017	Roadway			$10.68
38	38.2(b)	60	1,027	346	680	2	10	N	0	Roadway				680	4	Collector			0	Roadway	310		$2.34
38	38.3	60	3,075		3,075	2	8	N	0	LAFCD					0	Easement			0	LAFCD			$2.43
38	38.4(a)	60	11,474	57	11,417	6	5	N	0	Roadway			1	11417	4	Collector	3190	1	3315	Roadway	54		$16.00
38	38.4(b)	60	716	666	50	-	5	N	0	Roadway				50	0	Easement			0	Roadway	515		$2.76
38A	38A	60	4,545	4,545	-	4	11	N	0	Tunnel					0	Easement			0	Tunnel	303		$16.02
38B	38B.1	60	3,525	141	3,384	3	8	N	0	Roadway				3384	4	Collector	1950	1	753	Roadway			$5.31
38B	38B.2	60	580	513	66	-	5	N	0	LAFCD					0	Easement			0	LAFCD	341		$2.15
39	39	60	576		576	-	1	N	0	Roadway				576	4	Collector	575		0	Roadway			$0.79
3A	3A	60	19,580	1,686	17,894	27	10	N	3	Roadway			1	17894	Closure	Closure	4200	1	8019	Roadway			$31.56
3B	3B	60	2,669	76	2,593	-	8	N	1	Roadway				2593	Closure	Closure		1	0	Roadway			$3.92
4	4(a)	84	2,282		2,282	3	30	N	1	Roadway			1	2282	6	Arterial	2280		1121	Roadway			$4.19
4	4(a)OC	54	2,282		2,282	3	30	N	1	Roadway			1	2282	6	Arterial	2280		1121	Roadway			$3.05
4	4(b)OC	54	6,019	159	5,861	9	20	N	2	Roadway			1	5861	4	Collector	1500	1	2072	Roadway	16		$8.47
4	4(c)OC	54	6,031	243	5,788	5	20	N	3	Roadway				5788	4	Collector		1	1446	Roadway	-		$8.63
4	4(b)	84	6,019	159	5,861	9	20	N	2	Roadway			1	5861	4	Collector	1500	1	2072	Roadway	16		$11.69
4	4(c)	84	6,031	243	5,788	5	20	N	3	Roadway				5788	4	Collector		1	1446	Roadway	-		$11.99
40	40	60	3,846	160	3,686	1	10	N	0	Roadway			1	3686	4	Collector	3700	1	1262	Roadway			$5.82
41	41.1	60	2,644		2,644	-		N	0	Roadway				2644	2	Local	2600		0	Roadway	64		$3.65
41	41.2	60	1,106	755	351	-		N	0	LAFCD				0	0	Easement			0	LAFCD	1,106		$3.46
41	41.3	60	1,100		1,100	1		N	0	LAFCD				0	0	Easement			0	LAFCD	1,054		$1.30
41A	41A	60	1,165		1,165	1		N	0	Roadway				1165	4	Collector	1100		0	Roadway	1,072		$1.61
42	42	60	4,236		4,236	2	14	N	1	Roadway				4236	4	Collector	325		948	Roadway			$5.84
43	43	60	9,627	188	9,439	3	1	N	2	Roadway				9439	Closure	Closure	550	1	2717	Roadway			$13.88
43A	43A	60	654		654	1	1	N	1	Roadway				654	4	Collector	654		360	Roadway	-		$0.90
44	44.1	60	1,768	482	1,286	-	5	N	0	LAFCD					0	Easement			0	LAFCD			$3.15
44	44.2(a)	60	3,959	1,826	2,133	1	5	N	0	SCE					0	Easement			0	SCE	1,169		$8.14
44	44.2(b)	60	15,794	743	15,051	6	8	N	0	SCE					0	Easement			0	SCE	748		$15.02
44	44.3(a)	60	5,485		5,485	-	24	N	0	SCE					0	Easement			0	SCE	3,919		$4.38
44	44.3(b)	60	1,885	1,761	124	1	34	N	0	SCE					0	Easement			0	SCE	25		$6.31
44A	44A.1	60	4,931	892	4,039	4	5	N	0	LAFCD					0	Easement			0	LAFCD	177		$6.85
44A	44A.2	60	1,352		1,352	1	5	N	0	SCE					0	Easement			0	SCE	36		$1.08
45	45(a)	60	4,244		4,244	1	5	N	0	Roadway				4244	4	Collector	1750	1.5	2501	Roadway			$5.85
45	45(b)	60	7,235	175	7,060	4	8	N	0	Roadway				7060	4	Collector			6689	Roadway			$10.54
45A	45A	60	8,833	455	8,378	9	7	N	2	Roadway				8378	4	Collector	1825	3	4584	Roadway			$13.64
46	46	60	5,605	353	5,252	2	11	N	0	Roadway				5252	4	Collector	1120	2	4839	Roadway			$8.86
47	47	60	9,118	286	8,832	4	17	N	2	Roadway			1	8832	6	Arterial	6700	2	6165	Roadway			$13.49
47A	47A	60	16,619	1,214	15,405	3	58	N	5	Roadway			1	15405	6	Arterial	11900	4	10026	Roadway	96		$26.39
48	48	60	3,505		3,505	-	23	N	0	Roadway				3505	4	Collector		1	3500	Roadway			$4.83
4A	4A(a)	84	8,473	906	7,567	21	20	N	2	Roadway			4	7567	6	Arterial	6175	3	1931	Roadway	18		$19.05
4A	4A(b)	84	2,075	202	1,873	6	20	N	3	Roadway				1873	4	Collector	1100	1	392	Roadway			$4.58
4A	4A(c)	84	5,497	452	5,045	8	20	N	1	Roadway				5045	4	Collector	2800	2	171	Roadway	15		$11.81
4A	4A(d)	84	10,493	607	9,885	12	28	N	4	Roadway			1	9885	6	Arterial	2450	3	1442	Roadway	79		$21.62
4A	4A(e)	84	2,290	740	1,550	-	23	N	0	Roadway				1550	4	Collector	0		500	Roadway			$7.06
4A	4A(a)OC	54	8,473	906	7,567	21	20	N	2	Roadway			4	7567	6	Arterial	6175	3	1931	Roadway	18		$15.29
4A	4A(b)OC	54	2,075	202	1,873	6	20	N	3	Roadway				1873	4	Collector	1100	1	392	Roadway			$3.65
4A	4A(c)OC	54	5,497	452	5,045	8	20	N	1	Roadway				5045	4	Collector	2800	2	171	Roadway	15		$9.31
4A	4A(d)OC	54	10,493	607	9,885	12	28	N	4	Roadway			1	9885	6	Arterial	2450	3	1442	Roadway	79		$16.71
4A	4A(e)OC	84	2,290	740	1,550	-	23	N	0	Roadway				1550	4	Collector			500	Roadway			$6.29
4B	4B	84	3,326	497	2,829	1	14	N	0	Roadway			1	2829	4	Collector	1915	2	1332	Roadway	165		$8.04
4B	4BOC	54	3,326	497	2,829	1	14	N	0	Roadway			1	2829	4	Collector	1915	2	1332	Roadway	165		$6.63
5	5	84	11,011	5,489	5,521	8	17	Y	4	Roadway			1	5521	6	Arterial	3800	3	3279	Roadway			$35.42
5X	5X	84	11,011	348	10,663	8	17	Y	4	Roadway			1	10663	6	Arterial	8900	4	5690	Roadway			$21.25
51	51.1	60	2,871		2,871	1	27	N	1	Roadway				2871	4	Collector			662	Roadway			$3.96
51	51.2	60	929		929	-	31	N	0	LAFCD				0	0	Easement			0	LAFCD	382		$1.10
52	52.1(a)	60	2,605		2,605	2	43	N	0	Roadway				2605	Closure	Closure			1260	Roadway			$3.59
52	52.1(b)	60	3,513		3,513	-	81	N	0	Roadway				3513	4	Collector			1884	Roadway			$4.84

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Alignment No	Alignment Sub-Segment	Diameter	Pipe Length	Trenchless Construction	Trenched Construction	Major Utilities	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Street	Lanes of Traffic	Road Category & Traffic Impact	Median Improvements	Major Intersections	Residential/ Minor Commercial	Property Description	Waters of the US and State	Critical Habitats and Listed Species	Cost
		in	ft	ft	ft	ea	ft	Y/N	# Hits		length	length	ea	length	# of lanes		lf	ea	length		length	Y/N	$ mil
52	52.2	60	600		600	-	105	N	0	LAFCD					0	Easement			0	LAFCD	276		$0.71
52A	52A.1	60	4,266	1,207	3,060	1	39	N	0	River					0	Easement			0	LAFCD	3,724		$8.65
52A	52A.2	60	289		289	-	50	N	0	LAFCD					0	Easement			0	LAFCD	78		$0.34
52B	52B.1	60	3,777	608	3,169	-	79	N	0	River					0	Easement			0	LAFCD	3,777		$6.54
52B	52B.2	60	409	56	353	-	106	N	0	River					0	Easement			0	LAFCD	234		$0.68
52C	52C.1	60	1,531	141	1,391	-	113	N	0	River					0	Easement			0	LAFCD	1,531		$2.29
52C	52C.2	60	2,119		2,119	-	121	N	0	Roadway				2119	Closure	Closure			0	Roadway	224		$2.51
53	53(a)	60	5,769	665	5,104	1	41	N	0	Roadway				5104	4	Collector			3416	Roadway			$9.72
53	53(b)	60	2,674		2,674	-	76	N	0	Roadway				2674	4	Collector			2269	Roadway			$3.69
54	54	60	5,215	219	4,996	1	110	N	0	Roadway				4996	4	Collector		2	3795	Roadway			$7.90
54A	54A	60	6,556	124	6,433	2	91	N	0	Roadway				6433	2	Local			5015	Roadway			$9.44
55	55(a)	60	1,293		1,293	-	120	N	0	Roadway				1293	4	Collector	1290	1	1292	Roadway			$1.78
55	55(b)	60	1,819	256	1,563	1	110	N	0	Roadway				1563	4	Collector	1560	1	926	Roadway	42		$3.19
56	56	60	1,080		1,080	-	104	N	0	Roadway				1080	4	Collector	1080		0	Roadway			$1.49
57	57.1	60	5,416	717	4,699	7	8	N	1	Roadway			1	4699	6	Arterial	4900	3	5200	Roadway			$9.37
57	57.2	60	92		92	-	8	N	0	LAFCD					0	Easement			0	LAFCD	11		$0.14
58.1	58.1	60	1,705		1,705	-	109	N	0	SCE					0	Easement			0	SCE			$1.36
58.2	58.2(a)	60	682		682	-	119	N	0	Private					0	Easement			0	Private			$0.54
58.2	58.2(b)	60	963	961	2	-	124	N	0	Private					0	Easement			0	Private			$3.18
59	59	60	9,247	792	8,454	-	156	N	0	LAFCD					0	Easement			0	LAFCD	2,535		$9.31
5A	5A	84	26,729	6,950	19,778	25	23	Y	7	Roadway				19778	4	Collector	8150	6	1819	Roadway	159		$68.68
5AX	5AX	84	26,729	1,904	24,825	25	23	Y	7	Roadway			1	24825	4	Collector	13535	7	2899	Roadway	159		$55.05
6	6	84	10,324	1,474	8,850	20	20	N	5	Roadway			4	8850	6	Arterial	1050	2	2854	Roadway			$24.70
7	7.1(a)	84	5,105		5,105	4	20	N	3	Roadway				5105	6	Arterial	5100		1338	Roadway			$9.37
7	7.1(a)OC	54	5,105		5,105	4	20	N	3	Roadway				5105	6	Arterial	5100		1338	Roadway			$6.83
7	7.1(b)	60	34,046	2,215	31,831	53	13	N	12	Roadway			1	31831	4	Collector	8660	5	15355	Roadway			$53.49
7	7.2	60	4,372	545	3,828	9	8	N	0	SCE					0	Easement		2	0	SCE			$5.36
8	8(a)	84	7,373	452	6,922	8	20	N	2	Roadway			1	6922	6	Arterial	3850	1	1917	Roadway			$15.26
8	8(b)	84	10,591	715	9,876	10	27	N	3	Roadway			1	9876	6	Arterial	8750	3	1744	Roadway	82		$22.17
8	8(c)	84	2,629		2,629	2	27	N	1	Roadway				2629	6	Arterial	2470		254	Roadway			$4.82
8	8(d)	84	2,170	652	1,517	3	18	N	0	Roadway			1	1517	6	Arterial	1500		281	Roadway	165		$6.47
8	8(a)OC	54	7,373	452	6,922	8	20	N	2	Roadway			1	6922	6	Arterial	3850	1	1917	Roadway			$11.83
8	8(b)OC	54	10,591	715	9,876	10	27	N	3	Roadway			1	9876	6	Arterial	8750	3	1744	Roadway	82		$17.26
8	8(c)OC	54	2,629		2,629	2	27	N	1	Roadway			0	2629	6	Arterial	2470		254	Roadway			$3.52
8	8(d)OC	54	2,170	652	1,517	3	18	N	0	Roadway			1	1517	6	Arterial	1500		281	Roadway	165		$2.03
9	9	84	2,353		2,353	5	15	N	0	SCE		975			0	Easement			0	SCE	16		$2.93
9	9OC	54	2,353		2,353	5	15	N	0	SCE		975			0	Easement			0	SCE	16		$1.80
9A	9A	84	5,456		5,456	4	29	N	0	Roadway			1	5456	Closure	Closure		0	5400	Roadway			$10.01
9A	9AOC	54	5,456		5,456	4	29	N	0	Roadway			1	5456	Closure	Closure	0	0	5400	Roadway			$7.30

Appendix E. Decision Model Results

COARSE SCREENING RESULTS

Evaluation Criteria Scoring Table - Orange County Paths

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 1																									
Start Point:	195th St/Poineer Blvd																								
End Point:	South St/Bloomfield Ave																								
1.1	14A	0	235	1932	N	1	Roadway	3	1697		0	0	2	1697	3.00	920	2	999	1932	0	N	3.20	1932		1697
	11B(a)	4	169	3001	N	1	Roadway	3	2832		0	0	1	2832	3.00	1820	1	2338	3001	0	N	4.46	3001		2832
	11B(b)	3	200	2601	N	2	Roadway	3	2401		0	0	2	2401	3.00	1490	1	1210	2601	0	N	3.94	2601		2401
	sum	**7**	**604**	**7534**	**N**	**4**		**3.00**	**6930**		**0**	**0**	**5**	**6930**	**2.84**	**4230**	**4**	**4547**	**7534**	**0**	**N**	**11.59**	**7534**		**6930**
	Criteria	0.93	8.0%	100%	N	0.53		3.08		1.00			3.50		2.84	56.1%	2.80	60%	**1%**	0%	N	15.55			
	Score	1	3	5	1	5		3.08		1.00			5		2.84	5	5	5	1	1	1	3	**48**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	15.00		36.96		1.50			30.00		17.04	30.00	22.50	30.00	15.00	2.00	8.00	0.00	**274.00**	**45.20%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	7.50		18.48		2.75			55.00		31.24	55.00	41.25	41.25	7.50	3.00	12.00	0.00	**307.97**	**36.66%**	**"B" Total**
1.2	11A(c)	3	185	3015	N	0	Roadway	3	2830		0	0	1	2830	3.00	2040	1	139	3015	0	N	4.52	3015		2830
	14B	3	176	1868	N	1	Roadway	3	1692		0	0	0	1692	3.00	160	2	1400	1868	121	N	2.96	1868		1692
	11B(b)	3	200	2601	N	2	Roadway	3	2401		0	0	2	2401	3.00	1490	1	1210	2601	0	N	3.94	2601		2401
	sum	**9**	**561**	**7484**	**N**	**3**		**3.00**	**6923**		**0**	**0**	**3**	**6923**	**2.85**	**3690**	**4**	**2749**	**7484**	**121**	**N**	**11.41**	**7484**		**6923**
	Criteria	1.20	7.5%	100%	N	0.40		3.08		1.00			2.12		2.85	49.3%	2.82	37%	**0%**	2%	N	15.41			
	Score	3	3	5	1	5		3.08		1.00			5		2.85	3	5	3	1	1	1	1	**44**		**Raw Total**
	Weighted "A"	36.00	36.00	15.00	3.00	15.00		36.90		1.50			30.00		17.10	18.00	22.50	18.00	15.00	2.00	8.00	0.00	**274.00**	**45.20%**	**"A" Total**
	Weighted "B"	18.00	18.00	7.50	1.50	7.50		18.45		2.75			55.00		31.35	33.00	41.25	24.75	7.50	3.00	12.00	0.00	**281.55**	**42.10%**	**"B" Total**
1.3	11A(c)	3	185	3015	N	0	Roadway	3	2830		0	0	1	2830	1.00	2040	1	139	3015	0	N	4.52	3015		2830
	11A(d)	4	162	2636	N	0	Roadway	3	2474		0	0	1	2474	3.00	1860	1	1190	2636	159	N	3.95	2636		2474
	14C	2	209	1879	N	0	Roadway	3	1669		0	0	0	1669	5.00	1670	2	987	1879	0	N	3.06	1879		1669
	sum	**9**	**557**	**7530**	**N**	**0**		**3.00**	**6974**		**0**	**0**	**2**	**6974**	**2.54**	**5570**	**4**	**2316**	**7530**	**159**	**N**	**11.52**	**7530**		**6974**
	Criteria	1.20	7.4%	100%	N	0.00		3.07		1.00			1.40		2.54	74.0%	2.80	31%	**1%**	2%	N	15.36			
	Score	3	3	5	1	1		3.07		1.00			5		2.54	5	5	3	1	1	1	2	**43**		**Raw Total**
	Weighted "A"	36.00	36.00	15.00	3.00	3.00		36.89		1.50			30.00		15.26	30.00	22.50	18.00	15.00	2.00	8.00	0.00	**272.15**	**45.57%**	**"A" Total**
	Weighted "B"	18.00	18.00	7.50	1.50	1.50		18.44		2.75			55.00		27.98	55.00	41.25	24.75	7.50	3.00	12.00	0.00	**294.18**	**39.50%**	**"B" Total**
Path 2																									
Start Point:	Centralia St (Cresent Ave)/BloomField Ave																								
End Point:	SCE Easement/Walker St																								
2.1	13A	3	388	4166	N	0	Roadway	3	3779		0	0	0	3779	3.00	3500	1	566	4166	131	N	6.52	4166.3		3778.5
	11.1(b)	0	0	2039	N	0	SCE	1	2039		0	2039	0	0	1.00	0	0	0	2039	0	N	1.56	2039.2		2039.2
	11.2	1	0	501	N	0	LAFCD	1	501		0	0	0	0	1.00	0	0	0	501	215	N	0.75	501.4		501.4
	11.3(a)	1	149	2689	N	0	SCE	1	2541		0	2541	0	0	1.00	0	0	0	2689	0	N	2.82	2689.2		2540.6
	11.3(b)	0	0	2534	N	0	SCE	1	2534		0	2534	0	0	1.00	0	0	0	2534	0	N	1.94	2534.2		2534.2
	sum	**5**	**536**	**11930**	**N**	**0**		**1.66**	**11394**		**0**	**7114**	**0**	**3779**	**1.63**	**3500**	**1**	**566**	**11930**	**346**	**N**	**13.59**	**11930.3**		**11393.9**
	Criteria	0.42	4.5%	100%	N	0.00		1.77		2.19			0.00		1.63	29.3%	0.44	5%	**0%**	3%	N	17.89			
	Score	1	1	5	1	1		1.77		2.19			1		1.63	3	1	1	1	3	1	1	**27**		**Raw Total**
	Weighted "A"	12.00	12.00	15.00	3.00	3.00		21.22		3.29			6.00		9.80	18.00	4.50	6.00	15.00	6.00	8.00	0.00	**142.81**	**71.44%**	**"A" Total**
	Weighted "B"	6.00	6.00	7.50	1.50	1.50		10.61		6.03			11.00		17.97	33.00	8.25	8.25	7.50	9.00	12.00	0.00	**146.11**	**69.95%**	**"B" Total**
2.2	12(b)	3	523.7	5287	N	0	Roadway	3	4763		0	0	0	4763.2	3.00	0	0	913	5287	309	N	8.28	5287		4763
	13C	3	457	4122	N	1	Roadway	3	3665		0	0	0	3665.3	3.00	2330	2	440	4122	84	N	6.70	4122		3665
	11.3(b)	0	0	2534	N	0	SCE	1	2534		0	2534.2	0	0	1.00	0	0	0	2534	0	N	1.94	2534		2534
	sum	**6**	**980.7**	**11943**	**N**	**1**		**2.54**	**10963**		**0**	**2534.2**	**0**	**8428.5**	**2.41**	**2330**	**2**	**1353**	**11943**	**394**	**N**	**16.92**	**11943**		**10963**
	Criteria	0.50	8.2%	100%	N	0.08		2.66		1.42			0.00		2.41	19.5%	0.88	11%	**0%**	3%	N	22.42			
	Score	1	3	5	1	1		2.66		1.42			1		2.41	3	1	3	1	3	1	2	**32**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		31.89		2.14			6.00		14.47	18.00	4.50	18.00	15.00	6.00	8.00	0.00	**193.00**	**61.40%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		15.95		3.92			11.00		26.53	33.00	8.25	24.75	7.50	9.00	12.00	0.00	**186.39**	**61.67%**	**"B" Total**
2.3	12(b)	3	524	5287	N	0	Roadway	3	4763		0	0	0	4763	3.00	0	0	913	5287	309	N	8.28	5287		4763
	12(c)	1	251	2779	N	2	Roadway	3	2528		0	0	0	2528	3.00	0	1	842	2779	0	N	4.29	2779		2528
	13	2	0	4135	N	1	Roadway	3	4135		0	0	4	4135	3.00	0	0	2225	4135	70	N	5.53	4135		4135
	sum	**6**	**774**	**12201**	**N**	**3**		**3.00**	**11427**		**0**	**0**	**4**	**11427**	**2.87**	**0**	**1**	**3980**	**12201**	**379**	**N**	**18.10**	**12201**		**11427**
	Criteria	0.49	6.3%	100%	N	0.25		3.06		1.00			1.73		2.87	0.0%	0.43	33%	**2%**	3%	N	24.14			
	Score	1	3	5	1	3		3.06		1.00			5		2.87	1	1	3	1	3	1	3	**38**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		36.76		1.50			30.00		17.24	6.00	4.50	18.00	15.00	6.00	8.00	0.00	**218.00**	**56.40%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.38		2.75			55.00		31.60	11.00	8.25	24.75	7.50	9.00	12.00	0.00	**217.73**	**55.22%**	**"B" Total**

Evaluation Criteria Scoring Table - Santa Fe Spreading Grounds Paths

Path		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 4	**Start Point:**	Durfee Ave/Rush St																								
	End Point:	Valley Blvd/Peck Rd																								
	4.1	45A	9	455	8833	N	2	Roadway	3	8378		0	0	0	8378	3.00	1825	3	4584	8833	0	N	13.64	8833		8378
		sum	**9**	**455**	**8833**	**N**	**2**		**3.00**	**8378**		**0**	**0**	**0**	**8378**	**2.90**	**1825**	**3**	**4584**	**8833**	**0**	**N**	**13.64**	**8833**		**8378**
		Criteria	1.02	5.1%	100%	N	0.23		3.05		1.00			0.00		2.90	20.7%	1.79	52%	**0%**	0%	N	18.30			
		Score	3	3	5	1	3		3.05		1.00			1		2.90	3	3	3	1	1	1	1	**36**		**Raw Total**
		Weighted "A"	36.00	36.00	15.00	3.00	9.00		36.62		1.50			6.00		17.38	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**235.00**	**53.00%**	**"A" Total**
		Weighted "B"	18.00	18.00	7.50	1.50	4.50		18.31		2.75			11.00		31.87	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**218.43**	**55.08%**	**"B" Total**
	4.2	45(b)	4	175	7235	N	0	Roadway	3	7060		0	0	0	7060	3.00	0	0	6689	7235	0	N	10.54	7235		7060
		46	2	353	0	N	0	Roadway	3	5252		0	0	0	5252	3.00	1120	2	4839	5605	0	N	8.86	5605		5252
		sum	**6**	**527**	**7235**	**N**	**0**		**3.00**	**12312**		**0**	**0**	**0**	**12312**	**2.92**	**1120**	**2**	**11528**	**12840**	**0**	**N**	**19.40**	**12840**		**12312**
		Criteria	0.47	4.1%	56%	N	0.00		3.04		1.00			0.00		2.92	8.7%	0.82	90%	**45%**	0%	N	25.54			
		Score	1	1	5	1	1		3.04		1.00			1		2.92	1	1	5	5	1	1	2	**33**		**Raw Total**
		Weighted "A"	12.00	12.00	15.00	3.00	3.00		36.49		1.50			6.00		17.51	6.00	4.50	30.00	75.00	2.00	8.00	0.00	**232.00**	**53.60%**	**"A" Total**
		Weighted "B"	6.00	6.00	7.50	1.50	1.50		18.25		2.75			11.00		32.10	11.00	8.25	41.25	37.50	3.00	12.00	0.00	**199.59**	**58.95%**	**"B" Total**
Path 5	**Start Point:**	Peck Rd/San Gabriel River																								
	End Point:	San Gabriel River end of 44A																								
	5.1	44A.1	4	892	4931	N	0	LAFCD	1	4039		0	0	0	0	1.00	0	0	0	4931	177	N	6.85	4931		4039
		44A.2	1	0	1352	N	0	SCE	1	1352		0	0	0	0	1.00	0	0	0	1352	36	N	1.08	1352		1352
		sum	**5**	**892**	**6283**	**N**	**0**		**1.00**	**5391**		**0**	**0**	**0**	**0**	**1.00**	**0**	**0**	**0**	**6283**	**213**	**N**	**7.93**	**6283**		**5391**
		Criteria	0.80	14.2%	100%	N	0.00		1.43		1.00			0.00		1.00	0.0%	0.00	0%	**0%**	3%	N	10.50			
		Score	1	3	5	1	1		1.43		1.00			1		1.00	1	1	1	1	3	1	1	**24**		**Raw Total**
		Weighted "A"	12.00	36.00	15.00	3.00	3.00		17.11		1.50			6.00		6.00	6.00	4.50	6.00	15.00	6.00	8.00	0.00	**145.11**	**70.98%**	**"A" Total**
		Weighted "B"	6.00	18.00	7.50	1.50	1.50		8.55		2.75			11.00		11.00	11.00	8.25	8.25	7.50	9.00	12.00	0.00	**123.80**	**74.54%**	**"B" Total**
	5.2	38.4(b)	0	666	716	N	0	Roadway	3	50		0	0	0	50	1.00	0	0	0	716	515	N	2.76	716		50
		44.1	0	482	1768	N	0	LAFCD	1	1286		0	0	0	0	1.00	0	0	0	1768	0	N	3.15	1768		1286
		44.2(a)	1	1826	3959	N	0	SCE	1	2133		0	0	0	0	1.00	0	0	0	3959	1169	N	8.14	3959		2133
		sum	**1**	**2974**	**6443**	**N**	**0**		**1.03**	**3469**		**0**	**0**	**0**	**50**	**1.00**	**0**	**0**	**0**	**6443**	**1684**	**N**	**14.05**	**6443**		**3469**
		Criteria	0.16	46.2%	100%	N	0.00		2.40		1.00			0.00		1.00	0.0%	0.00	0%	**3%**	26%	N	18.73			
		Score	1	5	5	1	1		2.40		1.00			1		1.00	1	1	1	1	5	1	2	**30**		**Raw Total**
		Weighted "A"	12.00	60.00	15.00	3.00	3.00		28.80		1.50			6.00		6.00	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**184.80**	**63.04%**	**"A" Total**
		Weighted "B"	6.00	30.00	7.50	1.50	1.50		14.40		2.75			11.00		11.00	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**147.65**	**69.63%**	**"B" Total**
Path 6	Start Point:	Merced Ave/Los Angeles St																								
	End Point:	Stewart Ave/Live Oak Ave																								
	6.1	54A	2	124	0	N	0	Roadway	3	6433		0	0	0	6433	3.00	0	0	5015	6556	0	N	9.44	6556.3		6432.6
		sum	2	124	0	N	0		**3.00**	**6433**		0	0	0	6433	2.96	0	0	5015	6556	0	N	9.44	6556.30		6432.60
		Criteria	0.31	1.9%	0%	N	0.00		3.02		1.00			0.00		2.96	0.0%	0.00	76%	**0%**	0%	N	12.27			
		Score	1	1	1	1	1		3.02		1.00			1		2.96	1	1	5	1	1	1	1	24		Raw Total
		Weighted "A"	12.00	12.00	3.00	3.00	3.00	0.00	36.23	0.00	1.50			6.00	0.00	17.77	6.00	4.50	30.00	15.00	2.00	8.00	0.00	160.00	**68.00%**	"A" Total
		Weighted "B"	6.00	6.00	1.50	1.50	1.50	0.00	18.11	0.00	2.75			11.00	0.00	32.58	11.00	8.25	41.25	7.50	3.00	12.00	0.00	163.95	**66.28%**	"B" Total
	6.2	53(b)	0	0	0	N	0	Roadway	3	2674		0	0	0	2674	3.00	0	0	2269	2674	0	N	3.69	2674		2674
		54	1	219	0	N	0	Roadway	3	4996		0	0	0	4996	3.00	0	2	3795	5215	0	N	7.90	5215		4996
		55(a)	0	0	0	N	0	Roadway	3	1293		0	0	0	1293	3.00	1290	1	1292	1293	0	N	1.78	1293		1293
		sum	1	219	0	N	0		**3.00**	**8963**		0	0	0	8963	2.95	1290	3	7356	9182	0	N	13.37	9182		8963
		Criteria	0.11	2.4%	0%	N	0.00		3.02		1.00			0.00		2.95	14.0%	1.73	80%	**40%**	0%	N	17.38			
		Score	1	1	1	1	1		3.02		1.00			1		2.95	1	3	5	5	1	1	2	31		Raw Total
		Weighted "A"	12.00	12.00	3.00	3.00	3.00		36.29		1.50			6.00		17.71	6.00	13.50	30.00	75.00	2.00	8.00	0.00	229.00	**54.20%**	"A" Total
		Weighted "B"	6.00	6.00	1.50	1.50	1.50		18.14		2.75			11.00		32.48	11.00	24.75	41.25	37.50	3.00	12.00	0.00	210.37	**56.74%**	"B" Total

Evaluation Criteria Scoring Table - Santa Fe Spreading Grounds Paths

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 7	Start Point:	Lower Azusa Rd/San Gabriel River																								
	End Point:	Live Oak Ave/San Gabriel River (Junction of 52B, 52, and 56)																								
	7.1	44.3(b)	1	1761	0	N	0	SCE	1	124		0	0	0	0	1.00	0	0	0	1885	25	N	6.31	1885		124
		52.1(a)	2	0	0	N	0	Roadway	3	2605		0	0	0	2605	5.00	0	0	1260	2605	0	N	3.59	2605		2605
		52.1(b)	0	0	0	N	0	Roadway	3	3513		0	0	0	3513	3.00	0	0	1884	3513	0	N	4.84	3513		3513
		52.2	0	0	0	N	0	LAFCD	1	600		0	0	0	0	1.00	0	0	0	600	276	N	0.71	600		600
		sum	**3**	**1761**	**0**	**N**	**0**		**2.79**	**6841**		**0**	**0**	**0**	**6117**	**3.03**	**0**	**0**	**3144**	**8603**	**301**	**N**	**15.45**	**8603**		**6841**
		Criteria	0.35	20.5%	0%	N	0.00		3.04		1.00			0.00		3.03	0.0%	0.00	37%	2%	3%	N	20.35			
		Score	1	5	1	1	1		3.04		1.00			1		3.03	1	1	3	1	3	1	2	**29**		**Raw Total**
		Weighted "A"	12.00	60.00	3.00	3.00	3.00		36.44		1.50			6.00		18.17	6.00	4.50	18.00	15.00	6.00	8.00	0.00	**200.60**	**59.88%**	**"A" Total**
		Weighted "B"	6.00	30.00	1.50	1.50	1.50		18.22		2.75			11.00		33.30	11.00	8.25	24.75	7.50	9.00	12.00	0.00	**178.27**	**63.34%**	**"B" Total**
	7.2	52A.1	1	1207	0	N	0	River	5	3060		0	0	0	0	1.00	0	0	0	4266	3724	N	8.65	4266		3060
		52A.2	0	0	0	N	0	LAFCD	1	289		0	0	0	0	1.00	0	0	0	289	78	N	0.34	289		289
		52.1(b)	0	0	0	N	0	Roadway	3	3513		0	0	0	3513	3.00	0	0	1884	3513	0	N	4.84	3513		3513
		52.2	0	0	0	N	0	LAFCD	1	600		0	0	0	0	1.00	0	0	0	600	276	N	0.71	600		600
		sum	**1**	**1207**	**0**	**N**	**0**		**3.58**	**7461**		**0**	**0**	**0**	**3513**	**1.81**	**0**	**0**	**1884**	**8667**	**4078**	**N**	**14.54**	**8667**		**7461**
		Criteria	0.12	13.9%	0%	N	0.00		3.64		1.00			0.00		1.81	0.0%	0.00	22%	3%	47%	N	19.02			
		Score	1	3	1	1	1		3.64		1.00			1		1.81	1	1	3	1	5	1	1	**27**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	3.00		43.68		1.50			6.00		10.86	6.00	4.50	18.00	15.00	10.00	8.00	0.00	**180.54**	**63.89%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	1.50		21.84		2.75			11.00		19.92	11.00	8.25	24.75	7.50	15.00	12.00	0.00	**162.51**	**66.58%**	**"B" Total**
	7.3	52A.1	1	1207	0	N	0	River	5	3060		0	0	0	0	1.00	0	0	0	4266	3724	N	8.65	4266		3060
		52B.1	0	608	0	N	0	River	5	3169		0	0	0	0	1.00	0	0	0	3777	3777	N	6.54	3777		3169
		52B.2	0	56	0	N	0	River	5	353		0	0	0	0	1.00	0	0	0	409	234	N	0.68	409		353
		sum	**1**	**1871**	**0**	**N**	**0**		**5.00**	**6581**		**0**	**0**	**0**	**0**	**1.00**	**0**	**0**	**0**	**8452**	**7735**	**N**	**15.86**	**8452**		**6581**
		Criteria	0.12	22.1%	0%	N	0.00		4.78		1.00			0.00		1.00	0.0%	0.00	0%	0%	92%	N	20.89			
		Score	1	5	1	1	1		4.78		1.00			1		1.00	1	1	1	1	5	1	3	**30**		**Raw Total**
		Weighted "A"	12.00	60.00	3.00	3.00	3.00		57.34		1.50			6.00		6.00	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**201.34**	**59.73%**	**"A" Total**
		Weighted "B"	6.00	30.00	1.50	1.50	1.50		28.67		2.75			11.00		11.00	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**155.92**	**67.93%**	**"B" Total**
	7.4	53(a)	1	665	0	N	0	Roadway	3	5104		0	0	0	5104	3.00	0	0	3416	5769	0	N	9.72	5769		5104
	6.1	Path 6.1	2	124	0	N	0		3	6432.6		0	0	0	6433	2.96	0	0	5015	6556	0	N	9.44	6556		6433
		55(b)	1	256	0	N	0	Roadway	3	1563		0	0	0	1563	3.00	1560	1	926	1819	42	N	3.19	1819		1563
		52B.2	0	56	0	N	0	River	5	353		0	0	0	0	1.00	0	0	0	409	234	N	0.68	409		353
		sum	**4**	**1100**	**0**	**N**	**0**		**3.05**	**13453**		**0**	**0**	**0**	**13100**	**2.78**	**1560**	**1**	**9357**	**14553**	**276**	**N**	**23.02**	**14553**		**13453**
		Criteria	0.27	7.6%	0%	N	0.00		3.12		1.00			0.00		2.78	10.7%	0.36	64%	72%	2%	N	30.12			
		Score	1	3	1	1	1		3.12		1.00			1		2.78	1	1	5	5	1	1	4	**33**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	3.00		37.49		1.50			6.00		16.70	6.00	4.50	30.00	75.00	2.00	8.00	0.00	**244.19**	**51.16%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	1.50		18.74		2.75			11.00		30.62	11.00	8.25	41.25	37.50	3.00	12.00	0.00	**204.61**	**57.92%**	**"B" Total**
Path 8	Start Point:	Lower Azusa Rd/San Gabriel River																								
	End Point:	Live Oak Ln/"Essentially" Arrow Hwy (Junction of 52C and 58)																								
	8.1	Path 7.2	1	1206.5	0	N	0		4	7461		0	0	0	3513	1.81	0	0	1884	8667	4078	N	14.54	8667		7461
	7.2	56	0	0	0	N	0	Roadway	3	1080		0	0	0	1080	3.00	1080	0	0	1080	0	N	1.49	1080		1080
		58.1	0	0	0	N	0	SCE	1	1705		0	0	0	0	1.00	0	0	0	1705	0	N	1.36	1705		1705
		58.2(a)	0	0	0	N	0	Private	1	682		0	0	0	0	1.00	0	0	0	682	0	N	0.54	682		682
		sum	**1**	**1207**	**0**	**N**	**0**		**2.96**	**10928**		**0**	**0**	**0**	**4593**	**1.41**	**1080**	**0**	**1884**	**12134**	**4078**	**N**	**17.94**	**12134**		**10928**
		Criteria	0.08	9.9%	0%	N	0.00		3.06		1.00			0.00		1.41	8.9%	0.00	16%	4%	34%	N	23.47			
		Score	1	3	1	1	1		3.06		1.00			1		1.41	1	1	3	1	5	1	1	**26**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	3.00		36.77		1.50			6.00		8.48	6.00	4.50	18.00	15.00	10.00	8.00	0.00	**171.24**	**65.75%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	1.50		18.38		2.75			11.00		15.54	11.00	8.25	24.75	7.50	15.00	12.00	0.00	**154.67**	**68.19%**	**"B" Total**
	8.2	52A.1	1	1207	0	N	0	River	5	3060		0	0	0	0	1.00	0	0	0	4266	3724	N	8.65	4266		3059.5
		52B.1	0	608	0	N	0	River	5	3169		0	0	0	0	1.00	0	0	0	3777	3777	N	6.54	3776.8		3168.6
		52C.1	0	141	0	N	0	River	5	1391		0	0	0	0	1.00	0	0	0	1531	1531	N	2.29	1531.1		1390.6
		52C.2	0	0	0	N	0	Roadway	3	2119		0	0	0	2119.4	5.00	0	0	0	2119	224	N	2.51	2119.4		2119.4
		sum	**1**	**1955**	**0**	**N**	**0**		**4.56**	**9738**		**0**	**0**	**0**	**2119.4**	**1.72**	**0**	**0**	**0**	**11693**	**9255**	**N**	**19.98**	**11693.3**		**9738.1**
		Criteria	0.09	16.7%	0%	N	0.00		4.47		1.00			0.00		1.72	0.0%	0.00	0%	0%	79%	N	26.31			
		Score	1	5	1	1	1		4.47		1.00			1		1.72	1	1	1	1	5	1	2	**29**		**Raw Total**
		Weighted "A"	12.00	60.00	3.00	3.00	3.00		53.64		1.50			6.00		10.35	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**201.99**	**59.60%**	**"A" Total**
		Weighted "B"	6.00	30.00	1.50	1.50	1.50		26.82		2.75			11.00		18.97	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**162.05**	**66.67%**	**"B" Total**

Evaluation Criteria Scoring Table - Rio Hondo Paths

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 10	Start Point:	Artesia Blvd/LA River																								
	End Point:	Century Blvd/LA River (south of Hollydale Park)																								
	10.1	3.3(b)	24	11543	16575	N	3	LAFCD	1	5032		4130	0	0	0	1.00	0	0	0	16575	0	N	44.88	16575		5032
		sum	24	11543	16575	N	3		1.00	5032		4130	0	0	0	1.00	0	0	0	16575	0	N	44.88	16575		5032
		Criteria	1.45	69.6%	100%	N	0.18		3.09		2.00			0.00		1.00	0.0%	0.00	0%	0%	0%	N	60.58			
		Score	3	5	5	1	3		3.09		2.00			1		1.00	1	1	1	1	1	1	2	32		Raw Total
		Weighted "A"	36.00	60.00	15.00	3.00	9.00		37.07		3.00			6.00		6.00	6.00	4.50	6.00	15.00	2.00	8.00	0.00	216.57	56.69%	"A" Total
		Weighted "B"	18.00	30.00	7.50	1.50	4.50		18.54		5.49			11.00		11.00	11.00	8.25	8.25	7.50	3.00	12.00	0.00	157.53	67.60%	"B" Total
	10.2	3A	27	1686	19580	N	3	Roadway	3	17894		0	0	1	17894	5.00	4200	1	8019	19580	0	N	31.56	19580		17894
		sum	27	1686	19580	N	3		3.00	17894		0	0	1	17894	4.66	4200	1	8019	19580	0	N	31.56	19580		17894
		Criteria	1.38	8.6%	100%	N	0.15		3.09		1.00			0.27		4.66	21.5%	0.27	41%	18%	0%	N	42.34			
		Score	3	3	5	1	3		3.09		1.00			1		4.66	3	1	3	3	1	1	1	38		Raw Total
		Weighted "A"	36.00	36.00	15.00	3.00	9.00		37.03		1.50			6.00		27.93	18.00	4.50	18.00	45.00	2.00	8.00	0.00	266.97	46.61%	"A" Total
		Weighted "B"	18.00	18.00	7.50	1.50	4.50		18.52		2.75			11.00		51.21	33.00	8.25	24.75	22.50	3.00	12.00	0.00	236.48	51.37%	"B" Total
Path 11	Start Point:	Imperial Hwy/SCE Easement (east bank of LA River)																								
	End Point:	Ruchti Rd/SCE Easement (east bank of LA River)																								
	11.1	3.4(b)	0	0	1087	N	0	SCE	1	1087		0	0	0	0	1.00	0	0	0	1087	0	N	0.87	1087		1087
		sum	0	0	1087	N	0		1.00	1087		0	0	0	0	1.00	0	0	0	1087	0	N	0.87	1087.00		1087.00
		Criteria	0.00	0.0%	100%	N	0.00		1.00		1.00			0.00		1.00	0.0%	0.00	0%	0%	0%	N	1.14			
		Score	1	1	5	1	1		1.00		1.00			1		1.00	1	1	1	1	1	1	1	20		Raw Total
		Weighted "A"	12.00	12.00	15.00	3.00	3.00	0.00	12.00	0.00	1.50			6.00		6.00	6.00	4.50	6.00	15.00	2.00	8.00	0.00	112.00	77.60%	"A" Total
		Weighted "B"	6.00	6.00	7.50	1.50	1.50	0.00	6.00	0.00	2.75			11.00		11.00	11.00	8.25	8.25	7.50	3.00	12.00	0.00	103.25	78.77%	"B" Total
	11.2	3B	0	76	2669	N	1	Roadway	3	2593		0	0	0	2593	5.00	0	1	0	2669	0	N	3.92	2669		2593
		sum	0	76	2669	N	1		3.00	2593		0	0	0	2593	4.89	0	1	0	2669	0	N	3.92	2669		2593
		Criteria	0.00	2.8%	100%	N	0.37		3.03		1.00			0.00		4.89	0.0%	1.98	0%	146%	0%	N	5.20			
		Score	1	1	5	1	3		3.03		1.00			1		4.89	1	3	1	5	1	1	2	35		Raw Total
		Weighted "A"	12.00	12.00	15.00	3.00	9.00		36.34		1.50			6.00		29.32	6.00	13.50	6.00	75.00	2.00	8.00	0.00	234.66	53.07%	"A" Total
		Weighted "B"	6.00	6.00	7.50	1.50	4.50		18.17		2.75			11.00		53.75	11.00	24.75	8.25	37.50	3.00	12.00	0.00	207.67	57.29%	"B" Total
Path 12	Start Point:	Downey Ave/Artesia Blvd																								
	End Point:	Lakewood Blvd/SCE Easement																								
	12.1	19A(b)	7	307	0	N	1	Roadway	3	2476		0	0	0	2476	3.00	0	2	2231	2783	0	N	4.83	2783		2476
		19.1(c)	4	0	0	N	2	Roadway	3	1689		0	0	0	1689	3.00	1175	0	588	1689	0	N	2.33	1689		1689
		sum	11	307	0	N	3		3.00	4165		0	0	0	4165	2.86	1175	2	2819	4472	0	N	7.16	4472		4165
		Criteria	2.46	6.9%	0%	N	0.67		3.07		1.00			0.00		2.86	26.3%	2.36	63%	1%	0%	N	9.54			
		Score	3	3	1	1	5		3.07		1.00			1		2.86	3	5	5	1	1	1	2	39		Raw Total
		Weighted "A"	36.00	36.00	3.00	3.00	15.00		36.82		1.50			6.00		17.18	18.00	22.50	30.00	15.00	2.00	8.00	0.00	250.00	50.00%	"A" Total
		Weighted "B"	18.00	18.00	1.50	1.50	7.50		18.41		2.75			11.00		31.49	33.00	41.25	41.25	7.50	3.00	12.00	0.00	248.15	48.97%	"B" Total
	12.2	19B.1	9	531	0	N	0	Roadway	3	1234		0	0	0	1234	3.00	0	1	750	1765	0	N	3.92	1765		1234
		19B.2	2	113	0	N	1	SCE	1	2530		0	0	0	0	1.00	0	1	0	2643	0	N	2.54	2643		2530
		sum	11	644	0	N	1		1.66	3764		0	0	0	1234	1.56	0	2	750	4408	0	N	6.46	4408		3764
		Criteria	2.50	14.6%	0%	N	0.23		2.00		1.00			0.00		1.56	0.0%	2.40	17%	0%	0%	N	8.55			
		Score	3	3	1	1	3		2.00		1.00			1		1.56	1	5	3	1	1	1	1	30		Raw Total
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		23.97		1.50			6.00		9.36	6.00	22.50	18.00	15.00	2.00	8.00	0.00	199.33	60.13%	"A" Total
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		11.99		2.75			11.00		17.16	11.00	41.25	24.75	7.50	3.00	12.00	0.00	185.90	61.77%	"B" Total
Path 13	Start Point:	Del Amo Blvd/Cherry Ave																								
	End Point:	Lakewood Blvd/SCE Easement																								
	13.1	4A(b)	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	4.58	2075		1873
		19A(a)	20	412	0	N	6	Roadway	3	12192		0	0	0	12192	3.00	4200	3	5061	12604	0	N	18.87	12604		12192
	12.1 (Road)	Path 12.1	11	307	0	N	3		3	4165		0	0	0	4165	2.86	1175	2	2819	4472	0	N	7.16	4472		4165
		sum	37	921	0	N	12		3.00	18229		0	0	0	18229	2.87	6475	6	8272	19150	0	N	30.60	19150		18229
		Criteria	1.93	4.8%	0%	N	0.63		3.05		1.00			0.00		2.87	33.8%	1.65	43%	0%	0%	N	40.55			
		Score	3	1	1	1	5		3.05		1.00			1		2.87	3	3	3	1	1	1	1	32		Raw Total
		Weighted "A"	36.00	12.00	3.00	3.00	15.00		36.58		1.50			6.00		17.24	18.00	13.50	18.00	15.00	2.00	8.00	0.00	204.82	59.04%	"A" Total
		Weighted "B"	18.00	6.00	1.50	1.50	7.50		18.29		2.75			11.00		31.61	33.00	24.75	24.75	7.50	3.00	12.00	0.00	203.15	58.22%	"B" Total
	13.2	4A(b)	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	4.58	2075		1873
		4A(c)	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	11.81	5497		5045
		19.1(b)	8	519	0	N	1	Roadway	3	9538		0	0	2	9538	3.00	7725	3	2961	10058	0	N	15.54	10058		9538
		19.1(c)	4	0	0	N	2	Roadway	3	1689		0	0	0	1689	3.00	1175	0	588	1689	0	N	2.33	1689		1689
		sum	26	1173	0	N	7		3.00	18144		0	0	2	18144	2.88	12800	6	4112	19318	15	N	34.26	19318		18144
		Criteria	1.35	6.1%	0%	N	0.36		3.06		1.00			0.55		2.88	66.3%	1.64	21%	1%	0%	N	45.39			
		Score	3	3	1	1	3		3.06		1.00			3		2.88	5	3	3	1	1	1	2	37		Raw Total
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		36.73		1.50			18.00		17.27	30.00	13.50	18.00	15.00	2.00	8.00	0.00	247.00	50.60%	"A" Total
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.36		2.75			33.00		31.66	55.00	24.75	24.75	7.50	3.00	12.00	0.00	256.28	47.29%	"B" Total

Evaluation Criteria Scoring Table - Rio Hondo Paths

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 14	Start Point:	Lakewood Blvd/Rosecrans Ave																								
	End Point:	Columbia Way/Lakewood Blvd																								
	14.1	19.1(e)	11	993	7409	N	2	Roadway	3	6416		0	0	0	6416	5.00	5382	1	2040	7409	0	N	12.95	7409		6416
		sum	**11**	**993**	**7409**	**N**	**2**		**3.00**	**6416**		**0**	**0**	**0**	**6416**	**4.46**	**5382**	**1**	**2040**	**7409**	**0**	**N**	**12.95**	**7409**		**6416**
		Criteria	1.48	13.4%	100%	N	0.27		3.13		1.00			0.00		4.46	72.6%	0.71	28%	**0%**	0%	N	17.38			
		Score	3	3	5	1	3		3.13		1.00			1		4.46	5	1	3	1	1	1	1	**38**		**Raw Total**
		Weighted "A"	36.00	36.00	15.00	3.00	9.00		37.61		1.50			6.00		26.78	30.00	4.50	18.00	15.00	2.00	8.00	0.00	**248.39**	**50.32%**	**"A" Total**
		Weighted "B"	18.00	18.00	7.50	1.50	4.50		18.80		2.75			11.00		49.10	55.00	8.25	24.75	7.50	3.00	12.00	0.00	**241.66**	**50.30%**	**"B" Total**
	14.2	19C	10	1274	9190	N	0	Roadway	3	7916		0	0	2	7916	5.00	0	3.5	8136	9190	0	N	16.28	9190		7916
		sum	**10**	**1274**	**9190**	**N**	**0**		**3.00**	**7916**		**0**	**0**	**2**	**7916**	**4.45**	**0**	**3.5**	**8136**	**9190**	**0**	**N**	**16.28**	**9190**		**7916**
		Criteria	1.09	13.9%	100%	N	0.00		3.14		1.00			1.15		4.45	0.0%	2.01	89%	**24%**	0%	N	21.71			
		Score	3	3	5	1	1		3.14		1.00			5		4.45	1	5	5	5	1	1	2	**47**		**Raw Total**
		Weighted "A"	36.00	36.00	15.00	3.00	3.00		37.66		1.50			30.00		26.67	6.00	22.50	30.00	75.00	2.00	8.00	0.00	**332.34**	**33.53%**	**"A" Total**
		Weighted "B"	18.00	18.00	7.50	1.50	1.50		18.83		2.75			55.00		48.90	11.00	41.25	41.25	37.50	3.00	12.00	0.00	**317.98**	**34.61%**	**"B" Total**
Path 15	Start Point:	183rd St/San Gabriel River																								
	End Point:	Alondra Blvd/San Gabriel River																								
	15.1	20.6	0	0	0	N	0	Private	1	2180		0	0	0	0	1.00	0	0	0	2180	0	N	1.74	2180		2180
		20.7	2	1133	0	N	0	SCE	1	922		0	0	0	0	1.00	0	0	0	2055	0	N	5.31	2055		922
		20.8	5	0	0	N	0	SCE	1	1781		0	1781	0	0	1.00	0	0	0	1781	3	N	1.42	1781		1781
		20.9	7	1211	2402	N	0	SCE	1	1192		0	0	0	0	1.00	0	0	0	2402	281	N	5.84	2402		1192
		sum	**14**	**2344**	**2402**	**N**	**0**		**1.00**	**6074**		**0**	**1781**	**0**	**0**	**1.00**	**0**	**0**	**0**	**8417**	**283**	**N**	**14.32**	**8417**		**6074**
		Criteria	1.66	27.8%	29%	N	0.00		1.84		1.42			0.00		1.00	0.0%	0.00	0%	**0%**	3%	N	19.09			
		Score	3	5	3	1	1		1.84		1.42			1		1.00	1	1	1	1	3	1	1	**27**		**Raw Total**
		Weighted "A"	36.00	60.00	9.00	3.00	3.00		22.02		2.13			6.00		6.00	6.00	4.50	6.00	15.00	6.00	8.00	0.00	**192.66**	**61.47%**	**"A" Total**
		Weighted "B"	18.00	30.00	4.50	1.50	1.50		11.01		3.91			11.00		11.00	11.00	8.25	8.25	7.50	9.00	12.00	0.00	**148.43**	**69.48%**	**"B" Total**
	15.2	20A	13	1176	0	N	0	River	5	7480		0	0	0	0	1.00	0	0	0	8655	8250	N	16.70	8655		7480
		sum	**13**	**1176**	**0**	**N**	**0**		**5.00**	**7480**		**0**	**0**	**0**	**0**	**1.00**	**0**	**0**	**0**	**8655**	**8250**	**N**	**16.70**	**8655**		**7480**
		Criteria	1.50	13.6%	0%	N	0.00		4.86		1.00			0.00		1.00	0.0%	0.00	0%	**3%**	95%	N	21.99			
		Score	3	3	1	1	1		4.86		1.00			1		1.00	1	1	1	1	5	1	2	**29**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	3.00	0.00	58.37	0.00	1.50			6.00		6.00	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**202.37**	**59.53%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	1.50	0.00	29.19	0.00	2.75			11.00		11.00	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**156.44**	**67.83%**	**"B" Total**
	15.3	20B	18	1270	12168	N	4	Roadway	3	10898		0	0	5	10898	3.00	10890	3	5074	12168	87	N	20.59	12168		10898
		sum	**18**	**1270**	**12168**	**N**	**4**		**3.00**	**10898**		**0**	**0**	**5**	**10898**	**2.79**	**10890**	**3**	**5074**	**12168**	**87**	**N**	**20.59**	**12168**		**10898**
		Criteria	1.48	10.4%	100%	N	0.33		3.10		1.00			2.17		2.79	89.5%	1.30	42%	**45%**	1%	N	27.62			
		Score	3	3	5	1	3		3.10		1.00			5		2.79	5	3	3	5	1	1	3	**48**		**Raw Total**
		Weighted "A"	36.00	36.00	15.00	3.00	9.00		37.25		1.50			30.00		16.75	30.00	13.50	18.00	75.00	2.00	8.00	0.00	**331.00**	**33.80%**	**"A" Total**
		Weighted "B"	18.00	18.00	7.50	1.50	4.50		18.63		2.75			55.00		30.70	55.00	24.75	24.75	37.50	3.00	12.00	0.00	**313.58**	**35.51%**	**"B" Total**
Path 16	Start Point:	Firestone Blvd/LA River																								
	End Point:	Florence Ave/LA River																								
	16.1	21.1	0	378	1550	N	0	SCE	1	1172		0	415	0	0	1.00	0	0	0	1550	0	N	2.46	1550		1172
		21.2	0	0	939	N	0	Roadway	3	939		0	0	0	939	5.00	0	0	939	939	0	N	1.29	939		939
		21.3(a)	0	0	2748	N	0	SCE	1	2748		0	2748	0	0	1.00	0	0	2477	2748	0	N	2.20	2748		2748
		21.3(b)	1	298	1495	N	0	SCE	1	1197		0	0	0	0	1.00	0	0	0	1495	0	N	2.16	1495		1197
		sum	**1**	**676**	**6732**	**N**	**0**		**1.31**	**6056**		**0**	**3163**	**0**	**939**	**1.56**	**0**	**0**	**3416**	**6732**	**0**	**N**	**8.11**	**6732**		**6056**
		Criteria	0.15	10.0%	100%	N	0.00		1.58		1.94			0.00		1.56	0.0%	0.00	51%	**0%**	0%	N	10.75			
		Score	1	3	5	1	1		1.58		1.94			1		1.56	1	1	3	1	1	1	1	**26**		**Raw Total**
		Weighted "A"	12.00	36.00	15.00	3.00	3.00		18.96		2.91			6.00		9.35	6.00	4.50	18.00	15.00	2.00	8.00	0.00	**159.72**	**68.06%**	**"A" Total**
		Weighted "B"	6.00	18.00	7.50	1.50	1.50		9.48		5.33			11.00		17.14	11.00	8.25	24.75	7.50	3.00	12.00	0.00	**143.96**	**70.39%**	**"B" Total**
	16.2	21A	6	248	5773	N	0	River	5	5525		0	0	0	0	1.00	0	0	0	5773	5339	N	9.69	5773		5525
		21.3(b)	1	298	1495	N	0	SCE	1	1197		0	0	0	0	1.00	0	0	0	1495	0	N	2.16	1495		1197
		sum	**7**	**547**	**7268**	**N**	**0**		**4.29**	**6722**		**0**	**0**	**0**	**0**	**1.00**	**0**	**0**	**0**	**7268**	**5339**	**N**	**11.85**	**7268**		**6722**
		Criteria	0.96	7.5%	100%	N	0.00		4.27		1.00			0.00		1.00	0.0%	0.00	0%	**8%**	73%	N	15.70			
		Score	1	3	5	1	1		4.27		1.00			1		1.00	1	1	1	1	5	1	2	**30**		**Raw Total**
		Weighted "A"	12.00	36.00	15.00	3.00	3.00		51.20		1.50			6.00		6.00	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**183.20**	**63.36%**	**"A" Total**
		Weighted "B"	6.00	18.00	7.50	1.50	1.50		25.60		2.75			11.00		11.00	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**146.85**	**69.80%**	**"B" Total**
	16.3	25(a)	2	0	3447	N	0	Roadway	3	3447		0	0	0	3447	5.00	1300	0	1800	3447	0	N	4.75	3447		3447
		21B	4	372	6176	N	1	Roadway	3	5803		0	0	0	5803	3.00	210	2	3344	6176	0	N	9.58	6176		5803
		sum	**6**	**372**	**9622**	**N**	**1**		**3.00**	**9250**		**0**	**0**	**0**	**9250**	**3.64**	**1510**	**2**	**5144**	**9622**	**0**	**N**	**14.33**	**9622**		**9250**
		Criteria	0.62	3.9%	100%	N	0.10		3.04		1.00			0.00		3.64	15.7%	1.10	53%	**43%**	0%	N	18.87			
		Score	1	1	5	1	1		3.04		1.00			1		3.64	3	3	3	5	1	1	3	**37**		**Raw Total**
		Weighted "A"	12.00	12.00	15.00	3.00	3.00		36.46		1.50			6.00		21.83	18.00	13.50	18.00	75.00	2.00	8.00	0.00	**245.30**	**50.94%**	**"A" Total**
		Weighted "B"	6.00	6.00	7.50	1.50	1.50		18.23		2.75			11.00		40.03	33.00	24.75	24.75	37.50	3.00	12.00	0.00	**229.51**	**52.80%**	**"B" Total**

Evaluation Criteria Scoring Table - Rio Hondo Paths

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 17	Start Point:	Whittier Blvd/San Gabriel River																								
	End Point:	San Gabriel River Pkwy/San Gabriel River																								
	17.1	38.2(a)	6	68	0	N	1	Roadway	3	7480		0	0	2	7480	5.00	3735	1	5017	7549	0	N	10.68	7549		7480
		38.2(b)	2	346	0	N	0	Roadway	3	680		0	0	0	680	3.00	0	0	0	1027	310	N	2.34	1027		680
		38.3	2	0	3075	N	0	LAFCD	1	3075		0	0	0	0	1.00	0	0	0	3075	0	N	2.43	3075		3075
		sum	**10**	**415**	**3075**	**N**	**1**		**2.45**	**11236**		**0**	**0**	**2**	**8161**	**3.69**	**3735**	**1**	**5017**	**11650**	**310**	**N**	**15.45**	**11650**		**11236**
		Criteria	0.86	3.6%	26%	N	0.09		2.51		1.00			0.91		3.69	32.1%	0.45	43%	**53%**	3%	N	20.21			
		Score	1	1	3	1	1		2.51		1.00			5		3.69	3	1	3	5	3	1	1	**36**		**Raw Total**
		Weighted "A"	12.00	12.00	9.00	3.00	3.00		30.09		1.50			30.00		22.11	18.00	4.50	18.00	75.00	6.00	8.00	0.00	**252.20**	**49.56%**	**"A" Total**
		Weighted "B"	6.00	6.00	4.50	1.50	1.50		15.05		2.75			55.00		40.54	33.00	8.25	24.75	37.50	9.00	12.00	0.00	**257.33**	**47.08%**	**"B" Total**
	17.2	38.2(a)	6	68	0	N	1	Roadway	3	7480		0	0	2	7480	5.00	3735	1	5017	7549	0	N	10.68	7549		7480
		38B.1	3	141	3525	N	0	Roadway	3	3384		0	0	0	3384	3.00	1950	1	753	3525	0	N	5.31	3525		3384
		38B.2	0	513	580	N	0	LAFCD	1	66		0	0	0	0	1.00	0	0	0	580	341	N	2.15	580		66
		sum	**9**	**723**	**4105**	**N**	**1**		**2.99**	**10931**		**0**	**0**	**2**	**10864**	**4.15**	**5685**	**2**	**5770**	**11654**	**341**	**N**	**18.15**	**11654**		**10931**
		Criteria	0.77	6.2%	35%	N	0.09		3.05		1.00			0.91		4.15	48.8%	0.91	50%	**53%**	3%	N	24.04			
		Score	1	3	5	1	1		3.05		1.00			5		4.15	3	1	3	5	3	1	2	**42**		**Raw Total**
		Weighted "A"	12.00	36.00	15.00	3.00	3.00		36.61		1.50			30.00		24.89	18.00	4.50	18.00	75.00	6.00	8.00	0.00	**291.50**	**41.70%**	**"A" Total**
		Weighted "B"	6.00	18.00	7.50	1.50	1.50		18.30		2.75			55.00		45.63	33.00	8.25	24.75	37.50	9.00	12.00	0.00	**280.69**	**42.28%**	**"B" Total**
	17.3	38A	4	4545	0	N	0	Tunnel	1	0		0	0	0	0	1.00	0	0	0	4545	303	N	16.02	4545		0
		38.3	2	0	3075	N	0	LAFCD	1	3075		0	0	0	0	1.00	0	0	0	3075	0	N	2.43	3075		3075
		sum	**6**	**4545**	**3075**	**N**	**0**		**1.00**	**3075**		**0**	**0**	**0**	**0**	**1.00**	**0**	**0**	**0**	**7620**	**303**	**N**	**18.45**	**7620**		**3075**
		Criteria	0.79	59.6%	40%	N	0.00		2.79		1.00			0.00		1.00	0.0%	0.00	0%	**0%**	4%	N	24.60			
		Score	1	5	5	1	1		2.79		1.00			1		1.00	1	1	1	1	3	1	3	**30**		**Raw Total**
		Weighted "A"	12.00	60.00	15.00	3.00	3.00		33.47		1.50			6.00		6.00	6.00	4.50	6.00	15.00	6.00	8.00	0.00	**185.47**	**62.91%**	**"A" Total**
		Weighted "B"	6.00	30.00	7.50	1.50	1.50		16.74		2.75			11.00		11.00	11.00	8.25	8.25	7.50	9.00	12.00	0.00	**143.99**	**70.39%**	**"B" Total**

Evaluation Criteria Scoring Table - Rio Hondo Paths

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 19	**Start Point:**	Lakewood Blvd/Firestone Blvd																								
	End Point:	Rosemead Blvd/Gallatin Rd																								
	19.1	35	9	1828	0	N	4	Roadway	3	17359		0	0	2	17359	5.00	17300	7	7019	19187	0	N	31.81	19187		17359
		40	1	160	0	N	0	Roadway	3	3686		0	0	1	3686	3.00	3700	1	1262	3846	0	N	5.82	3846		3686
		37	7	154	0	N	4	Roadway	3	9822		0	0	4	9822	3.00	9000	1	4316	9977	0	N	14.25	9977		9822
		sum	**17**	**2143**	**0**	**N**	**8**		**3.00**	**30867**		**0**	**0**	**7**	**30867**	**3.92**	**30000**	**9**	**12597**	**33010**	**0**	**N**	**51.88**	**33010**		**30867**
		Criteria	0.51	6.5%	0%	N	0.24		3.06		1.00			1.12		3.92	90.9%	1.44	38%	**0%**	0%	N	51.88			
		Score	1	3	1	1	3		3.06		1.00			5		3.92	5	3	3	1	1	1	1	**37**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	9.00		36.78		1.50			30.00		23.53	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**241.31**	**51.74%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	4.50		18.39		2.75			55.00		43.14	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**277.78**	**42.87%**	**"B" Total**
	19.2	33	1	497	4950	N	1	Roadway	3	4454		0	0	1	4454	5.00	3325	4	3498	4950	0	N	8.42	4950		4454
		27	14	1384	0	N	1	Roadway	3	18235		0	0	3	18235	3.00	10600	6	8177	19619	0	N	31.21	19619		18235
		42	2	0	0	N	1	Roadway	3	4236		0	0	0	4236	3.00	325	0	948	4236	0	N	5.84	4236		4236
		29	9	367	0	N	0	Roadway	3	8352		0	0	1	8352	3.00	5000	2	1737	8719	0	N	13.20	8719		8352
		31	1	150	1834	N	0	Roadway	3	1684		0	0	0	1684	3.00	0	1	0	1834	0	N	3.01	1834		1684
		sum	**27**	**2398**	**6784**	**N**	**3**		**3.00**	**36960**		**0**	**0**	**5**	**36960**	**3.10**	**19250**	**13**	**14360**	**39358**	**0**	**N**	**61.69**	**39358**		**36960**
		Criteria	0.69	6.1%	17%	N	0.08		3.06		1.00			0.67		3.10	48.9%	1.74	36%	**19%**	0%	N	81.22			
		Score	1	3	3	1	1		3.06		1.00			5		3.10	3	3	3	3	1	1	3	**38**		**Raw Total**
		Weighted "A"	12.00	36.00	9.00	3.00	3.00		36.73		1.50			30.00		18.63	18.00	13.50	18.00	45.00	2.00	8.00	0.00	**254.36**	**49.13%**	**"A" Total**
		Weighted "B"	6.00	18.00	4.50	1.50	1.50		18.37		2.75			55.00		34.15	33.00	24.75	24.75	22.50	3.00	12.00	0.00	**261.76**	**46.17%**	**"B" Total**
	19.3	35	9	1828	0	N	4	Roadway	3	17359		0	0	2	17359	5.00	17300	7	7019	19187	0	N	31.81	19187		17359
		40	1	160	0	N	0	Roadway	3	3686		0	0	1	3686	3.00	3700	1	1262	3846	0	N	5.82	3846		3686
		32	3	176	0	N	0	Roadway	3	1715		0	0	0	1715	3.00	0	1	390	1890	0	N	3.17	1890		1715
		29	9	367	0	N	0	Roadway	3	8352		0	0	1	8352	3.00	5000	2	1737	8719	0	N	13.20	8719		8352
		31	1	150	1834	N	0	Roadway	3	1684		0	0	0	1684	3.00	0	1	0	1834	0	N	3.01	1834		1684
		sum	**23**	**2681**	**1834**	**N**	**4**		**3.00**	**32795**		**0**	**0**	**4**	**32795**	**3.83**	**26000**	**12**	**10408**	**35476**	**0**	**N**	**57.01**	**35476**		**32795**
		Criteria	0.65	7.6%	5%	N	0.11		3.08		1.00			0.60		3.83	73.3%	1.79	29%	**7%**	0%	N	74.59			
		Score	1	3	1	1	1		3.08		1.00			5		3.83	5	3	3	1	1	1	2	**36**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	3.00		36.91		1.50			30.00		22.96	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**234.87**	**53.03%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	1.50		18.45		2.75			55.00		42.10	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**273.81**	**43.69%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

Path		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 21	**Start Point:**	Main St/Sepulveda Blvd																								
	End Point:	Avalon Blvd/223rd St																								
	21.1	1A	18	462	0	N	0	Roadway	3	9269		0	0	2	9269	3.00	6070	3	2803	9731	0	N	19.74	9731		9269
		sum	**18**	**462**	**0**	**N**	**0**		**3.00**	**9269**		**0**	**0**	**2**	**9269**	**2.91**	**6070**	**3**	**2803**	**9731**	**0**	**N**	**19.74**	**9731**		**9269**
		Criteria	1.85	4.7%	0%	N	0.00		3.05		1.00			1.09		2.91	62.4%	1.63	29%	**4%**	0%	N	25.82			
		Score	3	1	1	1	1		3.05		1.00			5		2.91	5	3	3	1	1	1	2	**35**		**Raw Total**
		Weighted "A"	36.00	12.00	3.00	3.00	3.00		36.57		1.50			30.00		17.43	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**229.00**	**54.20%**	**"A" Total**
		Weighted "B"	18.00	6.00	1.50	1.50	1.50		18.28		2.75			55.00		31.96	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**263.49**	**45.81%**	**"B" Total**
	21.2	1(b)	3	0	0	N	1	Roadway	3	3407		0	0	1	3407	3.00	3340	0	1192	3407	0	N	6.25	3407		3407
		1B(a)	11	358	0	N	2	Roadway	3	5606		0	0	0	5606	3.00	5500	2	1364	5964	0	N	12.40	5964		5606
		sum	**14**	**358**	**0**	**N**	**3**		**3.00**	**9013**		**0**	**0**	**1**	**9013**	**2.92**	**8840**	**2**	**2556**	**9370**	**0**	**N**	**18.65**	**9370**		**9013**
		Criteria	1.49	3.8%	0%	N	0.32		3.04		1.00			0.56		2.92	94.3%	1.13	27%	**0%**	0%	N	24.56			
		Score	3	1	1	1	3		3.04		1.00			5		2.92	5	3	3	1	1	1	1	**36**		**Raw Total**
		Weighted "A"	36.00	12.00	3.00	3.00	9.00		36.46		1.50			30.00		17.54	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**235.00**	**53.00%**	**"A" Total**
		Weighted "B"	18.00	6.00	1.50	1.50	4.50		18.23		2.75			55.00		32.16	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**266.64**	**45.16%**	**"B" Total**
Path 22	**Start Point:**	JWPCP																								
	End Point:	Alameda St/Sepulveda Blvd																								
	22.1	1(a)	13	82	0	N	0	Roadway	3	3024		0	0	1	3024	3.00	1675	1	0	3106	0	N	6.04	3106		3024
		1(b)	3	0	0	N	1	Roadway	3	3407		0	0	1	3407	3.00	3340	0	1192	3407	0	N	6.25	3407		3407
		1(c)	60	926	0	N	7	Roadway	3	8337		0	0	0	8337	3.00	7490	2	7456	9263	0	N	20.24	9263		8337
		sum	**76**	**1009**	**0**	**N**	**8**		**3.00**	**14767**		**0**	**0**	**2**	**14767**	**2.87**	**12505**	**3**	**8648**	**15775**	**0**	**N**	**32.53**	**15775**		**14767**
		Criteria	4.82	6.4%	0%	N	0.51		3.06		1.00			0.67		2.87	79.3%	1.00	55%	**0%**	0%	N	43.65			
		Score	5	3	1	1	5		3.06		1.00			5		2.87	5	3	3	1	1	1	1	**42**		**Raw Total**
		Weighted "A"	60.00	36.00	3.00	3.00	15.00		36.77		1.50			30.00		17.23	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**289.00**	**42.20%**	**"A" Total**
		Weighted "B"	30.00	18.00	1.50	1.50	7.50		18.38		2.75			55.00		31.59	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**293.23**	**39.70%**	**"B" Total**
	22.2	1C	74	1286	0	N	7	Roadway	3	14914		0		1	14914	3.00	4700	2	7067	16200	0	N	34.82	16200		14914
		sum	**74**	**1286**	**0**	**N**	**7**		**3.00**	**14914**		**0**		**1**	**14914**	**2.84**	**4700**	**2**	**7067**	**16200**	**0**	**N**	**34.82**	**16200**		**14914**
		Criteria	4.57	7.9%	0%	N	0.43		3.08		0.0%			0.33		2.84	29.0%	0.65	44%	**3%**	0%	N	46.71			
		Score	5	3	1	1	5		3.08		0.00			1		2.84	3	1	3	1	1	1	2	**34**		**Raw Total**
		Weighted "A"	60.00	36.00	3.00	3.00	15.00		36.95		0.00			6.00		17.05	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**242.50**	**51.50%**	**"A" Total**
		Weighted "B"	30.00	18.00	1.50	1.50	7.50		18.48		0.00			11.00		31.25	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**207.73**	**57.28%**	**"B" Total**
Path 23	**Start Point:**	Carson St/Los Coyotes Diagonal																								
	End Point:	Centralia St/Studebaker Rd																								
	23.1	10A.1(a)	3	674	0	N	0	Roadway	3	1855		0	0	0	1855	3.00	0	0	177	2529	0	N	6.18	2529		1855
		sum	**3**	**674**	**0**	**N**	**0**		**3.00**	**1855**		**0**	**0**	**0**	**1855**	**2.47**	**0**	**0**	**177**	**2529**	**0**	**N**	**6.18**	**2529**		**1855**
		Criteria	1.19	26.7%	0%	N	0.00		3.27			1.00		0.00		2.47	0.0%	0.00	7%	**0%**	0%	N	8.18			
		Score	3	5	1	1	1		3.27			1.00		1		2.47	1	1	1	1	1	1	1	**26**		**Raw Total**
		Weighted "A"	36.00	60.00	3.00	3.00	3.00		39.20	0.00		1.50	0.00	6.00	0.00	14.80	6.00	4.50	6.00	15.00	2.00	8.00	0.00	**208.00**	**58.40%**	**"A" Total**
		Weighted "B"	18.00	30.00	1.50	1.50	1.50		19.60	0.00		2.75	0.00	11.00	0.00	27.13	11.00	8.25	8.25	7.50	3.00	12.00	0.00	**162.98**	**66.48%**	**"B" Total**
	23.2	8(d)	3	652	0	N	0	Roadway	3	1517		0	0	1	1517	5.00	1500	0	281	2170	165	N	6.47	2170		1517
		9	5	0	0	N	0	SCE	1	2353		0	975	0	0	1.00	0	0	0	2353	16	N	2.93	2353		2353
		sum	**8**	**652**	**0**	**N**	**0**		**1.78**	**3870**		**0**	**975**	**1**	**1517**	**2.34**	**1500**	**0**	**281**	**4522**	**182**	**N**	**9.40**	**4522**		**3870**
		Criteria	1.77	14.4%	0%	N	0.00		2.10		1.43			1.17		2.34	33.2%	0.00	6%	**79%**	4%	N	12.38			
		Score	3	3	1	1	1		2.10		1.43			5		2.34	3	1	1	5	3	1	2	**36**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	3.00		25.25		2.15			30.00	0.00	14.05	18.00	4.50	6.00	75.00	6.00	8.00	0.00	**269.94**	**46.01%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	1.50		12.62		3.94			55.00	0.00	25.76	33.00	8.25	8.25	37.50	9.00	12.00	0.00	**245.82**	**49.45%**	**"B" Total**
Path 23OC (54" pipe to OC)	**Start Point:**	Carson St/Los Coyotes Diagonal																								
	End Point:	Centralia St/Studebaker Rd																								
	23OC.1	10A.1(a)OC	3	674	0	N	0	Roadway	3	1855		0	0	0	1855	3.00	0	0	177	2529	0	N	5.25	2529		1855
		sum	**3**	**674**	**0**	**N**	**0**		**3.00**	**1855**		**0**	**0**	**0**	**1855**	**2.47**	**0**	**0**	**177**	**2529**	**0**	**N**	**5.25**	**2529**		**1855**
		Criteria	1.19	26.7%	0%	N	0.00		3.27		1.00			0.00		2.47	0.0%	0.00	7%	**0%**	0%	N	6.96			
		Score	3	5	1	1	1		3.27		1.00			1		2.47	1	1	1	1	1	1	1	**26**		**Raw Total**
		Weighted "A"	36.00	60.00	3.00	3.00	3.00		39.20		1.50			6.00	0.00	14.80	6.00	4.50	6.00	15.00	2.00	8.00	0.00	**208.00**	**58.40%**	**"A" Total**
		Weighted "B"	18.00	30.00	1.50	1.50	1.50		19.60		2.75			11.00	0.00	27.13	11.00	8.25	8.25	7.50	3.00	12.00	0.00	**162.98**	**66.48%**	**"B" Total**
	23OC.2	8(d)OC	3	652	0	N	0	Roadway	3	1517		0	0	1	1517	5.00	1500	0	281	2170	165	N	4.40	2170		1517
		9OC	5	0	0	N	0	SCE	1	2353		0	975	0	0	1.00	0	0	0	2353	16	N	1.80	2353		2353
		sum	**8**	**652**	**0**	**N**	**0**		**1.78**	**3870**		**0**	**975**	**1**	**1517**	**2.34**	**1500**	**0**	**281**	**4522**	**182**	**N**	**6.20**	**4522**		**3870**
		Criteria	1.77	14.4%	0%	N	0.00		2.10		1.43			1.17		2.34	33.2%	0.00	6%	**79%**	4%	N	8.16			
		Score	3	3	1	1	1		2.10		1.43			5		2.34	3	1	1	5	3	1	2	**36**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	3.00		25.25		2.15			30.00		14.05	18.00	4.50	6.00	75.00	6.00	8.00	0.00	**269.94**	**46.01%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	1.50		12.62		3.94			55.00		25.76	33.00	8.25	8.25	37.50	9.00	12.00	0.00	**245.82**	**49.45%**	**"B" Total**

SECONDARY SCREENING RESULTS

Evaluation Criteria Scoring Table - Orange County Paths

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 3																									
Start Point:	Centralia St/Studebaker Rd																								
End Point:	Orangethorpe Ave/Stanton Ave																								
3.1	10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
	10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
	10A.3	1	0	0	N	0	Roadway	3	435		0	0	0	435	3.00	375	0	0	435	0	N	0.80	435		435
	10A.4	0	0	0	N	0	SCE	1	911		0	0	0	0	1.00	0	0	0	911	0	N	0.70	911		911
	10A.5	0	0	0	N	0	SCE	1	271		0	0	0	0	1.00	0	0	0	271	0	N	0.21	271		271
	11.1(a)	8	1402	0	N	0	SCE	1	8332		0	3851	2	0	1.00	0	0	0	9733	175	N	13.21	9733		8332
	11.1(b)	0	0	2039	N	0	SCE	1	2039		0	2039	0	0	1.00	0	0	0	2039	0	N	1.56	2039		2039
	11.2	1	0	501	N	0	LAFCD	1	501		0	0	0	0	1.00	0	0	0	501	215	N	0.75	501		501
	11.3(a)	1	149	2689	N	0	SCE	1	2541		0	2541	0	0	1.00	0	0	0	2689	0	N	2.82	2689		2541
	11.3(b)	0	0	2534	N	0	SCE	1	2534		0	2534	0	0	1.00	0	0	0	2534	0	N	1.94	2534		2534
	16	5	990	13375	N	0	SCE	1	12385		0	2529	4	0	1.00	0	0	1146	13375	0	N	12.44	13375		12385
	17	0	117	3148	N	0	Roadway	3	3032		0	0	1	3032	3.00	0	0	689	3148	0	N	4.62	3148		3032
	sum	**18**	**3100**	**24287**	**N**	**0**		**1.34**	**35989**		**0**	**13494**	**7**	**6091**	**1.31**	**375**	**1**	**1835**	**39088**	**391**	**N**	**46.30**	**39088**		**35989**
	Criteria	0.46	7.9%	62%	N	0.00		1.55		1.69			0.95		1.31	1.0%	0.14	5%	**4%**	1%	N	61.34			
	Score	1	3	5	1	1		1.55		1.69			5		1.31	1	1	1	1	1	1	1	**28**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		18.59		2.54			30.00		7.87	6.00	4.50	6.00	15.00	2.00	8.00	0.00	**169.50**	**66.10%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		9.30		4.65			55.00		14.43	11.00	8.25	8.25	7.50	3.00	12.00	0.00	**167.87**	**65.48%**	**"B" Total**
3.2 Road Route	10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
	10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
	10A.3	1	0	0	N	0	Roadway	3	435		0	0	0	435	3.00	375	0	0	435	0	N	0.80	435		435
	20.1(a)	3	0	0	N	0	Roadway	3	3572		0	0	0	3572	3.00	2500	0	0	3572	0	N	4.93	3572		3572
	11A(b)	6	2004	0	N	0	Roadway	3	3239		0	0	0	3239	5.00	2500	0	0	5243	0	N	10.69	5243		3239
1.3	Path 1.3	9	557	7530	N	0		3	6973.6		0	0	2	6974	2.54	5570	4	2316	7530	159	N	11.52	7530		6974
	11B(c)	3	1965	7961	N	4	Roadway	3	5996		0	0	1	5996	3.00	5135	3	1909	7961	0	N	15.22	7961		5996
	15	5	2055	13257	N	6	Roadway	3	11202		0	0	3	11202	5.00	2790	4	9299	13257	26	N	22.46	13257		11202
	sum	**29**	**7023**	**28748**	**N**	**10**		**2.98**	**34426**		**0**	**0**	**6**	**34042**	**3.26**	**18870**	**12**	**13524**	**41449**	**185**	**N**	**72.88**	**41449**		**34426**
	Criteria	0.70	16.9%	69%	N	0.24		3.15		1.00			0.76		3.26	45.5%	1.53	33%	**10%**	0%	N	97.78			
	Score	1	5	5	1	3		3.15		1.00			5		3.26	3	3	3	3	1	1	5	**46**		**Raw Total**
	Weighted "A"	12.00	60.00	15.00	3.00	9.00		37.81		1.50			30.00		19.58	18.00	13.50	18.00	45.00	2.00	8.00	0.00	**292.39**	**41.52%**	**"A" Total**
	Weighted "B"	6.00	30.00	7.50	1.50	4.50		18.91		2.75			55.00		35.89	33.00	24.75	24.75	22.50	3.00	12.00	0.00	**282.04**	**42.00%**	**"B" Total**
3.3	12(a)	12	2662	0	N	2	Roadway	3	6549		0	0	0	6549	3.00	0	3	3341	9211	17	N	18.44	9211		6549
2.1	Path 2.1	5	536	11930	N	0		1.663249634	11394		0	7114	0	3779	1.63	3500	1	566	11930	346	N	13.59	11930		11394
	14	0	0	3121	N	2	Roadway	3	3121		0	0	0	3121	3.00	500	0	614	3121	0	N	4.18	3121		3121
	15	5	2055	13257	N	6	Roadway	3	11202		0	0	3	11202	5.00	2790	4	9299	13257	26	N	22.46	13257		11202
	sum	**22**	**5253**	**28308**	**N**	**10**		**2.53**	**32266**		**0**	**7114**	**3**	**24650**	**2.77**	**6790**	**8**	**13820**	**37519**	**389**	**N**	**58.66**	**37519**		**32266**
	Criteria	0.59	14.0%	75%	N	0.27		2.73		1.38			0.42		2.77	18.1%	1.13	37%	**0%**	1%	N	78.22			
	Score	1	3	5	1	3		2.73		1.38			3		2.77	3	3	3	1	1	1	3	**38**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		32.81		2.07			18.00		16.64	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**219.02**	**56.20%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		16.40		3.79			33.00		30.51	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**226.21**	**53.48%**	**"B" Total**
3.4	12(a)	12	2662	0	N	2	Roadway	3	6549		0	0	0	6549	3.00	0	3	3341	9211	17	N	18.44	9211		6549
2.1	Path 2.1	5	536	11930	N	0		2	11394		0	7114	0	3779	1.63	3500	1	566	11930	346	N	13.59	11930		11394
	16	5	990	13375	N	0	SCE	1	12385		0	2529	4	0	1.00	0	0	1146	13375	0	N	12.44	13375		12385
	17	0	117	3148	N	0	Roadway	3	3032		0	0	1	3032	3.00	0	0	689	3148	0	N	4.62	3148		3032
	sum	**22**	**4306**	**28454**	**N**	**2**		**1.80**	**33359**		**0**	**9643**	**5**	**13359**	**1.57**	**3500**	**4**	**5742**	**37665**	**364**	**N**	**49.09**	**37665**		**33359**
	Criteria	0.58	11.4%	76%	N	0.05		2.05		1.51			0.70		1.57	9.3%	0.56	15%	**0%**	1%	N	65.04			
	Score	1	3	5	1	1		2.05		1.51			5		1.57	1	1	3	1	1	1	2	**31**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		24.63		2.27			30.00		9.43	6.00	4.50	18.00	15.00	2.00	8.00	0.00	**188.83**	**62.23%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		12.31		4.16			55.00		17.29	11.00	8.25	24.75	7.50	3.00	12.00	0.00	**189.77**	**60.97%**	**"B" Total**
3.5	12(a)	12	2662	0	N	2	Roadway	3	6549		0	0	0	6549	3.00	0	3	3341	9211	17	N	18.44	9211		6549
2.3	Path 2.3	6	774	12201	N	3		3	11427		0	0	4	11427	2.87	0	1	3980	12201	379	N	18.10	12201		11427
Road Route	14	0	0	3121	N	2	Roadway	3	3121		0	0	0	3121	3.00	500	0	614	3121	0	N	4.18	3121		3121
	15	5	2055	13257	N	6	Roadway	3	11202		0	0	3	11202	5.00	2790	4	9299	13257	26	N	22.46	13257		11202
	sum	**23**	**5491**	**28579**	**N**	**13**		**3.00**	**32298**		**0**	**0**	**7**	**32298**	**3.26**	**3290**	**8**	**17234**	**37790**	**422**	**N**	**63.18**	**37790**		**32298**
	Criteria	0.61	14.5%	76%	N	0.34		3.15		1.00			0.98		3.26	8.7%	1.12	46%	**1%**	1%	N	84.23			
	Score	1	3	5	1	3		3.15		1.00			5		3.26	1	3	3	1	1	1	4	**39**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		37.74		1.50			30.00		19.58	6.00	13.50	18.00	15.00	2.00	8.00	0.00	**226.33**	**54.73%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.87		2.75			55.00		35.90	11.00	24.75	24.75	7.50	3.00	12.00	0.00	**233.02**	**52.08%**	**"B" Total**

Evaluation Criteria Scoring Table - Santa Fe Spreading Grounds Paths

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 9	**Start Point:** Peck Rd/San Gabriel River																								
	End Point: Arrow Hwy/605 Fwy																								
9.1	38.4(b)	0	666	716	N	0	Roadway	3	50		0	0	0	50	1.00	0	0	0	716	515	N	2.76	716		50
	43A	1	0	654	N	1	Roadway	3	654		0	0	0	654	3.00	654	0	360	654	0	N	0.90	654		654
	45(a)	1	0	4244	N	0	Roadway	3	4244		0	0	0	4244	3.00	1750	1.5	2501	4244	0	N	5.85	4244		4244
4.1	Path 4.1	9	455	8833	N	2		3	8378		0	0	0	8378	2.90	1825	3	4584	8833	0	N	13.64	8833		8378
	47	4	286	0	N	2	Roadway	3	8832		0	0	1	8832	5.00	6700	2	6165	9118	0	N	13.49	9118		8832
	47A	3	1214	0	N	5	Roadway	3	15405		0	0	1	15405	5.00	11900	4	10026	16619	96	N	26.39	16619		15405
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**18**	**3412**	**14447**	**N**	**10**		**2.63**	**46017**		**0**	**0**	**2**	**37563**	**3.48**	**22829**	**10.5**	**23636**	**49430**	**3146**	**N**	**72.34**	**49430**		**46017**
	Criteria	0.36	6.9%	29%	N	0.20		2.73		1.00			0.21		3.48	46.2%	1.12	48%	**0%**	6%	N	95.85			
	Score	1	3	3	1	3		2.73		1.00			1		3.48	3	3	3	1	5	1	2	**37**		**Raw Total**
	Weighted "A"	12.00	36.00	9.00	3.00	9.00		32.72		1.50			6.00		20.89	18.00	13.50	18.00	15.00	10.00	8.00	0.00	**212.61**	**57.48%**	**"A" Total**
	Weighted "B"	6.00	18.00	4.50	1.50	4.50		16.36		2.75			11.00		38.29	33.00	24.75	24.75	7.50	15.00	12.00	0.00	**219.90**	**54.78%**	**"B" Total**
9.2	38.4(b)	0	666	716	N	0	Roadway	3	50		0	0	0	50	1.00	0	0	0	716	515	N	2.76	716		50
	43A	1	0	654	N	1	Roadway	3	654		0	0	0	654	3.00	654	0	360	654	0	N	0.90	654		654
	45(a)	1	0	4244	N	0	Roadway	3	4244		0	0	0	4244	3.00	1750	1.5	2501	4244	0	N	5.85	4244		4244
4.1	Path 4.1	9	455	8833	N	2		3	8378		0	0	0	8378	2.90	1825	3	4584	8833	0	N	13.64	8833		8378
	47	4	286	0	N	2	Roadway	3	8832		0	0	1	8832	5.00	6700	2	6165	9118	0	N	13.49	9118		8832
	48	0	0	0	N	0	Roadway	3	3505		0	0	0	3505	3.00	0	1	3500	3505	0	N	4.83	3505		3505
	51.1	1	0	0	N	1	Roadway	3	2871		0	0	0	2871	3.00	0	0	662	2871	0	N	3.96	2871		2871
	51.2	0	0	0	N	0	LAFCD	1	929		0	0	0	0	1.00	0	0	0	929	382	N	1.10	929		929
8.1	Path 8.1	1	1206.5	0	N	0		3	10928		0	0	0	4593	1.41	1080	0	1884	12134	4078	N	17.94	12134		10928
	58.2(b)	0	961	0	N	0	Private	1	2		0	0	0	0	1.00	0	0	0	963	0	N	3.18	963		2
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**17**	**4367**	**14447**	**N**	**6**		**2.61**	**48845**		**0**	**0**	**1**	**33126**	**2.42**	**12009**	**7.5**	**19656**	**53212**	**7510**	**N**	**76.96**	**53212**		**48845**
	Criteria	0.32	8.2%	27%	N	0.11		2.72		1.00			0.10		2.42	22.6%	0.74	37%	**8%**	14%	N	101.33			
	Score	1	3	3	1	1		2.72		1.00			1		2.42	3	1	3	1	5	1	3	**33**		**Raw Total**
	Weighted "A"	12.00	36.00	9.00	3.00	3.00		32.65		1.50			6.00		14.53	18.00	4.50	18.00	15.00	10.00	8.00	0.00	**191.19**	**61.76%**	**"A" Total**
	Weighted "B"	6.00	18.00	4.50	1.50	1.50		16.33		2.75			11.00		26.64	33.00	8.25	24.75	7.50	15.00	12.00	0.00	**188.72**	**61.19%**	**"B" Total**
9.3	Path 5.1	5	892	6283	N	0		1	5391.1		0	0	0	0	1.00	0	0	0	6283	213	N	7.93	6283		5391
5.1	44.2(b)	6	743	15794	N	0	SCE	1	15051		0	0	0	0	1.00	0	0	0	15794	748	N	15.02	15794		15051
	44.3(a)	0	0	0	N	0	SCE	1	5485		0	0	0	0	1.00	0	0	0	5485	3919	N	4.38	5485		5485
8.1	Path 8.1	1	1206.5	0	N	0		3	10928		0	0	0	4593	1.41	1080	0	1884	12134	4078	N	17.94	12134		10928
	58.2(b)	0	961	0	N	0	Private	1	2		0	0	0	0	1.00	0	0	0	963	0	N	3.18	963		2
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**12**	**4595**	**22077**	**N**	**0.00**		**1.47**	**45311**		**0**	**0**	**0**	**4593**	**1.04**	**1080**	**0**	**1884**	**49906**	**11492**	**N**	**57.75**	**49906**		**45311**
	Criteria	0.24	9.2%	44%	N	0.00		1.71		1.00			0.00		1.04	2.2%	0.00	4%	**1%**	23%	N	76.52			
	Score	1	3	5	1	1		1.71		1.00			1		1.04	1	1	1	1	5	1	1	**27**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		20.47		1.50			6.00		6.23	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**152.69**	**69.46%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		10.23		2.75			11.00		11.42	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**131.90**	**72.87%**	**"B" Total**

Evaluation Criteria Scoring Table - Santa Fe Spreading Grounds Paths

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 9LA																									
Start Point:	Durfee Ave/Peck Rd																								
End Point:	Arrow Hwy/605 Fwy																								
9LA.1	45(a)	1	0	4244	N	0	Roadway	3	4244		0	0	0	4244	3.00	1750	1.5	2501	4244	0	N	5.85	4244		4244
4.1	Path 4.1	9	455	8833	N	2		3	8378		0	0	0	8378	2.90	1825	3	4584	8833	0	N	13.64	8833		8378
	47	4	286	0	N	2	Roadway	3	8832		0	0	1	8832	5.00	6700	2	6165	9118	0	N	13.49	9118		8832
	47A	3	1214	0	N	5	Roadway	3	15405		0	0	1	15405	5.00	11900	4	10026	16619	96	N	26.39	16619		15405
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**17**	**2747**	**13077**	**N**	**9**		**2.63**	**45314**		**0**	**0**	**2**	**36859**	**3.52**	**22175**	**10.5**	**23276**	**48060**	**2630**	**N**	**68.68**	**48060**		**45314**
	Criteria	0.35	5.7%	27%	N	0.19		2.71		1.00			0.22		3.52	46.1%	1.15	48%	0%	5%	N	91.00			
	Score	1	3	3	1	3		2.71		1.00			1		3.52	3	3	3	1	5	1	3	**38**		**Raw Total**
	Weighted "A"	12.00	36.00	9.00	3.00	9.00		32.46		1.50			6.00		21.15	18.00	13.50	18.00	15.00	10.00	8.00	0.00	**212.61**	**57.48%**	**"A" Total**
	Weighted "B"	6.00	18.00	4.50	1.50	4.50		16.23		2.75			11.00		38.77	33.00	24.75	24.75	7.50	15.00	12.00	0.00	**220.25**	**54.70%**	**"B" Total**
9LA.2	45(a)	1	0	4244	N	0	Roadway	3	4244		0	0	0	4244	3.00	1750	1.5	2501	4244	0	N	5.85	4244		4244
4.1	Path 4.1	9	455	8833	N	2		3	8378		0	0	0	8378	2.90	1825	3	4584	8833	0	N	13.64	8833		8378
	47	4	286	0	N	2	Roadway	3	8832		0	0	1	8832	5.00	6700	2	6165	9118	0	N	13.49	9118		8832
	48	0	0	0	N	0	Roadway	3	3505		0	0	0	3505	3.00	0	1	3500	3505	0	N	4.83	3505		3505
	51.1	1	0	0	N	1	Roadway	3	2871		0	0	0	2871	3.00	0	0	662	2871	0	N	3.96	2871		2871
	51.2	0	0	0	N	0	LAFCD	1	929		0	0	0	0	1.00	0	0	0	929	382	N	1.10	929		929
8.1	Path 8.1	1	1206.5	0	N	0		3	10928		0	0	0	4593	1.41	1080	0	1884	12134	4078	N	17.94	12134		10928
	58.2(b)	0	961	0	N	0	Private	1	2		0	0	0	0	1.00	0	0	0	963	0	N	3.18	963		2
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**16**	**3701**	**13077**	**N**	**5**		**2.60**	**48142**		**0**	**0**	**1**	**32422**	**2.43**	**11355**	**7.5**	**19296**	**51842**	**6994**	**N**	**73.30**	**51842**		**48142**
	Criteria	0.31	7.1%	25%	N	0.10		2.70		1.00			0.10		2.43	21.9%	0.76	37%	8%	13%	N	96.51			
	Score	1	3	3	1	1		2.70		1.00			1		2.43	3	1	3	1	5	1	4	**34**		**Raw Total**
	Weighted "A"	12.00	36.00	9.00	3.00	3.00		32.41		1.50			6.00		14.61	18.00	4.50	18.00	15.00	10.00	8.00	0.00	**191.02**	**61.80%**	**"A" Total**
	Weighted "B"	6.00	18.00	4.50	1.50	1.50		16.21		2.75			11.00		26.78	33.00	8.25	24.75	7.50	15.00	12.00	0.00	**188.73**	**61.19%**	**"B" Total**
9LA.3	43A	1	0	654	N	1	Roadway	3	654		0	0	0	654	3.00	654	0	360	654	0	N	0.90	654		654
	44.1	0	482	1768	N	0	LAFCD	1	1286		0	0	0	0	1.00	0	0	0	1768	0	N	3.15	1768		1286
	44.2(a)	1	1826	3959	N	0	SCE	1	2133		0	0	0	0	1.00	0	0	0	3959	1169	N	8.14	3959		2133
	44.2(b)	6	743	15794	N	0	SCE	1	15051		0	0	0	0	1.00	0	0	0	15794	748	N	15.02	15794		15051
	44.3(a)	0	0	0	N	0	SCE	1	5485		0	0	0	0	1.00	0	0	0	5485	3919	N	4.38	5485		5485
8.1	Path 8.1	1	1206.5	0	N	0		3	10928		0	0	0	4593	1.41	1080	0	1884	12134	4078	N	17.94	12134		10928
	58.2(b)	0	961	0	N	0	Private	1	2		0	0	0	0	1.00	0	0	0	963	0	N	3.18	963		2
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**9**	**6012**	**22175**	**N**	**1**		**1.52**	**43993**		**0**	**0**	**0**	**5247**	**1.06**	**1734**	**0**	**2244**	**50004**	**12448**	**N**	**62.02**	**50004**		**43993**
	Criteria	0.18	12.0%	44%	N	0.02		1.82		1.00			0.00		1.06	3.5%	0.00	4%	4%	25%	N	82.18			
	Score	1	3	5	1	1		1.82		1.00			1		1.06	1	1	1	1	5	1	2	**28**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		21.78		1.50			6.00		6.38	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**154.17**	**69.17%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		10.89		2.75			11.00		11.70	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**132.85**	**72.68%**	**"B" Total**
9LA.4	43A	1	0	654	N	1	Roadway	3	654		0	0	0	654	3.00	654	0	360	654	0	N	0.90	654		654
	38.4(b)	0	666	716	N	0	Roadway	3	50		0	0	0	50	1.00	0	0	0	716	515	N	2.76	716		50
	44A.1	4	892	4931	N	0	LAFCD	1	4039		0	0	0	0	1.00	0	0	0	4931	177	N	6.85	4931		4039
	44A.2	1	0	1352	N	0	SCE	1	1352		0	0	0	0	1.00	0	0	0	1352	36	N	1.08	1352		1352
	44.2(b)	6	743	15794	N	0	SCE	1	15051		0	0	0	0	1.00	0	0	0	15794	748	N	15.02	15794		15051
	44.3(a)	0	0	0	N	0	SCE	1	5485		0	0	0	0	1.00	0	0	0	5485	3919	N	4.38	5485		5485
8.1	Path 8.1	1	1206.5	0	N	0		3	10928		0	0	0	4593	1.41	1080	0	1884	12134	4078	N	17.94	12134		10928
	58.2(b)	0	961	0	N	0	Private	1	2		0	0	0	0	1.00	0	0	0	963	0	N	3.18	963		2
	59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
	sum	**13**	**5261**	**23447**	**N**	**1**		**1.50**	**46015**		**0**	**0**	**0**	**5296**	**1.06**	**1734**	**0**	**2244**	**51276**	**12007**	**N**	**61.41**	**51276**		**46015**
	Criteria	0.25	10.3%	46%	N	0.02		1.75		1.00			0.00		1.06	3.4%	0.00	4%	7%	23%	N	81.37			
	Score	1	3	5	1	1		1.75		1.00			1		1.06	1	1	1	1	5	1	1	**27**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		21.04		1.50			6.00		6.37	6.00	4.50	6.00	15.00	10.00	8.00	0.00	**153.41**	**69.32%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		10.52		2.75			11.00		11.69	11.00	8.25	8.25	7.50	15.00	12.00	0.00	**132.46**	**72.76%**	**"B" Total**

Evaluation Criteria Scoring Table - Rio Hondo Paths

Path 18

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Start Point:	Del Amo Blvd/LA River																								
End Point:	Garfield Ave/LA River																								
18.1	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
	4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
	7.1(b)	53	2215	0	N	12	Roadway	3	31831		0	0	1	31831	3.00	8660	5	15355	34046	0	N	53.49	34046		31831
	sum	**77**	**3121**	**0**	**N**	**15**		**3.00**	**41680**		**0**	**0**	**6**	**41680**	**3.30**	**17115**	**8**	**18407**	**44801**	**18**	**N**	**76.73**	**44801**		**41680**
	Criteria	1.72	7.0%	0%	N	0.33		3.07		1.00			0.71		3.30	38.2%	0.94	41%	**24%**	0%	N	101.66			
	Score	3	3	1	1	3		3.07		1.00			5		3.30	3	1	3	5	1	1	2	**39**		**Raw Total**
	Weighted "A"	36.00	36.00	3.00	3.00	9.00		36.84		1.50			30.00		19.80	18.00	4.50	18.00	75.00	2.00	8.00	0.00	**300.64**	**39.87%**	**"A" Total**
	Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.42		2.75			55.00		36.30	33.00	8.25	24.75	37.50	3.00	12.00	0.00	**274.47**	**43.55%**	**"B" Total**
18.2	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
	4(b)	9	159	0	N	2	Roadway	3	5861		0	0	1	5861	3.00	1500	1	2072	6019	16	N	11.69	6019		5861
	4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
	7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
	7.1(b)	53	2215	0	N	12	Roadway	3	31831		0	0	1	31831	3.00	8660	5	15355	34046	0	N	53.49	34046		31831
	sum	**74**	**2616**	**0**	**N**	**21**		**3.00**	**50868**		**0**	**0**	**3**	**50868**	**3.18**	**17540**	**7**	**21332**	**53484**	**16**	**N**	**90.73**	**53484**		**50868**
	Criteria	1.38	4.9%	0%	N	0.39		3.05		1.00			0.30		3.18	32.8%	0.69	40%	**48%**	0%	N	119.46			
	Score	3	1	1	1	3		3.05		1.00			1		3.18	3	1	3	5	1	1	3	**34**		**Raw Total**
	Weighted "A"	36.00	12.00	3.00	3.00	9.00		36.59		1.50			6.00		19.07	18.00	4.50	18.00	75.00	2.00	8.00	0.00	**251.66**	**49.67%**	**"A" Total**
	Weighted "B"	18.00	6.00	1.50	1.50	4.50		18.29		2.75			11.00		34.96	33.00	8.25	24.75	37.50	3.00	12.00	0.00	**217.01**	**55.37%**	**"B" Total**
18.3	3.1	4	0	0	N	0	LAFCD	1	4632		0	0	0	0	1.00	0	0	0	4632	0	N	3.66	4632		4632
	3.2	10	0	0	N	0	Roadway	3	4329		0	0	0	4329	3.00	0	0	0	4329	18	N	5.97	4329		4329
	3.3(a)	0	2126	0	N	0	LAFCD	1	69		0	0	0	0	1.00	0	0	0	2195	0	N	7.55	2195		69
10.1	Path 10.1	24	11543	16575	N	3		1	5032.1		4130	0	0	0	1.00	0	0	0	16575	0	N	44.88	16575		5032
	3.4(a)	10	0	4696	N	0	SCE	1	4696		0	2150	0	0	1.00	0	0	0	4696	0	N	3.75	4696		4696
11.1	Path 11.1	0	0	1087	N	0		1	1087		0	0	0	0	1.00	0	0	0	1087	0	N	0.87	1087		1087
	3.4(c)	1	371	2689	N	0	SCE	1	2318		0	570	0	0	1.00	0	0	0	2689	0	N	3.44	2689		2318
	sum	**49**	**14040**	**25048**	**N**	**3**		**1.39**	**22163**		**4130**	**2720**	**0**	**4329**	**1.24**	**0**	**0**	**0**	**36204**	**18**	**N**	**70.12**	**36204**		**22163**
	Criteria	1.35	38.8%	69%	N	0.08		2.40		1.61			0.00		1.24	0.0%	0.00	0%	**0%**	0%	N	94.08			
	Score	3	5	5	1	1		2.40		1.61			1		1.24	1	1	1	1	1	1	1	**28**		**Raw Total**
	Weighted "A"	36.00	60.00	15.00	3.00	3.00		28.83		2.41			6.00		7.44	6.00	4.50	6.00	15.00	2.00	8.00	0.00	**203.18**	**59.36%**	**"A" Total**
	Weighted "B"	18.00	30.00	7.50	1.50	1.50		14.42		4.42			11.00		13.63	11.00	8.25	8.25	7.50	3.00	12.00	0.00	**151.96**	**68.75%**	**"B" Total**

Evaluation Criteria Scoring Table - Rio Hondo Paths

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 20																									
Start Point:	Del Amo/Cherry Ave																								
End Point:	Rosemead Blvd/North of Gallatin Rd (start of 41)																								
20.1	7.1(b)	53	2215	0	N	12	Roadway	3	31831		0	0	1	31831	3.00	8660	5	15355	34046	0	N	53.49	34046		31831
	7.2	9	545	4372	N	0	SCE	1	3828		0	0	0	0	1.00	0	2	0	4372	0	N	5.36	4372		3828
	25(a)	2	0	3447	N	0	Roadway	3	3447		0	0	0	3447	5.00	1300	0	1800	3447	0	N	4.75	3447		3447
	25(b)	2	254	3849	N	0	Roadway	3	3595		0	0	0	3595	5.00	3500	2	3471	3849	0	N	5.98	3849		3595
	33	1	497	4950	N	1	Roadway	3	4454		0	0	1	4454	5.00	3325	4	3498	4950	0	N	8.42	4950		4454
19.3	Path 19.3	23	2681	1834	N	4		3	32794.9		0	0	4	32795	3.83	26000	12	10408	35476	0	N	57.01	35476		32795
	sum	**90**	**6192**	**18452**	**N**	**17.00**		**2.90**	**79949**		**0**	**0**	**6**	**76122**	**3.35**	**42785**	**25**	**34532**	**86141**	**0**	**N**	**135.02**	**86141**		**79949**
	Criteria	1.04	7.2%	21%	N	0.20		2.98		1.00			0.37		3.35	49.7%	1.53	40%	12%	0%	N	180.02			
	Score	3	3	3	1	3		2.98		1.00			3		3.35	3	3	3	3	1	1	2	**39**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	3.00	9.00		35.80		1.50			18.00		20.10	18.00	13.50	18.00	45.00	2.00	8.00	0.00	**272.89**	**45.42%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	1.50	4.50		17.90		2.75			33.00		36.84	33.00	24.75	24.75	22.50	3.00	12.00	0.00	**256.99**	**47.15%**	**"B" Total**
20.2	Path 13.1	37	921	0	N	12		3	18229		0	0	0	18229	2.87	6475	6	8272	19150	0	N	30.60	19150		18229
13.1 (Road)	19.1(d)	7	174	0	N	8	Roadway	3	8690.7		0	0	1	8691	3.00	4685	2	6262	8865	0	N	12.79	8865		8691
Road Option	Path 14.1	11	993	7409	N	2		3	6415.8		0	0	0	6416	4.46	5382	1	2040	7409	0	N	12.95	7409		6416
14.1	19.1(f)	4	365	6044	N	1	Roadway	3	5679.1		0	0	1	5679	5.00	4700	1	988	6044	0	N	9.39	6044		5679
19.3	Path 19.3	23	2681	1834	N	4		3	32794.9		0	0	4	32795	3.83	26000	12	10408	35476	0	N	57.01	35476		32795
	sum	**82**	**5135**	**15286**	**N**	**27**		**3.00**	**71810**		**0**		**6**	**71810**	**3.46**	**47242**	**22**	**27970**	**76944**	**0**	**N**	**122.75**	**76944**		**71810**
	Criteria	1.07	6.7%	20%	N	0.35		3.07		1.00			0.41		3.46	61.4%	1.51	36%	0%	0%	N	163.66			
	Score	3	3	3	1	3		3.07		1.00			3		3.46	5	3	3	1	1	1	1	**39**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	3.00	9.00		36.80		1.50			18.00		20.75	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**256.55**	**48.69%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	1.50	4.50		18.40		2.75			33.00		38.05	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**265.70**	**45.36%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

Path		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 24	Start Point:	JWPCP																								
	End Point:	Centralia St/Studebaker Rd																								
	24.1	8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
		8(b)	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	22.17	10591		9876
		8(c)	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	4.82	2629		2629
	23.1	Path 23.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	5.25	2529		1855
		10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
		10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
		sum	**25**	**2283**	**0**	**N**	**6.00**		**2.97**	**24291**		**0**	**0**	**2**	**23906**	**4.22**	**15070**	**5**	**4092**	**26574**	**82**	**N**	**54.76**	**26574**		**24291**
		Criteria	0.94	8.6%	0%	N	0.23		3.06		1.00			0.40		4.22	56.7%	0.99	15%	0%	0%	N	72.11			
		Score	1	3	1	1	3		3.06		1.00			3		4.22	5	1	3	1	1	1	1	**33**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	9.00		36.68		1.50			18.00		25.34	30.00	4.50	18.00	15.00	2.00	8.00	0.00	**222.03**	**55.59%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	4.50		18.34		2.75			33.00		46.47	55.00	8.25	24.75	7.50	3.00	12.00	0.00	**242.56**	**50.12%**	**"B" Total**
	24.2	7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
		4A(b)	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	4.58	2075		1873
		4A(c)	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	11.81	5497		5045
		4A(d)	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	21.62	10493		9885
		4B	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	8.04	3326		2829
		sum	**31**	**1758**	**0**	**N**	**11**		**3.00**	**24738**		**0**	**0**	**2**	**24738**	**4.00**	**13365**	**8**	**4675**	**26496**	**259**	**N**	**55.42**	**26496**		**24738**
		Criteria	1.17	6.6%	0%	N	0.42		3.07		1.00			0.40		4.00	50.4%	1.59	18%	0%	1%	N	73.90			
		Score	3	3	1	1	5		3.07		1.00			3		4.00	5	3	3	1	1	1	2	**40**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	15.00		36.80		1.50			18.00		23.99	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**259.79**	**48.04%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	7.50		18.40		2.75			33.00		43.99	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**271.64**	**44.14%**	**"B" Total**
	24.3	8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
		8(b)	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	22.17	10591		9876
		9A	4	0	0	N	0	Roadway	3	5456		0	0	1	5456	5.00	0	0	5400	5456	0	N	10.01	5456		5456
		4B	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	8.04	3326		2829
		sum	**23**	**1664**	**0**	**N**	**5**		**3.00**	**25083**		**0**	**0**	**4**	**25083**	**4.54**	**14515**	**6**	**10393**	**26746**	**247**	**N**	**55.47**	**26746**		**25083**
		Criteria	0.86	6.2%	0%	N	0.19		3.06		1.00			0.79		4.54	54.3%	1.18	39%	1%	1%	N	73.04			
		Score	1	3	1	1	3		3.06		1.00			5		4.54	5	3	3	1	1	1	3	**40**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	9.00		36.75		1.50			30.00		27.24	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**244.98**	**51.00%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	4.50		18.37		2.75			55.00		49.94	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**284.56**	**41.48%**	**"B" Total**
Path 24OC (54" pipe to OC)	Start Point:	JWPCP																								
	End Point:	Centralia St/Studebaker Rd																								
	24OC.1	8(a)OC	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	10.90	7373		6922
		8(b)OC	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	15.81	10591		9876
		8(c)OC	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	3.52	2629		2629
	23OC.1	Path 23OC.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	5.25	2529		1855
		10A.1(b)OC	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	4.99	2984		2625
		10A.2OC	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	0	0	468	0	N	0.78	468		384
		sum	**25**	**2283**	**0**	**N**	**6.00**		**2.97**	**24291**		**0**	**0**	**2**	**23906**	**4.22**	**15070**	**4**	**4092**	**26574**	**82**	**N**	**41.26**	**26574**		**24291**
		Criteria	0.94	8.6%	0%	N	0.23		3.06		1.00			0.40		4.22	56.7%	0.79	15%	0%	0%	N	54.33			
		Score	1	3	1	1	3		3.06		1.00			3		4.22	5	1	3	1	1	1	2	**34**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	9.00		36.68		1.50			18.00		25.34	30.00	4.50	18.00	15.00	2.00	8.00	0.00	**222.03**	**55.59%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	4.50		18.34		2.75			33.00		46.47	55.00	8.25	24.75	7.50	3.00	12.00	0.00	**242.56**	**50.12%**	**"B" Total**
	24OC.2	7.1(a)OC	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	6.83	5105		5105
		4A(b)OC	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	3.65	2075		1873
		4A(c)OC	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	9.31	5497		5045
		4A(d)OC	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	16.71	10493		9885
		4BOC	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	6.63	3326		2829
		sum	**31**	**1758**	**0**	**N**	**11**		**3.00**	**24738**		**0**	**0**	**2**	**24738**	**4.00**	**13365**	**8**	**4675**	**26496**	**259**	**N**	**43.13**	**26496**		**24738**
		Criteria	1.17	6.6%	0%	N	0.42		3.07		1.00			0.40		4.00	50.4%	1.59	18%	0%	1%	N	57.51			
		Score	3	3	1	1	5		3.07		1.00			3		4.00	5	3	3	1	1	1	3	**41**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	15.00		36.80		1.50			18.00		23.99	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**259.79**	**48.04%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	7.50		18.40		2.75			33.00		43.99	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**271.64**	**44.14%**	**"B" Total**
	24OC.3	8(a)OC	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	10.90	7373		6922
		8(b)OC	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	15.81	10591		9876
		9AOC	4	0	0	N	0	Roadway	3	5456		0	0	1	5456	5.00	0	0	5400	5456	0	N	7.30	5456		5456
		4BOC	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	6.63	3326		2829
		sum	**23**	**1664**	**0**	**N**	**5**		**3.00**	**25083**		**0**	**0**	**4**	**25083**	**4.54**	**14515**	**6**	**10393**	**26746**	**247**	**N**	**40.65**	**26746**		**25083**
		Criteria	0.86	6.2%	0%	N	0.19		3.06		1.00			0.79		4.54	54.3%	1.18	39%	1%	1%	N	53.52			
		Score	1	3	1	1	3		3.06		1.00			5		4.54	5	3	3	1	1	1	1	**38**		**Raw Total**
		Weighted "A"	12.00	36.00	3.00	3.00	9.00		36.75		1.50			30.00		27.24	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**244.98**	**51.00%**	**"A" Total**
		Weighted "B"	6.00	18.00	1.50	1.50	4.50		18.37		2.75			55.00		49.94	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**284.56**	**41.48%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 25 (w/ Signal Hill Tunnel)	Start Point:	Willow St/Cherry Ave																								
	End Point:	Carson St/Los Coyotes Diagonal																								
	25.1	5A	25	6950	0	Y	7	Roadway	3	19778		0	0	0	19778	3.00	8150	6	1819	26729	159	N	68.68	26729		19778
		sum	25	6950	0	Y	7		3.00	19778		0	0	0	19778	2.48	8150	6	1819	26729	159	N	68.68	26729		19778
		Criteria	0.94	26.0%	0%	Y	0.26		3.26		1.00			0.00		2.48	30.5%	1.19	7%	0%	1%	N	92.14			
		Score	1	5	1	5	3		3.26		1.00			1		2.48	3	3	1	1	1	1	2	35		Raw Total
		Weighted "A"	12.00	60.00	3.00	15.00	9.00		39.12		1.50			6.00		14.88	18.00	13.50	6.00	15.00	2.00	8.00	0.00	223.00	55.40%	"A" Total
		Weighted "B"	6.00	30.00	1.50	7.50	4.50		19.56		2.75			11.00		27.28	33.00	24.75	8.25	7.50	3.00	12.00	0.00	198.59	59.16%	"B" Total
	25.2	6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324	0	N	24.70	10324		8850
		8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
		8(b)	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	22.17	10591		9876
		8(c)	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	4.82	2629		2629
		sum	40	2640	0	N	11		3.00	28277		0	0	6	28277	4.66	16120	6	6769	30917	82	N	66.94	30917		28277
		Criteria	1.29	8.5%	0%	N	0.36		3.09		1.00			1.02		4.66	52.1%	1.02	22%	16%	0%	N	88.70			
		Score	3	3	1	1	3		3.09		1.00			5		4.66	5	3	3	3	1	1	1	42		Raw Total
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.02		1.50			30.00		27.95	30.00	13.50	18.00	45.00	2.00	8.00	0.00	299.98	40.00%	"A" Total
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.51		2.75			55.00		51.24	55.00	24.75	24.75	22.50	3.00	12.00	0.00	313.00	35.63%	"B" Total
Path 25X (w/o Signal Hill Tunnel)	Start Point:	Willow St/Cherry Ave																								
	End Point:	Carson St/Los Coyotes Diagonal																								
	25X.1	5AX	25	1904	0	Y	7	Roadway	3	24825		0	0	1	24825	3.00	13535	7	2899	26729	159	N	55.05	26728.6		24824.6
		sum	25	1904	0	Y	7		3.00	24825		0	0	1	24825	2.86	13535	7	2899	26729	159	N	55.05	26728.60		24824.60
		Criteria	0.94	7.1%	0%	Y	0.26		3.07			1.00		0.20		2.86	50.6%	1.38	11%	0%	1%	N	73.40			
		Score	1	3	1	5	3		3.07			1.00		1		2.86	5	3	3	1	1	1	1	36		Raw Total
		Weighted "A"	12.00	36.00	3.00	15.00	9.00	0.00	36.85	0.00		1.50	0.00	6.00	0.00	17.15	30.00	13.50	18.00	15.00	2.00	8.00	0.00	223.00	55.40%	"A" Total
		Weighted "B"	6.00	18.00	1.50	7.50	4.50	0.00	18.43	0.00		2.75	0.00	11.00	0.00	31.43	55.00	24.75	24.75	7.50	3.00	12.00	0.00	228.11	53.09%	"B" Total
	25X.2	6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324	0	N	24.70	10324		8850
		8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
		8(b)	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	22.17	10591		9876
		8(c)	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	4.82	2629		2629
		sum	40	2640	0	N	11		3.00	28277		0	0	6	28277	4.66	16120	6	6769	30917	82	N	66.94	30917		28277
		Criteria	1.29	8.5%	0%	N	0.36		3.09		1.00			1.02		4.66	52.1%	1.02	22%	16%	0%	N	88.70			
		Score	3	3	1	1	3		3.09		1.00			5		4.66	5	3	3	3	1	1	2	43		Raw Total
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.02		1.50			30.00		27.95	30.00	13.50	18.00	45.00	2.00	8.00	0.00	299.98	40.00%	"A" Total
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.51		2.75			55.00		51.24	55.00	24.75	24.75	22.50	3.00	12.00	0.00	313.00	35.63%	"B" Total
Path 26 (w/ Signal Hill Tunnel)	Start Point:	JWPCP																								
	End Point:	Studebaker Rd/Del Amo Blvd																								
	26.1	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		5	8	5489	0	Y	4	Roadway	3	5521		0	0	1	5521	5.00	3800	3	3279	11011	0	N	35.42	11011		5521
	25.1	Path 25.1	25	6950	0	Y	7		3	19778		0	0	0	19778	2.48	8150	6	1819	26729	159	N	68.68	26729		19778
	23.1	Path 23.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	6.18	2529		1855
		10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
		10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
		sum	162	16589	0	Y	24		2.99	52465		0	0	3	52081	2.48	28155	15	19920	69054	814	N	174.81	69054		52465
		Criteria	2.35	24.0%	0%	Y	0.35		3.23		1.00			0.23		2.48	40.8%	1.15	29%	0%	1%	N	235.99			
		Score	3	5	1	5	3		3.23		1.00			1		2.48	3	3	3	1	1	1	4	41		Raw Total
		Weighted "A"	36.00	60.00	3.00	15.00	9.00		38.75		1.50			6.00		14.87	18.00	13.50	18.00	15.00	2.00	8.00	0.00	258.62	48.28%	"A" Total
		Weighted "B"	18.00	30.00	1.50	7.50	4.50		19.37		2.75			11.00		27.25	33.00	24.75	24.75	7.50	3.00	12.00	0.00	226.88	53.34%	"B" Total
	26.2	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		5	8	5489	0	Y	4	Roadway	3	5521		0	0	1	5521	5.00	3800	3	3279	11011	0	N	35.42	11011		5521
		6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324	0	N	24.70	10324		8850
	24.1	Path 24.1	25	2283	0	N	6		3	24291		0	0	2	23906	4.22	15070	4	4092	26574	82	N	41.26	26574		24291
		sum	177	12279	0	Y	28		2.99	60964		0	0	9	60579	3.42	36125	14	24870	73243	736	N	158.66	73243		60964
		Criteria	2.42	16.8%	0%	Y	0.38		3.16		1.00			0.65		3.42	49.3%	1.01	34%	6%	1%	N	214.19			
		Score	3	5	1	5	3		3.16		1.00			5		3.42	3	3	3	1	1	1	1	43		Raw Total
		Weighted "A"	36.00	60.00	3.00	15.00	9.00		37.89		1.50			30.00		20.52	18.00	13.50	18.00	15.00	2.00	8.00	0.00	287.41	42.52%	"A" Total
		Weighted "B"	18.00	30.00	1.50	7.50	4.50		18.94		2.75			55.00		37.62	33.00	24.75	24.75	7.50	3.00	12.00	0.00	280.82	42.25%	"B" Total

Evaluation Criteria Scoring Table - Paths from JWPCP

Path		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 26 (w/ Signal Hill Tunnel)	26.3	1(a)	13	82	0	N	0	Roadway	3	3024		0	0	1	3024	3.00	1675	1	0	3106	0	N	6.04	3106		3024
	21.1	Path 21.1	18	462	0	N	0		3	9269		0	0	2	9269	2.91	6070	3	2803	9731	0	N	19.74	9731		9269
		1B(b)	16	1548	0	N	5	Roadway	3	7024		0	0	4	7024	5.00	6850	3	3232	8572	146	N	21.79	8572		7024
		1B(c)	36	1860	0	N	6	Roadway	3	17524		0	0	2	17524	5.00	17000	6	3756	19384	418	N	42.91	19384		17524
		4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
		4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
		4A(b)	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	4.58	2075		1873
		4A(c)	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	11.81	5497		5045
		4A(d)	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	21.62	10493		9885
		4B	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	8.04	3326		2829
		sum	**134**	**6616**	**0**	**N**	**22**		**3.00**	**66322**		**0**	**0**	**16**	**66322**	**4.02**	**48315**	**24**	**16180**	**72938**	**841**	**N**	**159.76**	**72938**		**66322**
		Criteria	1.84	9.1%	0%	N	0.30		3.09		1.00			1.16		4.02	66.2%	1.74	22%	6%	1%	N	211.68			
		Score	3	3	1	1	3		3.09		1.00			5		4.02	5	3	3	1	1	1	2	**40**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.09		1.50			30.00		24.12	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**266.21**	**46.76%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.54		2.75			55.00		44.23	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**291.02**	**40.15%**	**"B" Total**
	26.4	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
		2A	6	4774	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5595	0	N	24.57	5595		821
		4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
		8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
		8(b)	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	22.17	10591		9876
		8(c)	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	4.82	2629		2629
	23.1	Path 23.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	6.18	2529		1855
		10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
		10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
		sum	**178**	**10544**	**0**	**Y**	**22**		**2.70**	**61266**		**0**	**0**	**4**	**51996**	**2.95**	**31275**	**11**	**20183**	**71810**	**736**	**N**	**160.63**	**71810**		**61266**
		Criteria	2.48	14.7%	0%	Y	0.31		2.89		1.00			0.29		2.95	43.6%	0.81	28%	4%	1%	N	215.52			
		Score	3	3	1	5	3		2.89		1.00			1		2.95	3	1	3	1	1	1	3	**36**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	15.00	9.00		34.66		1.50			6.00		17.69	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**224.36**	**55.13%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	7.50	4.50		17.33		2.75			11.00		32.44	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**201.52**	**58.56%**	**"B" Total**
	Start Point:	JWPCP																								
	End Point:	Studebaker Rd/Del Amo Blvd																								
Path 26X (w/o Signal Hill Tunnel)	26X.1	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		5X	8	348	0	Y	4	Roadway	3	10663		0	0	1	10663	5.00	8900	4	5690	11011	0	N	21.25	11011		10663
	25X.1	Path 25X.1	25	1904	0	Y	7		3	24825		0	0	1	24825	2.86	13535	7	2899	26729	159	N	55.05	26729		24825
	23.1	Path 23.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	6.18	2529		1855
		10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
		10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
		sum	**162**	**6402**	**0**	**Y**	**24**		**2.99**	**62653**		**0**	**0**	**4**	**62269**	**3.02**	**38640**	**17**	**23411**	**69055**	**814**	**N**	**147.01**	**69055**		**62653**
		Criteria	2.35	9.3%	0%	Y	0.35		3.08		1.00			0.31		3.02	56.0%	1.30	34%	0%	1%	N	197.24			
		Score	3	3	1	5	3		3.08		1.00			1		3.02	5	3	3	1	1	1	2	**39**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	15.00	9.00		36.98		1.50			6.00		18.12	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**248.10**	**50.38%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	7.50	4.50		18.49		2.75			11.00		33.21	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**241.95**	**50.24%**	**"B" Total**
	26X.2	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		5X	8	348	0	Y	4	Roadway	3	10663		0	0	1	10663	5.00	8900	4	5690	11011	0	N	21.25	11011		10663
		6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324	0	N	24.70	10324		8850
	24.1	Path 24.1	25	2283	0	N	6		3	24291		0	0	2	23906	4.22	15070	4	4092	26574	82	N	41.26	26574		24291
		sum	**177**	**7138**	**0**	**Y**	**28**		**2.99**	**66105**		**0**	**0**	**9**	**65721**	**3.70**	**41225**	**15**	**27281**	**73243**	**736**	**N**	**144.48**	**73243**		**66105**
		Criteria	2.42	9.7%	0%	Y	0.38		3.09		1.00			0.65		3.70	56.3%	1.08	37%	6%	1%	N	193.85			
		Score	3	3	1	5	3		3.09		1.00			5		3.70	5	3	3	1	1	1	1	**43**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	15.00	9.00		37.04		1.50			30.00		22.21	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**276.25**	**44.75%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	7.50	4.50		18.52		2.75			55.00		40.71	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**293.48**	**39.64%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

Path	ID	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 26X (w/o Signal Hill Tunnel)	26X.3	1(a)	13	82	0	N	0	Roadway	3	3024		0	0	1	3024	3.00	1675	1	0	3106	0	N	6.04	3106		3024
	21.1	Path 21.1	18	462	0	N	0		3	9269		0	0	2	9269	2.91	6070	3	2803	9731	0	N	19.74	9731		9269
		1B(b)	16	1548	0	N	5	Roadway	3	7024		0	0	4	7024	5.00	6850	3	3232	8572	146	N	21.79	8572		7024
		1B(c)	36	1860	0	N	6	Roadway	3	17524		0	0	2	17524	5.00	17000	6	3756	19384	418	N	42.91	19384		17524
		4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
		4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
		4A(b)	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	4.58	2075		1873
		4A(c)	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	11.81	5497		5045
		4A(d)	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	21.62	10493		9885
		4B	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	8.04	3326		2829
		sum	**134**	**6616**	**0**	**N**	**22**		**3.00**	**66322**		**0**	**0**	**16**	**66322**	**4.02**	**48315**	**24**	**16180**	**72938**	**841**	**N**	**159.76**	**72938**		**66322**
		Criteria	1.84	9.1%	0%	N	0.30		3.09		1.00			1.16		4.02	66.2%	1.74	22%	**6%**	1%	N	211.68			
		Score	3	3	1	1	3		3.09		1.00			5		4.02	5	3	3	1	1	1	3	**41**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.09		1.50			30.00		24.12	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**266.21**	**46.76%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.54		2.75			55.00		44.23	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**291.02**	**40.15%**	**"B" Total**
	26X.4	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
		2A	6	4774	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5595	0	N	24.57	5595		821
		4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
		8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
		8(b)	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	22.17	10591		9876
		8(c)	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	4.82	2629		2629
	23.1	Path 23.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	6.18	2529		1855
		10A.1(b)	2	359	0	N	0	Roadway	3	2625		0	0	0	2625	3.00	0	0	0	2984	0	N	6.29	2984		2625
		10A.2	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	1	0	468	0	N	0.97	468		384
		sum	**178**	**10544**	**0**	**Y**	**22**		**2.70**	**61266**		**0**		**4**	**51996**	**2.95**	**31275**	**11**	**20183**	**71810**	**736**	**N**	**160.63**	**71810**		**61266**
		Criteria	2.48	14.7%	0%	Y	0.31		2.89		1.00			0.29		2.95	43.6%	0.81	28%	**4%**	1%	N	215.52			
		Score	3	3	1	5	3		2.89		1.00			1		2.95	3	1	3	1	1	1	4	**37**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	15.00	9.00		34.66		1.50			6.00		17.69	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**224.36**	**55.13%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	7.50	4.50		17.33		2.75			11.00		32.44	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**201.52**	**58.56%**	**"B" Total**
Path 27	**Start Point:**	Long Beach Blvd/Del Amo Blvd																								
	End Point:	Studebaker Rd/Del Amo Blvd																								
	27.1	4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
		4A(b)	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	4.58	2075		1873
		4A(c)	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	11.81	5497		5045
		4A(d)	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	21.62	10493		9885
		4B	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	8.04	3326		2829
		sum	**48**	**2664**	**0**	**N**	**10**		**3.00**	**27199**		**0**	**0**	**6**	**27199**	**3.99**	**14440**	**11**	**5268**	**29863**	**277**	**N**	**65.11**	**29863**		**27199**
		Criteria	1.61	8.9%	0%	N	0.33		3.09		1.00			1.06		3.99	48.4%	1.94	18%	**0%**	1%	N	86.26			
		Score	3	3	1	1	3		3.09		1.00			5		3.99	3	3	3	1	1	1	2	**38**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.07		1.50			30.00		23.94	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**254.01**	**49.20%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.54		2.75			55.00		43.89	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**268.68**	**44.74%**	**"B" Total**
	27.2	4(b)	9	159	0	N	2	Roadway	3	5861		0	0	1	5861	3.00	1500	1	2072	6019	16	N	11.69	6019		5861
		4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
	24.1	Path 24.1	25	2283	0	N	6		3	24291		0	0	2	23906	4.22	15070	4	4092	26574	82	N	41.26	26574		24291
		sum	**39**	**2684**	**0**	**N**	**11**		**2.98**	**35939**		**0**	**0**	**3**	**35555**	**3.60**	**16570**	**6**	**7610**	**38624**	**98**	**N**	**64.95**	**38624**		**35939**
		Criteria	1.01	7.0%	0%	N	0.28		3.05		1.00			0.41		3.60	42.9%	0.82	20%	**29%**	0%	N	86.06			
		Score	3	3	1	1	3		3.05		1.00			3		3.60	3	1	3	5	1	1	1	**37**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		36.60		1.50			18.00		21.59	18.00	4.50	18.00	75.00	2.00	8.00	0.00	**290.19**	**41.96%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.30		2.75			33.00		39.59	33.00	8.25	24.75	37.50	3.00	12.00	0.00	**255.63**	**47.43%**	**"B" Total**
Path 27OC (54" Pipe to OC)	**Start Point:**	Long Beach Blvd/Del Amo Blvd																								
	End Point:	Studebaker Rd/Del Amo Blvd																								
	27OC.1	4A(a)OC	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	15.29	8473		7567
		4A(b)OC	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	3.65	2075		1873
		4A(c)OC	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	9.31	5497		5045
		4A(d)OC	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	16.71	10493		9885
		4BOC	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	6.63	3326		2829
		sum	**48**	**2664**	**0**	**N**	**10**		**3.00**	**27199**		**0**	**0**	**6**	**27199**	**3.99**	**14440**	**11**	**5268**	**29863**	**277**	**N**	**51.59**	**29863**		**27199**
		Criteria	1.61	8.9%	0%	N	0.33		3.09		1.00			1.06		3.99	48.4%	1.94	18%	**0%**	1%	N	68.35			
		Score	3	3	1	1	3		3.09		1.00			5		3.99	3	3	3	1	1	1	1	**37**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.07		1.50			30.00		23.94	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**254.01**	**49.20%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.54		2.75			55.00		43.89	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**268.68**	**44.74%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

Path	Route	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 27OC (54" Pipe to OC)	27OC.2	4(b)OC	9	159	0	N	2	Roadway	3	5861		0	0	1	5861	3.00	1500	1	2072	6019	16	N	8.47	6019		5861
		4(c)OC	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	8.63	6031		5788
	24OC.1	Path 24OC.1	25	2283	0	N	6		3	24291		0	0	2	23906	4.22	15070	4	4092	26574	82	N	41.26	26574		24291
		sum	**39**	**2684**	**0**	**N**	**11**		**2.98**	**35939**		**0**	**0**	**3**	**35555**	**3.60**	**16570**	**6**	**7610**	**38624**	**98**	**N**	**58.36**	**38624**		**35939**
		Criteria	1.01	7.0%	0%	N	0.28		3.05		1.00			0.41		3.60	42.9%	0.82	20%	**29%**	0%	N	77.32			
		Score	3	3	1	1	3		3.05		1.00			3		3.60	3	1	3	5	1	1	2	**38**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		36.60		1.50			18.00		21.59	18.00	4.50	18.00	75.00	2.00	8.00	0.00	**290.19**	**41.96%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.30		2.75			33.00		39.59	33.00	8.25	24.75	37.50	3.00	12.00	0.00	**255.63**	**47.43%**	**"B" Total**
	Start Point:	JWPCP																								
	End Point:	Rosemead Blvd/North of Gallatin Rd (start of 41)																								
	28.1	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		5	8	5489	0	Y	4	Roadway	3	5521		0	0	1	5521	5.00	3800	3	3279	11011	0	N	35.42	11011		5521
		6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324	0	N	24.70	10324		8850
		7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
	20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
		sum	**238**	**15131**	**15286.4**	**Y**	**52**		**3.00**	**113588**		**0**	**0**	**13**	**113588**	**3.31**	**73397**	**32**	**50086**	**128719**	**655**	**N**	**249.51**	**128719**		**113588**
		Criteria	1.85	11.8%	12%	Y	0.40		3.12		1.00			0.53		3.31	57.0%	1.31	39%	**1%**	1%	N	338.91			
		Score	3	3	3	5	5		3.12		1.00			3		3.31	5	3	3	1	1	1	5	**48**		**Raw Total**
		Weighted "A"	36.00	36.00	9.00	15.00	15.00		37.41		1.50			18.00		19.85	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**274.26**	**45.15%**	**"A" Total**
		Weighted "B"	18.00	18.00	4.50	7.50	7.50		18.71		2.75			33.00		36.40	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**273.35**	**43.78%**	**"B" Total**
	28.2	1(a)	13	82	0	N	0	Roadway	3	3024		0	0	1	3024	3.00	1675	1	0	3106	0	N	6.04	3106		3024
	21.1	Path 21.1	18	462	0	N	0		3	9269		0	0	2	9269	2.91	6070	3	2803	9731	0	N	19.74	9731		9269
		1B(b)	16	1548	0	N	5	Roadway	3	7024		0	0	4	7024	5.00	6850	3	3232	8572	146	N	21.79	8572		7024
		1B(c)	36	1860	0	N	6	Roadway	3	17524		0	0	2	17524	5.00	17000	6	3756	19384	418	N	42.91	19384		17524
		4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
		4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
	20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
		sum	**189**	**9993**	**15286.4**	**N**	**41.00**		**3.00**	**118499**		**0**	**0**	**20**	**118499**	**3.63**	**87292**	**38**	**40813**	**128492**	**582**	**N**	**236.45**	**128492**		**118499**
		Criteria	1.47	7.8%	12%	N	0.32		3.08		1.00			0.82		3.63	67.9%	1.56	32%	**1%**	0%	N	315.27			
		Score	3	3	3	1	3		3.08		1.00			5		3.63	5	3	3	1	1	1	1	**41**		**Raw Total**
		Weighted "A"	36.00	36.00	9.00	3.00	9.00		36.93		1.50			30.00		21.78	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**269.71**	**46.06%**	**"A" Total**
		Weighted "B"	18.00	18.00	4.50	1.50	4.50		18.47		2.75			55.00		39.92	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**289.64**	**40.43%**	**"B" Total**
Path 28 (w/ Signal Hill Tunnel)	28.3	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
		2(b)	12	5393	0	Y	0	LAFCD	1	2013		0	0	0	0	1.00	0	0	0	7405	0	N	29.23	7405		2013
		4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
		4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
	20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
		sum	**260**	**14677**	**15286.4**	**Y**	**43.00**		**2.82**	**114038**		**0**	**0**	**13**	**103960**	**3.01**	**71902**	**30**	**45667**	**128715**	**673**	**N**	**243.60**	**128715**		**114038**
		Criteria	2.02	11.4%	12%	Y	0.33		2.96		1.00			0.53		3.01	55.9%	1.23	35%	**1%**	1%	N	328.86			
		Score	3	3	3	5	3		2.96		1.00			3		3.01	5	3	3	1	1	1	4	**45**		**Raw Total**
		Weighted "A"	36.00	36.00	9.00	15.00	9.00		35.49		1.50			18.00		18.06	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**264.55**	**47.09%**	**"A" Total**
		Weighted "B"	18.00	18.00	4.50	7.50	4.50		17.74		2.75			33.00		33.11	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**266.10**	**45.27%**	**"B" Total**
	28.4	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
		2A	6	4774	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5595	0	N	24.57	5595		821
		4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
		7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
	20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
		sum	**239**	**13395**	**15286.4**	**Y**	**46.00**		**2.84**	**113890**		**0**	**0**	**8**	**105004**	**2.97**	**68547**	**28**	**45399**	**127286**	**655**	**N**	**237.06**	**127286**		**113890**
		Criteria	1.88	10.5%	12%	Y	0.36		2.97		1.00			0.33		2.97	53.9%	1.16	36%	**0%**	1%	N	320.03			
		Score	3	3	3	5	3		2.97		1.00			1		2.97	5	3	3	1	1	1	2	**41**		**Raw Total**
		Weighted "A"	36.00	36.00	9.00	15.00	9.00		35.59		1.50			6.00		17.85	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**252.43**	**49.51%**	**"A" Total**
		Weighted "B"	18.00	18.00	4.50	7.50	4.50		17.79		2.75			11.00		32.72	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**243.76**	**49.87%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

Path 28 (w/o Signal Hill Tunnel)

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
28.5	Path 30.4	153	8261	0	Y	16		3	36976		0	0	2	28090	2.20	16205	6	16091	45236	655	N	104.95	45236		36976
30.4	8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
Road Option	19.1(a)	4	261	0	N	0	Roadway	3	5277		0	0	0	5277	3.00	4550	1	775	5538	16	N	11.16	5538		5277
	19.1(b)	8	519	0	N	1	Roadway	3	9538		0	0	2	9538	3.00	7725	3	2961	10058	0	N	15.54	10058		9538
	19.1(c)	4	0	0	N	2	Roadway	3	1689		0	0	0	1689	3.00	1175	0	588	1689	0	N	2.33	1689		1689
	19.1(d)	7	174	0	N	8	Roadway	3	8691		0	0	1	8691	3.00	4685	2	6262	8865	0	N	12.79	8865		8691
14.1	Path 14.1	11	993	7409	N	2		3	6416		0	0	0	6416	4.46	5382	1	2040	7409	0	N	12.95	7409		6416
	19.1(f)	4	365	6044	N	1	Roadway	3	5679		0	0	1	5679	5.00	4700	1	988	6044	0	N	9.39	6044		5679
19.3	Path 19.3	23	2681	1834	N	4		3	32795		0	0	4	32795	3.83	26000	12	10408	35476	0	N	57.01	35476		32795
	sum	**222**	**13706**	**15286.4**	**Y**	**36.00**		**2.84**	**113981**		**0**	**0**	**11**	**105095**	**2.95**	**74272**	**27**	**42030**	**127687**	**671**	**N**	**241.38**	**127687**		**113981**
	Criteria	1.74	10.7%	12%	Y	0.28		2.97		1.00			0.45		2.95	58.2%	1.12	33%	**0%**	1%	N	325.86			
	Score	3	3	3	5	3		2.97		1.00			3		2.95	5	3	3	1	1	1	3	**44**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	15.00	9.00		35.62		1.50			18.00		17.72	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**264.34**	**47.13%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	7.50	4.50		17.81		2.75			33.00		32.49	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**265.55**	**45.39%**	**"B" Total**
Start Point:	JWPCP																								
End Point:	Cherry Ave/Del Amo Blvd																								
28X.1	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
	5X	8	348	0	Y	4	Roadway	3	10663		0	0	1	10663	5.00	8900	4	5690	11011	0	N	21.25	11011		10663
	6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324	0	N	24.70	10324		8850
	7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
	sum	**238**	**9990**	**15286.4**	**Y**	**52**		**3.00**	**118730**		**0**	**0**	**13**	**118730**	**3.47**	**78497**	**33**	**52497**	**128719**	**655**	**N**	**235.33**	**128719**		**118730**
	Criteria	1.85	7.8%	12%	Y	0.40		3.08		1.00			0.53		3.47	61.0%	1.35	41%	**1%**	1%	N	319.66			
	Score	3	3	3	5	5		3.08		1.00			3		3.47	5	3	3	1	1	1	1	**45**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	15.00	15.00		36.93		1.50			18.00		20.81	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**274.74**	**45.05%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	7.50	7.50		18.47		2.75			33.00		38.16	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**274.87**	**43.47%**	**"B" Total**
28X.2	1(a)	13	82	0	N	0	Roadway	3	3024		0	0	1	3024	3.00	1675	1	0	3106	0	N	6.04	3106		3024
21.1	Path 21.1	18	462	0	N	0		3	9269		0	0	2	9269	2.91	6070	3	2803	9731	0	N	19.74	9731		9269
	1B(b)	16	1548	0	N	5	Roadway	3	7024		0	0	4	7024	5.00	6850	3	3232	8572	146	N	21.79	8572		7024
	1B(c)	36	1860	0	N	6	Roadway	3	17524		0	0	2	17524	5.00	17000	6	3756	19384	418	N	42.91	19384		17524
	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
	4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
	sum	**189**	**9993**	**15286.4**	**N**	**41.00**		**3.00**	**118499**		**0**	**0**	**20**	**118499**	**3.63**	**87292**	**38**	**40813**	**128492**	**582**	**N**	**236.45**	**128492**		**118499**
	Criteria	1.47	7.8%	12%	N	0.32		3.08		1.00			0.82		3.63	67.9%	1.56	32%	**1%**	0%	N	315.27			
	Score	3	3	3	1	3		3.08		1.00			5		3.63	5	3	3	1	1	1	2	**42**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	3.00	9.00		36.93		1.50			30.00		21.78	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**269.71**	**46.06%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	1.50	4.50		18.47		2.75			55.00		39.92	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**289.64**	**40.43%**	**"B" Total**
28X.3	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
	2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
	2(b)	12	5393	0	Y	0	LAFCD	1	2013		0	0	0	0	1.00	0	0	0	7405	0	N	29.23	7405		2013
	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
	4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
	sum	**260**	**14677**	**15286.4**	**Y**	**43.00**		**2.82**	**114038**		**0**	**0**	**13**	**103960**	**3.01**	**71902**	**30**	**45667**	**128715**	**673**	**N**	**243.60**	**128715**		**114038**
	Criteria	2.02	11.4%	12%	Y	0.33		2.96		1.00			0.53		3.01	55.9%	1.23	35%	**1%**	1%	N	328.86			
	Score	3	3	3	5	3		2.96		1.00			3		3.01	5	3	3	1	1	1	5	**46**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	15.00	9.00		35.49		1.50			18.00		18.06	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**264.55**	**47.09%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	7.50	4.50		17.74		2.75			33.00		33.11	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**266.10**	**45.27%**	**"B" Total**
28X.4	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
	2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
	2A	6	4774	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5595	0	N	24.57	5595		821
	4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
	7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
20.2 (Road)	Path 20.2	82	5135	15286	N	27		3	71810		0	0	6	71810	3.46	47242	22	27970	76944	0	N	122.75	76944		71810
	sum	**239**	**13395**	**15286.4**	**Y**	**46.00**		**2.84**	**113890**		**0**	**0**	**8**	**105004**	**2.97**	**68547**	**28**	**45399**	**127286**	**655**	**N**	**237.06**	**127286**		**113890**
	Criteria	1.88	10.5%	12%	Y	0.36		2.97		1.00			0.33		2.97	53.9%	1.16	36%	**0%**	1%	N	320.03			
	Score	3	3	3	5	3		2.97		1.00			1		2.97	5	3	3	1	1	1	3	**42**		**Raw Total**
	Weighted "A"	36.00	36.00	9.00	15.00	9.00		35.59		1.50			6.00		17.85	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**252.43**	**49.51%**	**"A" Total**
	Weighted "B"	18.00	18.00	4.50	7.50	4.50		17.79		2.75			11.00		32.72	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**243.76**	**49.87%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
	28X.5	Path 30.4	153	8261	0	Y	16		3	36976		0	0	2	28090	2.20	16205	6	16091	45236	655	N	104.95	45236		36976
	30.4	8(a)	8	452	0	N	2	Roadway	3	6922		0	0	1	6922	5.00	3850	1	1917	7373	0	N	15.26	7373		6922
	Road Option	19.1(a)	4	261	0	N	0	Roadway	3	5277		0	0	0	5277	3.00	4550	1	775	5538	16	N	11.16	5538		5277
		19.1(b)	8	519	0	N	1	Roadway	3	9538		0	0	2	9538	3.00	7725	3	2961	10058	0	N	15.54	10058		9538
		19.1(c)	4	0	0	N	2	Roadway	3	1689		0	0	0	1689	3.00	1175	0	588	1689	0	N	2.33	1689		1689
		19.1(d)	7	174	0	N	8	Roadway	3	8691		0	0	1	8691	3.00	4685	2	6262	8865	0	N	12.79	8865		8691
	14.1	Path 14.1	11	993	7409	N	2		3	6416		0	0	0	6416	4.46	5382	1	2040	7409	0	N	12.95	7409		6416
		19.1(f)	4	365	6044	N	1	Roadway	3	5679		0	0	1	5679	5.00	4700	1	988	6044	0	N	9.39	6044		5679
	19.3	Path 19.3	23	2681	1834	N	4		3	32795		0	0	4	32795	3.83	26000	12	10408	35476	0	N	57.01	35476		32795
		sum	**222**	**13706**	**15286.4**	**Y**	**36.00**		**2.84**	**113981**		**0**	**0**	**11**	**105095**	**2.95**	**74272**	**27**	**42030**	**127687**	**671**	**N**	**241.38**	**127687**		**113981**
		Criteria	1.74	10.7%	12%	Y	0.28		2.97		1.00			0.45		2.95	58.2%	1.12	33%	**0%**	1%	N	325.86			
		Score	3	3	3	5	3		2.97		1.00			3		2.95	5	3	3	1	1	1	4	**45**		**Raw Total**
		Weighted "A"	36.00	36.00	9.00	15.00	9.00		35.62		1.50			18.00		17.72	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**264.34**	**47.13%**	**"A" Total**
		Weighted "B"	18.00	18.00	4.50	7.50	4.50		17.81		2.75			33.00		32.49	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**265.55**	**45.39%**	**"B" Total**
Path 29	**Start Point:**	JWPCP																								
	End Point:	LA River/Del Amo Blvd																								
	29.1	1(a)	13	82	0	N	0	Roadway	3	3024		0	0	1	3024	3.00	1675	1	0	3106	0	N	6.04	3106		3024
	21.1	Path 21.1	18	462	0	N	0		3	9269		0	0	2	9269	2.91	6070	3	2803	9731	0	N	19.74	9731		9269
		1B(b)	16	1548	0	N	5	Roadway	3	7024		0	0	4	7024	5.00	6850	3	3232	8572	146	N	21.79	8572		7024
		1B(c)	36	1860	0	N	6	Roadway	3	17524		0	0	2	17524	5.00	17000	6	3756	19384	418	N	42.91	19384		17524
		sum	**83**	**3952**	**0**	**N**	**11**		**3.00**	**36841**		**0**	**0**	**9**	**36841**	**3.99**	**31595**	**13**	**9791**	**40793**	**564**	**N**	**90.47**	**40793**		**36841**
		Criteria	2.03	9.7%	0%	N	0.27		3.10		1.00			1.16		3.99	77.5%	1.68	24%	**0%**	1%	N	119.87			
		Score	3	3	1	1	3		3.10		1.00			5		3.99	5	3	3	1	1	1	1	**39**		**Raw Total**
		Weighted "A"	36.00	36.00	3.00	3.00	9.00		37.16		1.50			30.00		23.93	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**266.09**	**46.78%**	**"A" Total**
		Weighted "B"	18.00	18.00	1.50	1.50	4.50		18.58		2.75			55.00		43.87	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**290.70**	**40.22%**	**"B" Total**
	29.2	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559	655	N	24.74	9559		7535
		2(a)	18	211	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065
		2(b)	12	5393	0	Y	0	LAFCD	1	2013		0	0	0	0	1.00	0	0	0	7405	0	N	29.23	7405		2013
		sum	**154**	**8636**	**0**	**Y**	**13**		**2.38**	**32379**		**0**	**0**	**2**	**22301**	**2.04**	**16205**	**5**	**14645**	**41015**	**655**	**N**	**97.62**	**41015**		**32379**
		Criteria	3.75	21.1%	0%	Y	0.32		2.72		1.00			0.26		2.04	39.5%	0.64	36%	**1%**	2%	N	132.60			
		Score	5	5	1	5	3		2.72		1.00			1		2.04	3	1	3	1	1	1	2	**38**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		32.63		1.50			6.00		12.25	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**264.88**	**47.02%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.31		2.75			11.00		22.46	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**214.52**	**55.88%**	**"B" Total**
Path 30 (w/ Signal Hill Tunnel)	**Start Point:**	JWPCP																								
	End Point:	Cherry Ave/Carson St																								
	30.1	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2025	0	N	5	Roadway	3	7535		0	0	0	7535	3.00	3700	2	5997	9559.1	655	N	24.74	9559		7535
		5	8	5489	0	Y	4	Roadway	3	5521		0	0	1	5521	5.00	3800	3	3279	11010.5	0	N	35.42	11011		5521
		6	20	1474	0	N	5	Roadway	3	8850		0	0	4	8850	5.00	1050	2	2854	10324.1	0	N	24.70	10324		8850
		sum	**152**	**9996**	**0**	**Y**	**22**		**3.00**	**36673**		**0**	**0**	**7**	**36673**	**3.15**	**21055**	**10**	**20778**	**46669**	**655**	**N**	**117.39**	**46669**		**36673**
		Criteria	3.26	21.4%	0%	Y	0.47		3.21		1.00			0.79		3.15	45.1%	1.13	45%	**3%**	1%	N	160.44			
		Score	5	5	1	5	5		3.21		1.00			5		3.15	3	3	3	1	1	1	2	**47**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	15.00		38.57		1.50			30.00		18.88	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**316.45**	**36.71%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	7.50		19.29		2.75			55.00		34.62	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**293.15**	**39.71%**	**"B" Total**
	30.2	Path 29.2	154	8636	0	Y	13		2	32379		0	0	2	22301	2.04	16205	5	14645	41015	655	N	97.62	41015		32379
	29.2	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
		4(b)	9	159	0	N	2	Roadway	3	5861		0	0	1	5861	3.00	1500	1	2072	6019	16	N	11.69	6019		5861
		4(c)	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	11.99	6031		5788
		sum	**171**	**9038**	**0**	**Y**	**19**		**2.56**	**46310**		**0**	**0**	**4**	**36232**	**2.01**	**19985**	**7**	**19284**	**55348**	**671**	**N**	**125.49**	**55348**		**46310**
		Criteria	3.09	16.3%	0%	Y	0.34		2.80		1.00			0.38		2.01	36.1%	0.67	35%	**22%**	1%	N	170.46			
		Score	5	5	1	5	3		2.80		1.00			3		2.01	3	1	3	5	1	1	3	**45**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		33.59		1.50			18.00		12.03	18.00	4.50	18.00	75.00	2.00	8.00	0.00	**337.62**	**32.48%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.79		2.75			33.00		22.06	33.00	8.25	24.75	37.50	3.00	12.00	0.00	**266.61**	**45.17%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

		Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
			ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 30 (w/ Signal Hill Tunnel)	30.3	Path 29.2	154	8636	0	Y	13		2	32379		0	0	2	22301	2.04	16205	5	14645	41015	655	N	97.62	41015		32379
	29.2	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282	5.00	2280	0	1121	2282	0	N	4.19	2282		2282
		4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	19.05	8473		7567
		7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105	5.00	5100	0	1338	5105	0	N	9.37	5105		5105
		sum	**182**	**9542**	**0**	**Y**	**19**		**2.57**	**47334**		**0**	**0**	**7**	**37256**	**2.46**	**29760**	**8**	**19035**	**56876**	**673**	**N**	**130.22**	**56876**		**47334**
		Criteria	3.20	16.8%	0%	Y	0.33		2.81		1.00			0.65		2.46	52.3%	0.74	33%	**26%**	1%	N	176.88			
		Score	5	5	1	5	3		2.81		1.00			5		2.46	5	1	3	5	1	1	4	**50**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		33.76		1.50			30.00		14.76	30.00	4.50	18.00	75.00	2.00	8.00	0.00	**364.52**	**27.10%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.88		2.75			55.00		27.06	55.00	8.25	24.75	37.50	3.00	12.00	0.00	**315.69**	**35.08%**	**"B" Total**
	30.4	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2024.5	0	N	5	Roadway	3	7535		0	0	0	7534.6	3.00	3700	2	5997	9559.1	655	N	24.74	9559.1		7534.6
		2(a)	18	210.7	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065.3
		2A	6	4774.1	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5594.8	0	N	24.57	5594.8		820.7
		4(c)	5	242.8	0	N	3	Roadway	3	5788		0	0	0	5788.1	3.00	0	1	1446	6030.9	0	N	11.99	6030.9		5788.1
		sum	**153**	**8260.6**	**0**	**Y**	**16**		**2.52**	**36976**		**0**	**0**	**2**	**28089.5**	**2.20**	**16205**	**6**	**16091**	**45236.1**	**655**	**N**	**104.95**	**45236.1**		**36975.5**
		Criteria	3.38	18.3%	0%	Y	0.35		2.79		1.00			0.23		2.20	35.8%	0.70	36%	**0%**	1%	N	142.55			
		Score	5	5	1	5	3		2.79		1.00			1		2.20	3	1	3	1	1	1	1	**37**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		33.48		1.50			6.00		13.20	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**266.68**	**46.66%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.74		2.75			11.00		24.20	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**216.69**	**55.44%**	**"B" Total**
	Start Point:	JWPCP																								
	End Point:	Cherry Ave/Carson St																								
Path 30 (w/o Signal Hill Tunnel)	30X.1	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2024.5	0	N	5	Roadway	3	7535		0	0	0	7534.6	3.00	3700	2	5997	9559.1	655	N	24.74	9559.1		7534.6
		5X	8	348	0	Y	4	Roadway	3	10663		0	0	1	10663	5.00	8900	4	5690	11011	0	N	21.25	11011		10663
		6	20	1473.8	0	N	5	Roadway	3	8850		0	0	4	8850.3	5.00	1050	2	2854	10324.1	0	N	24.70	10324.1		8850.3
		sum	**152**	**4854.8**	**0**	**Y**	**22**		**3.00**	**41815**		**0**	**0**	**7**	**41814.7**	**3.59**	**26155**	**11**	**23189**	**46669.5**	**655**	**N**	**103.22**	**46669.5**		**41814.7**
		Criteria	3.26	10.4%	0%	Y	0.47		3.10		1.00			0.79		3.59	56.0%	1.24	50%	**3%**	1%	N	140.21			
		Score	5	3	1	5	5		3.10		1.00			5		3.59	5	3	3	1	1	1	1	**47**		**Raw Total**
		Weighted "A"	60.00	36.00	3.00	15.00	15.00		37.25		1.50			30.00		21.53	30.00	13.50	18.00	15.00	2.00	8.00	0.00	**305.77**	**38.85%**	**"A" Total**
		Weighted "B"	30.00	18.00	1.50	7.50	7.50		18.62		2.75			55.00		39.47	55.00	24.75	24.75	7.50	3.00	12.00	0.00	**307.34**	**36.79%**	**"B" Total**
	30X.2	Path 29.2	154	8636	0	Y	13		2	32379		0	0	2	22301	2.04	16205	5	14645	41015	655	N	97.62	41015		32379
	29.2	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282.2	5.00	2280	0	1121	2282.2	0	N	4.19	2282.2		2282.2
		4(b)	9	158.5	0	N	2	Roadway	3	5861		0	0	1	5860.5	3.00	1500	1	2072	6019	16	N	11.69	6019		5860.5
		4(c)	5	242.8	0	N	3	Roadway	3	5788		0	0	0	5788.1	3.00	0	1	1446	6030.9	0	N	11.99	6030.9		5788.1
		sum	**171**	**9037.5**	**0**	**Y**	**19**		**2.56**	**46310**		**0**	**0**	**4**	**36232.2**	**2.01**	**19985**	**7**	**19284**	**55347.5**	**671**	**N**	**125.49**	**55347.5**		**46310**
		Criteria	3.09	16.3%	0%	Y	0.34		2.80		1.00			0.38		2.01	36.1%	0.67	35%	**22%**	1%	N	170.46			
		Score	5	5	1	5	3		2.80		1.00			3		2.01	3	1	3	5	1	1	3	**45**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		33.59		1.50			18.00		12.03	18.00	4.50	18.00	75.00	2.00	8.00	0.00	**337.62**	**32.48%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.79		2.75			33.00		22.06	33.00	8.25	24.75	37.50	3.00	12.00	0.00	**266.61**	**45.17%**	**"B" Total**
	30X.3	Path 29.2	154	8636	0	Y	13		2	32379		0	0	2	22301	2.04	16205	5	14645	41015	655	N	97.62	41015		32379
	29.2	4(a)	3	0	0	N	1	Roadway	3	2282		0	0	1	2282.2	5.00	2280	0	1121	2282.2	0	N	4.19	2282.2		2282.2
		4A(a)	21	906	0	N	2	Roadway	3	7567		0	0	4	7566.7	5.00	6175	3	1931	8472.7	18	N	19.05	8472.7		7566.7
		7.1(a)	4	0	0	N	3	Roadway	3	5105		0	0	0	5105.4	5.00	5100	0	1338	5105.4	0	N	9.37	5105.4		5105.4
		sum	**182**	**9542.2**	**0**	**Y**	**19**		**2.57**	**47334**		**0**	**0**	**7**	**37255.7**	**2.46**	**29760**	**8**	**19035**	**56875.7**	**673**	**N**	**130.22**	**56875.7**		**47333.5**
		Criteria	3.20	16.8%	0%	Y	0.33		2.81		1.00			0.65		2.46	52.3%	0.74	33%	**26%**	1%	N	176.88			
		Score	5	5	1	5	3		2.81		1.00			5		2.46	5	1	3	5	1	1	4	**50**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		33.76		1.50			30.00		14.76	30.00	4.50	18.00	75.00	2.00	8.00	0.00	**364.52**	**27.10%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.88		2.75			55.00		27.06	55.00	8.25	24.75	37.50	3.00	12.00	0.00	**315.69**	**35.08%**	**"B" Total**
	30X.4	Path 22.1	76	1009	0	N	8		3	14767		0	0	2	14767	2.87	12505	3	8648	15775	0	N	32.53	15775		14767
	22.1	1(d)	48	2024.5	0	N	5	Roadway	3	7535		0	0	0	7534.6	3.00	3700	2	5997	9559.1	655	N	24.74	9559.1		7534.6
		2(a)	18	210.7	0	Y	0	LAFCD	1	8065		0	0	0	0	1.00	0	0	0	8276	0	N	11.11	8276		8065.3
		2A	6	4774.1	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5594.8	0	N	24.57	5594.8		820.7
		4(c)	5	242.8	0	N	3	Roadway	3	5788		0	0	0	5788.1	3.00	0	1	1446	6030.9	0	N	11.99	6030.9		5788.1
		sum	**153**	**8260.6**	**0**	**Y**	**16**		**2.52**	**36976**		**0**	**0**	**2**	**28089.5**	**2.20**	**16205**	**6**	**16091**	**45236.1**	**655**	**N**	**104.95**	**45236.1**		**36975.5**
		Criteria	3.38	18.3%	0%	Y	0.35		2.79		1.00			0.23		2.20	35.8%	0.70	36%	**0%**	1%	N	142.55			
		Score	5	5	1	5	3		2.79		1.00			1		2.20	3	1	3	1	1	1	2	**38**		**Raw Total**
		Weighted "A"	60.00	60.00	3.00	15.00	9.00		33.48		1.50			6.00		13.20	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**266.68**	**46.66%**	**"A" Total**
		Weighted "B"	30.00	30.00	1.50	7.50	4.50		16.74		2.75			11.00		24.20	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**216.69**	**55.44%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

Path 31OC (54" pipe to OC)

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Start Point:	Route B to OC Spreading Grounds if starting from Paramount Blvd/Del Amo Blvd or Cherry/Carson																								
End Point:	Stanton Ave/Orangethorpe Ave																								
31OC.1	4A(c)OC	8	452.2	0	N	1	Roadway	3	5045		0	0	0	5044.6	3.00	2800	2	171	5496.8	15	N	9.31	5496.8		5044.6
Road	4A(d)OC	12	607.2	0	N	4	Roadway	3	9885		0	0	1	9885.4	5.00	2450	3	1442	10492.6	79	N	16.71	10492.6		9885.4
	4A(e)OC	0	740.3	0	N	0	Roadway	3	1550		0	0	0	1550.1	3.00	0	0	500	2290.4	0	N	6.29	2290.4		1550.1
	11A(a)OC	0	420.9	0	N	0	Roadway	3	2123		0	0	0	2123.3	3.00	0	0	0	2544.2	154	N	4.37	2544.2		2123.3
	11A(b)	6	2004.3	0	N	0	Roadway	3	3239		0	0	0	3238.7	5.00	2500	0	0	5243	0	N	10.69	5243		3238.7
1.3	Path 1.3	9	557	7530	N	0		3	6974		0	0	2	6974	2.54	5570	4	2316	7530	159	N	11.52	7530		6974
	11B(c)	3	1965.3	7961	N	4	Roadway	3	5996		0	0	1	5995.7	3.00	5135	3	1909	7961	0	N	15.22	7961		5995.7
	15	5	2054.6	13256.9	N	6	Roadway	3	11202		0	0	3	11202.3	5.00	2790	4	9299	13256.9	26	N	22.46	13256.9		11202.3
	sum	**43**	**8801.5**	**28748.2**	**N**	**15**		**3.00**	**46014**		**0**	**0**	**7**	**46013.7**	**3.51**	**21245**	**16**	**15637**	**54815.2**	**433**	**N**	**96.58**	**54815.2**		**46013.7**
	Criteria	0.78	16.1%	52%	N	0.27		3.16		1.00			0.67		3.51	38.8%	1.54	29%	**0%**	1%	N	129.57			
	Score	1	5	5	1	3		3.16		1.00			5		3.51	3	3	3	1	1	1	1	**41**		**Raw Total**
	Weighted "A"	12.00	60.00	15.00	3.00	9.00		37.93		1.50			30.00		21.05	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**263.98**	**47.20%**	**"A" Total**
	Weighted "B"	6.00	30.00	7.50	1.50	4.50		18.96		2.75			55.00		38.59	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**269.81**	**44.51%**	**"B" Total**
31OC.2	4A(c)OC	8	452.2	0	N	1	Roadway	3	5045		0	0	0	5044.6	3.00	2800	2	171	5496.8	15	N	9.31	5496.8		5044.6
Road	4A(d)OC	12	607.2	0	N	4	Roadway	3	9885		0	0	1	9885.4	5.00	2450	3	1442	10492.6	79	N	16.71	10492.6		9885.4
	4BOC	1	497.1	0	N	0	Roadway	3	2829		0	0	1	2829.3	3.00	1915	2	1332	3326.4	165	N	6.63	3326.4		2829.3
	10A.2OC	0	83.1	0	N	0	Private	1	384		0	0	0	0	1.00	0	0	0	467.5	0	N	0.78	467.5		384.4
	12(a)	12	2662.2	0	N	2	Roadway	3	6549		0	0	0	6548.7	3.00	0	3	3341	9210.9	17	N	18.44	9210.9		6548.7
2.3 (Road)	Path 2.3	6	774	12201	N	3		3	11427		0	0	4	11427	2.87	0	1	3980	12201	379	N	18.10	12201		11427
	14	0	0	3120.9	N	2	Roadway	3	3121		0	0	0	3120.9	3.00	500	0	614	3120.9	0	N	4.18	3120.9		3120.9
	15	5	2054.6	13256.9	N	6	Roadway	3	11202		0	0	3	11202.3	5.00	2790	4	9299	13256.9	26	N	22.46	13256.9		11202.3
	sum	**44**	**7130.8**	**28578.7**	**N**	**18**		**2.98**	**50442**		**0**	**0**	**9**	**50057.7**	**3.45**	**10455**	**15**	**20179**	**57572.9**	**682**	**N**	**96.61**	**57572.9**		**50442.1**
	Criteria	0.76	12.4%	50%	N	0.31		3.11		1.00			0.83		3.45	18.2%	1.38	35%	**5%**	1%	N	128.81			
	Score	1	3	5	1	3		3.11		1.00			5		3.45	3	3	3	1	1	1	2	**40**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		37.33		1.50			30.00		20.68	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**239.00**	**52.20%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.66		2.75			55.00		37.91	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**256.82**	**47.18%**	**"B" Total**
31OC.3	8(a)OC	8	451.7	0	N	2	Roadway	3	6922		0	0	1	6921.5	5.00	3850	1	1917	7373.2	0	N	10.90	7373.2		6921.5
Road	8(b)OC	10	714.9	0	N	3	Roadway	3	9876		0	0	1	9876.2	5.00	8750	3	1744	10591.1	82	N	15.81	10591.1		9876.2
	8(c)OC	2	0	0	N	1	Roadway	3	2629		0	0	0	2628.8	5.00	2470	0	254	2628.8	0	N	3.52	2628.8		2628.8
23.1	Path 23OC.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	5.25	2529		1855
3.5 (Road)	Path 3.5	23	5491	28579	N	13		3	32298		0	0	7	32298	3.26	3290	8	17234	37790	422	N	63.18	37790		32298
	sum	**46**	**7332**	**28578.7**	**N**	**19**		**3.00**	**53579**		**0**	**0**	**9**	**53579.4**	**3.52**	**18360**	**12**	**21326**	**60911.4**	**504**	**N**	**98.66**	**60911.4**		**53579.4**
	Criteria	0.76	12.0%	47%	N	0.31		3.12		1.00			0.78		3.52	30.1%	1.04	35%	**11%**	1%	N	131.55			
	Score	1	3	5	1	3		3.12		1.00			5		3.52	3	3	3	3	1	1	3	**43**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		37.44		1.50			30.00		21.12	18.00	13.50	18.00	45.00	2.00	8.00	0.00	**269.57**	**46.09%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.72		2.75			55.00		38.73	33.00	24.75	24.75	22.50	3.00	12.00	0.00	**272.70**	**43.92%**	**"B" Total**

Evaluation Criteria Scoring Table - Paths from JWPCP

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 32OC (54" pipe to OC)																									
Start Point:	Cherry Ave/Carson St																								
End Point:	Stanton Ave/Orangethorpe Ave																								
32OC.1	8(a)OC	8	451.7	0	N	2	Roadway	3	6922		0	0	1	6921.5	5.00	3850	1	1917	7373.2	0	N	10.90	7373.2		6921.5
SCE Version	8(b)OC	10	714.9	0	N	3	Roadway	3	9876		0	0	1	9876.2	5.00	8750	3	1744	10591.1	82	N	15.81	10591.1		9876.2
	8(c)OC	2	0	0	N	1	Roadway	3	2629		0	0	0	2628.8	5.00	2470	0	254	2628.8	0	N	3.52	2628.8		2628.8
23.1	Path 23OC.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	5.25	2529		1855
3.1	Path 3.1	18	3100	24287	N	0		1	35989		0	13494	7	6091	1.31	375	1	1835	39088	391	N	46.30	39088		35989
	sum	**41**	**4940.5**	**24287.3**	**N**	**6**		**1.96**	**57270**		**0**	**13494**	**9**	**27372.3**	**2.32**	**15445**	**5**	**5927**	**62210.2**	**472**	**N**	**81.79**	**62210.2**		**57269.7**
	Criteria	0.66	7.9%	39%	N	0.10		2.12		1.43			0.76		2.32	24.8%	0.42	10%	2%	1%	N	108.37			
	Score	1	3	5	1	1		2.12		1.43			5		2.32	3	1	1	1	1	1	1	31		Raw Total
	Weighted "A"	12.00	36.00	15.00	3.00	3.00		25.42		2.15			30.00		13.94	18.00	4.50	6.00	15.00	2.00	8.00	0.00	194.01	61.20%	"A" Total
	Weighted "B"	6.00	18.00	7.50	1.50	1.50		12.71		3.94			55.00		25.56	33.00	8.25	8.25	7.50	3.00	12.00	0.00	203.71	58.11%	"B" Total
32OC.2	8(a)OC	8	451.7	0	N	2	Roadway	3	6922		0	0	1	6921.5	5.00	3850	1	1917	7373.2	0	N	10.90	7373.2		6921.5
Road Version	8(b)OC	10	714.9	0	N	3	Roadway	3	9876		0	0	1	9876.2	5.00	8750	3	1744	10591.1	81.508619	N	15.81	10591.1		9876.2
	8(c)OC	2	0	0	N	1	Roadway	3	2629		0	0	0	2628.8	5.00	2470	0	254	2628.8	0	N	3.52	2628.8		2628.8
23.1	Path 23OC.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	5.25	2529		1855
3.5	Path 3.5	23	5491	28579	N	13		3	32298		0	0	7	32298	3.26	3290	8	17234	37790	422	N	63.18	37790		32298
	sum	**46**	**7332**	**28578.7**	**N**	**19**		**3.00**	**53579**		**0**	**0**	**9**	**53579.4**	**3.52**	**18360**	**12**	**21326**	**60911.4**	**503.984241**	**N**	**98.66**	**60911.4**		**53579.4**
	Criteria	0.76	12.0%	47%	N	0.31		3.12		1.00			0.78		3.52	30.1%	1.04	35%	0%	1%	N	131.55			
	Score	1	3	5	1	3		3.12		1.00			5		3.52	3	3	3	1	1	1	2	40		Raw Total
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		37.44		1.50			30.00		21.12	18.00	13.50	18.00	15.00	2.00	8.00	0.00	239.57	52.09%	"A" Total
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.72		2.75			55.00		38.73	33.00	24.75	24.75	7.50	3.00	12.00	0.00	257.70	47.00%	"B" Total
Path 33OC (54" pipe to OC)																									
Start Point:	Route C to OC Spreading Grounds (Long Beach Blvd/Del Amo Blvd or LA River/405 Fwy)																								
End Point:	Stanton Ave/Orangethorpe Ave																								
33OC.1	4(a)OC	3	0	0	N	1	Roadway	3	2282		0	0	1	2282.2	5.00	2280	0	1121	2282.2	0	N	3.05	2282.2		2282.2
	4A(a)OC	21	906	0	N	2	Roadway	3	7567		0	0	4	7566.7	5.00	6175	3	1931	8472.7	17.783546	N	15.29	8472.7		7566.7
	4A(b)OC	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	3.65	2075		1873
31OC.2	Path 31OC.2	44	7131	28579	N	18		3	50442		0	0	9	50058	3.45	10455	15	20179	57573	682	N	96.61	57573		50442
	sum	**74**	**8238.6**	**28578.7**	**N**	**24**		**2.99**	**62164**		**0**	**0**	**14**	**61779.6**	**3.35**	**20010**	**19**	**23623**	**70402.6**	**699.460199**	**N**	**118.60**	**70402.6**		**62164**
	Criteria	1.05	11.7%	41%	N	0.34		3.11		1.00			1.05		3.35	28.4%	1.42	34%	4%	1%	N	159.12			
	Score	3	3	5	1	3		3.11		1.00			5		3.35	3	3	3	1	1	1	4	43		Raw Total
	Weighted "A"	36.00	36.00	15.00	3.00	9.00		37.27		1.50			30.00		20.11	18.00	13.50	18.00	15.00	2.00	8.00	0.00	262.39	47.52%	"A" Total
	Weighted "B"	18.00	18.00	7.50	1.50	4.50		18.64		2.75			55.00		36.87	33.00	24.75	24.75	7.50	3.00	12.00	0.00	267.76	44.93%	"B" Total
33OC.2	4(a)OC	3	0	0	N	1	Roadway	3	2282		0	0	1	2282.2	5.00	2280	0	1121	2282.2	0	N	3.05	2282.2		2282.2
	4(b)OC	9	158.5	0	N	2	Roadway	3	5861		0	0	1	5860.5	3.00	1500	1	2072	6019	16	N	8.47	6019		5860.5
	4(c)OC	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	8.63	6031		5788
32.1	Path 32OC.1	41	4941	24287	N	6		2	57270		0	13494	9	27372	2.32	15445	5	5927	62210	472	N	81.79	62210		57270
	sum	**58**	**5341.8**	**24287.3**	**N**	**12**		**2.16**	**71201**		**0**	**13494**	**11**	**41303.1**	**1.90**	**19225**	**7**	**10566**	**76542.3**	**488.095505**	**N**	**101.93**	**76542.3**		**71200.5**
	Criteria	0.76	7.0%	32%	N	0.16		2.29		1.35			0.76		1.90	25.1%	0.48	14%	13%	1%	N	135.91			
	Score	1	3	5	1	3		2.29		1.35			5		1.90	3	1	3	3	1	1	2	38		Raw Total
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		27.46		2.03			30.00		11.38	18.00	4.50	18.00	45.00	2.00	8.00	0.00	241.37	51.73%	"A" Total
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		13.73		3.72			55.00		20.87	33.00	8.25	24.75	22.50	3.00	12.00	0.00	234.32	51.81%	"B" Total
33OC.3	2AOC	6	4774.1	0	Y	0	LAFCD	1	821		0	0	0	0	1.00	0	0	0	5594.8	0	N	15.77	5594.8		820.7
	4(c)OC	5	243	0	N	3	Roadway	3	5788		0	0	0	5788	3.00	0	1	1446	6031	0	N	8.63	6031		5788
32.1	Path 32OC.1	41	4941	24287	N	6		2	57270		0	13494	9	27372	2.32	15445	5	5927	62210	472	N	81.79	62210		57270
	sum	**52**	**9957.4**	**24287.3**	**Y**	**9**		**2.04**	**63879**		**0**	**13494**	**9**	**33160.4**	**1.65**	**15445**	**6**	**7373**	**73835.9**	**472.095505**	**N**	**106.18**	**73835.9**		**63878.5**
	Criteria	0.70	13.5%	33%	Y	0.12		2.30		1.37			0.64		1.65	20.9%	0.43	10%	9%	1%	N	142.46			
	Score	1	3	5	5	1		2.30		1.37			5		1.65	3	1	1	1	1	1	3	36		Raw Total
	Weighted "A"	12.00	36.00	15.00	15.00	3.00		27.63		2.05			30.00		9.88	18.00	4.50	6.00	15.00	2.00	8.00	0.00	204.07	59.19%	"A" Total
	Weighted "B"	6.00	18.00	7.50	7.50	1.50		13.82		3.76			55.00		18.12	33.00	8.25	8.25	7.50	3.00	12.00	0.00	203.19	58.21%	"B" Total

Evaluation Criteria Scoring Table - Paths from JWPCP

	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Path 33OC (54" pipe to OC)																									
33OC.4	4(a)OC	3	0	0	N	1	Roadway	3	2282		0	0	1	2282.2	5.00	2280	0	1121	2282.2	0	N	3.05	2282.2		2282.2
	4A(a)OC	21	906	0	N	2	Roadway	3	7567		0	0	4	7567	5.00	6175	3	1931	8473	18	N	15.29	8473		7567
	4A(b)OC	6	202	0	N	3	Roadway	3	1873		0	0	0	1873	3.00	1100	1	392	2075	0	N	3.65	2075		1873
	4A(c)OC	8	452	0	N	1	Roadway	3	5045		0	0	0	5045	3.00	2800	2	171	5497	15	N	9.31	5497		5045
	4A(d)OC	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	16.71	10493		9885
	4BOC	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	6.63	3326		2829
	10A.3OC	1	0	0	N	0	Roadway	3	435		0	0	0	435	3.00	375	0	0	435	0	N	0.58	435		435
	10A.4	0	0	0	N	0	SCE	1	911		0	0	0	0	1.00	0	0	0	911	0	N	0.70	911		911
	10A.5	0	0	0	N	0	SCE	1	271		0	0	0	0	1.00	0	0	0	271	0	N	0.21	271		271
	11.1(a)	8	1402	0	N	0	SCE	1	8332		0	3851	2	0	1.00	0	0	0	9733	175	N	13.21	9733		8332
	11.1(b)	0	0	2039	N	0	SCE	1	2039		0	2039.2	0	0	1.00	0	0	0	2039	0	N	1.56	2039		2039
	11.2	1	0	501	N	0	LAFCD	1	501		0	0	0	0	1.00	0	0	0	501	215	N	0.75	501		501
	11.3(a)	1	149	2689	N	0	SCE	1	2541		0	2540.6	0	0	1.00	0	0	0	2689	0	N	2.82	2689		2541
	11.3(b)	0	0	2534	N	0	SCE	1	2534		0	2534.2	0	0	1.00	0	0	0	2534	0	N	1.94	2534		2534
	16	5	990	13375	N	0	SCE	1	12385		0	2529	4	0	1.00	0	0	1146	13375	0	N	12.44	13375		12385
	17	0	117	3148	N	0	Roadway	3	3032		0	0	1	3032	3.00	0	0	689	3148	0	N	4.62	3148		3032
	sum	**67**	**5321.7**	**24287.3**	**N**	**11**		**2.05**	**62460**		**0**	**13494**	**14**	**32947.3**	**2.55**	**17095**	**11**	**8224**	**67782**	**667.571463**	**N**	**93.46**	**67782**		**62460.3**
	Criteria	0.99	7.9%	36%	N	0.16		2.21		1.40			1.09		2.55	25.2%	0.86	12%	**0%**	1%	N	124.61			
	Score	1	3	5	1	3		2.21		1.40			5		2.55	3	1	3	1	1	1	1	**35**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		26.49		2.10			30.00		15.33	18.00	4.50	18.00	15.00	2.00	8.00	0.00	**214.42**	**57.12%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		13.25		3.84			55.00		28.10	33.00	8.25	24.75	7.50	3.00	12.00	0.00	**226.19**	**53.48%**	**"B" Total**
Start Point:	Route B to OC Spreading Grounds if starting from Lakewood Blvd/Del Amo Blvd or Lakewood Blvd/Carson																								
End Point:	Stanton Ave/Orangethorpe Ave																								
Path 34OC (54" pipe to OC)																									
34OC.1	4A(d)OC	12	607.2	0	N	4	Roadway	3	9885		0	0	1	9885.4	5.00	2450	3	1442	10492.6	79	N	16.71	10492.6		9885.4
Road	4A(e)OC	0	740	0	N	0	Roadway	3	1550		0	0	0	1550	3.00	0	0	500	2290	0	N	6.29	2290		1550
	11A(a)OC	0	421	0	N	0	Roadway	3	2123		0	0	0	2123	3.00	0	0	0	2544	154	N	4.37	2544		2123
	11A(b)	6	2004	0	N	0	Roadway	3	3239		0	0	0	3239	5.00	2500	0	0	5243	0	N	10.69	5243		3239
1.3	Path 1.3	9	557	7530	N	0		3	6974		0	0	2	6974	2.54	5570	4	2316	7530	159	N	11.52	7530		6974
	11B(c)	3	1965	7961	N	4	Roadway	3	5996		0	0	1	5996	3.00	5135	3	1909	7961	0	N	15.22	7961		5996
	15	5	2055	13257	N	6	Roadway	3	11202		0	0	3	11202	5.00	2790	4	9299	13257	26	N	22.46	13257		11202
	sum	**35**	**8349.3**	**28748.2**	**N**	**14**		**3.00**	**40969**		**0**	**0**	**7**	**40969.1**	**3.58**	**18445**	**14**	**15466**	**49318.4**	**417**	**N**	**87.27**	**49318.4**		**40969.1**
	Criteria	0.71	16.9%	58%	N	0.28		3.17		1.00			0.75		3.58	37.4%	1.50	31%	**0%**	1%	N	117.09			
	Score	1	5	5	1	3		3.17		1.00			5		3.58	3	3	3	1	1	1	1	**41**		**Raw Total**
	Weighted "A"	12.00	60.00	15.00	3.00	9.00		38.03		1.50			30.00		21.50	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**264.53**	**47.09%**	**"A" Total**
	Weighted "B"	6.00	30.00	7.50	1.50	4.50		19.02		2.75			55.00		39.42	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**270.68**	**44.33%**	**"B" Total**
34OC.2	4A(d)OC	12	607	0	N	4	Roadway	3	9885		0	0	1	9885	5.00	2450	3	1442	10493	79	N	16.71	10493		9885
Road	4BOC	1	497	0	N	0	Roadway	3	2829		0	0	1	2829	3.00	1915	2	1332	3326	165	N	6.63	3326		2829
	10A.2OC	0	83	0	N	0	Private	1	384		0	0	0	0	1.00	0	0	0	468	0	N	0.78	468		384
	12(a)	12	2662	0	N	2	Roadway	3	6549		0	0	0	6549	3.00	0	3	3341	9211	17	N	18.44	9211		6549
2.3	Path 2.3	6	774	12201	N	3		3	11427		0	0	4	11427	2.87	0	1	3980	12201	379	N	18.10	12201		11427
	14	0	0	3121	N	2	Roadway	3	3121		0	0	0	3121	3.00	500	0	614	3121	0	N	4.18	3121		3121
	15	5	2055	13257	N	6	Roadway	3	11202		0	0	3	11202	5.00	2790	4	9299	13257	26	N	22.46	13257		11202
	sum	**36**	**6678.6**	**28578.7**	**N**	**17**		**2.98**	**45398**		**0**	**0**	**9**	**45013.1**	**3.51**	**7655**	**13**	**20008**	**52076.1**	**666**	**N**	**87.30**	**52076.1**		**45397.5**
	Criteria	0.69	12.8%	55%	N	0.33		3.11		1.00			0.91		3.51	14.7%	1.32	38%	**6%**	1%	N	116.41			
	Score	1	3	5	1	3		3.11		1.00			5		3.51	1	3	3	1	1	1	2	**38**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		37.36		1.50			30.00		21.06	6.00	13.50	18.00	15.00	2.00	8.00	0.00	**227.43**	**54.51%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.68		2.75			55.00		38.62	11.00	24.75	24.75	7.50	3.00	12.00	0.00	**235.55**	**51.56%**	**"B" Total**
34OC.3	8(b)OC	10	715	0	N	3	Roadway	3	9876		0	0	1	9876	5.00	8750	3	1744	10591	82	N	15.81	10591		9876
Road	8(c)OC	2	0	0	N	1	Roadway	3	2629		0	0	0	2629	5.00	2470	0	254	2629	0	N	3.52	2629		2629
23.1	Path 23OC.1	3	674	0	N	0		3	1855		0	0	0	1855	2.47	0	0	177	2529	0	N	5.25	2529		1855
3.5 (Road)	Path 3.5	23	5491	28579	N	13		3	32298		0	0	7	32298	3.26	3290	8	17234	37790	422	N	63.18	37790		32298
	sum	**38**	**6880.3**	**28578.7**	**N**	**17**		**3.00**	**46658**		**0**	**0**	**8**	**46657.9**	**3.35**	**14510**	**11**	**19409**	**53538.2**	**504**	**N**	**87.76**	**53538.2**		**46657.9**
	Criteria	0.71	12.9%	53%	N	0.32		3.13		1.00			0.79		3.35	27.1%	1.08	36%	**9%**	1%	N	117.01			
	Score	1	3	5	1	3		3.13		1.00			5		3.35	3	3	3	1	1	1	3	**40**		**Raw Total**
	Weighted "A"	12.00	36.00	15.00	3.00	9.00		37.54		1.50			30.00		20.11	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**238.65**	**52.27%**	**"A" Total**
	Weighted "B"	6.00	18.00	7.50	1.50	4.50		18.77		2.75			55.00		36.86	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**255.88**	**47.38%**	**"B" Total**

FINAL SCREENING RESULTS

Evaluation Criteria Scoring Table - Final Route Comparisons

Routes	Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
		ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Start Point:	State Rd/Del Amo Blvd (Potential Pump Station No. 2 Location																								
End Point:	Miraloma Ave (OC Spreading Grounds)																								
Route A	10A.4	0	0	0	N	0	SCE	1	911		0	0	0	0	1.00	0	0	0	911	0	N	0.70	911		911
	10A.5	0	0	0	N	0	SCE	1	271		0	0	0	0	1.00	0	0	0	271	0	N	0.21	271		271
	11.1(a)	8	1402	0	N	0	SCE	1	8332		0	3851	2	0	1.00	0	0	0	9733	175	N	13.21	9733		8332
	11.1(b)	0	0	2039	N	0	SCE	1	2039		0	2039.2	0	0	1.00	0	0	0	2039	0	N	1.56	2039		2039
	11.2	1	0	501	N	0	LAFCD	1	501		0	0	0	0	1.00	0	0	0	501	215	N	0.75	501		501
	11.3(a)	1	149	2689	N	0	SCE	1	2541		0	2540.6	0	0	1.00	0	0	0	2689	0	N	2.82	2689		2541
	11.3(b)	0	0	2534	N	0	SCE	1	2534		0	2534.2	0	0	1.00	0	0	0	2534	0	N	1.94	2534		2534
	16	5	990	13375	N	0	SCE	1	12385		0	2529	4	0	1.00	0	0	1146	13375	0	N	12.44	13375		12385
	17	0	117	3148	N	0	Roadway	3	3032		0	0	1	3032	3.00	0	0	689	3148	0	N	4.62	3148		3032
	18.1	0	0	0	N	0	Roadway	3	1629		0	0	0	1629	3.00	520	0	635	1629	0	N	2.18	1629		1629
	18.2	2	564	0	N	0	SCE	1	1329		0	0	0	0	1.00	0	0	0	1894	0	N	3.07	1894		1329
	18.3	4	2366	0	N	12	Roadway	3	41565		0	0	2	41565	5.00	2090	10	25869	43931	56	N	64.12	43931		41565
	sum	**21**	**5587**	**24287.3**	**N**	**12.00**		**2.20**	**77067**		**0**	**13494**	**9**	**46225.1**	**3.12**	**2610**	**10**	**28339**	**82655**	**447**	**N**	**107.60**	**82,654.7**		**77067.4**
	Criteria	0.25	6.8%	29%	N	0.15		2.32		1.33			0.57		3.12	3.2%	0.64	34%	**82655**	1%	N	139.88			
	Score																						**0**		**Raw Total**
	Weighted "A"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"A" Total**
	Weighted "B"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"B" Total**
Start Point:	Paramount Blvd/Del Amo Blvd																								
End Point:	Miraloma Ave (OC Spreading Grounds)																								
Route B (Road Option)	Path 31OC.2	44	7131	28579	N	18		3	50442		0	0	9	50058	3.45	10455	15	20179	57573	682	N	96.61	57573		50442
	18.1	0	0	0	N	0	Roadway	3	1629		0	0	0	1629	3.00	520	0	635	1629	0	N	2.18	1629		1629
	18.2	2	564	0	N	0	SCE	1	1329		0	0	0	0	1.00	0	0	0	1894	0	N	3.07	1894		1329
	18.3	4	2366	0	N	12	Roadway	3	41565		0	0	2	41565	5.00	2090	10	25869	43931	56	N	64.12	43931		41565
Road	**sum**	**50**	**10061**	**28578.7**	**N**	**30.00**		**2.96**	**94965**		**0**	**0**	**11**	**93251.3**	**3.78**	**13065**	**25**	**46683**	**105026**	**738**	**N**	**165.98**	**105,026**		**94965**
	Criteria	0.48	9.6%	27%	N	0.29		3.06		1.00			0.55	3.78		12.4%	1.26	44%	**105025.7**	1%	N	215.77			
	Score																						**0**		**Raw Total**
	Weighted "A"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"A" Total**
	Weighted "B"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"B" Total**
Start Point:	LA River/Del Amo Blvd																								
End Point:	Miraloma Ave (OC Spreading Grounds)																								
Route C	Path 33OC.3	67	5322	24287	N	11		2	62460		0	13494	14	32947	2.55	17095	11	8224	67782	668	N	93.46	67782		62460
33OC.3	18.1	0	0	0	N	0	Roadway	3	1629		0	0	0	1629	3.00	520	0	635	1629	0	N	2.18	1629		1629
	18.2	2	564	0	N	0	SCE	1	1329		0	0	0	0	1.00	0	0	0	1894	0	N	3.07	1894		1329
	18.3	4	2366	0	N	12	Roadway	3	41565		0	0	2	41565	5.00	2090	10	25869	43931	56	N	64.12	43931		41565
	sum	**73**	**8252**	**24287.3**	**N**	**23.00**		**2.42**	**106983**		**0**	**13494**	**16**	**76140.9**	**2.92**	**19705**	**21**	**34728**	**115235**	**724**	**N**	**162.82**	**115,235**		**106983.2**
	Criteria	0.63	7.2%	21%	N	0.20		2.54		1.23			0.73		2.92	17.1%	0.96	30%	**115234.8**	1%	N	211.67			
	Score																						**0**		**Raw Total**
	Weighted "A"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"A" Total**
	Weighted "B"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"B" Total**

Routes to OC

Evaluation Criteria Scoring Table - Final Route Comparisons

Routes			Segments	Major Utilities	Trenchless Construction	Depth to Water	Seismic Hazard	Contaminated Soils Risk	Ease of Operations/ Accessibility	Ease of Operation Sub-Score	Length in Operational Situation	Parks	Non- SCE Parks & Rec Areas	SCE Parks & Rec Areas	Public Facilities	Length in Streets	Road Category & Traffic Impact	Center Medians	Major Intersections	Residential/ Minor Commercial	Total Alignment Length	Waters of the US and State	Critical Habitats and Listed Species	Cost	Pipe Length		Trench Length
				ea	ft	ft	Y/N	# Hits			length		length	length	ea	length		lf	ea	Length	Length	length	Y/N	$ mil	ft		ft
Routes to Santa Fe Spreading Grounds	Start Point:		Lower Azusa Rd/Peck Rd																								
	End Point:		Arrow Hwy/605 Fwy																								
	Route A		Path 9.3	12	4595	22077	N	0		1	45311		0	0	0	4593	1.04	1080	0	1884	49906	11492	N	57.75	49906		45311
		9.3	**sum**	**12**	**4595**	**22077.2**	**N**	**0.00**		**1.47**	**45311**		**0**	**0**	**0**	**4592.6**	**1.00**	**1080**	**0**	**1884**	**49906**	**11492**	**N**	**57.75**	**49,906**		**45310.8**
			Criteria	0.24	9.2%	44%	N	0.00		1.71		1.00			0.00		1.00	2.2%	0.00	4%	**49906**	23%	N	75.08			
			Score																						**0**		**Raw Total**
			Weighted "A"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"A" Total**
			Weighted "B"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"B" Total**
	Start Point:		Durfee Ave/Peck Rd																								
	End Point:		Arrow Hwy/605 Fwy																								
	Route B		45(a)	1	0	4244	N	0	Roadway	3	4244		0	0	0	4244	3.00	1750	1.5	2501	4244	0	N	5.85	4244		4244
		4.1	Path 4.1	9	455	8833	N	2		3	8378		0	0	0	8378	2.90	1825	3	4584	8833	0	N	13.64	8833		8378
			47	4	286	0	N	2	Roadway	3	8832		0	0	1	8832	5.00	6700	2	6165	9118	0	N	13.49	9118		8832
			47A	3	1214	0	N	5	Roadway	3	15405		0	0	1	15405	5.00	11900	4	10026	16619	96	N	26.39	16619		15405
			59	0	792	0	N	0	LAFCD	1	8454		0	0	0	0	1.00	0	0	0	9247	2535	N	9.31	9247		8454
			sum	**17**	**2747**	**13077.1**	**N**	**9.00**		**2.63**	**45314**		**0**	**0**	**2**	**36859.4**	**3.52**	**22175**	**10.5**	**23276**	**48060**	**2630**	**N**	**68.68**	**48,060**		**45313.5**
			Criteria	0.35	5.7%	27%	N	0.19		2.71		1.00			0.22		3.52	46.1%	1.15	48%	**48060**	5%	N	89.28			
			Score																						**0**		**Raw Total**
			Weighted "A"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"A" Total**
			Weighted "B"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"B" Total**
	Start Point:		Durfee Ave/Peck Rd																								
	End Point:		Arrow Hwy/605 Fwy																								
	Route C		Path 9LA.4	13	5261	23447	N	1		1	46015		0	0	0	5296	1.06	1734	0	2244	51276	12007	N	61.41	51276		46015
		9LA.4	**sum**	**13**	**5261**	**23446.8**	**N**	**1.00**		**1.50**	**46015**		**0**	**0**	**0**	**5296.4**	**1.01**	**1734**	**0**	**2244**	**51276**	**12007**	**N**	**61.41**	**51,276**		**46014.6**
			Criteria	0.25	10.3%	46%	N	0.02		1.75		1.00			0.00		1.01	3.4%	0.00	4%	**51275.6**	23%	N	79.83			
			Score																						**0**		**Raw Total**
			Weighted "A"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"A" Total**
			Weighted "B"	0.00	0.00	0.00	0.00	0.00		0.00		0.00			0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**		**"B" Total**
Complete RRWSP System from JWPCP to OC and Rio Hondo Spreading Grounds	Route A		**sum**	**258**	**29879**	**102238.6**	**Y**	**34.00**		**2.56**	**254050**		**395**	**18921**	**17**	**124383.5**	**2.09**	**42080**	**22**	**57174**	**283929**	**39083**	**N**	**439.80**	**283,929**		**254050.4**
			Criteria	0.91	10.5%	36%	Y	0.12		2.56		1.14			0.32		2.09	14.8%	0.41	20%	**0%**	14%	N	590.07			
			Score	1	3	5	5	1		2.56		1.14			1		2.09	1	1	3	1	5	1	1	**35**		**Raw Total**
			Weighted "A"	12.00	36.00	15.00	15.00	3.00		30.71		1.71			6.00		12.56	6.00	4.50	18.00	15.00	10.00	8.00	0.00	**193.47**	**61.31%**	**"A" Total**
			Weighted "B"	6.00	18.00	7.50	7.50	1.50		15.36		3.13			11.00		23.02	11.00	8.25	24.75	7.50	15.00	12.00	0.00	**171.50**	**64.73%**	**"B" Total**
	Route B (Road Option)		**sum**	**260**	**23743**	**72059.3**	**N**	**82.00**		**3.01**	**272952**		**0**	**0**	**33**	**262433**	**3.60**	**127357**	**74.5**	**113489**	**296695**	**6192**	**N**	**494.49**	**296,695**		**272952.1**
			Criteria	0.88	8.0%	24%	N	0.28		3.01		1.00			0.59		3.60	42.9%	1.33	38%	**4%**	2%	N	655.20			
			Score	1	3	3	1	3		3.01		1.00			5		3.60	3	3	3	1	1	1	3	**39**		**Raw Total**
			Weighted "A"	12.00	36.00	9.00	3.00	9.00		36.11		1.50			30.00		21.60	18.00	13.50	18.00	15.00	2.00	8.00	0.00	**232.71**	**53.46%**	**"A" Total**
			Weighted "B"	6.00	18.00	4.50	1.50	4.50		18.05		2.75			55.00		39.60	33.00	24.75	24.75	7.50	3.00	12.00	0.00	**254.91**	**47.58%**	**"B" Total**
	Route C		**sum**	**313**	**40711**	**111195.1**	**Y**	**42.00**		**2.26**	**260167**		**4130**	**19377**	**18**	**122255.2**	**1.97**	**41894**	**29**	**57750**	**300878**	**25648**	**N**	**466.94**	**300,878**		**260166.6**
			Criteria	1.04	13.5%	37%	Y	0.14		2.26		1.18			0.32		1.97	13.9%	0.51	19%	**6%**	9%	N	630.37			
			Score	3	3	5	5	1		2.26		1.18			1		1.97	1	1	3	1	5	1	2	**37**		**Raw Total**
			Weighted "A"	36.00	36.00	15.00	15.00	3.00		27.11		1.78			6.00		11.81	6.00	4.50	18.00	15.00	10.00	8.00	0.00	**213.19**	**57.36%**	**"A" Total**
			Weighted "B"	18.00	18.00	7.50	7.50	1.50		13.56		3.26			11.00		21.65	11.00	8.25	24.75	7.50	15.00	12.00	0.00	**180.46**	**62.89%**	**"B" Total**

Appendix F. Additional Details on Detailed Alternative Alignment Evaluation

Chapter 4 provides an overview of the detailed evaluation completed to select the Initial Preferred Alignment. Additional details are provided in this Appendix.

Evaluation Criteria

Descriptions of the evaluation criteria introduced in Chapter 4 are provided herein fo the following three major categories: factors that would add construction risk, factors that would result in social and community impacts, and factors that would have biological impacts.

Construction Risk

Major Utility Crossings

The major utility crossings criteria assessed construction risk due to the number and size of major utility crossings that would be encountered along each pipe segment. For this analysis, all of the utility information compiled by Metropolitan was evaluated to quantify what the number and type of major utility crossings would be and assess if a sufficiently wide corridor would exist for installation of a new pipeline of the sizes required, while meeting regulatory requirements and constructability needs. During preliminary and final design, it is anticipated that more detailed mapping and utility exploration would be conducted and that some adjustments to the feasibility-level alignments may be warranted.

The major utility crossings along each pipe segment were quantified based on utility data available at the time of the analysis. Major utilities are those most likely to affect alignment development by being likely to be located at a similar depth or those that cannot be readily relocated.

Major utility crossings that would be expected to affect construction risk are discussed below.

- Storm drains/culverts greater than 30 inches
- Gravity sewer mains/sewer force mains greater than 24 inches
- Water transmission (potable/reclaimed) mains greater than 24 inches
- Oil/gas transmission pipelines greater than 18 inches

Smaller sized utilities, including dry utilities, would be expected to cross over the recycled water conveyance pipelines or have a negligible effect on construction risk. As is customary in planning, design, and construction of utilities of this size and type, it is expected that, where needed, those smaller sized utilities would feasibly be avoided or relocated to accommodate the recycled water conveyance pipeline. For an alignment study of a large diameter conveyance system spanning nearly 40 miles across urban LA, crossing and paralle utilites are expected and inevitable

Construction risk was expected to increase with the frequency at which the major utilities would be encountered. From existing data, the number of major utilities that would be encountered during trenching activities along the alternative alignments ranged from a high of 186 crossings (Sepulveda Boulevard) to no major crossings for segments proposed within existing overhead utility and flood control district easements. On average across all segments, major utility crossings would be expected to be encountered at a rate of just more than one crossing per 1,000 ft of pipeline installed using cut-and-cover construction methods.

Based upon the statistical data gathered, a rating score of 1, 3, or 5 was assigned based on the number of potential crossings per 1,000 ft of proposed pipeline.

The information available at the time of publication of this FLDR was anticipated to be sufficiently indicative of the totality of major utilities along the alignments such that a preferred alignment could be identified. It may be warranted to revisit this assumption as more data is made available.

Trenchless Construction

Trenchless construction methods would be required along significant reaches of the pipeline alignments to meet the requirements for installation of new utilities across existing rights-of-way, such as the California Department of Transportation (Caltrans); to avoid impacts to existing infrastructure or surface improvements; and to minimize impacts to traffic flow along the highly developed urban corridor. Various methods of trenchless construction were evaluated for the FLDR, but risk was not expected to vary based on the applied trenchless construction method.

Features to be crossed using trenchless construction methods would include at-grade freeway and railroad crossings, river and flood control channel crossings, and major at-grade street intersections. Trenchless construction methods would also be used to avoid significant impacts to biologically sensitive lands and, depending on pumping alternatives, to address hydraulic design constraints (Segment 5A). Lastly, trenchless construction would be applied in select areas to traverse below existing residential and commercial structures (i.e., Segment 3), where a sufficiently wide corridor for cut-and-cover construction does not reasonably exist.

Overall, trenchless construction was assumed for slightly more than 11 percent of the total length of the alignments considered in this evaluation. Several pipe segments in lesser congested areas would have no trenchless segments, while many of the alignments near more heavily congested development would have significantly higher rates of trenchless construction.

For purposes of evaluating the construction risk associated with trenchless construction, a rating score of 1, 3, and 5 was assigned to each segment based on the percent of the total length of the alignment that would be installed with trenchless construction methods.

High Groundwater Conditions

The Desktop Geotechnical Evaluation described the soil parameters differentiating the alignments related to construction risk, including the depth below ground surface that groundwater is encountered (high groundwater conditions) and the presence of high permeability soils. With typical trench depths for pipelines constructed in existing streets and potential easement rights-of-way varying between 16 and 18 ft, construction risk would increase in permeable soils where the groundwater levels would fall within typical trench depths. Such areas would require additional construction controls such as dewatering and alternative shoring methods to preserve trench side walls.

Based on the Desktop Geotechnical Evaluation, high groundwater conditions are prevalent throughout much of the Project study area. For purposes of assessing construction risk related to expected groundwater conditions, the pipeline alternatives proposed in areas with historical high groundwater depths of less than 10 ft below ground surface were assumed to require dewatering during construction. Approximately 35 percent of the pipeline segments would be expected to encounter the combination of high groundwater (groundwater depth less than 10 ft) and permeable soils.

A rating score of 1, 3, or 5 was assigned based on the percent of the total alignment length that would fall within areas with depth to groundwater of less than 10 ft.

Alignment Length

For each alignment comparison included in the decision model, common start and end points were established. However, the length of each alignment between these points may have varied considerably depending on the focus for route selection (i.e., minimized community impacts, staying within an established utility corridor, etc.). To account for the increased potential of construction risk, along with greater impacts on the surrounding community associated with longer duration times to install longer pipe segments, alignment length was evaluated. As trenchless construction is evaluated individually, this criterion in essence accounts for the length of cut-and-cover construction. All other factors being equal, the shorter the length, the more preferred it would be.

For the purpose of this evaluation, the shortest proposed alignment alternative in each comparison was assigned a rating score of 1. Alignment alternatives with a proposed length within 10 percent of the shortest alignment were not considered to have a differentiator and were also assigned a rating score of 1. Alignment alternatives that were between 10 and 20 percent greater than the shortest proposed alignment length were assigned a rating score of 3. A rating score of 5 was given to alignment alternatives greater than 20 percent larger than the shortest proposed alignment length.

Seismic Hazard

For the purpose of assessing construction risk, an increased risk, along with the cost associated with additional seismic design requirements was associated with pipe segments or sub-segments that would cross an active seismic fault as identified in the Desktop Geotechnical Evaluation.

Based on the geotechnical mapping from the desktop evaluation, active seismic faults would be crossed by only a few of the alignment alternatives. Pipeline segments that would cross an active fault were assigned a rating score of 5. Conversely, pipeline segments that would not cross an active fault were assigned a rating score of 1.

Soil Contamination

Environmental data provided by Metropolitan and reviewed during the desktop evaluation completed by Black & Veatch included GIS records on leaking underground fuel tanks (LUFTs) and reported environmental storage cleanup sites. The desktop evaluation did not assess the presence of contaminated soils or estimate the cost for any remediation should hazardous materials or contaminated soils occur. However, for the purpose of assessing construction risk, an increased risk, along with the cost associated with additional requirements for intrinsically safe equipment and construction methods was associated with work that would traverse through known contaminated soil cleanup sites. Based on the GIS records, sites containing reported LUFTs or environmental storage cleanups within 75 ft of the roadway of where a pipe segment would travel were counted as a "hit". The number of "hits" along an alignment was equal to the number of sites with risk of soil contamination.

The frequency of "hits" encountered varied across the pipe segments that would be located in city streets, and appeared to be influenced by land use decisions that concentrated oil and gas refineries in the Carson/Long Beach area and gas stations on the corners of heavily traveled roadways. Within these areas, the number of "hits" encountered ranged from a high of 1.5 per 1,000 ft to 0 "hits" per 1,000 ft in less developed areas and in pipe segments proposed in easements or the river bed. On average, across all segments, the number of "hits" was quite low, occurring at a rate of slightly less than 0.15 "hits" per 1,000 ft of pipeline length.

A rating score of 1, 3, or 5 was assigned to each segment based on the number of "hits" that would be encountered per 1,000 ft of pipe installed.

Ease of Operations and Accessibility

The ease of operations and accessibility evaluation factor assessed both the potential impacts during construction and the ability to maintain installed pipelines and appurtenances depending on proposed pipeline location and methods of construction. This criterion accounted for a limited construction window, as well as limited access to perform routine operations and maintenance activities, for pipe segments that would be located in river and storm drain channels compared to streets and easement areas.

Increased risk was expected where physical access to the pipeline would be constrained or limited. Pipe segments proposed in easement areas using cut-and-cover construction methods would be the easiest to access and operate and received a ranking score of 1. Pipe segments that would be constructed using cut-and-cover methods in streets requiring traffic control to access received a ranking score of 3. Pipe segments that would be in river beds, regardless of the construction method, would have the highest risk due to accessibility and ease of operations and received a ranking score of 5. Pipe segments constructed using trenchless construction methods located in streets and easement areas would be more difficult to access than pipe segments in typical roadways, but less difficult to access than pipe segments in river beds, and were assigned a ranking score of 4.

A weighted score was calculated for each pipe segment or grouping of pipe segments as a ratio of the length receiving each ranking score (i.e., easement, street, tunnel, river channel) to the total segment length. A sample of how the segment weighted score was calculated using two ranking score categories is shown below:

$$(\text{Length}_1 \times \text{Ranking Score}_1 + \text{Length}_2 \times \text{Ranking Score}_2) \div (\text{Total Segment Length})$$

Social and Community Impacts

Parks and Recreation Areas

Several alternative pipeline routes were conceived to reduce direct impacts to parks and recreational facilities. To the extent feasible, alignments proposed within park areas were defined to avoid impacting existing structures (i.e., restrooms and maintenance buildings), athletic fields, areas with playground equipment, mature landscaping, and equestrian trails. In addition to assessing impacts to park facilities, the evaluation of parks and recreation areas included consideration of linear/dual-purpose park areas located within overhead utility easements (SCE) and along river and flood control channels (LACFCD). Many of these dual-purpose park areas are already significantly burdened with regionally important utilities and infrastructure, which may limit recreational uses to activities compatible with the existing utility. These same limitations on recreational uses suggest that a lower impact would occur for new utility construction in dual-purpose park areas compared to park areas not burdened with regionally significant utilities. As a result, the scoring system for parks and recreation considered not only the presence of a park area, but also whether the park area was located within a utility or flood control easement.

For the purpose of this evaluation, pipe segments that would not be constructed in a park were assigned a rating score of one. Pipe segments that would be constructed within a park or recreation area located on a utility easement were assigned a ranking score of 3. Pipe segments that would be located in a park or recreation area not inside a utility easement were assigned a ranking score of 5.

With several pipe segments incorporating both park and non-park reaches, a weighted score was calculated for each pipe segment or grouping of pipe segments as the ratio of the length of each ranking score (i.e., no parks, parks located in a utility easement, parks located outside of utility easements) to the total segment length. A sample of how the segment weighted score was calculated using two ranking score categories is shown below:

$$(\text{Length1} \times \text{Ranking Score1} + \text{Length2} \times \text{Ranking Score2}) \div (\text{Total Segment Length})$$

It is important to note the locations of parks and recreational areas were determined based on field observations and GIS mapping, and not on a review of any state or regional land use plans and zoning maps that may reflect undeveloped park areas or lands designated for future park use.

Public Facilities

The assessment of impacts related to public facilities identified high use and locally important businesses and institutions that would directly be affected by adjacent construction activities. The impacts may include access restrictions, traffic disruptions, and safety concerns. For businesses, the impacts may also include economic considerations.

The types of public facilities considered in this assessment included hospitals, schools, airports, civic/town centers, regional shopping centers, and auto malls. Hospitals were defined as large regional medical centers and not smaller health clinics and medical offices. Schools included larger public and private elementary through high school sites, as well as community colleges and universities. Shopping centers included regional malls and larger "big box" retail complexes. Public facilities were identified through field observations and GIS mapping.

Alignments were chosen so that they would avoid or minimize the impacts to public facilities, with some routes dropped from consideration due to the concentration of retail centers. In many cases where such facilities were unavoidable, the proposed alignments were adjusted, where possible, to the opposite side of the street from entrance driveways. For the FLDR, the public facility had to be located in front of the street where the pipeline alignment would be located. Additionally, this FLDR assumed that locating the pipeline on the side of the street furthest away from entrance driveways, combined with a robust traffic control strategy and careful timing of construction to avoid higher use times of the year, full unrestricted access to the public facilities could be maintained.

The frequency of public facilities that would be encountered varied across pipe segments located in city streets and appeared to be influenced by land use decisions that concentrated high use public facilities along more heavily traveled roadways. Within these areas, the number of public facilities that would be encountered ranged from a high of 2 to 3 per mile. Conversely, many pipe segments would encounter no public facilities in less developed areas. On average, across all segments, the frequency of public facilities was quite low, occurring at a rate of slightly more than one facility for every two miles of proposed pipeline length.

A rating score of 1, 3, or 5 was assigned to each segment based on the number of public facilities that would be encountered per mile of pipe installed.

Traffic Impacts

Traffic impacts would occur from the need to close traffic lanes and create a safe construction zone for pipe installation. The width of the construction zone would balance the impacts resulting from lane closures against the need to provide an effective width for reasonable construction progress. For cut-and-cover street construction, the minimum width of the construction zone would vary depending on pipe size, but was generally between 34 to 36 ft. This width would result in the need to close at least two traffic lanes when active construction was occurring.

This assessment was based on the length of pipe that would be located in the traveled roadway as well as the volume of traffic that would be impacted. Using the number of travel lanes as a surrogate for traffic count, each roadway was sorted into three general classes, or functional classifications. Roadways with six lanes of traffic (three lanes in each direction) were assumed to be minor arterial roads and have the greatest volume of traffic. Roadways with four lanes of traffic were assumed to be collector streets and have an intermediate volume of traffic and provide access to adjacent land uses. Roadways with two lanes of traffic were assumed to be local streets and have the least amount of traffic, but were typically found in residential neighborhoods and/or with on-street parking.

This criterion favors roadways with sufficiently wide public rights-of-way such that a corridor for the proposed pipeline would likely be available. Coupled with the detailed review of available utility information resulted in alignments only being considered that would appear to have sufficient space to construct the pipeline. Further, streets with sufficiently wide rights-of-way allows more space during construction, which improves the efficiency and allows space for laydown areas.

For the purpose of this evaluation, a rating score of 1 was assigned to pipe segments proposed in utility easements, tunnels, river beds, and other categories with no traffic impacts. Collector streets and local streets that would have adequate width for construction and traffic control while maintaining at least one lane of traffic in each direction were assigned a ranking score of 3. Minor arterial streets and all streets that would require a road closure were assumed to have the greatest risk of traffic impacts and were assigned a ranking score of 5.

A review of the Project study area shows that existing bus routes are predominately found on minor arterial roads for the alternatives being considered. This factor contributed to arterial roads receiving a ranking score of 5.

Initial functional classifications were based upon the number of traffic lanes serving as a surrogate for traffic volume. It was determined this level of detail was sufficiently indicative of the totality of traffic impacts along the alignments such that a preferred alignment could be identified.

Street and Median Improvements

Impacts to center medians would occur where the required width and position of the construction zone would be greater than the width of available traffic lanes and additional work space would be required by removing all or a portion of the center median. Because of the aesthetic (and in many cases emotional) value to the community, alignments were selected to avoid or minimize impacts to center medians with hardscape improvements and landscaping. In many cases throughout the Project area, improved center medians are home to mature trees. Alignments that avoid impacting these mature trees (either their removal or excessive trimming) were preferred.

This criterion also accounts for the added cost associated with reconstructing these features that were impacted during construction.

The assessment of impacts to center medians was based on the length of pipeline that would remove all or a portion of an improved center median. An improved center median was defined as having raised curb and gutter and any type of paving or landscaping improvements (including trees, shrubs and groundcover plantings) within the center median.

The length of pipe that would impact center medians was determined by reviewing GIS mapping to compare the proposed position of the pipe centerline and width of the construction zone to the measured width of the lanes of travel. Using conservative estimates, improved center medians would be impacted for approximately 30 percent of the total length of pipe installed in streets using cut-and-cover construction.

A rating score of 1, 3, or 5 was assigned to each segment based on the percent of the pipe length that would require removal of an improved center median.

Major Intersections

Roadway intersections often require additional traffic control measures or extensive detours for pipeline construction and the need to set up and manage traffic control measures could affect production speed and cost. Additional traffic control measures also introduce increased risk to the Project. At major intersections, it was assumed trenchless installation methods would be used to minimize traffic impacts.

This evaluation criterion addressed the construction impacts associated with the number of intersections that would need to be closed or detoured. Based on the traffic impact analysis prepared by Minagar, a total of 197 major intersections would be impacted along all of the pipeline segments. This translates to an average impact of slightly more than one intersection per mile of proposed pipe construction in streets.

A rating score of 1, 3, or 5 was assigned to each segment based on the number of major intersections that would be encountered per mile of pipe installed.

Residential and Minor Commercial

The residential and minor commercial evaluation criterion assessed the relative impacts pipeline construction would have on residential areas and adjacent minor or small commercial businesses. The types of development considered included single family residences, multiple family dwellings, and smaller commercial locations (not included in the Public Facilities evaluation factor). The impacts to residences and business locations included access restrictions and traffic disruptions. For businesses, the impacts also included potential economic considerations.

The assessment of residential and minor commercial impacts was determined as the length of pipe that would directly front existing driveways serving as access for existing residential and small commercial areas as described below.

- For single family residences, the segment length was included where the construction would result in the loss of driveway access. For residential areas on multi-lane streets, construction would have to be on the same side of the street as the affected driveway.
- For small commercial locations and multi-unit residential with a single driveway access, the segment length was included where the construction would impact or result in the loss of the single driveway.
- For small commercial and multi-dwelling residential areas accessed by more than one driveway, the segment length was not included where secondary driveway access was on a street not fronting the proposed construction.

This criterion also accounted for secondary construction impacts, such as noise dust, and visual impacts that construction of the pipeline near these facilities would have.

A rating score of 1, 3, or 5 was assigned to each segment based on the percent of the total alignment length that would impact access to residential and small commercial areas.

This level of evaluation did not attempt to differentiate the extent of impact beyond the level indicated above. It is likely that, for most circumstances, it would be feasible for the Contractor to maintain some level of access to residences or small commercial locations during the work, typically by providing temporary trench plating. Additionally, input from Metropolitan's real estate group should augment the scoring evaluation. Professional judgment about potential municipal, community, or individual objections; the potential cost to mitigate impacts and concerns; and the risk to Project schedule could result in selection of different alignments.

It may be warranted to assess the number of owners, residents, and tenants impacted the alternatives during future phases of work. However, at this planning level, it is not anticipated that adding this level of detail would impact the outcome of this analysis.

Biological Impacts

Waters of the U.S. or State

A preliminary assessment was made of potential impacts on Waters of the U.S. or State. The evaluation was conducted using available GIS databases delineating the extent of Waters of the U.S. or State within the Project study area. Metropolitan would gather more detailed information and complete additional more detailed analyses of potential environmental impacts, including impacts to wetland resources and Waters of the U.S. or State, as part of CEQA permitting that would be conducted subsequent to the FLDR.

For this evaluation, impacts were assessed where the pipeline alignment would cross areas designated as Waters of the U.S. or State using the available GIS databases. Due to the extent of pipe proposed within rights of way for flood control drainages and river channel, approximately 7.5 percent of the total length of all pipe segments would be within Waters of the U.S. or State.

Accordingly, a rating score of 1, 3, and 5 was assigned to each segment based on the percent of the total alignment length that would be located in areas designated as Waters of the U.S. or State.

CNDDB Habitats

A preliminary assessment was made of potential impacts on habitats listed from the CNDDB. The evaluation was conducted using available GIS databases delineating the extent of habitats within the Project study area. Metropolitan would gather more detailed information and complete additional more detailed analyses of habitats including endangered or listed species and cultural resources in subsequent design phases.

For this evaluation, impacts were assessed where the pipeline alignment would cross areas designated as habitats using the available CNDDB GIS databases.

SECONDARY SCREENING

Additional detail into the secondary screening step is provided in this section.

Paths to the Santa Fe Spreading Grounds

The secondary screening of alternatives leading to the Santa Fe Spreading Grounds was fairly straightforward and provides a good example of the evaluation process. Each alternative began at a common start point at Peck Road and the SG River and ended at the Santa Fe Spreading Grounds. Three segment combinations were developed and compared within the decision model as Path 9. Path 9 was based on the results from the coarse screening of Paths 4, 5, 6, 7, and 8. Path 9 can be seen on Figure F-1.

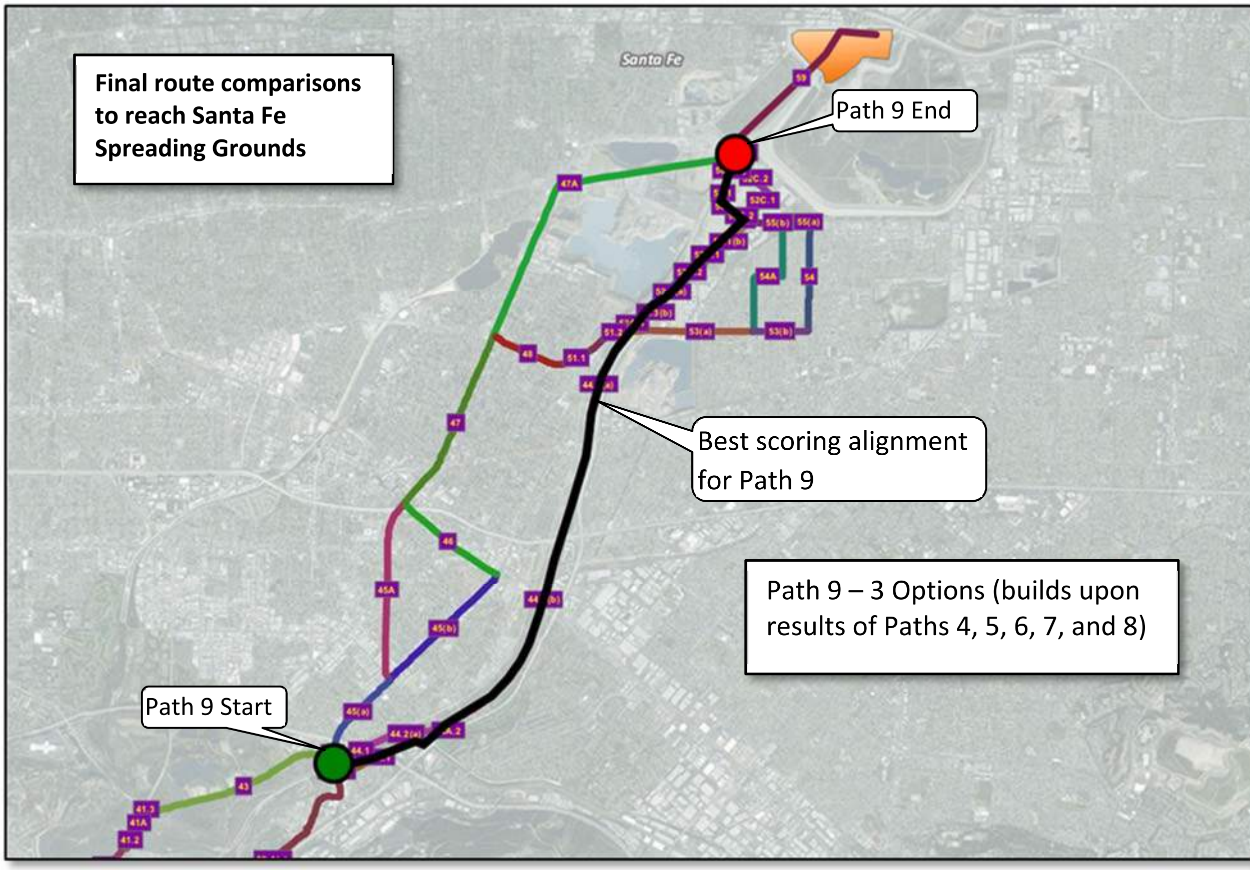


Figure F-1 **Path 9 (Santa Fe Spreading Grounds)**

Paths to the OC Spreading Grounds

Similar to the paths reaching out to the Santa Fe Spreading Grounds, the possible segment combinations to the OC Spreading Grounds are relatively straightforward with the only significant variation being the starting point at either the SG or Los Angeles Rivers or along the street alternative. Possible segment combinations were evaluated under Path 3 and included five optional routes starting from the San Gabriel River. Other starting points for Path 3 were included in the final route evaluation described later in this technical memorandum. Path 3 is shown on Figure F-2 and includes results from the coarse screening of Paths 1 and 2.

Paths to the Rio Hondo Spreading Grounds

Segment combinations to the Rio Hondo Spreading Grounds included separate north-south evaluations following either the Los Angeles River (Path 18) or street segments (Path 20). Both of these paths started along Del Amo Boulevard with the results shown on Figure F-5 and Figure F-7. Path 18 includes results from the coarse screening of paths 10 and 11, while Path 20 includes results from the coarse screening of Paths 13, 14 and 19.

FINE SCREENING

Fine screening evaluated built upon the results from the coarse and secondary screening and compared the three "Ultimate Routes," Route A, B, and C.

To simplify the decision model tables and illustrate how segments, sub-segments and Paths were evaluated and combined to determine the Ultimate Routes, schematics were developed for Routes A, B, and C. The schematic for Route A can be seen on Figure F-2. The Paths highlighted in green and blue were the preferred paths, best fulfilling the Project objectives and subsequently scoring the best in the decision model. The schematic helps illustrate how Paths combine to form longer alignments. It can also be used as a "roadmap" to the decision model result tables.

The results of the segments, sub-segments and Paths of Route A can be seen graphically on Figure F-3. A schematic of Route B can be seen on Figure F-4 and a graphic of Route B can be seen on the Figure F-5. A schematic of Route C can be seen on Figure F-6 and a graphic of Route C can be seen on the Figure F-7.

Decision model results for Routes A, B, and C can be seen in Appendix E.

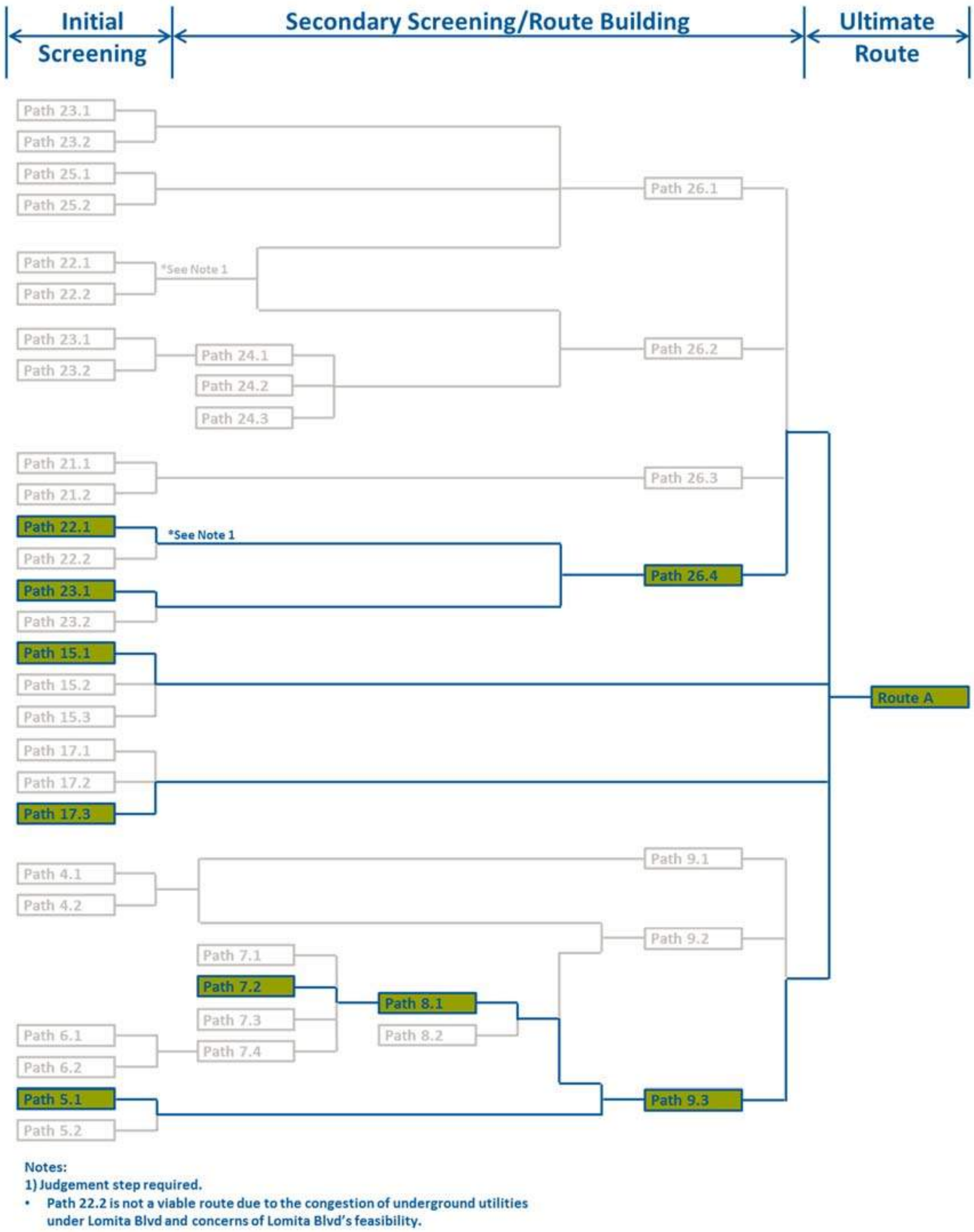


Figure F-2 Schematic of Route A - Weighting A (10/11/2016)

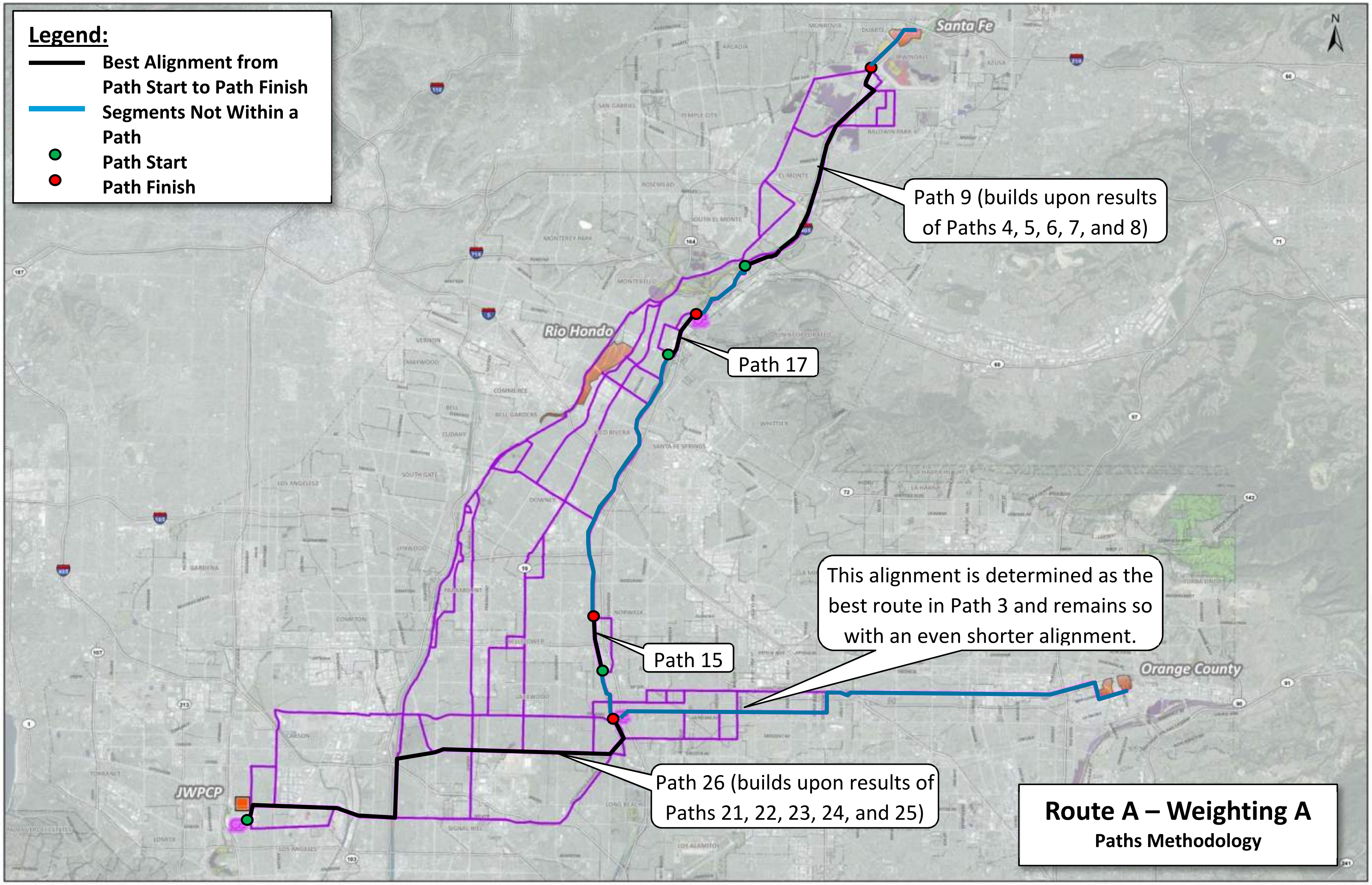


Figure F-3 **Route A - Weighting A (10/11/2016)**

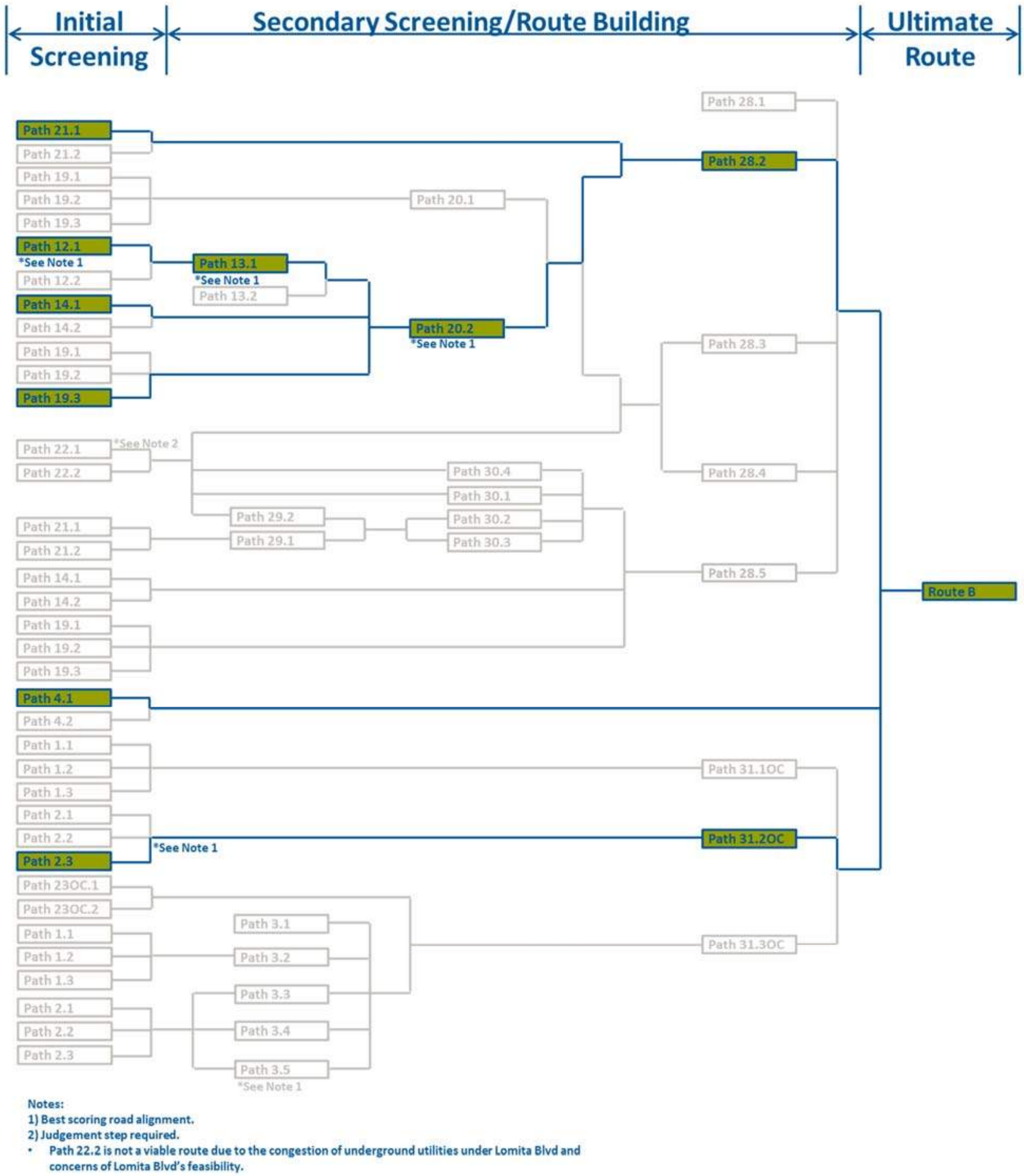


Figure F-4 Schematic of Route B - Weighting A (10/11/2016)

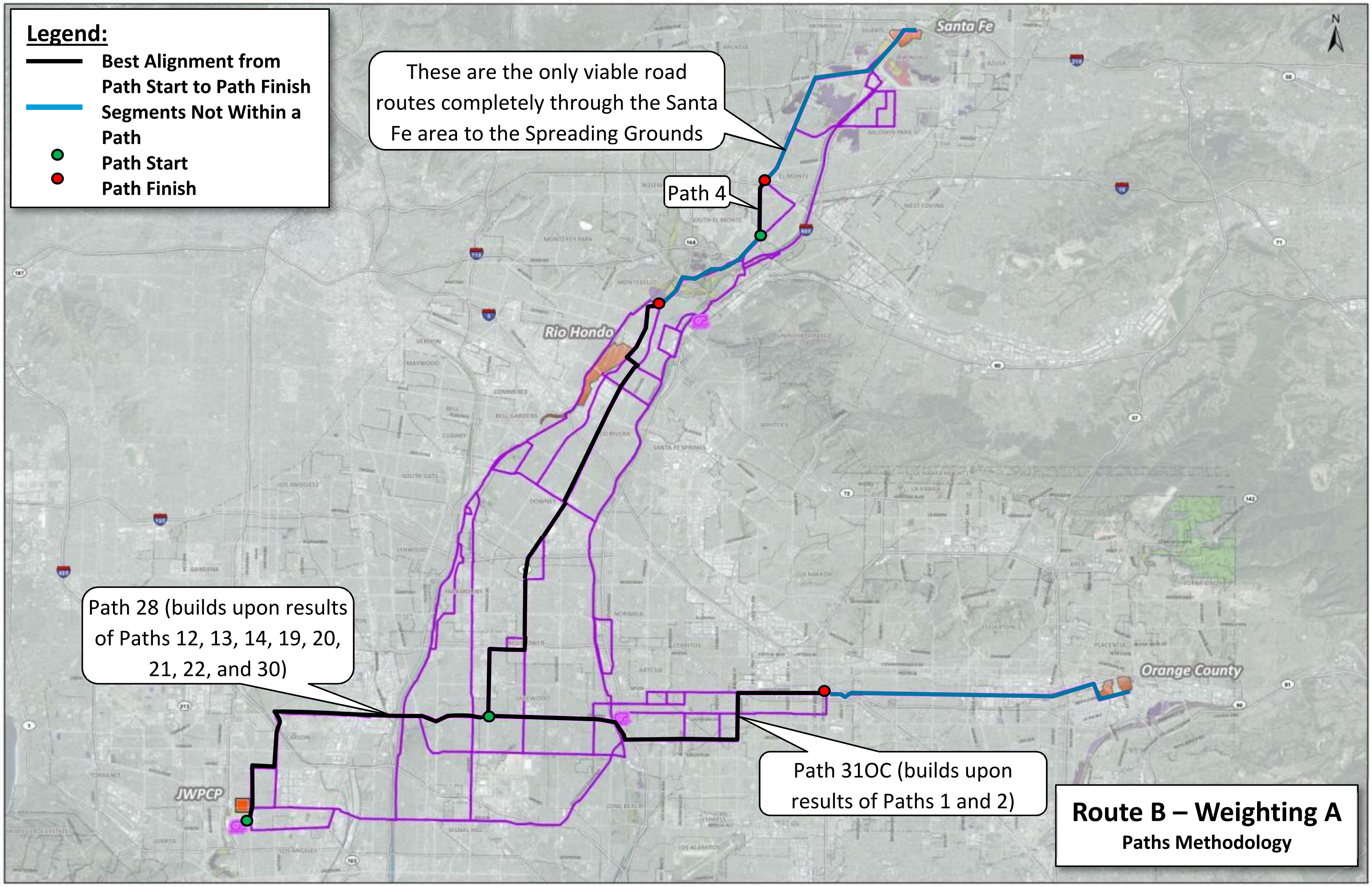
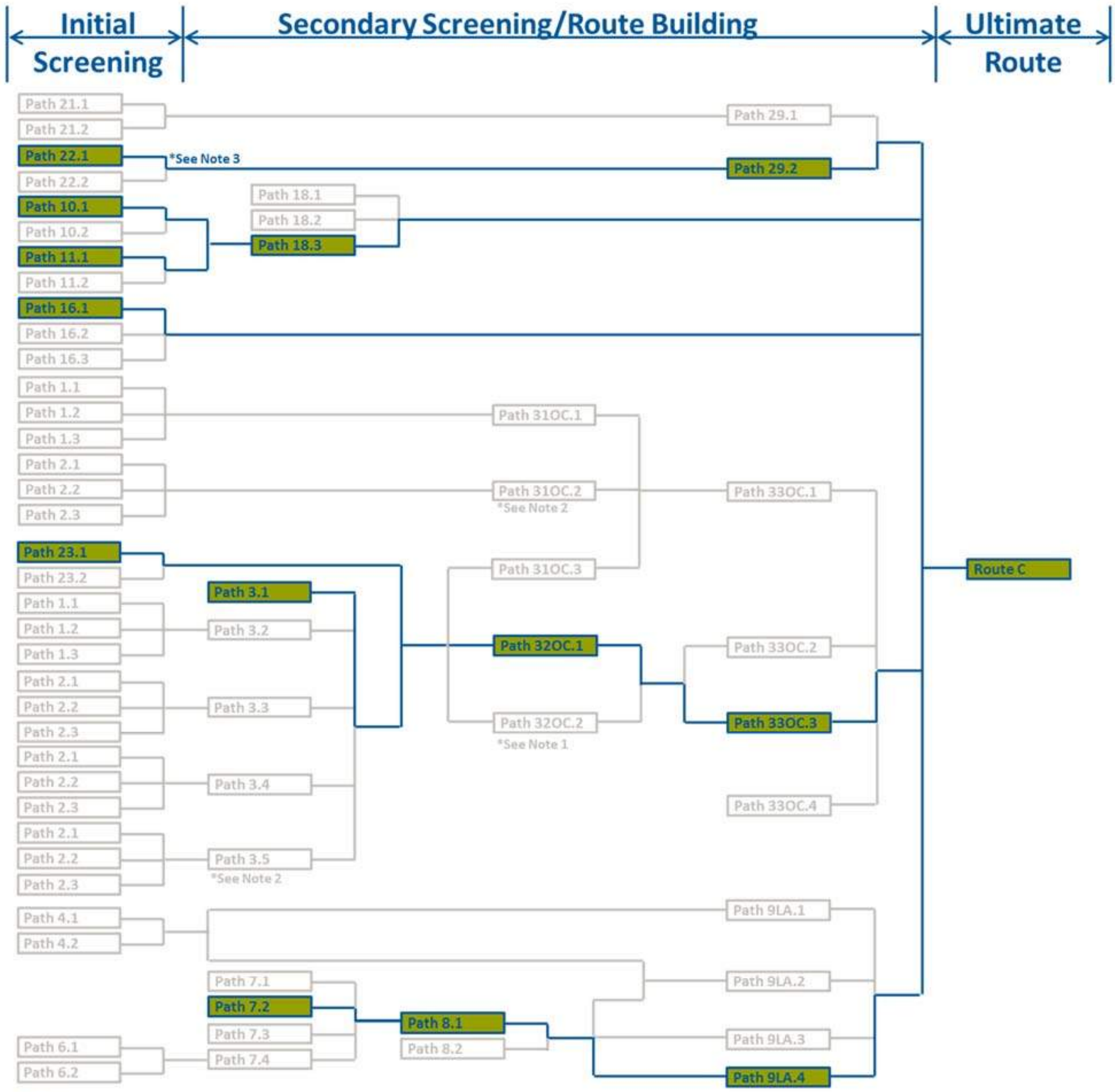


Figure F-5 Route B - Weighting A (10/11/2016)



Notes:
1) Path duplicates Path 32OC.1 but excludes SCE easements.
2) Best scoring road alignment.
3) Judgement step required.
- Path 22.2 is not a viable route due to the congestion of underground utilities under Lomita Blvd and concerns of Lomita Blvd's feasibility.

Figure F-6 Schematic of Route C - Weighting A (10/11/2016)

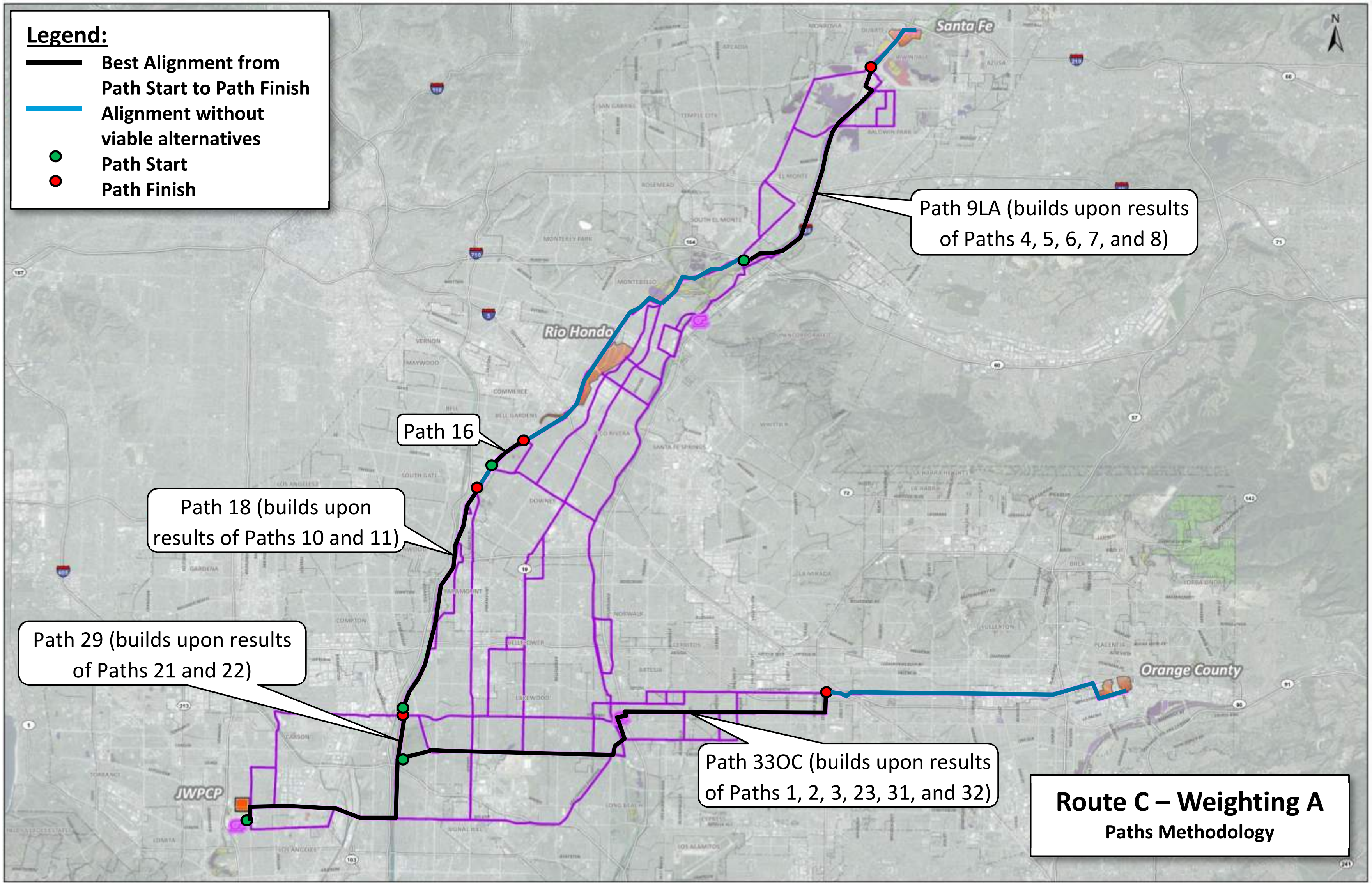


Figure F-7 **Route C - Weighting A (10/11/2016)**

Appendix G. Feasibility-Level Pipeline Plan Drawings

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LA River Alignment, Page 1

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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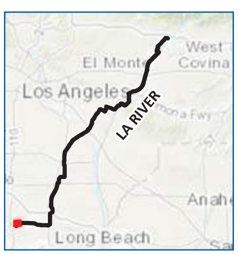

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LA River Alignment, Page 2

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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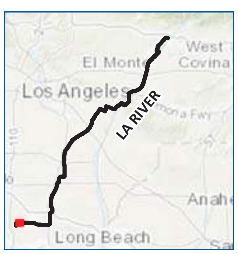

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LA River Alignment, Page 3

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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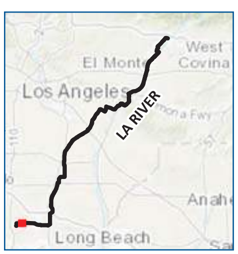

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LA River Alignment, Page 4

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 5

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 6

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 7

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 8

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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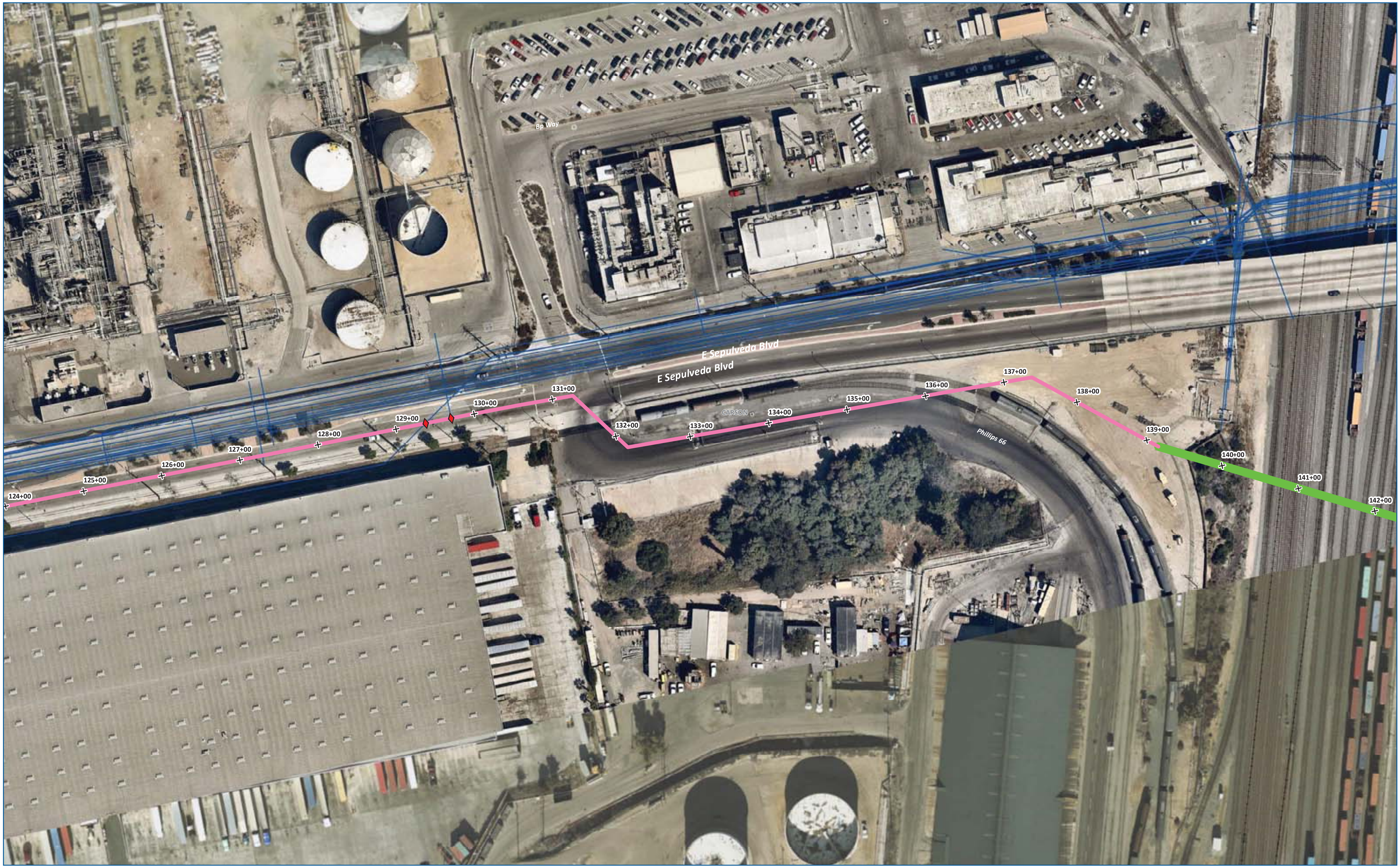

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LA River Alignment, Page 9

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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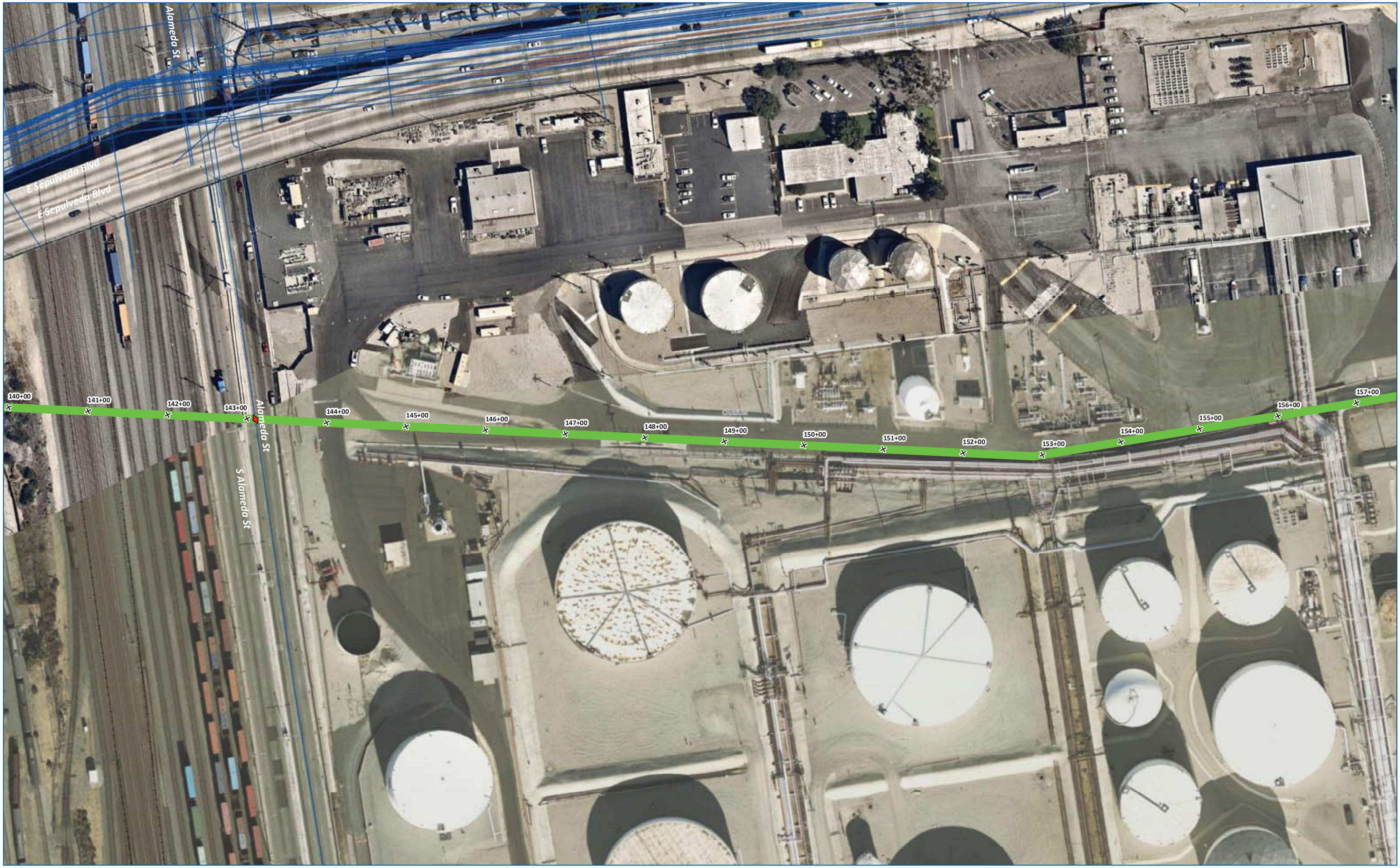

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LA River Alignment, Page 10

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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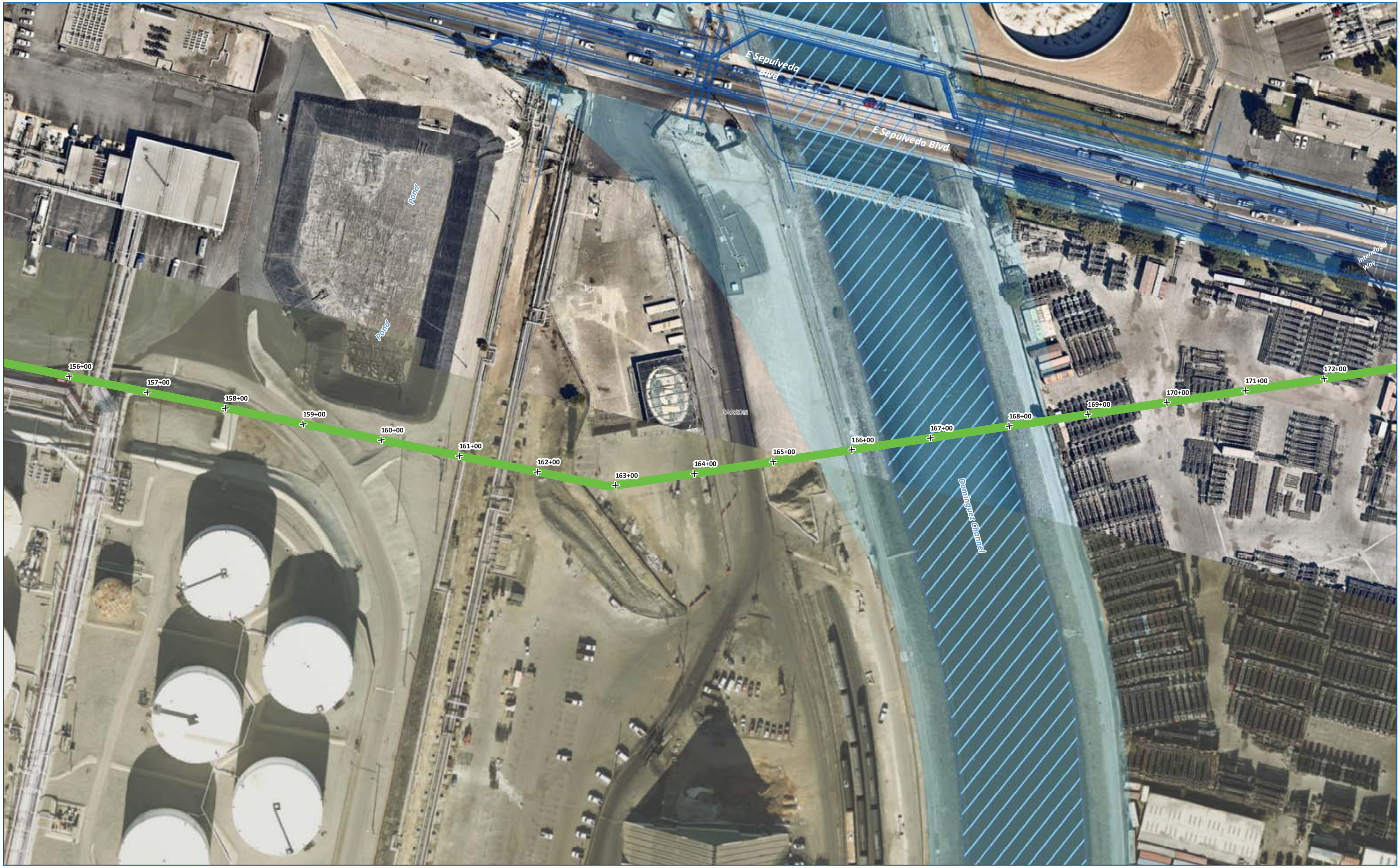

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LA River Alignment, Page 11

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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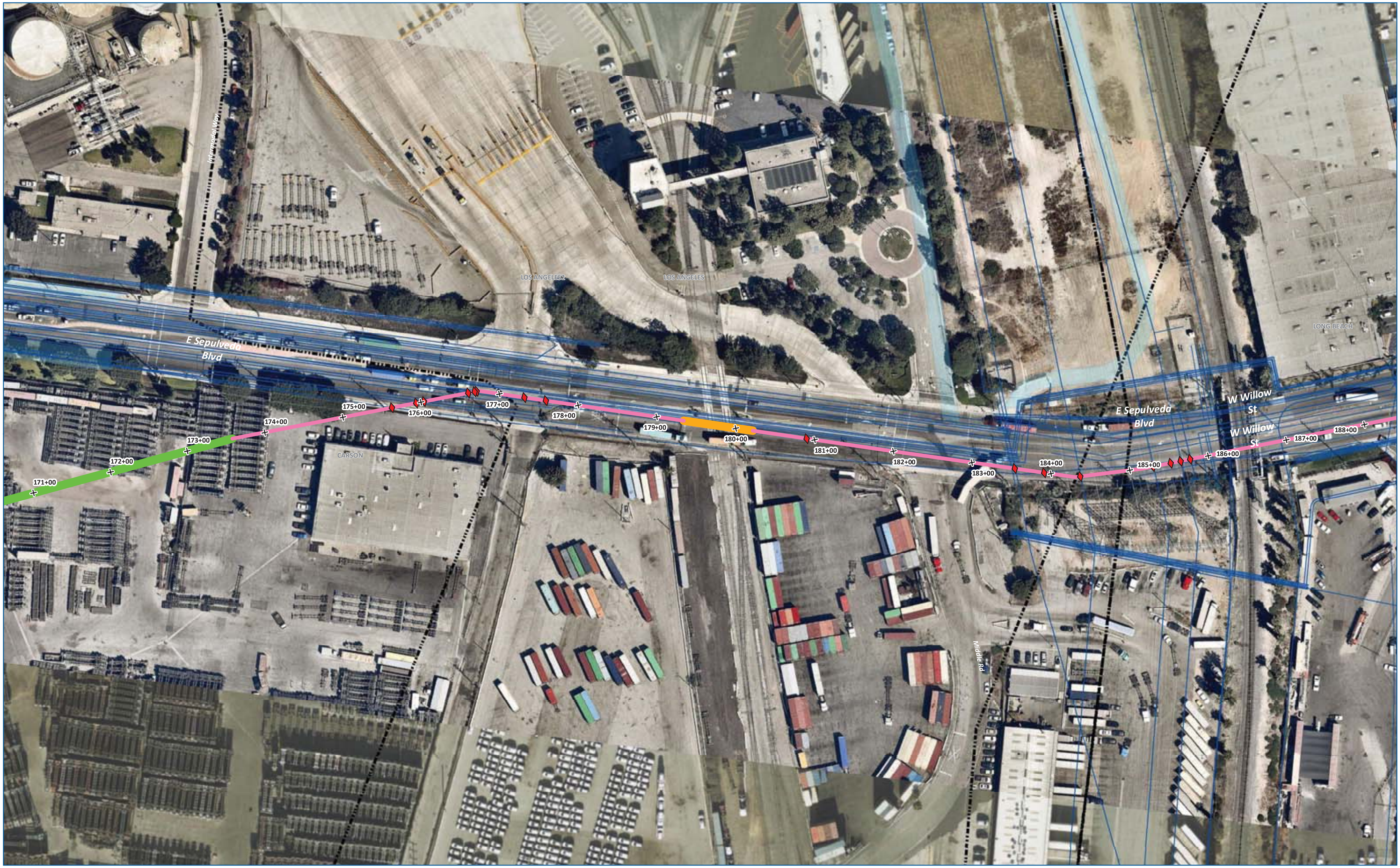

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LA River Alignment, Page 12

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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Feet

LA River Alignment, Page 13

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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Feet

LA River Alignment, Page 14

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 15

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 16

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 17

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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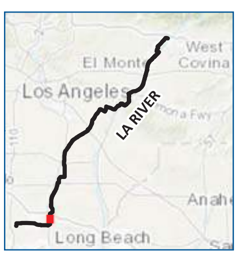

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LA River Alignment, Page 18

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
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- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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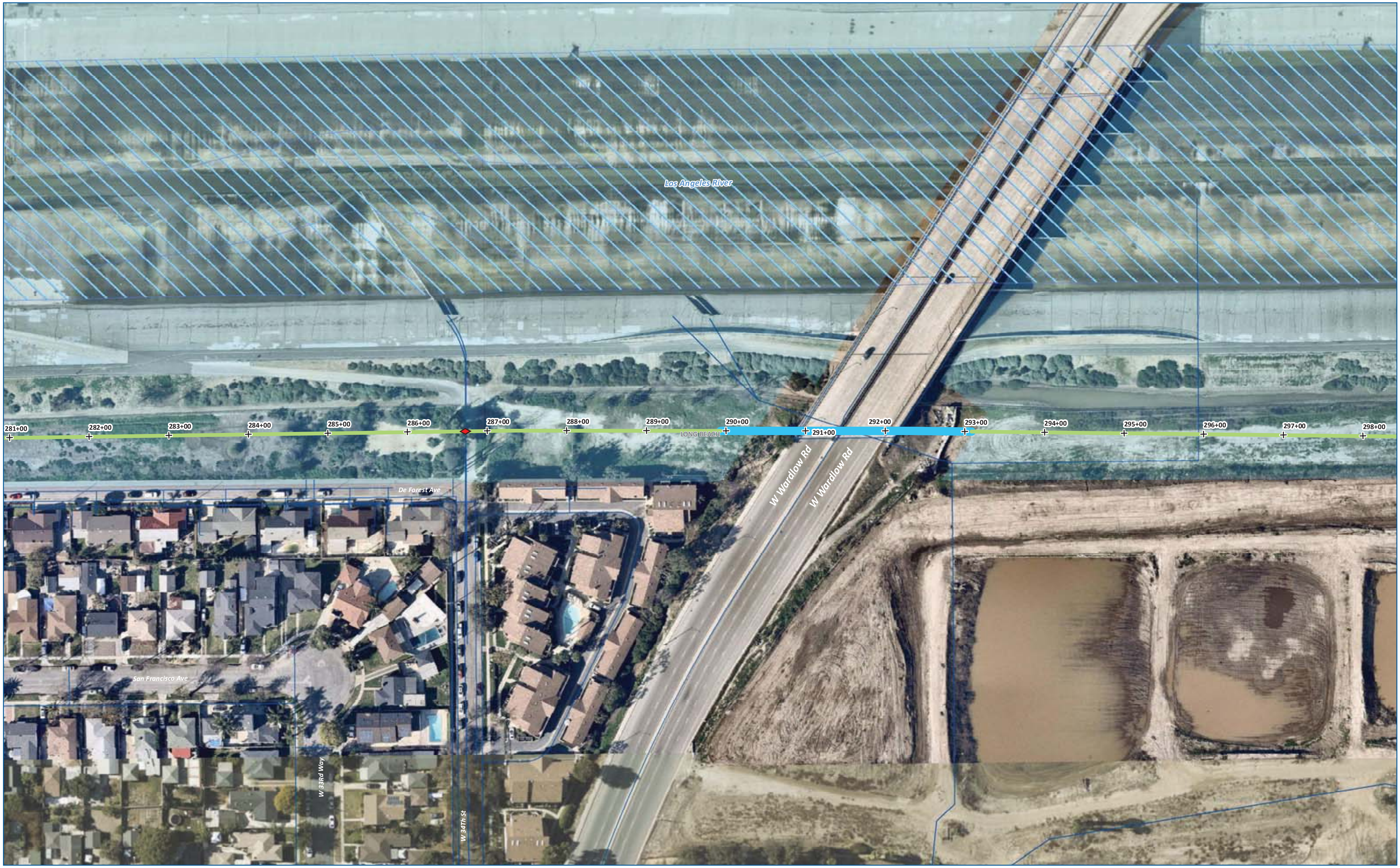

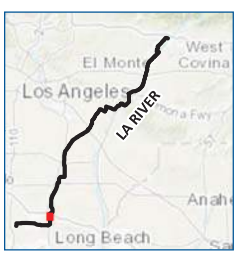

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LA River Alignment, Page 19

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 20

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 21

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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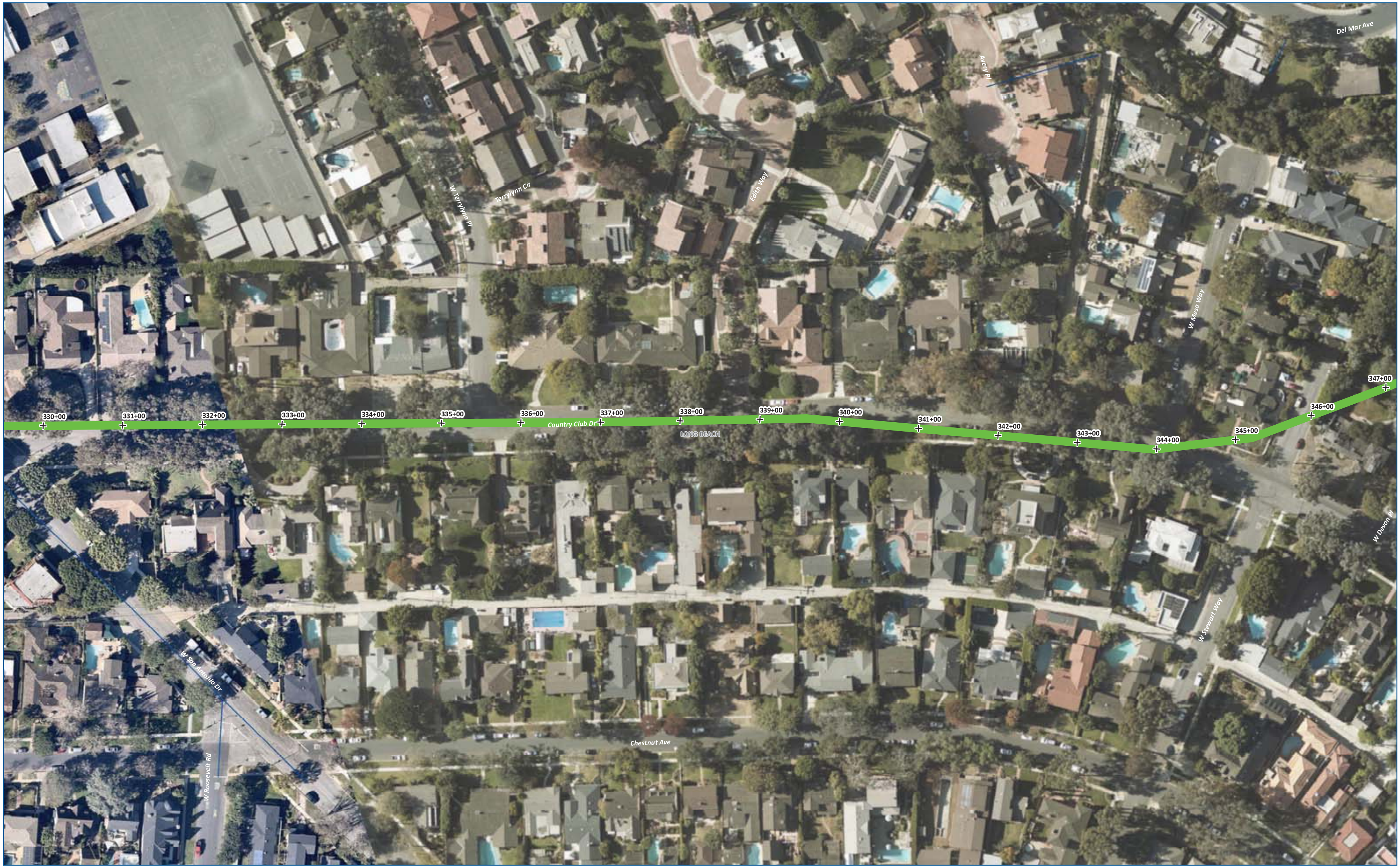

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LA River Alignment, Page 22

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
- Microtunnel
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- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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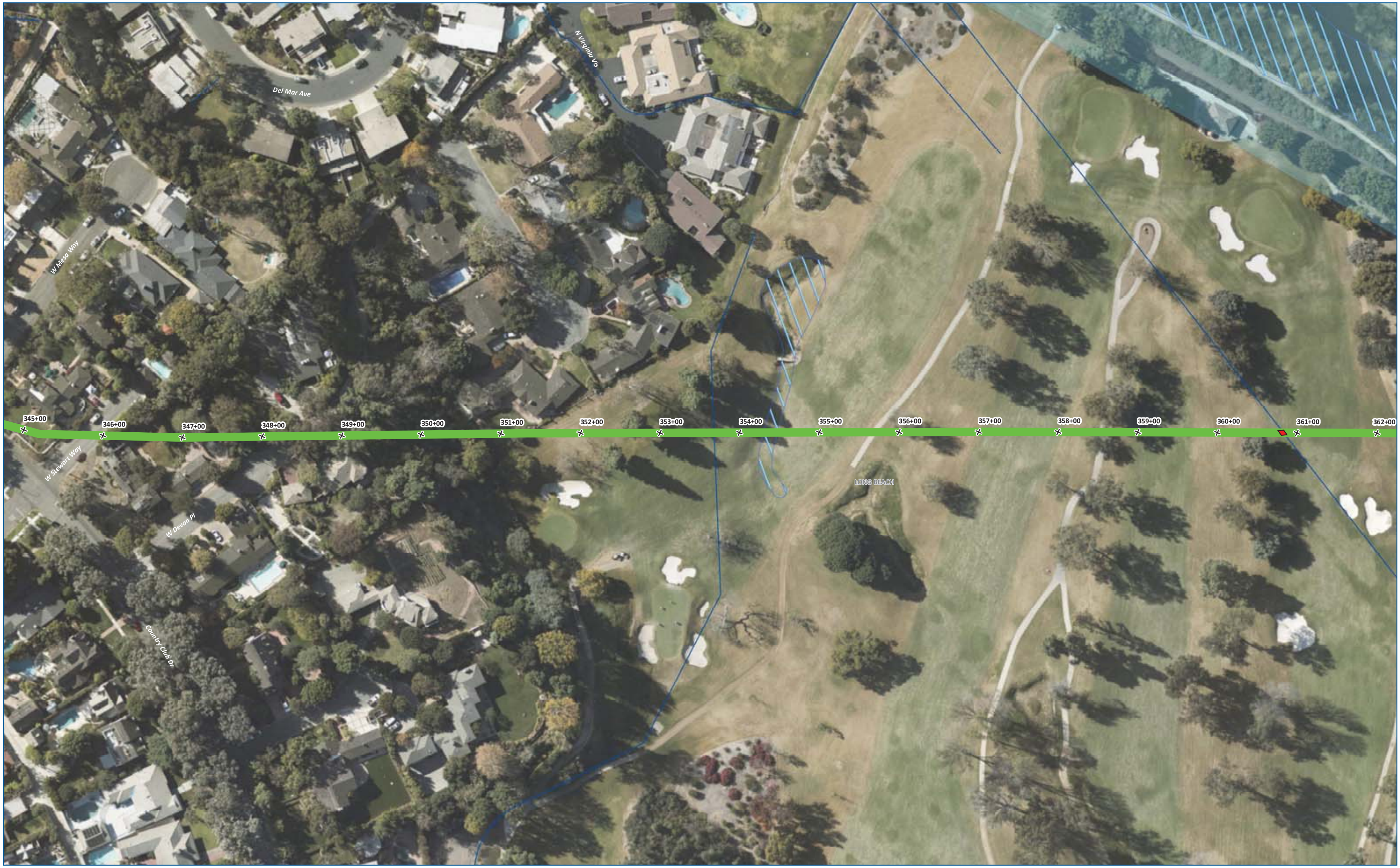

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LA River Alignment, Page 23

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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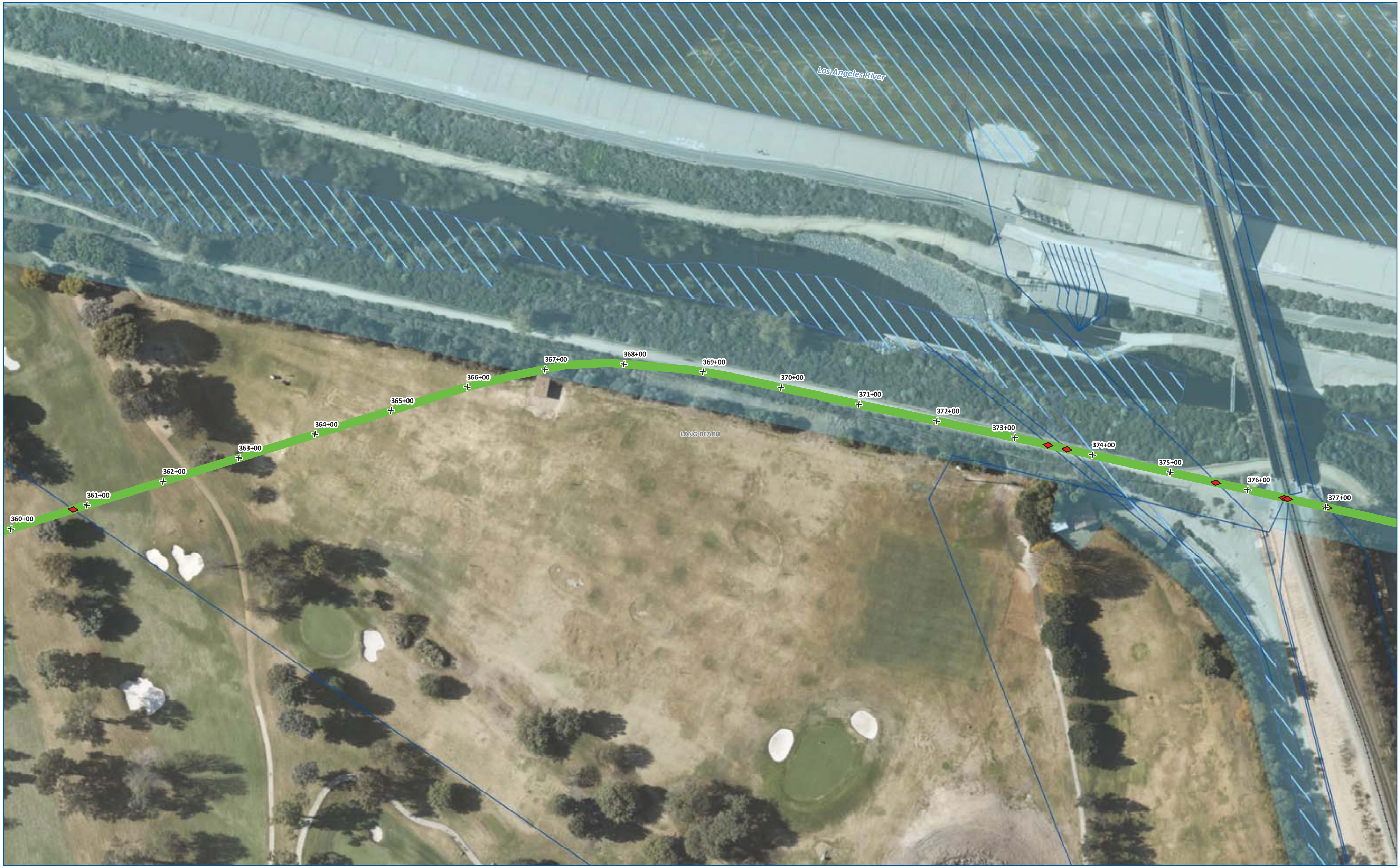

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LA River Alignment, Page 24

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
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- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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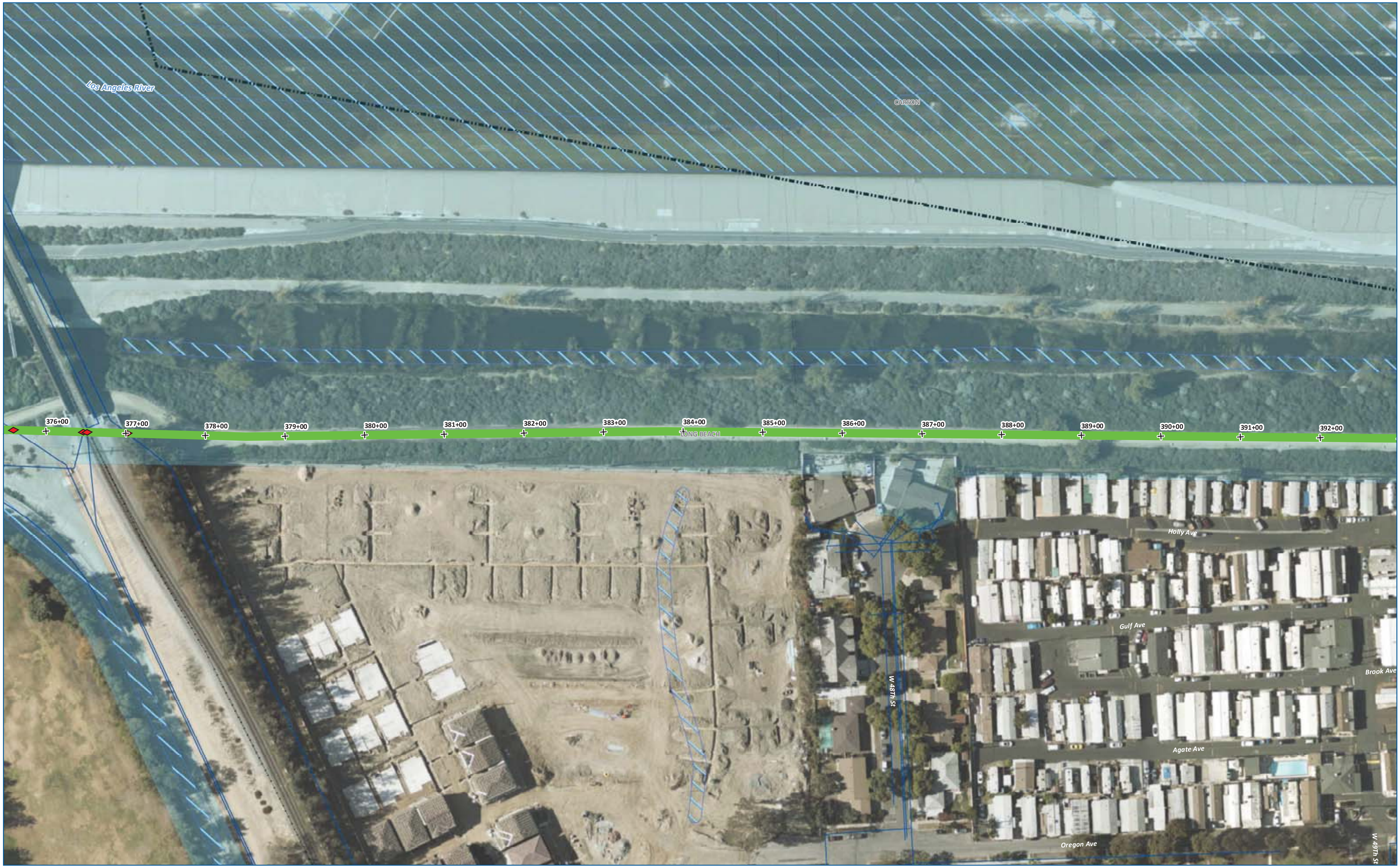

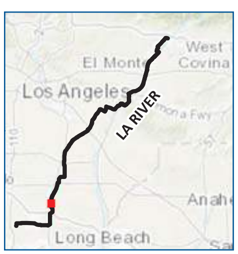

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LA River Alignment, Page 25

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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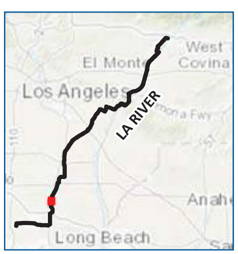

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LA River Alignment, Page 26

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 27

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 28

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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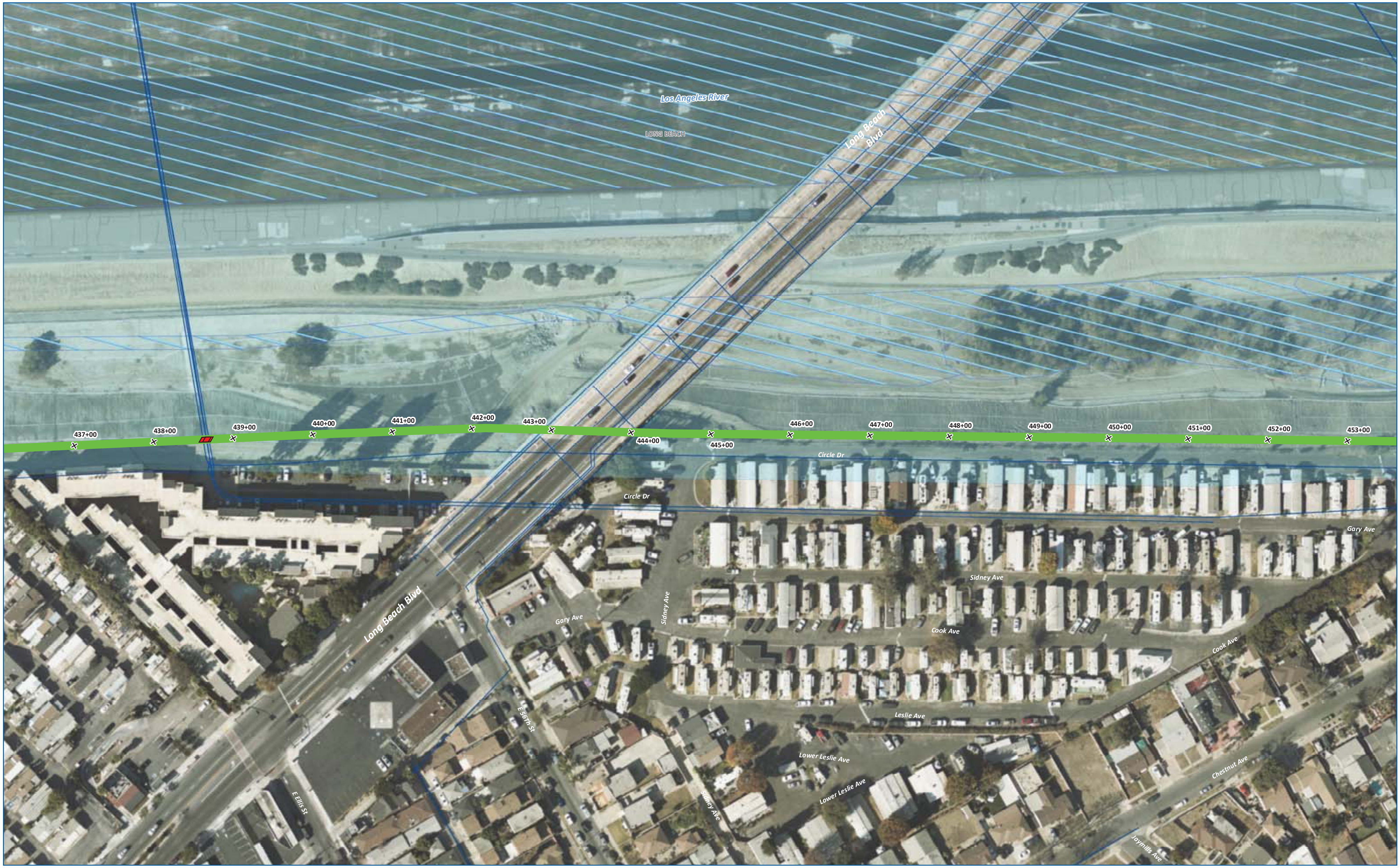

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LA River Alignment, Page 29

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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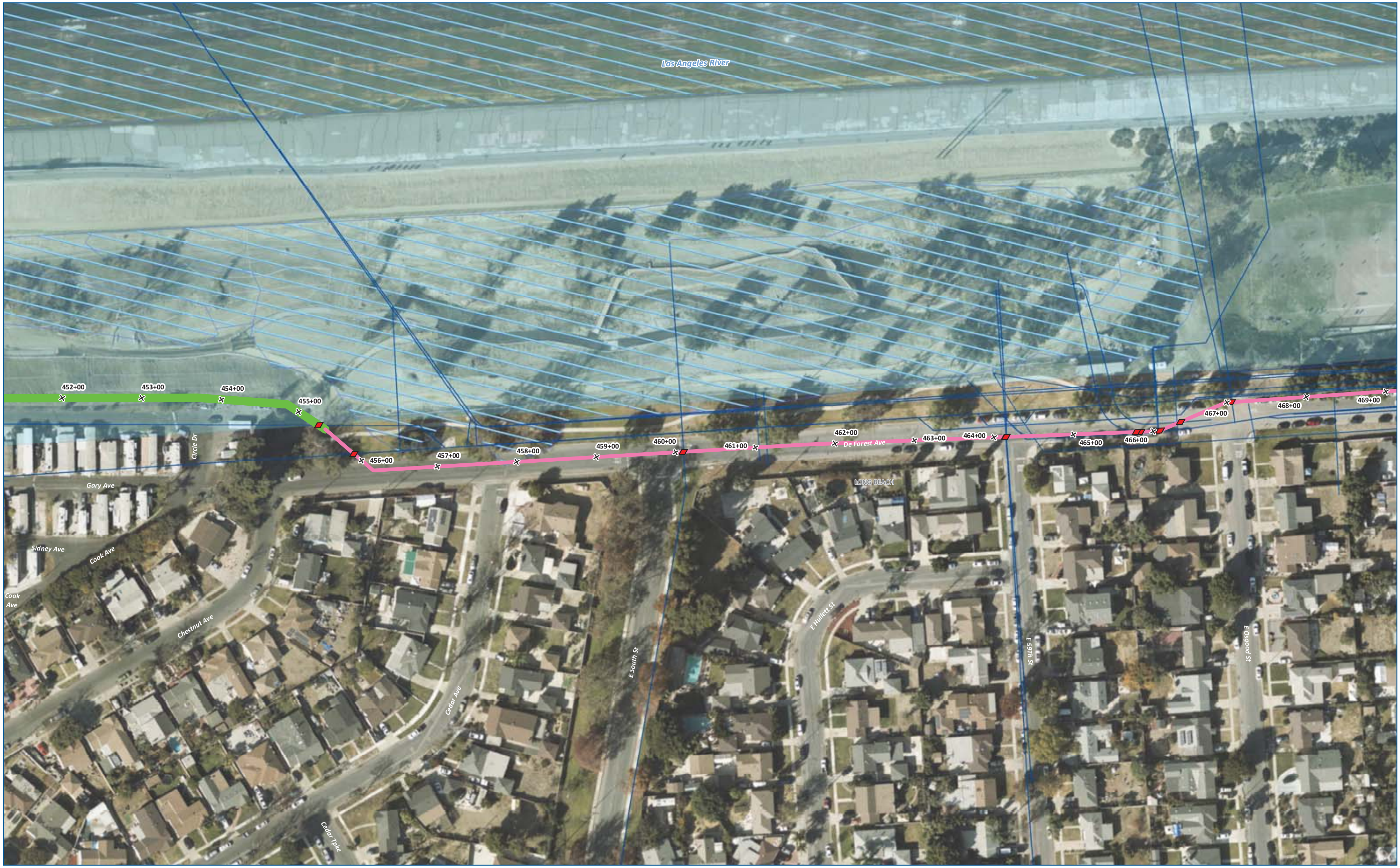

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LA River Alignment, Page 30

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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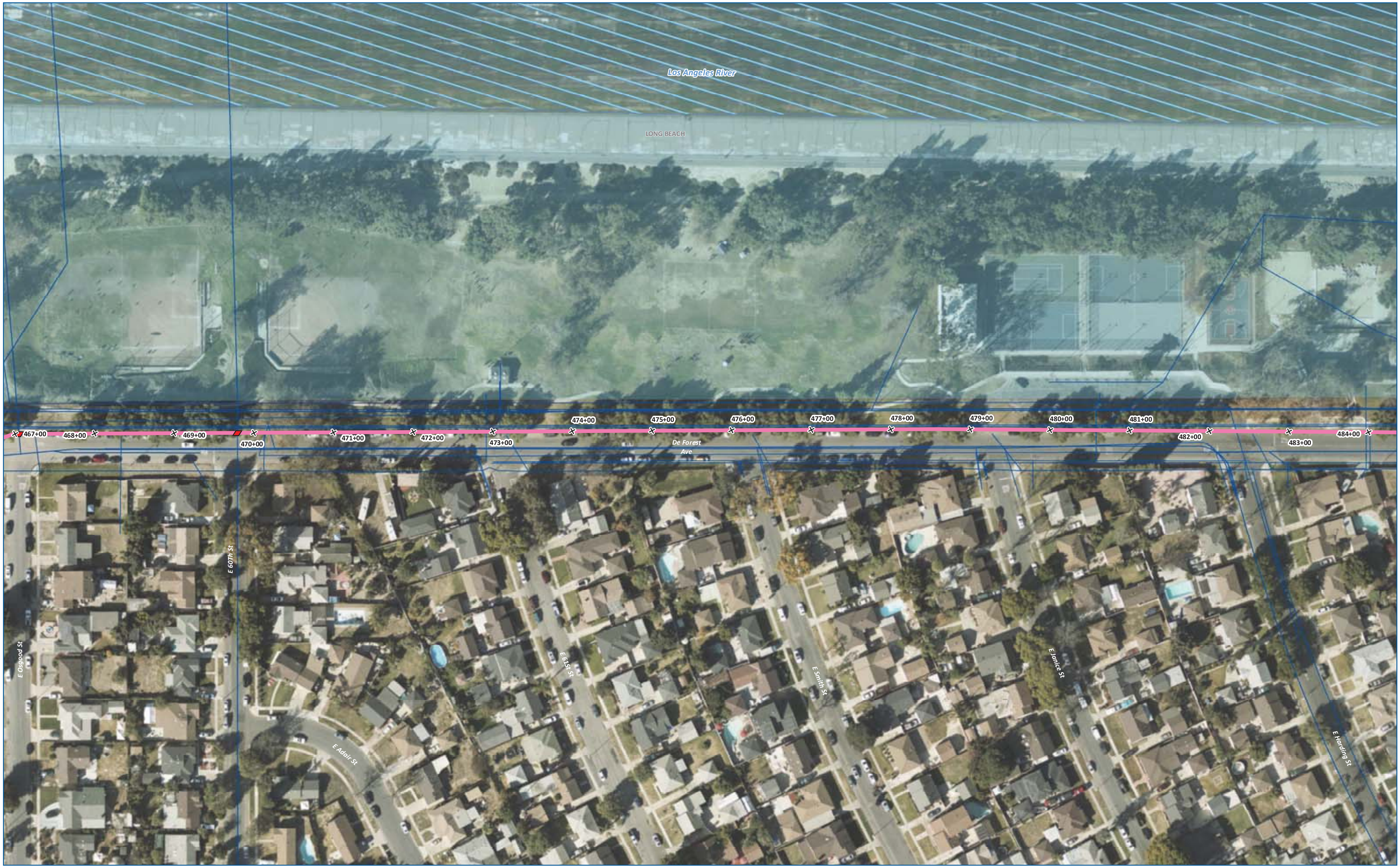

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LA River Alignment, Page 31

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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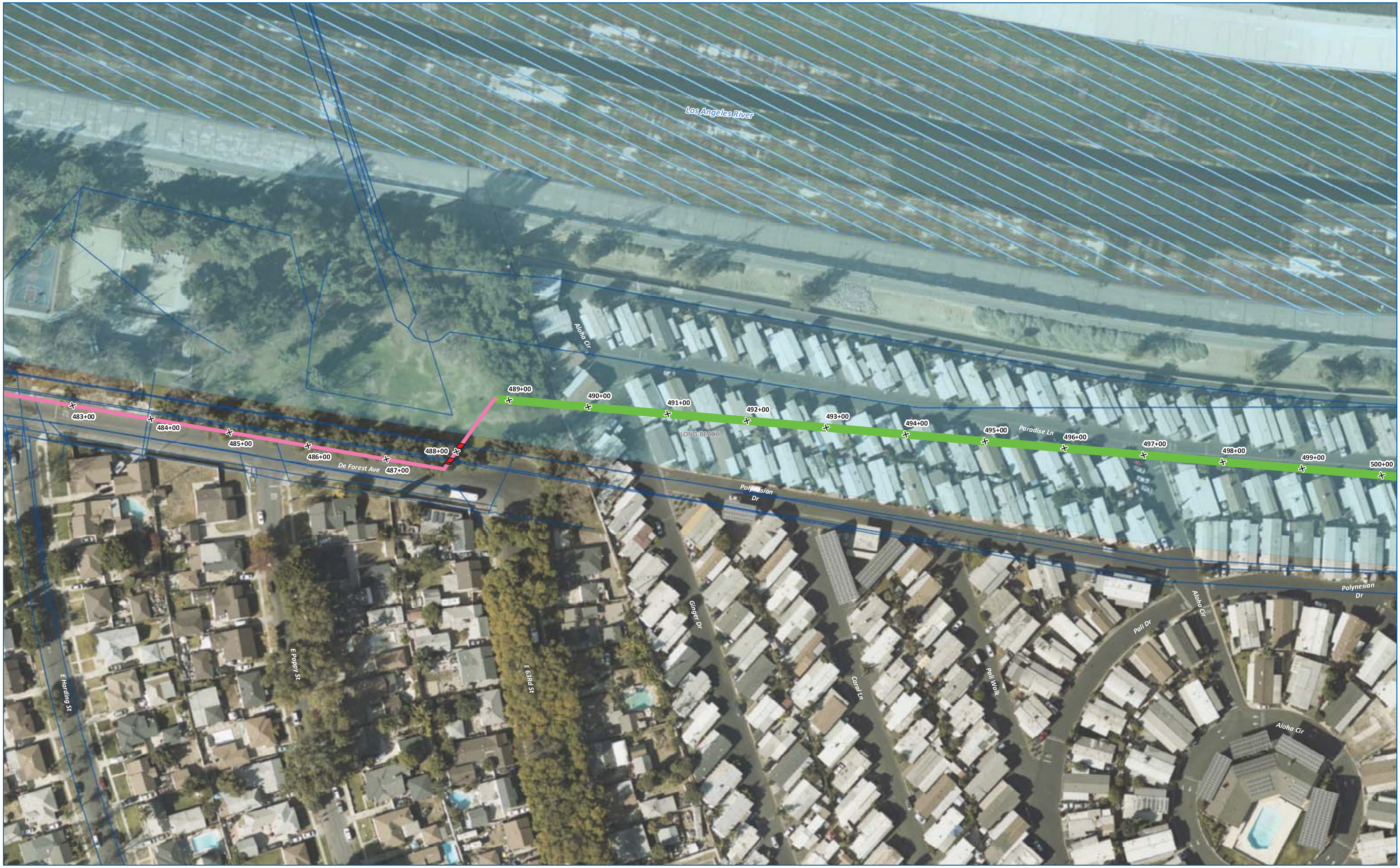

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LA River Alignment, Page 32

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
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- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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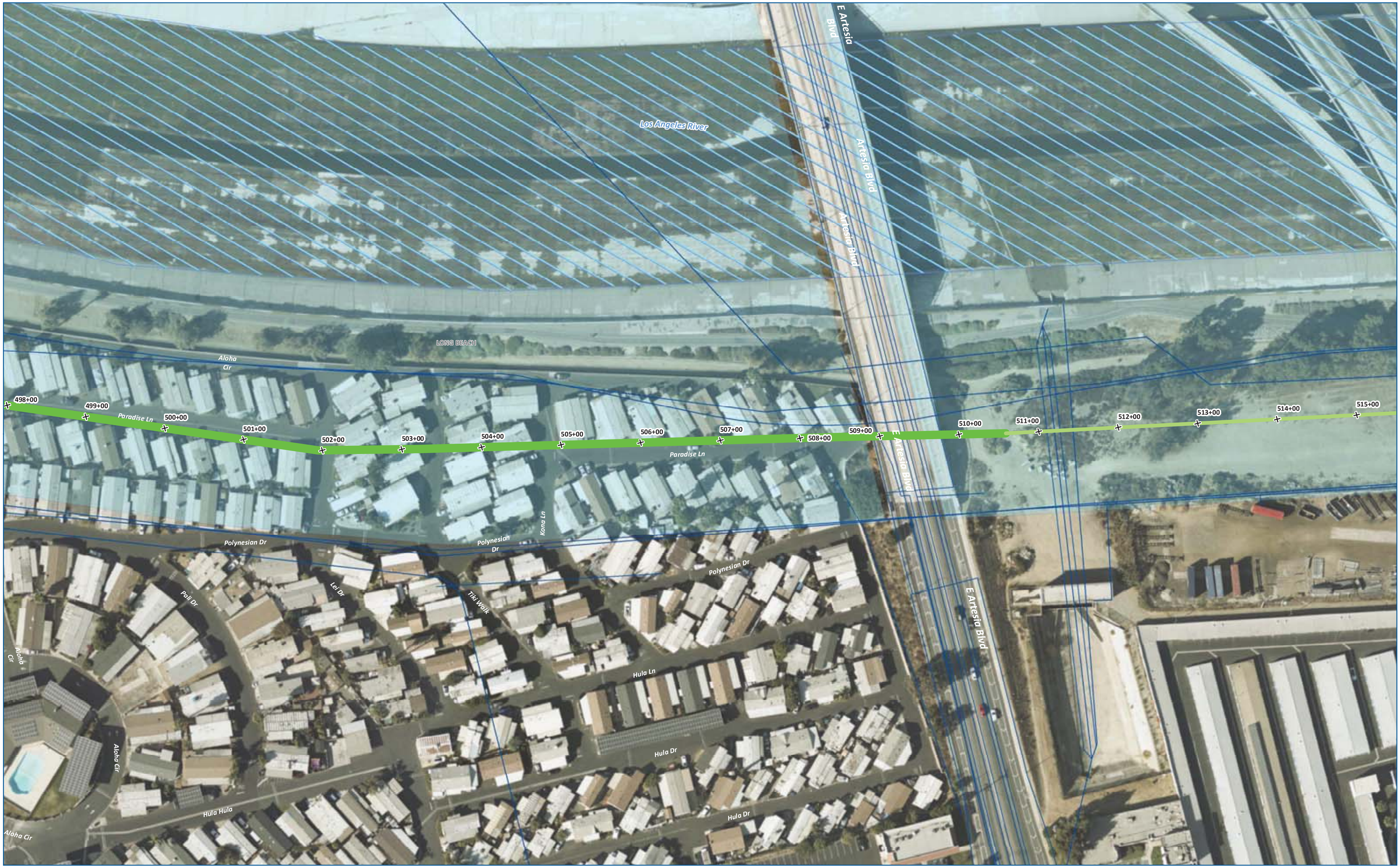

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LA River Alignment, Page 33

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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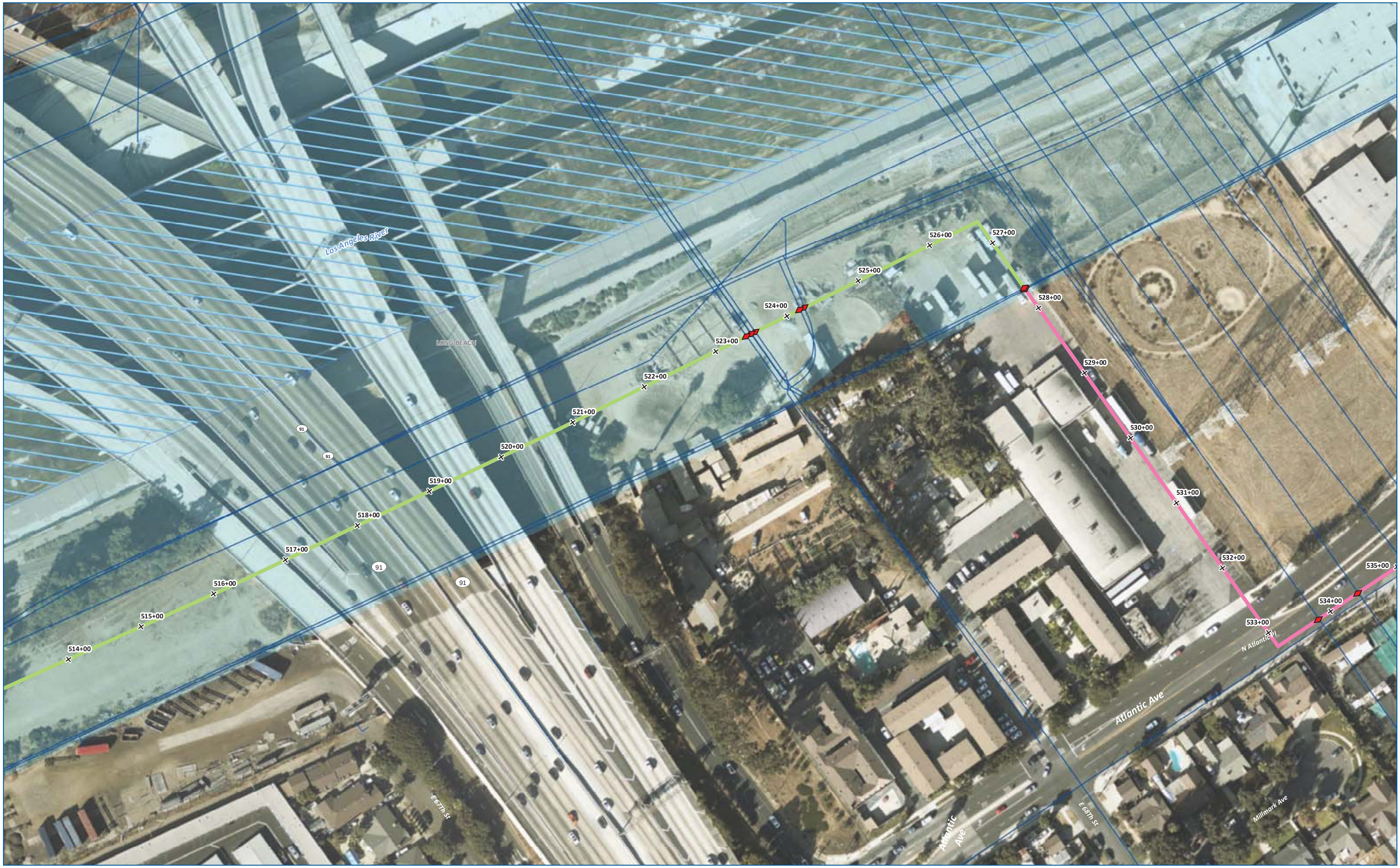

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LA River Alignment, Page 34

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 35

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 36

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 37

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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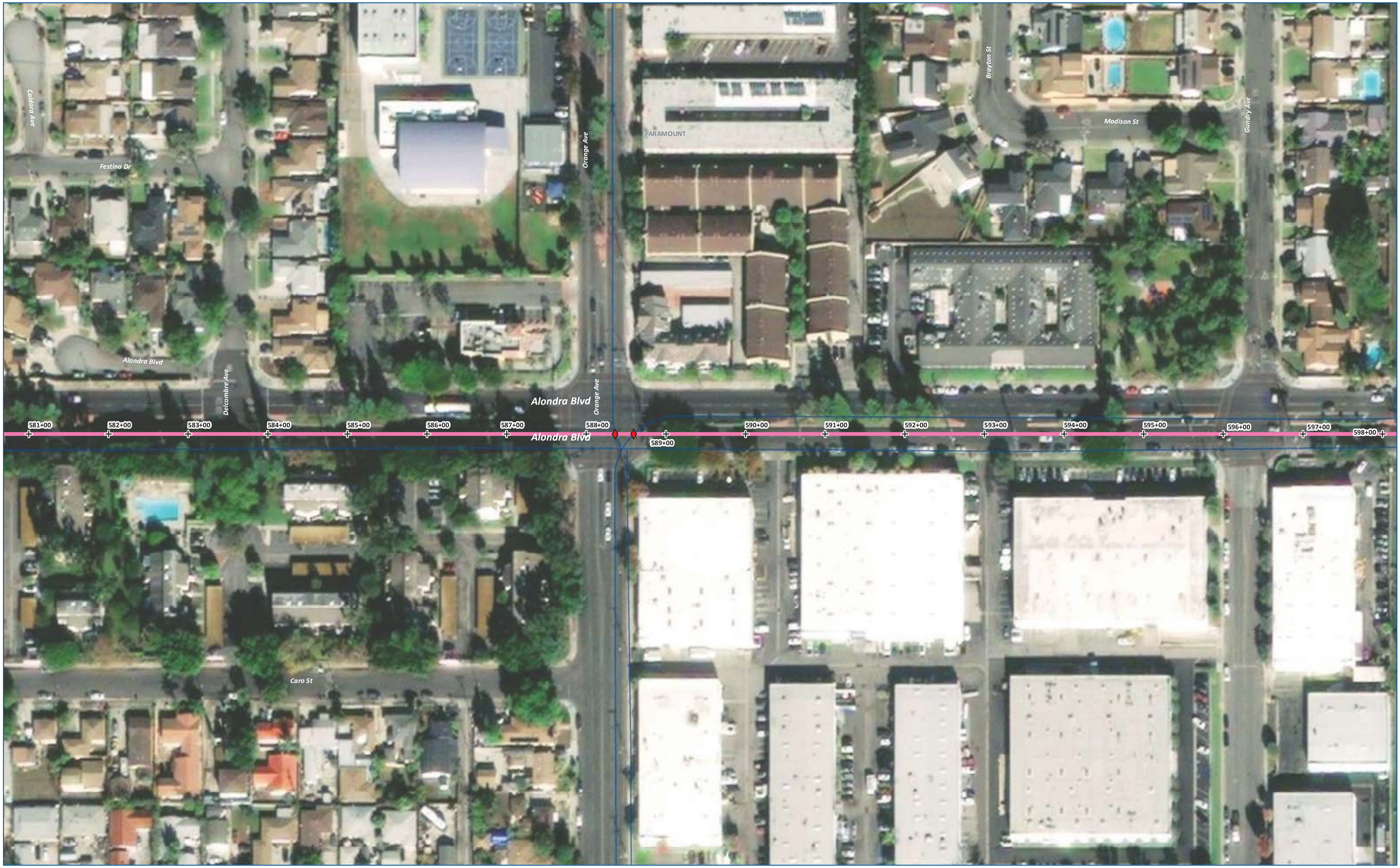

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LA River Alignment, Page 38

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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- Future IRRP
- City Utility

- Existing MWD Distribution System
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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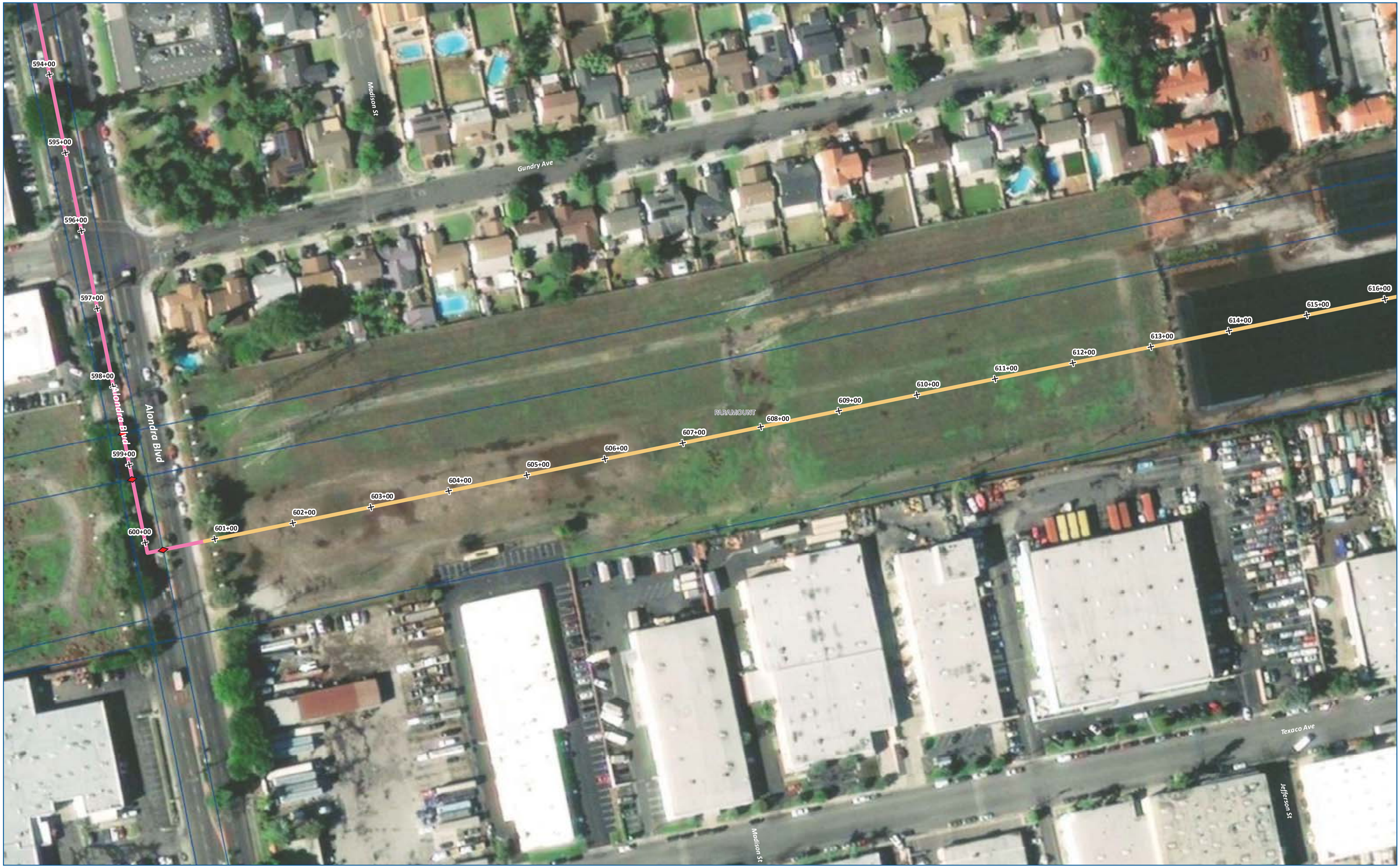

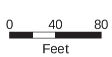

LA River Alignment, Page 39

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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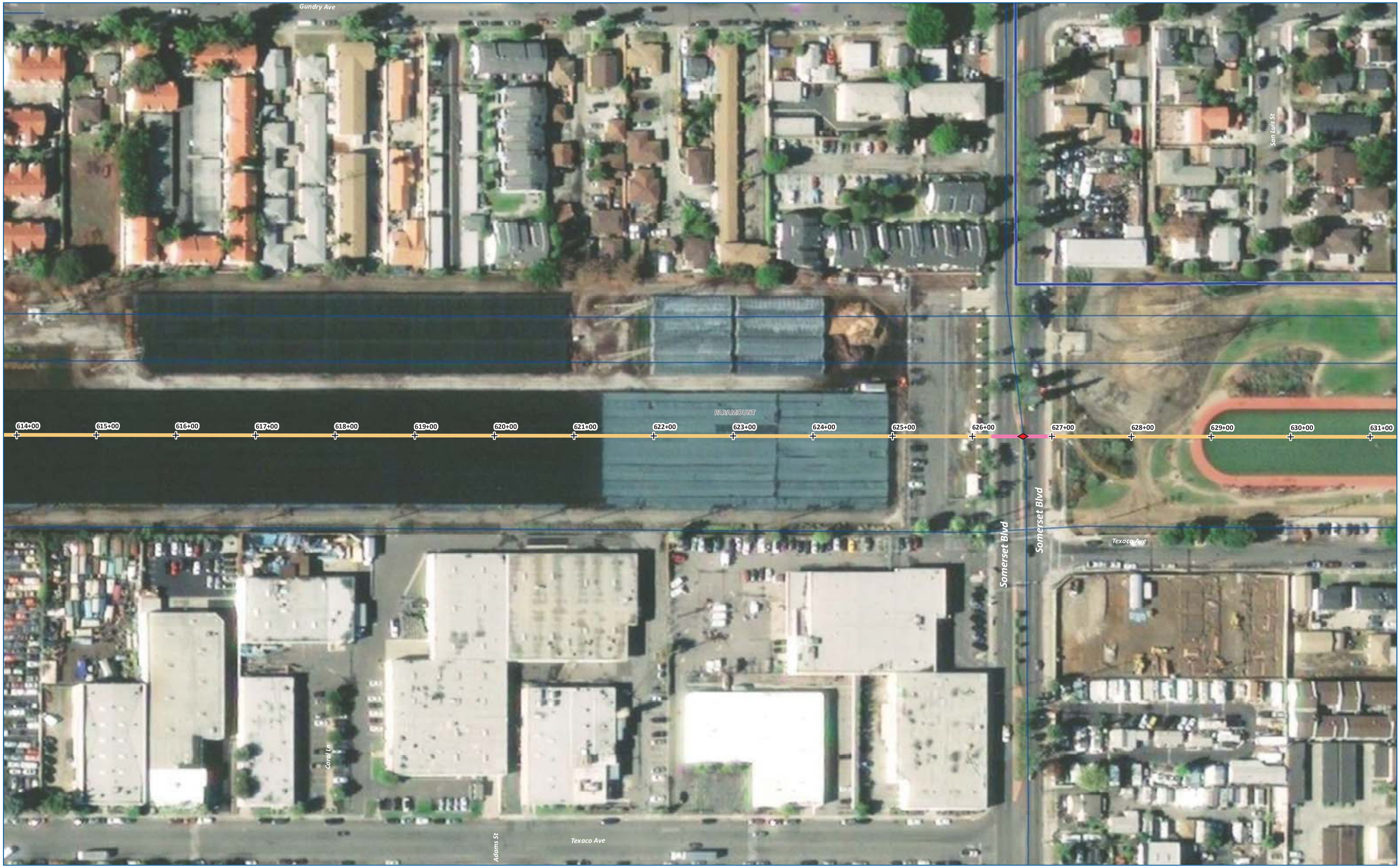

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LA River Alignment, Page 40

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 41

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 42

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 43

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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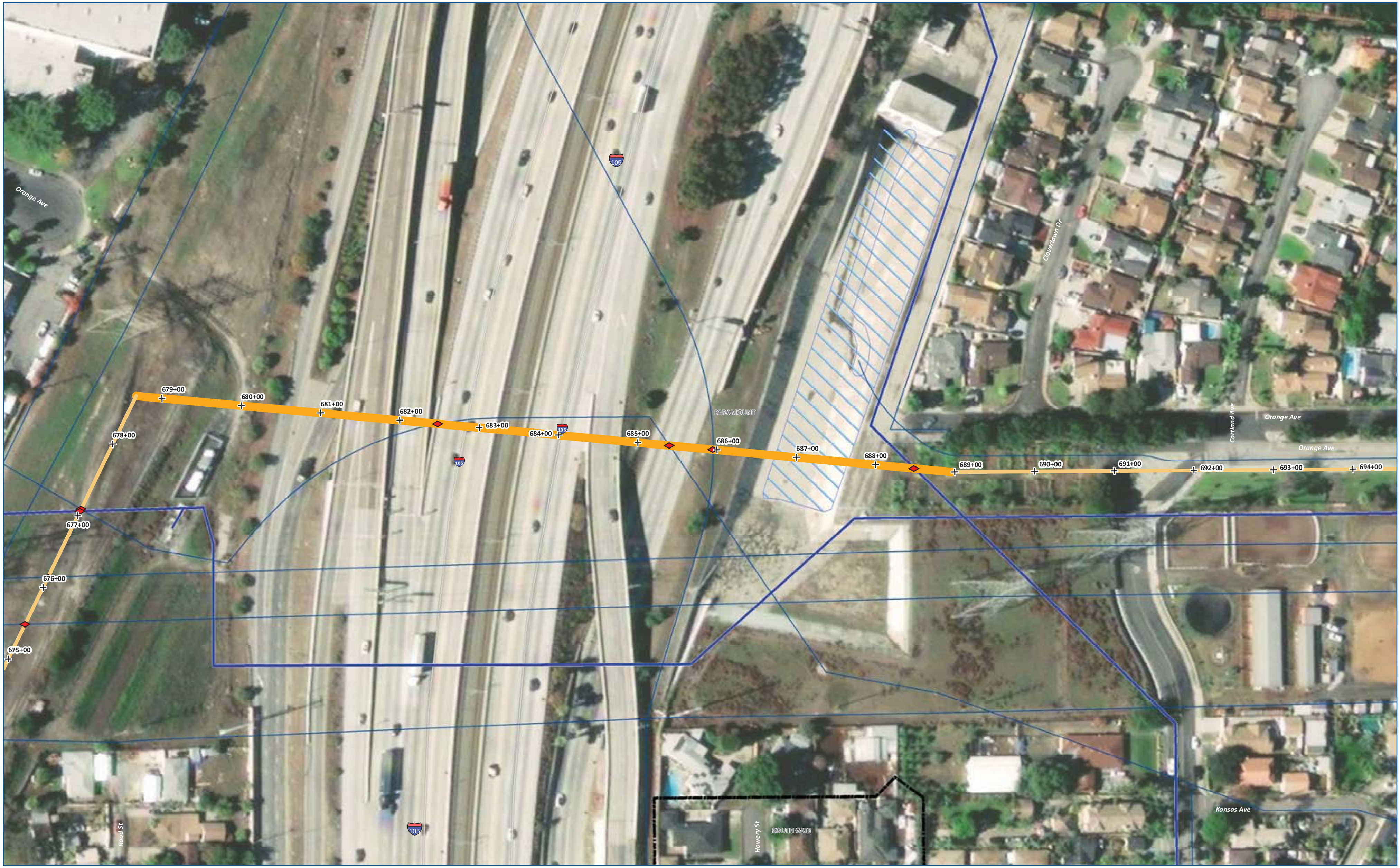

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LA River Alignment, Page 44

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 45

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance
for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 46

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 47

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 48

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 49

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 50

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 51

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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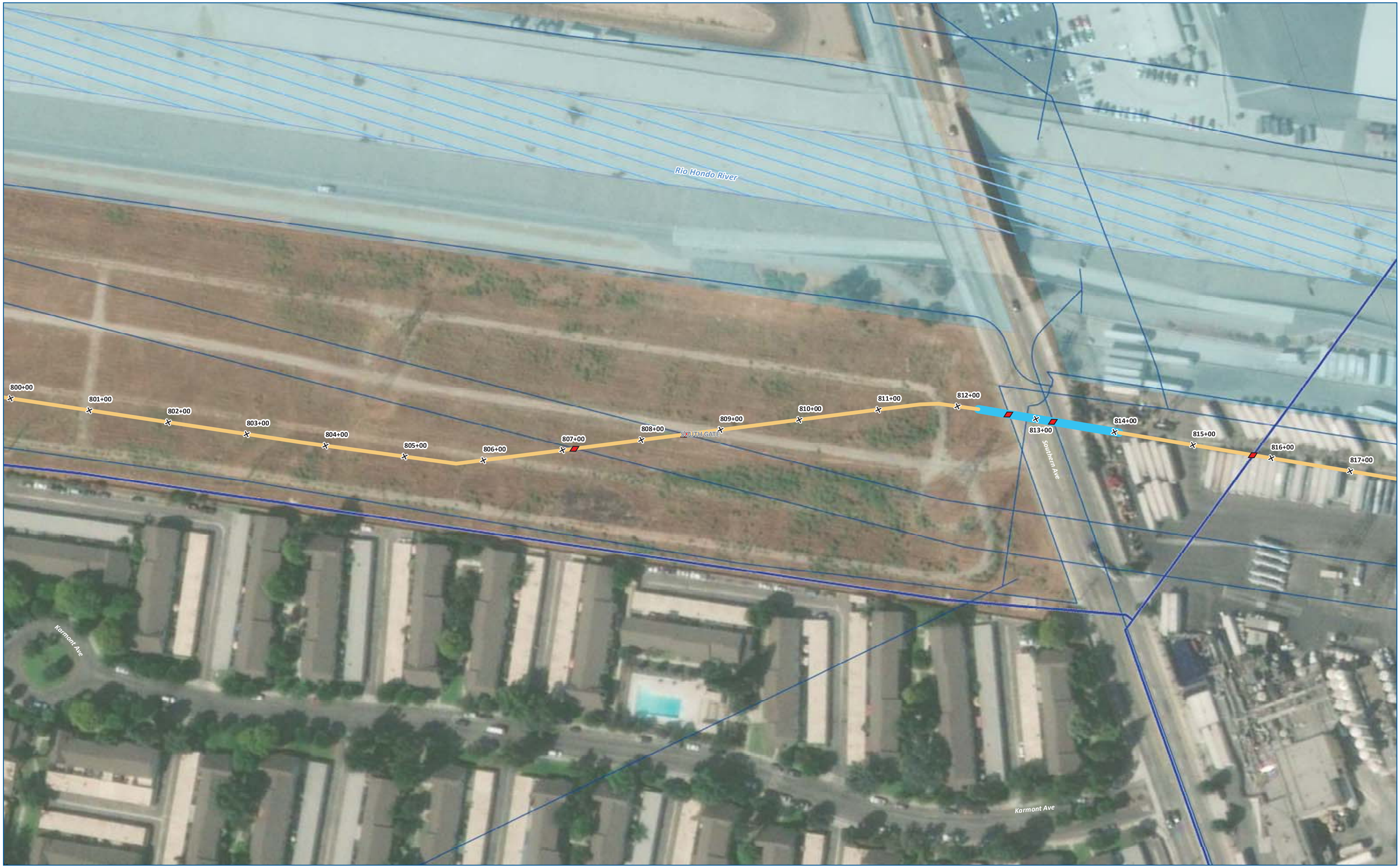

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LA River Alignment, Page 52

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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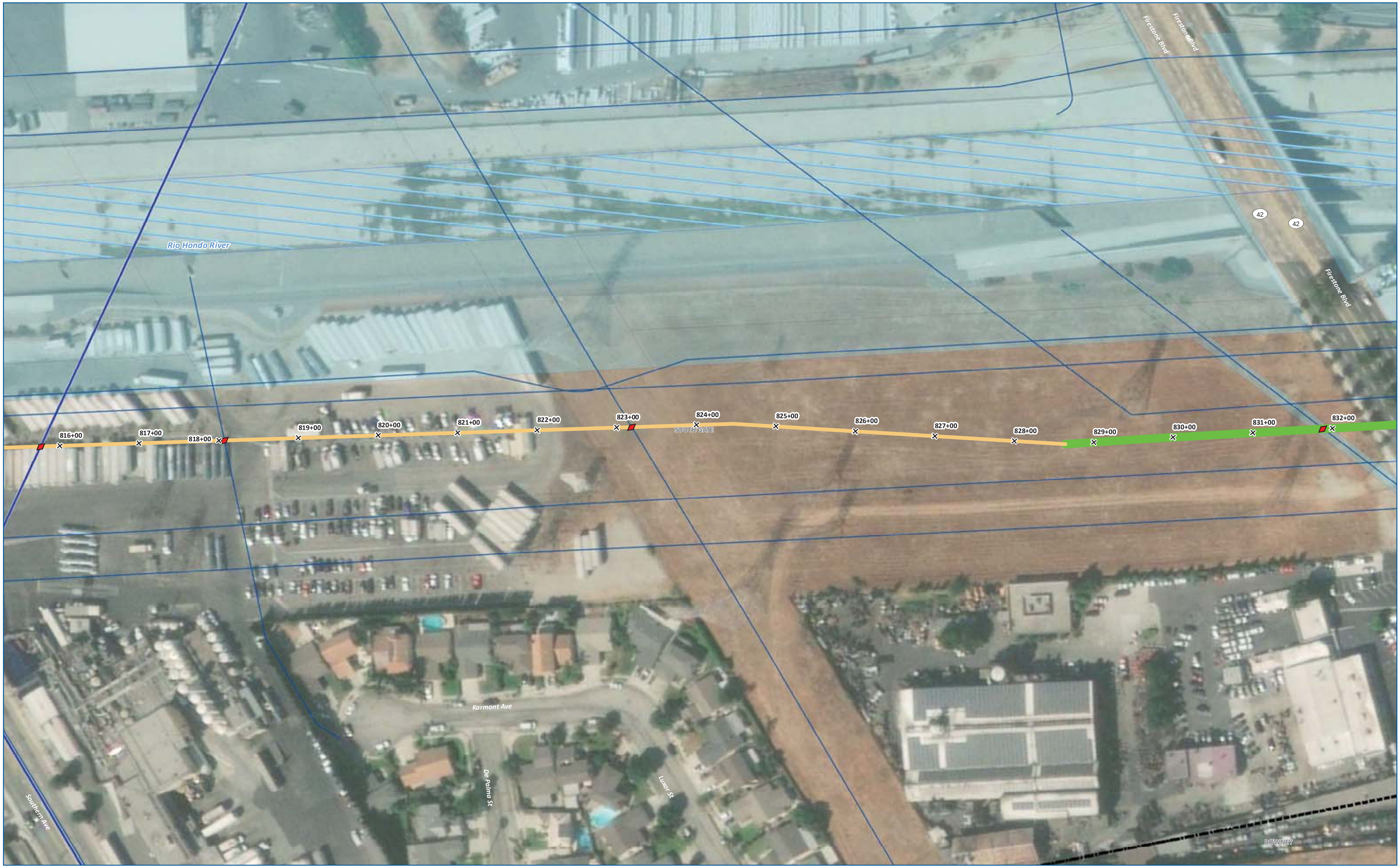

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LA River Alignment, Page 53

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 54

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 55

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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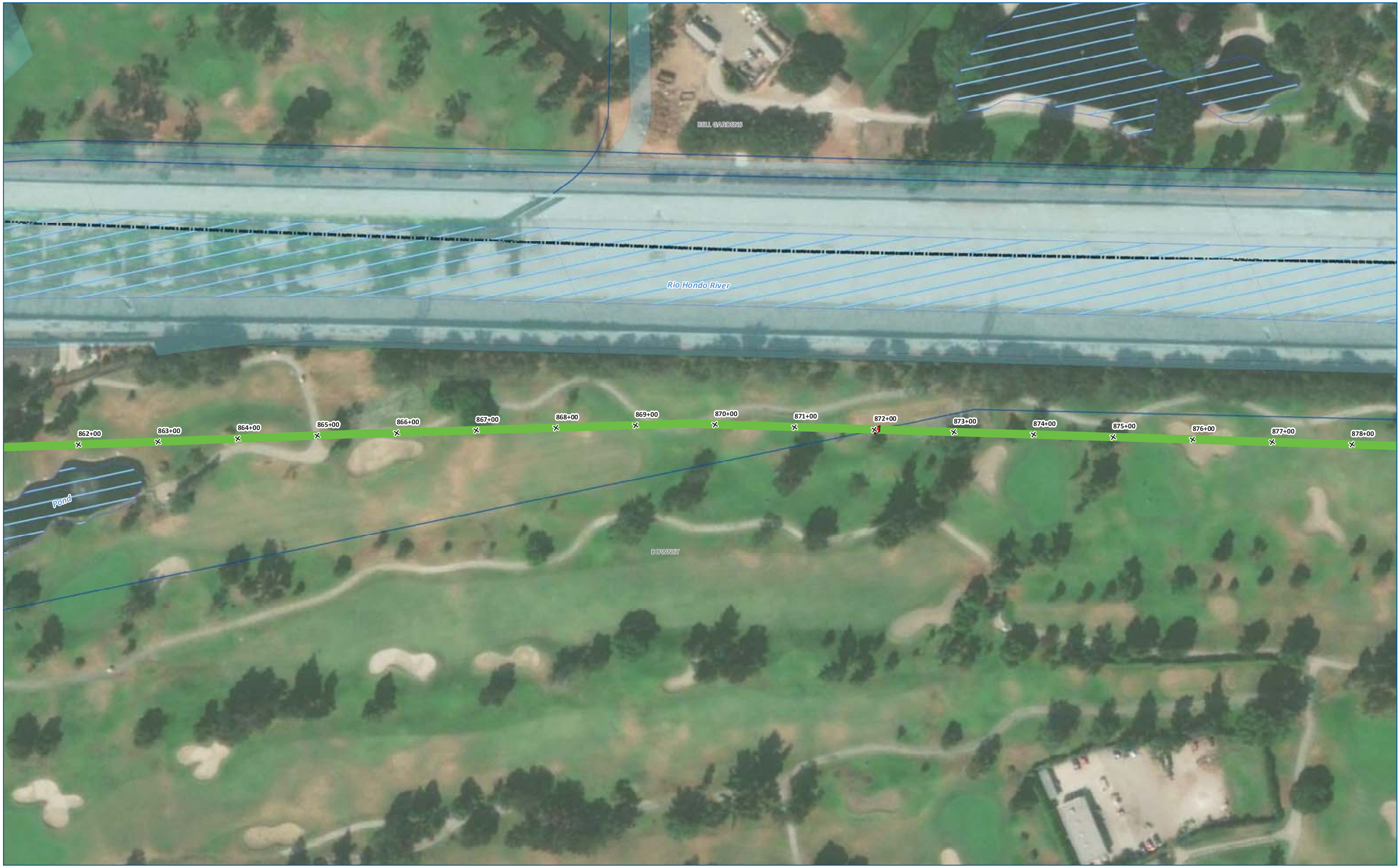

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LA River Alignment, Page 56

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 57

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 58

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 59

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 60

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 61

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 62

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 63

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 64

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 65

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 66

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 67

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 68

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 69

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance
for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 70

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 71

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 72

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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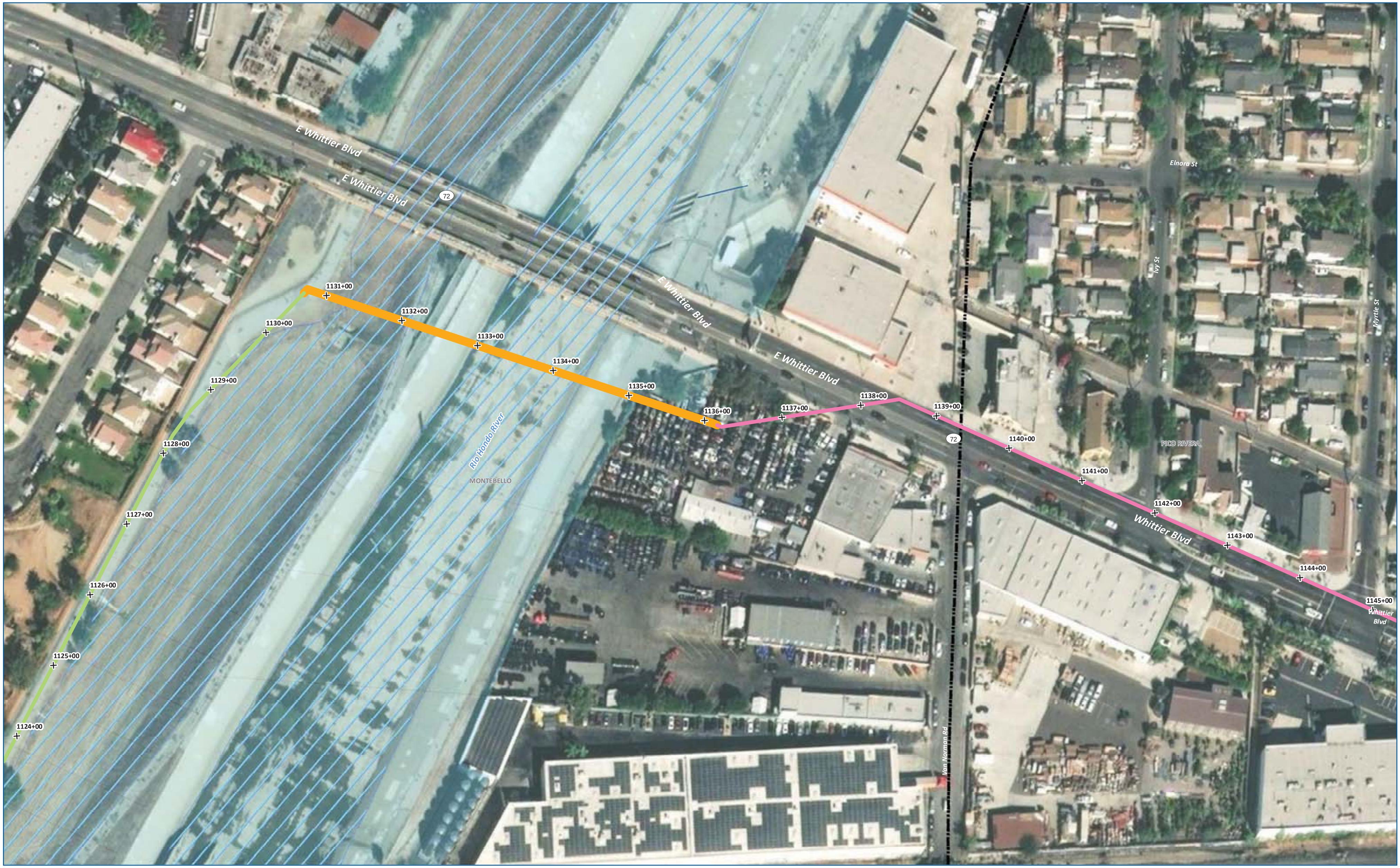

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LA River Alignment, Page 73

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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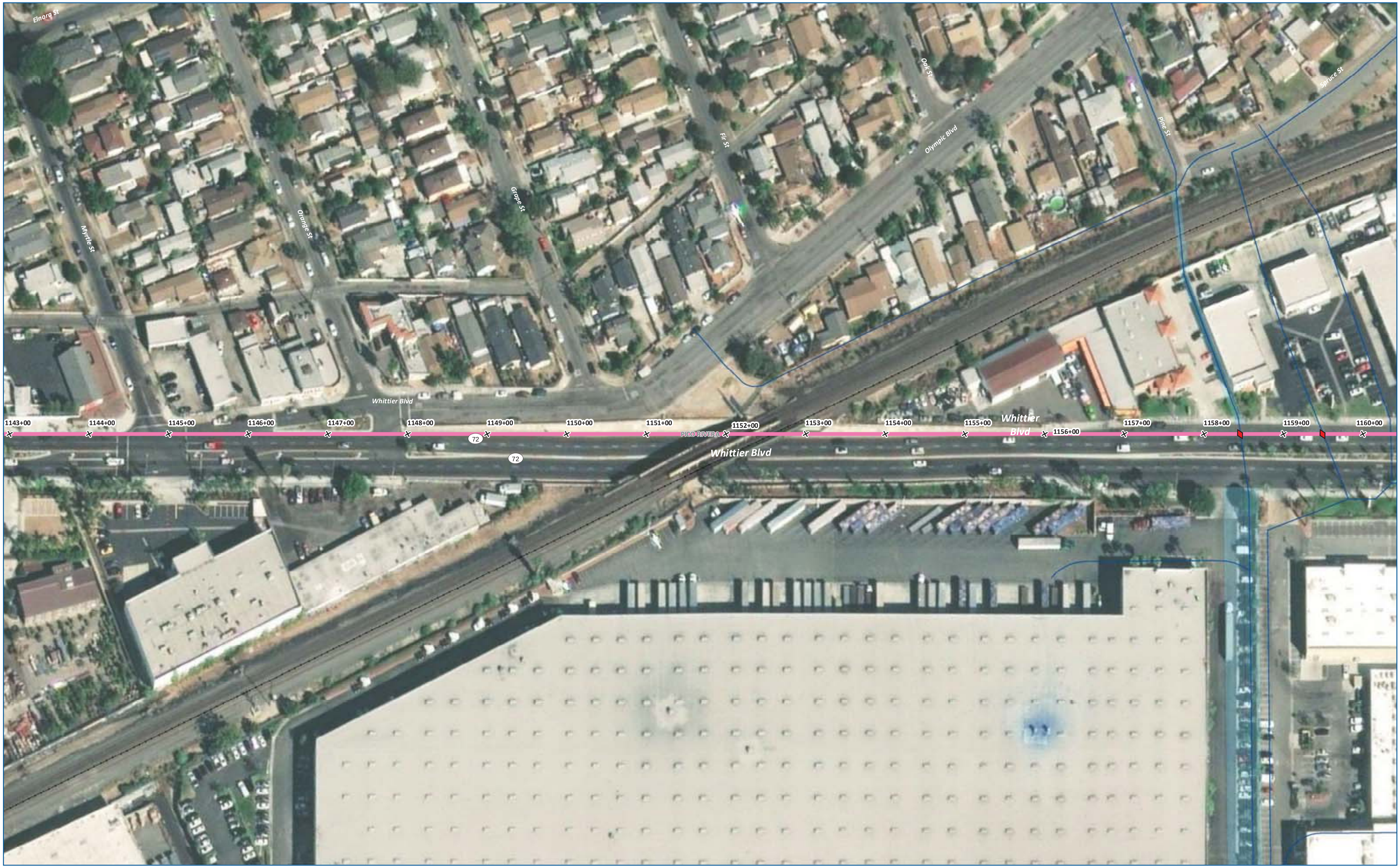

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LA River Alignment, Page 74

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 75

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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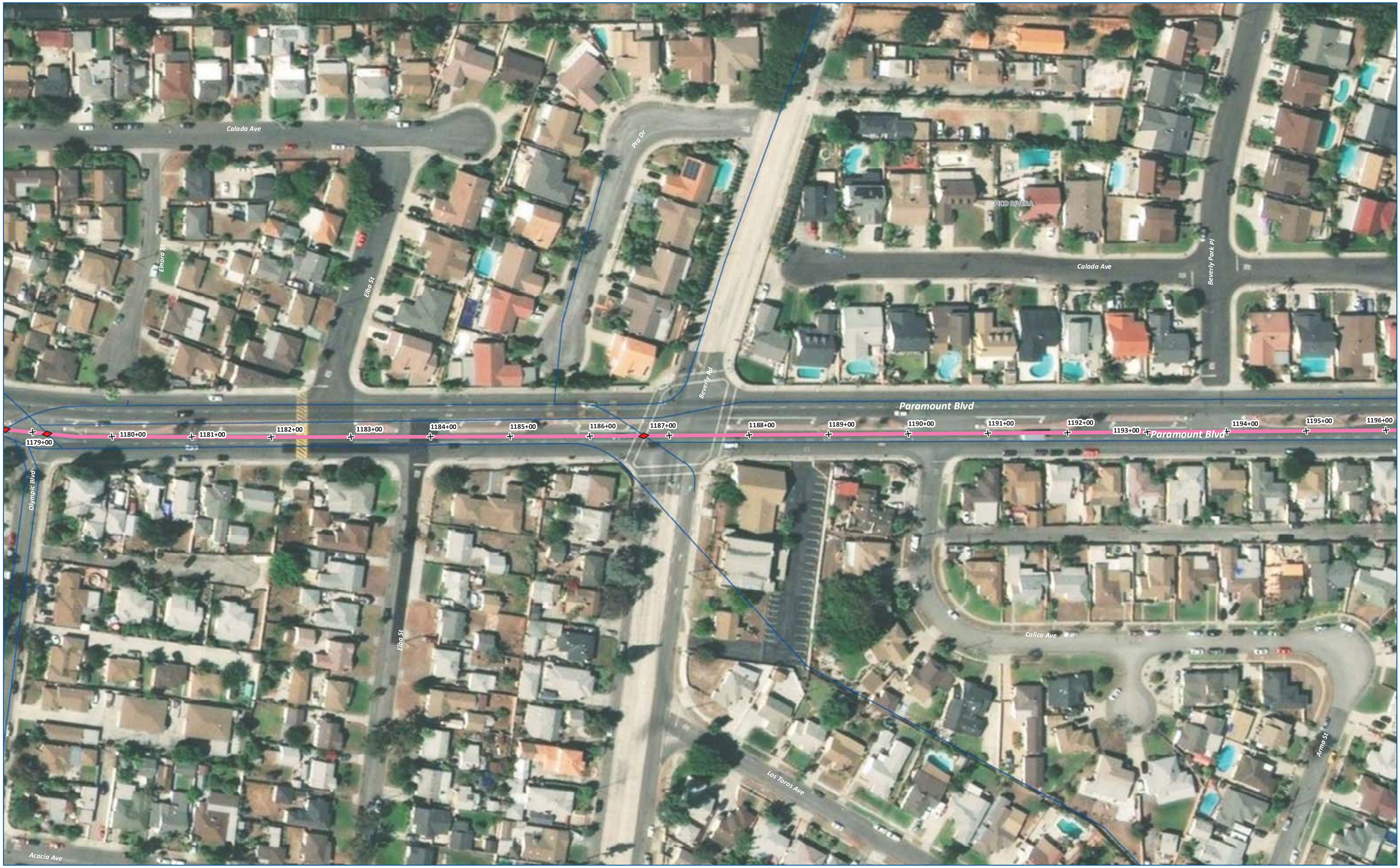

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LA River Alignment, Page 76

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 77

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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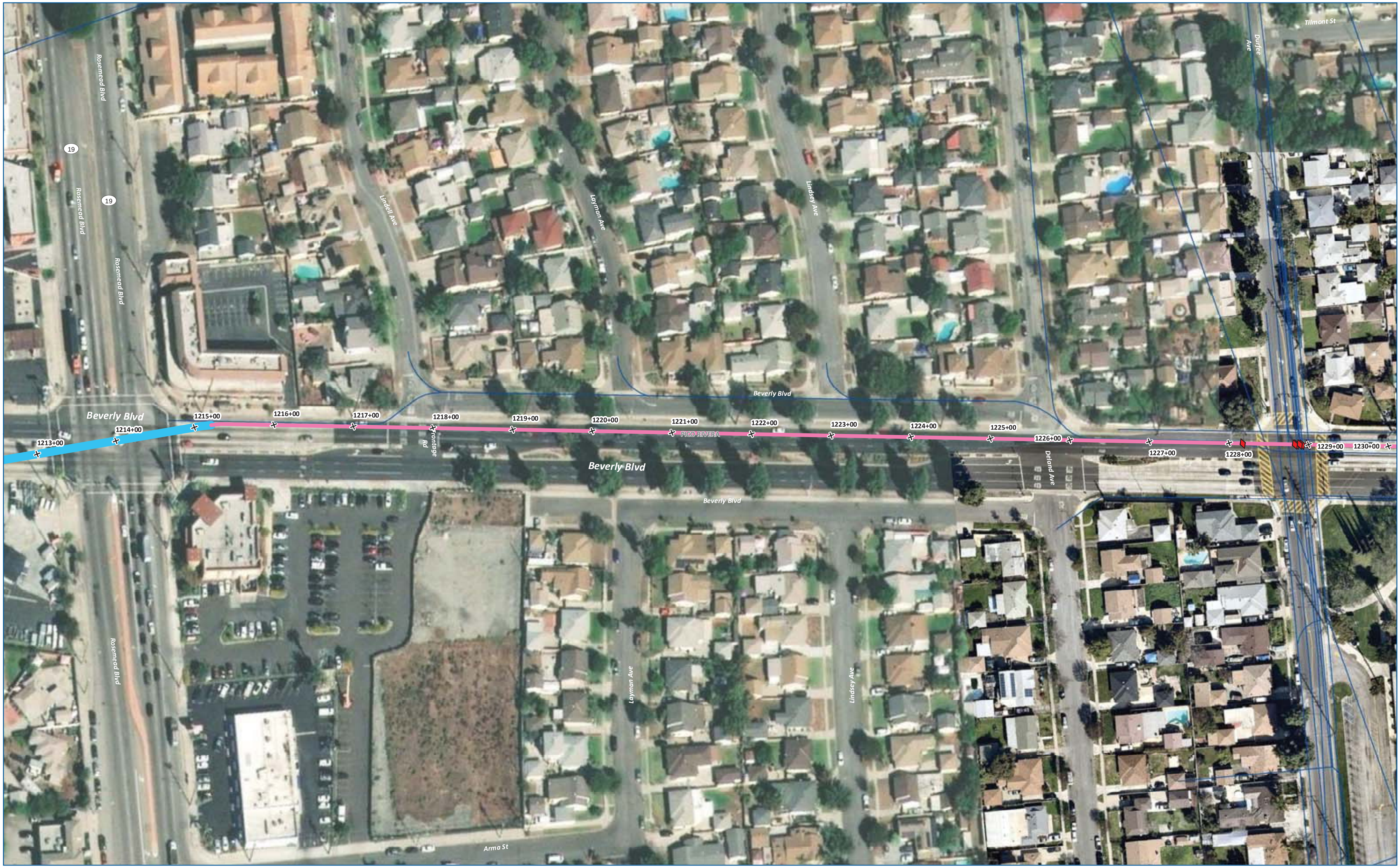

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LA River Alignment, Page 78

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 79

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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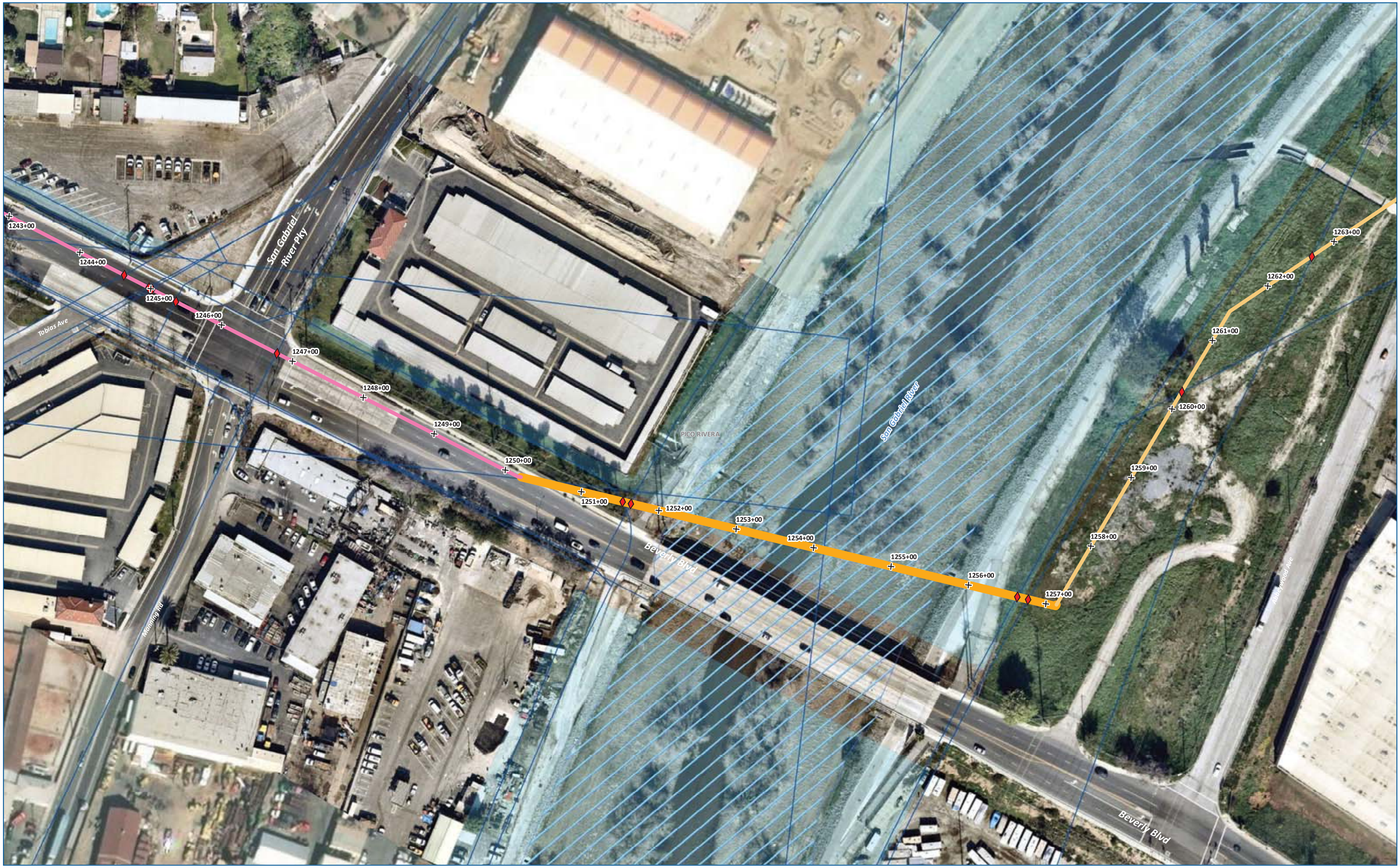

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LA River Alignment, Page 80

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance
for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 81

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Microtunnel
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- Existing MWD Distribution System
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- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 82

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 83

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
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3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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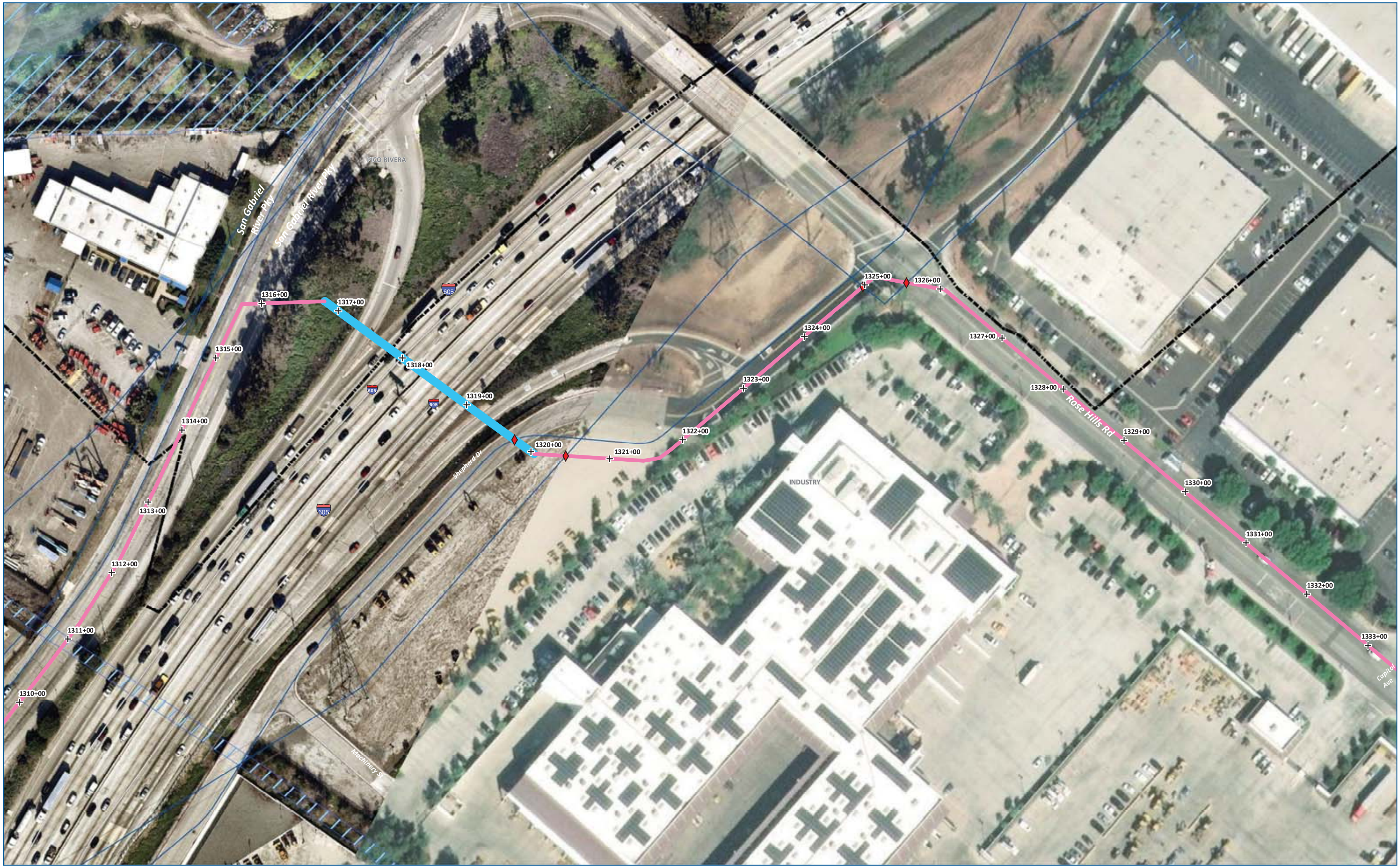

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LA River Alignment, Page 84

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Future IRRP
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- Existing MWD Distribution System
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 85

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 86

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 87

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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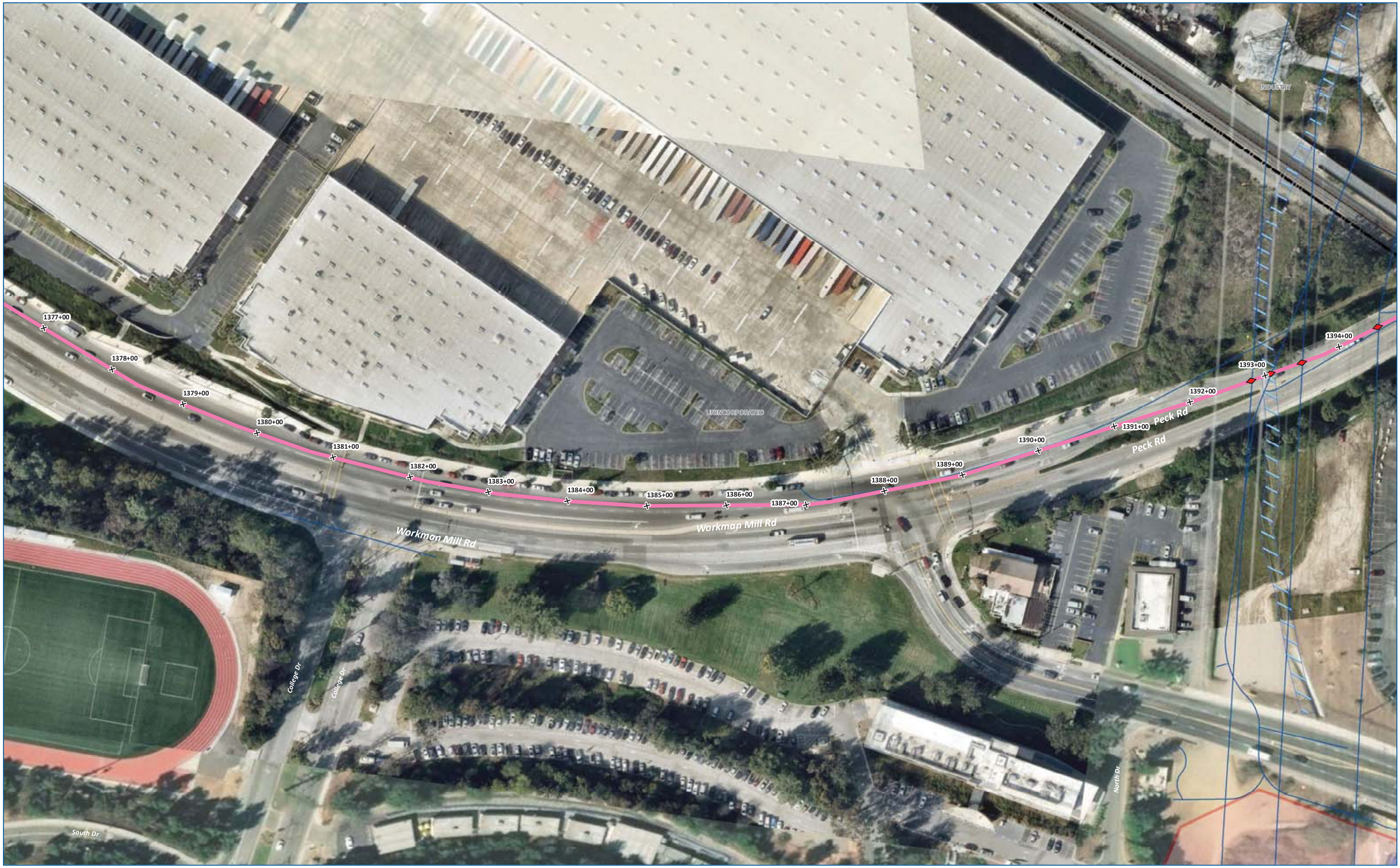

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LA River Alignment, Page 88

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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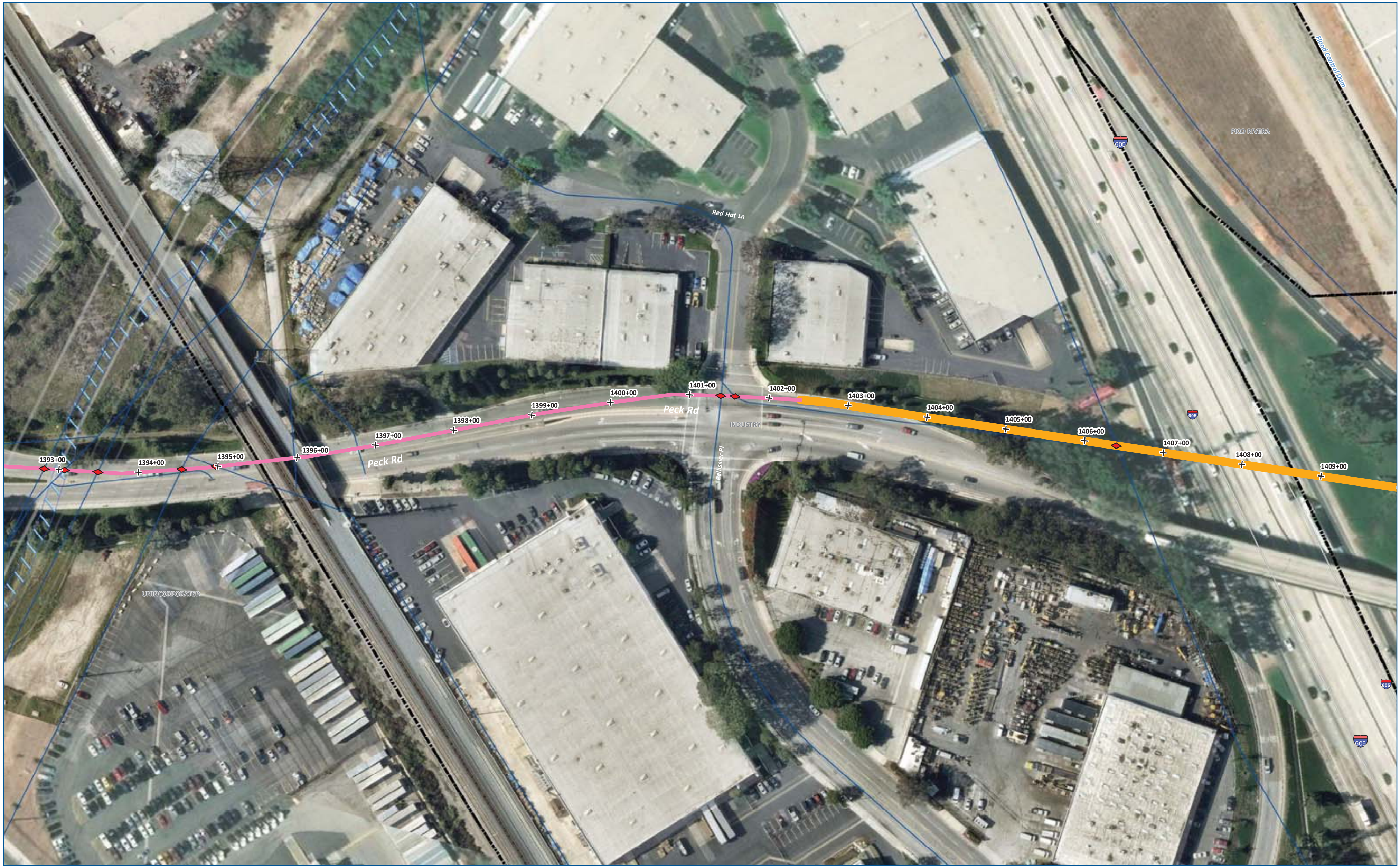

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LA River Alignment, Page 89

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 90

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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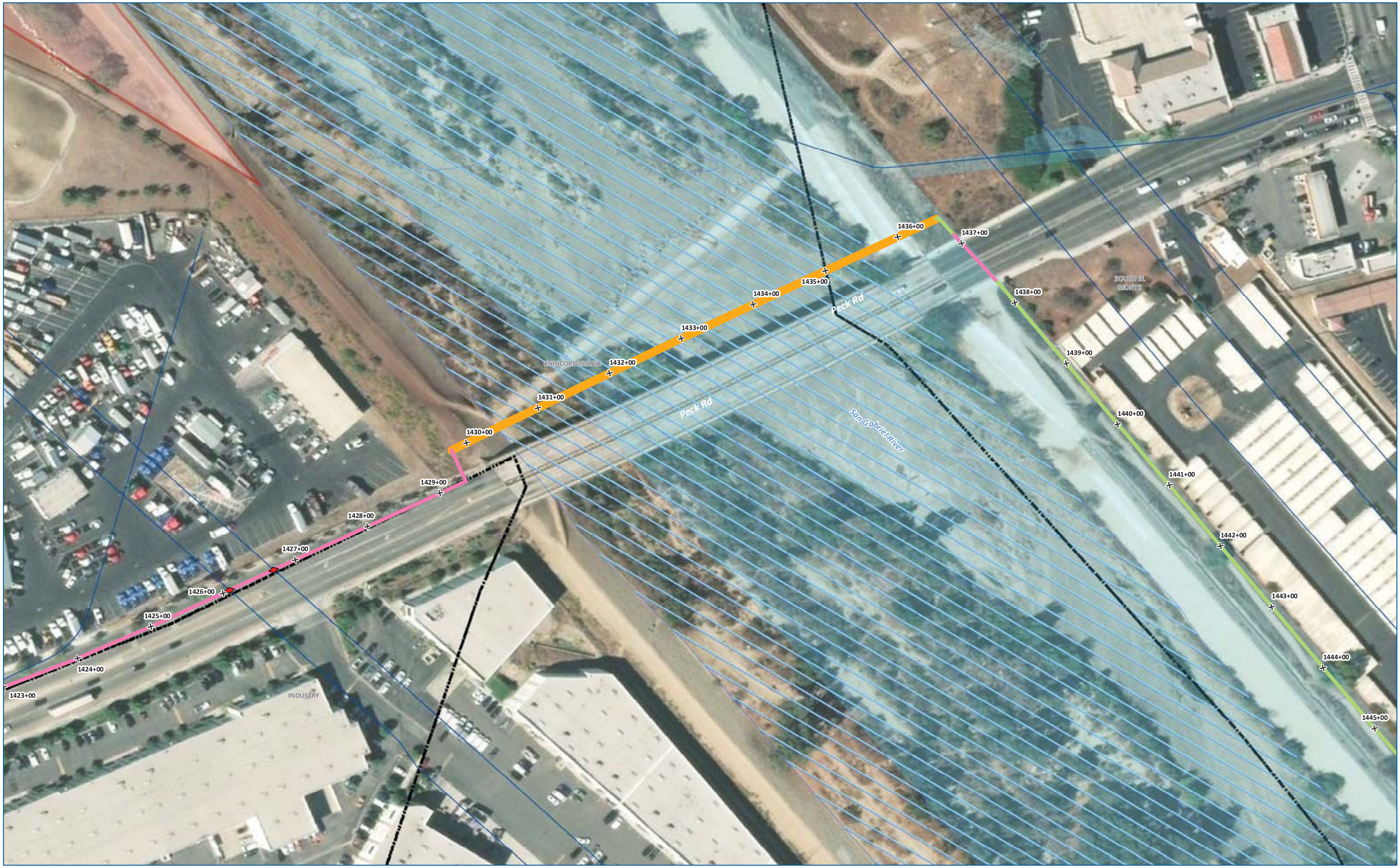

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LA River Alignment, Page 91

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 92

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 93

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
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- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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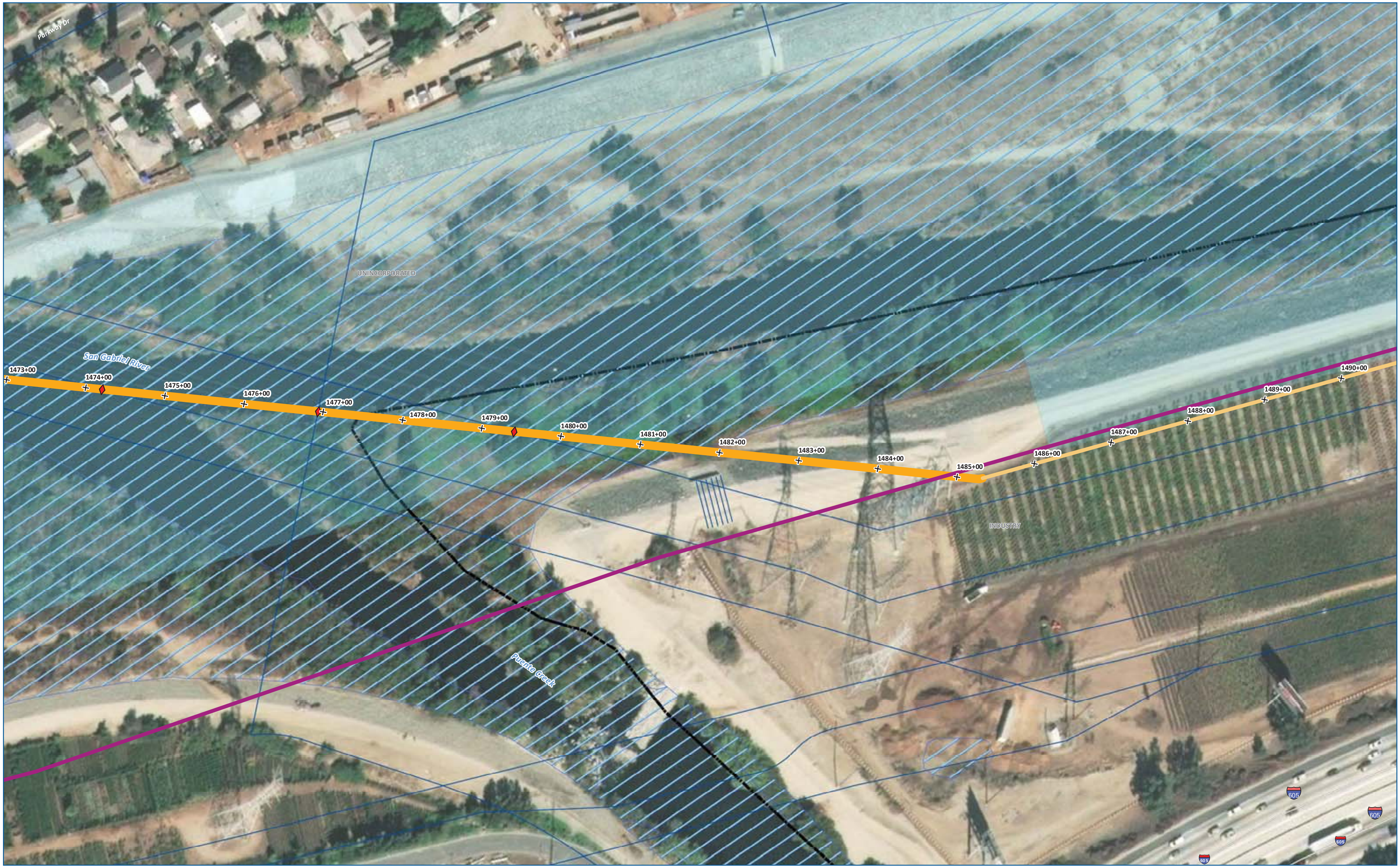

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LA River Alignment, Page 94

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 95

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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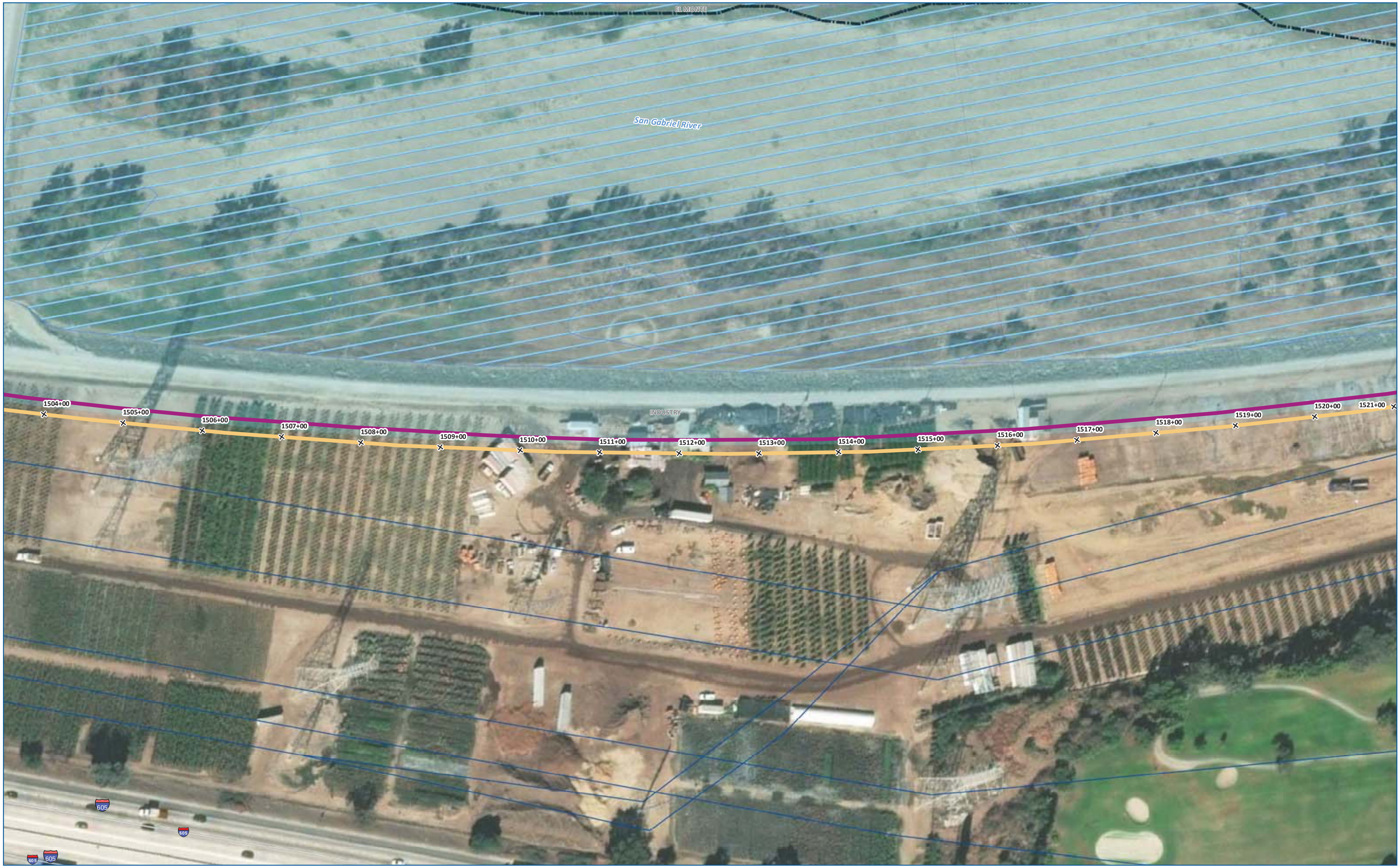

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LA River Alignment, Page 96

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Trenchless Construction Method
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- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
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- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 97

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 98

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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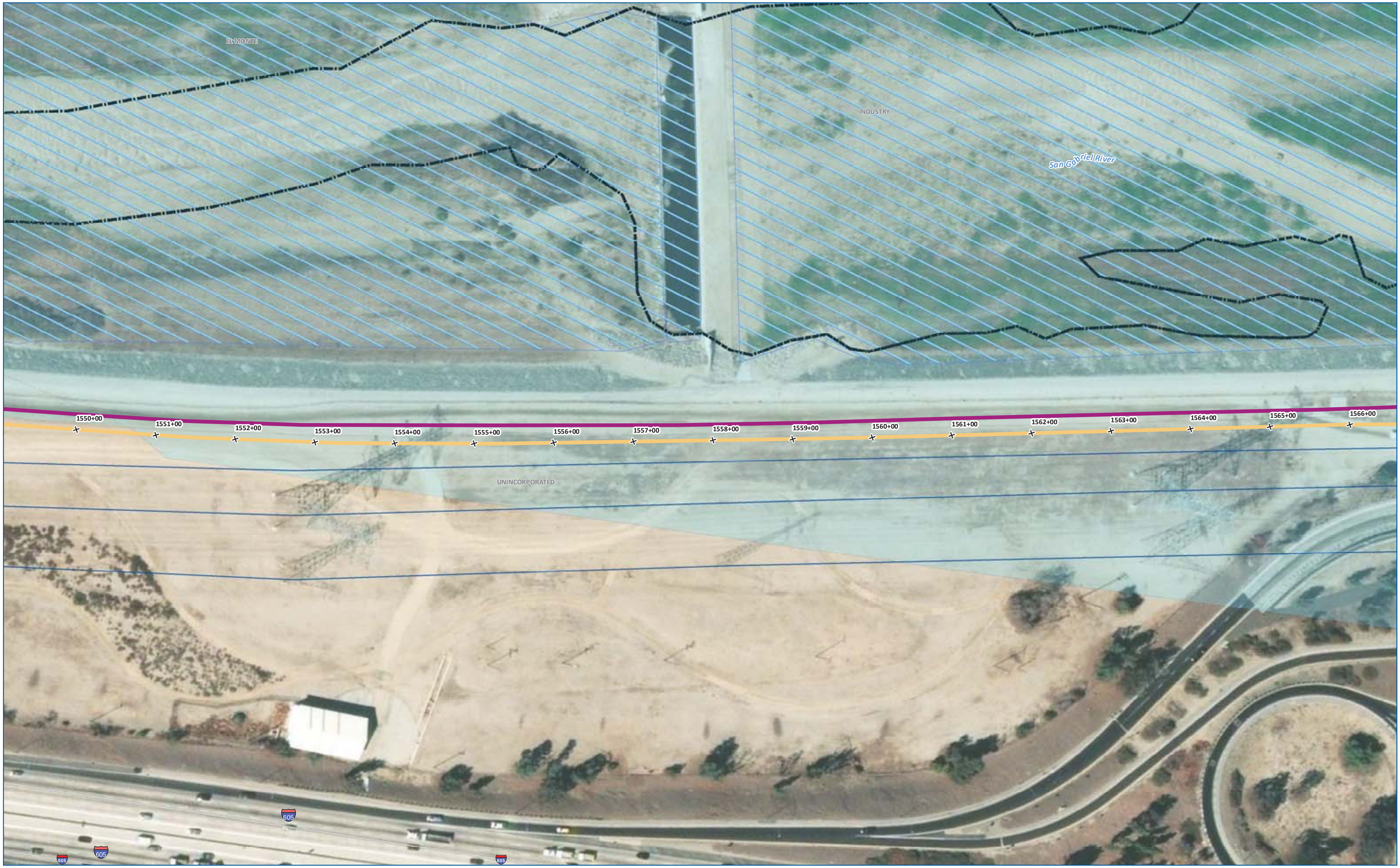

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LA River Alignment, Page 99

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Trenchless Construction Method
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- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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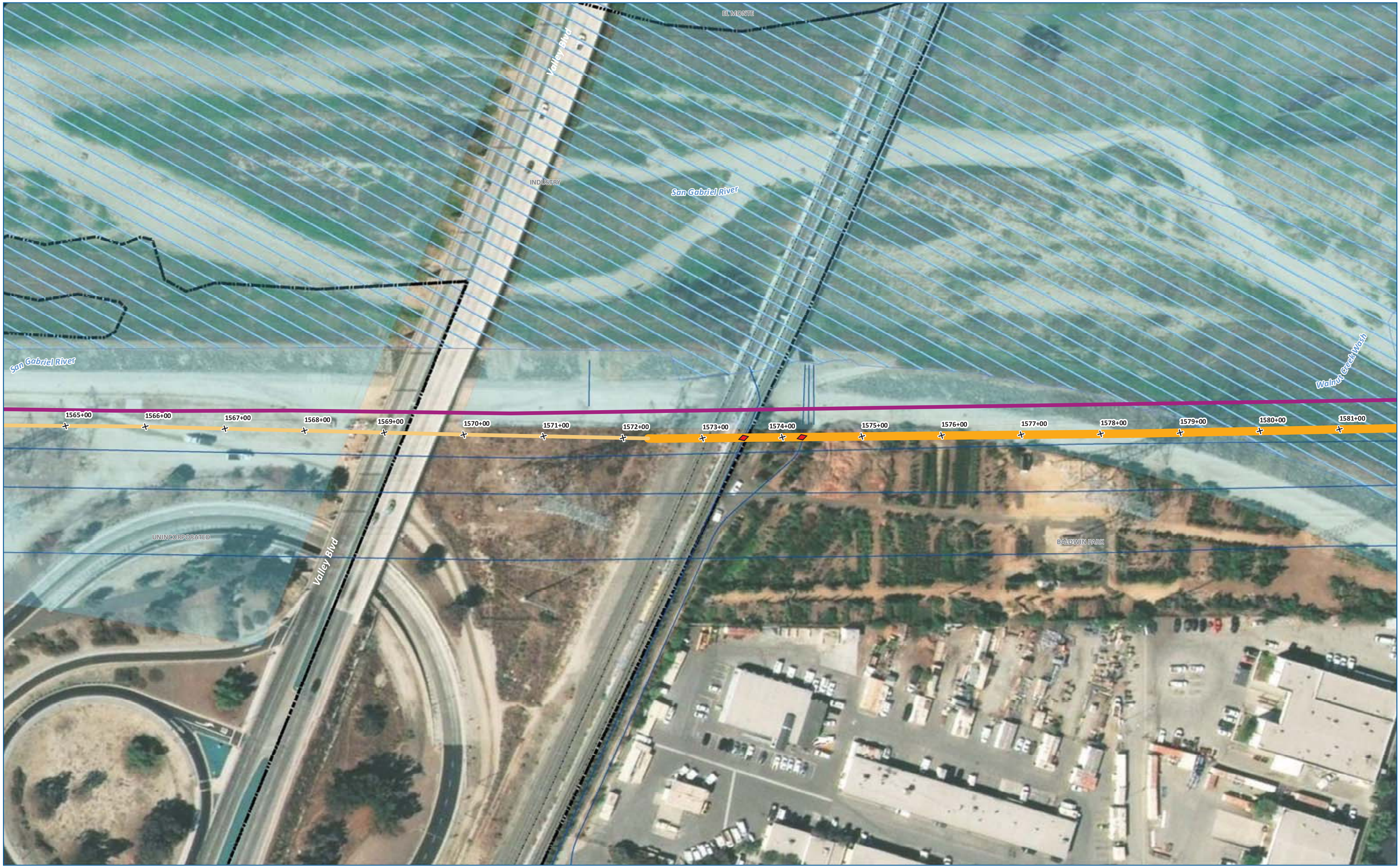

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LA River Alignment, Page 100

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 101

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 102

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 103

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 104

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
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Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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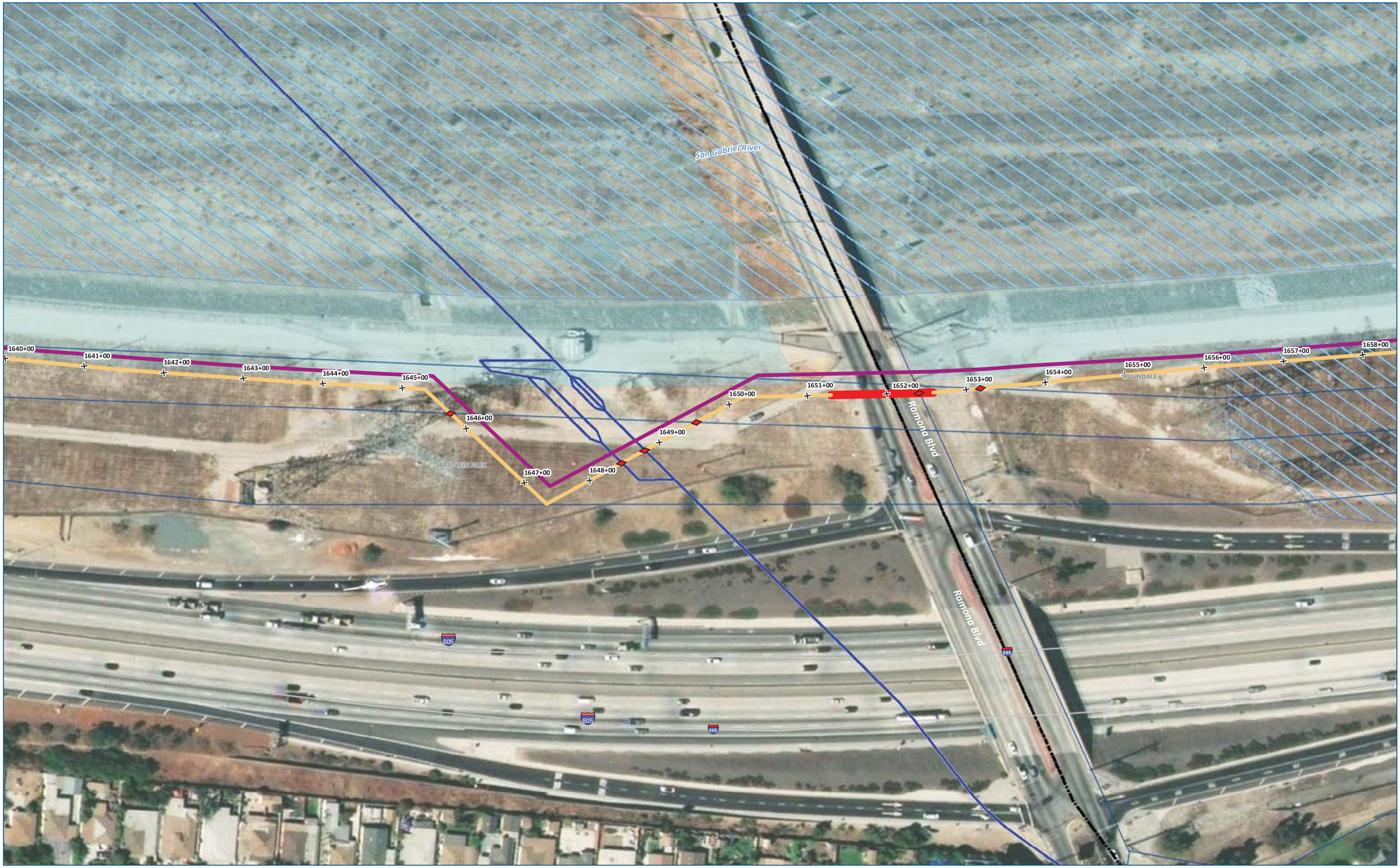

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LA River Alignment, Page 105

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 106

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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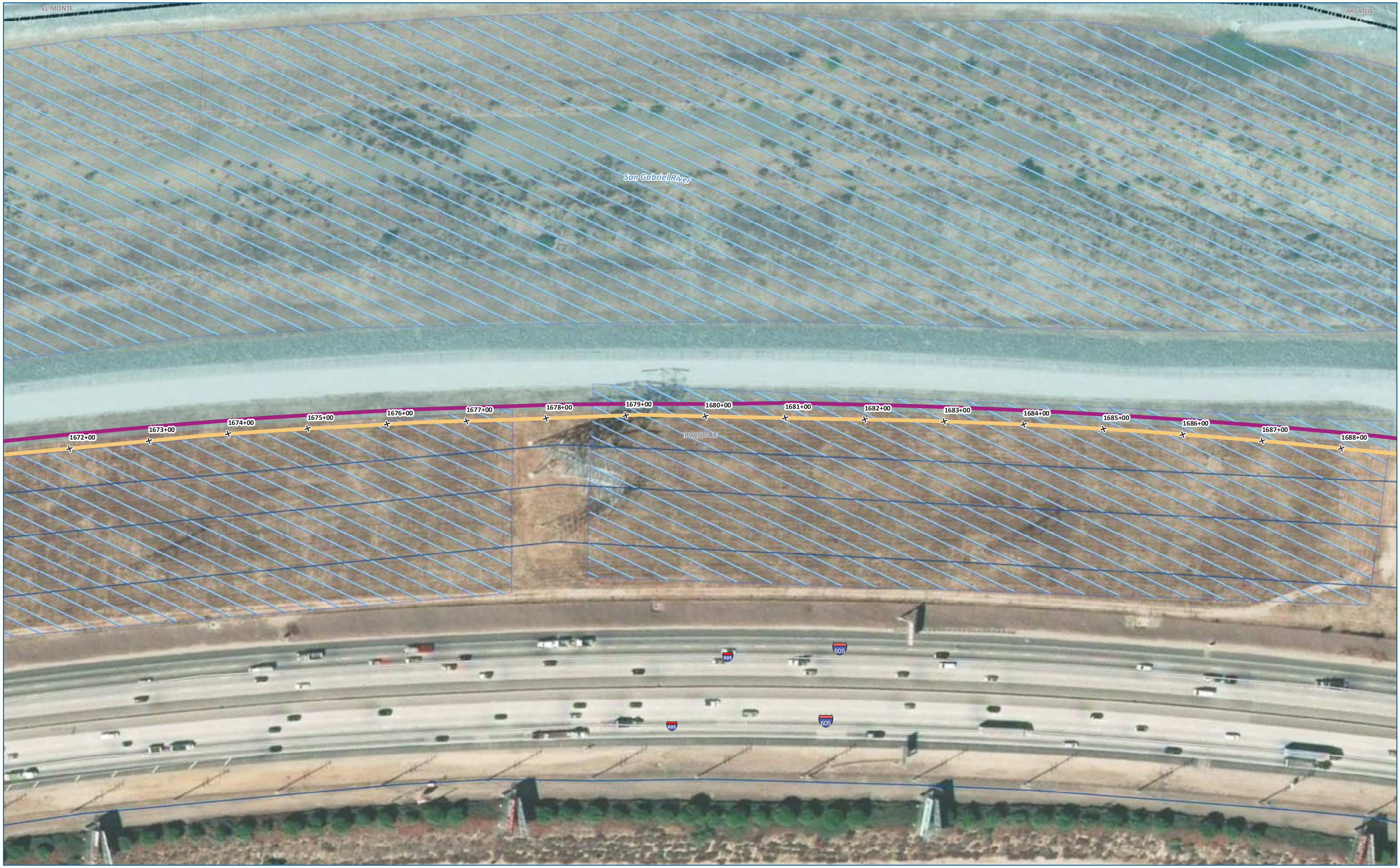

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LA River Alignment, Page 107

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 108

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 109

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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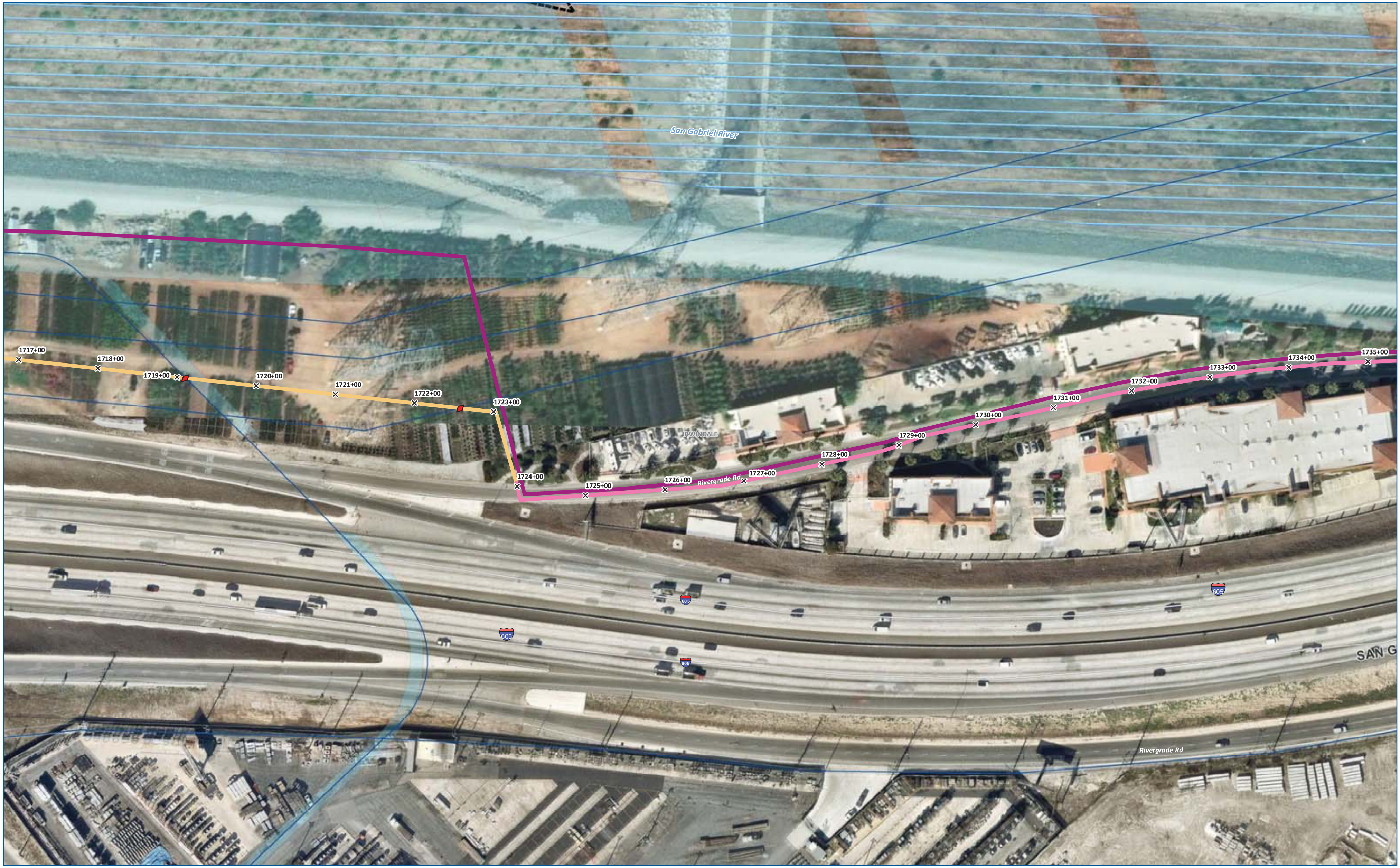

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LA River Alignment, Page 110

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 111

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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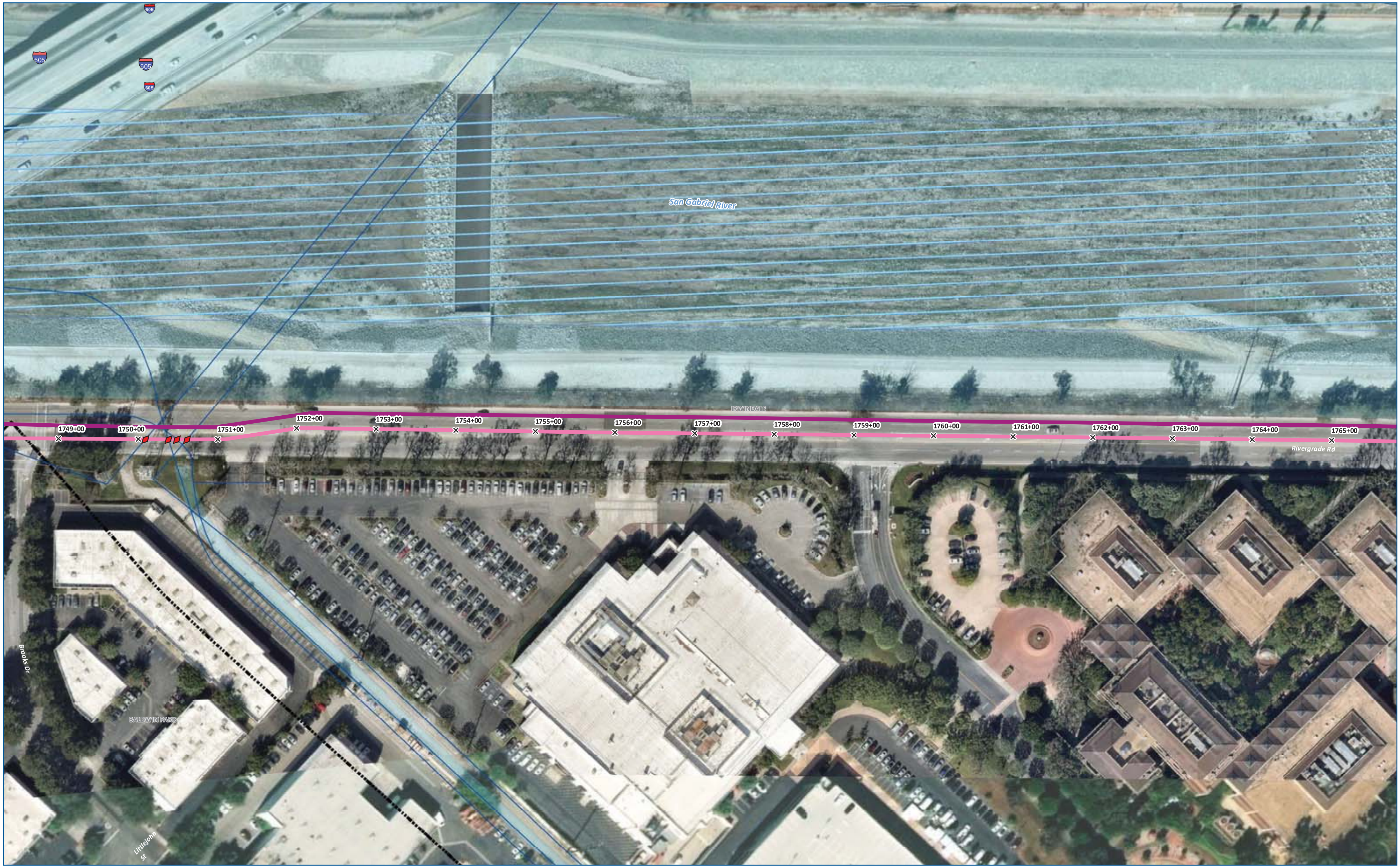

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LA River Alignment, Page 112

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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LA River Alignment, Page 113

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
		Existing MWD Distribution System
1 - Roadways	Traditional Tunnel	LA County Flood Control District
2 - SCE Easements	Jack & Bore	City Boundaries
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	Wetlands
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Critical Habitat
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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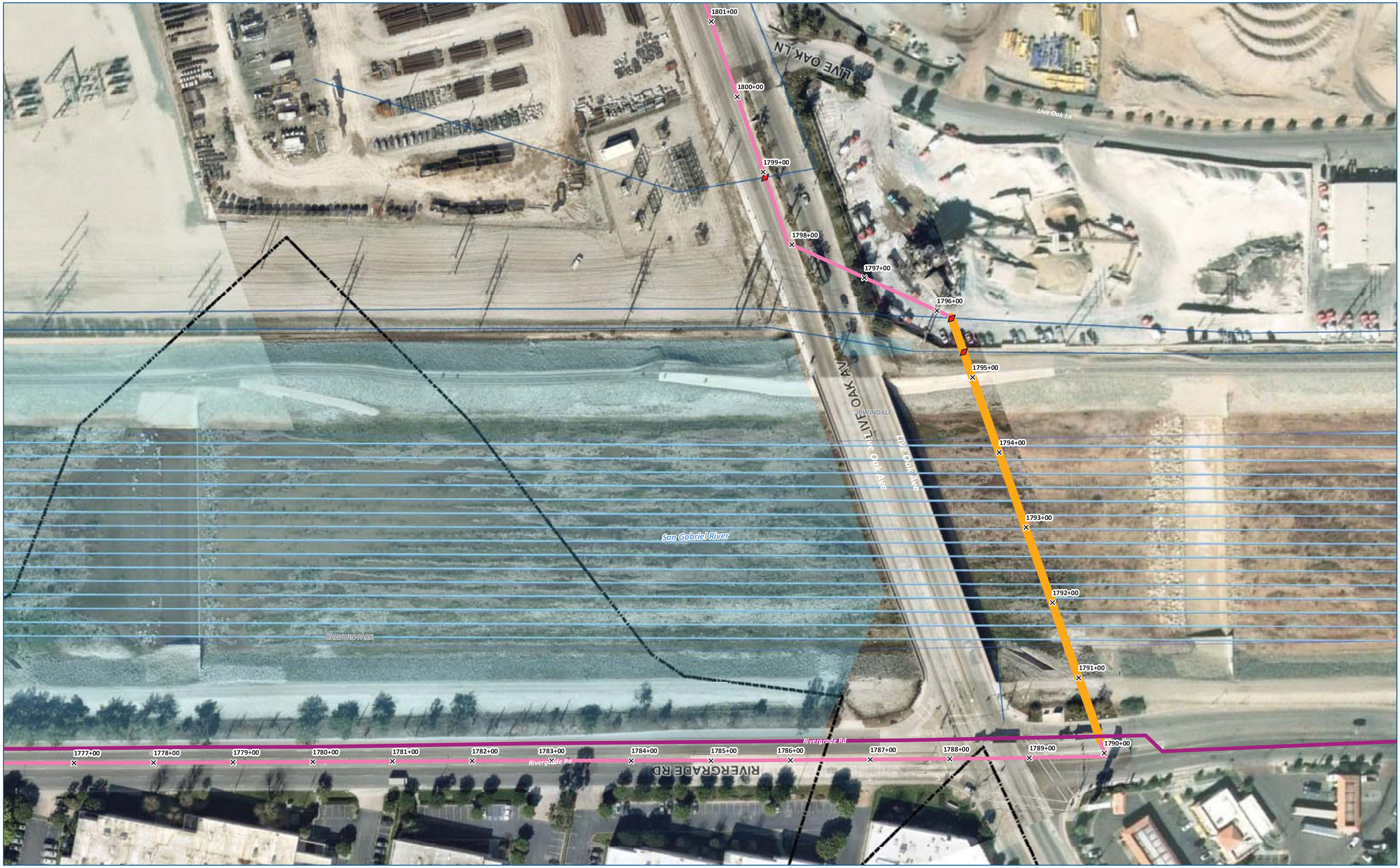

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LA River Alignment, Page 114

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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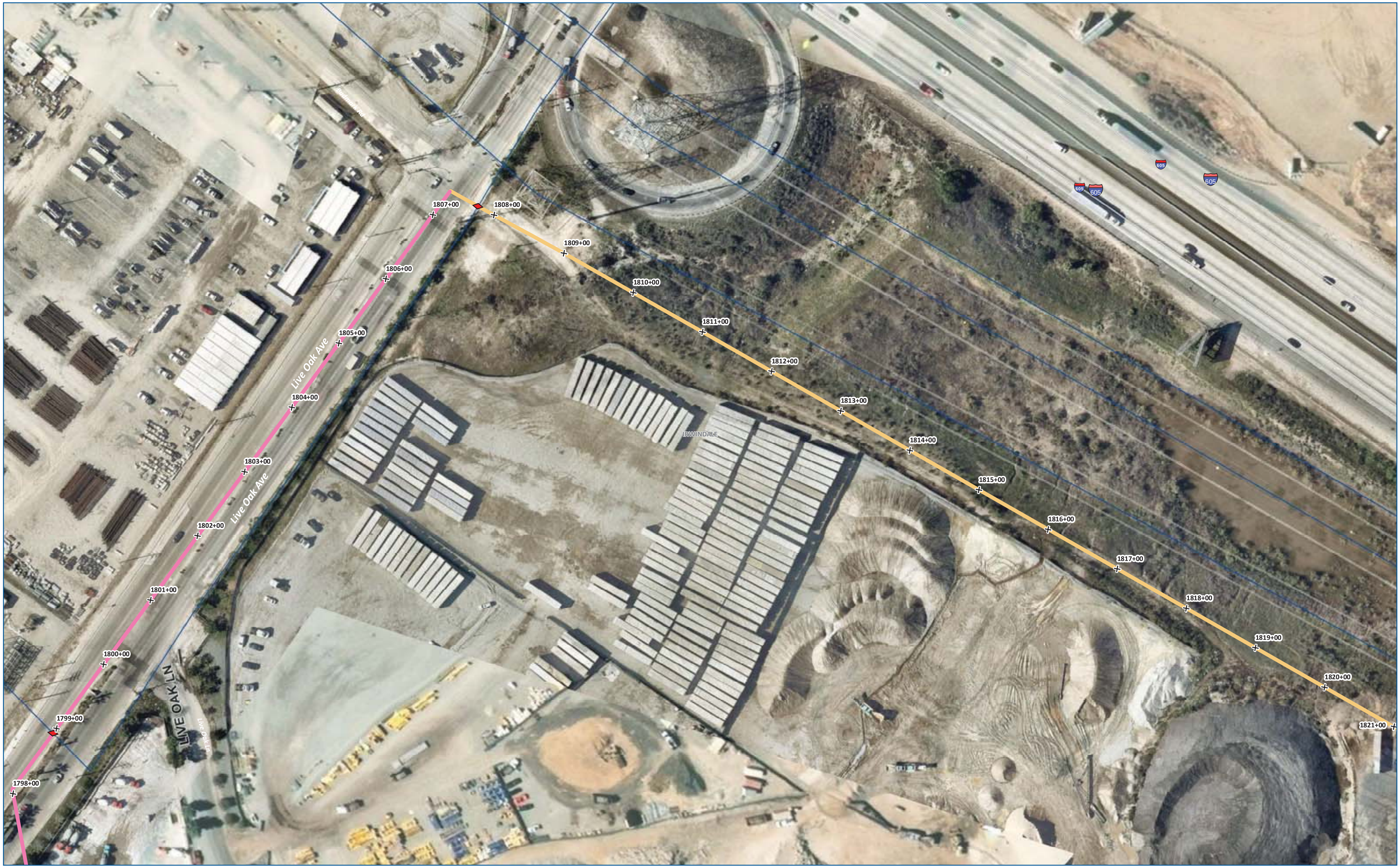

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LA River Alignment, Page 115

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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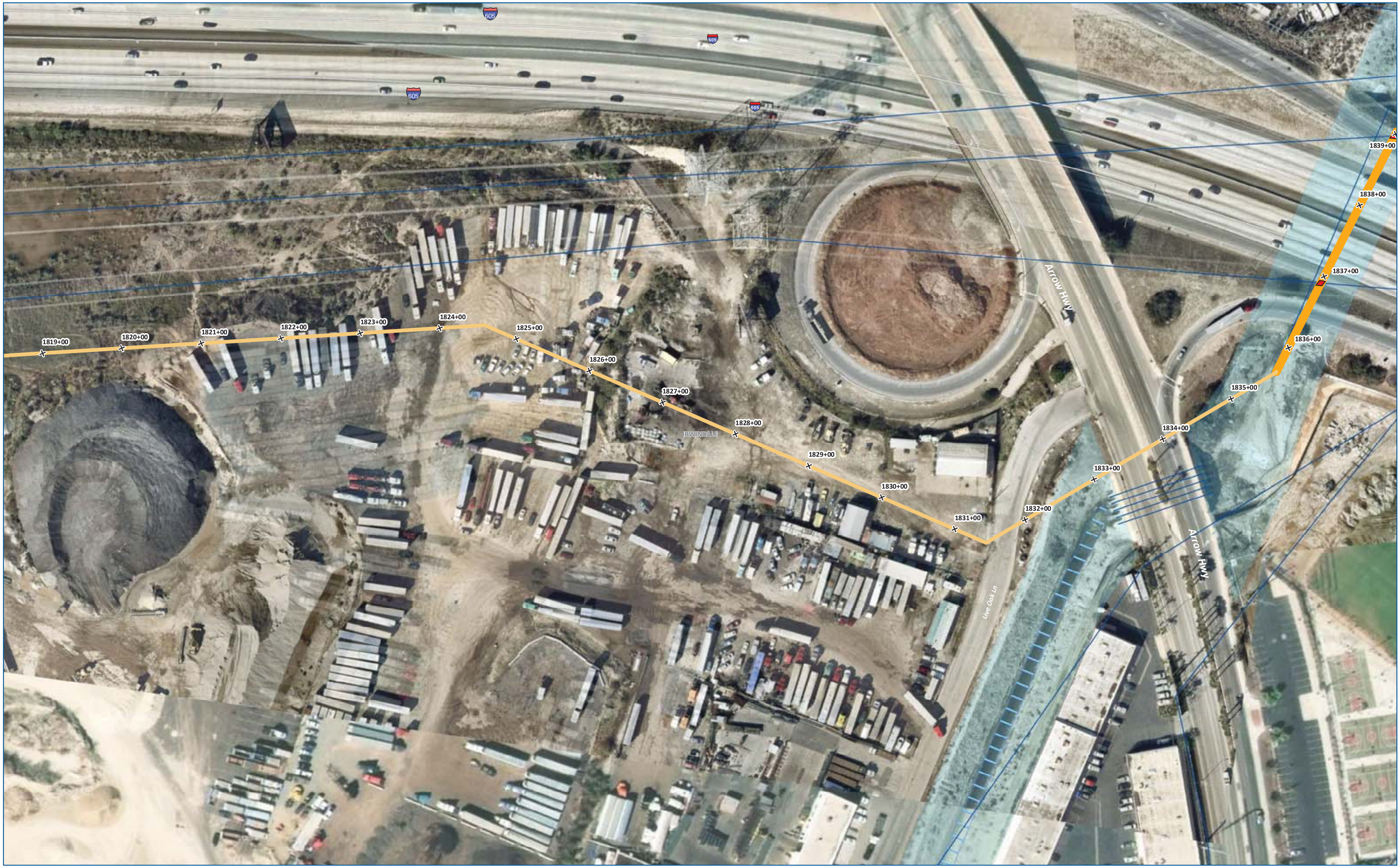

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LA River Alignment, Page 116

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 117

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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LA River Alignment, Page 118

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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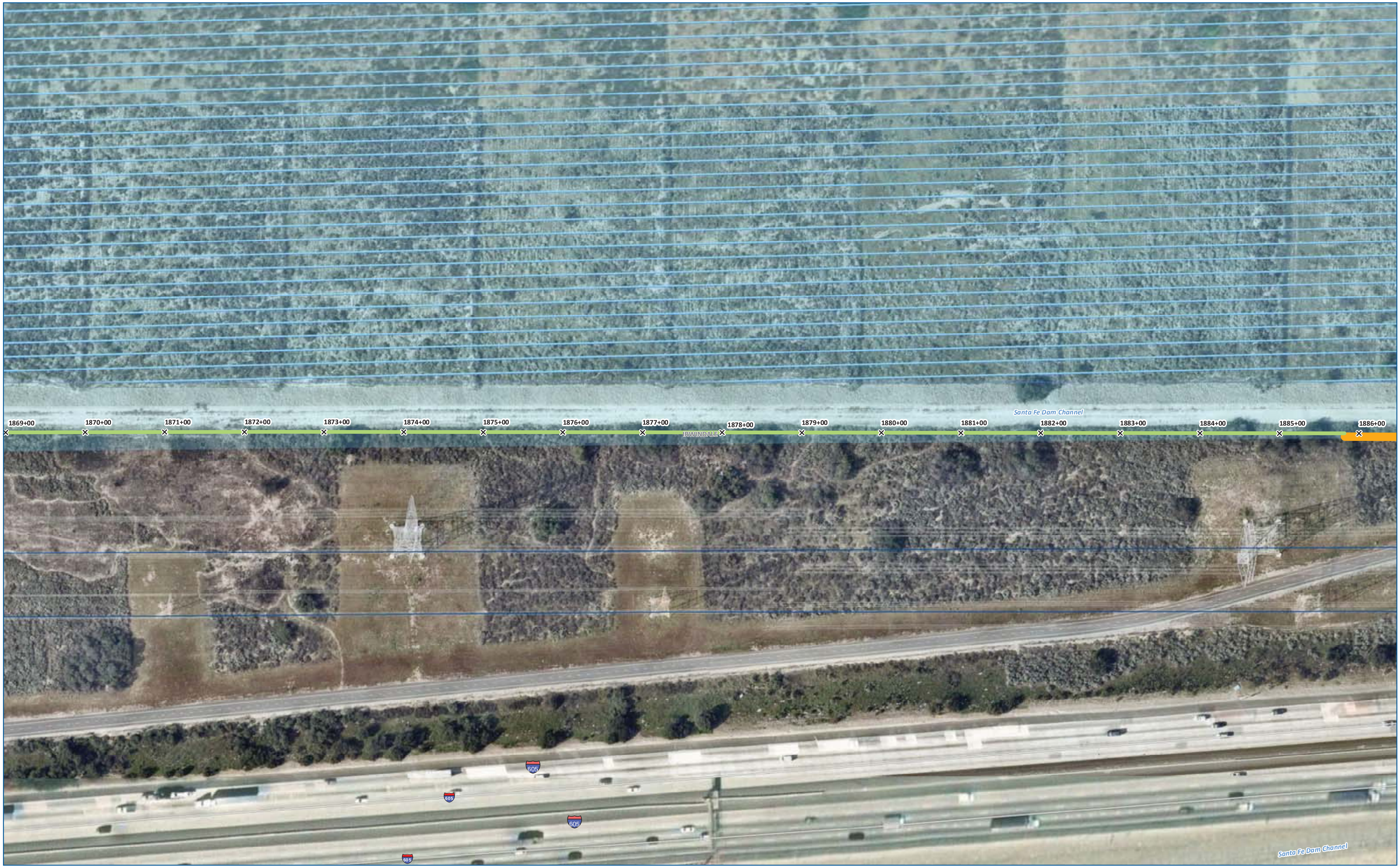

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LA River Alignment, Page 119

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Existing MWD Distribution System
2 - SCE Easements	Jack & Bore	LA County Flood Control District
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Boundaries
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Wetlands
3C - LACFD Easements (Lined River Channel)	Major Utility Crossings	Critical Habitat
Pump Stations	Future IRRP	
	City Utility	

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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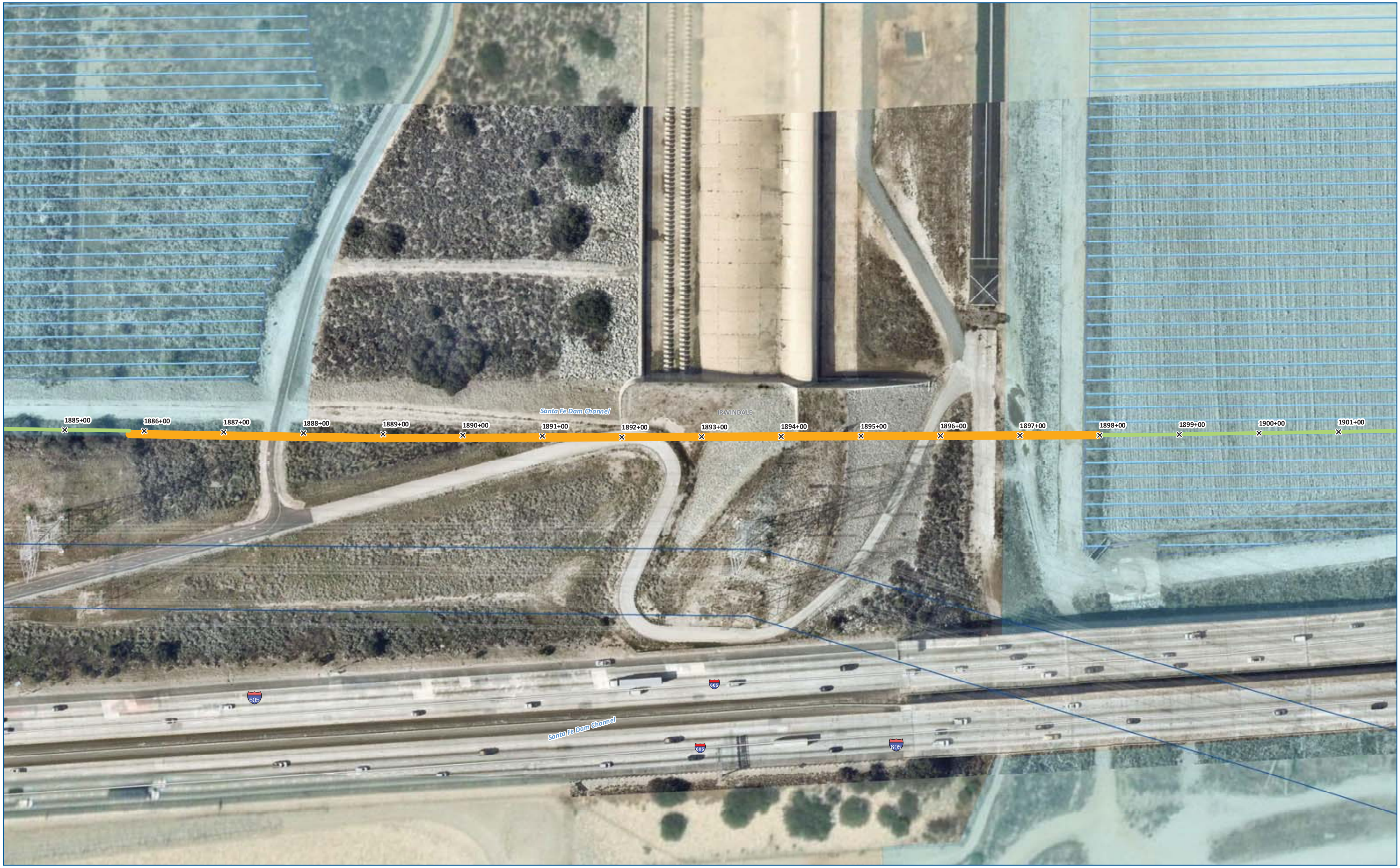

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LA River Alignment, Page 120

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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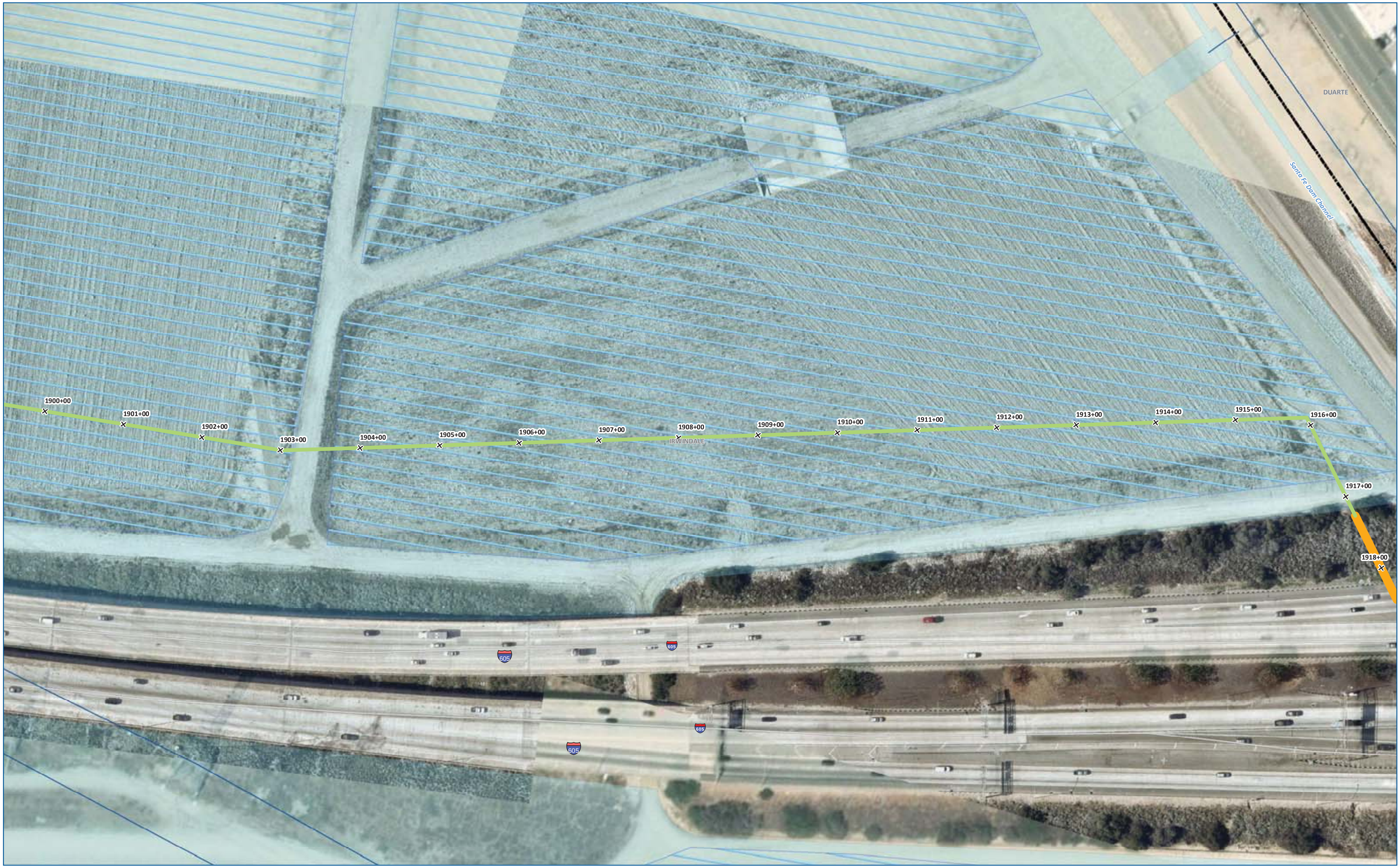

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LA River Alignment, Page 121

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program Los Angeles River Alignment

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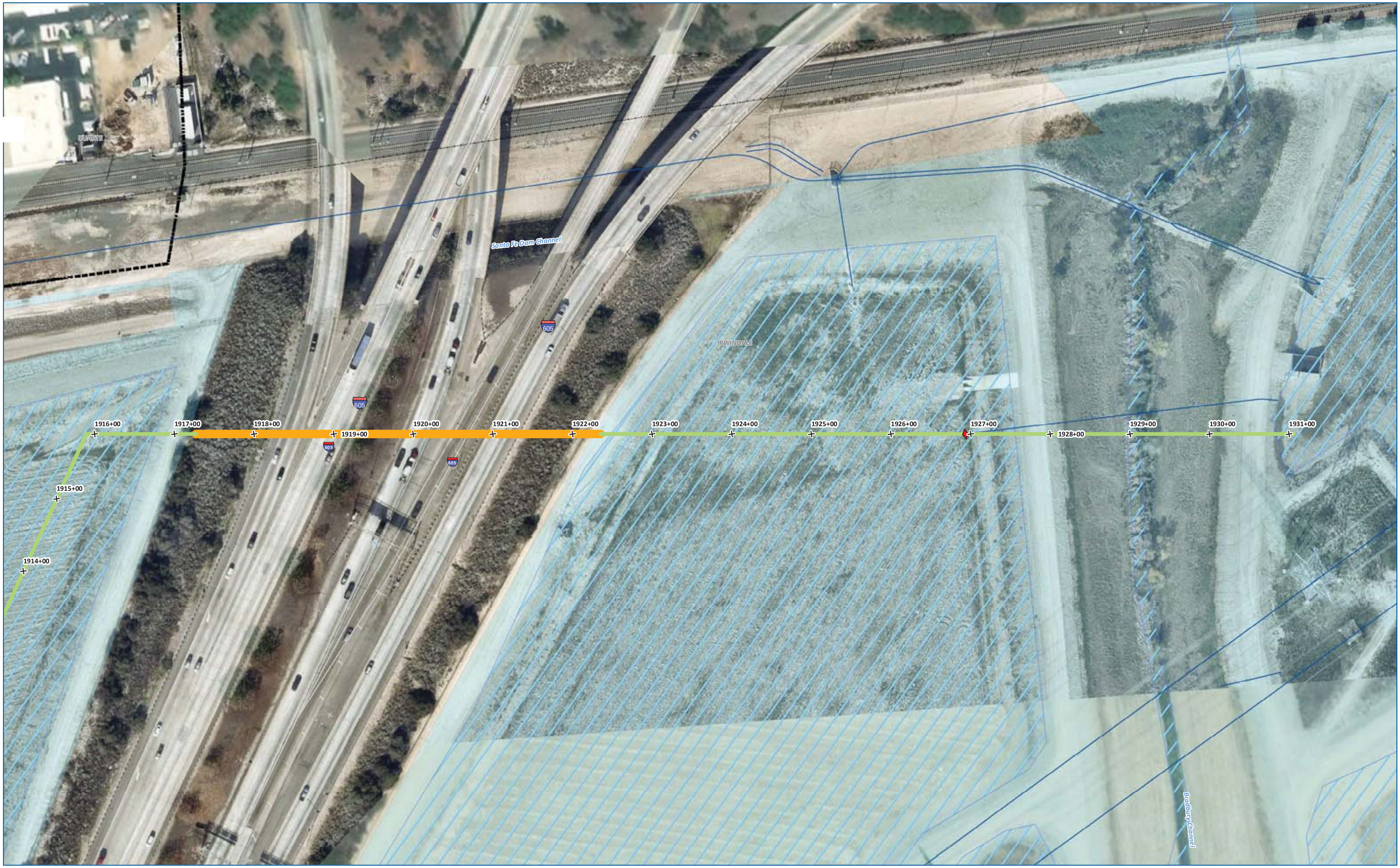

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LA River Alignment, Page 122

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel
- Major Utility Crossings
- Future IRRP
- City Utility

- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
Los Angeles River Alignment

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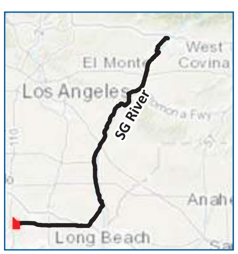

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SG River Alignment, Page 1

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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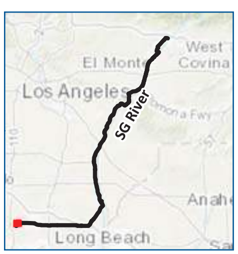

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SG River Alignment, Page 2

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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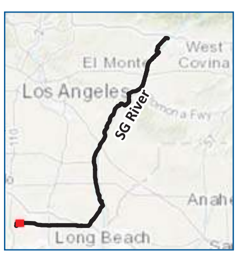

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SG River Alignment, Page 3

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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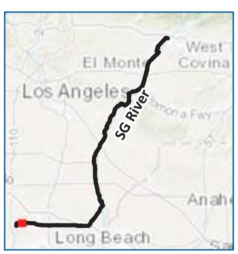

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SG River Alignment, Page 4

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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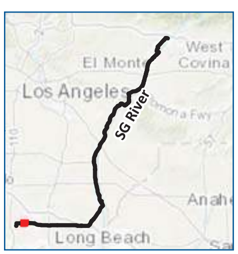

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SG River Alignment, Page 5

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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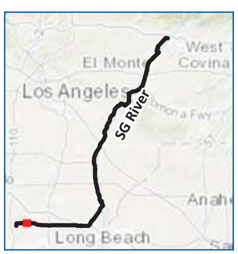

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SG River Alignment, Page 6

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 7

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 8

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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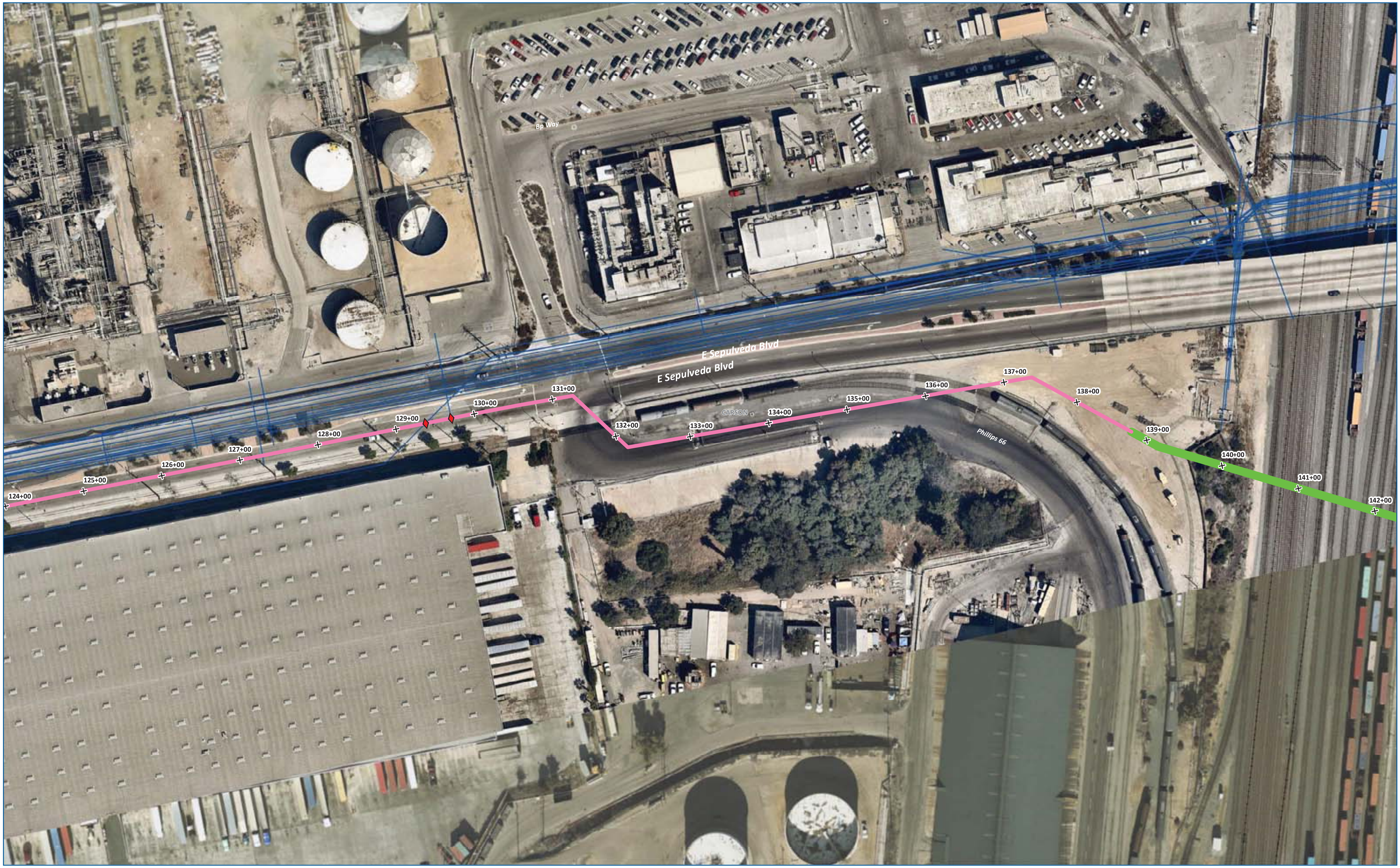

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SG River Alignment, Page 9

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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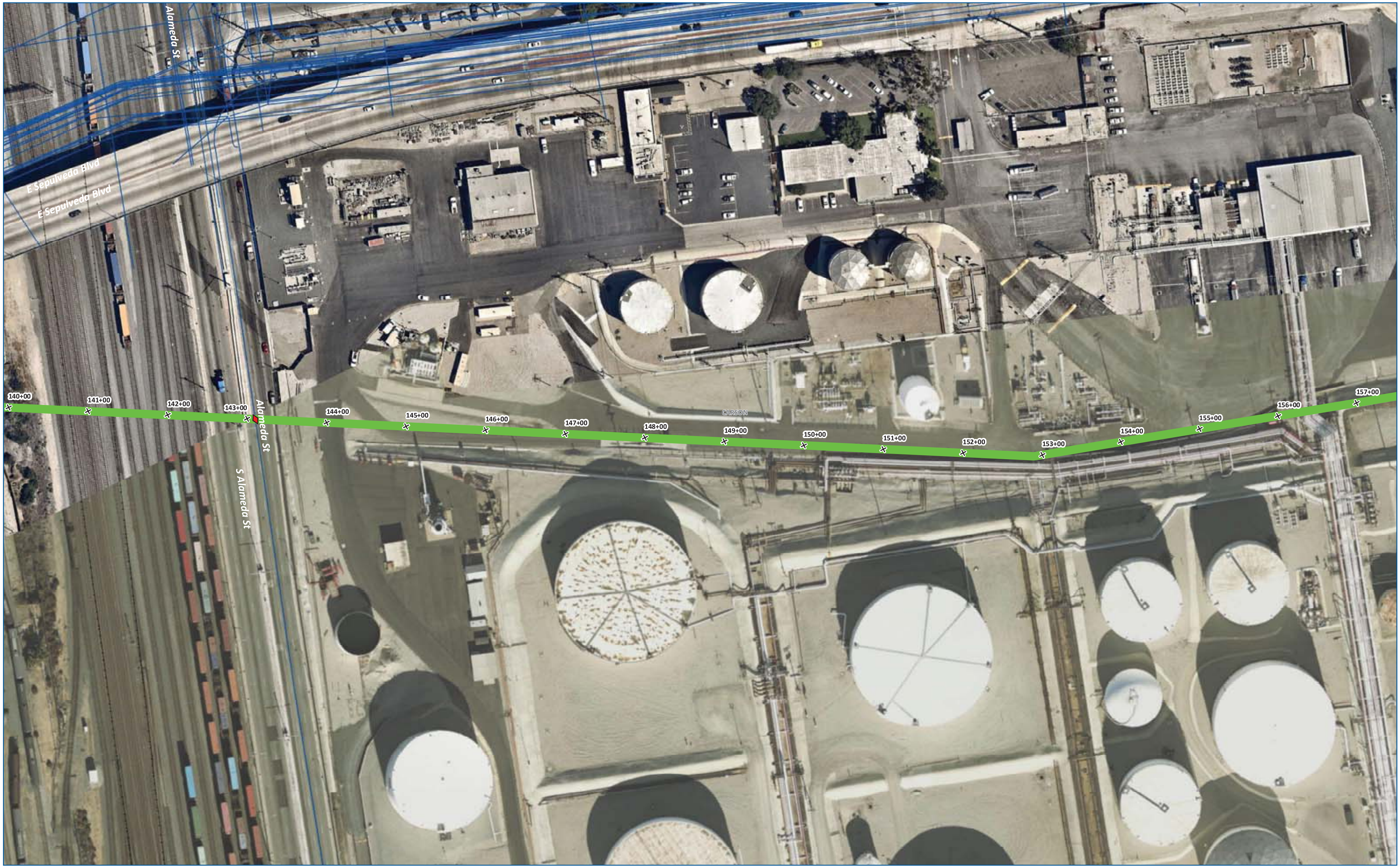

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SG River Alignment, Page 10

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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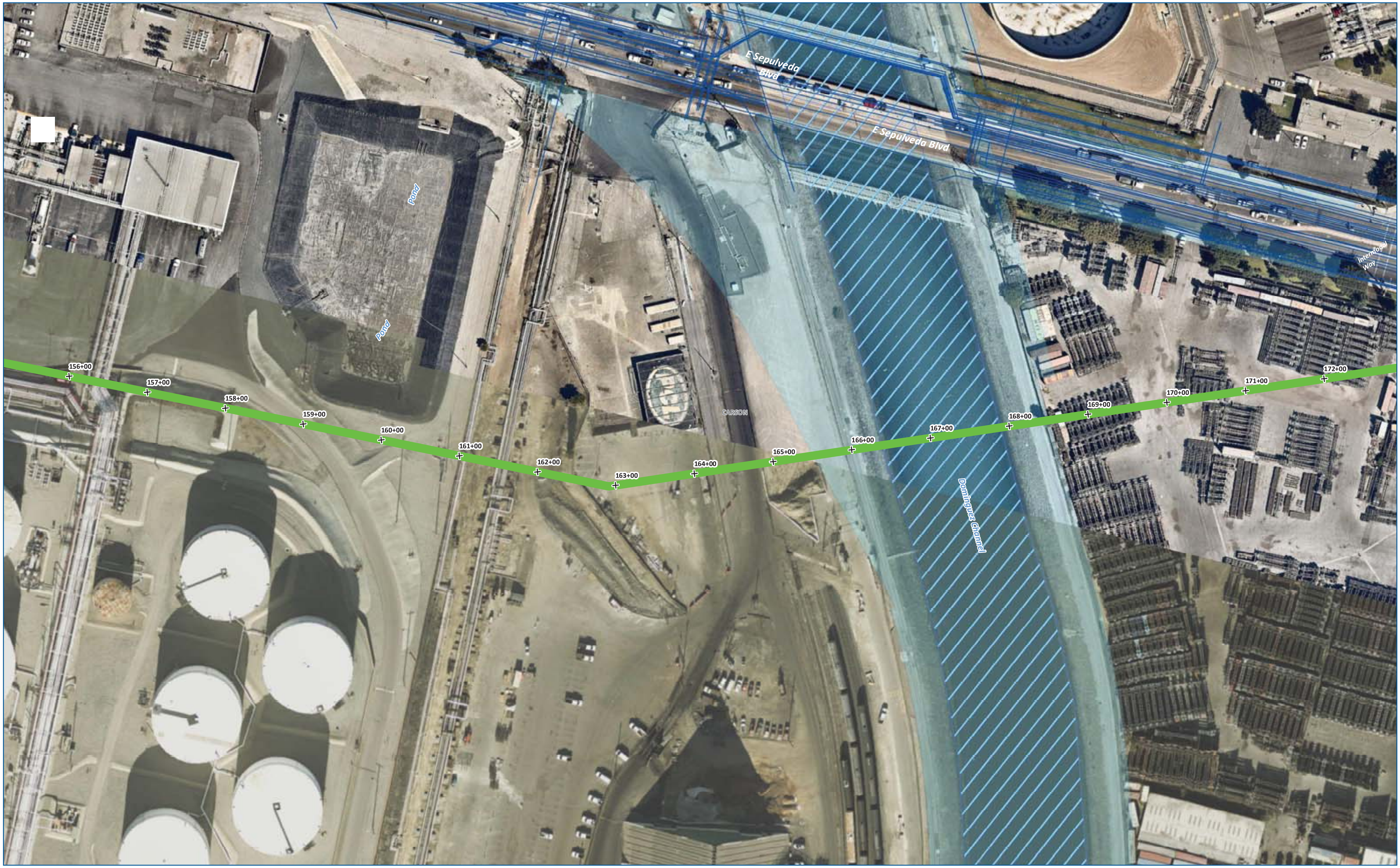

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SG River Alignment, Page 11

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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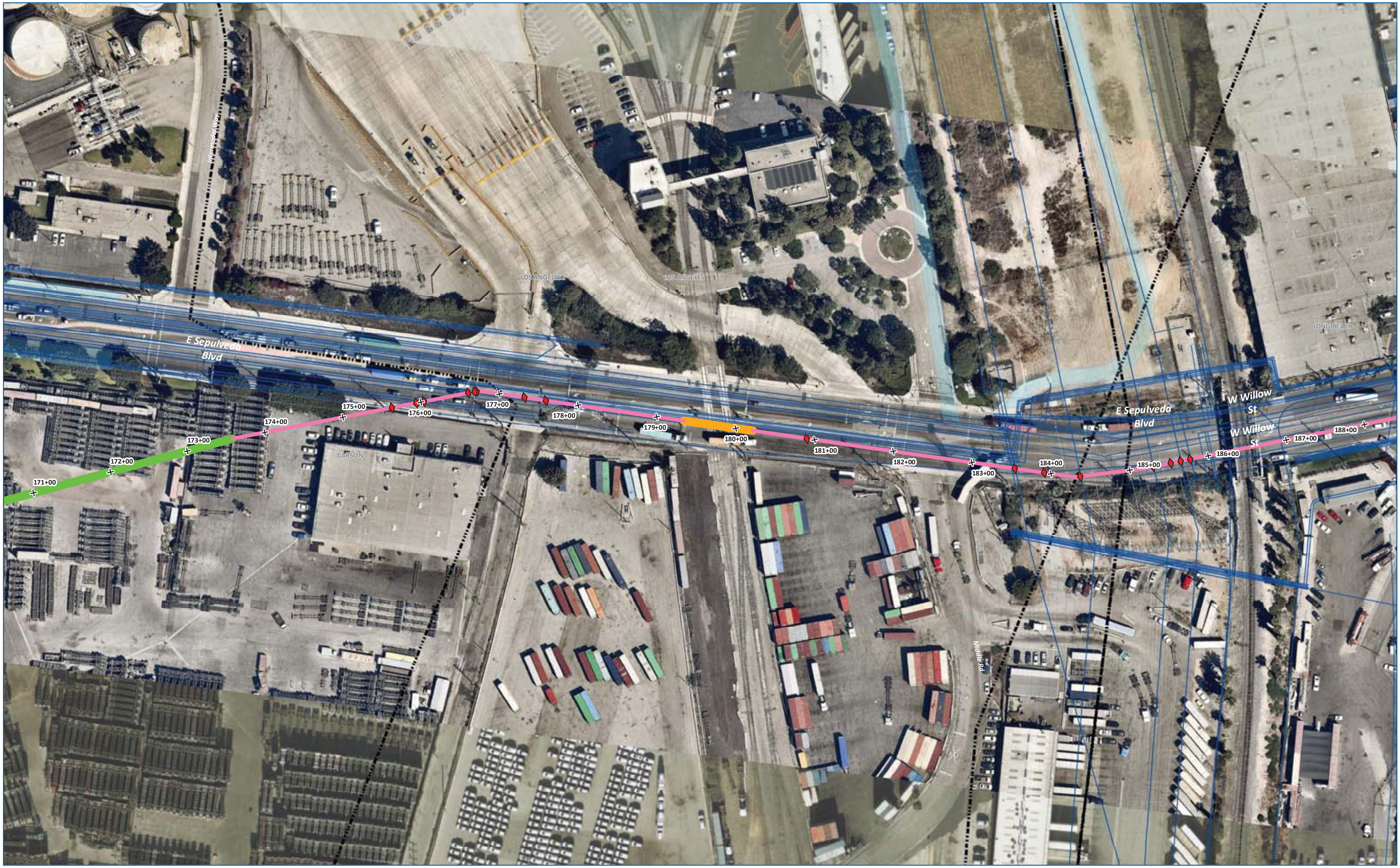

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SG River Alignment, Page 12

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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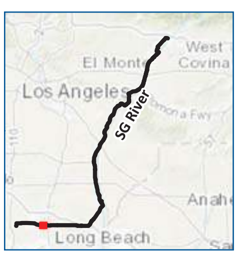

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SG River Alignment, Page 13

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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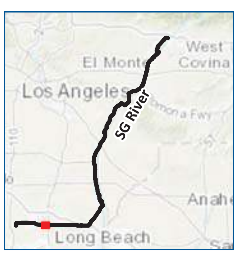

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SG River Alignment, Page 14

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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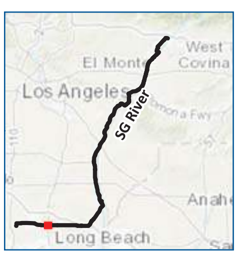

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SG River Alignment, Page 15

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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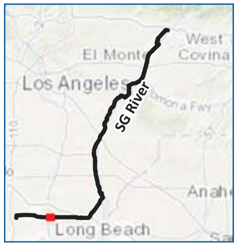

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SG River Alignment, Page 16

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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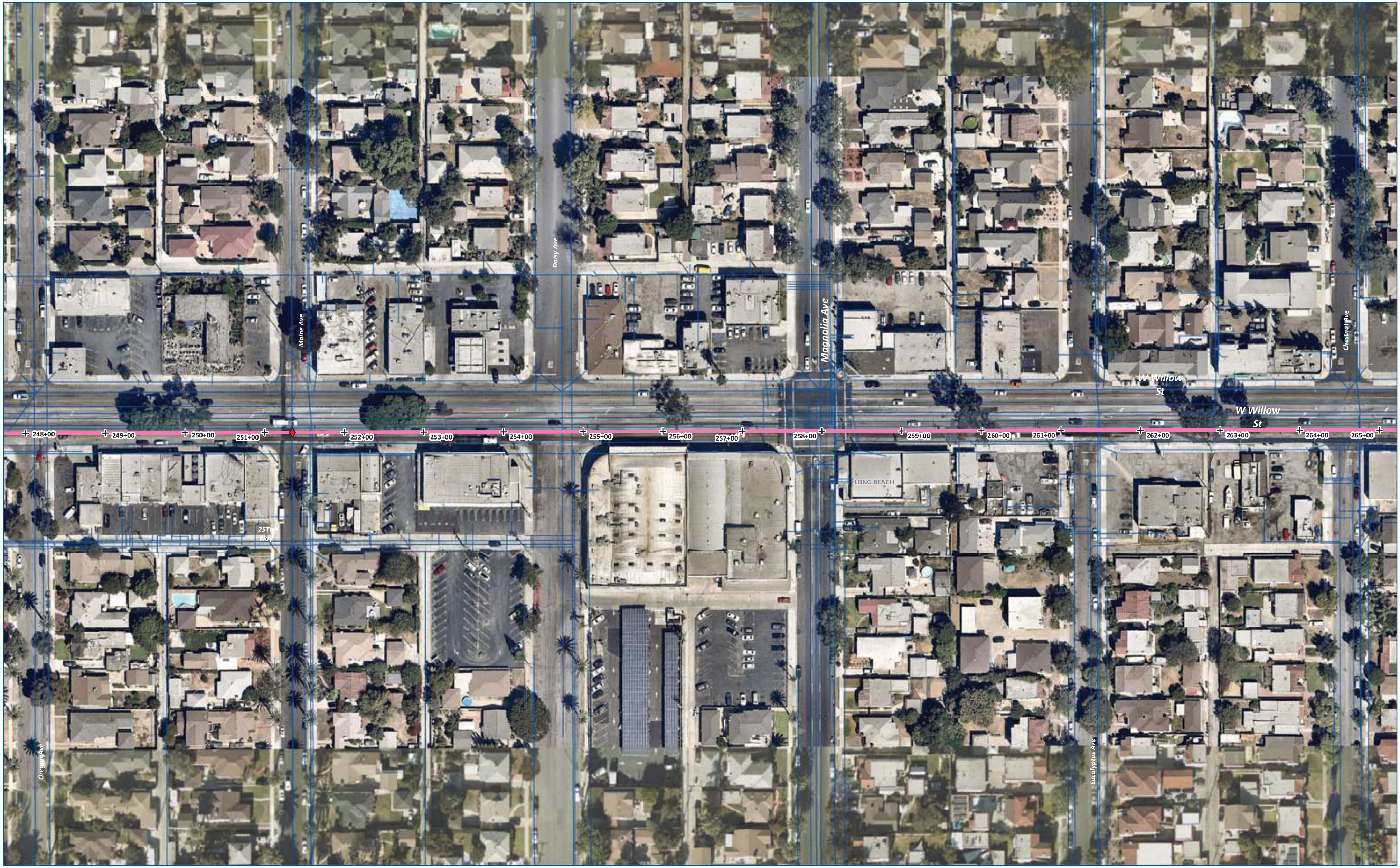

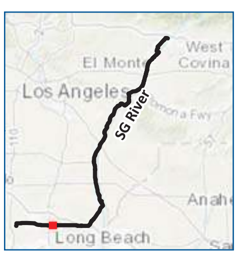

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SG River Alignment, Page 17

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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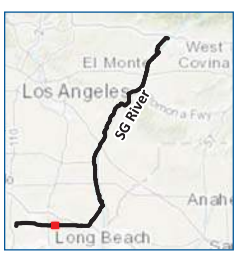

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SG River Alignment, Page 18

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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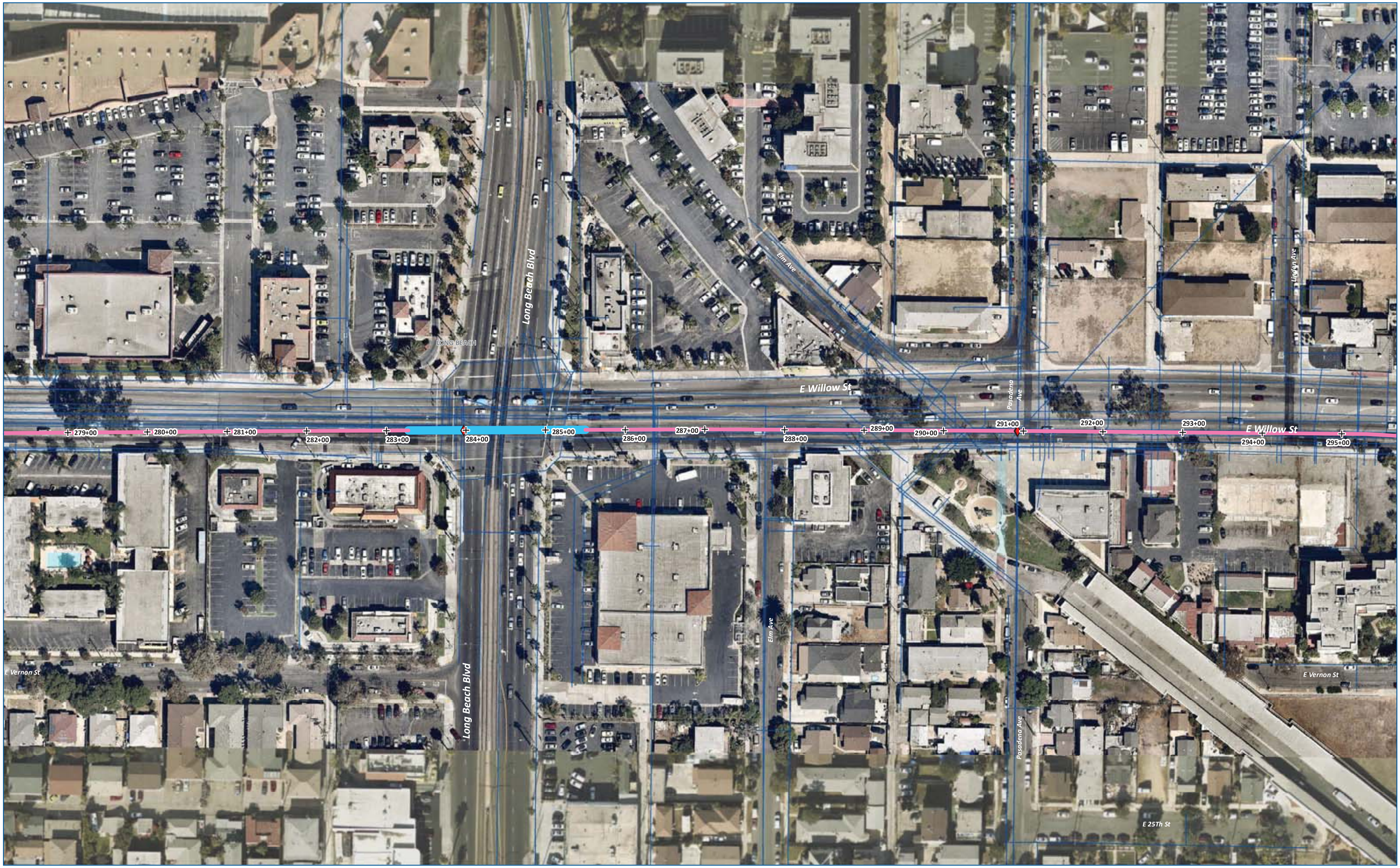

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SG River Alignment, Page 19

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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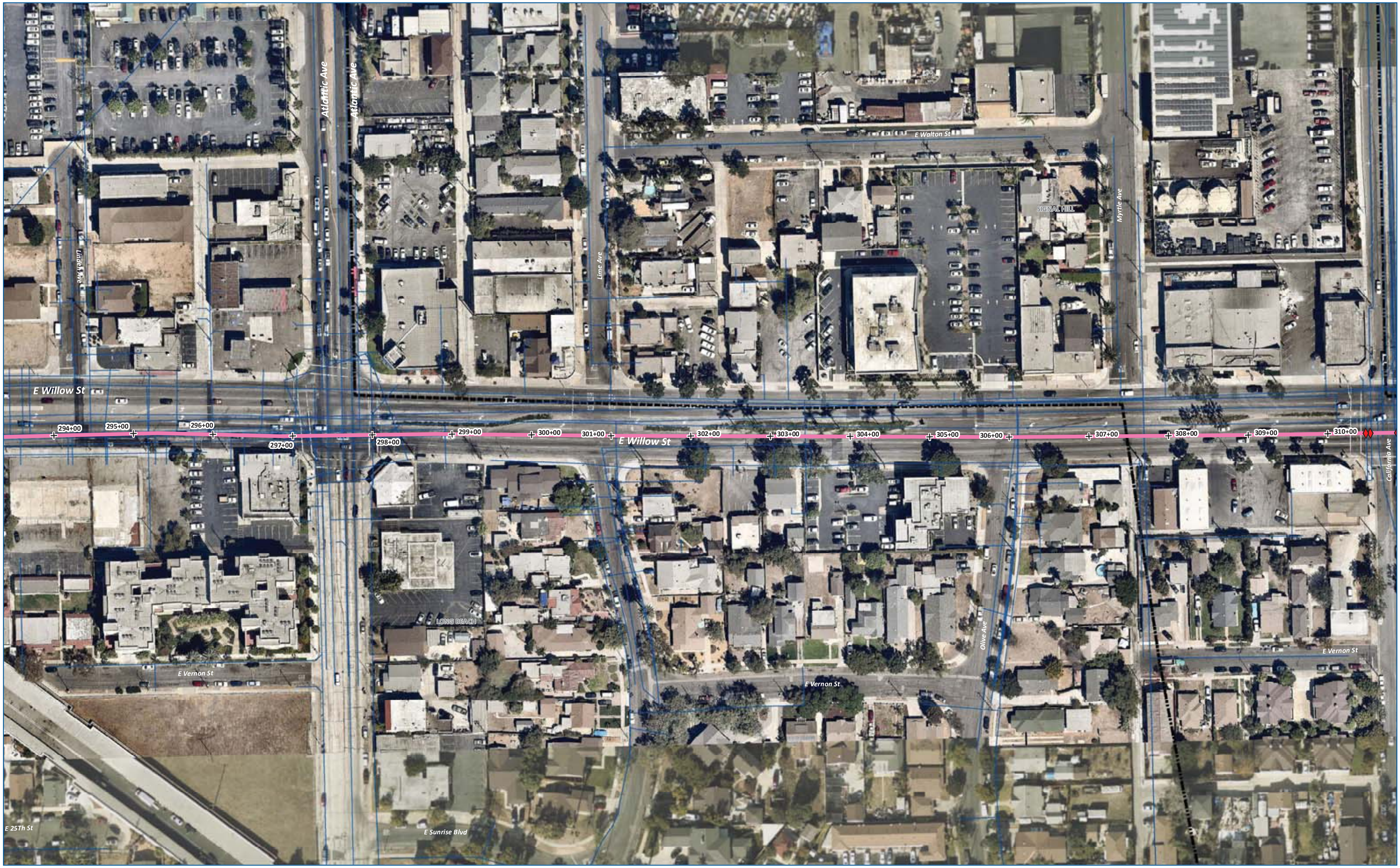

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SG River Alignment, Page 20

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 21

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 22

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 23

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 24

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 25

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
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- City Utility
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- City Boundaries
- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 26

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 27

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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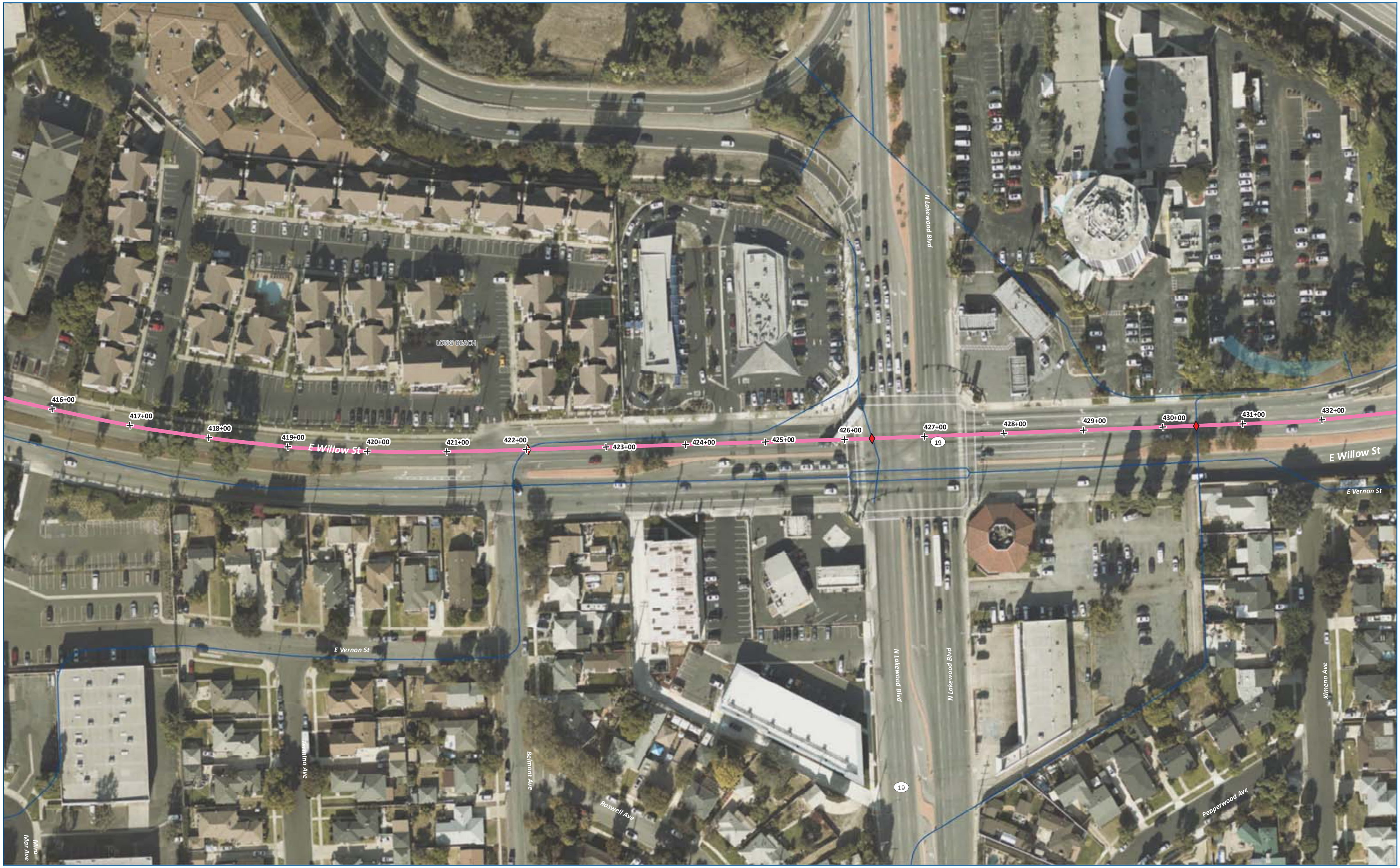

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SG River Alignment, Page 28

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 29

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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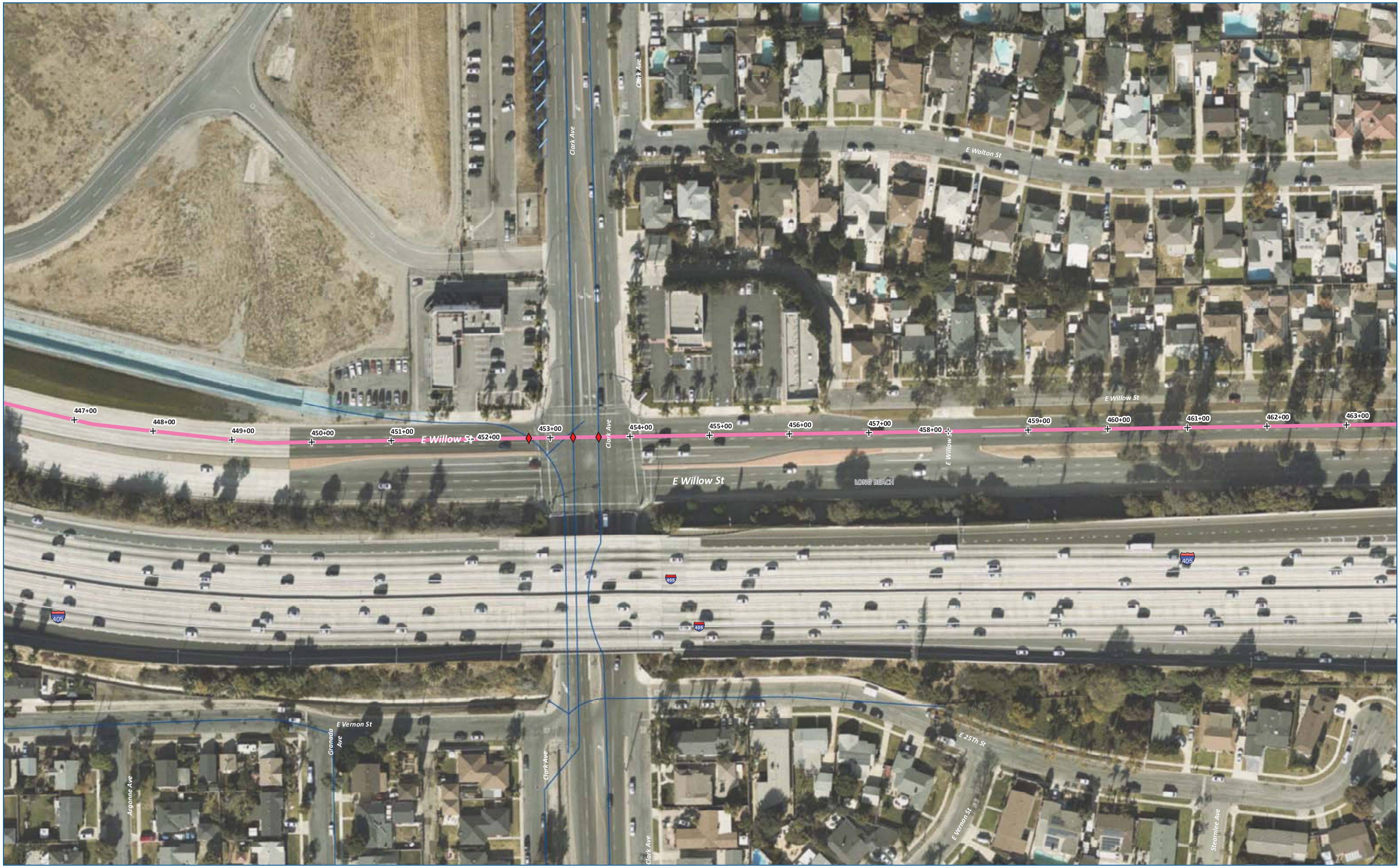

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SG River Alignment, Page 30

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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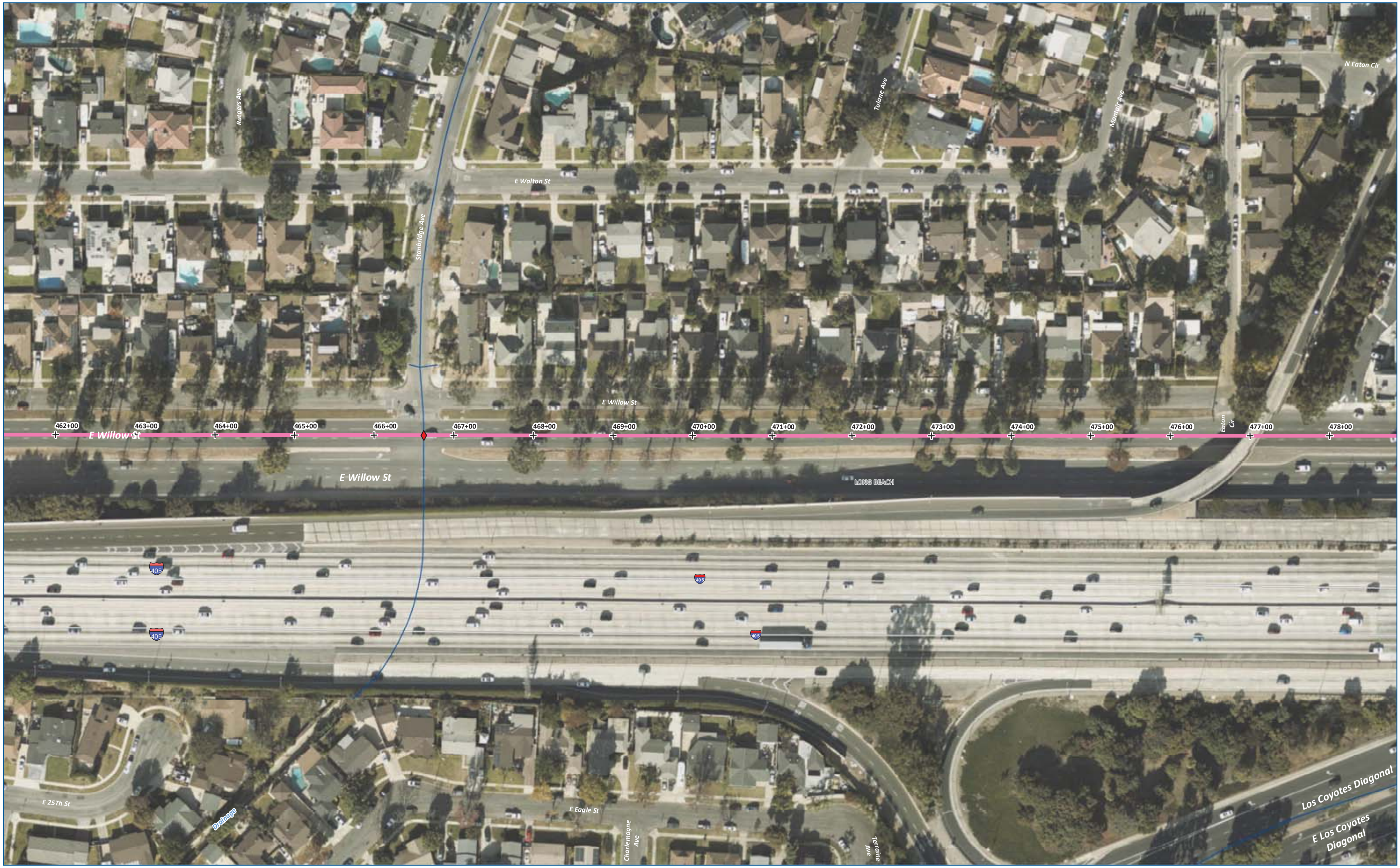

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SG River Alignment, Page 31

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 32

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 33

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 34

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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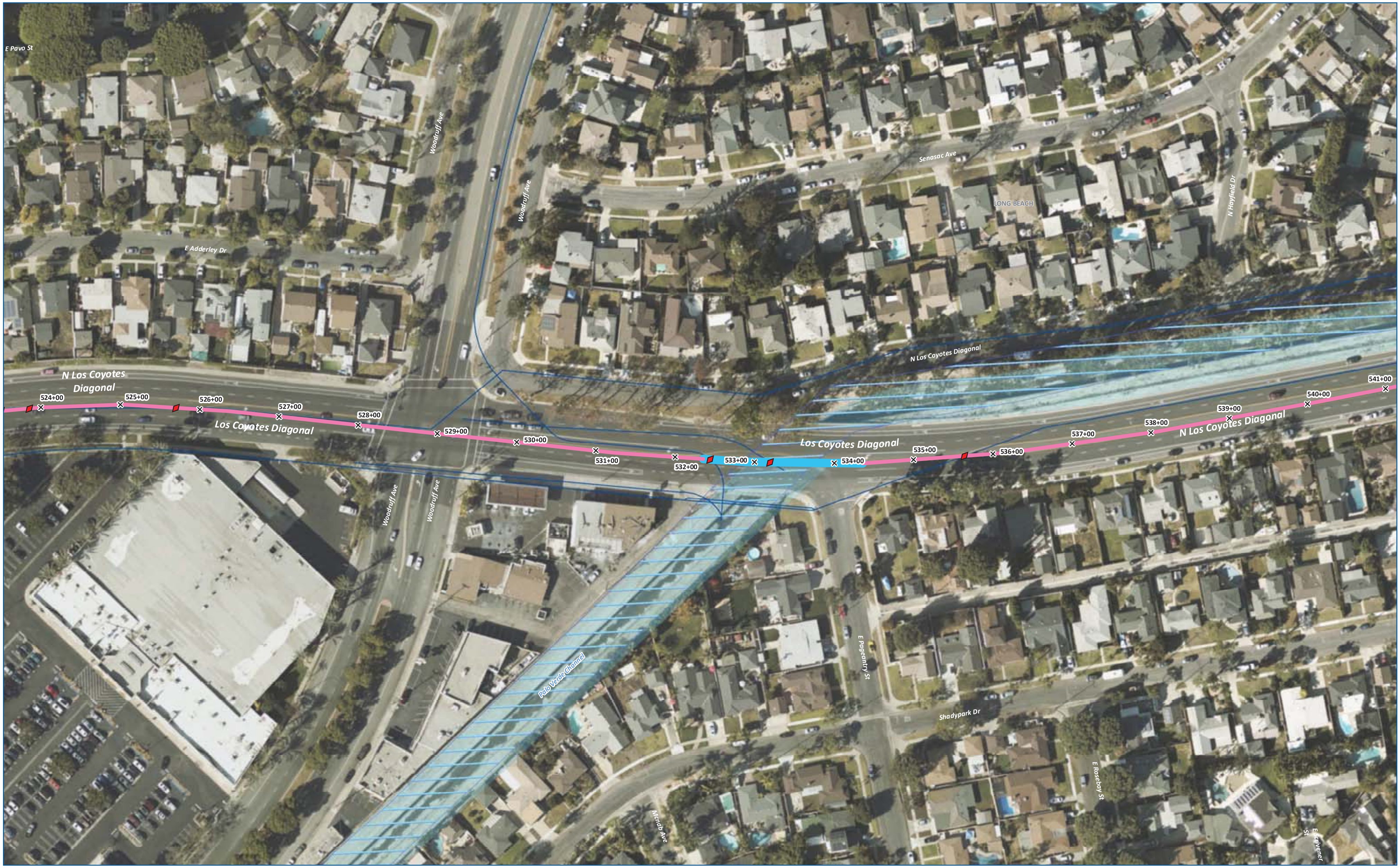

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SG River Alignment, Page 35

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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Feet

SG River Alignment, Page 36

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 37

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
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3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 38

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
- Traditional Tunnel
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- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 39

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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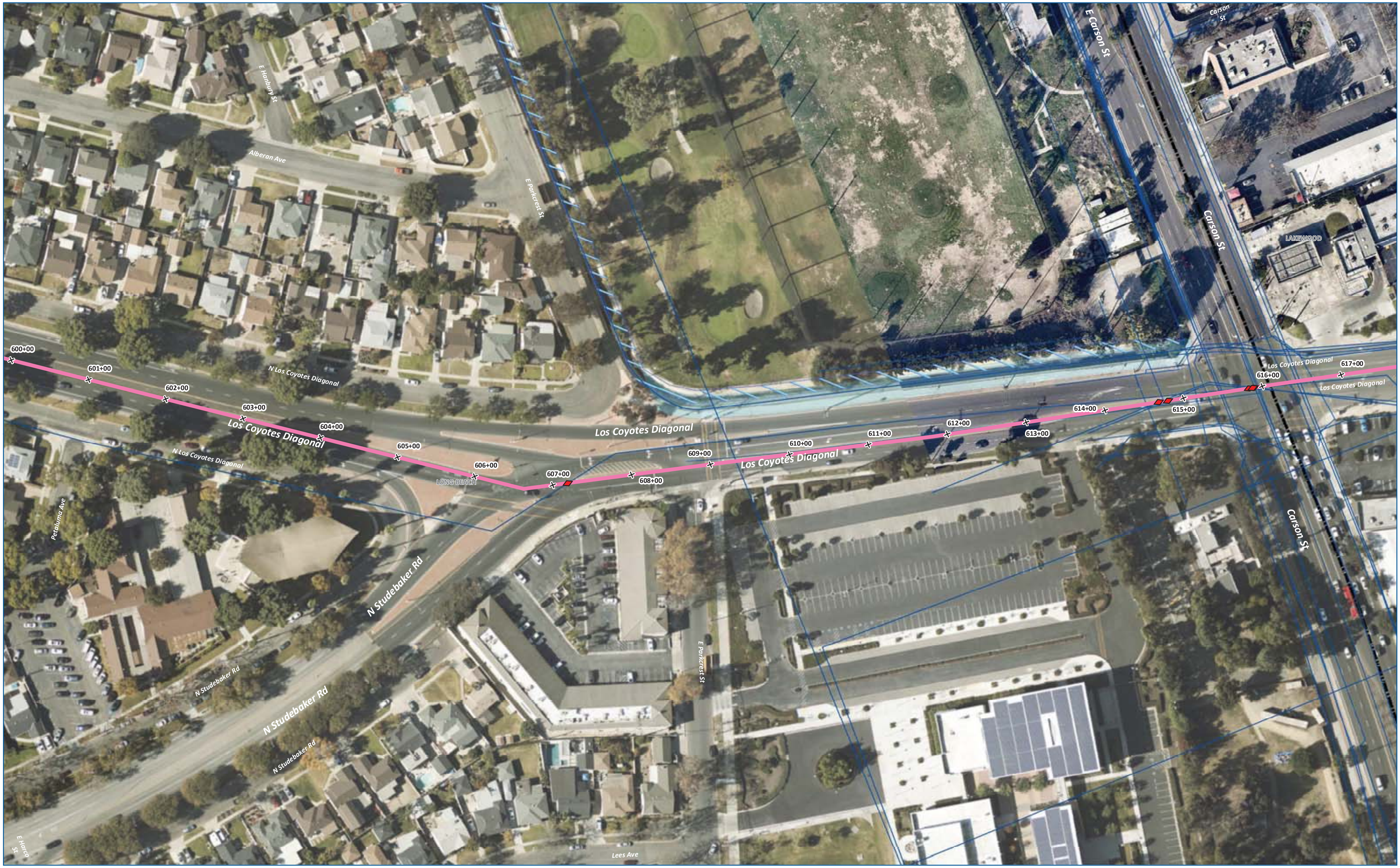

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SG River Alignment, Page 40

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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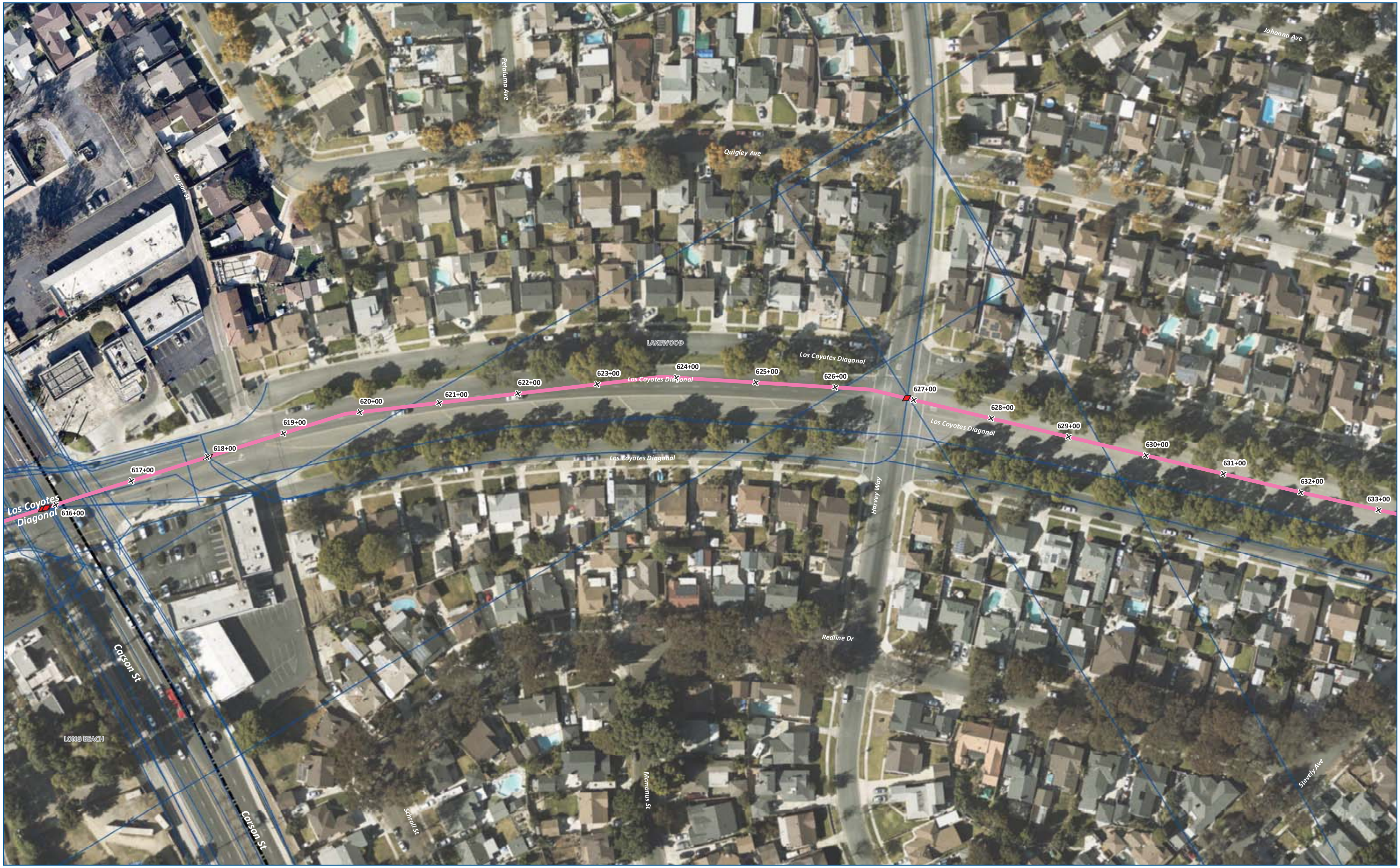

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SG River Alignment, Page 41

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 42

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 43

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 44

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
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- City Boundaries
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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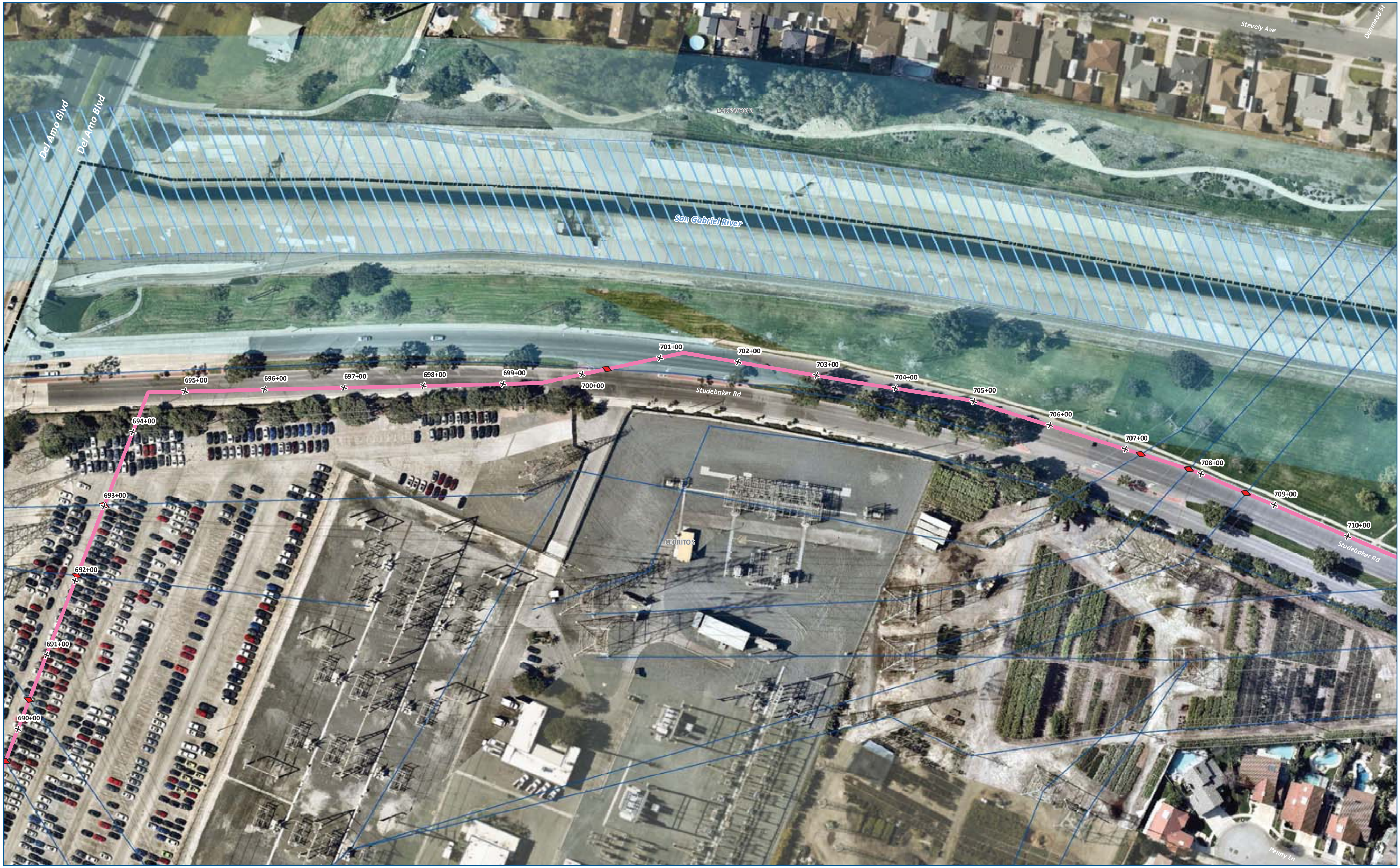

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SG River Alignment, Page 45

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 46

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Microtunnel

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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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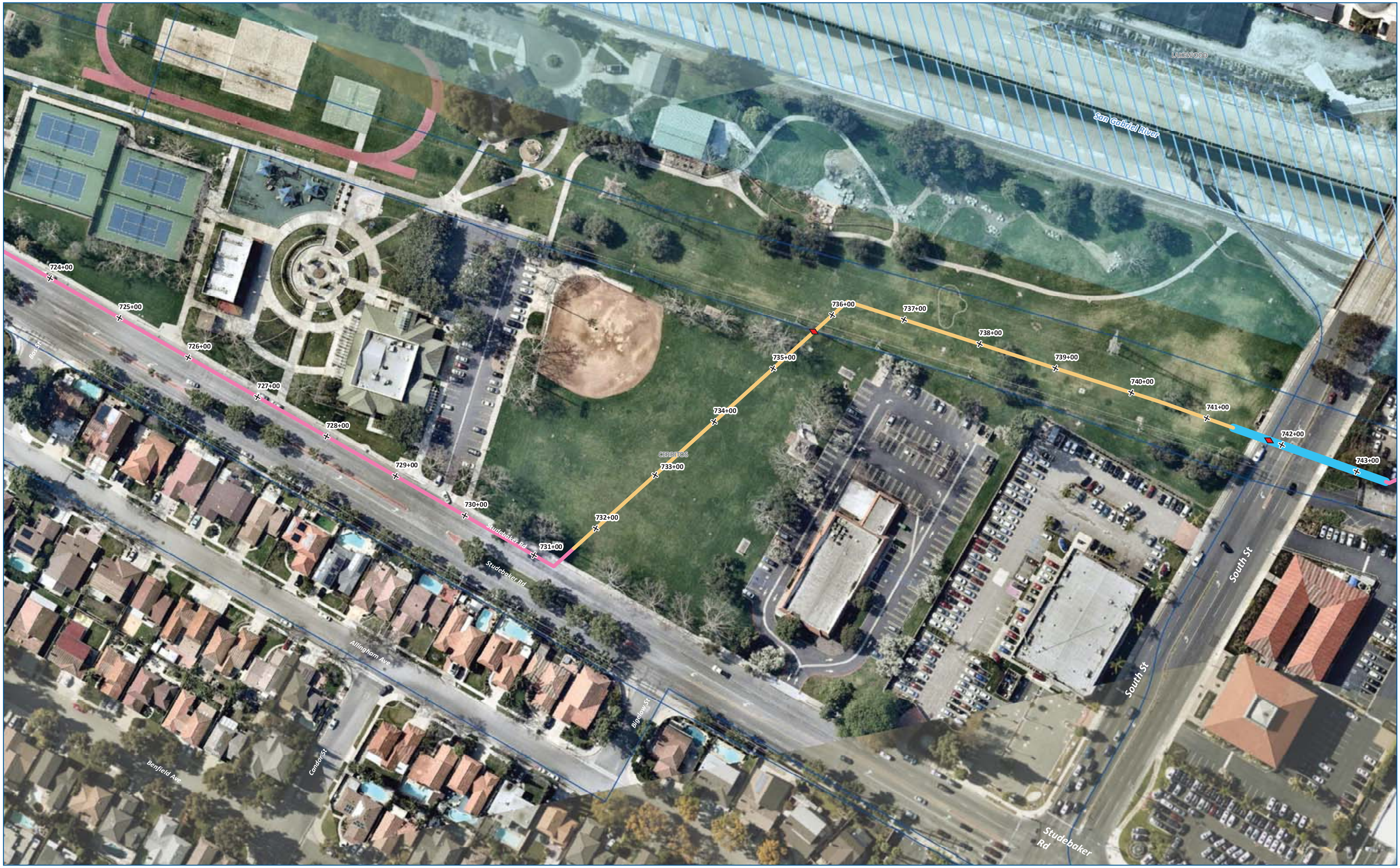

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SG River Alignment, Page 47

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
- Microtunnel

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- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 48

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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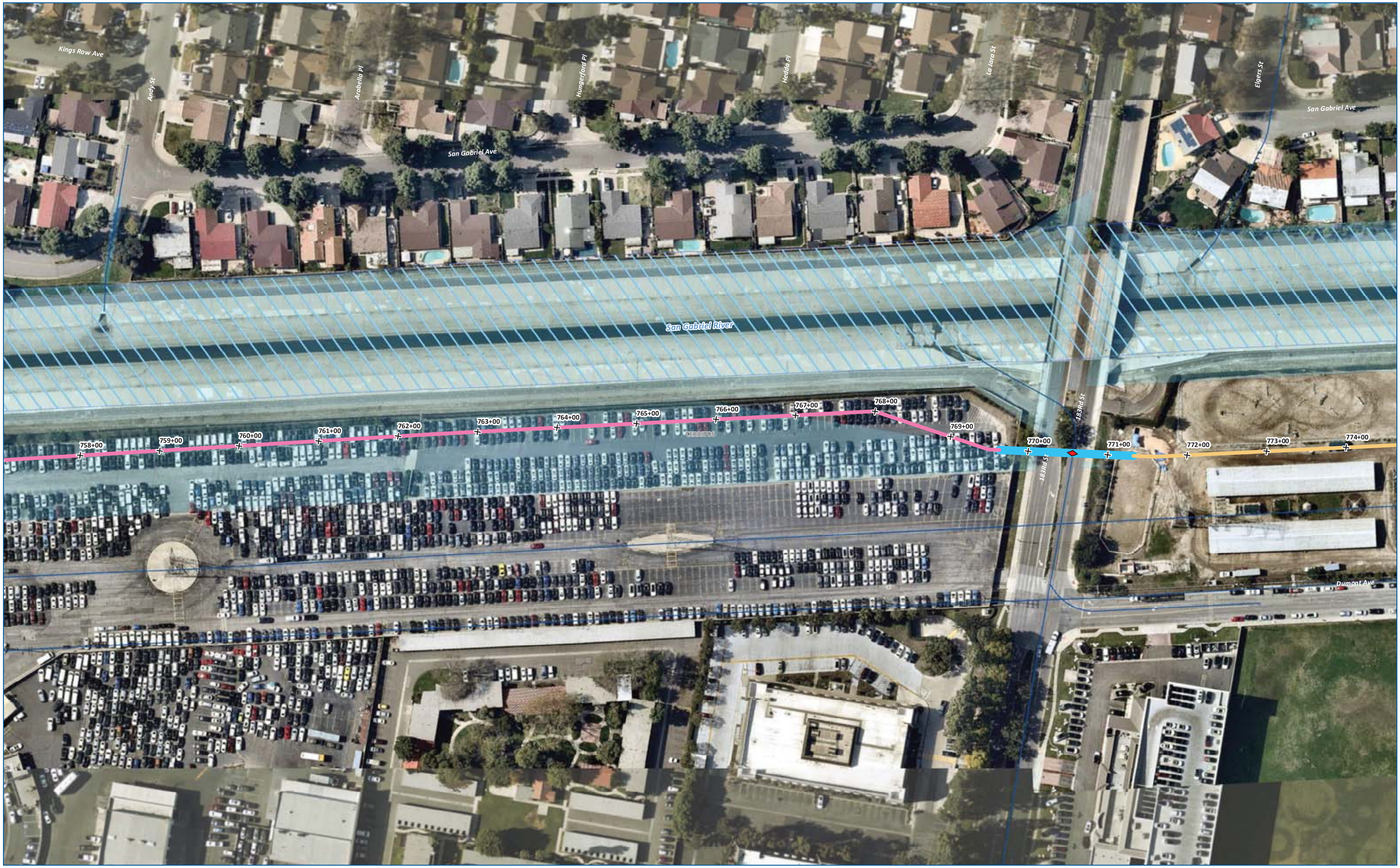

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SG River Alignment, Page 49

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 50

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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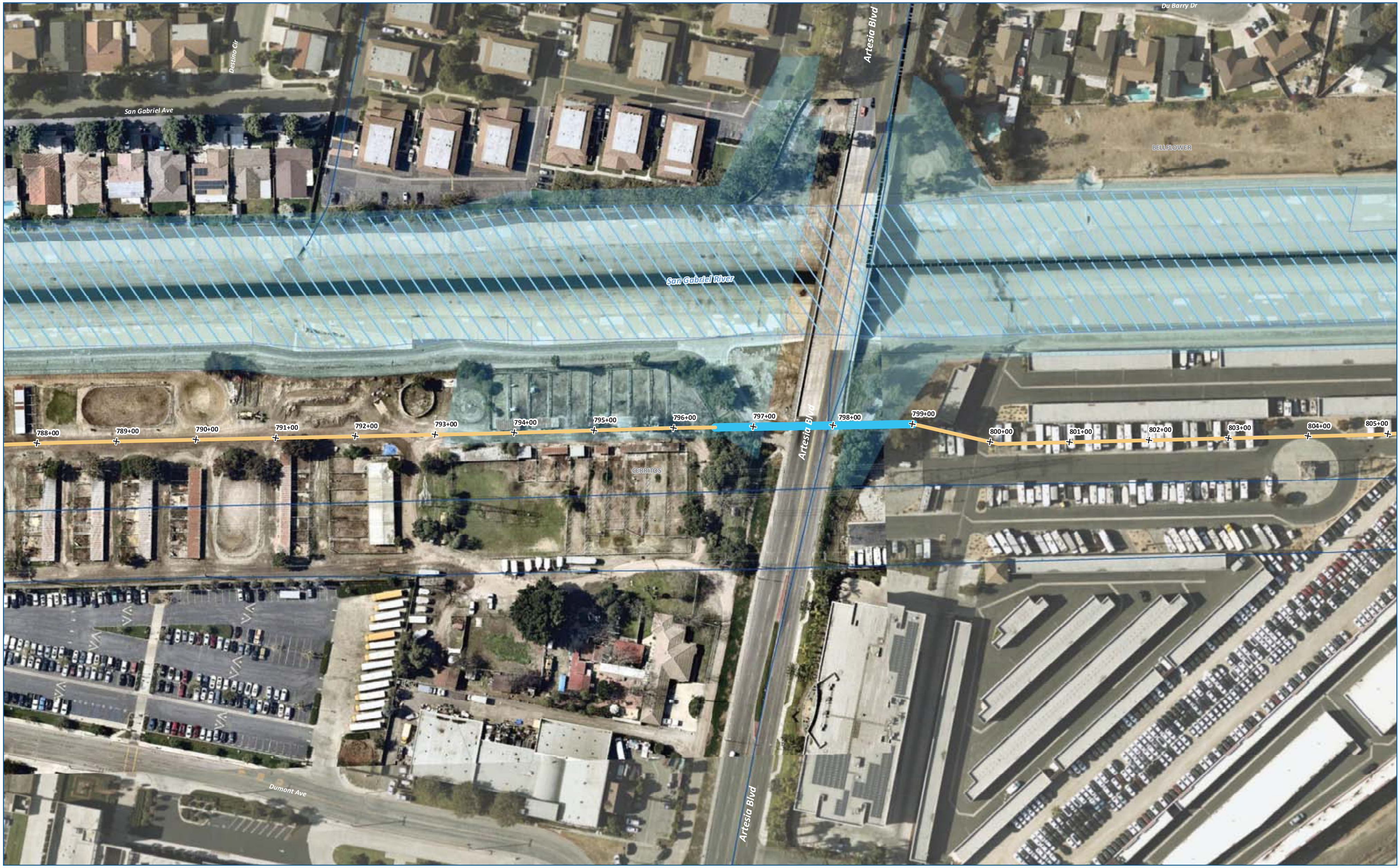

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SG River Alignment, Page 51

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
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- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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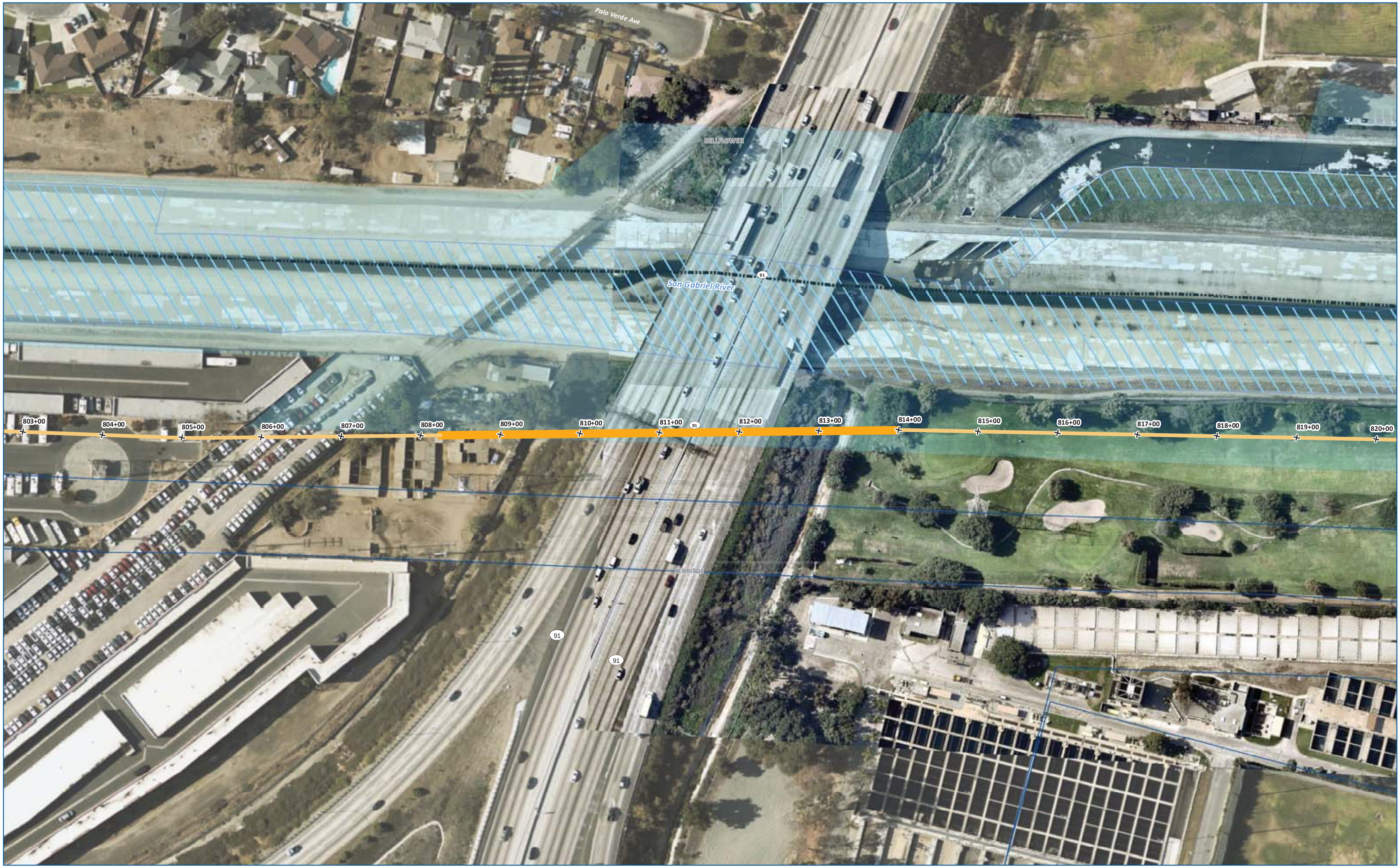

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SG River Alignment, Page 52

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
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- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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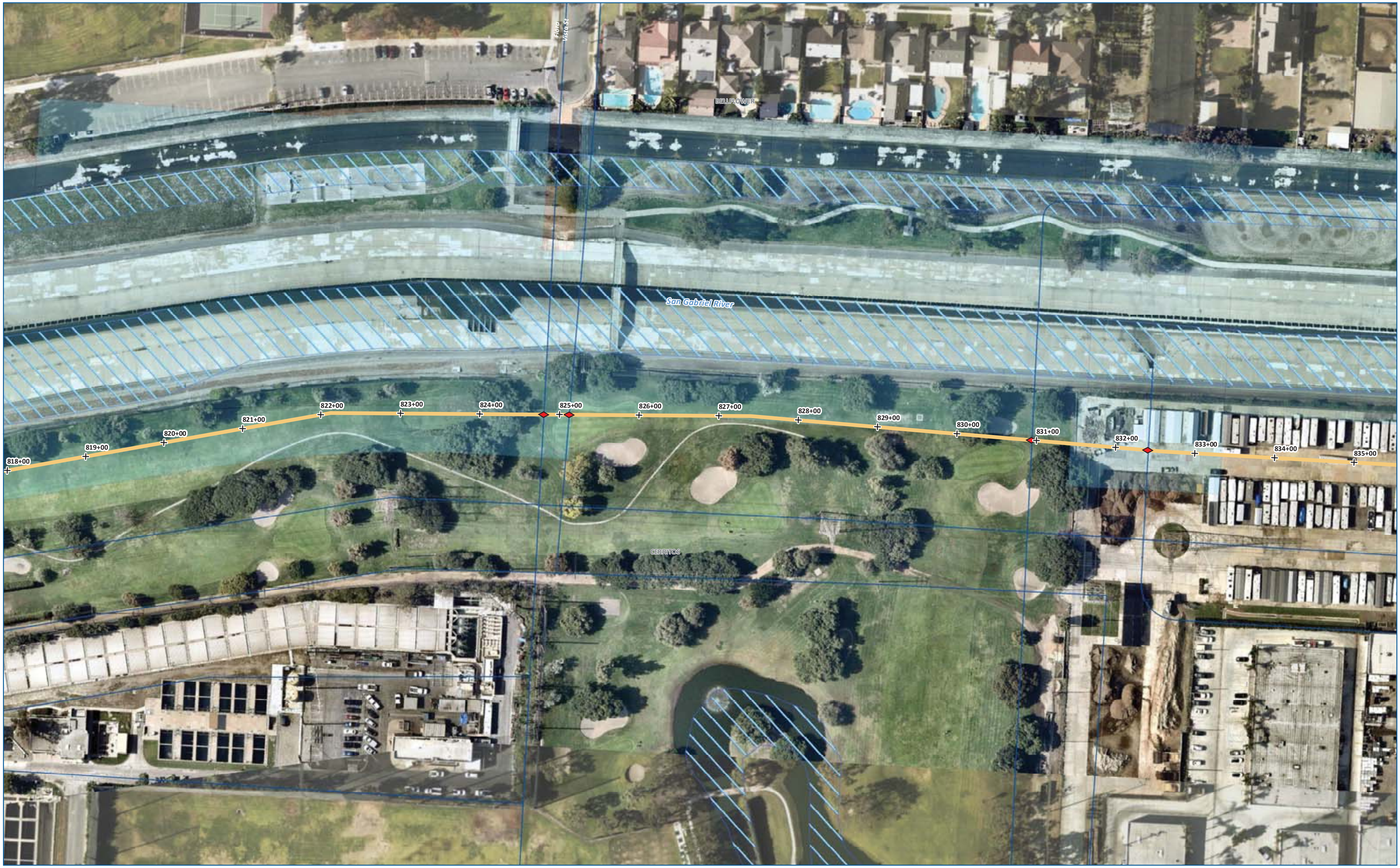

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SG River Alignment, Page 53

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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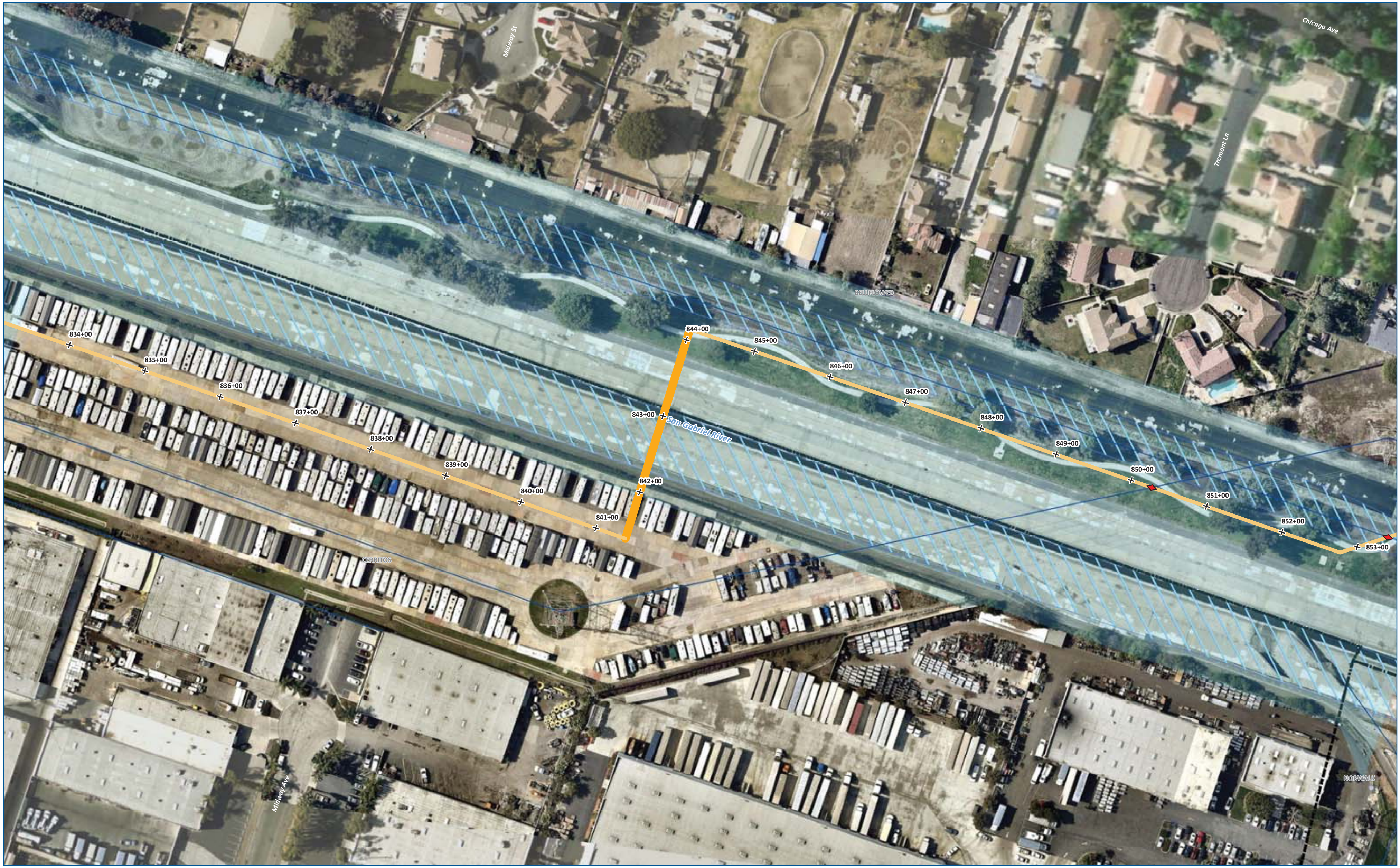

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SG River Alignment, Page 54

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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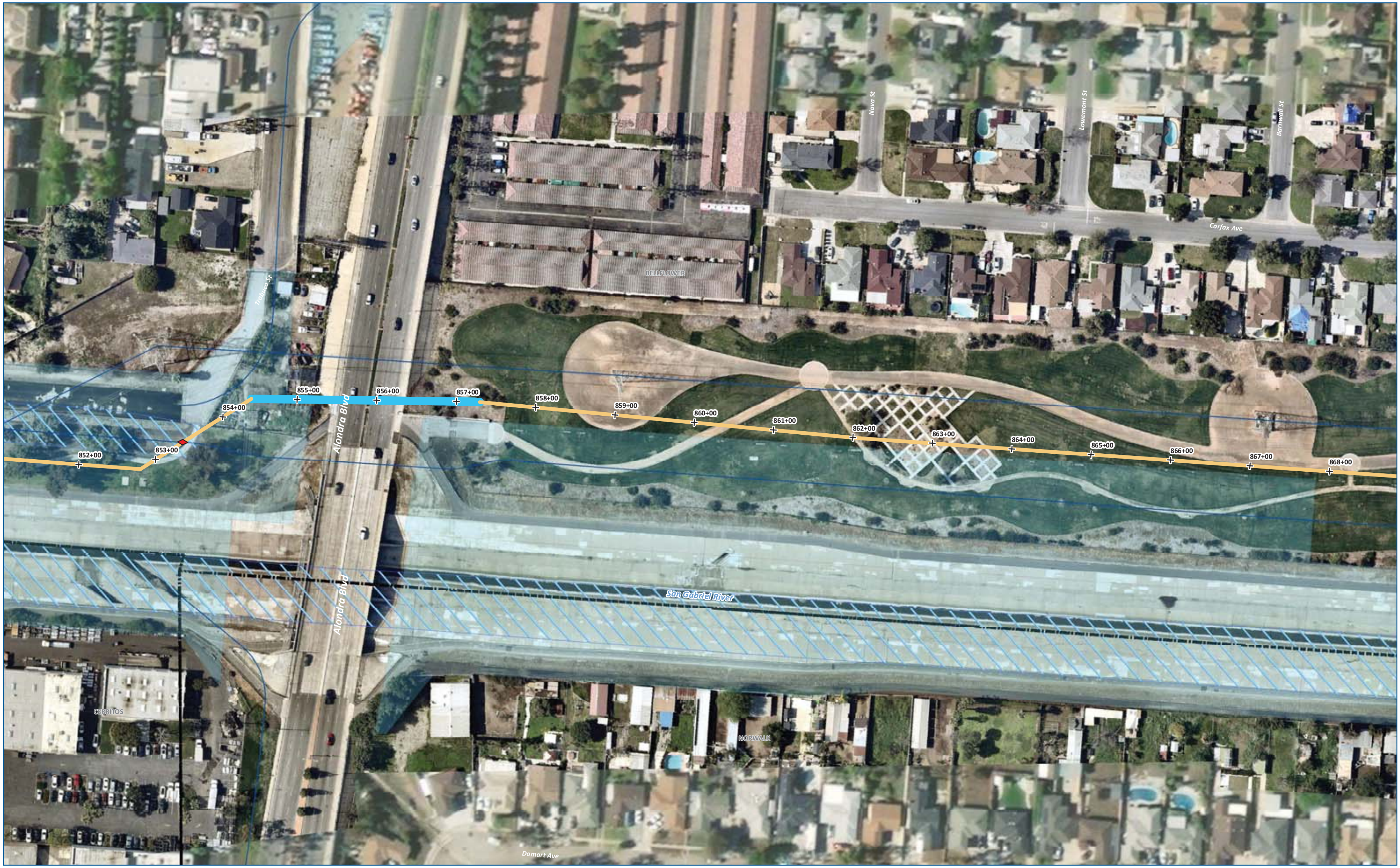

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SG River Alignment, Page 55

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 56

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 57

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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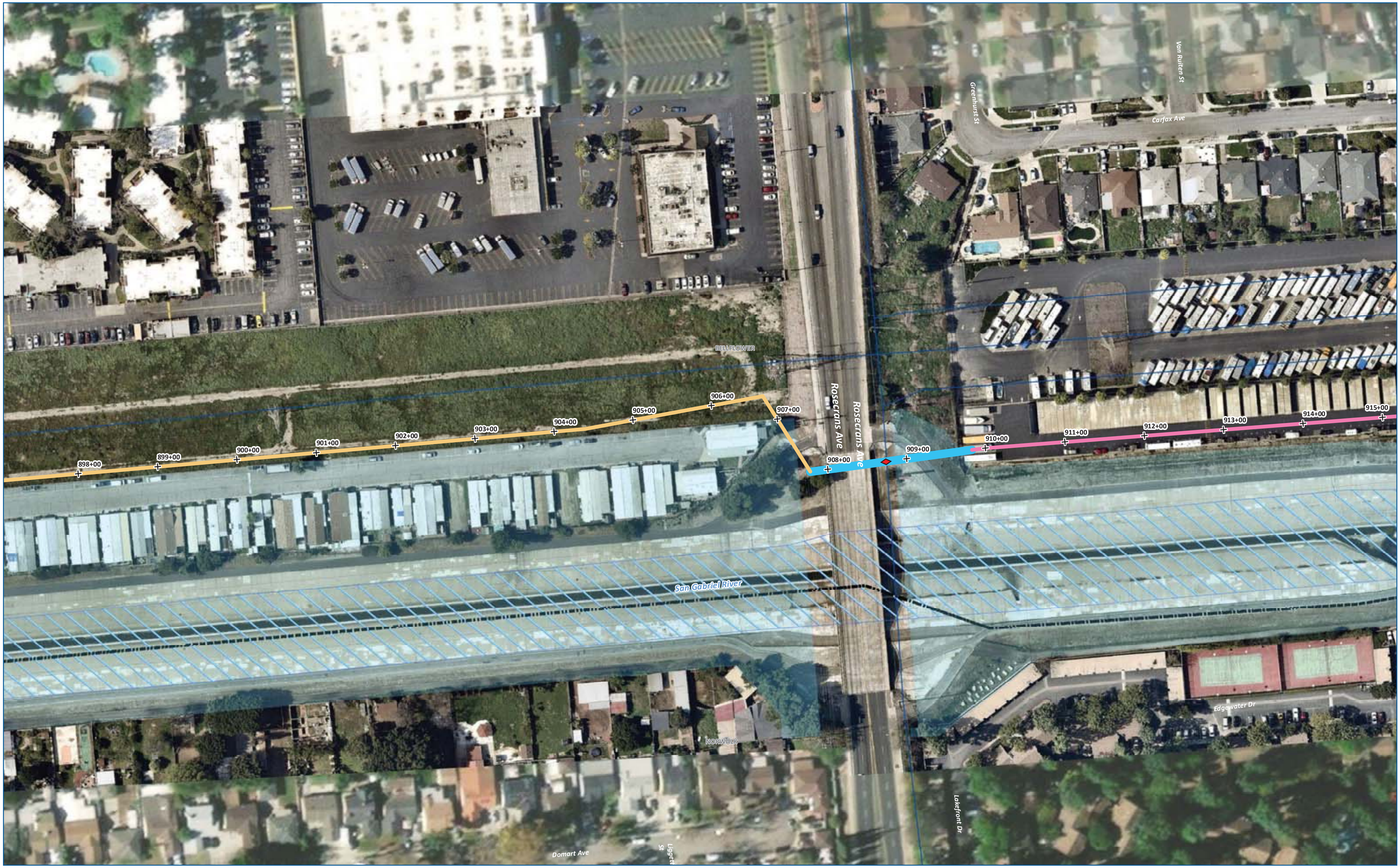

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SG River Alignment, Page 58

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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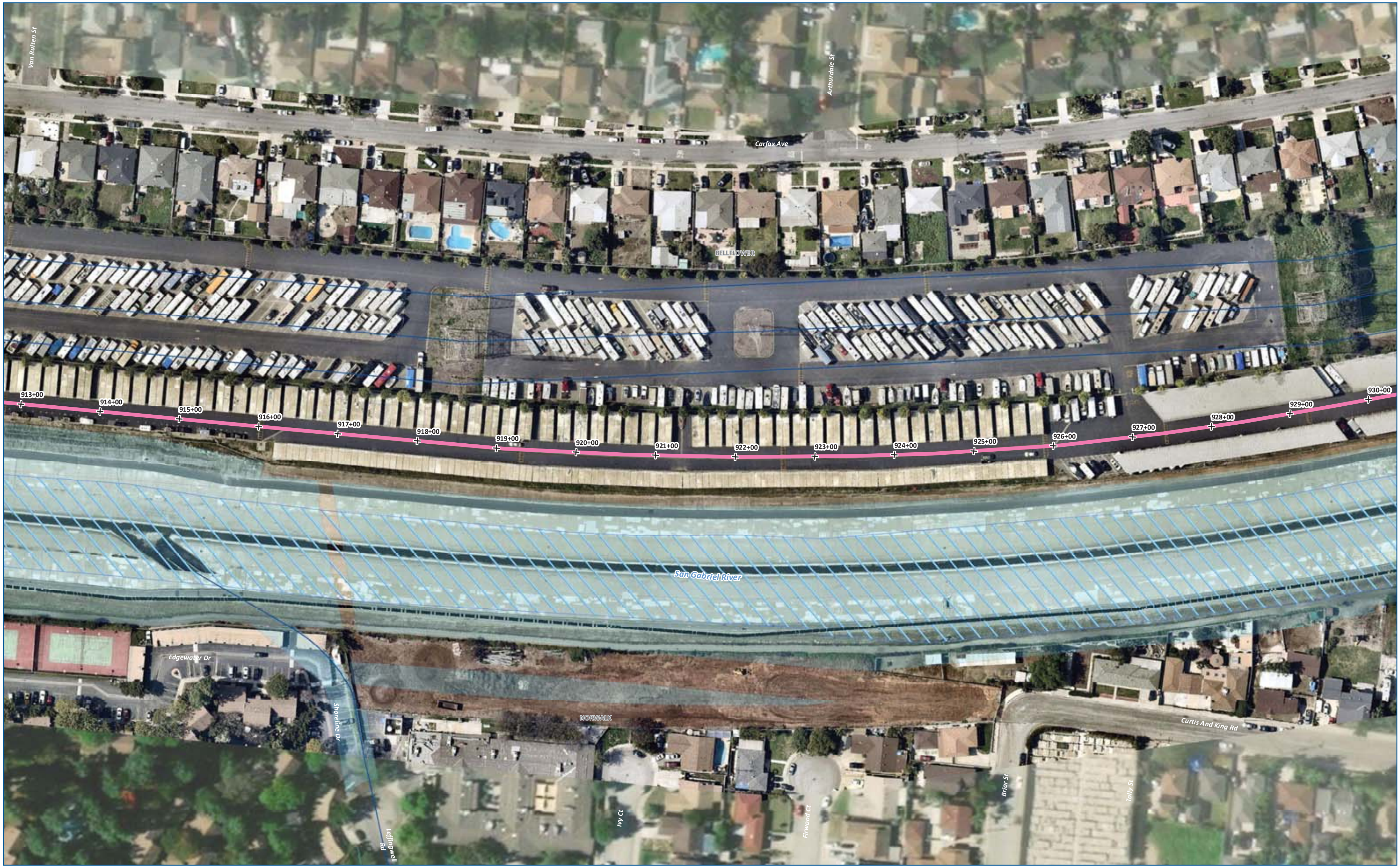

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SG River Alignment, Page 59

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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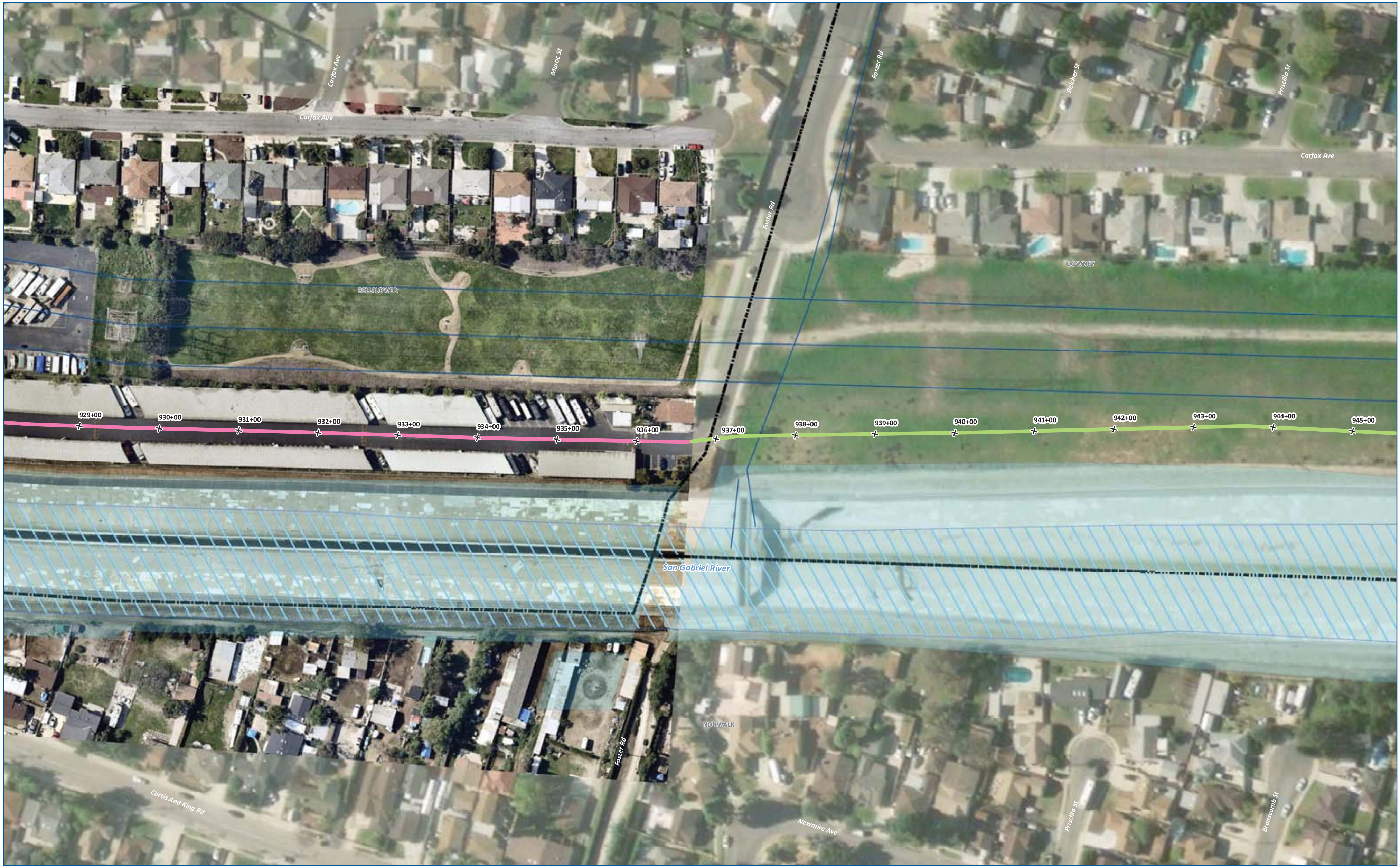

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SG River Alignment, Page 60

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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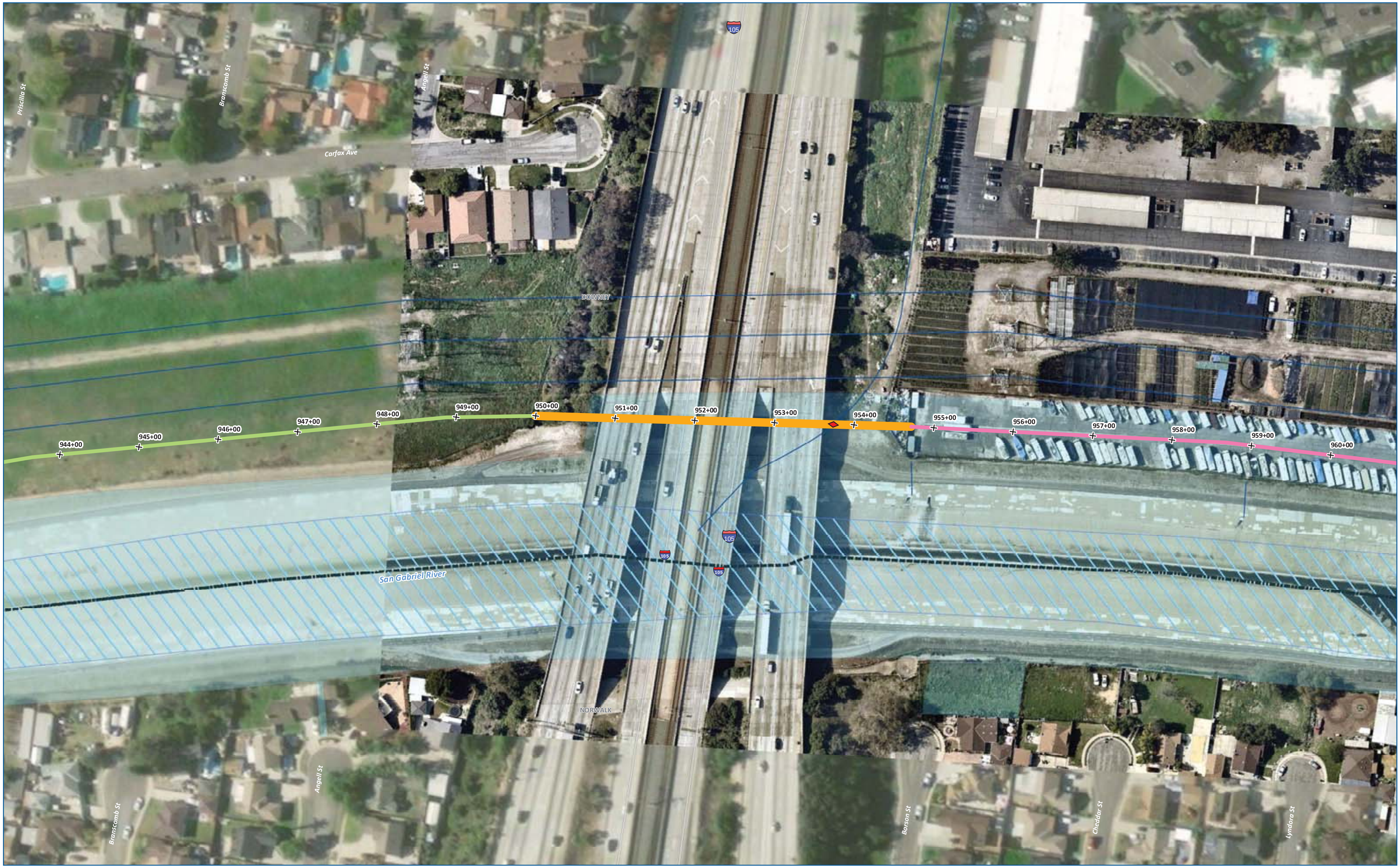

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SG River Alignment, Page 61

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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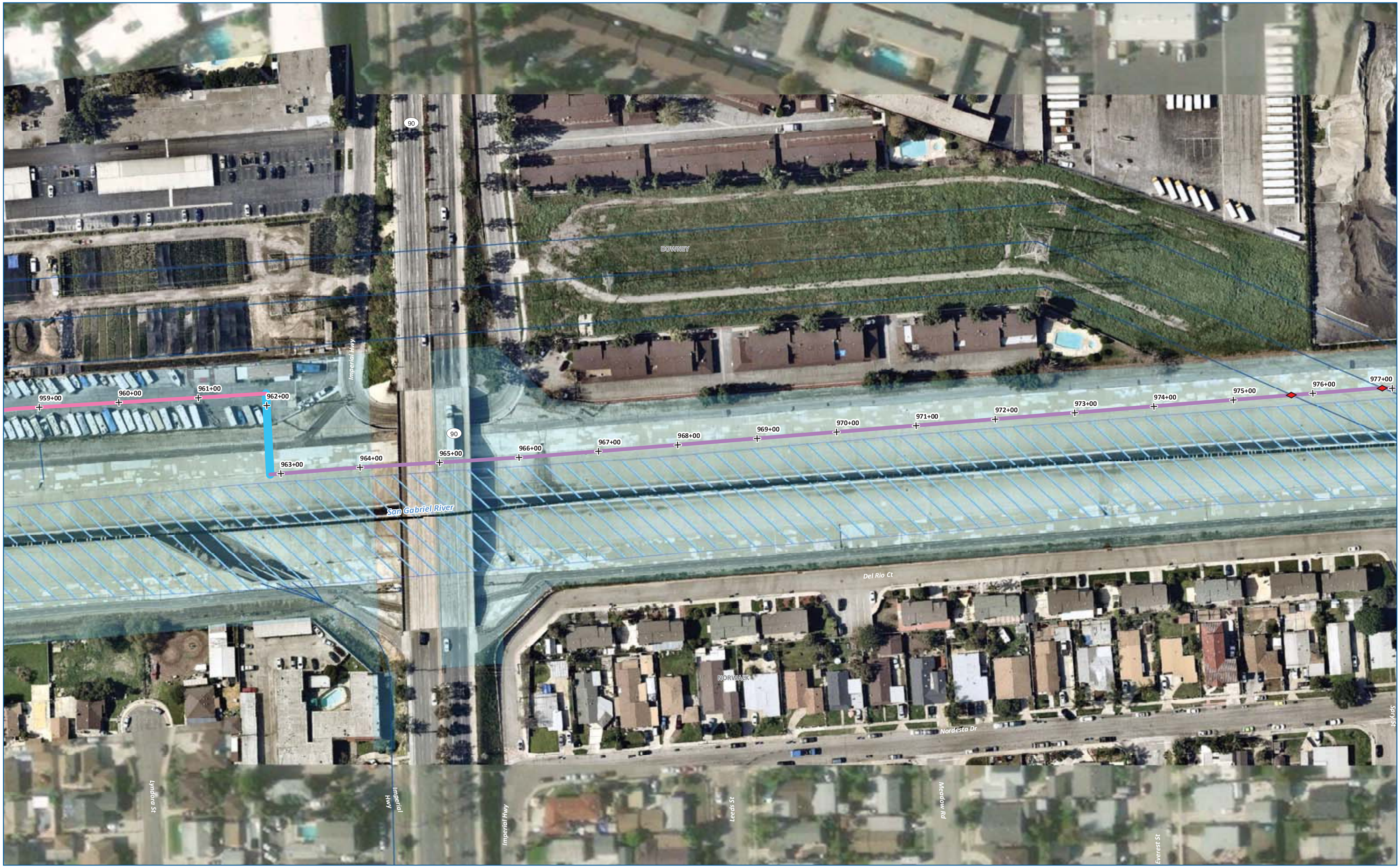

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SG River Alignment, Page 62

LEGEND

Open-Trench Construction Method

- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method

- Traditional Tunnel
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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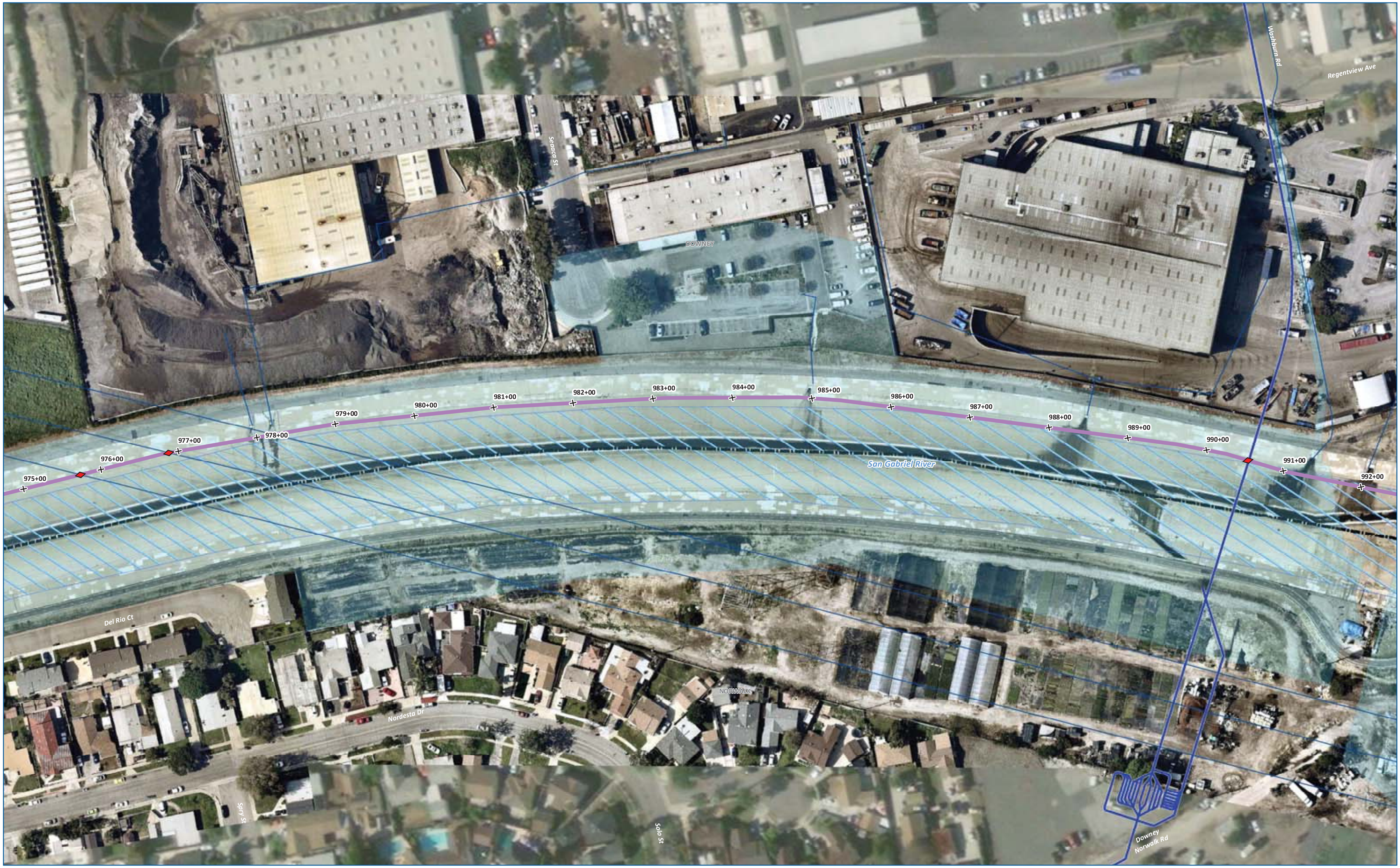

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SG River Alignment, Page 63

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 64

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 65

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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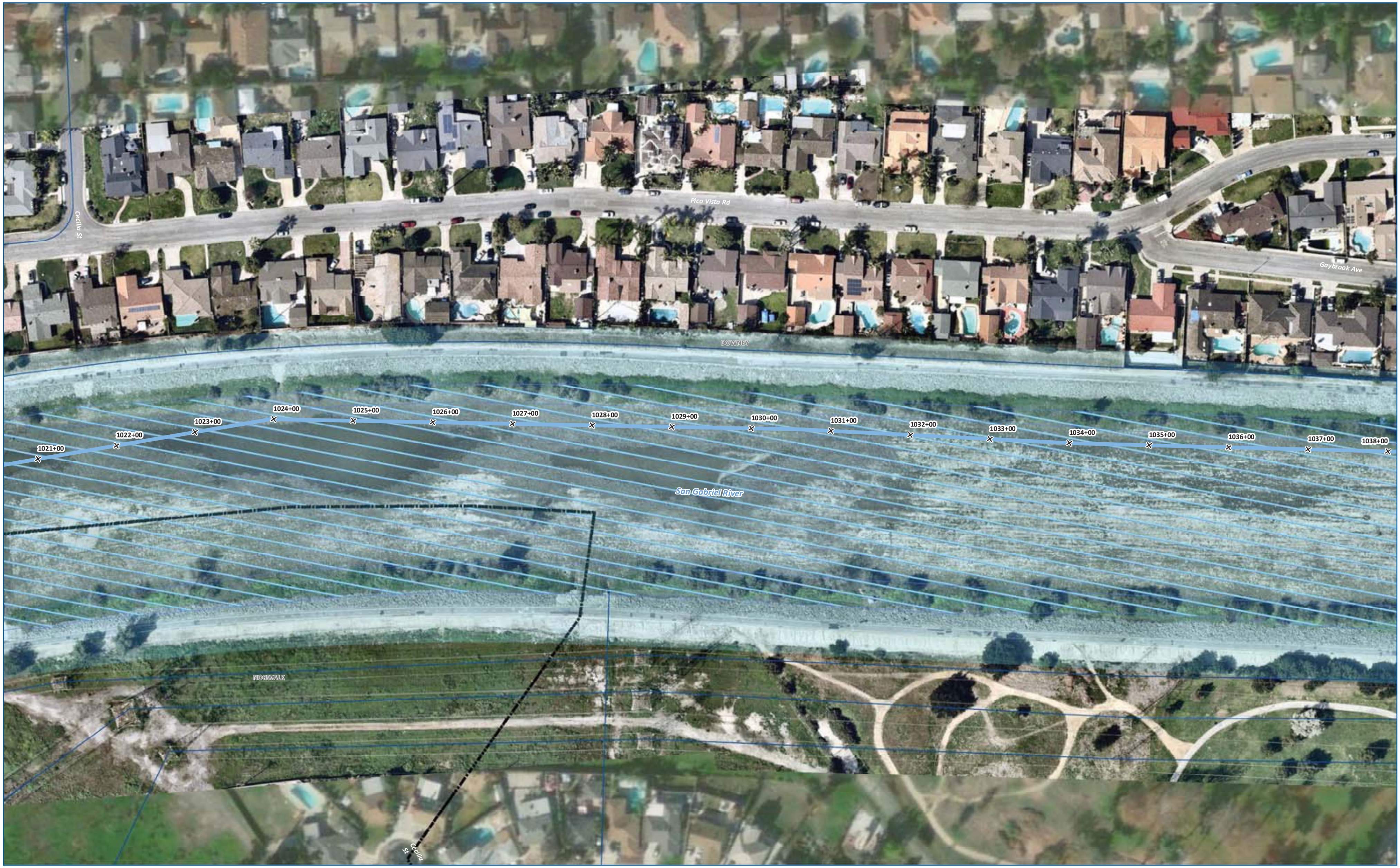

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SG River Alignment, Page 66

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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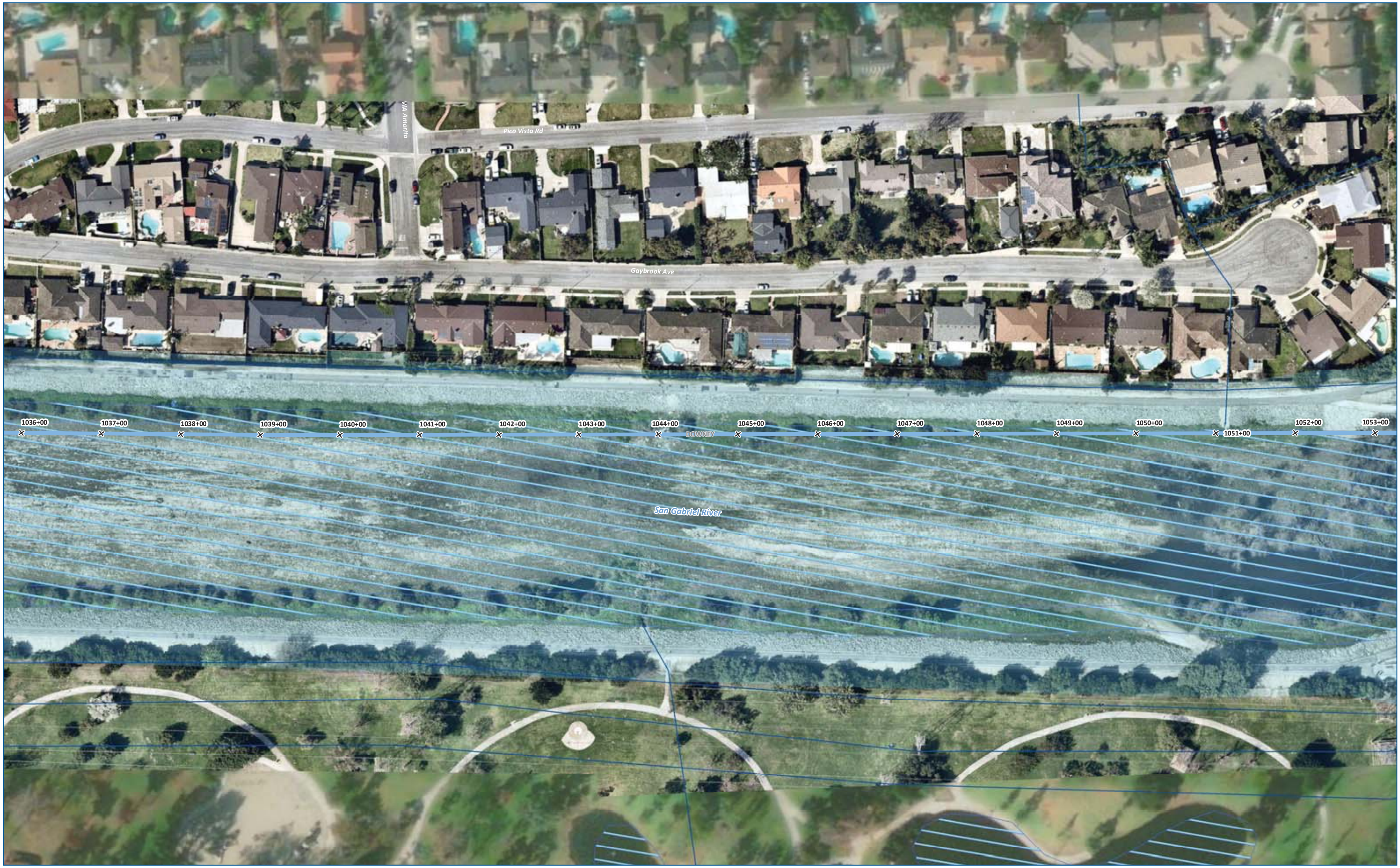

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SG River Alignment, Page 67

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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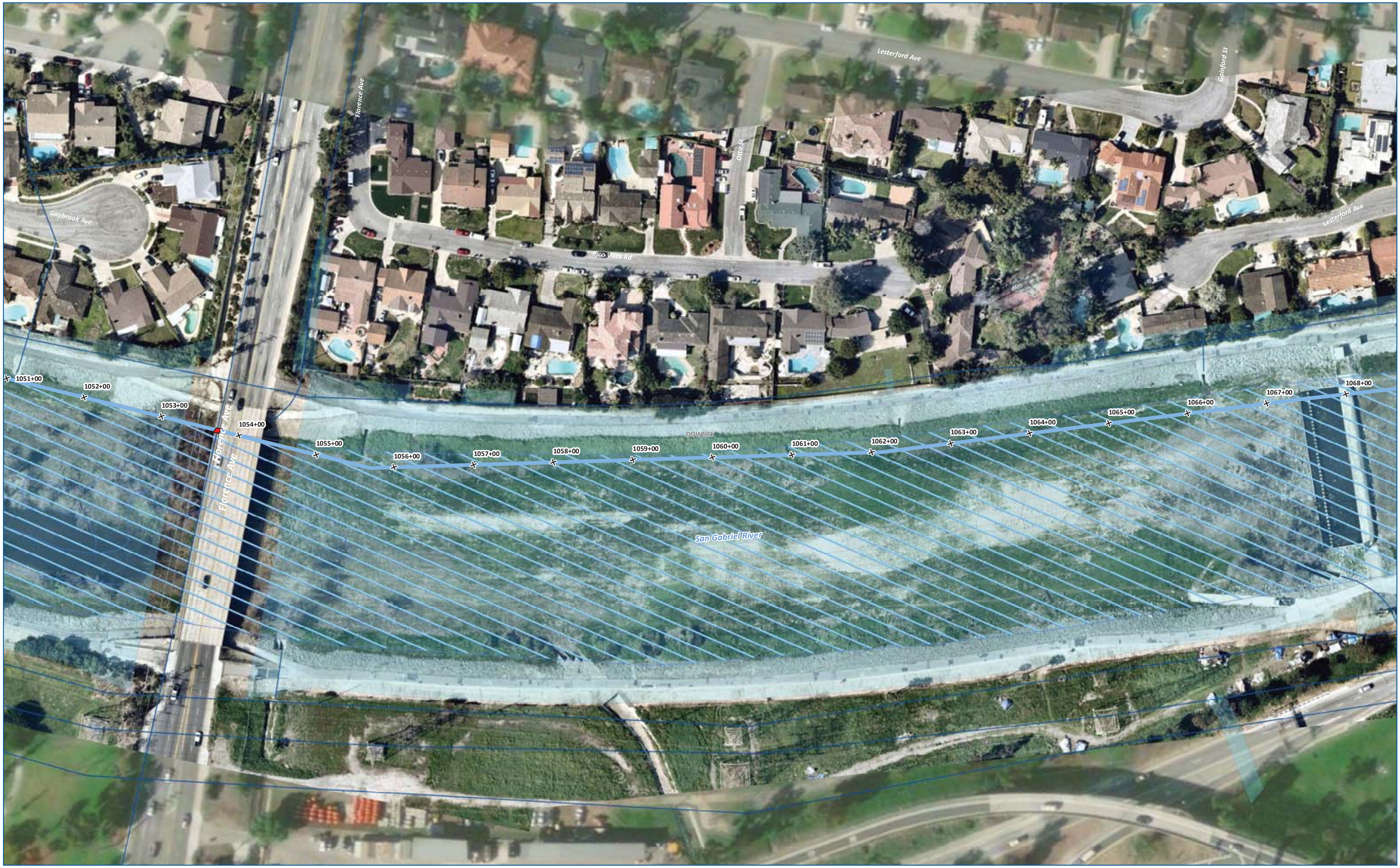

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SG River Alignment, Page 68

LEGEND

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- 1 - Roadways
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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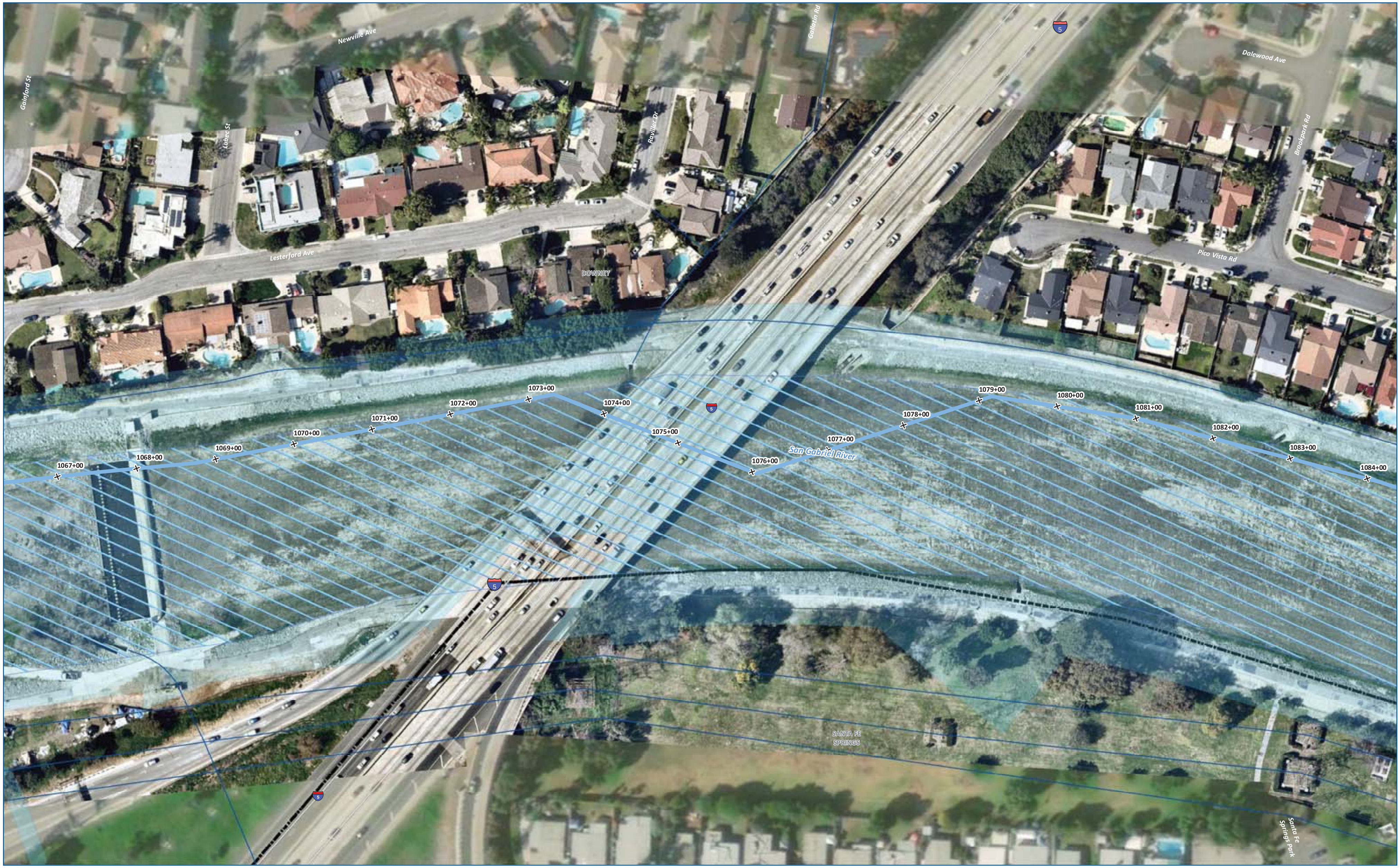

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SG River Alignment, Page 69

LEGEND

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- 1 - Roadways
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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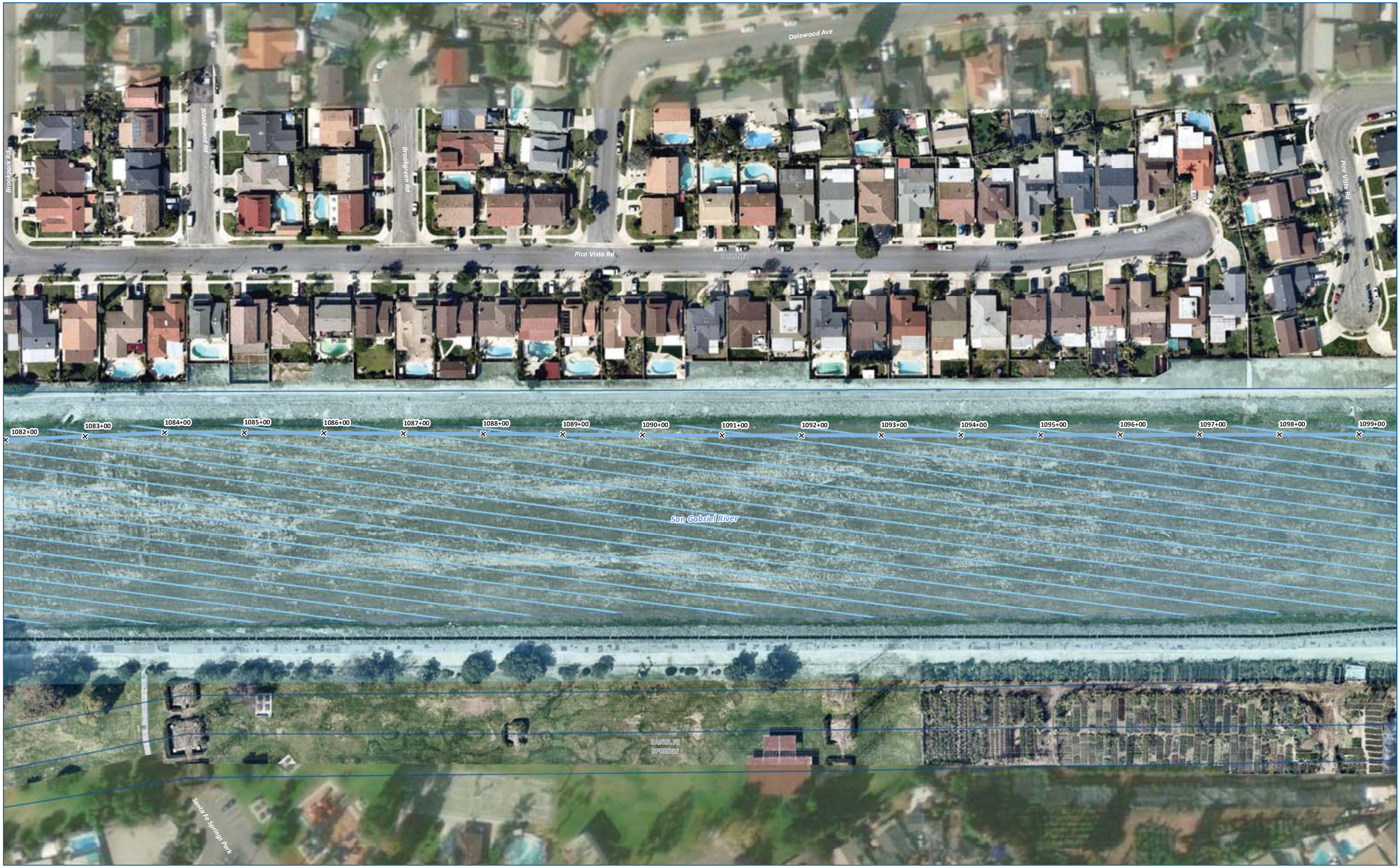

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SG River Alignment, Page 70

LEGEND

Open-Trench Construction Method
- 1 - Roadways
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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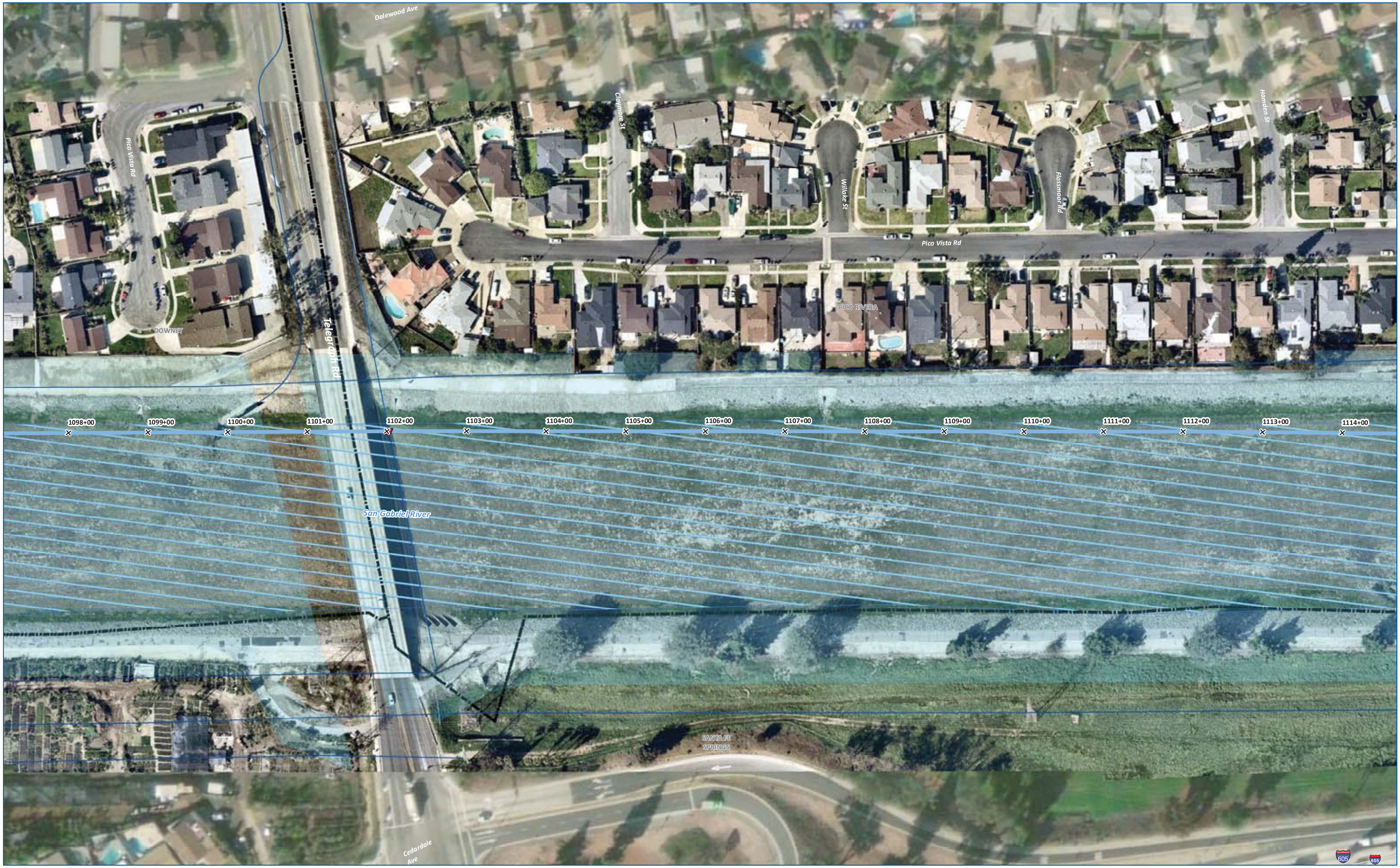

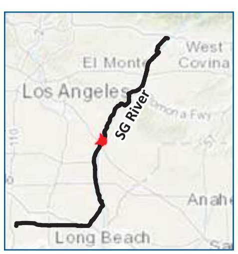

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SG River Alignment, Page 71

LEGEND

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- 1 - Roadways
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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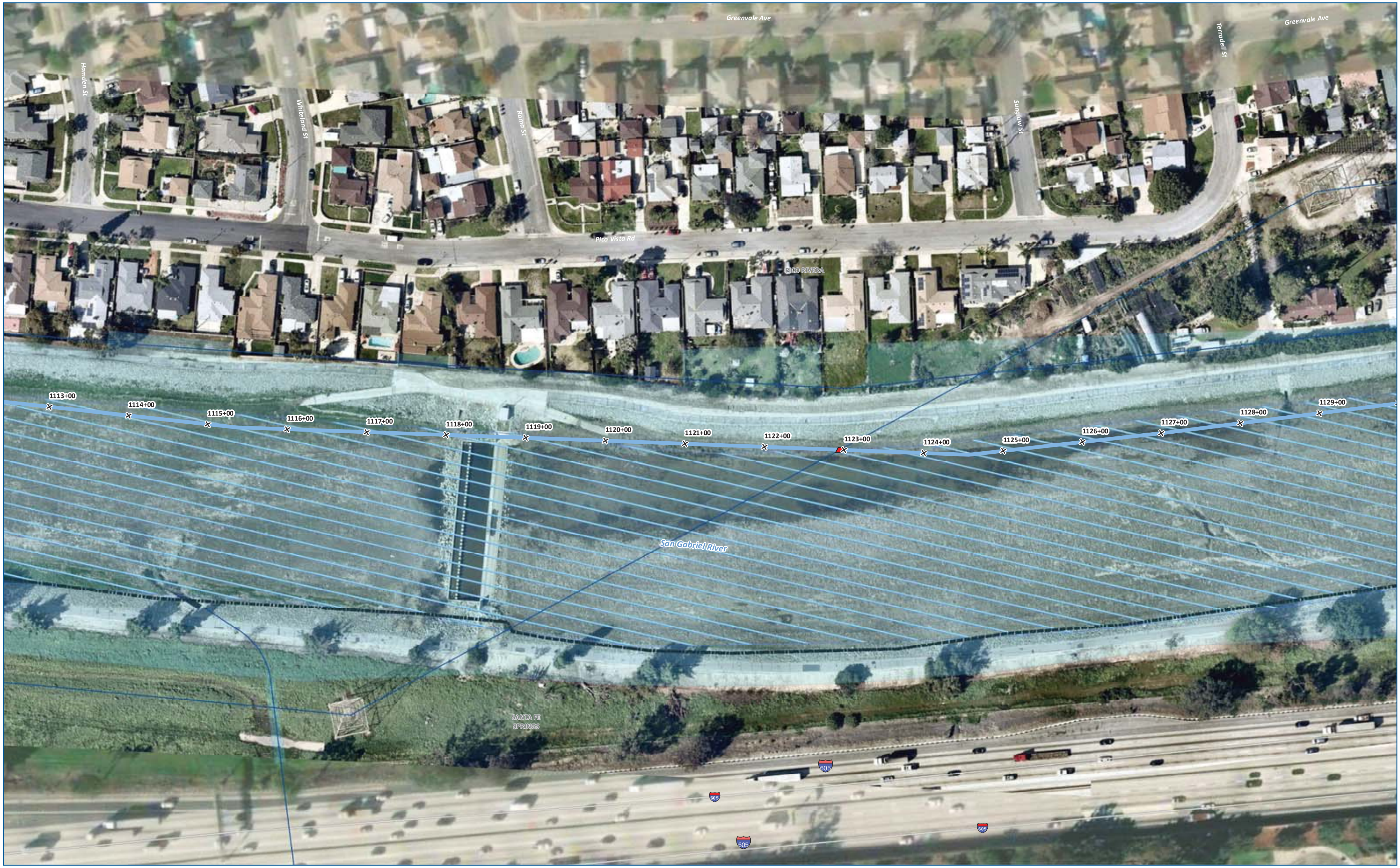

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SG River Alignment, Page 72

LEGEND

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- 1 - Roadways
- 2 - SCE Easements
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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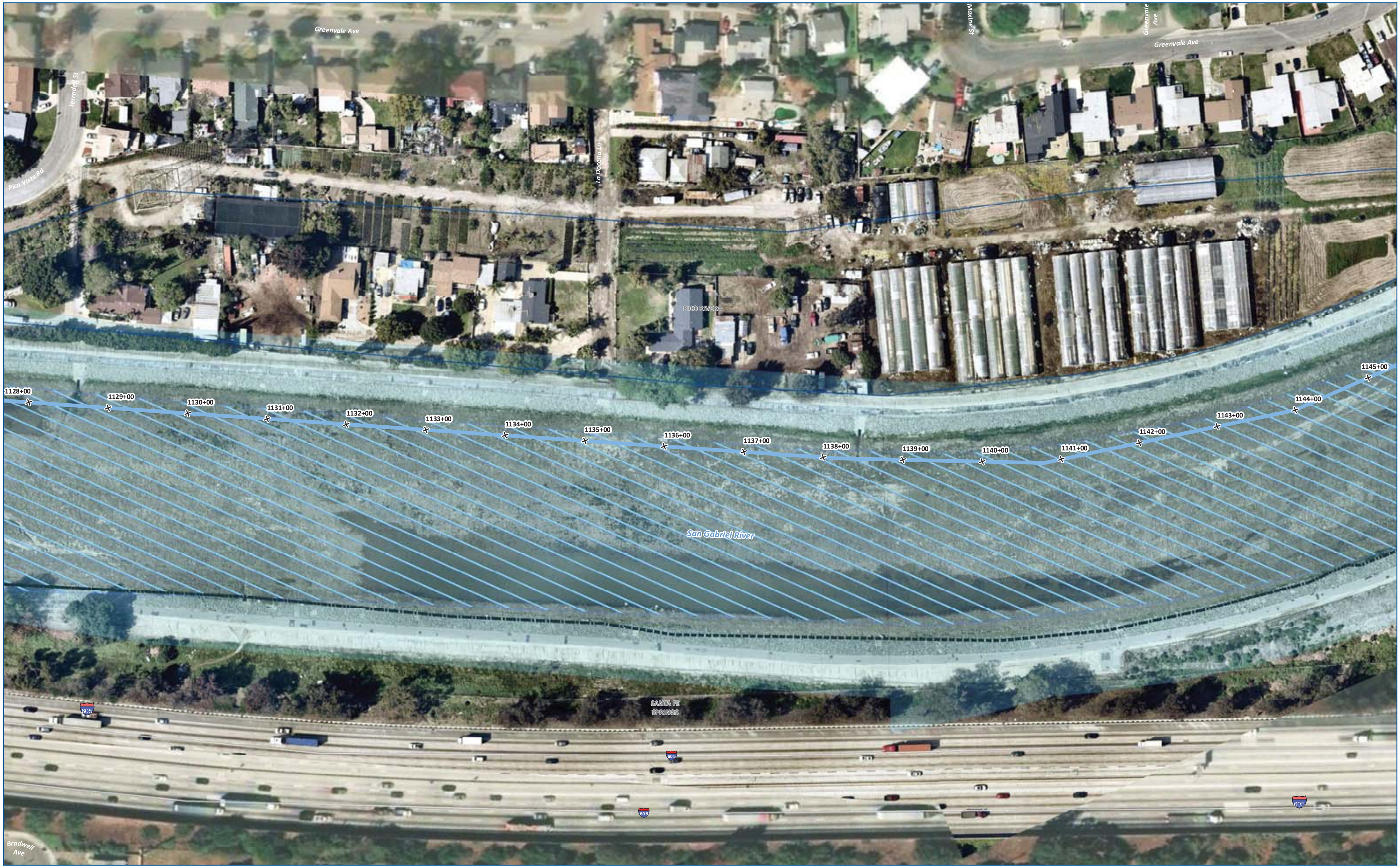

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SG River Alignment, Page 73

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 74

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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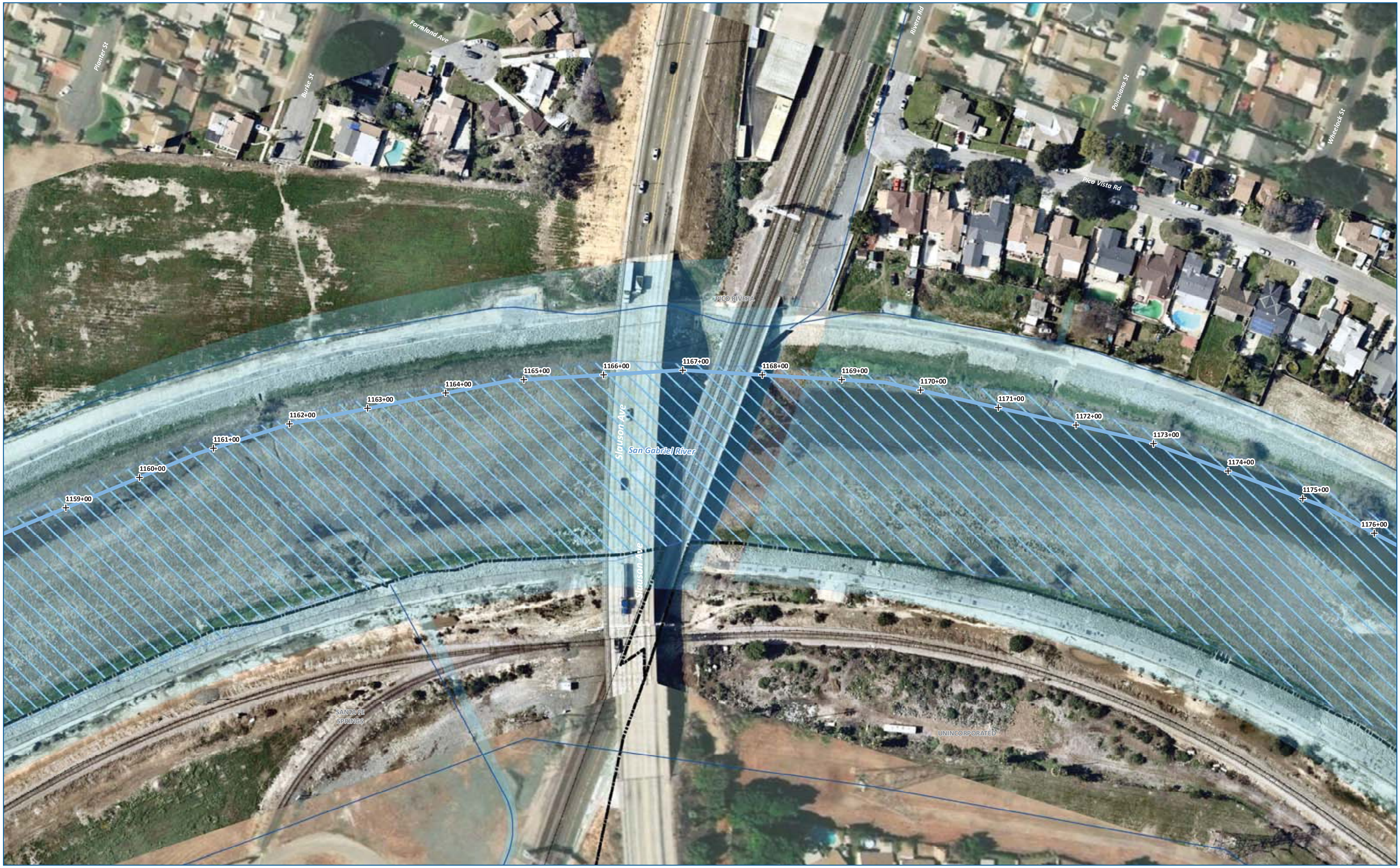

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SG River Alignment, Page 75

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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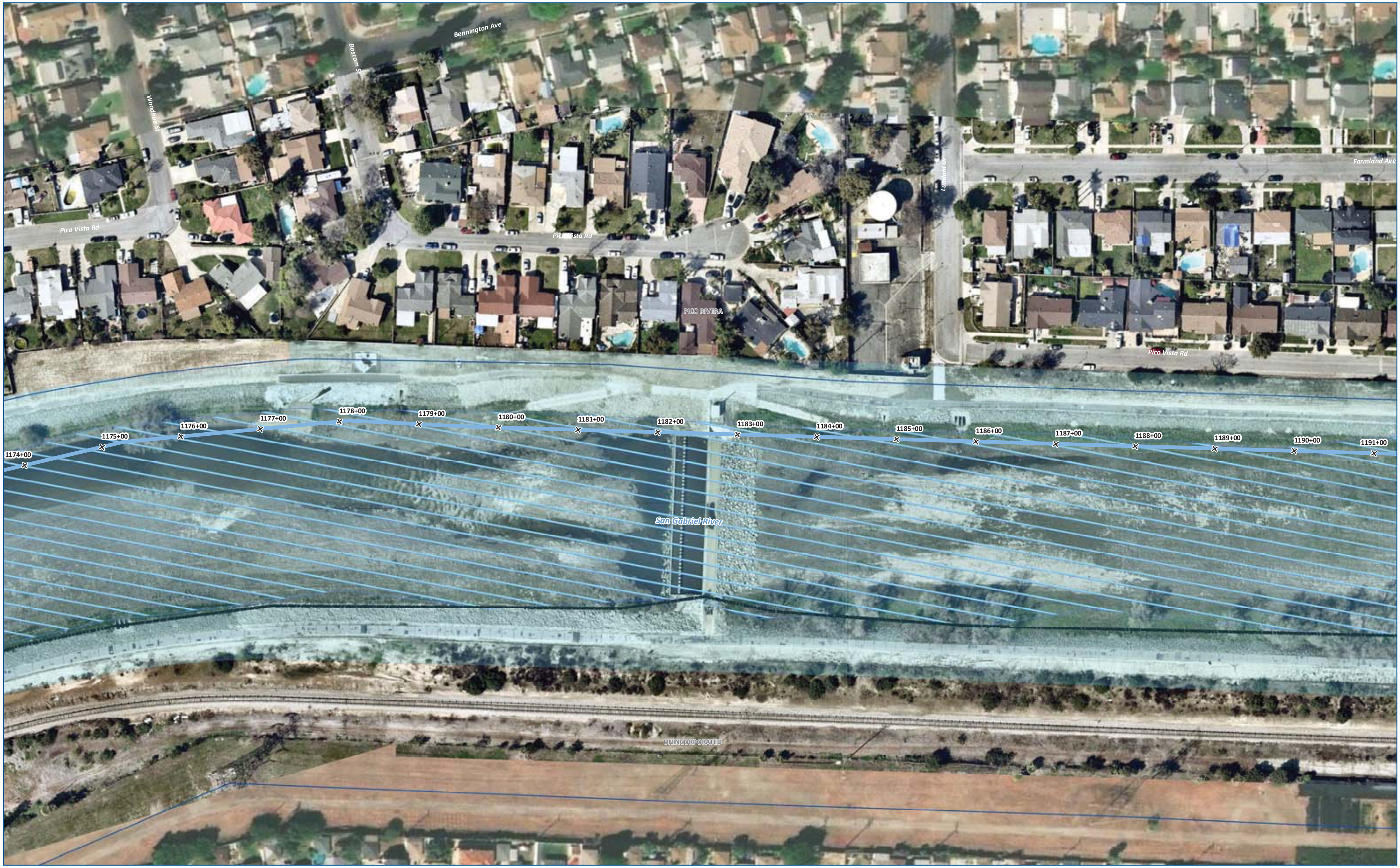

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SG River Alignment, Page 76

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- Jack & Bore w/Dewatering
- Microtunnel

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- LA County Flood Control District
- City Boundaries
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 77

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 78

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
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- City Utility
- Existing MWD Distribution System
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 79

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 80

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 81

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 82

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Trenchless Construction Method
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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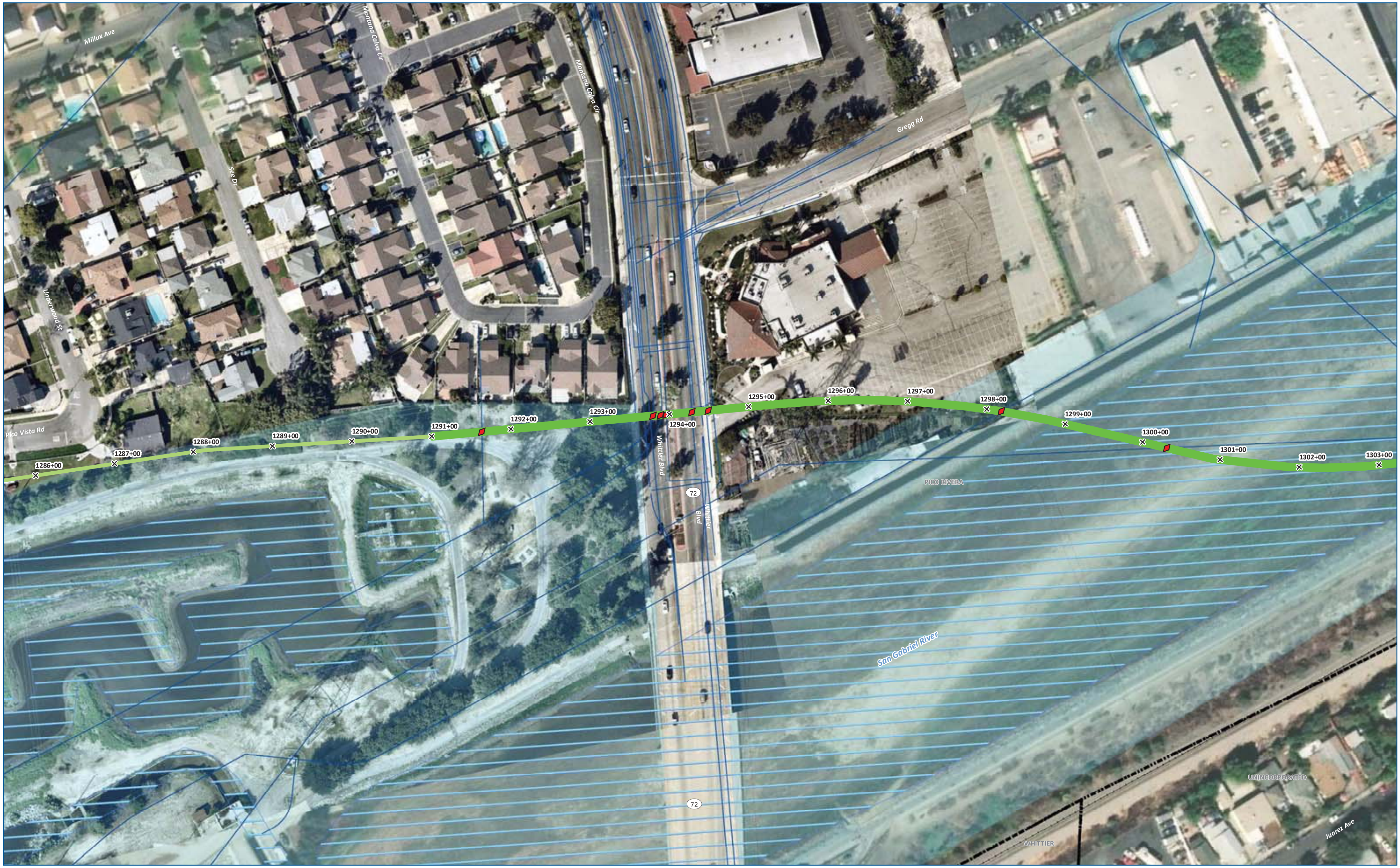

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SG River Alignment, Page 83

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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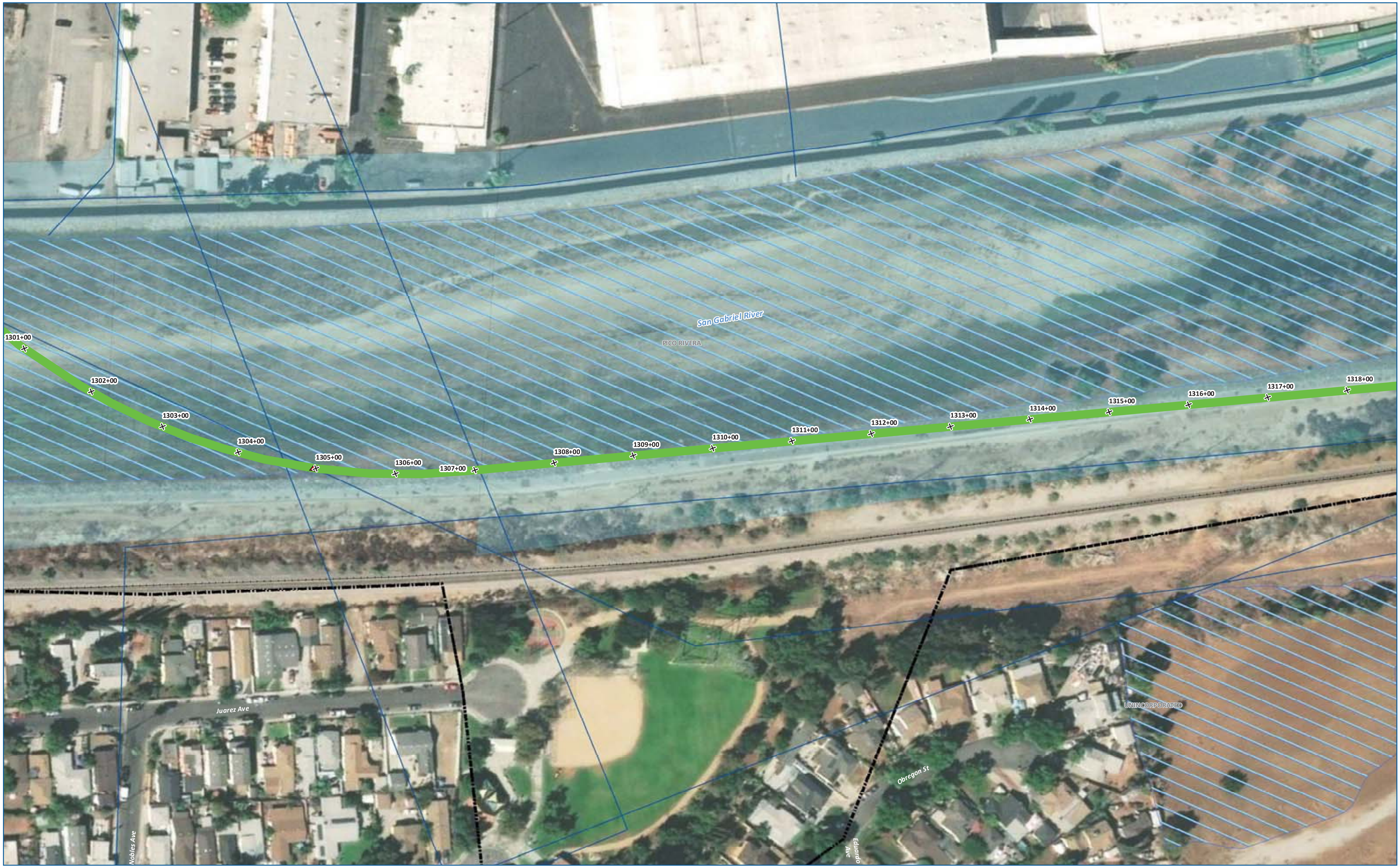

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SG River Alignment, Page 84

LEGEND

Open-Trench Construction Method
- 1 - Roadways
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San Gabriel River Alignment

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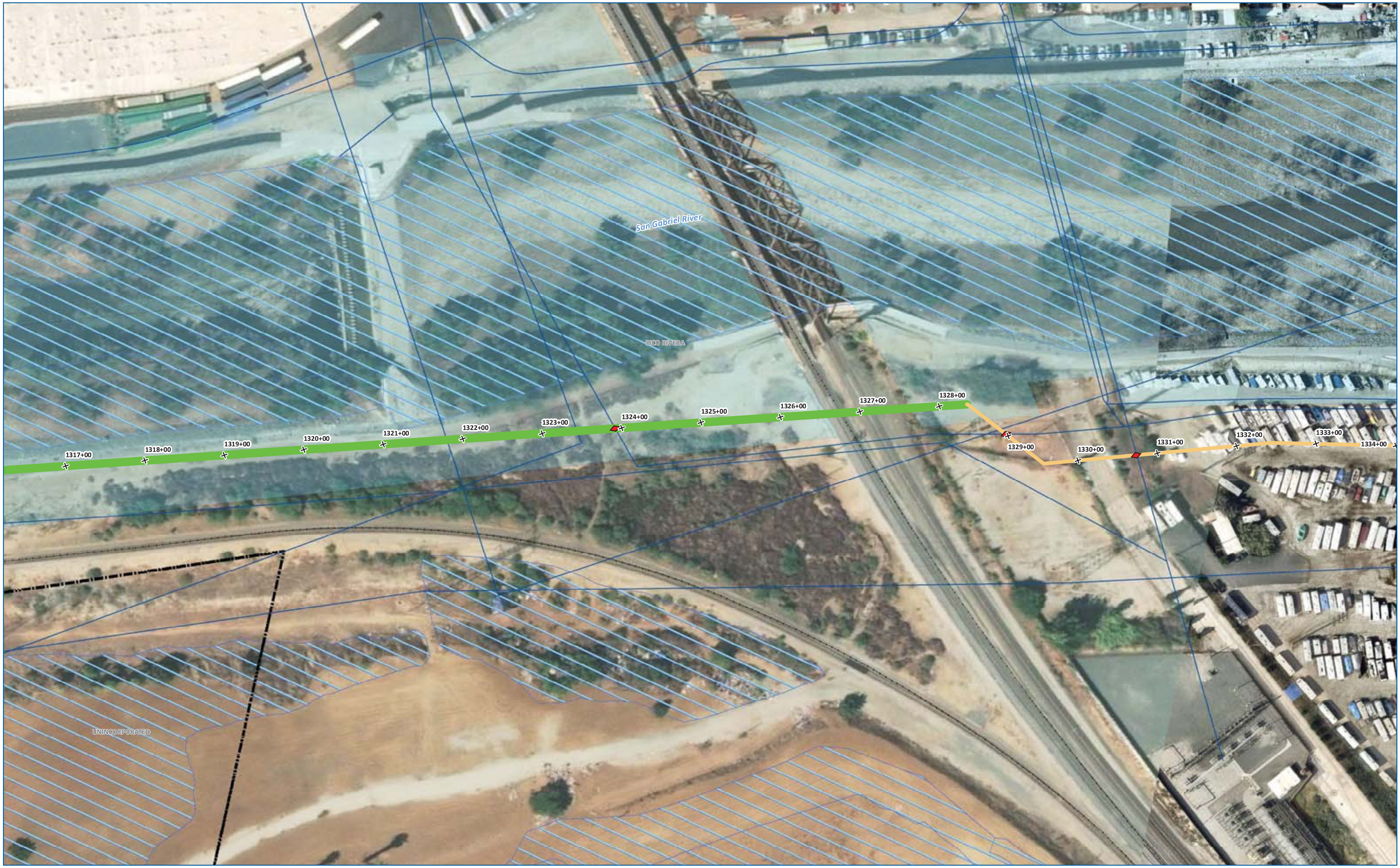

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SG River Alignment, Page 85

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 86

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
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		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 87

LEGEND

Open-Trench Construction Method
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 88

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
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		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 89

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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LEGEND

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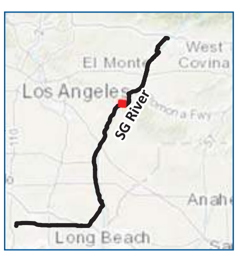

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SG River Alignment, Page 90

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 91

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 92

LEGEND

Open-Trench Construction Method

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- 2 - SCE Easements
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 93

LEGEND

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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 94

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
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Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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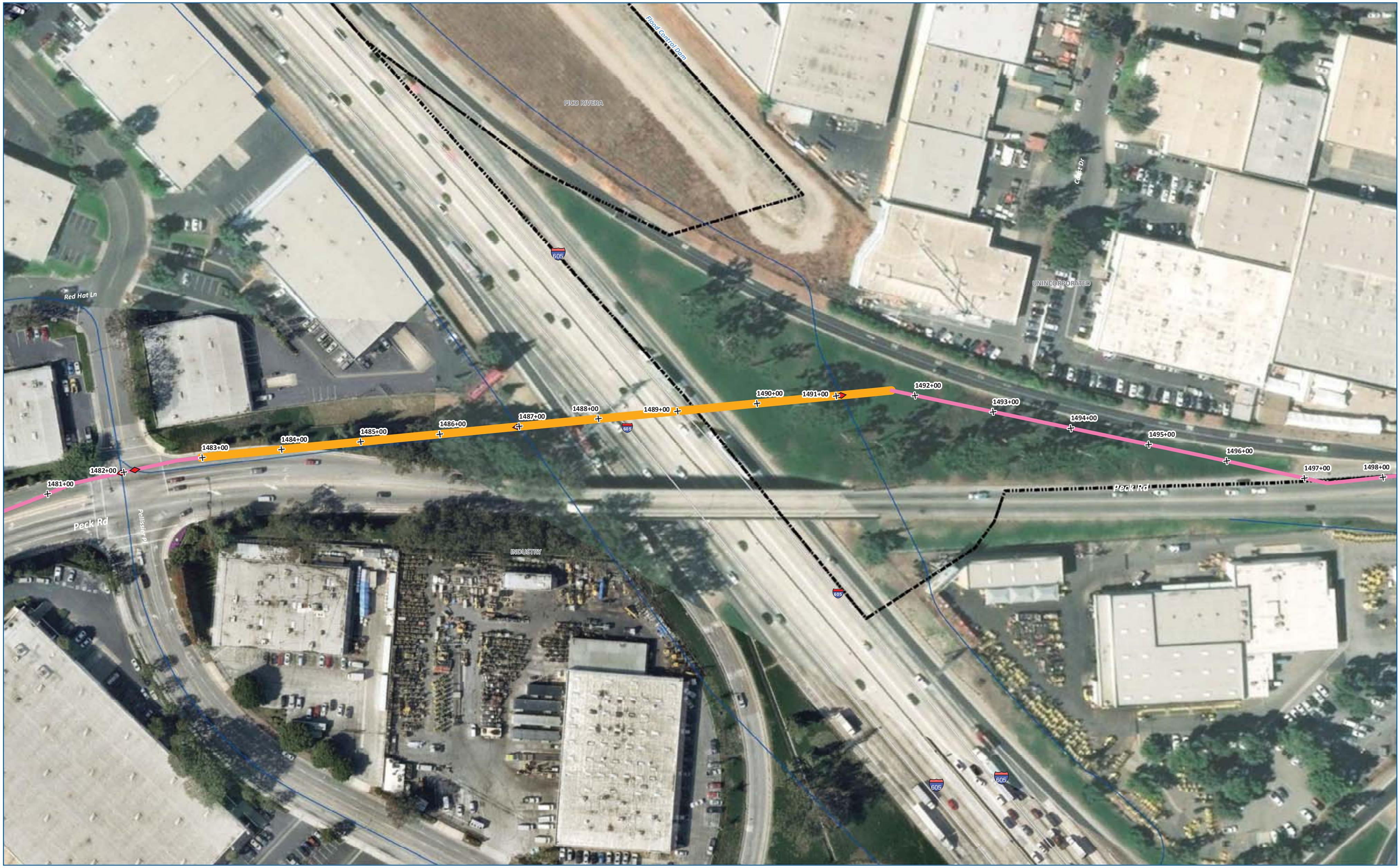

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SG River Alignment, Page 95

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 96

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 97

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- Jack & Bore w/Dewatering
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- City Utility
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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 98

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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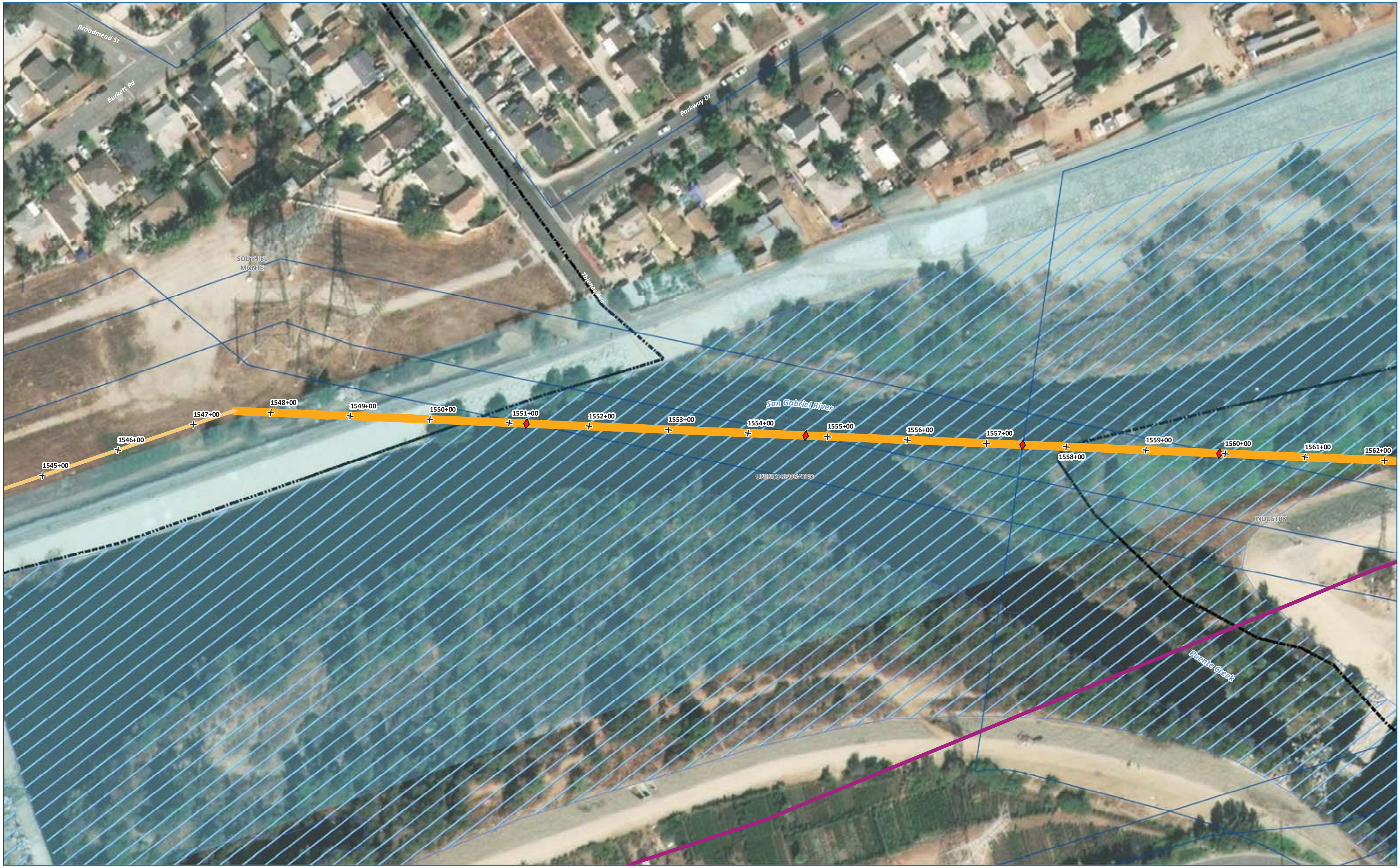

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SG River Alignment, Page 99

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 100

LEGEND

Open-Trench Construction Method

- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method

- Traditional Tunnel
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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 101

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 102

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
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- Jack & Bore w/Dewatering
- Microtunnel

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- City Utility
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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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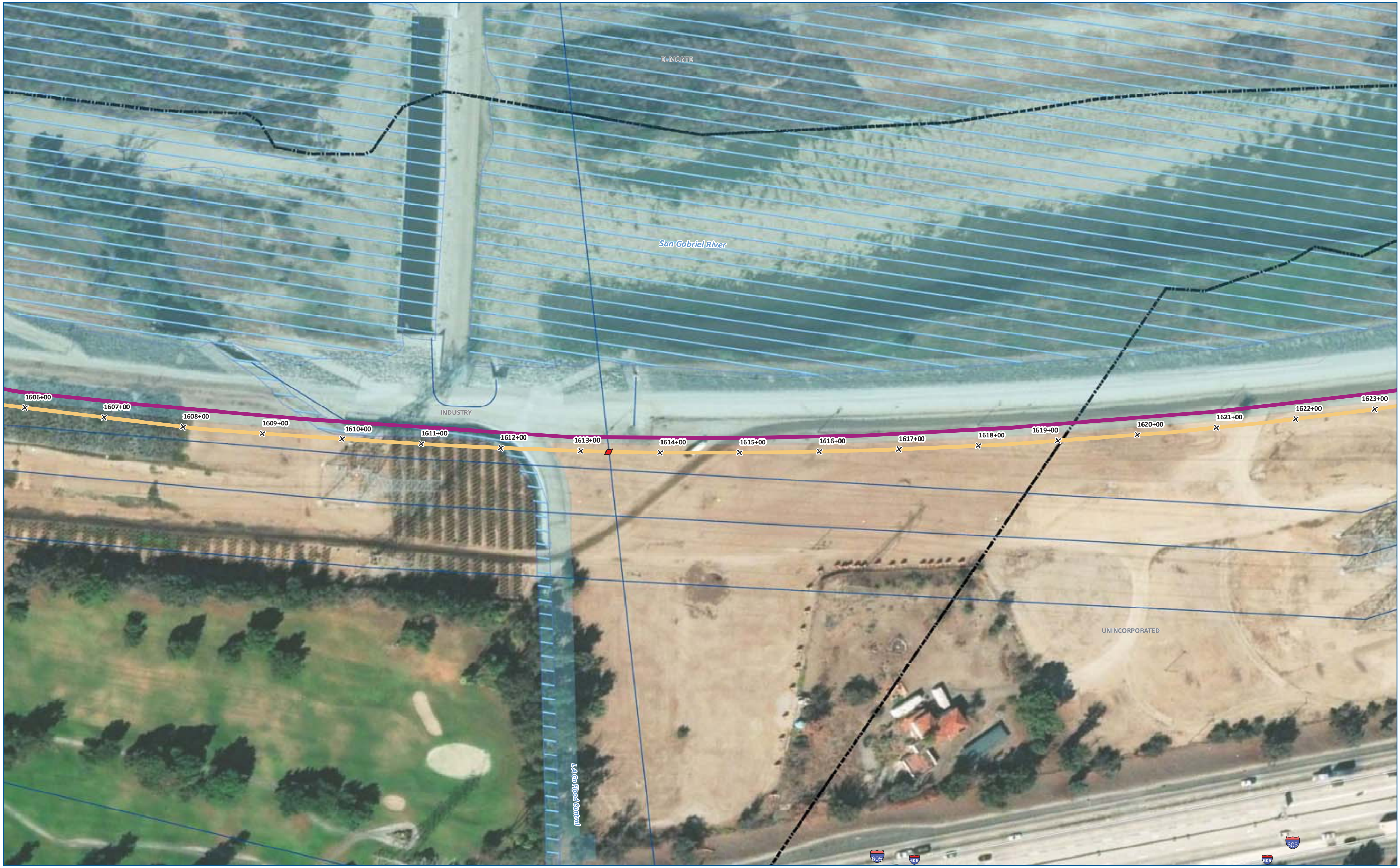

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SG River Alignment, Page 103

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- Microtunnel

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- City Utility
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- City Boundaries
- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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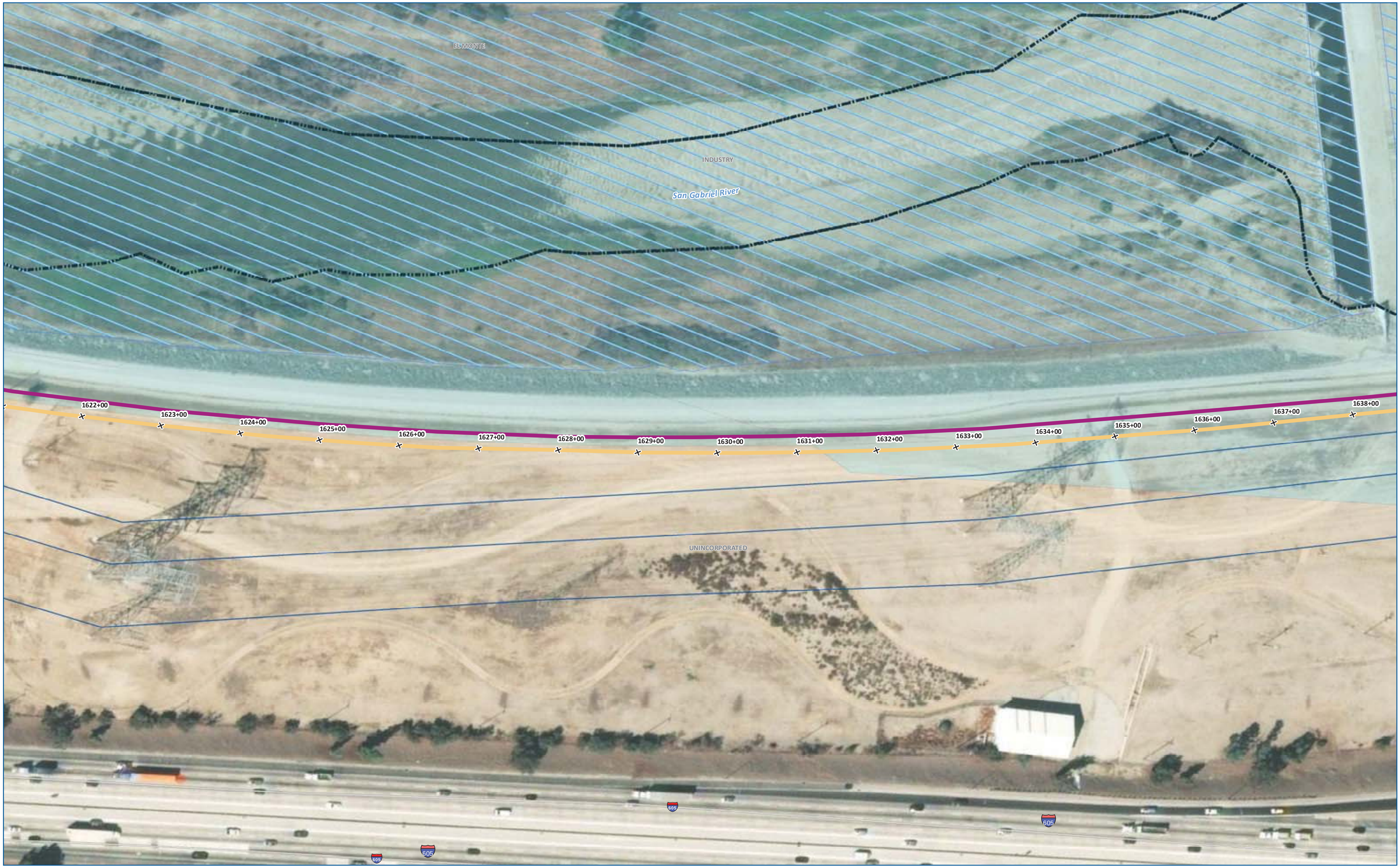

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SG River Alignment, Page 104

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 105

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 106

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 107

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Trenchless Construction Method
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- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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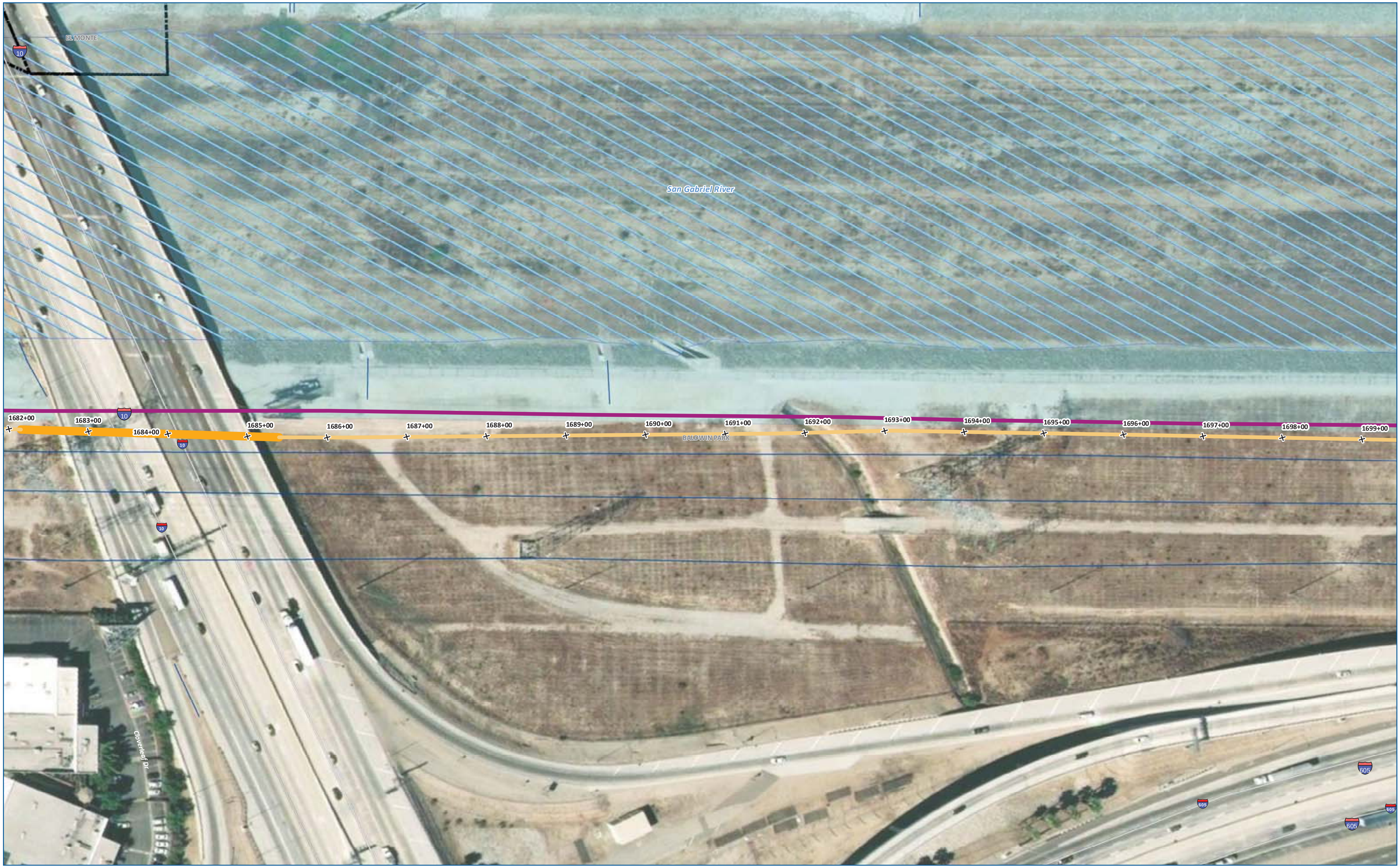

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SG River Alignment, Page 108

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
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- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
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- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 109

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 110

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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- Jack & Bore w/Dewatering
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- Major Utility Crossings
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- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 111

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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SG River Alignment, Page 112

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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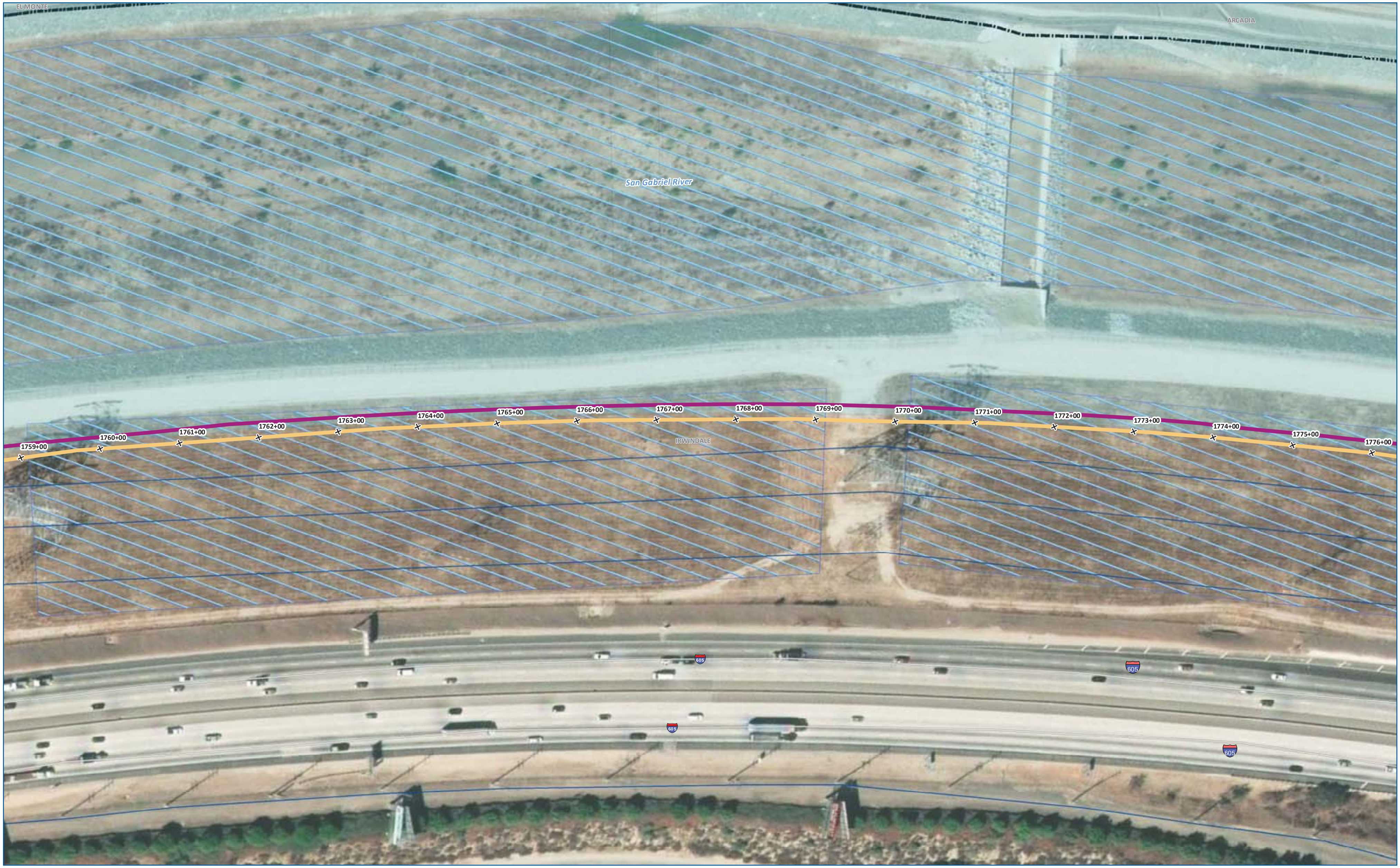

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SG River Alignment, Page 113

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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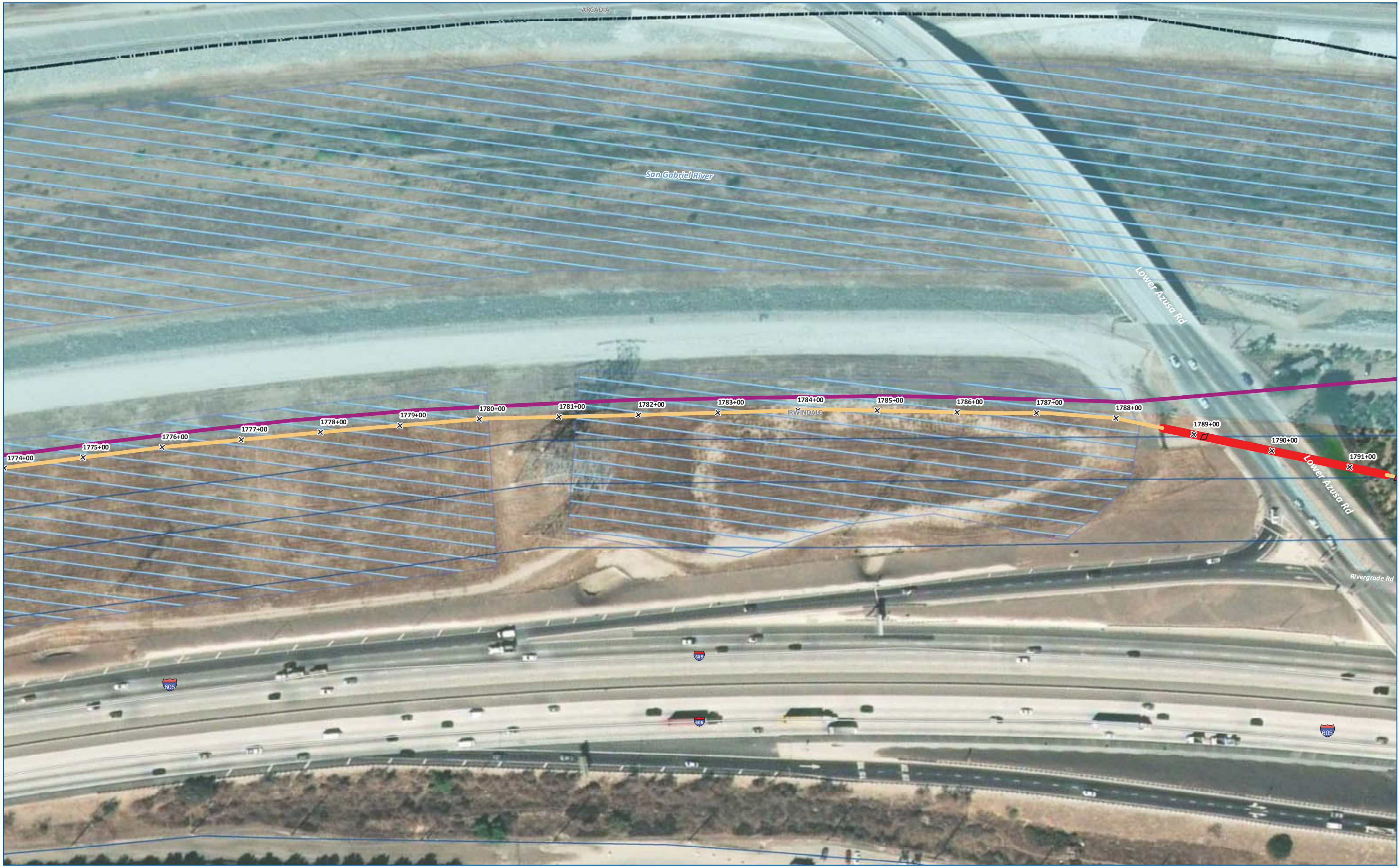

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SG River Alignment, Page 114

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
- Traditional Tunnel
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- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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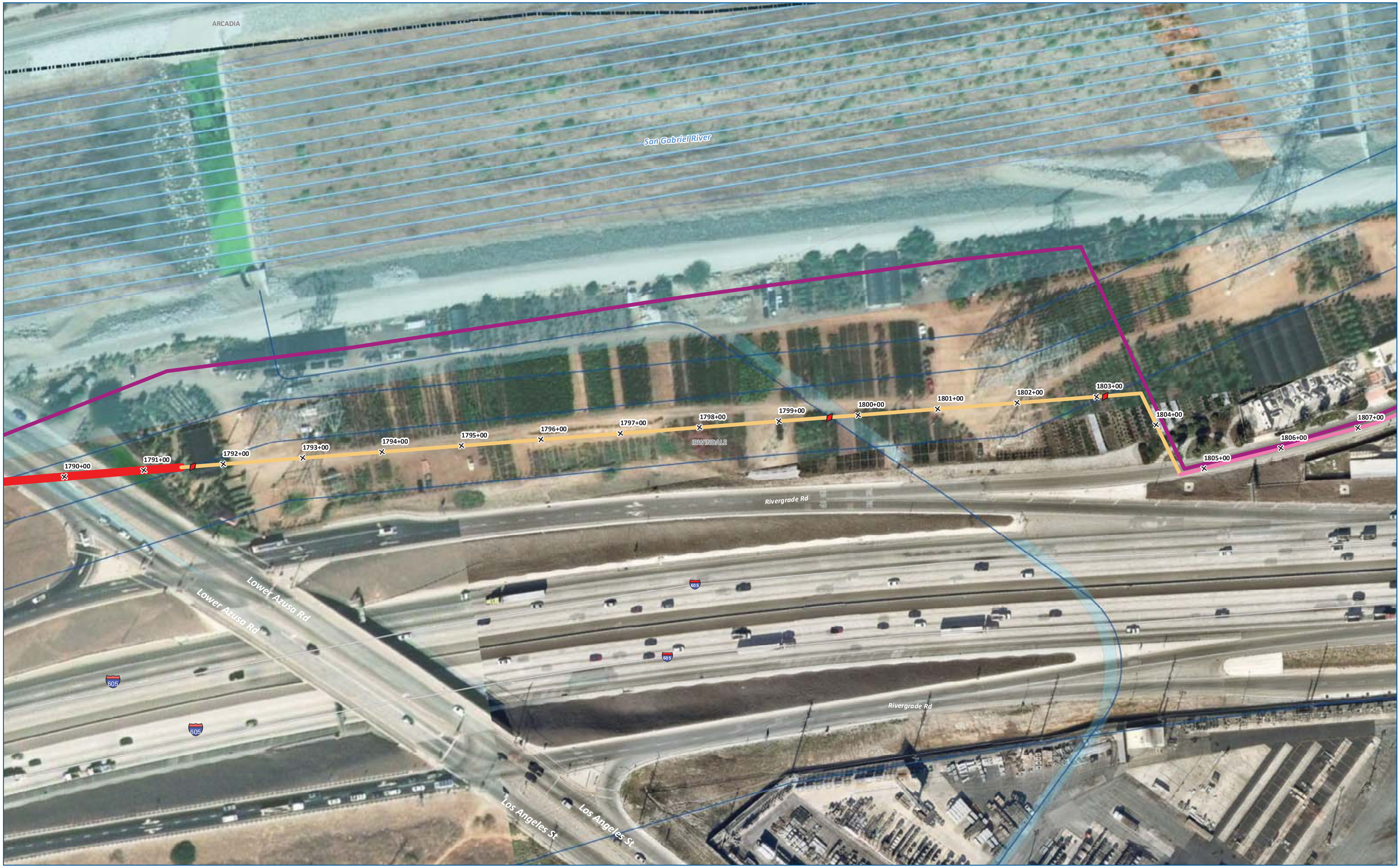

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SG River Alignment, Page 115

LEGEND

Open-Trench Construction Method

- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method

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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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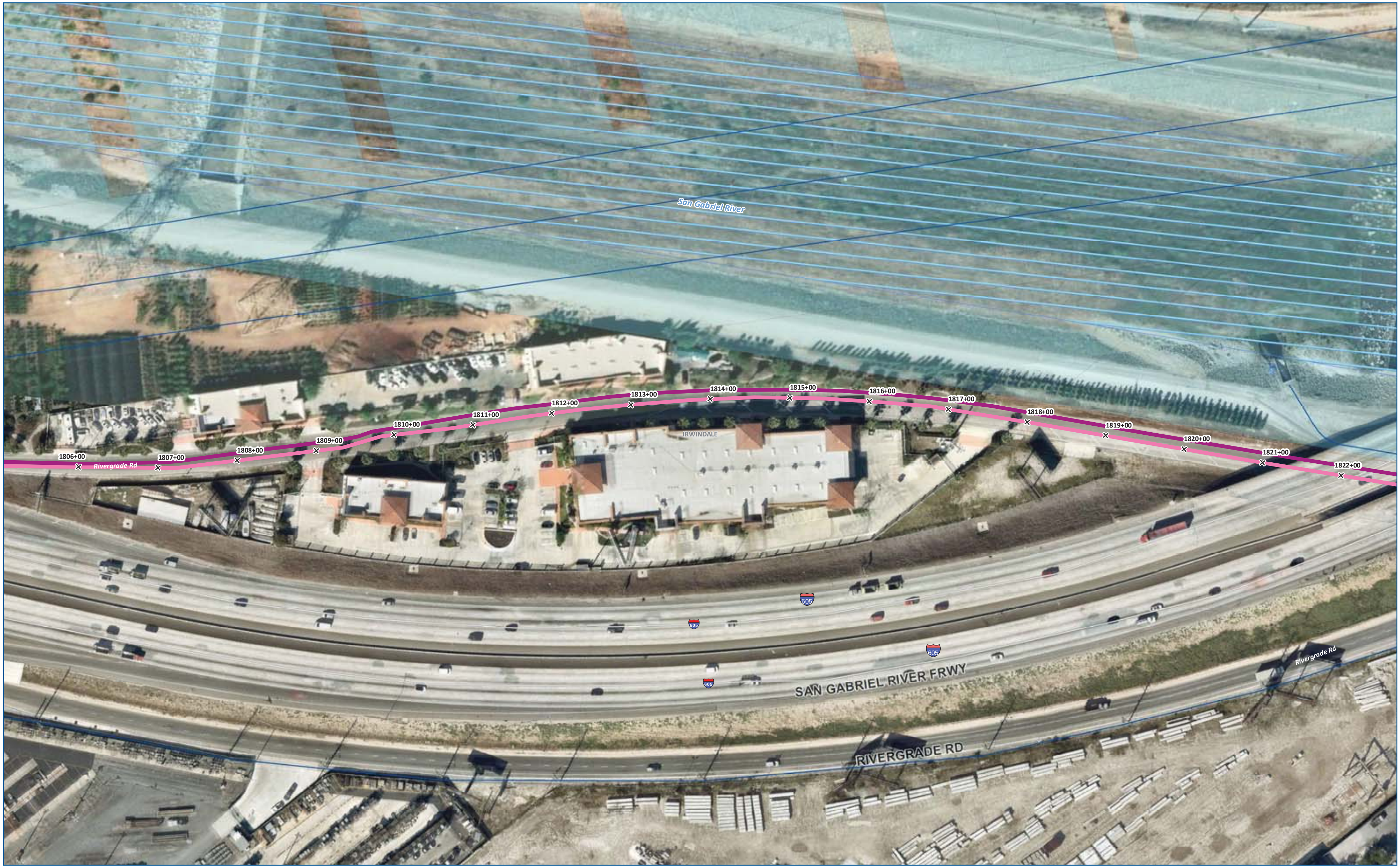

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SG River Alignment, Page 116

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
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Trenchless Construction Method
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- City Utility
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- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 117

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
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Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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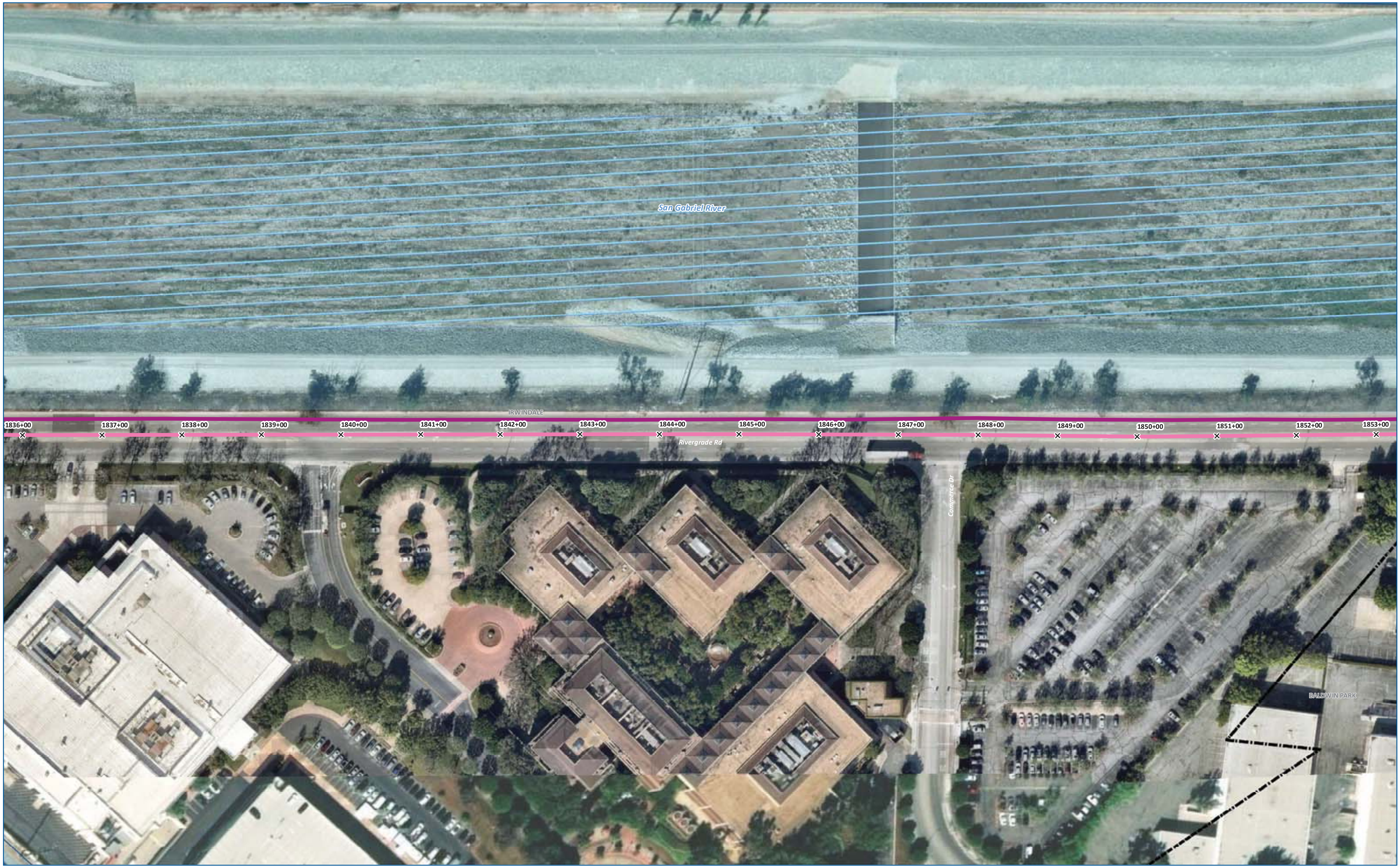

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SG River Alignment, Page 118

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 119

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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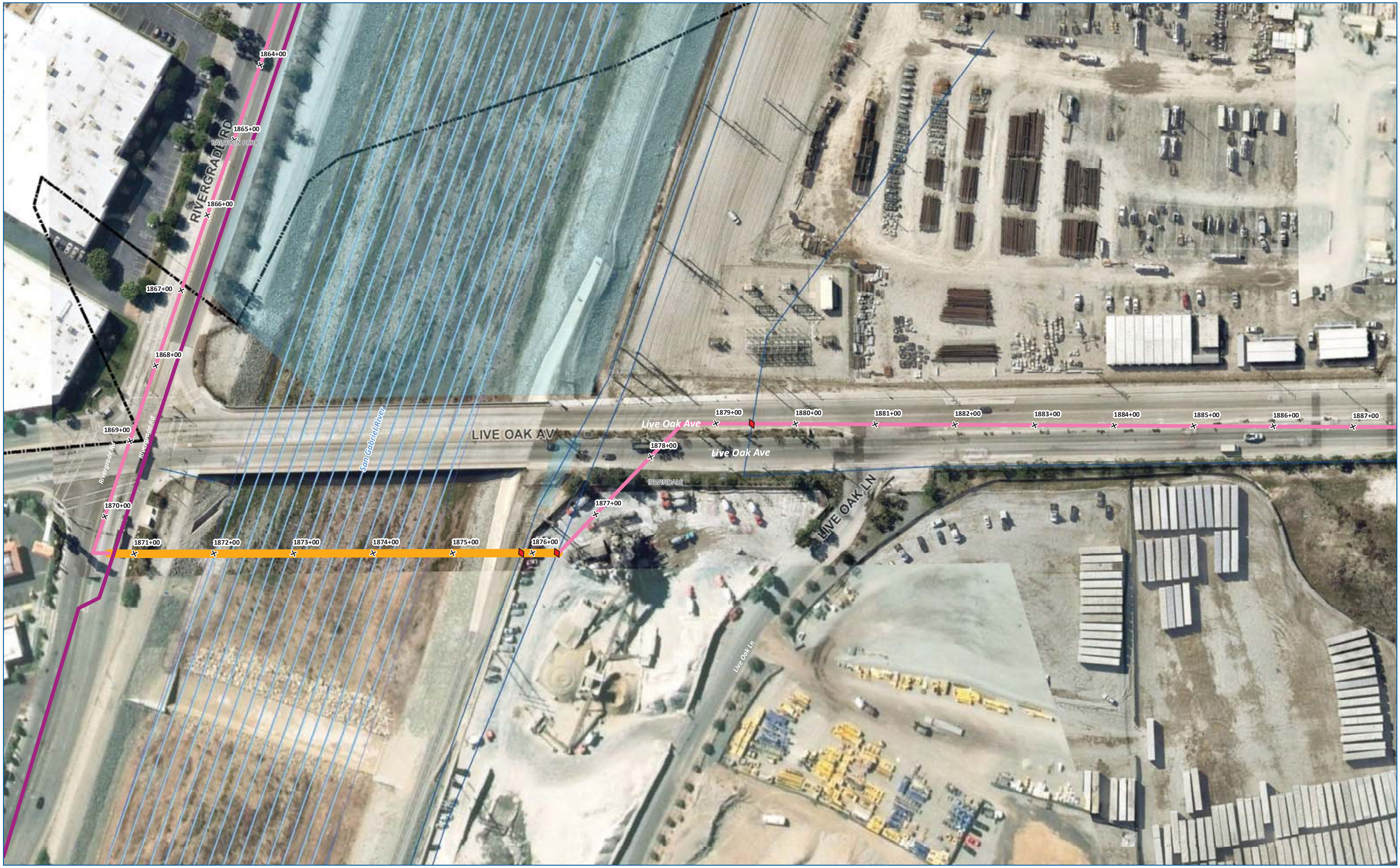

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SG River Alignment, Page 120

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Trenchless Construction Method
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- Wetlands
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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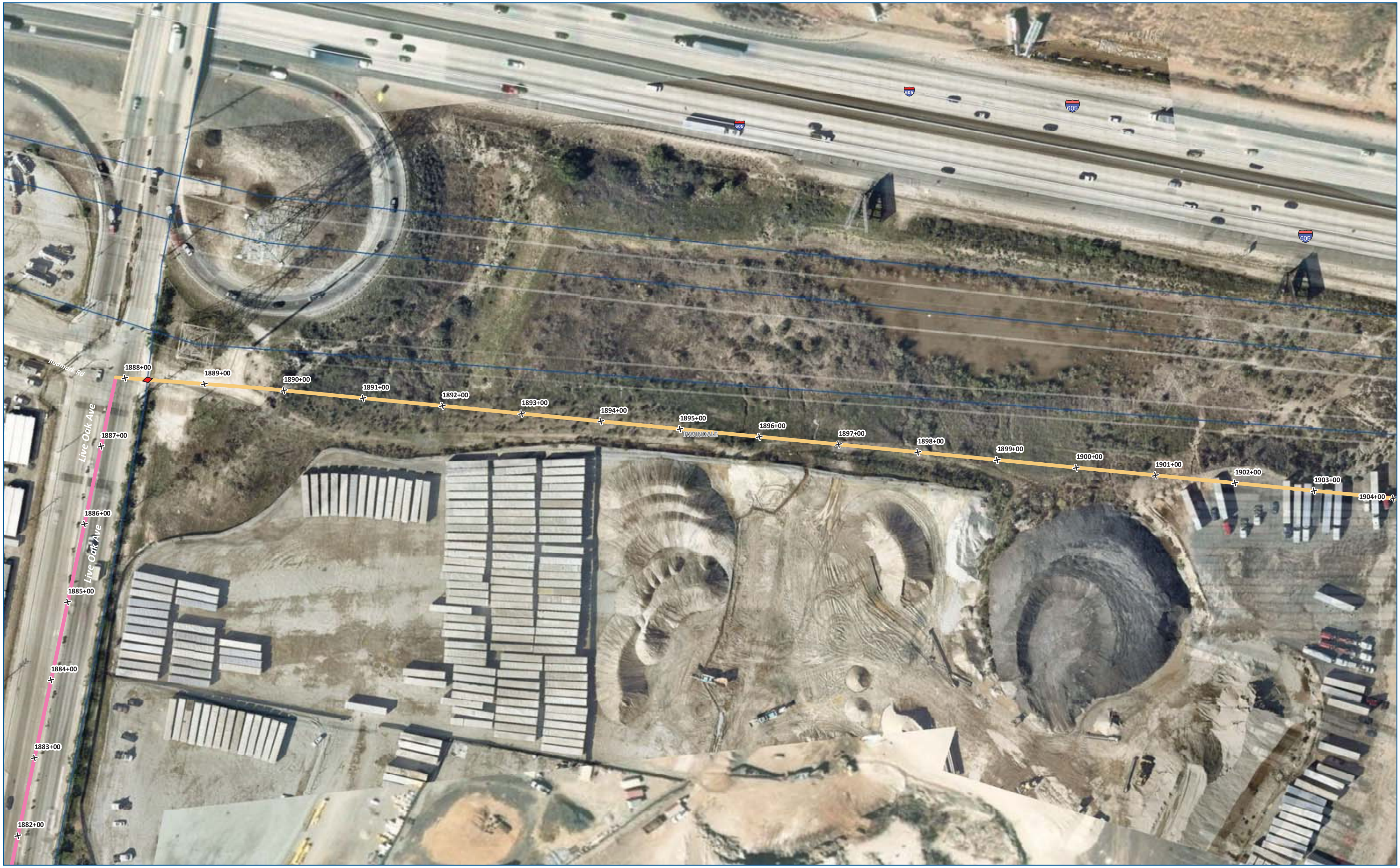

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SG River Alignment, Page 121

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

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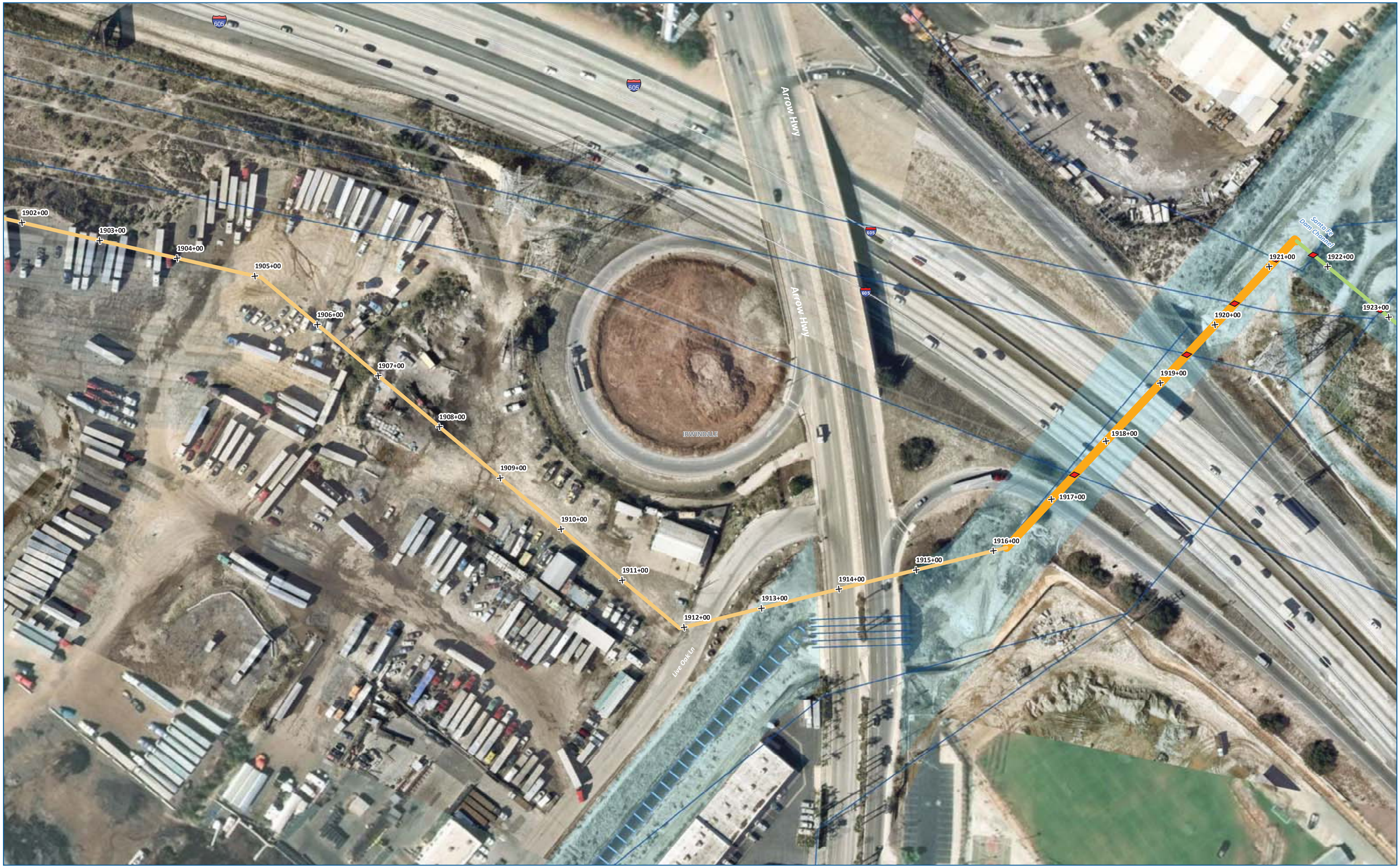

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SG River Alignment, Page 122

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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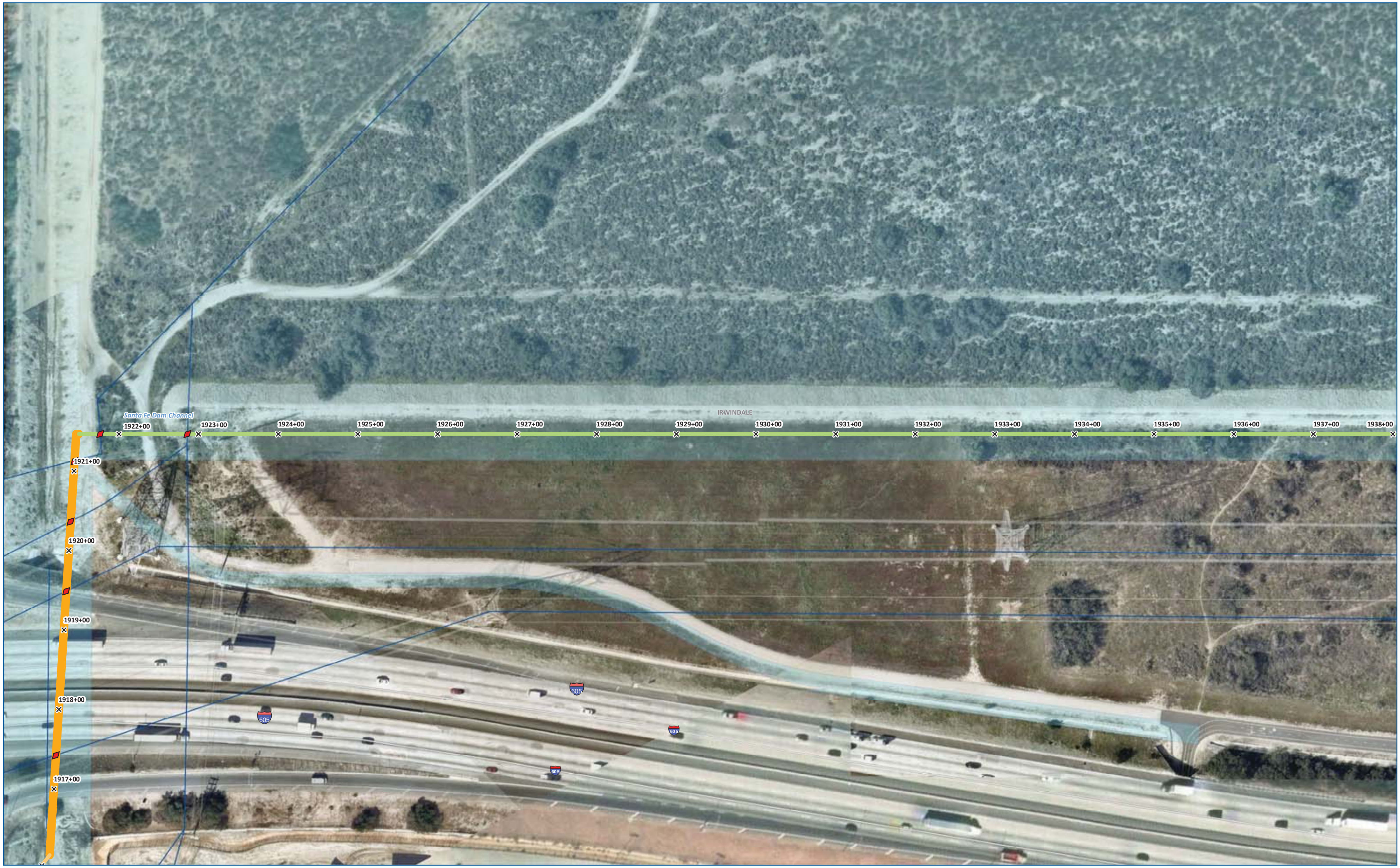

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SG River Alignment, Page 123

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 124

LEGEND

Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
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Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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SG River Alignment, Page 125

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
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- 3C - LACFD Easements (Lined River Channel)
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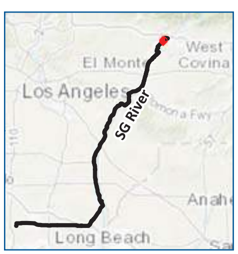
Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

BLACK & VEATCH

Mapbook_80 scale_Draft_v6_NEW_5_4_2020_SGRiver May 20, 2020



0 40 80
Feet

SG River Alignment, Page 126

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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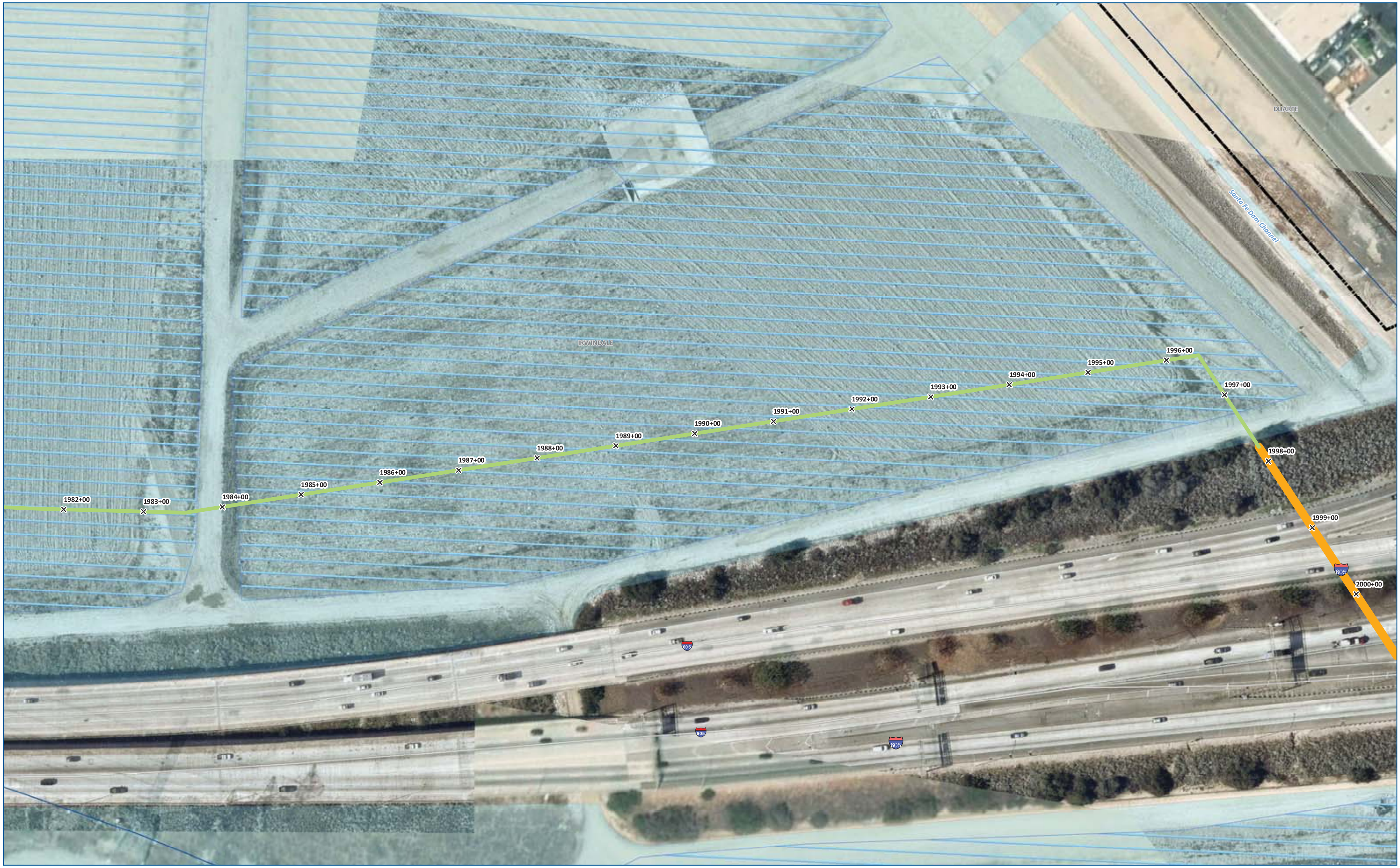

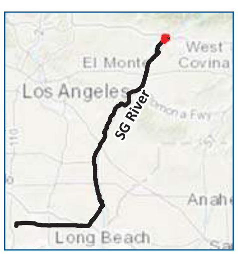

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Feet

SG River Alignment, Page 127

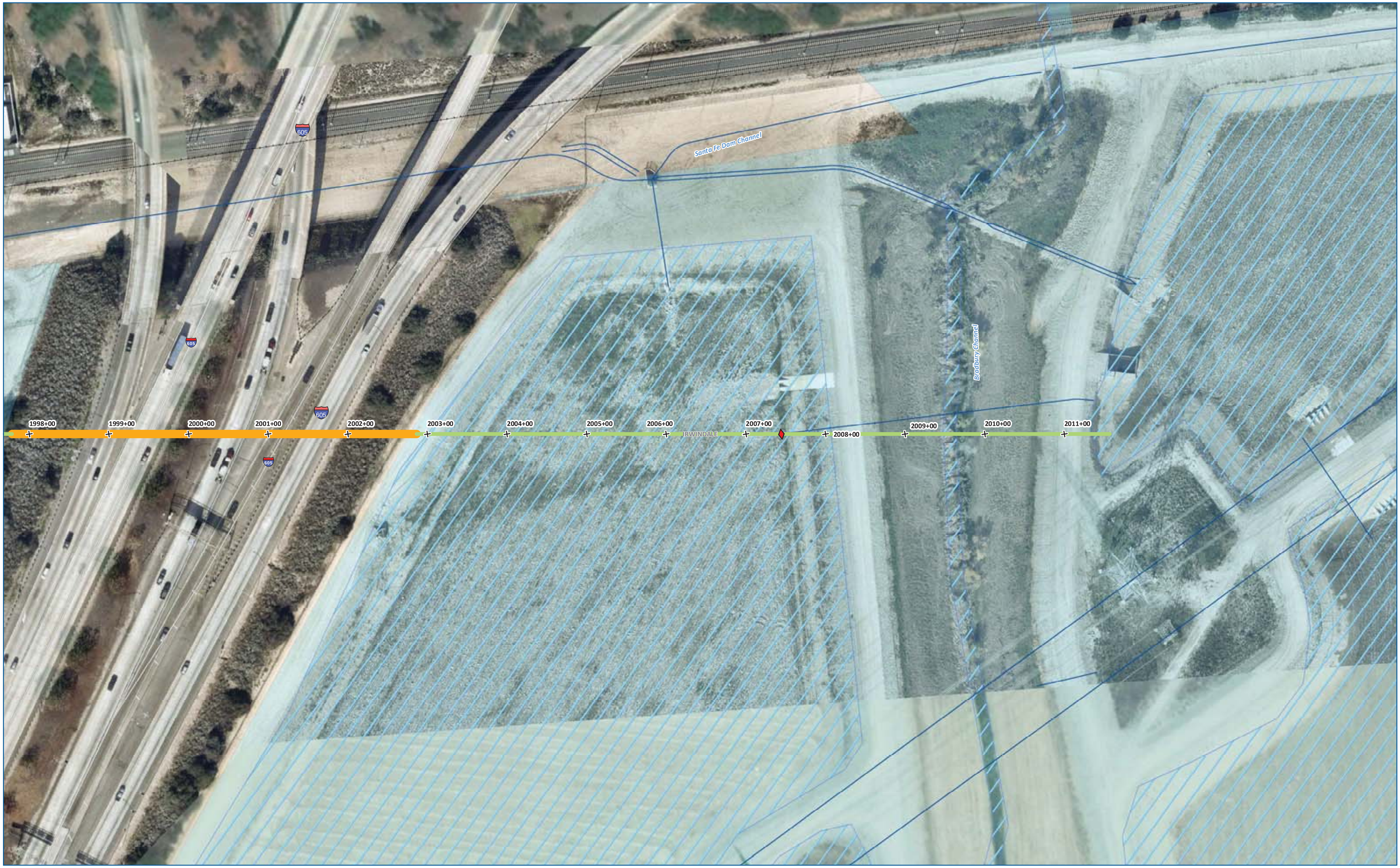
LEGEND

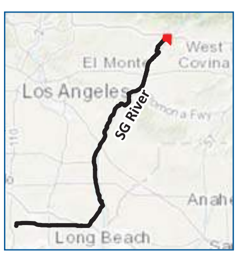
Open-Trench Construction Method	Trenchless Construction Method	
1 - Roadways	Traditional Tunnel	Major Utility Crossings
2 - SCE Easements	Jack & Bore	Future IRRP
3A - LACFD Easements (River Bank)	Jack & Bore w/Dewatering	City Utility
3B - LACFD Easements (Unlined River Channel)	Microtunnel	Existing MWD Distribution System
3C - LACFD Easements (Lined River Channel)		LA County Flood Control District
Pump Stations		City Boundaries
		Wetlands
		Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program
San Gabriel River Alignment

BLACK & VEATCH

Mapbook_80 scale_Draft_v6_NEW_5_4_2020_SGRiver May 20, 2020





0 40 80
Feet

SG River Alignment, Page 128

LEGEND

Open-Trench Construction Method
- 1 - Roadways
- 2 - SCE Easements
- 3A - LACFD Easements (River Bank)
- 3B - LACFD Easements (Unlined River Channel)
- 3C - LACFD Easements (Lined River Channel)
- Pump Stations

Trenchless Construction Method
- Traditional Tunnel
- Jack & Bore
- Jack & Bore w/Dewatering
- Microtunnel

- Major Utility Crossings
- Future IRRP
- City Utility
- Existing MWD Distribution System
- LA County Flood Control District
- City Boundaries
- Wetlands
- Critical Habitat

Feasibility-Level Design of Conveyance for Potential RW Program San Gabriel River Alignment

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Appendix H. Optimization of Pipe Sizes and Pumping Costs

This Appendix presents the pipe optimization calculations completed as part of this FLDR. The goals of the calculation were to optimize the pipe size of the SG River Alignment to balance pumping power cost with capital construction cost. The analysis compared the amortized capital costs and the annual energy consumption to determine the most cost effective pipe diameter. A more detailed evaluation should be conducted during preliminary design to validate costs.

Table H-1 presents the assumptions made to complete the pipe optimization calculations.

Table H-1 Pipe Optimization Assumptions

VARIABLES (ALL FACILITIES)	AMOUNT	UNITS
Pipeline Cost:	30	$/in-Dia / LF
Pump Station Power Usage:	1	Kilowatt hour (kWh)/ 1 ft of Lift for 1 acre-ft of water
Pump Station Power Cost:	0.15	$/kWh
Pump Efficiency:	80	%
Pump Station Cost:	5500	$/ 1 hP
Annual Interest Rate (PV)	4.5	%
Pipe Roughness Coefficient (C):	120	For new cement and mortar lined and coated pipe

Table H-2 presents inputs for PS-1 to PS-2.

Table H-2 Inputs for PS-1 to PS-2

PS-1 (JWPCP TO PS-2)		
Flow:	150	mgd
Pipeline Length:	68,478	Linear ft
Pipeline Length:	12.97	miles
Pump Station Elevation:	35	ft (mean sea level)
Discharge Elevation:	50	ft (mean sea level)
Pump Station Flow Values:		
	150	mgd
	104,167	gpm
	168,022	acre-ft /year

Table H-3 Inputs for PS-2 to OC Spreading Grounds

PS-2A (PS-2 TO OC SPREADING GROUNDS)		
Flow:	60	mgd
Pipeline Length:	83,172	Linear ft
Pipeline Length:	15.75	miles
Pump Station Elevation:	50	ft (mean sea level)
Discharge Elevation:	230	ft (mean sea level)
Pump Station Flow Values:		
	60	mgd
	41,667	gpm
	67,209	acre-ft /year

Table H-4 presents inputs for PS-2 to PS-3.

Table H-4 Inputs for PS-2 to PS-3

PS-2B (PS-2 TO PS-3)		
Flow:	80	mgd
Pipeline Length:	73,000	Linear ft
Pipeline Length:	13.83	miles
Pump Station Elevation:	50	ft (mean sea level)
Discharge Elevation:	220	ft (mean sea level)
Pump Station Flow Values:		
	80	mgd
	55,556	gpm
	89,612	acre-ft /year

Table H-5 presents inputs for Santa Fe Spreading Grounds.

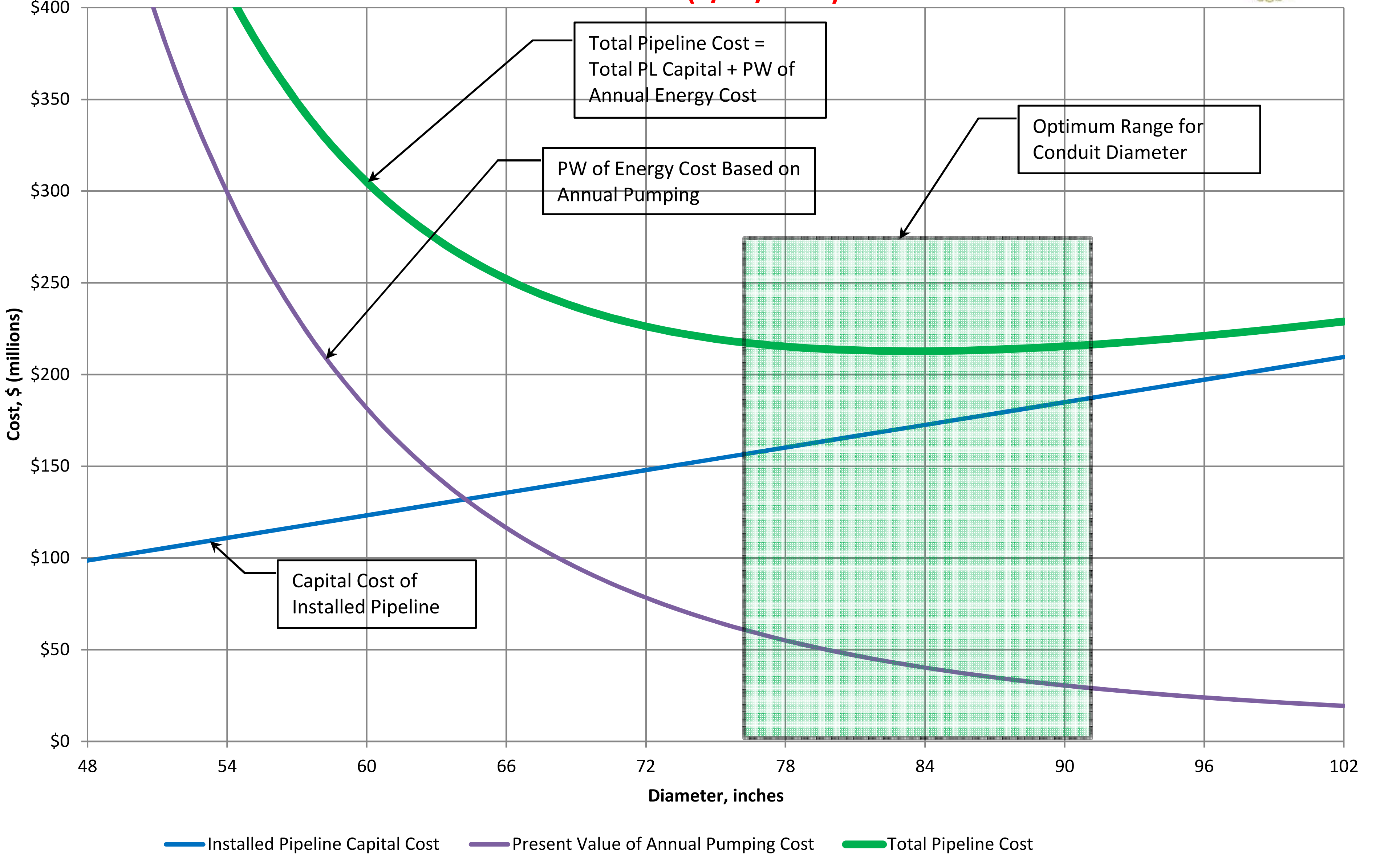
Table H-5 Inputs for PS-3 to Santa Fe Spreading Grounds

PS-3 (PS-3 TO SANTA FE SPREADING GROUNDS)		
Flow:	80	mgd
Pipeline Length:	58,800	Linear ft
Pipeline Length:	11.14	miles
Pump Station Elevation:	220	ft (mean sea level)
Discharge Elevation:	485	ft (mean sea level)
Pump Station Flow Values:		
	80	mgd
	55,556	gpm
	89,612	acre-ft /year

The results of the pipe optimization calculations are presented on the following figures.

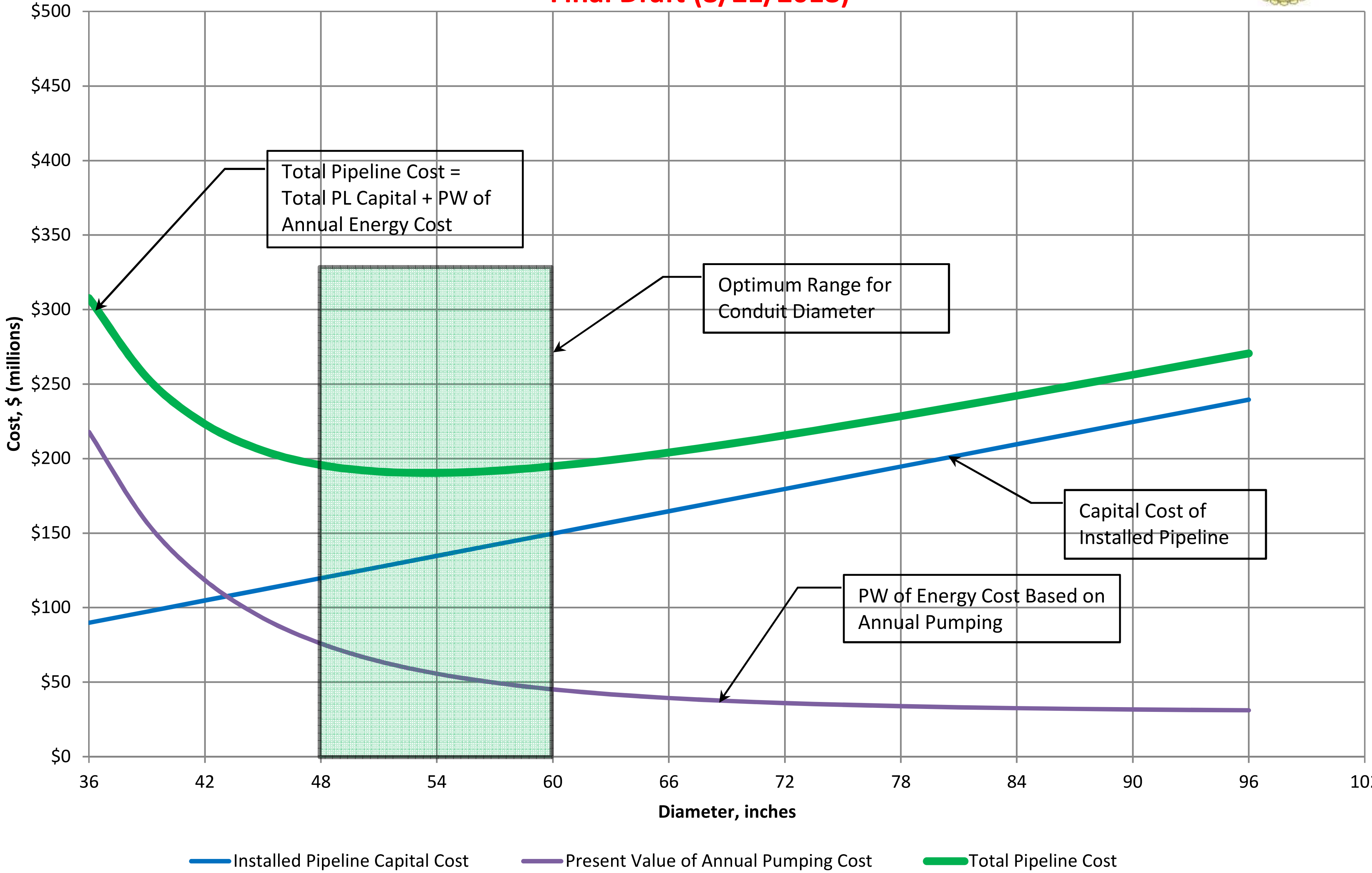
PS-1: Optimization of Pipeline Sizing and System Operation

Final Draft (8/21/2018)



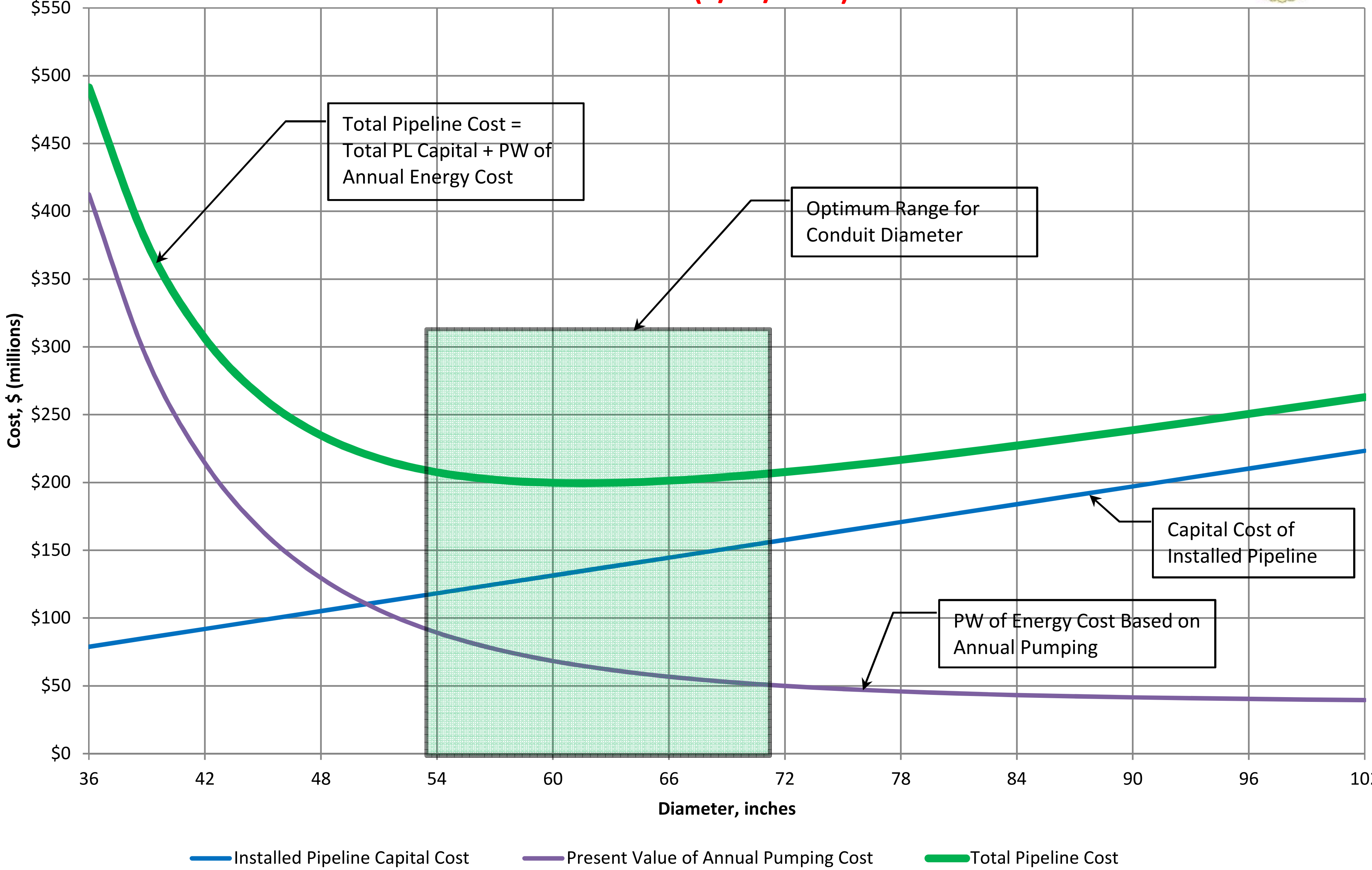
PS-2A: Optimization of Pipeline Sizing and System Operation

Final Draft (8/21/2018)



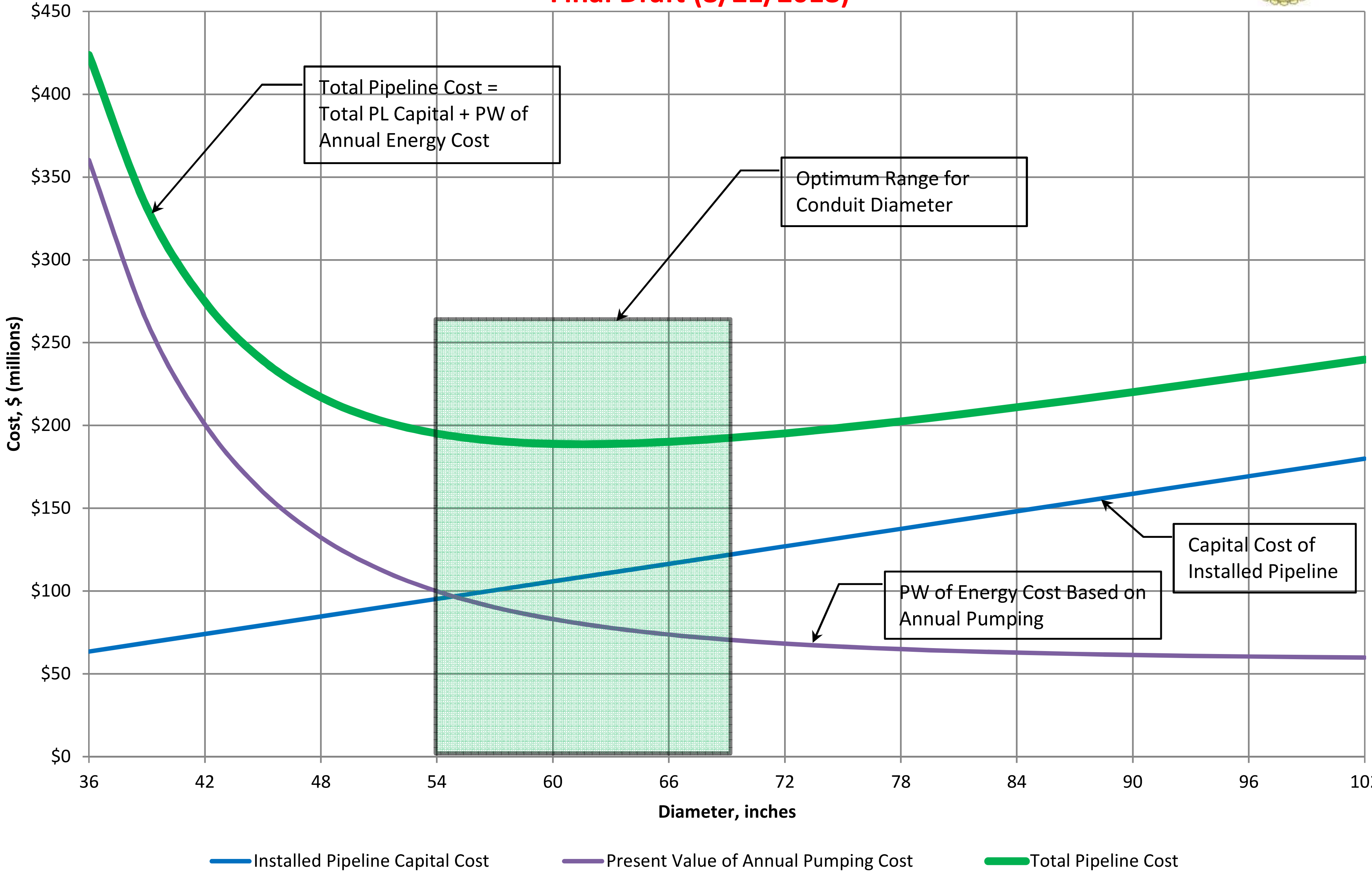
PS-2B: Optimization of Pipeline Sizing and System Operation

Final Draft (8/21/2018)



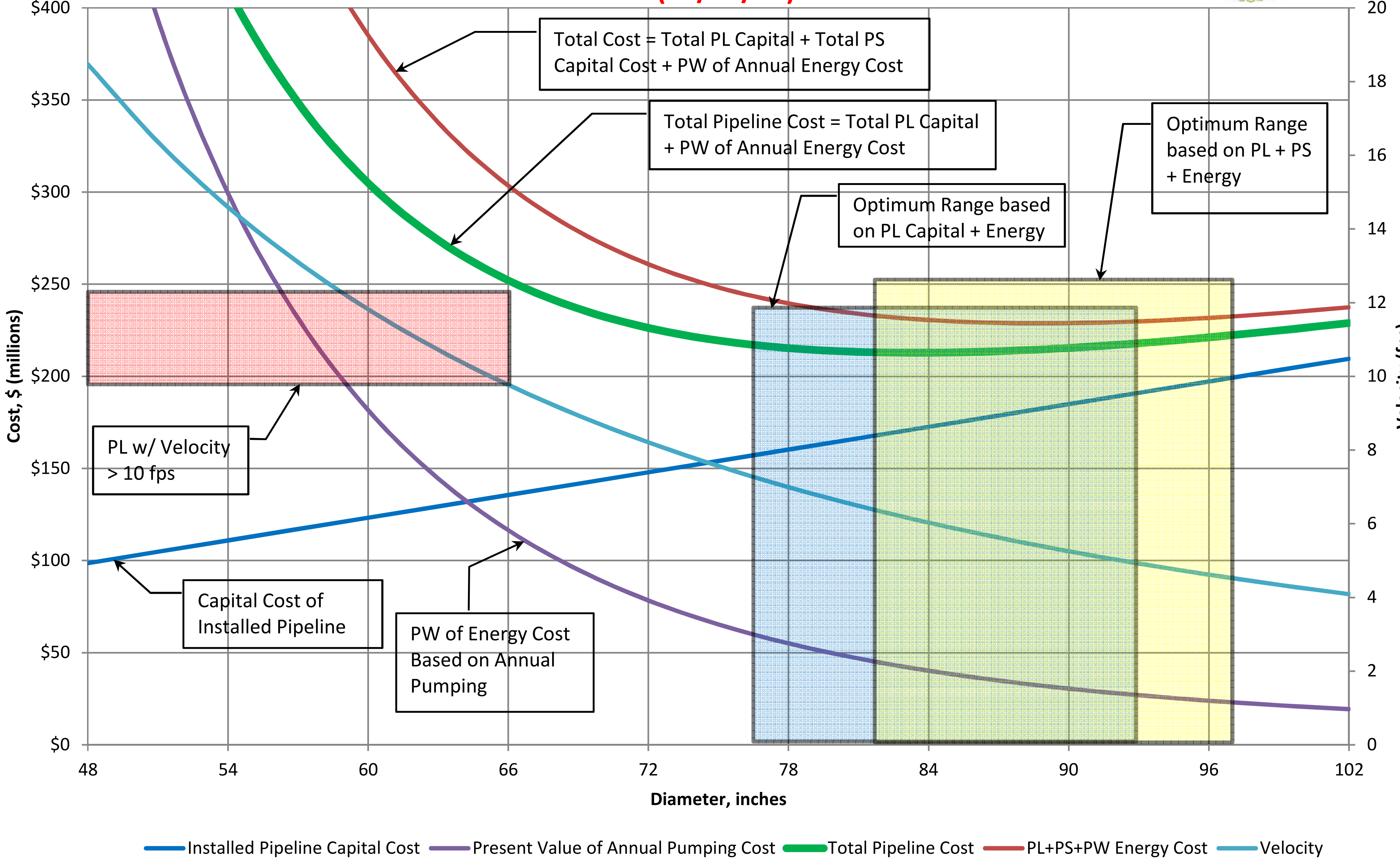
PS-3: Optimization of Pipeline Sizing and System Operation

Final Draft (8/21/2018)



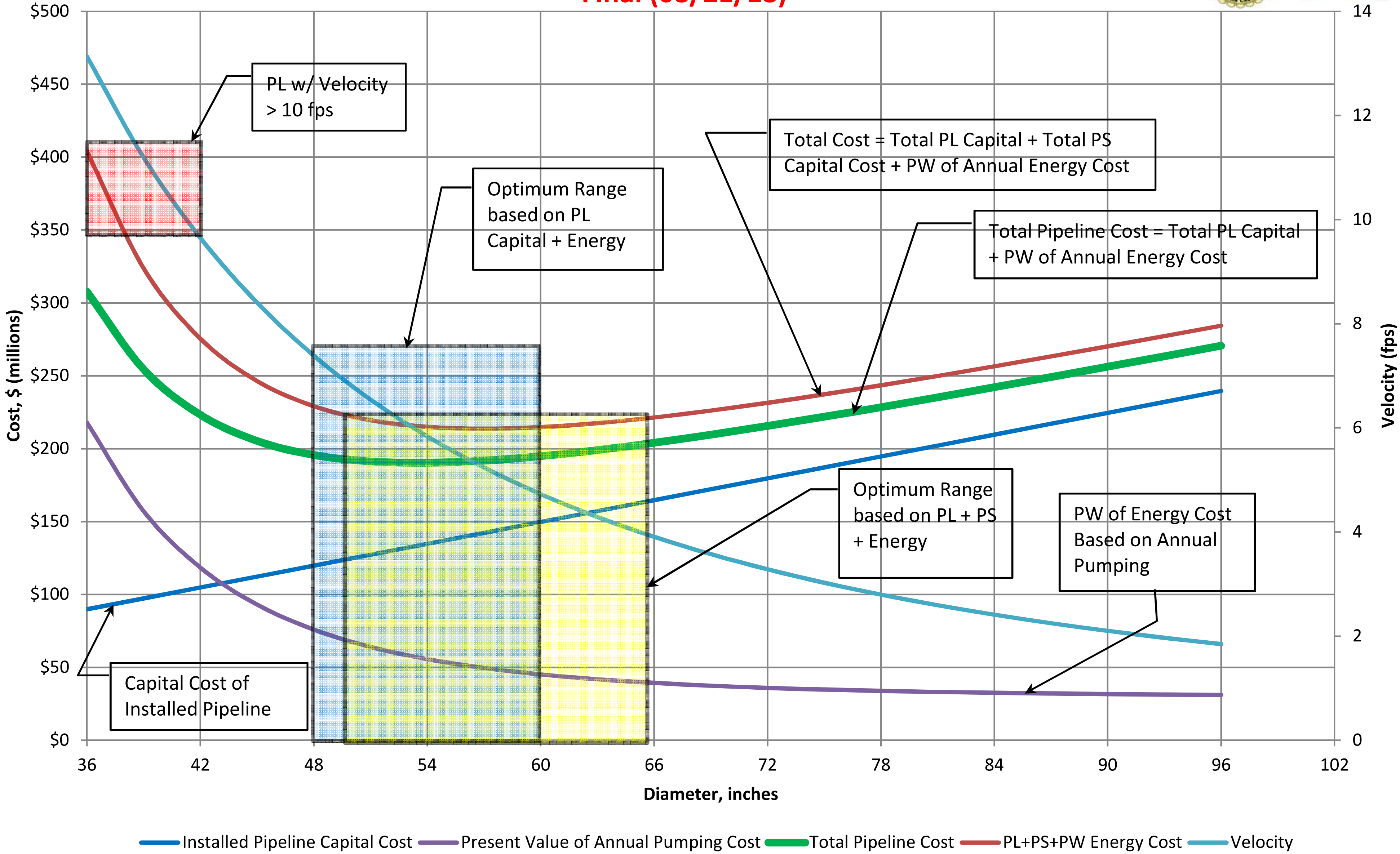
PS-1: Optimization of Pipeline Sizing and System Operation

Final (08/21/18)



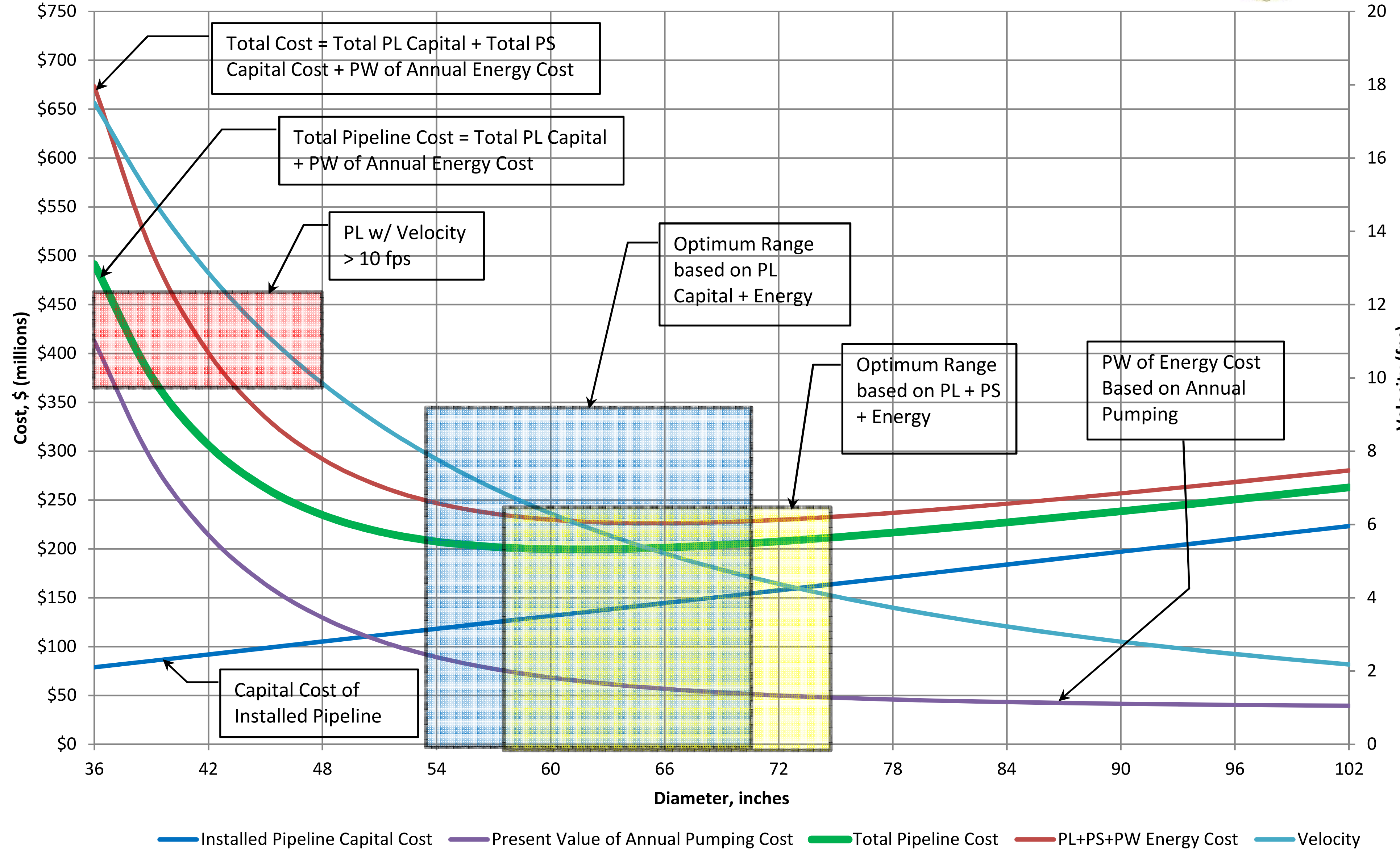
PS-2A: Optimization of Pipeline Sizing and System Operation

Final (08/21/18)



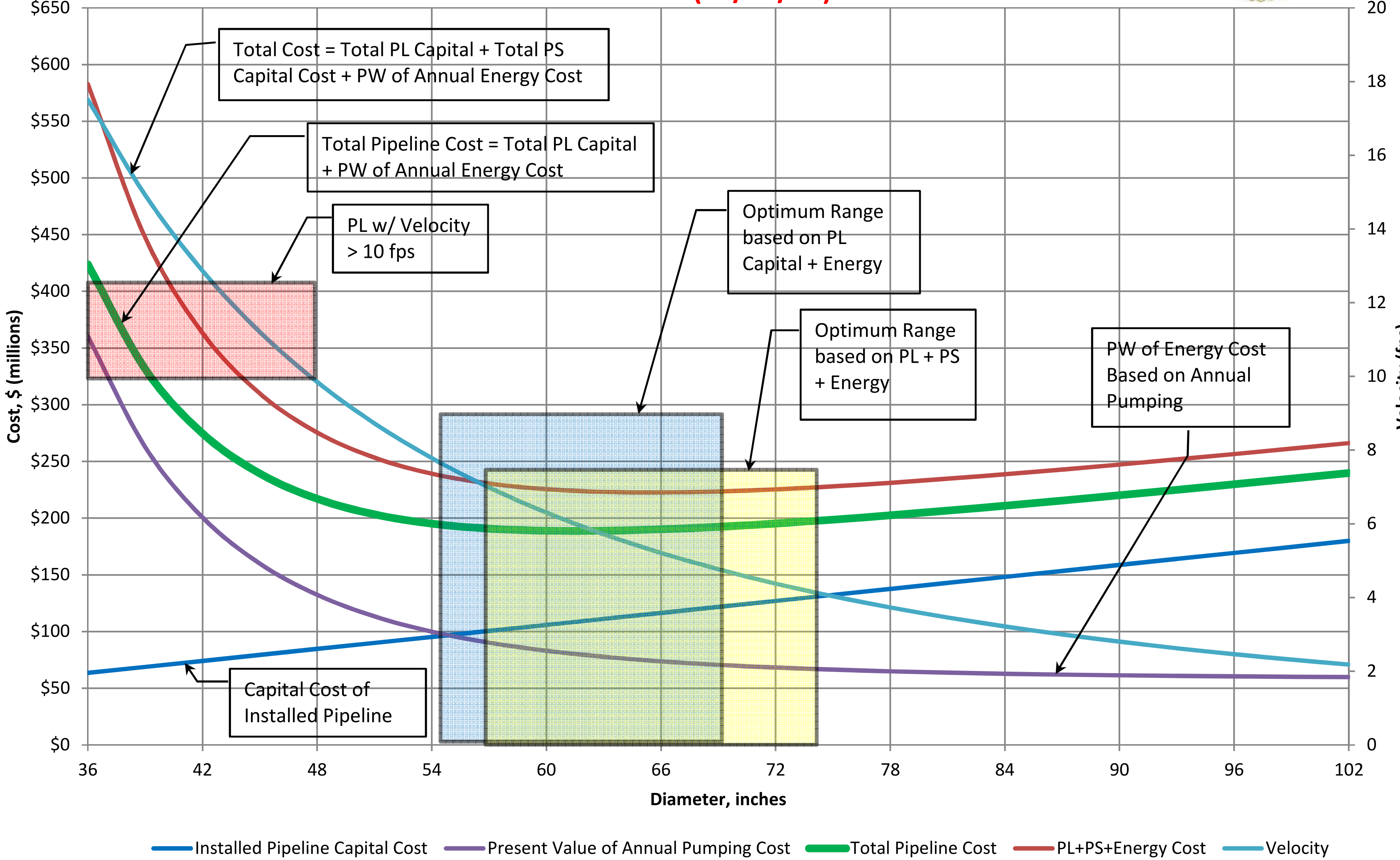
PS-2B: Optimization of Pipeline Sizing and System Operation

Final (08/21/18)



PS-3: Optimization of Pipeline Sizing and System Operation

Final Draft (08/21/18)



Appendix I. Steel Cylinder Design Calculations

This Appendix presents the steel cylinder design calculations completed as part of this CDR. The goals of the calculation were to select the preliminary pipeline plate thicknesses for the various conveyance pipeline segments, including provisions for depth of cover and surcharge loads. This was a basic segment by segment analysis to support cost estimating and provide an initial basis for pre-design development. More detailed, site specific calculations would be deferred to the preliminary design phase.

The pipe steel plate thickness was based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress. In addition, buckling pressure for the thinnest wall pipe and minimum plate thickness are considered.

For open trench installations, an installation depth of 10 feet is assumed. More detailed pipeline profiles will be determined during preliminary and final design. As a result, some segments will require deeper installations and therefore, different shell thicknesses.

Wall thicknesses were calculated for all reaches of the SG and LA River Alignments as well as Alternatives A and B.

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OWNER: *Metropolitan Water District of Southern California*
PROJECT: *MWD RW Conveyance*
PROJECT No: *191628*
TITLE: *Steel Pipe Wall Thickness Design - Pipeline Summary*
FILE No.:

Computed By *LJP*
Date *08/21/18*
Checked By *JAM*
Date *10/16/17*

Pipeline Information

Segment	Length (ft)	Inner Diameter (in)	Pressure (psi)	Depth of Cover (ft)	Calculated Wall Thickness (in)	Recommended Planning Thickness (in)[1]	Notes	Notes (cont.)
San Gabriel River Alignment								
Reach 1	68,478	84	175.32	25	0.500	0.500	HGL is 375 ft above grade at Dominguez channel + 25 ft cover + 4.5 ft to midpoint = 405 ft	
Reach 3 (included in Reach 1)	73,000	84	123.38	20	0.375	0.500	HGL is 265 ft above grade at beginning of Reach 3 + 20 ft cover = 285 ft	
Reach 4	59,682	84	154.11	20	0.375	0.500	HGL is 336 ft above grade at beginning of Reach 4 + 20 ft cover = 356 ft	
Los Angeles River Alignment								
Reach 1	133,428	84	158.44	25	0.375	0.500	HGL is 341 ft above grade at Dominguez channel + 25 ft cover = 366 ft	
Reach 2	59,682	84	154.11	20	0.375	0.500	HGL is 336 ft above grade at beginning of Reach 2 + 20 ft cover = 356 ft	
Alt A								
Reach 1 - Alt A	68,478	84	154.11	25.00	0.500	0.500	HGL is 455 ft above grade at Dominguez channel + 25 ft cover = 480 ft	
Reach 2 - Alt A	83,172	84	156.28	15.00	0.375	0.500	HGL is 346 ft above grade at beginning of Reach 2 + 15 ft cover = 361 ft	
Reach 3 - Alt A	73,000	84	158.44	20.00	0.375	0.500	HGL is 346 ft above grade at beginning of Reach 3 + 20 ft cover = 366 ft	
Alt B								
Reach 1 - Alt B	68,478	84	95.67	25.00	0.375	0.500	HGL is 196 ft above grade at Dominguez channel + 25 ft cover = 221 ft	
Reach 2 - Alt B	83,172	54	156.28	15.00	0.375	0.500	HGL is 346 ft above grade at beginning of Reach 2 + 15 ft cover = 361 ft	
Reach 3 - Alt B	73,000	60	146.32	20.00	0.375	0.500	HGL is 318 ft above grade at beginning of Reach 3 + 20 ft cover = 338 ft	
Reach 4	58,800	60	174.89	20.00	0.375	0.500	HGL is 384 ft above grade at beginning of Reach 4 + 20 ft cover = 404 ft	Same for Alt A and B

Notes:
1. It is recommended that a minimum thickness of 0.500 inch be used for planning purposes until more detailed hydraulic evaluations for final pump stations are completed during subsequent phases of planning and design.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	*ADC*
	PROJECT:	*MWD RW Conveyance*	Date	*05/11/20*
	PROJECT No:	*191628*	Checked By	*LJP*
	TITLE:	*Steel Pipe Wall Thickness Design - SG River: Reach 1*	Date	*05/12/20*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 1-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 84

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**86.00**				
Neutral Axis Dia, d_n (in)	**85.00**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	175				
Pressure = W+S	275	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

<u>Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:</u>

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.359**	**in**
			t =	*0.375*	*0.375 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	175	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	275	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.376**	**in**
			t =	*0.500*	*0.500 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

<u>Minimum Wall Thickness Required for Handling (Buried):</u>	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.358**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.376	in.
Recommended "t" for Internal Pressure/Handling =	**0.500**	**in.**
MWD Standard Pipe[3]	**0.500**	**in.**

Notes:

(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

Steel Pipe Wall Thickness Design

Reach 1-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) =	DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3)))	(M11 6-5)	
DI=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	43.00	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.010416667	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		311	239	549	0.31	0.36%	okay
6		466	119	585	0.34	0.39%	okay
8		621	60	681	0.40	0.46%	okay
10		776		776	0.46	0.53%	okay
14		1087		1087	0.64	0.74%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	ADC
	PROJECT:	*MWD RW Conveyance*	Date	05/11/20
	PROJECT No:	*191628*	Checked By	LJP
	TITLE:	*Steel Pipe Wall Thickness Design - SG River: Reach 1*	Date	05/12/20
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 1-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	175	psi	
Pmax =	275	psi	
Joint Dia =	86.00	inch	
Area =	5,809	sq. in.	
Thrust, T =	1,599,307	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	273.32		
t= steel wall thickness			
t from above calcs.=	**0.500**		
S, Stress in pipe=	11,703	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**	

Steel Pipe Wall Thickness Design

Reach 1-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E^{*}\varepsilon^{*}\Delta t$

Where

ΔS = Change in steel stress

E = Young's Modulus (steel) = 3.00E+07

ε = Coefficient of thermal expansion (steel) = 6.50E-06

Δt = Temperature Change =

Assume maximum temperature change= +/-50 degree, F

ΔS= +/- 9750 psi

1/2 Steel Yield Point = 21000 psi

ΔS less than 1/2 yield point? **Yes, okay**

Notes -

1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

BLACK & VEATCH			
	OWNER: *Metropolitan Water District of Southern California*	Computed By	*ADC*
	PROJECT: *MWD RW Conveyance*	Date	*05/11/20*
	PROJECT No: *191628*	Checked By	*LJP*
	TITLE: *Steel Pipe Wall Thickness Design - SG River: Reach 3*	Date	*05/12/20*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 3-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 84

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**85.75**				
Neutral Axis Dia, d_n (in)	**84.88**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	123				
Pressure = W+S	223	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.252**	**in**
			t =	*0.250*	*0.250 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	123	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	223	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.304**	**in**
			t =	*0.313*	*5/16 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.357**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.357	in.
Recommended "t" for Internal Pressure/Handling =	**0.375**	**in.**
MWD Standard Pipe[(3)]	**0.375**	**in.**

Notes:

(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

Steel Pipe Wall Thickness Design

Reach 3-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = Dl*(K*R^3*(We+(Wl/Dl)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

Dl=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	42.88	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.004394531	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection Dl*(K*R^3*(We+(Wl/Dl) {Dx}, in	Deflection Δx/OD %	
4		310	238	548	0.31	0.37%	okay
6		464	119	584	0.34	0.40%	okay
8		619	60	679	0.40	0.47%	okay
10		774		774	0.46	0.54%	okay
14		1084		1084	0.65	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: Dl, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	ADC
	PROJECT:	*MWD RW Conveyance*	Date	05/11/20
	PROJECT No:	*191628*	Checked By	LJP
	TITLE:	*Steel Pipe Wall Thickness Design - SG River: Reach 3*	Date	05/12/20
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 3-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	123	psi	
Pmax =	223	psi	
Joint Dia =	85.75	inch	
Area =	5,775	sq. in.	
Thrust, T =	1,290,018	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	272.53		
t= steel wall thickness			
t from above calcs.=	**0.375**		
S, Stress in pipe=	12,622	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
S < S_a ?	**Yes**		**OK - Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 3-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E*\varepsilon*\Delta t$

Where

ΔS = Change in steel stress

E = Young's Modulus (steel) = 3.00E+07

ε = Coefficient of thermal expansion (steel) = 6.50E-06

Δt = Temperature Change =

Assume maximum temperature change= +/-50 degree, F

ΔS= +/- 9750 psi

1/2 Steel Yield Point = 21000 psi

ΔS less than 1/2 yield point? **Yes, okay**

Notes -

1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 4-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): **84**

Steel Pipe Wall Thickness Calculations

(1) **Check t for Yield at 50%**

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**85.75**				
Neutral Axis Dia, d_n (in)	**84.88**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	175				
Pressure = W+S	275	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.358**	**in**
			t =	*0.375*	*0.375 available size*

(2) **Check t for Yield at 75%**

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	175	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	275	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.375**	**in**
			t =	*0.375*	*0.375 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.357**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.375	in.
Recommended "t" for Internal Pressure/Handling =	**0.375**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:

(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	*ADC*
	PROJECT:	*MWD RW Conveyance*	Date	*05/11/20*
	PROJECT No:	*191628*	Checked By	*LJP*
	TITLE:	*Steel Pipe Wall Thickness Design - SG River: Reach 4*	Date	*05/12/20*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 4-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	42.88	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.004394531	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		310	238	548	0.31	0.37%	okay
6		464	119	584	0.34	0.40%	okay
8		619	60	679	0.40	0.47%	okay
10		774		774	0.46	0.54%	okay
14		1084		1084	0.65	0.75%	okay

Notes:

(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

Steel Pipe Wall Thickness Design

Reach 4-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3)	Working Pressure, P =	175	psi
	Pmax =	275	psi
	Joint Dia =	85.75	inch
	Area =	5,775	sq. in.
	Thrust, T =	1,590,023	lbs.

Stress in pipe, S = T/c*t

c= steel circumference	272.53	
t= steel wall thickness		
t from above calcs.=	**0.375**	
S, Stress in pipe=	15,558	psi
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 4-San Gabriel River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$$\Delta S = E * \varepsilon * \Delta t$$

Where

ΔS = Change in steel stress

E = Young's Modulus (steel) = 3.00E+07

ε = Coefficient of thermal expansion (steel) = 6.50E-06

Δt = Temperature Change =

Assume maximum temperature change= +/-50 degree, F

ΔS= +/- 9750 psi

1/2 Steel Yield Point = 21000 psi

ΔS less than 1/2 yield point? **Yes, okay**

Notes -

1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	25.00 ft		Max D/t =	**240**
	300.00 in			
Outside Diameter	86.00		Min t =	0.358
H/D	3.49			
Thinnest Pipe Wall=	0.500 in		t =	0.500
Pipe OD=	86.00			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.828
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		25.00
ro = outside raius of steel cylinder (in)		43.00
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		300.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.559
I= Moment of Inertia = bt^3/12 =		0.01042
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 82.1 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.828		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1941	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	29.3	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 57.7 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.500 in**
H=	**25 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	15.00 ft		Max D/t =	**240**
	180.00 in			
Outside Diameter	85.75		Min t =	0.357
H/D	2.10			
Thinnest Pipe Wall=	0.375 in		t =	0.375
Pipe OD=	85.75			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.714
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		15.00
ro = outside raius of steel cylinder (in)		42.88
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		0.99
Hc = height of Ground surface above pipe (in)		180.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.399
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 60.9 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361 lb/in^3	
Hw= height of water in trench=	156 in =	13 Feet
Rw = water buoyancy factor =	0.714	
Wc = weight of soil cover on pipe		
Wc = OD*H*Gs =	1161 lb/in	
Gs = unit wt. Backfill=	130 lb/ft^3	
Pv, internal vacuum pressure =	**5 psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	20.3 psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? **Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures**

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 45.6 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.375 in**
H=	**15 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	20.00 ft		Max D/t =	**240**
	240.00 in			
Outside Diameter	85.75		Min t =	0.357
H/D	2.80			
Thinnest Pipe Wall=	0.375 in		t =	0.375
Pipe OD=	85.75			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.786
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		20.00
ro = outside raius of steel cylinder (in)		42.88
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.00
Hc = height of Ground surface above pipe (in)		240.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.478
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 61.5 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.786		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1548	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	24.8	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 41.7 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.375 in**
H=	**20 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Steel Pipe Wall Thickness Design

Reach 1-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 84

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**85.75**				
Neutral Axis Dia, d_n (in)	**84.88**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	158				
Pressure = W+S	258	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.323**	**in**
			t =	*0.375*	*0.375 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	158	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	258	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.352**	**in**
			t =	*0.375*	*0.375 available size*

Where:
t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.357**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.357	in.
Recommended "t" for Internal Pressure/Handling =	**0.375**	**in.**
MWD Standard Pipe[(3)]	**0.375**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

Steel Pipe Wall Thickness Design

Reach 1-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

W=unit wt. Backfill= 130.00 *

* assumed

E' = 3000 psi for CLSM backfill

DI=	1.10	deflection lag factor
K=	0.10	bedding constant
E'=(2)	3,000.00	modulus of soil reaction
r=	42.88	mean radius of pipe wall
E=	30,000,000.00	modulus of elasticity of pipe material
$I_{steel} = t_s^3/12$	0.004394531	*moment of inertia per unit length of pipe wall*
We=	Bc*W*Hc/144	dead load in pounds per inch

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Δx/OD %	
4		310	238	548	0.31	0.37%	okay
6		464	119	584	0.34	0.40%	okay
8		619	60	679	0.40	0.47%	okay
10		774		774	0.46	0.54%	okay
14		1084		1084	0.65	0.75%	okay

Notes:

(1) Max Deflection 2% - HS-20 Loading

(2) E' = 3000 for CLSM backfil.

(3) Criteria: DI, K, E', W

(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.

(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

Steel Pipe Wall Thickness Design

Reach 1-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3)	Working Pressure, P =	158	psi
	Pmax =	258	psi
	Joint Dia =	85.75	inch
	Area =	5,775	sq. in.
	Thrust, T =	1,492,521	lbs.

Stress in pipe, S = T/c*t

c= steel circumference	272.53	
t= steel wall thickness		
t from above calcs.=	**0.375**	
S, Stress in pipe=	14,604	psi
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi
S < S_a ?	**Yes**	**OK - Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 1-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E * \varepsilon * \Delta t$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 2-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 84

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**85.75**				
Neutral Axis Dia, d_n (in)	**84.88**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	154				
Pressure = W+S	254	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.315**	**in**
			t =	*0.375*	*0.375 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	154	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	254	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.346**	**in**
			t =	*0.375*	*0.375 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.357**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.357	in.
Recommended "t" for Internal Pressure/Handling =	**0.375**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:

(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

Steel Pipe Wall Thickness Design

Reach 2-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
$E'=^{(2)}$	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	42.88	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.004394531	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		310	238	548	0.31	0.37%	okay
6		464	119	584	0.34	0.40%	okay
8		619	60	679	0.40	0.47%	okay
10		774		774	0.46	0.54%	okay
14		1084		1084	0.65	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

Steel Pipe Wall Thickness Design

Reach 2-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	154	psi	
Pmax =	254	psi	
Joint Dia =	85.75	inch	
Area =	5,775	sq. in.	
Thrust, T =	1,467,521	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	272.53		
t= steel wall thickness			
t from above calcs.=	**0.375**		
S, Stress in pipe=	14,359	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**	

BLACK & VEATCH	**OWNER:** *Metropolitan Water District of Southern California*	**Computed By**	*ADC*
	PROJECT: *MWD RW Conveyance*	**Date**	*05/11/20*
	PROJECT No: *191628*	**Checked By**	*LJP*
	TITLE: *Steel Pipe Wall Thickness Design - LA River: Reach 2*	**Date**	*05/12/20*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 2-Los Angeles River Alignment

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$$\Delta S = E * \varepsilon * \Delta t$$

Where

ΔS = Change in steel stress

E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	25.00 ft		Max D/t =	**240**
	300.00 in			
Outside Diameter	86.00		Min t =	0.358
H/D	3.49			
Thinnest Pipe Wall=	0.500 in		t =	0.500
Pipe OD=	86.00			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.828
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		25.00
ro = outside raius of steel cylinder (in)		43.00
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		300.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.559
I= Moment of Inertia = bt^3/12 =		0.01042
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 82.1 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.828		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1941	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	29.3	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 57.7 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.500 in**
H=	**25 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	20.00	ft	Max D/t =	240
	240.00	in		
Outside Diameter	85.75		Min t =	0.357
H/D	2.80			
Thinnest Pipe Wall=	0.375	in	t =	0.375
Pipe OD=	85.75			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.786
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		20.00
ro = outside raius of steel cylinder (in)		42.88
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.00
Hc = height of Ground surface above pipe (in)		240.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.478
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 61.5 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.786		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1548	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	24.8	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 41.7 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5**	**psi**
t=	**0.375**	**in**
H=	**20**	**ft**
Composite E'=	**3,000**	**psi**
Safety Factor =	**2.0**	

BLACK & VEATCH	OWNER: *Metropolitan Water District of Southern California*	Computed By	*Follis*
	PROJECT: *MWD RW Conveyance*	Date	*10/04/17*
	PROJECT No: *191628*	Checked By	*JAM*
	TITLE: *Steel Pipe Wall Thickness Design - Alt A: Reach 1*	Date	*10/16/17*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 1-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 84

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**86.00**				
Neutral Axis Dia, d_n (in)	**85.00**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	154				
Pressure = W+S	254	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.316**	**in**
			t =	*0.500*	*1/2 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	154	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	254	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.347**	**in**
			t =	*0.500*	*1/2 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.358**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.358	in.
Recommended "t" for Internal Pressure/Handling =	**0.500**	**in.**
MWD Standard Pipe[3]	**0.500**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	*Follis*
	PROJECT:	*MWD RW Conveyance*	Date	*10/04/17*
	PROJECT No:	*191628*	Checked By	*JAM*
	TITLE:	*Steel Pipe Wall Thickness Design - Alt A: Reach 1*	Date	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 1-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	43.00	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.010416667	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		311	239	549	0.31	0.36%	okay
6		466	119	585	0.34	0.39%	okay
8		621	60	681	0.40	0.46%	okay
10		776		776	0.46	0.53%	okay
14		1087		1087	0.64	0.74%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

Steel Pipe Wall Thickness Design

Reach 1-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3)	Working Pressure, P =	154	psi
	Pmax =	254	psi
	Joint Dia =	86.00	inch
	Area =	5,809	sq. in.
	Thrust, T =	1,476,090	lbs.

Stress in pipe, S = T/c*t		
c= steel circumference	273.32	
t= steel wall thickness		
t from above calcs.=	**0.500**	
S, Stress in pipe=	10,801	psi
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 1-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E * \varepsilon * \Delta t$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

BLACK & VEATCH	OWNER: *Metropolitan Water District of Southern California*	Computed By	*Follis*
	PROJECT: *MWD RW Conveyance*	Date	*10/04/17*
	PROJECT No: *191628*	Checked By	*JAM*
	TITLE: *Steel Pipe Wall Thickness Design - Alt A: Reach 2*	Date	*10/16/17*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 2-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 54

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**54.00**				
Outside Diameter, d (in)	**55.63**				
Neutral Axis Dia, d_n (in)	**54.81**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	156				
Pressure = W+S	256	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

<u>Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:</u>

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.207**	**in**
			t =	*0.313*	*5/16 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**56**				
Working Pressure, (psi)	156	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	256	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.226**	**in**
			t =	*0.313*	*5/16 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

<u>Minimum Wall Thickness Required for Handling (Buried):</u>	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.232**	**in**
	t =	*0.250*	*1/4 available size*

Minimum "t" for Internal Pressure/Handling =	0.232	in.
Recommended "t" for Internal Pressure/Handling =	**0.313**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	**Computed By**	*Follis*
	PROJECT:	*MWD RW Conveyance*	**Date**	*10/04/17*
	PROJECT No:	*191628*	**Checked By**	*JAM*
	TITLE:	*Steel Pipe Wall Thickness Design - Alt A: Reach 2*	**Date**	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 2-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = Dl*(K*R^3*(We+(Wl/Dl)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

Dl=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=$^{(2)}$	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	27.81	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.002555358	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load {W_e}, lbs/in Hwd	Live Load (5) {W_l}, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection Dl*(K*R^3*(We+(Wl/Dl) {Dx}, in	Δx/OD %	
4		201	155	355	0.20	0.36%	okay
6		301	77	379	0.22	0.39%	okay
8		402	39	440	0.26	0.46%	okay
10		502		502	0.30	0.53%	okay
14		703		703	0.41	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: Dl, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

BLACK & VEATCH	**OWNER:**	*Metropolitan Water District of Southern California*	***Computed By***	*Follis*
	PROJECT:	*MWD RW Conveyance*	***Date***	*10/04/17*
	PROJECT No:	*191628*	***Checked By***	*JAM*
	TITLE:	*Steel Pipe Wall Thickness Design - Alt A: Reach 2*	***Date***	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 2-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	156	psi	
Pmax =	256	psi	
Joint Dia =	55.63	inch	
Area =	2,430	sq. in.	
Thrust, T =	622,810	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	177.90		
t= steel wall thickness			
t from above calcs.=	**0.313**		
S, Stress in pipe=	11,185	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**	

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	**Computed By**	*Follis*
	PROJECT:	*MWD RW Conveyance*	**Date**	*10/04/17*
	PROJECT No:	*191628*	**Checked By**	*JAM*
	TITLE:	*Steel Pipe Wall Thickness Design - Alt A: Reach 2*	**Date**	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 2-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E * \varepsilon * \Delta t$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 3-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 60

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**60.00**				
Outside Diameter, d (in)	**61.75**				
Neutral Axis Dia, d_n (in)	**60.88**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	158				
Pressure = W+S	258	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

<u>Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:</u>

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.233**	**in**
			t =	*0.375*	*0.375 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**62**				
Working Pressure, (psi)	158	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	258	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.253**	**in**
			t =	*0.375*	*0.375 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

<u>Minimum Wall Thickness Required for Handling (Buried):</u>	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.257**	**in**
	t =	*0.313*	*5/16 available size*

Minimum "t" for Internal Pressure/Handling =	0.257	in.
Recommended "t" for Internal Pressure/Handling =	**0.375**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

Steel Pipe Wall Thickness Design

Reach 3-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	30.88	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.004394531	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		223	172	395	0.22	0.36%	okay
6		334	86	420	0.24	0.39%	okay
8		446	43	489	0.28	0.46%	okay
10		557		557	0.33	0.53%	okay
14		780		780	0.46	0.74%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

BLACK & VEATCH	**OWNER:** *Metropolitan Water District of Southern California*	**Computed By**	*Follis*
	PROJECT: *MWD RW Conveyance*	**Date**	*10/04/17*
	PROJECT No: *191628*	**Checked By**	*JAM*
	TITLE: *Steel Pipe Wall Thickness Design - Alt A: Reach 3*	**Date**	*10/16/17*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 3-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	158	psi	
Pmax =	258	psi	
Joint Dia =	61.75	inch	
Area =	2,995	sq. in.	
Thrust, T =	773,974	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	197.13		
t= steel wall thickness			
t from above calcs.=	**0.375**		
S, Stress in pipe=	10,470	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
S < S_a ?	**Yes**	**OK - Internal Pressure Controls**	

Steel Pipe Wall Thickness Design

Reach 3-Alternative A

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$$\Delta S = E * \varepsilon * \Delta t$$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	25.00	ft	Max D/t =	240	
	300.00	in			
Outside Diameter	86.00		Min t =	0.358	
H/D	3.49				
Thinnest Pipe Wall=	0.500	in	t =	0.500	
Pipe OD=	86.00				

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.828
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		25.00
ro = outside raius of steel cylinder (in)		43.00
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		300.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.559
I= Moment of Inertia = bt^3/12 =		0.01042
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 82.1 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.828		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1941	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	29.3	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? **Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures**

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 57.7 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5**	**psi**
t=	**0.500**	**in**
H=	**25**	**ft**
Composite E'=	**3,000**	**psi**
Safety Factor =	**2.0**	

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	15.00	ft	Max D/t =	240	
	180.00	in			
Outside Diameter	55.63		Min t =	0.232	
H/D	3.24				
Thinnest Pipe Wall=	0.375	in	t =	0.375	
Pipe OD=	55.63				

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.714
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		15.00
ro = outside raius of steel cylinder (in)		27.81
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		180.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.399
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 95.2 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.714		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	753	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	20.3	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? **Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures**

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 79.9 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.375 in**
H=	**15 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	20.00	ft	Max D/t =	240	
	240.00	in			
Outside Diameter	61.75		Min t =	0.257	
H/D	3.89				
Thinnest Pipe Wall=	0.375	in	t =	0.375	
Pipe OD=	61.75				

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.786
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		20.00
ro = outside raius of steel cylinder (in)		30.88
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		240.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.478
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 86.2 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.786		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1115	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	24.8	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 66.4 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5**	**psi**
t=	**0.375**	**in**
H=	**20**	**ft**
Composite E'=	**3,000**	**psi**
Safety Factor =	**2.0**	

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	*Follis*
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	TITLE:	*Steel Pipe Wall Thickness Design - Alt B: Reach 1*	Date	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 1-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 84

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**84.00**				
Outside Diameter, d (in)	**85.75**				
Neutral Axis Dia, d_n (in)	**84.88**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	96				
Pressure = W+S	196	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.195**	**in**
			t =	*0.250*	*1/4 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**86**				
Working Pressure, (psi)	96	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	196	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.266**	**in**
			t =	*0.313*	*5/16 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	D/t =	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.357**	**in**
	t =	*0.375*	*0.375 available size*

Minimum "t" for Internal Pressure/Handling =	0.357	in.
Recommended "t" for Internal Pressure/Handling =	**0.375**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:

(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	**Computed By**	*Follis*
	PROJECT:	*MWD RW Conveyance*	**Date**	*10/04/17*
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	TITLE:	*Steel Pipe Wall Thickness Design - Alt B: Reach 1*	**Date**	*10/16/17*
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Steel Pipe Wall Thickness Design

Reach 1-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill=	130.00 *
K=	0.10	bedding constant		* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill	
r=	42.88	mean radius of pipe wall		
E=	30,000,000.00	modulus of elasticity of pipe material		
$I_{steel} = t_s^3/12$	0.004394531	*moment of inertia per unit length of pipe wall*		
We=	Bc*W*Hc/144	dead load in pounds per inch		

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load {W_e}, lbs/in Hwd	Live Load (5) {W_l}, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		310	238	548	0.31	0.37%	okay
6		464	119	584	0.34	0.40%	okay
8		619	60	679	0.40	0.47%	okay
10		774		774	0.46	0.54%	okay
14		1084		1084	0.65	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	Follis
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Steel Pipe Wall Thickness Design

Reach 1-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	96	psi	
Pmax =	196	psi	
Joint Dia =	85.75	inch	
Area =	5,775	sq. in.	
Thrust, T =	1,130,016	lbs.	

Stress in pipe, S = T/c*t

c= steel circumference	272.53	
t= steel wall thickness		
t from above calcs.=	**0.375**	
S, Stress in pipe=	11,057	psi
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	**Computed By**	*Follis*
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Steel Pipe Wall Thickness Design

Reach 1-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E * \varepsilon * \Delta t$

Where

ΔS = Change in steel stress

E = Young's Modulus (steel) = 3.00E+07

ε = Coefficient of thermal expansion (steel) = 6.50E-06

Δt = Temperature Change =

Assume maximum temperature change= +/-50 degree, F

ΔS= +/- 9750 psi

1/2 Steel Yield Point = 21000 psi

ΔS less than 1/2 yield point? **Yes, okay**

Notes -

1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

BLACK & VEATCH	**OWNER:** *Metropolitan Water District of Southern California*	***Computed By***	*Follis*
	PROJECT: *MWD RW Conveyance*	***Date***	*10/04/17*
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	TITLE: *Steel Pipe Wall Thickness Design - Alt B: Reach 2*	***Date***	*10/16/17*
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Steel Pipe Wall Thickness Design

Reach 2-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): **54**

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**54.00**					
Outside Diameter, d (in)	**55.50**					
Neutral Axis Dia, d_n (in)	**54.75**					
Lining (in)	0.50	Note 2				
Coating (in)	0.75	Note 2				
Working Pressure, (psi)	156					
Pressure = W+S	256	Surge is Max HGL + 100 psi				
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662				
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield				

<u>Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:</u>

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.207**	**in**
			t =	*0.250*	*1/4 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**56**				
Working Pressure, (psi)	156	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	256	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.226**	**in**
			t =	*0.250*	*1/4 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

<u>Minimum Wall Thickness Required for Handling (Buried):</u>	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.231**	**in**
	t =	*0.250*	*1/4 available size*

Minimum "t" for Internal Pressure/Handling =	0.231	in.
Recommended "t" for Internal Pressure/Handling =	**0.250**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

BLACK & VEATCH	OWNER: *Metropolitan Water District of Southern California*	Computed By	*Follis*
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Steel Pipe Wall Thickness Design

Reach 2-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	27.75	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.001302083	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		200	154	355	0.20	0.37%	okay
6		301	77	378	0.22	0.40%	okay
8		401	39	439	0.26	0.47%	okay
10		501		501	0.30	0.54%	okay
14		701		701	0.42	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	*Follis*
	PROJECT:	*MWD RW Conveyance*	Date	*10/04/17*
	PROJECT No:	*191628*	Checked By	*JAM*
	TITLE:	*Steel Pipe Wall Thickness Design - Alt B: Reach 2*	Date	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 2-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	156	psi	
Pmax =	256	psi	
Joint Dia =	55.50	inch	
Area =	2,419	sq. in.	
Thrust, T =	619,991	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	177.50		
t= steel wall thickness			
t from above calcs.=	**0.250**		
S, Stress in pipe=	13,972	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
S < S_a ?	**Yes**	**OK - Internal Pressure Controls**	

BLACK & VEATCH	**OWNER:** *Metropolitan Water District of Southern California*	**Computed By**	*Follis*
	PROJECT: *MWD RW Conveyance*	**Date**	*10/04/17*
	PROJECT No: *191628*	**Checked By**	*JAM*
	TITLE: *Steel Pipe Wall Thickness Design - Alt B: Reach 2*	**Date**	*10/16/17*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 2-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E*\varepsilon*\Delta t$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

BLACK & VEATCH	OWNER:	Metropolitan Water District of Southern California	Computed By	Follis
	PROJECT:	MWD RW Conveyance	Date	10/04/17
	PROJECT No:	191628	Checked By	JAM
	TITLE:	Steel Pipe Wall Thickness Design - Alt B: Reach 3	Date	10/16/17
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 3-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 60

Steel Pipe Wall Thickness Calculations

(1) **Check t for Yield at 50%**

Inside Diameter, d (in)	**60.00**				
Outside Diameter, d (in)	**61.63**				
Neutral Axis Dia, d_n (in)	**60.81**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	146				
Pressure = W+S	246	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.215**	**in**
			t =	*0.250*	*1/4 available size*

(2) **Check t for Yield at 75%**

Outside Diameter, d (in)	**62**				
Working Pressure, (psi)	146	Pipeline Profile Dwgs HGL (950 ft) Static			
Pressure = W+S	246	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000				
Allowable Steel Stress (Surge), S_a (psi)	31,500		**t =**	**0.241**	**in**
			t =	*0.250*	*1/4 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 1
Metropolitan Design Criteria	**t =**	**0.257**	**in**
	t =	*0.313*	*5/16 available size*

Minimum "t" for Internal Pressure/Handling =	0.257	in.
Recommended "t" for Internal Pressure/Handling =	**0.313**	**in.**
MWD Standard Pipe(3)	**0.375**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

BLACK & VEATCH	OWNER: *Metropolitan Water District of Southern California*	Computed By	*Follis*
	PROJECT: *MWD RW Conveyance*	Date	*10/04/17*
	PROJECT No: *191628*	Checked By	*JAM*
	TITLE: *Steel Pipe Wall Thickness Design - Alt B: Reach 3*	Date	*10/16/17*
	FILE No.:		

Steel Pipe Wall Thickness Design

Reach 3-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = Dl*(K*R^3*(We+(Wl/Dl)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

Dl=	1.10	deflection lag factor	W=unit wt. Backfill= 130.00 *
K=	0.10	bedding constant	* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill
r=	30.81	mean radius of pipe wall	
E=	30,000,000.00	modulus of elasticity of pipe material	
$I_{steel} = t_s^3/12$	0.002555358	*moment of inertia per unit length of pipe wall*	
We=	Bc*W*Hc/144	dead load in pounds per inch	

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection Dl*(K*R^3*(We+(Wl/Dl) {Dx}, in	Deflection Δx/OD %	
4		223	171	394	0.22	0.36%	okay
6		334	86	419	0.24	0.40%	okay
8		445	43	488	0.29	0.47%	okay
10		556		556	0.33	0.53%	okay
14		779		779	0.46	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: Dl, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

Steel Pipe Wall Thickness Design

Reach 3-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3) Working Pressure, P =	146	psi	
Pmax =	246	psi	
Joint Dia =	61.63	inch	
Area =	2,983	sq. in.	
Thrust, T =	734,714	lbs.	
Stress in pipe, S = T/c*t			
c= steel circumference	196.75		
t= steel wall thickness			
t from above calcs.=	**0.313**		
S, Stress in pipe=	11,931	psi	
Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi	
$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**	

Steel Pipe Wall Thickness Design

Reach 3-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E * \varepsilon * \Delta t$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

BLACK & VEATCH	OWNER:	*Metropolitan Water District of Southern California*	Computed By	*LJP*
	PROJECT:	*MWD RW Conveyance*	Date	*08/21/18*
	PROJECT No:	*191628*	Checked By	*JAM*
	TITLE:	*Steel Pipe Wall Thickness Design - Alt B: Reach 4*	Date	*10/16/17*
	FILE No.:			

Steel Pipe Wall Thickness Design

Reach 4-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 1 - Internal Pressure and Handling Condition

Existing Steel Pipe Diameter (in): 60

Steel Pipe Wall Thickness Calculations

(1) Check t for Yield at 50%

Inside Diameter, d (in)	**60.00**				
Outside Diameter, d (in)	**61.63**				
Neutral Axis Dia, d_n (in)	**60.81**				
Lining (in)	0.50	Note 2			
Coating (in)	0.75	Note 2			
Working Pressure, (psi)	175				
Pressure = W+S	275	Surge is Max HGL + 100 psi			
Yield Point, s (psi)	42,000	Per MWD Spec Section 02662			
Min, Yield Point, S (psi)	21,000	Based on Factor of 50% Yield			

Calculated Minimum Wall Thickness Required, Internal Pressure Calculation:

(M11 4-1)	Formula =	$t = pd/(2S_a)$	**t =**	**0.257**	**in**
			t =	*0.313*	*5/16 available size*

(2) Check t for Yield at 75%

Outside Diameter, d (in)	**62**			
Working Pressure, (psi)	175			
Pressure = W+S	275	Surge is Max HGL + 100 psi		
Yield Point, s (psi)	42,000			
Allowable Steel Stress (Surge), S_a (psi)	31,500	**t =**	**0.269**	**in**
		t =	*0.313*	*5/16 available size*

Where:

t = wall thickness (in)
p = pressure (Working + Surge)(psi)
d = OD of Pipe (in.) steel cylinder (no coatings)
S_a = Allowable Steel Stress (Surge), S_a (psi)

Minimum Wall Thickness Required for Handling (Buried):	**D/t =**	240.0	Note 2
Metropolitan Design Criteria	**t =**	**0.257**	**in**
	t =	*0.313*	*5/16 available size*

Minimum "t" for Internal Pressure/Handling =	0.269	in.
Recommended "t" for Internal Pressure/Handling =	**0.313**	**in.**
MWD Standard Pipe[3]	**0.375**	**in.**

Notes:
(1) D/t = 240, Metropolitan Water District standard.
(2) Cement mortar lining/coating strength not accounted for in steel cylinder thickness calculations.
(3) Minimum plate thickness from the MWD fabricated steel-plate pipe and fittings (K-Pipe) spec (02662) is 0.375 inches.

Steel Pipe Wall Thickness Design

Reach 4-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 2 - External Loading

delta (inches) = DI*(K*R^3*(We+(WI/DI)))/((E*I)+(0.061*E'*(r^3))) (M11 6-5)

DI=	1.10	deflection lag factor	W=unit wt. Backfill=	130.00 *
K=	0.10	bedding constant		* assumed
E'=(2)	3,000.00	modulus of soil reaction	E' = 3000 psi for CLSM backfill	
r=	30.81	mean radius of pipe wall		
E=	30,000,000.00	modulus of elasticity of pipe material		
$I_{steel} = t_s^3/12$	0.002555358	*moment of inertia per unit length of pipe wall*		
We=	Bc*W*Hc/144	dead load in pounds per inch		

Highway H-20 Loading Table (2% deflection max)

Depth of Cover {H}, ft		Earth Load $\{W_e\}$, lbs/in Hwd	Live Load (5) $\{W_l\}$, lbs/in	Trench Load {W}, lbs/in W_c+W_l	Deflection DI*(K*R^3*(We+(WI/DI) {Dx}, in	Deflection Δx/OD %	
4		223	171	394	0.22	0.36%	okay
6		334	86	419	0.24	0.40%	okay
8		445	43	488	0.29	0.47%	okay
10		556		556	0.33	0.53%	okay
14		779		779	0.46	0.75%	okay

Notes:
(1) Max Deflection 2% - HS-20 Loading
(2) E' = 3000 for CLSM backfil.
(3) Criteria: DI, K, E', W
(4) Used EI_{steel} only (conservative). Added strength of lining/coating not accounted for.
(5) Live Load based on M-11 Table 6-3 for HS-20 Loading. Live load negligable at depths greater than 8-feet.

Steel Pipe Wall Thickness Design

Reach 4-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 3 - Longitudinal Thrust

Assume Dead End thrust (T=Pmax*A)

(M11 13-3)	Working Pressure, P =	175	psi
	Pmax =	275	psi
	Joint Dia =	61.63	inch
	Area =	2,983	sq. in.
	Thrust, T =	819,935	lbs.
	Stress in pipe, S = T/c*t		
	c= steel circumference	196.75	
	t= steel wall thickness		
	t from above calcs.=	**0.313**	
	S, Stress in pipe=	13,315	psi
	Max allowable, S_a= min of 1/2 yield or 18,000 =	21000	psi
	$S < S_a$?	**Yes**	**OK - Internal Pressure Controls**

Steel Pipe Wall Thickness Design

Reach 4-Alternative B

Steel Pipe based on Metropolitan Design Criteria, M-11 and B&V EM 605.20. Wall thickness will be determined by one of four cases. Case 1 -internal pressure and/or handling requirements; Case 2 - external loading; Case 3 - longitudinal loading; and Case 4 - temperature stress.

Case 4 - Pipe Stress Due to Temperature Change

Formula (M11 8-2)

$\Delta S = E * \varepsilon * \Delta t$

Where

ΔS = Change in steel stress		
E = Young's Modulus (steel) =	3.00E+07	
ε = Coefficient of thermal expansion (steel) =	6.50E-06	
Δt = Temperature Change =		
Assume maximum temperature change=	+/-50	degree, F
ΔS=	+/- 9750	psi
1/2 Steel Yield Point =	21000	psi
ΔS less than 1/2 yield point?	**Yes, okay**	

Notes -
1 - Pipe assumed empty, no internal forces acting in conjunction with longitudinal forces

Is ΔS (Case 4) < S (Case 3)? **Yes, Internal Pressure Controls**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	25.00 ft		Max D/t =	**240**
	300.00 in			
Outside Diameter	85.75		Min t =	0.357
H/D	3.50			
Thinnest Pipe Wall=	0.375 in		t =	0.375
Pipe OD=	85.75			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=	2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h	0.828
hw = height of water surface above top of pipe (ft)	13.00
h = height of ground surface above top of pipe (ft)	25.00
ro = outside raius of steel cylinder (in)	42.88
Cn = scalar calibration factor for nonlinear effects	0.55
ps = factor to account for variability in stiffness of soil	0.90
kv = modulus correction facotr	0.74
Rh = correction factor for depth of fill	1.01
Hc = height of Ground surface above pipe (in)	300.000
B' = Elastic Coefficient = 1/{1+4e^(-0.065*H)}=	0.559
I= Moment of Inertia = bt^3/12 =	0.00439
E = Modulus of elasticity for steel, use	3.E+07
Composite E' = Modulus of elasticity for soil, use	3,000

Results:

qa= 61.9 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361 lb/in^3	
Hw= height of water in trench=	156 in =	13 Feet
Rw = water buoyancy factor =	0.828	
Wc = weight of soil cover on pipe		
Wc = OD*H*Gs =	1935 lb/in	
Gs = unit wt. Backfill=	130 lb/ft^3	
Pv, internal vacuum pressure =	**5 psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	29.3 psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? **Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures**

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 37.6 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.375 in**
H=	**25 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	15.00 ft		Max D/t =	240
	180.00 in			
Outside Diameter	55.50		Min t =	0.231
H/D	3.24			
Thinnest Pipe Wall=	0.375 in		t =	0.375
Pipe OD=	55.50			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=	2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h	0.714
hw = height of water surface above top of pipe (ft)	13.00
h = height of ground surface above top of pipe (ft)	15.00
ro = outside raius of steel cylinder (in)	27.75
Cn = scalar calibration factor for nonlinear effects	0.55
ps = factor to account for variability in stiffness of soil	0.90
kv = modulus correction facotr	0.74
Rh = correction factor for depth of fill	1.01
Hc = height of Ground surface above pipe (in)	180.000
B' = Elastic Coefficient = 1/{1+4e^(-0.065*H)}=	0.399
I= Moment of Inertia = bt^3/12 =	0.00439
E = Modulus of elasticity for steel, use	3.E+07
Composite E' = Modulus of elasticity for soil, use	3,000

Results:

qa= 95.4 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.714		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	752	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	20.3	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 80.1 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.375 in**
H=	**15 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	20.00 ft		Max D/t =	**240**
	240.00 in			
Outside Diameter	61.63		Min t =	0.257
H/D	3.89			
Thinnest Pipe Wall=	0.375 in		t =	0.375
Pipe OD=	61.63			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.786
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		20.00
ro = outside raius of steel cylinder (in)		30.81
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		240.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.478
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 86.4 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.786		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1113	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	24.8	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? **Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures**

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 66.5 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5 psi**
t=	**0.375 in**
H=	**20 ft**
Composite E'=	**3,000 psi**
Safety Factor =	**2.0**

Check buckling pressure for thinnest wall pipe

Maximum cover over pipe is	20.00	ft	Max D/t =	240
	240.00	in		
Outside Diameter	61.63		Min t =	0.257
H/D	3.89			
Thinnest Pipe Wall=	0.375	in	t =	0.375
Pipe OD=	61.63			

Equations:

Allowable buckling pressure = qa = {(1/(FS*ro)}*(1.2Cn*EI^.33*(ps*E'*kv)^.67*Rh (per AWWA M11 eqn 5-7)

Where:

FS= Safety Factor, Since H/D > 2=		2.000
Rw = Water buoyancy factor, 1-0.33 (hw/h), 0≤hw≤h		0.786
hw = height of water surface above top of pipe (ft)		13.00
h = height of ground surface above top of pipe (ft)		20.00
ro = outside raius of steel cylinder (in)		30.81
Cn = scalar calibration factor for nonlinear effects		0.55
ps = factor to account for variability in stiffness of soil		0.90
kv = modulus correction facotr		0.74
Rh = correction factor for depth of fill		1.01
Hc = height of Ground surface above pipe (in)		240.000
B' = Elastic Coefficient =	1/{1+4e^(-0.065*H)}=	0.478
I= Moment of Inertia = bt^3/12 =		0.00439
E = Modulus of elasticity for steel, use		3.E+07
Composite E' = Modulus of elasticity for soil, use		3,000

Results:

qa= 86.4 psi absolute

Check External loading combined with vacuum pressure

Equations:

Pa ≥ Gw*Hw+Rw*Wc/D +Pv M11 eqn 6-8

Where:

Gw = unit wt. of water =	0.0361	lb/in^3	
Hw= height of water in trench=	156	in =	13 Feet
Rw = water buoyancy factor =	0.786		
Wc = weight of soil cover on pipe			
Wc = OD*H*Gs =	1113	lb/in	
Gs = unit wt. Backfill=	130	lb/ft^3	
Pv, internal vacuum pressure =	**5**	**psi, (assumed)**	
Gw*Hw+Rw*Wc/D +Pv =	24.8	psi	

Is Pa ≥ Gw*Hw+Rw*Wc/D +Pv ? Yes - Buckling Pressures Do Not Exceed Allowable Buckling Pressures

Maximum Allowable Vacuum Pressure

Solve Equation for Pv Pv<Pa-Gw*Hw-Rw*Wc/D

Maximum Allowable Vacuum Pressure, Pv< 66.5 psi

Internal surge vacuum pressure is less than maximum allowable vacuum pressure

Conclusion:

Pipe can withstand vacuum for:

Pv =	**5**	**psi**
t=	**0.375**	**in**
H=	**20**	**ft**
Composite E'=	**3,000**	**psi**
Safety Factor =	**2.0**	

Appendix J. Preliminary Calculations and Equipment Selection for Pump Stations

CDM Smith	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
	PROJECT	RRWP	DATE CHECKED	10/26/17	COMPUTED BY	AG
	DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Pump System Curve Analysis
MWD RRWP
PS-1 Set A - 30-in

Station Description:

The station will consist of new pumps pumping through a 30-inch pipeline from PS-1 to West Coast Basin Injection Wells.
Each pump will be equipped with a dedicated VFD

1.0 Contents

1 Cover
2 System Curve Data
3 Pump Data
4 Curves

1.1 Purpose/Objective:

1. Develop approximate system curves to aid in initial pump sizing for various sceanrios

1.2 Procedure/Approach:

1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:

1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:

1. These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CDM Smith						
	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
	PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
	DETAIL	System Data	CHECKED BY	CAO		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head (High Darcy)
-Mannings friction estimate with low static head (Low Mannings)
-Mannings friction estimate with high static head (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

Assume 90 ft ground elevation at injection well locations.
Assume 20 psi (46 ft) of pressure required at injection well location

Pipe Length PS1 to West Basin	26,400	ft	<<--From preferred alignment per B&V
Kinematic viscosity, μ	0.0000093	ft2/s	<--Freshwater at 80 F

System Data (1-4)	Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
	System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
	Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44	Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44
	Discharge WSE or HGL (ft)	136	Discharge WSE or HGL (ft)	136	Discharge WSE or HGL (ft)	136	Discharge WSE or HGL (ft)	136
	Static Head (ft)	62	Static Head (ft)	92	Static Head (ft) =	62	Static Head (ft) =	92
	Flow (mgd)	15	Flow (mgd)	15	Flow (mgd)	15	Flow (mgd)	15
	Flow (gpm)	10,417	Flow (gpm)	10417	Flow (gpm)	10417	Flow (gpm)	10417
	Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
	Velocity (ft/s)	4.73	Velocity (ft/s)	4.73				
	Reynold's number, Re	1,276,542	Reynold's number, Re	1,276,542				
	Friction factor, f	0.0126	Friction factor, f	0.0156				
	Equivalent Diameter (in)	30	Equivalent Diameter (in)	30	Equivalent Diameter (in)	30	Equivalent Diameter (in)	30
	Friction Head (ft)	46	Friction Head (ft)	57	Friction Head (ft)	72	Friction Head (ft)	72
	Total Head (ft)	108	Total Head (ft)	149	Total Head (ft)	134	Total Head (ft)	164
Percent of Modeled Flow	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**
0%	0	62	0	92	0	62	0	92
20%	2083	64	2083	95	2083	66	2083	96
40%	4167	70	4167	103	4167	75	4167	105
60%	6250	80	6250	114	6250	90	6250	120
80%	8333	92	8333	130	8333	110	8333	140
100%	10417	108	10417	149	10417	134	10417	164
110%	11458	117	11458	160	11458	148	11458	178
120%	12500	127	12500	172	12500	163	12500	193
130%	13542	137	13542	185	13542	179	13542	209

CDM Smith	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
	PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
	DETAIL	Pump Data	CHECKED BY	CAO		

3.0 Pump Data

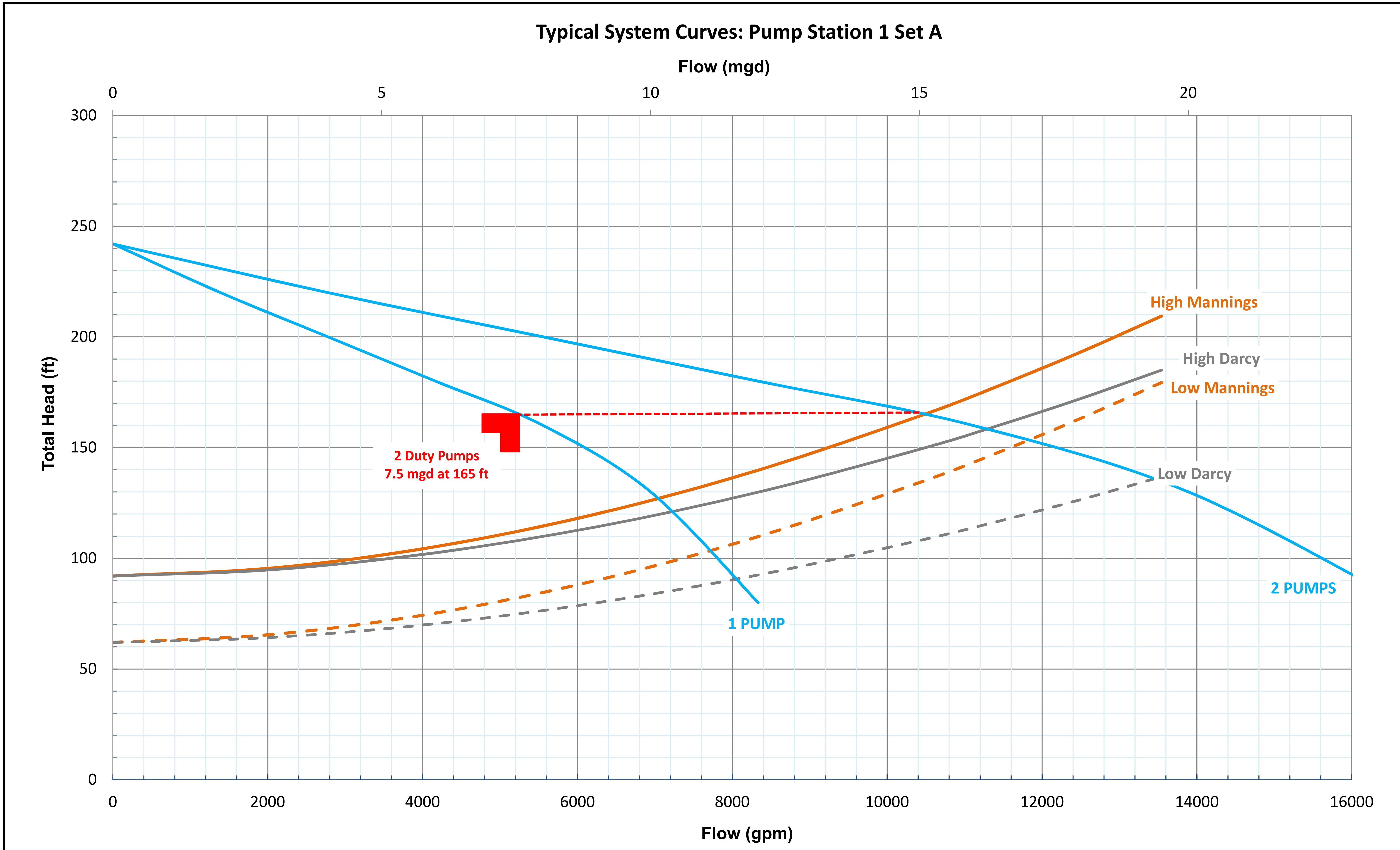
Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

PS-1 Pumps (Set A)

Pumps	1 Pump
Manf	FN
Model:	27ML-BRZ
Motor:	300 hp
Speed:	890 rpm
Impeller:	15.30 in
Head (ft)	**Flow (mgd)**
242	0
220	2
200	4
180	6
160	8
130	10
80	12
80	12

PS-1 Pumps (Set A)

Head (ft)	**1 PUMP**	**2 PUMPS**	**3 PUMPS**	**4 PUMPS**	
242	0	0			
220	2	4			
200	4	8			
180	6	12			
160	8	16			
130	10	20			
80	12	24			
80	12	24			



Typical System Curves: Pump Station 1 Set A
Flow (mgd)
0
5
10
15
20
300
250
200
150
100
50
0
Total Head (ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
Flow (gpm)
High Mannings
High Darcy
Low Mannings
Low Darcy
2 Duty Pumps
7.5 mgd at 165 ft
1 PUMP
2 PUMPS

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/25/17	COMPUTED BY	AG
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Pump System Curve Analysis
MWD RRWP
PS-1 Set B - 84-in

Station Description: **The station will consist of new pumps pumping through an 84-inch pipeline from PS-1 to both PS3 and Orange County Spreading Grounds. Purified water will be conveyed to a junction where PS-2 was previously located and subsequently split into two pipelines servine PS-3 and the Orange County Spreading Grounds, respectively. Each pump will be equipped with a dedicated VFD.**

1.0 Contents

1 Cover
2 System Curve Data
3 Pump Data
4 Curves

1.1 Purpose/Objective:

1. Develop approximate system curves to aid in initial pump sizing for various sceanrios

1.2 Procedure/Approach:

1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:

1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:

1. **These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.**
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CDM Smith	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
	PROJECT	RRWP	DATE CHECKED	10/25/2017	COMPUTED BY	AG
	DETAIL	System Data	CHECKED BY	CAO		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head (High Darcy)
-Mannings friction estimate with low static head (Low Mannings)
-Mannings friction estimate with high static head (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

It is assumed that there is approximately 20 ft of distribution head above the ground surface at the discahrge to the spreading basins

Pipe Length PS-1 to Juction	68,478	ft	<<--From Alt A alignment per B&V
Pipe Length Junction to OC Spreading Grounds	83,172	ft	<<--From Alt A alignment per B&V
Pipe Length Junction to PS-3	73,000	ft	<<--From Alt A alignment per B&V
Kinematic viscosity, μ	0.0000093	ft2/s	<--Freshwater at 80 F

System Data (1-4)

Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44	Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44
Juction Elevation (ft)	50	Juction Elevation (ft)	50	Juction Elevation (ft)	50	Juction Elevation (ft)	50
OCSG Discharge (ft)	250	OCSG Discharge (ft)	250	OCSG Discharge (ft)	250	OCSG Discharge (ft)	250
PS3 Forebay WSE or HGL (ft)	222	PS3 Forebay WSE or HGL (ft)	236	PS3 Forebay WSE or HGL (ft)	222	PS3 Forebay WSE or HGL (ft)	236
Static Head (ft)	176	Static Head (ft)	192	Static Head (ft)	176	Static Head (ft)	192
PS1 to Junction		PS1 to Junction		PS1 to Junction			
Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150
Flow (gpm)	104,167	Flow (gpm)	104167	Flow (gpm)	104167	Flow (gpm)	104167
Roughness (ft)	0.000225	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	6.03	Velocity (ft/s)	6.03				
Reynold's number, Re	4,559,078	Reynold's number, Re	4,559,078				
Friction factor, f	0.0107	Friction factor, f	0.0126				
Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84
Friction Head (ft)	59	Friction Head (ft)	69	Friction Head (ft)	77	Friction Head (ft)	77
Junction to OCSG		Junction to OCSG		Junction to OCSG		Junction to OCSG	
Flow (mgd)	60	Flow (mgd)	60	Flow (mgd)	60	Flow (mgd)	60
Flow (gpm)	41,667	Flow (gpm)	41667	Flow (gpm)	41667	Flow (gpm)	41667
Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	5.84	Velocity (ft/s)	5.84				
Reynold's number, Re	2,836,760	Reynold's number, Re	2,836,760				
Friction factor, f	0.0111	Friction factor, f	0.0137				
Equivalent Diameter (in)	54	Equivalent Diameter (in)	54	Equivalent Diameter (in)	54	Equivalent Diameter (in)	54
Friction Head (ft)	109	Friction Head (ft)	134	Friction Head (ft)	159	Friction Head (ft)	159
Junction to PS3		Junction to PS3		Junction to PS3		Junction to PS3	
Flow (mgd)	80	Flow (mgd)	80	Flow (mgd)	80	Flow (mgd)	80
Flow (gpm)	55,556	Flow (gpm)	55556	Flow (gpm)	55556	Flow (gpm)	55556
Roughness (ft)	0.000225	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	6.30	Velocity (ft/s)	6.30				
Reynold's number, Re	3,404,111	Reynold's number, Re	3,404,111				
Friction factor, f	0.0113	Friction factor, f	0.0134				
Equivalent Diameter (in)	60	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60
Friction Head (ft)	102	Friction Head (ft)	121	Friction Head (ft)	141	Friction Head (ft)	141
Total Friction Head (ft)	168	Total Friction Head (ft)	204	Total Friction Head (ft)	236	Total Friction Head (ft)	236
Total Head (ft)	344	Total Head (ft)	396	Total Head (ft)	412	Total Head (ft)	428

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/25/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

Percent of Modeled Flow	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)
0%	0	176					0	192
20%	20833	185	20833	202			20833	204
40%	41667	207	41667	229	41667	219	41667	235
60%	62500	241	62500	271	62500	268	62500	284
80%	83333	287	83333	327	83333	332	83333	348
100%	104167	344	104167	396	104167	412	104167	428
110%	114583	376	114583	435	114583	458	114583	474
120%	125000	411	125000	477	125000	507	125000	523
130%	135417	448	135417	523	135417	560	135417	576

	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
CDM Smith	PROJECT	RRWP	DATE CHECKED	43033	COMPUTED BY	AG
	DETAIL	Pump Data	CHECKED BY	CAO		

3.0 Pump Data

Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

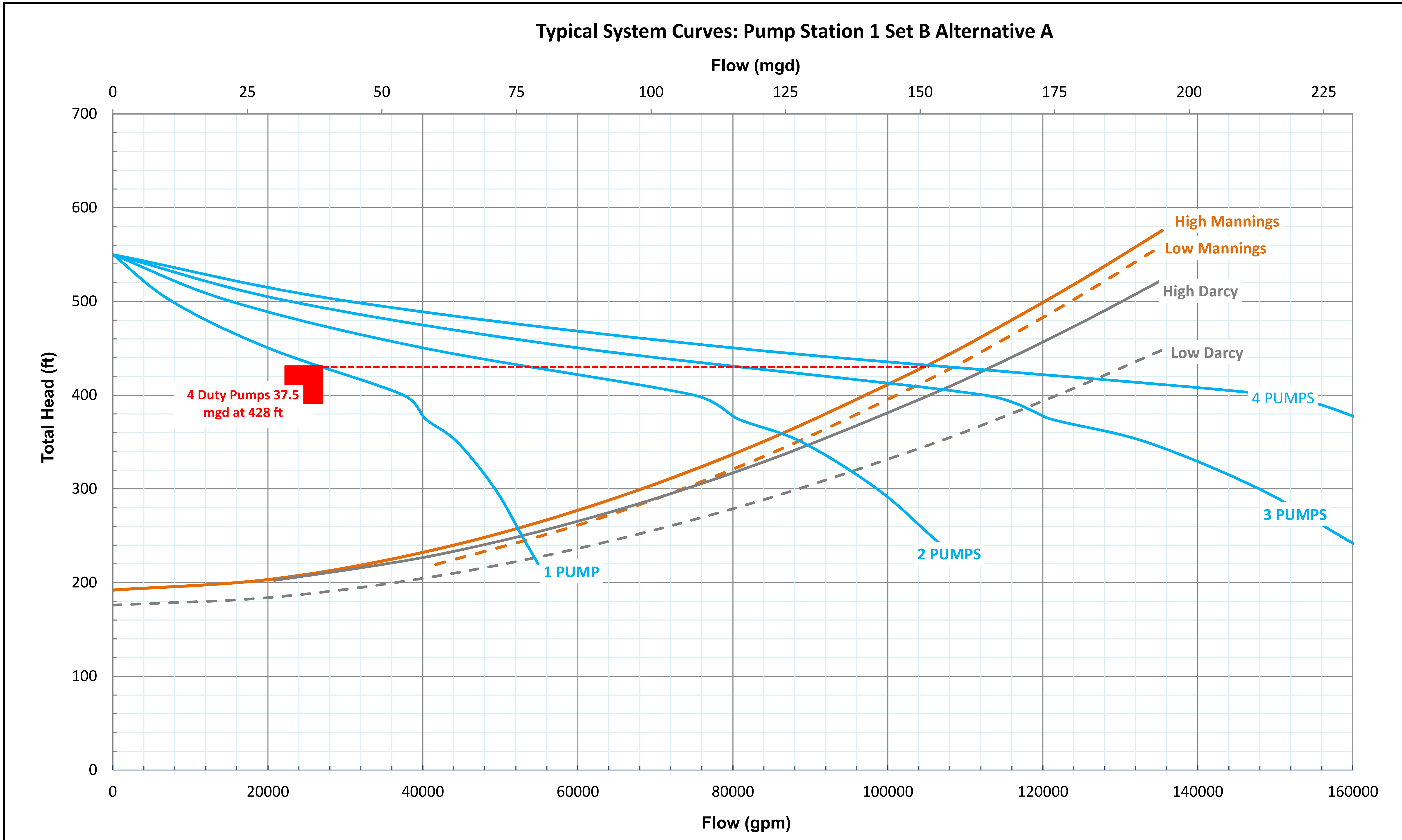
PS-1 Pumps (Set B) Alternative A

Sized for 37.5-mgd @ 428-ft TDH

Pumps	1 Pump
Manf	FN
Model:	63HRO 7000
Motor:	4500
Speed:	592
Impeller:	
Head (ft)	**Flow (mgd)**
550	0
500	11
450	29
400	54
375	58
350	64
300	71
250	76
220	79

PS-1 Pumps (Set B) Alternative A

Head (ft)	**1 PUMP**	**2 PUMPS**	**3 PUMPS**	**4 PUMPS**	
550	0	0	0	0	
500	11	22	33	44	
450	29	58	87	116	
400	54	108	162	216	
375	58	116	174	232	
350	64	128	192	256	
300	71	142	213	284	
250	76	152	228	304	
220	79	158	237	316	



Typical System Curves: Pump Station 1 Set B Alternative A
Flow (mgd)
0
25
50
75
100
125
150
175
200
225
700
600
500
400
300
200
100
0
Total Head (ft)
High Mannings
Low Mannings
High Darcy
Low Darcy
4 PUMPS
3 PUMPS
2 PUMPS
1 PUMP
4 Duty Pumps 37.5 mgd at 428 ft
0
20000
40000
60000
80000
100000
120000
140000
160000
Flow (gpm)

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/12/17
PROJECT	RRWP	DATE CHECKED	10/17/17	COMPUTED BY	AG
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Pump System Curve Analysis
MWD RRWP
PS-1 Set B - 84-in (Alt B)

Station Description: **The station will consist of new pumps pumping through an 84-inch pipeline from PS-1 to the Signal Hill Storage Tank for PS-2.**
Each pump will be equipped with a dedicated VFD

1.0 Contents

1 Cover
2 System Curve Data
3 Pump Data
4 Curves

1.1 Purpose/Objective: 1. Develop approximate system curves to aid in initial pump sizing for various sceanrios

1.2 Procedure/Approach:
1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:
1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:
1. These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses. These calculations also do not account for any intermediate hgih points in the pipeline alignment.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:
The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CDM Smith

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/12/17
PROJECT	RRWP	DATE CHECKED	10/17/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head (High Darcy)
-Mannings friction estimate with low static head (Low Mannings)
-Mannings friction estimate with high static head (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

Pipe Length PS-1 to Signal Hill Storage Tank	33,719	ft	<<--From Alt B alignment per B&V
Kinematic viscosity, μ	0.0000093	ft2/s	<--Freshwater at 80 F

System Data (1-4)	Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
	System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
	Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44	Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44
	Discharge WSE or HGL (ft)	180	Discharge WSE or HGL (ft)	180	Discharge WSE or HGL (ft)	180	Discharge WSE or HGL (ft)	180
	Static Head (ft)	106	Static Head (ft)	136	Static Head (ft) =	106	Static Head (ft) =	136
	Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150
	Flow (gpm)	104,167	Flow (gpm)	104167	Flow (gpm)	104167	Flow (gpm)	104167
	Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
	Velocity (ft/s)	6.03	Velocity (ft/s)	6.03				
	Reynold's number, Re	4,559,078	Reynold's number, Re	4,559,078				
	Friction factor, f	0.0103	Friction factor, f	0.0126				
	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84
	Friction Head (ft)	28	Friction Head (ft)	34	Friction Head (ft)	38	Friction Head (ft)	38
	Total Head (ft)	134	Total Head (ft)	170	Total Head (ft)	144	Total Head (ft)	174
Percent of Modeled Flow	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**
0%	0	106	0	136	0	106		136
20%	20833	107	20833	138	20833	108	20833	138
40%	41667	111	41667	142	41667	113	41667	143
60%	62500	117	62500	149	62500	121	62500	151
80%	83333	124	83333	159	83333	131	83333	161
100%	104167	134	104167	170	104167	144	104167	174
110%	114583	139	114583	177	114583	152	114583	182
120%	125000	145	125000	184	125000	159	125000	189
130%	135417	151	135417	192	135417	168	135417	198

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/12/17
PROJECT	RRWP	DATE CHECKED	43025	COMPUTED BY	AG
DETAIL	Pump Data	CHECKED BY	CAO		

3.0 Pump Data

Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

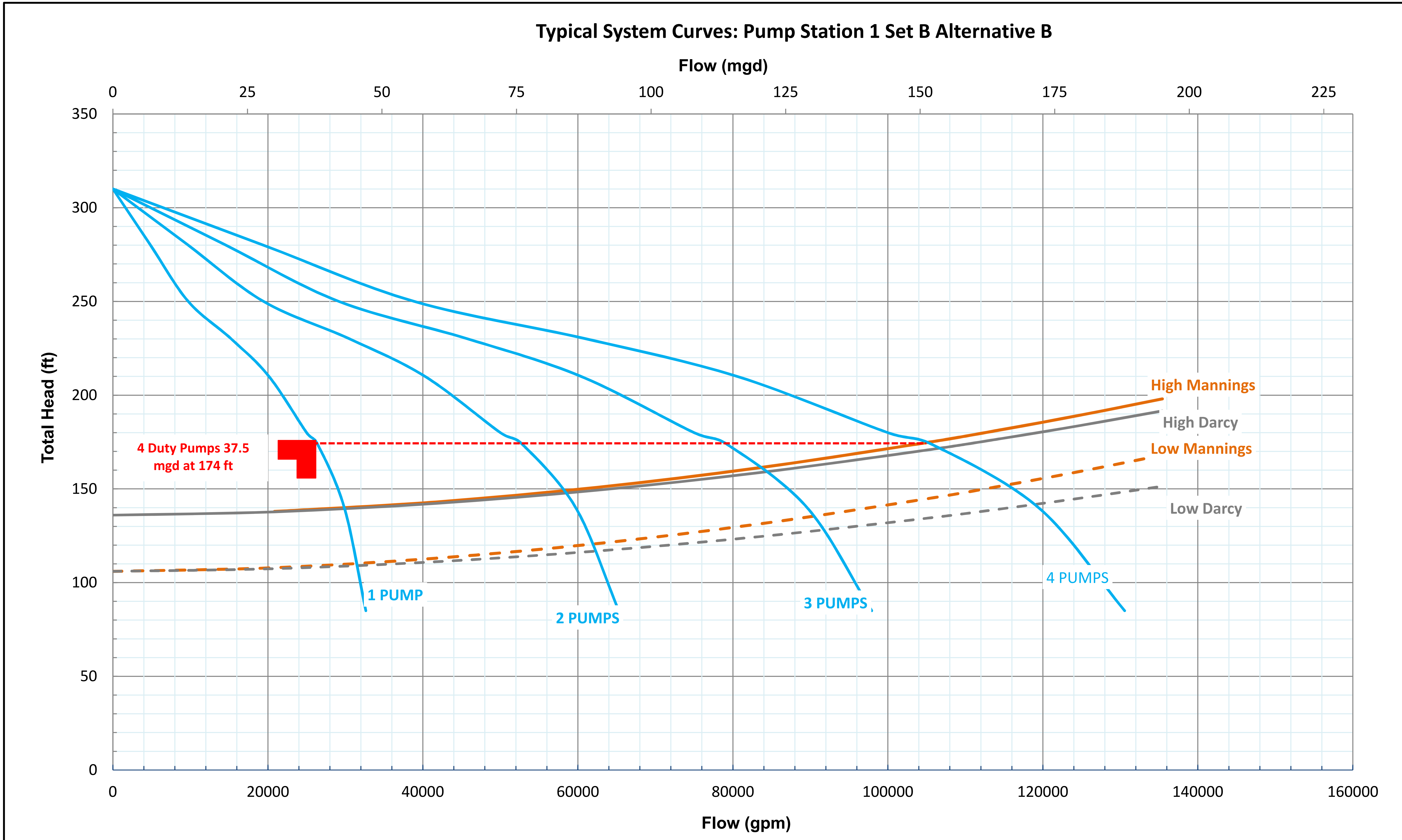
PS-1 Pumps (Set B) Alternative B

Sized for 150-mgd @ 174-ft TDH

Pumps	1 Pump
Manf	FN
Model:	44A-BRZ
Motor:	1500
Speed:	705
Impeller:	
Head (ft)	**Flow (mgd)**
310	0
280	7
250	14
230	22
210	29
180	36
174	38
140	43
85	47

PS-1 Pumps (Set B) Alternative B

Head (ft)	1 PUMP	2 PUMPS	3 PUMPS	4 PUMPS	
310	0	0	0	0	
280	7	14	21	28	
250	14	28	42	56	
230	22	44	66	88	
210	29	58	87	116	
180	36	72	108	144	
174	38	76	114	152	
140	43	86	129	172	
85	47	94	141	188	


Typical System Curves: Pump Station 1 Set B Alternative B
Flow (mgd)
0
25
50
75
100
125
150
175
200
225
Total Head (ft)
350
300
250
200
150
100
50
0
4 Duty Pumps 37.5 mgd at 174 ft
High Mannings
High Darcy
Low Mannings
Low Darcy
1 PUMP
2 PUMPS
3 PUMPS
4 PUMPS
0
20000
40000
60000
80000
100000
120000
140000
160000
Flow (gpm)

CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/18	COMPUTED BY	SEL
DETAIL	Cover Sheet	CHECKED BY	CTM		

Preliminary Pump System Curve Analysis
MWD RRWP
Alternative A-Backbone System: PS-1 Set B: 150 MGD, 84-in

Station Description: **The station will consist of new pumps pumping through an 84-inch pipeline from PS-1 to PS-3. This alternative, Alternative A-Backbone System, does not include PS-2 nor a junction at the previous location of PS-2. Thus, this alternative does not include pumping to the Orange County Spreading Grounds (OCSG). Both PS-1 and PS-3 will be equipped with a dedicated VFD.**

1.0 Contents

1.1 Purpose/Objective:

1. Develop approximate system curves to aid in initial pump sizing for various scenarios

1.2 Procedure/Approach:

1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:

1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:

1. **These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.**
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CDM Smith

CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/2018	COMPUTED BY	SEL
DETAIL	System Data	CHECKED BY	CTM		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head (High Darcy)
-Mannings friction estimate with low static head (Low Mannings)
-Mannings friction estimate with high static head (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

It is assumed that there is approximately 20 ft of distribution head above the ground surface at the discharge to the spreading basins

Pipe Length PS-1 to Junction	68,478	ft	<<--From Alt A alignment per B&V
Pipe Length Junction to PS-3	73,000	ft	<<--From Alt A alignment per B&V
Pipe Length Overall PS-1 to PS-3	**141,478**	ft	
Kinematic viscosity, μ	0.0000093	ft2/s	<<--Freshwater at 80 F

System Data (1-4)

Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44	Suction WSE or HGL (ft)	74	Suction WSE or HGL (ft)	44
Junction Elevation (ft)	50	Junction Elevation (ft)	50	Junction Elevation (ft)	50	Junction Elevation (ft)	50
OCSG Discharge (ft)		OCSG Discharge (ft)		OCSG Discharge (ft)		OCSG Discharge (ft)	
PS3 Forebay WSE or HGL (ft)	222	PS3 Forebay WSE or HGL (ft)	236	PS3 Forebay WSE or HGL (ft)	222	PS3 Forebay WSE or HGL (ft)	236
Static Head (ft)	148	Static Head (ft)	192	Static Head (ft)	148	Static Head (ft)	192
PS-1 to PS-3 Overall		**PS-1 to PS-3 Overall**		**PS-1 to PS-3 Overall**		**PS-1 to PS-3 Overall**	
Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150
Flow (gpm)	104167	Flow (gpm)	104167	Flow (gpm)	104167	Flow (gpm)	104167
Roughness (ft)	0.00015	Roughness (ft)	0.000225	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	6.03	Velocity (ft/s)	6.03				
Reynold's number, Re	4,559,078	Reynold's number, Re	4,559,078				
Friction factor, f	0.0103	Friction factor, f	0.0107				
Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84
Friction Head (ft)	117	Friction Head (ft)	122	Friction Head (ft)	160	Friction Head (ft)	160
Total Friction Head (ft)	117	Total Friction Head (ft)	122	Total Friction Head (ft)	160	Total Friction Head (ft)	160
Total Head (ft)	265	Total Head (ft)	314	Total Head (ft)	308	Total Head (ft)	**352**

CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/2018	COMPUTED BY	SEL
DETAIL	System Data	CHECKED BY	CTM		

Percent of Modeled Flow	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)
0%	0	148	0	192	0	148	0	192
20%	20833	154	20833	198	20833	156	20833	200
40%	41667	170	41667	214	41667	177	41667	221
60%	62500	194	62500	239	62500	210	62500	254
80%	83333	226	83333	273	83333	254	83333	298
100%	104167	265	104167	314	104167	308	104167	352
110%	114583	288	114583	337	114583	339	114583	383
120%	125000	312	125000	363	125000	372	125000	416
130%	135417	338	135417	390	135417	408	135417	452

CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/2018	COMPUTED BY	SEL
DETAIL	Pump Data	CHECKED BY	CTM		

3.0 Pump Data

Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

PS-1 Pumps (Set B) Alternative A-Backbone System

Sized for 150-mgd @ 352-ft TDH

Pumps	1 Pump
Manf	FN
Model:	63HRO 7000
Motor:	4500
Speed:	592
Impeller:	

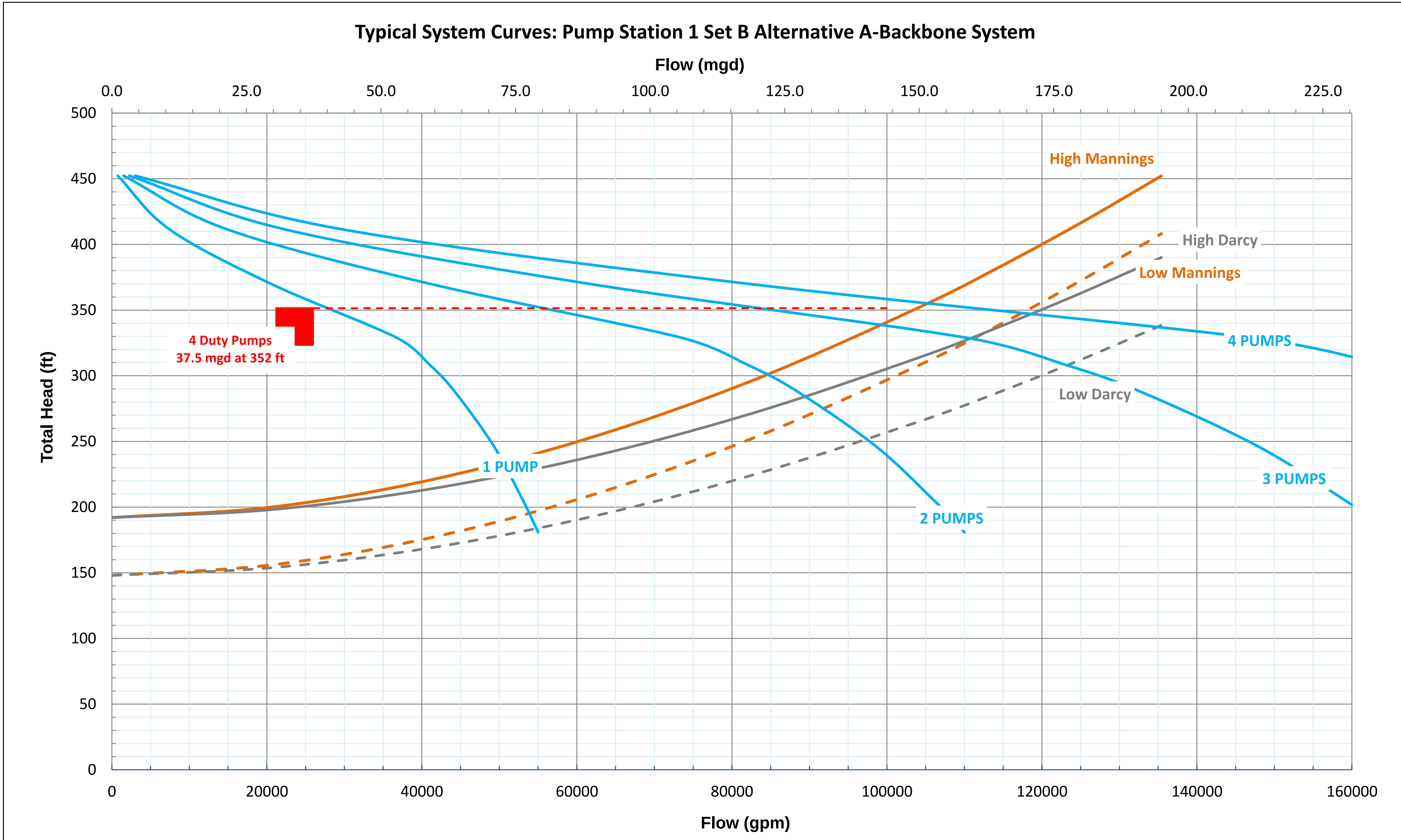
Old TDH	428
New TDH	352
Percentage	82%

<<-- achievable by impeller size reduction

Old TDH	New TDH	Head (ft)	Flow (mgd)
550	452	452.3	1.1
500	411	411.2	10.8
450	370	370.1	29.5
400	329	329.0	52.9
375	308	308.4	59.0
350	288	287.9	63.7
300	247	246.7	70.9
250	206	205.6	76.3
220	181	180.9	79.2

PS-1 Pumps (Set B) Alternative A-Backbone System

Head (ft)	1 PUMP	2 PUMPS	3 PUMPS	4 PUMPS	
452	1.1	2.2	3.2	4.3	
411	10.8	21.6	32.4	43.2	
370	29.5	59.0	88.6	118.1	
329	52.9	105.8	158.8	211.7	
308	59.0	118.1	177.1	236.2	
288	63.7	127.4	191.2	254.9	
247	70.9	141.8	212.8	283.7	
206	76.3	152.6	229.0	305.3	
181	79.2	158.4	237.6	316.8	



Typical System Curves: Pump Station 1 Set B Alternative A-Backbone System
Flow (mgd)
0.0
25.0
50.0
75.0
100.0
125.0
150.0
175.0
200.0
225.0
Total Head (ft)
500
450
400
350
300
250
200
150
100
50
0
High Mannings
High Darcy
Low Mannings
4 Duty Pumps
37.5 mgd at 352 ft
4 PUMPS
Low Darcy
1 PUMP
3 PUMPS
2 PUMPS
0
20000
40000
60000
80000
100000
120000
140000
160000
Flow (gpm)

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/17	COMPUTED BY	AG
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Pump System Curve Analysis
MWD RRWP
PS-2 Set A - 54-in

Station Description:

The station will consist of new pumps pumping through an 60-inch pipeline from PS-2 to Orange County Spreading Grounds.
Each pump will be equipped with a dedicated VFD

1.0 Contents

1.1 Purpose/Objective:

1. Develop approximate system curves to aid in initial pump sizing for various sceanrios

1.2 Procedure/Approach:

1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:

1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:

1. **These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.**
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:

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<<--text	green text with arrow = notes, assumptions, or references to data sources

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head and PS-2 Set B at 0 mgd (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head and PS-2 Set B at 80 mgd (High Darcy)
-Mannings friction estimate with low static head and PS-2 Set B at 0 mgd (Low Mannings)
-Mannings friction estimate with high static head and PS-2 Set B at 80 (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

It is assumed there is approximately 20 ft of distribution head above the ground surface at the discahrge to the spreading basins

Pipe Length Signal Hill to PS2	34,759	ft	<<--From preferred alignment per B&V
Pipe Length PS2 to OCSG	83,172	ft	<<--From preferred alignment per B&V
Kinematic viscosity, μ	0.0000093	ft2/s	<--Freshwater at 70 F

System Data (1-4)

Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
Suction WSE or HGL (ft)	196	Suction WSE or HGL (ft)	182	Suction WSE or HGL (ft)	196	Suction WSE or HGL (ft)	182
Discharge WSE or HGL (ft)	250	Discharge WSE or HGL (ft)	250	Discharge WSE or HGL (ft)	250	Discharge WSE or HGL (ft)	250
Static Head (ft)	54	Static Head (ft)	68	Static Head (ft) =	54	Static Head (ft) =	68
Signal Hill to PS2 (suction)		Signal Hill to PS2 (suction)		Signal Hill to PS2 (suction)		Signal Hill to PS2 (suction)	
PS-2 Set B Flow (mgd)	0	PS-2 Set B Flow (mgd)	80	PS-2 Set B Flow (mgd)	0	PS-2 Set B Flow (mgd)	80
Additional Suction Flow (mgd)	0	Additional Suction Flow (mgd)	10	Additional Suction Flow (mgd)	0	Additional Suction Flow (mgd)	10
PS-2 Set A Flow (mgd)	60	PS-2 Set A Flow (mgd)	60	PS-2 Set A Flow (mgd)	60	PS-2 Set A Flow (mgd)	60
PS-2 Set A Flow (gpm)	41,667	PS-2 Set A Flow (gpm)	41,667	PS-2 Set A Flow (gpm)	41,667	PS-2 Set A Flow (gpm)	41,667
Total Suction Flow (mgd)	60	Total Suction Flow (mgd)	150	Total Suction Flow (mgd)	60	Total Suction Flow (mgd)	150
Total Suction Flow (gpm)	41,667	Total Suction Flow (gpm)	104167	Total Suction Flow (gpm)	41667	Total Suction Flow (gpm)	104167
Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	2.41	Velocity (ft/s)	6.03				
Reynold's number, Re	1,823,631	Reynold's number, Re	4,559,078				
Friction factor, f	0.0112	Friction factor, f	0.0126				
Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84
Friction Head (ft)	5	Friction Head (ft)	35	Friction Head (ft)	6	Friction Head (ft)	39
PS2 to OCSG		PS2 to OCSG		PS2 to OCSG		PS2 to OCSG	
Flow (mgd)	60	Flow (mgd)	60	Flow (mgd)	60	Flow (mgd)	60
Flow (gpm)	41,667	Flow (gpm)	41667	Flow (gpm)	41667	Flow (gpm)	41667
Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	5.84	Velocity (ft/s)	5.84				
Reynold's number, Re	2,836,760	Reynold's number, Re	2,836,760				
Friction factor, f	0.0111	Friction factor, f	0.0137				
Equivalent Diameter (in)	54	Equivalent Diameter (in)	54	Equivalent Diameter (in)	54	Equivalent Diameter (in)	54
Friction Head (ft)	109	Friction Head (ft)	134	Friction Head (ft)	159	Friction Head (ft)	159
Total Head (ft)	168	Total Head (ft)	238	Total Head (ft)	219	Total Head (ft)	266

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CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

Percent of Modeled Flow	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)
0%	0	54	0	81	0	54	0	82
20%	8333	65	8333	90	8333	68	8333	93
40%	16667	79	16667	111	16667	89	16667	116
60%	25000	101	25000	142	25000	122	25000	153
80%	33333	131	33333	184	33333	165	33333	203
100%	41667	168	41667	238	41667	219	41667	266
110%	45833	189	45833	268	45833	250	45833	303
120%	50000	211	50000	301	50000	283	50000	342
130%	54167	235	54167	337	54167	318	54167	386

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	43031	COMPUTED BY	AG
DETAIL	Pump Data	CHECKED BY	CAO		

3.0 Pump Data

Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

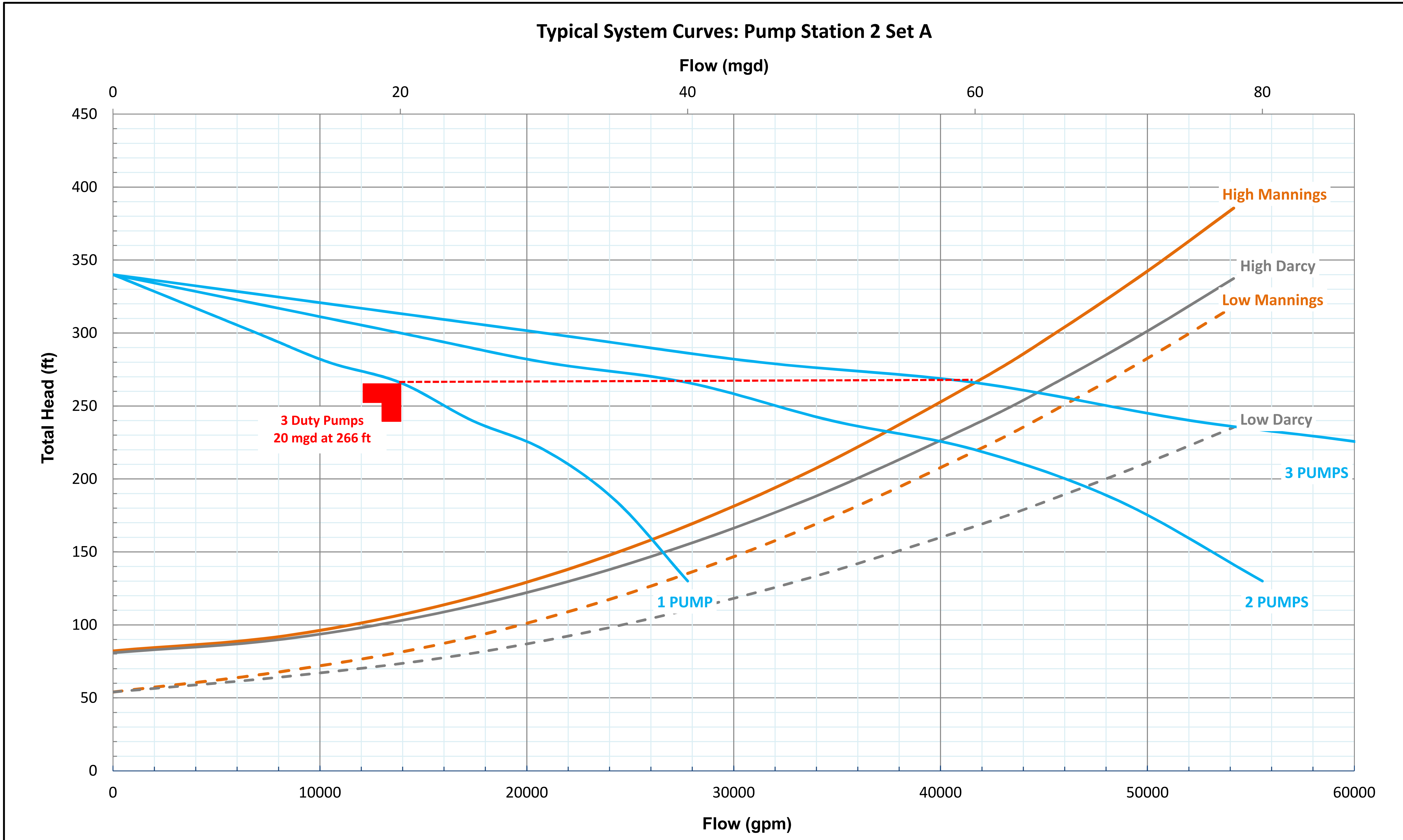
PS 2 Pumps (Set A)

Sized for 20-mgd @ 266-ft TDH

Pumps	1 Pump
Manf	FN
Model:	36G-BRZ
Motor:	1500
Speed:	880 rpm
Impeller:	27.32
Head (ft)	**Flow (mgd)**
340	0
300	10
280	15
266	20
240	25
220	30
185	35
130	40

PS-2 Pumps (Set A)

Head (ft)	1 PUMP	2 PUMPS	3 PUMPS	4 PUMPS	
340	0	0	0		
300	10	20	30		
280	15	30	45		
266	20	40	60		
240	25	50	75		
220	30	60	90		
185	35	70	105		
130	40	80	120		



Typical System Curves: Pump Station 2 Set A
Flow (mgd)
0
20
40
60
80
Total Head (ft)
450
400
350
300
250
200
150
100
50
0
High Mannings
High Darcy
Low Mannings
Low Darcy
3 PUMPS
2 PUMPS
1 PUMP
3 Duty Pumps
20 mgd at 266 ft
0
10000
20000
30000
40000
50000
60000
Flow (gpm)

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/17	COMPUTED BY	AG
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Pump System Curve Analysis
MWD RRWP
PS-2 Set B - 60-in

Station Description:

The station will consist of new pumps pumping through an 60-inch pipeline from PS-2 to PS-3.
Each pump will be equipped with a dedicated VFD

1.0 Contents

1 Cover
2 System Curve Data
3 Pump Data
4 Curves

1.1 Purpose/Objective:

1. Develop approximate system curves to aid in initial pump sizing for various sceanrios

1.2 Procedure/Approach:

1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:

1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:

1. These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head and PS-2 Set A at 0 mgd (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head and PS-2 Set A at 60 mgd (High Darcy)
-Mannings friction estimate with low static head and PS-2 Set B at 0 mgd (Low Mannings)
-Mannings friction estimate with high static head and PS-2 Set B at 60 mgd (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

Pipe Length Signal Hill Storage Tank to PS-2	34,759	ft	<<--From preferred alignment per B&V
Pipe Length PS-2 to PS-3	73,000	ft	<<--From preferred alignment per B&V
Kinematic viscosity, µ	0.0000093	ft2/s	<--Freshwater at 80 F

System Data (1-4)

Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
Suction WSE or HGL (ft)	196	Suction WSE or HGL (ft)	182	Suction WSE or HGL (ft)	196	Suction WSE or HGL (ft)	182
Discharge WSE or HGL (ft)	222	Discharge WSE or HGL (ft)	236	Discharge WSE or HGL (ft)	222	Discharge WSE or HGL (ft)	236
Static Head (ft)	26	Static Head (ft)	54	Static Head (ft) =	26	Static Head (ft) =	54
Signal Hill to PS2 (suction)		Signal Hill to PS2 (suction)		Signal Hill to PS2 (suction)		Signal Hill to PS2 (suction)	
PS-2 Set A Flow (mgd)	0	PS-2 Set A Flow (mgd)	60	PS-2 Set A Flow (mgd)	0	PS-2 Set A Flow (mgd)	60
Additional Suction Flow (mgd)	0	Additional Suction Flow (mgd)	10	Additional Suction Flow (mgd)	0	Additional Suction Flow (mgd)	10
PS-2 Set B Flow (mgd)	80	PS-2 Set B Flow (mgd)	80	PS-2 Set B Flow (mgd)	80	PS-2 Set B Flow (mgd)	80
PS-2 Set B Flow (gpm)	55,556	PS-2 Set B Flow (gpm)	55,556	PS-2 Set B Flow (gpm)	55,556	PS-2 Set B Flow (gpm)	55,556
Total Suction Flow (mgd)	80	Total Suction Flow (mgd)	150	Total Suction Flow (mgd)	80	Total Suction Flow (mgd)	150
Total Suction Flow (gpm)	55,556	Total Suction Flow (gpm)	104167	Total Suction Flow (gpm)	55556	Total Suction Flow (gpm)	104167
Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	3.22	Velocity (ft/s)	6.03				
Reynold's number, Re	2,431,508	Reynold's number, Re	4,559,078				
Friction factor, f	0.0109	Friction factor, f	0.0126				
Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84
Friction Head (ft)	9	Friction Head (ft)	35	Friction Head (ft)	11	Friction Head (ft)	39
PS2 to PS3		PS2 to PS3		PS2 to PS3		PS2 to PS3	
Flow (mgd)	80	Flow (mgd)	80	Flow (mgd)	80	Flow (mgd)	80
Flow (gpm)	55,556	Flow (gpm)	55556	Flow (gpm)	55556	Flow (gpm)	55556
Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
Velocity (ft/s)	6.30	Velocity (ft/s)	6.30				
Reynold's number, Re	3,404,111	Reynold's number, Re	3,404,111				
Friction factor, f	0.0108	Friction factor, f	0.0134				
Equivalent Diameter (in)	60	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60
Friction Head (ft)	98	Friction Head (ft)	121	Friction Head (ft)	141	Friction Head (ft)	141
Total Head (ft)	132	Total Head (ft)	210	Total Head (ft)	178	Total Head (ft)	235

CDM Smith

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

Percent of Modeled Flow	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)	Flow (gpm)	Head (ft)
0%	0	26	0	62	0	26	0	63
20%	11111	40	11111	71	11111	44	11111	73
40%	22222	53	22222	91	22222	63	22222	95
60%	33333	73	33333	120	33333	92	33333	129
80%	44444	99	44444	160	44444	131	44444	176
100%	55556	132	55556	210	55556	178	55556	235
110%	61111	151	61111	239	61111	206	61111	269
120%	66667	171	66667	270	66667	235	66667	306
130%	72222	193	72222	304	72222	267	72222	346

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/23/2017	COMPUTED BY	AG
DETAIL	Pump Data	CHECKED BY	CAO		

3.0 Pump Data

Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

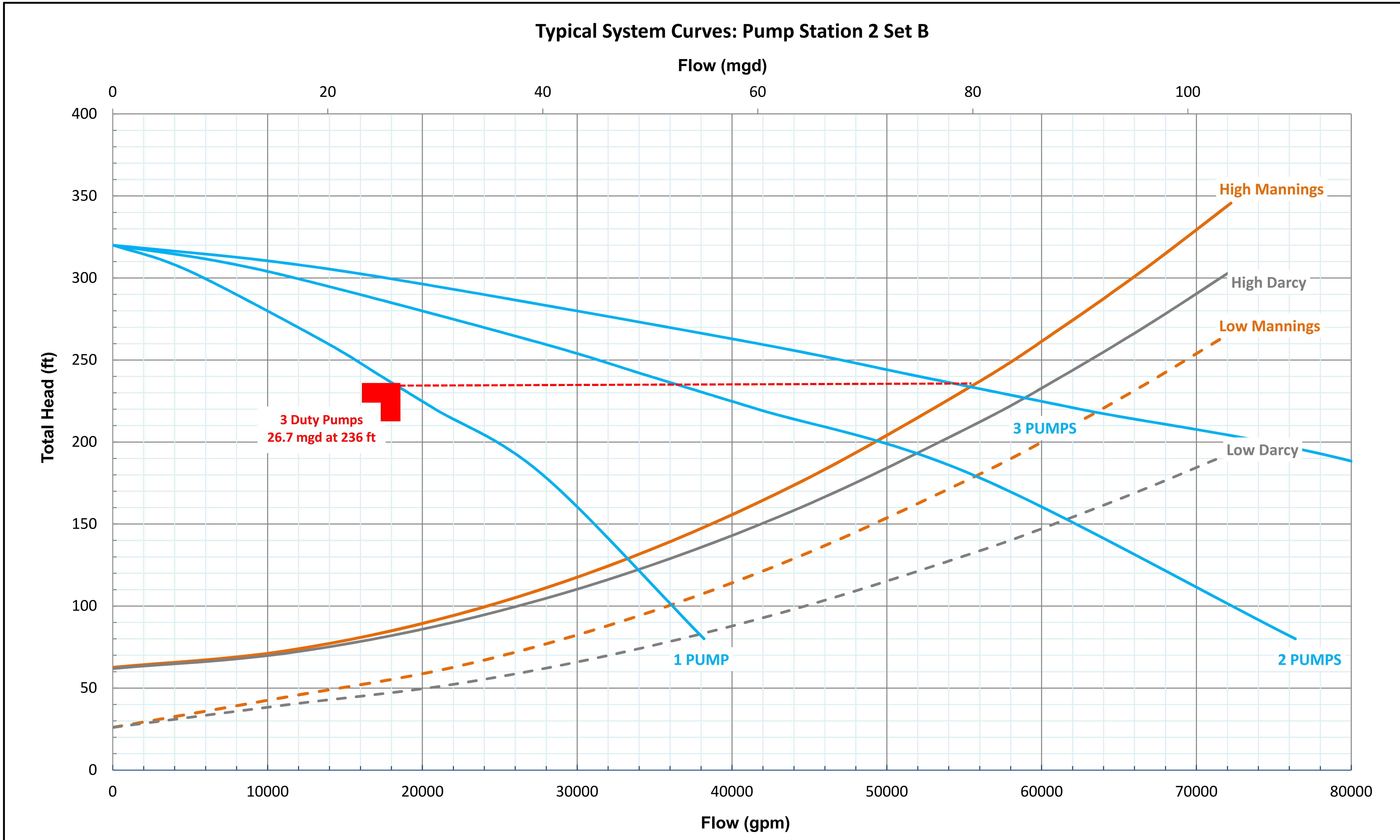
PS 2 Pumps (Set B)

Sized for 26.7-mgd @ 235-ft TDH

Pumps	1 Pump
Manf	Sulzer
Model:	SJT-BKn 840/022
Motor:	1750
Speed:	705
Impeller:	33.86
Head (ft)	**Flow (mgd)**
320	0
310	5
295	10
260	20
240	25
220	30
180	40
80	55

PS2 Pumps (Set B

Head (ft)	1 PUMP	2 PUMPS	3 PUMPS	4 PUMPS	
320	0	0	0		
310	5	10	15		
295	10	20	30		
260	20	40	60		
240	25	50	75		
220	30	60	90		
180	40	80	120		
80	55	110	165		



Typical System Curves: Pump Station 2 Set B
Flow (mgd)
0
20
40
60
80
100
400
350
300
250
200
150
100
50
0
Total Head (ft)
High Mannings
High Darcy
Low Mannings
3 Duty Pumps
26.7 mgd at 236 ft
3 PUMPS
Low Darcy
1 PUMP
2 PUMPS
0
10000
20000
30000
40000
50000
60000
70000
80000
Flow (gpm)

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/26/17	COMPUTED BY	AG
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Pump System Curve Analysis
MWD RRWP
PS-3 - 60-in

Station Description: **The station will consist of new pumps pumping through an 60-inch pipeline from PS-3 to the Sante Fe Spreading Grounds.**
Each pump will be equipped with a dedicated VFD

1.0 Contents

1.1 Purpose/Objective: 1. Develop approximate system curves to aid in initial pump sizing for various sceanrios

1.2 Procedure/Approach:
1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:
1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:
1. **These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.**
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:
The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
DETAIL	System Data	CHECKED BY	CAO		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head (High Darcy)
-Mannings friction estimate with low static head (Low Mannings)
-Mannings friction estimate with high static head (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

It is assumed there is approximately 20 ft of distribution head above the ground surface at the discahrge to the spreading basins

Pipe Length PS-3 to Santa Fe	67,600	ft	<<--From preferred alignment per B&V
Kinematic viscosity, μ	0.0000093	ft2/s	<--Freshwater at 80 F

System Data (1-4)

	Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
	System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
	Suction WSE or HGL (ft)	236	Suction WSE or HGL (ft)	222	Suction WSE or HGL (ft)	236	Suction WSE or HGL (ft)	222
	Discharge WSE or HGL (ft)	505	Discharge WSE or HGL (ft)	505	Discharge WSE or HGL (ft)	505	Discharge WSE or HGL (ft)	505
	Static Head (ft)	269	Static Head (ft)	283	Static Head (ft) =	269	Static Head (ft) =	283
	Flow (mgd)	80	Flow (mgd)	80	Flow (mgd)	80	Flow (mgd)	80
	Flow (gpm)	55,556	Flow (gpm)	55556	Flow (gpm)	55556	Flow (gpm)	55556
	Roughness (ft)	0.00015	Roughness (ft)	0.00075	Manning's n	0.012	Manning's n	0.012
	Velocity (ft/s)	6.30	Velocity (ft/s)	6.30				
	Reynold's number, Re	3,404,111	Reynold's number, Re	3,404,111				
	Friction factor, f	0.0108	Friction factor, f	0.0134				
	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60	Equivalent Diameter (in)	60
	Friction Head (ft)	90	Friction Head (ft)	112	Friction Head (ft)	131	Friction Head (ft)	131
	Total Head (ft)	359	Total Head (ft)	395	Total Head (ft)	400	Total Head (ft)	414
Percent of Modeled Flow	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**
0%	0	269	0	283	0	269	0	283
20%	11111	274	11111	289	11111	276	11111	290
40%	22222	286	22222	304	22222	293	22222	307
60%	33333	304	33333	326	33333	320	33333	334
80%	44444	329	44444	357	44444	356	44444	370
100%	55556	359	55556	395	55556	400	55556	414
110%	61111	377	61111	416	61111	425	61111	439
120%	66667	396	66667	440	66667	452	66667	466
130%	72222	416	72222	465	72222	481	72222	495

	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/20/17
CDM Smith	PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
	DETAIL	Pump Data	CHECKED BY	CAO		

3.0 Pump Data

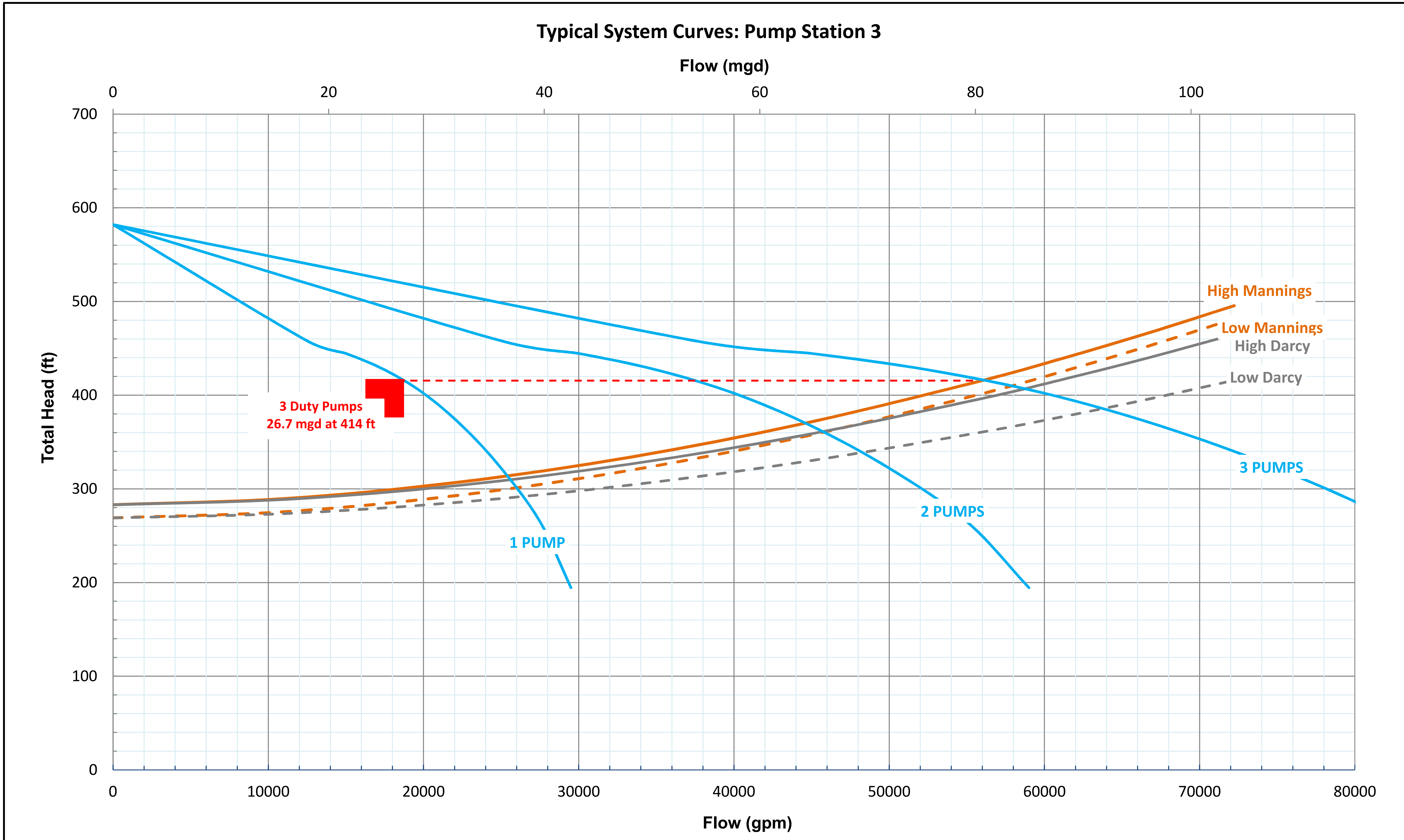
Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

PS-3 Pumps

Pumps	1 Pump
Manf	Pentair
Model:	48HRO 7000
Motor:	2750 hp
Speed:	710 rpm
Impeller:	
Head (ft)	**Flow (mgd)**
582	0
458	18
444.5	22
427	25
402	29
367	32
322	36
265	40
194.5	42

PS-3 Pumps

Head (ft)	**1 PUMP**	**2 PUMPS**	**3 PUMPS**		
582	0	0	0		
458	18	36	54		
444.5	21.6	43.2	64.8		
427	25.2	50.4	75.6		
402	28.8	57.6	86.4		
367	32.4	64.8	97.2		
322	36	72	108		
265	39.6	79.2	118.8		
194.5	42.48	84.96	127.44		


Typical System Curves: Pump Station 3
Flow (mgd)
0
20
40
60
80
100
700
600
500
400
300
200
100
0
Total Head (ft)
High Mannings
Low Mannings
High Darcy
Low Darcy
3 Duty Pumps
26.7 mgd at 414 ft
1 PUMP
2 PUMPS
3 PUMPS
0
10000
20000
30000
40000
50000
60000
70000
80000
Flow (gpm)

CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/18	COMPUTED BY	SEL
DETAIL	Cover Sheet	CHECKED BY	CTM	Rev 1: 8-13-18 CAO - Updated pipeline length	

Preliminary Pump System Curve Analysis
MWD RRWP
Alternative A-Backbone System: PS-3 150 MGD, 84-in

Station Description: **The station will consist of new pumps pumping through an 84-inch pipeline from PS-3 to the Sante Fe Spreading Grounds. Each pump will be equipped with a dedicated VFD.**

1.0 Contents

1.1 Purpose/Objective:

1. Develop approximate system curves to aid in initial pump sizing for various scenarios

1.2 Procedure/Approach:

1. Enter basic system data to generate approximate system curves (Sheet 2). Calculations are based on Manning's equation per MWD Hydraulic Design Manual supplemented with Darcy Weisbach for comparison.
2. Enter representative candidate pump flow and head data (Sheet 3)
3. Review pump and system interaction and interate as necessary (Sheet 4)

1.3 Data and References:

1. Metropolitan Water District of Southern California - Engineering Services Section, 2006. Hydraulic Design Manual ESD-121
2. United States Bureau of Reclamation, 1992. Engineering Monograph No. 7 - Friction Factors for Large Conduits Flowing Full
3. See associated report for pipeline alignments, pipe sizing, station locations, and elevations.

1.4 Assumptions and Limitations:

1. **These are preliminary calculations intended for planning purposes only. Detailed pump analysis shall be performed during design stages of project.**
2. Manning's n-value = 0.012 per MWD Hydraulic Design Manual
3. Pipe roughness values per US Bureau of Reclamation Nomograph No. 7
4. These preliminary calculations do not include fitting losses as they are assumed to be negligable compared to static and pipe friction losses.
5. Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CDM Smith

CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/2018	COMPUTED BY	SEL
DETAIL	System Data	CHECKED BY	CTM		

2. System Curve Data

This sheet presents the hydraulic data used to generate estimated system curves for 4 conditions:
-Darcy Weisbach friction estimate with low roughness and static head (Low Darcy)
-Darcy Weisbach friction estimate with high roughness and static head (High Darcy)
-Mannings friction estimate with low static head (Low Mannings)
-Mannings friction estimate with high static head (High Mannings)

Total head is calculated at peak flow and then a curve is interpolated between static and peak flow

The rated point for this conceptual design level is based on the Manning's estimate with high static head per MWD Hydraulic Design Guide

It is assumed there is approximately 20 ft of distribution head above the ground surface at the discahrge to the spreading basins

Pipe Length PS-3 to Santa Fe	58,800	ft	<<--From preferred alignment per B&V
Kinematic viscosity, μ	0.0000093	ft2/s	<<--Freshwater at 80 F

System Data (1-4)	Darcy-Weisbach Low Curve		Darcy-Weisbach High Curve		Manning's Low Curve		Manning's High Curve	
	System Curve ID	Low Darcy	System Curve ID	High Darcy	System Curve ID =	Low Mannings	System Curve ID =	High Mannings
	Suction WSE or HGL (ft)	236	Suction WSE or HGL (ft)	222	Suction WSE or HGL (ft)	236	Suction WSE or HGL (ft)	222
	Discharge WSE or HGL (ft)	505	Discharge WSE or HGL (ft)	505	Discharge WSE or HGL (ft)	505	Discharge WSE or HGL (ft)	505
	Static Head (ft)	269	Static Head (ft)	283	Static Head (ft) =	269	Static Head (ft) =	283
	Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150	Flow (mgd)	150
	Flow (gpm)	104167	Flow (gpm)	104167	Flow (gpm)	104167	Flow (gpm)	104167
	Roughness (ft)	0.00015	Roughness (ft)	0.000225	Manning's n	0.012	Manning's n	0.012
	Velocity (ft/s)	6.03	Velocity (ft/s)	6.03				
	Reynold's number, Re	4,559,078	Reynold's number, Re	4,559,078				
	Friction factor, f	0.0103	Friction factor, f	0.0107				
	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84	Equivalent Diameter (in)	84
	Friction Head (ft)	49	Friction Head (ft)	51	Friction Head (ft)	67	Friction Head (ft)	67
	Total Head (ft)	318	Total Head (ft)	334	Total Head (ft)	336	Total Head (ft)	**350**
Percent of Modeled Flow	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**	**Flow (gpm)**	**Head (ft)**
0%	0	269	0	283	0	269	0	283
20%	20833	271	20833	286	20833	272	20833	286
40%	41667	278	41667	292	41667	281	41667	295
60%	62500	288	62500	303	62500	295	62500	309
80%	83333	301	83333	317	83333	313	83333	327
100%	104167	318	104167	334	104167	336	104167	350
110%	114583	327	114583	343	114583	348	114583	362
120%	125000	337	125000	354	125000	362	125000	376
130%	135417	348	135417	365	135417	377	135417	391

Number of Duty Pumps 4

Rated Flow Per Pump	**26,042**	**gpm**
	37.5	**mgd**
Rated Head Per Pump	**350**	**ft**

Estimated motor size 3060 hp

	CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
CDM Smith	PROJECT	RRWP	DATE CHECKED	9/17/2018	COMPUTED BY	SEL
	DETAIL	Pump Data	CHECKED BY	CTM		

3.0 Pump Data

Use this sheet to enter the pump performance data from the manufacturer's data sheet for a typical Candidate Pump

PS-3 Pumps Alternative A-Backbone System

Sized for 150-mgd @ 350-ft TDH

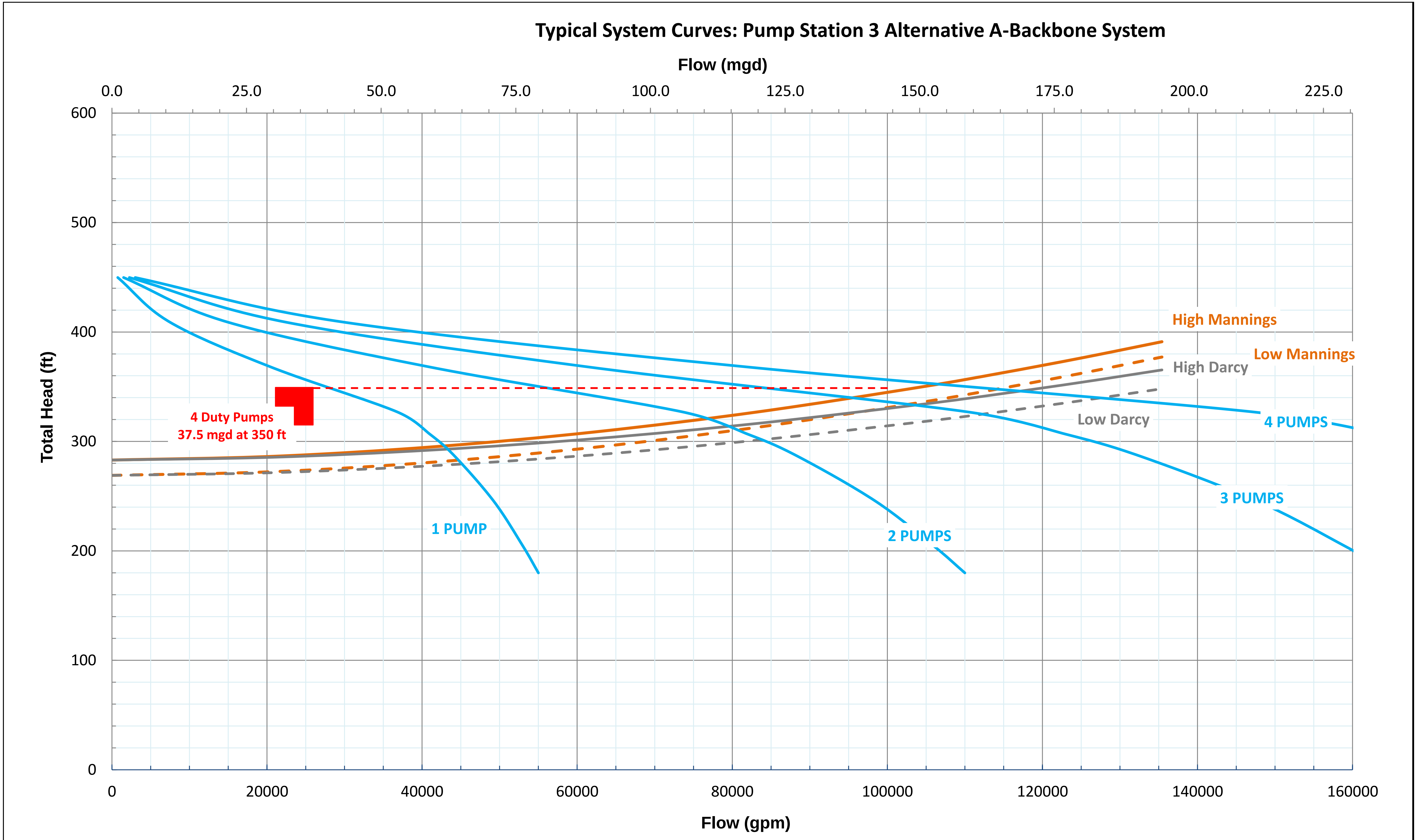
Pumps	1 Pump
Manf	FN
Model:	63HRO 7000
Motor:	4500
Speed:	592
Impeller:	

Old TDH	428
New TDH	350
Percentage	82% <<-- achievable by impeller size reduction

Old Head	Head		Head (ft)	Flow (mgd)
550		450	449.8	1.1
500		409	408.9	10.8
450		368	368.0	29.5
400		327	327.1	52.9
375		307	306.7	59.0
350		286	286.2	63.7
300		245	245.3	70.9
250		204	204.4	76.3
220		180	179.9	79.2

PS-1 Pumps (Set B) Alternative A

Head (ft)	1 PUMP	2 PUMPS	3 PUMPS	4 PUMPS	
450	1.1	2.2	3.2	4.3	
409	10.8	21.6	32.4	43.2	
368	29.5	59.0	88.6	118.1	
327	52.9	105.8	158.8	211.7	
307	59.0	118.1	177.1	236.2	
286	63.7	127.4	191.2	254.9	
245	70.9	141.8	212.8	283.7	
204	76.3	152.6	229.0	305.3	
180	79.2	158.4	237.6	316.8	



Typical System Curves: Pump Station 3 Alternative A-Backbone System
Flow (mgd)
0.0
25.0
50.0
75.0
100.0
125.0
150.0
175.0
200.0
225.0
Total Head (ft)
600
500
400
300
200
100
0
Flow (gpm)
0
20000
40000
60000
80000
100000
120000
140000
160000
High Mannings
Low Mannings
High Darcy
Low Darcy
4 Duty Pumps
37.5 mgd at 350 ft
1 PUMP
2 PUMPS
3 PUMPS
4 PUMPS

I. Objective
Evaluate discharge header pipe sizes for PS1, PS2 (Alt B only), and PS3.

II. Design Criteria
Discharge header sizes will match the respective transmission pipeline sizes identified for each reach.

According to the MWD Hydraulic Design Manual, the design velocity for transmission pipelines 48 inches or larger is 7-8 fps.

III. Flow Rates
Design flow rates for each reach are as follows:

1	PS-1 to Signal Hill/Flow Split Junction	Q_1 =	150	MGD	104,167	gpm
2	PS-1 to West Coast Basin Injection Wells	Q_2 =	15	MGD	10,417	gpm
3	Flow Split Junction/PS-2 to OC Spreading Ground:	Q_3 =	60	MGD	41,667	gpm
4	Flow Split Junction/PS-2 to PS3	Q_4 =	80	MGD	55,556	gpm
5	PS-3 to Santa Fe Spreading Grounds	Q_5 =	80	MGD	55,556	gpm

IV. Calculations

Flow Stream 1:PS-1 to Signal Hill/Flow Split Junction

A1=	38.48	ft²	Pipe area
D1=	7.00	ft	Pipe diameter (ft)
D1=	84.00	in	Pipe diameter (in)
V1=	**6.03**	**fps**	**Flow velocity**

Flow Stream 2:PS-1 to West Coast Basin Injection Wells

A2=	4.91	ft²	Pipe area
D2=	2.50	ft	Pipe diameter (ft)
D2=	30.00	in	Pipe diameter (in)
V2=	**4.73**	**fps**	**Flow velocity**

Flow Stream 3:Flow Split Junction/PS-2 to OC Spreading Grounds

A3=	15.90	ft²	Pipe area
D3=	4.50	ft	Pipe diameter (ft)
D3=	54.00	in	Pipe diameter (in)
V3=	**5.84**	**fps**	**Flow velocity**

Flow Stream 4:Flow Split Junction/PS-2 to PS3

A4=	19.63	ft²	Pipe area
D4=	5.00	ft	Pipe diameter (ft)
D4=	60.00	in	Pipe diameter (in)
V4=	**6.30**	**fps**	**Flow velocity**

Flow Stream 5:PS-3 to Santa Fe Spreading Grounds

A5=	19.63	ft²	Pipe area
D5=	5.00	ft	Pipe diameter (ft)
D5=	60.00	in	Pipe diameter (in)
V5=	**6.30**	**fps**	**Flow velocity**

I. Objective

Determine discharge lateral pipe sizes for PS1, PS2 (Alt B only), and PS3.

II. Design Criteria

HI 9.6.6 recommends that discharge lateral flow velocities should not exceed 15 fps. For the purposes of this study, the maximum flow velocity is assumed to be 10 fps in order to reduce friction losses and life-cycle costs.

III. Flow Rates

Design flow rates for each reach are as follows:

1	PS-1 to Signal Hill/PS-3 & OC Spreading Grour	Q_1 =	150	MGD	104,167	gpm
2	PS-1 to West Coast Basin Injection Wells	Q_2 =	15	MGD	10,417	gpm
3	PS-2 to OC Spreading Grounds	Q_3 =	60	MGD	41,667	gpm
4	PS-2 to PS3	Q_4 =	80	MGD	55,556	gpm
5	PS-3 to Santa Fe Spreading Grounds	Q_5 =	80	MGD	55,556	gpm

IV. Calculations

Discharge Laterals

							# of Pumps
1	PS-1 to Signal Hill/PS-3 & OC Spreading Grour	Q_1 =	37.5	MGD	26,042	gpm	5
2	PS-1 to West Coast Basin Injection Wells	Q_2 =	7.5	MGD	5,208	gpm	3
3	PS-2 to OC Spreading Grounds	Q_3 =	20	MGD	13,889	gpm	4
4	PS-2 to PS3	Q_4 =	26.7	MGD	18,519	gpm	4
5	PS-3 to Santa Fe Spreading Grounds	Q_5 =	26.7	MGD	18,519	gpm	4

Flow Stream 1:PS-1 to Signal Hill/PS-3 & OC Spreading Grounds

A1=	7.07	ft²	Pipe area
D1=	3.00	ft	Pipe diameter (ft)
D1=	36.00	in	Pipe diameter (in)
V1=	**8.21**	**fps**	**Flow velocity**

Flow Stream 2:PS-1 to West Coast Basin Injection Wells

A2=	1.40	ft²	Pipe area
D2=	1.33	ft	Pipe diameter (ft)
D2=	16.00	in	Pipe diameter (in)
V2=	**8.31**	**fps**	**Flow velocity**

Flow Stream 3:PS-2 to OC Spreading Grounds

A3=	3.14	ft²	Pipe area
D3=	2.00	ft	Pipe diameter (ft)
D3=	24.00	in	Pipe diameter (in)
V3=	**9.85**	**fps**	**Flow velocity**

Flow Stream 4:PS-2 to PS3

A4=	4.91	ft²	Pipe area
D4=	2.50	ft	Pipe diameter (ft)
D4=	30.00	in	Pipe diameter (in)
V4=	**8.40**	**fps**	**Flow velocity**

Flow Stream 5:PS-3 to Santa Fe Spreading Grounds

A5=	4.91	ft²	Pipe area
D5=	2.50	ft	Pipe diameter (ft)
D5=	30.00	in	Pipe diameter (in)
V5=	**8.40**	**fps**	**Flow velocity**

I. Objective
Determine suction header pipe sizes for PS1, PS2 (Alt B only), and PS3.

II. Design Criteria
Design flow velocities at 5 fps or lower to be within range of the max allowable flow velocities at the suction laterals (4 fps).

III. Flow Rates

1	PS 1	Q_1 =	165	MGD	114,583	gpm
2	PS 2	Q_2 =	140	MGD	97,222	gpm
3	PS 3	Q_3 =	80	MGD	55,556	gpm

IV. Calculations

Flow Stream 1:PS 1

A1=	56.75	ft²	Pipe area
D1=	8.50	ft	Pipe diameter (ft)
D1=	102.00	in	Pipe diameter (in)
V1=	**4.50**	**fps**	**Flow velocity**

Flow Stream 2:PS 2

A1=	38.48	ft²	Pipe area
D1=	7.00	ft	Pipe diameter (ft)
D1=	84.00	in	Pipe diameter (in)
V1=	**5.63**	**fps**	**Flow velocity**

Flow Stream 3:PS 3

A3=	28.27	ft²	Pipe area
D3=	6.00	ft	Pipe diameter (ft)
D3=	72.00	in	Pipe diameter (in)
V3=	**4.38**	**fps**	**Flow velocity**

I. Objective
Determine suction lateral pipe sizes for PS1, PS-2 (Alt B only) and PS3.

II. Design Criteria
According to the HI 9.8, the maximum flow velocity recommended for an suction lateral entering a closed-bottom can below the elevation of the discharge lateral is 4 fps.

III. Flow Rates
The following are the design flow rates for each pump station.

1	PS1 Set B	Q_1 =	150	MGD	104,167	gpm
2	PS1 Set A	Q_2 =	15	MGD	10,417	gpm
3	PS2 Set A	Q_3 =	60	MGD	41,667	gpm
4	PS2 Set B	Q_4 =	80	MGD	55,556	gpm
5	PS3	Q_5 =	80	MGD	55,556	gpm

IV. Calculations
The following are the range of flow rates that are considered to size the suction laterals. In addition to the design flow rate of each pump, the pipe capacity was assessed for up to 150% of the rated design point evaluate the maximum flow velocity that could occur within the pipes. The use of VFD's can prevent higher flow runout.

				Rated Design Point		**150% Design Point**	
		# of Pumps		mgd	gpm	mgd	gpm
1	PS1 Set B	5	Q_1 =	37.5	26,042	56.3	39,063
2	PS1 Set A	3	Q_2 =	7.5	5,208	11.3	7,813
3	PS2 Set A	4	Q_2 =	20	13,889	30.0	20,833
4	PS2 Set B	4	Q_2 =	26.7	18,519	40.0	27,778
5	PS3	4	Q_2 =	26.7	18,519	40.0	27,778

Flow Stream 1:PS1 Set B
At rated design flow rate:

A1=	23.76	ft²	Pipe area
D1=	5.50	ft	Pipe diameter (ft)
D1=	66.00	in	Pipe diameter (in)
V1=	**2.44**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A1=	23.76	ft²	Pipe area
D1=	5.50	ft	Pipe diameter (ft)
D1=	66.00	in	Pipe diameter (in)
V1=	**3.66**	**fps**	**Flow velocity**

Flow Stream 2:PS1 Set A
At rated design flow rate:

A2=	4.91	ft²	Pipe area
D2=	2.50	ft	Pipe diameter (ft)
D2=	30.00	in	Pipe diameter (in)
V2=	**2.36**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A2=	4.91	ft²	Pipe area
D2=	2.50	ft	Pipe diameter (ft)
D2=	30.00	in	Pipe diameter (in)
V2=	**3.55**	**fps**	**Flow velocity**

Flow Stream 3:PS2 Set A
At rated design flow rate:

A2=	12.57	ft²	Pipe area
D2=	4.00	ft	Pipe diameter (ft)
D2=	48.00	in	Pipe diameter (in)
V2=	**2.46**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A2=	12.57	ft²	Pipe area
D2=	4.00	ft	Pipe diameter (ft)
D2=	48.00	in	Pipe diameter (in)
V2=	**3.69**	**fps**	**Flow velocity**

Flow Stream 4:PS2 Set B

At rated design flow rate:

A2=	15.90	ft^2	Pipe area
D2=	4.50	ft	Pipe diameter (ft)
D2=	54.00	in	Pipe diameter (in)
V2=	**2.59**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A2=	15.90	ft^2	Pipe area
D2=	4.50	ft	Pipe diameter (ft)
D2=	54.00	in	Pipe diameter (in)
V2=	**3.89**	**fps**	**Flow velocity**

Flow Stream 5:PS3

At rated design flow rate:

A5=	15.90	ft^2	Pipe area
D5=	4.50	ft	Pipe diameter (ft)
D5=	54.00	in	Pipe diameter (in)
V5=	**2.59**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A5=	15.90	ft^2	Pipe area
D5=	4.50	ft	Pipe diameter (ft)
D5=	54.00	in	Pipe diameter (in)
V5=	**3.89**	**fps**	**Flow velocity**

I. Objective

Evaluate discharge header pipe sizes for PS-1 and PS-3 for the Alternative A-Backbone System.

II. Design Criteria

Discharge header sizes will match the respective transmission pipeline sizes identified for each reach.

According to the MWD Hydraulic Design Manual, the design velocity for transmission pipelines 48 inches or larger is 7-8 fps.

III. Flow Rates

Design flow rates for each reach are as follows:

1	**PS-1 to PS-3**	Q1 =	150	MGD	104,167	gpm
2	**PS-3 to Santa Fe Spreading Grounds**	Q2 =	150	MGD	104,167	gpm

IV. Calculations

Flow Stream 1:PS-1 to PS-3

A1=	38.48	ft²	Pipe area
D1=	7.00	ft	Pipe diameter (ft)
D1=	84.00	in	Pipe diameter (in)
V1=	**6.03**	**fps**	**Flow velocity**

Flow Stream 2:PS-3 to Santa Fe Spreading Grounds

A2=	38.48	ft²	Pipe area
D2=	7.00	ft	Pipe diameter (ft)
D2=	84.00	in	Pipe diameter (in)
V2=	**6.03**	**fps**	**Flow velocity**

CDM Smith	Client: **MWD**	Job No.: **114706**		Computed By: **SEL**	
	Project: **RRWP**	Date Checked: **9/17/2018**		Date: **9/7/2018**	
	Detail: **Process Mechanical Pipe Sizing (Alt A-Backbone)**	Checked By: **CTM**		Page No.: **2**	

I. Objective

Determine discharge lateral pipe sizes for PS-1 and PS-3 for the Alternative A-Backbone System.

II. Design Criteria

HI 9.6.6 recommends that discharge lateral flow velocities should not exceed 15 fps. For the purposes of this study, the maximum flow velocity is assumed to be 10 fps in order to reduce friction losses and life-cycle costs.

III. Flow Rates

Design flow rates for each reach are as follows:

1 PS-1 to PS-3	Q1 =	150	MGD	104,167	gpm
2 PS-3 to Santa Fe Spreading Grounds	Q2 =	150	MGD	104,167	gpm

IV. Calculations

Discharge Laterals						# of Pumps (4 in operation + 1 standby)
1 PS-1 to Signal Hill/PS-3 & OC Spreading Grounds	Q1 =	37.5	MGD	26,042	gpm	5
2 PS-3 to Santa Fe Spreading Grounds	Q2 =	37.5	MGD	26,042	gpm	5

Flow Stream 1:PS-1 to PS-3

	A1=	7.07	ft²	Pipe area
	D1=	3.00	ft	Pipe diameter (ft)
	D1=	36.00	in	Pipe diameter (in)
Rated Flow	**V1=**	**8.21**	**fps**	**Flow velocity**
Maximum Discharge		**12.31**	fps	

Flow Stream 2:PS-3 to Santa Fe Spreading Grounds

	A2=	7.07	ft²	Pipe area
	D2=	3.00	ft	Pipe diameter (ft)
	D2=	36.00	in	Pipe diameter (in)
	V2=	**8.21**	**fps**	**Flow velocity**
Maximum Discharge		**12.31**	fps	

I. Objective

Determine suction header pipe sizes for PS-1 and PS-3 for the Alternative A-Backbone System.

II. Design Criteria

Design flow velocities at 5 fps or lower to be within range of the max allowable flow velocities at the suction laterals (4 fps).

III. Flow Rates

1	**PS-1 to PS-3**	Q1 =	150	MGD	104,167	gpm
2	**PS-3 to Santa Fe Spreading Grounds**	Q2 =	150	MGD	104,167	gpm

IV. Calculations

Flow Stream 1:PS-1 to PS-3

A1=	56.75	ft²	Pipe area
D1=	8.50	ft	Pipe diameter (ft)
D1=	102.00	in	Pipe diameter (in)
V1=	**4.09**	**fps**	**Flow velocity**

Flow Stream 2:PS-3 to Santa Fe Spreading Grounds

A2=	56.75	ft²	Pipe area
D2=	8.50	ft	Pipe diameter (ft)
D2=	102.00	in	Pipe diameter (in)
V2=	**4.09**	**fps**	**Flow velocity**

I. Objective
Determine suction lateral pipe sizes for PS-1 and PS-3 for the Alternative A-Backbone System.

II. Design Criteria
According to the HI 9.8, the maximum flow velocity recommended for a suction lateral entering a closed-bottom can below the elevation of the discharge lateral is 4 fps.

III. Flow Rates
The following are the design flow rates for each pump station.

1	**PS-1 to PS-3**	Q1 =	150	MGD	104,167	gpm
2	**PS-3 to Santa Fe Spreading Grounds**	Q2 =	150	MGD	104,167	gpm

IV. Calculations
The following are the range of flow rates that are considered to size the suction laterals. In addition to the design flow rate of each pump, the pipe capacity was assessed for up to 150% of the rated design point evaluate the maximum flow velocity that could occur within the pipes. The use of VFD's can prevent higher flow runout.

				Rated Design Point		**150% Design Point**	
		# of Pumps		mgd	gpm	mgd	gpm
1	PS-1 to PS-3	5	Q_1 =	37.5	26,042	56.3	39,063
2	PS-3 to Santa Fe Spreading Grounds	5	Q_2 =	37.5	26,042	56.3	39,063

Flow Stream 1:PS-1 to PS-3
At rated design flow rate:

A1=	23.76	ft²	Pipe area
D1=	5.50	ft	Pipe diameter (ft)
D1=	66.00	in	Pipe diameter (in)
V1=	**2.44**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A1=	23.76	ft²	Pipe area
D1=	5.50	ft	Pipe diameter (ft)
D1=	66.00	in	Pipe diameter (in)
V1=	**3.66**	**fps**	**Flow velocity**

Flow Stream 2:PS-3 to Santa Fe Spreading Grounds
At rated design flow rate:

A2=	23.76	ft²	Pipe area
D2=	5.50	ft	Pipe diameter (ft)
D2=	66.00	in	Pipe diameter (in)
V2=	**2.44**	**fps**	**Flow velocity**

At 150% of rated design flow rate:

A2=	23.76	ft²	Pipe area
D2=	5.50	ft	Pipe diameter (ft)
D2=	66.00	in	Pipe diameter (in)
V2=	**3.66**	**fps**	**Flow velocity**

MWD Recycled Water Pump Station 1 Set A

Pump Can Size Evaluation

CLIENT	MWD	JOB NO.	8768-114706	DATE	7/19/17
PROJECT	RRWP	DATE CHECKED	7/21/2017	COMPUTED BY	ET
DETAIL	PS-1 Set A Can Sizing	CHECKED BY	CAO		

ENTER THE DESIGN FLOWRATE:

FLOW RATE (GPM)	5,208	7.5 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	78.00	Pentair Model 27ML-BRZ, length of bowl assem
ID OF SUCTION NOZZLE (INCHES)	30.00	
ID OF BARREL (INCHES)	36.75	Upsized from recommended Pentair Model 27M
OD OF BOWL (INCHES)	26.60	Pentair Model 27ML
OD OF BELL (INCHES)	22.50	Pentair Model 27ML

INLET FRICTION LOSS: **0.10 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.55 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.37	**FPS**
VELOCITY IN BARREL @ BOWL	3.32	**FPS**
VELOCITY IN BARREL @ BELL	2.53	**FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	7,813	150% of rated design point (105% of BEP)
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	78.00	
ID OF SUCTION NOZZLE (INCHES)	30.00	
ID OF BARREL (INCHES)	36.75	
OD OF BOWL (INCHES)	26.60	
OD OF BELL (INCHES)	22.50	

INLET FRICTION LOSS: **0.24 FEET**

TOTAL FRICTION LOSS IN BARREL: **1.23 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.56	**FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	4.98	**FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	3.79	**FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 1 Set B (Alternative A)

Pump Can Size Evaluation

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/25/17
PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
DETAIL	PS-1 Set B (Alternative A) Can Sizing	CHECKED BY	CAO		

ENTER THE DESIGN FLOWRATE:

FLOW RATE (GPM)	26,042	37.5 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	192.00	2 * ID of barrel
ID OF SUCTION NOZZLE (INCHES)	66.00	
ID OF BARREL (INCHES)	96.00	Pentair Model 63HRO 7000
OD OF BOWL (INCHES)	64.00	Pentair Model 63HRO 7000
OD OF BELL (INCHES)	64.00	Pentair Model 63HRO 7000

INLET FRICTION LOSS: **0.11 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.28 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.45 **FPS**
VELOCITY IN BARREL @ BOWL	2.09 **FPS**
VELOCITY IN BARREL @ BELL	2.09 **FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	39,063	150% of rated design point (105% of BEP)
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	192.00	
ID OF SUCTION NOZZLE (INCHES)	66.00	
ID OF BARREL (INCHES)	96.00	
OD OF BOWL (INCHES)	64.00	
OD OF BELL (INCHES)	64.00	

INLET FRICTION LOSS: **0.25 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.63 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.68 **FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	3.13 **FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	3.13 **FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 1 Set B (Alternative B)

Pump Can Size Evaluation

CDM Smith				
CLIENT	MWD	JOB NO.	8768-114706	DATE 10/25/17
PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY AG
DETAIL	PS-1 Set B (Alternative B) Can Sizing	CHECKED BY	CAO	

ENTER THE DESIGN FLOWRATE:

FLOW RATE (GPM)	26,042	37.5 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	142.50	2 * ID of barrel
ID OF SUCTION NOZZLE (INCHES)	66.00	
ID OF BARREL (INCHES)	71.25	Pentair Model 44A-BRZ
OD OF BOWL (INCHES)	43.00	Pentair Model 44A-BRZ
OD OF BELL (INCHES)	40.00	Pentair Model 44A-BRZ

INLET FRICTION LOSS: **0.11 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.53 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.45	**FPS**
VELOCITY IN BARREL @ BOWL	3.31	**FPS**
VELOCITY IN BARREL @ BELL	3.07	**FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	39,063	150% of rated design point (105% of BEP)
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	142.50	
ID OF SUCTION NOZZLE (INCHES)	66.00	
ID OF BARREL (INCHES)	71.25	
OD OF BOWL (INCHES)	43.00	
OD OF BELL (INCHES)	40.00	

INLET FRICTION LOSS: **0.25 FEET**

TOTAL FRICTION LOSS IN BARREL: **1.19 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.68	**FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	4.96	**FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	4.61	**FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 1 Set B (Alternative A-Backbone)
Pump Can Size Evaluation

CDM Smith	CLIENT: MWD	JOB NO.: 8768-114706	DATE: 9/7/18		
	PROJECT: RRWP	DATE CHECKED: 9/17/2018	COMPUTED BY: SEL		
	DETAIL: PS-1 Set B (Alternative A-Backbone) Can Sizing	CHECKED BY: CTM			

ENTER THE DESIGN FLOWRATE:

Pentair 63HRO 7000 (Preliminary Selection)

FLOW RATE (GPM)	26,042	37.5 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	192.00	2 * ID of barrel
ID OF SUCTION NOZZLE (INCHES)	66.00	Same as the suction laterals
ID OF BARREL (INCHES)	96.00	Can on pump data sheet
OD OF BOWL (INCHES)	64.00	Internal Feature on pump data sheet
OD OF BELL (INCHES)	64.00	Suction Bell on pump data sheet

INLET FRICTION LOSS: **0.11 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.28 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.45	**FPS**
VELOCITY IN BARREL @ BOWL	2.09	**FPS**
VELOCITY IN BARREL @ BELL	2.09	**FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	39,063	150% of rated design point (105% of BEP)
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	192.00	
ID OF SUCTION NOZZLE (INCHES)	66.00	
ID OF BARREL (INCHES)	96.00	
OD OF BOWL (INCHES)	64.00	
OD OF BELL (INCHES)	64.00	

INLET FRICTION LOSS: **0.25 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.63 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.68	**FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	3.13	**FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	3.13	**FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 2 Set A

Pump Can Size Evaluation

CDM Smith	CLIENT	MWD	JOB NO.	8768-114706	DATE	10/25/17
	PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
	DETAIL	PS-2 Set A Can Sizing (Alternative B only)	CHECKED BY	CAO		

ENTER THE DESIGN FLOWRATE:

FLOW RATE (GPM)	13,889	20 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	83.25	Pentair Model 36G-BRZ, length of bowl assembly
ID OF SUCTION NOZZLE (INCHES)	48.00	
ID OF BARREL (INCHES)	60.00	
OD OF BOWL (INCHES)	35.75	Pentair Model 36G-BRZ
OD OF BELL (INCHES)	40.00	Pentair Model 36G-BRZ

INLET FRICTION LOSS: **0.11 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.34 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.47	**FPS**
VELOCITY IN BARREL @ BOWL	2.45	**FPS**
VELOCITY IN BARREL @ BELL	2.85	**FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	20,833	150% of rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	83.25	
ID OF SUCTION NOZZLE (INCHES)	48.00	
ID OF BARREL (INCHES)	60.00	
OD OF BOWL (INCHES)	35.75	
OD OF BELL (INCHES)	40.00	

INLET FRICTION LOSS: **0.26 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.75 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.71	**FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	3.68	**FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	4.27	**FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 2 Set A

Pump Can Size Evaluation

CLIENT	MWD	JOB NO.	8768-114706	DATE	10/25/17
PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	AG
DETAIL	PS-2 Set B Can Sizing (Alternative B only)	CHECKED BY	CAO		

ENTER THE DESIGN FLOWRATE:

FLOW RATE (GPM)	18,542	26.7 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	132.00	2*ID
ID OF SUCTION NOZZLE (INCHES)	54.00	
ID OF BARREL (INCHES)	66.00	
OD OF BOWL (INCHES)	43.00	Pentair Model 44B-BRZ
OD OF BELL (INCHES)	43.00	Pentair Model 44B-BRZ

INLET FRICTION LOSS: **0.13 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.48 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.61	**FPS**
VELOCITY IN BARREL @ BOWL	3.03	**FPS**
VELOCITY IN BARREL @ BELL	3.03	**FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	27,813	150% of rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	132.00	
ID OF SUCTION NOZZLE (INCHES)	54.00	
ID OF BARREL (INCHES)	66.00	
OD OF BOWL (INCHES)	43.00	
OD OF BELL (INCHES)	43.00	

INLET FRICTION LOSS: **0.28 FEET**

TOTAL FRICTION LOSS IN BARREL: **1.08 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.91	**FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	4.55	**FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	4.55	**FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 3

Pump Can Size Evaluation

CLIENT	MWD	JOB NO.	8768-114706	DATE	7/19/17
PROJECT	RRWP	DATE CHECKED	10/26/2017	COMPUTED BY	ET
DETAIL	PS-3 Can Sizing	CHECKED BY	CAO		

ENTER THE DESIGN FLOWRATE:

FLOW RATE (GPM)	18,542	26.7 MGD, rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	144.00	2 * ID of Barrel
ID OF SUCTION NOZZLE (INCHES)	54.00	
ID OF BARREL (INCHES)	72.00	Pentair Model 48HRO 7000
OD OF BOWL (INCHES)	48.00	Pentair Model 48HRO 7000
OD OF BELL (INCHES)	48.00	Pentair Model 48HRO 7000

INLET FRICTION LOSS: **0.13 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.40 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.61 **FPS**
VELOCITY IN BARREL @ BOWL	2.64 **FPS**
VELOCITY IN BARREL @ BELL	2.64 **FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	27,813	150% of rated design point (119% of BEP)
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	144.00	
ID OF SUCTION NOZZLE (INCHES)	54.00	
ID OF BARREL (INCHES)	72.00	
OD OF BOWL (INCHES)	48.00	
OD OF BELL (INCHES)	48.00	

INLET FRICTION LOSS: **0.28 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.89 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.91 **FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	3.96 **FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	3.96 **FPS**	Maximum of 5 feet/second

MWD Recycled Water Pump Station 3
Pump Can Size Evaluation

CDM Smith						
CLIENT	MWD	JOB NO.	8768-114706	DATE	9/7/18
PROJECT	RRWP	DATE CHECKED	9/17/2018	COMPUTED BY	SEL
DETAIL	PS-3 Can Sizing (Alternative A-Backbone)	CHECKED BY	CTM		

ENTER THE DESIGN FLOWRATE:

Pentair 63HRO 7000 (Preliminary Selection)

FLOW RATE (GPM)	26,042	37.5 MGD rated design point
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	192.00	2 * ID of barrel
ID OF SUCTION NOZZLE (INCHES)	66.00	Same as the suction laterals
ID OF BARREL (INCHES)	96.00	Can on pump data sheet
OD OF BOWL (INCHES)	64.00	Internal Feature on pump data sheet
OD OF BELL (INCHES)	64.00	Suction Bell on pump data sheet

INLET FRICTION LOSS: **0.11 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.28 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	2.45 **FPS**
VELOCITY IN BARREL @ BOWL	2.09 **FPS**
VELOCITY IN BARREL @ BELL	2.09 **FPS**

ENTER THE MAXIMUM FLOWRATE:

FLOW RATE (GPM)	39,063	150% of rated design point (119% of BEP)
LENGTH FROM CENTERLINE OF SUCTION TO LIP OF THE BELL (INCHES)	192.00	
ID OF SUCTION NOZZLE (INCHES)	66.00	
ID OF BARREL (INCHES)	96.00	
OD OF BOWL (INCHES)	64.00	
OD OF BELL (INCHES)	64.00	

INLET FRICTION LOSS: **0.25 FEET**

TOTAL FRICTION LOSS IN BARREL: **0.63 FEET**
(INCLUDES INLET FRICTION LOSS)

VELOCITY AT SUCTION NOZZLE	3.68 **FPS**	Maximum of 4 feet/second
VELOCITY IN BARREL @ BOWL	3.13 **FPS**	Maximum of 5 feet/second
VELOCITY IN BARREL @ BELL	3.13 **FPS**	Maximum of 5 feet/second

CLIENT	MWD	JOB NO.	114706	DATE	10/18/17
PROJECT	Conveyance	DATE CHECKED	10/27/17	COMPUTED BY	AG
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Surge Tank Sizing
MWD RRWP
PS1, PS2, and PS3

Description: **Preliminary sizing of surge tanks for PS-1 (Alternative A and B), PS-2, and PS-3.**

1.0 Contents

1 Cover
2 PS1 (Alt A)
3 PS1 (Alt B)
4 PS2
5 PS3

1.1 Purpose/Objective:

1 Calculate preliminary sizes of surge tanks needed at PS1, PS2, and PS3.

1.2 Procedure/Approach:

1 See below

1.3 Data and References:

Surge tank sizing based on paper: Simple Guid for Design of Air Vessels for Water Hammer Protection of Pumping Lines by D. Stephenson DOI: 10.1061/(ASCE)0733-9429(2002)128:8(792)

1.4 Assumptions and Limitations:

1. Calculations are PRELIMINARY only for initial sizing of facilities. They shall not be used in final design.
2. Final sizing of surge tanks should be based on computer transient modeling.

Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
<<--text	green text with arrow = notes, assumptions, or references to data sources

CLIENT	MWD	JOB NO.	114706	DATE	10/18/17
PROJECT	Conveyance	DATE CHECKED	10/27/2017	COMPUTED BY	AG
DETAIL	PS1 (Alt A) Surge Tank Sizing	CHECKED BY	CAO		

Scenario:	(1) 84-in + 54-in	(1) 84-in + 60-in		
Parameter	**Value**	**Value**	**Unit**	**Notes**
Steady State Pumping Head, H_0	428	428	ft	
Pipe length PS1 to end, L	151,650	141,478	ft	
(Equivalent Diameter) Pipeline diameter, D_p	69.18	72.61	in	Equivalent diameters based on combined diameter/length of pipeline
Flow	150	150	MGD	
Cross sectional area, A	26.10	28.76	ft^2	
Initial velocity, V_0	8.9	8.1	ft/s	
Figure 3 - Max and min head envelopes using incompressible flow theory				
Min Head, H_{min}	128.4	128.4	ft	30% of steady state
Max Head, H_{max}	642	642	ft	50% above steady state
H_{min}/H_0	0.3	0.3	dimensionless	
H_{max}/H_0	1.5	1.5	dimensionless	
Dimensionless gas volume, S'	0.9	0.9	dimensionless	Read from Figure 3
Gas volume at steady state operating pressure, S_0	20,440	17,307	ft^3	Volume of air
Figure 4 - Air and Vessel Volumes				
SgH_0/ALV_0^2	2	2	dimensionless	Read from Figure 4
Air vessel volume, S	45,423	38,460	ft^3	
Capacity of proposed surge tanks	8,000	8,000	ft^3	
No. New surge tanks required	6	5	no. tanks	
New Tank Diameter	12	12	ft	Max feasible
New Tank Overall Length	85	85	ft	Based on tank volume + 20% for end caps
Surge pad Length	202	172	ft	
Surge pad Width	100	100	ft	

CLIENT	MWD	JOB NO.	114706	DATE	10/18/17
PROJECT	Conveyance	DATE CHECKED	10/27/2017	COMPUTED BY	AG
DETAIL	PS1 (Alt B) Surge Tank Sizing	CHECKED BY	CAO		

Parameter	Value	Unit	Notes
Steady State Pumping Head, H_0	174	ft	
Pipe length PS1 to Signal Hill, L	33,719	ft	
(Equivalent Diameter) Pipeline diameter, D_p	84	in	
Flow	150	MGD	
Cross sectional area, A	38.48	ft^2	
Initial velocity, V_0	6.0	ft/s	
Figure 3 - Max and min head envelopes using incompressible flow theory			
Min Head, H_{min}	52.2	ft	30% of steady state
Max Head, H_{max}	261	ft	50% above steady state
H_{min}/H_0	0.3	dimensionless	
H_{max}/H_0	1.5	dimensionless	
Dimensionless gas volume, S'	0.9	dimensionless	Read from Figure 3
Gas volume at steady state operating pressure, S_0	7,582	ft^3	Volume of air
Figure 4 - Air and Vessel Volumes			
SgH_0/ALV_0^2	2	dimensionless	Read from Figure 4
Air vessel volume, S	16,849	ft^3	
Capacity of proposed surge tanks	5,500	ft^3	
No. New surge tanks required	4	no. tanks	
New Tank Diameter	12	ft	Max feasible
New Tank Overall Length	58	ft	Based on tank volume + 20% for end caps
Surge pad Length	141	ft	
Surge pad Width	80	ft	

CLIENT	MWD	JOB NO.	114706	DATE	10/18/17
PROJECT	Conveyance	DATE CHECKED	10/27/2017	COMPUTED BY	AG
DETAIL	PS2 (Alt B) Surge Tank Sizing	CHECKED BY	CAO		

Scenario:	**(1) 54-in**	**(1) 60-in**		
Parameter	**Value**	**Value**	**Unit**	**Notes**
Steady State Pumping Head, H_0	266	235	ft	
Pipe length PS1 to PS2, L	82,870	64,480	ft	
(Equivalent Diameter) Pipeline diameter, D_p	54	60	in	
Flow	60	80	MGD	
Cross sectional area, A	15.90	19.63	ft^2	
Initial velocity, V_0	5.8	6.3	ft/s	
Figure 3 - Max and min head envelopes using incompressible flow theory				
Min Head, H_{min}	106.4	94	ft	40% of steady state
Max Head, H_{max}	399	352.5	ft	50% above steady state
H_{min}/H_0	0.4	0.4	dimensionless	
H_{max}/H_0	1.5	1.5	dimensionless	
Dimensionless gas volume, S'	1	1	dimensionless	Read from Figure 3
Gas volume at steady state operating pressure, S_0	5,243	6,650	ft^3	Volume of air
Figure 4 - Air and Vessel Volumes				
SgH_0/ALV_0^2	3	3	dimensionless	Read from Figure 4
Air vessel volume, S	15,730	19,950	ft^3	
Capacity of proposed surge tanks	8,000	8,000	ft^3	
No. New surge tanks required	2	3	no. tanks	
New Tank Diameter	12	12	ft	Max feasible
New Tank Overall Length	85	85	ft	Based on tank volume + 20% for end caps
Surge pad Length	80	110	ft	
Surge pad Width	100	100	ft	

CDM Smith	CLIENT	MWD	JOB NO.	114706	DATE	10/18/17
	PROJECT	Conveyance	DATE CHECKED	10/27/2017	COMPUTED BY	AG
	DETAIL	PS3 Surge Tank Sizing	CHECKED BY	CAO		

Parameter	Value	Unit	Notes
Steady State Pumping Head, H_0	414	ft	
Pipe length PS1 to PS2, L	67,600	ft	
(Equivalent Diameter) Pipeline diameter, D_p	60	in	
Flow	80	MGD	
Cross sectional area, A	19.63	ft^2	
Initial velocity, V_0	6.3	ft/s	
Figure 3 - Max and min head envelopes using incompressible flow theory			
Min Head, H_{min}	165.6	ft	40% of steady state
Max Head, H_{max}	621	ft	50% above steady state
H_{min}/H_0	0.4	dimensionless	
H_{max}/H_0	1.5	dimensionless	
Dimensionless gas volume, S'	1	dimensionless	Read from Figure 3
Gas volume at steady state operating pressure, S_0	3,957	ft^3	Volume of air
Figure 4 - Air and Vessel Volumes			
SgH_0/ALV_0^2	3	dimensionless	Read from Figure 4
Air vessel volume, S	11,872	ft^3	
Capacity of proposed surge tanks	8,000	ft^3	
No. New surge tanks required	2	no. tanks	
New Tank Diameter	12	ft	Max feasible
New Tank Overall Length	85	ft	Based on tank volume + 20% for end caps
Surge pad Length	80	ft	
Surge pad Width	100	ft	

CLIENT	MWD	JOB NO.	114706	DATE	9/18/18
PROJECT	Conveyance	DATE CHECKED	9/18/18	COMPUTED BY	CM
DETAIL	Cover Sheet	CHECKED BY	CAO		

Preliminary Surge Tank Sizing
MWD RRWP
PS1-Set B and PS3 (Alt A - Backbone)

Description: **Preliminary sizing of surge tanks for PS-1 and PS-3 in the Alt A-Backbone configuration**

1.0 Contents

1	Cover
2	PS1
3	PS3

1.1 Purpose/Objective: 1 Calculate preliminary sizes of surge tanks needed at PS1 and PS3 in the Alt-A Backbone configuration

1.2 Procedure/Approach: 1 See below

1.3 Data and References:

Surge tank sizing based on paper: Simple Guid for Design of Air Vessels for Water Hammer Protection of Pumping Lines by D. Stephenson DOI: 10.1061/(ASCE)0733-9429(2002)128:8(792)

1.4 Assumptions and Limitations:

1. Calculations are PRELIMINARY only for initial sizing of facilities. They shall not be used in final design.
2. Final sizing of surge tanks should be based on computer transient modeling.

Additional assumptions are noted throughout this document in green text.

1.5 Legend:

The following text and cell color codes are used in this spreadsheet and indicate the following:

	blue shaded cell = value that requires manual input
text	black text = notes, equations, and results that do not need updating for typical calculations
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CLIENT	MWD	JOB NO.	114706	DATE	9/18/2018
PROJECT	Conveyance	DATE CHECKED	9/18/2018	COMPUTED BY	CM
DETAIL	PS-1 (Alt A-Backbone) Surge Tank Sizing	CHECKED BY	CAO		

Scenario:	Alt_A		
Parameter	**Value**	**Unit**	**Notes**
Steady State Pumping Head, H_0	352	ft	
Pipe length PS1 to end, L	141,478	ft	
(Equivalent Diameter) Pipeline diameter, D_p	84.00	in	
Flow	150	MGD	
Cross sectional area, A	38.48	ft^2	
Initial velocity, V_0	6.0	ft/s	
Figure 3 - Max and min head envelopes using incompressible flow theory			
Min Head, H_{min}	105.6	ft	30% of steady state
Max Head, H_{max}	528	ft	50% above steady state
H_{min}/H_0	0.3	dimensionless	
H_{max}/H_0	1.5	dimensionless	
Dimensionless gas volume, S'	0.9	dimensionless	Read from Figure 3
Gas volume at steady state operating pressure, S_0	15,725	ft^3	Volume of air
Figure 4 - Air and Vessel Volumes			
SgH_0/ALV_0^2	2	dimensionless	Read from Figure 4
Air vessel volume, S	34,945	ft^3	
Capacity of proposed surge tanks	6,000	ft^3	
No. New surge tanks required	6	no. tanks	
New Tank Diameter	12	ft	Max feasible
New Tank Overall Length	64	ft	Based on tank volume + 20% for end caps
Surge pad Length	202	ft	
Surge pad Width	100	ft	

CLIENT	MWD	JOB NO.	114706	DATE	9/18/2018
PROJECT	Conveyance	DATE CHECKED	9/18/2018	COMPUTED BY	CM
DETAIL	PS-3 (Alt A-Backbone) Surge Tank Sizing	CHECKED BY	CAO		

Parameter	Value	Unit	Notes
Steady State Pumping Head, H_0	360	ft	
Pipe length PS1 to PS2, L	58,800	ft	
(Equivalent Diameter) Pipeline diameter, D_p	84	in	
Flow	150	MGD	
Cross sectional area, A	38.48	ft^2	
Initial velocity, V_0	6.0	ft/s	
Figure 3 - Max and min head envelopes using incompressible flow theory			
Min Head, H_{min}	144	ft	40% of steady state
Max Head, H_{max}	540	ft	50% above steady state
H_{min}/H_0	0.4	dimensionless	
H_{max}/H_0	1.5	dimensionless	
Dimensionless gas volume, S'	0.9	dimensionless	Read from Figure 3
Gas volume at steady state operating pressure, S_0	6,390	ft^3	Volume of air
Figure 4 - Air and Vessel Volumes			
SgH_0/ALV_0^2	3	dimensionless	Read from Figure 4
Air vessel volume, S	21,301	ft^3	
Capacity of proposed surge tanks	6,000	ft^3	
No. New surge tanks required	4	no. tanks	
New Tank Diameter	12	ft	Max feasible
New Tank Overall Length	64	ft	Based on tank volume + 20% for end caps
Surge pad Length	141	ft	
Surge pad Width	100	ft	

CLIENT	Metropolitan	JOB NO.	8768-114706	DATE	10/26/17
PROJECT	Recycle Water System	DATE CHECKED	10/27/17	COMPUTED BY	CAO
DETAIL	Cover Sheet	CHECKED BY	AG	CALC #	

Purpose: Size preliminary balancing tank volumes at each pump station based on preliminary design information.

Assumptions:

1) No need for diurnal storage
2) If conveyance system shuts down AWTF can react in 35-40 min and/or discharge to current outfall
3) No need for storage to provide only off-peak power pumping
4) No need to serve continuing demands if system is shut off
5) Surge control by hydro-pneumatic tanks requires no more than 0.5 mg in downstream forebay
6) Pumps on VFD's results in no significant flow gaps
7) System controls will provide well coordinated/syncronized operation between stations. If this fails, overflow to adjacent water way can be allowed.
8) PS-3 can react to communication failure in 10 minutes
9) Signal Hill Storage Tank (Alternative B) may have other sizing considerations based on future users.

Calculation

1. Check Critical Times; Make sure Ramp Rates per Pump Exceed Critical Time to Minimize Surge During Controlled Starts and Stops

Pipeline Celerity, c = 3600 fps <<-Approx for Rigid Pipe

Critical Time, $t_c = 2L/c$

Segment	Length L (ft)	t_c (sec)	
PS-1 to PS-3	141478	79	
PS-1 to OC	151650	84	<<--Round up to 120 sec (2 min) to be conservative
PS-3 to Rio	67600	38	

*Note: Alternative B (with PS-2) result in shorter critical times

CLIENT	Metropolitan	JOB NO.	8768-114706	DATE	10/26/17
PROJECT	Recycle Water System	DATE CHECKED	10/27/17	COMPUTED BY	CAO
DETAIL	Cover Sheet	CHECKED BY	AG	CALC #	

2. Pump Ramping Parameters

Ramp Up Time Per Pump = 2 min <<--See above; also typical from previous systems
Delay Time Between Pump Ramps = 1 min <<--Typical
Post Ramp Delay = 2 min <<--Typical

3. Estimate Total Ramping Time

Station	Station Capacity (mgd)	Number of Duty Pump	Ramp Time for Pumps (min)	Delay Time Between Pumps (min)	Total Ramp Up Time (min)	Ramp Down Time (min)
PS-1	150	4	8	4	14	11
PS-2	80	3	6	6	14	8
PS-3	80	3	6	6	14	8

4. Storage Volumes based on Reaction Time

1. Consider ramp imbalance
2. Select based on allowable reaction time: 35-40 minutes for PS-1, 10 minutes for PS-2 and PS-3 (controls over ramp imbalance)

Condition Description	Flow Rate (mgd)	Flow Rate (gpm)	Reaction Time (min)									
	mgd	gpm	5	10	15	20	25	30	35	40	50	60
PS-1 to Flow Split Junction (Alt A) or Signal Hill Tank (Alt B)	**150**	**104167**	1.0	2.1	3.1	4.2	5.2	6.3	7.3	8.3	10.4	12.5
PS-2 Peak Capacity (Alt B only)	**140**	**97222**	1.0	1.9	2.9	3.9	4.9	5.8	6.8	7.8	9.7	11.7
Flow Split Junction (Alt A) or PS-2 (Alt B) to Orange County Peak Capacity	**60**	**41667**	0.4	0.8	1.3	1.7	2.1	2.5	2.9	3.3	4.2	5.0
Flow Split Junction (Alt A) or PS-2 (Alt B) to PS-3 and PS-3 Peak Capacity	**80**	**55556**	0.6	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.6	6.7
PS-1 Single Pump Capacity	**37.5**	**26042**	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.6	3.1
PS-2 (Alt B only) Single Pump Capacity	**20**	**13889**	0.1	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7
PS-3 Single Pump Capacity	**26.7**	**18542**	0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.9	2.2
Estimated Ramp-Up/Ramp-Down Imbalance	**5.0**	**3472**	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4

5. Recommended Volumes Based on Criteria

PS-1 = 7.5 MG <<--35 to 40 minutes at 150 mgd (PS-1 peak capacity)
PS-2 = 2.0 MG <<--10+ minutes based on 140 mgd (PS-2 peak capacity)
PS-3 = 1.5 MG <<--10+ minutes based on 80 mgd (PS-3 peak capacity)

6. Strorage Times at Various Flow Rates for Recommended Volumes

Condition Description	Flow Rate (mgd)	Flow Rate (gpm)	PS-1 7.5 MG	PS-2 2.0 MG	PS-3 1.5 MG
Estimated Ramp Imbalance	5	3,472	1,080	288	216
Flow Split Junction (Alt A) and PS-2 (Alt B) to PS-3 and PS-3 Single Pump Capacity	26.7	18,542	202	54	40
PS-1 Single Pump Capacity	37.5	26,042	144	38	29
Flow Split Junction (Alt A) and PS-2 (Alt B) to Orange County Capacity	60	41,667	90	24	18
Flow Split Junction (Alt A) and PS-2 (Alt B) to PS-3 Capacity	80	55,556	68	18	14
PS-2 (Alt B only) Peak Capacity	140	97,222	39	10	N/A
PS-1 to Flow Split Junction (Alt A) and Signal Hill Tank (Alt B) Capacity	150	104,167	36	10	N/A

7. Final Tank Dimensions with operating minimum and maximum levels

Distance from bottom of tank to low level shut-off =	2	ft	<<-Assumed for conceptual design
Distance from high level shut-off to overflow =	3	ft	<<-Assumed for conceptual design
PS-1 Forebay Tank Diameter =	200	ft	<<-Assumed for conceptual design site constraints
Signal Hill Storage Tank Diameter =	145	ft	<<-Assumed for conceptual design site constraints
PS-3 Forebay Tank Diameter =	125	ft	<<-Assumed for conceptual design site constraints

Station	Working Storage (MG)	Storage (cu-ft)	Diameter (ft)	Area (sq ft)	Working Storage Depth (ft)	Floor to Overflow Height (ft)
PS-1	7.5	1002674	200	31416	32	36.9
Signal Hill	2.0	267380	145	16513	16	21.2
PS-3	1.5	200535	125	12272	16	21.3

8. Conclusion and limitations

Conceptual design should be based on circular tanks with characteristics described in table above. Signal Hill Storage Tank volume should be refined based on future users and detailed surge analysis.

CDM Smith

CLIENT	Metropolitan	JOB NO.	8768-114706	DATE	9/19/18
PROJECT	Recycle Water System	DATE CHECKED	9/20/18	COMPUTED BY	CTM
DETAIL	Cover Sheet	CHECKED BY	CO	CALC #	

Purpose:

Size preliminary balancing tank volumes at each pump station based on preliminary design information.

These calculations are for the Alt A-Backbone System Scenario

Assumptions:

1) No need for diurnal storage
2) If conveyance system shuts down AWTF can react in 35-40 min and/or discharge to current outfall
3) No need for storage to provide only off-peak power pumping
4) No need to serve continuing demands if system is shut off
5) Surge control by hydro-pneumatic tanks requires no more than 0.5 mg in downstream forebay
6) Pumps on VFD's results in no significant flow gaps
7) System controls will provide well coordinated/syncronized operation between stations. If this fails, overflow to adjacent water way can be allowed.
8) PS-3 can react to communication failure in 10 minutes

Calculation

1. Check Critical Times; Make sure Ramp Rates per Pump Exceed Critical Time to Minimize Surge During Controlled Starts and Stops

Pipeline Celerity, c = 3600 fps <<-Approx for Rigid Pipe

Critical Time, $t_c = 2L/c$

Segment	Length L (ft)	Critical Time, t_c (sec)
PS-1 to PS-3	141478	79
PS-3 to Rio	58800	33

CLIENT	Metropolitan	JOB NO.	8768-114706	DATE	9/19/18
PROJECT	Recycle Water System	DATE CHECKED	9/20/18	COMPUTED BY	CTM
DETAIL	Cover Sheet	CHECKED BY	CO	CALC #	

2. Pump Ramping Parameters

Ramp Up Time Per Pump =	2	min	<<--See above; also typical from previous systems
Delay Time Between Pump Ramps =	1	min	<<--Typical
Post Ramp Delay =	2	min	<<--Typical

3. Estimate Total Ramping Time

Station	Station Capacity (mgd)	Number of Duty Pump	Ramp Time for Pumps (min)	Delay Time Between Pumps (min)	Total Ramp Up Time (min)	Ramp Down Time (min)
PS-1	150	4	8	4	14	11
PS-3	150	4	8	8	18	11

4. Storage Volumes based on Reaction Time

1. Consider ramp imbalance
2. Select based on allowable reaction time: 35-40 minutes for PS-1, 10 minutes for PS-3 (controls over ramp imbalance)

Condition Description	Flow Rate (mgd)	Flow Rate (gpm)	Reaction Time (min)									
	mgd	gpm	5	10	15	20	25	30	35	40	50	60
PS-1 to PS-3	**150**	**104167**	1.0	2.1	3.1	4.2	5.2	6.3	7.3	8.3	10.4	12.5
PS-3 Peak Capacity	**150**	**104167**	1.0	2.1	3.1	4.2	5.2	6.3	7.3	8.3	10.4	12.5
PS-3 Single Pump Capacity	**37.5**	**26042**	0.3	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.6	3.1
Estimated Ramp-Up/Ramp-Down Imbalance	**5.0**	**3472**	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4

5. Recommended Volumes Based on Criteria

PS-1 =	7.5	MG	<<--35 to 40 minutes at 150 mgd (PS-1 peak capacity)
PS-3 =	2.5	MG	<<--10+ minutes based on 80 mgd (PS-3 peak capacity)

6. Storage Times at Various Flow Rates for Recommended Volumes

Condition Description	Flow Rate (mgd)	Flow Rate (gpm)	PS-1 7.5 MG	PS-3 2.5 MG
Estimated Ramp Imbalance	5	3,472	1,080	360
PS-1 Single Pump Capacity	37.5	26,042	144	n/a
PS-1 Peak Capacity	150	104,167	36	n/a
PS-3 Single Pump Capacity	37.5	26,042	n/a	48
PS-3 Peak Capacity	150	104,167	n/a	12

7. Final Tank Dimensions with operating minimum and maximum levels

Distance from bottom of tank to low level shut-off =	2	ft	<<-Assumed for conceptual design
Distance from high level shut-off to overflow =	3	ft	<<-Assumed for conceptual design
PS-1 Forebay Tank Diameter =	200	ft	<<-Assumed for conceptual design site constraints
PS-3 Forebay Tank Diameter =	150	ft	<<-Assumed for conceptual design site constraints

Station	Working Storage (MG)	Storage (cu-ft)	Diameter (ft)	Area (sq ft)	Working Storage Depth (ft)	Floor to Overflow Height (ft)
PS-1	7.5	1002674	200	31416	32	36.9
PS-3	2.5	334225	150	17671	19	23.9

8. Conclusion and limitations

Conceptual design should be based on circular tanks with characteristics described in table above.

Appendix K. Concept Pump Performance Curves

Customer	: PS1 Set A
Project name	:

Pump Performance Datasheet

Encompass 2.0 - 17.2.3.0

Item number	: Default	Size	: 27ML-BRZ
Service	: Recycled Water	Stages	: 3
Quantity	: 2	Based on curve number	: 27_TURB_3500_1200_BR Rev 140306
Quote number	:	Date last saved	: 29 Jun 2017 3:33 PM

Operating Conditions

Flow, rated	: 7.50 MG/day
Differential head / pressure, rated (requested)	: 165.0 ft
Differential head / pressure, rated (actual)	: 165.2 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 890 rpm
Impeller diameter, rated	: 15.30 in
Impeller diameter, maximum	: 16.25 in
Impeller diameter, minimum	: 14.00 in
Efficiency (bowl / pump)	: 81.10 / - %
NPSH required / margin required	: 12.52 / 0.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 68 / 210 Metric units
Minimum Continuous Stable Flow	: 5.40 MG/day
Head, maximum, rated diameter	: 246.9 ft
Head rise to shutoff (bowl / pump)	: 49.63 / - %
Flow, best eff. point (bowl / pump)	: 8.99 / - MG/day
Flow ratio, rated / BEP (bowl / pump)	: 83.41 / - %
Diameter ratio (rated / max)	: 94.15 %
Head ratio (rated dia / max dia)	: 85.89 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast iron bowl - Standard impeller material

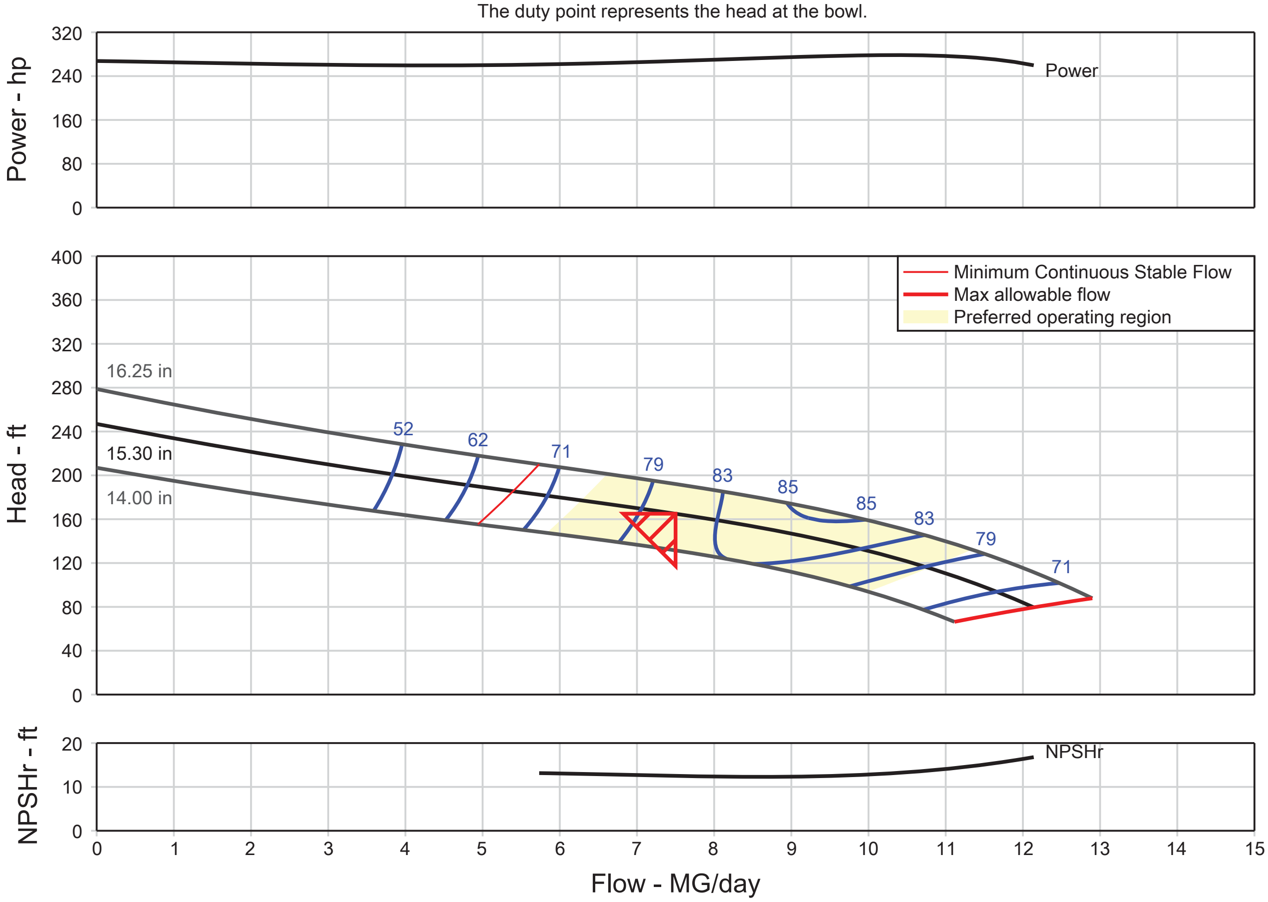
Pressure Data

Maximum working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 217 hp
Power (bowl / pump)	: 268 / - hp
Power, maximum, rated diameter	: 278 hp
Minimum recommended motor rating	: 300 hp / 224 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



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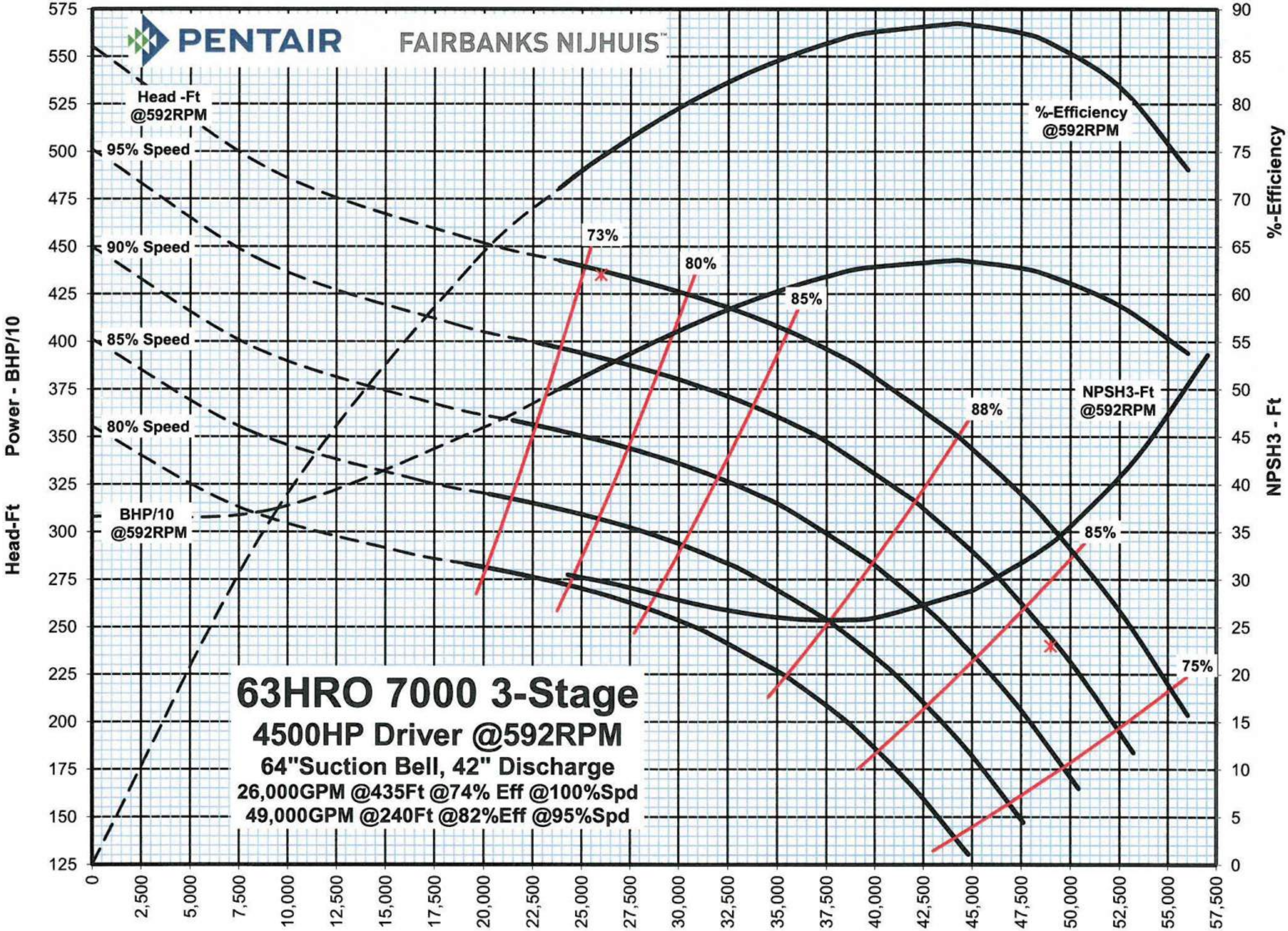
PS-1 Set B Alt A



A. Sdano - PE

63HRO W160175.xlsx, Printed 8/2/2016

PENTAIR

Customer :
Project name : **PS-1 Set B Alt B**

Pump Performance Datasheet

Encompass 2.0 - 17.4.2.0

Item number	: Default	Size	: 44A-BRZ
Service	:	Stages	: 2
Quantity	: 1	Based on curve number	: 44_TURB_3670_0720_BR Rev 130808
Quote number	:	Date last saved	: 11 Oct 2017 4:19 PM

Operating Conditions

Flow, rated	: 26,041.7 USgpm
Differential head / pressure, rated (requested)	: 174.0 ft
Differential head / pressure, rated (actual)	: 174.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 705 rpm
Impeller diameter, rated	: 31.74 in
Impeller diameter, maximum	: 32.74 in
Impeller diameter, minimum	: 27.62 in
Efficiency (bowl / pump)	: 87.39 / 85.38 %
NPSH required / margin required	: 35.08 / 0.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 70 / 152 Metric units
Minimum Continuous Stable Flow	: 14,320.9 USgpm
Head, maximum, rated diameter	: 309.9 ft
Head rise to shutoff (bowl / pump)	: 78.09 / 82.03 %
Flow, best eff. point (bowl / pump)	: 24,611.1 / 24,220.6 USgpm
Flow ratio, rated / BEP (bowl / pump)	: 105.81 / 107.52 %
Diameter ratio (rated / max)	: 96.95 %
Head ratio (rated dia / max dia)	: 91.94 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Near miss

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast iron bowl - Standard impeller material

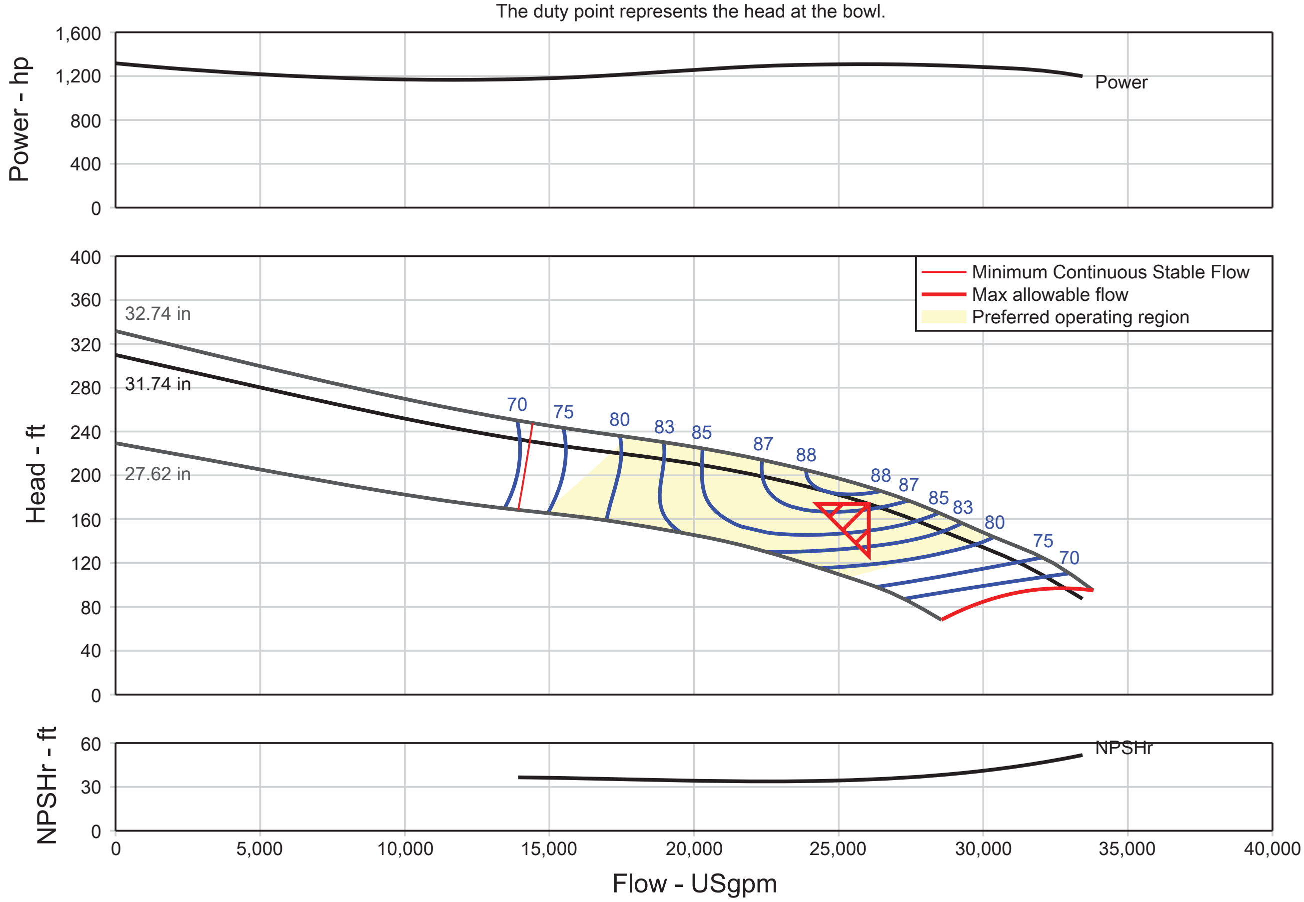
Pressure Data

Maximum working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 1,144 hp
Power (bowl / pump)	: 1,309 / 1,311 hp
Power, maximum, rated diameter	: 1,318 hp
Minimum recommended motor rating	: 1,500 hp / 1,119 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



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PENTAIR

Customer : **PS-2 Set A**
Project name :

Pump Performance Datasheet

Encompass 2.0 - 17.4.2.0

Item number	: Default	Size	: 36G-BRZ
Service	:	Stages	: 2
Quantity	: 1	Based on curve number	: 36_TURB_4120_0900_BR Rev 130808
Quote number	:	Date last saved	: 20 Oct 2017 3:52 PM

Operating Conditions

Flow, rated	: 20.00 MG/day
Differential head / pressure, rated (requested)	: 266.0 ft
Differential head / pressure, rated (actual)	: 266.3 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 880 rpm
Impeller diameter, rated	: 27.32 in
Impeller diameter, maximum	: 27.72 in
Impeller diameter, minimum	: 24.74 in
Efficiency (bowl / pump)	: 71.62 / 70.53 %
NPSH required / margin required	: 29.69 / 0.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 75 / 202 Metric units
Minimum Continuous Stable Flow	: 18.15 MG/day
Head, maximum, rated diameter	: 335.3 ft
Head rise to shutoff (bowl / pump)	: 26.05 / 27.78 %
Flow, best eff. point (bowl / pump)	: 31.25 / 30.12 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 64.00 / 66.39 %
Diameter ratio (rated / max)	: 98.56 %
Head ratio (rated dia / max dia)	: 95.71 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Near miss

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast iron bowl - Standard impeller material

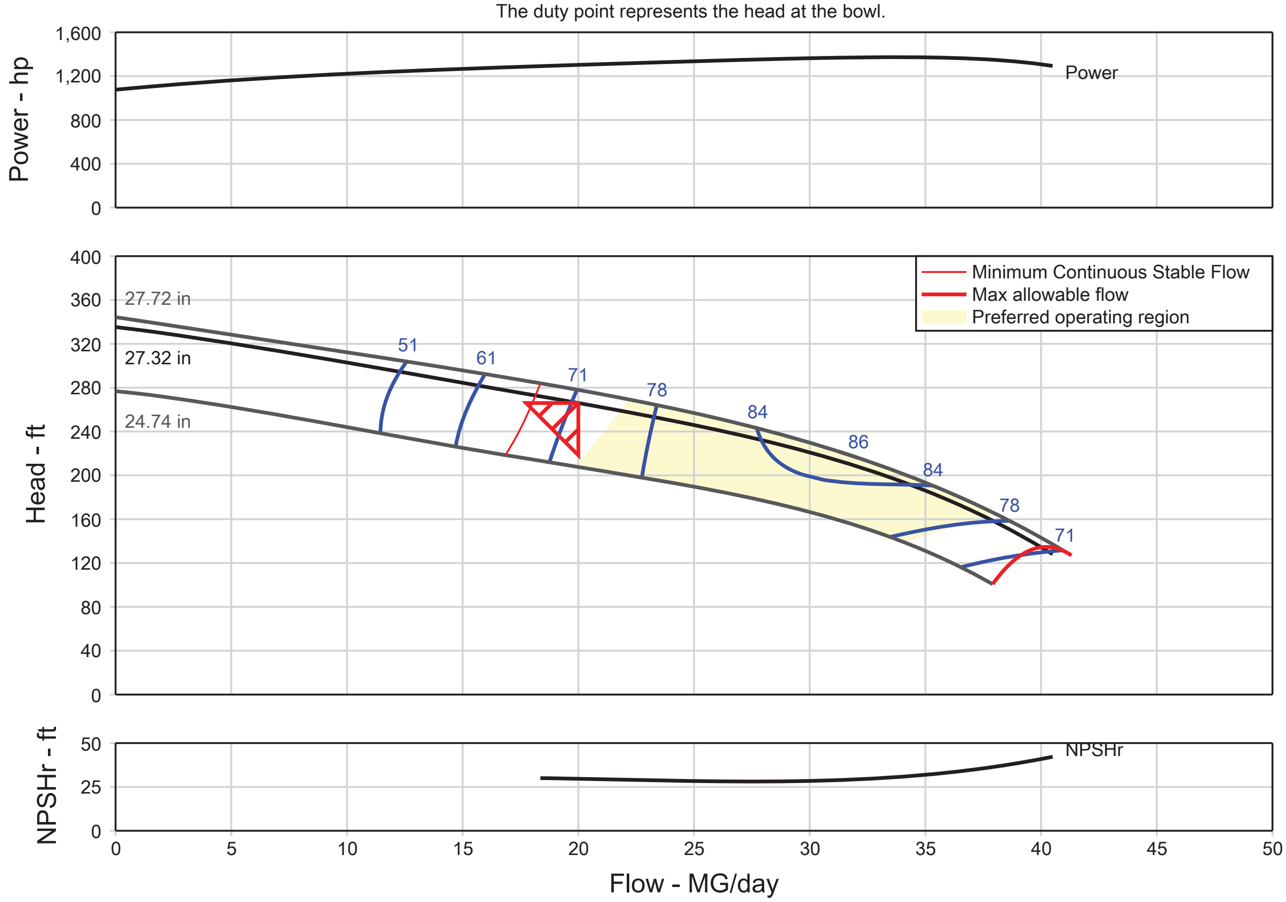
Pressure Data

Maximum working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 933 hp
Power (bowl / pump)	: 1,302 / 1,304 hp
Power, maximum, rated diameter	: 1,375 hp
Minimum recommended motor rating	: 1,500 hp / 1,119 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



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Customer :	PS-2 Set B
Project name :	

Pump Performance Datasheet

Encompass 2.0 - 17.4.2.0

Item number	: Default	Size	: 44B-BRZ
Service	:	Stages	: 2
Quantity	: 1	Based on curve number	: 44_TURB_3750_0720_BR Rev 140317
Quote number	:	Date last saved	: 19 Oct 2017 4:06 PM

Operating Conditions

Flow, rated	: 26.70 MG/day
Differential head / pressure, rated (requested)	: 235.0 ft
Differential head / pressure, rated (actual)	: 235.2 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 705 rpm
Impeller diameter, rated	: 31.87 in
Impeller diameter, maximum	: 31.94 in
Impeller diameter, minimum	: 28.78 in
Efficiency (bowl / pump)	: 77.66 / 76.62 %
NPSH required / margin required	: 28.64 / 0.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 71 / 183 Metric units
Minimum Continuous Stable Flow	: 21.58 MG/day
Head, maximum, rated diameter	: 319.9 ft
Head rise to shutoff (bowl / pump)	: 36.13 / 37.77 %
Flow, best eff. point (bowl / pump)	: 38.05 / 37.13 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 70.16 / 71.90 %
Diameter ratio (rated / max)	: 99.78 %
Head ratio (rated dia / max dia)	: 99.43 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Near miss

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast iron bowl - Standard impeller material

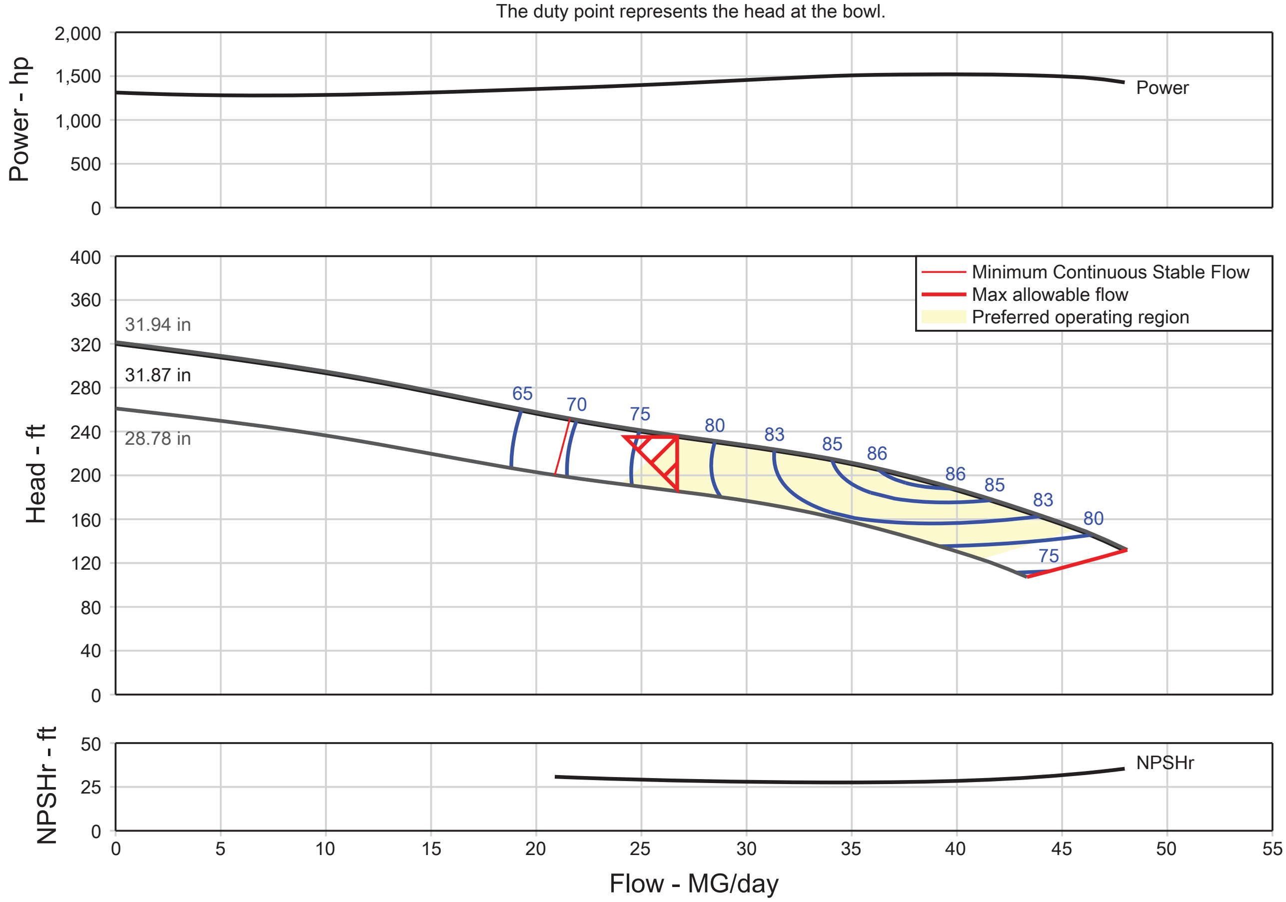
Pressure Data

Maximum working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 1,100 hp
Power (bowl / pump)	: 1,417 / 1,419 hp
Power, maximum, rated diameter	: 1,523 hp
Minimum recommended motor rating	: 1,750 hp / 1,305 kW

Bowl performance. Adjusted for construction and viscosity.
The duty point represents the head at the bowl.



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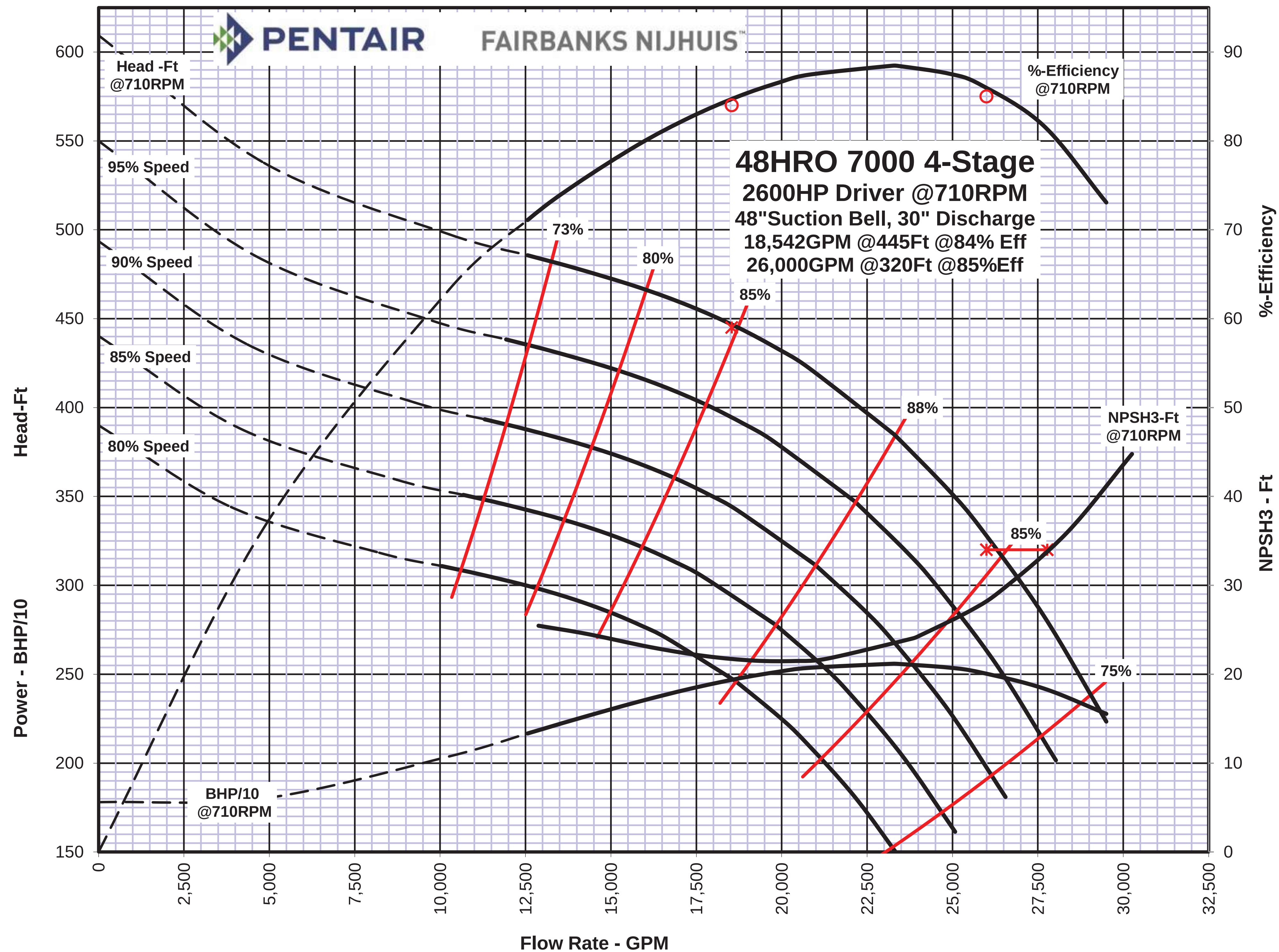
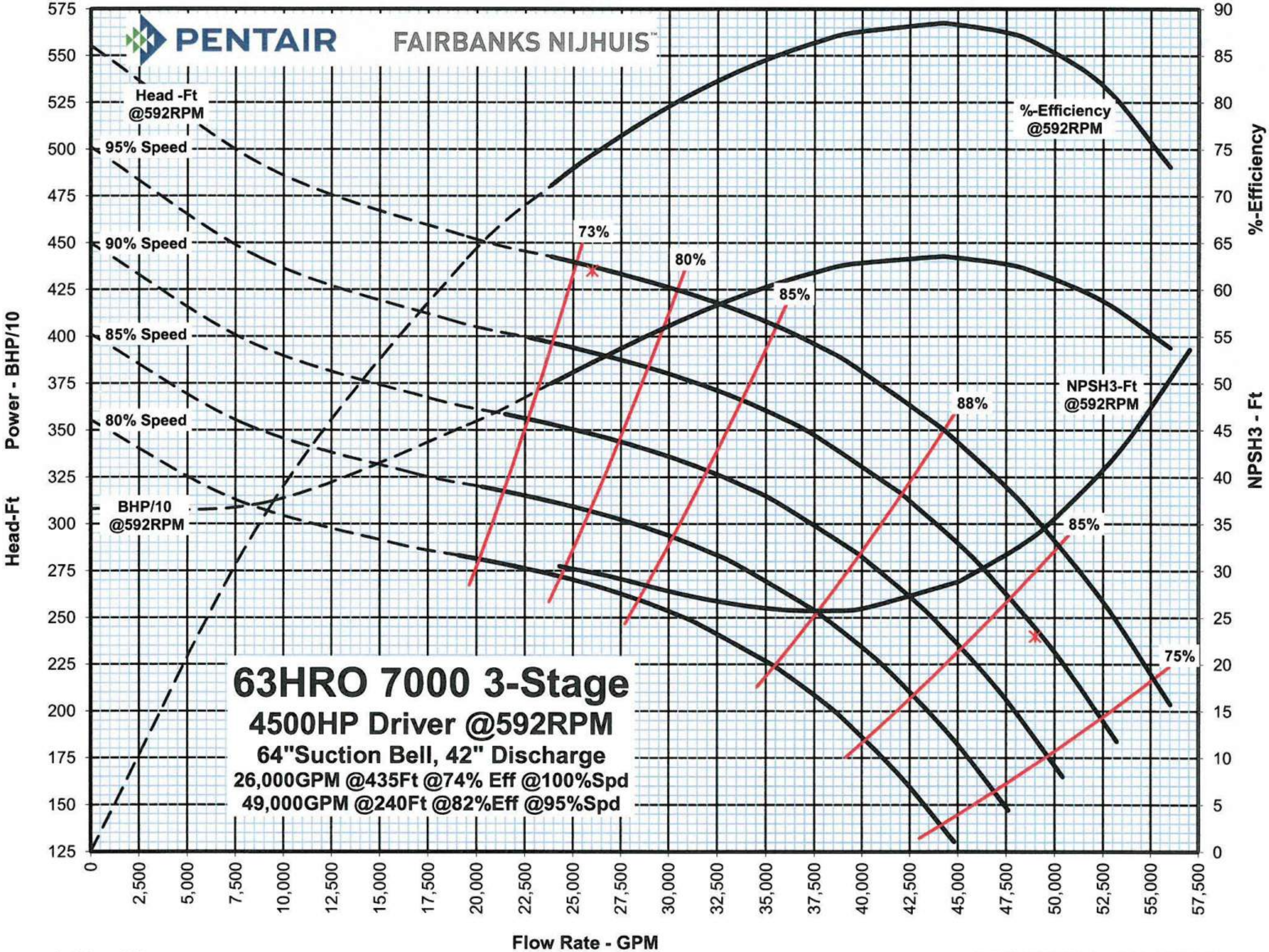
PS-3 Reduced Speed/Impeller for revised 397-ft head condition



A. Sdano - PE

48HRO MWD W160175.xlsx, Printed 7/11/2017

PS-1 and PS-3 Alt A-Backbone: same pump as PS-1 Set B Alt A, but reduce speed and impeller size



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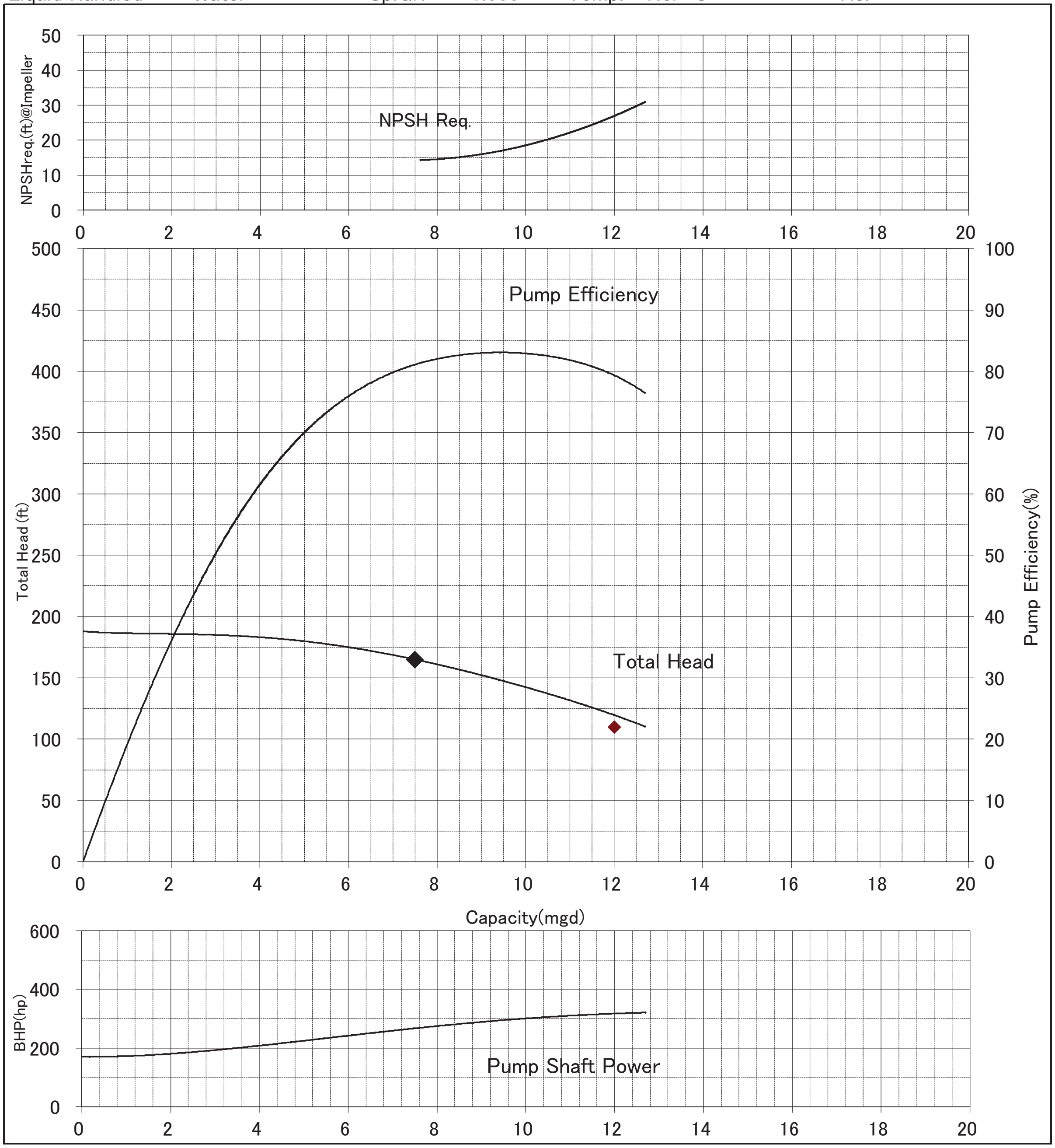
63HRO W160175.xlsx, Printed 8/2/2016

PUMP CHARACTERISTIC CURVE DATE: 7/7/2017

Item No.	PS-1 Set A	Doc.No.	PB7A5947010-001
Customer	CDM Smith / MWD	Service	WATER SUPPLY
EBARA Ser.No.	Proposal	Model	600X400VYBM

Specified Condition 7.5 mgd x 165 ft x 890 rpm x 350 hp

Liquid Handled Water Sp.Gr. 1.000 Temp. Nor ℃ Vis.



App'd by ES Check'd by Prep'd by Eiji Shibata

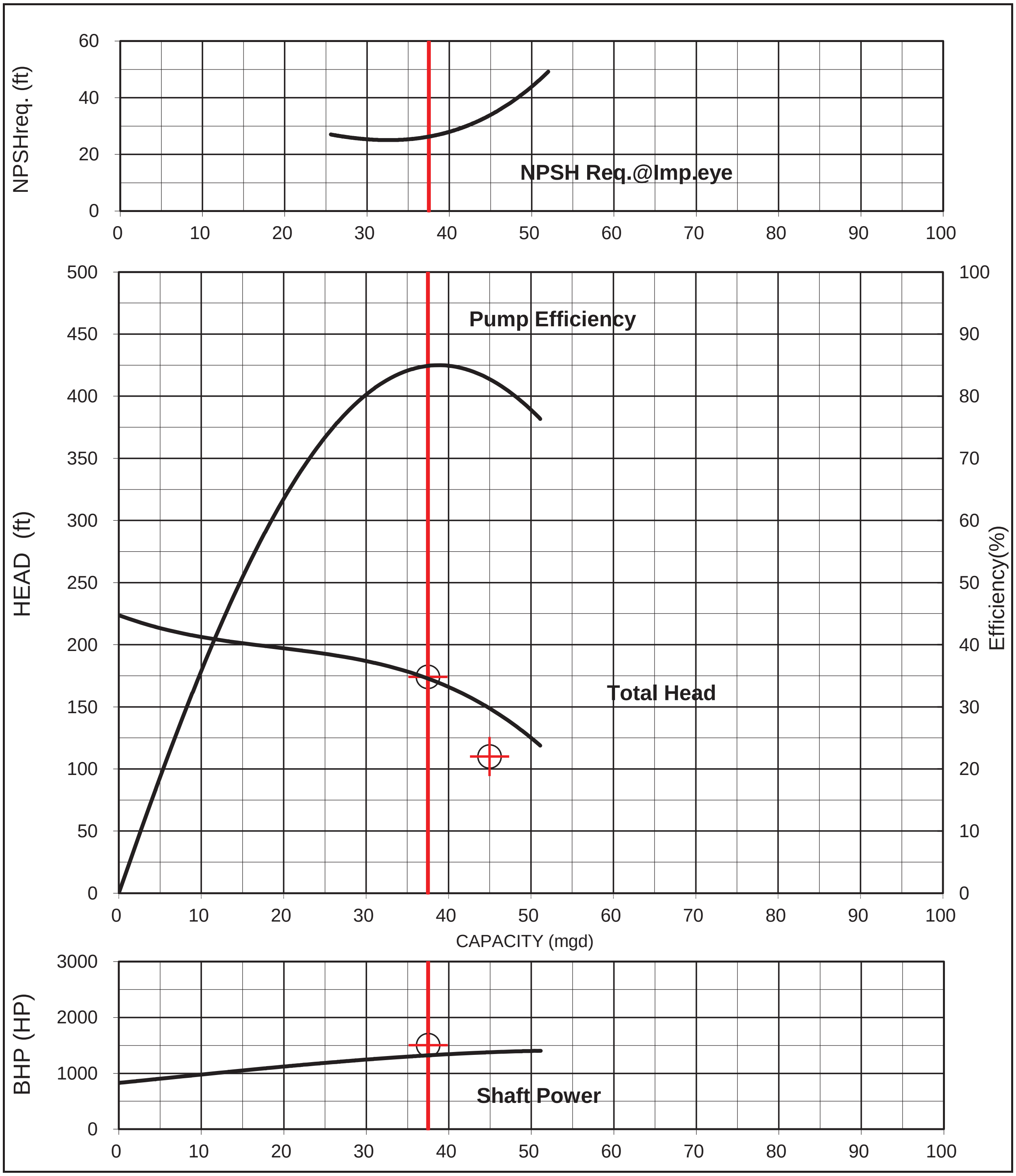
EBARA CORPORATION

PUMP CHARACTERISTIC CURVE **DATE: 2017/10/25**

Item No.	PS-1 Set B-Option 1	Doc.No. :	PB7A5947020-002		
Customer	CDM Smith / MWD	Service :	Water Supply		
Ser.No.	Proposal	Model :	1500X900VYBM	Qt'y :	5sets

Specified Condition	37.5 mgd x 174 ft x 710 min-1 x 1500 HP

Liquid Handled	Water	Sp.Gr.	1.000	Temp.	℃	Vis. -



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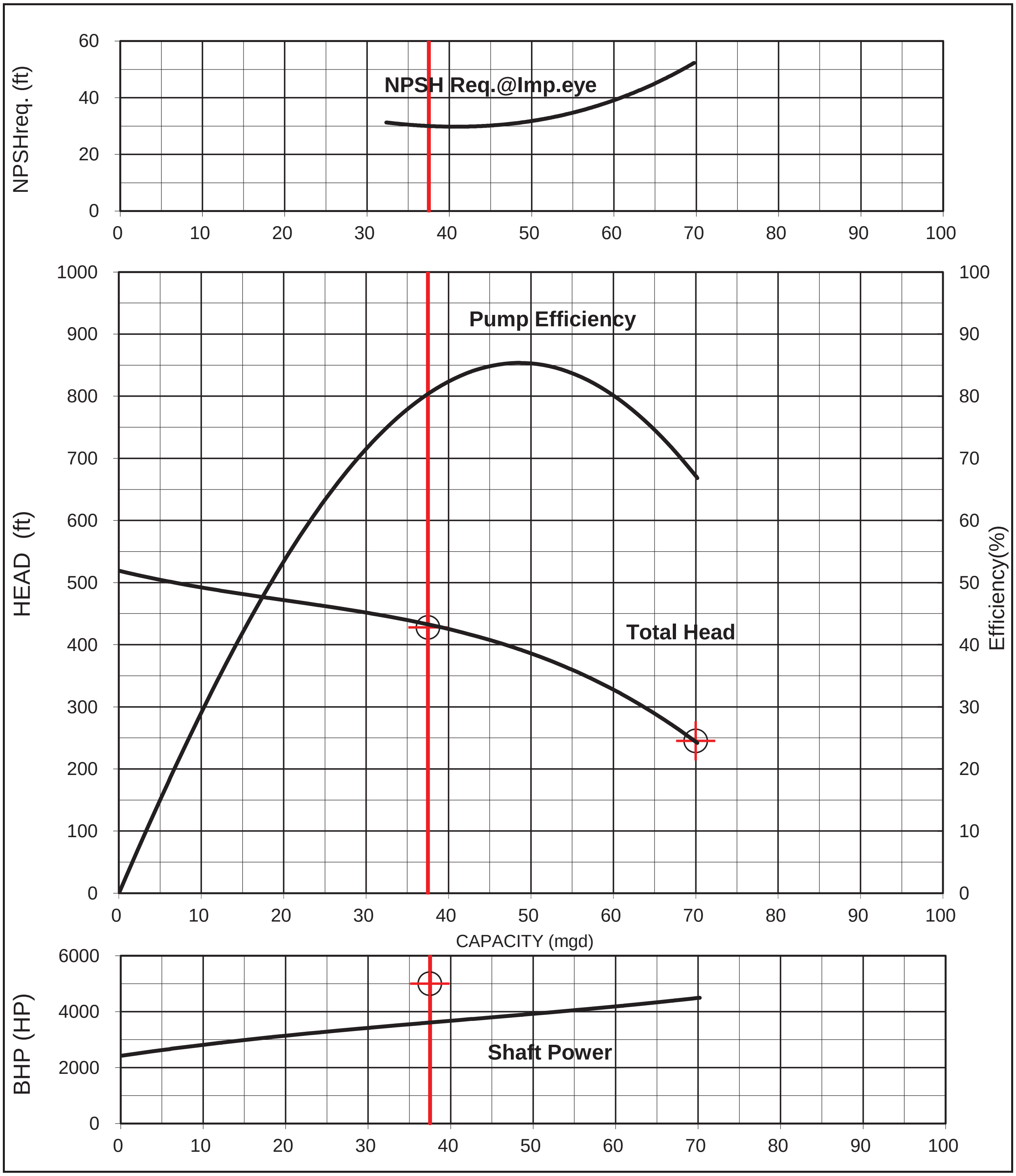
PUMP CHARACTERISTIC CURVE				DATE: 2017/10/25
Item No. PS-1 Set B-Option 2		Doc.No. : PB7A5947030-002		
Customer CDM Smith / MWD		Service : Water Supply		
Ser.No.	Proposal	Model : 1500X1000VYB2M	Qt'y :	5sets
Specified Condition	37.5 mgd x 428 ft x 710 min-1 x 5000 HP			
Liquid Handled	Water	Sp.Gr. 1.000	Temp. ℃	Vis. -



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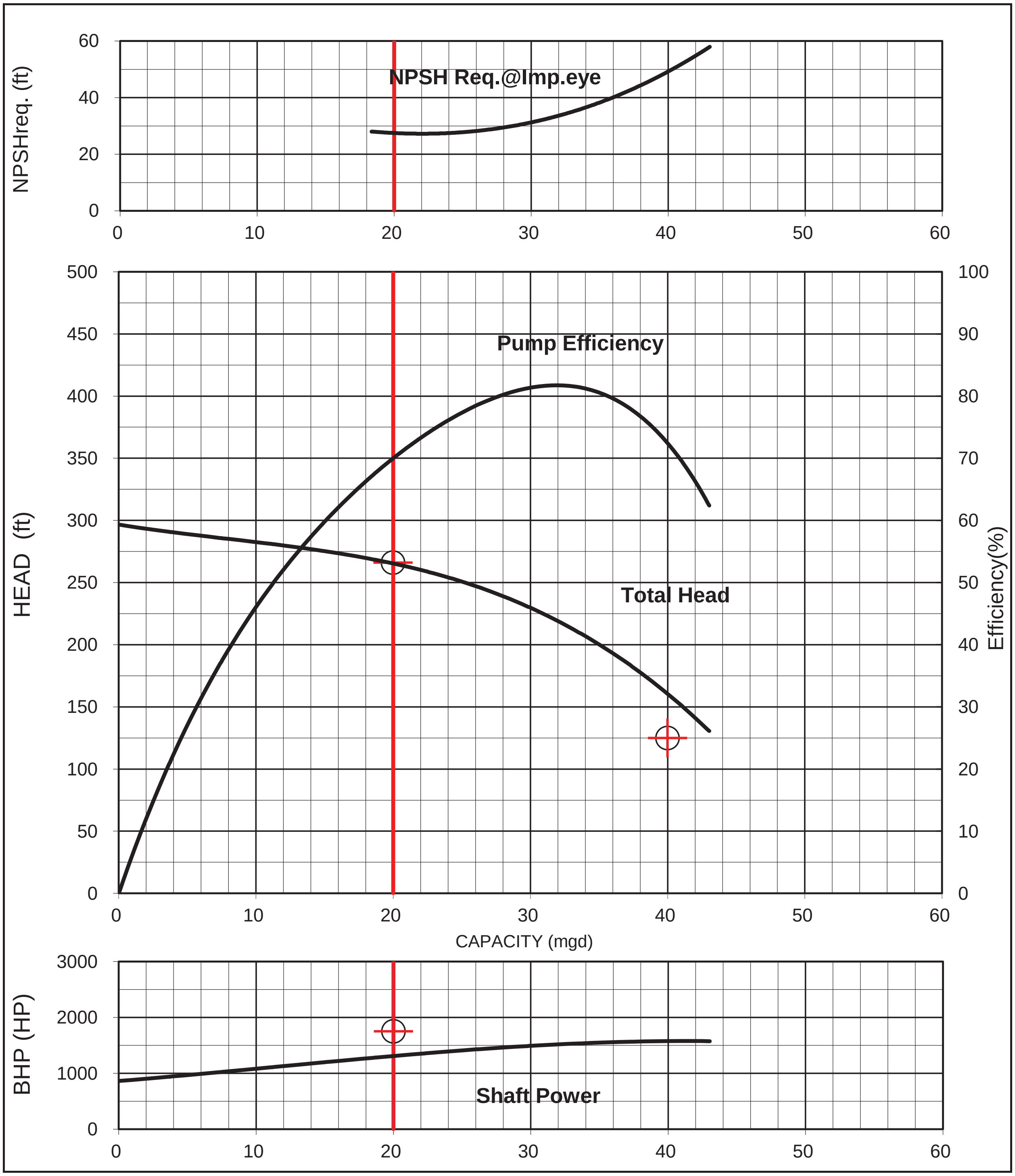
EBARA CORPORATION

PUMP CHARACTERISTIC CURVE				DATE: 2017/10/25
Item No. PS-2 Set A		Doc.No. : PB7A5947040-002		
Customer CDM Smith / MWD		Service : Water Supply		
Ser.No.	Proposal	Model : 1000X800VYBM	Qt'y :	4sets
Specified Condition	20 mgd x 266 ft x 890 min-1 x 1750 HP			
Liquid Handled	Water Sp.Gr. 1.000	Temp. ℃	Vis. -	



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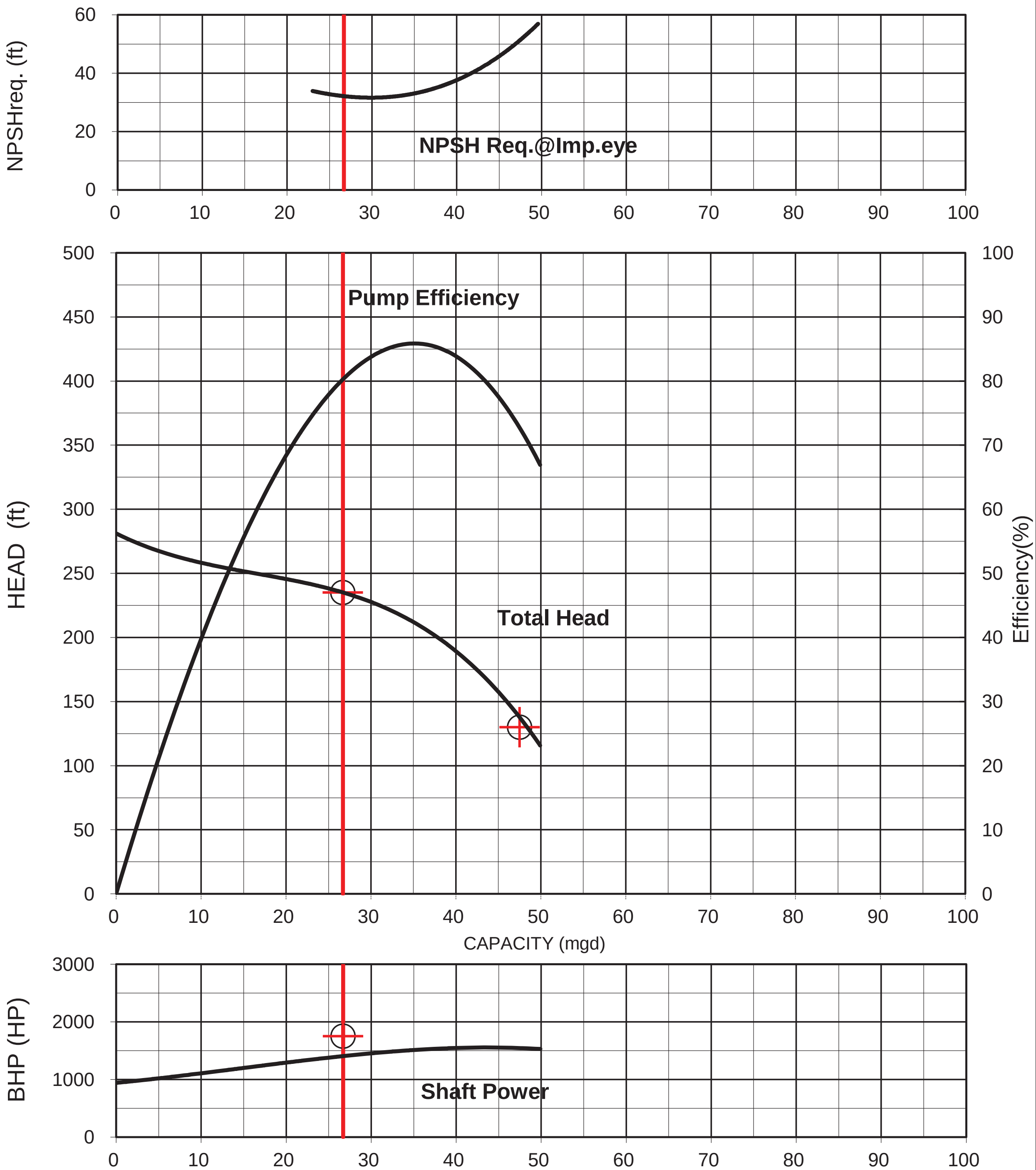
PUMP CHARACTERISTIC CURVE				**DATE: 2017/10/25**
Item No.	PS-2 Set B	Doc.No. :	PB7A5947050-002	
Customer	CDM Smith / MWD	Service :	Water Supply	
Ser.No.	Proposal	Model :	1200X900VYBM	Qt'y : 4sets
Specified Condition	26.7 mgd x 235 ft x 890 min-1 x 1750 HP			
Liquid Handled	Water	Sp.Gr. 1.000	Temp. ℃	Vis. -



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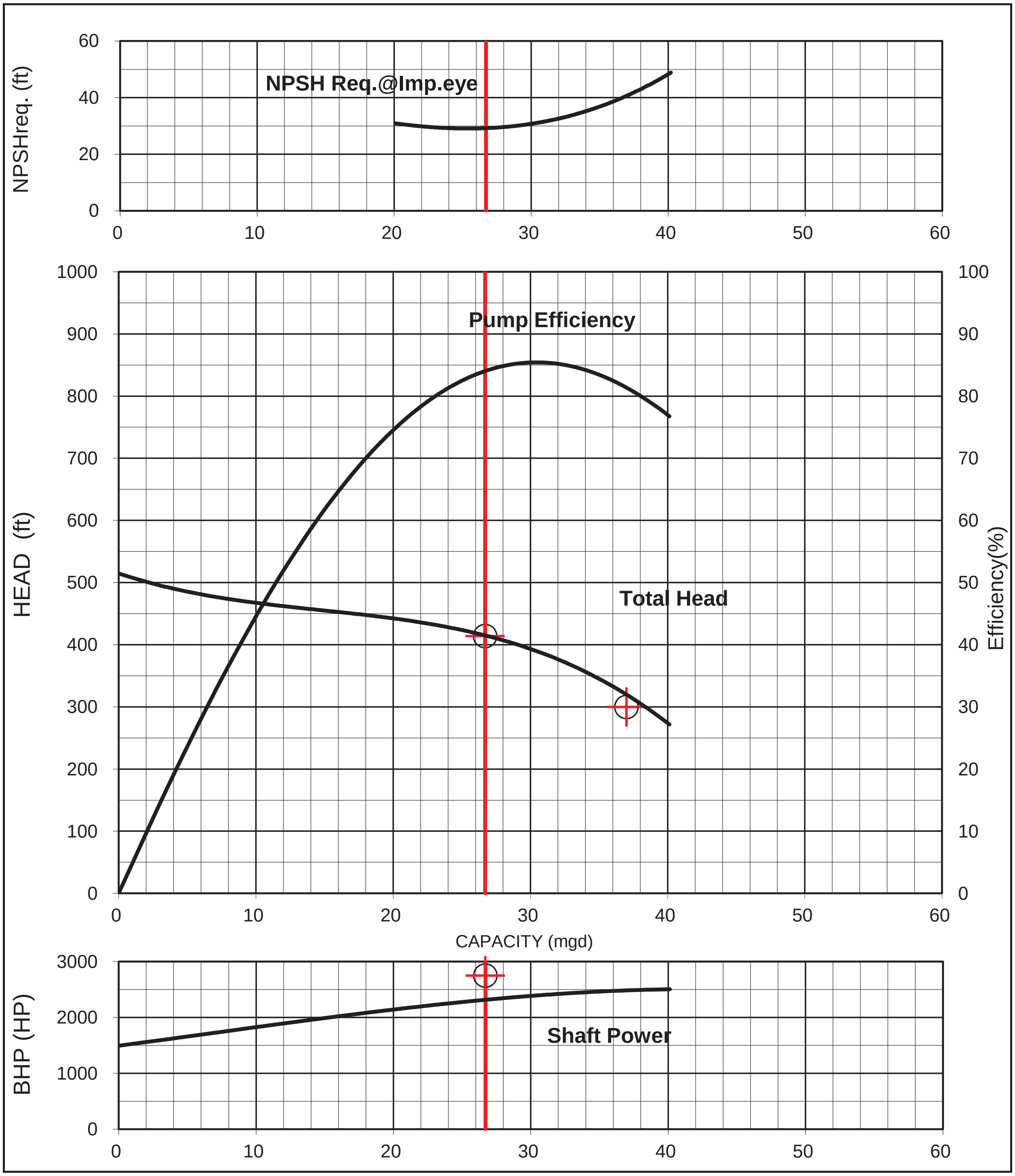
PUMP CHARACTERISTIC CURVE				DATE: 2017/10/25
Item No. PS-3		Doc.No. : PB7A5947060-002		
Customer CDM Smith / MWD		Service : Water Supply		
Ser.No.	Proposal	Model : 1200X800VYB2M	Qt'y :	4sets
Specified Condition	26.7 mgd x 414 ft x 890 min-1 x 2750 HP			
Liquid Handled	Water	Sp.Gr. 1.000	Temp. ℃	Vis. -



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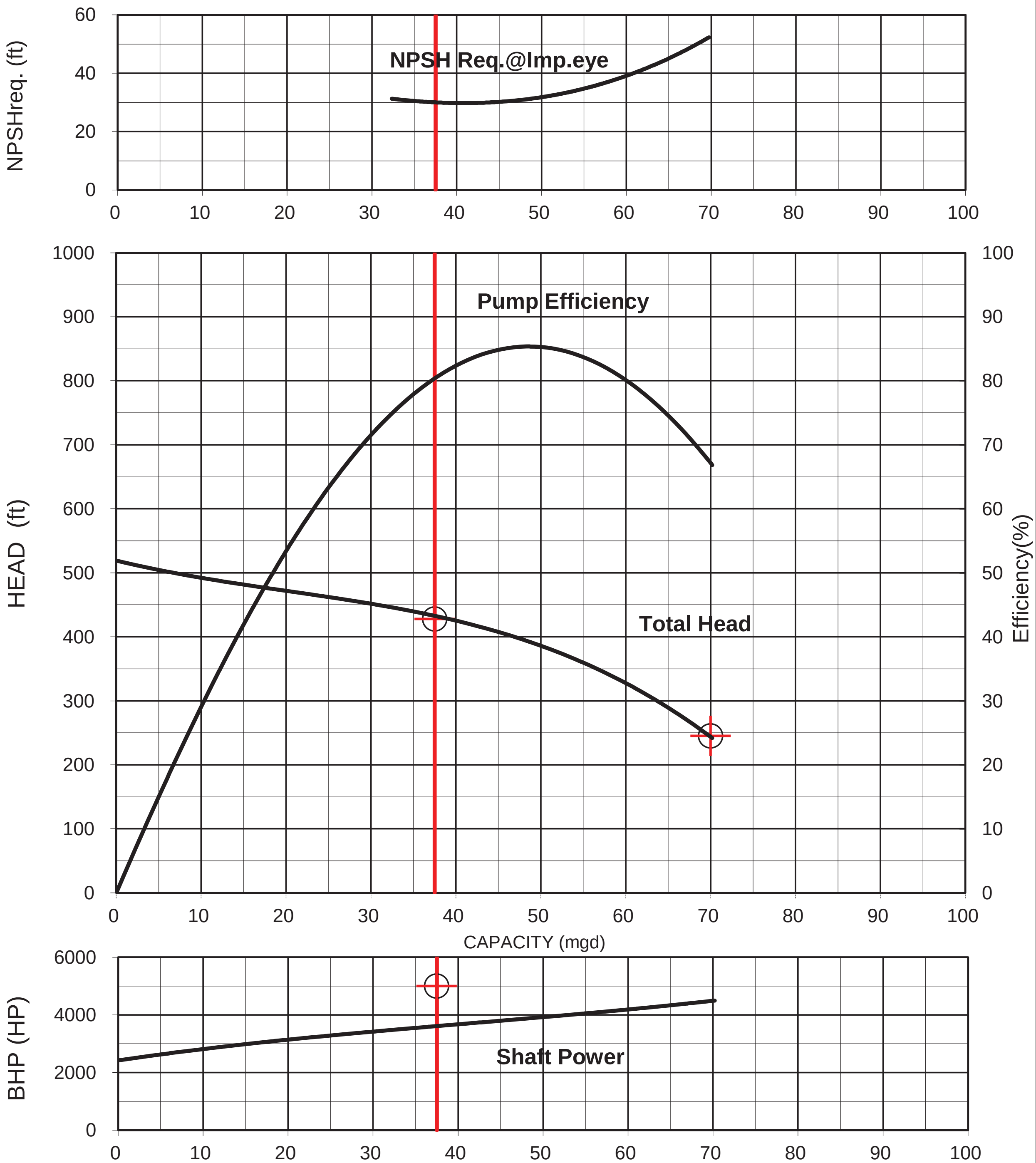
Reduced Speed/Impeller for revised 397-ft head condition

PS-1 and PS-3 Alt A-Backbone: same pump as PS-1 Set B Alt A, but reduce speed and impeller size

PUMP CHARACTERISTIC CURVE

DATE:

Item No.	PS-1 Set B Alternative A-Backbone	:	PB7A5947030-002		
Customer	CDM Smith / MWD	Service :	Water Supply		
Ser.No.	Proposal	Model :	1500X1000VYB2M	Qt'y :	5sets
Specified Condition	37.5 mgd x 352 ft x 710 min-1 x 5000 HP				
Liquid Handled	Water	Sp.Gr. 1.000	Temp. ℃	Vis. -	



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SULZER

Pump Performance Datasheet

Customer	: CDM Smith	Sulzer Reference ID	: USA.7574-NWW.17.0254-P0
Inquiry Number/ID	:	Type / Size	: SJT-28GMC
Item number	: 10-23 PS-1 Set A (New)	Stages	: 2
Service	: Reclained Water	Based on curve number	: SJT-848.000-63-11-00 Rev SJT-28GMC
Quantity	: 4	Date of Last Update	: 23 Oct 2017 8:57 PM

Operating Conditions

Flow, rated	: 7.50 MG/day
Differential head / pressure, rated (requested)	: 165.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 885 rpm
Impeller diameter, rated	: 19.88 in
Impeller diameter, maximum	: 22.25 in
Impeller diameter, minimum	: 19.63 in
Efficiency (bowl / pump)	: 79.76 / 77.85 %
NPSH (3% head drop) / margin required	: 11.84 / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 48 / 177 Metric units
MCSF	: 2.40 MG/day
Head, maximum, rated diameter	: 211.1 ft
Head rise to shutoff (bowl / pump)	: 24.19 / 26.89 %
Flow, best eff. point (bowl / pump)	: 9.49 / 9.04 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 79.06 / 83.00 %
Diameter ratio (rated / max)	: 89.36 %
Head ratio (rated dia / max dia)	: 75.44 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast Iron Bowl, AL. Bronze Impeller

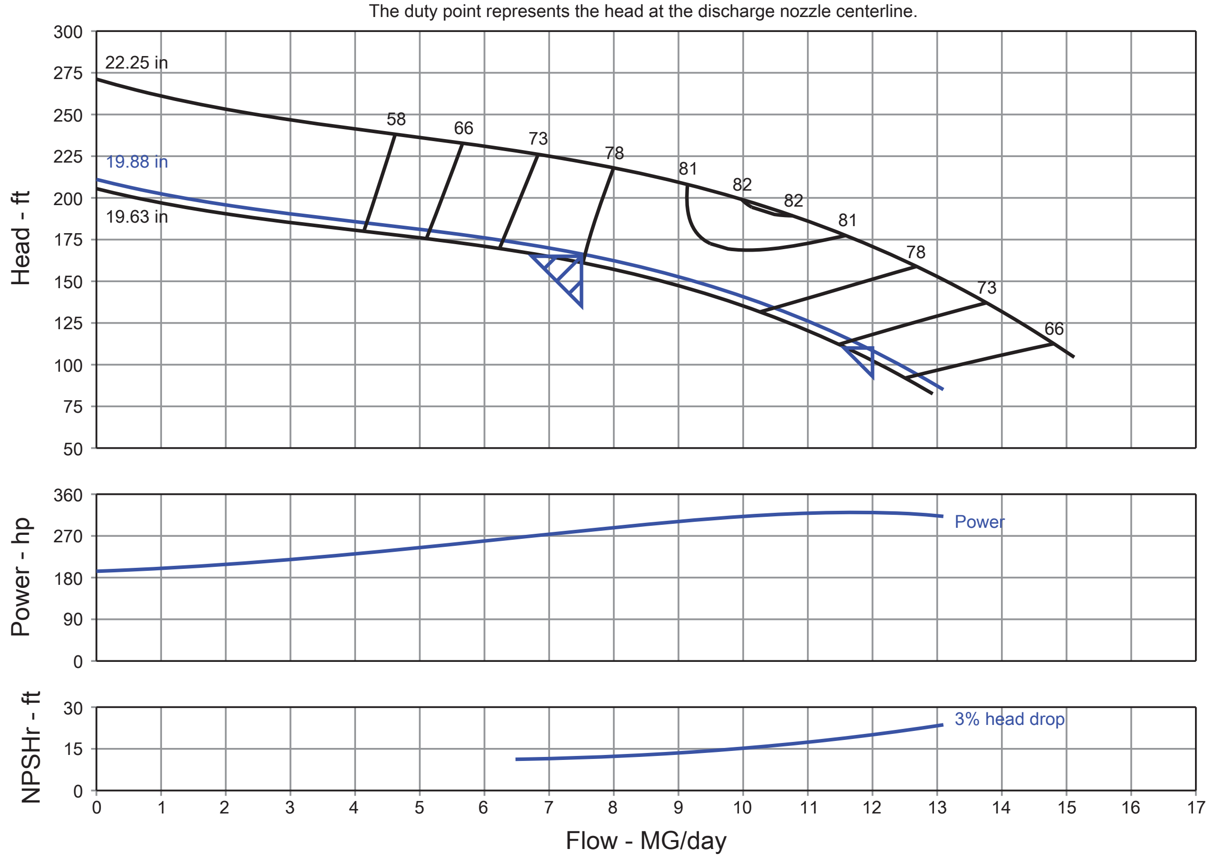
Pressure Data

Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 223 hp
Power (bowl / pump)	: 280 / 281 hp
Power, maximum, rated diameter	: 321 hp
Minimum recommended motor rating	: 350 hp / 261 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift. The duty point represents the head at the discharge nozzle centerline.



Pump Performance Datasheet

Customer	: MWD Recycled Water	Sulzer Reference ID	:
Inquiry Number/ID	: PS-1 Set B - Alt A	Type / Size	: SJT-56TMC
Item number	: Default	Stages	: 4
Service	: Recycled Water	Based on curve number	: SJT-873.001-66-21-00 Rev SJT-56TMC
Quantity	: 1	Date of Last Update	: 10/26/2017 7:39 PM

Operating Conditions

Flow, rated	: 37.50 MG/day
Differential head / pressure, rated (requested)	: 428.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 595 rpm
Impeller diameter, rated	: 37.44 in
Impeller diameter, maximum	: 38.78 in
Impeller diameter, minimum	: 35.65 in
Efficiency (bowl / pump)	: 74.76 / 74.42 %
NPSH (3% head drop) / margin required	: - / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 76 / 234 Metric units
MCSF	: 13.54 MG/day
Head, maximum, rated diameter	: 593.2 ft
Head rise to shutoff (bowl / pump)	: 37.60 / 38.02 %
Flow, best eff. point (bowl / pump)	: 57.02 / 56.48 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 65.77 / 66.39 %
Diameter ratio (rated / max)	: 96.56 %
Head ratio (rated dia / max dia)	: 90.69 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Near miss

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast Steel Bowl, AL. Bronze Impeller

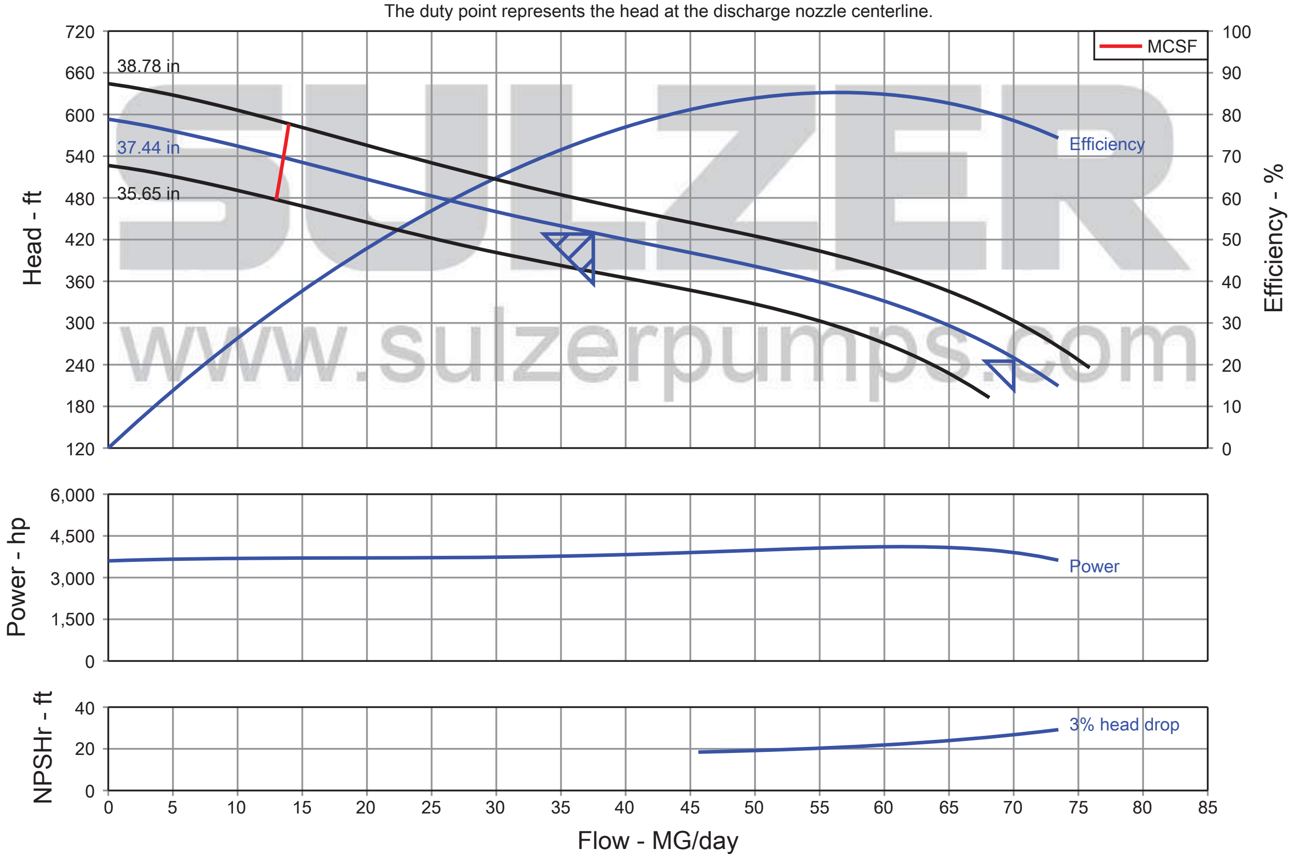
Pressure Data

Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 2,834 hp
Power (bowl / pump)	: 3,791 / 3,797 hp
Power, maximum, rated diameter	: 4,112 hp
Minimum recommended motor rating	: 4,000 hp / 2,983 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift.
The duty point represents the head at the discharge nozzle centerline.



SULZER

Pump Performance Datasheet

Customer	: CDM Smith	Sulzer Reference ID	: USA.7574-NWW.17.0254-P0
Inquiry Number/ID	:	Type / Size	: SJT-38KMC
Item number	: 10-23 PS-1 Set B Alt B	Stages	: 3
Service	: Reclaimed Water	Based on curve number	: SJT-897.000-64-21-00 Rev SJT-38KMC
Quantity	: 4	Date of Last Update	: 23 Oct 2017 8:59 PM

Operating Conditions

Flow, rated	: 37.50 MG/day
Differential head / pressure, rated (requested)	: 174.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 705 rpm
Impeller diameter, rated	: 29.72 in
Impeller diameter, maximum	: 30.00 in
Impeller diameter, minimum	: 27.00 in
Efficiency (bowl / pump)	: 89.10 / 87.96 %
NPSH (3% head drop) / margin required	: 18.89 / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 99 / 243 Metric units
MCSF	: 9.39 MG/day
Head, maximum, rated diameter	: 392.3 ft
Head rise to shutoff (bowl / pump)	: 119.87 / 122.37 %
Flow, best eff. point (bowl / pump)	: 36.96 / 36.70 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 101.47 / 102.19 %
Diameter ratio (rated / max)	: 99.08 %
Head ratio (rated dia / max dia)	: 96.00 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast Iron Bowl, AL. Bronze Impeller

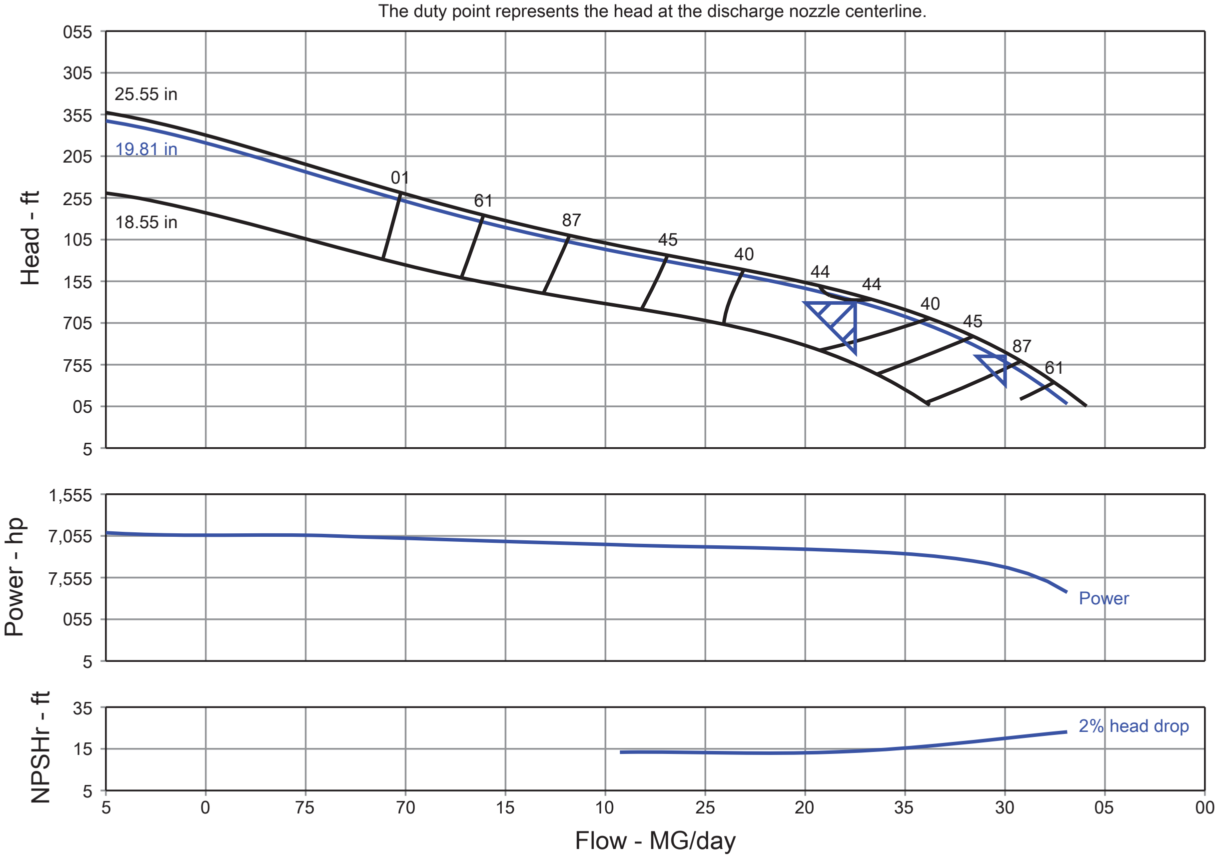
Pressure Data

Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 1,173 hp
Power (bowl / pump)	: 1,317 / 1,319 hp
Power, maximum, rated diameter	: 1,538 hp
Minimum recommended motor rating	: 1,750 hp / 1,305 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift.
The duty point represents the head at the discharge nozzle centerline.



Pump Performance Datasheet

Customer	: CDM Smith	Sulzer Reference ID	: USA.7574-NWW.17.0254-P0
Inquiry Number/ID	:	Type / Size	: SJT-BKn 680/022
Item number	: 10-23 PS-2 Set A	Stages	: 2
Service	: Reclaimed Water	Based on curve number	: SJT-068.022-64-11-00 Rev SJT BKN680-022
Quantity	: 4	Date of Last Update	: 23 Oct 2017 8:44 PM

Operating Conditions

Flow, rated	: 20.00 MG/day
Differential head / pressure, rated (requested)	: 266.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 880 rpm
Impeller diameter, rated	: 28.58 in
Impeller diameter, maximum	: 29.59 in
Impeller diameter, minimum	: 26.04 in
Efficiency (bowl / pump)	: 73.81 / 73.43 %
NPSH (3% head drop) / margin required	: 25.51 / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 86 / 177 Metric units
MCSF	: -
Head, maximum, rated diameter	: 366.3 ft
Head rise to shutoff (bowl / pump)	: 36.04 / 36.70 %
Flow, best eff. point (bowl / pump)	: 32.16 / 31.44 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 62.19 / 63.61 %
Diameter ratio (rated / max)	: 96.61 %
Head ratio (rated dia / max dia)	: 88.22 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast Iron Bowl, AL. Bronze Impeller

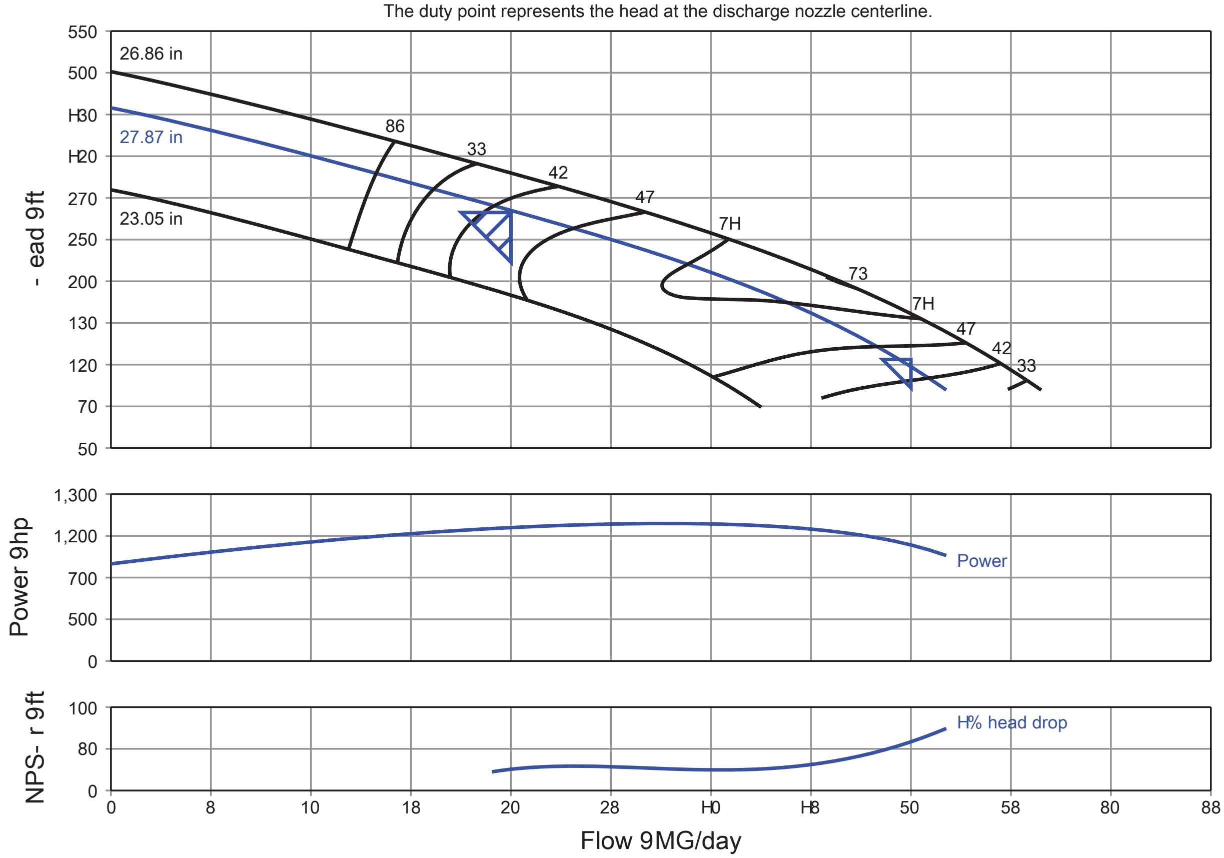
Pressure Data

Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 944 hp
Power (bowl / pump)	: 1,279 / 1,280 hp
Power, maximum, rated diameter	: 1,319 hp
Minimum recommended motor rating	: 1,500 hp / 1,119 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift.
The duty point represents the head at the discharge nozzle centerline.



Pump Performance Datasheet

Customer	: CDM Smith	Sulzer Reference ID	: USA.7574-NWW.17.0254-P0
Inquiry Number/ID	:	Type / Size	: SJT-BKn 840/022
Item number	: 10-23 PS-2 Set B	Stages	: 2
Service	: Reclaimed Water	Based on curve number	: SJT-068.021-65-11-00 Rev SJT BKN840-022
Quantity	: 4	Date of Last Update	: 23 Oct 2017 8:50 PM

Operating Conditions

Flow, rated	: 26.70 MG/day
Differential head / pressure, rated (requested)	: 235.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 705 rpm
Impeller diameter, rated	: 33.86 in
Impeller diameter, maximum	: 35.70 in
Impeller diameter, minimum	: 31.42 in
Efficiency (bowl / pump)	: 74.53 / 73.83 %
NPSH (3% head drop) / margin required	: - / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 86 / 177 Metric units
MCSF	: -
Head, maximum, rated diameter	: 324.3 ft
Head rise to shutoff (bowl / pump)	: 35.81 / 37.08 %
Flow, best eff. point (bowl / pump)	: 42.10 / 40.30 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 63.42 / 66.25 %
Diameter ratio (rated / max)	: 94.83 %
Head ratio (rated dia / max dia)	: 80.46 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast Iron Bowl, AL. Bronze Impeller

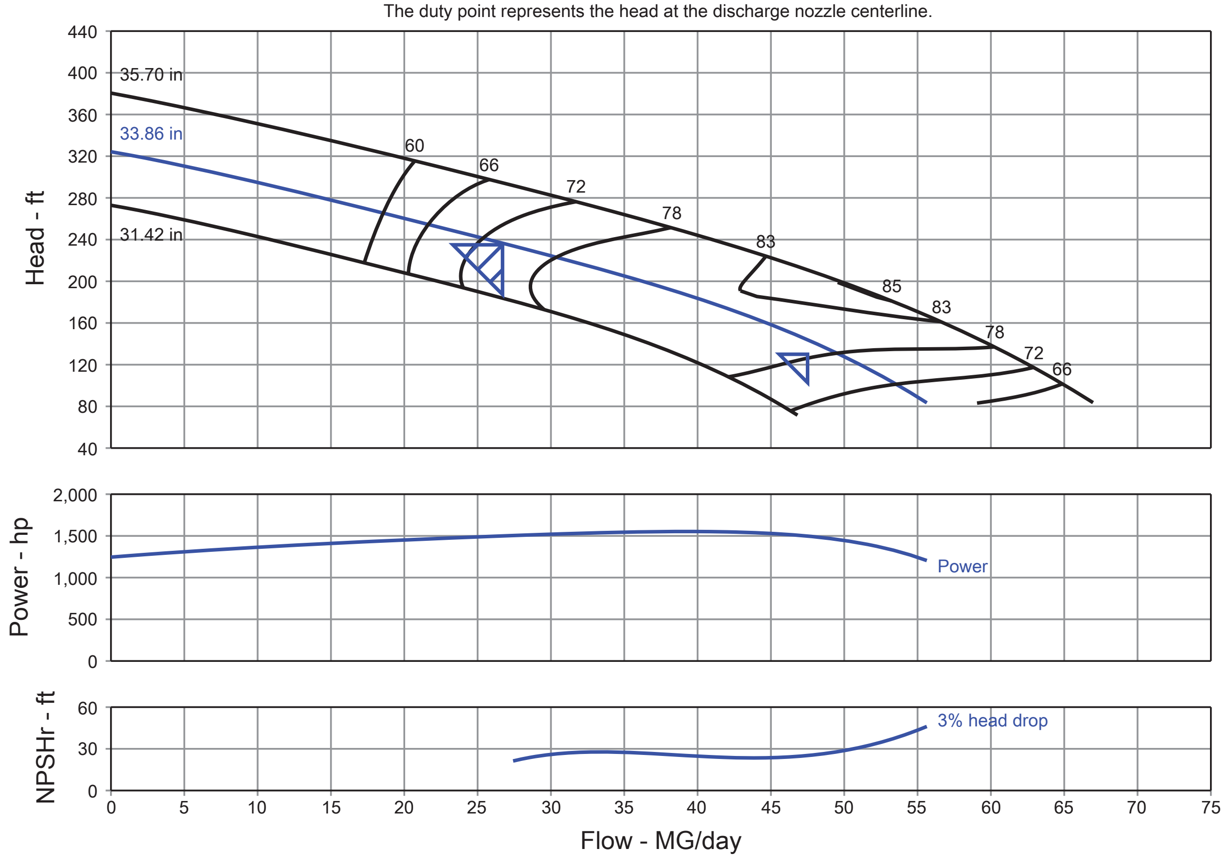
Pressure Data

Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Maximum power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 1,118 hp
Power (bowl / pump)	: 1,499 / 1,500 hp
Power, maximum, rated diameter	: 1,553 hp
Minimum recommended motor rating	: 1,750 hp / 1,305 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift.
The duty point represents the head at the discharge nozzle centerline.



Pump Performance Datasheet

Customer	: MWD Recycled Water	Sulzer Reference ID	:
Inquiry Number/ID	: PS-3	Type / Size	: SJT-42CLC
Item number	: Default	Stages	: 4
Service	: Recycled Water	Based on curve number	: SJT-867.001-64-11-00 Rev SJT-42CLC
Quantity	: 1	Date of Last Update	: 10/26/2017 8:26 PM

Operating Conditions	
Flow, rated	: 26.70 MG/day
Differential head / pressure, rated (requested)	: 414.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance	
Speed, rated	: 705 rpm
Impeller diameter, rated	: 31.73 in
Impeller diameter, maximum	: 34.00 in
Impeller diameter, minimum	: 29.50 in
Efficiency (bowl / pump)	: 77.66 / 77.08 %
NPSH (3% head drop) / margin required	: 20.50 / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 68 / 182 Metric units
MCSF	: 9.10 MG/day
Head, maximum, rated diameter	: 622.4 ft
Head rise to shutoff (bowl / pump)	: 48.93 / 49.79 %
Flow, best eff. point (bowl / pump)	: 36.01 / 35.40 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 74.14 / 75.42 %
Diameter ratio (rated / max)	: 93.33 %
Head ratio (rated dia / max dia)	: 82.16 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

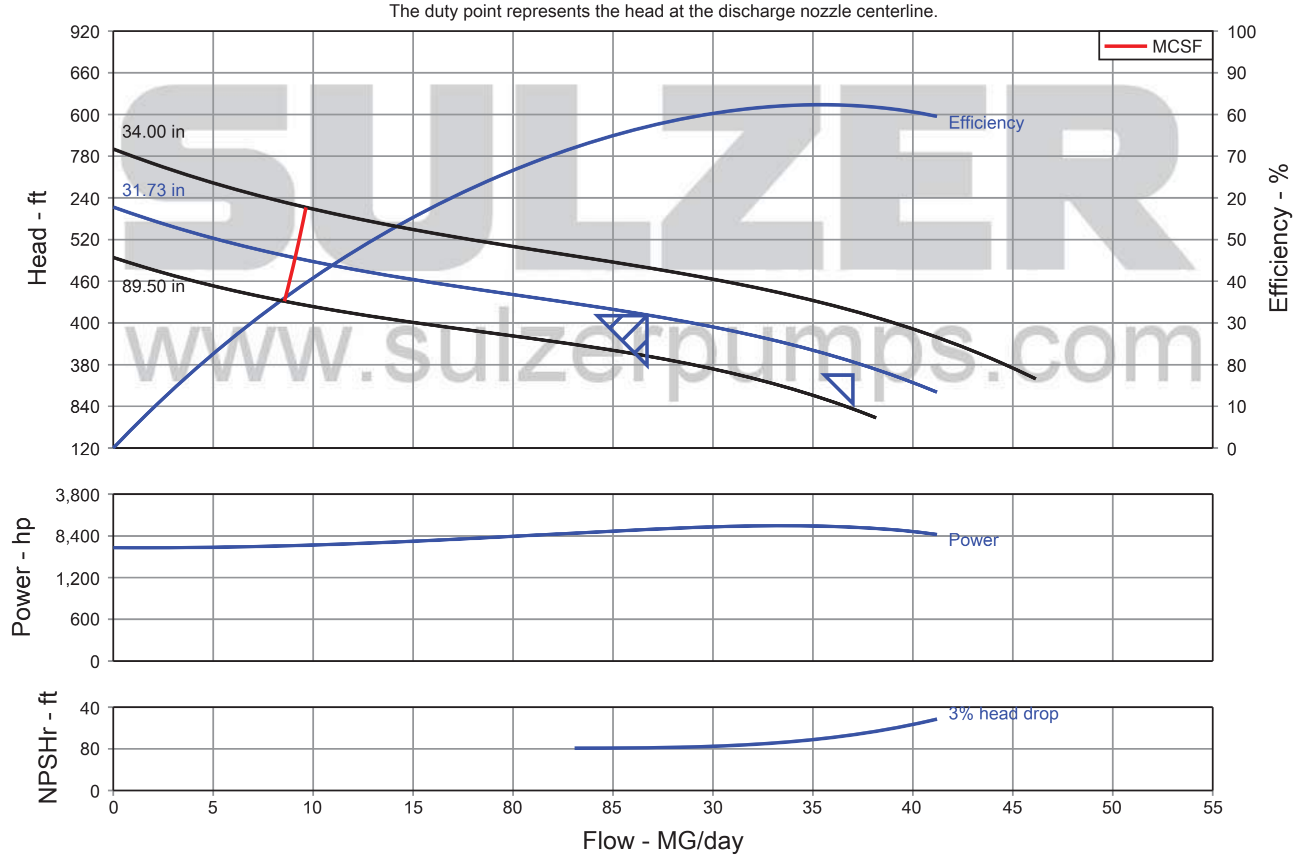
Liquid	
Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material	
Material selected	: Cast Iron Bowl, AL. Bronze Impeller

Pressure Data	
Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)	
Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 1,956 hp
Power (bowl / pump)	: 2,519 / 2,523 hp
Power, maximum, rated diameter	: 2,595 hp
Minimum recommended motor rating	: 2,750 hp / 2,051 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift.
The duty point represents the head at the discharge nozzle centerline.



Reduced Speed/Impeller for revised 397-ft head condition

PS-1 and PS-3 Alt A-Backbone: same pump as PS-1 Set B Alt A, but reduce speed and impeller size

SULZER

Pump Performance Datasheet

Customer	: MWD Recycled Water
Inquiry Number/ID	: PS-1 Set B - Alt A-Backbone
Item number	: Default
Service	: Recycled Water
Quantity	: 1

Sulzer Reference ID	:
Type / Size	: SJT-56TMC
Stages	: 4
Based on curve number	: SJT-873.001-66-21-00 Rev SJT-56TMC
Date of Last Update	: 10/26/2017 7:39 PM

Operating Conditions

Flow, rated	: 37.50 MG/day
Differential head / pressure, rated (requested)	: 352.0 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 595 rpm
Impeller diameter, rated	: 37.44 in
Impeller diameter, maximum	: 38.78 in
Impeller diameter, minimum	: 35.65 in
Efficiency (bowl / pump)	: 74.76 / 74.42 %
NPSH (3% head drop) / margin required	: - / 2.00 ft
nq (imp. eye flow) / S (imp. eye flow)	: 76 / 234 Metric units
MCSF	: 13.54 MG/day
Head, maximum, rated diameter	: 593.2 ft
Head rise to shutoff (bowl / pump)	: 37.60 / 38.02 %
Flow, best eff. point (bowl / pump)	: 57.02 / 56.48 MG/day
Flow ratio, rated / BEP (bowl / pump)	: 65.77 / 66.39 %
Diameter ratio (rated / max)	: 96.56 %
Head ratio (rated dia / max dia)	: 90.69 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Near miss

Liquid

Liquid type	: Water
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, rated / max	: 68.00 / 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.34 psi.a

Material

Material selected	: Cast Steel Bowl, AL. Bronze Impeller

Pressure Data

Maximum casing/bowl working pressure	: See the Additional Data page
Maximum allowable working pressure	: See the Additional Data page
Maximum allowable suction pressure	: 150.0 psi.g
Hydrostatic test pressure	: See the Additional Data page

Driver & Power Data (@Max density)

Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 2,834 hp
Power (bowl / pump)	: 3,791 / 3,797 hp
Power, maximum, rated diameter	: 4,112 hp
Minimum recommended motor rating	: 4,000 hp / 2,983 kW

Pump performance. Adjusted for construction, viscosity, friction and power losses of lineshaft and thrust bearings. Not adjusted for any static lift.
The duty point represents the head at the discharge nozzle centerline.