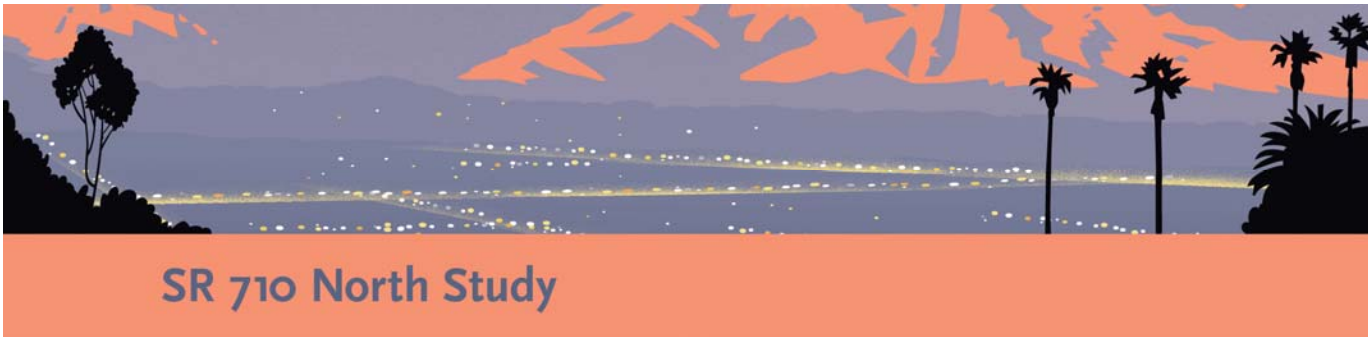


Parts 2/3 – Project Report/Environmental Studies Documentation Phase

Advanced Conceptual Engineering Report Bus Rapid Transit Alternative

SR 710 North Study

Los Angeles County, California

Prepared for

Metro

Los Angeles County
Metropolitan Transportation Authority

April 7, 2014

CH2MHILL®

1000 Wilshire Boulevard
Suite 2100
Los Angeles, California 90017

Executive Summary

Introduction

The State Route (SR) 710 Study includes an evaluation of transportation alternatives for the study area generally bounded by the Interstate (I)-210 freeway on the north, the I-605 freeway on the east, the I-10 freeway on the south, and the I-5 and SR 2 freeways on the west.

Background

Project Description

There are five alternatives being considered in the SR 710 North Study. The alternatives are No Build, Transportation System Management/ Transportation Demand Management (TSM/TDM), Bus Rapid Transit (BRT), Light Rail Transit (LRT), and Freeway Tunnel. These options were evaluated and refined through sequential screening processes to identify the alternatives that best meet the need and purpose of the study. The alternatives recommended for further evaluation in the Alternatives Analysis (AA) (CH2M HILL, 2012a) are as follows:

- No Build Alternative
- TSM/TDM Alternative
- Alternative BRT-6 with possible refinements
- Alternative LRT-4A /B with possible refinements
- Alternative F-7 with possible refinements

BRT Design

The BRT Alternative would provide higher-speed, high-frequency bus service through a combination of new, dedicated bus lanes, also referred to as exclusive bus lanes, and mixed-flow traffic lanes to key destinations between East Los Angeles and Pasadena. The proposed route length is approximately 12 miles one way.

Design Criteria

Goals and objectives of the BRT Alternative include:

- Improve performance and reduce total travel times
- Provide reliability
- Improve north-south mobility
- Provide congestion relief on local streets
- Increase ridership

The proposed BRT system would incorporate several key elements: identifiable running ways, enhanced stations and stops, distinctive vehicles, improved fare collection technology, Intelligent Transportation Systems (ITS) technology to enhance operations, service and operating plan, and branding and image. Alternative BRT-6 was selected as the highest performing BRT alternative during the AA. Based on the feedback and comments after the AA, there were several areas of Alternative BRT-6 for which refinements were considered:

- Improvements to bus travel speeds and reliability
- Reduced effects on on-street parking
- Greater service connectivity at south and north ends of the corridor
- Conformance with bus stop spacing and consistency with Route 762 stop locations
- Potential utilization of electric vehicles
- Increased ridership

Alternative BRT-6/6A is further refined as discussed in this report and is subsequently referred to as the BRT Alternative.

Existing Conditions

The existing surface streets along the corridor of the BRT Alternative include Atlantic Boulevard, Garfield Avenue, Huntington Drive, Fair Oaks Avenue, Del Mar Boulevard, Hill Street, Colorado Boulevard, and Lake Avenue. On-street parking can be found throughout the corridor. Different types of land uses can be found in the study area and include single-family residences, multi-family dwellings, apartment complexes, retail and commercial businesses, shopping centers, parks, and schools. A significant majority of the commercial activity along the corridor is located in Pasadena, East Los Angeles, or Monterey Park; whereas the portions of South Pasadena and Alhambra adjacent to the corridor are mostly residential.

There are 21 existing bus routes that traverse along the proposed corridor of the BRT Alternative. Specifically, for the arterials upon which the BRT Alternative is proposed to operate, the key existing transit services are Metro Local 260 and Metro Rapid 762. These two lines have the most overlap with the proposed BRT Alternative; therefore, the ridership numbers of these two lines were reviewed. Key findings are as follows:

- Average daily ridership on weekdays is 12,429 for Route 260 and 4,905 for Route 762.
- Based on estimated daily vehicle trips, average ridership per vehicle trip is higher for Route 260 (about 115.1 on weekdays) than for Route 762 (about 72.1).
- Passenger trip lengths are longer for Route 762 (about 5.5 miles) than for Route 260 (about 4.1 miles on weekdays).

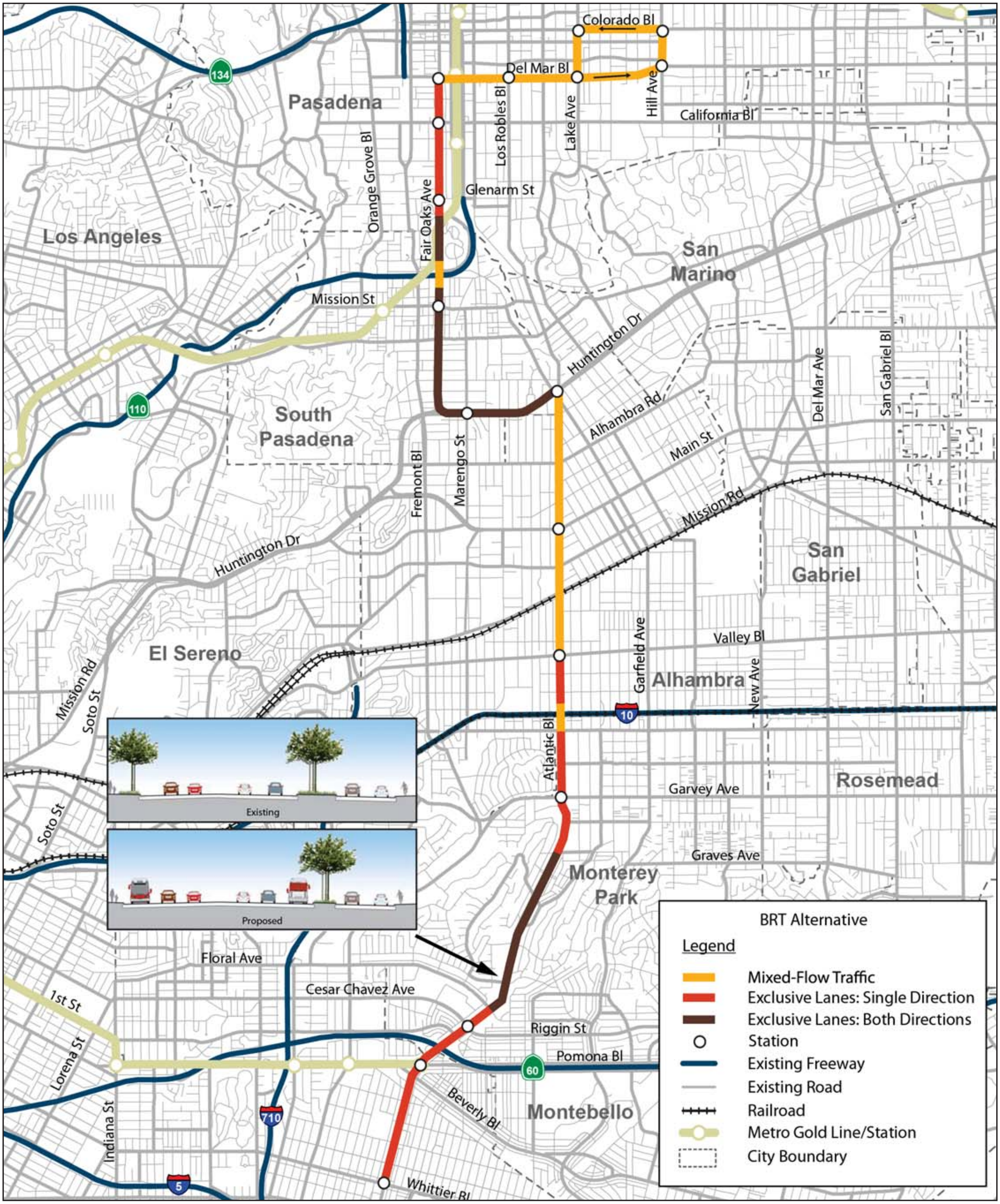
The design team also conducted a survey of the speed and delay of Route 762. Travel time and delay information was collected on several runs that were conducted during the morning and evening peak hours. Delays were recorded separately by type (intersection, bus stop, or congestion). Results indicate that the variations between the scheduled run time and recorded run time are the greatest on the p.m. runs.

Engineering Considerations

Engineering considerations include design and operating speeds, horizontal alignment, running ways, peak-period bus lanes, intersection improvements, stations, utilities, drainage, traffic, parking, traffic signal/street lights, and landscaping. The 12-mile route would begin at Atlantic Boulevard and Whittier Boulevard in the south; then follow Atlantic Boulevard, Huntington Drive, Fair Oaks Avenue, and Del Mar Boulevard; and end with a terminal loop in Pasadena to the north. The terminal loop would travel along Del Mar Boulevard, Hill Street, Colorado Boulevard, and Lake Avenue. Figure ES-1 illustrates the BRT Alternative. Where feasible, buses would run in dedicated bus lanes adjacent to the curb, either in one direction or both directions, during peak periods. In addition to peak period bus lanes, intersection improvements have been included at 47 signalized intersections that experience peak-hour traffic congestion. The BRT Alternative would generally affect on-street parking only during peak traffic periods.

When applicable, the TSM/TDM Alternative improvements would also be constructed as part of the BRT Alternative. These improvements would provide additional enhancements to maximize the efficiency of the existing transportation system by improving capacity and reducing the effects of bottlenecks and chokepoints.

A total of 17 BRT stations with amenities would be placed, on average, at approximately 0.8-mile intervals at major activity centers and cross streets. Typical station amenities would include new shelters, branding elements, seating, wind screens, leaning rails, variable message signs (VMS; next bus information), lighting, bus waiting signals, trash receptacles, and stop markers. Some of these stops will be combined with existing stops, while in some cases, new stops for BRT will be provided.



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SOURCE: CH2M HILL (2013)
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PRE-DELIBERATIVE DRAFT

FIGURE ES-1
BRT Alternative
SR 710 North Study
Los Angeles County,California

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Potential utility conflicts were identified. Due to the nature of the type of improvements, mainly roadway widening and sidewalk width reduction, utility conflicts were generally power pole relocations. Drainage improvements in the BRT Alternative include lateral pipe extension and catch basin relocation due to roadway widening.

The design team also evaluated installation of treatment best management practices (BMPs) and proposed the following BMPs at various locations along the corridor:

- 1 biofiltration swale
- 28 catch basin screens and inserts
- 48 tree box filters

Each city along the corridor of the BRT Alternative has developed a bicycle master plan that is summarized in this report. In the BRT Alternative, only Class III bike routes can be provided in South Pasadena along Huntington Drive and Fair Oaks Avenue, and in Monterey Park along Atlantic Boulevard. Proper signage will be provided and read, "Bike Ok" similar to the Metro Rapid signage along Wilshire Boulevard. Roadway signing and striping were developed using the Manual of Uniform Traffic Control Devices, and will follow the standards of each municipality as required in the next phase.

Construction staging will involve outside lane closures only to avoid the need for complete alternate routes and/or detours. Construction will maintain at least one lane per direction open to use to minimize impacts to businesses and residents. Customized construction staging has been defined for each of the following categories:

- Roadway and station improvements
- Traffic signal modifications
- Street lighting modifications
- Modifications to on-ramps at SR 60

Traffic signal modifications will be required at most intersections along the corridor of the BRT Alternative where there is proposed street widening. Traffic signal modifications include replacement, relocation, and upgrades. Street lighting modifications will primarily consist of relocation of light poles due to roadway widening and include decorative poles.

Bus Operations and Service Planning

Routing

The route alignment of the BRT Alternative is described in the engineering considerations. The BRT service would replicate the existing Metro Rapid 762 service for much of its length, with a new eastward connection in Pasadena to Pasadena City College (PCC) and California Institute of Technology (Caltech). The existing Metro Rapid 762 service would be shortened on its northern end and would operate between Compton and East Los Angeles, terminating at East Los Angeles Community College.

Vehicles and Technology

For the BRT Alternative, an articulated 60-foot bus with three low-floor doors was used as the basis of the design. Based on an average one-way route length of approximately 12 miles and an estimated average travel time of 50.0 minutes, the BRT Alternative would require 12 peak vehicles for 10-minute frequency service and 6 off-peak vehicles for 20-minute service.

Fare Collection

The following are fare collection features assumed in the BRT Alternative:

- Install rear-door Transit Access Pass (TAP) validators on BRT vehicles
- For TAP patrons: boarding at any door, validation at TAP validator or farebox
- For cash patrons: boarding at front door, payment at farebox
- Roaming fare inspectors on vehicles to enforce fare payment at rear doors (consistent with current policy)

Intelligent Transportation Systems/Technologies

Transit Signal Priority (TSP) is being implemented along this corridor. A 2004 pilot project implemented by Los Angeles County Metropolitan Transportation Authority (Metro) along the Crenshaw Boulevard corridor indicated that bus signal priority improves bus travel time and reduces signal delay. The study revealed that there is an average 12 percent reduction in red signal delay during a.m. and p.m. peak periods. The BRT Alternative would expect a similar reduction in red signal delay with the implementation of TSP.

Service and Operating Plans

BRT service would operate from 5:00 a.m. to 9:00 p.m. on weekdays and 7:00 a.m. to 7:00 p.m. on Saturday and Sunday. BRT service would operate on a peak frequency of every 10 minutes and an off-peak frequency of every 20 minutes. The BRT service would generally replace, within the study area, the existing Metro Route 762 service. Combined with the existing Metro 260, the improved frequency would provide exceptional service between East Los Angeles and Pasadena. The total estimated annual operating cost for the BRT service is $5,703,872. The reduction in service hours for the truncated Metro Rapid 762 line would result in a total estimated annual operating cost reduction of $3,017,266.

Two BRT Feeder Alternatives were advanced based on comments and recommendations from Metro:

- Pomona/Beverly BRT Station to Montebello/Commerce Metrolink Stations
- Del Mar BRT Station to El Monte Bus Station

The estimated annual operating cost of BRT Feeder Routes is $7,467,768.

Therefore, the total estimated annual operating cost of the BRT Alternative with Feeder Routes is $10,154,374.

The TSM/TDM Alternative includes significant enhancements to the frequency of 20 existing bus services throughout the study area. The TSM/TDM Alternative would complement the implementation of the BRT Alternative by improving connectivity to and from major corridors, and expanding the reach as a whole. The total TSM/TDM estimated annual operating cost is $13,258,521.

Branding and Image

Metro rapid services use specially branded buses and enhanced bus stops that include special shelters, color coding, information kiosk, and “next trip” display. Specific branding and image allow patrons to identify stations easily and become familiar with the BRT transit service.

Safety/Security

With the BRT Alternative, improved reliability would reduce the likelihood of travel delays. A patron’s concern about safety and security due to longer waits at the stops would be reduced. Safety and security features in the BRT Alternative include:

- Station shelter improvements (lighting)
- Signal priority (TSM/TDM) being implemented by Metro (2014)
- Next bus passenger information system
- Americans with Disabilities Act (ADA) compliance
- Intersection Improvements

Supporting Facilities

Preferred supporting facilities such as bus layover areas and a maintenance facility should be determined in the next phase of design to accommodate the proposed BRT Alternative. Several potential locations for bus layovers and maintenance facilities were identified.

Station Architecture

Three conceptual station cases (A, B, and C) were developed based on the sidewalk width available and context of location. Case A is proposed in locations where there is only an 8-foot sidewalk, low patronage, and/or adjacent property conflicts. Case B is proposed in locations where there are 8-foot sidewalks, higher patronage, and adjacent properties with setback. Case C has sidewalks greater than 8 feet, higher patronage, and adjacent properties with setback. Coordination with the local agencies on station design and maintenance would occur in the next phase of design.

Geological Conditions

Primary geologic seismic hazards within the BRT study area include faulting and seismic ground shaking. Secondary seismic hazards include liquefaction, seismically induced landslides, and seismically induced settlement. Potential non-seismic geologic hazards include slope stability, ground settlement, collapsible soils, expansive materials, and erosion. The Preliminary Geotechnical Report prepared for the SR 710 North Study (CH2M HILL, 2013d) discusses these geologic hazards as well as geotechnical considerations for design and construction of the roadway and retaining walls. Suggested pavement sections for the roadway and bus pads are also presented in the report.

Right-of-Way

The proposed roadway improvements, bus stations, and widening of existing street right-of-way will require partial fee acquisitions and temporary construction easements at various locations along the BRT corridor. The partial acquisitions are minor impacts to commercial and residential properties.

Constraints and Issues to be Resolved in Next Phase

Items to be resolved in next phase include pavement design, bus technology, fare collection, access management, geotechnical exploration, and signal coordination.

Contents

Figures

Signature Page

The following individuals have participated in the preparation of the *SR 710 North Study, Advanced Conceptual Engineering Report Bus Rapid Transit Alternative*, or have completed quality review, or both.

Prepared by:

Susan Chau, P.E.
Civil Engineer, CH2M HILL

Vincent Chio, P.E.
Civil Engineer, CH2M HILL

Tim Bevan, P.E.
BRT Task Lead, CH2M HILL

Reviewed by:

Matt Johnson, P.E.
Civil Engineer, CH2M HILL

Acronyms and Abbreviations

AA	Alternatives Analysis
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ARTS	Area Rapid Transit System
ATM	Active Traffic Management
BMP	best management practice
BRT	Bus Rapid Transit
BRTOPT	Bus Rapid Transit Operational Performance Tool
Cal State LA	California State University, Los Angeles
Caltech	California Institute of Technology
CEQA	California Environmental Quality Act
Caltrans	California Department of Transportation
CMS	changeable message sign(s)
CNG	compressed natural gas
EB	eastbound
EIR/EIS	environmental impact report/environmental impact statement
ft	foot/feet
ft^2	square feet
FTA	Federal Transit Administration
FY	fiscal year
I	Interstate
IEN	Information Exchange Network
ITS	Intelligent Transportation System
JPL	Jet Propulsion Laboratory
LRT	Light Rail Transit
Metro	Los Angeles County Metropolitan Transportation Authority
mi	miles
mph	miles per hour
MSA	Metropolitan Statistical Area
NABI	North American Bus Industries
NB	northbound
NE	northeast
NEPA	National Environmental Policy Act

NW	northwest
O&M	operations and maintenance
PA/ED	Project Approval/Environmental Documentation
PCC	Pasadena City College
PGR	Preliminary Geotechnical Report
ROW	right-of-way
SB	southbound
SCE	Southern California Edison
SE	southeast
SR	State Route
SW	southwest
TAP	Transit Access Pass
TCRP	Transit Cooperative Research Program
TDM	Transportation Demand Management
TMP	Transportation Management Plan
TSSP	Traffic Signal Synchronization Program
TSM	Transportation System Management
TSP	Transit Signal Priority
US	United States [Route]
VMS	variable message sign(s)
WB	westbound

SECTION 1
Introduction

The California Department of Transportation (Caltrans), in cooperation with the Los Angeles County Metropolitan Transportation Authority (Metro) proposes transportation improvements to improve mobility and relieve congestion in the area between State Route (SR) 2 and Interstates 5, 10, 210 and 605 (I-5, I-10, I-210, and I-605, respectively) in east/northeast Los Angeles and the western San Gabriel Valley. Caltrans is the Lead Agency under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

1.1 Study Area

The study area for the SR 710 North Study as depicted in Figure 1-1 is approximately 100 square miles and generally bounded by I-210 on the north, I-605 on the east, I-10 on the south, and I-5 and SR 2 on the west.

1.2 Need and Purpose of Project

Due to the lack of continuous north-south transportation facilities in the study area, there is congestion on freeways, cut-through traffic that affects local streets, and low-frequency transit operations in the study area. Therefore, the following project purpose has been established.

The purpose of the proposed action is to effectively and efficiently accommodate regional and local north-south travel demands in the study area of the western San Gabriel Valley and east/northeast Los Angeles, including the following considerations:

- Improve efficiency of the existing regional freeway and transit networks.
- Reduce congestion on local arterials adversely affected by accommodating regional traffic volumes.
- Minimize environmental impacts related to mobile sources.

The study area is centrally located within the extended urbanized area of Southern California. With few exceptions, the area from Santa Clarita in the north to San Clemente in the south (a distance of approximately 90 miles [mi]) is continuously urbanized. Physical features such as the San Gabriel Mountains and Angeles National Forest on the north, and the Puente Hills and Cleveland National Forest on the south, have concentrated urban activity between the Pacific Ocean and these physical constraints. This urbanized area functions as a single social and economic region that is identified by the Census Bureau as the Los Angeles-Long Beach-Santa Ana Metropolitan Statistical Area (MSA).

There are seven major east-west freeway routes:

- State Route 118 (SR 118)
- United States Route 101 (US-101)/State Route 134 (SR 134)/I-210
- I-10
- State Route 60 (SR 60)
- Interstate 105 (I-105)
- State Route 91 (SR 91)
- State Route 22 (SR 22)

There are seven major north-south freeway routes:

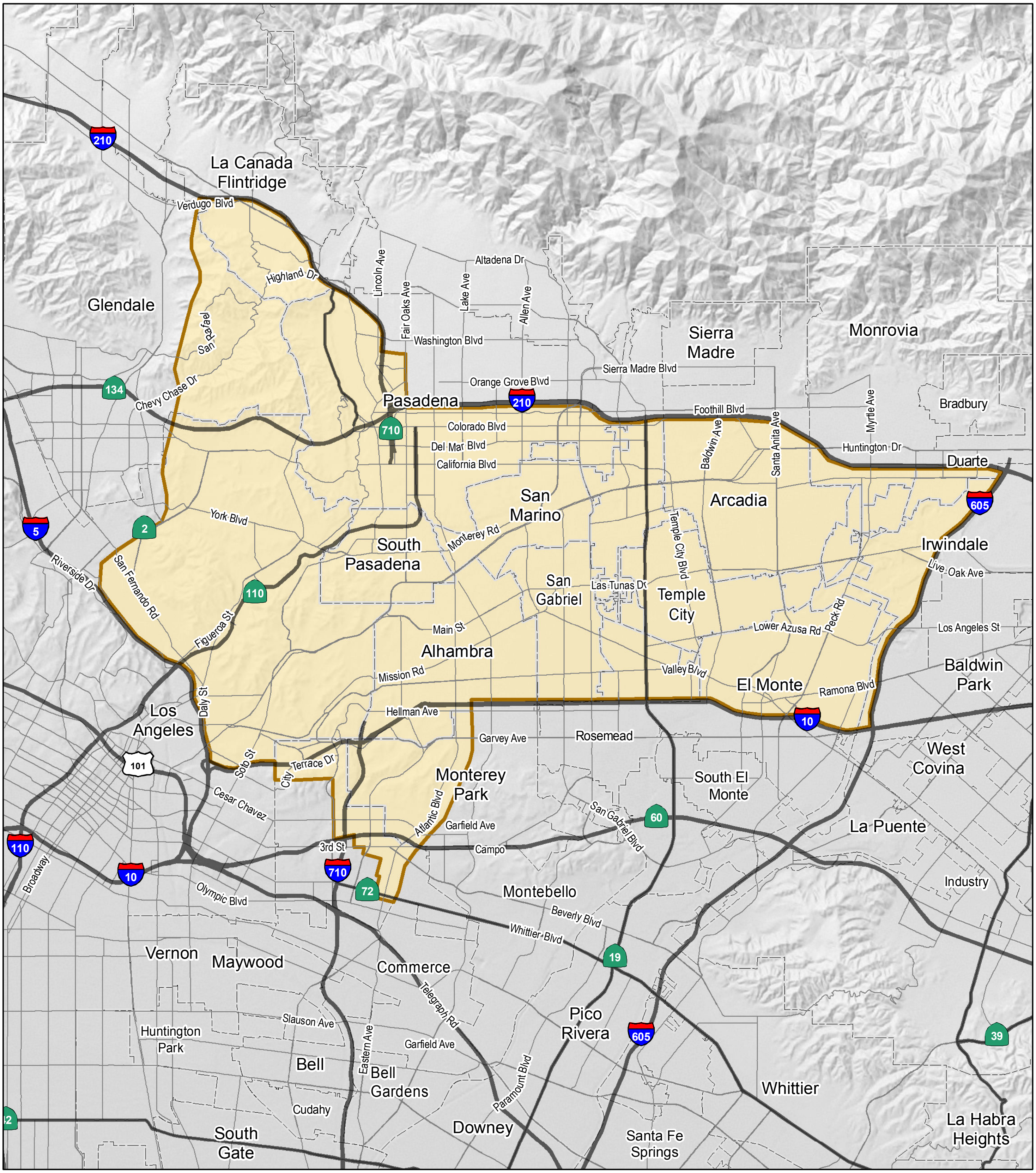
- Interstate 405 (I-405)
- US-101/State Route 170 (SR 170)
- I-5
- Interstate 110 (I-110)/State Route 110 (SR 110)

- Interstate 710 (I-710)
- I-605
- State Route 57 (SR 57)

All of these major routes are located in the central portion of the Los Angeles-Long Beach-Santa Ana MSA. Of the seven north-south routes, four are located partially within the study area (I-5, I-110/SR 110, I-710, and I-605), two of which (I-110/SR 110 and I-710) terminate within the study area without connecting to another freeway. As a result, a substantial amount of north-south regional travel demand is concentrated on a few freeways, or diverted to local streets within the study area. This effect is exacerbated by the overall southwest-to-northeast orientation of I-605, which makes it an unappealing route for traffic between the southern part of the region and the urbanized areas to the northwest in the San Fernando Valley, the Santa Clarita Valley, and the Arroyo-Verdugo region.

The lack of continuous north-south transportation facilities in the study area has the following consequences, which have been identified as the elements of need for the project:

- Degradation of the overall efficiency of the larger regional transportation system
- Congestion on freeways in the study area
- Congestion on the local streets in the study area
- Poor transit operations within the study area



LEGEND

SR 710 North Study Area

FIGURE 1-1

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SOURCE: ESRI (2008); LSA (2013)

PRE-DELIBERATIVE DRAFT

FIGURE 1-1
Study Area
SR 710 North Study
Los Angeles County, California

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SECTION 2

Background

2.1 Project Description

Five alternatives are being considered in the SR 710 North Study. The alternatives are No Build, Transportation System Management/ Transportation Demand Management (TSM/TDM), Bus Rapid Transit (BRT), Light Rail Transit (LRT), and Freeway Tunnel. These options were evaluated and refined through sequential screening processes to identify the alternatives that best meet the need and purpose of the study. The alternatives recommended for further evaluation in the Alternatives Analysis (AA) report (CH2M HILL, 2012a) are as follows:

- No Build Alternative
- TSM/TDM Alternative
- Alternative BRT-6 with possible refinements (subsequently referred to as the BRT Alternative)
- Alternative LRT-4A /B with possible refinements (subsequently referred to as the LRT Alternative)
- Alternative F-7 with possible refinements (subsequently referred to as the Freeway Tunnel Alternative)

2.1.1 No Build

The No Build Alternative includes projects/planned improvements through 2035 that are contained in the Federal Transportation Improvement Program, as listed in the Southern California Association of Governments 2012 Regional Transportation Plan/Sustainable Communities Strategy Measure R and the funded portion of Metro's 2009 Long Range Transportation Plan. The No Build Alternative does not include any planned improvements to the SR 710 Corridor. Figure 2-1 illustrates the No Build Alternative.

2.1.2 TSM/TDM Alternative

The TSM/TDM Alternative consists of strategies and improvements to increase efficiency and capacity for all modes in the transportation system with lower capital cost investments and/or lower potential impacts. The TSM/TDM Alternative is designed to maximize the efficiency of the existing transportation system by improving capacity and reducing the effects of bottlenecks and chokepoints. Components of the TSM/TDM Alternative are shown in Figure 2-2. TSM strategies increase the efficiency of existing facilities (i.e., TSM strategies are actions that increase the number of vehicle trips that a facility can carry without increasing the number of through lanes).

2.1.2.1 Transportation System Management

TSM strategies include Intelligent Transportation System (ITS), local street and intersection improvements, and Active Traffic Management (ATM):

- **ITS Improvements:** ITS improvements include traffic signal upgrades, synchronization and transit prioritization, arterial changeable message signs (CMS), and arterial video and speed data collection systems. The TSM/TDM Alternative includes signal optimization on corridors with signal coordination hardware already installed by Metro's Traffic Signal Synchronization Program (TSSP). These corridors include Del Mar Avenue, Rosemead Boulevard, Temple City Boulevard, Santa Anita Avenue, Fair Oaks Avenue, Fremont Avenue, and Peck Road. The only remaining major north-south corridor in the San Gabriel Valley in which TSSP has not been implemented is Garfield Avenue; therefore, TSSP on this corridor is included in the TSM/TDM Alternative. The locations are shown in Table 2-1. The following provide a further explanation of the ITS elements listed above:

- Traffic signal upgrades include turn arrows, vehicle and/or bicycle detection, pedestrian countdown timers, incorporation into regional management traffic center for real-time monitoring of traffic and updating of signal timing.
- Synchronization is accomplished through signal coordination to optimize travel times and reduce delay.
- Transit signal prioritization includes adjusting signal times for transit vehicles to optimize travel times for public transit riders.
- Arterial CMS are used to alert travelers about unusual road conditions, special event traffic, accident detours, and other incidents.
- Video and speed data collection includes cameras and other vehicle detection systems that are connected to a central monitoring location, allowing for faster detection and response to traffic incidents and other unusual traffic conditions.

TABLE 2-1
TSM/TDM Alternative Elements

ID No.	Description	Location
	ITS Improvements	
ITS-1	Transit Signal Priority	Rosemead Boulevard (from Foothill Boulevard to Del Amo Boulevard)
ITS-2	Install Video Detection System on SR 110	SR 110 north of US 101
ITS-3	Install Video Detection System at Intersections	At key locations in study area
ITS-4	Arterial Speed Data Collection	On key north/south arterials
ITS-5	Install Arterial CMS	At key locations in study area
ITS-6	Traffic Signal Synchronization on Garfield Avenue	Huntington Drive to I-10
ITS-7	Signal optimization on Del Mar Avenue	Huntington Drive to I-10
ITS-8	Signal optimization on Rosemead Boulevard	Foothill Boulevard to I-10
ITS-9	Signal optimization on Temple City Boulevard	Duarte Road to I-10
ITS-10	Signal optimization on Santa Anita Avenue	Foothill Boulevard to I-10
ITS-11	Signal optimization on Peck Road	Live Oak Avenue to I-10
ITS-12	Signal optimization on Fremont Avenue	Huntington Drive to I-10

- **Local Street and Intersection Improvements:** The local street and intersection improvements are within the Cities of Los Angeles, Pasadena, South Pasadena, Alhambra, San Gabriel, Rosemead, and San Marino. Table 2-2 outlines the location of the proposed improvements to local streets, intersections, and freeway ramps as well as two new local roadways. As identified in Table 2-2, Other Road Improvement T-1 (Valley Boulevard to Mission Road Connector Road) would only be constructed with the BRT and TSM/TDM Alternatives.
- **Active Traffic Management:** ATM technology and strategies are also included in the TSM/TDM Alternative. The major elements of ATM are arterial speed data collection and CMS. Data on arterial speeds would be collected and distributed through Los Angeles County's Information Exchange Network (IEN). Many technologies are available for speed data collection or the data could be purchased from a third-party provider. Travel time data collected through this effort could be provided to navigation system providers for distribution to the traveling public. In addition, arterial CMS or "trailblazer" message signs would be installed at key locations to make travel time and other traffic data available to the public.

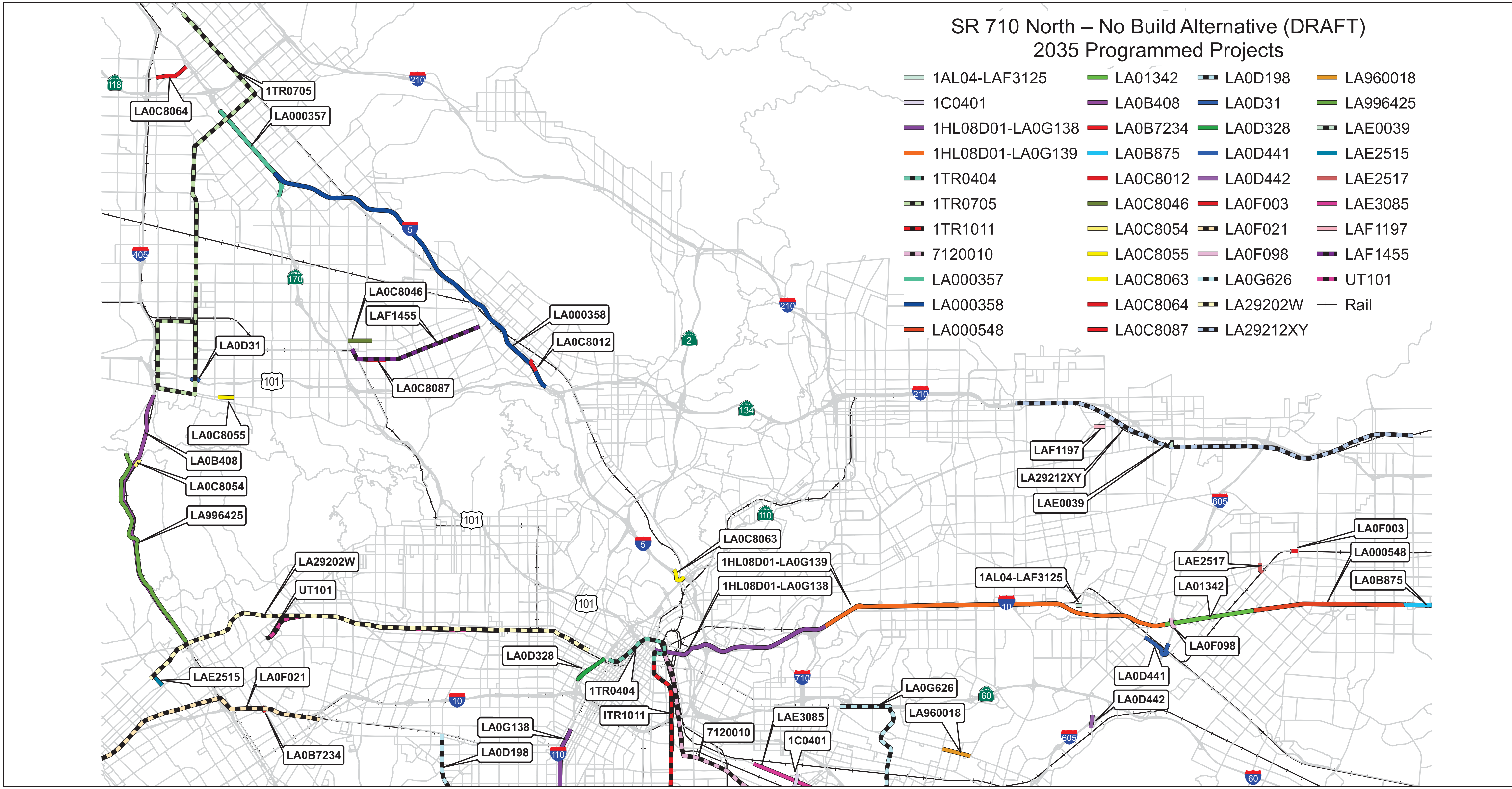

FIGURE 1-2

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SOURCE: CH2M HILL (2013)

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FIGURE 2-1
No Build Alternative
SR 710 North Study
Los Angeles County,California

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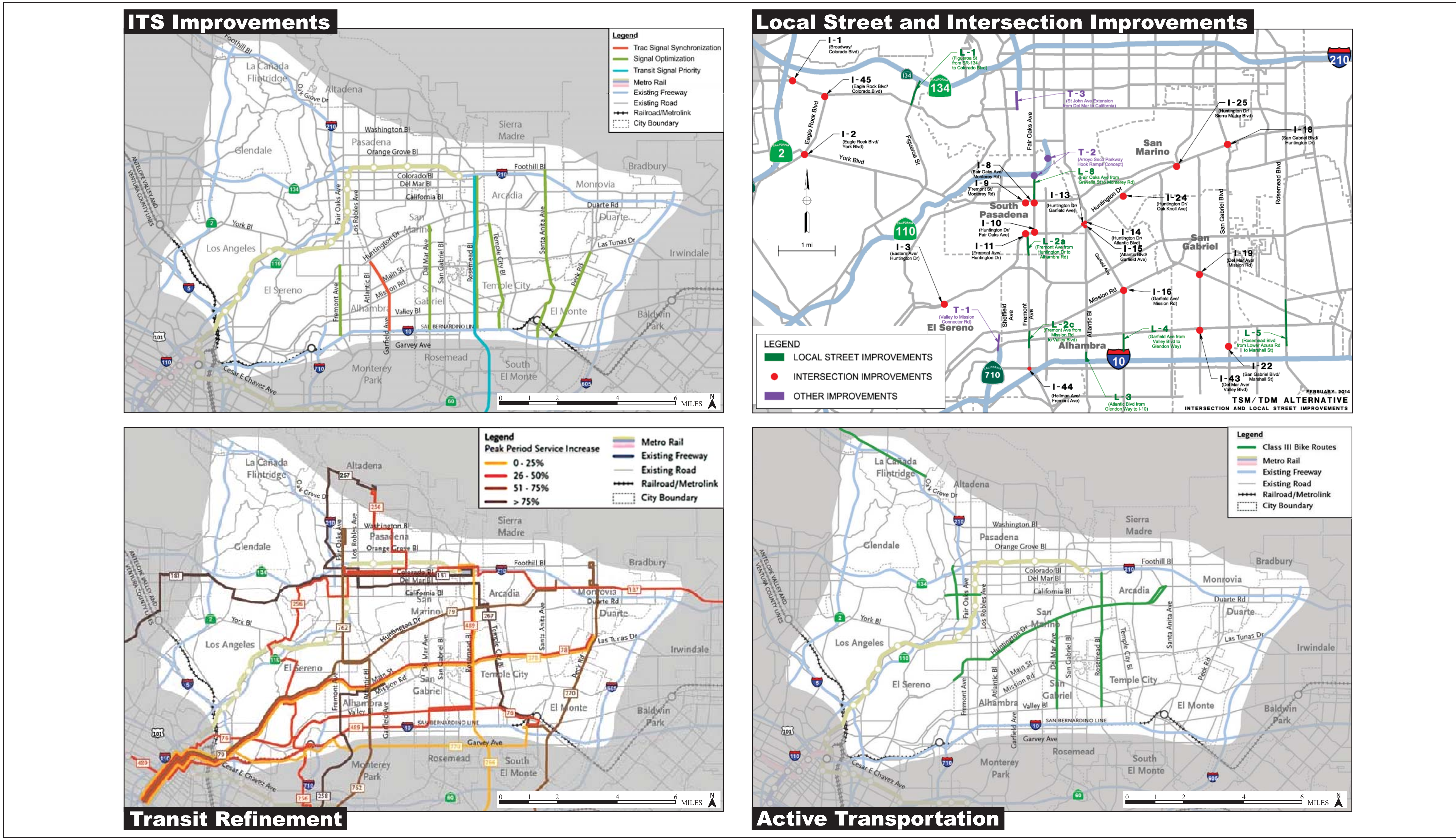

FIGURE 2-2
TSM/TDM Alternative
SR 710 North Study
Los Angeles County, California

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SOURCE: CH2M HILL (2013)
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TABLE 2-2
Local Street and Intersection Improvements of the TSM/TDM Alternative

ID No.	Description	Location
	Local Street Improvements	
L-1	Figueroa Street from SR 134 to Colorado Boulevard	City of Los Angeles (Eagle Rock)
L-2a	Fremont Avenue from Huntington Drive to Alhambra Road	City of South Pasadena
L-2c	Fremont Avenue from Mission Road to Valley Boulevard	City of Alhambra
L-3[1]	Atlantic Boulevard from Glendon Way to I-10	City of Alhambra
L-4	Garfield Avenue from Valley Boulevard to Glendon Way	City of Alhambra
L-5	Rosemead Boulevard from Lower Azusa Road to Marshall Street	City of Rosemead
L-8[1]	Fair Oaks Avenue from Grevelia Street to Monterey Road	City of South Pasadena
	Intersection Improvements	
I-1	West Broadway/Colorado Boulevard	City of Los Angeles (Eagle Rock)
I-2	Eagle Rock Boulevard/York Boulevard	City of Los Angeles (Eagle Rock)
I-3	Eastern Avenue/Huntington Drive	City of Los Angeles (El Sereno)
I-8	Fair Oaks Avenue/Monterey Road	City of South Pasadena
I-9	Fremont Street/Monterey Road	City of South Pasadena
I-10	Huntington Drive/Fair Oaks Avenue	City of South Pasadena
I-11	Fremont Avenue/Huntington Drive	City of South Pasadena
I-13	Huntington Drive/Garfield Avenue	Cities of Alhambra/South Pasadena/San Marino
I-14	Huntington Drive/Atlantic Boulevard	Cities of Alhambra/South Pasadena/San Marino
I-15	Atlantic Boulevard/Garfield Avenue	Cities of Alhambra/South Pasadena/San Marino
I-16	Garfield Avenue/Mission Road	City of Alhambra
I-18	San Gabriel Boulevard/Huntington Drive	City of San Marino/Unincorporated Los Angeles County (East Pasadena/East San Gabriel)
I-19	Del Mar Avenue/Mission Road	City of San Gabriel
I-22	San Gabriel Boulevard/Marshall Street	City of San Gabriel
I-24	Huntington Drive/Oak Knoll Avenue	City of San Marino
I-25	Huntington Drive/Sierra Madre Boulevard	City of San Marino
I-43	Del Mar Avenue/Valley Boulevard	City of San Gabriel
I-44	Hellman Avenue/Fremont Avenue	City of Alhambra
I-45	Eagle Rock Boulevard/Colorado Boulevard	City of Los Angeles (Eagle Rock)
	Other Road Improvements	
T-1[2]	Valley Boulevard to Mission Road Connector Road	Cities of Alhambra/Los Angeles (El Sereno)
T-2	SR 110/Fair Oaks Avenue Hook Ramps	Cities of South Pasadena/Pasadena
T-3[3]	St. John Avenue Extension between Del Mar Boulevard and California Avenue	City of Pasadena

[1] Local Street Improvements L-3 and L-8 would not be constructed with the BRT Alternative.
[2]Other Road Improvement T-1 would only be constructed with the BRT and TSM/TDM Alternatives.
[2]Other Road Improvement T-3 would not be constructed with either the single-bore or dual-bore design variation of the Freeway Tunnel Alternative.
NB – northbound
SB – southbound

2.1.2.2 Transportation Demand Management

TDM strategies focus on regional means of reducing the number of vehicle trips and vehicle miles traveled as well as increasing vehicle occupancy. TDM strategies facilitate higher vehicle occupancy or reduce traffic congestion by expanding the traveler's transportation options in terms of travel method, travel time, travel route, travel costs, and the quality and convenience of the travel experience. The TDM strategies include reducing the demand for travel during peak periods, reducing the use of motor vehicles, shifting the use of motor vehicles to uncongested times of the day, encouraging rideshare and transit use, eliminating trips (i.e., telecommuting), and improved transportation options. The TDM strategies include expanded bus service, bus service improvements, and bicycle improvements:

- **Expanded Bus Service and Bus Service Improvements:** Transit service improvements included in the TSM/TDM Alternative are summarized in Tables 2-3 and 2-4 and illustrated in Figure 2-2. The transit service improvements enhance bus headways between 10 and 30 minutes during the peak hour and 15 to 60 minutes during the off-peak period. Bus headways are the amount of time between consecutive bus trips (traveling in the same direction) on the bus route. Some of the bus service enhancements almost double existing bus service.
- **Bicycle Facility Improvements:** The bicycle facility improvements include on-street Class III bicycle facilities that support access to transit facilities through the study area, and expansion of bicycle parking facilities at existing Metro Gold Line stations. Proposed bicycle facility improvements are outlined in Table 2-4.

TABLE 2-3
Transit Refinements of the TSM/TDM Alternative

Bus Route	Operator	Route Type	Route Description	Existing Headways		Enhanced Headways	
				Peak	Off-Peak	Peak	Off-Peak
70	Metro	Local	From Downtown Los Angeles to El Monte via Garvey Avenue	10-12	15	10	15
770	Metro	Rapid	From Downtown Los Angeles to El Monte via Garvey Avenue/Cesar Chavez Avenue	10-13	15	10	15
76	Metro	Local	From Downtown Los Angeles to El Monte via Valley Boulevard	12-15	16	10	15
78	Metro	Local	From Downtown Los Angeles to Irwindale via Las Tunas Drive	10-20	16-40	10	15
378	Metro	Limited	From Downtown Los Angeles to Irwindale via Las Tunas Drive	18-23	-	20	30
79	Metro	Local	From Downtown Los Angeles to Santa Anita via Huntington Drive	20-30	40-45	15	30
180	Metro	Local	From Hollywood to Altadena via Los Feliz/ Colorado Boulevard	30	30-32	15	30
181	Metro	Local	From Hollywood to Pasadena via Los Feliz/ Colorado Boulevard	30	30-32	15	30
256	Metro	Local	From Commerce to Altadena via Hill Avenue/ Avenue 64/Eastern Avenue	45	45	30	40
258	Metro	Local	From Paramount to Alhambra via Fremont Avenue/Eastern Avenue	48	45-55	20	30
260	Metro	Local	From Compton to Altadena via Fair Oaks Avenue/Atlantic Boulevard	16-20	24-60	15	30
762[1]	Metro	Rapid	From Compton to Altadena via Atlantic Boulevard	25	30-60	15	30
266	Metro	Local	From Lakewood to Pasadena via Rosemead Boulevard/Lakewood Boulevard	30-35	40-45	15	30
267	Metro	Local	From El Monte to Pasadena via Temple City Boulevard/Del Mar Boulevard	30	30	15	30

TABLE 2-3
Transit Refinements of the TSM/TDM Alternative

Bus Route	Operator	Route Type	Route Description	Existing Headways		Enhanced Headways	
				Peak	Off-Peak	Peak	Off-Peak
485	Metro	Express	From Union Station to Altadena via Fremont/ Lake Avenue	40	60	30	60
487	Metro	Express	From Westlake to El Monte via Santa Anita Avenue/Sierra Madre Boulevard/San Gabriel Boulevard	18-30	45	15	30
489	Metro	Express	From Westlake to East San Gabriel via Rosemead Boulevard	18-20	-	15	-
270	Metro	Local	From Norwalk to Monrovia via Workman Mill/ Peck Road	40-60	60	30	60
780	Metro	Rapid	From West LA to Pasadena via Fairfax Avenue/ Hollywood Boulevard/Colorado Boulevard	10-15	22-25	10	20
187	Foothill	Local	From Pasadena to Montclair via Colorado Boulevard/Huntington Drive/Foothill Boulevard	20	20	15	15

[1] This route would not be included as part of the BRT Alternative because the BRT Alternative would replace this service.
Express – Express Bus
Foothill – Foothill Transit
Rapid – Bus Rapid Transit

TABLE 2-4
Active Transportation and Bus Enhancements of the TSM/TDM Alternative

ID No.	Description	Location
	Bus Service Improvements	
Bus-1	Additional bus service	See Table 2-3 and Figure 2-2
Bus-2	Bus stop enhancements	Along TSM routes
	Bicycle Facility Improvements	
Bike-1	Rosemead Boulevard bike route (Class III)	Colorado Boulevard to Valley Boulevard (through Los Angeles County, Temple City, Rosemead)
Bike-2	Del Mar Avenue bike route (Class III)	Huntington Drive to Valley Boulevard (through San Marino, San Gabriel)
Bike-3	Huntington Drive bike route (Class III)	Mission Road to Santa Anita Avenue (through the City of Los Angeles, South Pasadena, San Marino, Alhambra, Los Angeles County, Arcadia)
Bike-4	Foothill Boulevard bike route (Class III)	In La Cañada Flintridge
Bike-5	Orange Grove bike route (Class III)	Walnut Street to Columbia Street (in Pasadena)
Bike-6	California Boulevard bike route (Class III)	Grand Avenue to Marengo Avenue (in Pasadena)
Bike-7	Add bike parking at transit stations	Metro Gold Line stations
Bike-8	Improve bicycle detection at existing intersections	Along bike routes in study area

2.1.3 Bus Rapid Transit Alternative

The BRT Alternative would provide higher-speed, high-frequency bus service through a combination of new, dedicated bus lanes, also referred to as exclusive bus lanes, and mixed-flow traffic lanes to key destinations between East Los Angeles and Pasadena. The proposed route length is approximately 12 miles. Figure 2-3 illustrates the BRT Alternative.

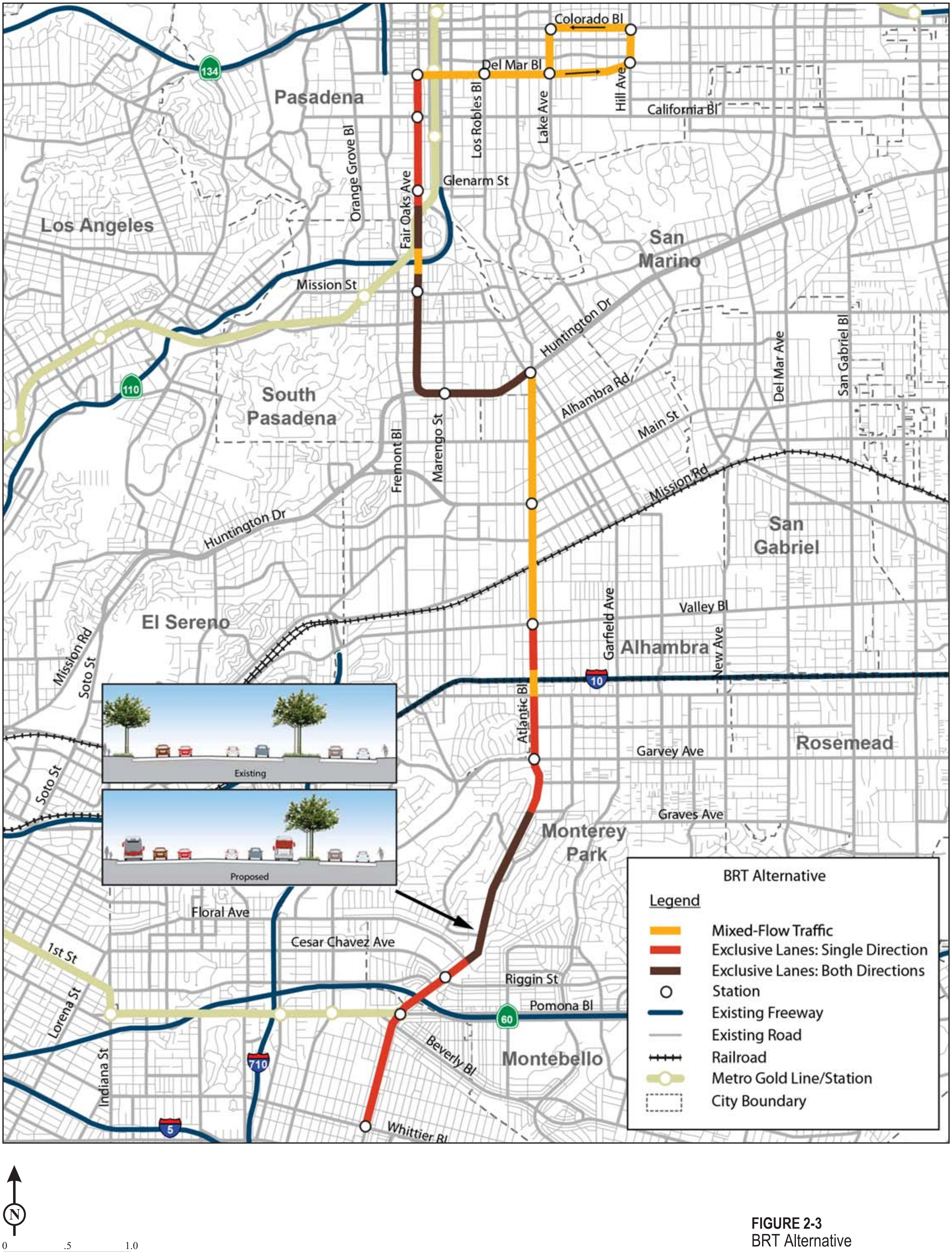
The BRT Alternative includes the BRT trunk line arterial street and station improvements, frequent bus service, new bus feeder services, and enhanced connecting bus services. The BRT Alternative also includes the active transportation and local street and intersection improvements that are part of the TSM/TDM Alternative where applicable. BRT includes the bus enhancements identified in the TSM/TDM Alternative, except for improvements to Route 762.

Buses are expected to operate every 10 minutes during peak hours and every 20 minutes during off-peak hours. The BRT service would generally replace, within the study area, the existing Metro Route 762 service. The 12-mile route would begin at Atlantic Boulevard and Whittier Boulevard to the south; then follow Atlantic Boulevard, Huntington Drive, Fair Oaks Avenue, and Del Mar Boulevard; and end with a terminal loop in Pasadena to the north. Buses operating in the corridor would be given Transit Signal Priority (TSP) from a baseline TSP project that will be implemented separately by Metro.

Where feasible, buses would run in dedicated bus lanes adjacent to the curb, either in one direction or both directions, during peak periods. The new dedicated bus lanes would generally be created within the existing street right-of-way (ROW) through a variety of methods that include restriping the roadway, restricting on-street parking during peak periods, and narrowing medians, planted parkways, or sidewalks. Buses would share existing lanes with other traffic in cases where there is not enough ROW. The exclusive lanes would be exclusive to buses and right-turning traffic during a.m. and p.m. peak hours only. At other times of day, the exclusive lanes would be either available for on-street parking use or general traffic use.

A total of 17 BRT stations with amenities would be placed, on average, at approximately 0.8-mile intervals at major activity centers and cross streets. Typical station amenities would include new shelters, branding elements, seating, wind screens, leaning rails, variable message signs (VMS; next bus information), lighting, bus waiting signals, trash receptacles, and stop markers. Some of these stops will be combined with existing stops, while in some cases, new stops for BRT will be provided. The BRT service would include 60-foot articulated buses with three doors, and would have fare collection technology such as on-board smart card (Transit Access Pass [TAP] card) readers to reduce dwell times at stations. The BRT stops would be provided at the following 17 locations:

- Atlantic Boulevard at Whittier Boulevard
- Atlantic Boulevard between Pomona Boulevard and Beverly Boulevard
- Atlantic Boulevard at Cesar Chavez Avenue/Riggin Street
- Atlantic Boulevard at Garvey Avenue
- Atlantic Boulevard at Valley Boulevard
- Atlantic Boulevard at Main Street
- Huntington Drive at Garfield Avenue
- Huntington Drive at Marengo Avenue
- Fair Oaks Avenue at Mission Street
- Fair Oaks Avenue at Glenarm Street
- Fair Oaks Avenue at California Boulevard
- Fair Oaks Avenue at Del Mar Boulevard
- Del Mar Boulevard at Los Robles Avenue
- Del Mar Boulevard at Lake Avenue
- Del Mar Boulevard at Hill Avenue (single direction only)
- Colorado Boulevard at Hill Avenue (single direction only)
- Colorado Boulevard at Lake Avenue (single direction only)



SOURCE: CH2M HILL (2013)
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FIGURE 2-3
BRT Alternative
SR 710 North Study
Los Angeles County,California

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Additionally, this alternative would include bus feeder routes that would connect additional destinations with the BRT mainline. Two bus feeder routes are proposed: one that would run along Colorado Boulevard, Rosemead Boulevard, and Valley Boulevard to the El Monte transit station; and another bus feeder route that would travel from Atlantic Boulevard near the Gold Line station to the Metrolink stations in the cities of Commerce and Montebello via Beverly Boulevard and Garfield Avenue. In addition, other existing bus services in the study area would be increased in frequency and/or span of service.

The TSM/TDM Alternative improvements would also be constructed as part of the BRT Alternative. These improvements would provide additional enhancements to maximize the efficiency of the existing transportation system by improving capacity and reducing the effects of bottlenecks and chokepoints. As identified in Table 2-1, Other Road Improvement T-1 (Valley Boulevard to Mission Road Connector Road) is one of the TSM/TDM Alternative improvements that would be constructed with the BRT Alternative. Local Street Improvements L-8 (Fair Oaks Avenue from Grevelia Street to Monterey Road) and the reversible lane component of L-3 (Atlantic Boulevard from Glendon Way to I-10) would not be constructed with the BRT Alternative.

2.1.4 Light Rail Transit Alternative

The LRT Alternative would include passenger rail operated along a dedicated guideway, similar to other Metro light rail lines. The LRT alignment is approximately 7.5 mi long, with 3 mi of aerial segments and 4.5 mi of bored tunnel segments. Figure 2-4 illustrates the LRT Alternative.

The LRT Alternative would begin at an aerial station on Mednik Avenue adjacent to the existing East Los Angeles Civic Center Station on the Metro Gold Line. The alignment would remain elevated as it travels north on Mednik Avenue, west on Floral Drive, north across Corporate Center Drive, and then along the west side of I-710, primarily in Caltrans ROW, to a station adjacent to the California State University, Los Angeles (Cal State LA). The alignment would descend into a tunnel south of Valley Boulevard and travel northeast to Fremont Avenue, north under Fremont Avenue, and easterly to Fair Oaks Avenue. The alignment would then cross under SR 110 and end at an underground station beneath Raymond Avenue adjacent to the existing Fillmore Station on the Metro Gold Line.

Two directional tunnels are proposed with tunnel diameters approximately 20 ft each, located approximately 60 ft below the ground surface. Other supporting tunnel systems include emergency evacuation cross passages for pedestrians, a ventilation system consisting of exhaust fans at each portal and an exhaust duct along the entire length of the tunnel, fire detection and suppression systems, communications and surveillance systems, and 24-hour monitoring, similar to the existing LRT system.

Trains would operate at speeds of up to 65 miles per hour (mph) approximately every 5 minutes during peak hours and 10 minutes during off-peak hours.

Seven stations would be located along the LRT alignment at Mednik Avenue in East Los Angeles, Floral Drive in Monterey Park, Cal State LA, Fremont Avenue in Alhambra, Huntington Drive in South Pasadena, Mission Street in South Pasadena, and Fillmore Street in Pasadena. The Fremont Avenue Station, the Huntington Drive Station, the Mission Street Station, and the Fillmore Street Station would be underground stations. New Park-and-Ride facilities would be provided at all of the proposed stations except for the Mednik Avenue, Cal State LA, and Fillmore Street stations.

A maintenance yard to clean, maintain, and store light rail vehicles would be located on both sides of Valley Boulevard at the terminus of SR 710. A track spur from the LRT mainline to the maintenance yard would cross above Valley Boulevard.

Two bus feeder services would be provided. One would travel from the Commerce Station on the Orange County Metrolink line and the Montebello Station on the Riverside Metrolink line to the Floral Station, via East Los Angeles College. The other would travel from the El Monte Bus Station to the Fillmore Station via Rosemead and Colorado Boulevards. In addition, other existing bus services in the study area would be increased in frequency and/or span of service.

As part of the LRT Alternative, the I-710 southbound on-ramp at Valley Boulevard would be modified.

The TSM/TDM Alternative improvements would also be constructed as part of the LRT Alternative. These improvements would provide the additional enhancements to maximize the efficiency of the existing transportation system by improving capacity and reducing the effects of bottlenecks and chokepoints. The only component of the TSM/TDM Alternative improvements that would not be constructed with the LRT Alternative is Other Road Improvement T-1 (Valley Boulevard to Mission Road Connector Road).

2.1.5 Freeway Tunnel Alternative

The alignment for the Freeway Tunnel Alternative starts at the existing southern stub of SR 710 in Alhambra, just north of I-10, and connects to the existing northern stub of SR 710, south of the I-210/SR 134 interchange in Pasadena. The Freeway Tunnel Alternative has two design variations: a dual-bore tunnel and a single-bore tunnel. Both tunnel design variations would include the following tunnel support systems: emergency evacuation for pedestrians and vehicles, air scrubbers, a ventilation system consisting of exhaust fans at each portal, an exhaust duct along the entire length of the tunnel and jet fans within the traffic area of the tunnel, fire detection and suppression systems, communications and surveillance systems, and 24-hour monitoring. An operations and maintenance (O&M) building would be constructed at the northern and southern ends of the tunnel. There would be no operational restrictions for the tunnel, with the exception of vehicles carrying flammable or hazardous materials. Figure 2-5 illustrates the dual-bore and single-bore tunnel design variations for the Freeway Tunnel Alternative.

As part of both design variations of the Freeway Tunnel Alternative, the I-710 northbound off-ramp and southbound on-ramp at Valley Boulevard would be modified.

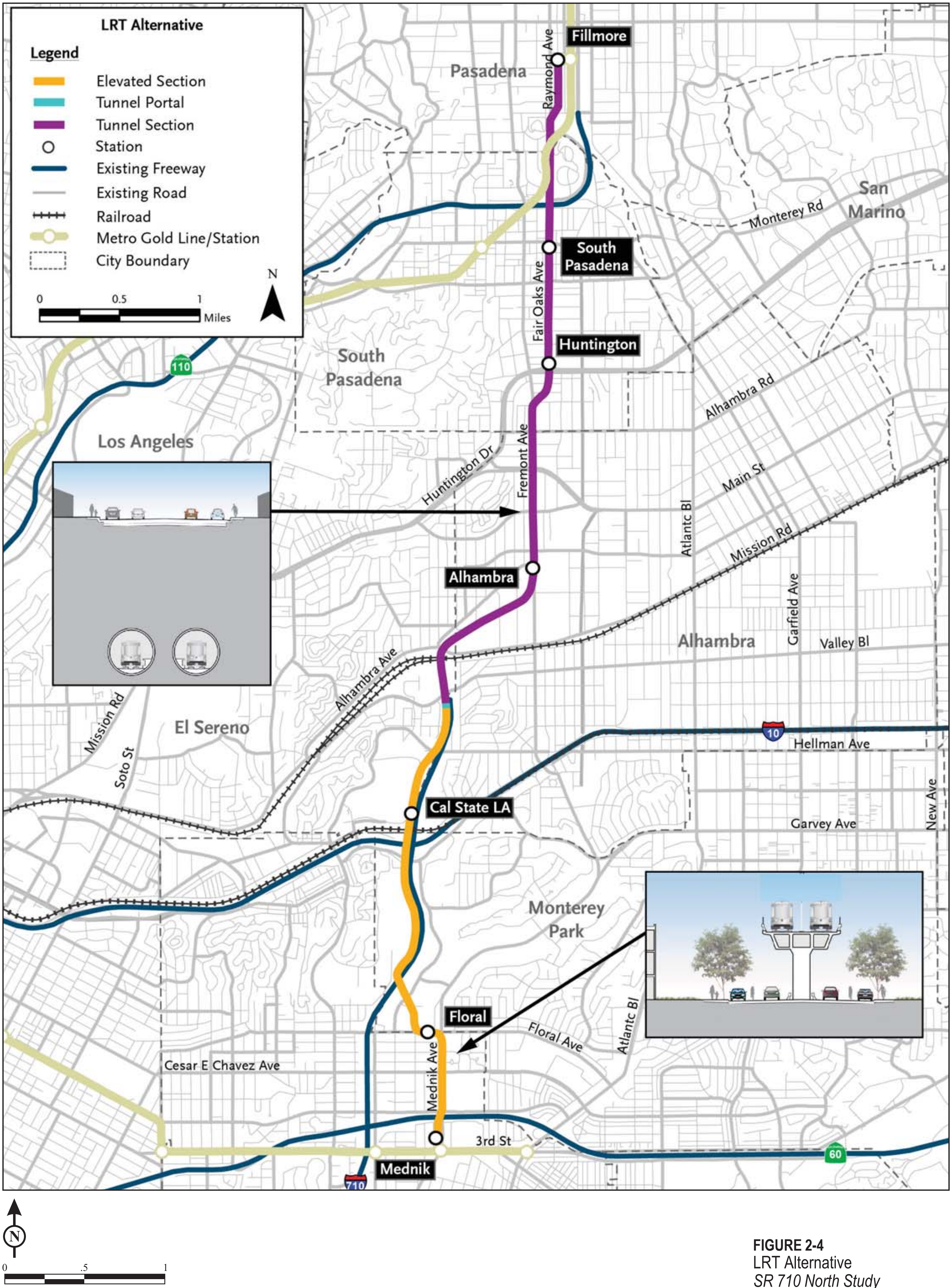
The TSM/TDM Alternative improvements would also be constructed as part of the Freeway Tunnel Alternative, including either the dual-bore or single-bore design variations. These improvements would provide the additional enhancements to maximize the efficiency of the existing transportation system by improving capacity and reducing the effects of bottlenecks and chokepoints. The only components of the TSM/TDM Alternative improvements that would not be constructed with the Freeway Tunnel Alternative are Other Road Improvements T-1 (Valley Boulevard to Mission Road Connector Road) and T-3 (St John Avenue Extension from Del Mar Boulevard to California Avenue).

2.1.5.1 Design Variations

The Freeway Tunnel Alternative includes two design variations. These variations relate to the number of tunnels constructed. The dual-bore design variation includes two tunnels that independently convey northbound and southbound vehicles. The single-bore design variation includes one tunnel that carries both northbound and southbound vehicles. Each of these design variations is described below.

- **Dual-Bore Tunnel:** The dual-bore tunnel variation is approximately 6.3 mi long, with 4.2 mi of bored tunnel, 0.7 mi of cut-and-cover tunnel, and 1.4 mi of at-grade segments. The dual-bore tunnel variation would consist of two side-by-side tunnels (one northbound, one southbound), each tunnel of which would have two levels. Each tunnel would consist of two lanes of traffic on each level, traveling in one direction, for a total of four lanes in each tunnel. The northbound tunnel would be constructed for northbound traffic, and the southbound tunnel would be constructed for southbound traffic. Each bored tunnel would have an outside diameter of approximately 60 ft and would be located approximately 120 to 160 ft below the ground surface. Vehicle cross passages would be provided throughout this tunnel variation that would connect one tunnel to the other tunnel for use in an emergency situation. Figure 2-5 illustrates the dual-bore tunnel variation of the Freeway Tunnel Alternative.

  Short segments of cut-and-cover tunnels would be located at the south and north termini to provide access via portals to the bored tunnels. The portal at the southern terminus would be located south of Valley Boulevard. The portal at the northern terminus would be located north of Del Mar Boulevard. No intermediate interchanges are planned for the tunnel.



SOURCE: AECOM (2013)

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FIGURE 2-4
LRT Alternative
SR 710 North Study
Los Angeles County,California

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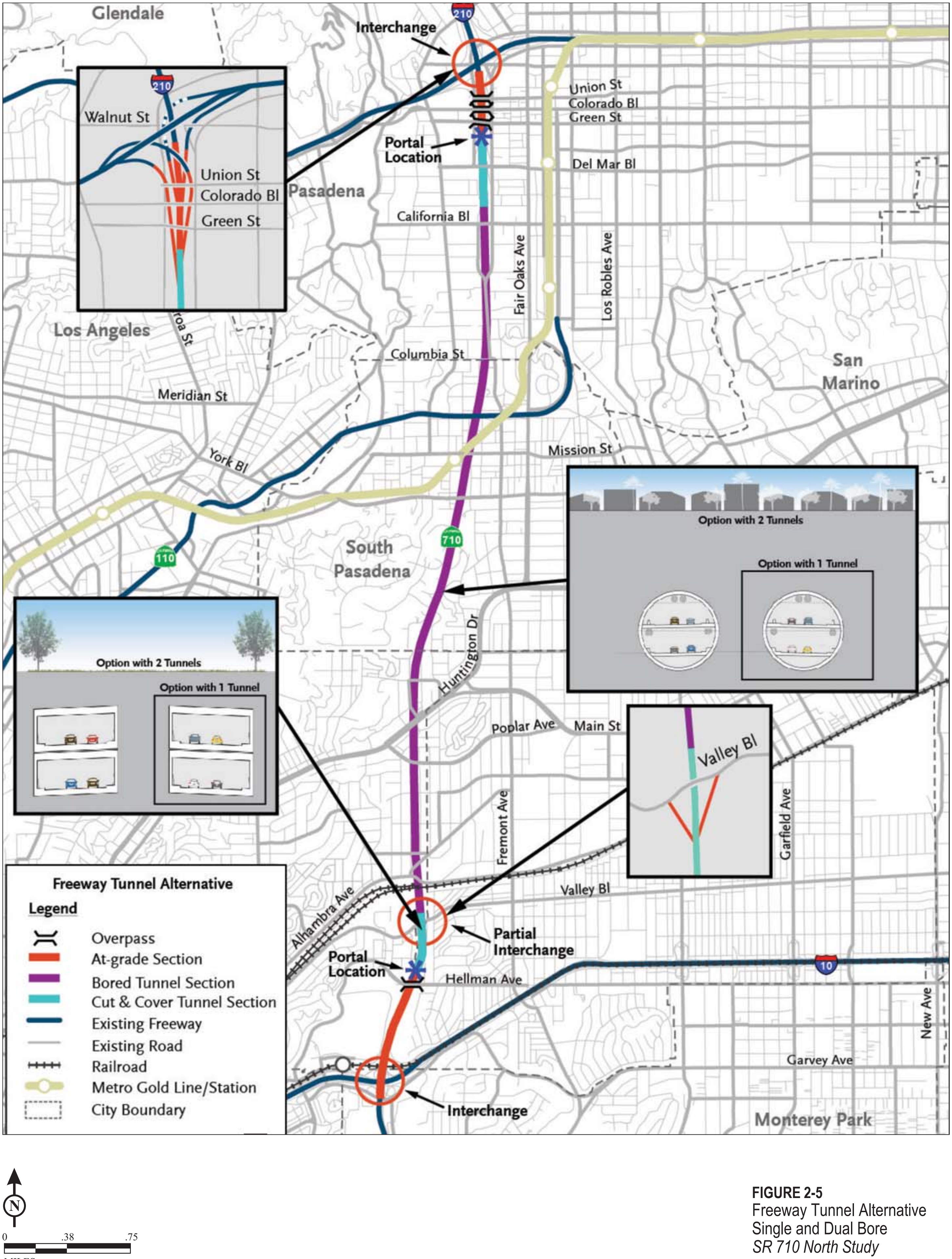

SOURCE: CH2M HILL (2013)
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FIGURE 2-5
Freeway Tunnel Alternative
Single and Dual Bore
SR 710 North Study
Los Angeles County,California

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- **Single-Bore Tunnel:** The single-bore tunnel design variation is also approximately 6.3 mi long, with 4.2 mi of bored tunnel, 0.7 mi of cut-and-cover tunnel, and 1.4 mi of at-grade segments. The single-bore tunnel variation would consist of one tunnel with two levels. Each level would have two lanes of traffic traveling in one direction. The northbound traffic would traverse the upper level, and the southbound traffic would traverse the lower level. The single-bore tunnel would provide a total of four lanes. The single-bore tunnel would also have an outside diameter of approximately 60 ft and would be located approximately 120 to 160 ft below the ground surface. The single-bore tunnel would be in the same location as the northbound tunnel in the dual-bore tunnel design variation. Figure 2-6 illustrates the single-bore tunnel variation cross section of the Freeway Tunnel Alternative.

2.1.5.2 Operational Variations

Five operational variations have been identified for the Freeway Tunnel Alternative, as described below:

- **Freeway Tunnel Alternative without Tolls:** The facility would operate as a conventional freeway with lanes open to all vehicles. This operational variation would be considered for only the dual-bore tunnel design variation.

- **Freeway Tunnel Alternative with Trucks Excluded:** The facility would operate as a conventional freeway; however, trucks would be excluded from using the tunnel. This operational variation would be considered for the dual-bore tunnel only. Signs would be provided along I-210, SR 134, I-710, and I-10 to provide advance notice of the truck restriction.

- **Freeway Tunnel Alternative with Tolls:** This operational variation would be considered for both the dual- and single-bore tunnels described above. All vehicles, including trucks, using the tunnel would be tolled.

- **Freeway Tunnel Alternative with Tolls and Trucks Excluded:** The facility would operate as a conventional freeway; however, trucks would be excluded from using the tunnel. This operational variation would be considered for the single-bore tunnel only. All automobiles would be tolled; however, trucks would be excluded from using the tunnel. Signs would be provided along I-210, SR 134, I-710, and I-10 to provide advance notice of the truck restriction.

- **Freeway Tunnel Alternative with Toll and Express Bus:** This operational variation would be considered for the single-bore tunnel only. The single bore freeway tunnel would operate as a tolled facility and include an Express Bus component. The Express Bus would be allowed in any of the travel lanes in the tunnel; no bus-restricted lanes would be provided. The Express Bus route would start at the Commerce Station on the Orange County Metrolink line, and then serve the Montebello Station on the Riverside Metrolink line and East Los Angeles College before entering I-710 at Floral Drive. The bus would travel north to Pasadena via the proposed freeway tunnel, making a loop serving Pasadena City College, the California Institute of Technology, and downtown Pasadena before re-entering the freeway and making the reverse trip.

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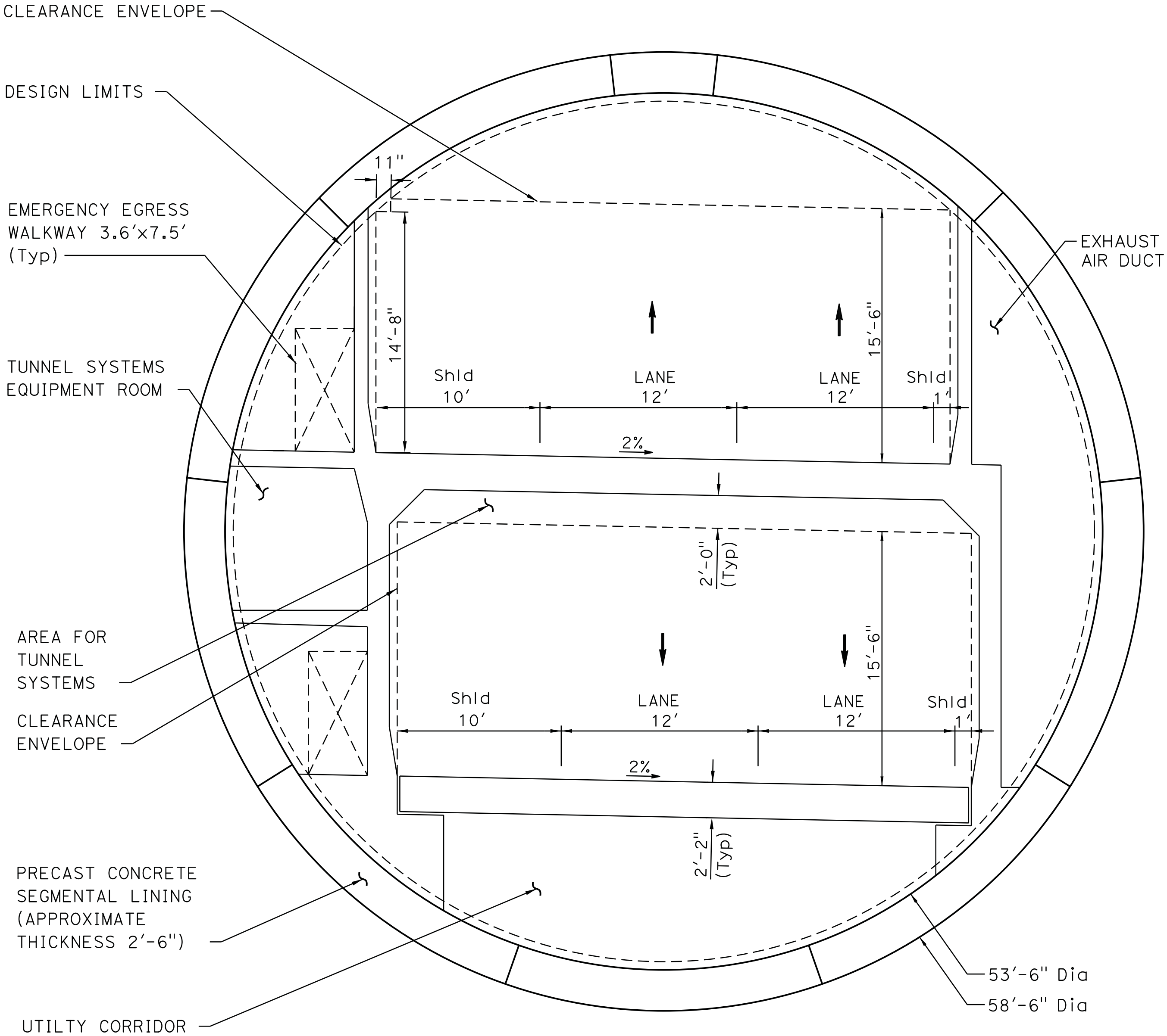

SOURCE: CH2M HILL (2013)

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FIGURE 2-6
Freeway Tunnel Alternative
Single Bore Cross Section
SR 710 North Study
Los Angeles County,California

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SECTION 3

Bus Rapid Transit Design

3.1 Design Criteria

The BRT Alternative integrates high-quality transit service with station facilities and passenger amenities, and is designed to provide higher capacity with shorter travel time compared to traditional bus services. The study corridor for the BRT Alternative includes the cities of Alhambra, East Los Angeles, Monterey Park, Pasadena, San Marino, and South Pasadena.

In past studies during the AA Phase, 27 BRT options were considered throughout the study area. The BRT options were identified for potential routes based upon the study Purpose and Need, and the opportunity to connect to major travel destinations. Also the availability of street ROW along street corridors was considered. The resulting options were evaluated and refined through a three-step screening process to identify the best performing options that best meet the purpose and need of the study. The factors in the screening process included ridership potential, minimal potential community effects, reduction of local street congestion, and accommodation of regional north-south travel. The screening process identified seven of the initial 27 BRT options to be considered for conceptual engineering and initial evaluation which was presented in the Alternatives Analyses Report.

After consideration of projects needs and objectives, service to major destinations, available ROW, and maintaining traffic lanes, a total of two BRT alternatives with one additional design variation (developed during the evaluation process) were selected for additional evaluation, BRT-1, BRT-6, and BRT-6A. These options were then evaluated on factors such as general traffic lanes, on-street parking, sidewalk and median widths, and potential right-of way property effects.

Among the remaining BRT alternatives, the measures for the objectives related to transportation system performance were similar to one another, with Alternative BRT-1 performing slightly better at reducing transit travel times, but Alternatives BRT-6 and BRT-6A performing slightly better at increasing access to high-frequency transit service and increasing north-south transit patronage. Therefore, performance on the transportation objectives does not clearly favor one alternative over the others. However, Alternatives BRT-6 and BRT-6A could be implemented with no full right-of-way acquisition and would also have a smaller potential impact on sensitive habitat. In the Alternatives Analysis Report (CH2M HILL, 2012a), BRT-6/6A was identified and recommended as the best performing BRT option for Project Approval/Environmental Documentation (PA/ED).

3.1.1 Goals and Objectives

The following goals and objectives are identified for the BRT Alternative:

- Improve bus travel speed
- Provide reliability in services
- Improve north-south mobility
- Provide congestion relief on local streets
- Increase transit ridership

The proposed BRT system would incorporate several key elements of BRT (identifiable running ways, enhanced stations and stops, distinctive vehicles, fare collection, and ITS/technology) to enhance operations, service and operating plans, branding, and image. The performance of these elements has a significant impact on the overall success of the BRT system.

Alternative BRT-6 was selected as the highest performing BRT alternative during the AA. Based on the feedback and comments after the AA, there were several areas of Alternative BRT-6/6A for which refinements were considered:

- **Improvements to bus travel speeds and reliability**. As configured in the AA, Alternative BRT-6 included exclusive lanes along the mid-block portions of the alignment. However, buses would operate in mixed flow traffic at intersections. Therefore, speeds and reliability would not be very good even though a significant investment in infrastructure reconstruction would be required.
- **Reduced effects on on-street parking**. Alternative BRT-6, as defined, would require displacement of on-street parking along the entire route, especially if this would be a 24-hour operation.
- **Greater service connectivity at south and north ends of the corridor**. Alternative BRT-6 essentially terminated at Whittier Boulevard in the south. In the north, a loop to serve the east part of downtown Pasadena was included. To improve the performance of the BRT Alternative, other service locations at the ends of the corridor will be considered.
- **Conformance with bus stop spacing and consistency with Route 762 stop locations**. Route 762 is an existing Metro Rapid line that operates in the corridor. Options will be evaluated to either replicate the Route 762 stop locations, or combine Route 762 with the BRT operation.
- **Potential use of electric vehicles.** Electric vehicles are potentially the next generation of zero-emission and low-emission vehicles. Metro currently operates clean air compressed natural gas (CNG) buses on most routes.

The BRT Alternative (Alternative BRT-6/6A) is further refined and discussed in Section 3.3.1.

3.2 Existing Conditions

3.2.1 Surface Streets

The BRT Alternative uses the following surface streets (posted speeds are noted in parentheses):

- Atlantic Boulevard (30, 35, and 40 mph)
- Huntington Drive (40 mph)
- Fair Oaks Avenue (35 mph)
- Colorado Boulevard (25 and 30 mph)
- Del Mar Boulevard (30 mph)
- Hill Avenue (30 mph)
- Lake Avenue (25 mph)

The widths and conditions of these roadways vary widely depending on the function of the roadway and surrounding land uses. See Appendix A (Advanced Conceptual Engineering Drawings) for more information on the width of each roadway listed above.

Atlantic Boulevard is typically a four-lane arterial roadway with a two-way left-turn median lane and two lanes per direction. The two-way left-turn median lane ends north of Valley Boulevard. Atlantic Boulevard connects with two major freeways along the corridor, SR 60 and I-10. All major intersections are signalized and typically provide crosswalks for pedestrians in all directions. Atlantic Boulevard provides sidewalks in both directions except from Brightwood Street to El Repetto Drive.

Garfield Avenue is a four-lane arterial roadway that intersects with Atlantic Boulevard and Huntington Drive.

Huntington Drive is a six-lane arterial roadway with a 16-foot-wide raised median with landscaping and three lanes per direction. There are only three signalized intersections along the BRT corridor on Huntington Drive. The majority of the intersections along Huntington Drive are one-way stop controlled intersections for local streets. Sidewalks are provided on both sides of the roadway. There is a channelized right-turn lane from Huntington Drive to Fair Oaks Avenue and a channelized left-turn lane from Fair Oaks Avenue to Huntington Drive.

Fair Oaks Avenue along the BRT corridor is typically a four-lane arterial roadway with either a raised median or left-turn median. Fair Oaks Avenue provides on-ramp and off-ramp access to SR 110. The overcrossing of

SR 110 on Fair Oaks Avenue is a historic bridge. The majority of the intersections are signalized and provide crosswalks in all directions. Recently, there were street improvements completed on Fair Oaks Avenue between Monterey Road and Columbia Street.

In the north loop, Del Mar Boulevard and Colorado Boulevard are classified as both four-lane arterial roadways. However, Hill Avenue and Lake Avenue are both four-lane collector roadways. All roadways provide sidewalks and crosswalks at major intersections. At major intersections along the north loop, the intersections are signalized.

3.2.2 Land Uses

The BRT Alternative serves the following cities, from north to south: Pasadena, South Pasadena, Alhambra, Monterey Park, and East Los Angeles. There is a range of land uses adjacent to the BRT Alternative corridor alignment, including single-family residences, multi-family dwellings, apartment complexes, retail and commercial businesses, shopping centers, parks, and schools. A significant majority of the commercial activity along the corridor is located in Pasadena, East Los Angeles, or Monterey Park; whereas the portions of South Pasadena and Alhambra adjacent to the corridor are mostly residential (Alhambra has some commercial activity at major intersections).

Major land uses along the corridor alignment, from the northern terminus of the route to the southern terminus, are as follows:

- **Pasadena City College (PCC)**: Located on the southeast corner of Colorado Boulevard and Hill Avenue. One of the nation's largest community colleges with about 40,000 students.
- **California Institute of Technology (Caltech)**: Located on the northwest corner of California Boulevard and Hill Avenue. World-renowned science and engineering university with about 2,300 students.
- **Paseo Colorado**: Located on the south side of Colorado Boulevard, between Marengo Avenue and Los Robles Avenue. Pasadena outdoor mall that opened in 2001, including retail stores, a movie theater, a grocery store, office space, and upstairs condominiums.
- **Old Town Pasadena**: Runs along Colorado Boulevard between Pasadena Avenue and Arroyo Parkway. Pasadena's historic commercial center, with numerous retail stores, restaurants, and other entertainment destinations.
- **Pasadena Central Park**: Located along Fair Oaks Avenue between Dayton Street and Del Mar Boulevard. A 9.2-acre park in Central Pasadena.
- **Huntington Memorial Hospital**: Located next to Fair Oaks Avenue between California Boulevard and Bellefontaine Street. Nonprofit, community-based medical center in Pasadena.
- **War Memorial Park**: Located along Fair Oaks Avenue just north of Mound Street. A 2-acre park and one of South Pasadena's cultural historic landmarks.
- **South Pasadena Middle School**: Located on Fair Oaks Avenue between Rollin Street and Oak Street.
- **Atlantic Times Square**: Located at the southeast corner of Atlantic Boulevard and Hellman Avenue. Recently opened outdoor mall in Monterey Park with retail stores, restaurants, a movie theater, and upstairs condominiums.
- **Landmark Shopping Center**: Located at the northeast corner of Atlantic Boulevard and Garvey Avenue. Shopping center in Monterey Park with retail stores, supermarkets, and restaurants.
- **Monterey Park Mall Shopping Center**: Located on Atlantic Boulevard, between Newmark Avenue and Harding Avenue. Shopping center in Monterey Park with retail stores, supermarkets, and restaurants.
- **Cascades Park**: Located at Atlantic Boulevard and El Portal Place. A 2-acre park in Monterey Park with a landscaped waterfall.
- **Monterey Park Hospital**: Located next to Atlantic Boulevard between Cadiz Street and Sevilla Street.

- **East Los Angeles College**: Located on Avenida Cesar Chavez, just west of Atlantic Boulevard. Community college in Monterey Park with about 30,000 students.
- **Atlantic Square Shopping Center**: Located at the northeast corner of Atlantic Boulevard and Riggin Street. Shopping center in Monterey Park with retail stores, supermarkets, and restaurants.
- **Garfield High School**: Located on East 6th Street in East Los Angeles, just west of Atlantic Boulevard.
- **Atlantic Avenue Park**: Located at the northeast corner of Atlantic Boulevard and East 6th Street in East Los Angeles.

3.2.3 Bus Routes

As noted in the Existing Conditions System Performance Report (CH2M HILL, 2012b), the SR 710 study area as a whole is served by 16 local transit agencies, with both bus and rail services, including Metro Bus and Rail, Metrolink, Arcadia Transit, Alhambra Transit, Baldwin Park, Duarte Transit, El Sol East LA Shuttle, El Monte Transit, Foothill Transit, Glendale Beeline, Los Angeles Department of Transportation, Monrovia Transit, Monterey Park Spirit Bus Lines, Pasadena Area Rapid Transit System (ARTS), Rosemead Explorer, and South Pasadena Gold Link. The transit service types provided include commuter rail (Metrolink), light rail (Metro Gold Line), and numerous types of bus service (rapid, express, limited, local, and shuttle).

Specifically, for the arterials upon which the BRT Alternative is proposed to operate (Colorado Boulevard, Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard), the key existing transit services are Metro Local 260 and Metro Rapid 762, which are described as follows:

- Metro Local 260: This route operates between Fair Oaks Avenue and Woodbury Road in Altadena and the Artesia Blue Line Station in Compton. The route runs on the segments of Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard where the BRT Alternative is proposed to operate, with stops about every 0.25 to 0.50 mile along the alignment.
- Metro Rapid 762: This route operates between Fair Oaks Avenue and Colorado Boulevard in Pasadena and the Artesia Blue Line Station in Compton. The route runs on the segments of Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard where the BRT Alternative is proposed to operate, with stops about every 0.50 to 1.00 mile along the alignment (limited stops).

Table 3-1 summarizes the approximate spans of service for Routes 260 and 762. Route 260 runs on weekdays, Saturdays, and Sundays, while Route 762 runs on weekdays only.

TABLE 3-1
Metro Routes 260 and 762, Spans of Service

Route	Type	Service Span (Weekdays)	Service Span (Saturdays)	Service Span (Sundays)
260	Local	4:00 a.m. to 11:45 p.m.	5:00 a.m. to 11:45 p.m.	6:00 a.m. to 11:45 p.m.
762	Rapid	5:00 a.m. to 9:00 p.m.	None	None

Source: Los Angeles Metro, www.metro.net

Table 3-2 summarizes the approximate service frequencies, running times, and speeds for Routes 260 and 762 in the study area.

TABLE 3-2
Metro Routes 260 and 762, Frequencies and Speeds

Route	Time Period	Approximate Frequency	Estimated Route Length Within Study Area (miles)	Estimated Running Time Within Study Area (minutes)[1]	Estimated Speed Within Study Area (mph)[2]
260	a.m. Peak (6:00 a.m. to 9:00 a.m.)	12 to 20 min	9.2	41	13.5
	Midday (9:00 a.m. to 3:00 p.m.)	20 min	9.2	44	12.5
	p.m. Peak (3:00 p.m. to 6:00 p.m.)	12 to 20 min	9.2	47	11.7
	Evening (6:00 p.m. to 9:00 p.m.)	30 to 60 min	9.2	40	13.8
	Saturday (5:00 a.m. to 11:45 p.m.)	15 to 20 min	9.2	43	12.8
	Sunday (6:00 a.m. to 11:45 p.m.)	15 to 20 min	9.2	40	13.8
762	a.m. Peak (6:00 a.m. to 9:00 a.m.)	15 to 20 min	9.2	36	15.3
	Midday (9:00 a.m. to 3:00 p.m.)	30 min	9.2	39	14.2
	p.m. Peak (3:00 p.m. to 6:00 p.m.)	25 min	9.2	41	13.5
	Evening (6:00 p.m. to 9:00 p.m.)	30 min	9.2	37	14.9

Source: Los Angeles Metro, www.metro.net. Route length and running time within the study area are estimated from Fair Oaks and Colorado to Atlantic and Pomona (Atlantic and Whittier is not listed as a scheduled time point).
Estimated running time within study area includes delay times at intersection and bus stops.
[2]Estimated speed within study area includes delay times at intersection and bus stops.

The main findings as shown in Table 3-3 are as follows:

- Metro Local 260: This route generally operates at 12- to 20-minute service frequencies, and is scheduled to complete its north-south trip through the study area in 40 to 47 minutes depending on time of day. Based on an estimated route length in the study area of 9.2 miles, this translates to an estimated average speed of 11.7 to 13.8 mph.
- Metro Rapid 762: This route operates at 15- to 30-minute frequencies, and is scheduled to complete its north-south trip through the study area in 36 to 41 minutes depending on time of day. This translates to an estimated average speed of 13.5 to 15.3 mph.

A number of other existing bus routes traverse a shorter distance on the proposed BRT Alternative route alignment. These routes are as follows:

- Metro Local 68: Serves Monterey Park, Downtown Los Angeles, and East Los Angeles. Certain runs (about one every 40 to 60 minutes) operate on Atlantic Boulevard between Riggin and 1st.
- Metro Local 79: Serves South Pasadena, Arcadia, and Downtown Los Angeles, with service about every 30 to 40 minutes. A portion of the route includes Huntington Drive between Fair Oaks Avenue and Garfield Avenue.
- Metro Local 180/181: Serves Pasadena, Altadena, Eagle Rock, Glendale, and Hollywood, with service about every 15 to 20 minutes (sum of both routes). Portions of the routes include Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.

- Metro Local 256: Serves Pasadena, Altadena, East Los Angeles, Highland Park, and Monterey Hills, with service about every 45 minutes. A portion of the route includes Colorado Boulevard between Raymond and Hill.
- Metro Local 267: Serves Pasadena, Altadena, Arcadia, Temple City, and El Monte with service about every 30 minutes. Portions of the route include Del Mar Boulevard between Los Robles Avenue and Hill Avenue.
- Metro Local 485: Serves East Los Angeles, Alhambra, South Pasadena, San Marino, Pasadena, and Altadena with service every 30 minutes. Portions of the route include Huntington Drive between Fair Oaks Avenue and Garfield Avenue, as well as Lake Avenue between Del Mar Boulevard and Colorado Boulevard.
- Metro Local 686/687: Serves Pasadena and Altadena, with service about every 20 minutes (sum of both routes). Portions of the routes include Fair Oaks Avenue between Colorado Boulevard and Glenarm Street, and Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.
- Metro Rapid 770: Serves Monterey Park, El Monte, Downtown Los Angeles, and East Los Angeles, with service about every 10 to 15 minutes. A portion of the route includes Atlantic Boulevard between Garvey and Riggin.
- Metro Rapid 780: Serves Pasadena, Eagle Rock, Glendale, Hollywood, Los Angeles (Mid-City), and West Hollywood, with service about every 10 to 15 minutes. A portion of the route includes Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.
- Foothill Transit Route 187: Serves Pasadena, Claremont, Glendora, and Montclair, with service about every 20 minutes. A portion of the route includes Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.
- Montebello Transit Route 10: Serves Monterey Park, Montebello, and Whittier, with service about every 12 to 15 minutes. A portion of the route includes Atlantic Boulevard between Floral and Whittier Boulevard.
- Monterey Park Spirit Bus: Four Spirit Bus routes serve portions of the route alignment, with service ranging from every 30 to 40 minutes per route:
  - Route 1 runs on Atlantic Boulevard between Emerson and Riggin.
  - Route 2 runs on Atlantic Boulevard between Garvey and Floral.
  - Route 4 runs on Atlantic Boulevard between Emerson and Garvey.
  - Route 5 runs on Atlantic Boulevard between Floral and Riggin.
- Pasadena ARTS Shuttle: Four Pasadena ARTS Shuttle routes serve portions of the route alignment, with service ranging from every 20 to 60 minutes per route:
  - Route 10 runs on Colorado Boulevard between Fair Oaks Avenue and Lake Avenue.
  - Routes 20, 51, and 52 run on Fair Oaks Avenue between Del Mar Boulevard and Glenarm Street.

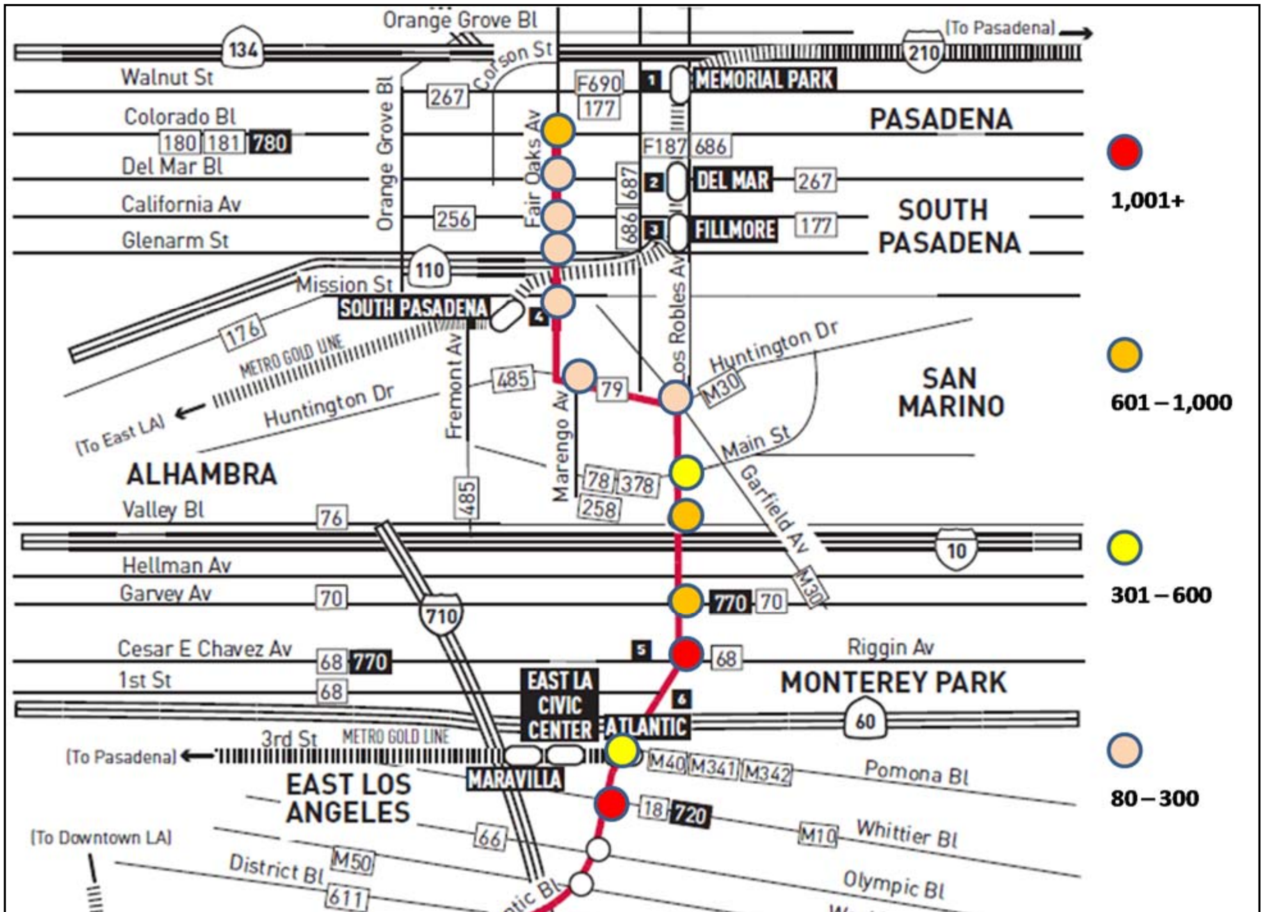
3.2.4 Ridership

This section provides stop-level and route-level ridership numbers for Metro Local 260 and Rapid 762, which have the most overlap with the proposed BRT Alternative route alignment.

3.2.4.1 Stop-Level Ridership

Figure 3-1 shows average daily boarding by stop location (sum of both directions of travel) for Metro Local 260 and Metro Rapid 762 on Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard within the study area, based on Metro stop-level ridership data. This is shown only for the 13 common stops shared by Routes 260 and 762 within the study area – Fair Oaks Avenue and Colorado Boulevard at the north end; Atlantic Boulevard and Whittier Boulevard at the south end.

FIGURE 3-1
Metro Routes 260 and 762, Average Daily Boarding By Stop



Source: Los Angeles Metro, January 2011 data.

With the exception of Fair Oaks Avenue and Colorado Boulevard, the stop locations with the highest levels of boarding activity are all located in the southern part of the study area – in particular Atlantic Boulevard and Cesar Chavez Avenue/Riggin Street, and Atlantic Boulevard and Whittier Boulevard, which have an average of over 1,000 daily boarding.

Some of these stops are served by other Metro routes in addition to Routes 260 and 762. These stops include Fair Oaks Avenue and Colorado Boulevard (also served by Routes 686/687), Huntington Drive and Marengo Avenue (also served by 79), and Atlantic Boulevard and Riggin Street (also served by 770). With the existing dataset, it is not possible to break out the boarding between Routes 260 and 762 or between these other routes.

3.2.4.2 Route-Level Ridership

Table 3-3 shows fiscal year (FY) 2012 route-level ridership and passenger mile data for Routes 260 and 762. The numbers provided are for the entire route length, not limited to the study area.

TABLE 3-3
Metro Routes 260 and 762, Route-Level Ridership Data

Route Name	Time Period	FY 2012 Ridership	FY 2012 Passenger Miles	Average Daily Ridership	Average Daily Passenger Miles	Average Passenger Trip Length (in miles)	Estimated Average Ridership per Vehicle Trip
260	Weekdays	3,169,375	13,110,843	12,429	51,415	4.1	115.1
	Saturdays	582,465	2,675,423	10,990	50,480	4.6	105.7
	Sundays	478,969	2,181,030	8,258	37,604	4.6	93.8
762	Weekdays	1,250,791	6,918,824	4,905	27,133	5.5	72.1

Source: Los Angeles Metro, FY 2012 data

Key findings as shown in Table 3-3 are as follows:

- Average daily ridership on weekdays is 12,429 for Route 260 and 4,905 for Route 762.
- Based on estimated daily vehicle trips, average ridership per vehicle trip is higher for Route 260 (about 115.1 on weekdays) than for Route 762 (about 72.1).
- Passenger trip lengths are longer for Route 762 (about 5.5 miles) than for Route 260 (about 4.1 miles on weekdays).

3.2.5 Bus Travel Times

To supplement Metro's operational data, the design team conducted a survey of the speed and delay of Route 762. The methodology, data collected, results, and key observations are discussed below.

3.2.5.1 Methodology

A total of 12 runs to collect travel time and delay information (6 in the northbound direction and 6 in the southbound direction) were conducted during the morning and evening commute hours (7:00 a.m. to 9:00 a.m., and 4:00 p.m. to 6:00 p.m.) over a period of 4 weekdays in December 2012. During each run, the data collector boarded the bus at an existing 762 bus stop, noted the start time, recorded the amount of delay upon each delay event on the ride, and noted the end time after he/she got off the bus. The majority of the runs began at Whittier Boulevard and Atlantic Boulevard at the south and ended at Colorado Boulevard and Fair Oaks Avenue at the north, or vice versa.

3.2.5.2 Data Collected

On each run, the total run time, observed delays, and nature of each delay event were recorded. Three types of delays were separately recorded:

- Delay caused by a red light at the signalized intersection ahead
- Delay caused by the bus pulling out to a bus stop serving passengers and merging back with traffic
- Delay for other reasons, such as heavy traffic, extra wait time at stop, etc.

A summary of the data collected is provided in Appendix B.

3.2.5.3 Summary of Results and Key Observations

The recorded total run time and percent of total delays versus run time ratio on each run are presented in Table 3-4.

TABLE 3-4
Summary of Recorded Total Run Time and Percentage Delay to Total Run Time from Survey Runs

	Southbound Runs						Northbound Runs					
	Dec 18 a.m.	**Dec 19 a.m.**	**Dec 10 p.m.**	**Dec 18 p.m.**	**Dec 19 p.m.**	**Dec 20 p.m.**	**Dec 18 a.m.**	**Dec 19 a.m.**	**Dec 10 p.m.**	**Dec 18 p.m.**	**Dec 19 p.m.**	**Dec 20 p.m.**
Recorded Run Time (minutes)	37.4	40.0	40.5	47.3	52.3	46.4	38.9	37.6	48.0	41.0	47.5	50.8
% Delay to Total	35%	40%	32%	47%	52%	52%	32%	38%	35%	43%	40%	52%

Results indicate that the delay time constituted more than 50 percent of the total run time on Route 762 during the p.m. peak hours on December 18 and 19, 2012. The high variability of the run times during the p.m. periods should also be noted.

According to the bus schedule effective June 17, 2012, the estimated run times for Route 762 are 36 minutes for the a.m. peak periods and 41 minutes for the p.m. peak periods between Atlantic Boulevard at Pomona Boulevard and Fair Oaks Avenue at Colorado Boulevard. Since the survey run times were recorded over a longer distance, a direct comparison between scheduled run times and recorded run times cannot be made. If adjustments to the scheduled run times are made using assumed average travel speeds, however, a comparison can be made; those results are presented in Table 3-5.

TABLE 3-5
Comparison between Recorded Run Time and Scheduled Run Time of Metro Rapid Route 762

	Southbound Runs						**Northbound Runs**					
	Dec 18 a.m.	**Dec 19 a.m.**	**Dec 10 p.m.**	**Dec 18 p.m.**	**Dec 19 p.m.**	**Dec 20 p.m.**	**Dec 18 a.m.**	**Dec 19 a.m.**	**Dec 10 p.m.**	**Dec 18 p.m.**	**Dec 19 p.m.**	**Dec 20 p.m.**
Recorded Run Time (minutes)	37.4	40.0	40.5	47.3	52.3	46.4	38.9	37.6	48.0	41.0	47.5	50.8
Scheduled Run Time (minutes)*	39.7	39.7	44.7	44.7	44.7	44.7	39.7	39.7	44.7	44.7	44.7	44.7

*Adjustments were applied to the Metro bus schedule to account for different starting points at the south end (Pomona vs. Whittier).

Results indicate that the variations between the scheduled run time and recorded run time are the greatest on the p.m. runs. In particular, the recorded run time is over 7 minutes longer than the scheduled run time in the southbound direction on December 19, 2012 (p.m.).

Locations with the longest delays (greater than 50 seconds at signals; 20 seconds at stops; and 50 seconds for other reasons) are listed in Table 3-6.

TABLE 3-6
Locations with Longest Delays between Atlantic Boulevard at Whittier Boulevard and Fair Oaks Avenue at Del Mar Boulevard

Locations	**Reasons for delay**
Atlantic Boulevard at Whittier Boulevard	Signal and bus stop
Atlantic Boulevard at Beverly Boulevard	Signal
Atlantic Boulevard at Pomona Boulevard	Signal and bus stop
Atlantic Boulevard at SR 60 ramps	Signal; heavy traffic approaching the SR 60 interchange
Atlantic Boulevard at Cesar Chavez Avenue/Riggin Street	Signal and bus stop
Atlantic Boulevard at Garvey Avenue	Signal and bus stop
Atlantic Boulevard at Valley Boulevard	Signal and bus stop
Atlantic Boulevard at Shorb Street	Signal; heavy traffic approaching the intersection

TABLE 3-6
Locations with Longest Delays between Atlantic Boulevard at Whittier Boulevard and Fair Oaks Avenue at Del Mar Boulevard

Locations	Reasons for delay
Atlantic Boulevard at Mission Road/Front Street	Signal; heavy traffic approaching the intersection
Atlantic Boulevard at Main Street	Signal and bus stop
Atlantic Boulevard at Garfield Avenue	Signal (northbound left-turn only)
Huntington Drive at Garfield Avenue	Signal (northbound left-turn only)
Huntington Drive at Fair Oaks Avenue	Signal (southbound left-turn only)
Fair Oaks Avenue at Mission Street	Signal
Fair Oaks Avenue at SR 110 ramps (including State Street and Grevalia Street)	Signal; heavy traffic approaching the SR 110 interchange
Fair Oaks Avenue at California Boulevard	Signal
Fair Oaks Avenue at Del Mar Boulevard	Signal and bus stop

It should be noted that the majority of the recorded delays occurred at traffic signals, bus stops, or heavy traffic approaching busy intersections or freeway interchanges.

3.3 Engineering Considerations

3.3.1 Horizontal Alignment

After consideration of the project needs and objectives, service to major destinations, available ROW, and maintaining traffic lanes, a total of two BRT Alternatives with one additional design variation (developed during the evaluation process) were selected for conceptual engineering and initial environmental evaluation. These alternatives were then evaluated on factors such as general traffic lanes, on-street parking, sidewalk and median widths, and ROW impacts. In the AA Report (CH2M HILL, 2012a), Alternatives BRT-6 and BRT-6A were identified and recommended for Project Approval/Environmental Documentation.

Alternative BRT-6, as identified and recommended in the AA phase, would provide BRT service between Atlantic Boulevard at Whittier Boulevard in East Los Angeles, and PCC and Caltech in Pasadena. Northbound BRT vehicles would travel north along Atlantic Boulevard to Huntington Drive, then briefly west along Huntington Drive to Fair Oaks Avenue, and then north along Fair Oaks Avenue into Pasadena. In Pasadena, the BRT vehicles travel along Colorado Boulevard, making a loop to Caltech and PCC via Hill Avenue, California Boulevard, and Lake Avenue. The total length of the route would be 13.8 miles. Figure 3-2 illustrates the alignment of Alternative BRT-6.

A second option, Alternative BRT-6A, is a design variation of Alternative BRT-6. Alternative BRT-6A, as identified and recommended in the AA phase, is able to provide exclusive bus lanes for a longer part of the route than Alternative BRT-6. Instead of traveling both eastbound and westbound on Colorado Boulevard, Alternative BRT-6A would travel only eastbound on Colorado Boulevard and return westbound on California Boulevard after stopping at PCC and Caltech. Alternative BRT-6A was also developed to address ROW constraints on Fair Oaks Avenue north of Glenarm Street in Pasadena. There is sufficient room in this section for an exclusive bus lane in one direction only. By operating in only one direction on Fair Oaks Avenue in this section (and the other on Raymond Avenue), Alternative BRT-6A is able to provide exclusive bus lanes for a longer part of the route than does Alternative BRT-6. The total length of the route would be 14.2 miles. Figure 3-2 illustrates the alignment of Alternative BRT-6A.

Based on the previous AA review and public/agency comments regarding the performance for the BRT-6 and BRT-6A Alternatives, refinements were made to those alignments at several locations. In BRT-6 and BRT-6A Alternatives, the north loop had run along either Colorado Boulevard or California Boulevard, respectively. Along this segment in the BRT 6/6A Alternative, continuous dedicated bus lanes were proposed and would displace on-street parking. These routes also operated through several highly congested streets and intersections, had bus stops that have many buses stopping/blocking the stop areas, and the loops' eastbound and westbound locations were spaced farther apart with a slightly longer travel distance. Due to the potential performance concerns of BRT 6 and BRT-6A, the BRT Alternative route has been further refined to run along Del Mar Boulevard, which is adjacent to Colorado Boulevard and approximately mid-way between Colorado Boulevard and California Boulevard. Del Mar Boulevard is convenient to high density residential, school, and shopping. However, with this configuration, the BRT vehicle will travel through a rail crossing where Del Mar Boulevard intersects with Metro Gold Line between Arroyo Parkway and Raymond Avenue. Mitigations to reduce performance impacts due to the rail crossing would be implemented through signal coordination. The proposed segment running along Del Mar Boulevard is less congested than Colorado Boulevard, but the less congested eastern portion of Colorado Boulevard will still be utilized to serve residential areas and the two college campuses.

Although the BRT-6A option allowed longer exclusive bus lanes in the corridor, this option did not move forward in the refined BRT Alternative. Since the northern loop portion has moved from California Boulevard to Del Mar Boulevard, access to main activity centers and facilities were necessary on Fair Oaks Avenue between these segments. Fair Oaks Avenue is convenient to medical facilities, shopping, and would attract more ridership. Figure 2-3 illustrates the alignment of the refined BRT Alternative.

Another potential refinement that was reviewed after the AA phase included an extension to the Jet Propulsion Laboratory (JPL). However, a connecting service line already exists on that segment along Fair Oaks to JPL. Review of the operations suggested that by increasing the Metro bus service along the existing route to JPL, the BRT Alternative would not need to replace or duplicate that service.

The direction of travel on the loop portion of the alignment could be configured in either a clockwise or counterclockwise direction. The proposed design uses a counterclockwise direction to utilize existing station locations to reduce confusion for existing riders. Although left-turns generally result in longer signalized intersection delays, signal synchronization and TSP would help mitigate those delays.

3.3.2 Identifiable Running Ways

The BRT Alternative is an urban street BRT running way. Based on feedback from Technical Advisory Committee meetings that followed the AA, a spreadsheet-based model, hereby referred to as the Bus Rapid Transit Operational Performance Tool (BRTOPT), was developed to analyze different bus lane configurations for the running way of the BRT Alternative. The BRTOPT evaluated travel time performance and the potential effects of three BRT running way scenarios, future no build scenario, and two existing conditions scenarios for the purpose of comparison:

1) 2013 Existing Conditions
2) 2013 Existing Conditions with TSP Improvements
3) 2035 No Build Condition with TSP Improvements
4) 2035 Future Condition with Mixed Flow and Right-Side BRT Lanes with TSP Improvements
5) 2035 Future Condition with Continuous Right-Side BRT Lanes with TSP Improvements
6) 2035 Future Condition with Median BRT Lanes with TSP Improvements

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Legend:

- Mixed-Flow Traffic
- Exclusive Lanes: Single Direction
- Exclusive Lanes: Both Directions
- Station (All)
- Station (BRT-6)
- Station (BRT-6A)
- Railroad
- Existing Freeway
- Existing Road
- Metro Gold Line/Station
- City Boundary

FIGURE 3-2
BRT-6/6A
SR 710 North Study
Los Angeles County, California

PRE-DELIBERATIVE DRAFT

CH2MHILL.

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In Scenario 4, BRT vehicles would run in mixed flow lanes where adding exclusive right-side BRT lanes to the roadway would require acquisition of private properties.

The BRTOPT analyzes the BRT corridor in subsegments defined by bus operating conditions. The conditions include: signalized intersections, approaches to and departures from intersections, mid-block segments, bus stop zones, approaches to and departures from bus stop zones. In general, speeds and delays used in the model for existing conditions and existing conditions with TSP improvements were based on:

- Actual field observations of Metro Rapid 762 performance
- Ongoing Metro TSP project for the Atlantic Boulevard and Fair Oaks Avenue corridors
- 2004 Crenshaw Boulevard Corridor Bus Signal Priority Pilot Project Before/After Study
- Sample VISSIM (an industry-standard traffic flow simulation software) analyses from other similar studies with TSP applications

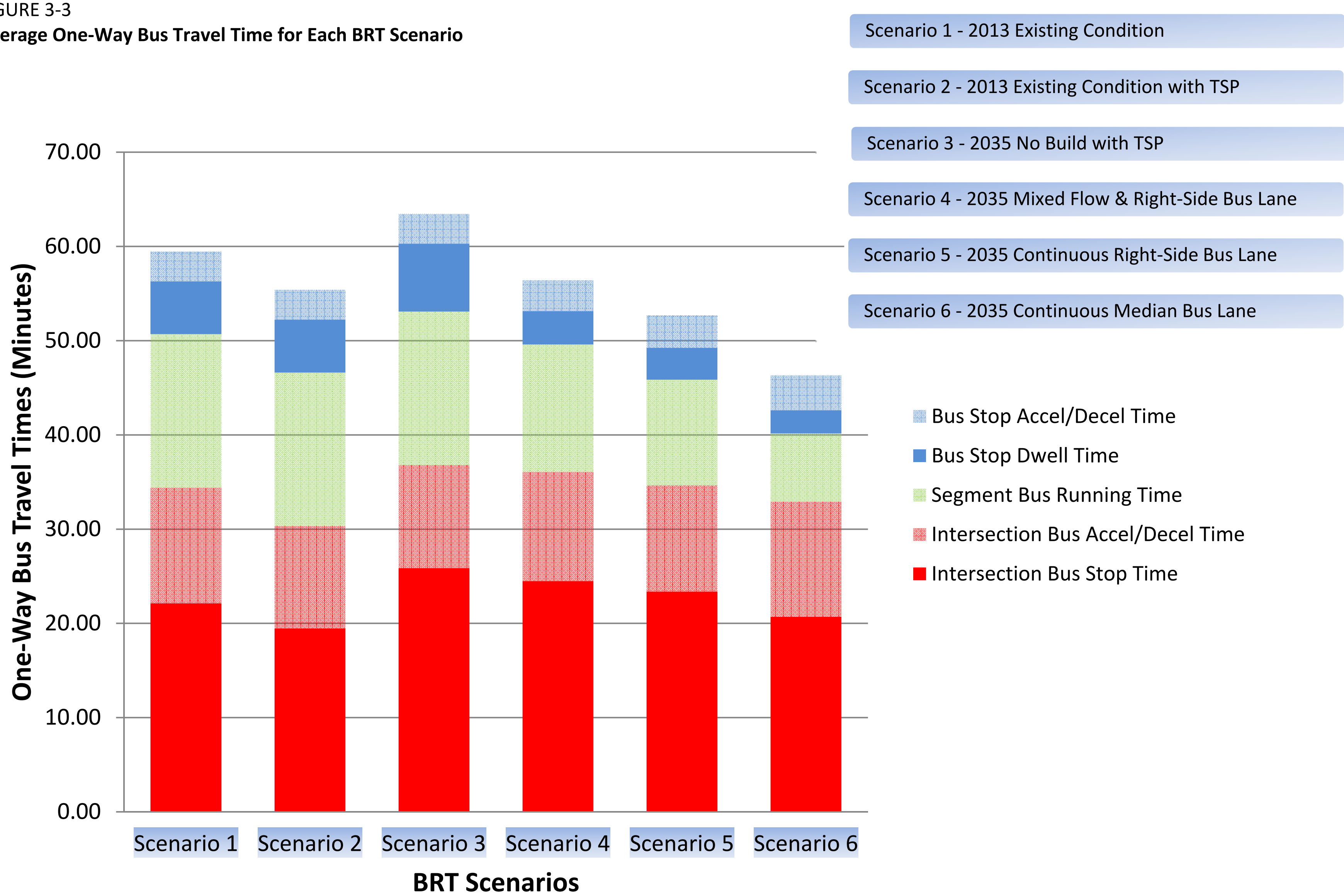
Using the BRTOPT, the results of the travel time analysis for each scenario are shown in Table 3-7.

TABLE 3-7
Average One-Way Bus Travel Times for Each BRT Scenario

	BRT Scenarios	One-Way Bus Travel Times (Minutes)
1	2013 Existing Conditions	59
2	2013 Existing Conditions with TSP	55
3	2035 No Build with TSP	63
4	2035 BRT Mixed Flow and Right-Side with TSP	56
5	2035 BRT Continuous Right-Side Lane with TSP	53
6	2035 BRT Median Lane with TSP	46

Looking at the histogram in Figure 3-3, which shows the makeup of the BRT operating conditions for each scenario, the bus spends most of its time at the intersection. The blocks of red indicate that the bus is either stopped at the intersection or accelerating from and decelerating to an intersection. With the BRT improvements, intersection dwell times and bus stop dwell times would be reduced. BRT vehicles will also travel more closely to full speed with exclusive lanes and will spend less time travelling from one segment to another, hence, the smaller block of green in future scenarios. For comparison purposes only, a scenario with a 2035 No Build condition without TSP improvements will result in a one-way estimated travel time of 69 minutes but is not included in Table 3-7 or the histogram in Figure 3-3.

FIGURE 3-3
Average One-Way Bus Travel Time for Each BRT Scenario



Besides travel times, parking and ROW effects of the three 2035 future build conditions were also evaluated. A summary of the results is presented in Table 3-8.

TABLE 3-8
BRT Running Way Scenario Analysis Results

Scenarios	One-Way Bus Travel Times (Minutes)	Total No. of Partial and Full Property Take	Total Acreage of Partial and Full Property Take	No. of a.m./p.m. Parking Spaces Potentially Displaced	No. of Permanent Parking Spaces Potentially Displaced
Mixed-Flow and Right-Side Bus Lane	56	34	0.32	1,100	70
Continuous Right-Side Bus Lane	53	463	64.11	1,800	100
Continuous Median Bus Lane	46	582	69.47	0	1,900

Results of the analysis shown in Table 3-8 reveal that bus travel times are 3 and 10 minutes shorter for the Continuous Right-Side Bus Lanes and Continuous Median Bus Lane scenarios, respectively, when compared with the Mixed-Flow and Right-Side Bus Lane scenario. However, the two continuous bus lane scenarios have remarkably greater impacts to the commercial and residential communities. Therefore, it is recommended that the Mixed-Flow and Right-Side Bus Lane scenario be considered for further engineering and environmental review since it has the lowest potential effects to properties and parking, and yet provides time savings compared to the future No Build condition. Additional details are presented in Appendix C. The bus operations speed improvements due to dedicated bus lanes would have a partial affect on ridership. However, it should be noted that there are many factors that affect ridership. Details on how bus travel time could potentially affect ridership are presented in Appendix D.

3.3.2.1 Peak-Period Bus Lanes

The dedicated bus lanes in Alternative BRT-6/6A recommended in the AA would be created by use of on-street parking lanes, narrowing of landscaped medians or sidewalks, or removal of planter strips adjacent to sidewalks. Displacement or elimination of heavily used on-street parking can create significant inconvenience to the communities and can have an adverse effect on businesses. Therefore, the BRT Alternative has been refined to limit use of parking lanes for bus transit to the peak traffic periods only, typically from 7:00 to 9:00 a.m. and 4:00 to 6:00 p.m. The peak-period dedicated bus lanes for BRT vehicles or other buses are open to parking or mixed-flow traffic outside the peak traffic periods during the morning and afternoon commutes. The peak-period bus lanes minimize conflicts between buses and other traffic on the roadway and therefore reduce delays and travel times. The dedicated bus lanes are also shared with other transit vehicles, and right-turn traffic at intersections and driveways. The bus lane would not be physically separated from general traffic; therefore, queue jumps, adequate signage, markings, education, and ongoing enforcement will be important to ensure the speed and reliability of the BRT service.

The exclusive bus lanes would be created generally in existing ROW through a variety of methods, including restriping the roadway, prohibiting on-street parking, narrowing medians, narrowing planted parkways, and/or narrowing sidewalks. Full property acquisition was not expected to be required for the BRT Alternative based on the initial development of this alternative. In some areas, exclusive bus lanes could not be provided without substantial ROW acquisition. In these areas, the BRT buses would share existing lanes with other traffic.

Limits of peak-period bus lanes in the BRT Alternative and descriptions of proposed work approaches are listed in Table 3-9.

TABLE 3-9
Summary of Proposed Peak-Period Bus Lane Segments

Peak Period Bus Lane Segments			Existing Cross Section (Curb to Curb)	Proposed Cross Section (Curb to Curb)	Proposed Widening	Proposed Work Approach
Direction	**Location**	**From/To**				
NB	Atlantic Boulevard	Whittier/ Floral	70 - 88 feet	75 - 88 feet	0 - 5 feet	• Restripe • Reduce Sidewalk Widths • Prohibit On-Street Parking During Peak Periods
SB	Atlantic Boulevard	Corona/ EB SR 60 On-Ramp	84 - 88 feet	84 - 95 feet	7 feet*	• Restripe • ROW Acquisition*
NB & SB	Atlantic Boulevard	Floral/ Garvey	70 - 80 feet	76 - 84 feet	0 - 6 feet	• Restripe • Reduce Sidewalk & Median Widths • Reduce Width of Planted Parkways • Prohibiting On-Street Parking During Peak Periods
SB	Atlantic Boulevard	Hellman/ Garvey	70 - 80 feet	72 - 89 feet	2 - 6 feet, 12 feet*	• Restripe • Reduce Sidewalk Widths • ROW Acquisition*
SB	Atlantic Boulevard	Valley/ Norwood	70 - 76 feet	76 - 85 feet	6 feet, 9 feet*	• Restripe • ROW Acquisition*
NB and SB	Huntington Drive	Garfield/ Fair Oaks	110 feet	110 feet	0 feet	• Restripe • Prohibit On-Street Parking During Peak Periods
NB and SB	Fair Oaks Avenue	Spruce/ Columbia	76 - 110 feet	82 - 122 feet	6 - 12 feet	• Restripe • Reduce Sidewalk Widths • Prohibit On-Street Parking During Peak Periods
NB	Fair Oaks Avenue	Columbia/ Del Mar	62 feet	65 - 76 feet	3 - 14 feet	• Restripe • Reduce Sidewalk Widths • Prohibit On-Street Parking During Peak Periods

* Widening caused by the addition of a queue jumper bus bay, which is further discussed in Section 3.3.4.
EB – eastbound

3.3.3 Typical Section

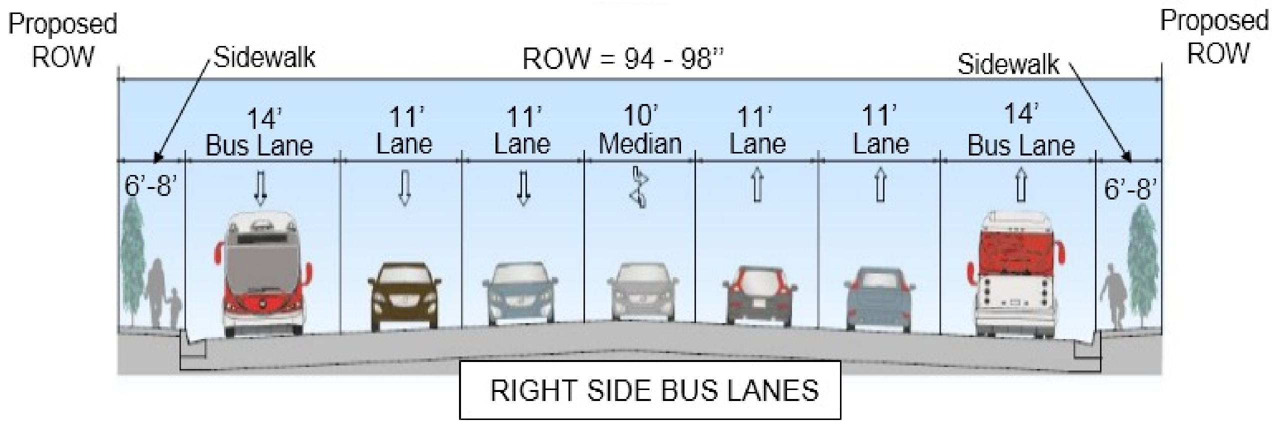
Generally, there are nine typical section configurations where construction will be required along the BRT corridor; these are summarized in Table 3-10. Lane widths vary by segment. In all cases, sidewalks are located on either side of the roadway with a minimum width of 6 ft.

TABLE 3-10
Typical Section Segments

No.	Typical Section	Segment Location
1	• SB On-Street Parking • 2 SB Through Lanes • Median • 2 NB Through Lanes • NB BRT Lane • NB On-Street Parking	Atlantic Boulevard: • Whittier Boulevard to Corona Street Fair Oaks Avenue: • Arlington Drive to Hurlbut Street • Bellefontaine Street to Del Mar Boulevard
2	• SB BRT Lane • 2 SB Through Lanes • Median • 2 NB Through Lanes • NB BRT Lane	Atlantic Boulevard: • Corona Street to First Street • Floral Drive to El Portal Place
3	• 3 SB Through Lanes • Median • 2 NB Through Lanes • NB BRT Lane	Atlantic Boulevard: • First Street to Floral Drive
4	• SB BRT Lane • 2 SB Through Lanes • Median • 2 NB Through Lanes • NB On-Street Parking	Atlantic Boulevard: • El Portal Place to Newmark Avenue • Emerson Avenue to Hellman Avenue • Glendon Way to Valley Boulevard
5	• SB BRT Lane • 2 SB Through Lanes • Median • 2 NB Through Lanes • NB BRT Lane	Atlantic Boulevard: • Valley Boulevard to Shorb Street
6	• 2 SB Through Lanes • Median • 2 NB Through Lanes • NB BRT Lane	Atlantic Boulevard: • San Marino Avenue to Commonwealth Avenue Fair Oaks Avenue: • State Street to Arlington Drive • Hurlbut Street to Bellefontaine Street
7	• 3 SB Through Lanes • 2 NB Through Lanes	Garfield Avenue: • Atlantic Boulevard to Huntington Drive
8	• SB BRT Lane • 3 SB Through Lanes • Median • 3 NB Through Lanes • NB BRT Lane	Huntington Drive: • Garfield Avenue to Fair Oaks Avenue
9	• SB On-Street Parking • SB BRT Lane • 3 SB Through Lanes • Median • 3 NB Through Lanes • NB BRT Lane • NB On-Street Parking	Fair Oaks Avenue: • Huntington Drive to Monterey Road

An example of a typical section with right-side bus lanes in both directions is shown in Figure 3-4.

FIGURE 3-4
Typical Section: Right-Side Bus Lanes in Both Directions



3.3.4 Intersection Improvements/Queue Jump

In addition to peak period bus lanes, 47 intersection improvements have been included at select signalized intersections, many of which experience peak-hour traffic congestion. A queue jump or bypass lanes allows BRT vehicles to bypass traffic queues approaching an intersection. The queue jump lane is created by converting the right-turn lane or adding a lane long enough to allow transit vehicles to bypass the traffic queues. In addition, a transit signal phase can be added to the intersection to provide transit vehicles an early green time so that they can bypass the general traffic. Addition of through lanes in select roadway segments and other TSM/TDM improvements that reduce congestion delays are also included. Intersection improvements are summarized in Table 3-11.

TABLE 3-11
Intersection Improvements

Intersection	Direction	Improvements	Benefits	ROW Acquisition Yes/No	Construction
Atlantic Boulevard/ Whittier Boulevard	NB	• Striped exclusive right-turn lane with bus exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping.
Atlantic Blvd/ Hubbard Street, Sixth Street, Eagle Street, Sixth Street, Fourth Street	NB	• Exclusive bus lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance	No	Narrowing of the sidewalk. Roadway widening. Restriping.
Atlantic Boulevard/ Beverly Boulevard	NB	• New 11-foot auxiliary right-turn lane with a length of 175 feet • Farthest through-lane designated as an exclusive bus lane • 14-foot through-lane queue jump	Bypass traffic queue. Minimize delay at intersections. Improve travel-time performance.	Yes	Narrowing of the sidewalk. Restriping ROW acquisition.
Atlantic Boulevard/ Pomona Boulevard	SB	• Exclusive bus lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance	No	Narrowing of the sidewalk. Roadway widening. Restriping.
Atlantic Boulevard/ EB Route 60 Off-Ramp	SB	• Exclusive bus lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance	No	Restriping. Roadway widening. Median Width Reduction.
Atlantic Boulevard/ First Street, Cesar Chavez Avenue	SB	• Exclusive bus lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Reduction.
Atlantic Boulevard/ Brightwood Street, El Repetto Drive, Sevilla Street, Cadiz Street, El Portal Place	NB/SB	• Exclusive Bus Lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Reduction.
Atlantic Boulevard/Harding Avenue, Newmark Avenue	NB	• Exclusive Bus Lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Reduction.
Atlantic Boulevard/ Garvey Avenue	NB	• New 12-foot auxiliary right-turn lane with a length of 125 feet • Right-turn lane also serves as an exclusive bus lane • 12-foot right-turn lane queue jump on far-side with a length of 300 feet • Far-side bus bay	Bypass through traffic queue. Minimize delay at intersections. Improve travel-time performance. Improve safety of merging into traffic.	Yes	Narrowing of the sidewalks. Restriping. ROW acquisition.
Atlantic Boulevard/Emerson Avenue	NB	• Exclusive Bus Lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Reduction.
Atlantic Boulevard/Glendon Way	NB/SB	• Proposed island on Glendon Way	Prohibits left turns to and from Atlantic Blvd and eliminates left turn delays. Improves travel-time performance.	No	Raised Median on Glendon Way. Restriping. Signal Modification.
Atlantic Boulevard/ Valley Boulevard	NB	• New 10-foot auxiliary right-turn lane with a length of 135 feet • Farthest through-lane designated as an exclusive bus lane • 12-foot through-lane queue jump with a length of 185 feet • Far-side bus bay	Bypass traffic queue. Minimize delay at intersections. Improve travel-time performance. Improve safety of merging into traffic.	Yes	Narrowing of the sidewalks. Restriping. ROW acquisition.
Atlantic Boulevard/Mission Road, Front Street	SB	• 12-foot right-turn lane queue jump with a length of 140 feet • Right-turn lane also serves as a dedicated bus lane • New 11-foot through lane between Mission and Front • Exit taper after Front Street	Bypass through traffic queue. Minimize delay at intersections. Improve travel-time performance. Improve safety of merging into traffic.	Yes	Narrowing of the sidewalks. Restriping. ROW acquisition.
Atlantic Boulevard/ Garfield Avenue	SB	• Addition of 11-foot right-turn lanes on Huntington and Garfield over a span of 460 feet • Right-turn lane on Huntington will also serve as an exclusive bus lane	Bypass through traffic queue. Minimize delay at intersections. Improve travel-time performance	Yes	Narrowing of the sidewalks. Restriping. ROW acquisition.
Huntington Drive/Fletcher Avenue, Marengo Avenue	EB/WB	• Striped exclusive bus lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Median Width Reduction.
Huntington Drive/Fair Oaks Avenue	WB/SB	• Added 3rd Left Turn Lane from Fair Oaks Avenue to Huntington Drive • New Exclusive Right Turn Bus Lane from Huntington Drive to Fair Oaks Avenue	Minimize delay at intersections for all vehicles. Improves travel-time performance.	No	Restriping. Median Width Reduction. Roadway Widening.
Fair Oaks Avenue/Spruce Street, Oak Street, Rollin Street, Bank Street, Monterey Road, Oxley Street, El Centro Street, Mission Street, Hope Street	NB/SB	• Exclusive bus lane in both NB/SB direction with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Width Reduction. Median Width Reduction.
Fair Oaks Avenue/Grevelia Street, State Street	NB	• New 10-foot auxiliary right-turn lane with a length of 150 feet • Farthest through-lane designated as an exclusive bus lane • 14-foot through-lane queue jump before Grevelia with a length of 150 feet • 14-foot right-turn lane queue jump before State with a length of 105 feet • Dedicated bus lane at end of queue jump	Bypass through traffic queue. Minimize delay at intersections. Improve travel-time performance. No merging into traffic out of the queue jump.	Yes	Narrowing of the sidewalks. Restriping. ROW acquisition.
Fair Oaks Avenue/Columbia Street	NB/SB	• Exclusive bus lane in both NB/SB direction with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Width Reduction. Median Width Reduction.
Fair Oaks Avenue/Glenarm Street, Bellefontaine Street, Fillmore Street, Congress Street, California Boulevard, Del Mar Boulevard	NB	• Exclusive bus lane with right turn exempt	Bypass traffic queue. Minimize delay at intersections. Improves travel-time performance.	No	Restriping. Roadway widening. Sidewalk Width Reduction. Median Width Reduction.

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3.3.5 TSM/TDM Improvements

When applicable, improvements proposed in the TSM/TDM Alternative were included as a base concept in the BRT Alternative. These intersection improvements are summarized in Table 3-12.

TABLE 3-12
TSM/TDM Improvements along BRT Alternative

Location	Improvement
Atlantic Boulevard/Glendon Way Intersection	Construct triangular channelizing islands that prohibit left-turn movements from all legs at intersection to reduce intersection delay.
Atlantic Boulevard/Norwood Place Intersection	Construct triangular channelizing islands that prohibit left-turn movements from all legs at intersection to reduce intersection delay.
Atlantic Boulevard/Garfield Avenue/ Huntington Drive Intersection	Exclusive right-turn lane added on Garfield Avenue north and south of Huntington Drive to reduce intersection delay.
Huntington Drive/Fair Oaks Avenue Intersection	Third left-turn lane added to left-turn movement from southbound Fair Oaks Avenue to eastbound Huntington Drive to provide more capacity.
Fair Oaks Avenue/SR 110 Interchange	Hook ramp improvements. See TSM/TDM Alternative for full detail.

The reversible lane proposed in the TSM/TDM Alternative along Fair Oaks Avenue between Monterey Road and Mission Street was not feasible in the BRT Alternative. The proposed reversible lane in the median of Fair Oaks Avenue is in conflict with the proposed raised median (for the BRT) designed to prohibit left-turn movements from driveways. The left-turns would present a safety issue since there likely will be a difference in speeds in the bus lane versus general traffic lane, and the raised median is a mitigation measure. Also, the design of the terminus of the reversible lane at Fair Oaks Avenue and Grevelia Street is in conflict with the dedicated bus lane. The exclusive bus lane would have to be shortened by several hundred feet.

The reversible lane along Atlantic Boulevard between Glendon Way and Norwood Place proposed in the TSM/TDM Alternative would require a width of at least 12 ft and is not recommended for the BRT Alternative. The two-way left-turn median lane on Atlantic and Fair Oaks is only 10 ft wide and would need an additional 2 ft from the street cross section. However, in order to provide a 12-ft reversible median lane, on-street parking would be eliminated in the northbound direction along Atlantic Boulevard from Glendon Way to Valley Boulevard, or there would be narrower bus lanes on Atlantic Boulevard, which would not meet Metro standard.

3.3.6 Roadway Design

The roadway geometric design elements of the BRT Alternative were developed using the following list of reference documents:

- 2012 Metro Transit Service Policy
- Metro BRT Design Criteria, 2008
- Highway Design Manual, California Department of Transportation, May 2012
- A Policy on Geometric Design of Highways and Streets, AASHTO, 2011, 6th Edition
- Standard Plans Los Angeles County Public Works, 2000
- 2010 ADA Standards for Accessible Design

Table 3-13 summarizes the roadway design criteria established for each design element of the project. Roadway improvements proposed within Caltrans ROW include the SR 60 and Atlantic Boulevard interchange, I-10 and Atlantic Boulevard Interchange, and SR 110 and Fair Oaks Avenue interchange. Design exceptions for the improvements proposed at these locations are identified in the Draft SR 710 Study Project Report (CH2M HILL, 2014c, in progress).

3.3.7 Stations

Proper station placement and spacing achieves a balance of convenience to the BRT patrons and general traffic. Stations were generally located near medical facilities, schools, major retail malls, multi-unit apartments, transfer points with other bus or transit systems, and other major activity centers to attract a large number of transit riders. The photographs here are examples of major activity centers along the corridor.

During the AA phase, 19 stations were proposed. Two of those locations, Cadiz and Alhambra, from the BRT-6 Alternative were eliminated after the AA phase because they were inconsistent with the existing Metro Rapid 762 stops. Stations would be at approximately 0.8-mile intervals on average, at major activity centers and cross streets, as listed in Table 3-14.

Photographs of Major Activity Centers. Top to bottom: Retail Area in South Pasadena, Metro Gold Line Station in East Los Angeles, Medical Facilities in Pasadena, Caltech in Pasadena

TABLE 3-13
SR 710 North Study - BRT Alternative Preliminary Engineering - Proposed Roadway Geometric Design Criteria

Design Element	Geometric Design Criteria		Notes/Source
	Atlantic Boulevard and Fair Oaks Avenue	Huntington Drive	
GENERAL			
Design Classification	Major Arterial (At.) and Minor Arterial (F.O.)	Major Arterial	Southern California Association of Governments
Posted Speed (mph)	25-35	40	Field Visit
Design Speed (mph)	35	40	AASHTO Pages 7-27
Design Vehicle	SU, 60-foot Articulated Bus at specific locations	SU, 60-foot Articulated Bus at specific locations	
HORIZONTAL ALIGNMENT			
Lane Drop and Lane Width Reduction	L = WV	L = WV	Caltrans HDM 206.3
Curb Return Radius (feet)	Match existing radius at curb return	Match existing radius at curb return	Turn movements will be checked using AutoTurn
Stopping Sight Distance (feet)	25 mph=150 feet/30 mph=200 feet/35mph=250 feet	40 mph=300 feet	Caltrans Page 200-1.
Intersection Sight Distance (feet)	275/330/385	440	Caltrans Page 400-18
Decision Sight Distance (feet)	30 mph=450 feet/35mph=525 feet	40 mph=600 feet	Caltrans Page 200-3
CROSS SECTION			
Clear space for wheelchair loading at front door	5 feet x 8 feet (w x d)	5 feet x 8 feet (w x d)	Caltrans DIB 82-03 or ADAAG 10.2.1(1)
Street Cross Slope (%)	1% min/2% max/match existing	1% min/2% max/match existing	Metro BRT Design Criteria 3.10.3.E
Maximum gradient for ramps (%)	8.33	8.33	Ramps will be designed in accordance with ADA requirements and Los Angeles County standards
Curb Height (inch)	6	6	APWA 120-0/Metro BRT Design Criteria 3.8.8.C
Bus Pad			
Pad Length	90 feet minimum or match platform length	90 feet minimum or match platform length	Los Angeles County/APWA Std Plan S-433-0
Pad Width	12 feet	12 feet	Los Angeles County/APWA Std Plan S-433-0
Bus Lane (Adjacent to Curb)			
Lane Width	14 feet typical, 12 feet minimum	14 feet	Metro Transit Service Policy 3.2.B page 21
Cross Slope (%)	+2% or -2%	+2% or -2%	Bus lane may be designed to slope towards the median depending on existing condition
Travel Lanes			
Through Lane Width	10 feet minimum	11 feet minimum	Metro BRT Design Criteria 3.10.3.B
Left Turn Lane Width	10 feet minimum	10 feet minimum	Metro BRT Design Criteria 3.10.3.B
Cross Slope (%)	1% min/2% max towards curb	1% min/2% max towards curb	Metro BRT Design Criteria 3.10.3.G
Sidewalk			
Clear Width	6 feet minimum	6 feet minimum	2010 ADA Standard 403.5.3: 5-foot Minimum (Passing Space Provided At All Times)
Width at bus stops/stations	8 feet minimum	8 feet minimum	Caltrans DIB 82-03 or ADAAG 10.2.1(1)
Cross Slope	1:48 Maximum (2.08%)	1:48 Maximum (2.08%)	2010 ADA Standard 403.3
Running Slope	1:20 Maximum (5%)	1:20 Maximum (5%)	2010 ADA Standard 403.3
Median			
Two-Way Left Turn Lane Width	10 feet minimum	10 feet minimum	Metro BRT Design Criteria 3.10.3.B

All references to Metro BRT Design Criteria are intended to refer to "Metro BRT Design Criteria", Metro 2008
All references to AASHTO are intended to refer to "A Policy on Geometric Design of Highways and Streets", AASHTO 2011
All references to Caltrans are intended to refer to "Highway Design Manual", May 2012
All references to Los Angeles County are intended to refer to "Standard Plans Los Angeles County Public Works", 2000
All references to Metro Transit Service Policy are intended to refer to "2012 Metro Transit Service Policy"

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TABLE 3-14
BRT Alternative Station Locations

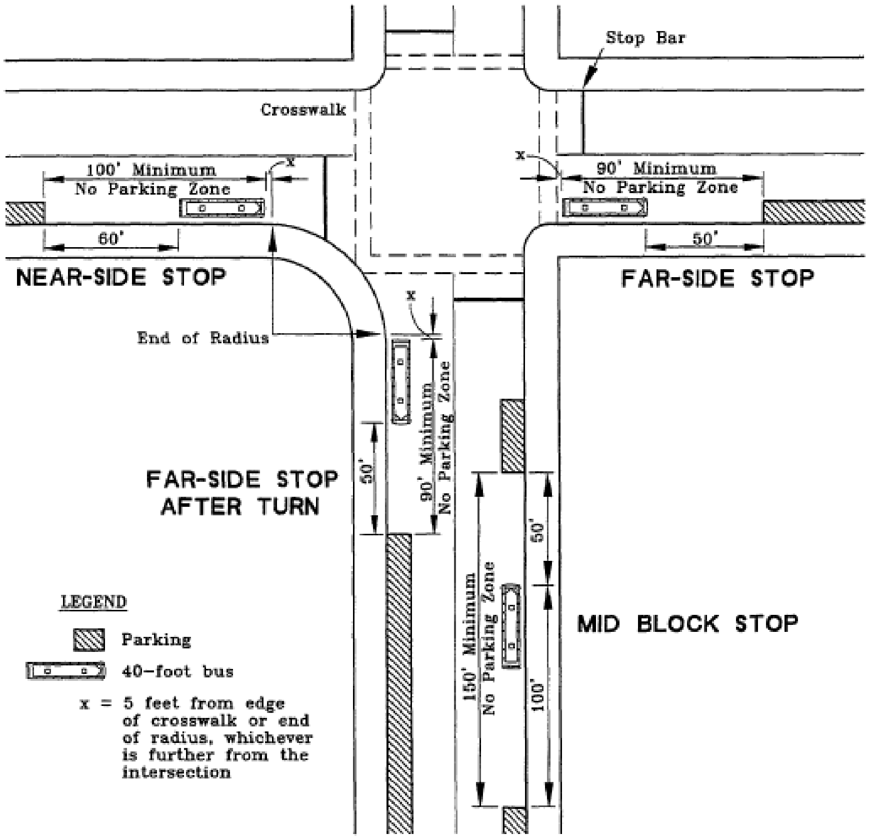
Atlantic Boulevard at Whittier Boulevard
Atlantic Boulevard at Pomona Boulevard
Atlantic Boulevard at Cesar Chavez Avenue/Riggin Street
Atlantic Boulevard at Garvey Avenue
Atlantic Boulevard at Valley Boulevard
Atlantic Boulevard at Main Street
Huntington Drive at Garfield Avenue
Huntington Drive at Marengo Avenue
Fair Oaks Avenue at Mission Street
Fair Oaks Avenue at Glenarm Street
Fair Oaks Avenue at California Boulevard
Fair Oaks Avenue at Del Mar Boulevard
Del Mar Boulevard at Los Robles Boulevard
Del Mar Boulevard at Lake Avenue
Del Mar Boulevard at Hill Avenue
Colorado Boulevard at Hill Avenue
Colorado Boulevard at Lake Avenue

3.3.7.1 Station Design

Stations will be designed to accommodate a 60-foot articulated bus, as well as Metro’s current vehicle fleet. Bus zone designs, including location of loading areas relative to the intersection and minimum length of no parking zone, are based on Transit Cooperative Research Program (TCRP) Report 19, Guidelines for the Location and Design of Bus Stops, prepared for the Federal Transit Administration (FTA) (Transit Cooperative Research Program, 1996), and 2012 Metro Transit Service Policy (Metro, 2012). Curb-side bus stops, queue jumper bus bays, and partial open bus bay stops are proposed as shown in Figures 3-5, 3-6, and 3-7.

Curb-side bus stops provide easy access for bus operators, have minimal delays, are simple to install, are inexpensive, and are easy to relocate.

FIGURE 3-5
Curb-Side Bus Zones

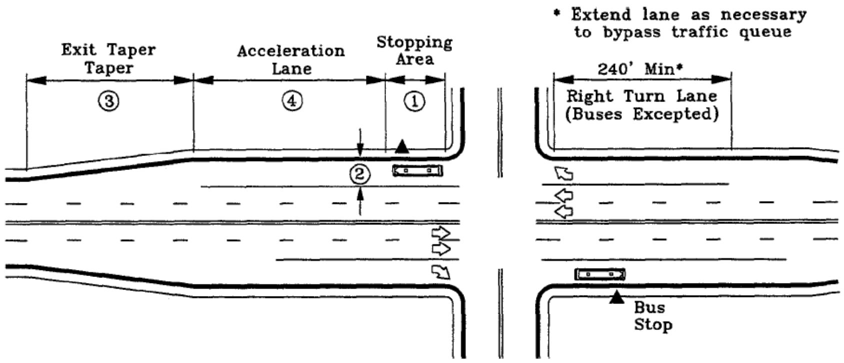


Notes:
1) Add 20 feet to bus stop zones for an articulated bus.
2) Increase bus stop zone by 50 feet for each additional standard 40-foot bus or 70 feet for each additional 60-foot articulated bus expected to be at the stop simultaneously. See Table 3 for the suggested bus stop capacity requirements based on a range of bus flow rates and passenger service times.

Source: TCRP Chapter 19

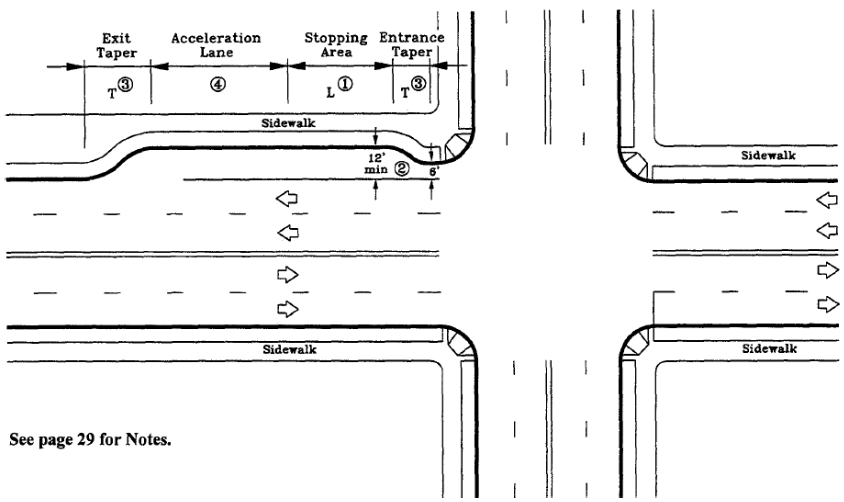
Queue jumper bus bays allow BRT vehicles to bypass queues at a signal and decelerate through an intersection. Both queue jumper bus bays and partial open bus bays allow BRT vehicles to board out of the travel lane; they are also in a protected area away from general traffic, and help to minimize delay through traffic. Because of ROW constraints, recommended acceleration lane lengths and tapers listed in TCRP could not be provided at the proposed bus bays.

FIGURE 3-6
Queue Jumper Bus Bay



Source: TCRP Chapter 19

FIGURE 3-7
Partial Open Bus Bay



Source: TCRP Chapter 19

3.3.7.2 Separated BRT and Local Bus Stops at Stations

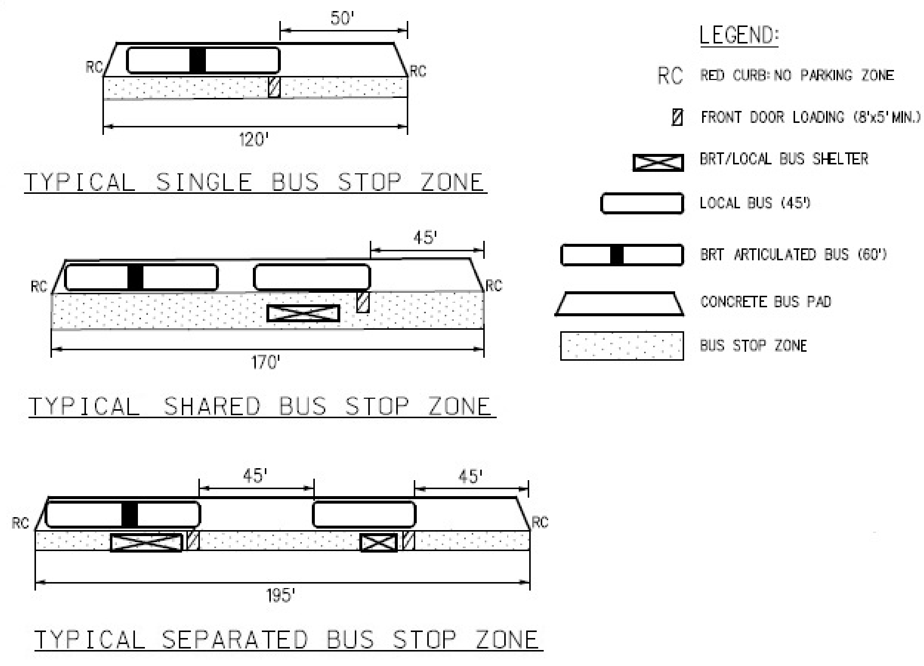
All proposed BRT stations are located at intersections where one or more local bus routes currently provide a stop. To avoid unnecessary crosswalk movements and minimize patronage confusion, it is proposed to create a combined station on either the near-side or the far-side of the intersection that would serve both the BRT and local buses (see additional discussions on pros and cons of near-side and far-side stops in Section 3.3.7.3). At the combined stations served by multiple local bus routes, it can be expected that the BRT vehicle and one of the local buses would arrive within seconds of each other occasionally, therefore creating a need for a longer bus stop zone and two separate boarding areas. Ideally two separate boarding areas should be provided at all proposed BRT stations to allow for maximum flexibility; however, the longer bus stop zone would typically displace on-street parking or in some cases require additional right of way from private properties.

Below are three types of bus stop zones proposed in the BRT Alternative:

- Single – Single bus stop zones accommodate one 45-ft or 60-ft articulated bus at a time
- Shared – Shared bus stop zones are longer than Single bus zones so they can accommodate both a 60-ft articulated bus and a 45-ft bus at the same time. However, only one boarding/alighting location is provided at the station. In this configuration, the bus that arrives first (a 60-ft or 45-ft bus) will pull to the designated boarding/alighting area near the front of the stop, and the second bus will stop behind the first bus. The bus that arrives second will need to wait for the first bus to depart before it can depart.
- Separated – Separated bus stop zones also accommodate both a 60-ft articulated bus and a 45-ft bus at the same time. In this configuration, two separate boarding/alighting areas and shelters will be provided and the BRT bus stop zone will be separated from the local bus stop zone by a minimum distance of 45 feet to allow space for a bus to pull in and out of the bus stop whether or not another bus is in the bus zone.

Figure 3-8 illustrate the concept of the three different bus zone types.

FIGURE 3-8
Proposed Bus Zone Types



For illustration purposes, the local bus is shown downstream of the BRT bus in the figures above. However, the positions of the BRT bus and local bus are interchangeable.

The minimum lengths of bus stop zones for Single, Shared, and Separated stops are established based on discussions with Metro staff and guidelines set forth in the 2012 Metro Transit Service Policy (Metro, 2012). Table 3-15 list the different types of bus stop zones proposed in the BRT Alternative and the minimum lengths required.

TABLE 3-15
Type of Bus Stop Zones

Type of Bus Stop Zone Design	Minimum Length (feet)
Far-Side Single Curb-Side Bus Stop Zone	120
Far-Side Shared Curb-Side Bus Stop Zone	170
Far-Side Separated Curb-Side Bus Stop Zone	195
Near-Side Shared Curb-Side Bus Stop Zone	170
Single Queue Jumper Bus Bay Stopping Area*	70*
Separated Queue Jumper Bus Bay Stopping Area*	150*
Shared Partial Open Bus Bay Stopping Area*	120*

*Bus Stop Zone lengths do not include acceleration lane and exit taper.

The approach to assigning the bus stop zone to each proposed BRT station was based on a preliminary bus stop capacity analysis and a preliminary review of existing constraints. The expected number of occasions that a local bus and a BRT bus arrive at the same time, within the a.m. and p.m. peak hour windows, was estimated based on the scheduled arrival times from existing local bus timetables, proposed headways of the BRT service, proposed feeder bus improvements, and proposed TSM bus improvements. Because actual arrival time can deviate from schedules with variable traffic conditions, a time conflict is assumed when two or more buses are expected to arrive within zero to one minute of each other. Based on the expected number of time conflicts, each BRT station was classified as a potentially low, moderate, or high time conflict stop. Generally, BRT stop locations with low time conflicts are assigned as single bus stop zones. For moderate and high time conflict stops, either shared or separated bus stop zones are assigned based on availability of space. Although separated bus stop zones are ideal in moderate and high time conflict locations, in some cases either Single or Shared bus stop zones are proposed because of potential ROW impacts and parking displacements. In the next phase of design, each bus stop zone will be re-evaluated for the feasibility of a longer shared stop or a separated stop.

3.3.7.3 Far-Side/Near-Side Stops

If the BRT Alternative is selected as the preferred alternative at the conclusion of this study, the feasibility of the Separated stops (195-ft bus stop zone) will be re-evaluated at all BRT station locations in the next phase of design.

The advantages and disadvantages of far-side stops and near-side stops are summarized in Table 3-16.Far-side stops are generally preferred over near-side stops to maximize the benefits of TSP.

Two of the local bus stops are proposed to be relocated from their current near-side location to a far-side location to coincide with the northbound Valley Station and southbound Glenarm Station. All but three BRT stations are located on the far-side. A far-side stop was not feasible at northbound Pomona Station, northbound Fair Oaks/ Del Mar Station, and Hill Station due to inadequate space, an unreasonable walk to the activity center, or constraints of the existing facilities.

TABLE 3-16
Comparative Analysis of Bus Stop Locations

	Advantages	Disadvantages
Far-Side Stop	• Minimizes conflicts between right-turning vehicles and buses • Provides additional right-turn capacity by making curb lane available for traffic • Minimizes sight distance problems on approaches to intersection • Encourages pedestrians to cross behind the bus • Creates shorter deceleration distances for buses since the bus can use the intersections to decelerate • Results in bus drivers being able to take advantage of the gaps in traffic flow that are created at signalized intersections	• May result in the intersections being blocked during peak periods by stopping buses • May obscure sight distance for crossing vehicles • May increase sight distance problems for crossing pedestrians • Can cause a bus to stop far-side after stopping for a red light, which interferes with both bus operations and all other traffic • May increase number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light • Could result in traffic queued into intersection when a bus is stopped in travel lane
Near-Side Stop	• Minimizes interferences when traffic is heavy on the far side of the intersection • Allows passengers to access buses closest to crosswalk • Results in the width of the intersection being available for the driver to pull away from curb • Eliminates the potential of double stopping • Allows passengers to board and alight while the bus is stopped at a red light • Provides driver with the opportunity to look for oncoming traffic, including other buses with potential passengers	• Increases conflicts with right-turning vehicles • May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians • May cause sight distance to be obscured for cross vehicles stopped to the right of the bus • May block the through lane during peak period with queuing buses • Increases sight distance problems for crossing pedestrians

Source: TCRP Chapter 19 (FTA, 1996)

3.3.7.4 Summary of BRT Stations

Table 3-17 summarizes the characteristics of all proposed BRT stations. All stations will be designed in accordance with the Americans with Disabilities Act (ADA). A minimum sidewalk width of 8 feet, boarding space, and a detectable warning surface are some of the items that would be included. Additional details on station cases and passenger amenities can be found in Section 5.

TABLE 3-17
Summary of Proposed BRT Stations

Proposed BRT Station	Direction	Case[1]	Location	Bus Stop Zone Length (feet)
Whittier	NB	A	Far-Side	120
	SB	C	Far-Side	120
Pomona	NB	A	Near-Side	170
	SB	B	Far-Side	195
Cesar Chavez	NB	B	Far-Side	195
	SB	B	Far-Side	195
Garvey	NB	B	Far-Side	120*
	SB	B	Far-Side	170
Valley	NB	A	Far-Side	170*
	SB	A	Far-Side	195
Main	NB	B	Far-Side	120
	SB	A	Far-Side	170
Huntington/Garfield	SB	A	Far-Side	170
	WB	C	Far-Side	195
Marengo	WB	C	Far-Side	170
	EB	C	Far-Side	170
Mission	NB	A	Far-Side	120
	SB	B	Far-Side	120
Glenarm	NB	B	Far-Side	120
	SB	B	Far-Side	120
California	NB	A	Far-Side	180
	SB	A	Far-Side	195
Fair Oaks/Del Mar	NB	B	Near-Side	205
	SB	A	Far-Side	170
Los Robles	EB	A	Far-Side	170
	WB	B	Far-Side	120
Lake	EB	C	Far-Side	170
	WB	C	Far-Side	195
Hill	EB	B	Far-Side	200
Colorado/Hill	WB	C	Far-Side	230
Colorado/Lake	SB	B	Far-Side	70*

*Bus Stop Zone length does not include acceleration lane and exit taper. Additional space downstream of bus stop zone is available.
[1] Station cases A, B, and C are defined in Section 5 of this report.
WB – westbound

3.3.8 Utilities

Utility analysis was based on evaluating the various utility as-built drawings and facility maps, and conducting field visits. Dig Alert service was used to generate a list of utility owners within the study area. As-built or facility map information was collected from these utility owners and reviewed. Aerial photography research was conducted; field observations during site visits were also recorded. These resources were used to create an existing utility composite map overlaid with the proposed roadwork to identify potential conflicts in the expanded study area.

The proposed work is mostly surface-related street widening and construction of bus stop features that will not involve deep excavations; therefore, utility conflicts consist mostly of power pole relocations. Street widening will impact power poles at various places along the BRT alignment, therefore requiring their relocation. These poles typically carry electrical and telecommunication lines. The sidewalk reconstruction and raised medians require shallow excavations and are not expected to generate any utility conflicts, other than resetting utility boxes, valves, manholes or vaults to the new grades. Traffic signal and street light modifications are expected and are discussed in Section 3.3.10.5 and Section 3.3.12, respectively.

The proposed design would require relocation of 18 power poles and associated overhead power and telecommunication lines. No easements are required for the relocations. All the utility conflicts identified are power pole relocations due to street widening and/or curb radius changes; the relocations will continue to be within the existing or proposed public ROW. The potential utility conflicts are summarized in Table 3-18.

TABLE 3-18
Potential Utility Conflicts

Conflict	Sheet	Owner	Location	Station
1	U-002	SCE	NW corner of Atlantic Boulevard and Hubbard Street	18+52
2	U-002	SCE	NE corner of Atlantic Boulevard and Hubbard Street	18+52
3	U-002	SCE	SW corner of Atlantic Boulevard and Sixth Street	26+50
4	U-002	SCE	SE corner of Atlantic Boulevard and Sixth Street	26+59
5	U-003	SCE	NW corner of Atlantic Boulevard and Eagle Street	35+52
6	U-003	SCE	NE corner of Atlantic Boulevard and Eagle Street	35+52
7	U-004	SCE	NW corner of Atlantic Boulevard and Fourth Street	44+02
8	U-004	SCE	NE corner of Atlantic Boulevard and Fourth Street	44+02
9	U-005	SCE	SW corner of Atlantic Boulevard and Repetto Street	47+78
10	U-010	SCE	Atlantic Boulevard north of Floral Drive	101+37
11	U-014	SCE	NW corner of Atlantic Boulevard and Cadiz Street	144+05
12	U-019	SCE	Atlantic Boulevard north of Emerson Avenue	206+05
13	U-023	SCE	Atlantic Boulevard north of San Marino Avenue	262+98
14	U-023	SCE	Atlantic Boulevard north of San Marino Avenue	264+62
15	U-023	SCE	SW corner of Atlantic Boulevard and Front Street	265+16
16	U-026	SCE	Atlantic Boulevard and Garfield Avenue	343+63
17	U-026	SCE	Garfield Avenue north of Huntington Drive	404+40
18	U-026	SCE	Garfield Avenue north of Huntington Drive	405+14

Source: D'Leon Consulting Engineers (D'Leon, 2013)
SCE – Southern California Edison
NW – northwest
NE – northeast
SW – southwest
SE – southeast

3.3.9 Drainage

Based on the topographic data provided by United States Geological Survey quadrangles maps, the general terrain in the project vicinity slopes from north to south. The existing drainage systems along the BRT Alternative corridor include curbs, gutters, curb opening inlets, lateral pipes, and main trunk line pipes to county storm drain systems. The proposed widening will alter the existing flow line to the proposed curb line. Lateral pipes will need to be extended, and existing catch basins will need to be relocated. Also, in order to meet watershed water quality requirements, the design team evaluated installation of treatment best management practices (BMPs) for the BRT Alternative. The following BMPs were proposed at various locations along the corridor:

- 1 biofiltration swale
- 28 catch basin screens and inserts
- 48 tree box filters

Additional information and details describing the systems impacted and proposed mitigation measures can be found in the SR 710 North Study, Preliminary Drainage Report, dated October 2013 (CH2M HILL, 2013b). This report also documents the hydrologic and hydraulic conditions of the project site using established procedures and methodologies.

3.3.10 Bike Lanes and Routes

Each city along the corridor of the BRT Alternative has an approved bicycle master plan. Table 3-19 summarizes the existing and proposed bicycle routes identified in the bicycle master plans of each municipality along the BRT corridor.

TABLE 3-19
Planned Bike Routes along the Corridor of the BRT Alternative

Local Municipality	Document	Existing/Proposed Bike Route
County of Los Angeles (East Los Angeles)	Bicycle Master Plan Final Plan March 2012	No Existing and Proposed Routes Along BRT Corridor
Monterey Park	Monterey Park General Plan Figure C-4, Bicycle Route Plan July 2001	City Bicycle Route on Atlantic Boulevard El Portal Place to Mabel Avenue (0.5-mile)
Alhambra	Alhambra Bicycle Master Plan (Draft Plan) February 2013	No Existing and Proposed Routes Along BRT Corridor
South Pasadena	Cycle South Pasadena Bicycle Master Plan Update August 2011	Class II Bike Lane Proposed along Huntington Drive from Garfield Avenue to Fair Oaks Avenue (0.9-mile) Class II Bike Lane Proposed along Fair Oaks Avenue from Huntington Drive to Columbia Street (1.3 miles)
Pasadena	Bicycle Transportation Plan Department of Transportation December 2012	No Existing and Proposed Routes Along BRT Corridor

Class II Bike Lanes are exclusive lanes for bike travel. According to the American Association of State Highway and Transportation Officials (AASHTO), bike lanes should have a minimum width of 5 feet, pavement delineation, and proper signage. These bike lanes are one-way facilities on either side of a roadway. Bike lanes are located adjacent to the curb where no on-street parking exists. If on-street parking is provided, the bike lanes are striped to the left side of the parking lane. Class III Bicycle Routes share use with motor vehicle traffic and have designated signage.

In the No Build Alternative and TSM/TDM Alternative, Class II Bike Lanes and Class III Bike Routes are proposed in South Pasadena as described in Table 3-19. However, in the BRT Alternative, only Class III bike routes can be provided. Bicyclists will share the BRT lanes in South Pasadena along Huntington Drive (0.9-mile), along Fair Oaks

Avenue from Huntington Drive to Columbia Street (1.3 miles), and in Monterey Park along Atlantic Boulevard (0.5-mile). Proper signage will be provided and read “Bike Ok” similar to the Metro Rapid signage along Wilshire Boulevard, as shown in Figure 3-9. However, for the bike route proposed in Monterey Park’s Bicycle Route Plan, bike lanes can be shared with the BRT lane in the southbound direction only in the BRT Alternative. In the northbound direction, it will be shared with general traffic lanes.

FIGURE 3-9
Example of Shared Use Bicycle Sign

Although many of the bicycle routes are not planned to be within the BRT corridor, many other bicycle routes have been proposed throughout the adjacent area. In the Los Angeles County jurisdiction, a bicycle boulevard is proposed on Woods Avenue and a Class III bike route on Margaret Avenue in East Los Angeles. Woods Avenue is two blocks west of, and runs parallel to, Atlantic Boulevard from Olympic Boulevard to Pomona Boulevard, approximately 1.2 miles. Margaret Avenue is east of, and runs parallel to, Atlantic Boulevard from Hubbard Street to Pomona Boulevard, approximately 0.9 mile. In Monterey Park, a Class III Bicycle Route parallel to Atlantic Boulevard is proposed along Garfield Avenue from Pomona Boulevard to Hellman Avenue, approximately 2.5 miles. The Alhambra Bicycle Master Plan (Draft) recommends Class II and III Bike Routes on parallel streets. The Class III bike route along 6th Street runs from Hellman Avenue to Main Street, approximately 1.6 miles. The limits of the proposed Class II Bike Lanes and Class III Bike Route on Marengo Avenue extend from the I-10 Freeway to Alhambra Road, approximately 1.8 miles. The Class III bike route is recommended along Marguerita Avenue from Hellman Avenue to Alhambra Road, approximately 1.8 miles. A Class III Bike route is also recommended on Alhambra Road, which is parallel to Huntington Drive from Garfield Avenue to Fair Oaks Avenue, approximately 1.1 miles. According to the City of South Pasadena 2011 Bicycle Master Plan, existing Class II Bike Lanes are located parallel to Atlantic Boulevard on Marengo Avenue from south of Huntington Drive to Mission Street (0.8-mile) and a proposed Class I path along the SCE easement from south of Huntington Drive to Grevelia Street (1.4 miles). In the City of Pasadena Final Bicycle Transportation Plan, a parallel existing Class II Bike Lane is located on Marengo from Glenarm to Del Mar (0.8-mile); a Class III Bike Route is located along Marengo Avenue from Del Mar Boulevard to Woodbury Road (3.2 miles); and a parallel existing Class III enhanced bike route is located along Los Robles Avenue from the northern to southern limits of Pasadena (4.3 miles).

3.3.11 Roadway Signing and Striping

Roadway signing and striping were developed using the Manual of Uniform Traffic Control Devices, and will follow the standards of each municipality as required in the next phase of design.

3.3.12 Construction Staging and Maintenance of Traffic

Descriptions and details of the construction staging, transportation management plan, and traffic control are provided in Appendix E.

3.3.13 Traffic Signals

Traffic signal modifications will be required at most of the intersections along the corridor of the BRT Alternative where there is proposed street widening. Traffic signal modifications may include replacement of signal poles, relocation of signal poles, and upgrades to other signal equipment. Additional information and details regarding traffic signal modifications are provided in Appendix F.

The existing traffic signals on Del Mar Boulevard, Lake Avenue, Hill Avenue and Colorado Boulevard on the BRT corridor are proposed to be upgraded with TSP equipment similar to that installed on the Atlantic and Fair Oaks corridors. The benefits and characteristics of TSP technology are discussed in Section 4.4.1. Signal coordination is proposed to be implemented between the traffic signals on Del Mar Boulevard and the Metro Gold Line grade crossing in order to improve BRT travel times.

3.3.14 Street Lights

Street lighting modifications will primarily consist of relocation of light poles due to roadway widening, and will include replacement decorative poles. Additional information and details regarding street lighting modifications are provided in Appendix F.

3.3.15 Landscaping

The landscape design concept for the BRT Alternative is developed to meet the following objectives:

- Preserve the existing trees and other vegetation as much as possible
- Introduce new trees or vegetation to replace any trees or vegetation impacted by the proposed roadway modifications
- Look for opportunities to add low groundcover/vegetation at constrained locations where larger-diameter trees are not feasible

Five design concepts are developed to address the different site conditions and proposed roadway configuration along the corridor.

Condition 1:

The proposed modifications to the roadway would include:

- Addition of exclusive bus lanes in both directions by narrowing the landscape buffer on the east and concrete sidewalk on the west
- Removal of existing trees in the landscape buffer and in tree wells in sidewalk
- Addition of a raised median for access control and landscaping

The design elements in the landscape concept include:

- New trees in the landscape buffer and tree wells in sidewalk to replace the existing trees removed due to construction of bus lanes. ADA compliant tree grates in areas of narrow sidewalks.
- New trees and low groundcover in the raised median

Condition 2:

The proposed modifications to the roadway would include:

- Addition of exclusive bus lanes in both directions by narrowing the concrete sidewalk on the east and west
- Removal of existing trees in the landscape buffer and in tree wells in sidewalk

The design elements in the landscape concept include:

- New trees and tree wells in sidewalk to replace the existing trees removed due to construction of bus lanes. ADA compliant tree grates in areas of narrow sidewalks.

Condition 3:

The proposed modifications to the roadway would include:

- Addition of exclusive bus lanes in both directions by narrowing the concrete sidewalk on the east and west
- Removal of existing trees in the landscape buffer and in tree wells in sidewalk
- Addition of a raised median for access control and landscaping

The design elements in the landscape concept include:

- Prune existing tree roots back three feet from the back of curb.
- Install a root barrier at the back of median curb to redirect root growth.

Condition 4:

The proposed modifications to the roadway would include addition of exclusive bus lanes in both directions by narrowing the concrete sidewalk on east and west.

The design elements in the landscape concept include:

- New trees and tree wells in sidewalk to replace the existing trees removed due to construction of bus lanes. ADA compliant tree grates in areas of narrow sidewalks.
- New trees and low groundcover in the raised median.
- Optional low seat wall or bench, thematic texture, and accent lighting.

Condition 5:

The proposed modifications to the roadway would include:

- Addition of exclusive bus lanes in one direction by narrowing the concrete sidewalk on east and west.
- Removal of existing trees and tree wells in sidewalk.

The design elements in the landscape concept include:

- New trees and tree wells in sidewalk to replace the existing trees removed as a result of the construction of bus lanes. ADA-compliant tree grates in areas of narrow sidewalks.

Illustrations of the specified landscaping conditions are provided in Appendix G. Table 3-20 summarizes the conditions to be applied throughout the BRT corridor.

TABLE 3-20
Landscaping Condition by Location

Location		Landscaping Condition
Atlantic Boulevard	Whittier Boulevard to Repetto Street	Condition 2
Atlantic Boulevard	At Repetto Street	Condition 4
Atlantic Boulevard	At Corona Street	Condition 4
Atlantic Boulevard	At Pomona Blvd	Condition 4
Atlantic Boulevard	At EB 60 Off-Ramp	Condition 4
Atlantic Boulevard	At 60 Freeway	Condition 4
Atlantic Boulevard	At WB 60 On-Ramp	Condition 4
Atlantic Boulevard	At First Street	Condition 2
Atlantic Boulevard	Floral Drive to Brightwood Street	Condition 4
Atlantic Boulevard	Brightwood Street to Sevilla Street	Condition 1
Atlantic Boulevard	Sevilla Street to Newmark Avenue	Condition 4
Atlantic Boulevard	At Newmark Avenue	Condition 2B
Atlantic Boulevard	Mabel Avenue to Emerson Avenue	Condition 2
Atlantic Boulevard	Emerson Avenue to Hellman Avenue	Condition 2B
Atlantic Boulevard	At Emerson Avenue	Condition 2B
Atlantic Boulevard	Glendon Way to Shorb Street	Condition 2
Atlantic Boulevard	San Marino Ave. to Front Street	Condition 2
Atlantic Boulevard	Washington Street to Main Street	Condition 2B
Huntington Drive	Garfield to Fair Oaks Avenue	Condition 3
Fair Oaks Avenue	Huntington Drive to Spruce Street	Condition 4*
Fair Oaks Avenue	Spruce Street to Columbia Street	Condition 4
Fair Oaks Avenue	State Street to Arlington Drive	Condition 4
Fair Oaks Avenue	Arlington Drive to Del Mar Boulevard	Condition 5

*Condition only applied on one side of the street.

SECTION 4

Bus Operation and Service Planning

4.1 Routing

The route alignment of the BRT Alternative is described in Section 3.3.1. The BRT service would replicate the existing Metro Rapid 762 service for much of its length, with a new eastward connection in Pasadena to PCC and Caltech. The existing Metro Rapid 762 service would be shortened on its northern end and would operate between Compton and East Los Angeles, terminating at East Los Angeles Community College.

4.2 Vehicles and Technology

Two options for vehicles are available in the BRT Alternative:

- **Standard 40-foot or 45-foot buses,** based on specifications from Metro's existing standard bus fleet used for Metro Rapid services. These are CNG vehicles manufactured by North American Bus Industries (NABI).
- **Articulated 60-foot buses with two or three doors,** based on specifications from Metro's existing articulated bus fleet used for Metro Rapid services. These are CNG vehicles manufactured by NABI, and feature low-floor boarding to facilitate passenger entry and exit. Metro has nearly 400 articulated buses in its existing vehicle fleet that are used for both Metro Local and Metro Rapid services. The 60-foot articulated buses have 57 seats.

For the BRT Alternative, an articulated 60-foot bus with three doors was used as the basis of the design (Figure 4-1). Metro is currently exploring the viability of all-electric vehicles, and those may be considered for this alternative in the future.

FIGURE 4-1
BRT Articulated 60-foot Bus

Source: http://en.wikipedia.org/wiki/Metro_Rapid

Based on an average one-way route length of approximately 12 miles and an estimated average travel time of 50.0 minutes, the BRT Alternative would require 12 peak vehicles for 10-minute frequency service and 6 off-peak vehicles for 20-minute service. When considering a 20 percent spare ratio, 15 vehicles and 8 vehicles would be required for peak and off-peak hours, respectively.

Feeder bus routes will operate 45-foot standard buses. The El Monte – Pasadena route is proposed to have a cycle time of 160 minutes, which would require 8 buses for operation. The Pomona/Beverly – Commerce route has a proposed cycle time of 60 minutes and would require 3 buses for operation. When considering a 20 percent spare ratio, 10 vehicles and 4 vehicles would be required for the El Monte-Pasadena and Pomona/Beverly-Commerce routes, respectively.

4.3 Fare Collection

Fare collection methods used by other U.S. transit agencies for BRT lines were examined to determine the best application for the BRT Alternative. For the BRT Alternative, which operates in shared ROW with local services and has shared stops, the following fare collection features are assumed:

- Install rear-door TAP validators on BRT vehicles
- For TAP patrons: boarding at any door, validation at TAP validator or farebox
- For cash patrons: boarding at front door, payment at farebox
- Roaming fare inspectors on vehicles to enforce fare payment at rear doors (consistent with current policy)

The fare collection approach facilitates improved customer convenience, increased boarding capacity, and reduced dwell time while considering fare policy consistency, station constraints, and long-term technological roadmaps. Because the fare collection system may change in coming years, finding an approach that allows the most flexibility was a key consideration. Other methods of fare collection that can provide similar benfits include use of ticket vending machines, stand-alone validators, fare gates, and greater use of electronic fare payment through personal computers and cell phones. For the purposes of this study, the above features were assumed because they require less infrastructure, have smaller footprints, and have been proven in applications on other transit systems. Also the assumed features have lower potential for vandalism because they are not located at in the filed at bus stops. Benefits of the assumed features include:

- Ability to board at any door so that dwell times could be reduced
- Can be adapted/upgraded to future fare payment technologies at a relatively low cost
- Cash customers pay at fare box, which is consistent with the rest of the Metro system
- Leverages TAP fare media, which Metro has fully adopted
- Onboard validation provides more detailed ridership data and service planning potential
- Fare enforcement can target inspections on buses with a low percentage of validation
- TAP media is available at an extensive third-party vendor network, expanding customer convenience
- Avoids expensive capital and infrastructure costs associated with fare equipment
- Allows marketing to stay consistent with existing fare policy, minimizing disruption to customer behavior

Further details on BRT fare collection systems used by other U.S. transit agencies and comparisons of fare collection options are presented in Appendix H. Other methods of fare collection can be reconsidered during design as a result of the growing improvements to technology.

4.4 Intelligent Transportation Systems/Technologies

4.4.1 Transit Signal Priority

TSP is being implemented along this corridor. According to a TSP Tool created by a combination of Dana Woodbury, Joel Falter, and KOA Transportation Consultant (Falter et al., 2012); an article by Selman Altun and Peter Furth (Altun et al., 2012); and the FTA-funded Peer-to-Peer Information Exchange on BRT Report (FTA, 2012), Metro's Rapid and BRT routes use a conditional active TSP system based on headways. Implementation of TSP will extend the green time, have the ability to shorten the red signal, hold a green signal until the bus crosses an intersection during a noncoordinated (free) option, and include a phase call typically used for queue jumper operations.

TSP works best with far-side stops. Metro uses TSP to maintain consistent headways between vehicles. Bus travel times are more predictable between the upstream priority request detection point and the intersection. As a result, the probability of the bus clearing the intersection is increased and more likely on schedule.

A 2004 pilot project implemented by Metro along the Crenshaw Boulevard corridor indicated that bus signal priority improves bus travel time and reduces signal delay. The study revealed that there is an average 12 percent reduction in red signal delay during a.m. and p.m. peak periods. With TSP implemented in the BRT Alternative, a similar reduction in red signal delay is expected.

4.4.2 Variable Message Signs

Timely, relevant, accurate, and readily available trip information is important to minimize a patron's confusion about using transit service. Riders should always be kept informed about the status of their trip. By providing real-time information through VMS, passengers will know when the next vehicle will arrive, or if there has been a service disruption and the expected delay time.

4.5 Service and Operating Plans

According to the BRT Operating Plan Technical Memorandum (see Appendix I) (CH2M HILL , 2014a), BRT service would operate from 5:00 a.m. to 9:00 p.m. on weekdays and 7:00 a.m. to 7:00 p.m. on Saturday and Sunday. The BRT service would operate on a peak frequency of every 10 minutes and an off-peak frequency of every 20 minutes. The BRT service would generally replace, within the study area, the existing Metro Rapid 762 service. Combined with the existing Metro 260 route, the improved frequency would provide exceptional service between East Los Angeles and Pasadena. The total estimated annual operating cost for the BRT service is $5,703,872.

The reduction in service hours for the truncated Metro Rapid 762 line would result in a total estimated operating cost reduction of $3,017,266.

4.5.1 Feeder Bus

Two BRT Feeder Alternatives were advanced based on comments and recommendations from Metro:

- Pomona/Beverly BRT Station to Montebello/Commerce Metrolink Stations
- Del Mar BRT Station to El Monte Bus Station

The estimated operating cost of BRT Feeder Routes is $7,467,768.

Therefore, the total estimated annual operating cost of the BRT Alternative with Feeder Routes is $10,154,374. Additional detail on route and services can be found in the BRT Operating Plan Technical Memorandum (see Appendix I) (CH2M HILL , 2014a).

4.5.2 Transportation System Management

The TSM Alternative includes significant enhancements to the frequency of 20 existing bus services throughout the study area. The TSM Alternative would complement the implementation of the BRT Alternative by improving connectivity to and from major corridors and expanding the reach as a whole. The total TSM estimated annual operating cost is $13,258,521.

The approach to developing the preliminary operating plan, the O&M cost methodology, BRT feeder alternatives, and TSM Alternative (bus components) for the BRT Alternative is presented in Appendix I.

4.6 Branding and Image

Metro Rapid services use specially branded buses and enhanced bus stops that include special shelters, information kiosk, and "next trip" display. The route color coding, distinct shelters and stations should be developed in the next phase. Specific branding and image allow patrons to identify stations easily and become familiar with the BRT transit service.

4.7 Safety/Security

With the BRT Alternative, improved reliability would reduce the likelihood of travel delays. A patron's concern about safety and security due to longer waits at the stops would be reduced. Stops will be located at well-lit areas with ample sidewalk space for ADA compliance and queuing for buses. Some proposed bus stop zones are longer than existing to accommodate more than one bus at a time, therefore reducing the likelihood of buses blocking other traffic in the roadway.

The Final Safety and Security Technical Memorandum for the SR 710 Study will be available at the completion of the Environmental Documentation phase. The safety and security features in the BRT Alternative, as will be listed in the safety and security discussion in the Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the SR 710 North Study (LSA Associates, 2013, in progress), include the following:

- Station shelter improvements (lighting)
- Signal priority (TSM/TDM) being implemented by Metro (2014)
- Next bus passenger information system
- ADA compliance
- Intersection improvements

4.8 Supporting Facilities

Supporting facilities such as bus layover areas and a maintenance facility should be provided in the next phase of design to accommodate the proposed BRT Alternative.

A layover area is defined as a lane or area that has the capability of berthing a bus without blocking other normal traffic. Bus layovers should generally be located near or along the transit route close to the termini while not disrupting the service. Bus operators would use the layover for breaks, to allow time for better schedule adherence if behind schedule, and/or safety inspection. Several potential possible layover location options at the southern and northern termini of the proposed BRT route have been identified.

<u>Potential possible location options for a layover near the southern terminus include:</u>

- NB Goodrich Boulevard between Grace Place and Whittier Boulevard (Existing bus layover for Metro Bus 720)
- EB Olympic Boulevard between Amalia Avenue and Goodrich Boulevard
- SB Atlantic Boulevard between Corona Street and Repetto Street
- WB Louis Place or NB Woods Avenue near Animo Charter Middle School #1

<u>Potential possible location options for a layover near the northern terminus include:</u>

- WB Colorado Boulevard between Hill Avenue and Holliston Avenue
- EB Green Street between Hill Ave and Holliston Avenue
- EB Colorado Boulevard between Hill Avenue and Harkness Avenue (Existing bus layover area for Metro Buses)
- EB Del Mar Blvd between Michigan Avenue and Chester Avenue

When determining the preferred location for layovers, the following considerations will need to be addressed in the next phase of design to avoid or minimize impacts:

On-street parking displacements

Sight distance at intersections and driveways

Conflicts with sharing layover point with other bus routes

Coordination with local municipalities and other transit agencies should also take place in the next phase of design to finalize the preferred bus layover locations.

In addition, the BRT Alternative includes new BRT vehicles that would need to be serviced at a bus maintenance facility. The three existing Metro bus maintenance facilities closest to the proposed route are:

- Division 9 in El Monte (approximately 9.5 miles from the southern terminus of the BRT Alternative)
- Division 10 in East Los Angeles (approximately 6.5 miles from the southern terminus of the BRT Alternative)
- Division 13 in Los Angeles near Union Station (approximately 6.7 miles from the southern terminus of the BRT Alternative); currently under construction

The team has conducted a preliminary evaluation of the current and future planned bus storage capacity at Metro maintenance facilities, and concluded that the BRT Alternative does not require the construction of a new bus maintenance facility based on the number of new buses required. Details of this evaluation are presented in Appendix J.

SECTION 5

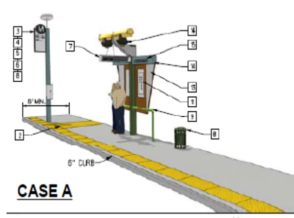
Station Architecture

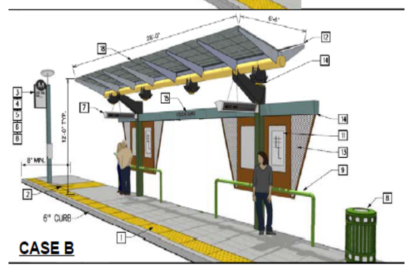
Three conceptual station cases (A, B, and C) were developed based on the sidewalk width available and context of location. Case A is proposed in locations where there is only an 8-foot sidewalk, low patronage, and/or adjacent property conflicts. Case B is proposed in locations where there are 8-foot sidewalks, higher patronage, and adjacent properties with setback. Case C has sidewalks greater than 8 feet, higher patronage, and adjacent properties with setback.

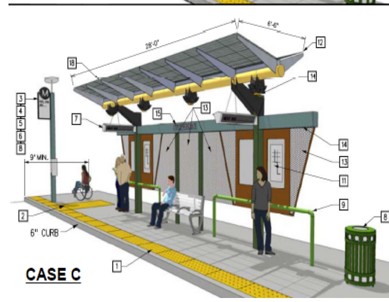
Stations will be architecturally enhanced to create a brand. Table 5-1 summarizes a list of amenities applicable to each station case. Stops will be well-lit areas and will be ADA compliant. Detectable warning surfaces will be provided at the front bus door entry. Where space is available, shelters will be provided. Shelters provide enhanced comfort and safety for waiting passengers as well as protection from climate conditions, and help to identify the stop or station. Trash receptacles provide a place to discard trash and keep bus stops and surroundings clean. Pedestrian-scale lighting at the station increases visibility, increases perceptions of comfort and security, and discourages misuse of bus stops once transit operations are no longer in-service.

TABLE 5-1
Amenities at Each BRT Station Case

No.	Amenity Description	Case A	Case B	Case C
1	Warning Strip/Truncated Domes	√	√	√
2	8 x 5 feet Min. Front Door Loading	√	√	√
3	Bus Stop Sign (BRT Only) with Braille Sign	√	√	√
4	Bus Stop Sign with Braille Sign & Information Locator	√	√	√
5	Bus Waiting Signal With Braille sign	√	√	√
6	Brand Sign	√	√	√
7	Variable Message Sign	√	√	√
8	(Next Bus Arrival) With Public Address System	√	√	√
9	Trash Receptacle	√	√	√
10	Leaning Rail	√	√	√
11	Bench Only	-	-	√
12	Route Map	√	√	√
13	Canopy	-	√	√
14	Wind Screen	-	-	√
15	Lighting	√	√	√
16	Station ID	√	√	√
17	Way Finding Sign	√	√	√
18	Advertising Panel	-	√	√
19	Solar Power Panels	-	√	√







The concepts developed for shelters and station amenities are representative solutions, and will need to be refined based on local preferences. Since the proposed stations would be in street right of way rather than Metro right of way, agreements are needed between Metro and the local agencies to address the long-term maintenance needs. Revenues from advertisements on shelter panels or kiosks at the proposed stations could potentially cover the full cost of maintenance. One option is to develop an agreement between Metro and a vendor desired by the local agency to allow sharing of revenues to cover maintenance costs. Another option is for Metro to assume responsibility for maintenance with permission by the local agencies to perform work on their streets. The final station design and maintenance agreements would need to be coordinated in the next phase of design between Metro and the local agencies.

SECTION 6

Geological Conditions

Geologic primary seismic hazards within the BRT study area include faulting and seismic ground shaking. The BRT Alternative crosses one active fault (the Raymond fault) and one potentially active fault (the San Rafael fault). Secondary seismic hazards include liquefaction, seismically induced landslides, and seismically induced settlement. Potential nonseismic geologic hazards include slope stability, ground settlement, collapsible soils, expansive materials, and erosion. Additional information and details on the seismic hazards, groundwater, hazardous waste, and naturally occurring oil and gas, as well as potential nonseismic geologic hazards are presented in the Preliminary Geotechnical Report (PGR) prepared for the SR 710 North Study (CH2M HILL, 2014e).

The PGR also discusses geotechnical considerations for design and construction of the roadway and retaining walls. The pavement sections for the widening should be provided in accordance with the Caltrans Highway Design Manual (Caltrans, 2012). For preliminary pavement design, a flexible pavement is considered with an assumed subgrade R-value of 15 (Subgrade Type II) and a traffic index of 10. The preliminary pavement section of 6-inch asphalt concrete on top of 7-inch Class 2 aggregate base over 14-inch Class 1 aggregate sub-base is estimated for the conceptual cost estimate.

Concrete bus pads are proposed at each bus station. Based on Section 620 of the Caltrans Highway Design Manual (Caltrans, 2012), the minimum pavement structure for bus pads should be 10-inch joint plane concrete pavement with dowel bars at transverse joints on top of 6-inch lean concrete base or Type A hot mix asphalt over 6 inches of aggregate sub-base. Additional information and details on geotechnical considerations for design and construction are presented in the PGR (CH2M HILL, 2014e).

SECTION 7

Right-of-Way

The proposed roadway improvements, bus stations, and widening of existing street ROW will require partial fee acquisitions and temporary construction easements at various locations along the BRT corridor. The partial acquisitions are minor impacts to commercial and residential properties and there are no displacements as a result of these acquisitions. Because of the roadway widening, a number of commercial and residential driveways will need to be repaired and rights of entry will need to be obtained. The construction contractor will perform this work as part of their contract; however, right of entry will need to be obtained from property owners in order to gain access to the property to perform the work. See the Relocation Impact Report by CH2M HILL dated February 2014 (CH2M HILL, 2014f) for the estimated square footage of ROW and TCE acquisitions and additional details on other ROW items.

SECTION 8

Constraints and Issues to be Resolved in Next Phase

Items to be resolved in the next phase include bus technology, fare collection, communication equipment at stations, bus stop zone design, access management on roadways with added bus lanes, exact locations for bus use of parking spaces, and signal coordination with Metro Gold Line grade crossings. Appropriate contingencies in the preliminary cost estimate have been established to account for details not yet developed.

SECTION 9
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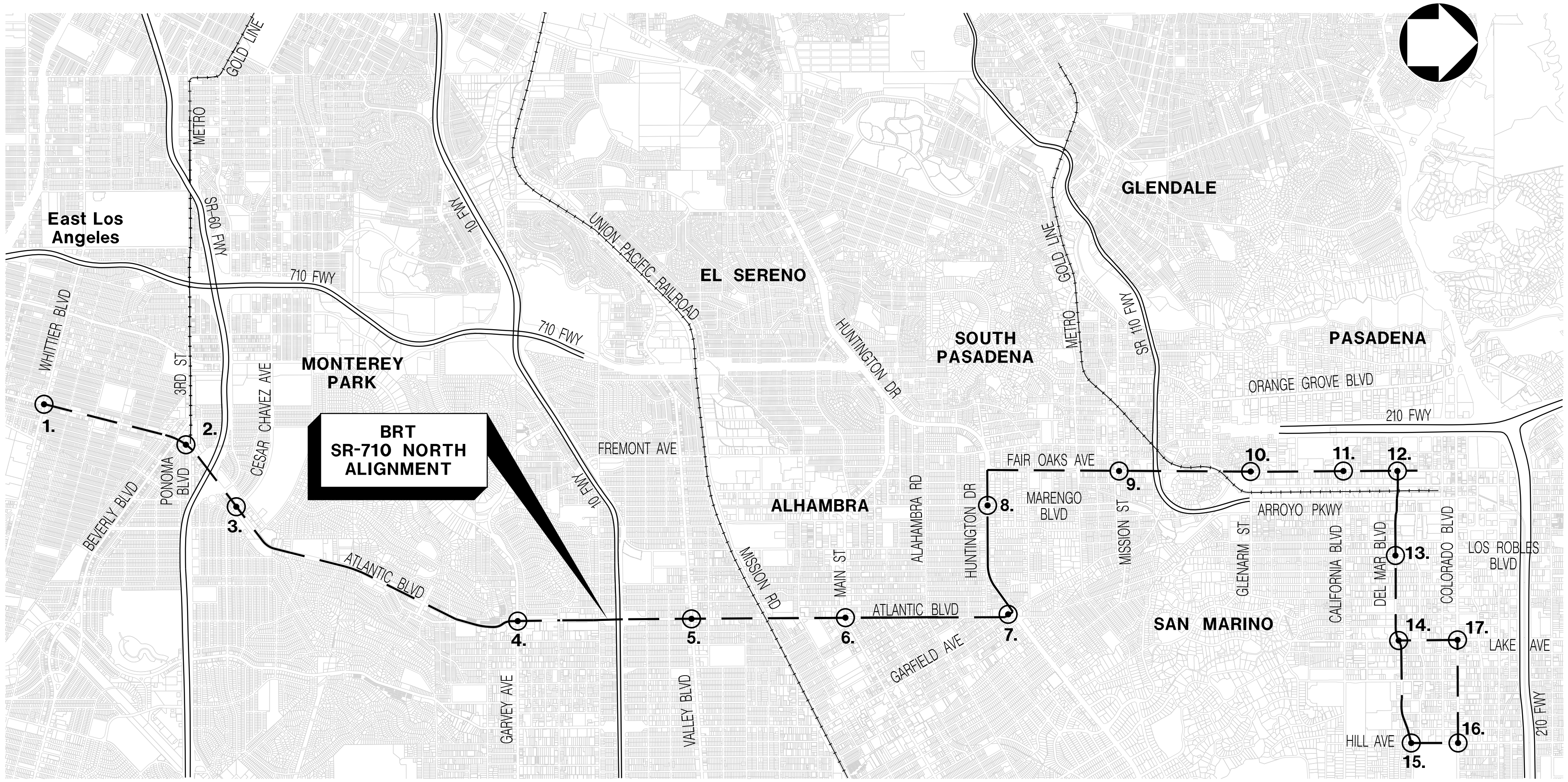
Appendix A
Advanced Conceptual Engineering Drawings



WORK IN PROGRESS

ADVANCED CONCEPTUAL ENGINEERING

SR-710 NORTH STUDY

MARCH 2015

CONTRACT NO. PS4710-2755

PROPOSED BRT STATIONS:

1. WHITTIER
2. POMONA
3. CESAR CHAVEZ
4. GARVEY
5. VALLEY
6. MAIN
7. HUNTINGTON/GARFIELD
8. MARENGO
9. MISSION
10. GLENARM
11. CALIFORNIA
12. FAIR OAKS/DEL MAR
13. LOS ROBLES
14. LAKE
15. HILL
16. COLORADO/HILL
17. COLORADO/LAKE

SR-710 NORTH STUDY - BRT ALTERNATIVE

Metro

Metropolitan Transportation Authority

CH2MHILL

SHT NO.	DWG NO.	DRAWING TITLE
		GENERAL
	-	COVER SHEET
	G-001	INDEX OF DRAWINGS
	G-002	GENERAL PLAN
	G-003	KEY MAP
	G-004	KEY MAP
	G-005	KEY MAP
	G-006	KEY MAP
	G-007	KEY MAP
	G-008	DETAILS
		CIVIL
	C-201	PLAN STA 6+19 TO STA 17+00 - SHEET 1 OF 48
	C-202	PLAN STA 17+00 TO STA 27+00 - SHEET 2 OF 48
	C-203	PLAN STA 27+00 TO STA 37+00 - SHEET 3 OF 48
	C-204	PLAN STA 37+00 TO STA 47+00 - SHEET 4 OF 48
	C-205	PLAN STA 47+00 TO STA 56+00 - SHEET 5 OF 48
	C-206	PLAN STA 56+00 TO STA 65+00 - SHEET 6 OF 48
	C-207	PLAN STA 65+00 TO STA 76+00 - SHEET 7 OF 48
	C-208	PLAN STA 76+00 TO STA 86+00 - SHEET 8 OF 48
	C-209	PLAN STA 86+00 TO STA 95+50 - SHEET 9 OF 48
	C-210	PLAN STA 95+50 TO STA 107+00 - SHEET 10 OF 48
	C-211	PLAN STA 107+00 TO STA 118+00 - SHEET 11 OF 48
	C-212	PLAN STA 118+00 TO STA 129+00 - SHEET 12 OF 48
	C-213	PLAN STA 129+00 TO STA 140+00 - SHEET 13 OF 48
	C-214	PLAN STA 140+00 TO STA 151+00 - SHEET 14 OF 48
	C-215	PLAN STA 151+00 TO STA 162+00 - SHEET 15 OF 48
	C-216	PLAN STA 162+00 TO STA 173+50 - SHEET 16 OF 48
	C-217	PLAN STA 173+50 TO STA 184+00 - SHEET 17 OF 48
	C-218	PLAN STA 184+00 TO STA 196+00 - SHEET 18 OF 48
	C-219	PLAN STA 196+00 TO STA 208+00 - SHEET 19 OF 48
	C-220	PLAN STA 208+00 TO STA 219+00 - SHEET 20 OF 48
	C-221	PLAN STA 224+00 TO STA 236+00 - SHEET 21 OF 48
	C-222	PLAN STA 236+00 TO STA 248+00 - SHEET 22 OF 48
	C-223	PLAN STA 258+50 TO STA 269+50 - SHEET 23 OF 48
	C-224	PLAN STA 269+50 TO STA 280+50 - SHEET 24 OF 48
	C-225	PLAN STA 285+50 TO STA 296+50 - SHEET 25 OF 48
	C-226	PLAN STA 339+00 TO STA 503+00 - SHEET 26 OF 48
	C-227	PLAN STA 503+00 TO STA 513+00 - SHEET 27 OF 48
	C-228	PLAN STA 513+00 TO STA 523+00 - SHEET 28 OF 48
	C-229	PLAN STA 523+00 TO STA 534+00 - SHEET 29 OF 48
	C-230	PLAN STA 534+00 TO STA 545+00 - SHEET 30 OF 48
	C-231	PLAN STA 545+00 TO STA 610+00 - SHEET 31 OF 48
	C-232	PLAN STA 610+00 TO STA 620+50 - SHEET 32 OF 48
	C-233	PLAN STA 620+50 TO STA 631+00 - SHEET 33 OF 48
	C-234	PLAN STA 631+00 TO STA 640+50 - SHEET 34 OF 48
	C-235	PLAN STA 640+50 TO STA 651+00 - SHEET 35 OF 48
	C-236	PLAN STA 651+00 TO STA 661+00 - SHEET 36 OF 48
	C-237	PLAN STA 661+00 TO STA 670+50 - SHEET 37 OF 48
	C-238	PLAN STA 670+50 TO STA 681+00 - SHEET 38 OF 48
	C-239	PLAN STA 681+00 TO STA 692+00 - SHEET 39 OF 48
	C-240	PLAN STA 692+00 TO STA 703+00 - SHEET 40 OF 48
	C-241	PLAN STA 703+00 TO STA 714+50 - SHEET 41 OF 48
	C-242	PLAN STA 714+50 TO STA 726+50 - SHEET 42 OF 48
	C-243	PLAN STA 726+50 TO MATCH EXIST - SHEET 43 OF 48
	C-244	PLAN DEL MAR/LOS ROBLES STATION - SHEET 44 OF 48
	C-245	PLAN DEL MAR/LAKE STATION - SHEET 45 OF 48
	C-246	PLAN DEL MAR/HILL STATION - SHEET 46 OF 48
	C-247	PLAN COLORADO/HILL STATION - SHEET 47 OF 48
	C-248	PLAN COLORADO/LAKE STATION - SHEET 48 OF 48
	X-001	TYPICAL SECTIONS - SHEET 1 OF 7
	X-002	TYPICAL SECTIONS - SHEET 2 OF 7
	X-003	TYPICAL SECTIONS - SHEET 3 OF 7
	X-004	TYPICAL SECTIONS - SHEET 4 OF 7
	X-005	TYPICAL SECTIONS - SHEET 5 OF 7
	X-006	TYPICAL SECTIONS - SHEET 6 OF 7
	X-007	TYPICAL SECTIONS - SHEET 7 OF 7

SHT NO.	DWG NO.	DRAWING TITLE
		ARCHITECTURE
	A-101	STATION CASES AMENITIES, RENDERINGS
	A-102	STATION CASES PLAN AND ELEVATIONS
		UTILITY DRAWINGS
	U-001	UTILITY PLAN STA 6+00 TO STA 17+00 - SHEET 1 OF 48
	U-002	UTILITY PLAN STA 17+00 TO STA 27+00 - SHEET 2 OF 48
	U-003	UTILITY PLAN STA 27+00 TO STA 37+00 - SHEET 3 OF 48
	U-004	UTILITY PLAN STA 37+00 TO STA 47+00 - SHEET 4 OF 48
	U-005	UTILITY PLAN STA 47+00 TO STA 56+00 - SHEET 5 OF 48
	U-006	UTILITY PLAN STA 56+00 TO STA 65+00 - SHEET 6 OF 48
	U-007	UTILITY PLAN STA 65+00 TO STA 76+00 - SHEET 7 OF 48
	U-008	UTILITY PLAN STA 76+00 TO STA 86+00 - SHEET 8 OF 48
	U-009	UTILITY PLAN STA 86+00 TO STA 95+50 - SHEET 9 OF 48
	U-010	UTILITY PLAN STA 95+50 TO STA 107+00 - SHEET 10 OF 48
	U-011	UTILITY PLAN STA 107+00 TO STA 118+00 - SHEET 11 OF 48
	U-012	UTILITY PLAN STA 118+00 TO STA 129+00 - SHEET 12 OF 48
	U-013	UTILITY PLAN STA 129+00 TO STA 140+00 - SHEET 13 OF 48
	U-014	UTILITY PLAN STA 140+00 TO STA 151+00 - SHEET 14 OF 48
	U-015	UTILITY PLAN STA 151+00 TO STA 162+00 - SHEET 15 OF 48
	U-016	UTILITY PLAN STA 162+00 TO STA 173+50 - SHEET 16 OF 48
	U-017	UTILITY PLAN STA 173+50 TO STA 184+00 - SHEET 17 OF 48
	U-018	UTILITY PLAN STA 184+00 TO STA 196+00 - SHEET 18 OF 48
	U-019	UTILITY PLAN STA 196+00 TO STA 208+00 - SHEET 19 OF 48
	U-020	UTILITY PLAN STA 208+00 TO STA 219+00 - SHEET 20 OF 48
	U-021	UTILITY PLAN STA 224+00 TO STA 236+00 - SHEET 21 OF 48
	U-022	UTILITY PLAN STA 236+00 TO STA 248+00 - SHEET 22 OF 48
	U-023	UTILITY PLAN STA 258+50 TO STA 269+50 - SHEET 23 OF 48
	U-024	UTILITY PLAN STA 269+50 TO STA 280+50 - SHEET 24 OF 48
	U-025	UTILITY PLAN STA 285+50 TO STA 296+50 - SHEET 25 OF 48
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	U-027	UTILITY PLAN STA 503+00 TO STA 513+00 - SHEET 27 OF 48
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	U-029	UTILITY PLAN STA 523+00 TO STA 534+00 - SHEET 29 OF 48
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	U-034	UTILITY PLAN STA 631+00 TO STA 640+50 - SHEET 34 OF 48
	U-035	UTILITY PLAN STA 640+50 TO STA 651+00 - SHEET 35 OF 48
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	U-037	UTILITY PLAN STA 661+00 TO STA 670+50 - SHEET 37 OF 48
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	U-042	UTILITY PLAN STA 714+50 TO STA 726+50 - SHEET 42 OF 48
	U-043	UTILITY PLAN STA 726+50 TO MATCH EXIST - SHEET 43 OF 48
	U-044	UTILITY PLAN DEL MAR/LOS ROBLES STATION - SHEET 44 OF 48
	U-045	UTILITY PLAN DEL MAR/LAKE STATION - SHEET 45 OF 48
	U-046	UTILITY PLAN DEL MAR/HILL STATION - SHEET 46 OF 48
	U-047	UTILITY PLAN COLORADO/HILL STATION - SHEET 47 OF 48
	U-048	UTILITY PLAN COLORADO/LAKE STATION - SHEET 48 OF 48

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
INDEX OF DRAWINGS

CONTRACT NO
DRAWING NO G-001
REV
SCALE NONE
SHEET NO

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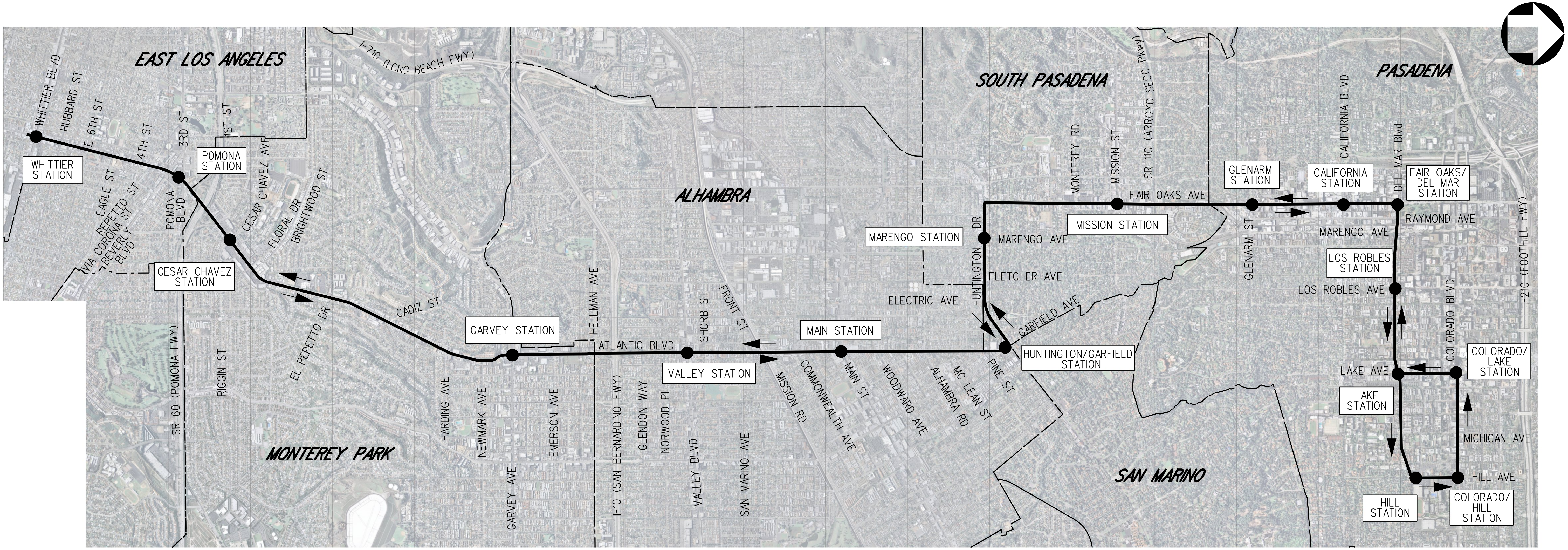

PROPOSED BRT STATIONS	WHITTIER		POMONA		CESAR CHAVEZ		GARVEY		VALLEY		MAIN		HUNTINGTON/ GARFIELD		MARENGO		MISSION		GLENARM		CALIFORNIA		FAIR OAKS/ DEL MAR		LOS ROBLES		LAKE		HILL	COLORADO/ HILL	COLORADO/ LAKE
DIRECTION	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	SB	WB	EB	WB	NB	SB	NB	SB	NB	SB	SB	NB	EB	WB	EB	WB	EB	WB	SB
CASE A*	X		X						X	X		X	X				X				X	X		X	X						
CASE B*				X	X	X	X	X			X							X	X	X			X			X			X		X
CASE C*		X												X	X	X											X	X		X	

* SEE DRAWING No. A-101 FOR DEFINITION OF STATION CASES A, B, AND C.

LEGEND:
- NB - NORTHBOUND
- SB - SOUTHBOUND
- EB - EASTBOUND
- WB - WESTBOUND
- DIRECTION OF TRAVEL FOR PROPOSED BRT SERVICE

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
GENERAL PLAN

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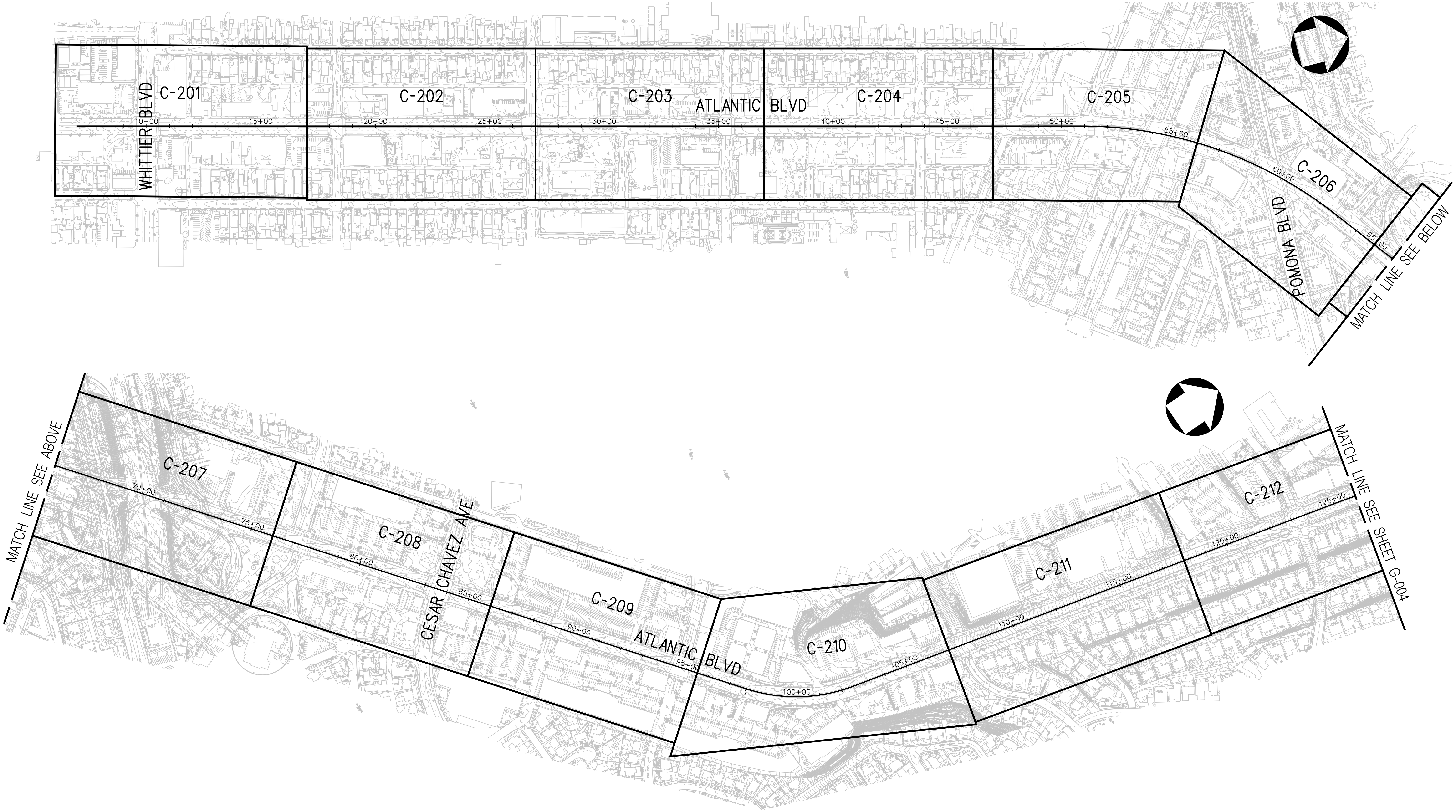

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
KEY MAP

CONTRACT NO
DRAWING NO G-003
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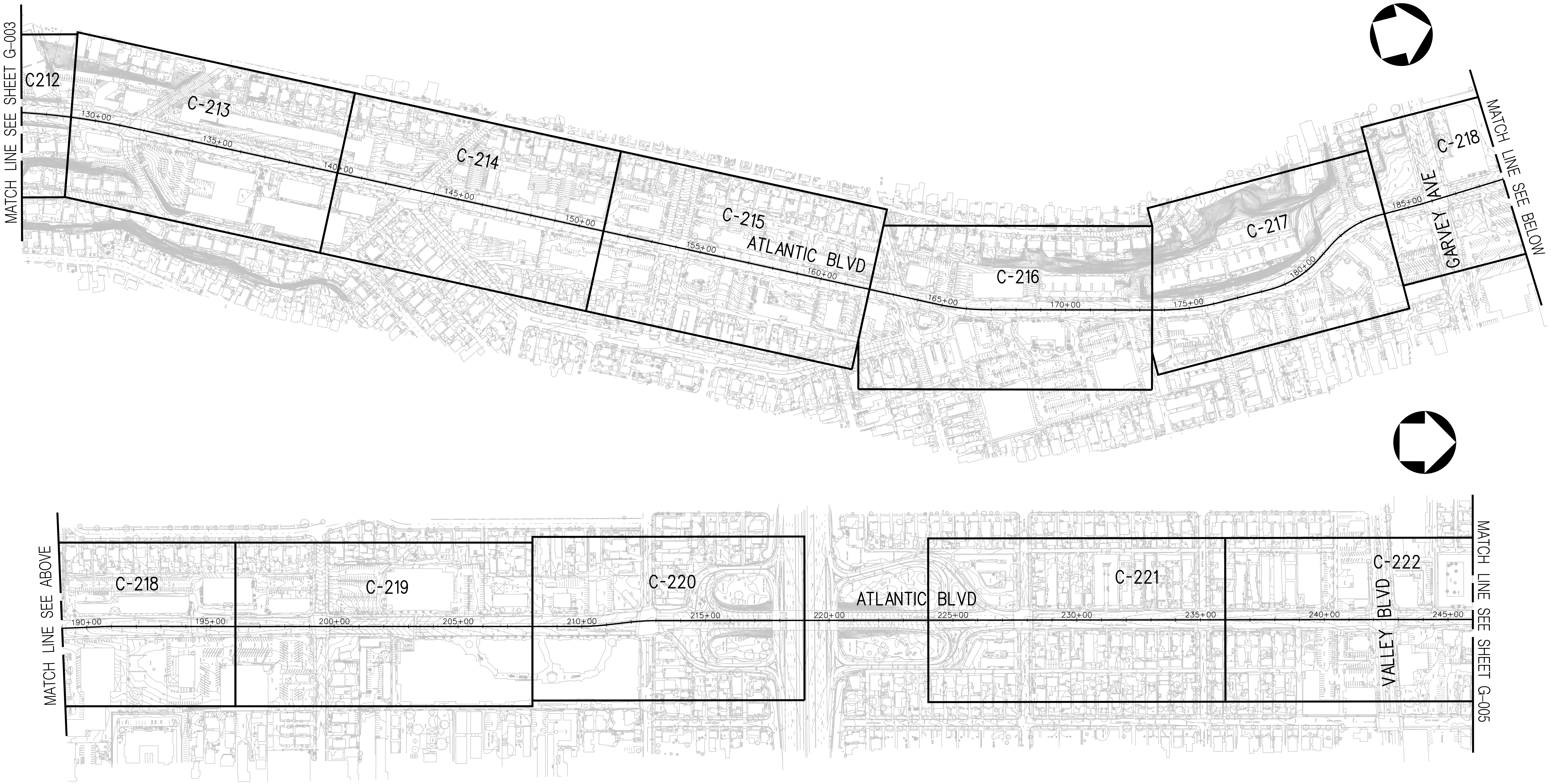

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT ADVANCED CONCEPTUAL DESIGN KEY MAP

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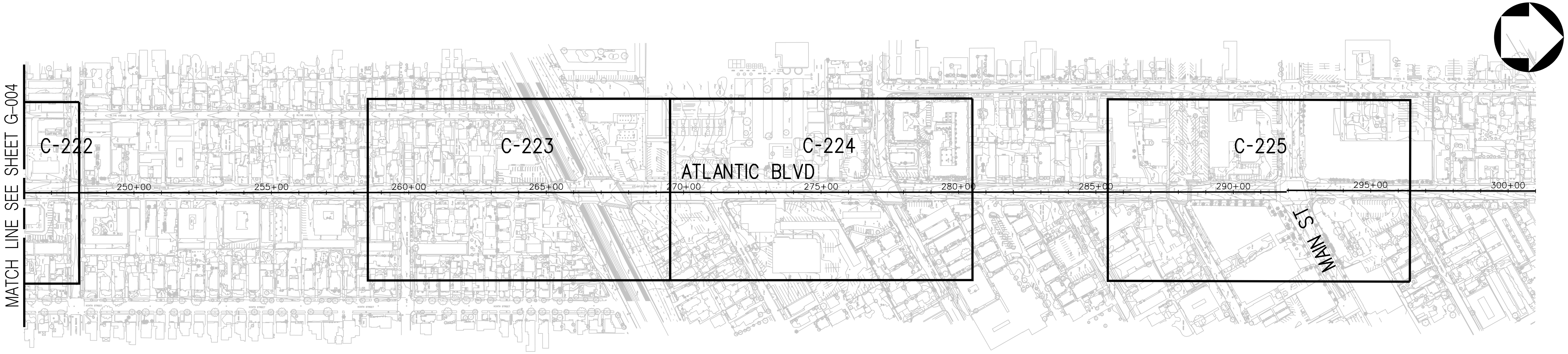

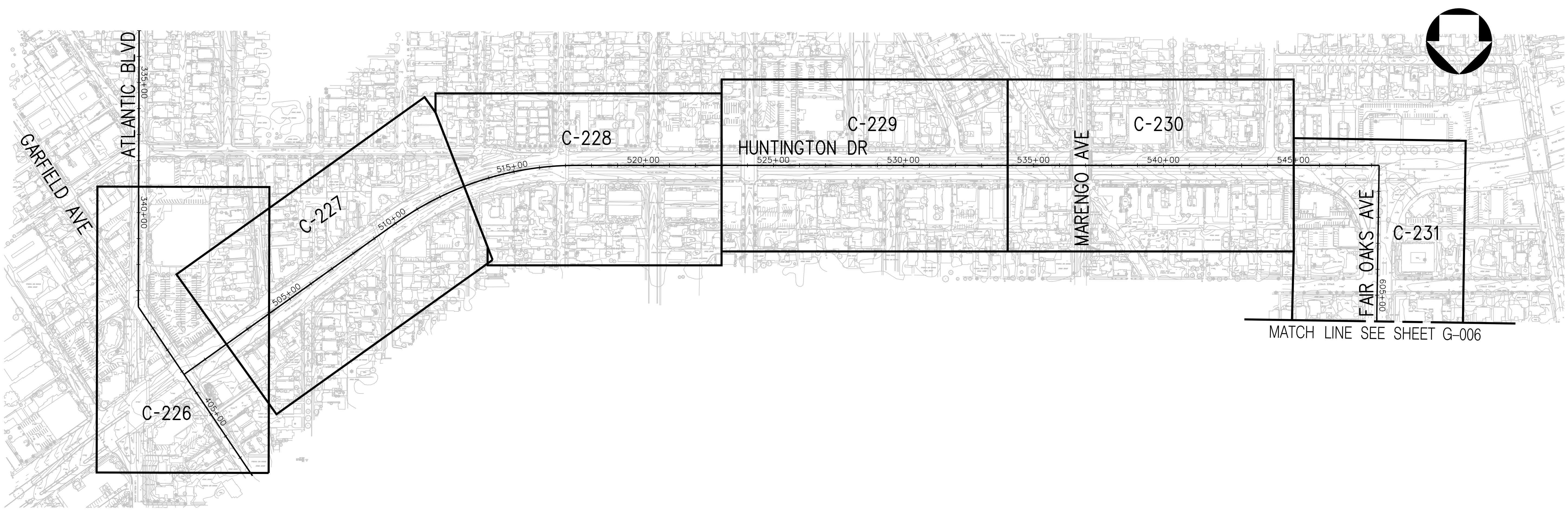

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
KEY MAP

CONTRACT NO
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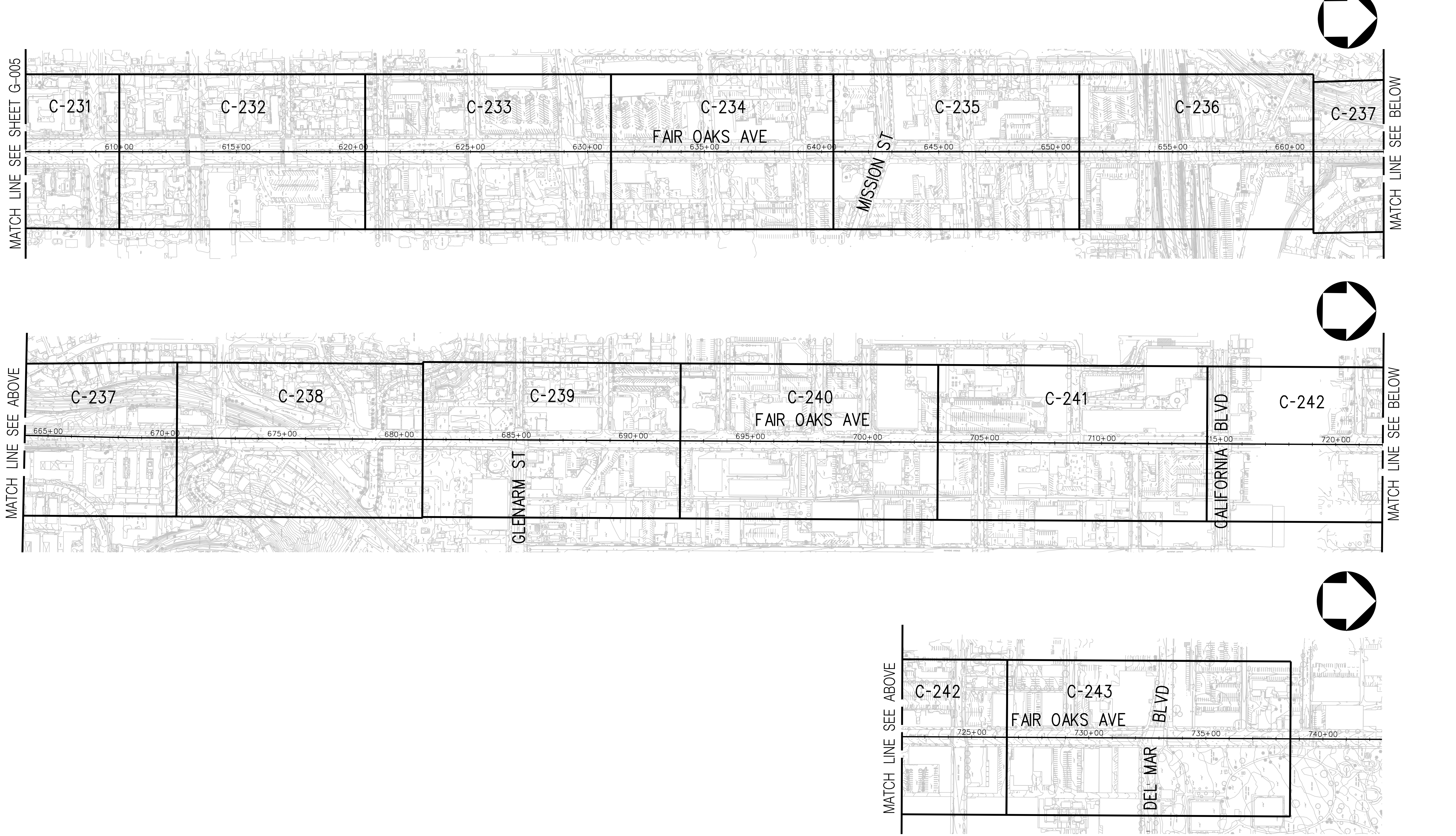

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

710 NORTH STUDY-BRT ADVANCED CONCEPTUAL DESIGN KEY MAP

CONTRACT NO

DRAWING NO G-006

REV

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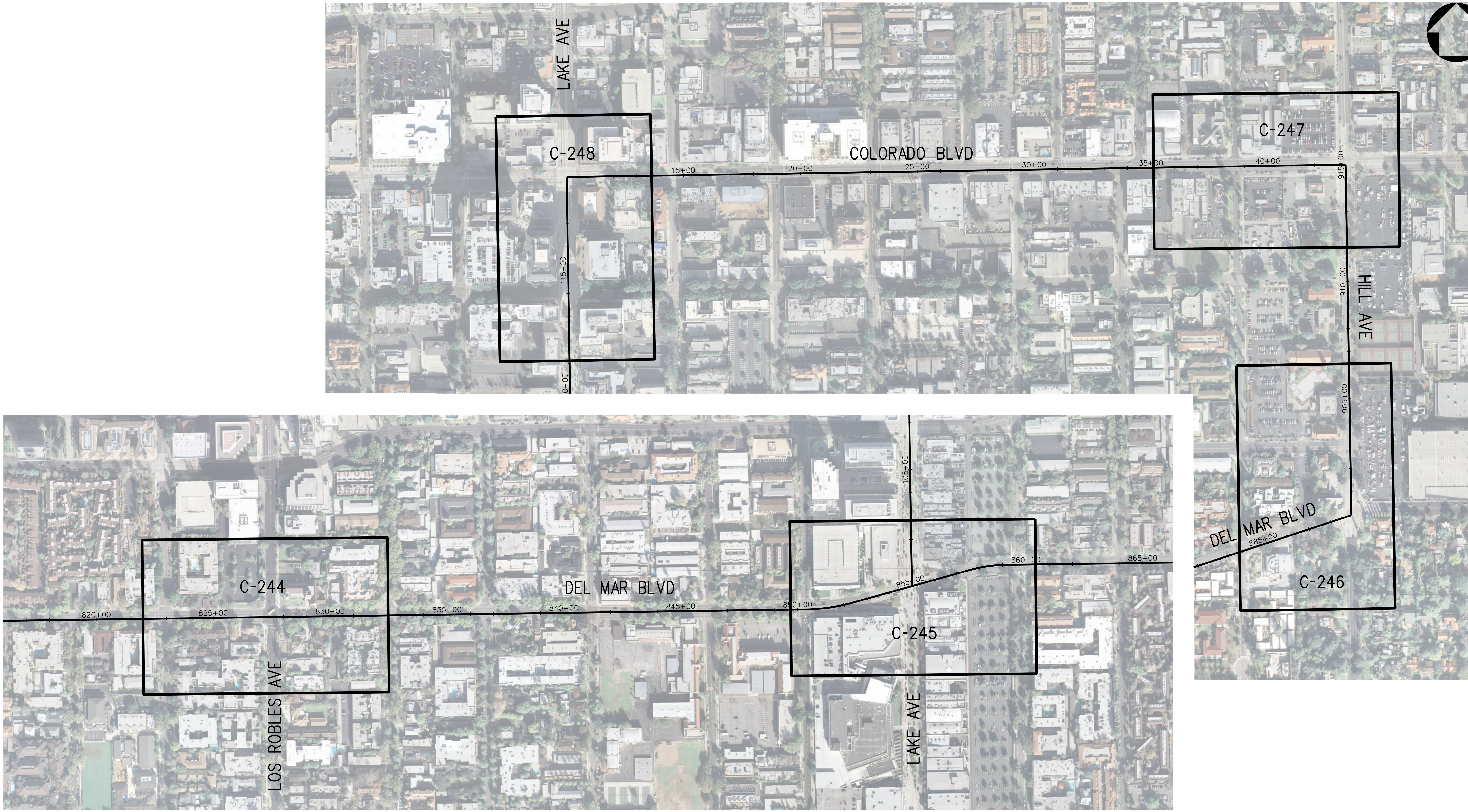

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
KEY MAP

CONTRACT NO
DRAWING NO G-007
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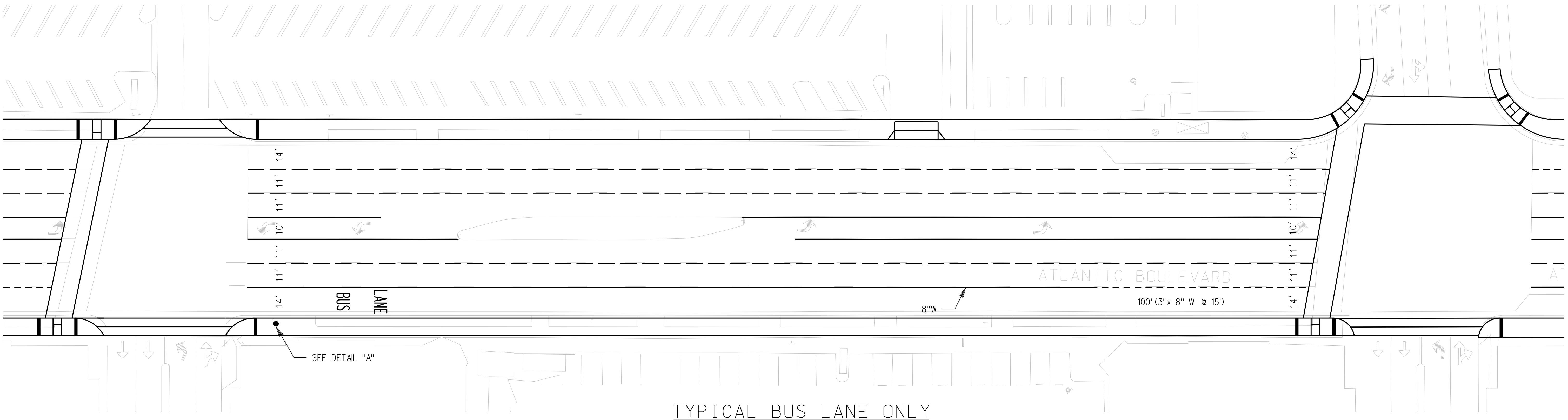
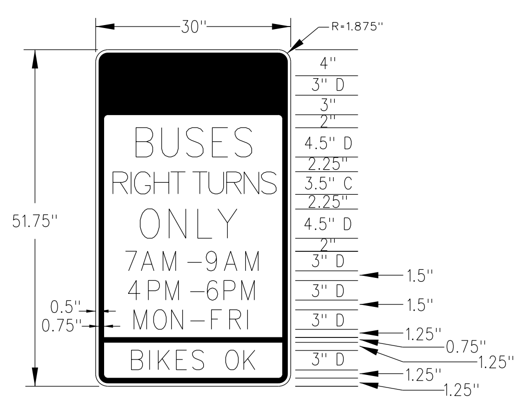


TYPICAL BUS LANE ONLY STRIPING DETAIL

NO SCALE

NOTES:

1. BUS SIGN DETAIL B SHOULD BE INSTALLED AT THE INTERSECTION PRIOR TO THE BEGINNING OF THE BUS LANE.
2. BUS SIGN DETAIL C SHOULD BE INSTALLED AT THE END OF THE BUS LANE.
3. IF A MESSAGE CONSISTS OF MORE THAN ONE WORD, IT SHOULD READ "UP", I.E., THE FIRST WORD SHOULD BE NEAREST TO THE DRIVER.
4. THE SPACE BETWEEN WORDS SHOULD BE AT LEAST FOUR TIMES THE HEIGHT OF THE CHARACTERS FOR LOW SPEED ROADS, BUT NOT MORE THAN TEN TIMES THE HEIGHT OF THE CHARACTERS. THE SPACE MAY BE REDUCED APPROPRIATELY WHERE THERE IS A LIMITED SPACE BECAUSE OF LOCAL CONDITIONS.
5. MINOR VARIATIONS IN DIMENSIONS MAY BE ACCEPTED BY THE ENGINEER.
6. PORTIONS OF A LETTER, NUMBER, OR SYMBOL MAY BE SEPARATED BY CONNECTING SEGMENTS NOT TO EXCEED 2" IN WIDTH.

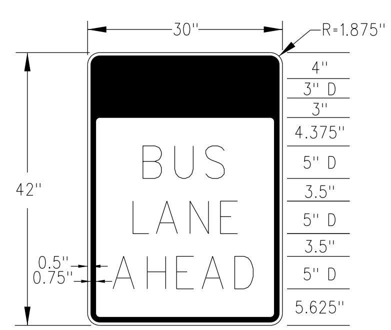


MOD.SR60-3(CA)

TOP COLORS: BORDER & LEGEND - WHITE (RETROREFLECTIVE)
BACKGROUND - BLACK
BOTTOM COLORS: BORDER & LEGEND - BLACK
BACKGROUND - WHITE (RETROREFLECTIVE)

DETAIL "A"

NO SCALE



SR60-1(CA)

TOP COLORS: BORDER & LEGEND - WHITE (RETROREFLECTIVE)
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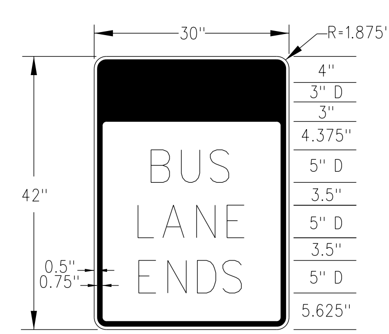
BACKGROUND - WHITE (RETROREFLECTIVE)

DETAIL "B"

NO SCALE



SR60-7(CA)

TOP COLORS: BORDER & LEGEND - WHITE (RETROREFLECTIVE)
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BACKGROUND - WHITE (RETROREFLECTIVE)

DETAIL "C"

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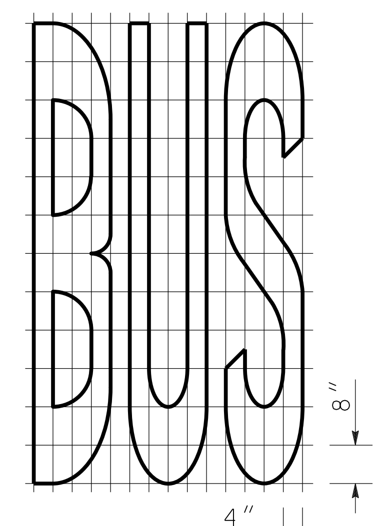

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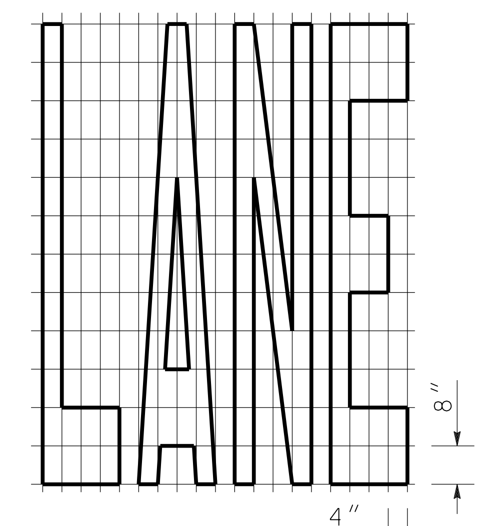

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THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY	S. CHAU
DRAWN BY	H. ANDERSON
CHECKED BY	V. CHIO
IN CHARGE	T. BEVAN
DATE	11/26/13

Metro

LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
DETAILS

CONTRACT NO	
DRAWING NO	G-008
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SCALE	NO SCALE
SHEET NO	

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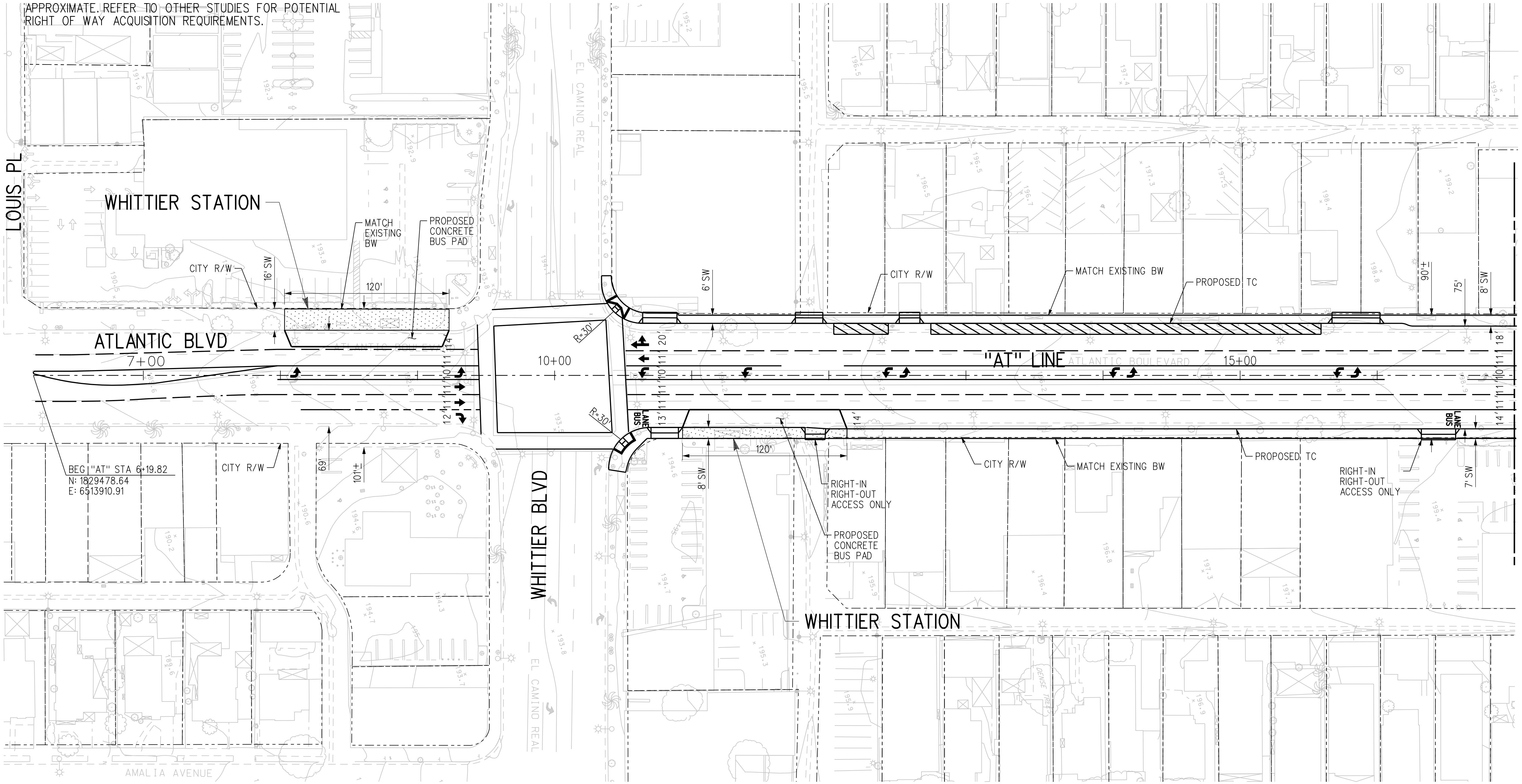
GENERAL NOTES:

1. ON-STREET PARKING ALLOWED IN BUS LANES EXCEPT DURING PEAK PERIODS, WHICH ARE TENTATIVELY DEFINED AS 7-9AM AND 4-6PM.
2. CONCRETE BUS PAD TO BE REPLACED AT EXISTING BUS STOPS WHERE CURB IS TO BE RECONSTRUCTED.
3. PARCEL BOUNDARIES AND CITY R/W LINES SHOWN ARE APPROXIMATE. REFER TO OTHER STUDIES FOR POTENTIAL RIGHT OF WAY ACQUISITION REQUIREMENTS.

LEGEND

- EXISTING BUS STOP
- EXISTING BUS STOP WITH SHELTER
- PROPOSED DRIVEWAY
- POTENTIAL AREA AVAILABLE FOR ON-STREET PARKING (SEE NOTE 1.)
- PROPOSED BRT STATION AREA & BUS STOP ZONE



40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 6+19 TO STA 17+00
SHEET 1 OF 48

CONTRACT NO
DRAWING NO C-201
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

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4/9/2015 11:59:39 AM
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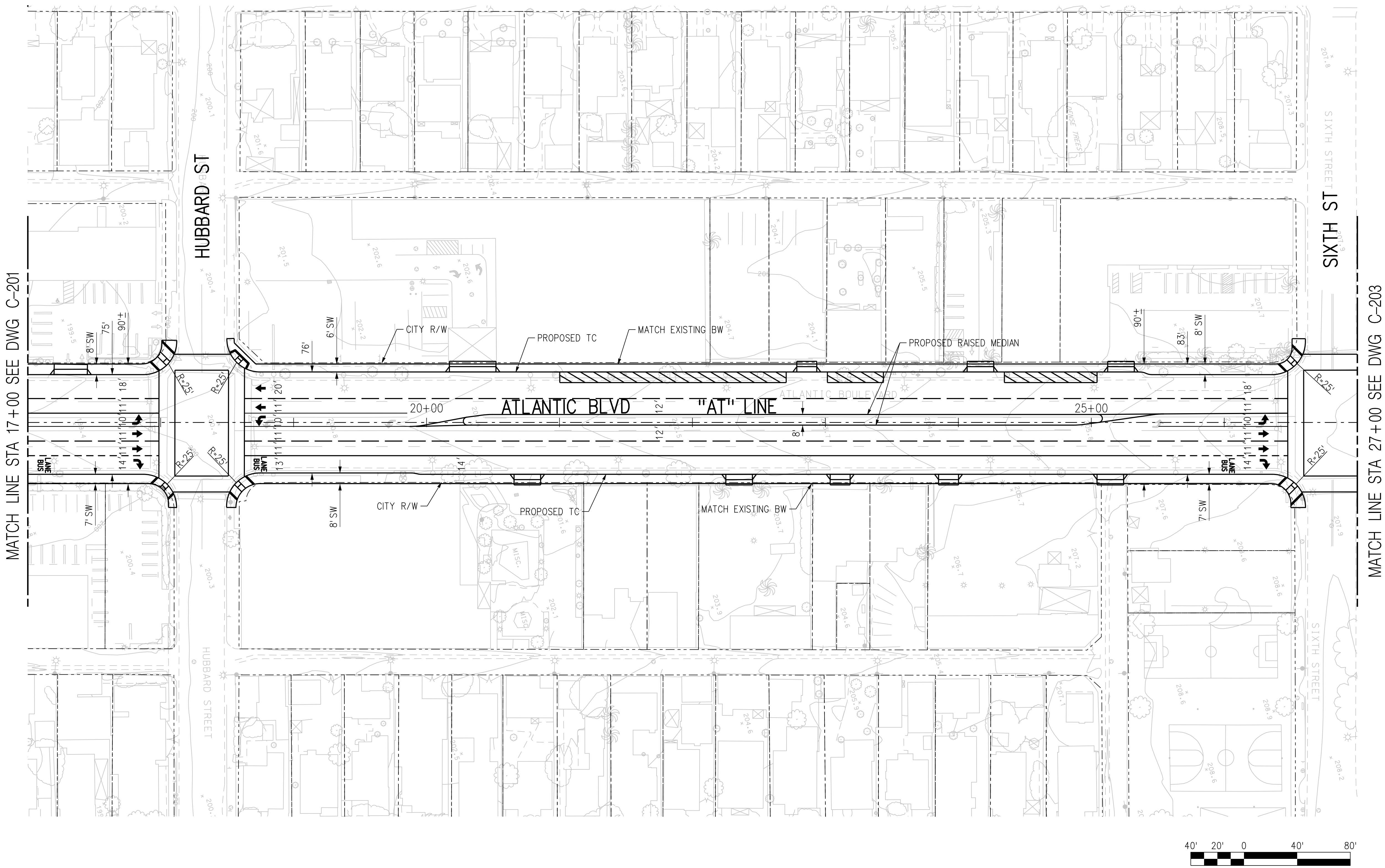

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 17+00 TO STA 27+00
SHEET 2 OF 48

CONTRACT NO
DRAWING NO C-202
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 428908_BW.TBL
Plot Driver: iplotdrvm.plt
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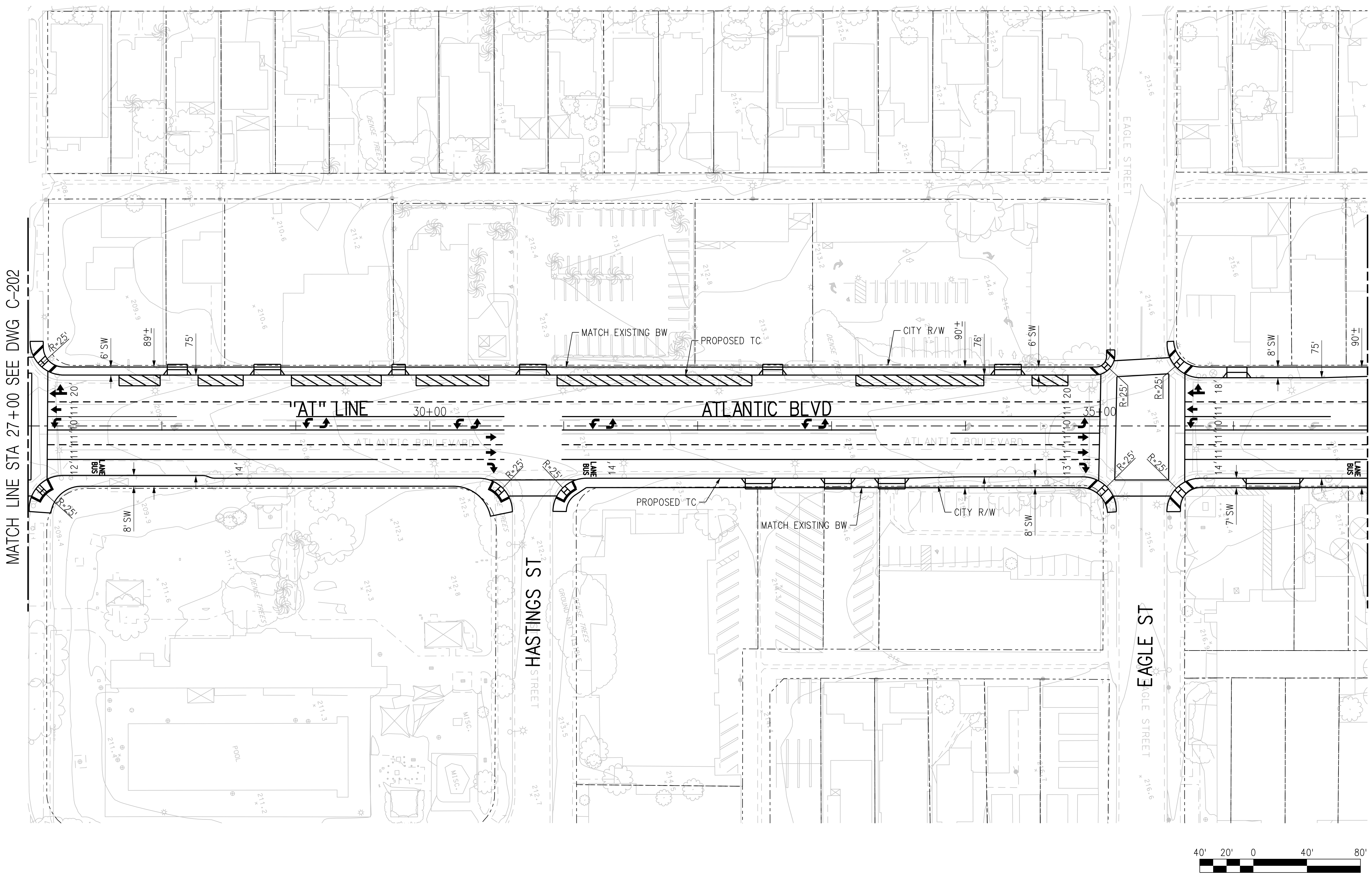

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 27+00 TO STA 37+00
SHEET 3 OF 48

CONTRACT NO
DRAWING NO C-203
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 428908_BW.TBL
Plot Driver: iplotdrvm.plt
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4/9/2015
11:59:59 AM
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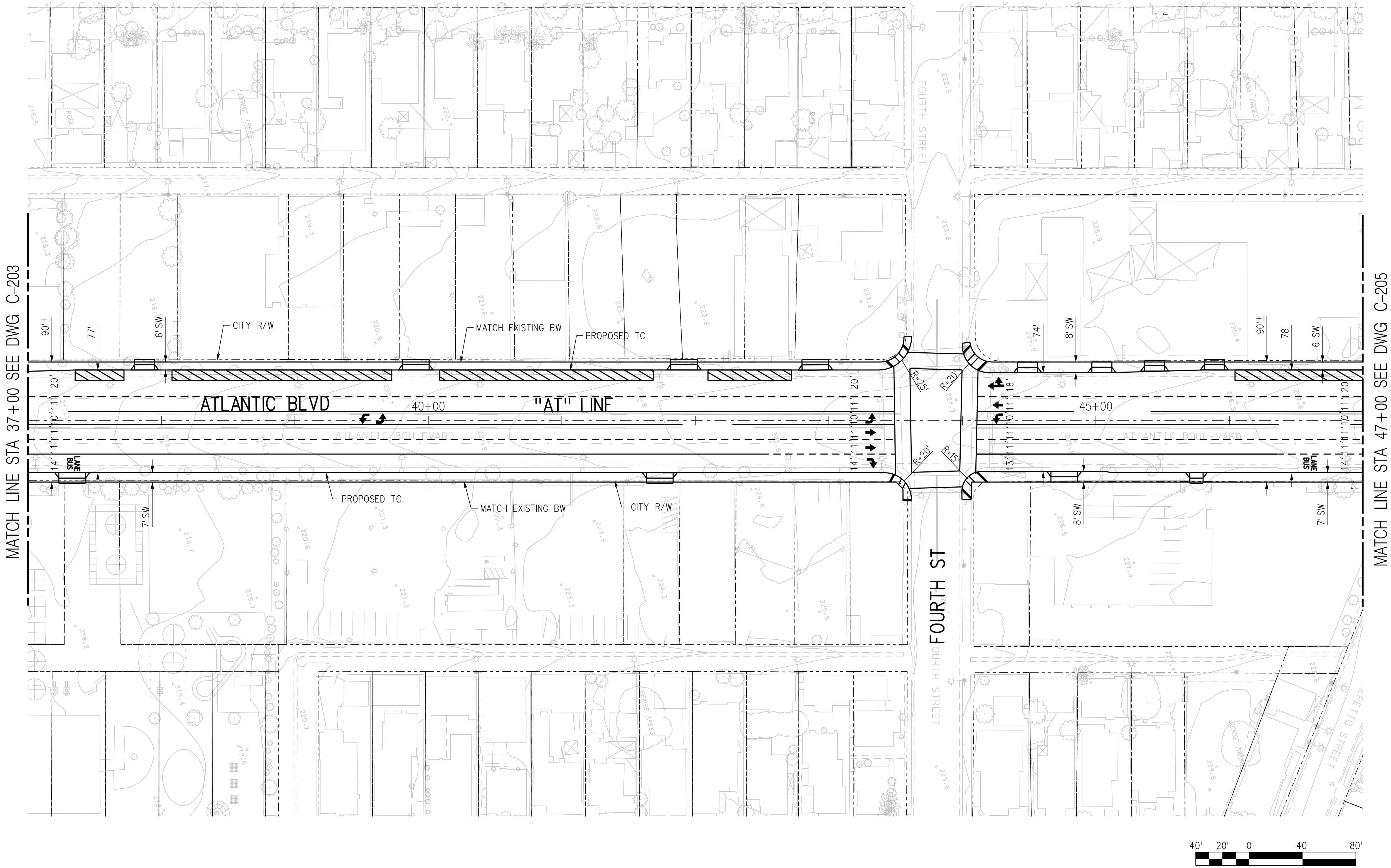


THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

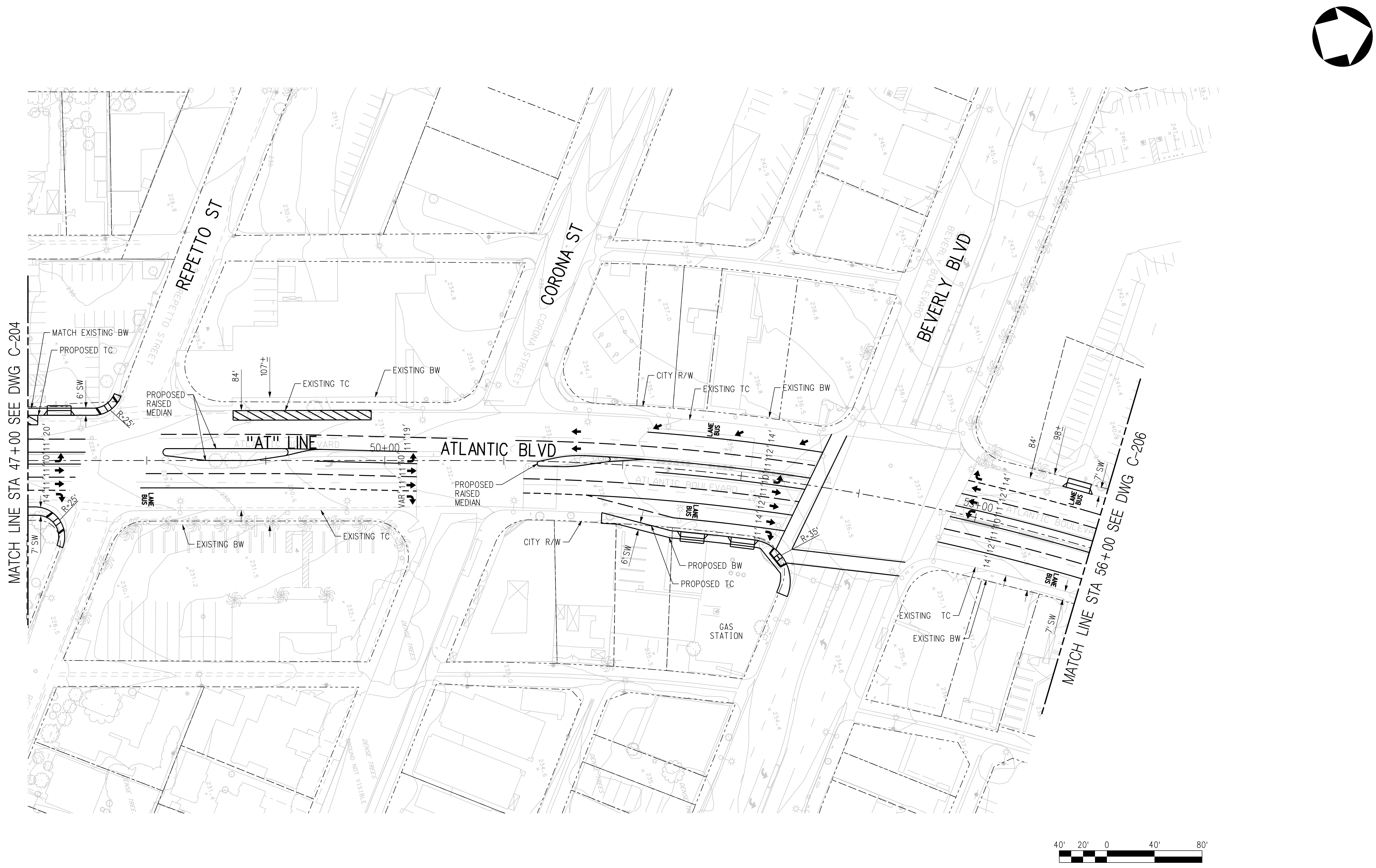
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 37+00 TO STA 47+00
SHEET 4 OF 48

CONTRACT NO
DRAWING NO C-204
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



40' 20' 0 40' 80'

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

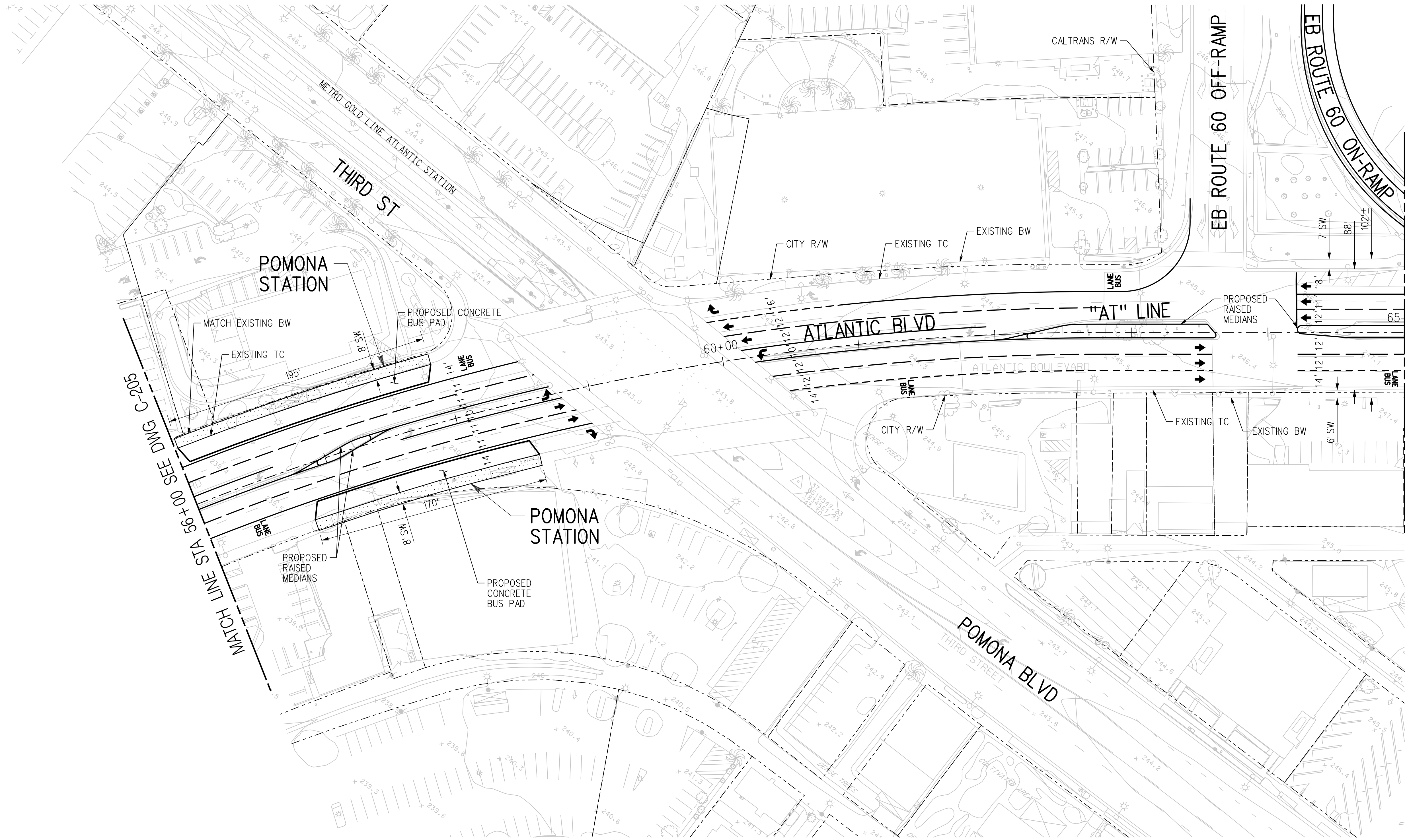
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 47+00 TO STA 56+00
SHEET 5 OF 48

CONTRACT NO
DRAWING NO C-205
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

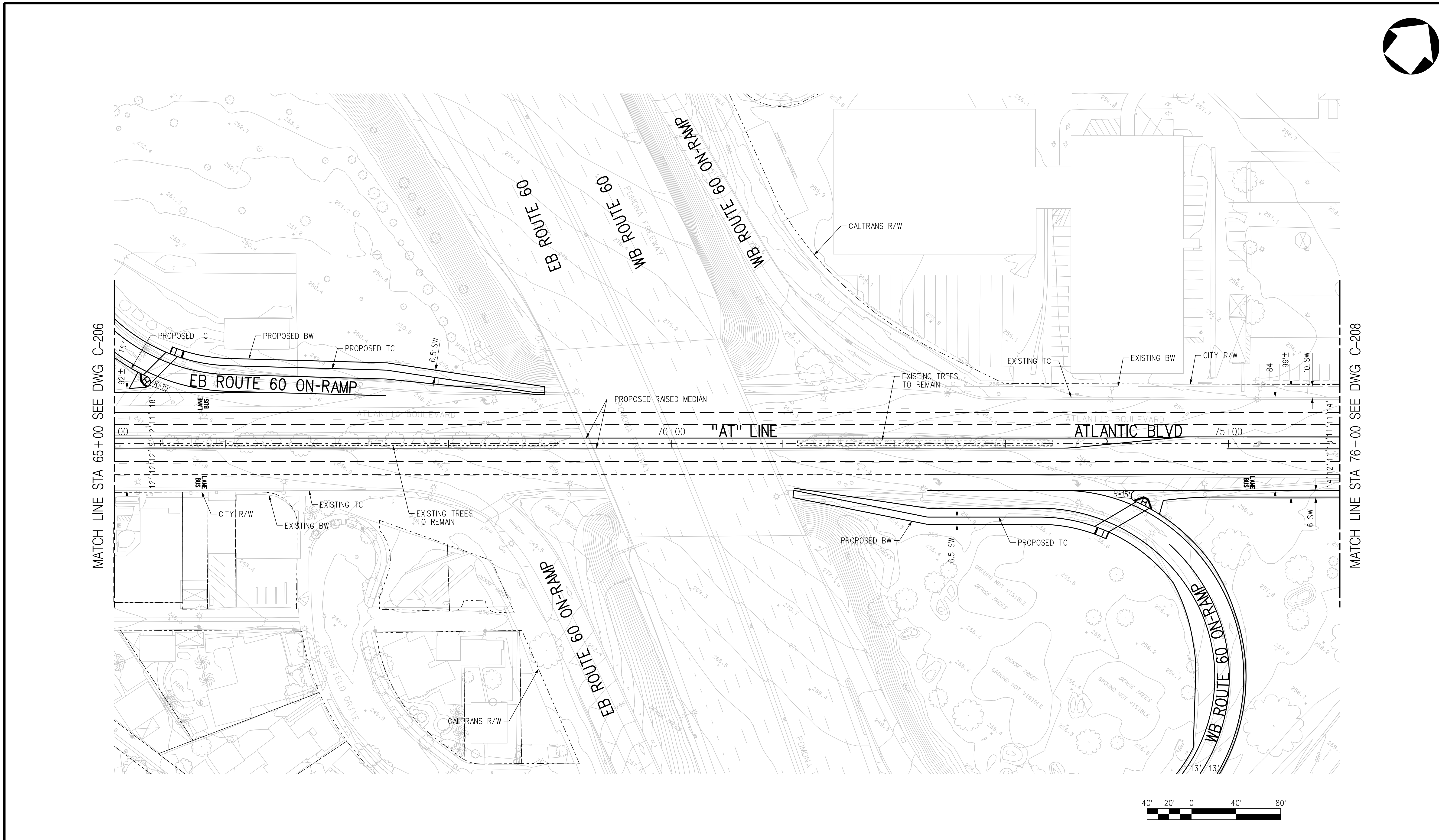
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 56+00 TO STA 65+00
SHEET 6 OF 48

CONTRACT NO
DRAWING NO C-206
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

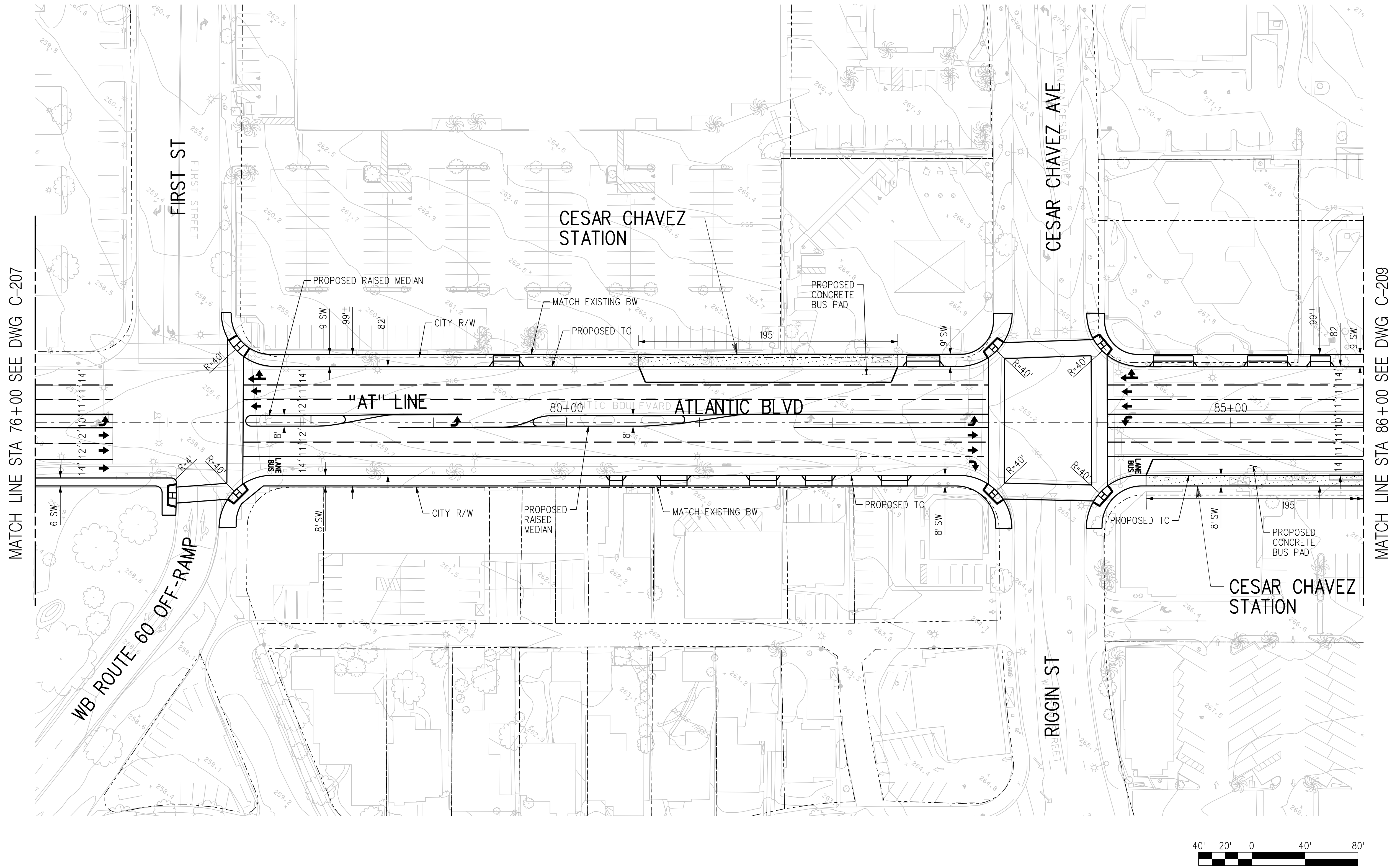
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 65+00 TO STA 76+00
SHEET 7 OF 48

CONTRACT NO
DRAWING NO C-207
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

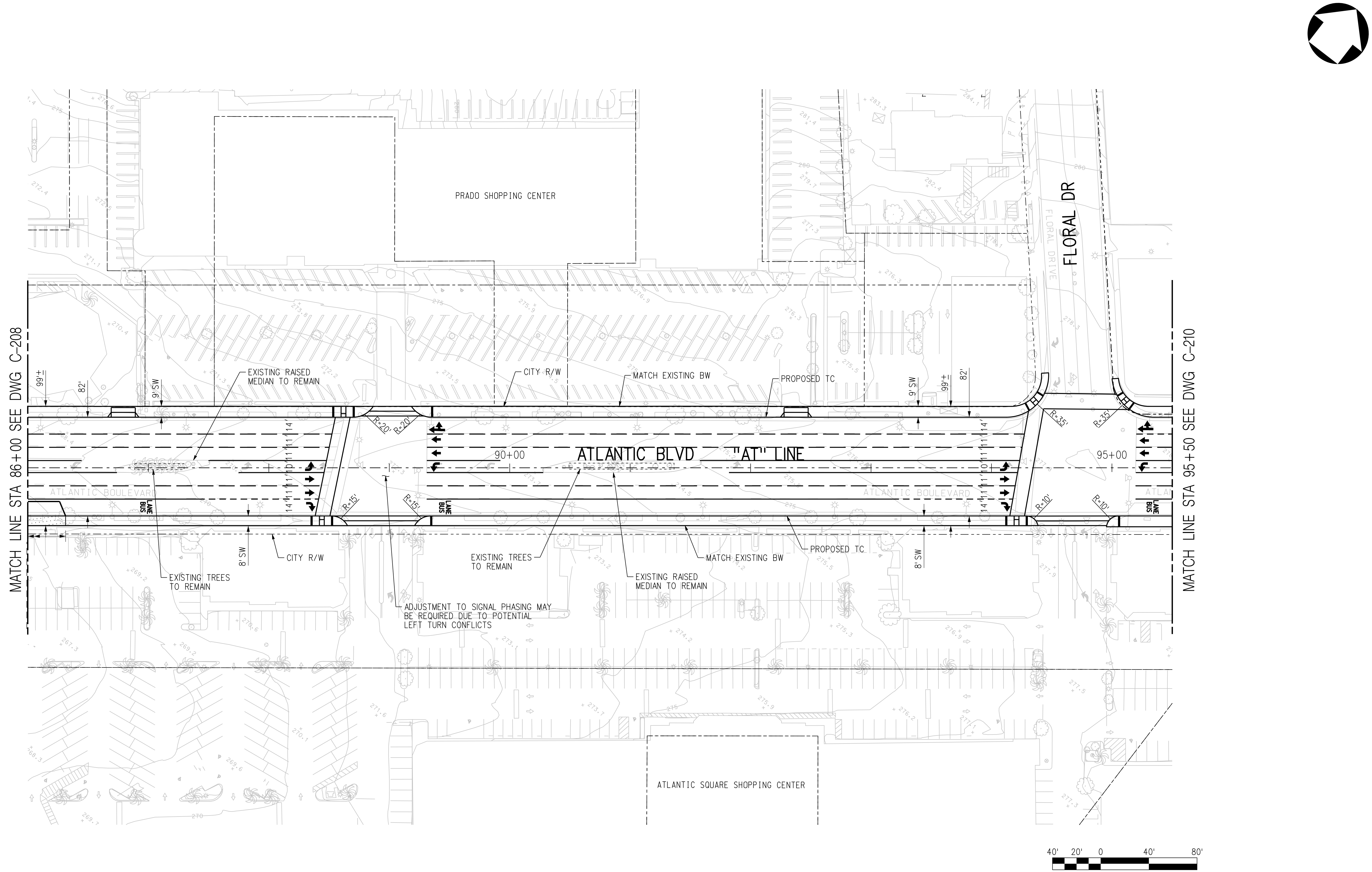
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 76+00 TO STA 86+00
SHEET 8 OF 48

CONTRACT NO
DRAWING NO C-208
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 86+00 TO STA 95+50
SHEET 9 OF 48

CONTRACT NO
DRAWING NO C-209
REV
SCALE 1" = 40'
SHEET NO

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THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

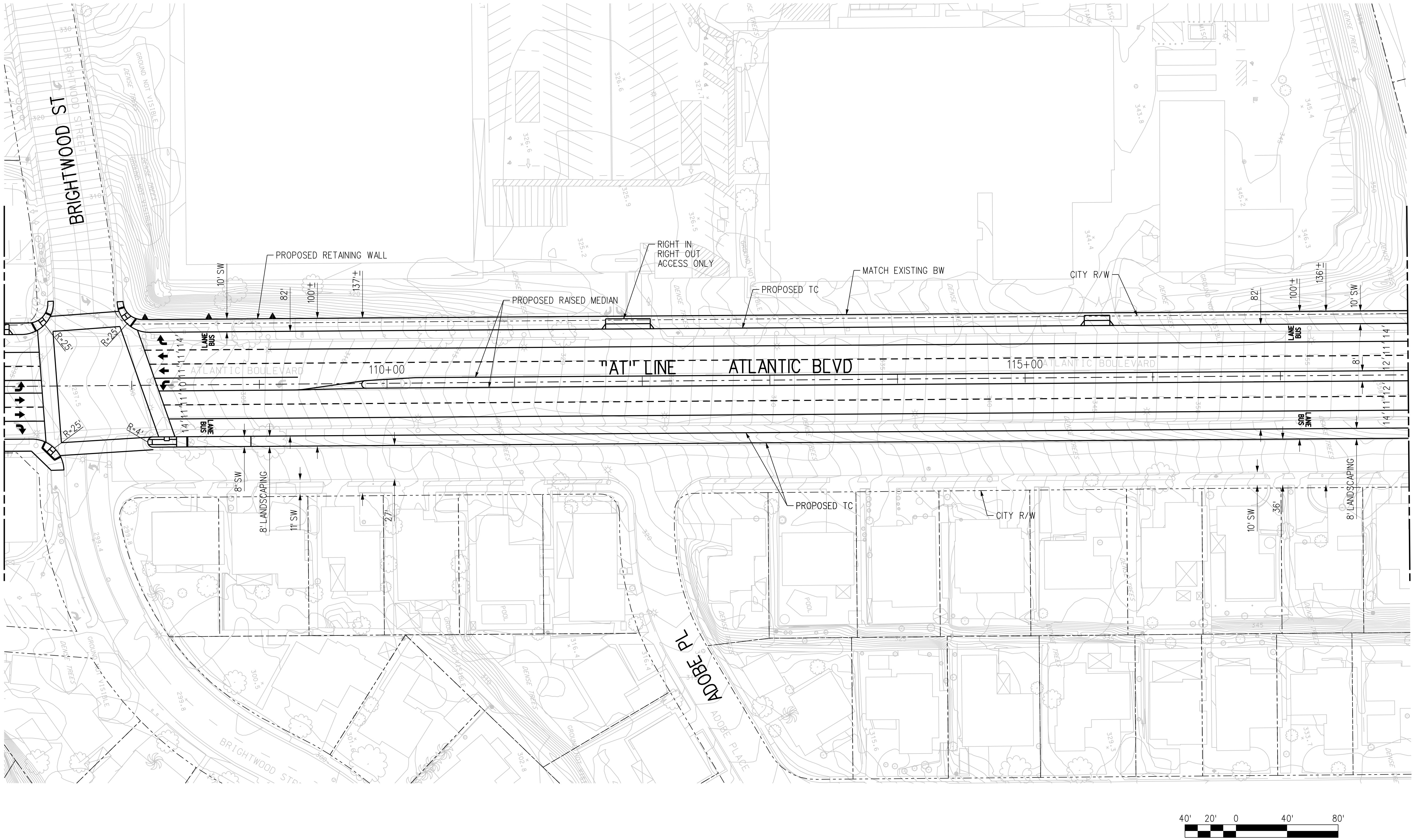
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 95+50 TO STA 107+00
SHEET 10 OF 48

CONTRACT NO
DRAWING NO C-210
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 107+00 TO STA 118+00
SHEET 11 OF 48

CONTRACT NO
DRAWING NO C-211
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 428908_BW.TBL
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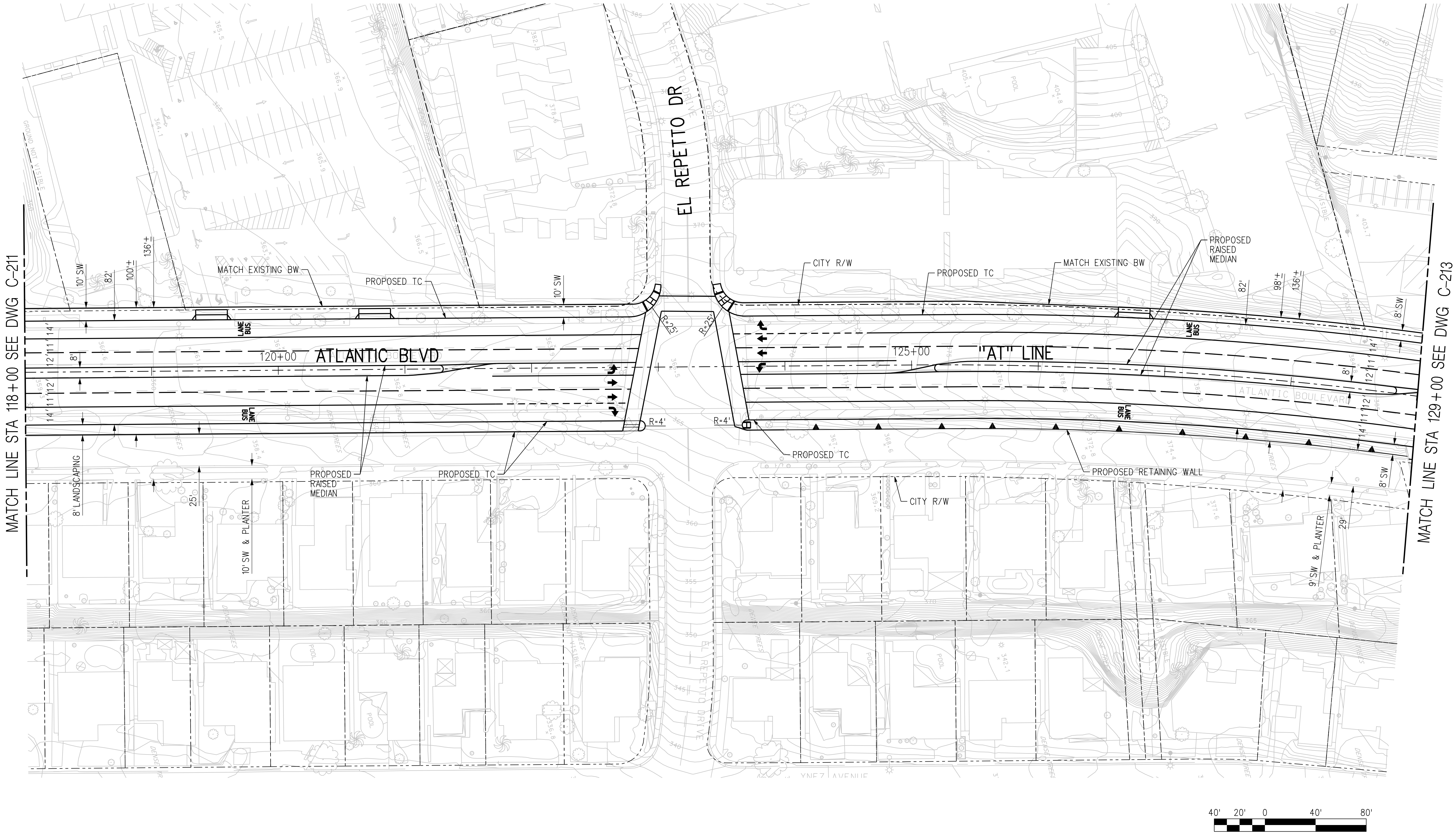

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 118+00 TO STA 129+00
SHEET 12 OF 48

CONTRACT NO
DRAWING NO C-212
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 428908_BW.TBL
Plot Driver: iplotdrvm.plt
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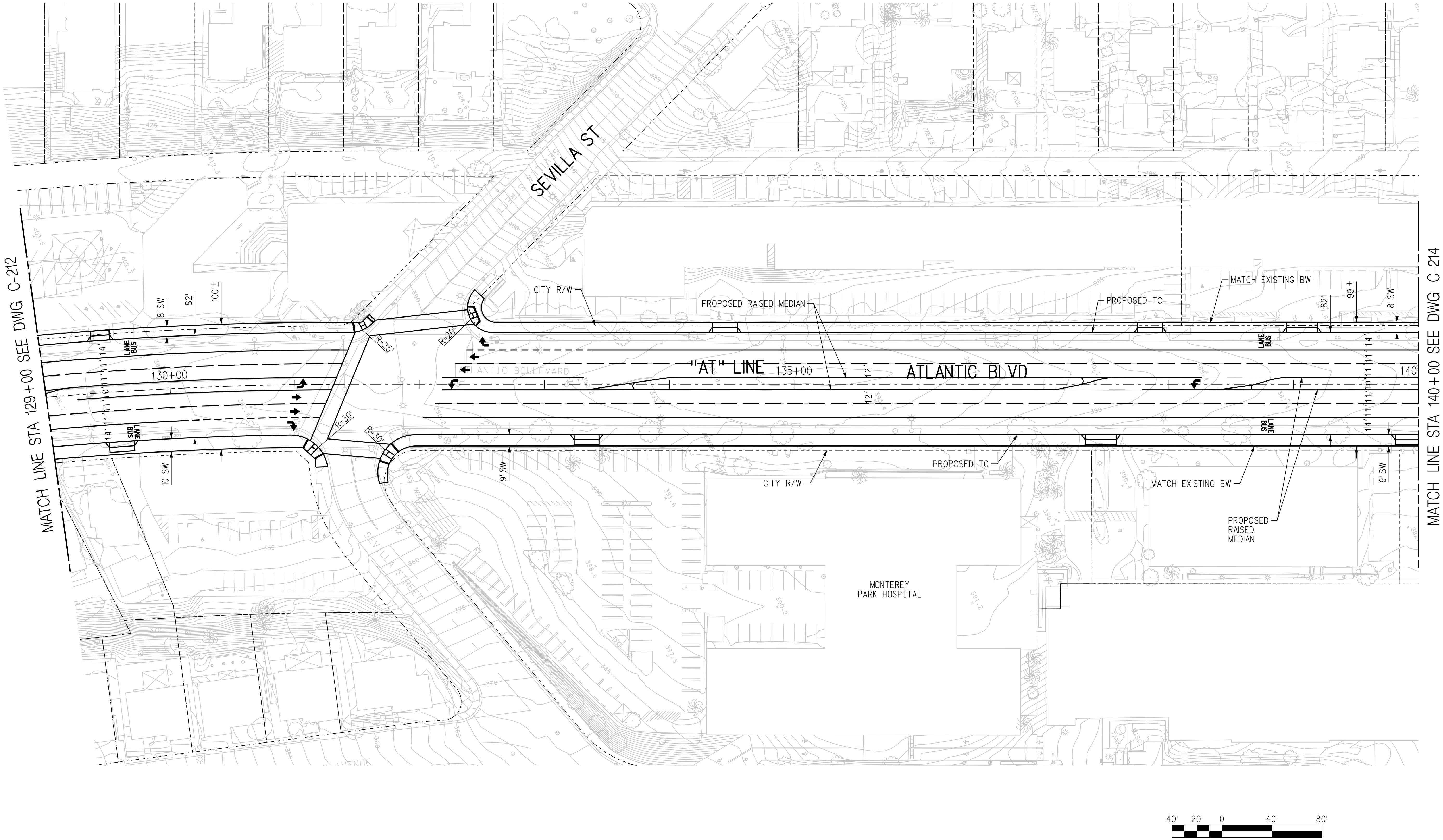

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Plot Driver= iplotdrvm.plt

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DENPWP02$

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

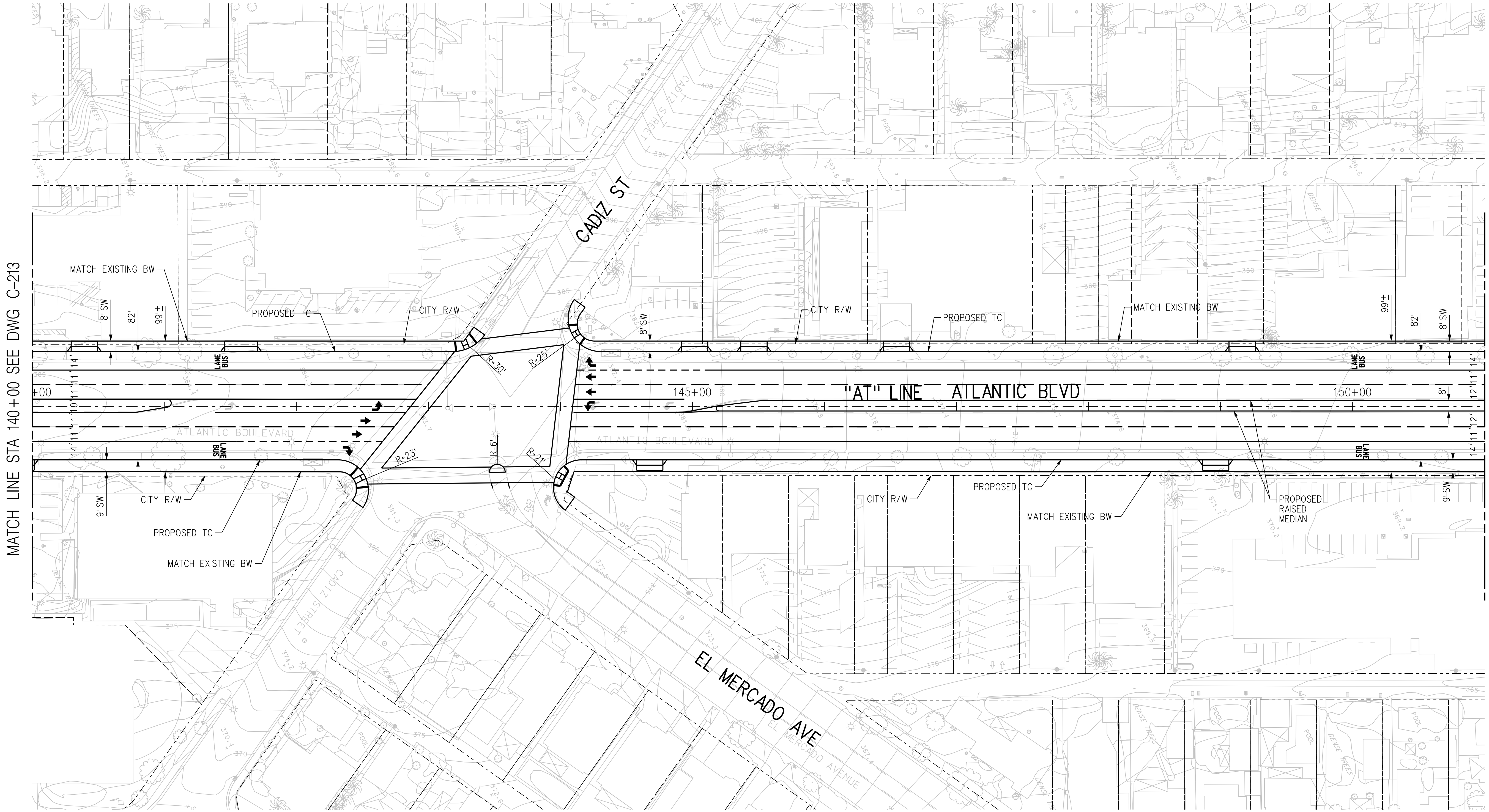
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 129+00 TO STA 140+00
SHEET 13 OF 48

CONTRACT NO
DRAWING NO C-213
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



40' 20' 0 40' 80'

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 140+00 TO STA 151+00
SHEET 14 OF 48

CONTRACT NO

DRAWING NO C-214

REV

SCALE 1" = 40'

SHEET NO

Model Name= Default

Pentable= 428908_BW.TBL
Plot Driver= iplotdrvm.plt
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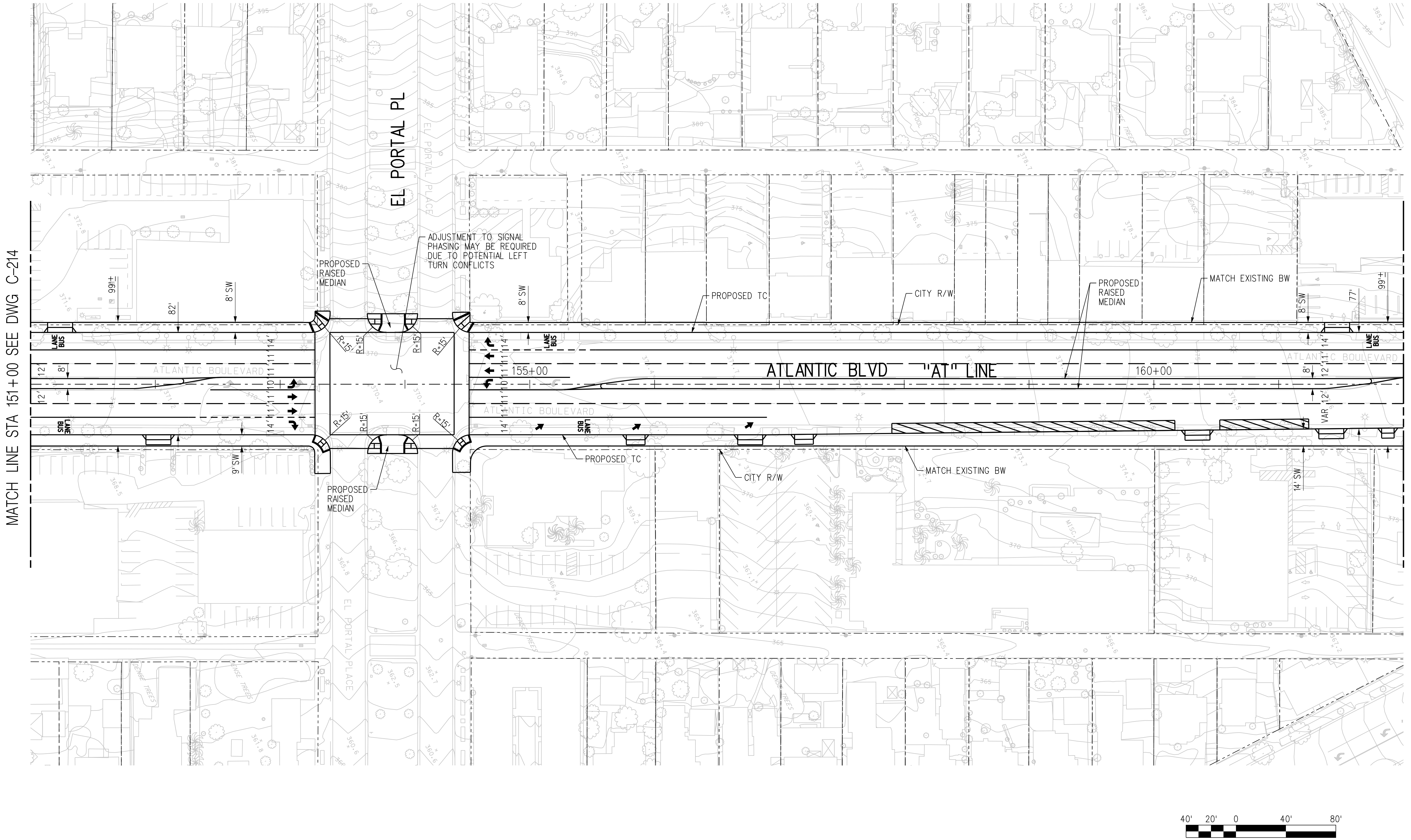

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/19/14

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

710 NORTH STUDY-BRT ADVANCED CONCEPTUAL DESIGN PLAN

STA 151+00 TO STA 162+00

SHEET 15 OF 48

CONTRACT NO

DRAWING NO C-215

REV

SCALE 1" = 40'

SHEET NO

Model Name= Default

Pentable= 428908_BW.TBL

Plot Driver= iplotdrvm.plt

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4/9/2015 12:00:00 PM

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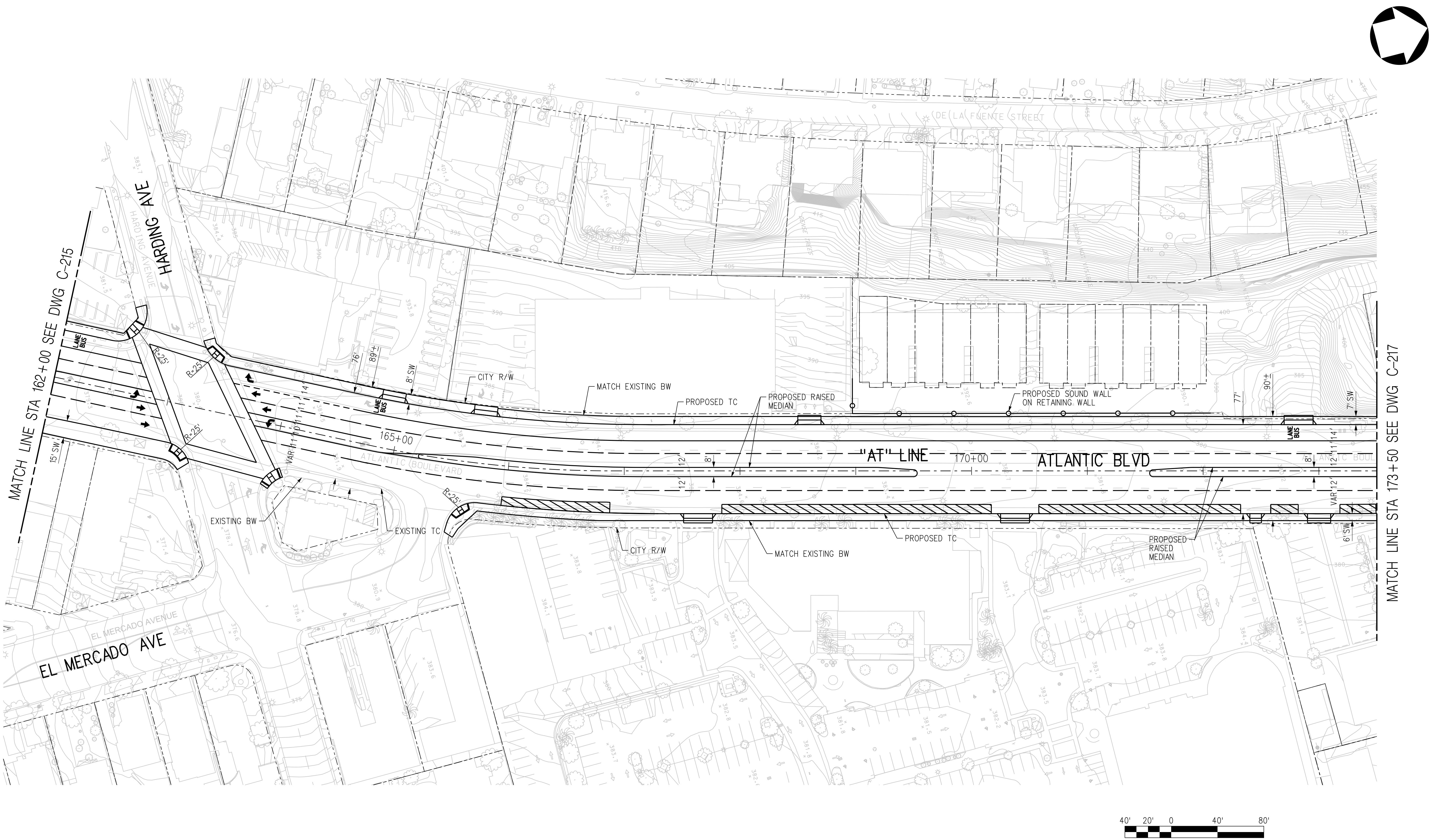


THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 9/17/14

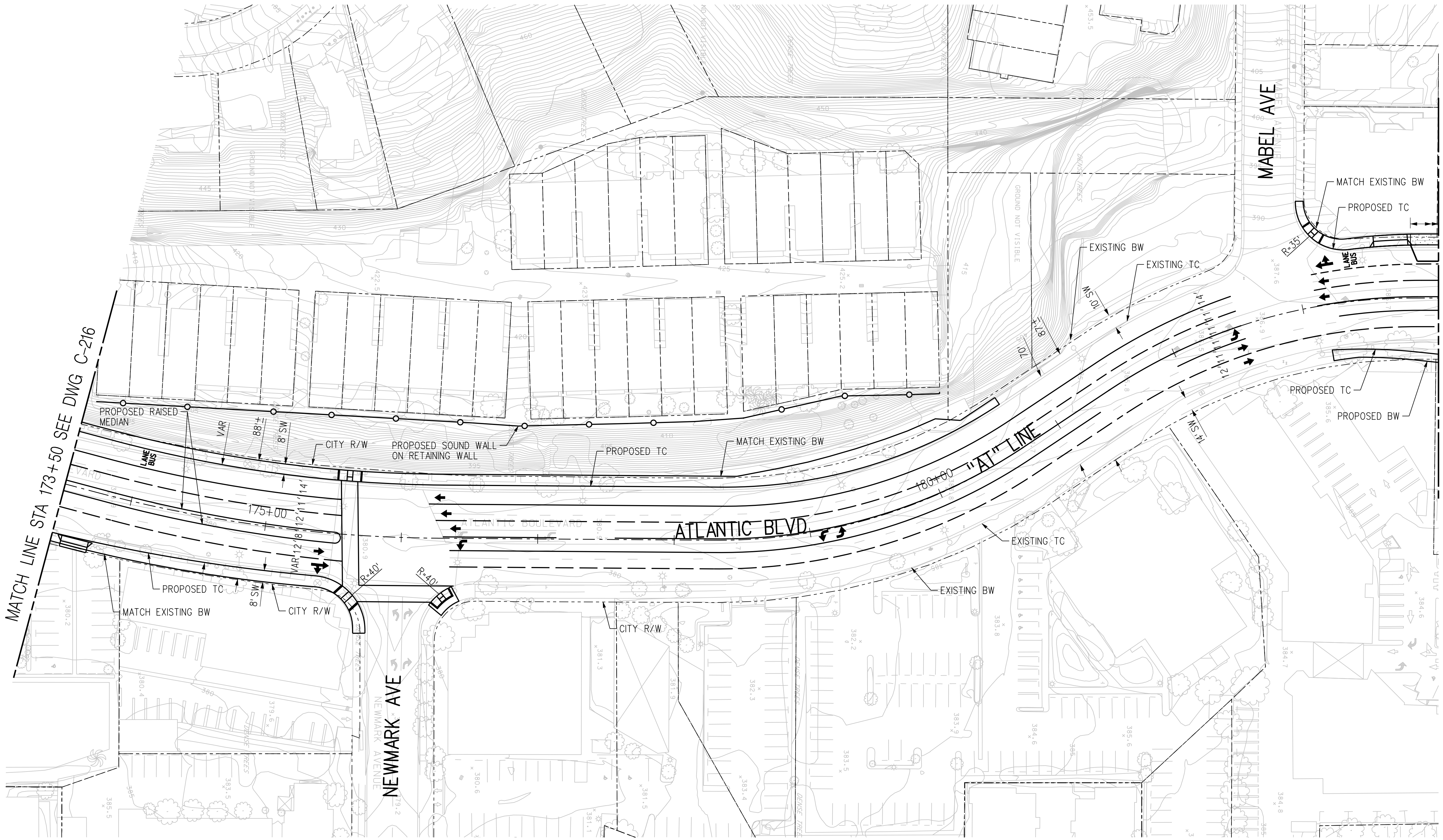
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 162+00 TO STA 173+50
SHEET 16 OF 48

CONTRACT NO
DRAWING NO C-216
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 9/17/14

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 173+50 TO STA 184+00
SHEET 17 OF 48

CONTRACT NO
DRAWING NO C-217
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

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Pentable: 428908_BW.TBL
4/9/2015 12:00:32 PM
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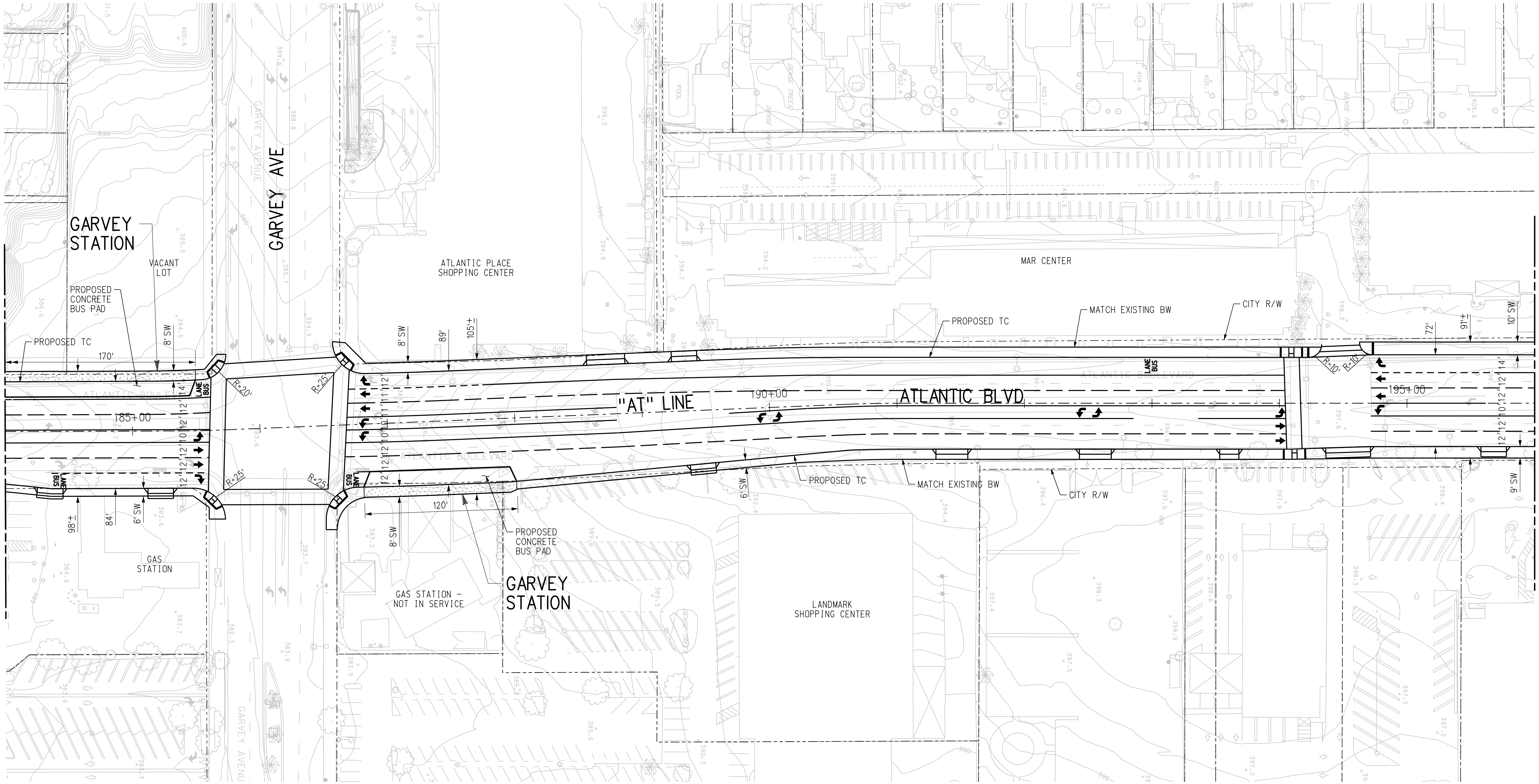


40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

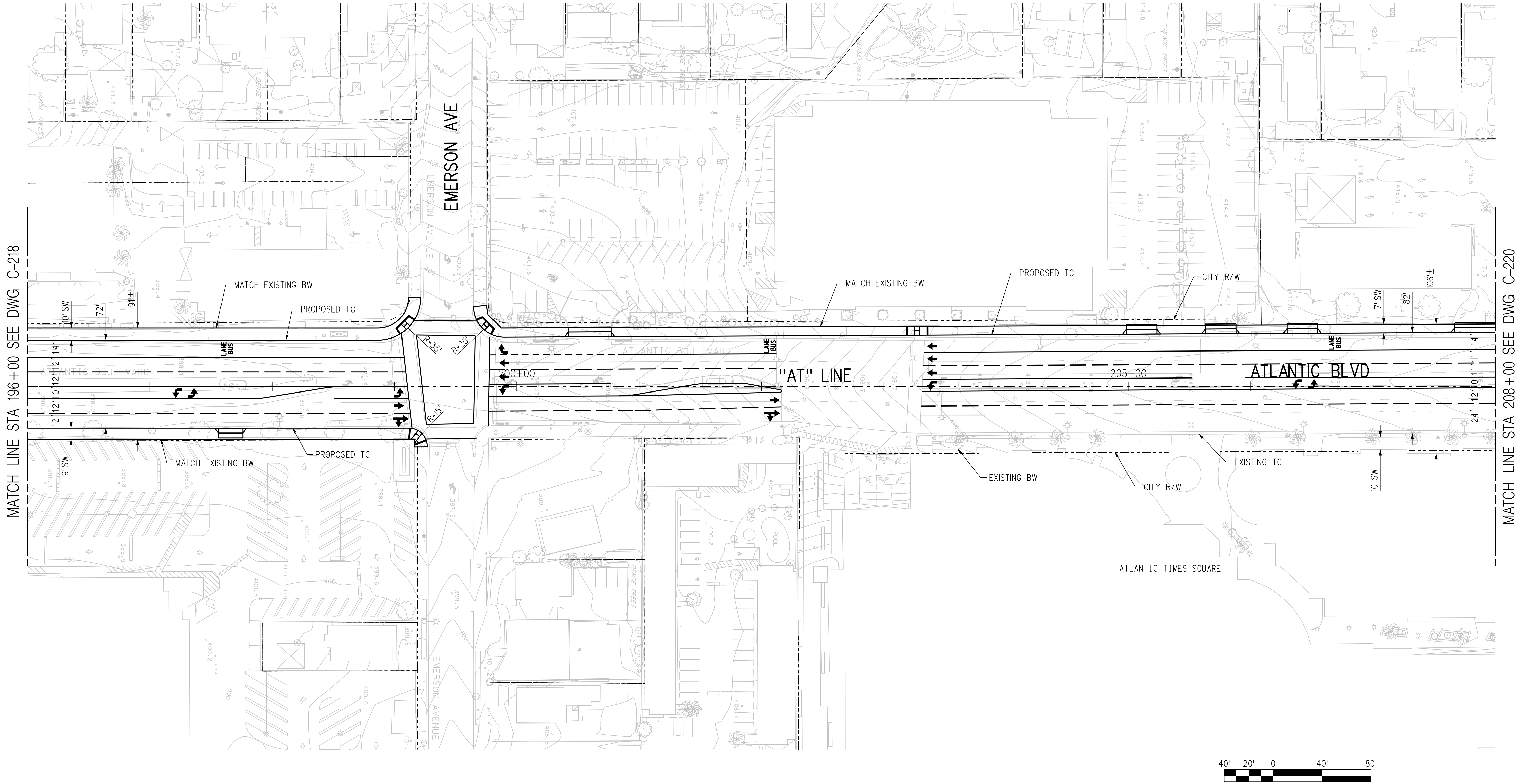
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 184+00 TO STA 196+00
SHEET 18 OF 48

CONTRACT NO
DRAWING NO C-218
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

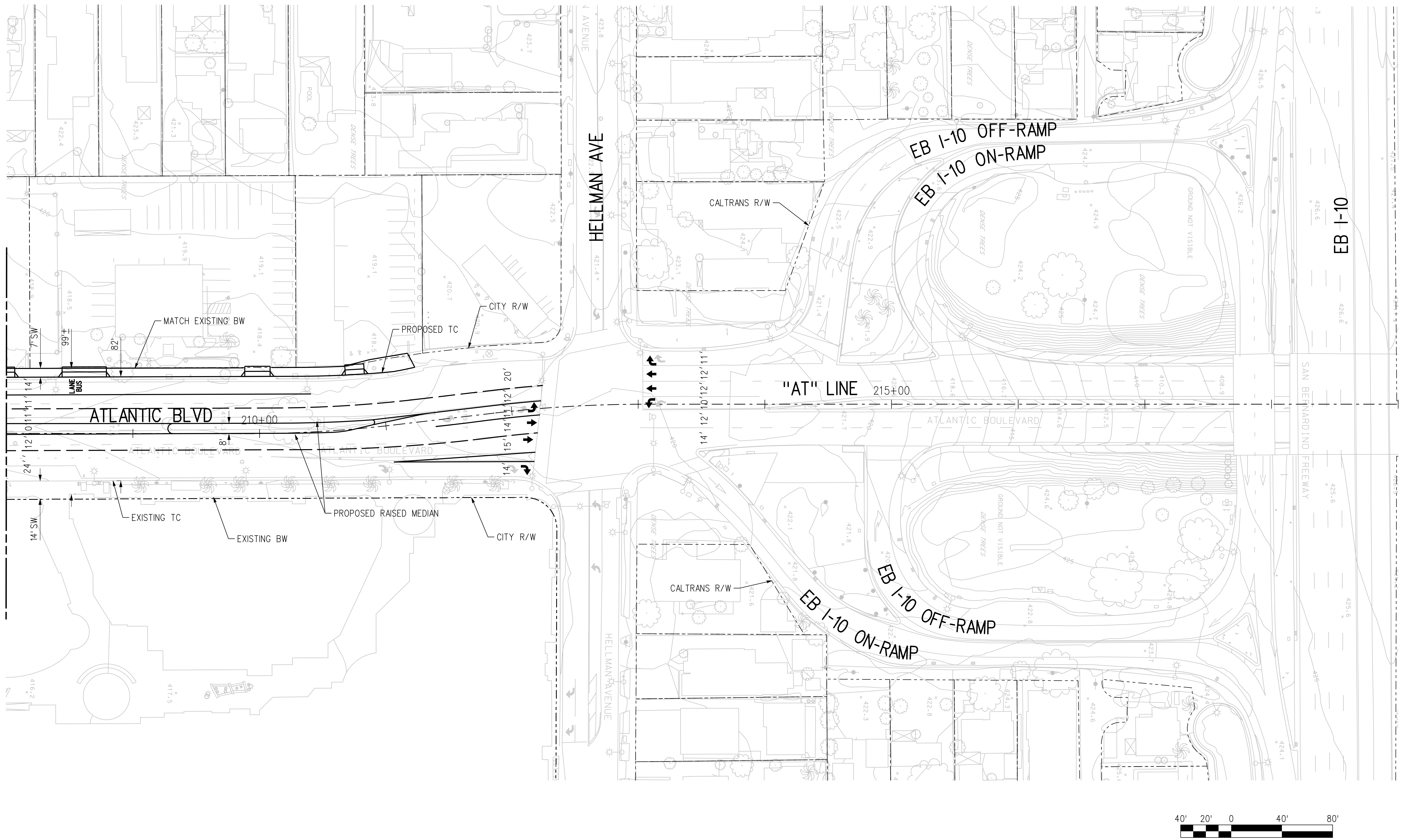
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 196+00 TO STA 208+00
SHEET 19 OF 48

CONTRACT NO
DRAWING NO C-219
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 208+00 TO STA 219+00
SHEET 20 OF 48

CONTRACT NO
DRAWING NO C-220
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 428908_BW.TBL
Plot Driver: iplotdrvm.plt
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4/9/2015
10:59:49 AM
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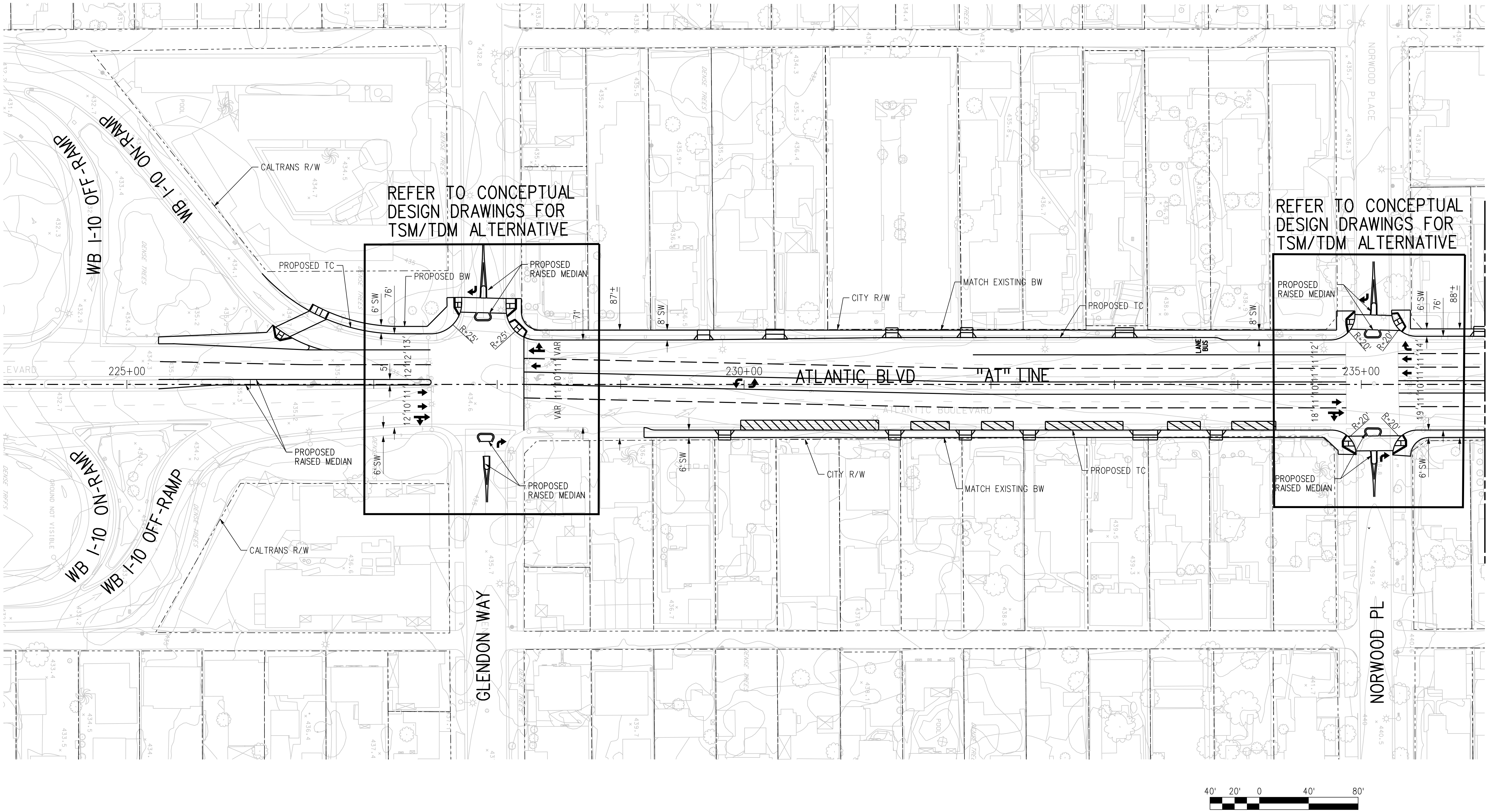


THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

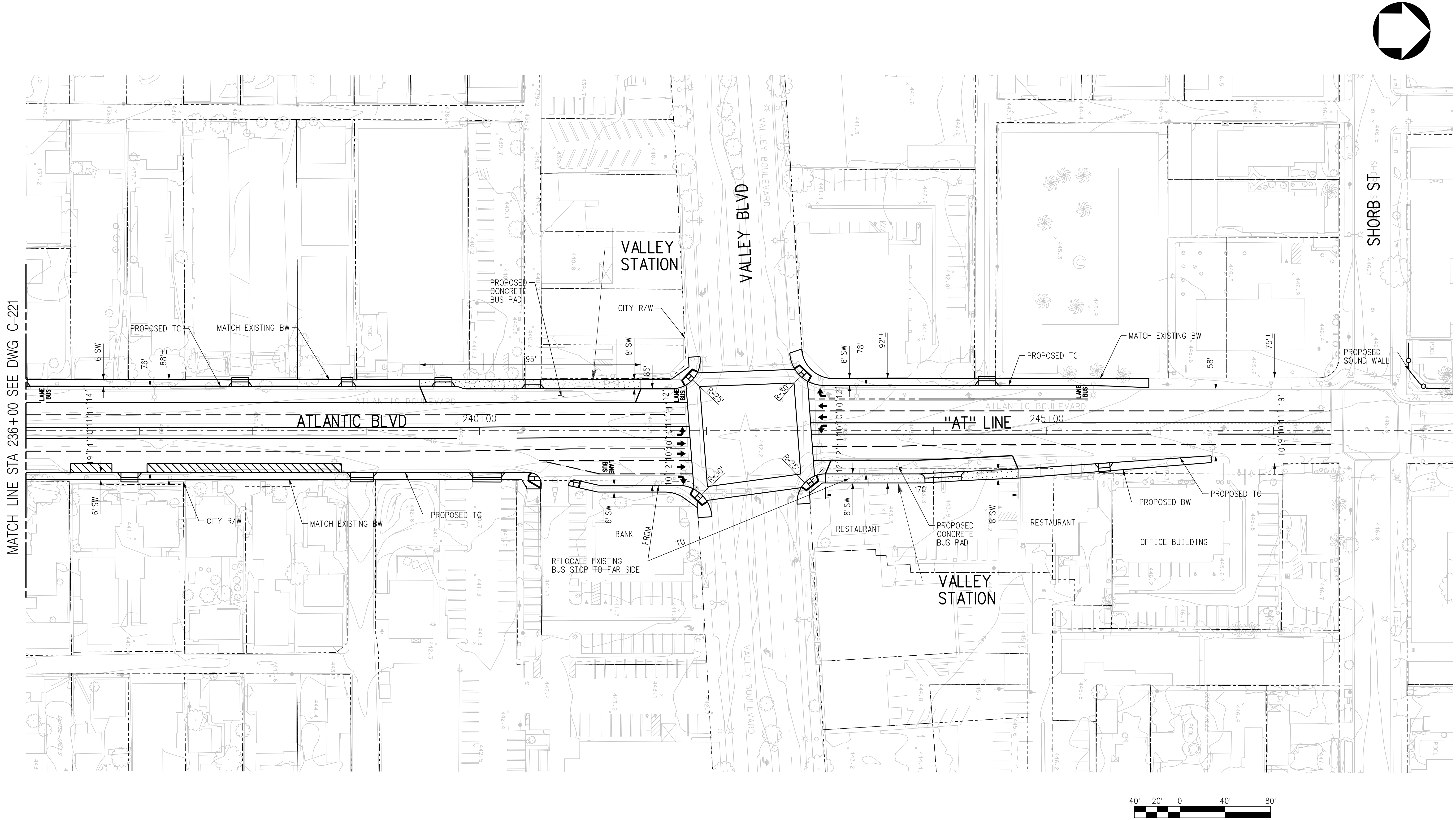
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 224+00 TO STA 236+00
SHEET 21 OF 48

CONTRACT NO
DRAWING NO C-221
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 9/17/14

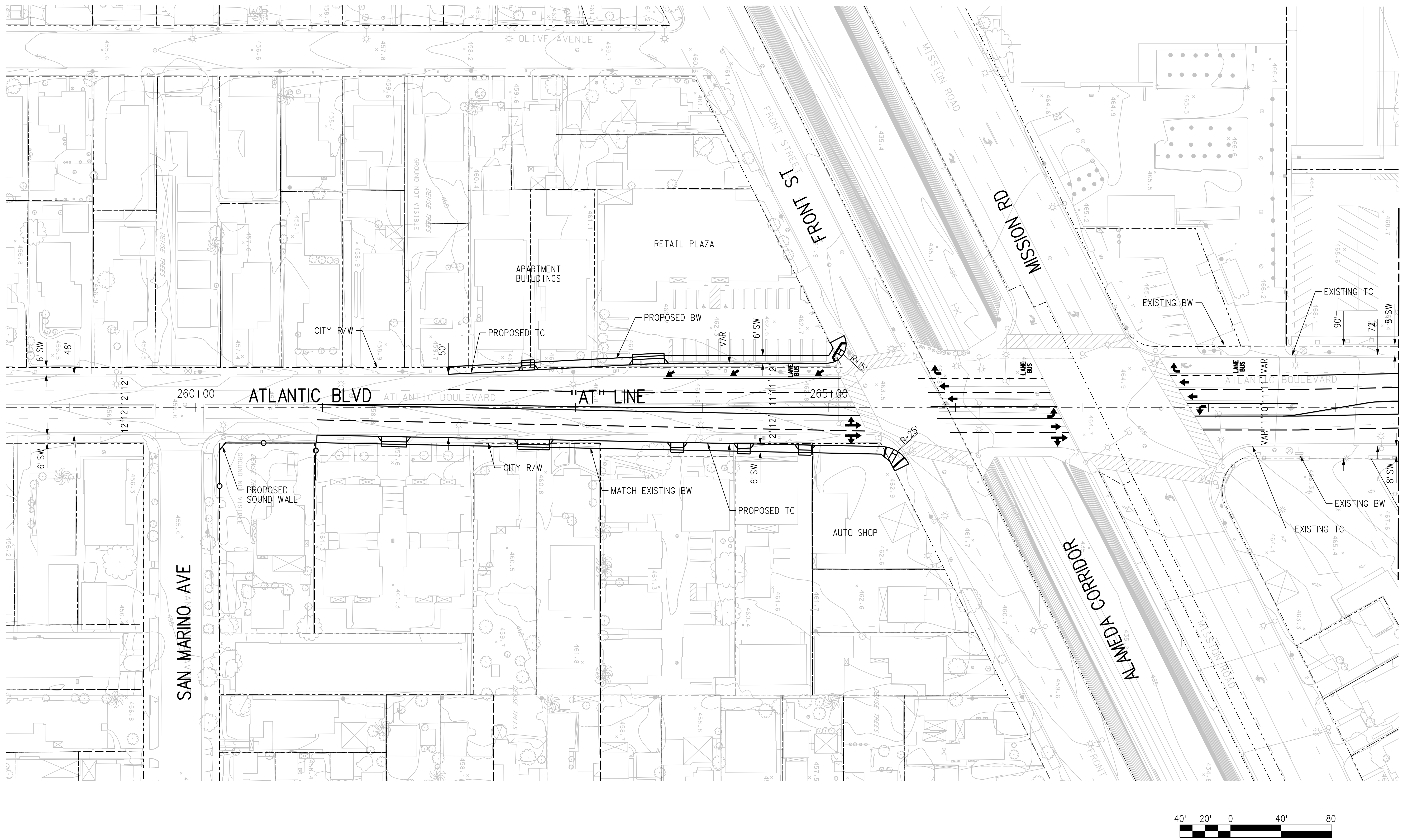
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 236+00 TO STA 248+00
SHEET 22 OF 48

CONTRACT NO
DRAWING NO C-222
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 9/17/14

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

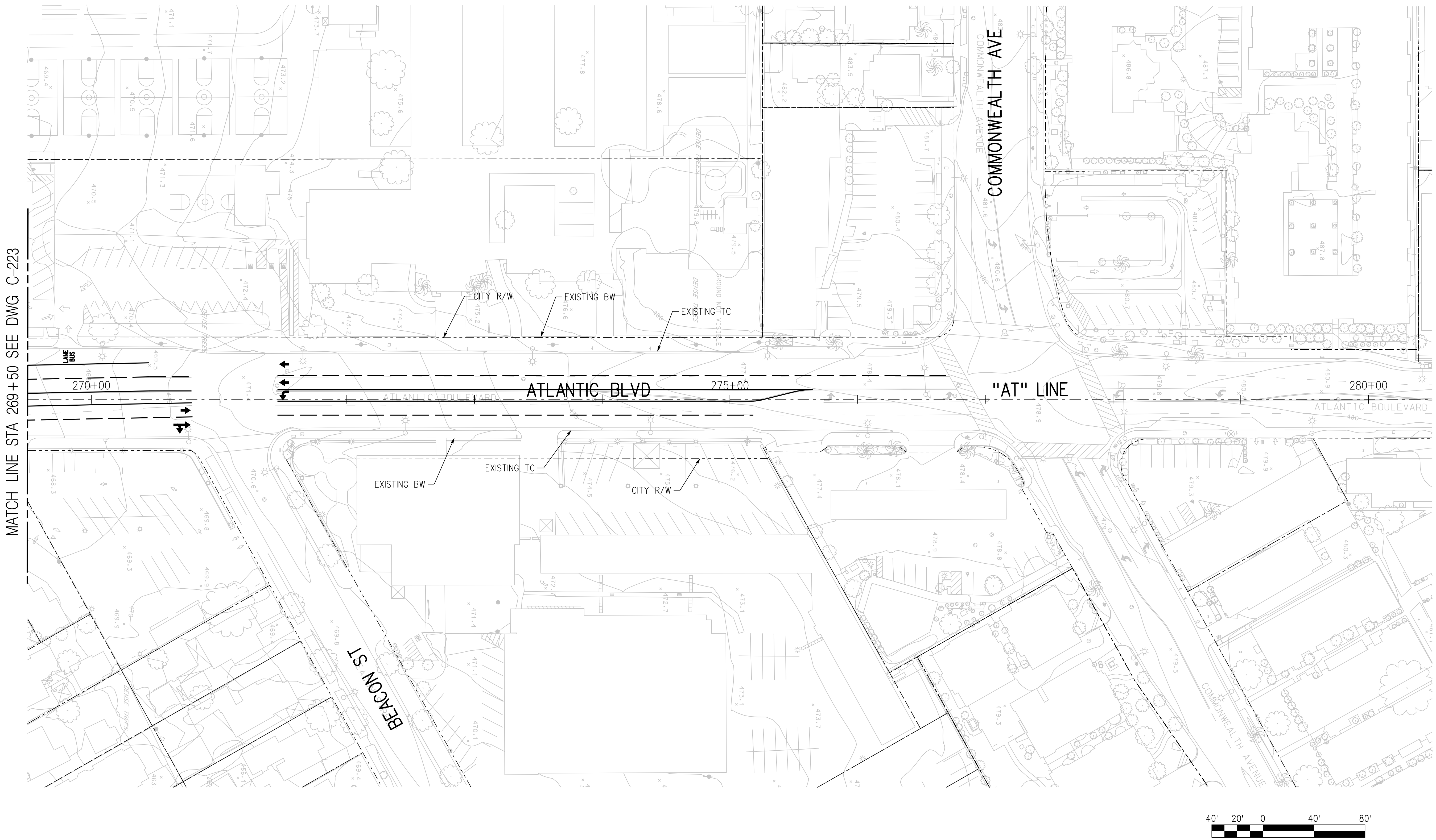
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 258+50 TO STA 269+50
SHEET 23 OF 48

CONTRACT NO
DRAWING NO C-223
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 4289083_BW.TBL
Plot Driver= iplotdrvm.plt
4/9/2015
12:00:30 PM
DENPWP02$



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

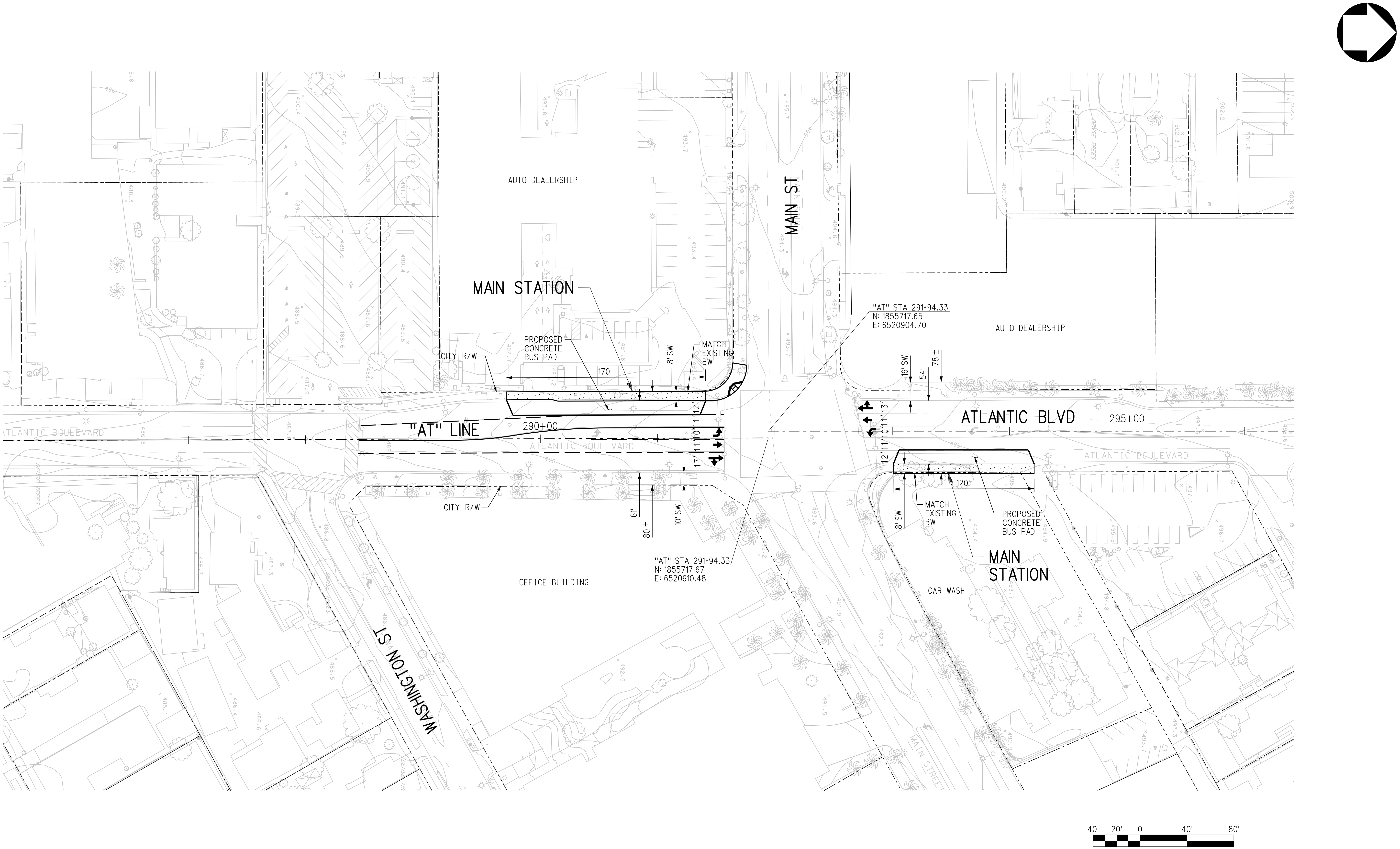
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 269+50 TO STA 280+50
SHEET 24 OF 48

CONTRACT NO
DRAWING NO C-224
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

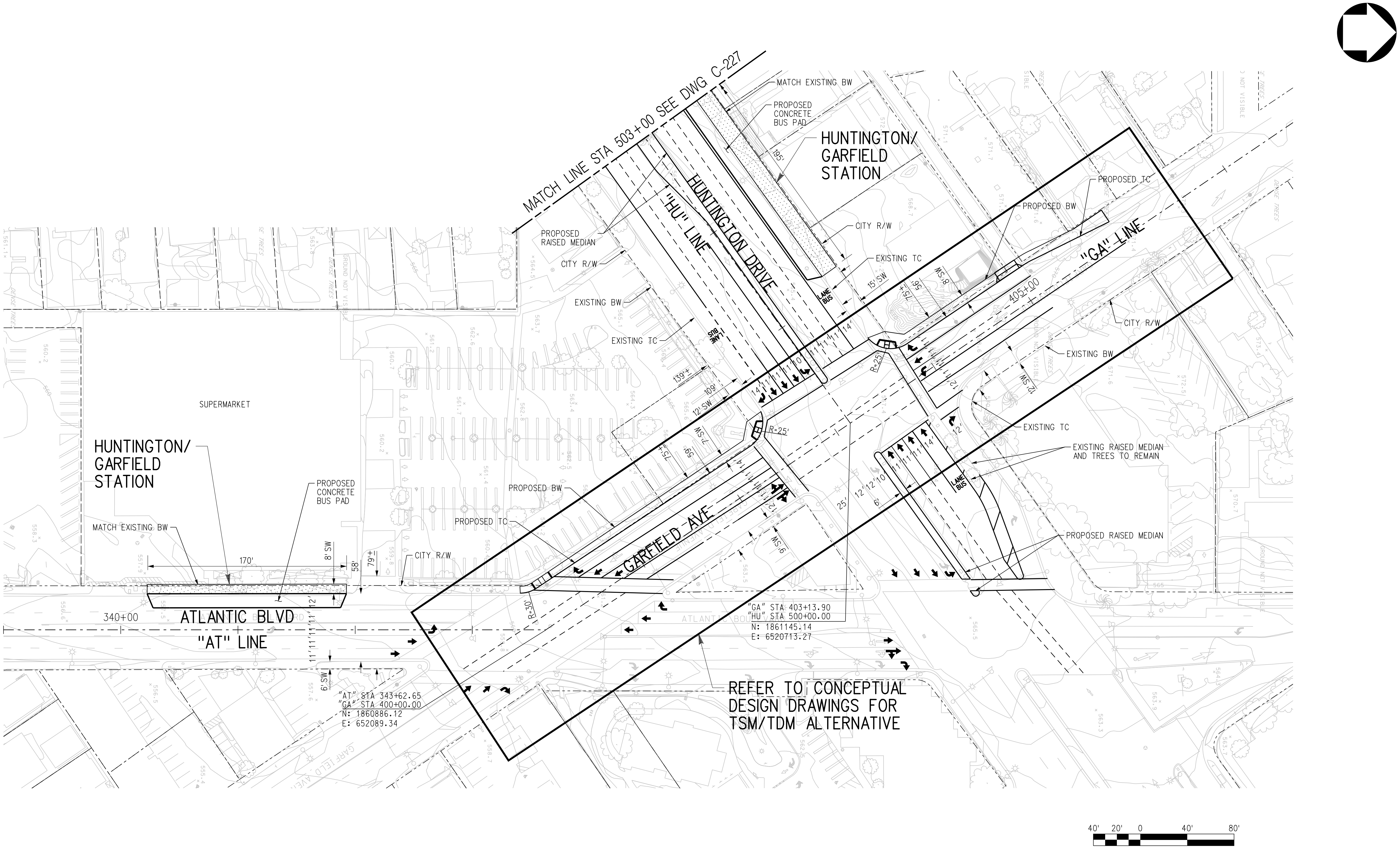
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 285+50 TO STA 296+50
SHEET 25 OF 48

CONTRACT NO
DRAWING NO C-225
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 4288908_BW.TBL
Plot Driver= iplotdrvm.plt
4/9/2015
12:00:01 PM
DENPW03$



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

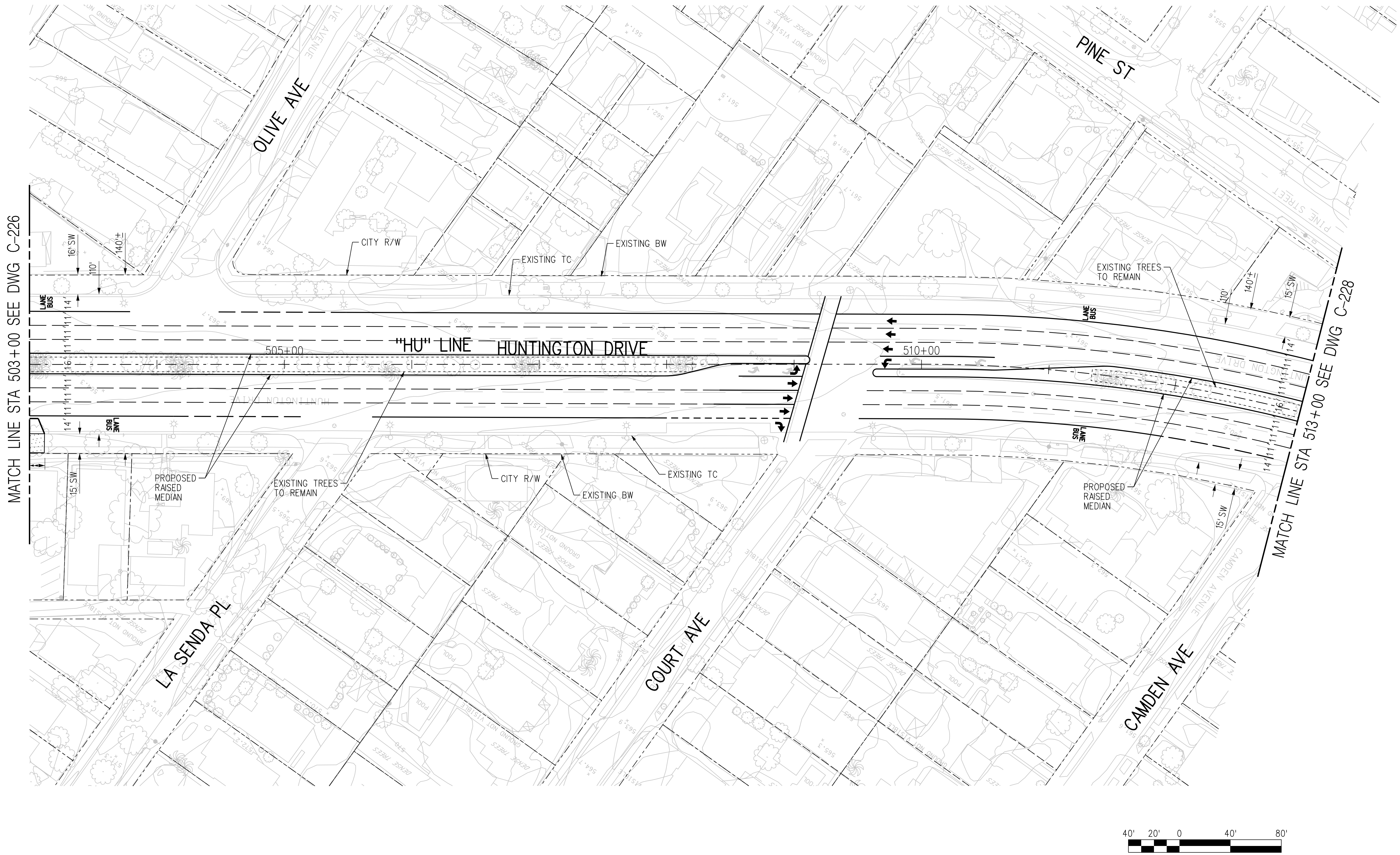
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 339+00 TO STA 503+00
SHEET 26 OF 48

CONTRACT NO
DRAWING NO C-226
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

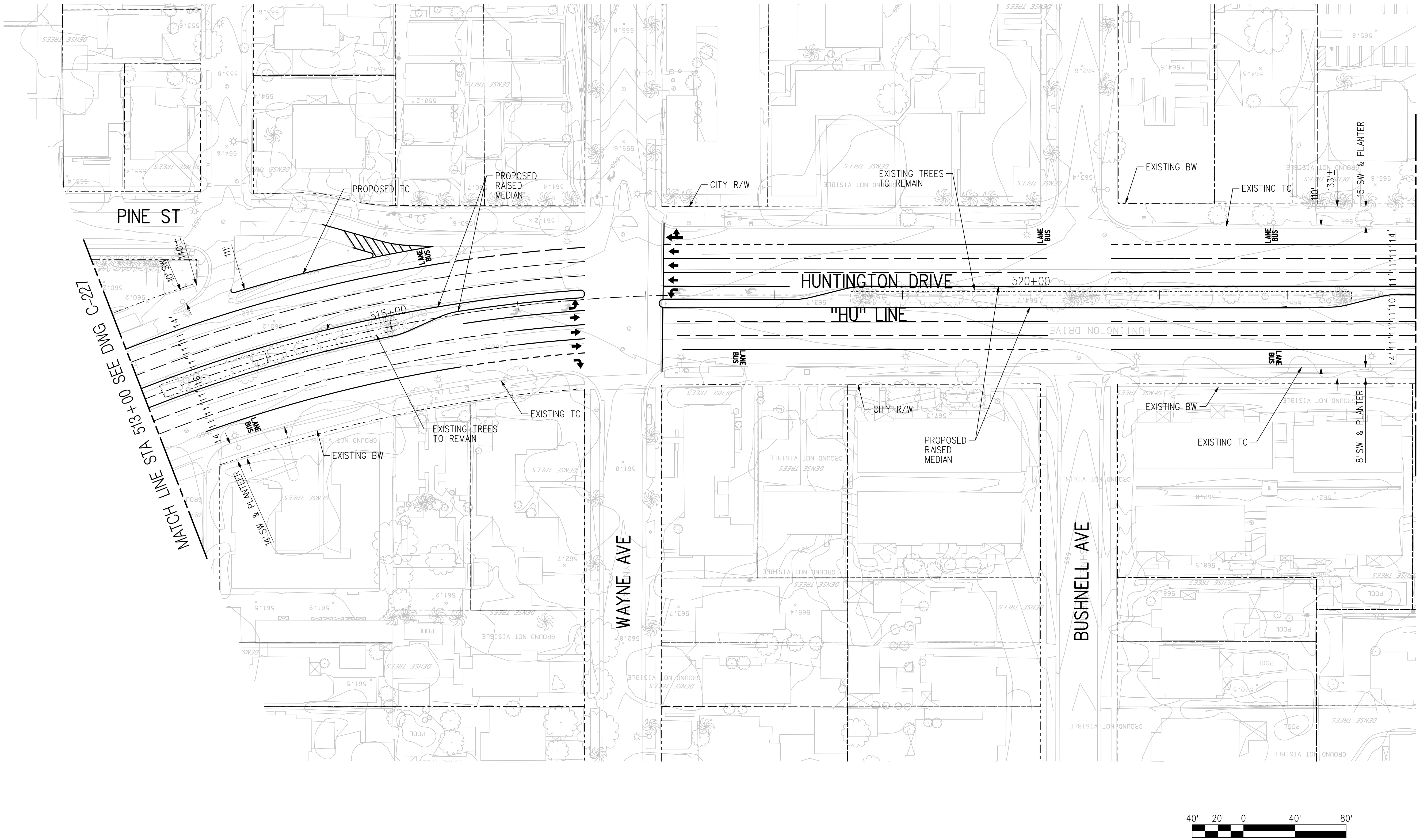
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 503+00 TO STA 513+00
SHEET 27 OF 48

CONTRACT NO
DRAWING NO C-227
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

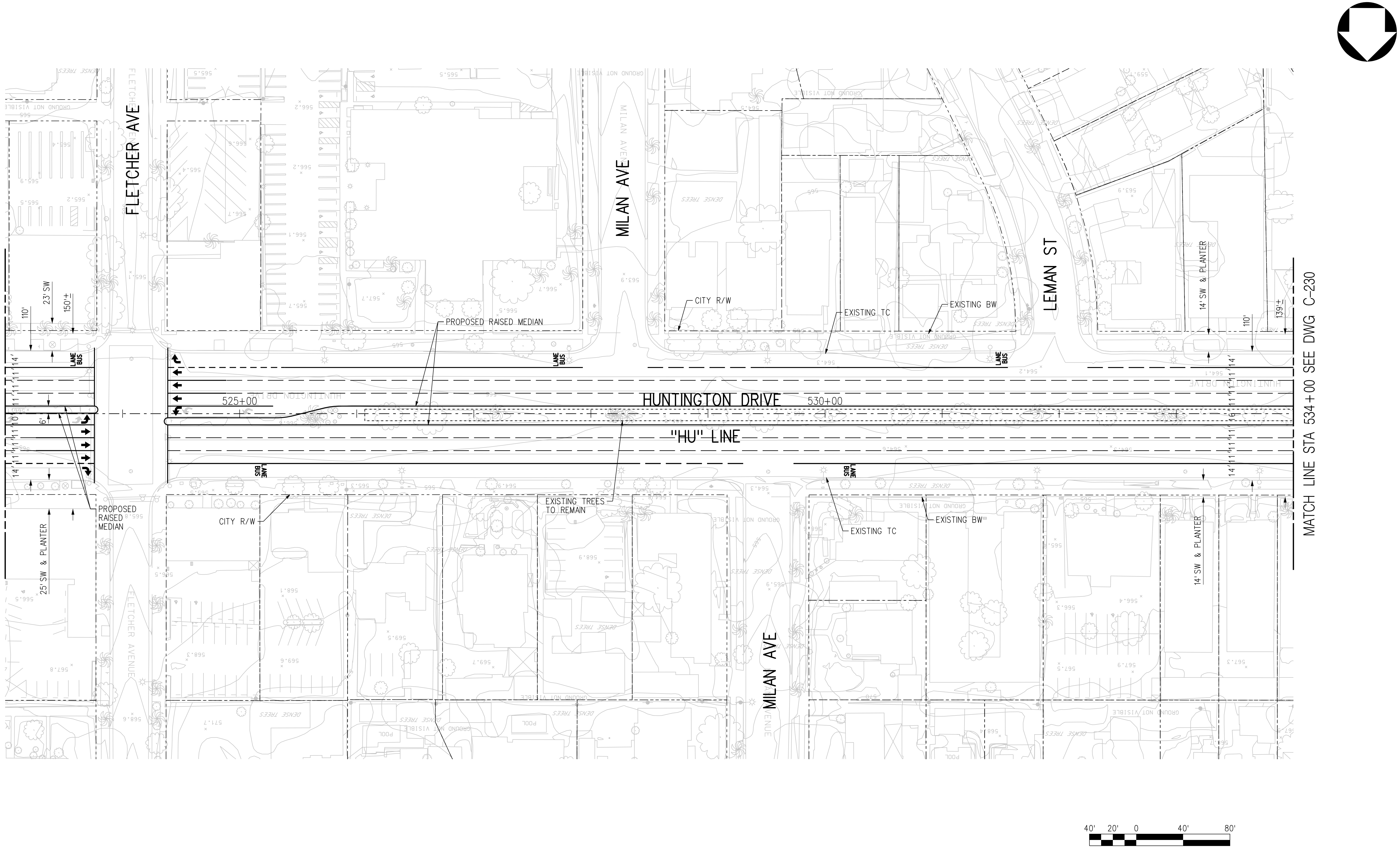
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 513+00 TO STA 523+00
SHEET 28 OF 48

CONTRACT NO
DRAWING NO C-228
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

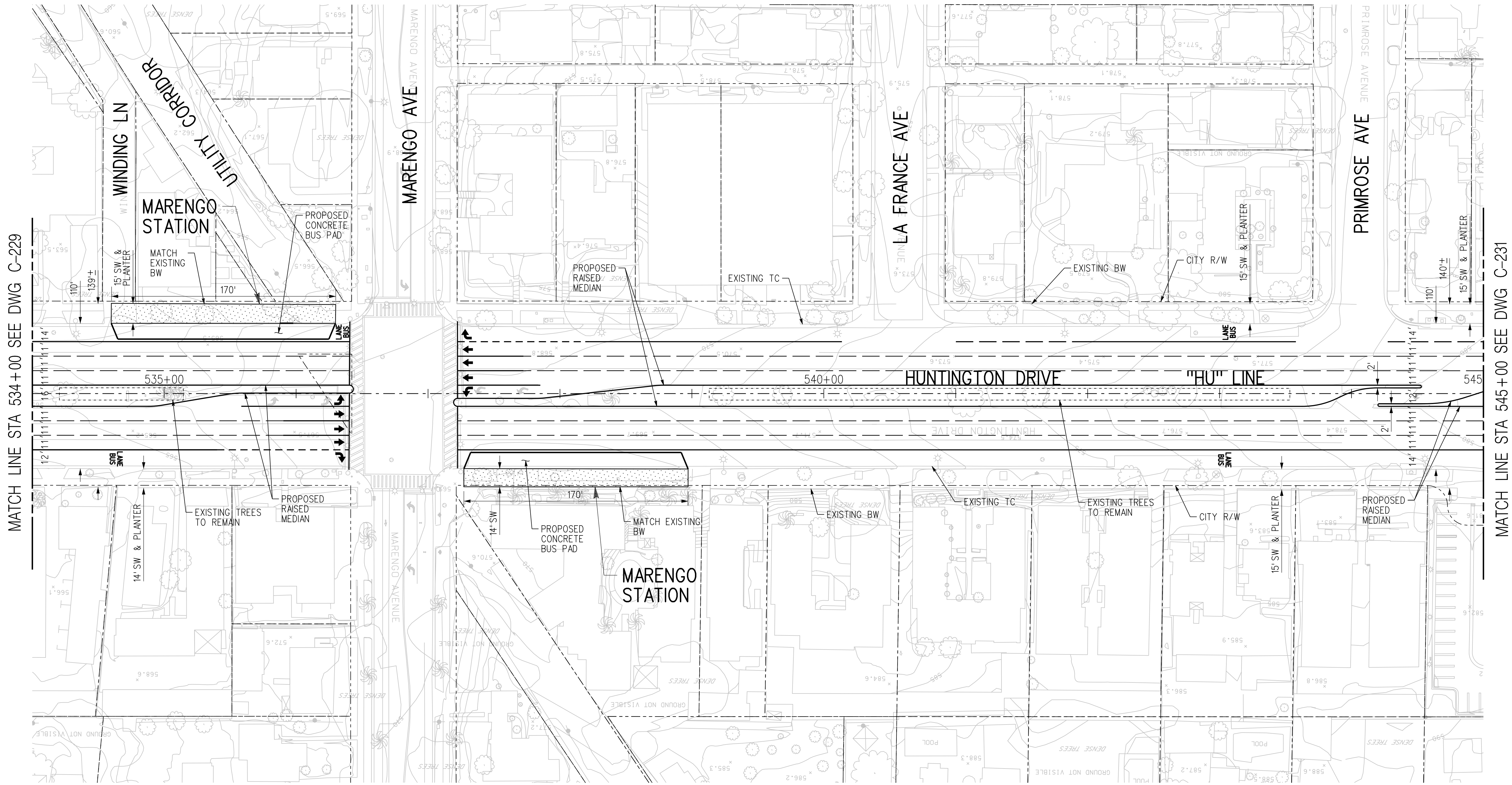
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 523+00 TO STA 534+00
SHEET 29 OF 48

CONTRACT NO
DRAWING NO C-229
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



40' 20' 0 40' 80'

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 534+00 TO STA 545+00
SHEET 30 OF 48

CONTRACT NO
DRAWING NO C-230
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 4289083_BW.TBL
Plot Driver: iplotdrvm.plt
\\denpwp01\pwicsjobs\95781\79037_391\C0XXX-C-030.plg
4/9/2015
12:00:46 PM
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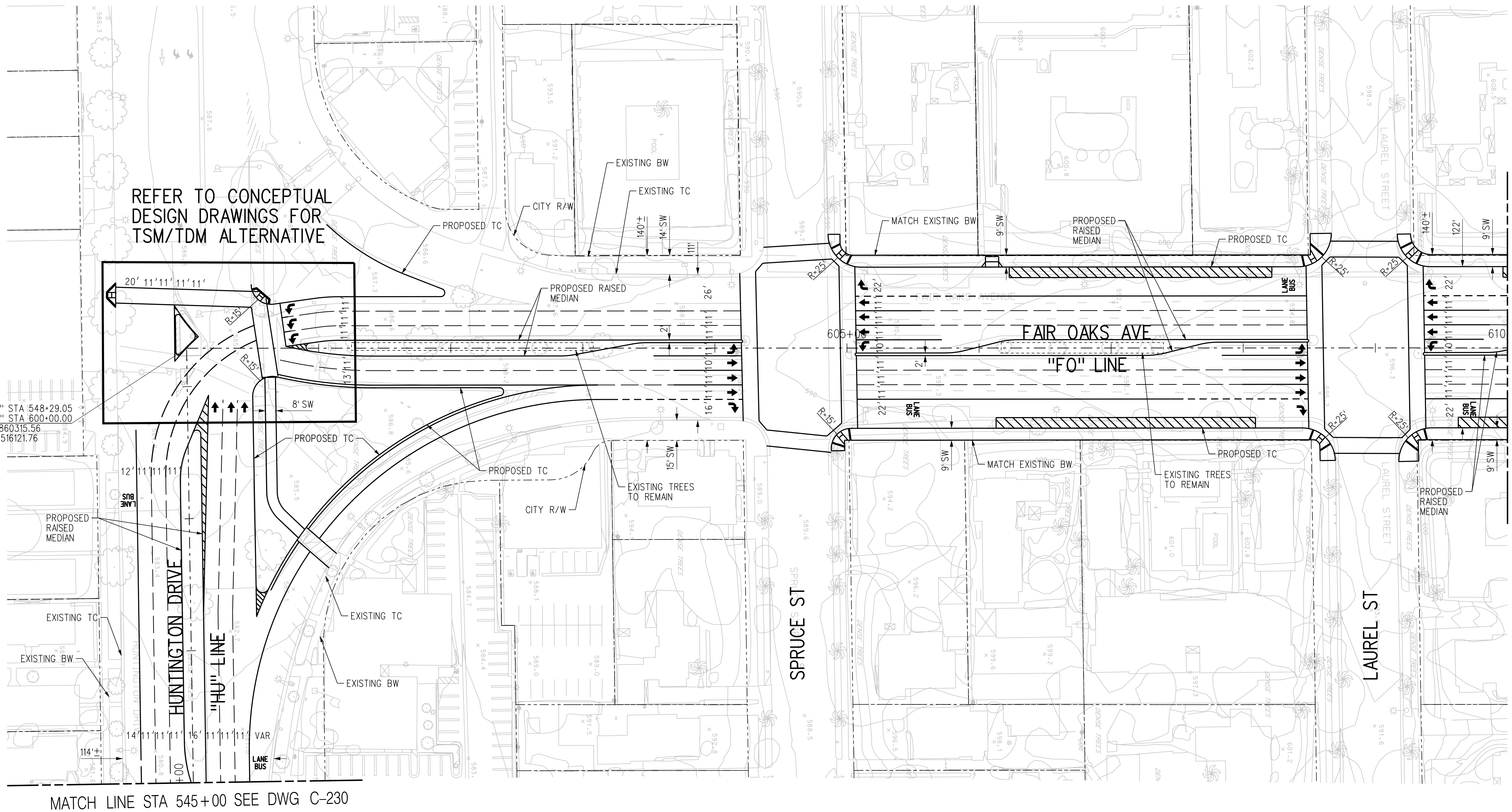


THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

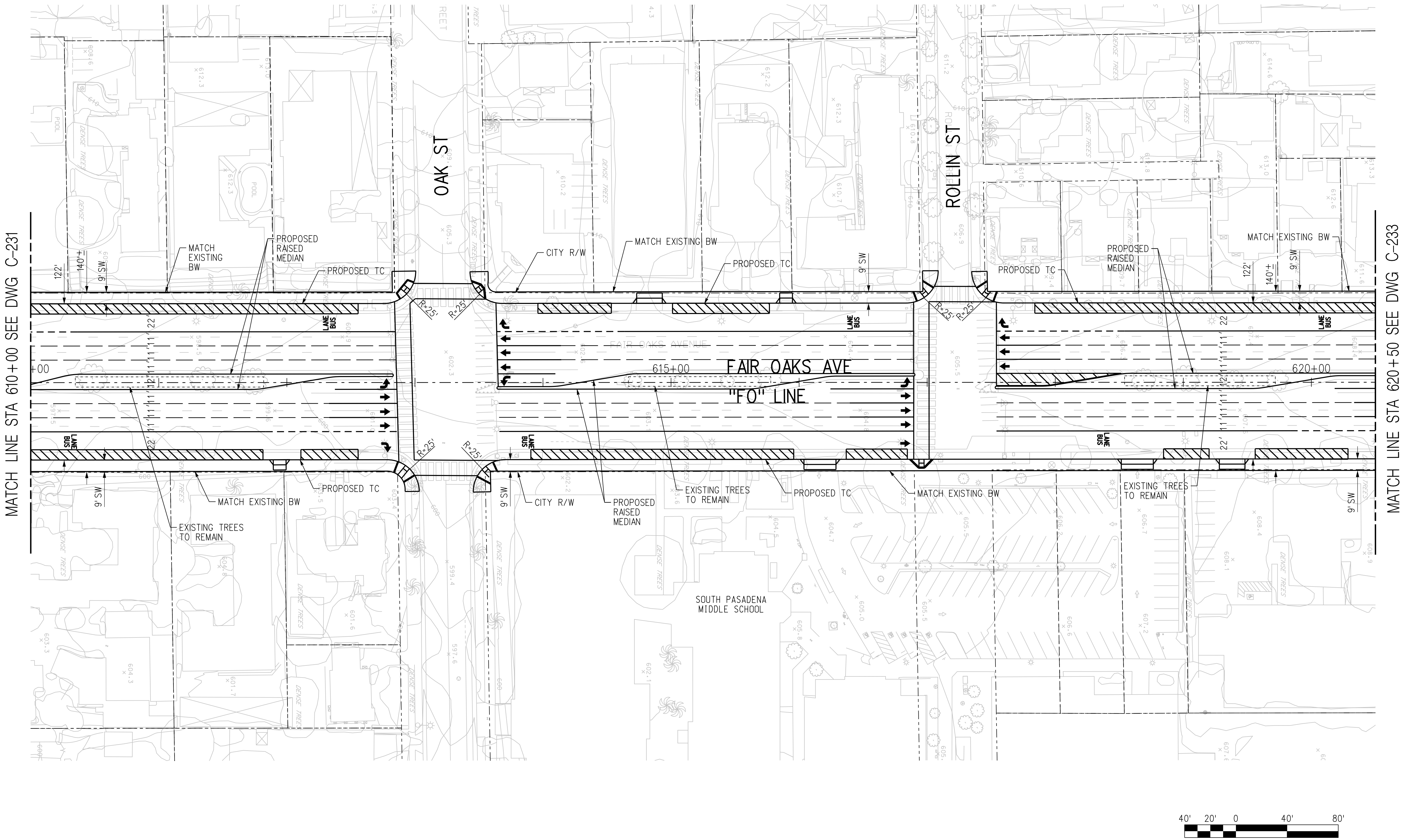
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 545+00 TO STA 610+00
SHEET 31 OF 48

CONTRACT NO
DRAWING NO C-231
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.	

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 610+00 TO STA 620+50
SHEET 32 OF 48

CONTRACT NO
DRAWING NO C-232
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 42BB9OB_BW.TBL
Plot Driver= iplotdrvm.plt
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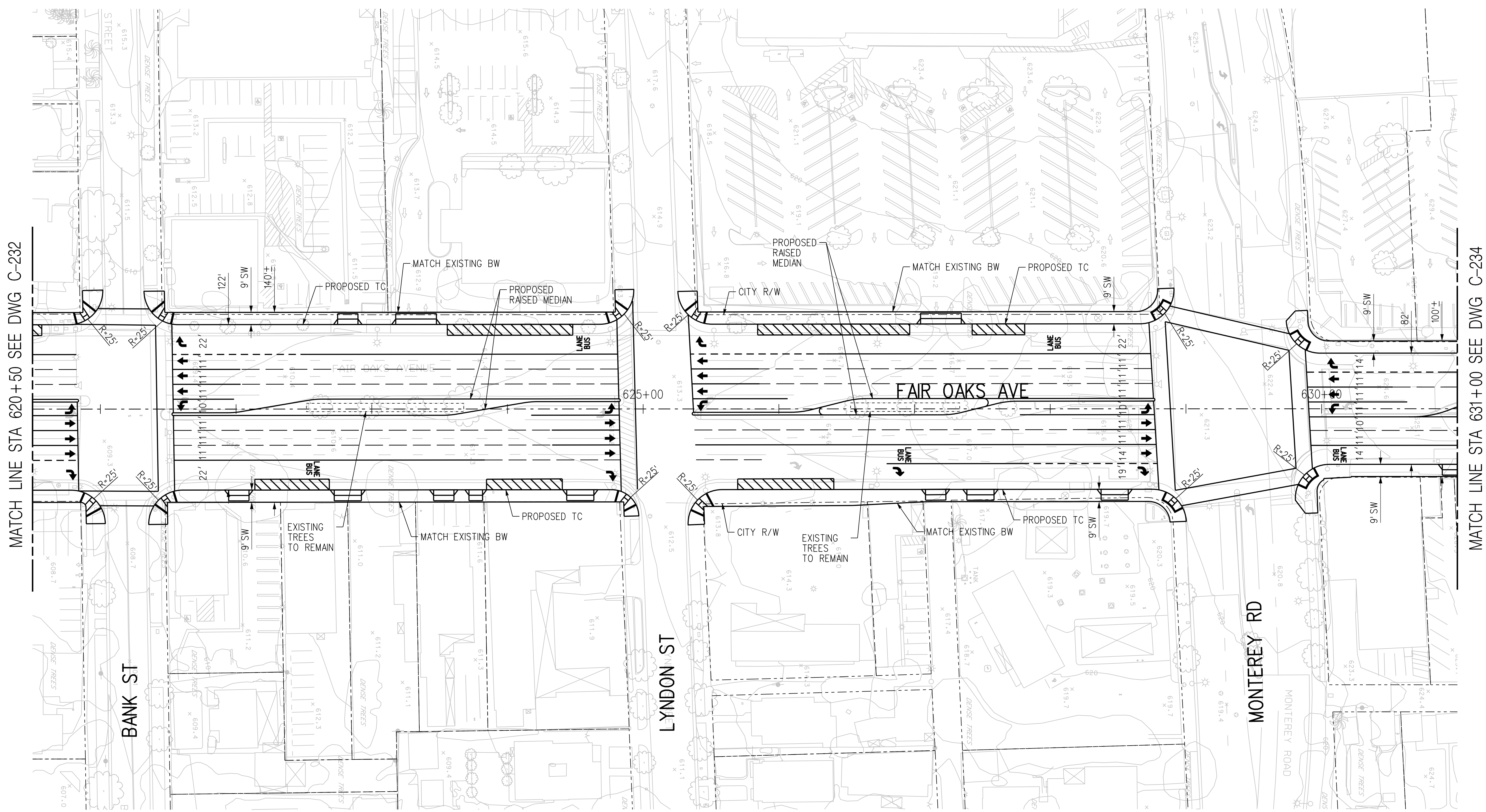
4/9/2015
12:01:51 PM
DENPWP02$



40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 12/11/14

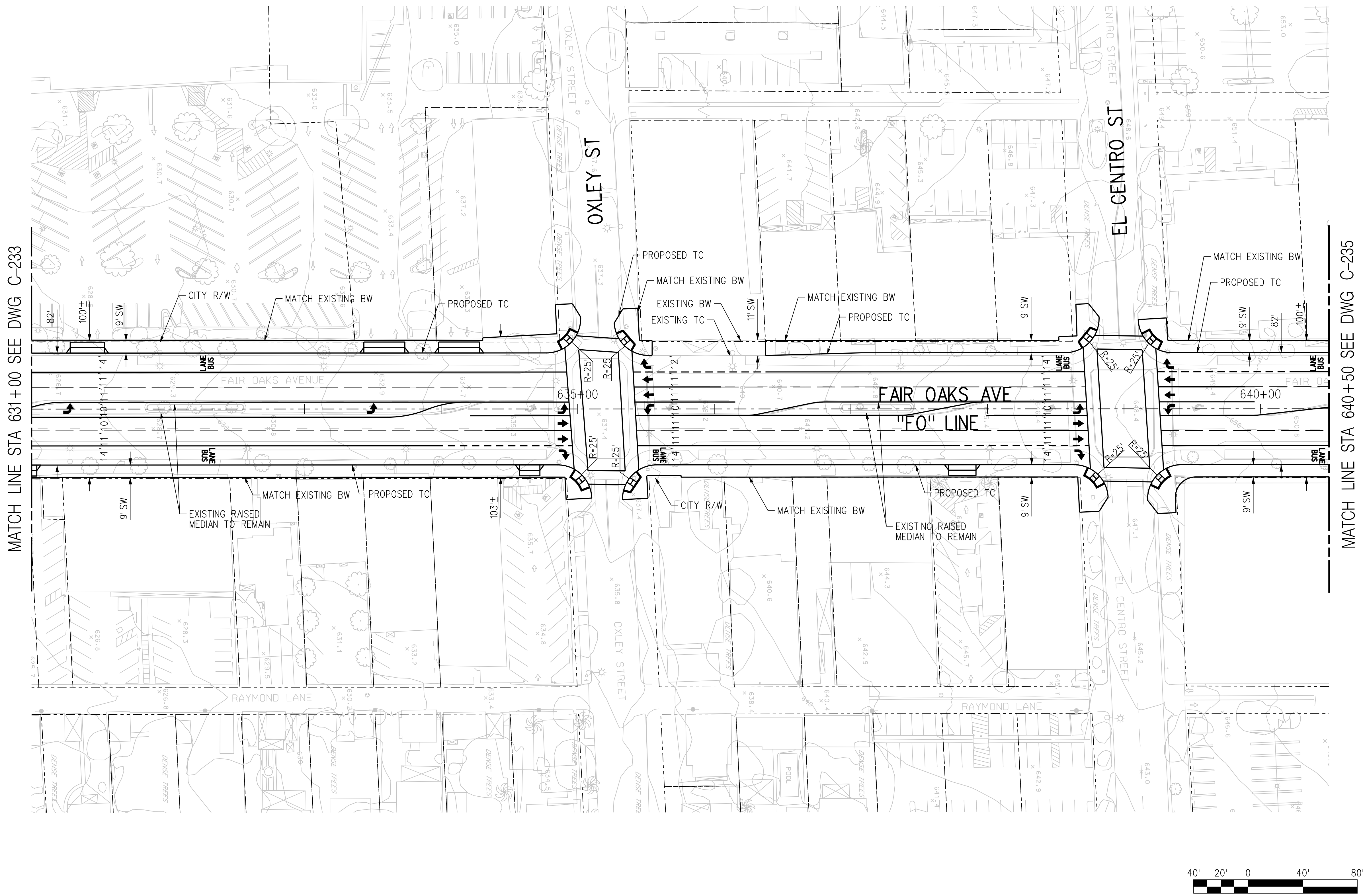
Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 620+50 TO STA 631+00
SHEET 33 OF 48

CONTRACT NO
DRAWING NO C-233
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 9/12/14

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

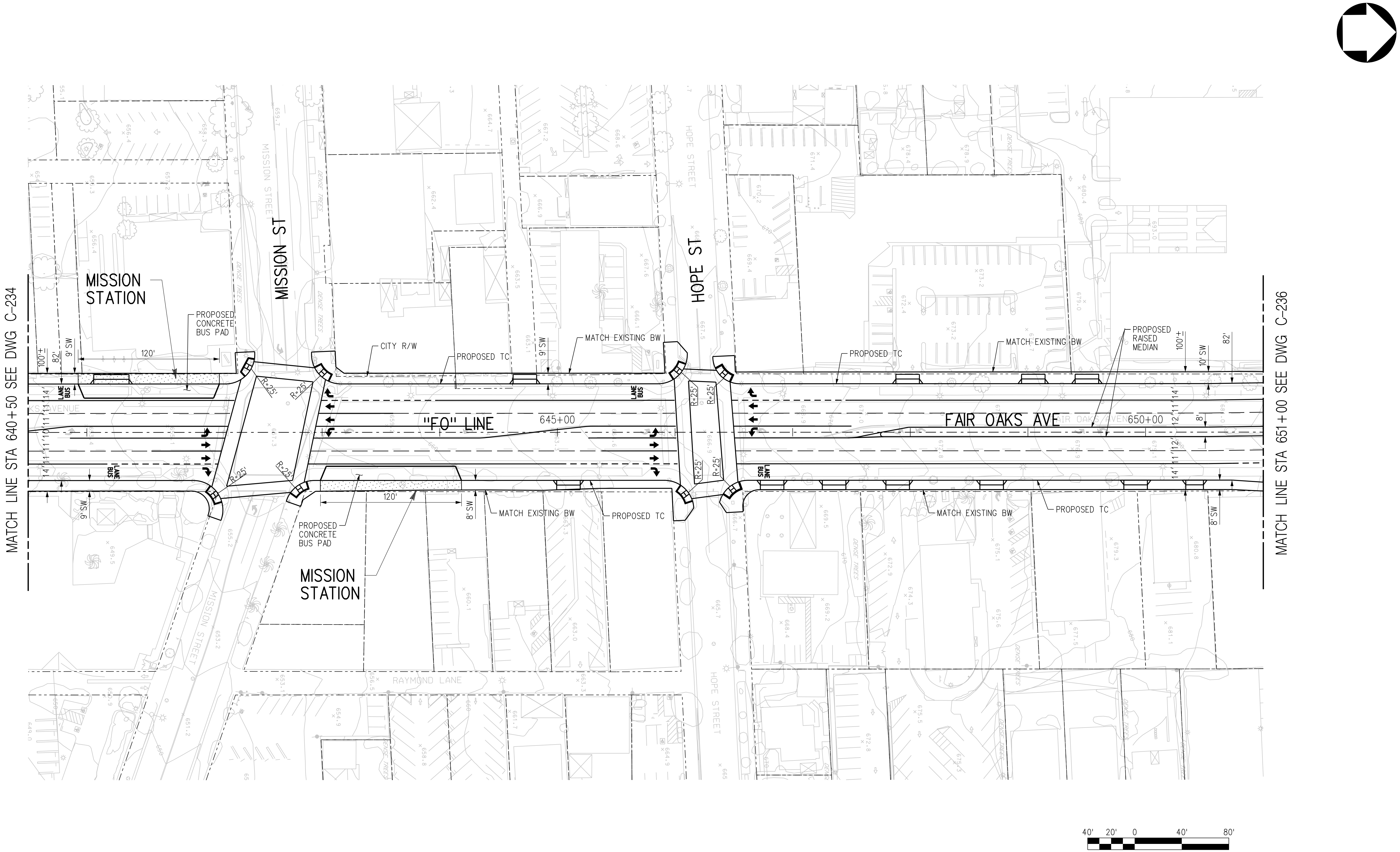
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 631+00 TO STA 640+50
SHEET 34 OF 48

CONTRACT NO
DRAWING NO C-234
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 428908_BW.TBL
Plot Driver= iplotdrvm.plt
4/9/2015
11:59:58 AM
DENPWP03$



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

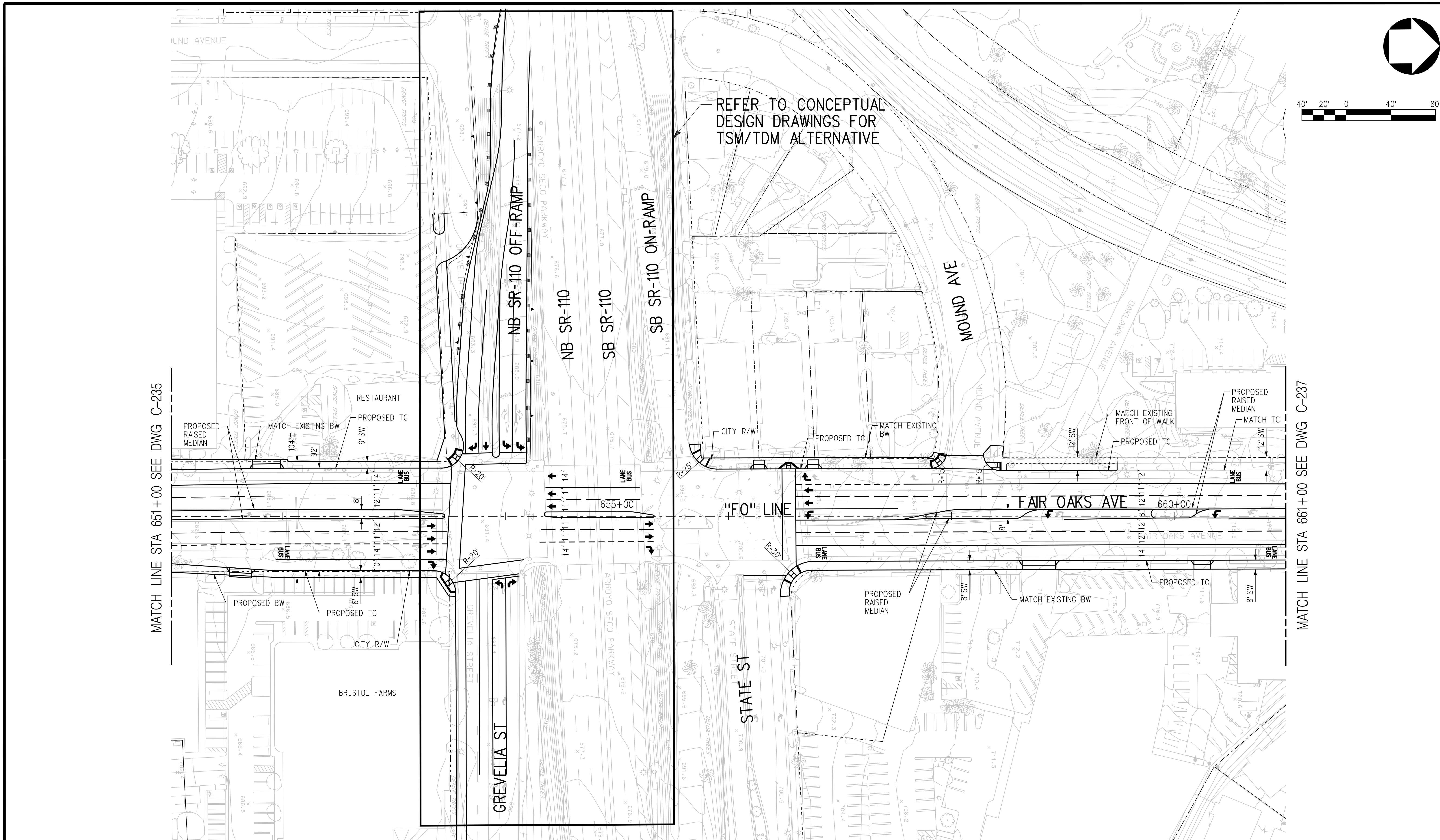
CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 640+50 TO STA 651+00
SHEET 35 OF 48

CONTRACT NO
DRAWING NO C-235
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 4289098_BW.TBL
Plot Driver= iplotdrvm.plt
\\denpwp01\pwcsjobs\95781\79037_44\COXXX-C-035.plg
4/9/2015 12:00:06 PM
DENPWP03$



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 01/20/15

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

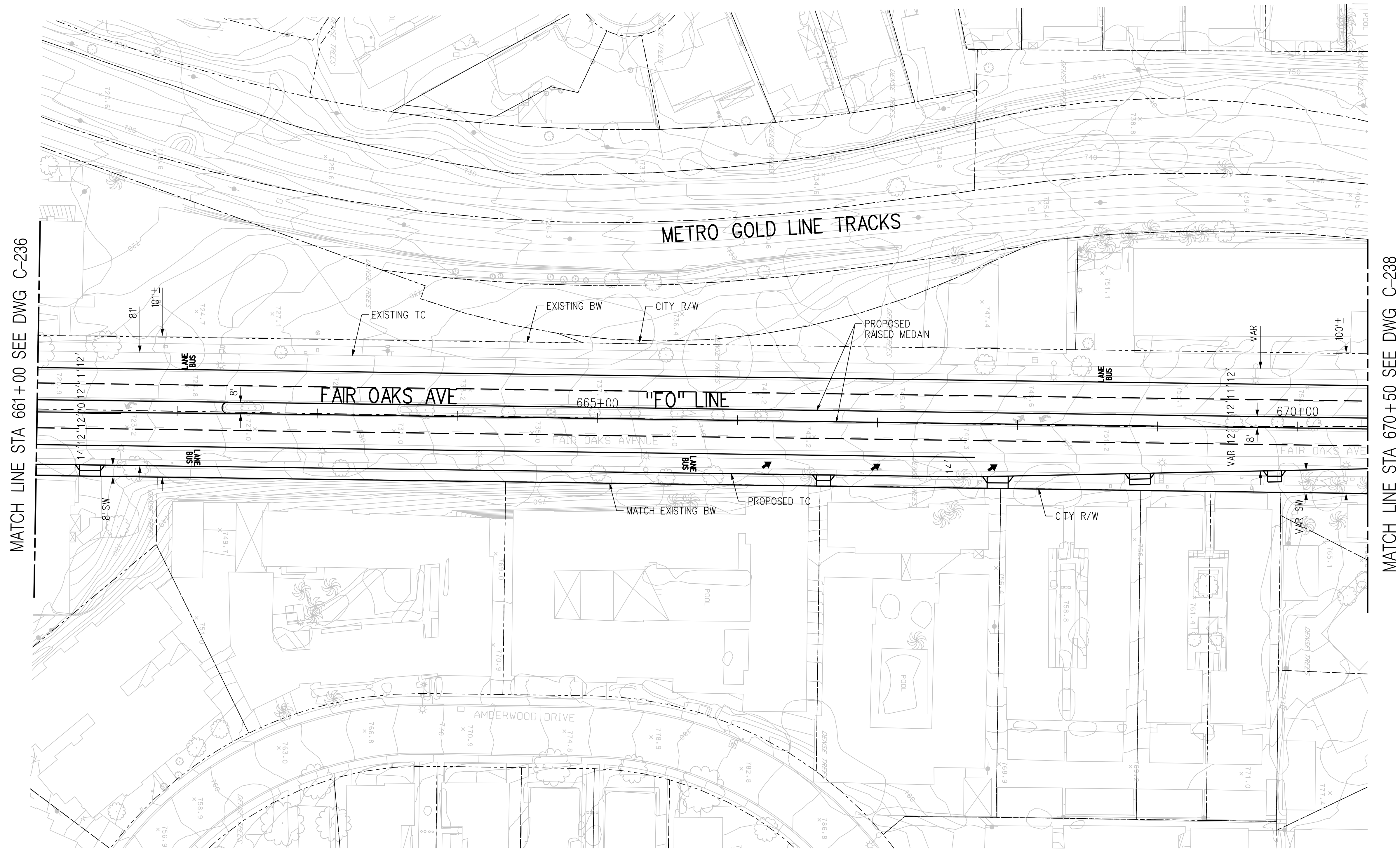
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 651+00 TO STA 661+00
SHEET 36 OF 48

CONTRACT NO
DRAWING NO C-236
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 4289D8_BW.TBL
Plot Driver: iplotdrvm.plt
\\denpwp01\pwicsjobs\95781\7903745\OXXX-C-036.plg
4/9/2015
12:00:51 PM
DENPWP02$



40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 01/20/15

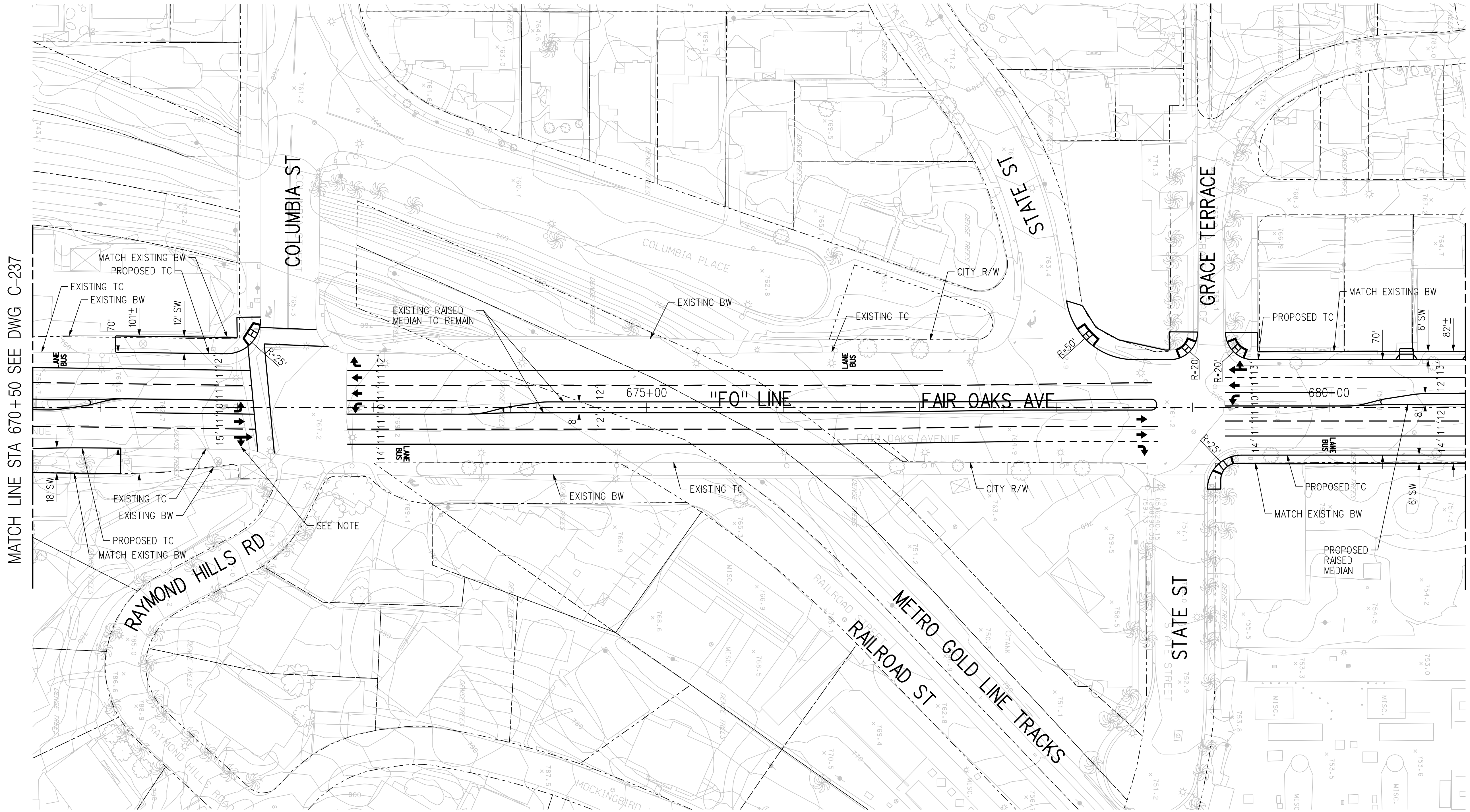
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 661+00 TO STA 670+50
SHEET 37 OF 48

CONTRACT NO
DRAWING NO C-237
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



NOTE: RECOMMEND ADDING A NO RIGHT TURN SIGN FOR VEHICLES OTHER THAN AUTOMOBILES DUE TO TIGHT TURN.

40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 01/20/15

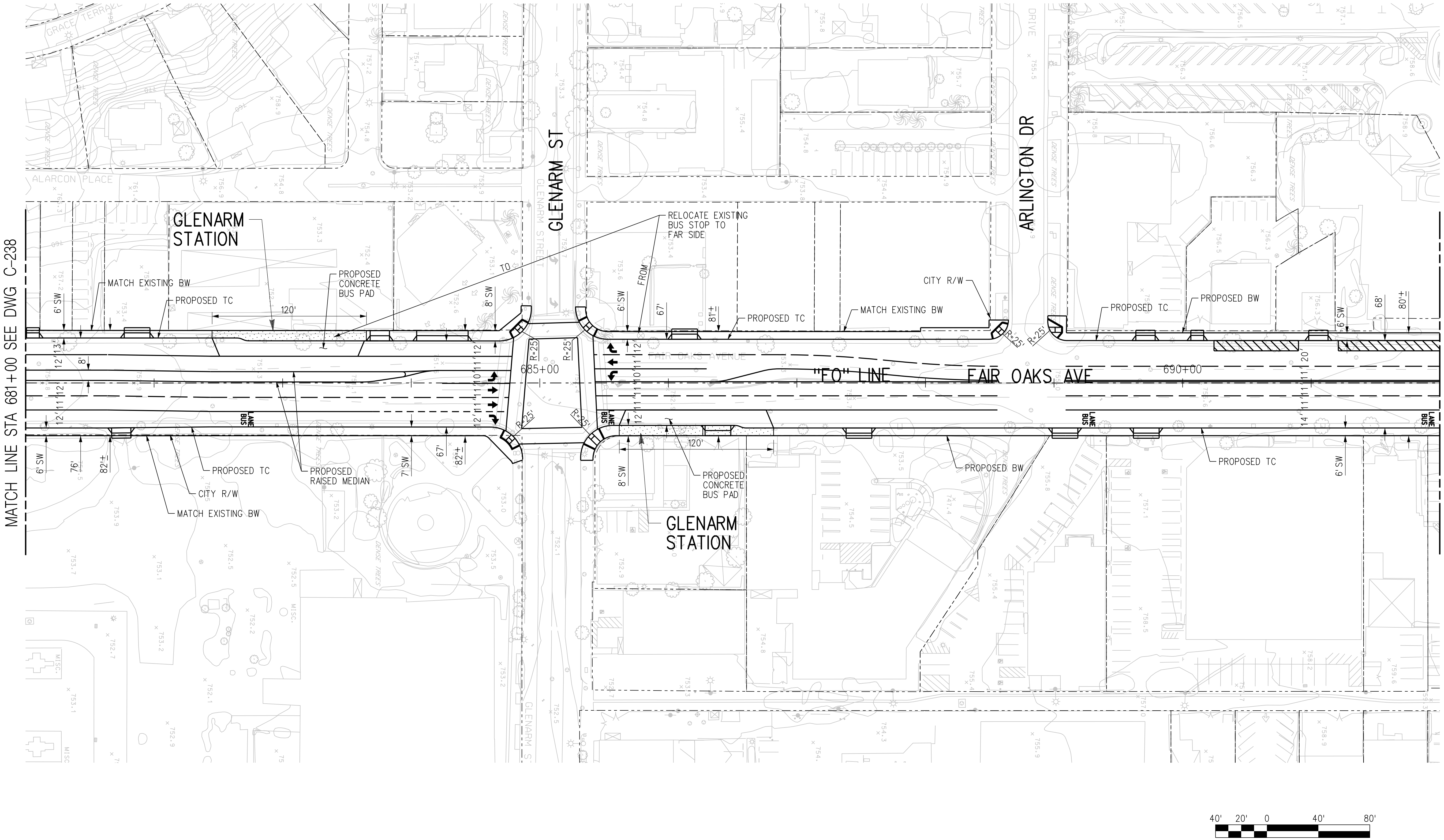
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 670+50 TO STA 681+00
SHEET 38 OF 48

CONTRACT NO
DRAWING NO C-238
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 681+00 TO STA 692+00

SHEET 39 OF 48

CONTRACT NO
DRAWING NO C-239
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 428908_BW.TBL
Plot Driver= iplotdrvm.plt
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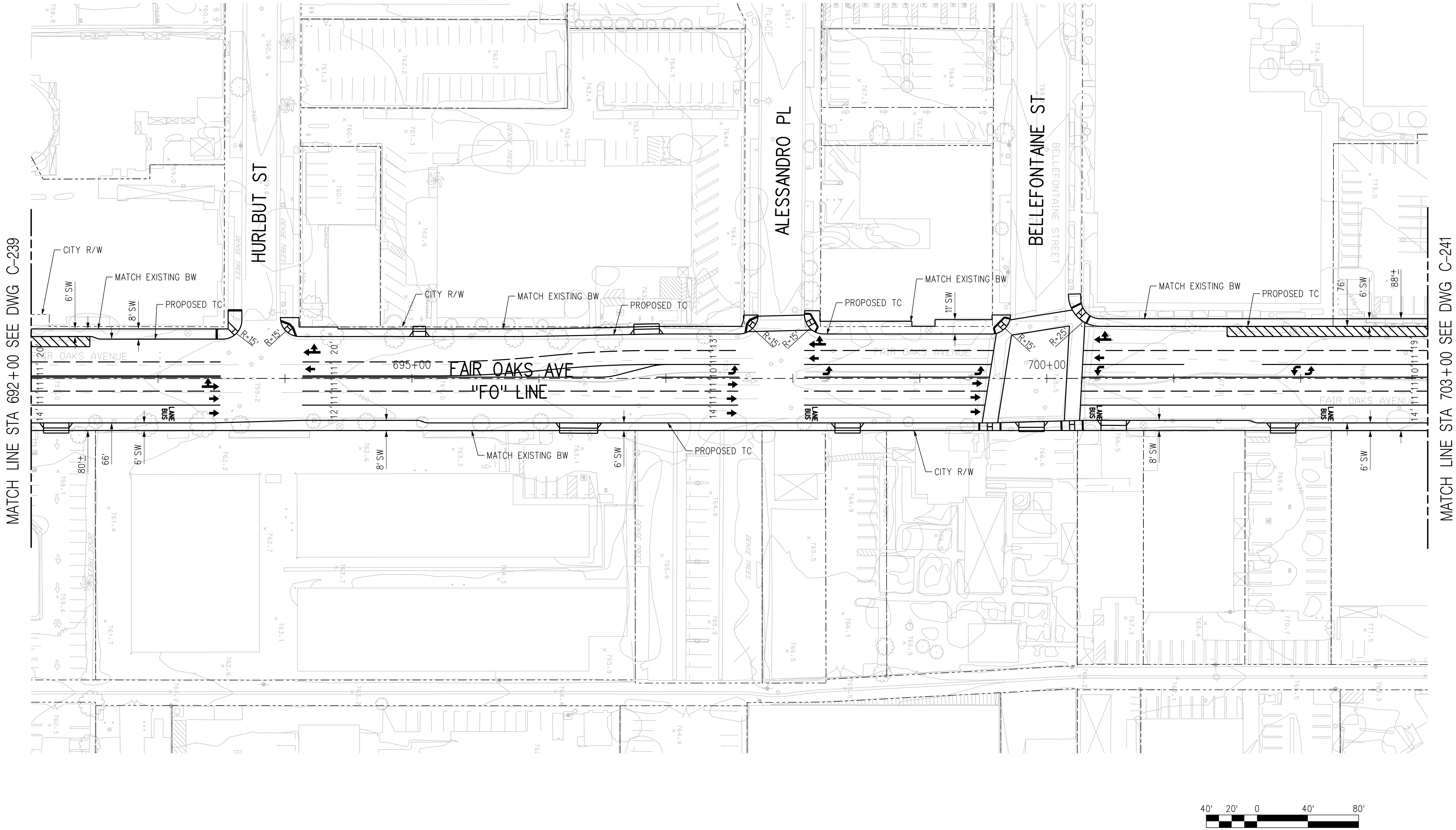
4/9/2015
12:01:54 PM
DENPWP02$



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

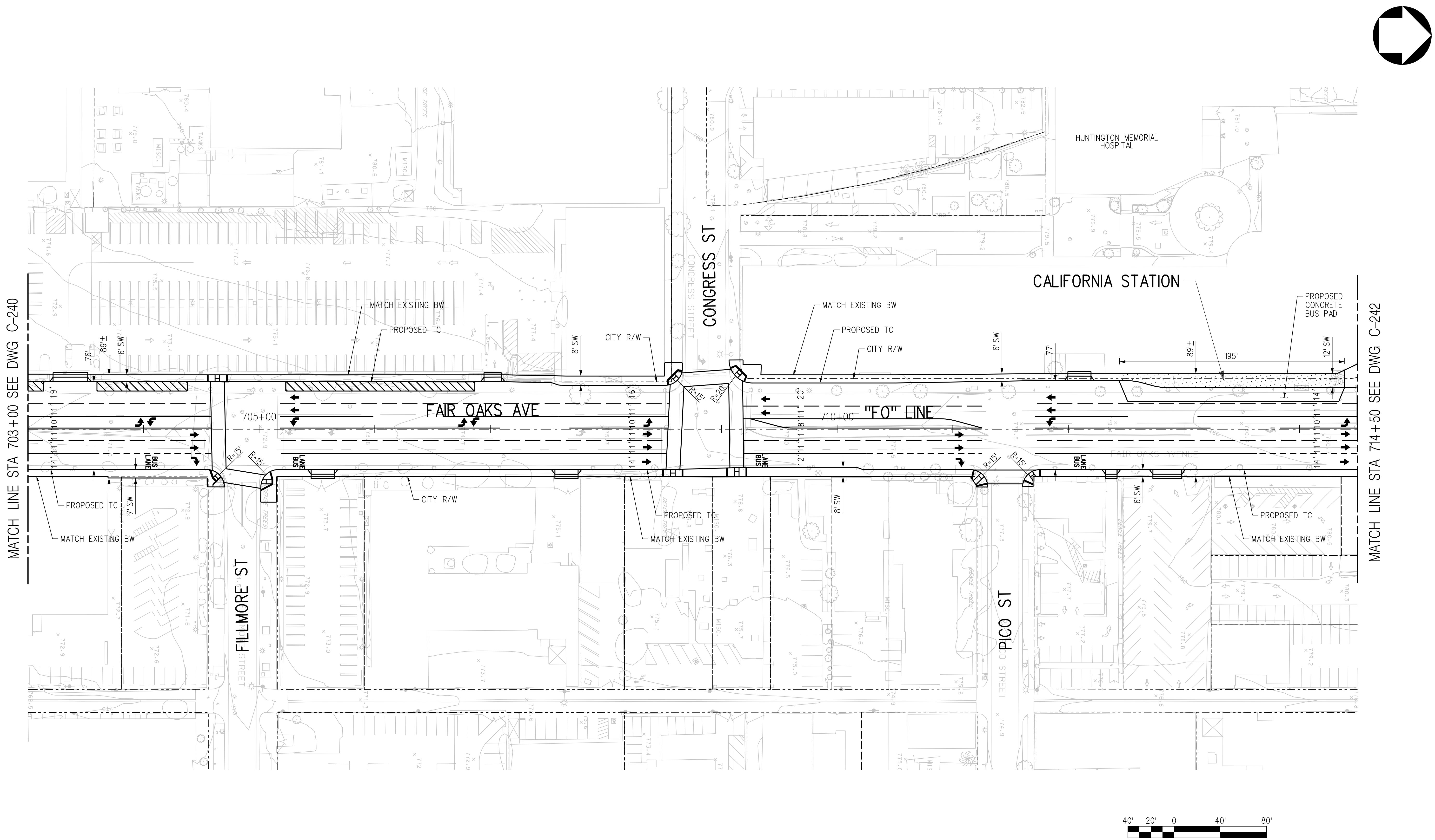
CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

710 NORTH STUDY-BRT ADVANCED CONCEPTUAL DESIGN PLAN STA 692+00 TO STA 703+00

SHEET 40 OF 48

CONTRACT NO
DRAWING NO C-240
REV
SCALE 1" = 40'
SHEET NO

Pentable: 4288908_BW.TBL
Plot Driver: iplotdrvm.plt
4/9/2015
12:00:08 PM
DENPWP03$
Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

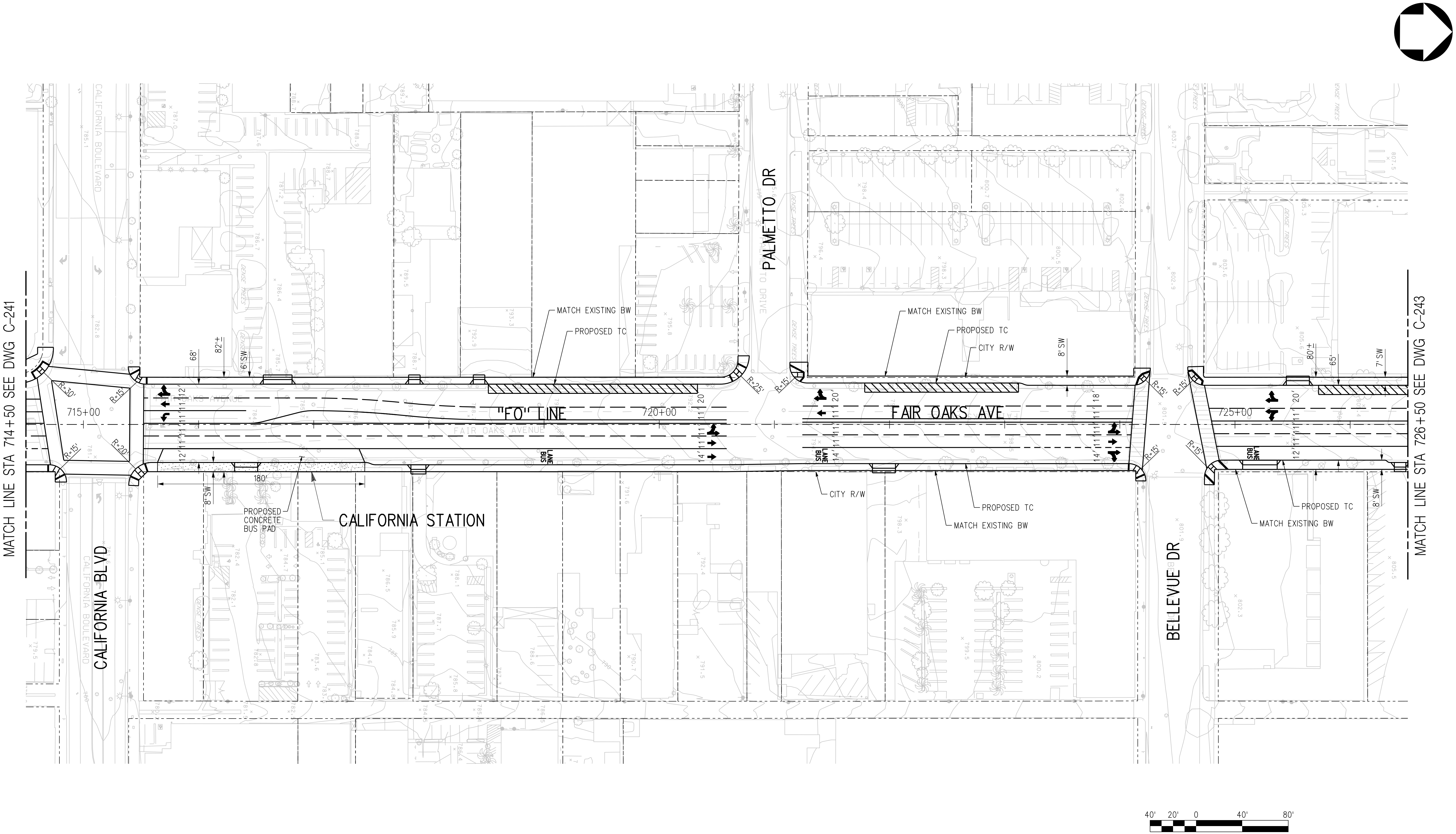
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 703+00 TO STA 714+50

SHEET 41 OF 48

CONTRACT NO
DRAWING NO C-241
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

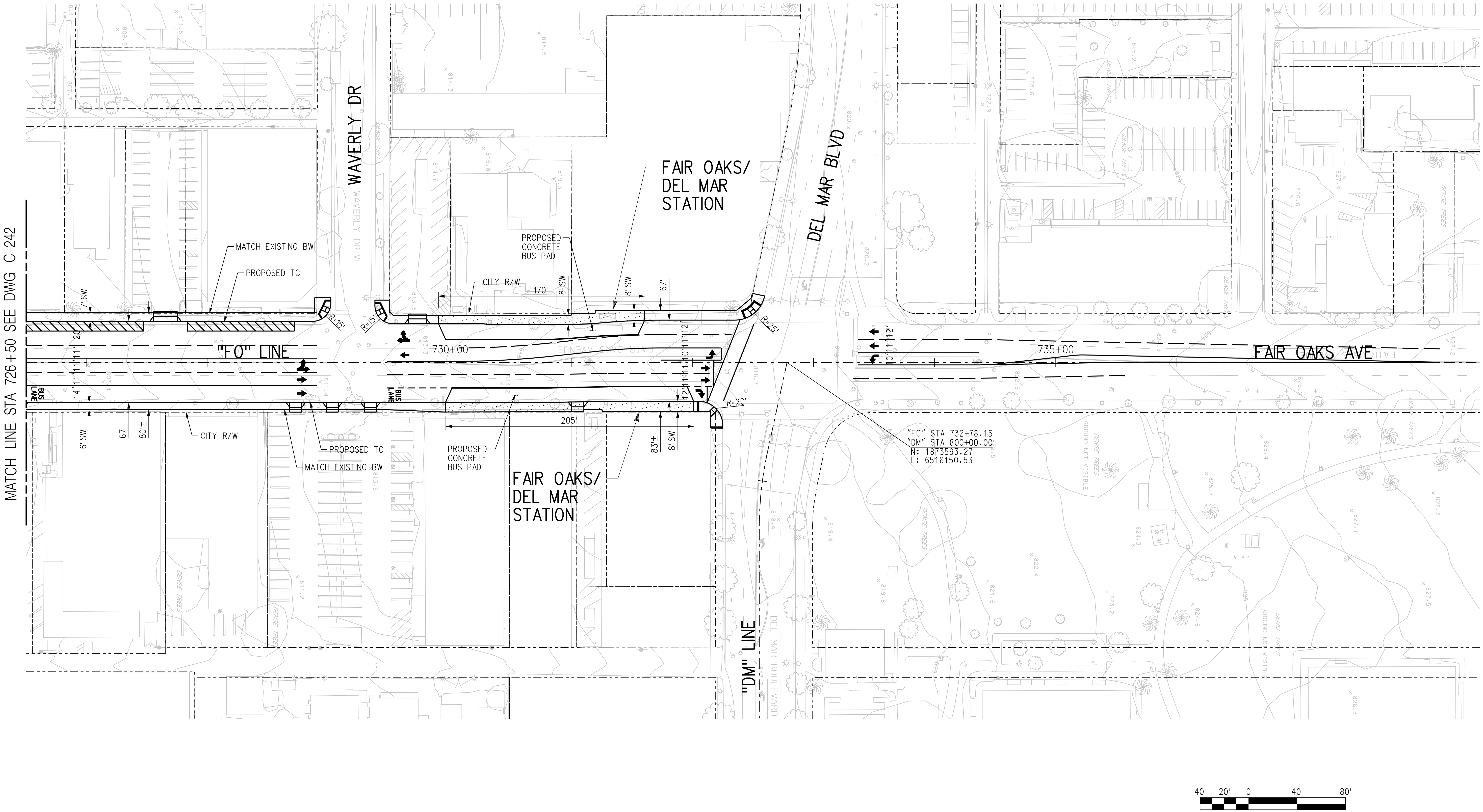
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 714+50 TO STA 726+50
SHEET 42 OF 48

CONTRACT NO
DRAWING NO C-242
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
STA 725+50 TO MATCH Exist
SHEET 43 OF 48

CONTRACT NO
DRAWING NO C-243
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

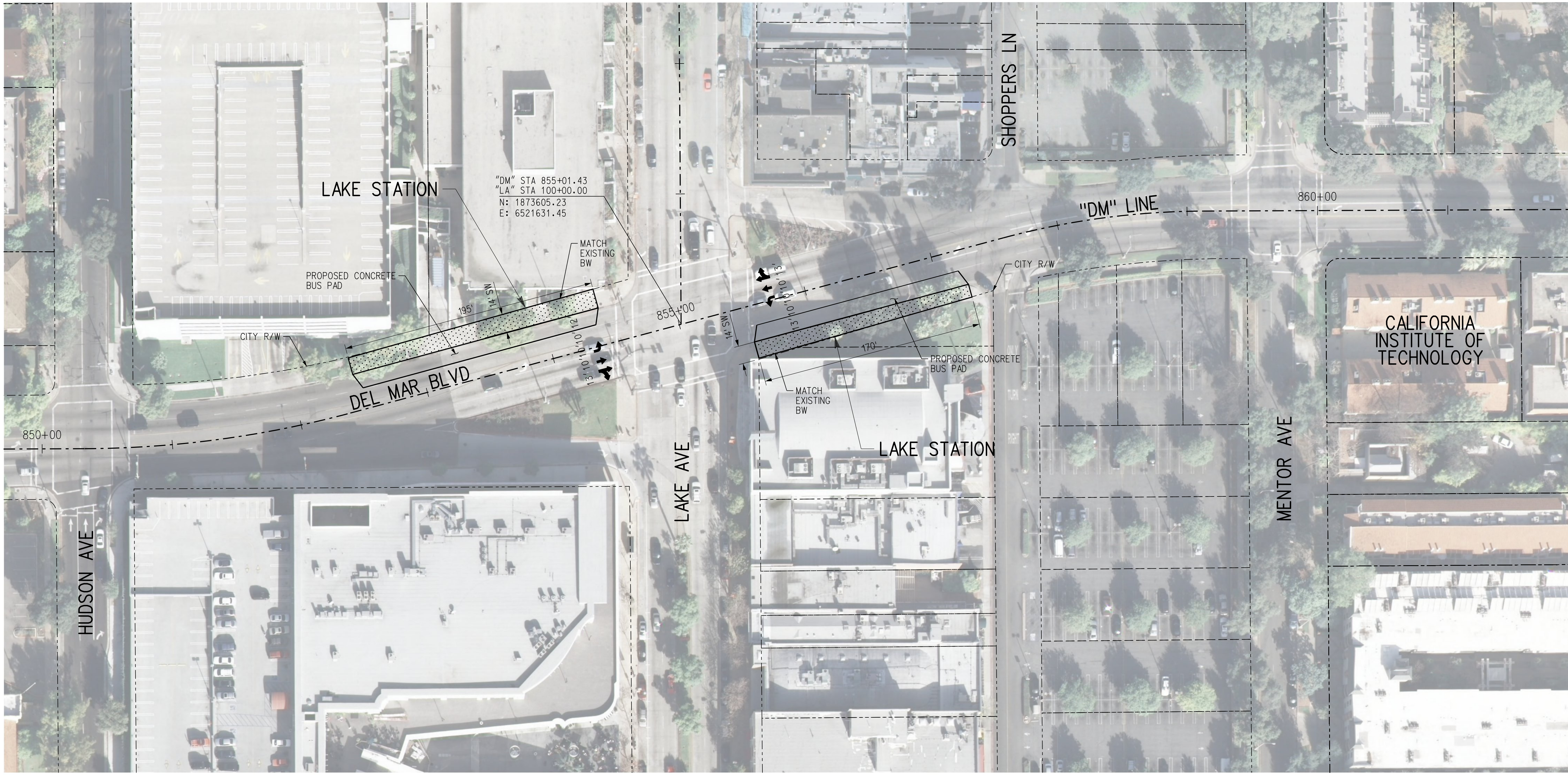
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
DEL MAR AND LOS ROBLES STATION
SHEET 44 OF 48

CONTRACT NO
DRAWING NO C-244
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
DEL MAR AND LAKE STATION
SHEET 45 OF 48

CONTRACT NO
DRAWING NO C-245
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
HILL AND DEL MAR STATION
SHEET 46 OF 48

CONTRACT NO
DRAWING NO C-246
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 4289088_BW.TBL
Plot Driver= iplotdrvm.plt
\\denpwp01\pwicsjobs\957811\79037_5\7C0XXX-C-046.plg
4/9/2015
12:02:24 PM
DENPWP01$

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
COLORADO AND HILL STATION
SHEET 47 OF 48

CONTRACT NO
DRAWING NO C-247
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 428908_BW.TBL
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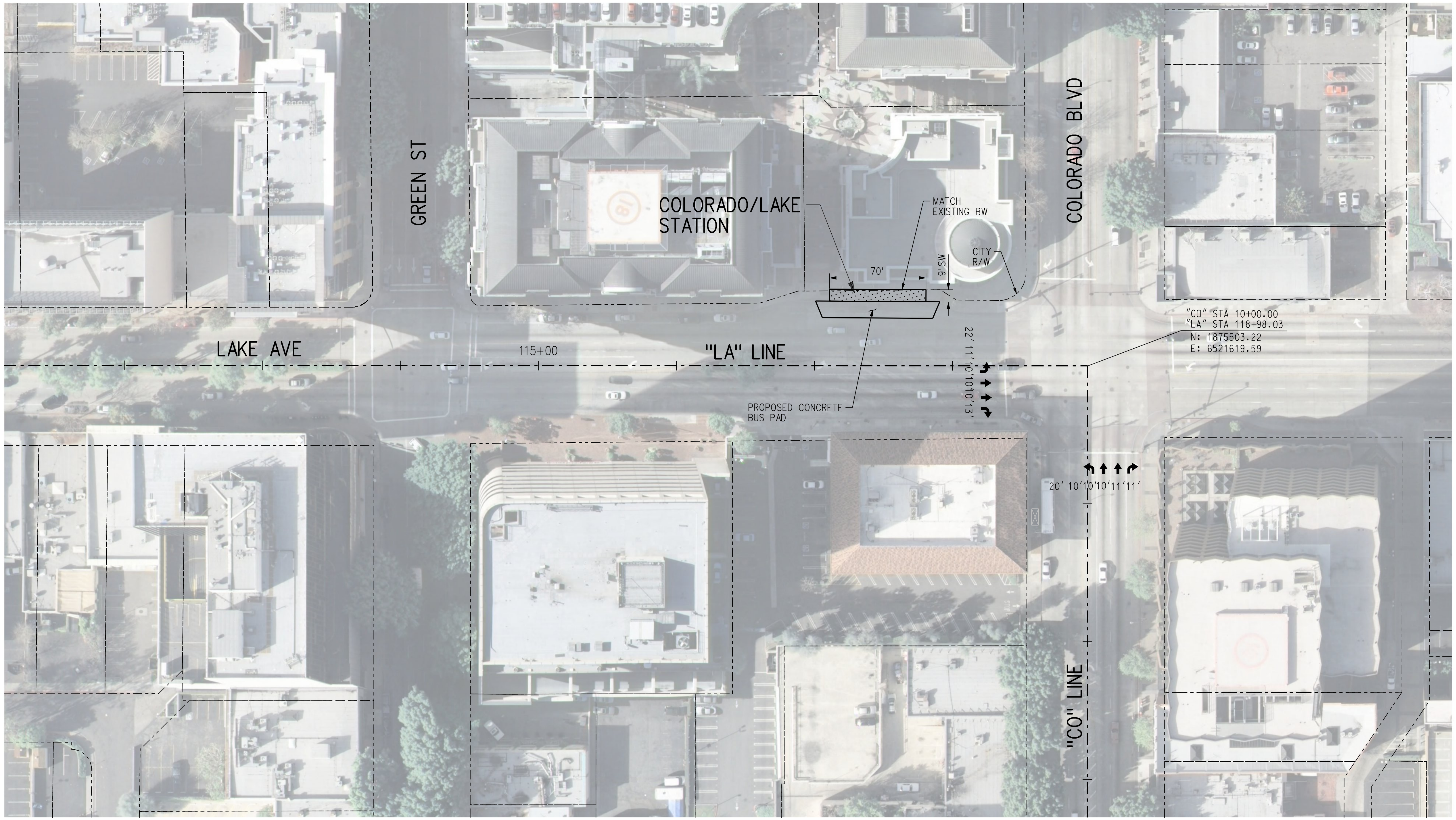
4/9/2015
12:02:11 PM
DENPWP01$



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.	REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER

DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 11/26/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
PLAN
LAKE AND COLORADO STATION
SHEET 48 OF 48

CONTRACT NO

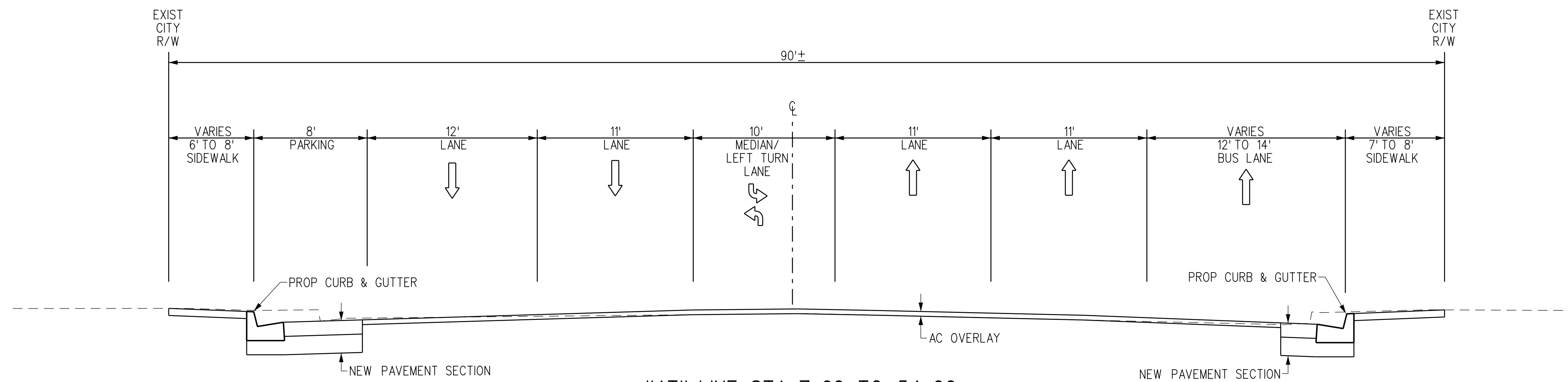
DRAWING NO C-248

REV

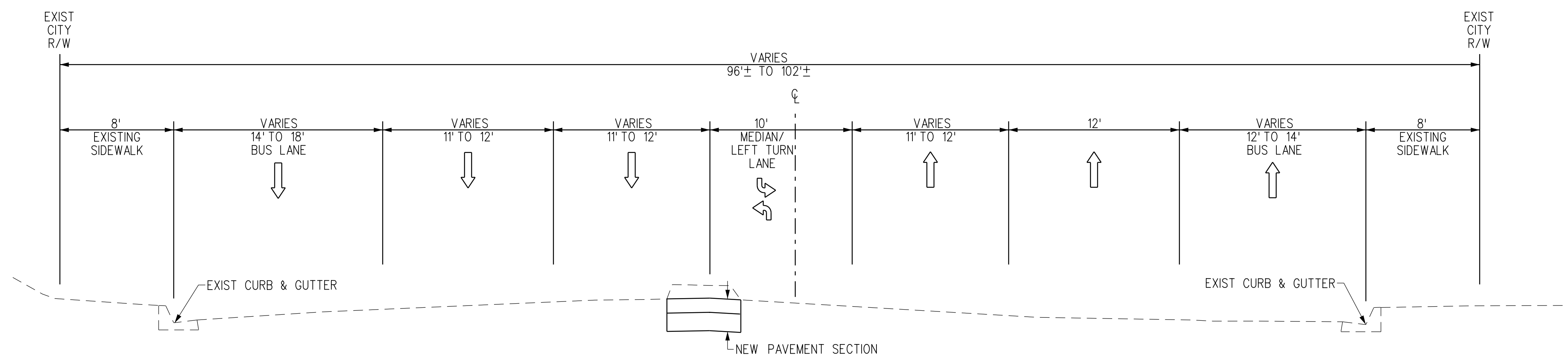
SCALE 1" = 40'

SHEET NO

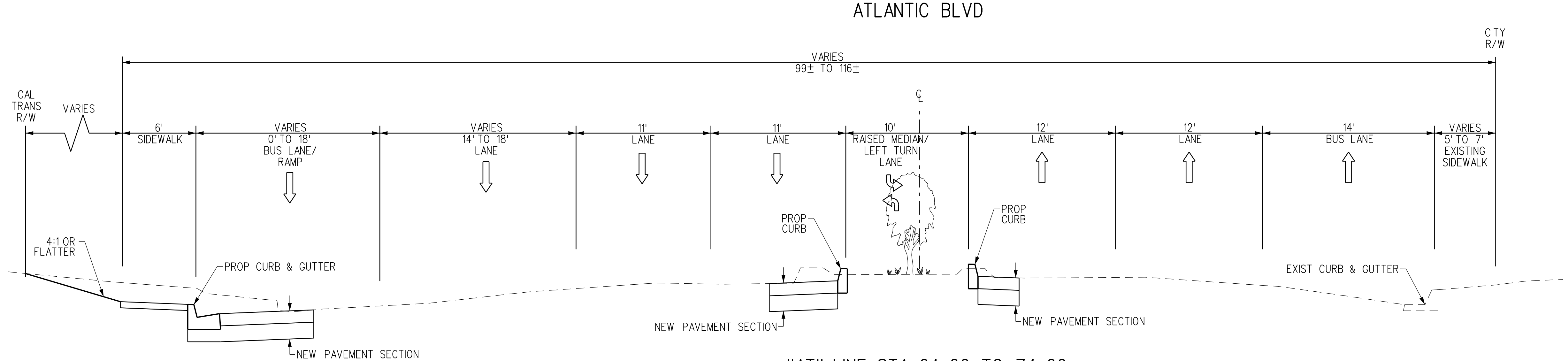
Model Name: Default



"AT" LINE STA 7+60 TO 54+00
ATLANTIC BLVD



"AT" LINE STA 54+00 TO 64+00
ATLANTIC BLVD



"AT" LINE STA 64+00 TO 74+00
ATLANTIC BLVD

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

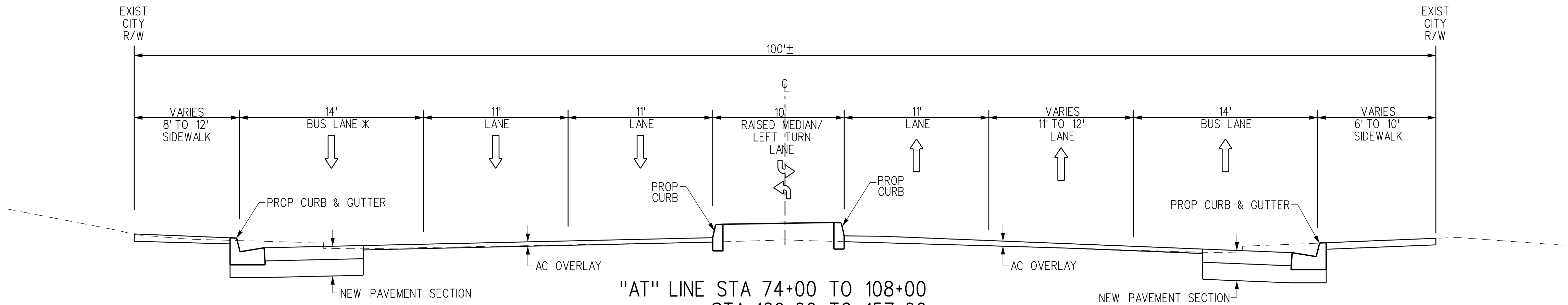
710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 1 OF 7

CONTRACT NO
DRAWING NO X-001
REV
SCALE NOT TO SCALE
SHEET NO

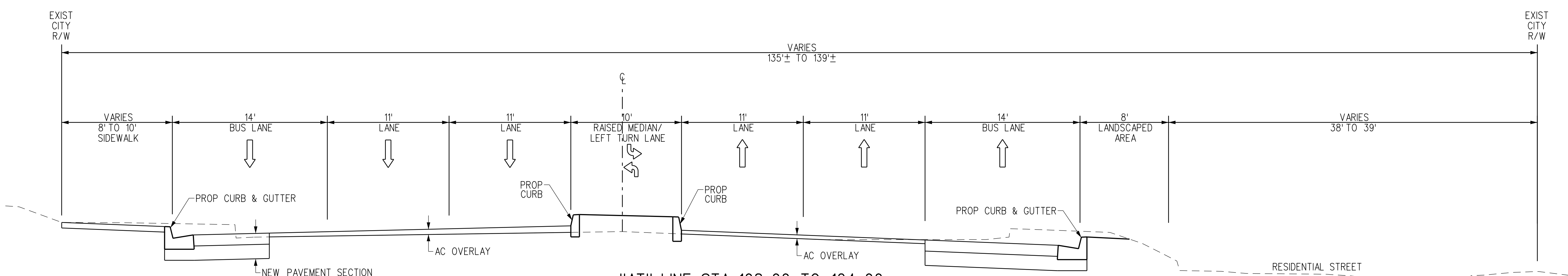
Model Name= Default

Pentable= 4289008_BW.tbl
Plot Driver= iplotdrvm.plt
9/19/2014
3:55:59 PM
DENPWP01$

⁎ LANE IS NOT EXCLUSIVELY FOR BUSES
FROM STA 74+00 TO 95+00



"AT" LINE STA 74+00 TO 108+00
STA 129+00 TO 157+00
ATLANTIC BLVD



"AT" LINE STA 108+00 TO 124+00
ATLANTIC BLVD

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

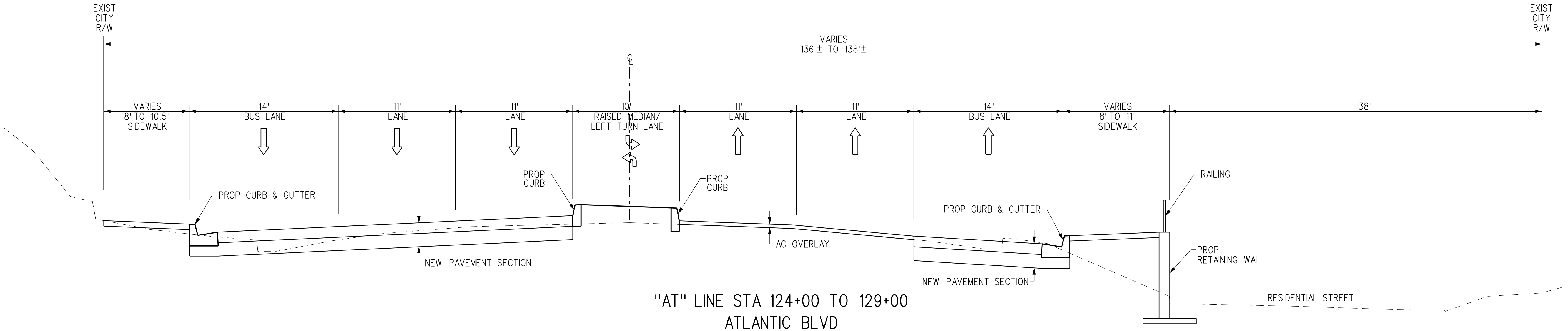
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 2 OF 7

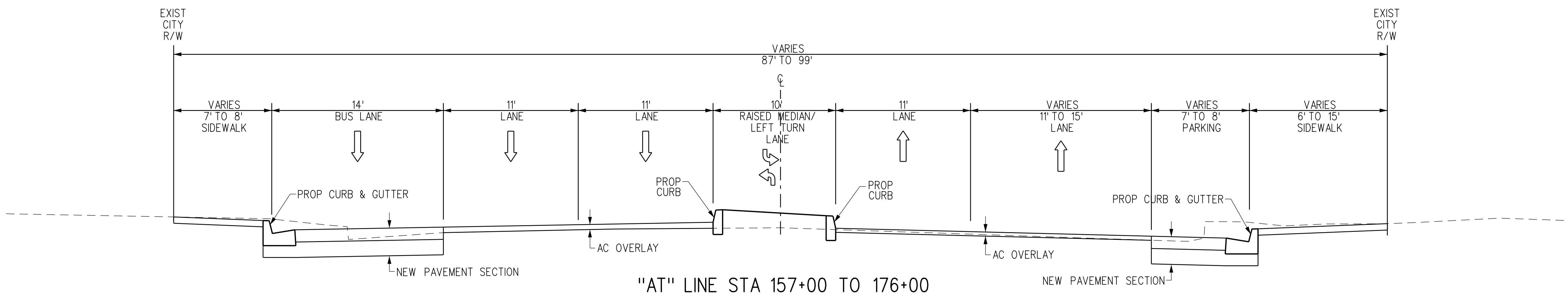
CONTRACT NO
DRAWING NO X-002
REV
SCALE NOT TO SCALE
SHEET NO

Model Name: Default

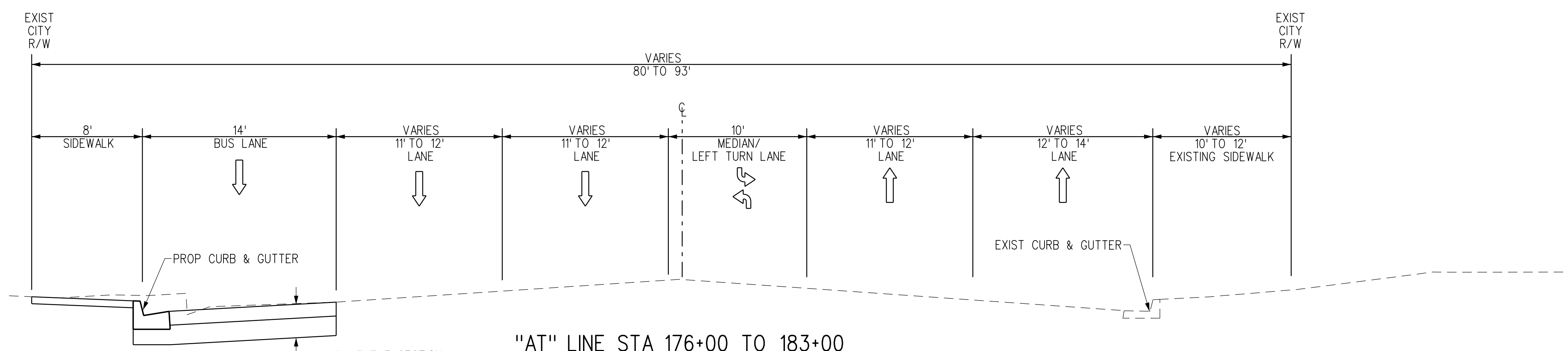
\\denpwp01\pwcsjob_workingdir\6008\17903_69\COXXX-X-002.plg   Plot Driver: iplotdrvm.plt   Pentable: 428908_BW.TBL
11/25/2013   7:28:07 PM   DENPWP03$



"AT" LINE STA 124+00 TO 129+00
ATLANTIC BLVD



"AT" LINE STA 157+00 TO 176+00
STA 232+00 TO 240+00
ATLANTIC BLVD



"AT" LINE STA 176+00 TO 183+00
STA 200+00 TO 203+00
ATLANTIC BLVD

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

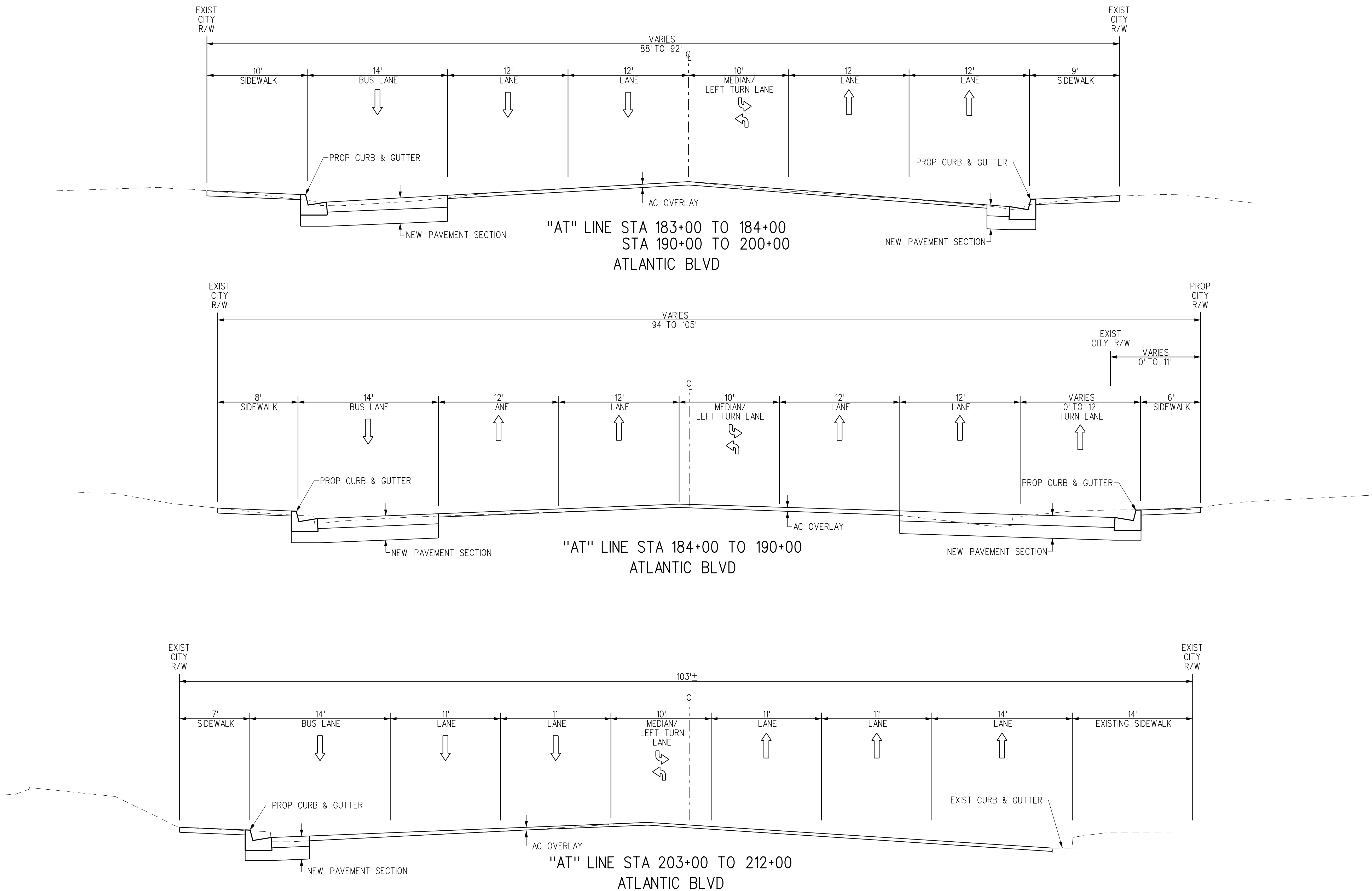
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 3 OF 7

CONTRACT NO
DRAWING NO X-003
REV
SCALE NOT TO SCALE
SHEET NO

Model Name: Default



THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

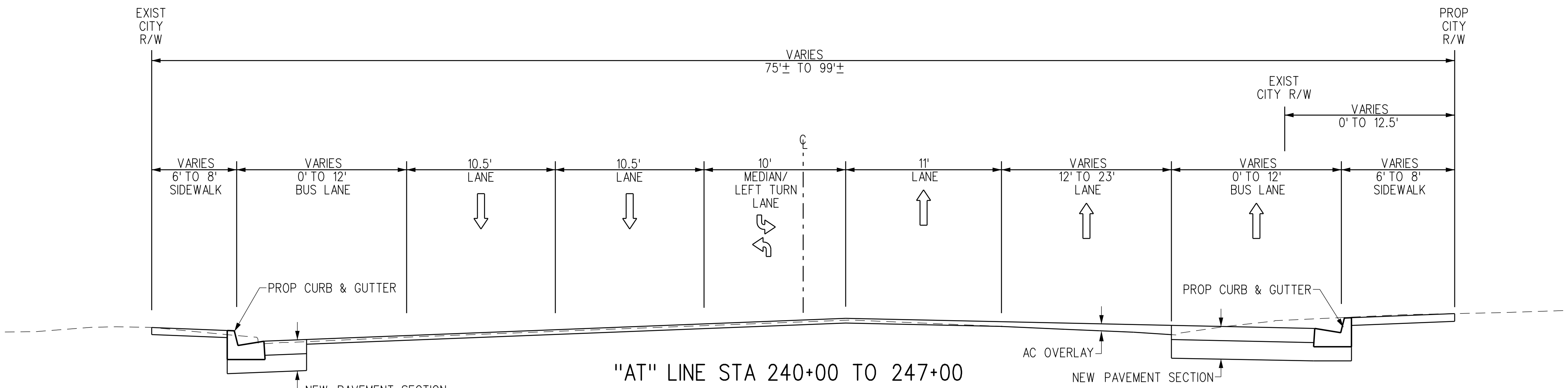
Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

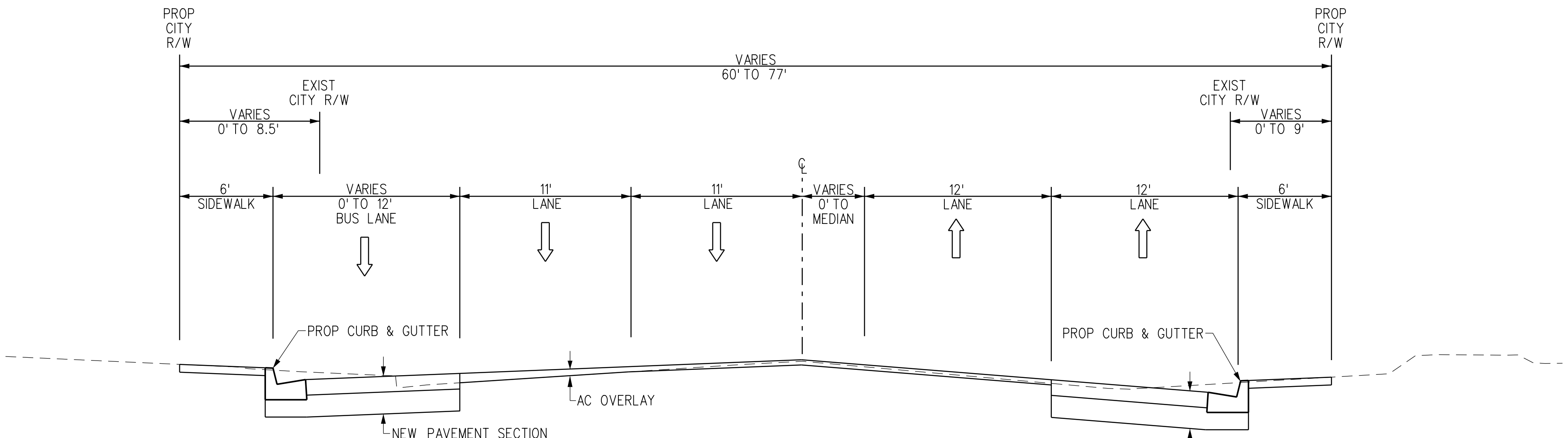
710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 4 OF 7

CONTRACT NO
DRAWING NO X-004
REV
SCALE NOT TO SCALE
SHEET NO

Model Name: Default



"AT" LINE STA 240+00 TO 247+00
ATLANTIC BLVD



"AT" LINE STA 261+00 TO 266+00
ATLANTIC BLVD

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 5 OF 7

CONTRACT NO
DRAWING NO X-005
REV
SCALE NOT TO SCALE
SHEET NO

Model Name: Default

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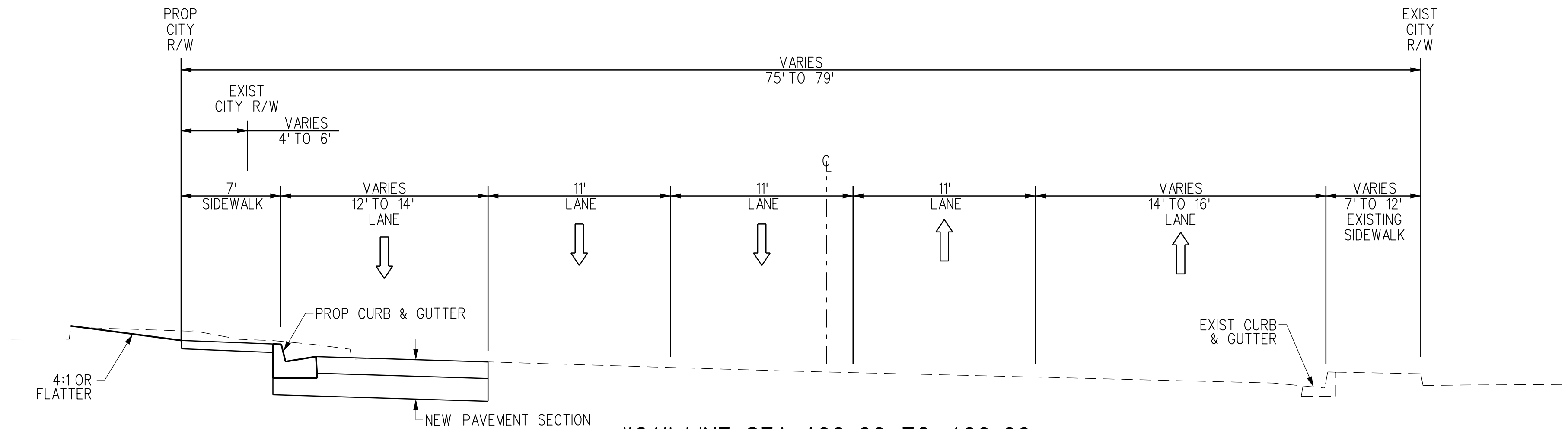
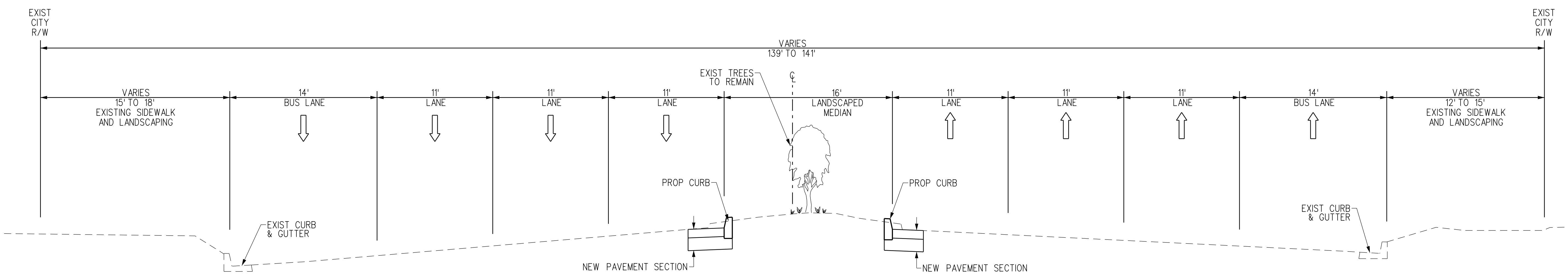
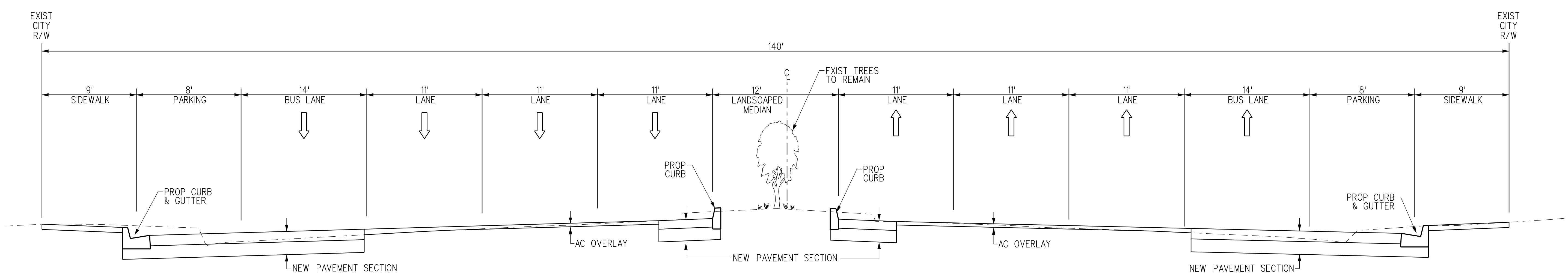


"GA" LINE STA 400+00 TO 406+00
GARFIELD AVE



"HT" LINE STA 500+00 TO 547+00
HUNTINGTON DRIVE



"FO" LINE STA 600+00 TO 629+00
FAIR OAKS AVE

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

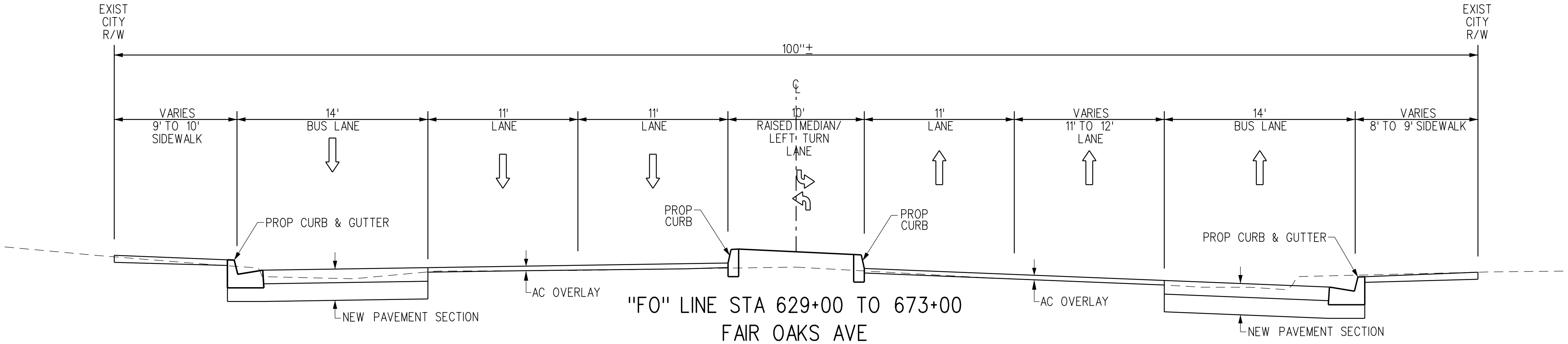
DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

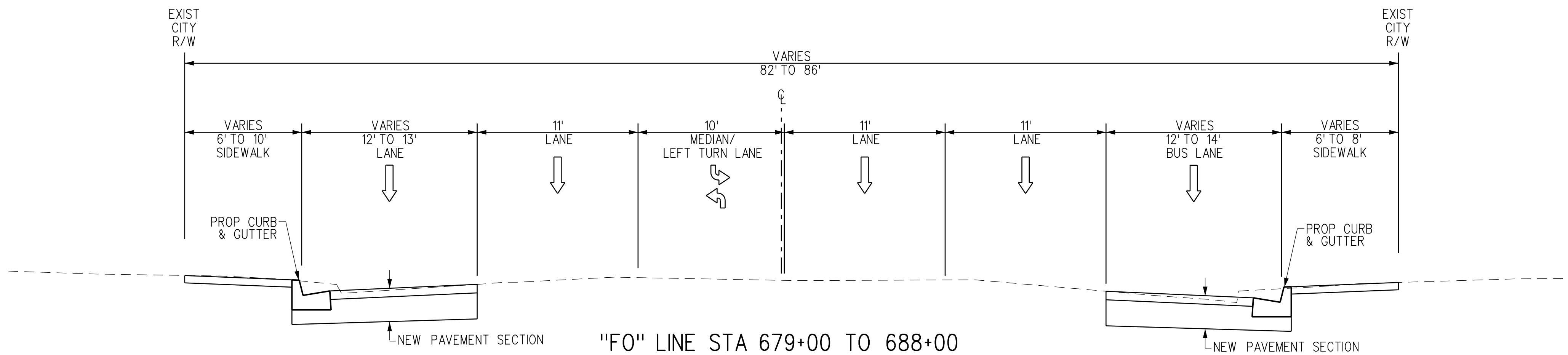
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 6 OF 7

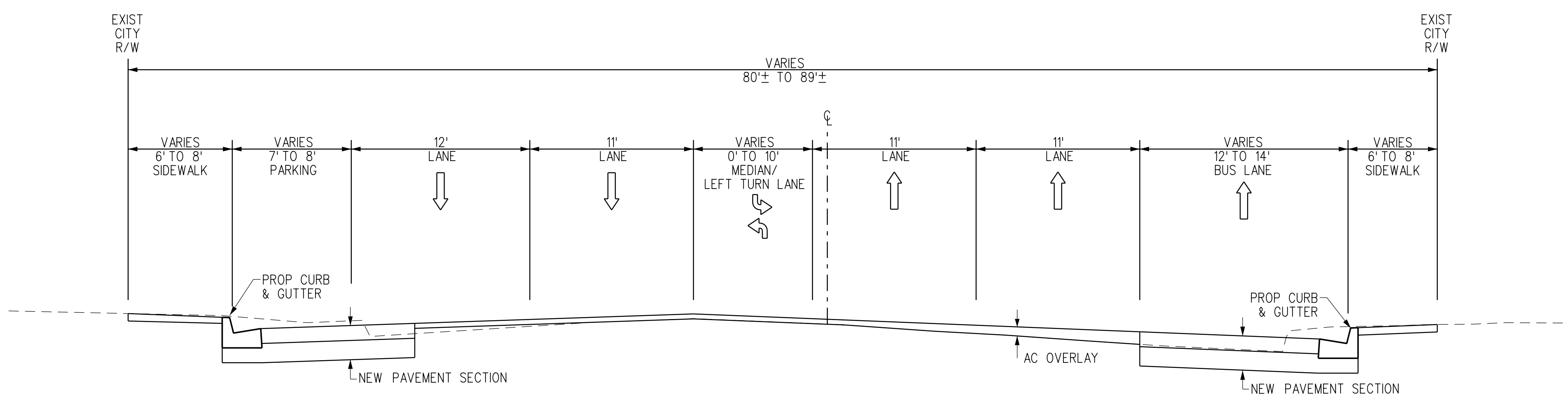
CONTRACT NO
DRAWING NO X-006
REV
SCALE NOT TO SCALE
SHEET NO



"FO" LINE STA 629+00 TO 673+00
FAIR OAKS AVE



"FO" LINE STA 679+00 TO 688+00
STA 696+00 TO 700+00
STA 713+00 TO 718+00
STA 730+00 TO 732+00
FAIR OAKS AVE



"FO" LINE STA 688+00 TO 696+00
STA 700+00 TO 713+00
STA 718+00 TO 730+00

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY S. CHAU
DRAWN BY H. ANDERSON
CHECKED BY V. CHIO
IN CHARGE T. BEVAN
DATE 8/20/13

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

710 NORTH STUDY-BRT
ADVANCED CONCEPTUAL DESIGN
TYPICAL SECTIONS
SHEET 7 OF 7

CONTRACT NO
DRAWING NO X-007
REV
SCALE NOT TO SCALE
SHEET NO

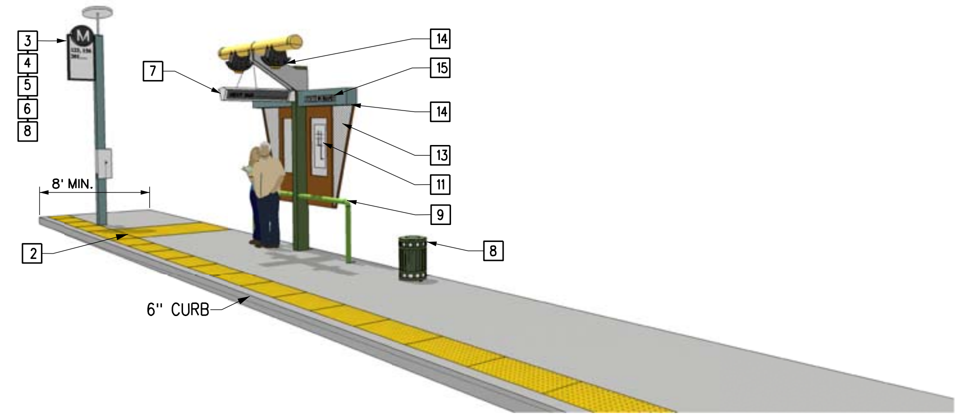
Model Name: Default

NOTES:

1. SEE GENERAL PLAN DRAWING NO.G-002 FOR STATION CASE DESIGNATIONS

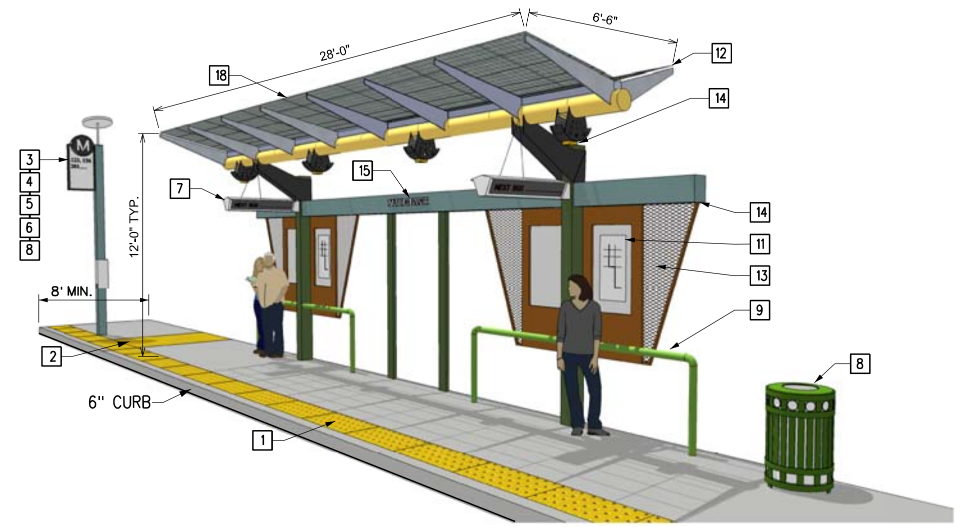
ITEM No.	AMENITIES	STATION CASES		
		CASE A	CASE B	CASE C
1	WARNING STRIP/TRUNCATED DOMES	✓	✓	✓
2	8'X 5' MIN. FRONT DOOR LOADING	✓	✓	✓
3	BUS STOP SIGN (BRT ONLY) WITH BRAILLE SIGN.	✓	✓	✓
4	BUS STOP SIGN WITH BRAILLE SIGN AND INFORMATION LOCATOR.	✓	✓	✓
5	BUS WAITING SIGNAL WITH BRAILLE SIGN	✓	✓	✓
6	BRAND SIGN	✓	✓	✓
7	VARIABLE MESSAGE SIGN (NEXT BUS ARRIVAL) WITH PUBLIC ADDRESS SYSTEM	✓	✓	✓
8	TRASH RECEPTACLE	✓	✓	✓
9	LEANING RAIL	✓	✓	✓
10	BENCH ONLY	—	—	✓
11	ROUTE MAP	✓	✓	✓
12	CANOPY	—	✓	✓
13	WIND SCREEN	—	—	✓
14	LIGHTING	✓	✓	✓
15	STATION ID	✓	✓	✓
16	WAY FINDING SIGN	✓	✓	✓
17	ADVERTISING PANEL	—	✓	✓
18	SOLAR POWER PANELS	—	✓	✓

AMENITIES LIST



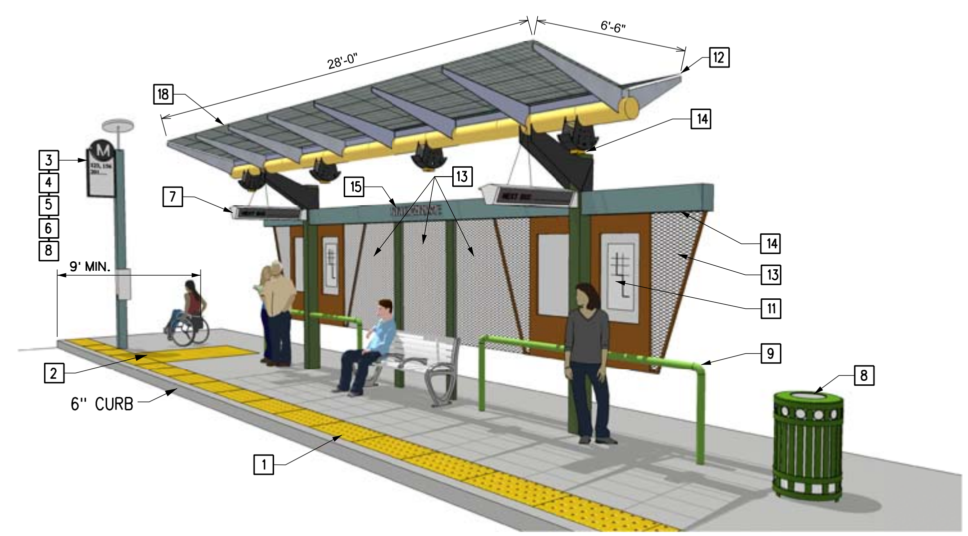
CASE A

8 FOOT SIDEWALKS/LOWER PATRONAGE/ ADJACENT PROPERTY CONFLICTS



CASE B

8 FOOT SIDEWALKS/HIGHER PATRONAGE/ ADJACENT PROPERTIES WITH SETBACK



CASE C

GREATER THAN 8 FOOT SIDEWALKS/HIGHER PATRONAGE/ ADJACENT PROPERTIES WITH SETBACK

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY K.SRIVONGSE
DRAWN BY C.HERNANDEZ
CHECKED BY W.VILLALOBOS
IN CHARGE F.VILLALOBOS
DATE 08/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

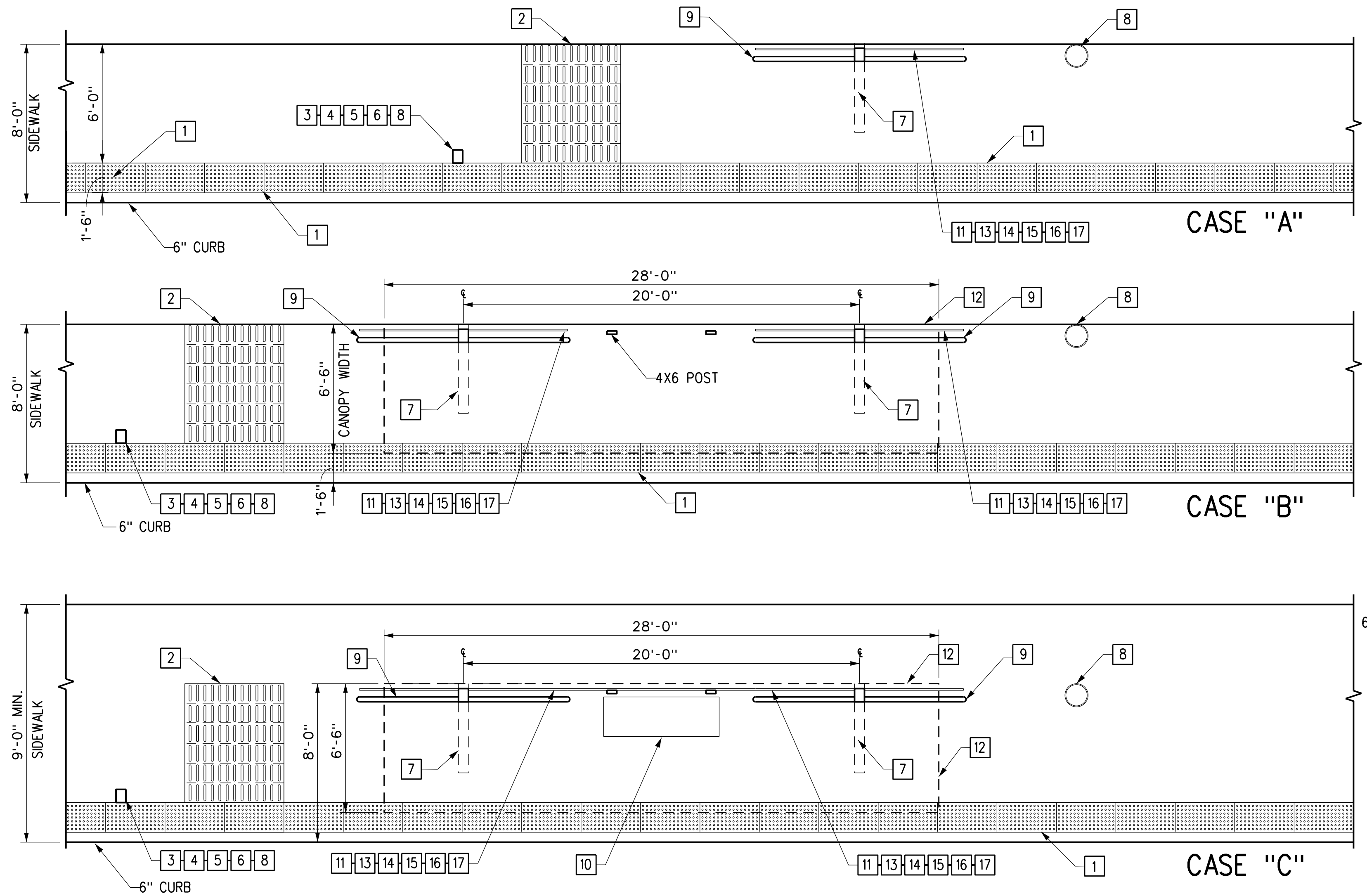
CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

BARRIO PLANNERS INCORPORATED
5271 east beverly boulevard los angeles, calif. 90022 323 726 7734

710 NORTH STUDY-BRT ALTERNATIVE
CONCEPTUAL DESIGN
STATION CASES
AMENITIES, RENDERINGS

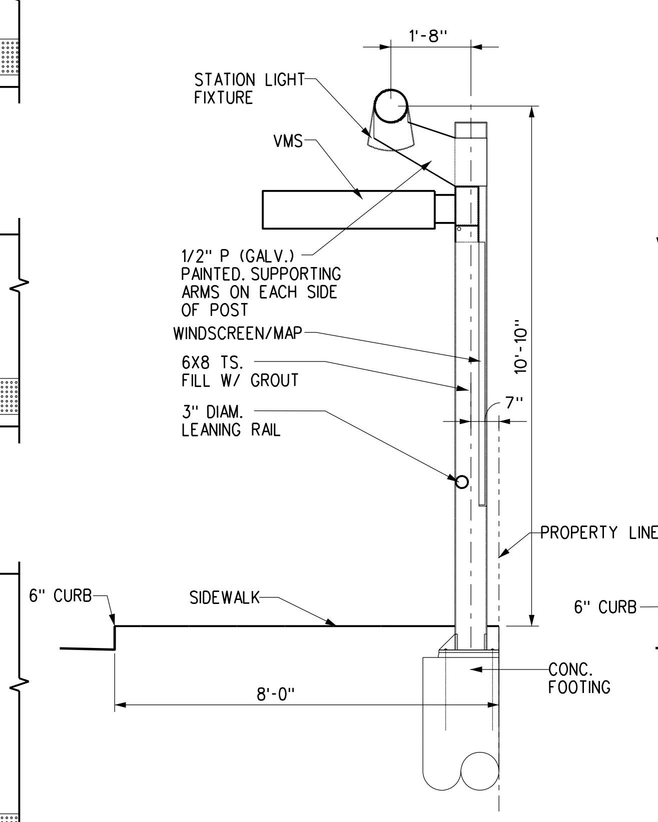
CONTRACT NO
DRAWING NO A-101
REV
SCALE NOT TO SCALE
SHEET NO

Pentable• $PENTBL$$
Plot Driver• $PLTDRV$$
$FILEA$
$DATE$
$TIME$
$USER$
Model Name• $MODELNAME$

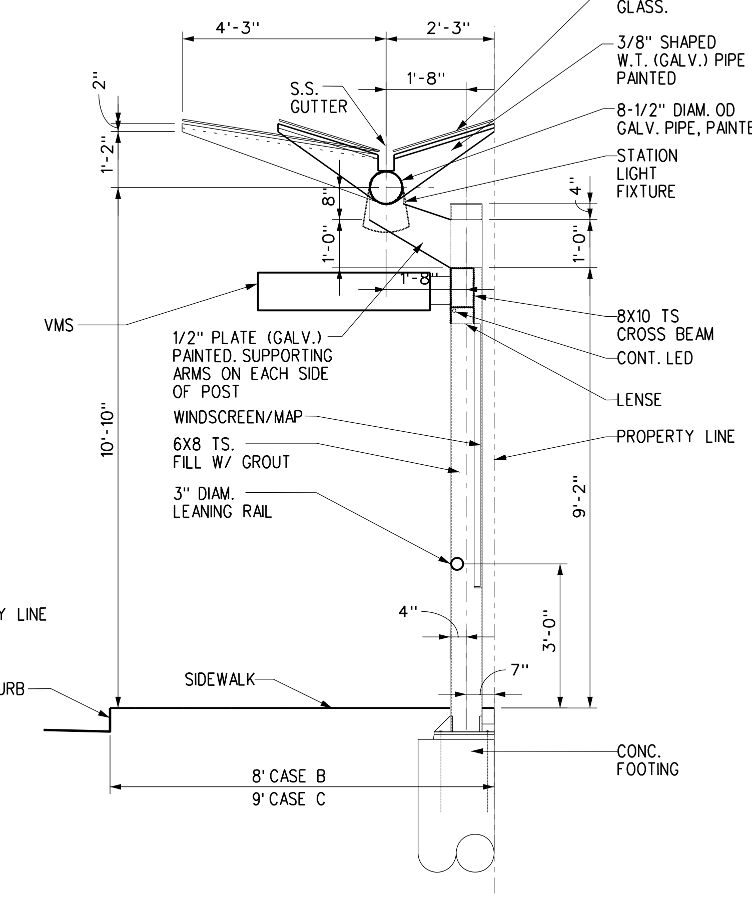


STATION CASES - PLAN VIEW
1/4"=1'-0"

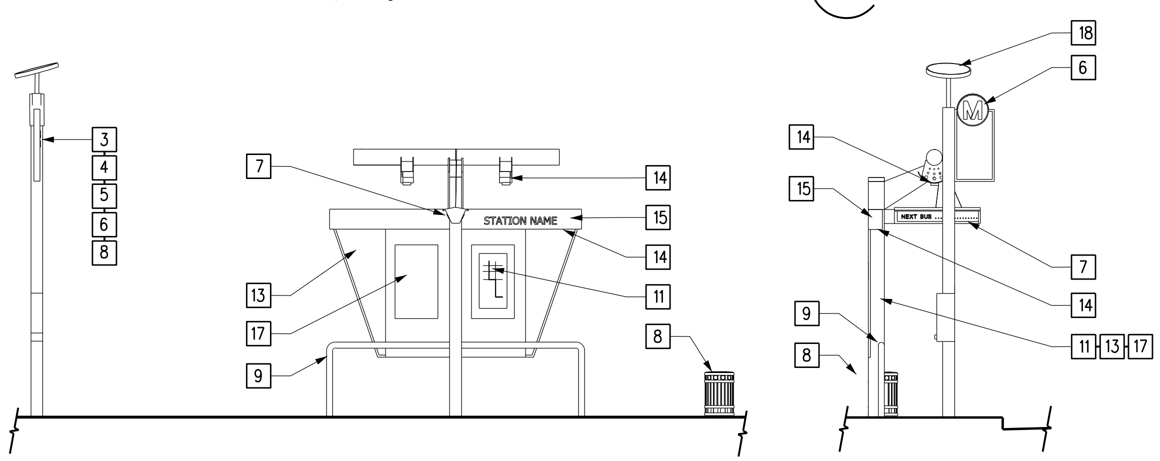
NOTES:
1. SEE SHEET A-101 FOR LEGEND OF STATION AMENITIES



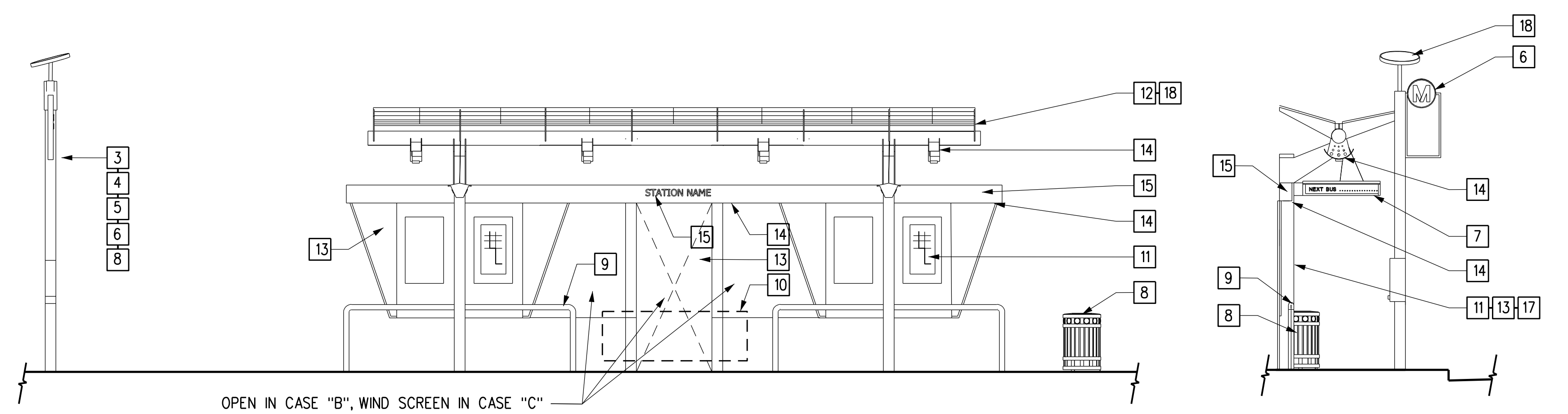
SECTION DETAIL
1/2"=1'-0"
CASE A



SECTION DETAIL
1/2"=1'-0"
CASE B, C



FRONT & SIDE ELEV.
1/4"=1'-0"
CASE A



FRONT & SIDE ELEV.
1/4"=1'-0"
CASE B, C

NOTES:
1. CASE C CONTAINS A BENCH AND A SCREEN IN THE CENTER. REFER TO A-102, CASE "C" RENDERING.

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY K. SRIVONGSE
DRAWN BY C.HERNANDEZ
CHECKED BY W.VILLALOBOS
IN CHARGE F.VILLALOBOS
DATE 08/20/13

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

BARRIO PLANNERS INCORPORATED
5271 east beverly boulevard los angeles, calif. 90022 323 726 7734

710 NORTH STUDY-BRT ALTERNATIVE
CONCEPTUAL DESIGN
STATION CASES
PLAN AND ELEVATIONS

CONTRACT NO
DRAWING NO A-102
REV
SCALE AS NOTED
SHEET NO

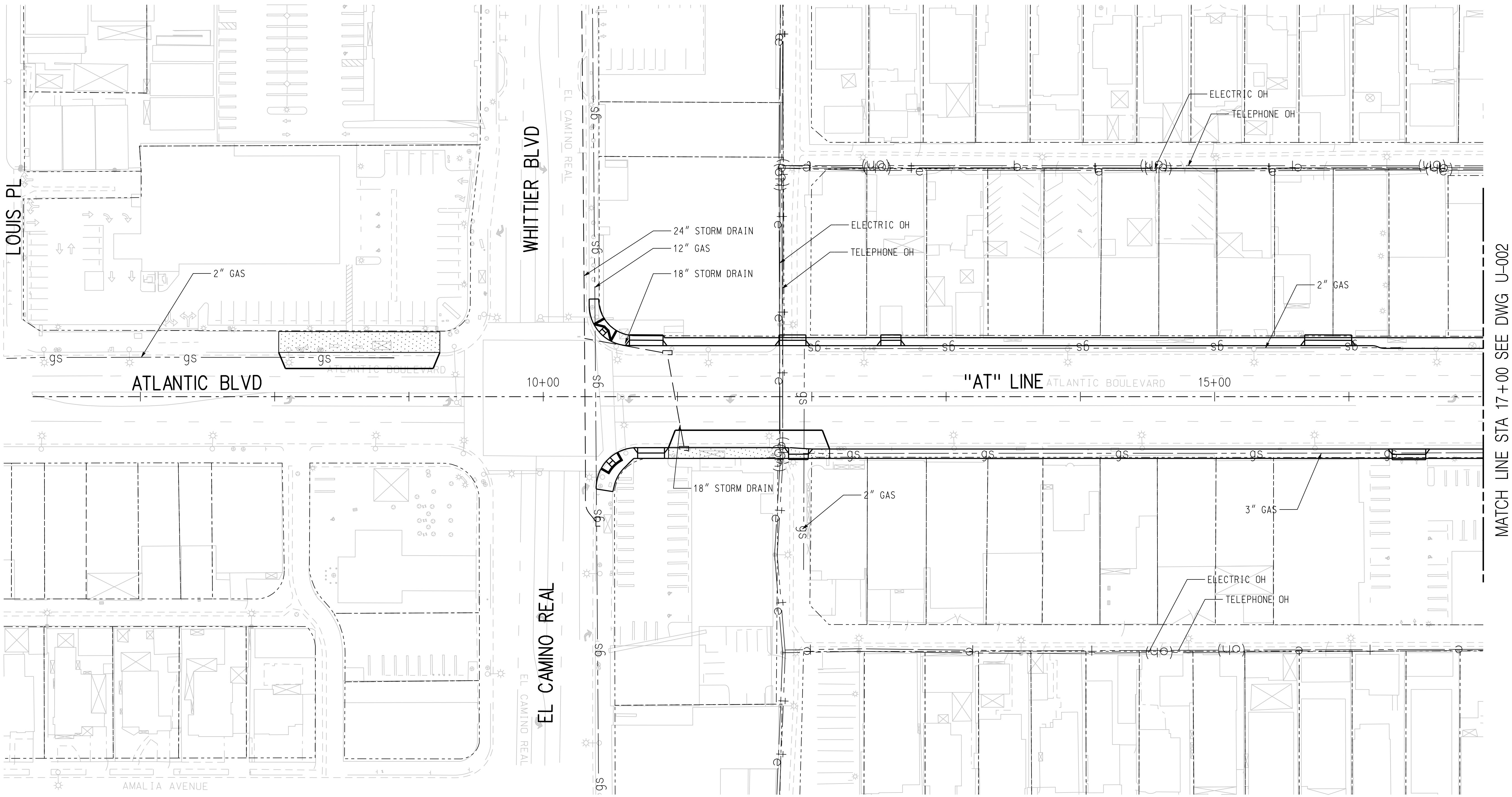
Model Name= $MODELNAME$

GENERAL NOTES:

1. EXISTING UTILITIES ALONG THE NORTH LOOP IN PASADENA ARE UNAVAILABLE AT THIS TIME. ADDITIONAL INFORMATION WILL BE COLLECTED AND ADDED TO DRAWING NO. U-044 THROUGH U-048 BEFORE THE FINAL SUBMITTAL.
2. UTILITY PLANS ARE NOT INCLUDED FOR AREAS WITH NO PROPOSED CONSTRUCTION.

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

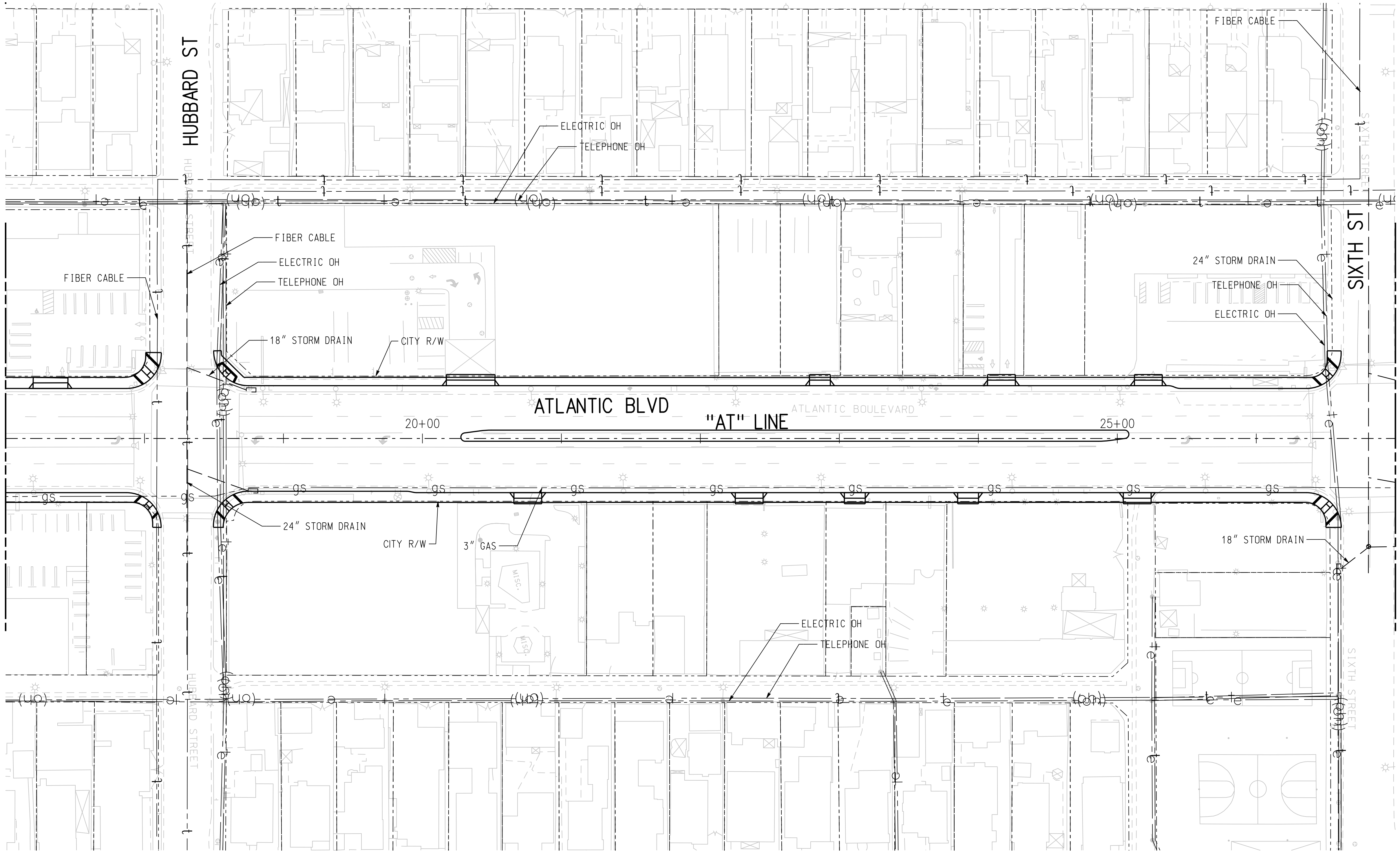
STA 06+00 TO STA 17+00
SHEET 1 OF 48

CONTRACT NO
DRAWING NO U-001
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 17+00 TO STA 27+00
SHEET 2 OF 48

CONTRACT NO

DRAWING NO U-002

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 27+00 TO STA 37+00
SHEET 3 OF 48

CONTRACT NO

DRAWING NO U-003

REV

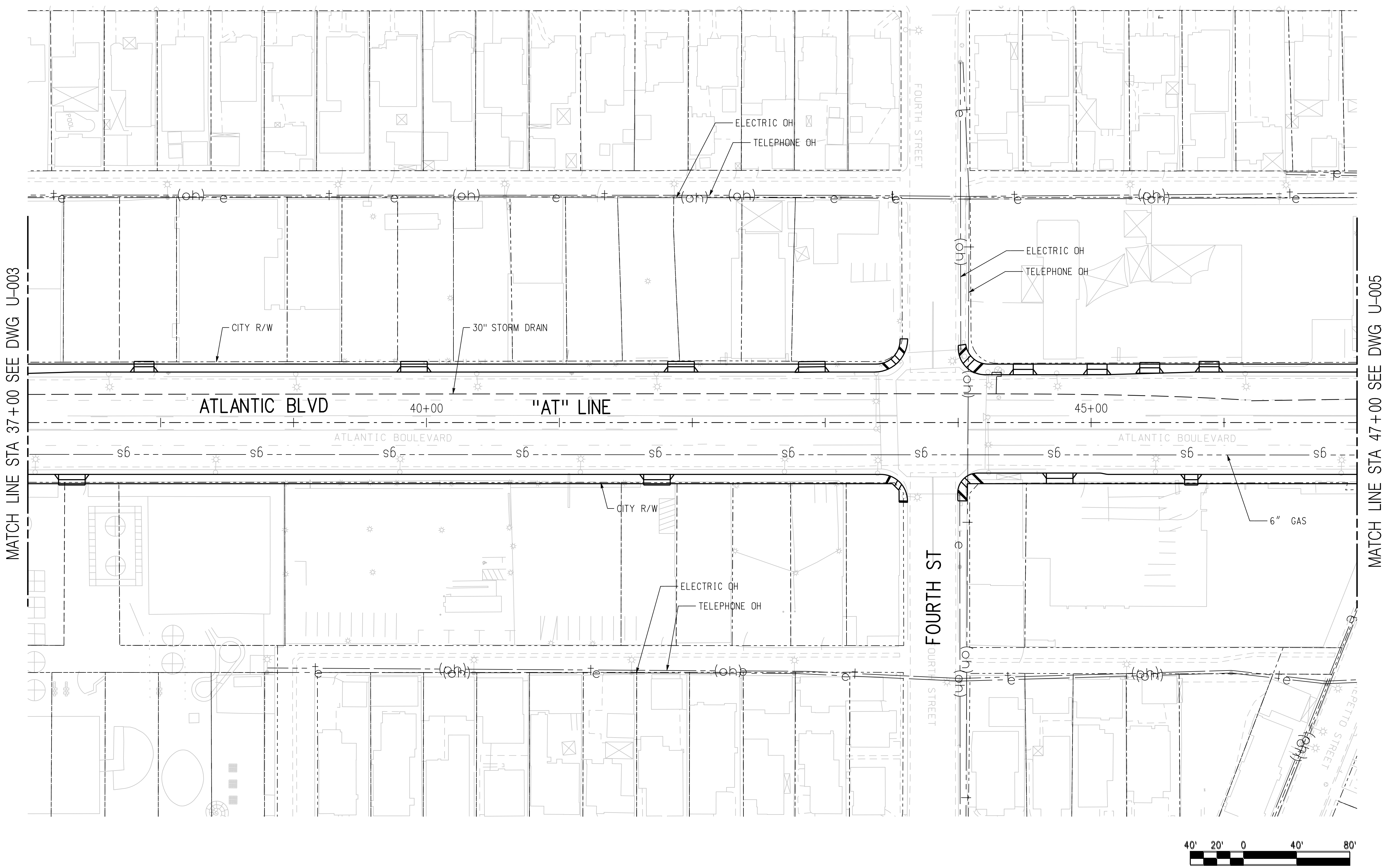
SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 37+00 TO STA 47+00
SHEET 4 OF 48

CONTRACT NO

DRAWING NO U-004

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.

40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 47+00 TO STA 56+00
SHEET 5 OF 48

CONTRACT NO
DRAWING NO U-005
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

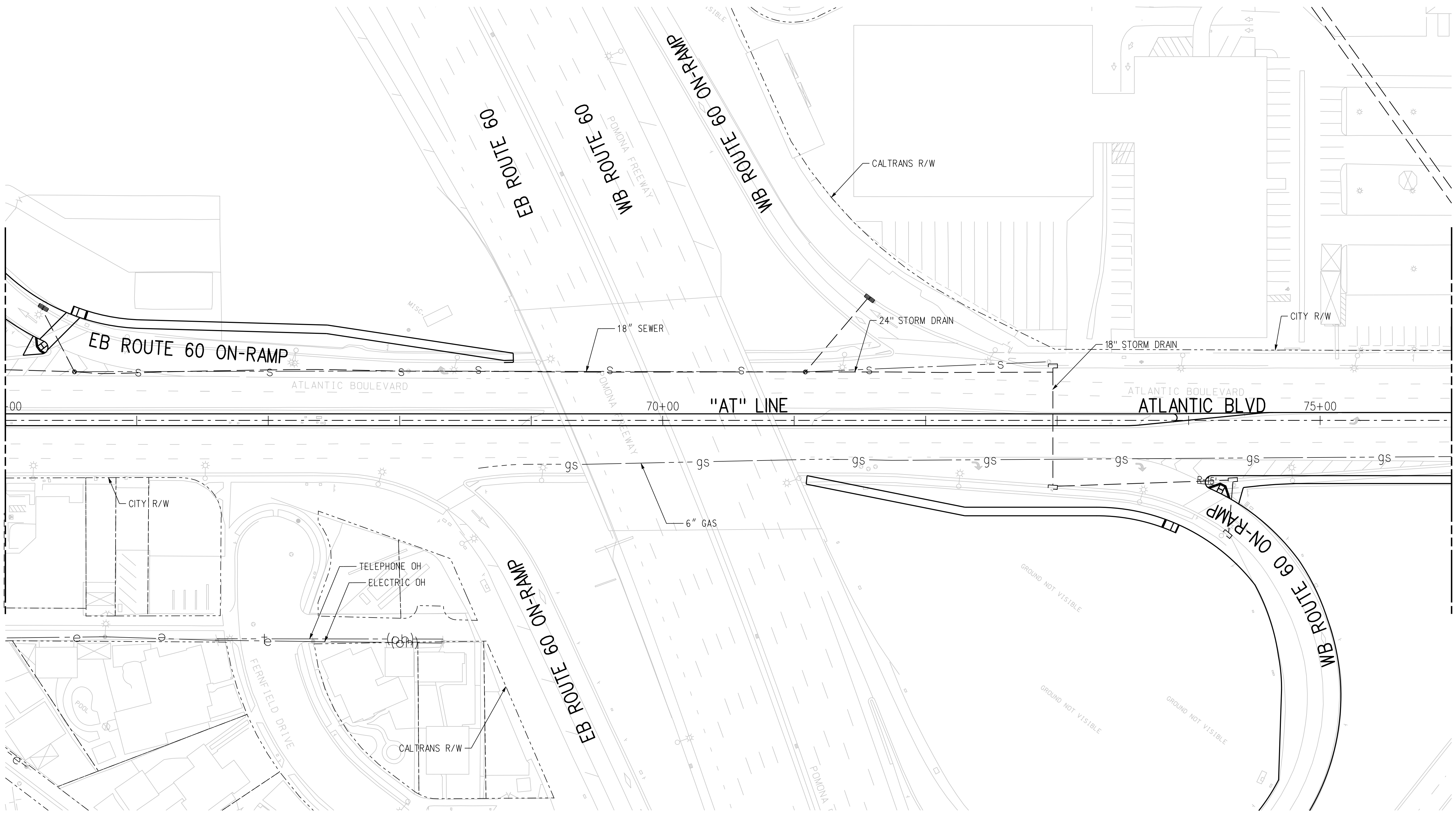
STA 56+00 TO STA 65+00
SHEET 6 OF 48

CONTRACT NO
DRAWING NO U-006
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

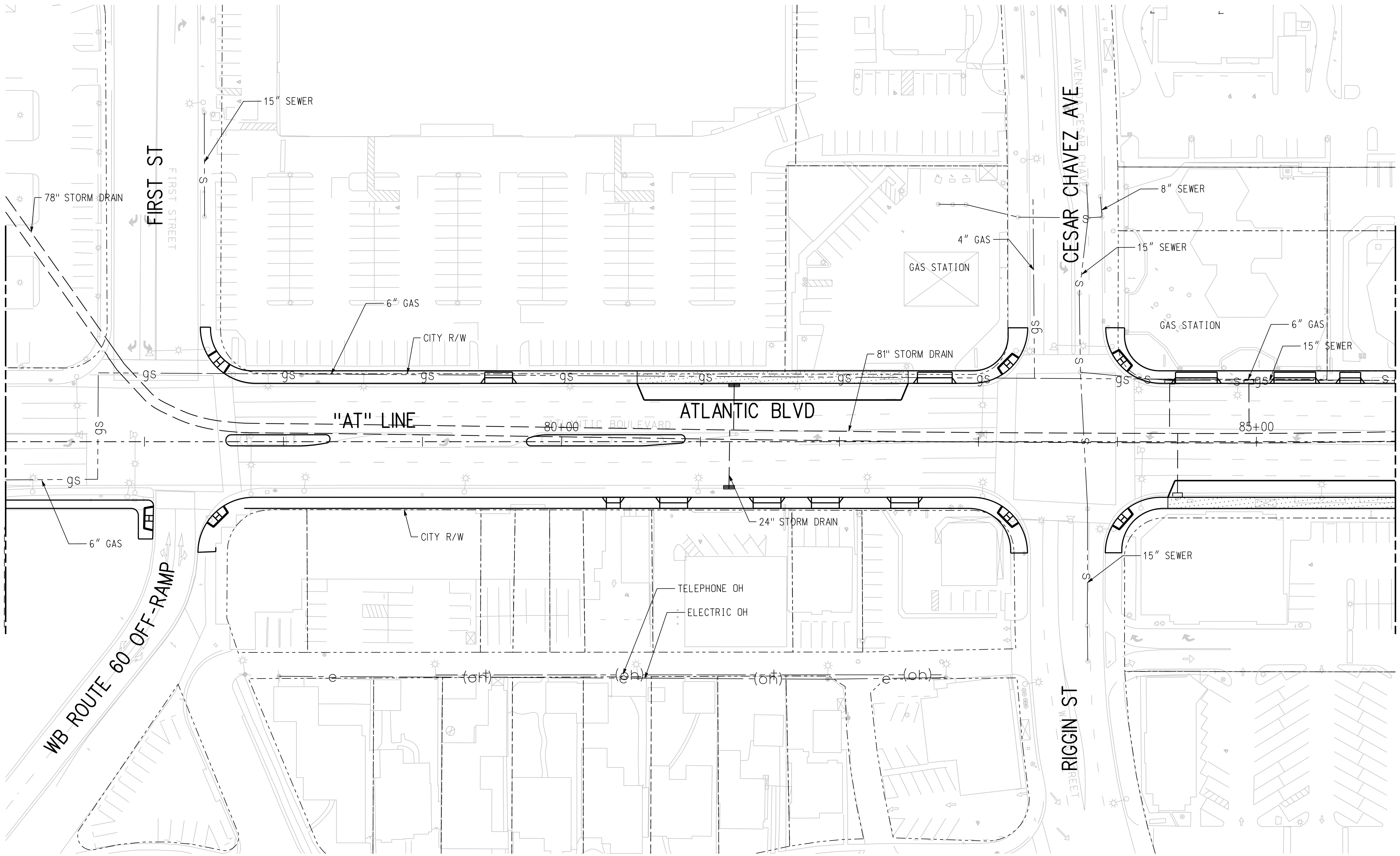
STA 65+00 TO STA 76+00
SHEET 7 OF 48

CONTRACT NO
DRAWING NO U-007
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

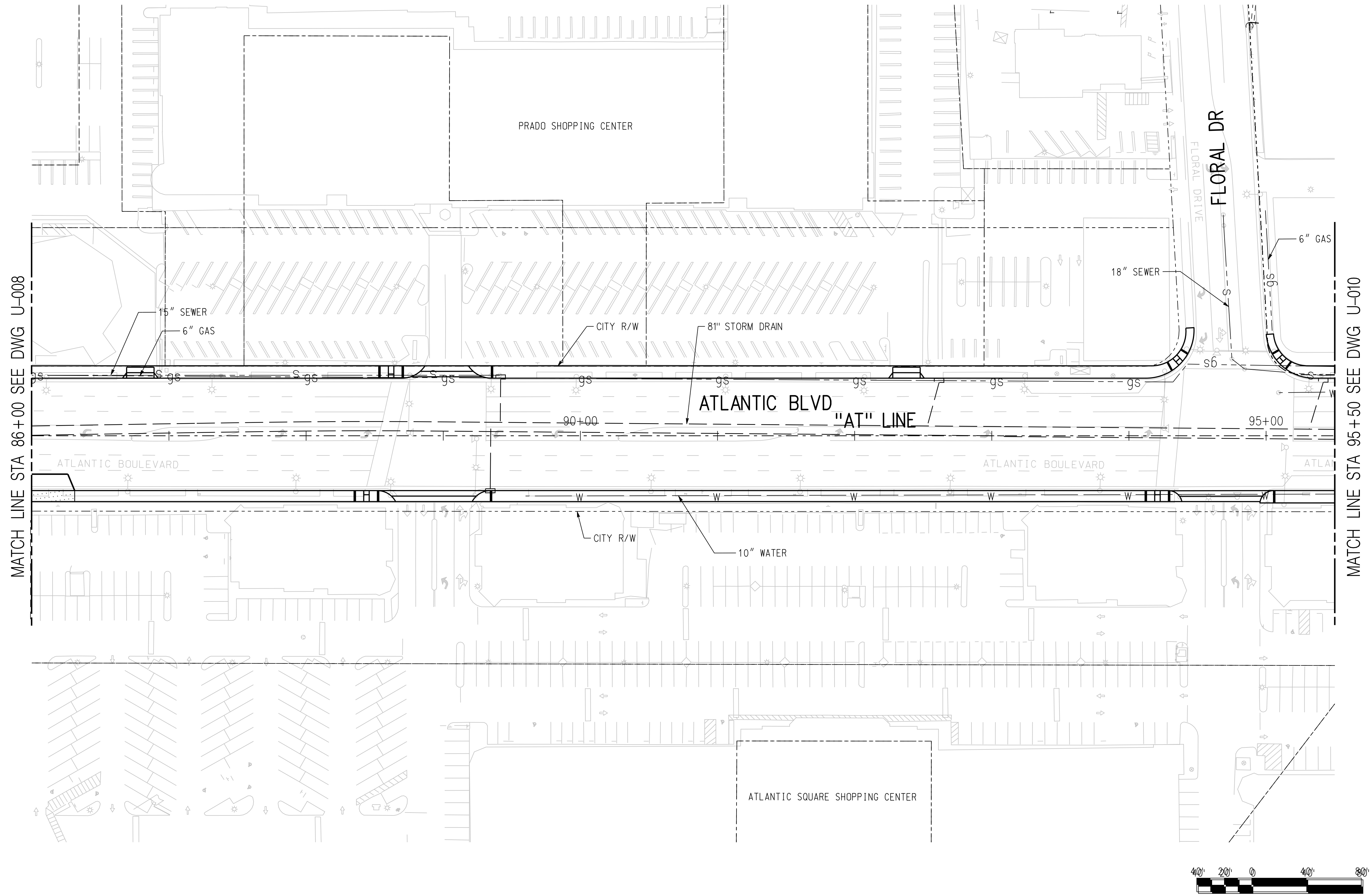
STA 76+00 TO STA 86+00
SHEET 8 OF 48

CONTRACT NO
DRAWING NO U-008
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 86+00 TO STA 95+50
SHEET 9 OF 48

CONTRACT NO

DRAWING NO U-009

REV

SCALE 1" = 40'

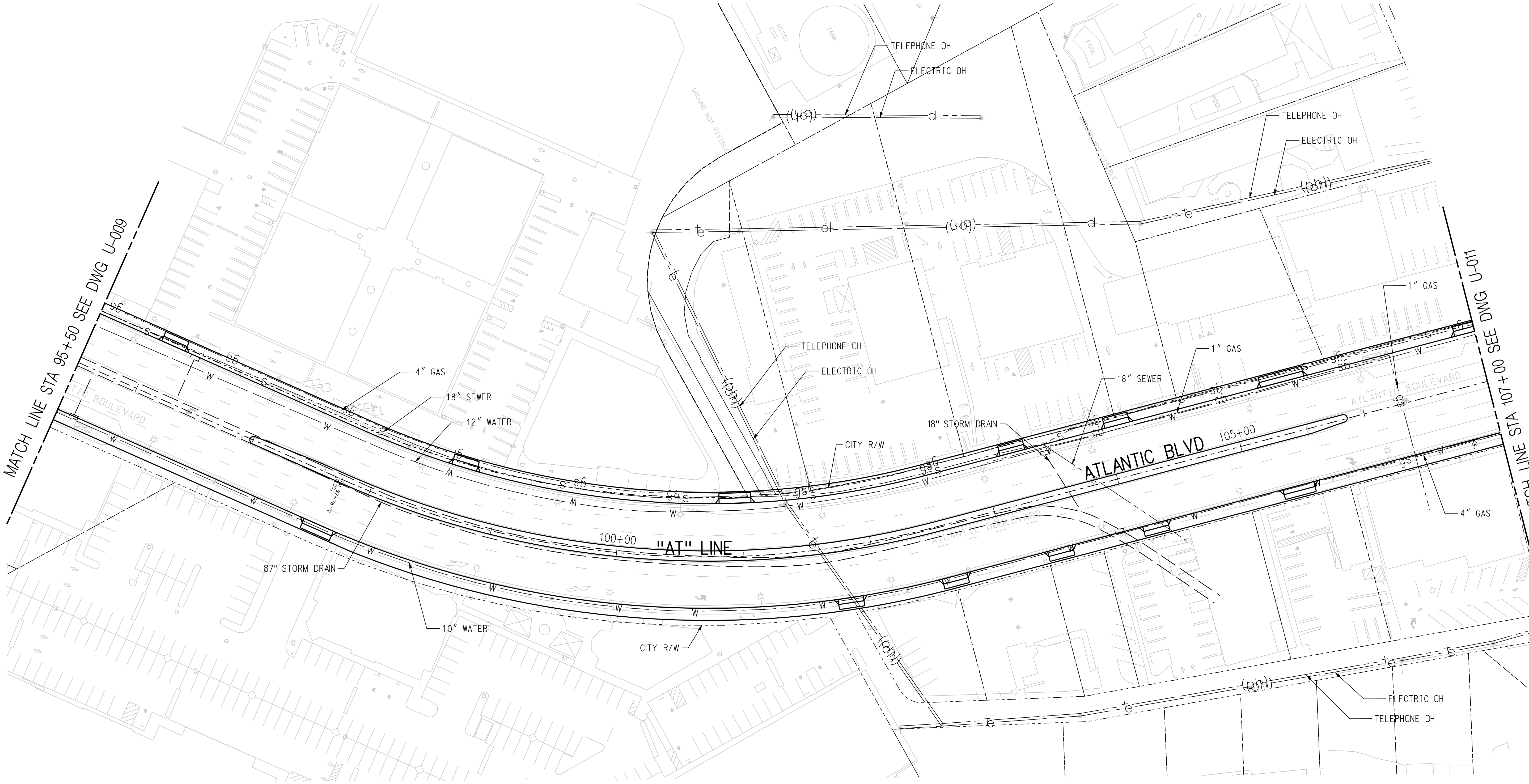
SHEET NO

Model Name: Default

Pentable: 428908_BW.TBL
Plot Driver: iplotdrvm.plt
\\denpwp01\pwicsjobs\103169\29177_IN\C0XXX-U-009.plg
5/14/2015
6:58:12 PM
DENPWP02$

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 95+50 TO STA 107+00
SHEET 10 OF 48

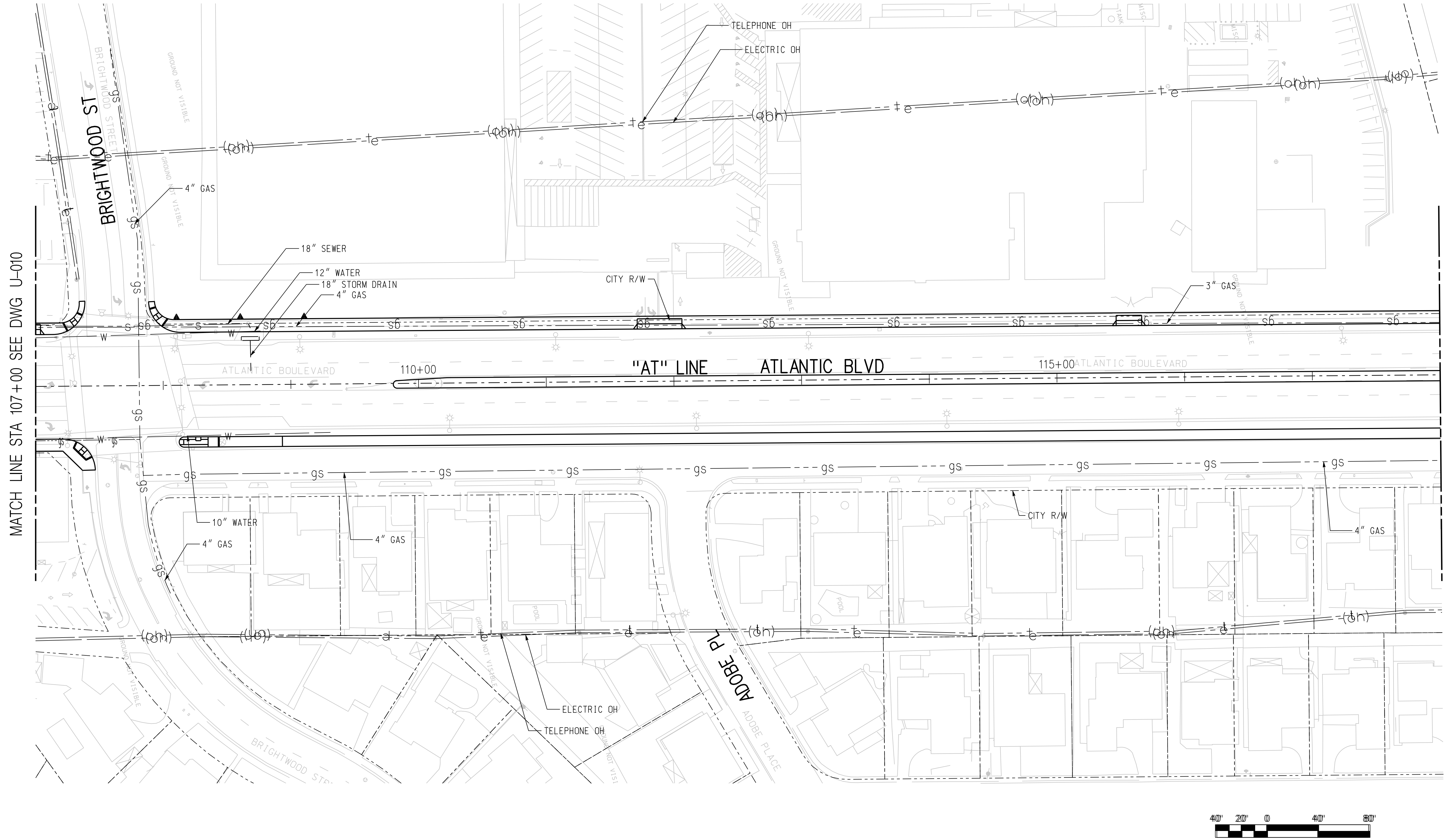
CONTRACT NO
DRAWING NO U-010
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

Pentable: 4289068_BW.TBL
Plot Driver: iplotdrvm.plt
\\denpw01\pwcsjobs\103169\29117_121\COXXX-U-010.plg
5/14/2015 6:59:30 PM
DENPW03$

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 107+00 TO STA 118+00
SHEET 11 OF 48

CONTRACT NO

DRAWING NO U-011

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 118+00 TO STA 129+00
SHEET 12 OF 48

CONTRACT NO

DRAWING NO U-012

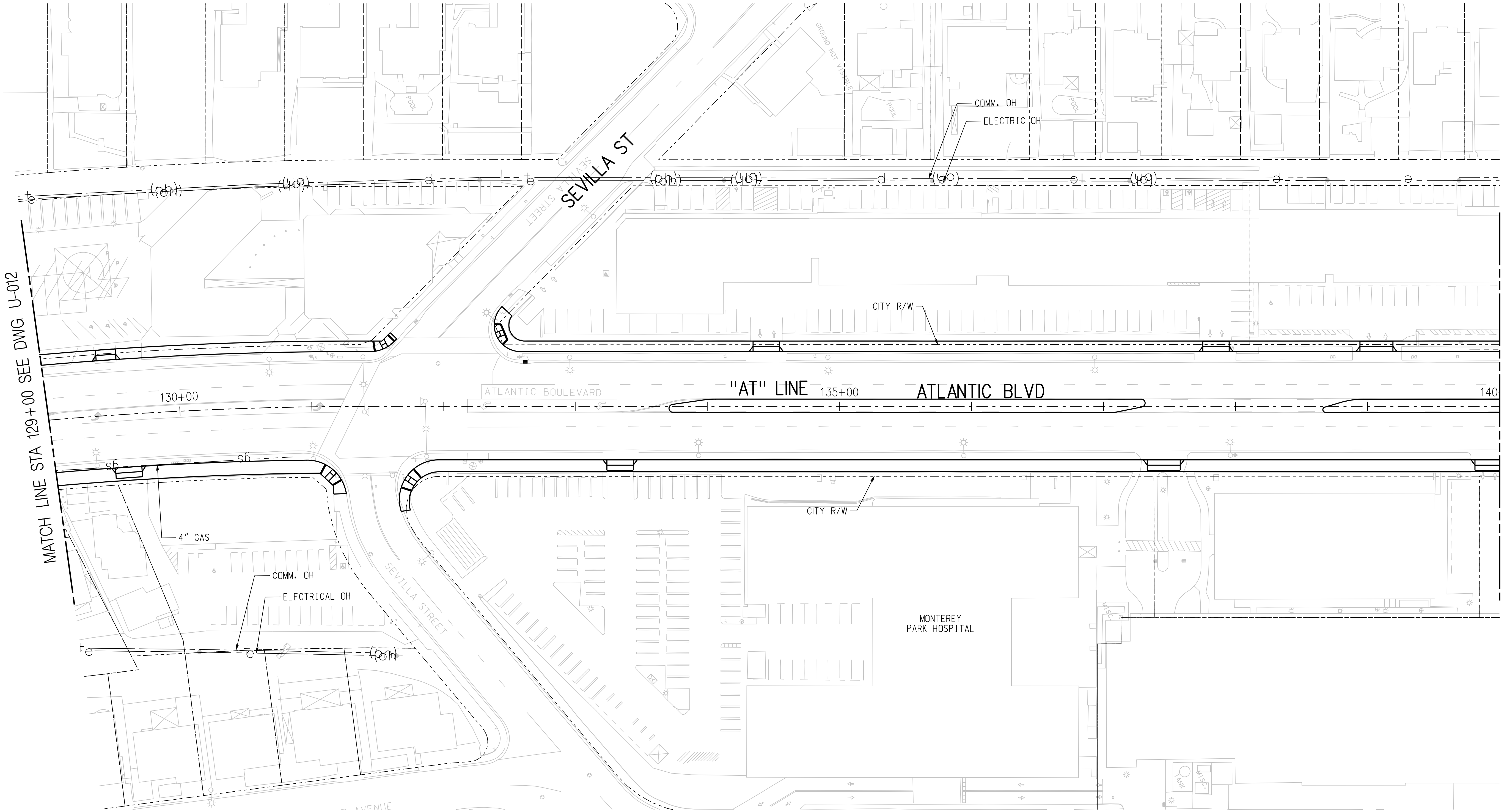
REV

SCALE 1" = 40'

SHEET NO

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

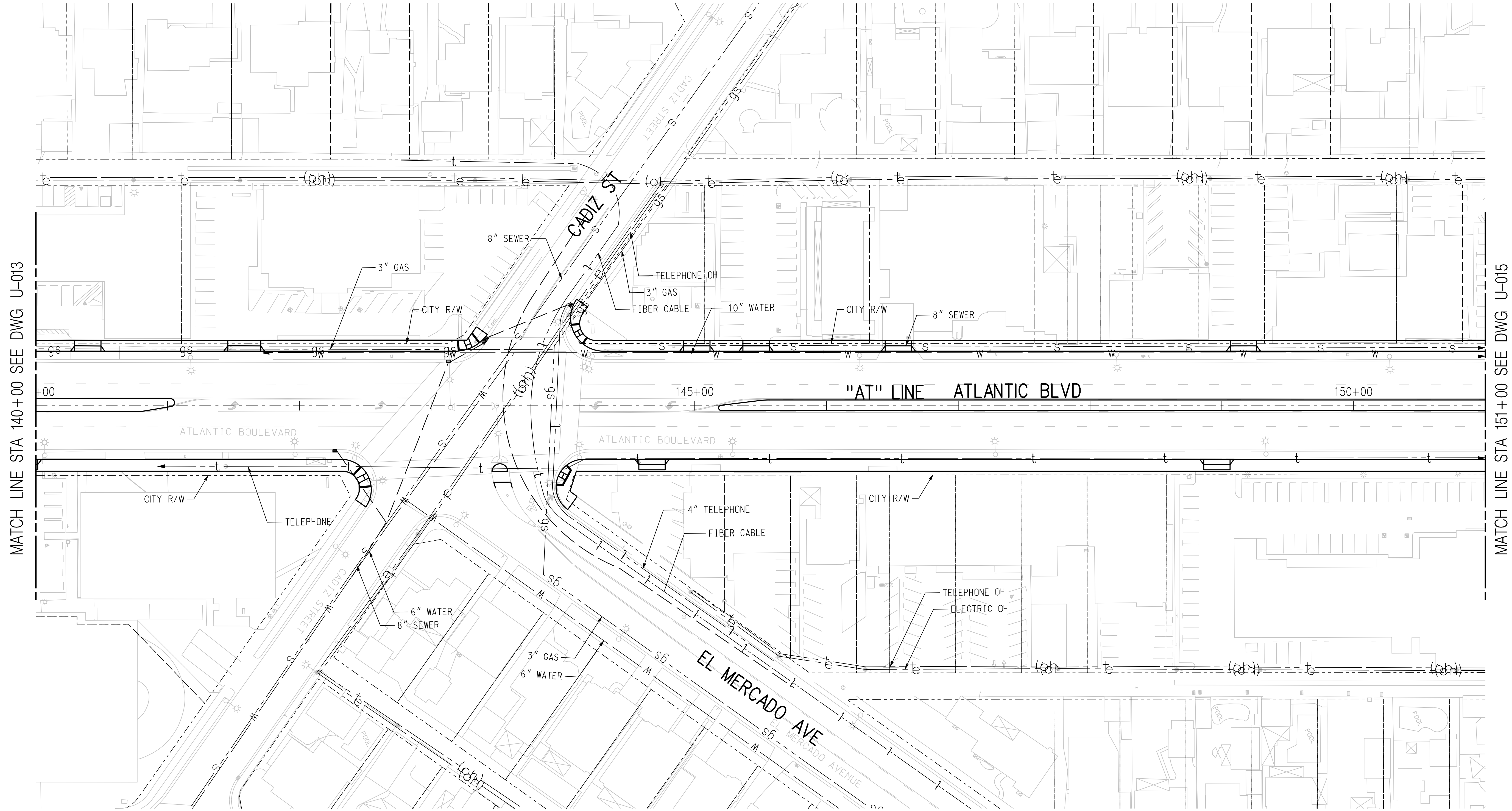
STA 129+00 TO STA 140+00
SHEET 13 OF 48

CONTRACT NO
DRAWING NO U-013
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

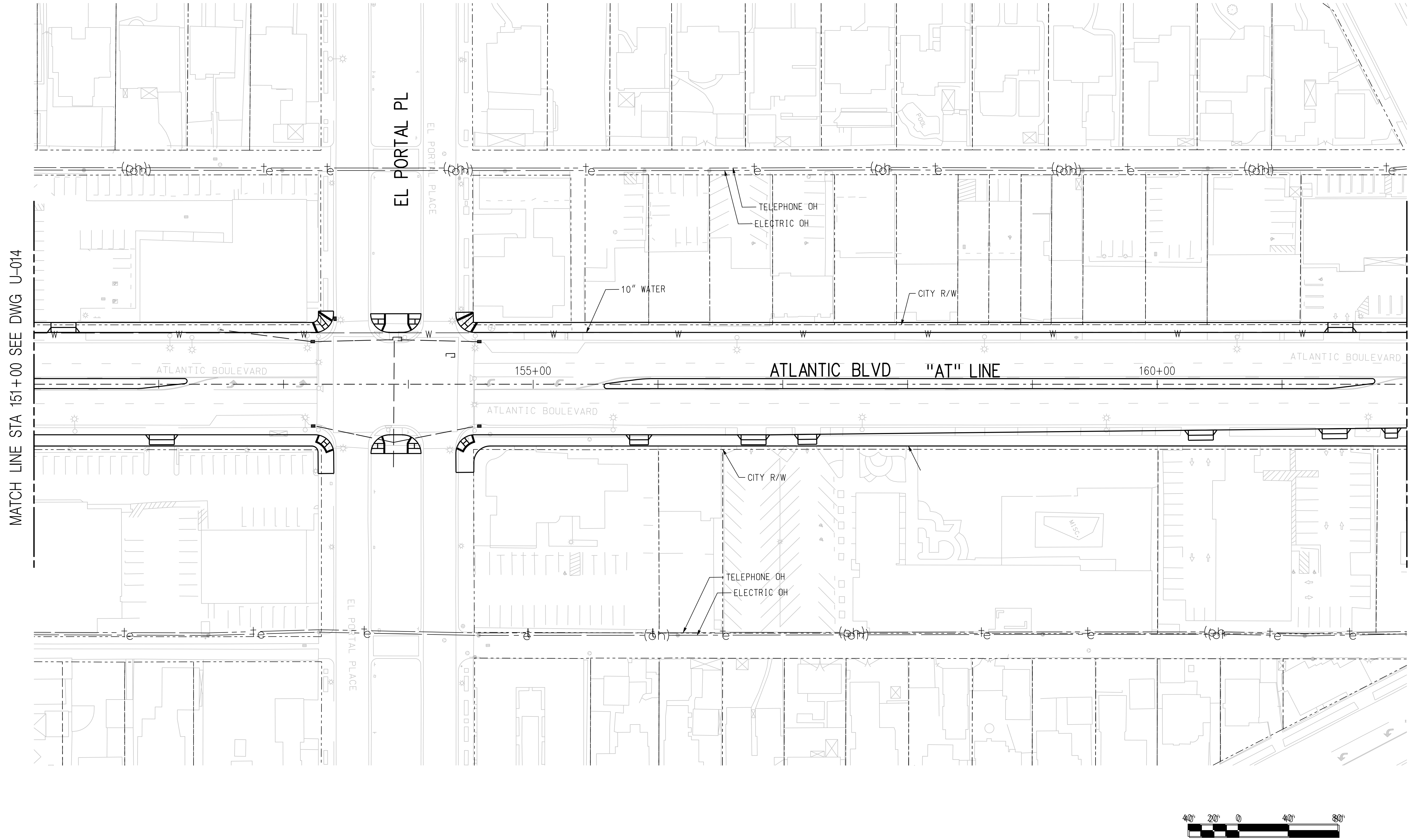
STA 140+00 TO STA 151+00
SHEET 14 OF 48

CONTRACT NO
DRAWING NO U-014
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI

DRAWN BY S. SAMAAN

CHECKED BY P. SPITERI

IN CHARGE D. LEON

DATE 10/01/2013

Metro

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 151+00 TO STA 162+00
SHEET 15 OF 48

CONTRACT NO

DRAWING NO U-015

REV

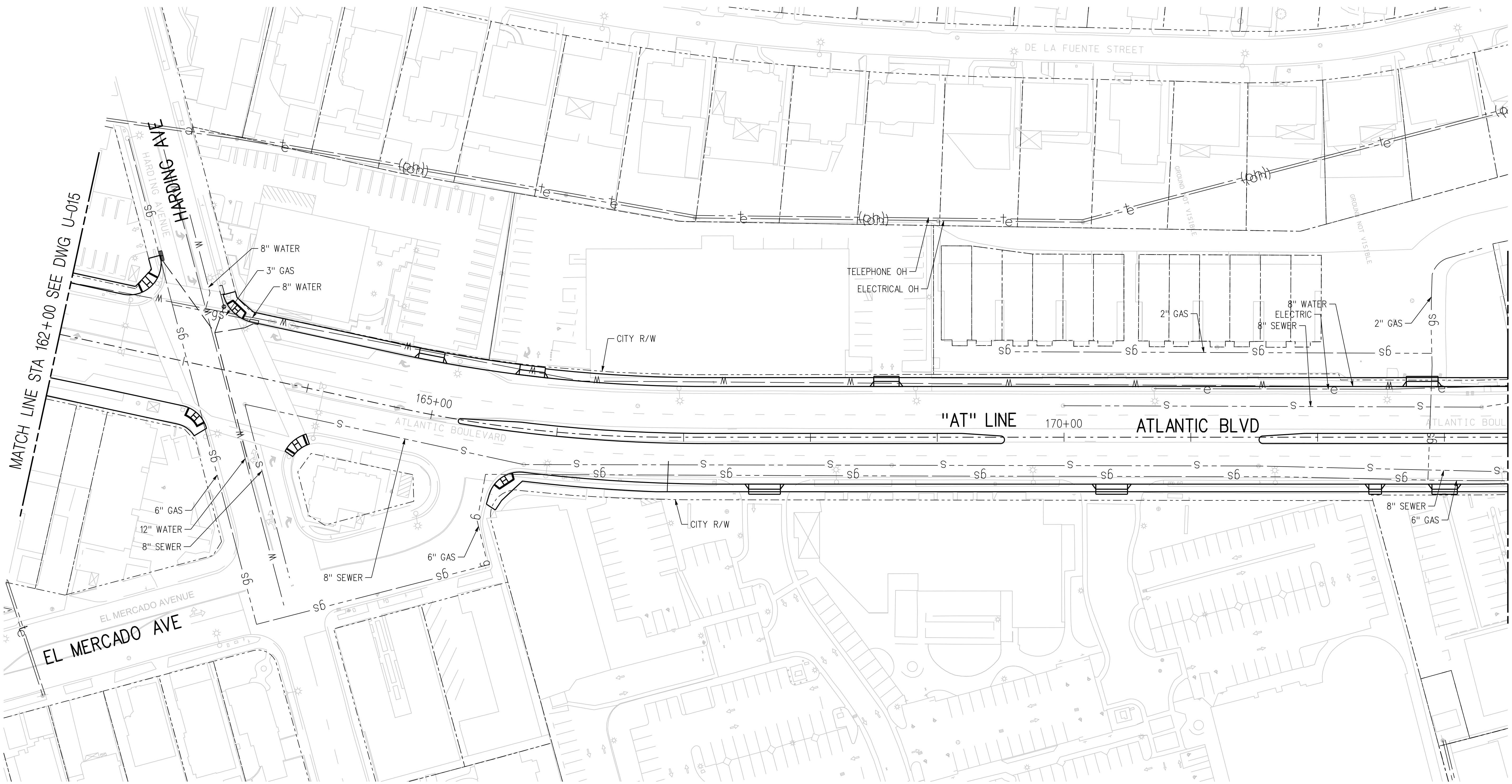
SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 162+00 TO STA 173+50
SHEET 16 OF 48

CONTRACT NO

DRAWING NO U-016

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

Pentable: 4289908_BW.TBL
Plot Driver: iplotdrvm.plt
5/14/2015

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.

40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

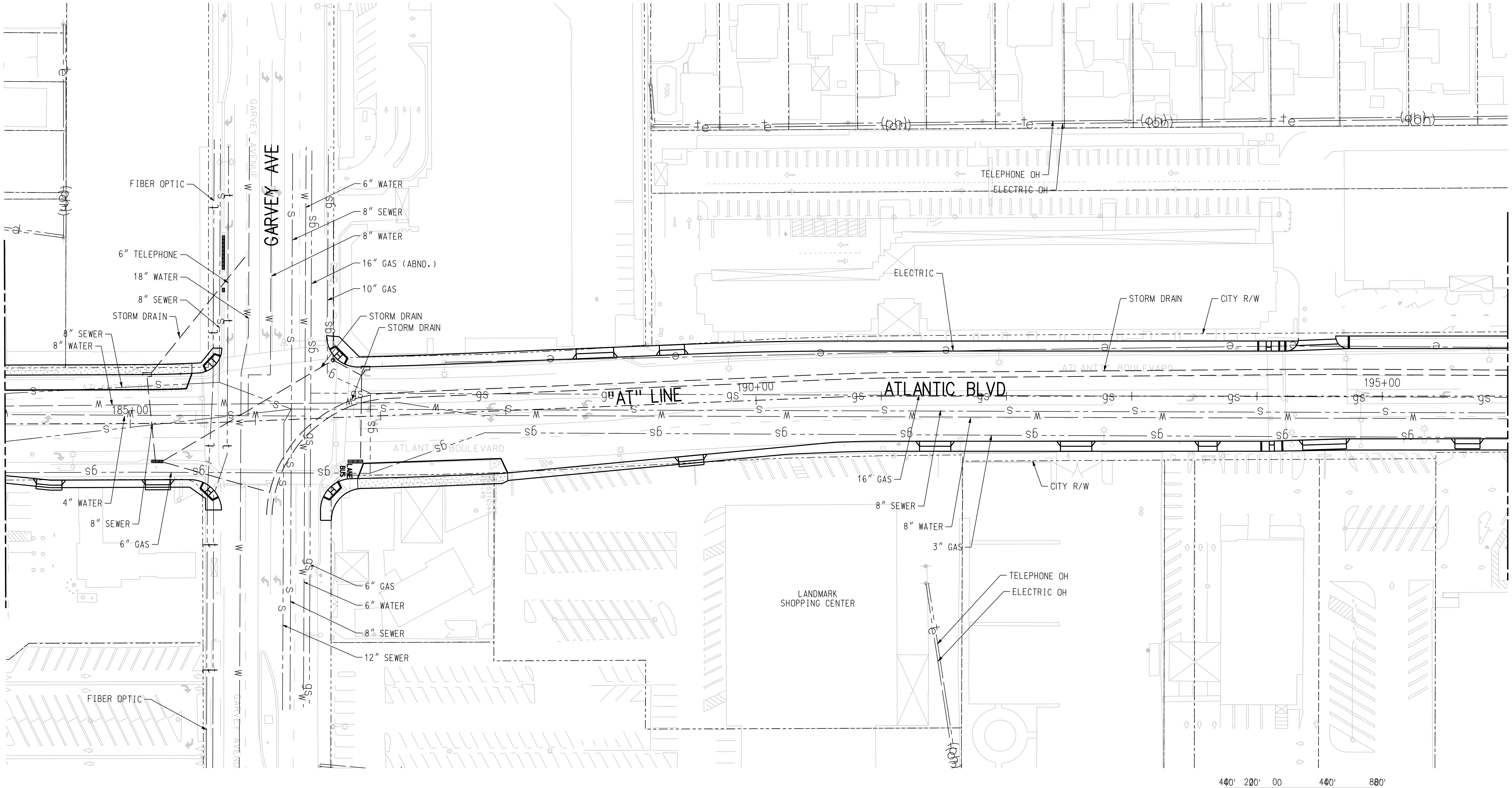
STA 173+50 TO STA 184+00
SHEET 17 OF 48

CONTRACT NO
DRAWING NO U-017
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

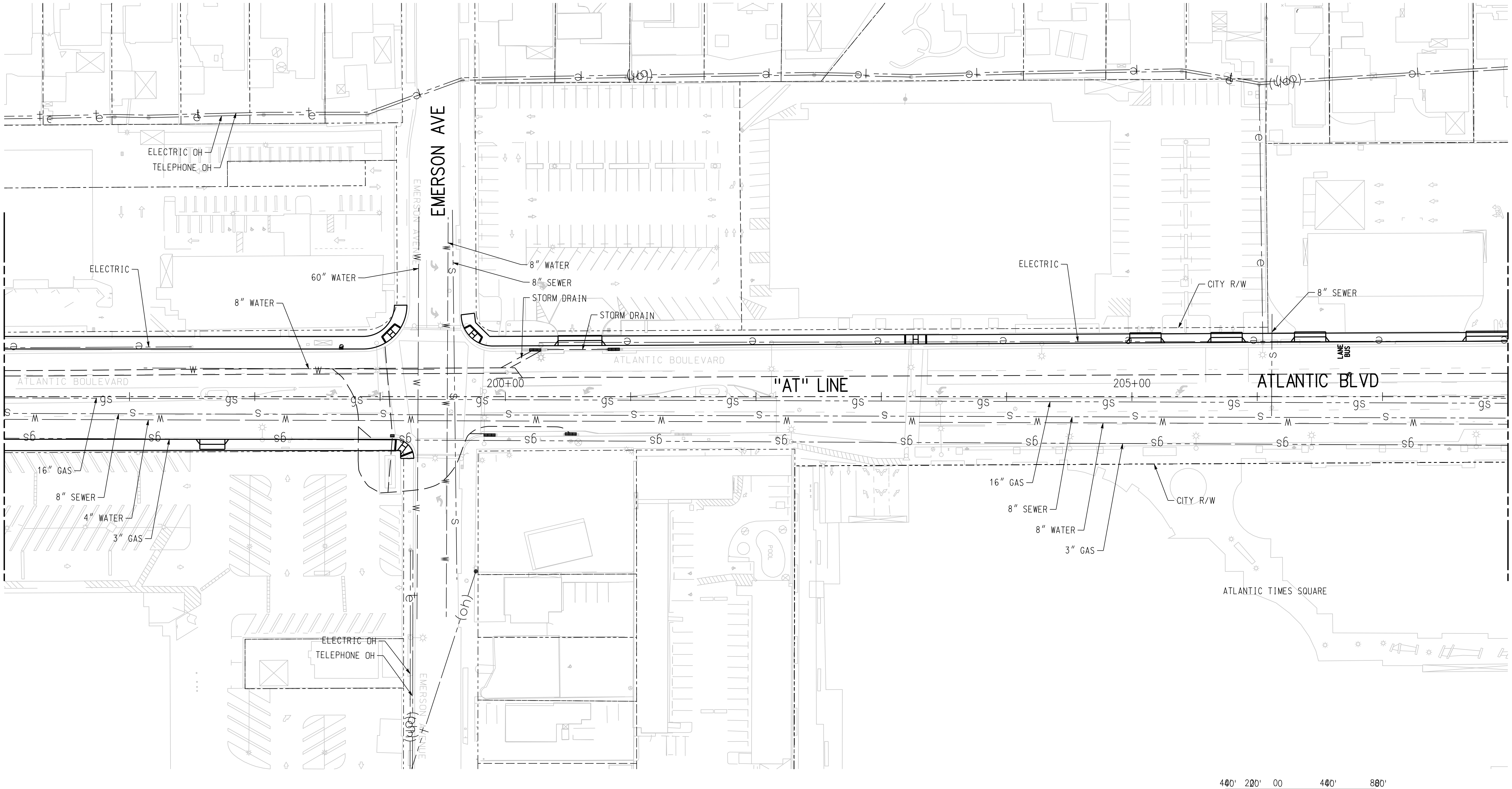
STA 184+00 TO STA 196+00
SHEET 18 OF 48

CONTRACT NO
DRAWING NO U-018
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

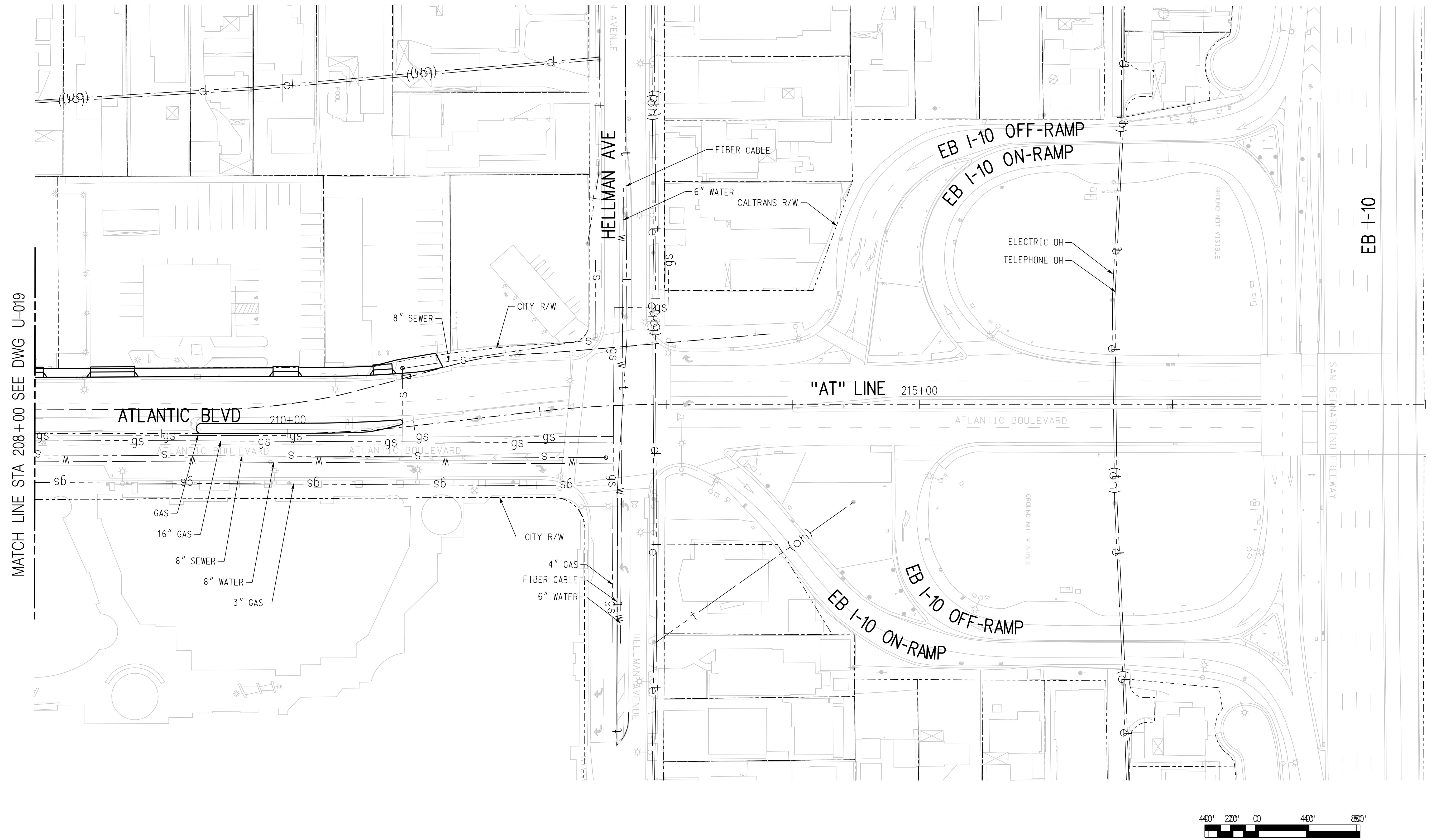
710 NORTH STUDY-BRT
UTILITY PLAN

STA 196+00 TO STA 208+00
SHEET 19 OF 48

CONTRACT NO
DRAWING NO U-019
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:
EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

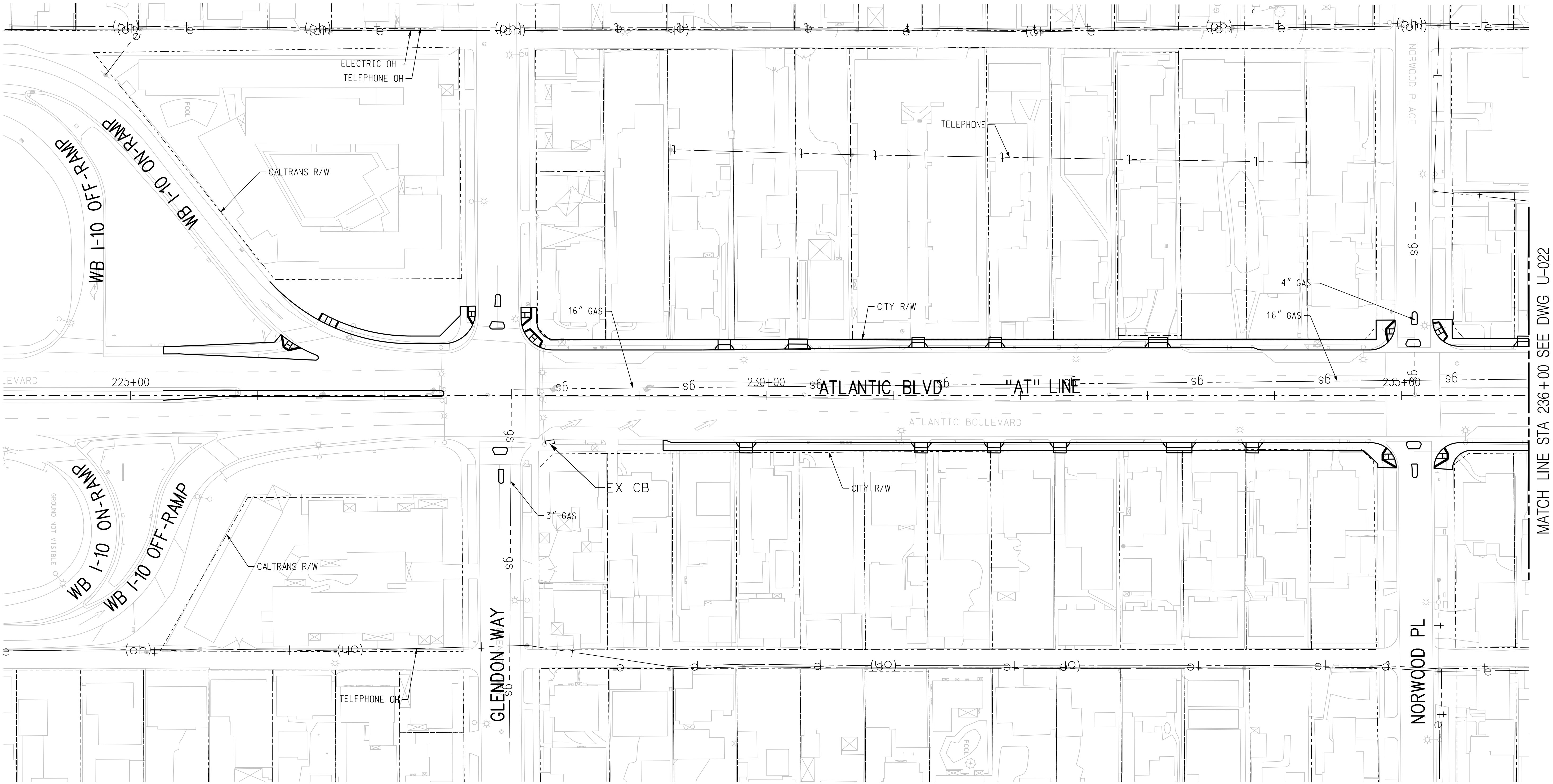
STA 208+00 TO STA 219+00
SHEET 20 OF 48

CONTRACT NO
DRAWING NO U-020
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 224+00 TO STA 236+00
SHEET 21 OF 48

CONTRACT NO

DRAWING NO U-021

REV

SCALE 1" = 40'

SHEET NO

Model Name= Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.

MATCH LINE STA 236+00 SEE DWG U-021

400' 200' 0 400' 800'

DRAFT – NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

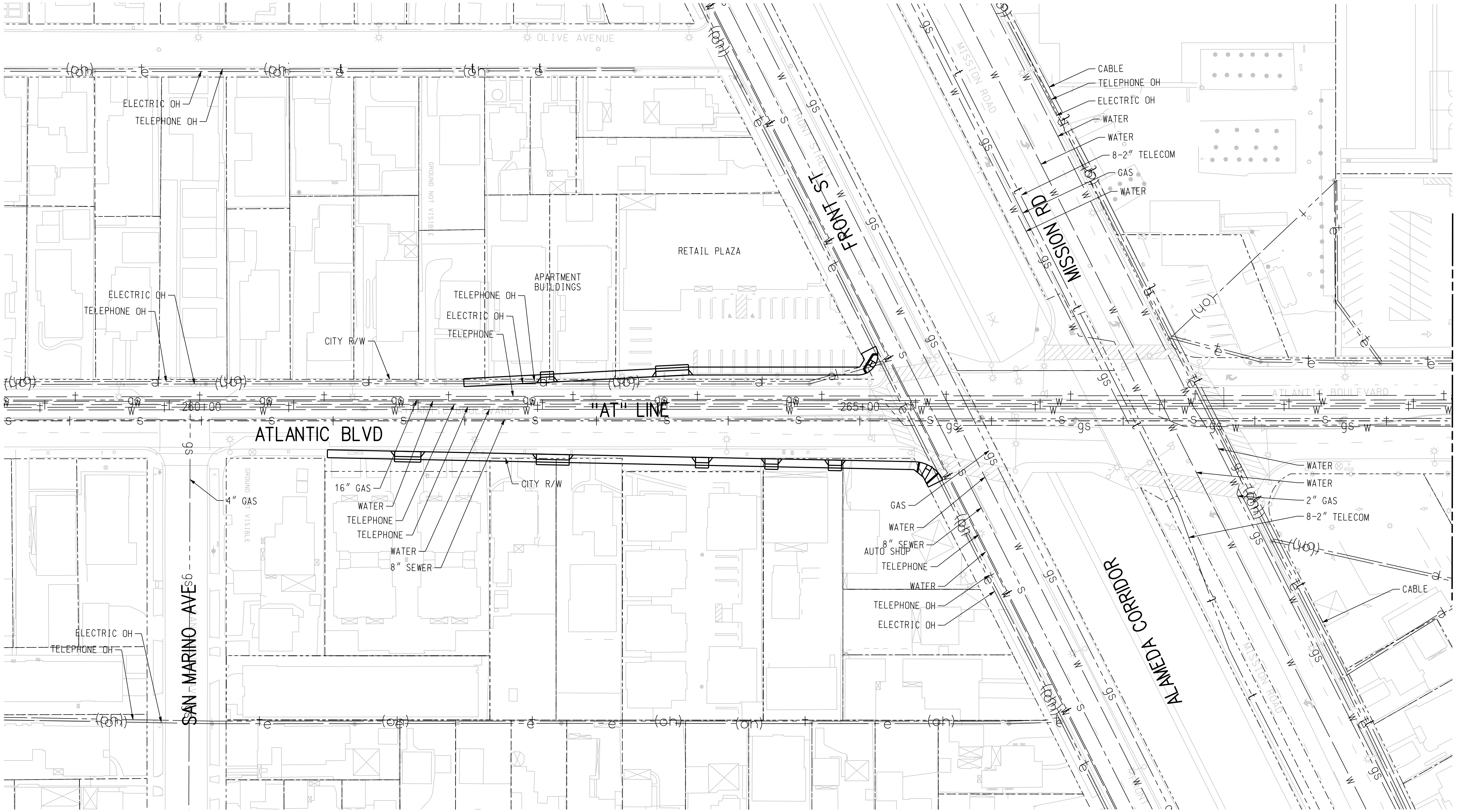
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 236+00 TO STA 248+00
SHEET 22 OF 48

CONTRACT NO
DRAWING NO U-022
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



40' 20' 0 40' 80'

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

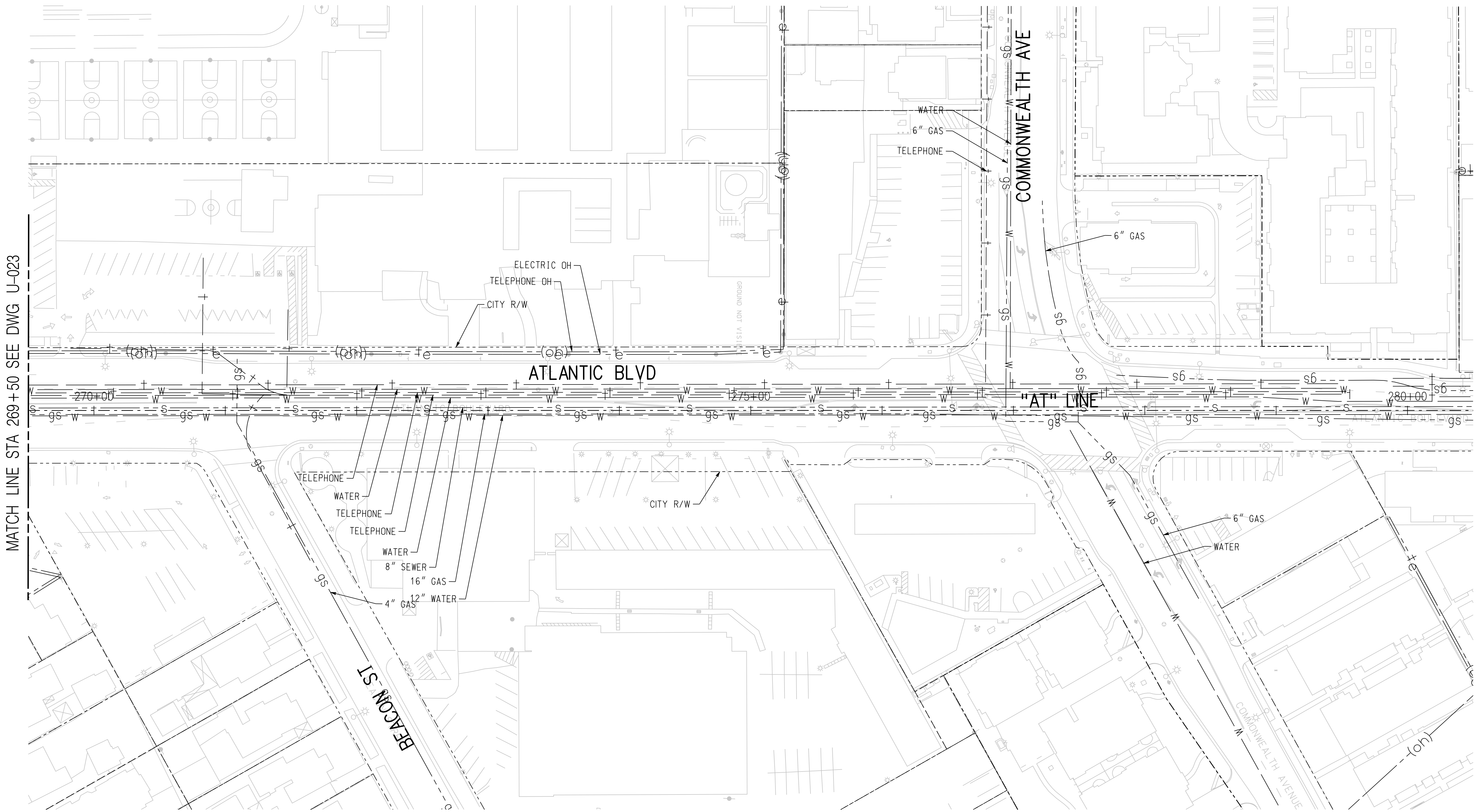
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 258+50 TO STA 269+50
SHEET 23 OF 48

CONTRACT NO
DRAWING NO U-023
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



DRAFT – NOT FOR CONSTRUCTION

SCALE: 40' 20' 0 40' 80'

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY: P. SPITERI
DRAWN BY: S. SAMAAN
CHECKED BY: P. SPITERI
IN CHARGE: D. LEON
DATE: 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

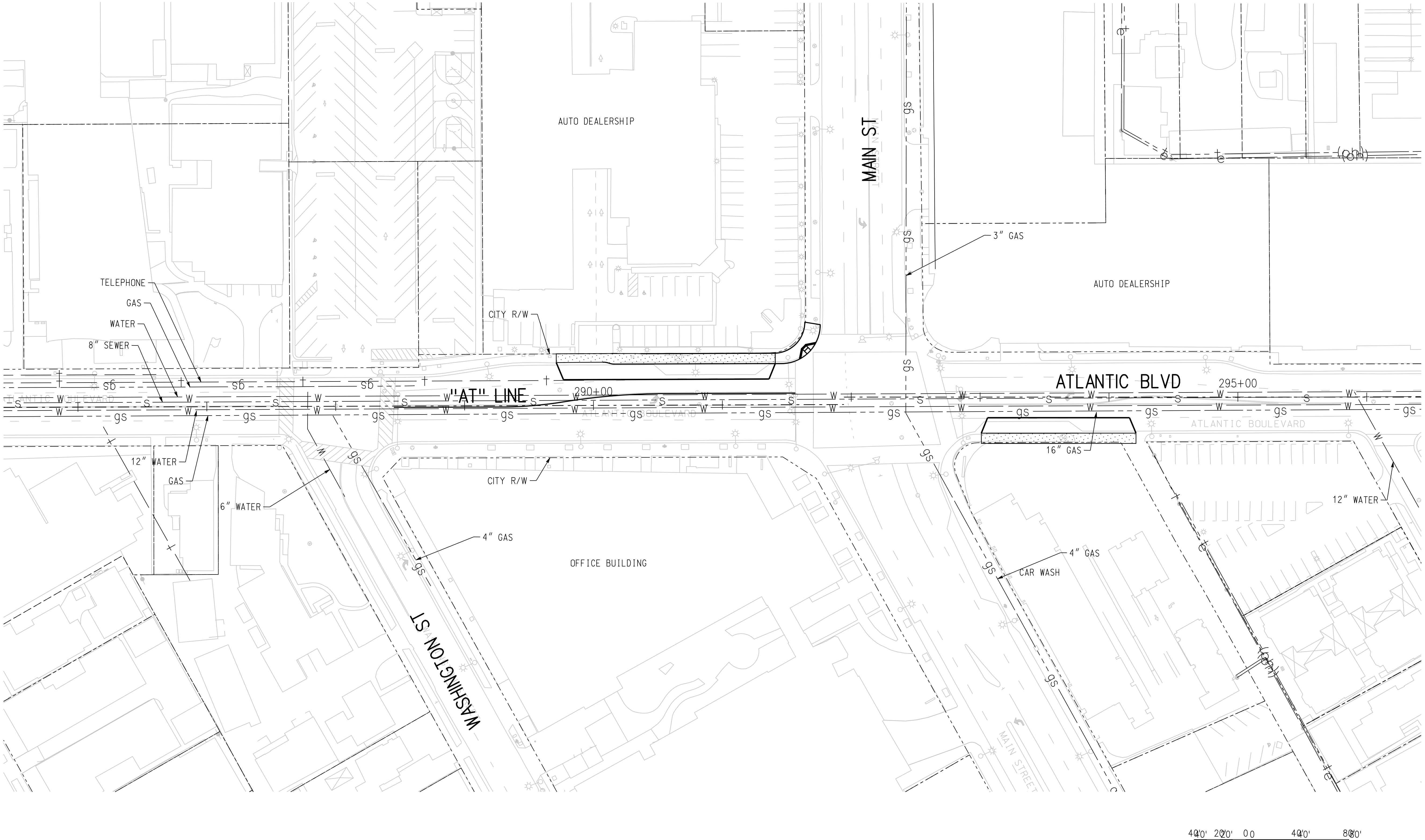
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 269+50 TO STA 280+50
SHEET 24 OF 48

CONTRACT NO
DRAWING NO: U-024
REV
SCALE: 1" = 40'
SHEET NO

Model Name: Default



DRAFT – NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

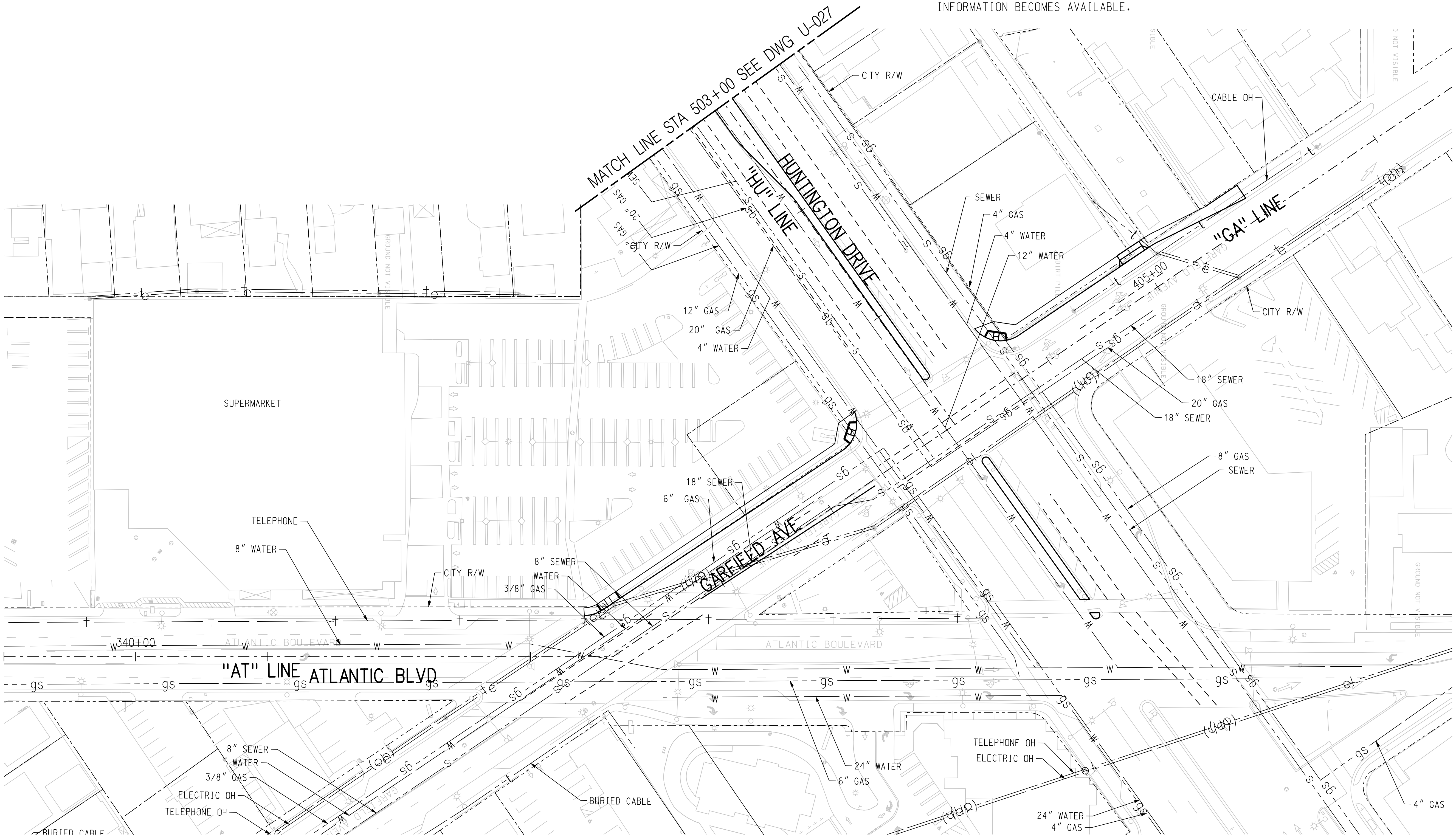
STA 285+50 TO STA 296+50
SHEET 25 OF 48

CONTRACT NO
DRAWING NO U-025
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.	REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

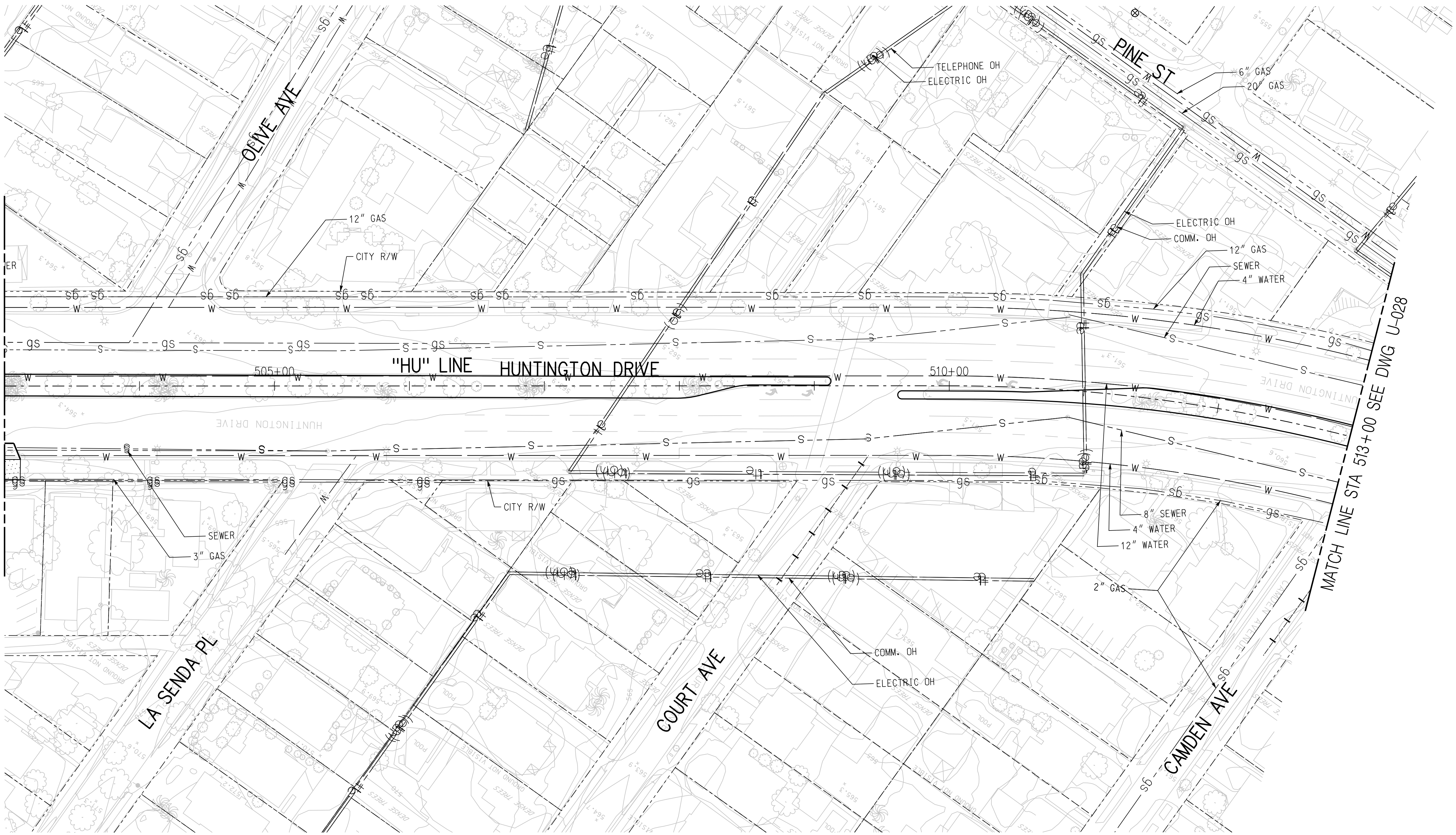
DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 339+00 TO STA 503+00
SHEET 26 OF 48

CONTRACT NO
DRAWING NO U-026
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



40' 20' 0 40' 80'

DRAFT – NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

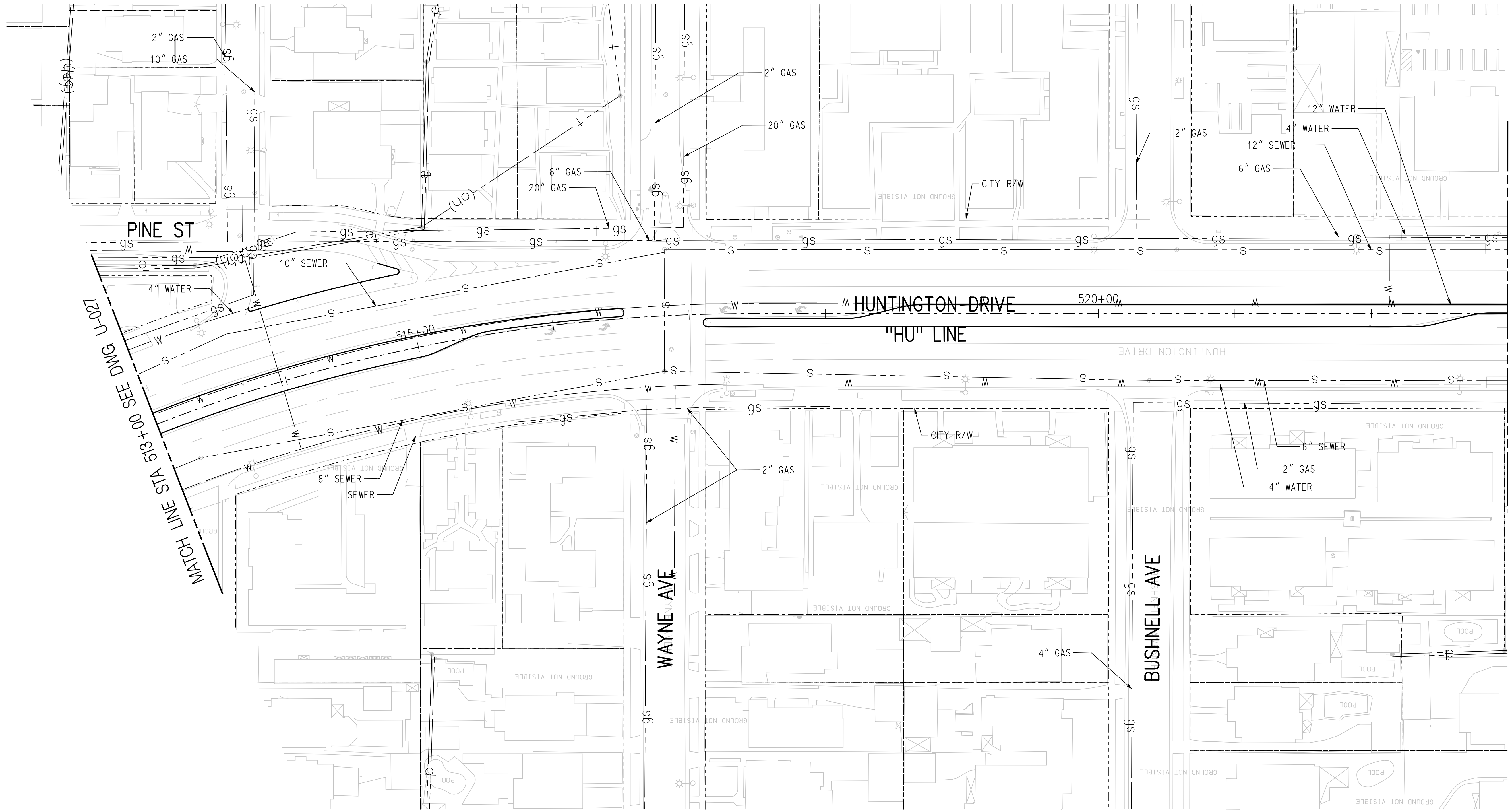
STA 503+00 TO STA 513+00
SHEET 27 OF 48

CONTRACT NO
DRAWING NO U-027
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 513+00 TO STA 523+00
SHEET 28 OF 48

CONTRACT NO

DRAWING NO U-028

REV

SCALE 1" = 40'

SHEET NO

Model Name= Default

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Plot Driver= iplotdrvm.plt
5/14/2015
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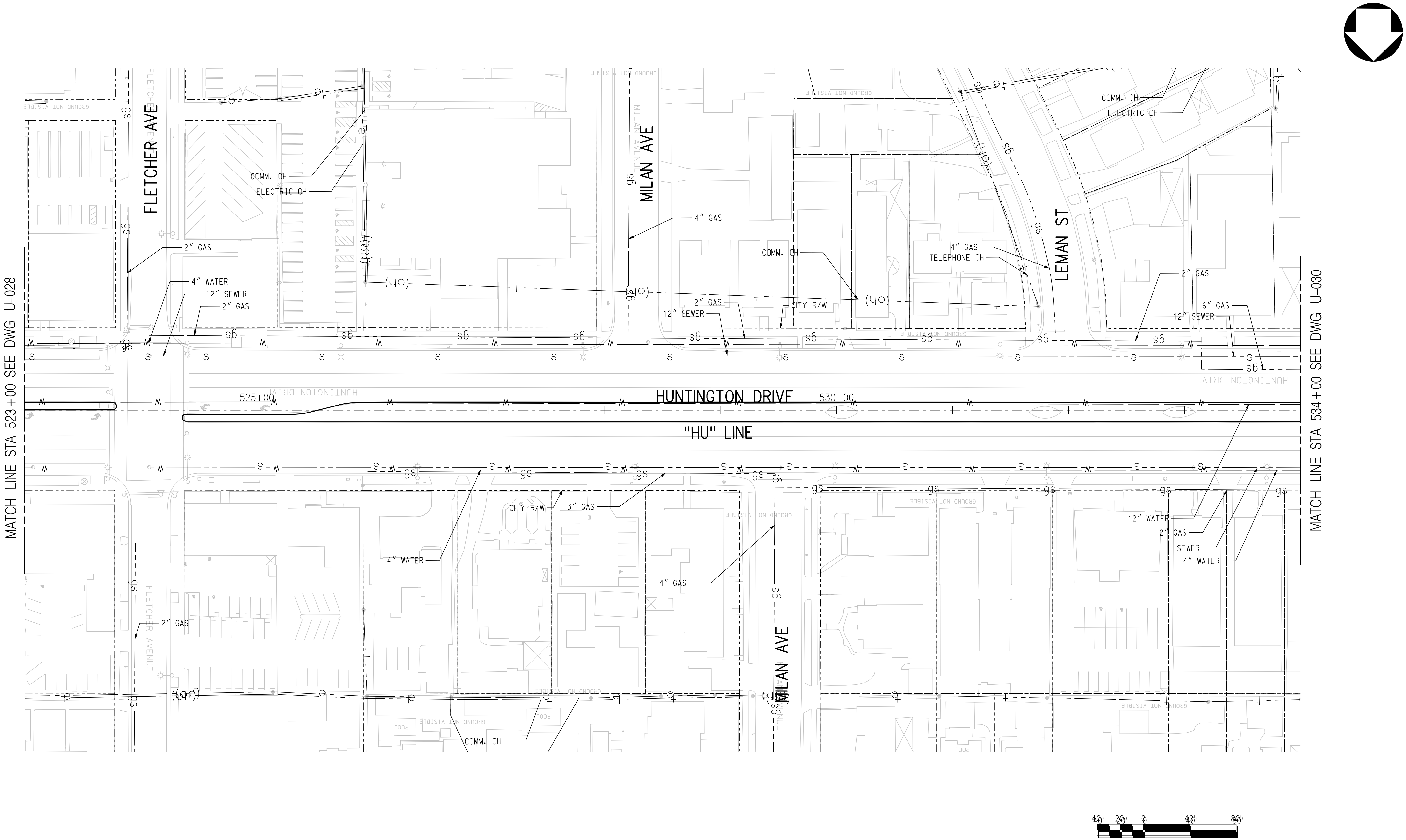
DENPWP01S



DRAFT – NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 523+00 TO STA 534+00
SHEET 29 OF 48

CONTRACT NO
DRAWING NO U-029
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

Pentable= 4289080_BW.TBL
Plot Driver= iplotdrvm.plt
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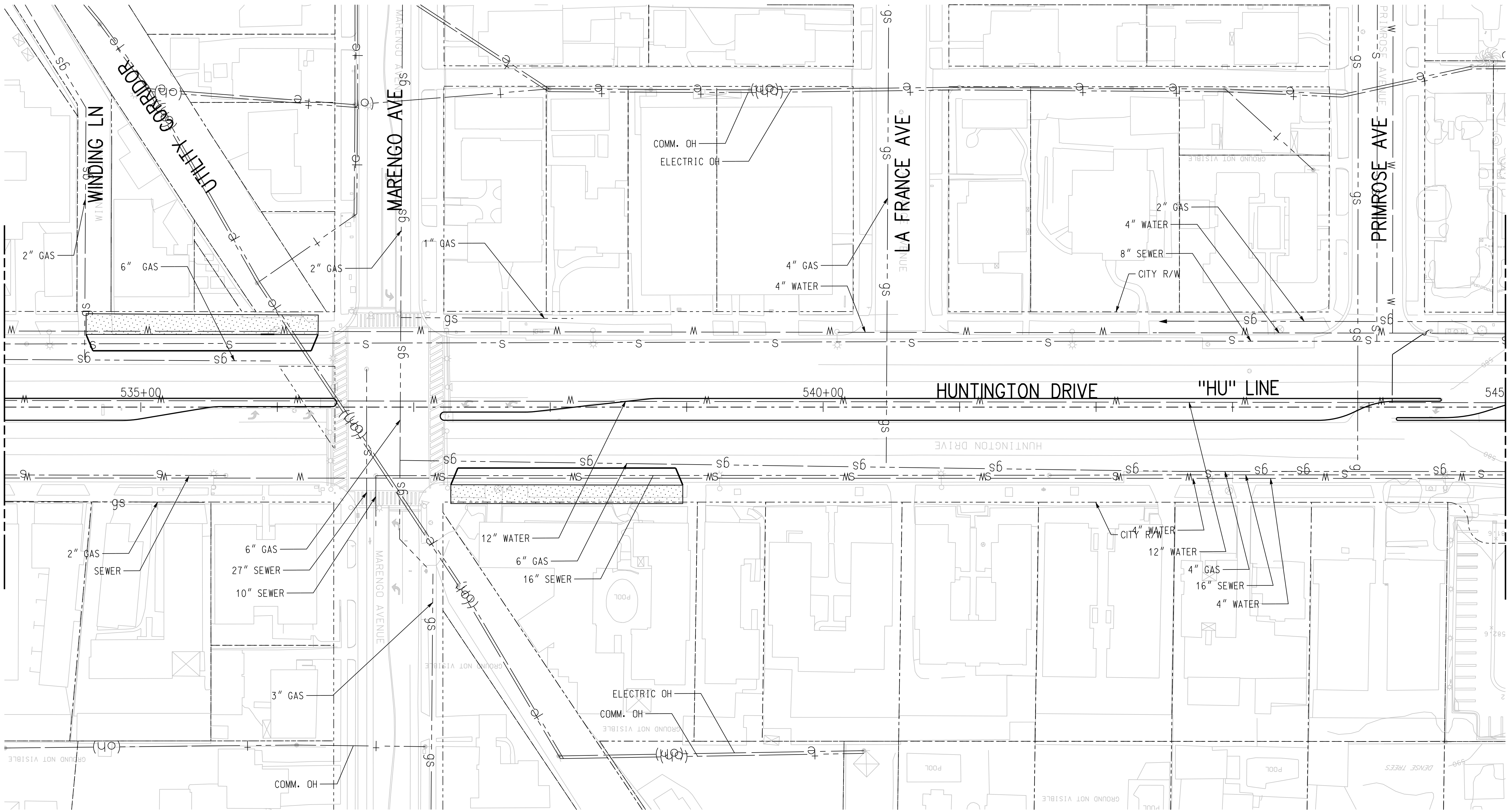
DENPWP01$



DRAFT – NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT UTILITY PLAN

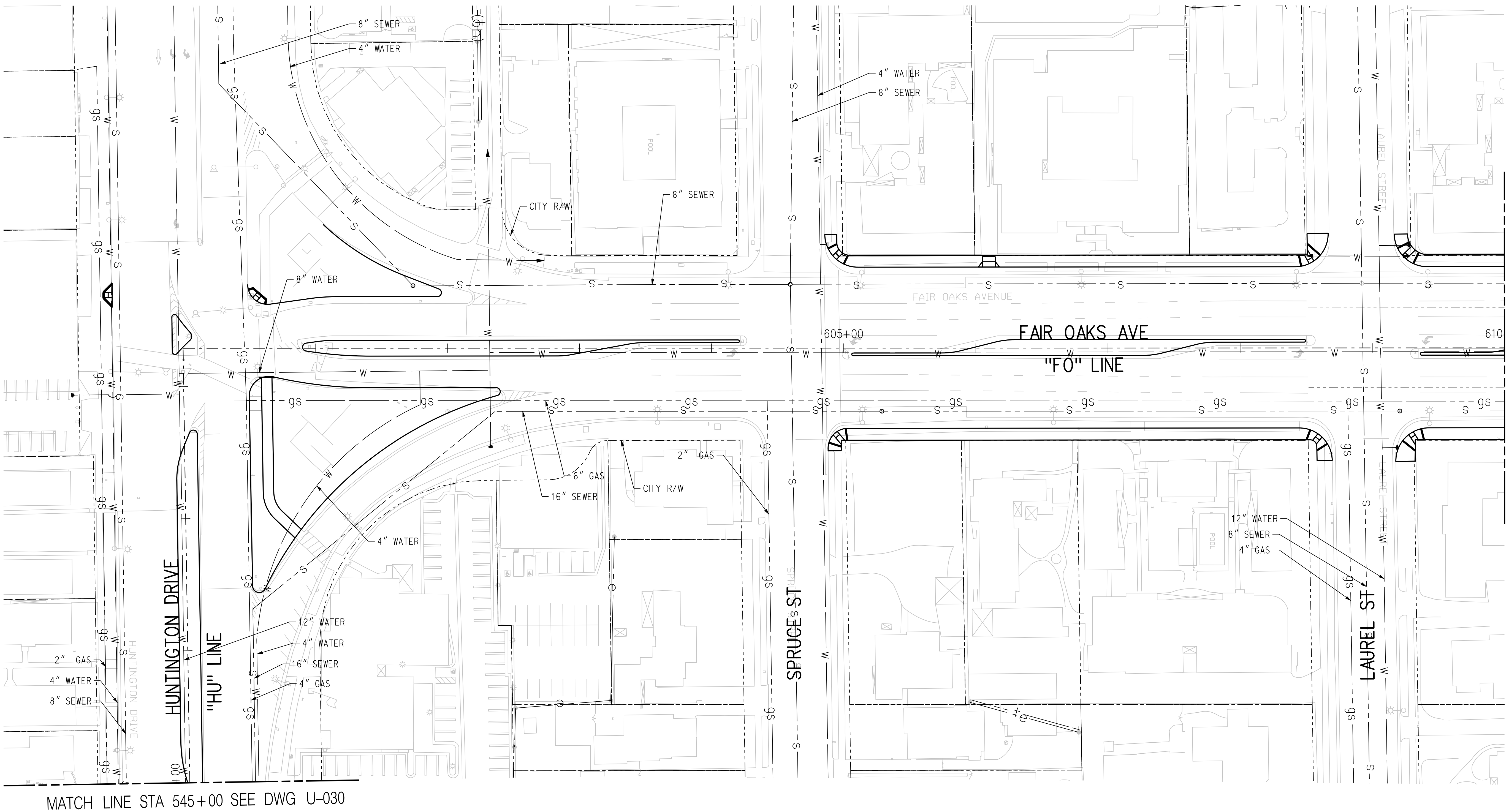
STA 534+00 TO STA 545+00
SHEET 30 OF 48

CONTRACT NO
DRAWING NO U-030
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



40' 20' 0 40' 80'

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

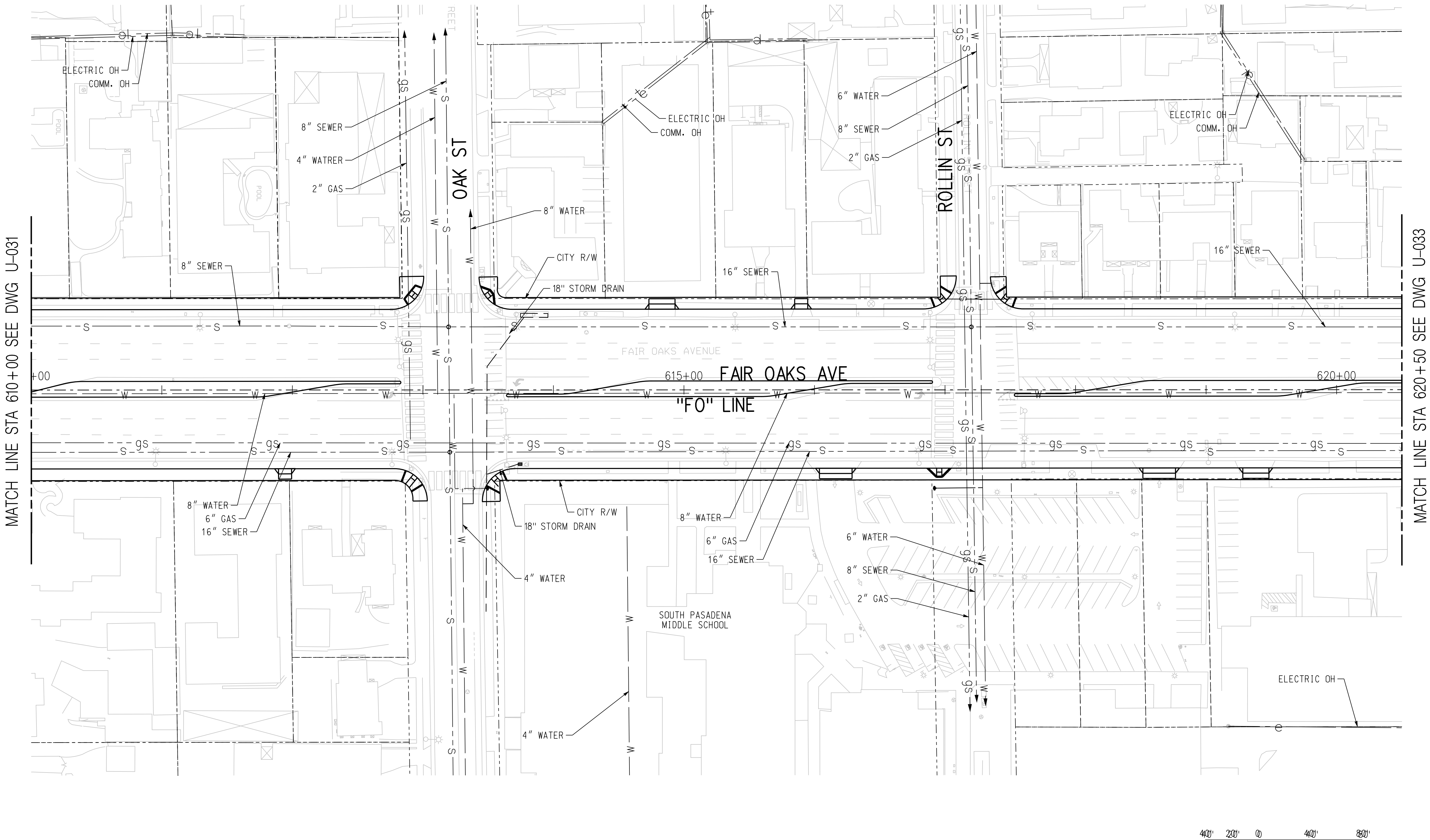
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 545+00 TO STA 610+00
SHEET 31 OF 48

CONTRACT NO
DRAWING NO U-031
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 610+00 TO STA 620+50
SHEET 32 OF 48

CONTRACT NO

DRAWING NO U-032

REV

SCALE 1" = 40'

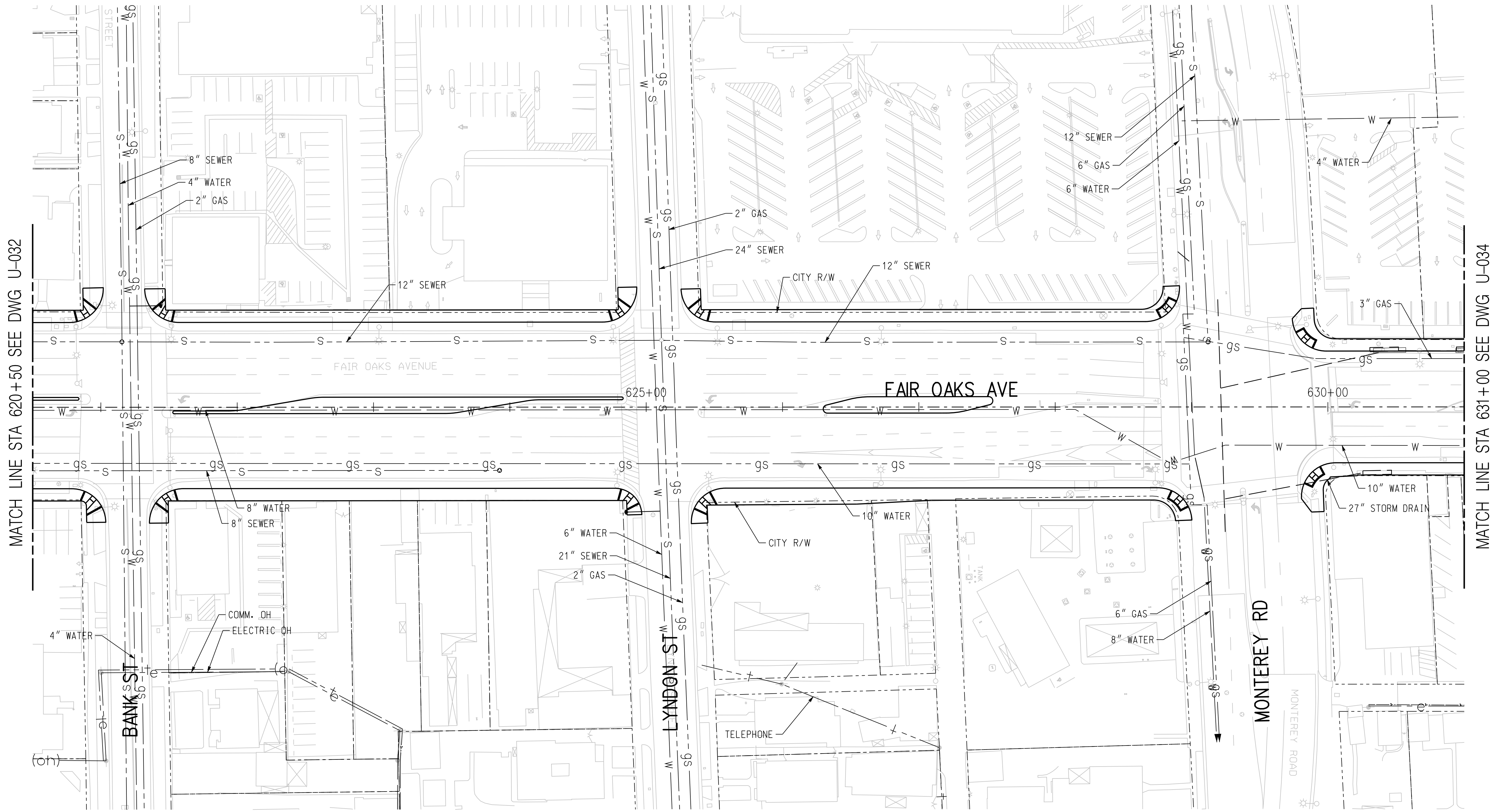
SHEET NO

Model Name= Default

Pentable= 4289308_BW.TBL
Plot Driver= iplotdrvm.plt
5/14/2015
6:58:48 PM
DENPWP02$

NOTE:

EXISTING UTILITIES FROM CITY OF SOUTH PASADENA, SOUTHERN CALIFORNIA EDISON, AND AT&T ARE NOT AVALIABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVALIABLE.



40' 20' 0 40' 80'

DRAFT - NOT FOR CONSTRUCTION

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 620+50 TO STA 631+00
SHEET 33 OF 48

CONTRACT NO

DRAWING NO U-033

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

Pentable: 428908_BW.TBL

Plot Driver: iplotdrvm.plt

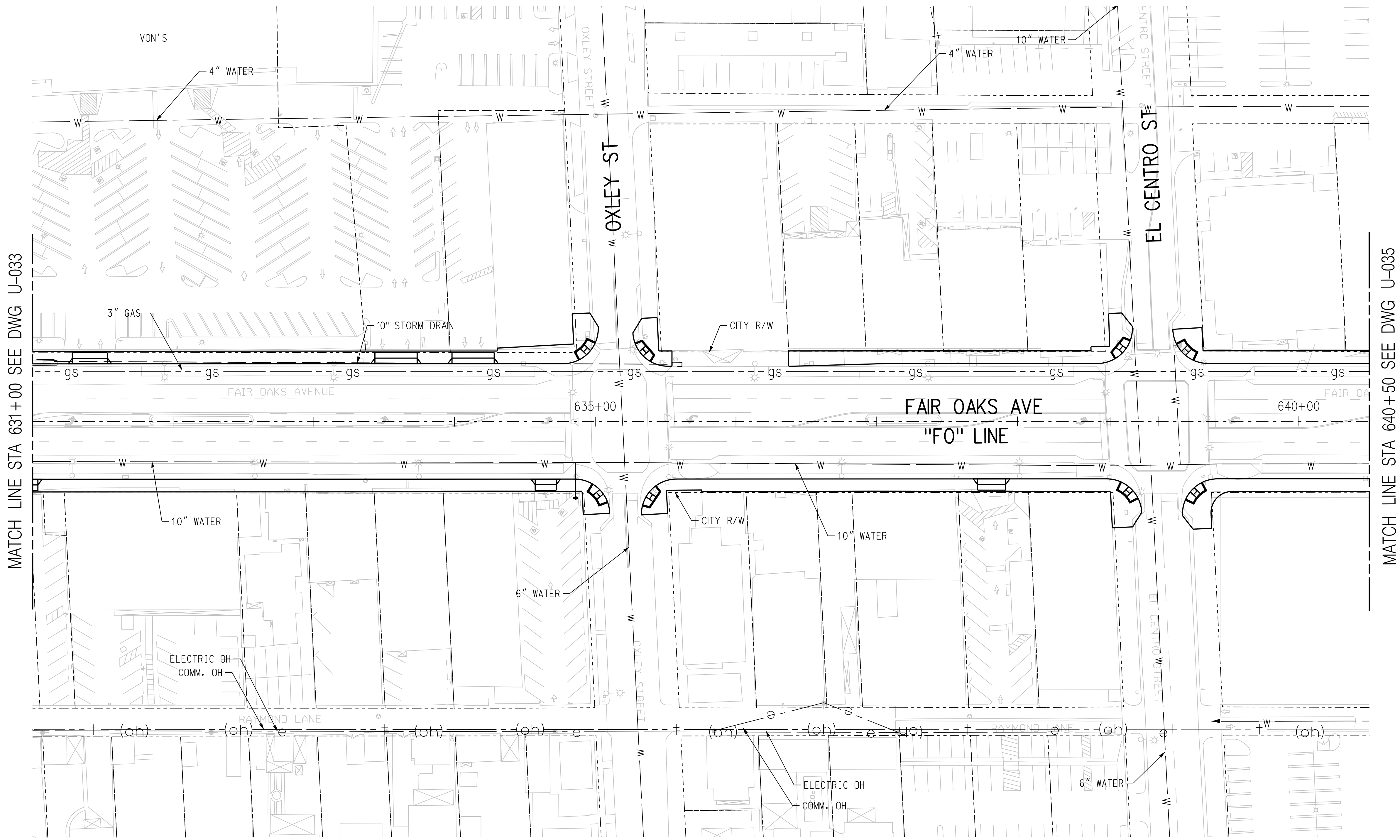
\\denpwp01\pwcsjobs\103169\9117_33\CUXXX-U-033.plg

5/14/2015 7:04:42 PM

DENPWP03$

NOTES:

EXISTING UTILITIES FROM LOS ANGELES COUNTY AND AT&T ARE NOT AVAILABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVAILABLE.



DRAFT - NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

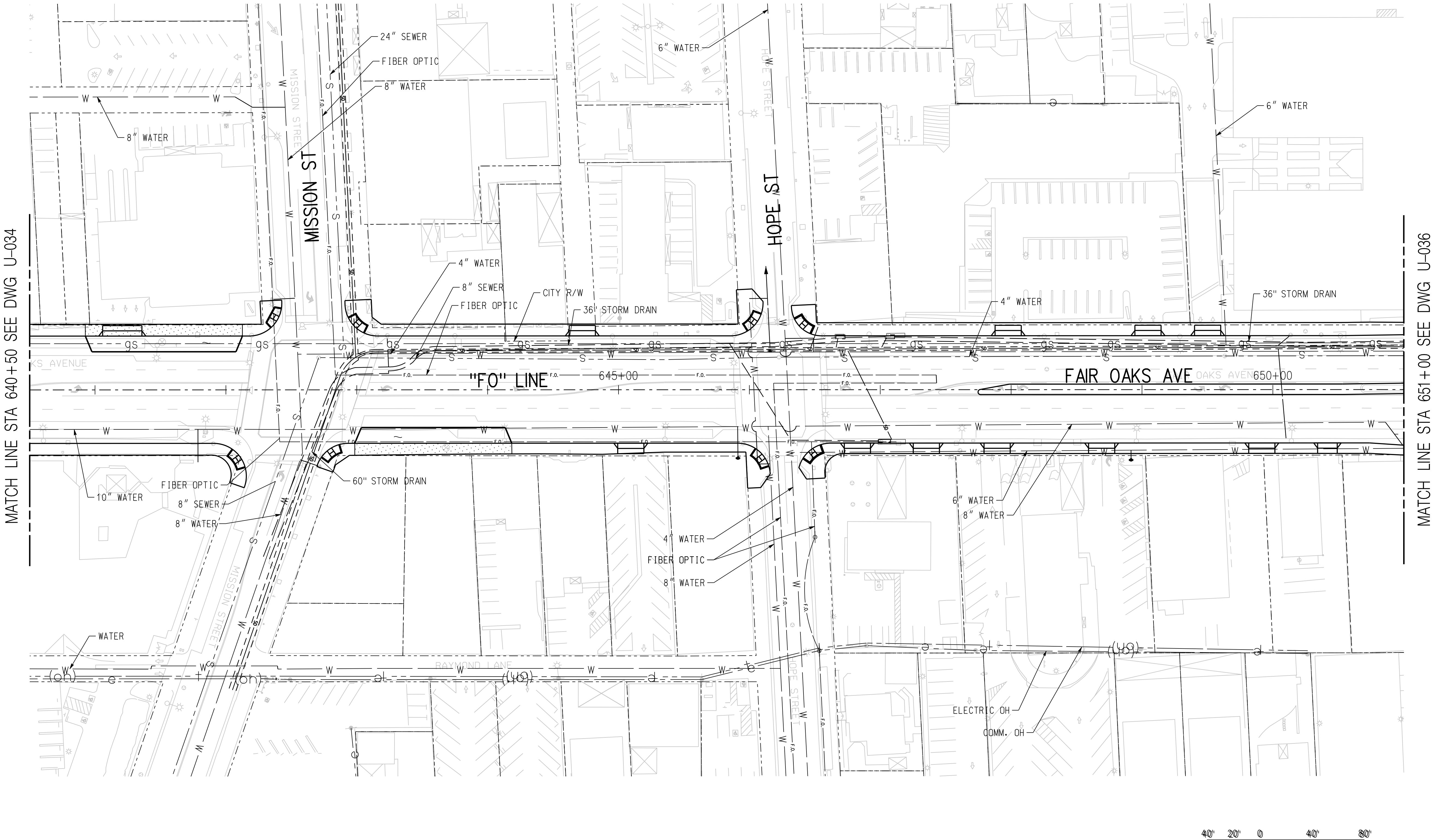
DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 631+00 TO STA 640+50
SHEET 34 OF 48

CONTRACT NO
DRAWING NO U-034
REV
SCALE 1" = 40'
SHEET NO

Model Name: Default



DRAFT – NOT FOR CONSTRUCTION

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

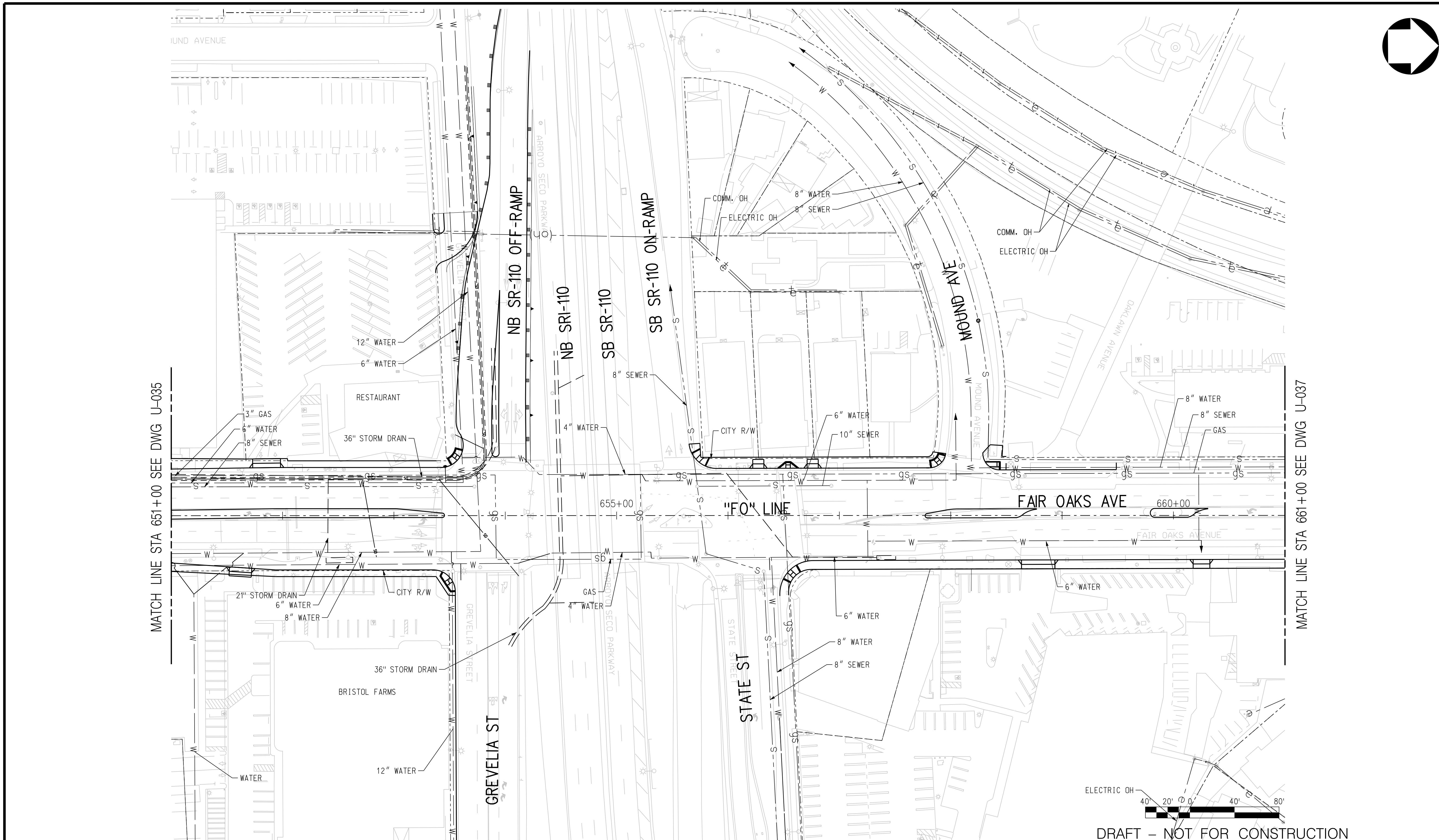
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT UTILITY PLAN

STA 640+50 TO STA 651+00
SHEET 35 OF 48

CONTRACT NO
DRAWING NO U-035
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 651+00 TO STA 661+00
SHEET 36 OF 48

CONTRACT NO

DRAWING NO U-036

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

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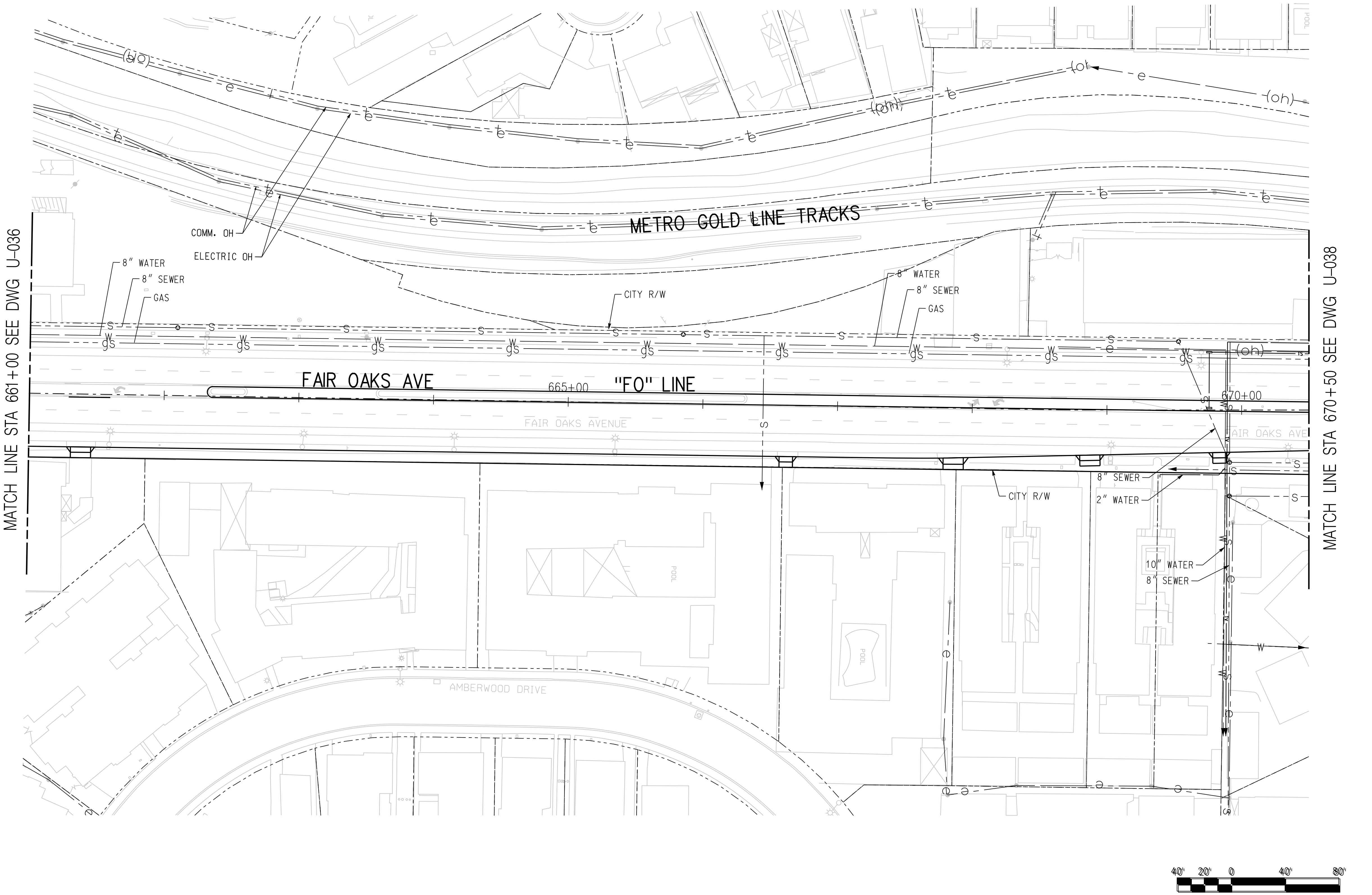

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DATE 10/01/2013

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CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 661+00 TO STA 670+50
SHEET 37 OF 48

CONTRACT NO
DRAWING NO U-037
REV
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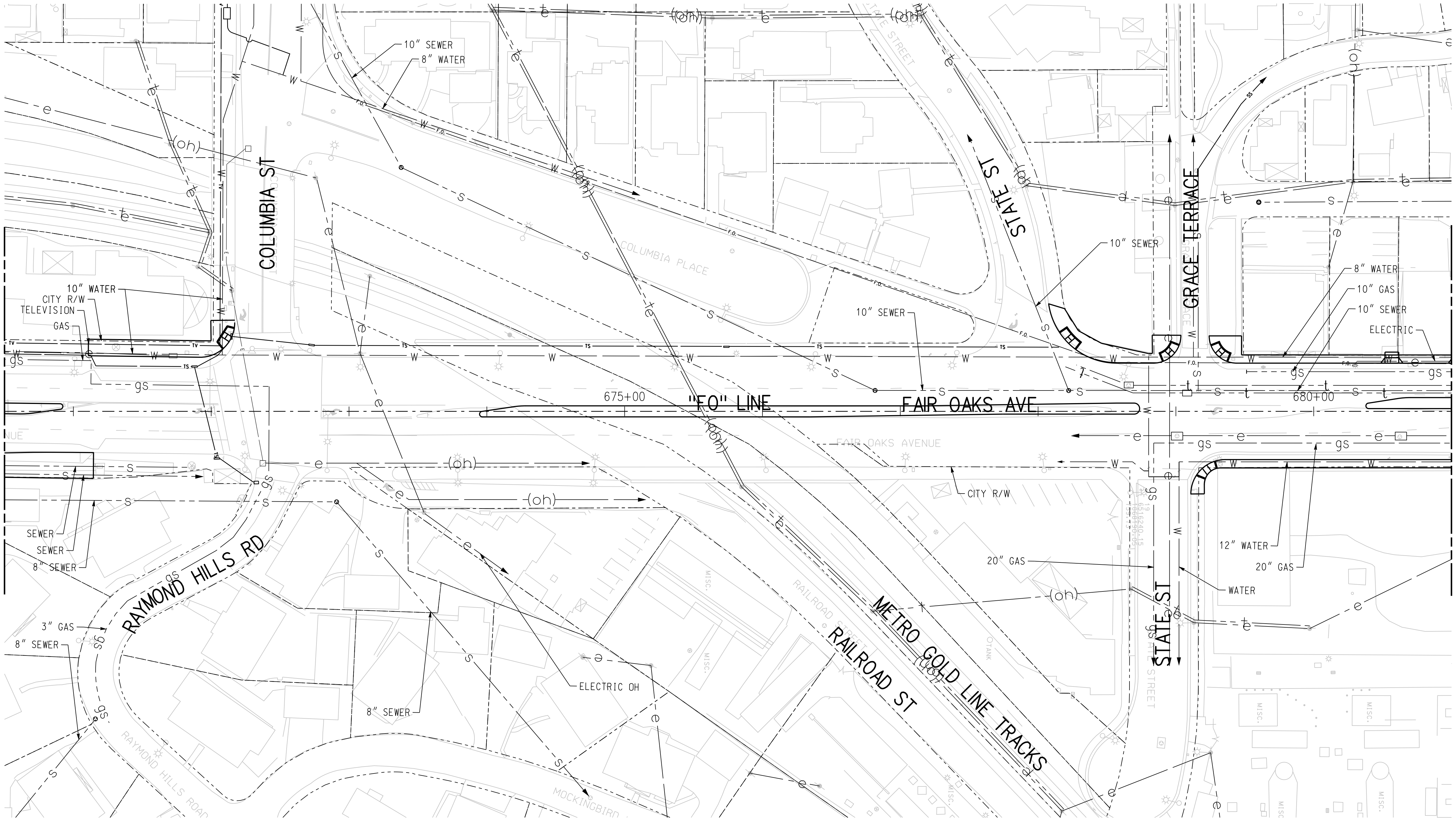

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Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 670+50 TO STA 681+00
SHEET 38 OF 48

CONTRACT NO
DRAWING NO U-038
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SHEET NO

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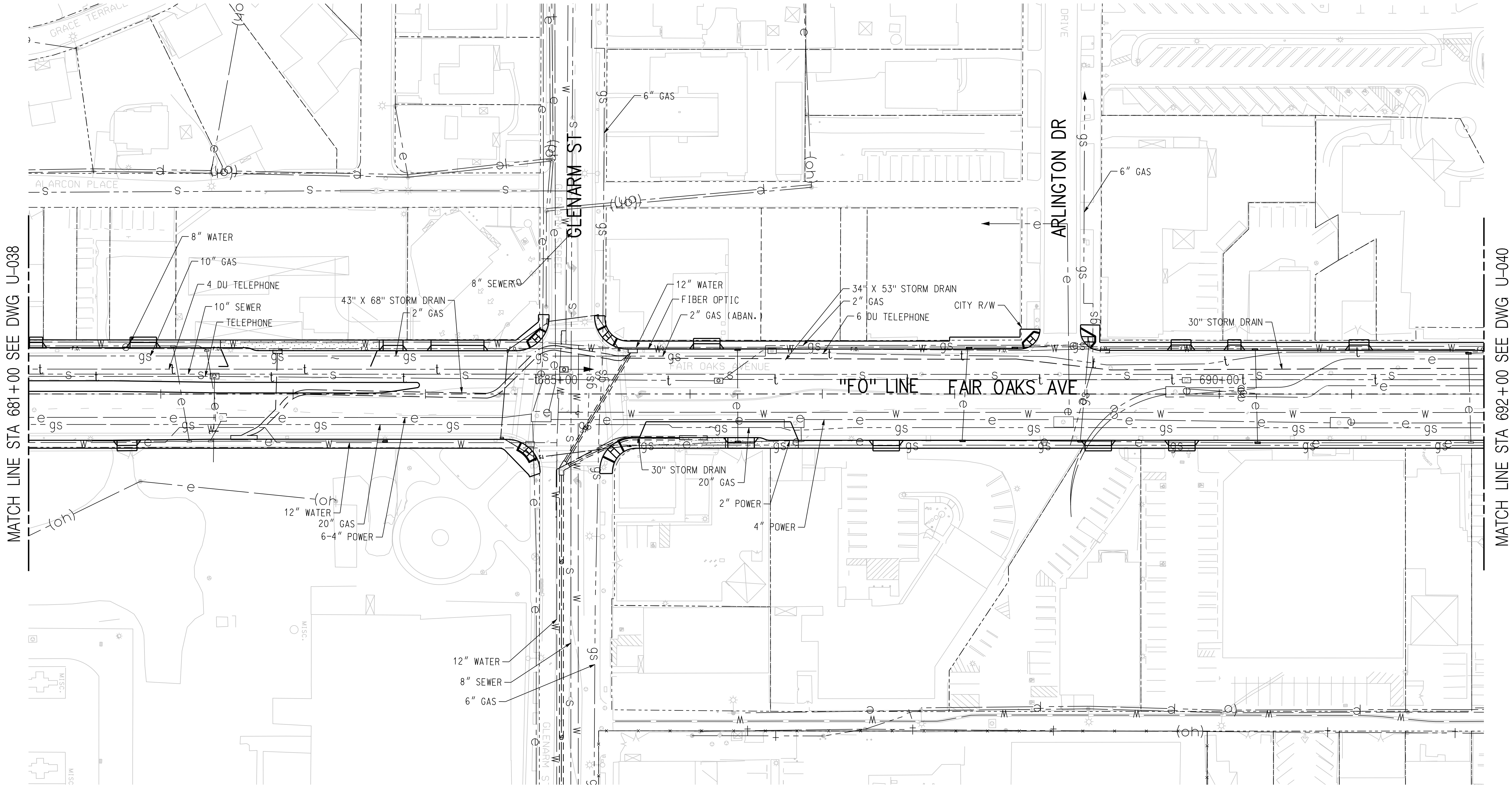

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DRAFT – NOT FOR CONSTRUCTION

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Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 681+00 TO STA 692+00
SHEET 39 OF 48

CONTRACT NO

DRAWING NO U-039

REV

SCALE 1" = 40'

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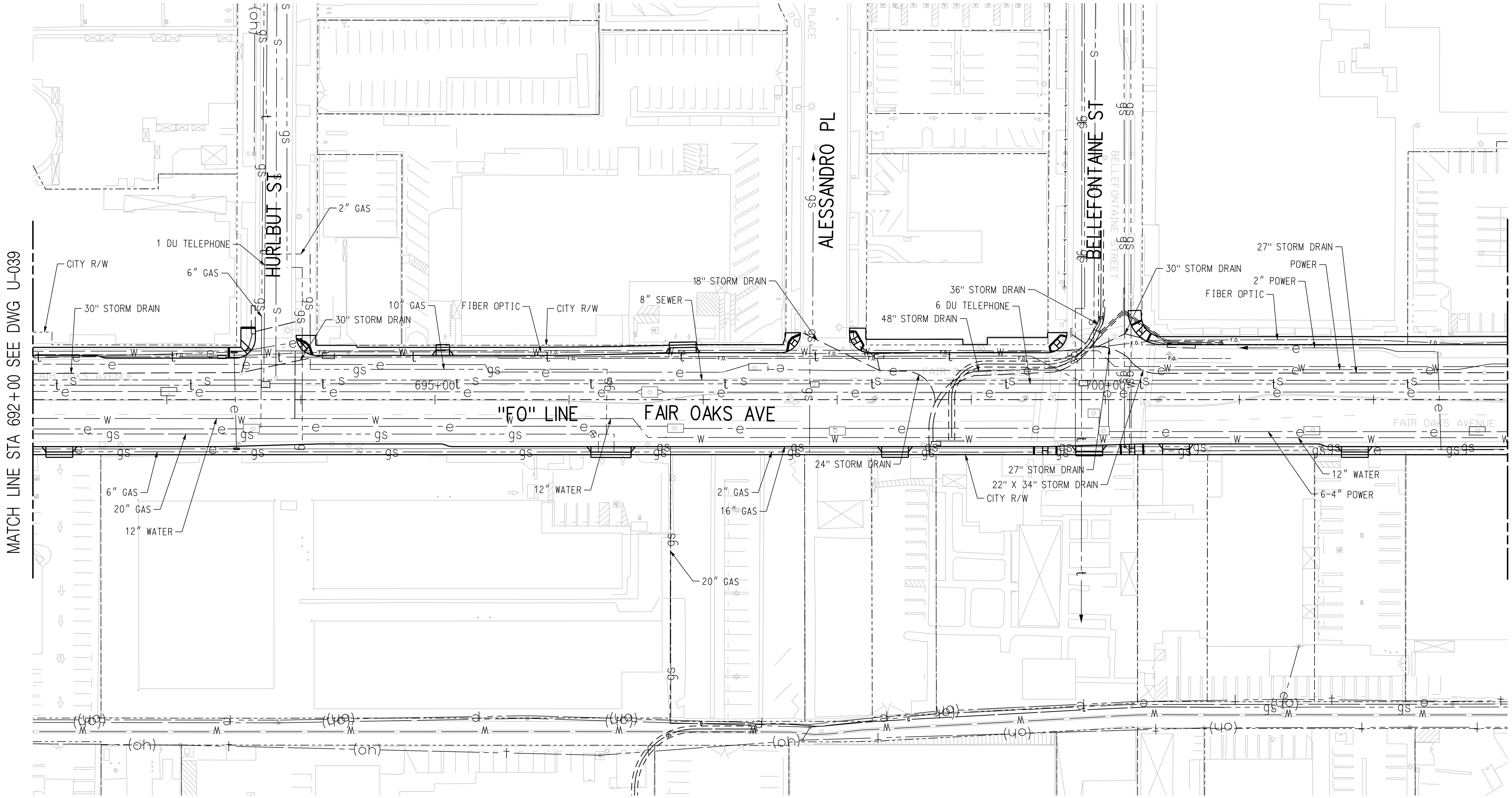

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CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

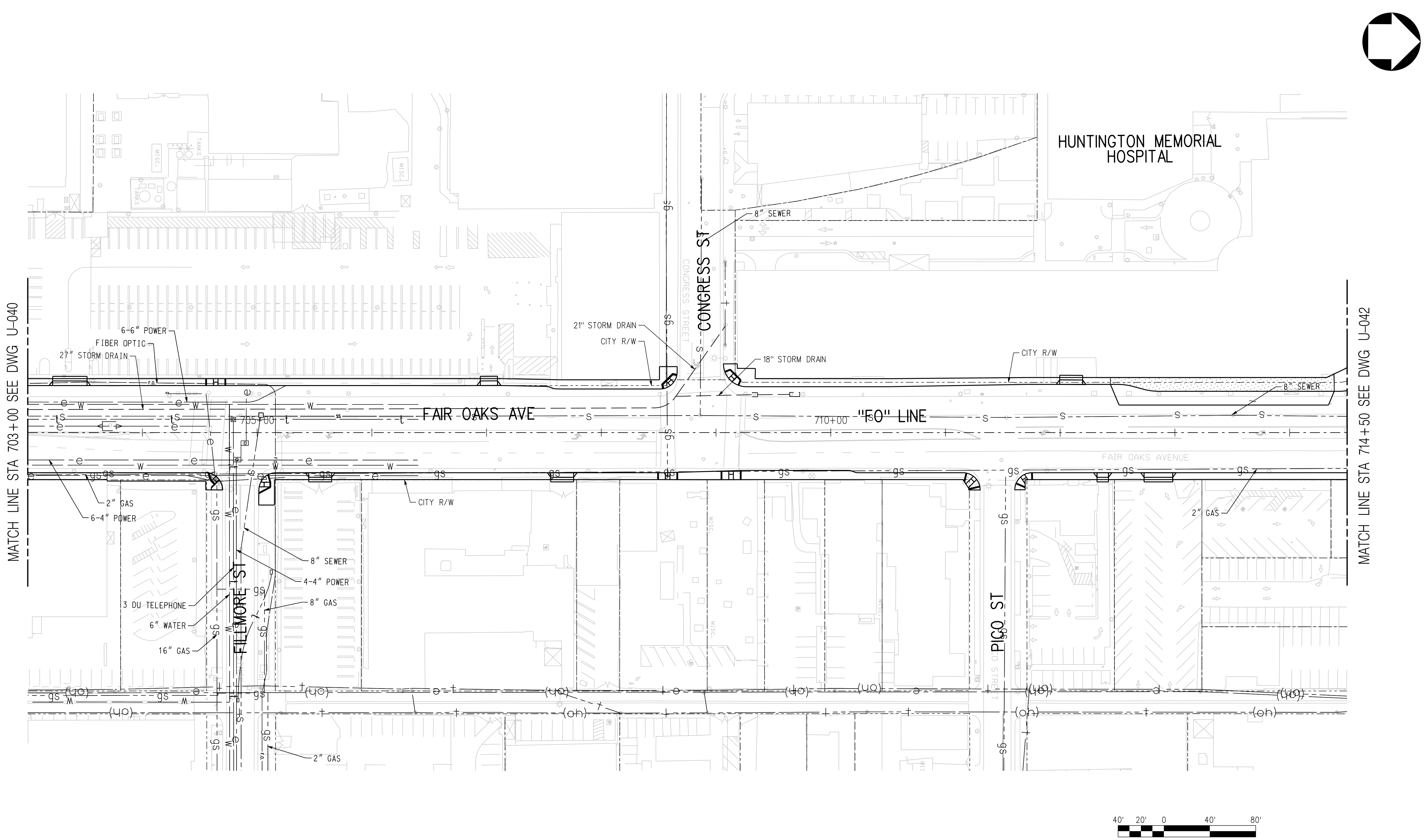
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 692+00 TO STA 703+00
SHEET 40 OF 48

CONTRACT NO
DRAWING NO U-040
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

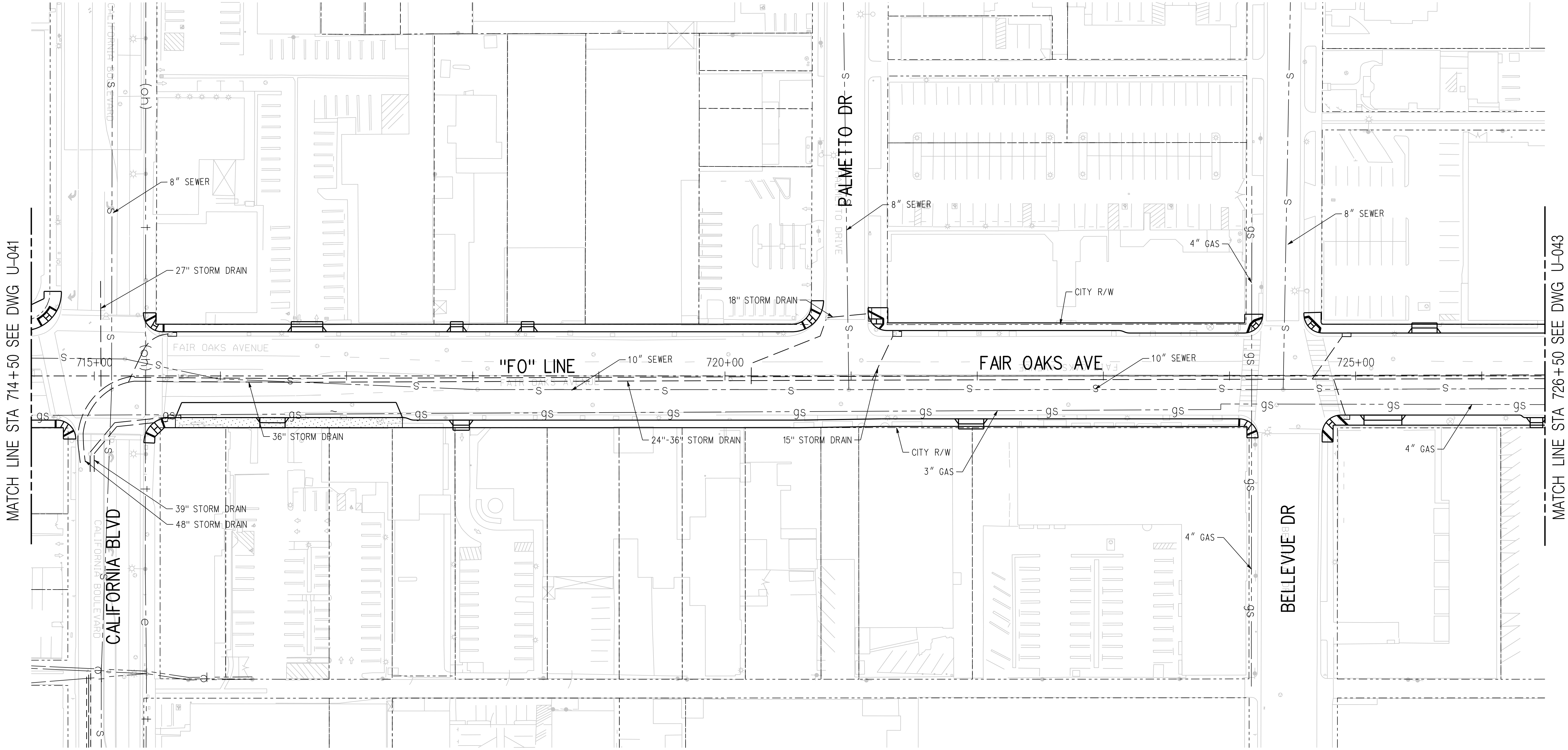
DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 703+00 TO STA 714+50
SHEET 41 OF 48

CONTRACT NO
DRAWING NO U-041
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default



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IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 714+50 TO STA 726+50
SHEET 42 OF 48

CONTRACT NO
DRAWING NO U-042
REV
SCALE 1" = 40'
SHEET NO

Model Name= Default

NOTE:

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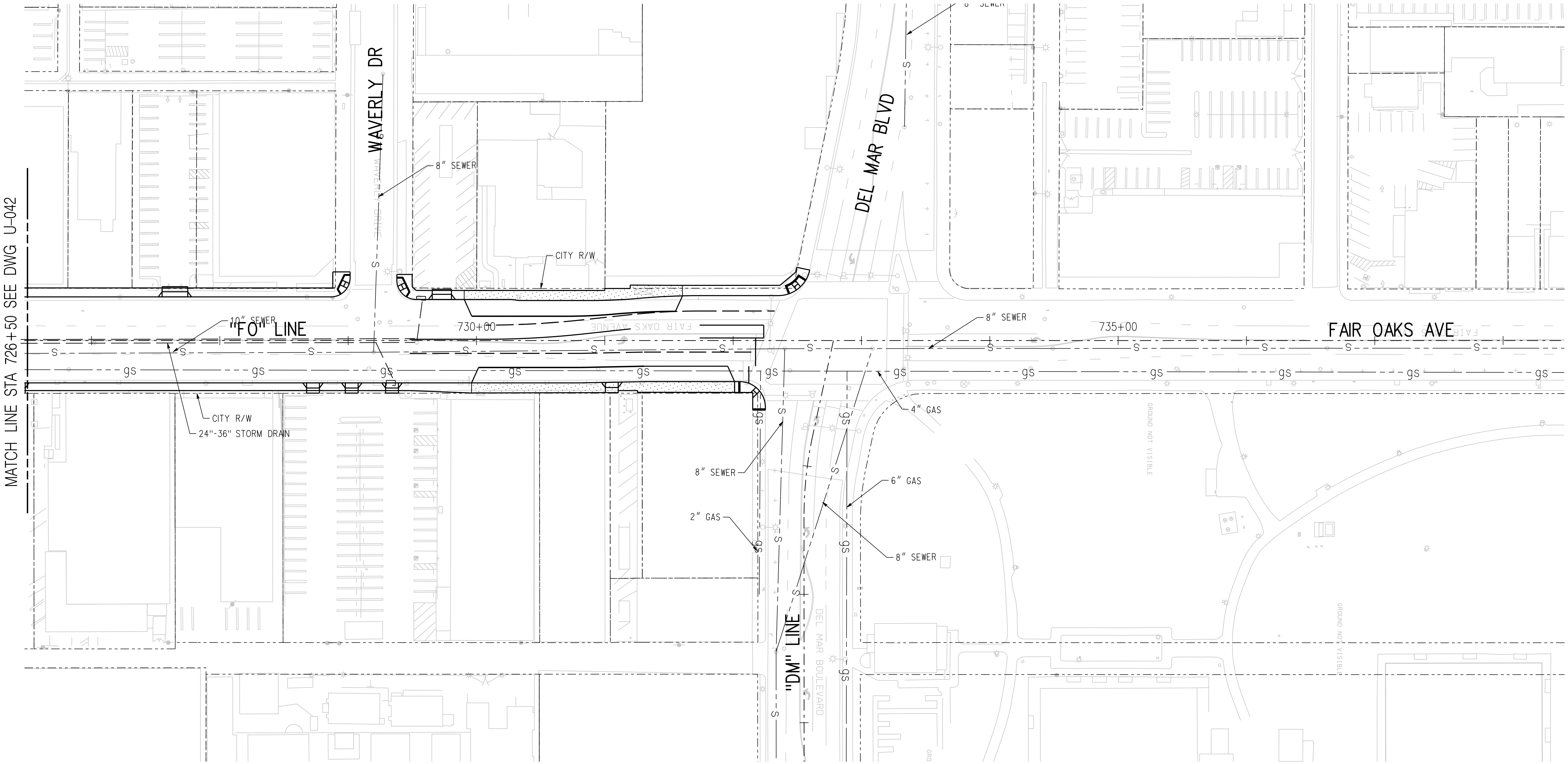

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
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IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

STA 725+50 TO MATCH Exist
SHEET 43 OF 48

CONTRACT NO

DRAWING NO U-043

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTE:

EXISTING UTILITIES FROM CITY OF PASADENA, SOUTHERN CALIFORNIA EDISON, AND AT&T ARE NOT AVALIABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVALIABLE.

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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LOS ANGELES COUNTY
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1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

DEL MAR AND LOS ROBLES STATION
SHEET 44 OF 48

CONTRACT NO

DRAWING NO U-044

REV

SCALE 1" = 40'

SHEET NO

Model Name= Default

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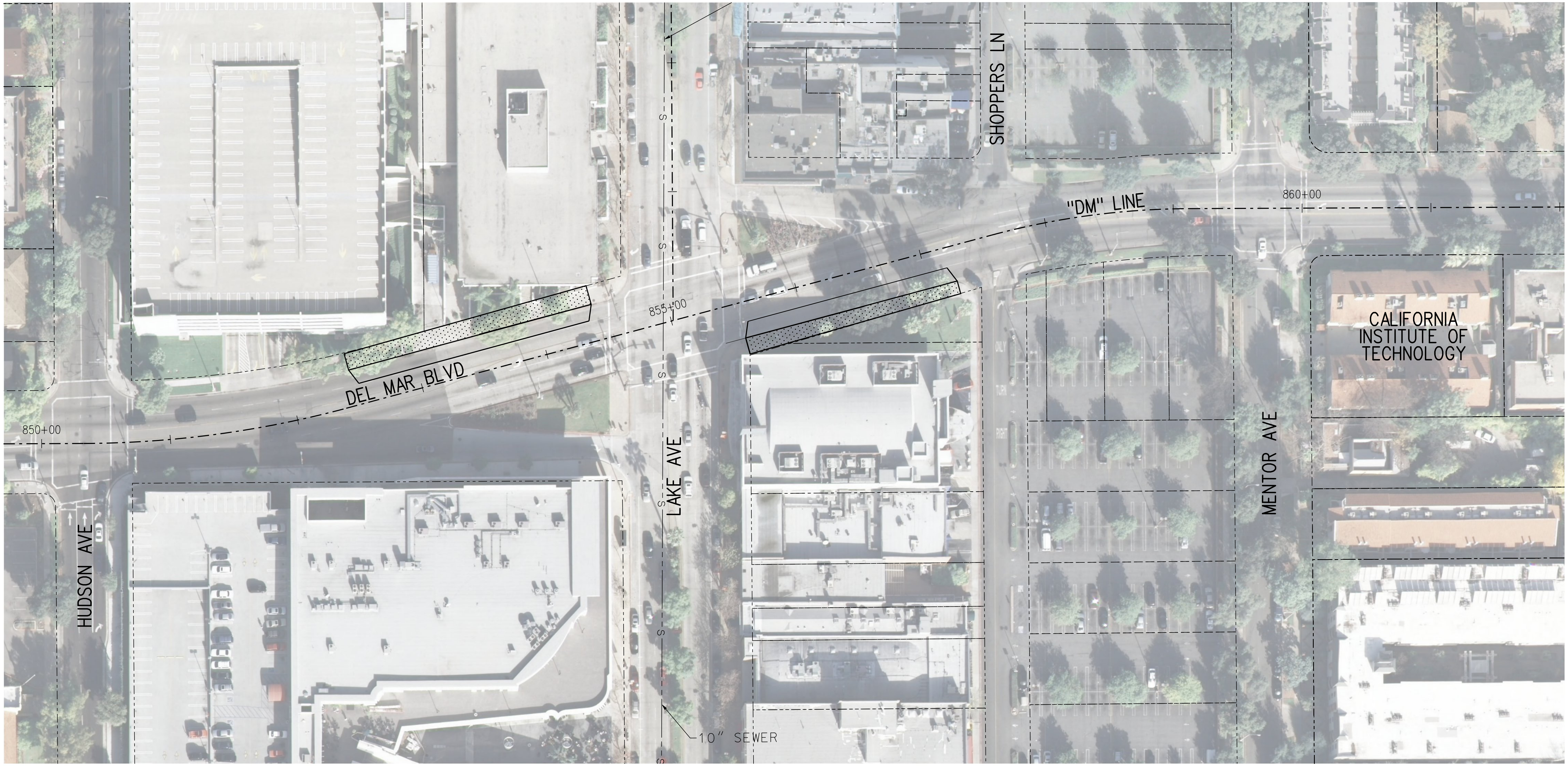
NOTE:

EXISTING UTILITIES FROM CITY OF PASADENA, SOUTHERN CALIFORNIA EDISON, AND AT&T ARE NOT AVALIABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVALIABLE.



40' 20' 0 40' 80'

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IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL 1000 WILSHIRE BLVD SUITE 2100 LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS 3605 LONG BEACH BLVD, SUITE 235 LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

DEL MAR AND LAKE STATION
SHEET 45 OF 48

CONTRACT NO

DRAWING NO U-045

REV

SCALE 1" = 40'

SHEET NO

Model Name: Default

NOTES:

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40' 20' 0 40' 80'

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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IN CHARGE D. LEON
DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

HILL AND DEL MAR STATION
SHEET 46 OF 48

CONTRACT NO

DRAWING NO U-046

REV

SCALE 1" = 40'

SHEET NO

Model Name= Default

NOTE:
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40' 20' 0 40' 80'

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY P. SPITERI
DRAWN BY S. SAMAAN
CHECKED BY P. SPITERI
IN CHARGE D. LEON
DATE 10/01/2013

LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

Metro

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

COLORADO AND HILL STATION
SHEET 47 OF 48

CONTRACT NO
DRAWING NO U-047
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SHEET NO

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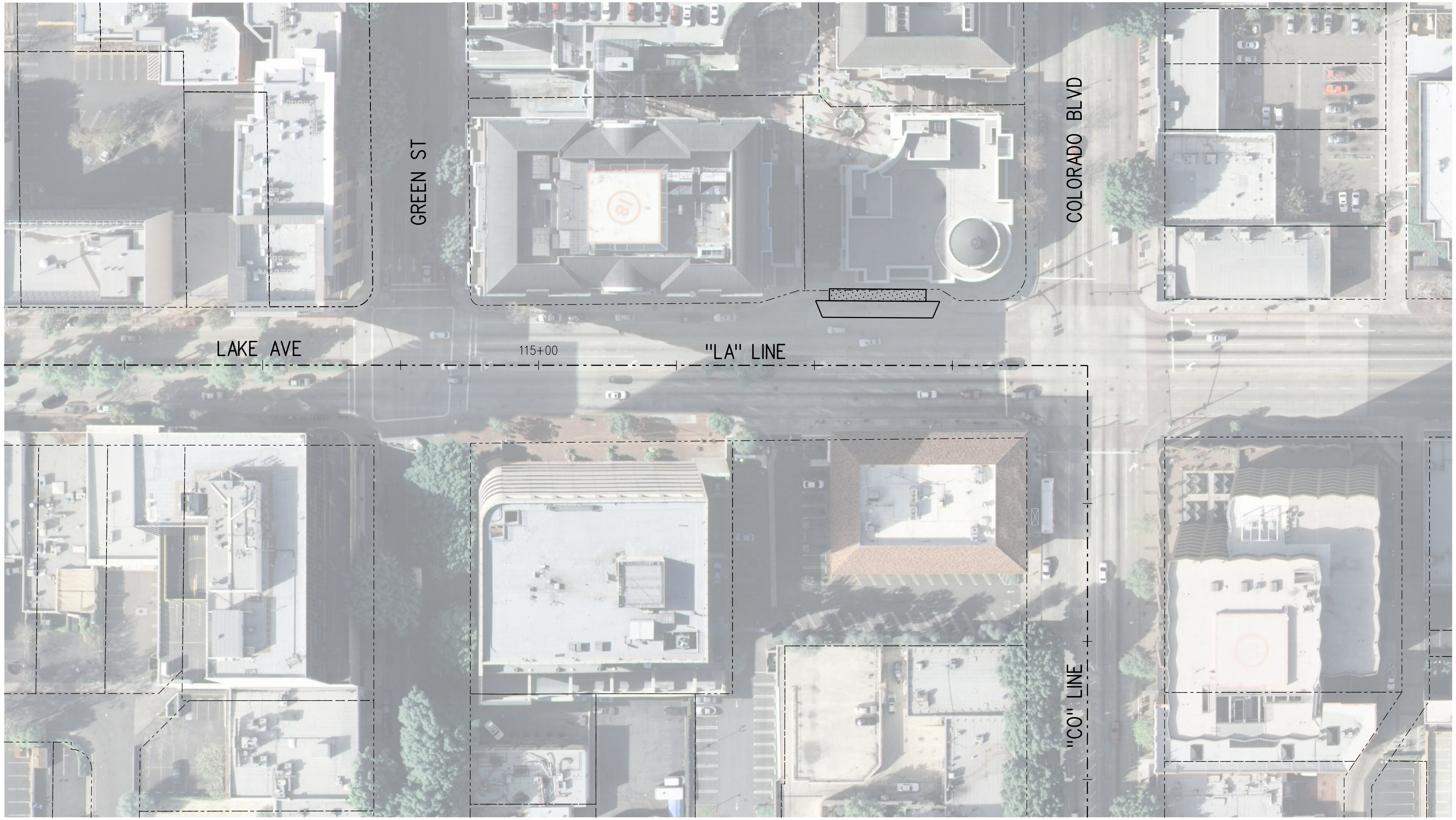
NOTE:

EXISTING UTILITIES FROM CITY OF PASADENA, SOUTHERN CALIFORNIA EDISON, AND AT&T ARE NOT AVALIABLE AT THIS TIME, AND WILL BE ADDED TO THE FINAL SUBMITTAL WHEN MORE INFORMATION BECOMES AVALIABLE.



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DATE 10/01/2013

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
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SUITE 2100
LOS ANGELES, CA 90017

DLEON CONSULTING ENGINEERS
3605 LONG BEACH BLVD, SUITE 235
LONG BEACH, CA 90807

710 NORTH STUDY-BRT
UTILITY PLAN

LAKE AND COLORADO STATION
SHEET 48 OF 48

CONTRACT NO

DRAWING NO U-048

REV

SCALE 1" = 40'

SHEET NO

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Appendix B
Review of BRT Alternative Refinement Options, Alternative BRT-6 Technical Memorandum

DRAFT TECHNICAL MEMORANDUM

Review of Bus Rapid Transit Alternative Refinement Options, Alternative BRT-6, SR 710 Study

PREPARED FOR:	Michelle Smith/Metro
COPY TO:	Caltrans Study Team
PREPARED BY:	CH2M HILL Team
DATE:	February 12, 2013
PROJECT NUMBER:	428908

Introduction

The Bus Rapid Transit (BRT) Alternative is one of five alternatives recommended for further evaluation as part of the State Route (SR) 710 Study. This technical memorandum is a review of refinement options for the BRT Alternative. The intent of this memorandum is to review options and recommend which options should be included in the refined version of the BRT Alternative for further evaluation in preliminary engineering and environmental review.

Background

Overall Study

The review of potential refinements to the BRT Alternative is being conducted as a portion of the SR 710 Study. The SR 710 Study includes an evaluation of transportation alternatives for the study area generally bounded by the Interstate (I)-210 freeway on the north, the I-605 freeway on the east, the I-10 freeway on the south, and the I-5 and SR 2 freeways on the west. The SR 710 Study is composed of three parts:

- Alternatives Analyses (AA)
- Project Analyses
- Environmental Documentation

The refinements are being considered in the Project Analyses for Alternative BRT-6, which was recommended for further evaluation after the AA phase.

Description of Alternative BRT-6

Alternative BRT-6, as identified and recommended in the AA phase, would provide BRT service between Atlantic Boulevard at Whittier Boulevard in East Los Angeles, and Pasadena City College (PCC) and the California Institute of Technology (Caltech) in Pasadena. Northbound BRT vehicles would travel north along Atlantic Boulevard to Huntington Drive, then briefly west along Huntington Drive to Fair Oaks Avenue, and then north along Fair Oaks Avenue into Pasadena. In Pasadena, the BRT vehicles would travel along Colorado Boulevard, making a loop to PCC and Caltech via Hill Avenue, California Boulevard, and Lake Avenue. The total length of the route would be

13.8 miles. Figure 1 illustrates the alignment of Alternative BRT-6.

Portions of the Alternative BRT-6 route were assumed to operate with both exclusive bus lanes and mixed-flow lanes. The Alternative BRT-6 vehicles were proposed to operate in exclusive lanes, roughly adjacent to the curb, in the following general areas:

- Atlantic Boulevard from Whittier Boulevard to Beverly Boulevard (northbound only)
- Atlantic Boulevard from Floral Avenue to Harding Avenue
- Atlantic Boulevard from Harding Avenue to Valley Boulevard (southbound only)
- Huntington Drive from Atlantic Boulevard to Fair Oaks Avenue
- Fair Oaks Avenue from Huntington Drive to Columbia Street
- Fair Oaks Avenue from Columbia Street to Del Mar Boulevard (northbound only)
- Colorado Boulevard from Fair Oaks Avenue to Hill Avenue
- Hill Avenue from Del Mar Boulevard to California Boulevard
- California Boulevard from Hill Avenue to Lake Avenue
- Lake Avenue from California Boulevard to Colorado Boulevard

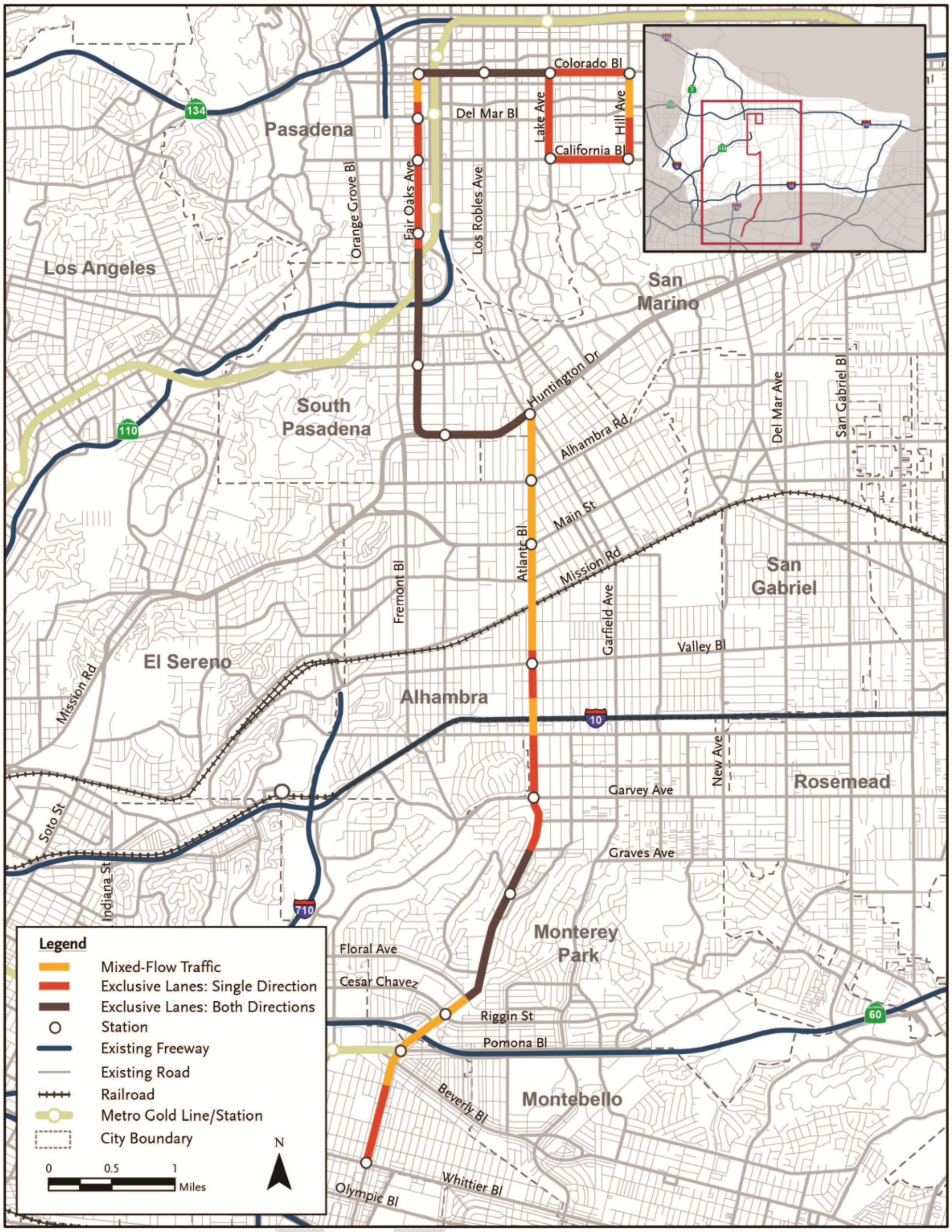
The exclusive lanes would be created generally in existing right-of-way through a variety of methods, including restriping the roadway; prohibiting on-street parking; and narrowing medians, planted parkways, and sidewalks. No property acquisition was expected to be required for Alternative BRT-6 based on the initial development of this alternative. In some areas, exclusive lanes could not be provided without substantial right-of-way acquisition. In these areas, the buses would share existing lanes with other traffic. Bus stops would be at approximately ½-mile intervals, at major activity centers and cross streets, as shown in Table 1.

TABLE 1
Alternative BRT-6 Stop Locations from Whittier Boulevard to Colorado Boulevard

Atlantic Boulevard at Whittier Boulevard
Atlantic Boulevard between Pomona Boulevard and Beverly Boulevard
Atlantic Boulevard at Cesar Chavez Avenue/Riggin Street
Atlantic Boulevard at Cadiz Street*
Atlantic Boulevard at Garvey Avenue
Atlantic Boulevard at Valley Boulevard
Atlantic Boulevard at Main Street
Atlantic Boulevard at Alhambra Road*
Huntington Drive at Garfield Road
Huntington Drive at Marengo Avenue
Fair Oaks Avenue at Mission Street
Fair Oaks Avenue at Glenarm Street
Fair Oaks Avenue at California Boulevard
Fair Oaks Avenue at Del Mar Boulevard
Fair Oaks Avenue at Colorado Boulevard

*Not a stop along Metro Rapid Route 762; may be eliminated upon further analysis.

FIGURE 1
Alignment of Alternative BRT-6



Alternative BRT-6 and Outstanding Issues to be Addressed in Refinements

Alternative BRT-6 was selected as the highest performing BRT Alternative during the AA. Based on the AA, there were several areas of Alternative BRT-6 for which improvements could be considered:

- **Improvements to bus travel speeds and reliability**. As configured in the AA, Alternative BRT-6 included exclusive lanes along the mid-block portions of the alignment. However buses would operate in mixed flow traffic at intersections. Therefore, speeds and reliability would not be very good even though a significant investment in infrastructure reconstruction would be required.
- **Reduced effects on on-street parking**. Alternative BRT-6, as defined, would require displacement of on-street parking along the entire route, especially if this would be a 24-hour operation.
- **Greater service connectivity at south and north ends of the corridor**. Alternative BRT-6 essentially terminated at Whittier Boulevard in the south. In the north, a loop to serve the east part of downtown Pasadena was included. To improve the performance of the BRT Alternative, other service locations at the ends of the corridor will be considered. This topic will be addressed in a separate memorandum.
- **Conformance with bus stop spacing and consistency with Route 762 stop locations**. Route 762 is an existing Metro Rapid line that operates in the corridor. Options will be evaluated to either replicate the Route 762 stop locations, or combine Route 762 with the BRT operation.

Existing Conditions

Surface Streets

Alternative BRT-6 uses the following surface streets (posted speeds are noted in parentheses):

- Atlantic Boulevard (30, 35, and 40 miles per hour [mph])
- Huntington Drive (40 mph)
- Fair Oaks Avenue (35 mph)
- Colorado Boulevard (25 and 30 mph)
- California Boulevard (30 mph)
- Hill Avenue (30 mph)
- Lake Avenue (25 mph)

The widths and conditions of these roadways vary widely depending on the function of the roadway and surrounding land uses. The majority of these roadways are four-lane arterial roads (two lanes in each direction); however, there are also two-lane collector roads (such as Hill Avenue) and a six-lane arterial parkway with matured landscaping in the medians and sidewalks (such as Huntington Drive). A detailed inventory of typical street cross-sections in the study area is provided in Attachment A.

On-Street Parking

The existing streets included in the Alternative BRT-6 alignment provide a variety of on-street free and paid parking options, including unrestricted parking, parking with time restrictions, metered parking stalls, parking with other restrictions such as 1-hour limit, and no parking on street sweeping days. Combining aerial photography with field verifications, the team created an inventory of existing on-street parking conditions, including the number of parking spaces (striped or unstriped), nature of restrictions if any, limits of loading zone, passenger drop-off zone, etc., in a “block-by-block” fashion. There are approximately 1,650 parking spaces along the alignment between Atlantic Boulevard at Whittier Boulevard on the south end, and Fair Oaks Avenue at Del Mar Boulevard on the north end, traversing five cities. A summary from the on-street parking inventory is provided in Attachment B.

Land Uses

Alternative BRT-6 serves the following cities, from north to south: Pasadena, South Pasadena, Alhambra, Monterey Park, and East Los Angeles. There is a range of land uses adjacent to the Alternative BRT-6 corridor alignment, including single-family residences, multi-family dwellings, apartment complexes, retail and commercial businesses, shopping centers, parks, and schools. A significant majority of the commercial activity along the corridor is located in either Pasadena or Monterey Park, whereas the portions of South Pasadena and Alhambra adjacent to the corridor are mostly residential (Alhambra has some commercial activity at major intersections).

Major land uses along the corridor alignment, from the northern terminus of the route to the southern terminus, are as follows:

- **Pasadena City College**: Located on the southeast corner of Colorado Boulevard and Hill Avenue. One of the nation’s largest community colleges with about 40,000 students.
- **California Institute of Technology (Caltech)**: Located on the northwest corner of California Boulevard and Hill Avenue. World-renowned science and engineering university with about 2,300 students.
- **Paseo Colorado**: Located on the south side of Colorado Boulevard, between Marengo Avenue and Los Robles Avenue. Pasadena outdoor mall that opened in 2001, including retail stores, a movie theater, a grocery store, office space, and upstairs condominiums.
- **Old Town Pasadena**: Runs along Colorado Boulevard between Pasadena Avenue and Arroyo Parkway. Pasadena’s historic commercial center, with numerous retail stores, restaurants, and other entertainment destinations.
- **Pasadena Central Park**: Located along Fair Oaks Avenue between Dayton Street and Del Mar Boulevard. A 9.2-acre park in Central Pasadena.
- **Huntington Memorial Hospital**: Located next to Fair Oaks Avenue between California Boulevard and Bellefontaine Street. Non-profit, community-based medical center in Pasadena.
- **War Memorial Park**: Located along Fair Oaks Avenue, just north of Mound Street. A 2-acre park and one of South Pasadena’s cultural historic landmarks.
- **South Pasadena Middle School**: Located on Fair Oaks Avenue between Rollin Street and Oak Street.
- **Atlantic Times Square**: Located at the southeast corner of Atlantic Boulevard and Hellman Avenue. Recently opened outdoor mall in Monterey Park with retail stores, restaurants, a movie theater, and upstairs condominiums.
- **Landmark Shopping Center**: Located at the northeast corner of Atlantic Boulevard and Garvey Avenue. Shopping center in Monterey Park with retail stores, supermarkets, and restaurants.
- **Monterey Park Mall Shopping Center**: Located on Atlantic Boulevard, between Newmark Avenue and Harding Avenue. Shopping center in Monterey Park with retail stores, supermarkets, and restaurants.
- **Cascades Park**: Located at Atlantic Boulevard and El Portal Place. A 2-acre park in Monterey Park with a landscaped waterfall.
- **Monterey Park Hospital**: Located next to Atlantic Boulevard between Cadiz Street and Sevilla Street.
- **East Los Angeles College**: Located on Avenida Cesar Chavez, just west of Atlantic Boulevard. Community college in Monterey Park with about 30,000 students.
- **Atlantic Square Shopping Center**: Located at the northeast corner of Atlantic Boulevard and Riggin Street. Shopping center in Monterey Park with retail stores, supermarkets, and restaurants.
- **Garfield High School**: Located on East 6th Street in East Los Angeles, just west of Atlantic Boulevard.

- **Atlantic Avenue Park**: Located at the northeast corner of Atlantic Boulevard and East 6th Street, in East Los Angeles.

Bus Routes (Metro Local, Metro Rapid, Pasadena ARTS, etc.) and Service Frequencies

As noted in the *Existing Conditions System Performance Report* (October 2012), the SR 710 study area as a whole is served by 16 local transit agencies, with both bus and rail services, including Metro Bus and Rail, Metrolink, Arcadia Transit, Alhambra Transit, Baldwin Park, Duarte Transit, El Sol East LA Shuttle, El Monte Transit, Foothill Transit, Glendale Beeline, Los Angeles Department of Transportation (LADOT), Monrovia Transit, Monterey Park Spirit Bus Lines, Pasadena Area Rapid Transit System (ARTS), Rosemead Explorer, and South Pasadena Gold Link. The transit service types provided include commuter rail (Metrolink), light rail (Metro Gold Line), and numerous types of bus service (rapid, express, limited, local, and shuttle).

Specifically, for the arterials upon which Alternative BRT-6 is proposed to operate (Colorado Boulevard, Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard), the key existing transit services are Metro Local 260 and Metro Rapid 762, which are described as follows:

- Metro Local 260: This route operates between Fair Oaks Avenue and Woodbury Road in Altadena and the Artesia Blue Line Station in Compton. The route runs on the segments of Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard where Alternative BRT-6 is proposed to operate, with stops about every 0.25 to 0.50 mile along the alignment.
- Metro Rapid 762: This route operates between Fair Oaks Avenue and Colorado Boulevard in Pasadena and the Artesia Blue Line Station in Compton. The route runs on the segments of Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard, where Alternative BRT-6 is proposed to operate, with stops about every 0.50 to 1.00 mile along the alignment (limited stops).

Table 2 summarizes the approximate spans of service for Routes 260 and 762. Route 260 runs on weekdays, Saturdays, and Sundays, while Route 762 runs on weekdays only.

TABLE 2
Metro Routes 260 and 762, Spans of Service

Route	Type	Service Span (Weekdays)	Service Span (Saturdays)	Service Span (Sundays)
260	Local	4:00 a.m. to 11:45 p.m.	5:00 a.m. to 11:45 p.m.	6:00 a.m. to 11:45 p.m.
762	Rapid	5:00 a.m. to 9:00 p.m.	None	None

Source: Los Angeles Metro, www.metro.net

Table 3 summarizes the approximate service frequencies, running times, and speeds for Routes 260 and 762 in the study area.

TABLE 3
Metro Routes 260 and 762, Frequencies and Speeds

Route	Time Period	Approximate Frequency	Estimated Route Length Within Study Area (miles)	Estimated Running Time Within Study Area (minutes)	Estimated Speed Within Study Area (mph)
260	A.M. Peak (6:00 a.m. to 9:00 a.m.)	12 to 20 min	9.2	41	13.5
	Midday (9:00 a.m. to 3:00 p.m.)	20 min	9.2	44	12.5
	P.M. Peak (3:00 p.m. to 6:00 p.m.)	12 to 20 min	9.2	47	11.7

TABLE 3
Metro Routes 260 and 762, Frequencies and Speeds

Route	Time Period	Approximate Frequency	Estimated Route Length Within Study Area (miles)	Estimated Running Time Within Study Area (minutes)	Estimated Speed Within Study Area (mph)
	Evening (6:00 p.m. to 9:00 p.m.)	30 to 60 min	9.2	40	13.8
	Saturday (5:00 a.m. to 11:45 p.m.)	15 to 20 min	9.2	43	12.8
	Sunday (6:00 a.m. to 11:45 p.m.)	15 to 20 min	9.2	40	13.8
762	A.M. Peak (6:00 a.m. to 9:00 a.m.)	15 to 20 min	9.2	36	15.3
	Midday (9:00 a.m. to 3:00 p.m.)	30 min	9.2	39	14.2
	P.M. Peak (3:00 p.m. to 6:00 p.m.)	25 min	9.2	41	13.5
	Evening (6:00 p.m. to 9:00 p.m.)	30 min	9.2	37	14.9

Source: Los Angeles Metro, www.metro.net. Route length and running time within the study area are estimated from Fair Oaks and Colorado to Atlantic and Pomona (Atlantic and Whittier is not listed as a scheduled time point).

The main findings as shown in Table 3 are as follows:

- Metro Local 260: This route generally operates at 12- to 20-minute service frequencies, and is scheduled to complete its north-south trip through the study area in 40 to 47 minutes depending on time of day. Based on an estimated route length in the study area of 9.2 miles, this translates to an estimated average speed of 11.7 to 13.8 mph.
- Metro Rapid 762: This route operates at 15- to 30-minute frequencies, and is scheduled to complete its north-south trip through the study area in 36 to 41 minutes depending on time of day. This translates to an estimated average speed of 13.5 to 15.3 mph.

A number of other existing bus routes traverse a shorter distance on the proposed Alternative BRT-6 route alignment. These routes are as follows:

- Metro Local 68: Serves Monterey Park, Downtown Los Angeles, and East Los Angeles. Certain runs (about one every 40 to 60 minutes) operate on Atlantic Boulevard between Riggin and 1st.
- Metro Local 79: Serves South Pasadena, Arcadia, and Downtown Los Angeles, with service about every 30 to 40 minutes. A portion of the route includes Huntington Drive between Fair Oaks Avenue and Garfield Road.
- Metro Local 177: Serves Pasadena and La Canada Flintridge, with service about every 30 minutes during weekday peak periods. A portion of the route includes California Boulevard between Lake and Hill.
- Metro Local 180/181: Serves Pasadena, Altadena, Eagle Rock, Glendale, and Hollywood, with service about every 15 to 20 minutes (sum of both routes). Portions of the routes include Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.
- Metro Local 256: Serves Pasadena, Altadena, East Los Angeles, Highland Park, and Monterey Hills, with service about every 45 minutes. A portion of the route includes Colorado Boulevard between Raymond and Hill.
- Metro Local 686/687: Serves Pasadena and Altadena, with service about every 20 minutes (sum of both routes). Portions of the routes include Fair Oaks Avenue between Colorado Boulevard and Glenarm Street, and Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.

- Metro Rapid 770: Serves Monterey Park, El Monte, Downtown Los Angeles, and East Los Angeles, with service about every 10 to 15 minutes. A portion of the route includes Atlantic Boulevard between Garvey and Riggin.
- Metro Rapid 780: Serves Pasadena, Eagle Rock, Glendale, Hollywood, Los Angeles (Mid-City), and West Hollywood, with service about every 10 to 15 minutes. A portion of the route includes Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.
- Foothill Transit Route 187: Serves Pasadena, Claremont, Glendora, and Montclair, with service about every 20 minutes. A portion of the route includes Colorado Boulevard between Fair Oaks Avenue and Hill Avenue.
- Montebello Transit Route 10: Serves Monterey Park, Montebello, and Whittier, with service about every 12 to 15 minutes. A portion of the route includes Atlantic Boulevard between Floral and Whittier Boulevard.
- Monterey Park Spirit Bus: Four Spirit Bus routes serve portions of the route alignment, with service ranging from every 30 to 40 minutes per route:
  - Route 1 runs on Atlantic Boulevard between Emerson and Riggin.
  - Route 2 runs on Atlantic Boulevard between Garvey and Floral.
  - Route 4 runs on Atlantic Boulevard between Emerson and Garvey.
  - Route 5 runs on Atlantic Boulevard between Floral and Riggin.
- Pasadena ARTS Shuttle: Four Pasadena ARTS Shuttle routes serve portions of the route alignment, with service ranging from every 20 to 60 minutes per route:
  - Route 10 runs on Colorado Boulevard between Fair Oaks Avenue and Lake Avenue.
  - Routes 20, 51, and 52 run on Fair Oaks Avenue between Del Mar Boulevard and Glenarm Street.

Bus Stop Locations and Amenities

A complete list of existing bus stops within the study area is provided in Attachment C. Those of particular interest are the stops on Metro Rapid Route 762 from Whittier Boulevard to Colorado Boulevard, as shown in Table 1.

All but three of the stops, in both the northbound and southbound directions, are located on the far side of the intersection. Most stops are parking-lane far-side stops; i.e., the bus would occupy a parking lane when it is stopped. At some locations where no on-street parking is provided, the bus would occupy a through-lane or a right-turn lane while stopping. These stop locations are illustrated in Figure 2.

It should also be noted from Attachment C that several bus stops on Colorado Boulevard accommodate up to eight bus routes from three different transit agencies.

The existing stops on Route 762 listed in Table 1 provide different amenities to passengers, ranging from a basic stop post and a stone bench to the more enhanced shelters with integrated seats.

Transit Operations

Since Metro Rapid Route 762 runs in the same corridor as the proposed BRT Alternative, the team has researched the operating characteristics of Route 762, which are presented below, to develop an understanding of the key issues and operating constraints that exist in the corridor.

To supplement Metro's operational data, the CH2M HILL team also has conducted a survey of the speed and delay of Route 762. The methodology, data collected, results, and key observations are discussed in the following sections.

Methodology

A total of 12 runs to collect travel time and delay information (6 in the northbound direction and 6 in the southbound direction) were conducted during the morning and evening commute hours (7:00 a.m. to 9:00 a.m., and 4:00 p.m. to 6:00 p.m.) over a period of 4 weekdays in December 2012. During each run, the data collector boarded the bus at an existing 762 bus stop, noted the start time, recorded the amount of delay upon each delay event on the ride, and noted the end time after he/she got off the bus. The majority of the runs began at Whittier

Boulevard and Atlantic Boulevard at the south and ended at Colorado Boulevard and Fair Oaks Avenue at the north, or vice versa.

Data Collected

On each run, the total run time, observed delays, and nature of each delay event were recorded. Three types of delays are separately recorded:

- Delay due to a red light at the signalized intersection ahead
- Delay due to the bus pulling out to a bus stop serving passengers and merging back with traffic
- Delay due to other reasons such as heavy traffic, extra wait time at stop, etc.

A summary of the data collected is provided in Attachment D.

Summary of Results and Key Observations

The recorded total run time and percent of total delays versus run time ratio on each run are presented in Table 4.

TABLE 4
Summary of Recorded Total Run Time and Percentage Delay to Total Run Time from Survey Runs

	Southbound Runs						Northbound Runs					
	Dec 18 A.M.	**Dec 19 A.M.**	**Dec 10 P.M.**	**Dec 18 P.M.**	**Dec 19 P.M.**	**Dec 20 P.M.**	**Dec 18 A.M.**	**Dec 19 A.M.**	**Dec 10 P.M.**	**Dec 18 P.M.**	**Dec 19 P.M.**	**Dec 20 P.M.**
Recorded Run Time (minutes)	37.4	40.0	40.5	47.3	52.3	46.4	38.9	37.6	48.0	41.0	47.5	50.8
% Delay to Total	35%	40%	32%	47%	52%	52%	32%	38%	35%	43%	40%	52%

Results indicate that the delay time constitutes more than 50 percent of the total run time on Route 762 during the p.m. peak hours on December 18, 2012, and December 19, 2012. The high variability of the run times during the p.m. periods should also be noted.

According to the bus schedule effective June 17, 2012, the estimated run times for Route 762 are 36 minutes for the a.m. peak periods and 41 minutes for the p.m. peak periods between Atlantic Boulevard at Pomona Boulevard and Fair Oaks Avenue at Colorado Boulevard. Since the survey run times were recorded over a longer distance, a direct comparison between scheduled run times and recorded run times cannot be made. If adjustments to the scheduled run times are made using assumed average travel speeds, however, a comparison can be made and those results are presented in Table 5.

TABLE 5
Comparison between Recorded Run Time and Scheduled Run Time of Metro Rapid Route 762

	Southbound Runs						Northbound Runs					
	Dec 18 A.M.	**Dec 19 A.M.**	**Dec 10 P.M.**	**Dec 18 P.M.**	**Dec 19 P.M.**	**Dec 20 P.M.**	**Dec 18 A.M.**	**Dec 19 A.M.**	**Dec 10 P.M.**	**Dec 18 P.M.**	**Dec 19 P.M.**	**Dec 20 P.M.**
Recorded Run Time (minutes)	37.4	40.0	40.5	47.3	52.3	46.4	38.9	37.6	48.0	41.0	47.5	50.8
Scheduled Run Time (minutes)*	39.7	39.7	44.7	44.7	44.7	44.7	39.7	39.7	44.7	44.7	44.7	44.7

*Adjustments were applied to the Metro bus schedule to account for different starting points at the south end (Pomona vs. Whittier).

Results indicate that the variations between the scheduled run time and recorded run time are the greatest on the p.m. runs. In particular, the recorded run time is over 7 minutes longer than the scheduled run time in the southbound direction on December 19 p.m..

Locations with the longest delays (greater than 50 seconds at signals; 20 seconds at stops; and 50 seconds for other reasons) are listed in Table 6.

TABLE 6

Locations with the Longest Delays between Atlantic Boulevard at Whittier Boulevard and Fair Oaks Avenue at Del Mar Boulevard

Locations	Reasons for delay
1. Atlantic Boulevard at Whittier Boulevard	Signal and bus stop
2. Atlantic Boulevard at Beverly Boulevard	Signal
3. Atlantic Boulevard at Pomona Boulevard	Signal and bus stop
4. Atlantic Boulevard at SR 60 ramps	Signal; heavy traffic approaching the SR 60 interchange
5. Atlantic Boulevard at Cesar Chavez Avenue/Riggin Street	Signal and bus stop
6. Atlantic Boulevard at Garvey Avenue	Signal and bus stop
7. Atlantic Boulevard at Valley Boulevard	Signal and bus stop
8. Atlantic Boulevard at Shorb Street	Signal; heavy traffic approaching the intersection
9. Atlantic Boulevard at Mission Road/Front Street	Signal; heavy traffic approaching the intersection
10. Atlantic Boulevard at Main Street	Signal and bus stop
11. Atlantic Boulevard at Garfield Avenue	Signal (northbound left-turn only)
12. Huntington Drive at Garfield Avenue	Signal (northbound left-turn only)
13. Huntington Drive at Fair Oaks Avenue	Signal (southbound left-turn only)
14. Fair Oaks Avenue at Mission Street	Signal
15. Fair Oaks Avenue at SR 110 ramps (including State Street and Grevalia Street)	Signal; heavy traffic approaching the SR 110 interchange
16. Fair Oaks Avenue at California Boulevard	Signal
17. Fair Oaks Avenue at Del Mar Boulevard	Signal and bus stop

It should be noted that the vast majority of the recorded delays occurred at traffic signals, bus stops, or heavy traffic approaching busy intersections or freeway interchanges.

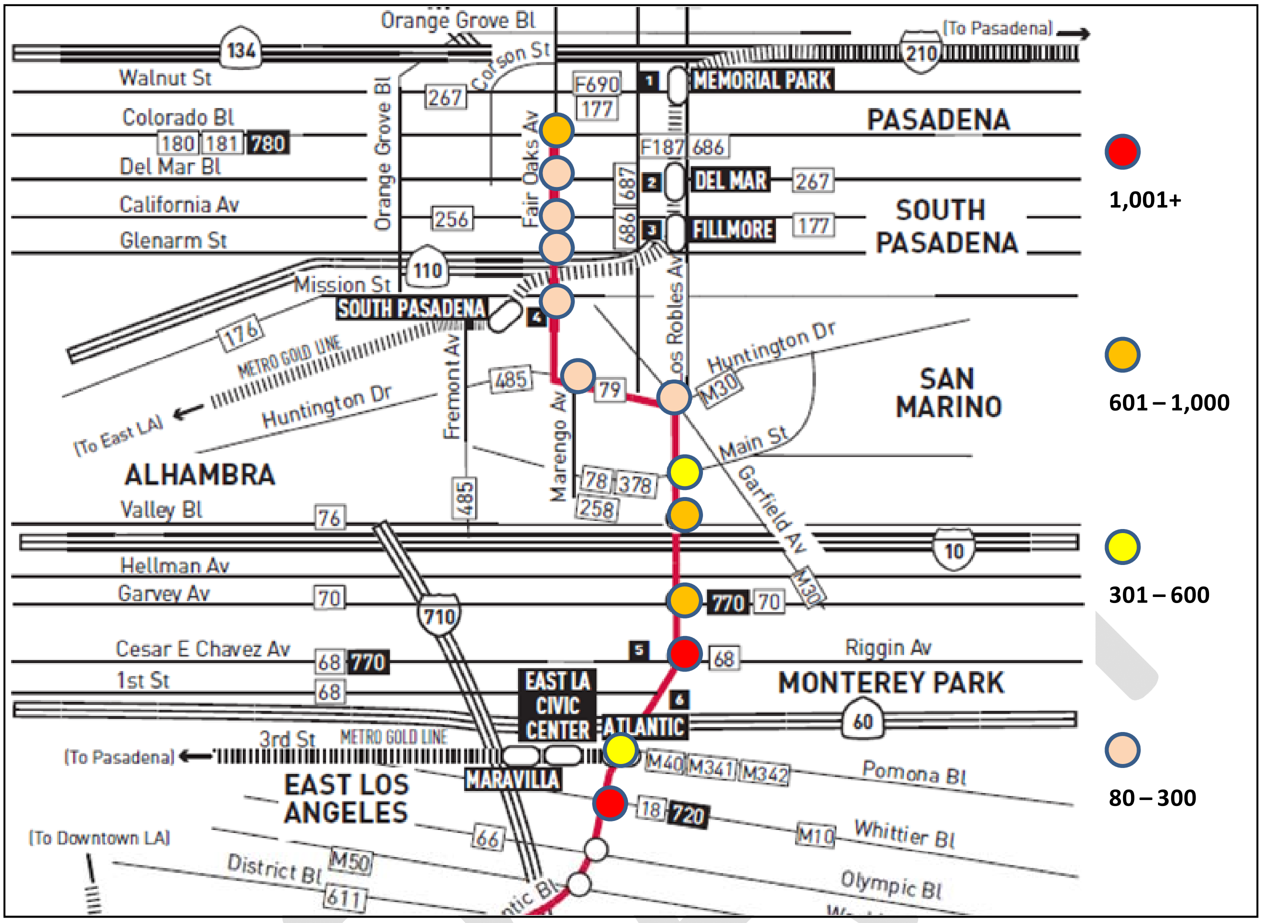
Boarding Volumes by Stops

This section provides stop-level and route-level ridership numbers for Metro Routes 260 and 762, which have the most overlap with the proposed Alternative BRT-6 route alignment.

Stop-Level Ridership

Figure 2 shows average daily boardings by stop location (sum of both directions of travel) for Metro Local 260 and Metro Rapid 762 on Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard within the study area, based on Metro stop-level ridership data. This is shown only for the 13 common stops shared by Routes 260 and 762 within the study area – Fair Oaks Avenue and Colorado Boulevard at the north end; Atlantic Boulevard and Whittier Boulevard at the south end.

FIGURE 2
Metro Routes 260 and 762, Average Daily Boardings by Stop



Source: Los Angeles Metro, January 2011 data

With the exception of Fair Oaks Avenue and Colorado Boulevard, the stop locations with the highest levels of boarding activity are all located in the southern part of the study area – in particular Atlantic Boulevard and Cesar Chavez Avenue/Riggin Street, and Atlantic Boulevard and Whittier Boulevard, which have an average of over 1,000 daily boardings.

Some of these stops are served by other Metro routes in addition to Routes 260 and 762. These stops include Fair Oaks Avenue and Colorado Boulevard (also served by Routes 686/687), Huntington Drive and Marengo Avenue (also served by 79), and Atlantic Boulevard and Riggin Street (also served by 770). With the existing dataset, it is not possible to break out the boardings between Routes 260 and 762 or between these other routes.

Route-Level Ridership

Table 7 shows Fiscal Year (FY) 2012 route-level ridership and passenger mile data for Routes 260 and 762. The numbers provided are for the entire route length, not limited to the study area.

TABLE 7
Metro Routes 260 and 762, Route-Level Ridership Data

Route Name	Time Period	FY 2012 Ridership	FY 2012 Passenger Miles	Average Daily Ridership	Average Daily Passenger Miles	Average Passenger Trip Length (in miles)	Estimated Average Ridership per Vehicle Trip
260	Weekdays	3,169,375	13,110,843	12,429	51,415	4.1	115.1
	Saturdays	582,465	2,675,423	10,990	50,480	4.6	105.7
	Sundays	478,969	2,181,030	8,258	37,604	4.6	93.8
762	Weekdays	1,250,791	6,918,824	4,905	27,133	5.5	72.1

Source: Los Angeles Metro, FY 2012 data

Key findings as shown in Table 7 are as follows:

- Average daily ridership on weekdays is 12,429 for Route 260 and 4,905 for Route 762.
- Based on estimated daily vehicle trips, average ridership per vehicle trip is higher for Route 260 (about 115.1 on weekdays) than for Route 762 (about 72.1).
- Passenger trip lengths are longer for Route 762 (about 5.5 miles) than for Route 260 (about 4.1 miles on weekdays).

Summary of BRT Concept and BRT System Elements

Bus Rapid Transit (BRT) is defined by the American Public Transportation Association (APTA) as:

> "…a suite of elements that creates a high-quality rapid transit experience using rubber-tired vehicles. This experience often includes a high degree of performance (especially speed and reliability), ease of use, careful attention to aesthetics, and comprehensive planning that includes associated land uses. BRT seeks to meet or exceed these characteristics through the careful application of selected elements."

The review of refinements for the BRT Alternative includes consideration of options by system element. The seven elements of BRT, as identified by APTA, are as follows:

1. Running Ways
2. Stations and Stops
3. Vehicles
4. Fare Collection
5. Intelligent Transportation Systems/Technologies
6. Service and Operating Plans
7. Branding and Image

Metro is operating, or planning for, several types of BRT services including:

- Basic Metro Rapid Line service, operating in mixed flow traffic on multiple arterial street corridors
- Planned Wilshire BRT service, which will operate in curb lanes during peak hours and in mixed flow traffic during off-peak hours
- Silver Line service, which operates in freeway managed access lanes and in mixed flow traffic lanes on downtown streets
- Orange Line service, operating mostly in at-grade, exclusive busway lanes

Each of these BRT services has varying levels of application of BRT system elements. The review of potential refinements for the BRT Alternative will review the range of applications that have been/are being applied to the current Metro services, and seek to incorporate the highest levels that are appropriate to fit the context. BRT Element 6, Service and Operating Plans, will be addressed in a separate memorandum. The other six BRT elements are discussed below.

BRT Element 1: Running Way Options

Dedicated Bus Lanes and Busways

This option provides a dedicated lane for transit vehicles on local arterials through lane addition or conversion, or on a segregated and exclusive right-of-way. The dedicated lane or busway minimizes traffic conflicts and therefore reduces delays and travel time. Typically used in an urban setting, the dedicated bus lanes are also shared with other transit vehicles, right-turn traffic, and/or driveway access. These lanes are designated for transit use at all times.

The dedicated bus lanes in Alternative BRT-6 recommended in the AA would be created by removal of on-street parking, narrowing of landscaped median or sidewalks, or removal of planter strips adjacent to sidewalks. Displacement or elimination of heavily used on-street parking can create significant inconvenience to the communities and can have an adverse effect on businesses. Therefore, options will be considered that limit use of parking lanes for bus transit to the peak traffic periods only.

Peak-Period Bus Lanes

This option includes the dedicated bus lanes described above, except that the lanes are open to parking or mixed-flow traffic outside the peak traffic periods during the morning and afternoon commutes, typically from 7:00 to 9:00 a.m. and 4:00 to 7:00 p.m. The BRT service would operate in the dedicated bus lanes during peak periods, and along with mixed-flow traffic outside of peak periods.

In contrast with the 24-hour dedicated bus lane option, this option would only impact on-street parking during peak traffic periods. The number of on-street parking spaces with new parking restrictions would be the same as dedicated bus lanes. Even though the parking restriction would only be enforced during peak hours, the proposal may still be an issue to the communities and businesses. Enforcement of parking restriction can also be challenging initially since drivers may not be familiar with the changes.

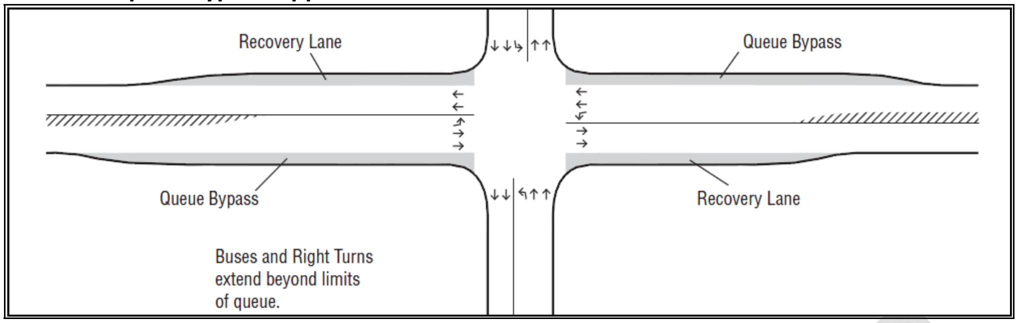
Nonexclusive/Mixed-Flow Lanes with Queue Jump Lanes

In this option, the BRT service operates in the mixed-flow lanes; however, improvements need to be provided at select signalized intersections and/or roadway segments that experience peak-hour traffic congestion. Queue jump or bypass lanes can be implemented at intersections to allow transit vehicles to bypass traffic queues approaching an intersection. The queue jump lane is created by converting the right-turn lane or an added lane long enough to allow transit vehicles to bypass the traffic queues. In addition, a transit signal phase can be added to the intersection to provide transit vehicles an early green time so that they can bypass the general traffic. Lastly, addition of through lanes in select roadway segments and other Transportation System Management/ Transportation Demand Management (TSM/TDM) improvements that can reduce congestion delays will also be included.

Queue Jumper

At signalized intersections that are heavily congested during peak hours, a queue bypass lane (or queue jumper) could be installed on the near-side of an intersection to allow buses to bypass the queue, with an optional separate transit signal phase. It is important to also provide a recovery lane or a bus bay on the far-side of the intersection to enable re-entry of buses to traffic. In a typical application, buses are allowed to use the right-turn lane for through movement (often accompanied by a “bus exempt” sign), as shown in Figure 3.

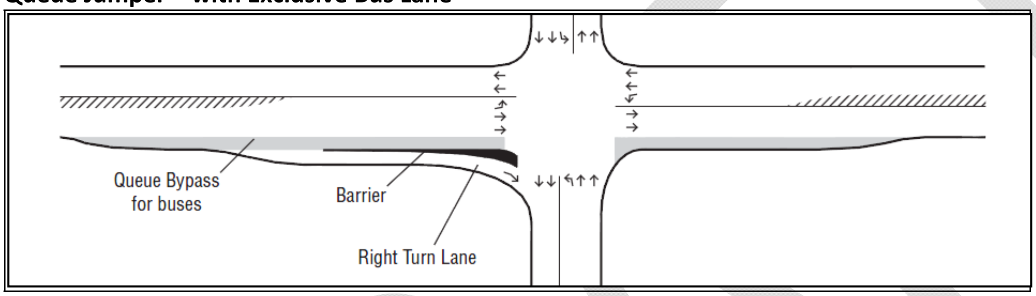
FIGURE 3
Queue Jumper – Typical Application



Source: Transportation Research Board (TRB), Transit Cooperative Research Program (TCRP) Report 90, Volume 2, Figure 3-9

When right-turn volumes are high during the peak hour, an exclusive bus lane should be considered, as illustrated in Figure 4.

FIGURE 4
Queue Jumper – with Exclusive Bus Lane



Source: TRB, TCRP Report 90, Volume 2, Figure 3-9

Median Exclusive Lanes, Two-Way Operations or Reversible Lane

Another concept that is applied for BRT projects along arterial streets is to develop median-running exclusive bus lanes. Ideally, these would be two-way busways with raised curbs to control access between the busway lanes and adjacent general purpose traffic. Median busways should be a minimum of 28 feet wide, including raised curbs. In additional to the space needed for the lanes, additional width is needed for stations. The stations can either be offset by direction on each side of street intersections, or combined at one location to serve both directions. Split stations require an additional 10-foot minimum width. A combined station can require a 20-foot width.

In the United States, examples of BRT projects that have incorporated median busways along portions of the alignments include the EmX in Eugene, Oregon; the SDX in Las Vegas, Nevada; and the Healthline in Cleveland, Ohio. A median busway can enable higher speed, uninterrupted bus operations. A median busway can also be presented as a higher brand of infrastructure with distinctly colored pavement and enhanced stations. Some of the disadvantages for developing a median busway are: need for access points at each end for bus ingress/egress; the extra width at intersections often is not available without substantial land use impacts; the separate busway approach lanes at intersections require special phases within the signal operations; and often the median busways can have traffic safety risks due to intrusions into the busway by general traffic or due to added bus movements and conflict points within intersections.

Much of the study corridor does not have enough width to fit a median busway. The only potential location that has more width would be from the Huntington Drive/Garfield Avenue intersection, running along Huntington Drive, to Fair Oaks Avenue, then north along Fair Oaks to the intersection of Fair Oaks Avenue/Monterey Road. This would be about 1.5 miles in length. However, developing a median busway along Huntington Drive would require removal of existing median landscaping. The extra width required at intersections would also require some right-of-way acquisition. Some on-street parking stalls would need to be removed to allow space for the median lanes and existing general traffic lanes. In addition, a separate station would be required to serve the BRT operation at Huntington Drive/Morengo Avenue, while a station in the same vicinity would still be required on the outside traffic lanes to serve the local bus operations, so duplicate stations would be needed.

Another concept would be to develop a single lane that is reversible, which would require less space. However, a reversible bus lane would require special signal controls to prevent the potential for buses in opposing directions from using the same lane. The reversible lanes become a major restriction to the capacity of the BRT operation.

Median bus lanes are not practical for application on this corridor due to the problems identified above.

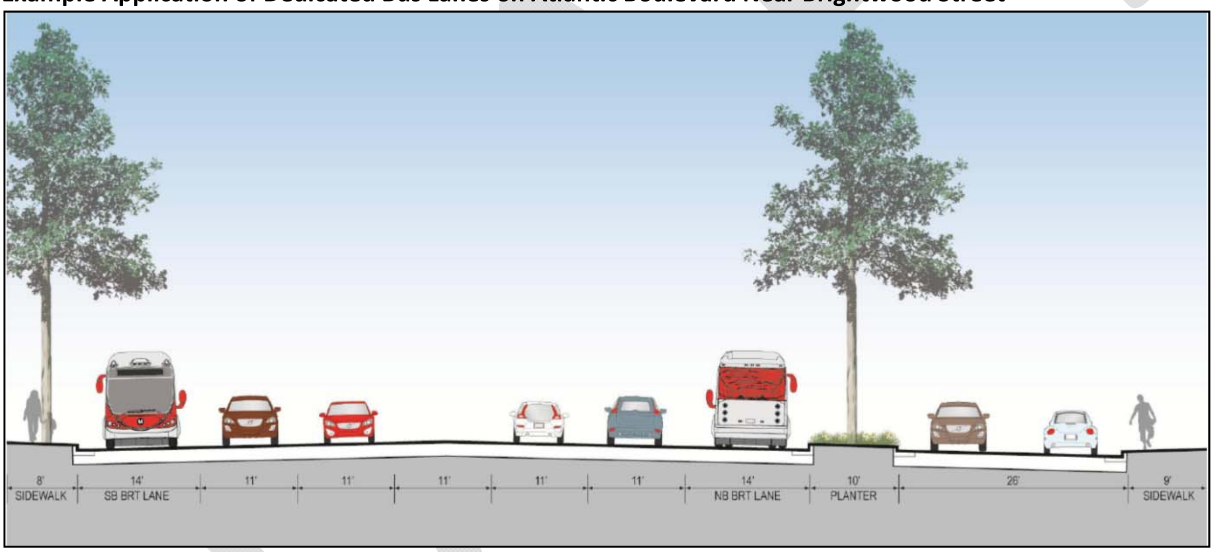
Applications of Running Way Options

The existing surface streets in the study corridors do not offer opportunities for a segregated busway with exclusive right-of-way. Dedicated bus lanes on portions of Atlantic Boulevard, Huntington Drive, and Fair Oaks Avenue could be achieved with some or all of the following modifications to the existing roadway:

- Removal of on-street parking or available shoulder
- Narrowing of landscaped or paved medians
- Narrowing or removal of planter strips adjacent to sidewalks
- Narrowing of concrete sidewalks

Figure 5 illustrates an example application of dedicated bus lanes on Atlantic Boulevard near Brightwood Street in Monterey Park.

FIGURE 5
Example Application of Dedicated Bus Lanes on Atlantic Boulevard Near Brightwood Street



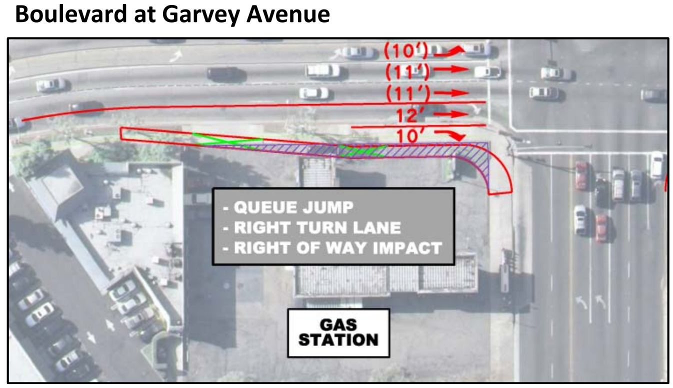
(Source: SR 710 Study, Draft Alternative Analysis Report, CH2M HILL, October 2012)

Since on-street parking may be heavily used in some corridors where commercial activities occur, or near higher-density housing, the concept of a peak-period bus lane may be better accepted by the communities.

Portions of Atlantic Boulevard and Fair Oaks Avenue have such narrow right-of-way that even parking or shoulder lanes do not exist. In most cases, any significant roadway widening would result in impacts to buildings or other structures on private properties. Therefore, BRT service would operate in mixed-flow traffic lanes in these areas.

Results from the speed and delay survey previously discussed suggest that a significant number of delays

FIGURE 6
Example Application of Queue Jump Lane on Atlantic Boulevard at Garvey Avenue



occur at or approaching signalized intersections. Queue jump lanes can be very effective in reducing delays in transit travel time, typically require only minor right-of-way take, and do not impact buildings. Figure 6 illustrates an example application of a queue jump lane on Atlantic Boulevard at Garvey Avenue in Monterey Park.

The signalized intersections with long delays listed in Table 6 have been evaluated for queue jump lane applications. Concepts of the potential running way improvements are presented in Attachment E.

BRT Element 2: Stations and Stops

Bus Bulb

Also referred to as “bus bulb-outs” or “curb extensions,” a bus bulb involves extending the sidewalk into the street so that buses do not need to pull out of a travel lane to serve passengers at a stop. A common reason for installing bus bulbs is when buses experience problems re-entering traffic during peak hours after pulling out to a bus bay. At BRT stations where transit ridership is high, a bus bulb can also provide a larger space for passengers and other pedestrians, as well as opportunities for amenities. Bus bulbs can be applied on the far-side or near-side of an intersection, or in mid-block locations; bus bulbs are typically used where a parking lane exists. The installation typically requires the elimination of two or more parking spaces or a loading zone.

Bus Bay with Acceleration Lane

Also referred to as “bus pull-outs,” this option involves providing adequate distances at a bus station zone for buses entering the station, decelerating to a stop, stopping area, accelerating to through speed, and re-entering traffic. The length of the stopping area depends on the length of the transit vehicles used on the bus route. If applied appropriately, the enhanced bus bays can improve transit operations and through-traffic operations. In general, the bus bays on either the far-side or near-side of the intersections are shorter than bus bays at mid-block locations and are sometimes referred to as “open bus bays.” The installation typically requires the elimination of two or more parking spaces or a loading zone.

Separated Stop for BRT

At BRT stations where transit ridership is high and other bus lines are served, more than one loading position may be needed. Metro Transit Service Policy provides recommendations on the required number of bus loading positions based on bus flow rates (buses per hour) and passenger service time. An example configuration is BRT vehicle in the front loading position and the Metro Rapid and Local buses sharing the rear loading position. The installation typically requires the elimination of two or more parking spaces or a loading zone.

Far-Side Stop

Far-side stop locations are required to realize the full benefits of Transit Signal Priority (TSP). If the stop is on the near-side of the intersection, a bus may have to stop in front of the signal even during a green signal phase, thus forgoing the advantage of the signal priority. Far-side stop locations are required in accordance with Metro Rapid Program Service Warrants.

Level Boarding

Providing near-level boarding for passenger access to buses at stations/stops is a way to reduce dwell times for operations while also improving rider comfort. Rail transit systems provide level boarding access at stations with controlled grades of rail lines and platform grading. Therefore, passengers can have easy access to/from vehicles. Also, access-challenged passengers can gain access more easily/quickly. For BRT systems, near-level boarding can be provided by raising station/stop platform heights to slightly below the elevation of low floor buses. Low floor buses have floor heights that range to as low as approximately 13 inches. Near-level platform heights should be slightly lower so that the bus grade will always be higher to allow plug doors to open. There are many examples of median and right-side stations along arterial BRT projects in the United States with near-level boarding, including Cleveland Healthline, Las Vegas MAX, and Eugene Lane Transit Franklin Green Line BRT projects. The disadvantage for developing near-level boarding at stations along arterial streets is the need to accomplish grade transitions to conform around stations. When sidewalk widths are limited, then grade differences are difficult to fit within the right-of-way. The default option is the existing, typical curb height of 6 inches. Generally, when buses stop at curb stations, there will be a 6-plus inch vertical gap. Buses can kneel for passengers, although that takes a small amount of time. Use of access ramps takes additional time.

Driver-Assisted/Guided Access to Stops

Another option is to provide physical or optical guidance to stops. This option is used to reduce the lateral gap between the bus and the edge of the station platform so that the bus can dock more closely at stations. Using guideways for the length of the BRT alternative would be impractical because the alignment runs along arterial streets. Applications specifically for guided stops have been applied on BRT systems in the United States. Examples include use of a guide wheel on the bus along with a light strip in the pavement on the Cleveland Healthline; rub strips or shaped curbs and experimental guide lights in pavement on the Eugene Lane Transit Franklin line; and a computerized optical guidance system with white strips on the Las Vegas MAX BRT line. The MAX system was subsequently abandoned because the paint stripe required constant cleaning and, therefore, that system was performing irregularly. Guided stops are more important when the platform height is raised to enable near-level boarding. A simple approach is to use rub strips or shaped curbs along with visible markings to guide the bus operator. The bus operator would need to operate at lower speeds approaching the stations.

Amenities

Amenities for BRT stations such as shelters, benches, lighting, light emitting diode (LED) displays (Next Bus), and ticket vending machines, contribute to a positive identity and image of the BRT service, which will attract more riders. The Metro Rapid Route 720 service is a local example of a strong brand, and could be used as a model for the BRT Alternative. Figure 7 shows pictures of the amenities at a typical stop along Metro Rapid 720.

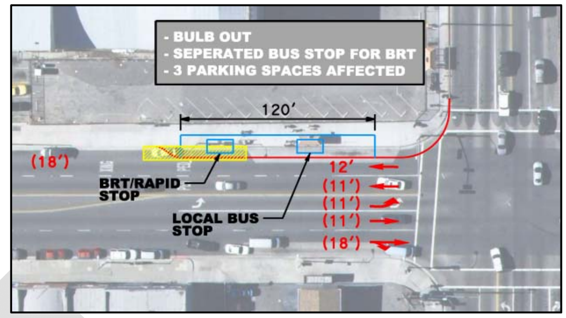
FIGURE 7
Amenities at a Typical Stop Along Metro Rapid Route 720

Additional amenities beyond those provided for Metro Rapid Route 720 should be considered if a stronger and/or different brand is desired for the BRT Alternative.

Applications of Station Options

The existing 762 stops are located at intersections, either on the near-side or the far-side. Bus bulbs are likely not feasible at near-side stops since bus bulbs would conflict with right-turn traffic. On the other hand, far-side stops lend themselves to bus bulb applications when private right-of-ways are not significantly impacted (impacts to buildings are considered significant). In addition, bus bulbs will be considered at stop locations where the sidewalks are narrow. Some sidewalks within the study corridors are as narrow as 6 feet. An example application of bus bulbs is shown in Figure 8.

FIGURE 8
Example Application of Bus Bulb and Separate Stop for BRT on Atlantic Boulevard at Whittier Boulevard



The stop locations with high volumes and/or long delays listed in Table 6 have been evaluated for bus bulbs, bus bays with acceleration lane, far-side stops, and separated stops for BRT.

Table 8 lists the three Route 762 stops that are located on the near-side of the intersection, and the issues involved in relocating them to the far-side.

TABLE 8
Existing Near-Side Stops on Metro Rapid Route 762

Direction	Stop Location	Issues
Northbound	Atlantic Boulevard at Pomona Boulevard	Require modification to the Chevron gas station driveway on Atlantic Boulevard
Northbound	Atlantic Boulevard at Valley Boulevard	Require modification to the Pizza Hut/Popeye's Chicken driveway on Atlantic Boulevard
Southbound	Fair Oaks Avenue at Glenarm Street	Require closure/modification to the liquor store driveway on Fair Oaks Avenue

Concepts of the potential stop improvements are presented in Attachment E.

BRT Element 3: Vehicles

Two options for vehicles are available for the BRT Alternative:

- **Standard 40-foot or 45-foot buses,** based on specifications from Metro's existing standard bus fleet used for Metro Rapid services. These are compressed natural gas (CNG) vehicles manufactured by NABI.
- **Articulated 60-foot buses with two or three doors,** based on specifications from Metro's existing articulated bus fleet used for Metro Rapid services. These are CNG vehicles manufactured by NABI, and feature low-floor boarding to facilitate passenger entry and exit. Metro has nearly 400 articulated buses in its existing vehicle fleet that are used for both Metro Local and Metro Rapid services.

Metro Rapid buses are colored red and labeled "Metro Rapid" as opposed to Metro Local buses, which have an orange paint scheme.

As compared to standard buses, articulated buses have the benefits of greater capacity and multiple-door entry and exit, with a turning radius that is similar to or better than standard buses due to the pivoting joint in the center of the vehicle. Each BRT vehicle is proposed to be 60 feet in length with three doors, with a front door, middle door, and rear door on the right side. The seated capacity is about 57 passengers; the seated plus standing capacity is about 80 passengers.

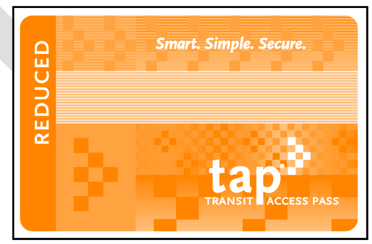
Figure 9 provides a photograph of an existing Metro Rapid BRT vehicle.

FIGURE 9
Bus Rapid Transit (BRT) Articulated Bus

Source: http://en.wikipedia.org/wiki/Metro_Rapid

BRT Element 4: Fare collection

The three primary fare collection options considered for the BRT Alternative include:



- **Front Door Boarding Only**: This is the standard method of fare collection currently in place for Metro bus services. All patrons board at the front door only. Patrons pay with cash or token at the farebox, or pay with a TAP card (loaded with a valid pass or e-purse) at a stand-beside TAP card processor.

- **Front Door or Rear Door Boarding**: With this alternative, a TAP card processor is placed at the rear door of the vehicle. Patrons who have a valid TAP card would have the option to board and pay at the rear door. The operator receives a signal notification with each rear door boarding that confirms a valid TAP card payment was made. However, the operator must still visually verify that every patron who is boarding at the rear door is using a TAP card to board. Alternatively, fare inspectors can monitor select trips.

- **Off-Board Fare Collection**: With this alternative, fare collection would be done off-board similar to the Metro Rail system. A minimum of one ticket vending machine (TVM) for each direction of travel is placed at each BRT stop location throughout the route alignment. These TVMs, consistent with those used at Metro Rail stations, allow patrons to purchase a new TAP card or load fare payment onto an existing TAP card. Patrons tag their TAP card at a stand-alone validator (SAV) prior to boarding the BRT vehicle, and could board the vehicle at either door. There is also a minimum of one SAV per direction per stop location. Fare enforcement on the vehicles is based on proof of payment, using roving fare inspectors.

Front door or rear door boarding would speed up boarding times relative to the front door boarding only alternative, by allowing patrons with a TAP card to board at either door. This could reduce dwell times at major stop locations by 10 seconds or more per stop, depending on the number of patrons who are boarding.

Off-board fare collection for the complete route would have significantly higher capital costs than the other alternatives due to the need to install TVMs and SAVs at each stop location. It would be possible to consider a hybrid approach, with TVMs and SAVs installed only at the highest-volume stops to speed up boarding times at those specific stop locations.

BRT Element 5: Intelligent Transportation Systems (ITS)/Technologies

There are several ITS or other technologies that can be considered along BRT corridors to improve speed and reliability and/or customer comfort, convenience, and security. These include TSP, Variable Message Signs (VMS) for providing 'next bus' information, Passenger Assistance Telephones (PTELs), and surveillance cameras.

- **Transit Signal Priority (TSP)**: TSP involves adding signal capability to enable conditional signal priority for buses. Metro is in the process of implementing TSP equipment at all signalized intersections along Route 762 between Artesia and Pasadena/Colorado, except on Huntington Drive. The TSP installations are part of a broader effort to improve signal operations/synchronization along the Metro Rapid street corridors. Therefore, operational benefits to general traffic and local bus service may also occur. The operation and programming of priority levels will be dependent on local agency policies. These TSP installations will be operational in Fall 2013. Metro has established estimated bus travel time savings percentages based on detailed review of before and after studies conducted in the Crenshaw Boulevard Corridor. Based on the Crenshaw Boulevard Corridor study, bus travel time can be reduced by approximately 6 percent due to TSP operations.

- **Variable Message Signs (VMS)**: Dynamic VMS could be provided at BRT-6 stop locations to provide real-time vehicle arrival information, as well as operations and special events messages as appropriate. These highly visible LED signs inform passengers of the estimated arrival times of the next BRT bus. The arrival time information is computed by the same system that is used for TSP, based on the actual speed of the bus, and is typically accurate to within 1 minute. Figure 10 provides a picture of an existing Metro Rapid VMS.

FIGURE 10
Metro Variable Message Sign

- **Passenger Assistance Telephones (PTELs)**: PTELs could be provided at high-volume stops to enable patrons to contact the Metro Operations Control Center (OCC) for assistance if needed.

BRT Element 6: Service and Operating Plan

This topic will be presented in a separate technical memorandum.

BRT Element 7: Branding and Image

As shown in Figure 11, BRT stops would have distinct branding and shelters that are similar to the existing Metro Rapid system. This includes canopies and benches at each stop location, with appropriate lighting during evenings. VMS would be provided to give real-time vehicle arrival information, as noted above. Each stop location would also have a route map, route schedule, and branded signage to distinguish the BRT service from other bus services.

FIGURE 11
Metro Rapid Station and Shelter

Evaluation Criteria for Review of Potential Refinement Packages

This section describes evaluation criteria to be used to review the potential refinement options for the BRT Alternative. For the review of refinement options, evaluation criteria are proposed to address many of the objectives for developing the refinements. The criteria of travel time savings, reliability, and comfort and convenience relate to trying to improve the operating performance and increase ridership. The criteria of effects on parking, and physical and right-of-way effects relate to initial issues with this alternative that were identified in the AA phase.

1. **Travel time savings**. Potential to reduce total bus travel time for the trunk line between Atlantic Boulevard/Whittier Boulevard in the south and Fair Oaks Avenue/Del Mar Boulevard in the north.
2. **Reliability**. Potential to improve the likelihood that bus trip times will be consistently the same and that buses arrive and depart stops at expected schedule times.
3. **Comfort and convenience**. Degree to which passengers will have ease of use and access, a feeling of being more safe and secure, and having enhanced environment and aesthetics along with protection from weather.
4. **Effects on parking**. Assessment of possible displacements of on-street parking stalls, along with the significance and type of parking affected (e.g., adjacent to retail commercial land uses; paid/metered parking stalls, etc.).
5. **Physical and right-of-way effects**. The potential need to widen the roadway into physical features (such as structures, or off-street parking lots) and/or requires acquisition of right-of-way.

Development of Packages

Potential BRT system packages have been developed to evaluate for application as the BRT Alternative. These packages include combinations of BRT system elements as described above. The potential packages are listed in Table 9.

Package 1 would be similar to Alternative BRT-6 in the AA phase. Package 2 would be mixed-flow bus lane with intersection improvements and queue jump lanes. Package 3 would be a hybrid of Packages 1 and 2. Package 4 would be similar to Package 3, but with 24-hour dedicated bus lanes and additional BRT amenities.

TABLE 9
Potential BRT System Packages

Elements	Package 1 (BRT-6 AA)	Package 2 (Low)	Package 3 (Medium)	Package 4 (High)
Running Ways				
24-hour Dedicated Bus Lanes	X			X
Peak-Period Bus Lanes			X	
Mixed-flow Lanes	X	X	X	X
Queue Jump Lane		X	X	X
Median Exclusive Bus Lanes				X
Reversible Bus Lanes				
Special: Widening at SR-60 and 110 Interchanges			X	X
Stations				
Bus Bulbs		X		
Bus Bay with Acceleration Lane		X		
Separate Stops for BRT High Volume Stops		X	X	X
Relocate Near-side Stops to Far-side		X	X	X
Level Boarding				X
Driver Assisted/Guided Access				X
Amenities-Basic	X	X		
Amenities-Enhanced			X	
Amenities-Special				X
Vehicles				
40-foot or 45-foot Bus				
60-foot Articulated Bus-3 Doors	X	X	X	X

TABLE 9
Potential BRT System Packages

Elements	Package 1 (BRT-6 AA)	Package 2 (Low)	Package 3 (Medium)	Package 4 (High)
Fare Collection				
Front-door Boarding	X	X		
Front-door and Rear-door Boarding			X	X
Off-board Fare Collection	X	X	X	X
ITS Technology				
Transit Signal Priority (TSP) (Metro baseline project)	X	X	X	X
Variable Message Signs (VMS)			X	X
Passenger Assistance Telephones (PTELs)				X
Surveillance Cameras				X
Branding and Image				
Similar Branding and Image as Metro Rapid Lines	X	X		
Similar Branding and Image as Wilshire BRT Line			X	
Special Branding and Image				X

Evaluation and Recommendations

An evaluation of the four packages of BRT refinement options was conducted using the evaluation criteria discussed previously: travel time savings, schedule reliability, comfort and convenience, potential effects on parking, and physical/right-of-way impacts. A brief discussion of each package is provided below.

Package 1 (BRT-6 from AA)

This package would yield the lowest potential bus travel time savings. TSP is assumed to be implemented as part of the No Action Alternative. After TSP, the percent reduction in travel time for Package 1 is roughly 5 to 10 percent. The percent delay time reduction would be 15 to 20 percent. Package 1 includes exclusive bus lanes; however, these would not extend to intersections. At intersections, buses would need to merge with right-turning traffic. Most of the delay along the corridor is caused at intersections and at bus stops. Therefore, bus lanes that do not extend through the approaches to intersections would have limited travel time savings benefit. The continuous exclusive lanes would help with travel time reliability. Comfort would not be as good with no assumed upgrades for stations. The 24-hour dedication of curb lanes would displace approximately 1,350 on-street parking stalls along the corridor. The slight road widenings to fit the curbside lanes would not require right-of-way acquisition. However, the sidewalk widths would need to be reduced in some locations along the corridor.

Package 2 (Lower Level of BRT Options)

Package 2 would be focused at improving elements that cause delay, especially street intersections. This package includes improvements at 17 locations along the corridor. Therefore, after reductions due to TSP, Package 2 would potentially reduce travel time by 10 to 15 percent, and reduce delay time by 30 to 35 percent. Travel reliability would be greatly improved. Comfort and convenience would be improved due to station enhancements. Approximately 35 parking stalls would be permanently displaced in intersection areas along the corridor (approximately 2 percent of total corridor parking) and an additional approximately 80 stalls would be affected during peak periods. This package would require a total of ¼ acre of right-of-way at intersection areas distributed along the corridor.

Package 3 (Medium Level of BRT Options)

This package combines features from Packages 1 and 2. Not counting the TSP benefits, Package 3 would potentially reduce travel times by 15 to 20 percent, and would have delay time reductions of 45 to 50 percent. Travel time reliability would be greatly improved. Comfort and convenience would be greatly improved with the station enhancements. Approximately 35 parking stalls would be permanently displaced in intersection areas along the corridor. Also, because this package includes peak-period dedicated bus lanes, roughly 1,350 parking spaces would be affected during peak periods. This package would require ¼ acre of right-of-way at intersection and interchange areas distributed along the corridor.

Package 4 (High Level of BRT Options)

Package 4 would be similar to Package 3, but with a few more amenities. After travel time savings due to TSP, Package 4 would potentially reduce travel times by another 20 to 25 percent and would have delay time reductions of 50 to 55 percent. Transit customer comfort and convenience would be the highest for the four packages, due to the addition of special station branding and amenities such as passenger assistance phones and surveillance cameras. The potential effects on parking stalls and right-of-way requirements would be roughly 1,385 stalls along the corridor due to both intersection/interchange improvements and 24-hour right-side bus lanes.

Recommended Package of Refinements for the BRT Alternative

Based on the review of options for refinement of the BRT Alternative, Package 3 is recommended for further development and evaluation in the Project Analyses and Environmental Documentation phases. Package 3 will help to achieve significant travel time savings along with improvements to schedule reliability. Package 3 will also provide a higher-level brand and image for transit in this corridor and would be consistent with the BRT service levels proposed for the Wilshire BRT project. Potential effects on parking have been reduced by limiting use of dedicated bus lanes to peak periods. The intersection improvements being proposed to help improve speed and reliability for buses have initially been selected because they would have less potential effect on parking and right-of-way. These improvements can be reviewed further to confirm which improvements to include in the BRT Alternative. Some of these intersection improvements might be included within the TSM/TDM Alternative. Package 3 is recommended over Package 4 because of the 24-hour parking displacements that were assumed to be included in Package 4. Also, the extra features included in Package 4, such as level boarding (raised platforms) or driver assisted/guided access would be more challenging to implement and are not common to other Los Angeles Metro BRT projects.

List of Attachments

A. Typical Street Cross-Sections in the Study Area

B. Summary of On-Street Parking Inventory and Impacts

C. Existing Bus Stops Within the Study Area

D. Summary of On-Board Speed and Delay Survey

E. Conceptual Design Drawings of Intersection and Stop Improvements

Attachment A
Typical Street Cross-Sections in the Study Area

Typical Cross Section Widths Along BRT 6 Corridor

Section #	Crossing Roadways	Southbound/Eastbound						Northbound/Westbound					Curb to Curb Width	ROW Width
		SW/Planter	Shld/Park	Lane #3	Lane #2	Lane #1	Median	Lane #1	Lane #2	Lane #3	Shld/Park	SW/Planter		
Alantic Blvd (going north)														
1	**Whittier Blvd**	10'	8'		11'	11'	10'	11'	11'		8'	10'	70'	90'
	Repetto Ave													
2	Repetto Ave	6'		11'	11'	13'	14'	13'	11'	11'		6'	84'	96'
	Pomona Blvd													
3	Pomona Blvd	6'		12'	11'	13'	16'	13'	11'	12'		6'	88'	100'
	SR-60 WB Off-Ramp/1st St													
4	SR-60 WB Off-Ramp/1st St	10'		12'	11'	11'	11'	11'	11'		8'	14'	75'	99'
	Riggin St/Cesar Chavez													
5	Riggin St/Cesar Chavez	10'		13'	11'	11'	10'	11'	11'	13'		10'	80'	100'
	Floral Ave													
6	Floral Ave	10'		13'	11'	11'	10'	11'	11'	13'		10'	80'	100'
	Brightwood St													
7	Brightwood St	15'	8'		11'	11'	10'	11'	11'		8'	16'	70'	136'*
	Sevilla St													
8	Sevilla St	12'	8'		11'	11'	10'	11'	11'		8'	14'	70'	96'
	Cadiz St													
9	Cadiz St	12'	8'		11'	11'	10'	11'	11'		8'	14'	70'	96'
	Harding Ave													
10	Harding Ave	10'	8'		11'	11'	10'	11'	11'		8'	10'	70'	90'
	Garvey Ave													
11	Garvey Ave	13'	8'		11'	11'	10'	11'	11'		8'	12'	70'	95'
	Emerson Ave													
12	Emerson Ave	10'	8'		10'	11'	11'	11'	11'	10'	8'	15'	80'	105'
	Hellman Ave													
13	Hellman Ave	6'			14'	14'	8'	14'	14'			6'	64'	76'
	Glendon Way													
14	Glendon Way	9'	8'		12'	10'	10'	10'	11'		8'	9'	69'	87'
	Valley Blvd													
15	Valley Blvd	8'		12'	10'	10'	8.5'	9'	10'			7'	60'	75'
	Shorb St													
16	Shorb St	6'			12'	11'		11'	12'			6'	46'	58'
	Mission Rd													
17	Mission Rd	10'	8'		12'	11'		11'	12'		8'	8'	62'	80'
	Commonwealth Ave													
18	Commonwealth Ave	6'			13'	11'		11'	13'			8'	48'	62'
	Main St													
19	Main St	6'			15'	10'		10'	12'		8'	7'	55'	68'
	Wooddard St													
20	Wooddard St	6'			13'	10'		10'	13'			8'	46'	60'
	Alhambra Rd													
21	Alhambra Rd	8'			13'	10'		10'	13'			8'	46'	62'
	Pine St													
22	Pine St	6'			14'	11'	11'	11'	11'			6'	58'	70'
	Garfield Ave													
23	Garfield Ave	6'			14'	11'	11'	11'	11'			6'	58'	70'
	Huntington Dr													
Huntington Dr (going west)														
24	**Garfield Ave**	16'	10'	12'	12'	12'	18'	12'	12'	12'	10'	16'	110'	142'
	Marengo Ave													
25	Marengo Ave	16'	10'	12'	12'	12'	18'	12'	12'	12'	10'	16'	110'	142'
	Fair Oaks Ave													
Fair Oaks Ave (going north)														
26	Huntington Dr	16'	10'	12'	12'	12'	18'	12'	12'	12'	10'	16'	110'	142'
	Monterey Rd													
27	Monterey Rd	10	8		12	12	12	12	12		8	10	76'	96'
	Mission St													
28	Mission St	10	8		12	12	12	12	12		8	10	76'	96'
	I-110 Overpass													
29	I-110 Overpass	10	8		12	14	8	14	12		8	10	76'	96'
	State St													
30	State St	8	8		12	11		11	12		8	8	62'	78'
	Glenarm St													

Section #	Crossing Roadways	Southbound/Eastbound					Median	Northbound/Westbound					Curb to Curb Width	ROW Width
		SW/Planter	Shld/Park	Lane #3	Lane #2	Lane #1	Median	Lane #1	Lane #2	Lane #3	Shld/Park	SW/Planter		
31	Glenarm St **California Blvd**	8	8		12	11		11	12		8	8	62'	78'
32	California Blvd **Del Mar Blvd**	8	8		12	11		11	12		8	8	62'	78'
33	Del Mar Blvd Green St	10	8		12	11	2	11	12		8	8	64'	82'
34	Green St **Colorado Blvd**	9			11	10	9	10	11			10	51'	70'
Colorado Blvd (going east)														
35	Fair Oaks Ave **Los Robles Ave**	14	7		11	15		13	12		7	11	65'	90'
36	Los Robles Ave **Lake Ave**	14	7		12	11	10	11	12		7	14	70	98
37	Lake Ave **Hill Ave**	16	7		12	11	10	11	12		7	16	70'	102'
Hill Ave (going south)														
38	Colorado Blvd Del Mar Blvd	10	7		11	10	10	10	12			10	60	80
39	Del Mar Blvd California Blvd	10	12			12		12			12	10	48	68
Lake Ave (going south)														
40	Colorado Blvd Del Mar Blvd	14	7		12	11	8	11	12		7	14	68	96
41	Del Mar Blvd California Blvd	14	7		12	11	8	11	12		7	14	68	96
California Blvd (going west)														
42	**Hill Ave** Wilson Ave	10	8			11	10	11			8	10	48	68
43	Wilson Ave **Lake Ave**	10	8			11	10	11			8	10	48	68
44	Lake Ave Hudson Ave	10			11	10	10	10	11			10	52	72
45	Hudson Ave **Los Robles Ave**	10			14	11		11	14			10	50	70
46	Los Robles Ave Raymond Ave	10			14	11		11	14			10	50	70

Attachment B
Summary of On-Street Parking Inventory and Impacts

Table 1 - Summary of Parking Inventory and Impacts along BRT Trunk Line*

	Total	*East Los Angeles*	*Monterey Park*	*Alhambra*	*South Pasadena*	*Pasadena*
Number of existing parking spaces	1657	*12%*	*29%*	*17%*	*33%*	*9%*
Number of existing parking spaces with time-of-day restrictions	240	*15%*	*2%*	*83%*	*0%*	*0%*
Number of existing parking spaces impacted by proposed peak period bus lane	1348	*12%*	*35%*	*6%*	*35%*	*12%*
Number of existing parking spaces impacted by proposed intersection and stop improvements (peak period)	78	*35%*	*15%*	*26%*	*24%*	*0%*
Number of existing parking spaces impacted by proposed intersection and stop improvements (permanent)	34	*18%*	*26%*	*0%*	*56%*	*0%*

Table 2 - Summary of Existing Parking Spaces along BRT Trunk Line*

	Unrestricted	Time-of-day Restriction	Metered	Other Restrictions	(Yellow) Loading	(White) Passenger	(Green) <1 hour
Atlantic Blvd	400	240	0	266	4	29	23
Huntington Dr	219	0	0	0	0	0	2
Fair Oaks Ave	257	0	0	183	5	13	16
Total	876	240	0	449	9	42	41

Table 3 - Summary of On-Street Parking Impacted by Proposed Peak-Period Bus Lane - BRT Trunk Line*

	Unrestricted	Time-of-day Restriction	Metered	Other Restrictions	(Yellow) Loading	(White) Passenger	(Green) <1 hour
Atlantic Blvd	400	0	0	266	4	29	23
Huntington Dr	219	0	0	0	0	0	2
Fair Oaks Ave	203	0	0	168	5	13	16
Total	822	0	0	434	9	42	41

*BRT-6 Trunk Line begins at Atlantic Blvd/Whittier Blvd on the south and ends at Fair Oaks Ave/Del Mar Blvd on the north. The Trunk Line includes all of Atlantic Blvd, all of Huntington Dr, and parts of Fair Oaks Ave from Huntington Dr to Del Mar Blvd.

Attachment C
Existing Bus Stops Within the Study Area

Existing Bus Lines and Stations Along BRT 6 Corridor

		F - Far Side of Intersection N - Near Side of Intersection	METRO																																Montebello Bus Line		Monterey Park Spirit		Pasadena ARTS												Foothill Transit			
ID	Station		BRT 6		762		770		780		260		68		79		177		180		181		256		268		485		686		687		762		10		1	2	10		20		31		32		51		52		187		690	
			NB	SB	NB	SB	NB	SB	EB	WB	NB	SB	NB	SB	NB	SB	NB	SB	EB	WB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	WB	EB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	EB	WB	EB	WB
			F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N
1	Atlantic Blvd	Whittier Blvd	X	X	F	F					F	F																																										
2	Atlantic Blvd	Hubbard St									F	F																							F	F																		
3	Atlantic Blvd	6th St									F	F																							F	F																		
4	Atlantic Blvd	Eagle St									N	N																							N	N																		
5	Atlantic Blvd	4th St									F	N																							F	N																		
6	Atlantic Blvd	Pomona Blvd	X	X	N	F					N	F																							N	F																		
7	Atlantic Blvd	Cesar Chavez Ave (Riggin Ave)	X	X	F	F	F				F	F	F	F																					F	F																		
8	Atlantic Blvd	Floral Dr									F	F																																										
9	Atlantic Blvd	Brightwood St									F	F																										F																
10	Atlantic Blvd	El Repetto Dr									F	F																										F																
11	Atlantic Blvd	Sevilla St									F	F																									F	F																
12	Atlantic Blvd	Cadiz St	X	X							N	N																									N	N																
13	Atlantic Blvd	El Portal Pl									N	N																									N	N																
14	Atlantic Blvd	Harding Ave									N	N																									N	N																
15	Atlantic Blvd	Newmark Ave									N	F																									N	F																
16	Atlantic Blvd	Garvey Ave	X	X	F	F		F			F	F																									F	F																
17	Atlantic Blvd	Emerson Ave									F	F																									N																	
18	Atlantic Blvd	Hellman Ave									N																																											
19	Atlantic Blvd	Glendon Way									F	N																																										
20	Atlantic Blvd	Norwood Pl									F	F																																										
21	Atlantic Blvd	Valley Blvd	X	X	N	F					N	F																																										
22	Atlantic Blvd	San Marino Ave									F	F/N																																										
23	Atlantic Blvd	Mission Rd/Front St									F	N																																										
24	Atlantic Blvd	Commonwealth									F	F																																										
25	Atlantic Blvd	Main St	X	X	F	F					F	F																																										
26	Atlantic Blvd	Woodward Ave									N	N																																										
27	Atlantic Blvd	Alhambra	X	X							N	N																																										
28	Atlantic Blvd	2nd St/Spruce St									N	F																																										
29	Atlantic Blvd	Pine St									N	F																																										
30	Atlantic Blvd	Garfield Ave				F						F																								F																		
31	Huntington Dr	Garfield Ave	X	X	F						F				F												F																											
32	Huntington Dr	Court Ave									N	F/N			N	F/N											N	F/N																										
33	Huntington Dr	Fletcher Ave									N	F			N	F											N	F																										
34	Huntington Dr	Marengo	X	X	F	F					F	F			F	F											F	F																										
35	Huntington Dr	Primrose Ave													F/N	F											F/N	F																										
36	Fair Oaks Ave	Spruce St/Fair Oaks Ave									F	N																																										
37	Fair Oaks Ave	Rollin St									F/N	F																																										
38	Fair Oaks Ave	Monterey Rd									N	F																																										
39	Fair Oaks Ave	Mission St	X	X	F	F					F	F																																										
40	Fair Oaks Ave	Mound Ave									F/N	N																																										
41	Fair Oaks Ave	Raymond Hill Rd/Columbia St									N	F																																										
42	Fair Oaks Ave	Glenarm St	X	X	F	N					F	N																													F	N												
43	Fair Oaks Ave	Hurlbut St																																							F/N	F						F		F				
44	Fair Oaks Ave	Bellefontaine St									F	F																		F		F									F	F						F		F				
45	Fair Oaks Ave	Congress St									F	F																		F		F									F	F						F		F				
46	Fair Oaks Ave	California Blvd	X	X	F	F					F	F																		F		F									F	F					F	F	F	F				
47	Fair Oaks Ave	Bellevue Dr									F	F																		F		F									F	F						F		F				
48	Fair Oaks Ave	Del Mar Blvd	X	X	F	F					F	F																		F		F										F						F		F				
49	Fair Oaks Ave	Dayton St									F																																											
50	Fair Oaks Ave	Green St										F																		F		F				F																		

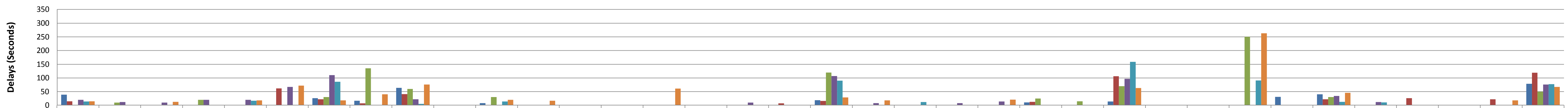
		F - Far Side of Intersection N - Near Side of Intersection	METRO																																Montebello Bus Line		Monterey Park Spirit		Pasadena ARTS												Foothill Transit			
			BRT 6		762		770		780		260		68		79		177		180		181		256		268		485		686		687		762		10		1	2	10		20		31		32		51		52		187		690	
ID	Station		NB	SB	NB	SB	NB	SB	EB	WB	NB	SB	NB	SB	NB	SB	NB	SB	EB	WB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	WB	EB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	EB	WB	EB	WB
			F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N
51	**Fair Oaks Ave**	**Colorado Blvd**	**X**	**X**	**F**	**F**					**F**	**F**																		**F**		**F**																						
52	Fair Oaks Ave	Holly St									F	N						N																																	N			F
53	Fair Oaks Ave	Walnut St									N	F						F																																	F			N
54	Fair Oaks Ave	Chestnut St									F																																				F		F					
55	Fair Oaks Ave	Villa St									F	N																																			F	N	F	N				
56	**Fair Oaks Ave**	**Orange Grove Blvd**	**X**	**X**		**F**					**F**	**F**																													**F**						**F**	**F**	**F**	**F**				
57	Fair Oaks Ave	Painter St									F	N																													F	N					F	N	F	N				
58	Fair Oaks Ave	Mountain St									F	F																													F	F						F		F				
59	Fair Oaks Ave	Jackie Robinson Center									F/N	F/N																													F/N	F/N												
60	Fair Oaks Ave	Hammond St									N	F																													N	F												
61	Fair Oaks Ave	Claremont St									F	F																													F	F												
62	**Fair Oaks Ave**	**Washington Blvd**	**X**	**X**							**F**	**F**																													**F**	**F**												
63	Fair Oaks Ave	Howard St									F																														F	F		F		F								
64	Fair Oaks Ave	Penn St									F																														F	F		F		F								
65	Fair Oaks Ave	Tremont St									F	F																													F	F		F		F								
66	Fair Oaks Ave	Montana St									F	F																													F	F		F		F								
67	**Fair Oaks Ave**	**Woodbury Rd**	**X**	**X**							**N**	**F**																													**N**	**F**		**F**		**F**								
68	Colorado Blvd	Fair Oaks Ave							F	F								F	F	F	F	F	F							F		F							F												F			
69	**Colorado Blvd**	**Raymond Ave**	**X**	**X**														**F**	**F**	**F**	**F**	**F**	**F**						**F**		**F**								**F**												**F**			
70	Colorado Blvd	Arroyo Pkwy																	F	F	F	F	F						F	F	F	F							F												F	F		
71	Colorado Blvd	Marengo Ave																	F	F	F	F	F	F					F	F	F	F							F													F		
72	Colorado Blvd	Garfield Ave																	F	F	F	F	F	F					F	F	F	F							F													F		
73	**Colorado Blvd**	**Los Robles Ave**	**X**	**X**					**F**	**F**									**F**	**F**	**F**	**F**	**F**	**F**					**F**	**F**		**F**							**F**												**F**	**F**		
74	Colorado Blvd	Oakland Ave																					F	F					F	F									F															
75	Colorado Blvd	Madison Ave																	F	F	F	F	F	F					F	F									F															
76	Colorado Blvd	El Molino Ave																					F	F					F	F									F												F	F		
77	Colorado Blvd	Oak Knoll Ave																	F		F		F						F																									
78	Colorado Blvd	Hudson Ave																					F	F					F	F									F															
79	Colorado Blvd	Lake Ave	X	X					F	F									F	F	F	F	F	F					F	F									F													F		
80	Colorado Blvd	Mentor Ave																			F		F						F																									
81	Colorado Blvd	Catalina Ave																					F	F					F	F																					F	F		
82	Colorado Blvd	Wilson Ave																			F	F	F	F					F	F																								
83	Colorado Blvd	Michigan Ave																				F		F						F																								
84	Colorado Blvd	Chester Ave																			F		F						F																									
85	**Colorado Blvd**	**Hill Ave**	**X**	**X**					**F**	**F**											**F**	**F**		**F**					**F**	**F**																					**F**	**F**		
86	**Hill Ave**	**Del Mar Blvd**	**X**	**X**													**F**																																					
87	Hill Ave	San Pasqual St															F	F																																				
88	**Hill Ave**	**California Blvd**	**X**	**X**														**F**																																				
89	California Blvd	Caltech															F	N																																				
90	California Blvd	Wilson Ave															F	F																																				
91	**California Blvd**	**Lake Ave**	**X**	**X**													**F**	**F**																							**F**	**F**												
92	California Blvd	Hudson Ave															F	F																							F	F												
93	California Blvd	El Molino Ave															F	F																							F	F												
94	**California Blvd**	**Los Robles Ave**	**X**	**X**													**F**	**F**																							**F**	**F**												
95	California Blvd	Marengo Ave															F	F																								F												
96	California Blvd	Arroyo Pkwy															F	F						F																		F												
97	Raymond Ave	Glenarm St																											F		F																F		F					
98	Raymond Ave	Fillmore St																											F		F																F		F					
99	Raymond Ave	California Blvd															F						F						F		F																F		F					
100	Glenarm St	Fair Oaks Ave																											F		F										F													
101	Woodbury Rd	Glenrose Ave																																										F		F								
102	**Woodbury Rd**	**Lincoln Ave**	**X**	**X**																					**F**	**N**																												
103	Woodbury Rd	Casitas Ave																							F	F																												

		F - Far Side of Intersection N - Near Side of Intersection	METRO																																Montebello Bus Line		Monterey Park Spirit		Pasadena ARTS												Foothill Transit			
ID	Station		BRT 6		762		770		780		260		68		79		177		180		181		256		268		485		686		687		762		10		1	2	10		20		31		32		51		52		187		690	
			NB	SB	NB	SB	NB	SB	EB	WB	NB	SB	NB	SB	NB	SB	NB	SB	EB	WB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	WB	EB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	EB	WB	EB	WB
			F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N	F/N
104	Woodbury Rd	Windsor Ave																							N	F																												
105	Oak Grove Dr	Berkshire Pl																N							N	N																							N					
106	**Oak Grove Dr**	**Foothill Blvd**	**X**	**X**													**F**	**N**							**F**	**N**																							**F**	**N**				

Attachment D
Summary of On-Board Speed and Delay Survey

Figure 1 - Results from the Speed and Delay Survey of Metro Rapid Route 720; Total Delays Shown

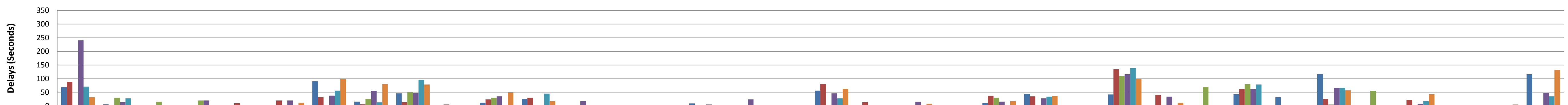
Atlantic Blvd - Northbound Runs - Total Delays



	Whittier Blvd	Hubbard St	6th St	Eagle St	4th St	Beverly Blvd	Pomona Blvd	US 60 I/C	Cesar Chavez/Riggin Ave	Mall Entrance	Floral Dr	Brightwood St	El Repetto Dr	Sevilla St	Cadiz St	El Portal Pl	Harding Ave	Newmark Ave	Garvey Ave
Dec 18 AM	39	0	0	0	0	0	26	17	64	0	8	0	0	0	0	0	0	0	19
Dec 19 AM	15	0	0	0	0	62	22	7	41	0	0	0	0	0	0	0	0	7	16
Dec 10 PM	0	10	0	20	0	0	30	135	60	0	30	0	0	0	0	0	0	0	120
Dec 18 PM	20	12	10	20	20	67	110	0	22	0	0	0	0	0	0	0	10	0	107
Dec 19 PM	14	0	0	0	17	0	86	0	5	0	14	0	0	0	0	0	0	0	90
Dec 20 PM	15	0	13	0	18	72	18	40	76	0	20	17	0	0	61	0	0	0	29

	BofA driveway	Emerson Ave	ATS Garage Entrance	Hellman Ave	Glendon Way	Norwood Pl	Valley Blvd	Shorb St	San Marino Ave	Mission Rd/Front St	Commonwealth	Main St	Woodward Ave	Alhambra	2nd St	Pine St	Garfield Ave
Dec 18 AM	0	0	0	0	11	0	14	0	0	0	31	40	0	0	0	0	79
Dec 19 AM	0	0	0	0	13	0	106	0	0	0	0	22	0	26	0	22	119
Dec 10 PM	0	0	0	0	25	15	70	0	0	250	0	30	0	0	0	0	50
Dec 18 PM	8	0	8	14	0	0	97	0	0	0	0	34	12	0	0	0	76
Dec 19 PM	0	12	0	0	0	0	159	0	0	91	0	13	11	0	0	0	77
Dec 20 PM	18	0	0	21	0	0	63	0	0	263	0	46	0	0	0	18	67

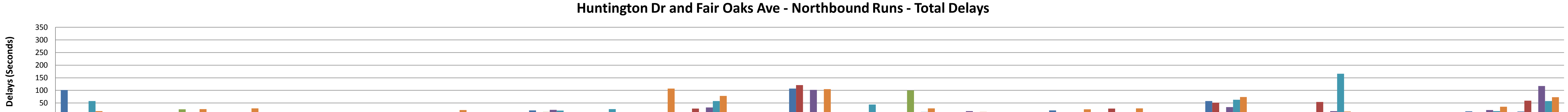
Atlantic Blvd - Southbound Runs - Total Delays



	Whittier Blvd	Hubbard St	6th St	Eagle St	4th St	Beverly Blvd	Pomona Blvd	US 60 I/C	Cesar Chavez/Riggin Ave	Mall Entrance	Floral Dr	Brightwood St	El Repetto Dr	Sevilla St	Cadiz St	El Portal Pl	Harding Ave	Newmark Ave	Garvey Ave
Dec 18 AM	69	6	0	0	0	0	90	16	46	0	12	26	0	0	0	9	0	0	56
Dec 19 AM	89	0	0	0	10	20	32	6	14	5	24	30	0	0	0	0	0	0	81
Dec 10 PM	0	30	15	20	0	0	0	25	50	0	30	0	0	0	0	0	0	0	0
Dec 18 PM	240	14	0	20	0	20	38	55	47	0	35	0	17	0	0	5	24	0	46
Dec 19 PM	71	28	0	0	0	0	56	13	96	0	0	45	0	0	0	0	0	0	28
Dec 20 PM	32	0	0	0	0	12	99	80	79	0	49	18	0	0	0	0	0	0	63

	BofA driveway	Emerson Ave	ATS Garage Entrance	Hellman Ave	Glendon Way	Norwood Pl	Valley Blvd	Shorb St	San Marino Ave	Mission Rd/Front St	Commonwealth	Main St	Woodward Ave	Alhambra	2nd St	Pine St	Garfield Ave
Dec 18 AM	0	0	0	11	44	0	42	0	0	43	32	117	0	0	0	0	116
Dec 19 AM	14	0	0	37	35	0	135	40	0	62	0	26	0	22	0	0	0
Dec 10 PM	0	0	0	30	0	0	110	0	70	80	0	5	55	0	0	0	0
Dec 18 PM	0	15	0	16	28	0	116	34	0	62	0	67	0	8	0	0	48
Dec 19 PM	0	0	0	0	34	0	138	0	0	79	0	67	0	17	0	0	35
Dec 20 PM	0	8	0	18	36	0	99	12	0	0	0	57	0	43	0	5	132

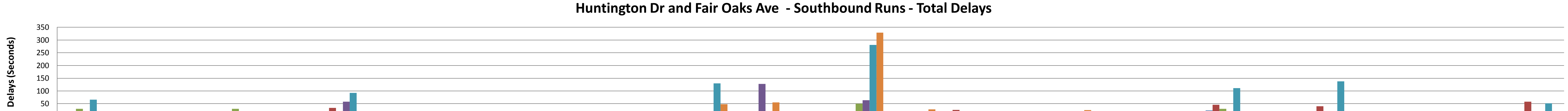
Huntington Dr and Fair Oaks Ave - Northbound Runs - Total Delays



	Garfield Ave	Court Ave	Fletcher Ave	Marengo	Primrose Ave	Spruce St/Huntington	Oak St	Rollin St	Bank St	Monterey Rd	Oxley St	El Centro St	Mission St	Hope St
Dec 18 AM	101	0	0	0	0	0	14	0	0	21	0	0	7	0
Dec 19 AM	12	0	0	0	0	0	0	0	0	0	0	0	28	0
Dec 10 PM	5	0	25	5	0	5	0	0	0	15	0	10	0	0
Dec 18 PM	10	0	12	0	0	0	0	0	0	23	8	0	32	0
Dec 19 PM	58	0	0	0	0	0	0	0	0	20	26	0	58	0
Dec 20 PM	18	0	26	29	0	0	12	22	0	0	0	107	78	0

	Grevalia S of I-110	State St N of 110	Raymond Hill/Columbia	Glenarm St	Hurlbut St	Bellefontaine St	Fillmore St	Congress St	California Blvd	Bellevue Dr	Del Mar Blvd	Valley St	Dayton St	Green St	Colorado Blvd
Dec 18 AM	107	0	0	10	0	21	0	9	58	0	12	0	0	17	16
Dec 19 AM	121	0	12	0	0	7	28	0	51	0	54	0	0	0	59
Dec 10 PM	0	0	100	0	10	0	0	0	0	0	0	0	0	0	0
Dec 18 PM	102	0	0	18	0	0	0	7	34	0	18	0	0	22	117
Dec 19 PM	0	44	15	10	0	9	0	0	63	0	166	0	0	18	58
Dec 20 PM	105	0	29	15	0	25	29	14	74	0	16	11	0	35	73

Huntington Dr and Fair Oaks Ave - Southbound Runs - Total Delays



	Garfield Ave	Court Ave	Fletcher Ave	Marengo	Primrose Ave	Spruce St/Huntington	Oak St	Rollin St	Bank St	Monterey Rd	Oxley St	El Centro St	Mission St	Hope St
Dec 18 AM	0	0	0	11	0	0	0	0	0	0	0	0	0	0
Dec 19 AM	14	0	0	0	0	34	0	20	0	13	0	0	14	0
Dec 10 PM	30	0	0	30	0	20	20	0	0	15	0	15	10	0
Dec 18 PM	13	0	0	11	0	58	20	0	0	0	0	0	17	128
Dec 19 PM	66	0	0	12	0	93	13	0	0	0	0	0	130	0
Dec 20 PM	15	0	0	0	0	0	20	21	0	0	0	0	48	55

	Grevalia south of I-110	State St north of 110	Raymond Hill Rd/Columbia	Glenarm St	Hurlbut St	Bellefontaine St	Fillmore St	Congress St	California Blvd	Bellevue Dr	Del Mar Blvd	Valley St	Dayton St	Green St	Colorado Blvd
Dec 18 AM	0	0	0	0	0	0	0	0	24	0	0	0	0	0	18
Dec 19 AM	0	0	13	26	0	0	0	0	46	0	40	0	0	0	58
Dec 10 PM	0	50	20	20	0	0	0	0	30	0	0				
Dec 18 PM	0	64	0	5	0	0	0	0	15	0	14	0	0	0	20
Dec 19 PM	0	281	0	4	0	0	0	13	111	0	138	0	0	0	52
Dec 20 PM	0	329	28	0	0	25	0	20	13	0	10	0	0	0	10

Figure 2A - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 10 PM Northbound Run

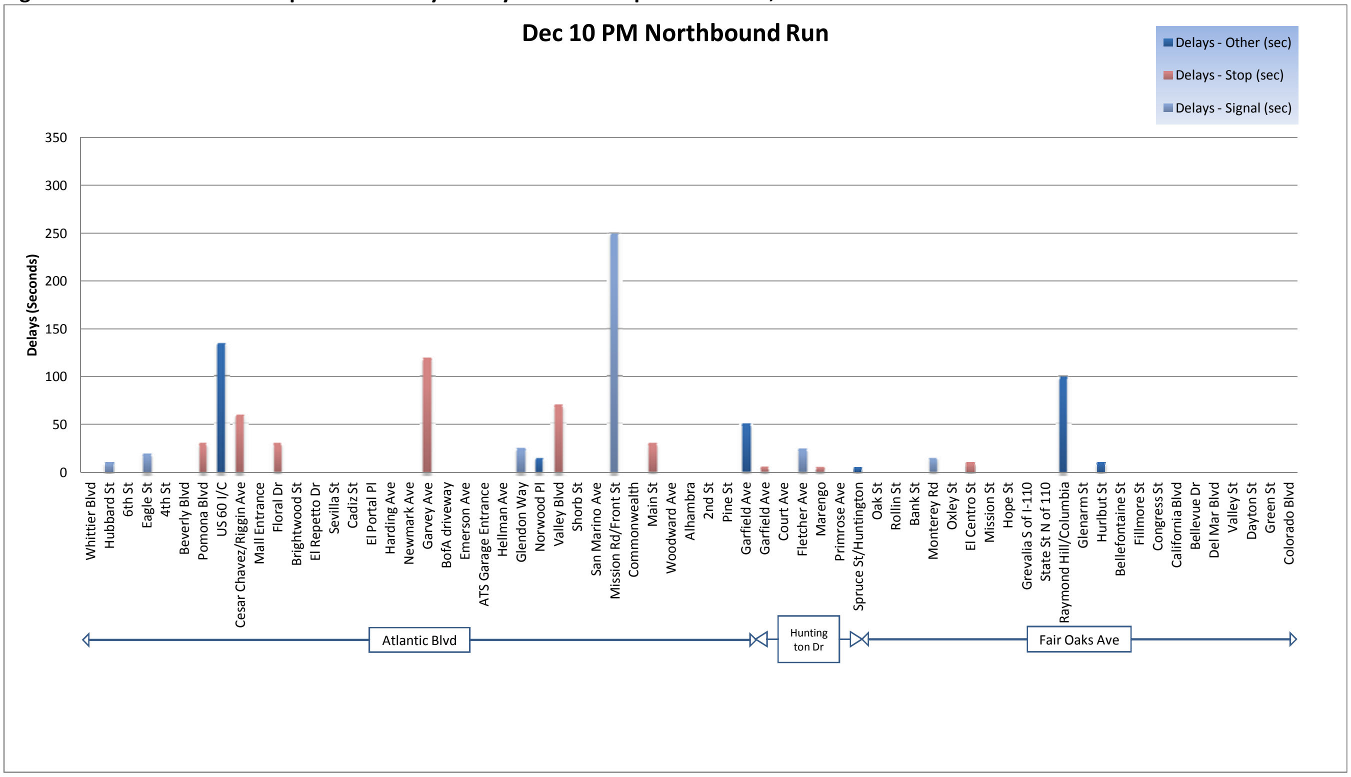


Figure 2B - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 10 PM Southbound Run

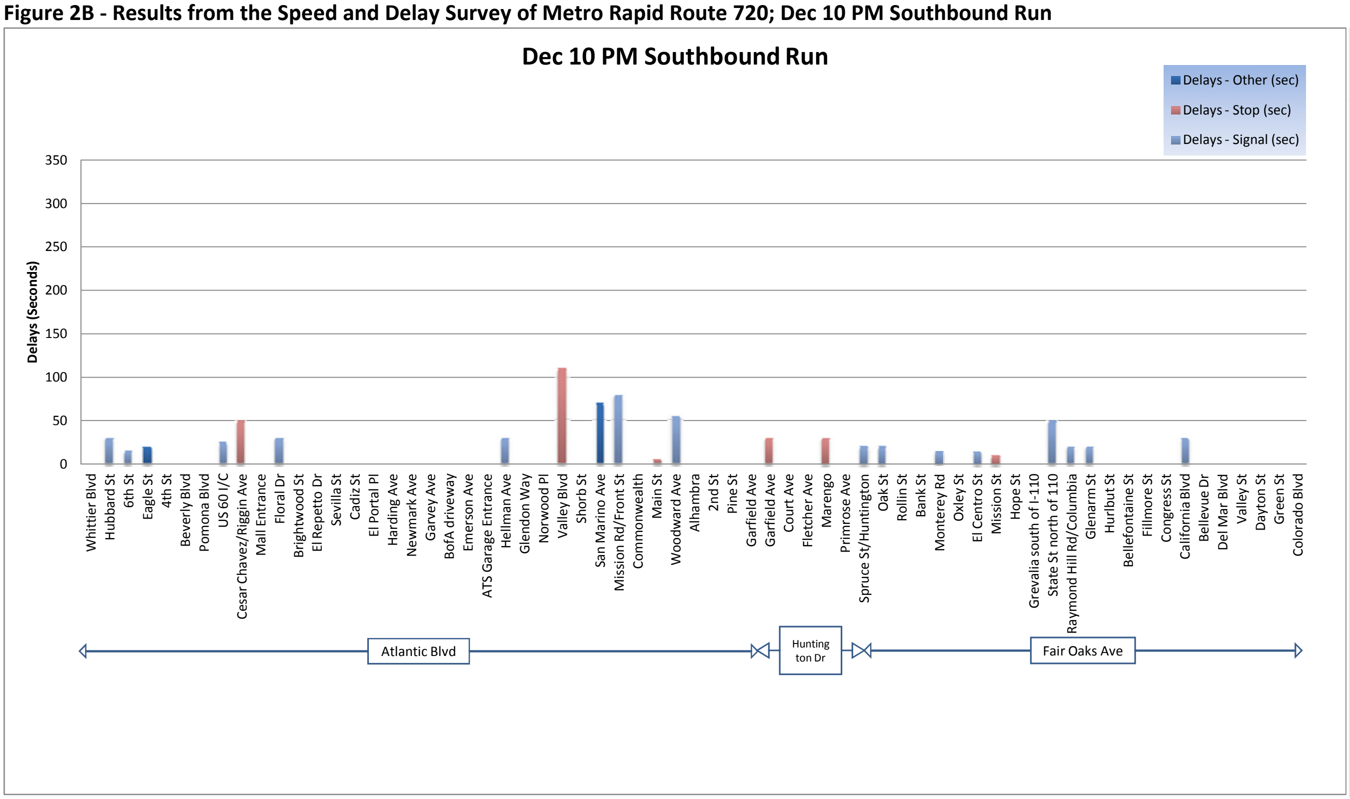


Figure 3A - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 18 AM Northbound Run

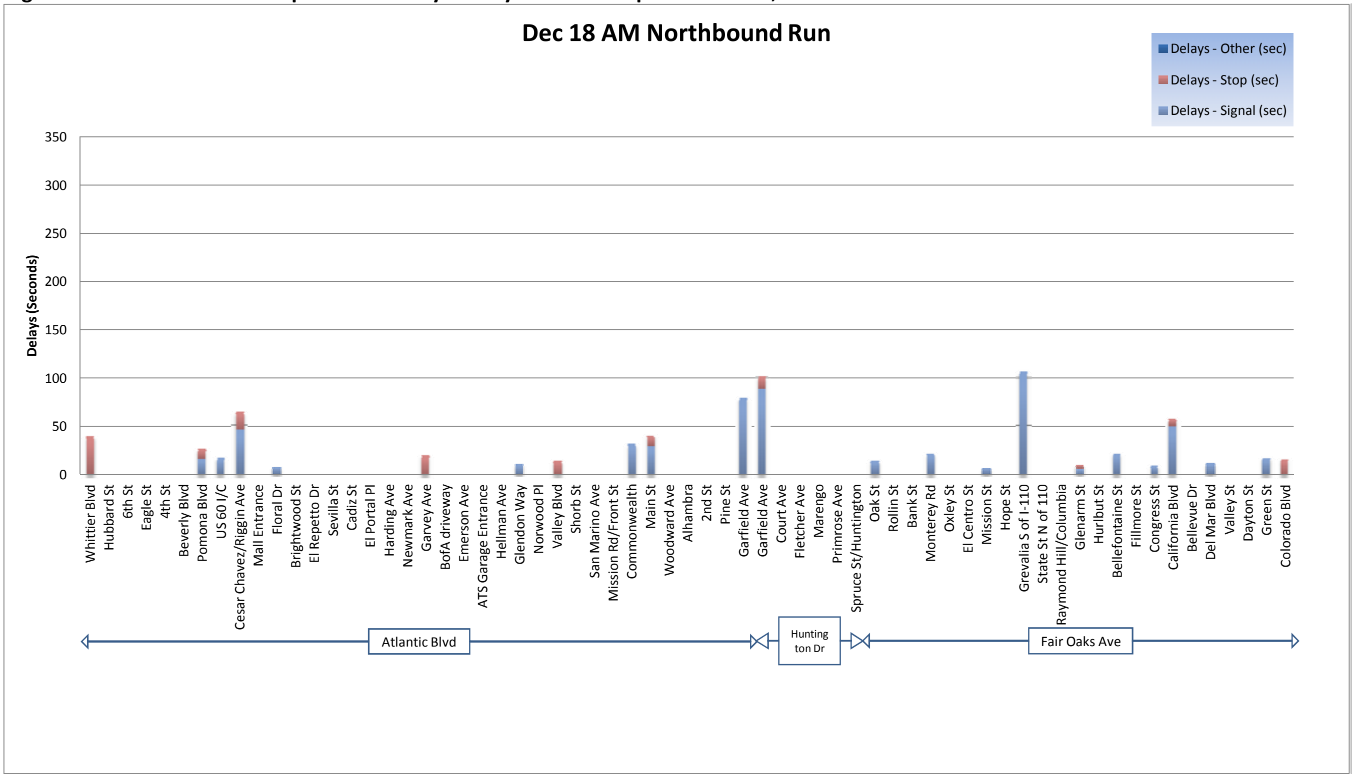


Figure 3B - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 18 AM Southbound Run

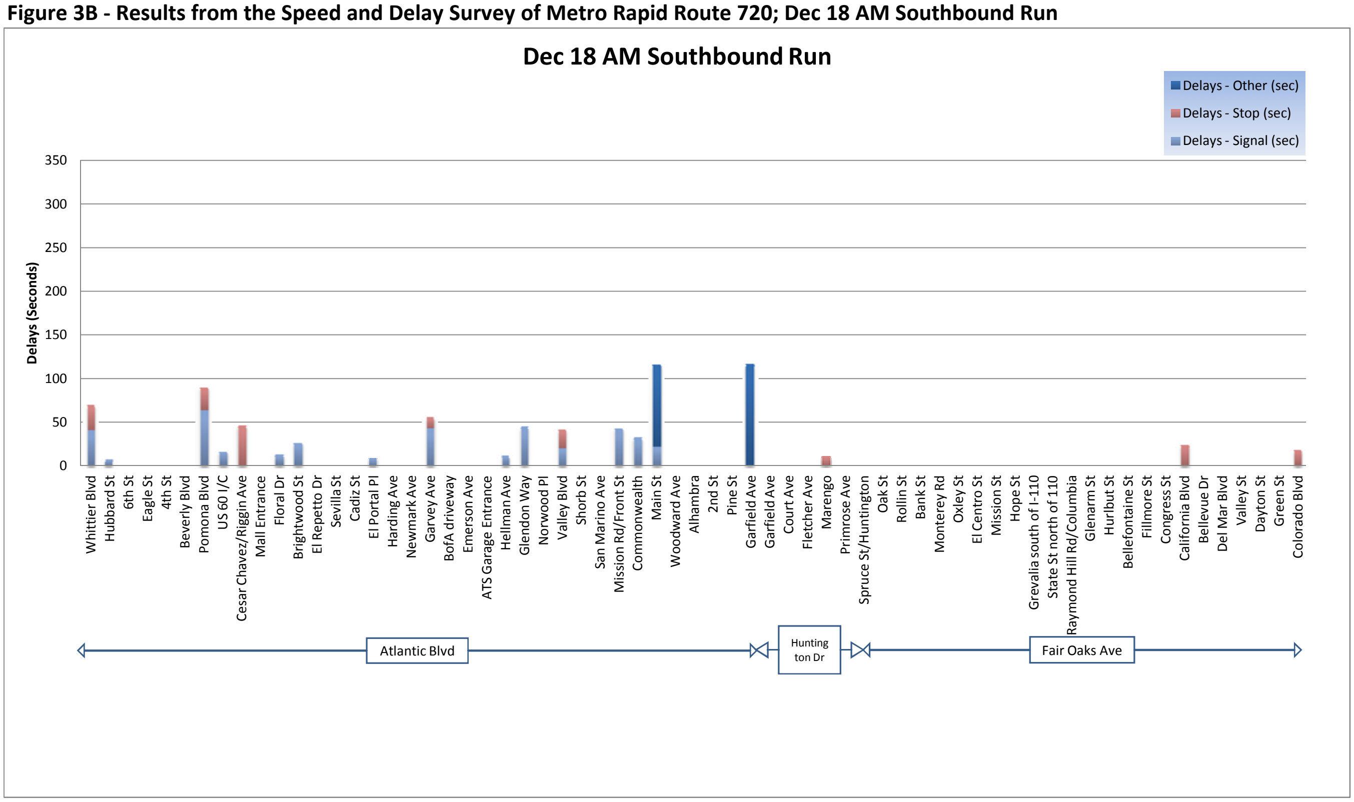


Figure 4A - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 18 PM Northbound Run

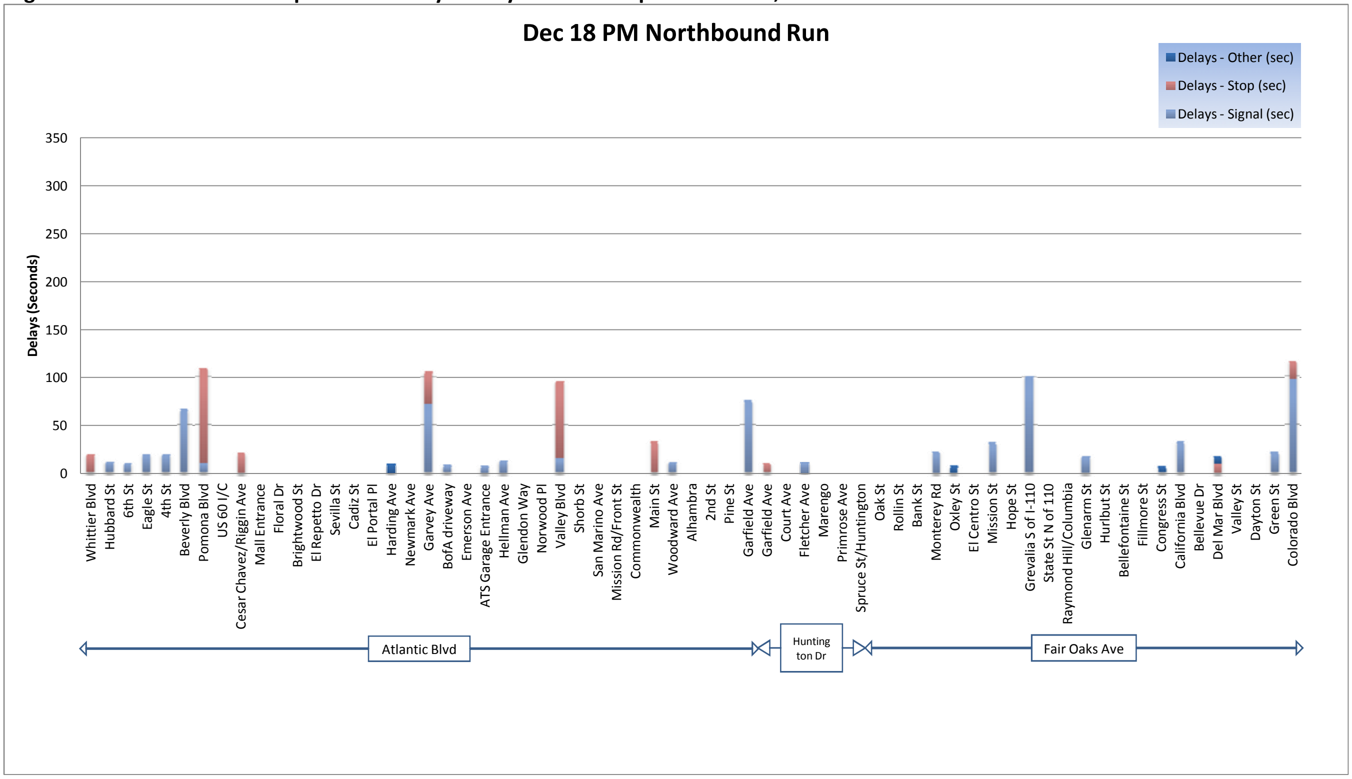


Figure 4B - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 18 PM Southbound Run

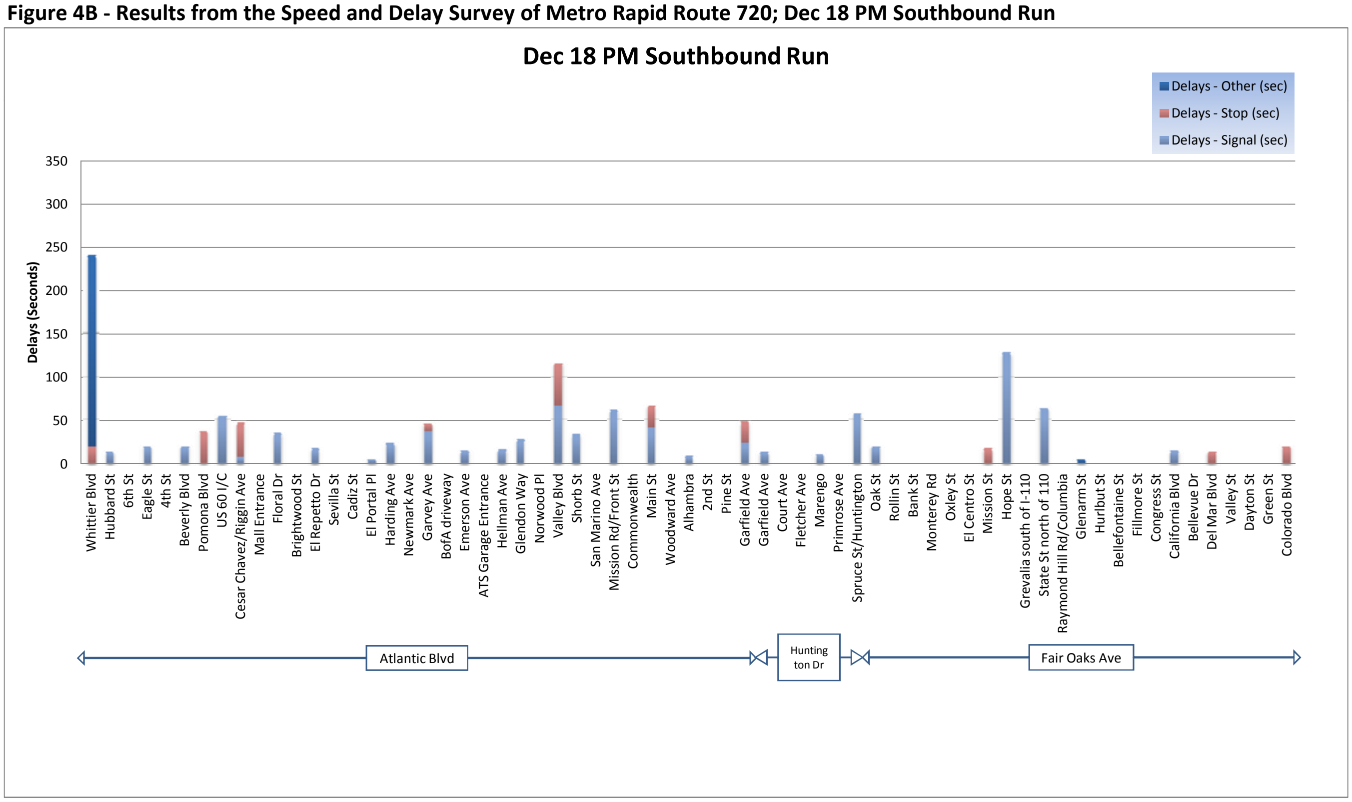


Figure 5A - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 19 AM Northbound Run

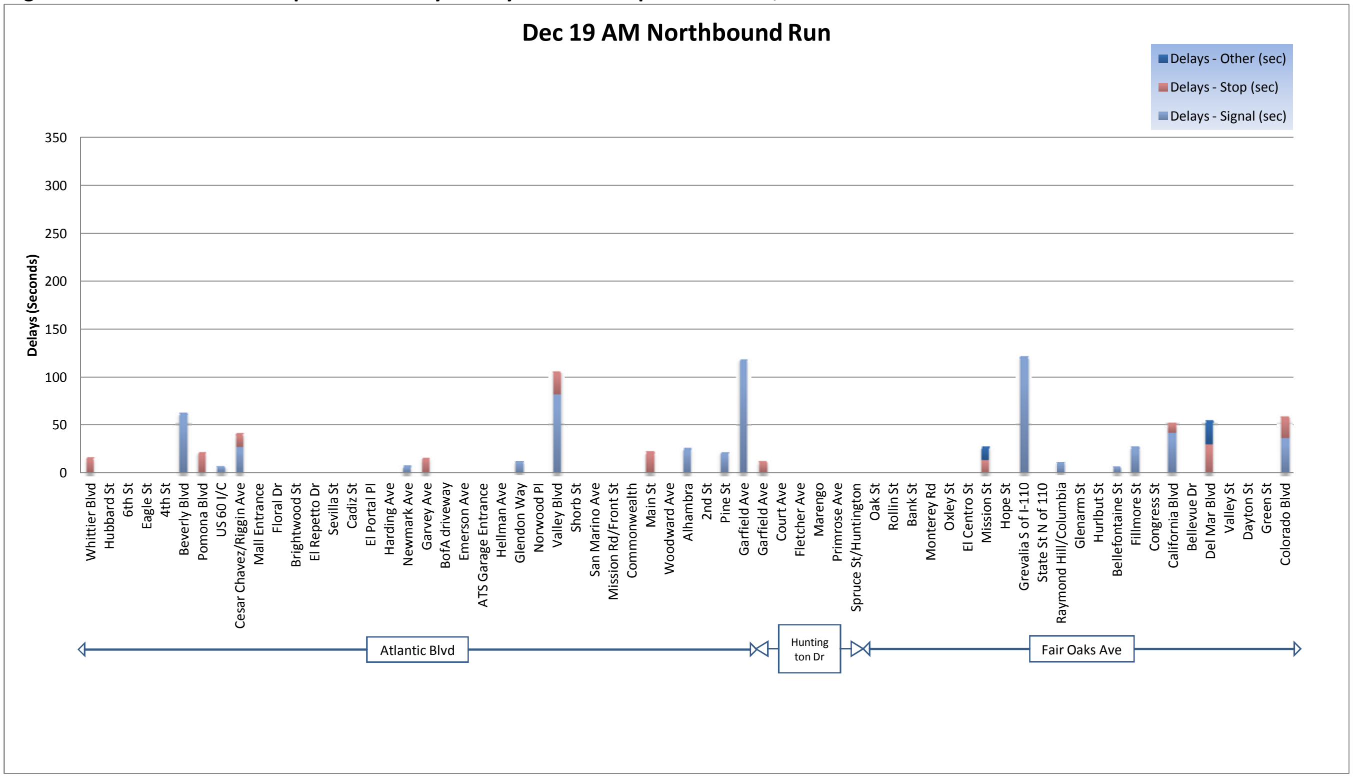


Figure 5B - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 19 AM Southbound Run

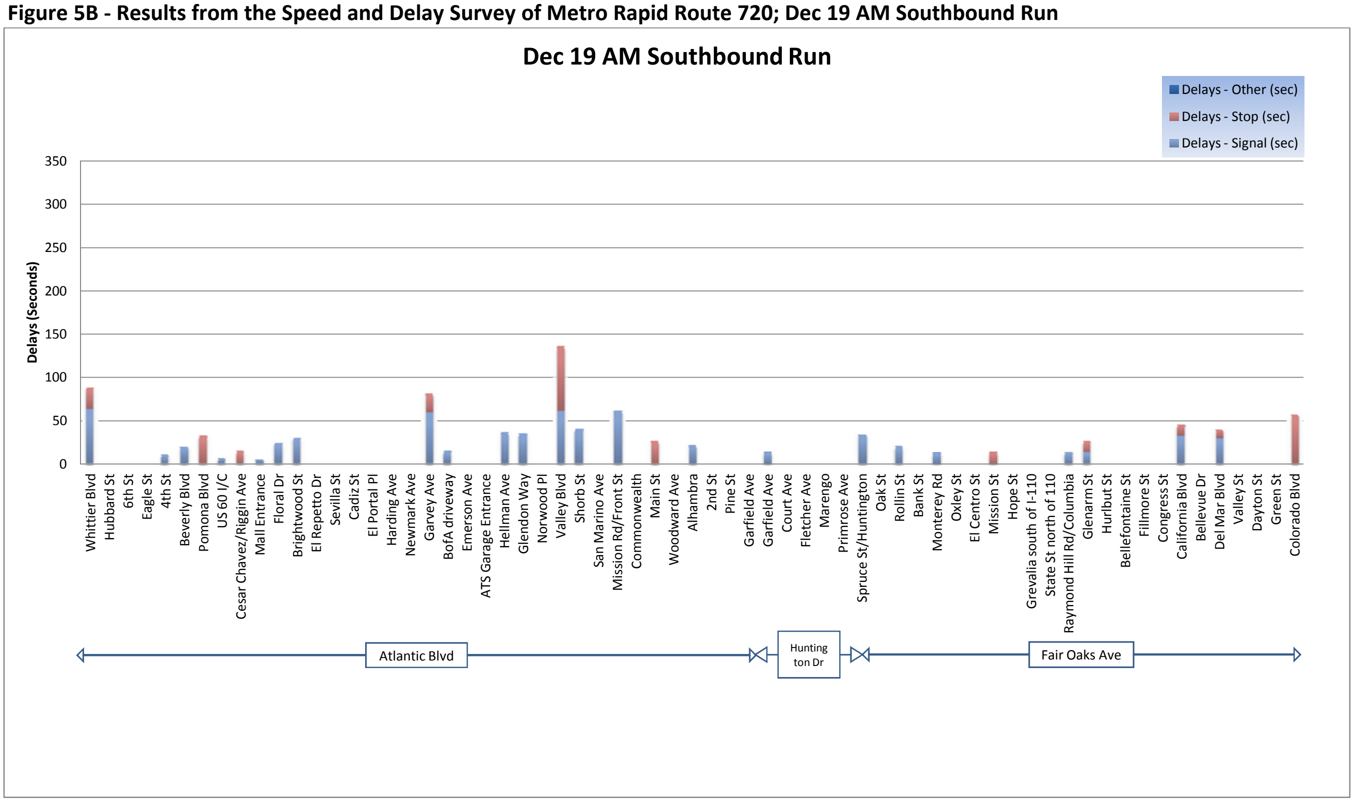


Figure 6A - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 19 PM Northbound Run

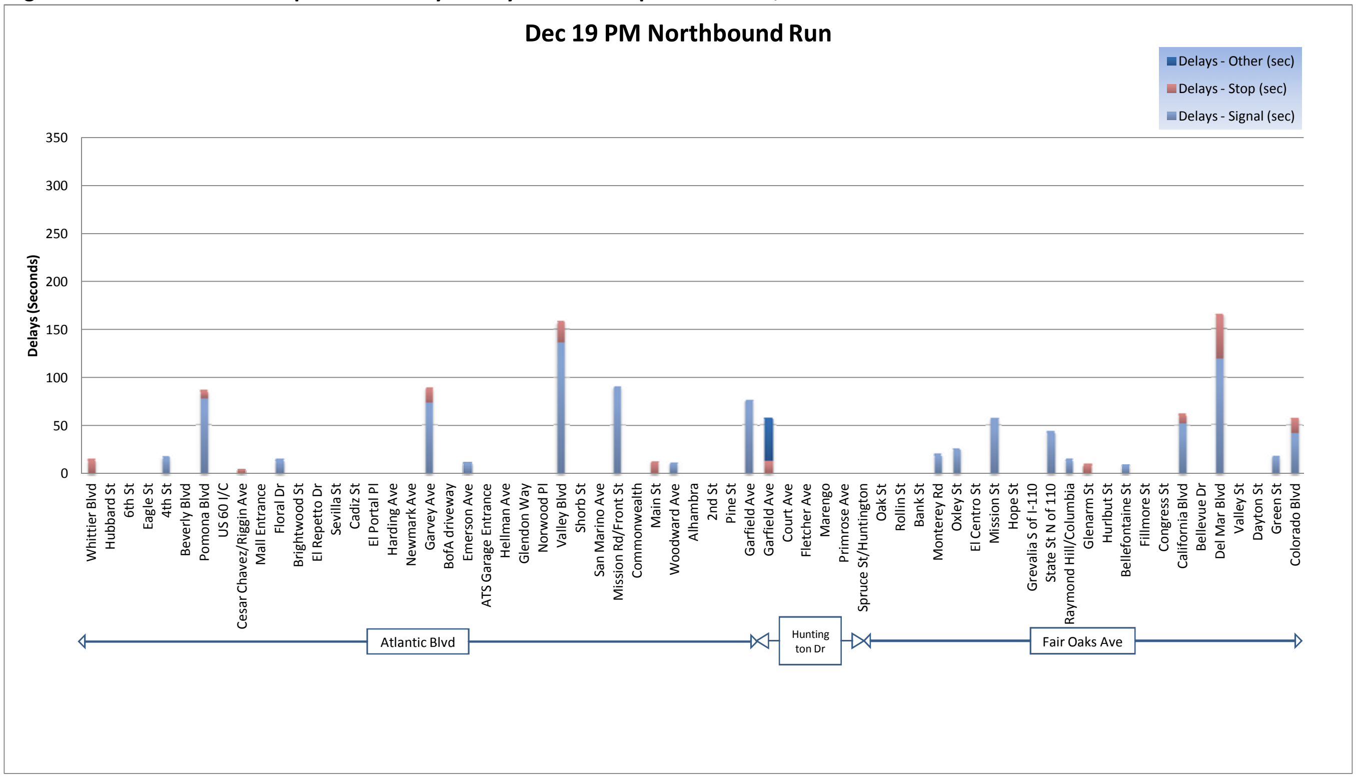


Figure 6B - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 19 PM Southbound Run

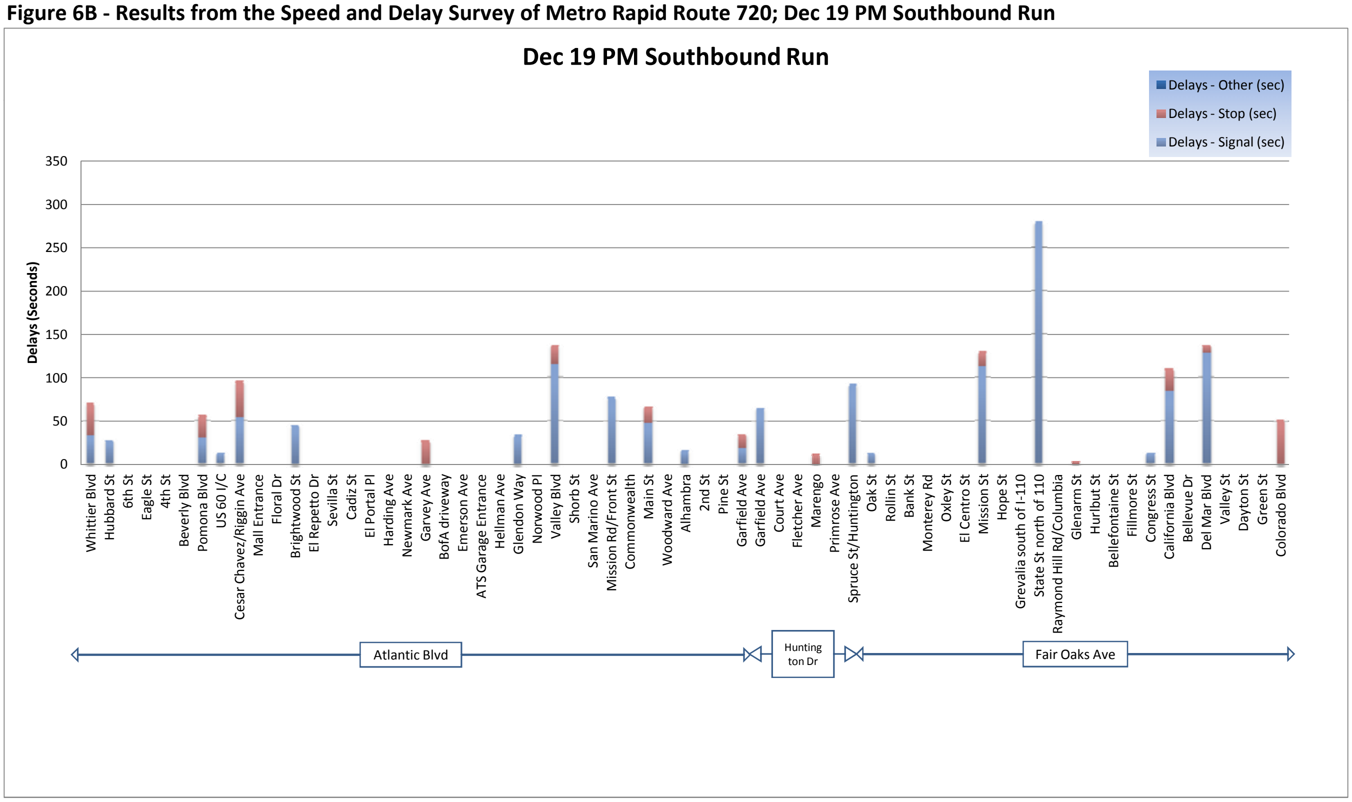


Figure 7A - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 20 PM Northbound Run

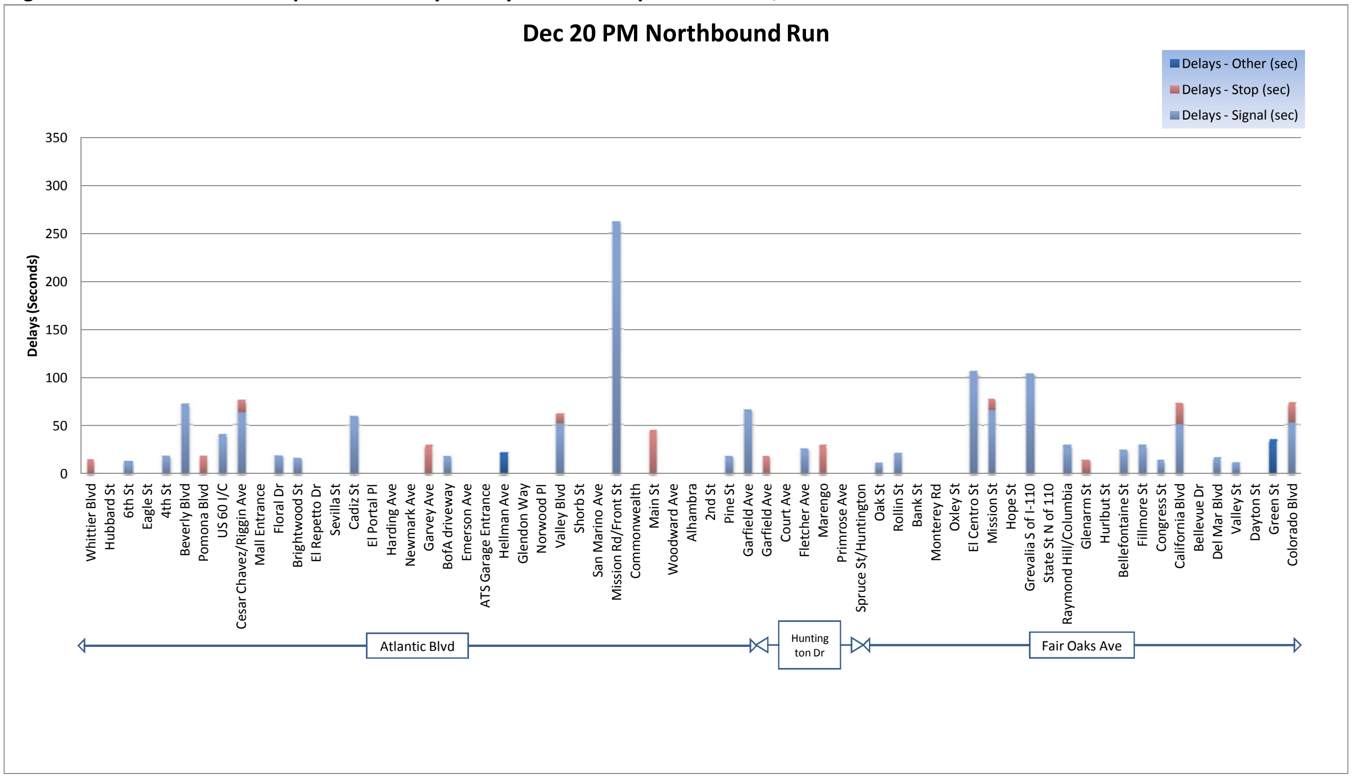
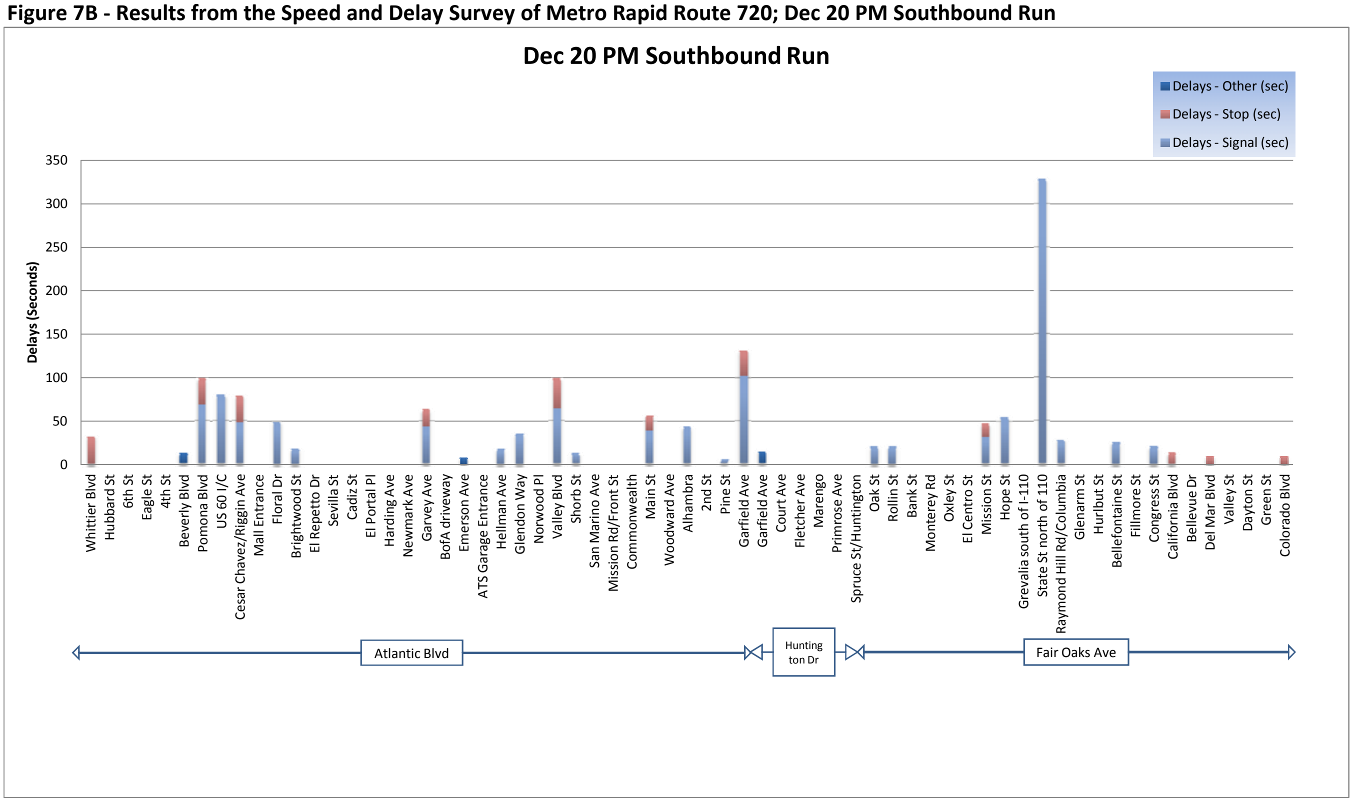


Figure 7B - Results from the Speed and Delay Survey of Metro Rapid Route 720; Dec 20 PM Southbound Run



Attachment E
Conceptual Design Drawings of Intersection and Stop Improvements

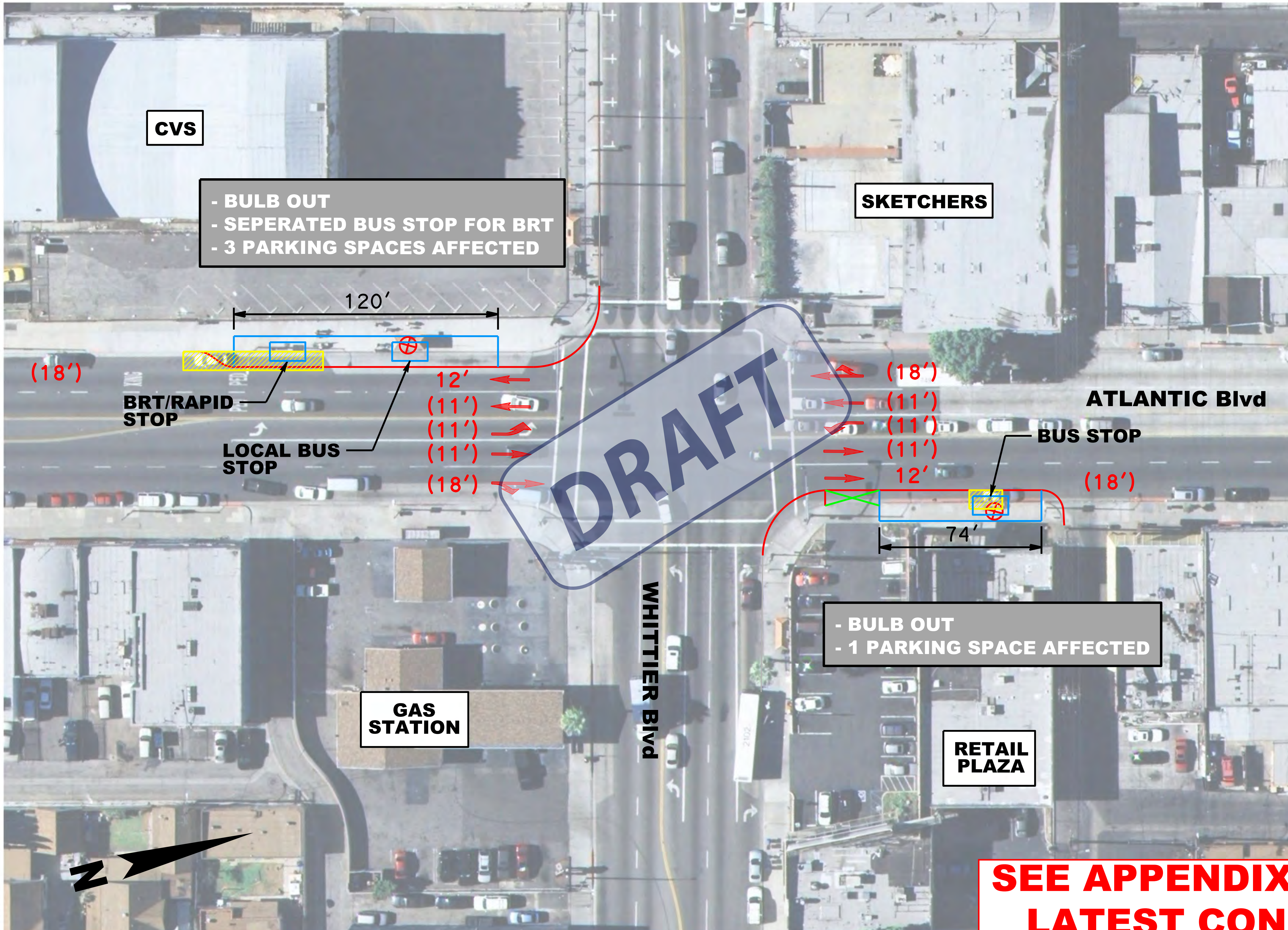
SR 710 Study

Review of Bus Rapid Transit Alternative Refinement Options

Legend: Intersection - Proposed stops in BRT 6 **X** - Recommended X - Feasible but not recommended

Intersection		Queue Jump Treatments								Bulb Out		Bus Bay Acceleration Lane		Separate Bus Stop for BRT		Included in TSM/TDM Alt.?	# of Parking Spaces Impacted (Permanent)		# of Parking Spaces Impacted (Peak-Period Only)		Impact To Private Property (Square Ft)	
		Right Turn Lane	Right Turn w/ Buses Exempt	Added Bus/Thru Lane	Recovery Lane	Right Turn Lane	Right Turn w/ Buses Exempt	Added Bus/Thru Lane	Recovery Lane													
		NB				SB				NB	SB	NB	SB	NB	SB	Y/N	NB	SB	NB	SB	NB	SB
1	Atlantic Blvd & Whittier Blvd									X	X				X	No	1	3	0	0	0	0
2	Atlantic Blvd & Beverly Blvd	X					X		X					N/A	N/A	No	0	0	2	1	800	0
3	Atlantic Blvd & Pomona Blvd						X		X		X		X	X	X	No	0	0	8	0	0	0
4	Atlantic Blvd & 60 Fwy			X				X						N/A	N/A	No	0	0	16	0	0	0
5	Atlantic Blvd & Cesar Chavez/ Riggin Ave			X										X	X	No	0	0	12	0	0	0
6	Atlantic Blvd & Garvey Ave	X		X	X		X		X	X	X	X	X	X		No	9	0	0	0	1700	550
7	Atlantic Blvd & Valley Blvd	X		X	X		X		X	X	X	X	X			No	0	0	0	20	2800	0
8	Atlantic Blvd & Mission Rd/ Front St						X	X	X					N/A	N/A	No	0	0	0	0	0	2500
9	Atlantic Blvd & Main St											X		X	X	No	0	0	0	0	0	0
10	Atlantic Blvd & Garfield Ave										X			N/A	X	**Yes**	TBD	TBD	TBD	TBD	TBD	TBD
11*	Huntington Dr & Garfield Ave									X					N/A	**Yes**	TBD	TBD	TBD	TBD	TBD	TBD
12*	Fair Oaks Ave & Huntington													N/A	N/A	**Yes**	TBD	TBD	TBD	TBD	TBD	TBD
13	Fair Oaks Ave & Mission St			X										X		No	0	0	12	0	0	0
14	Fair Oaks Ave & Hope St			X										N/A	N/A	No	0	0	7	0	0	N/A
15	Fair Oaks Ave & Grevelia/I-110	X		X					X					N/A	N/A	Yes	4	8	0	0	1600	0
16	Fair Oaks Ave & State St/I-110	X		X			X		X			X	X	N/A	N/A	Yes	7	0	0	0	0	0
17	Fair Oaks Ave & California Blvd		X		X					X	X	X	X		X	No	2	0	0	0	0	N/A

* Conceptual design drawing of this intersection is not included. Intersection improvements to be developed as part of the TSM/TDM Alternative.



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

0 25 50 100

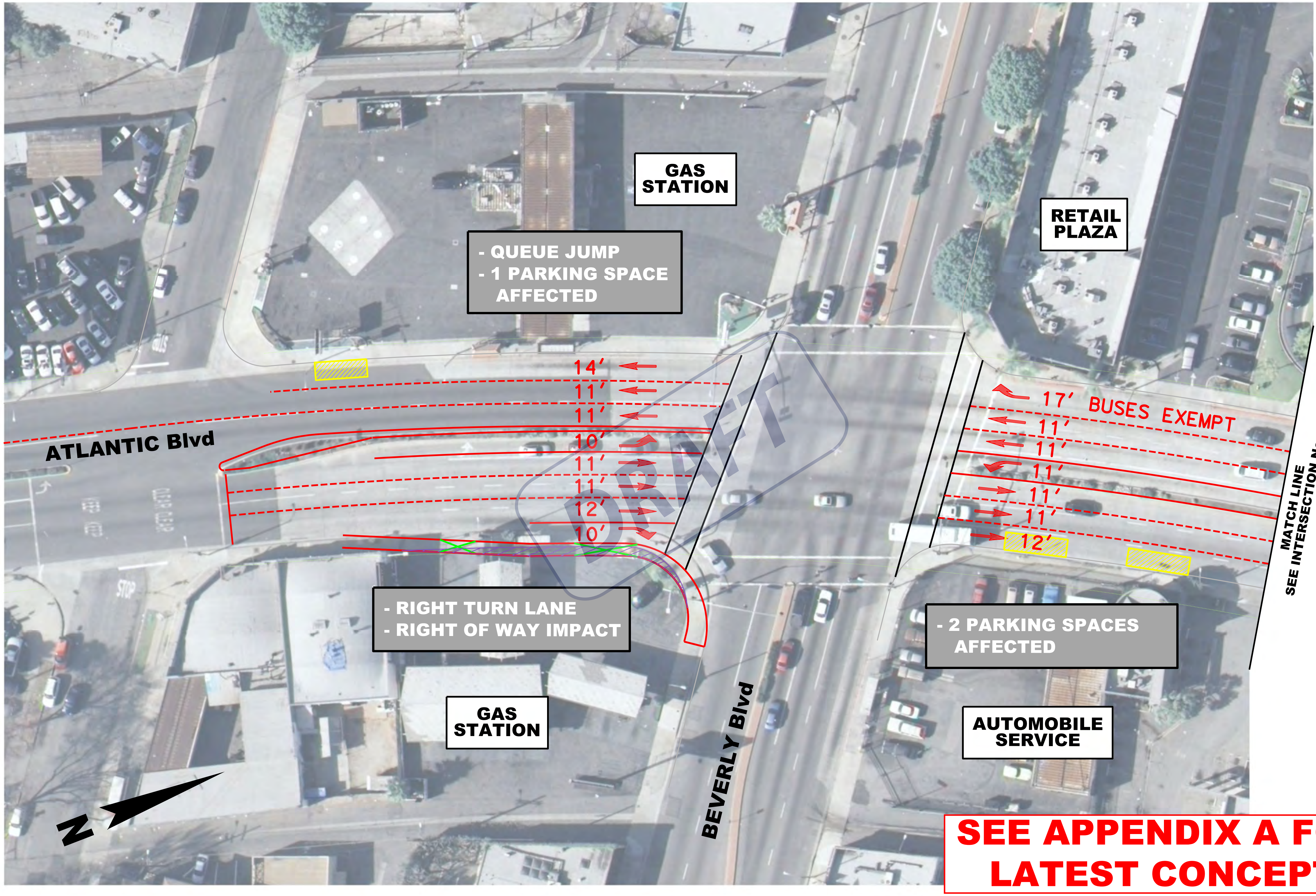
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 1: Atlantic Blvd & Whittier Blvd

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

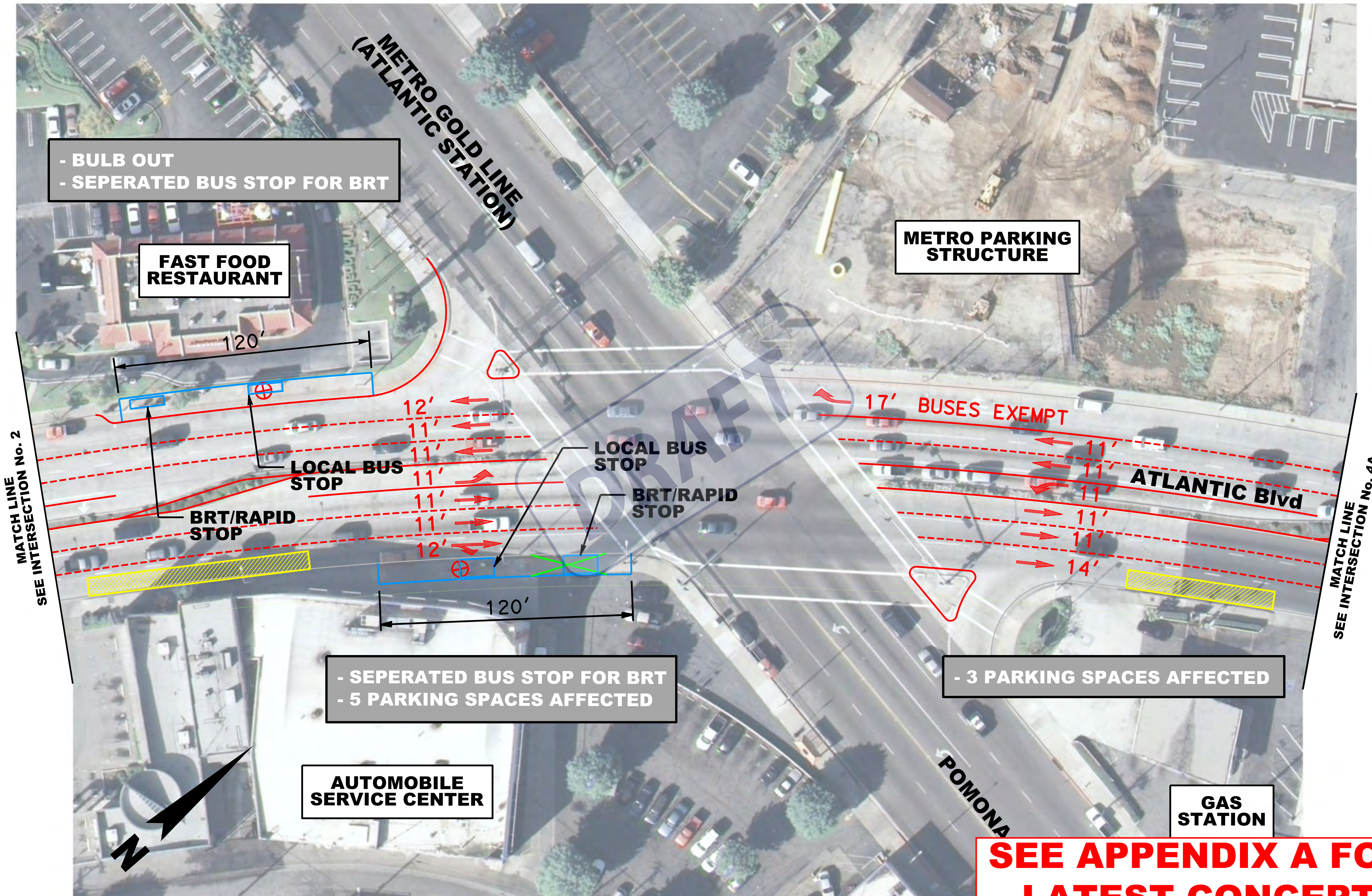
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 2: Atlantic Blvd & Beverly Blvd

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

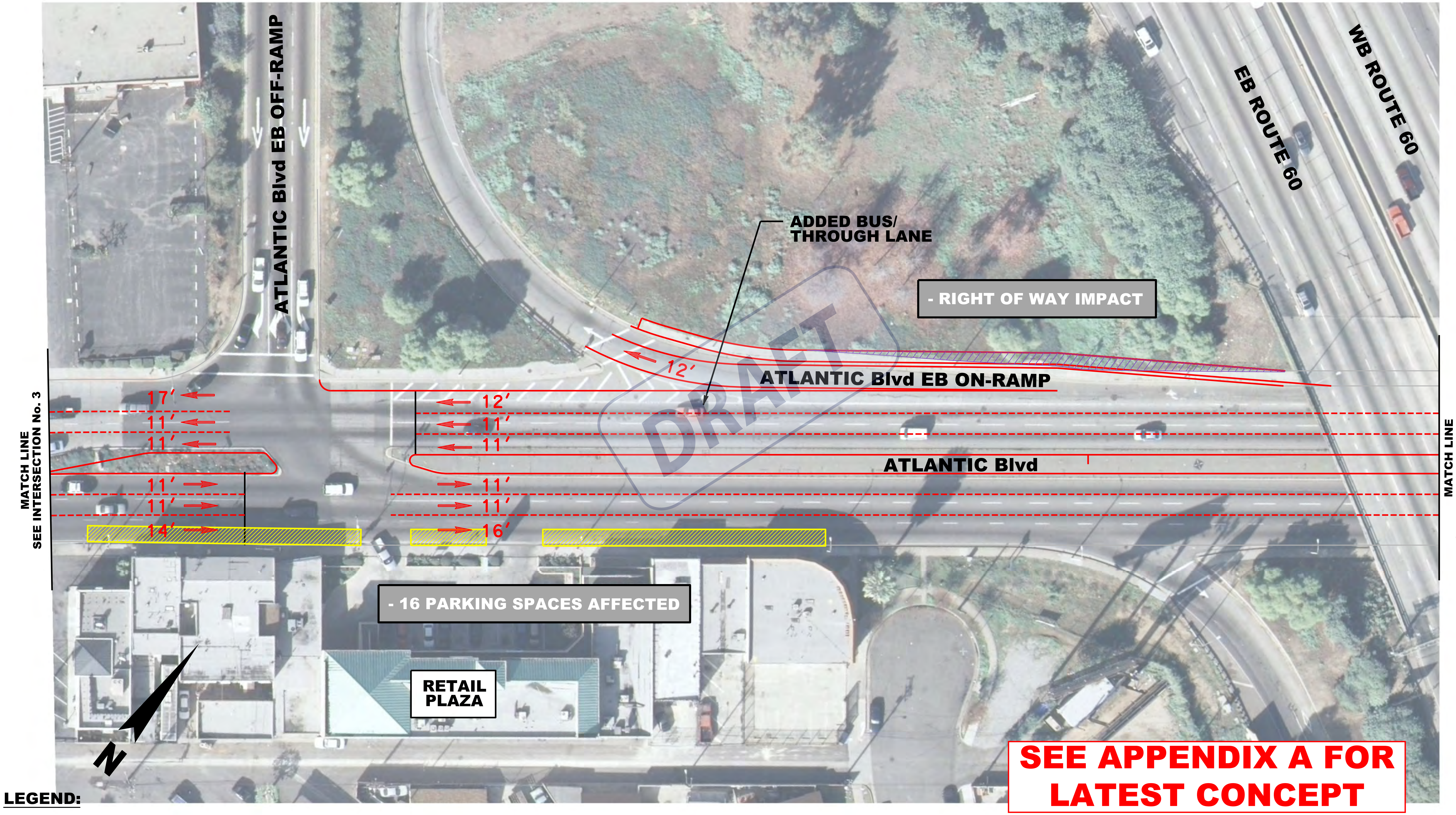
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 3: Atlantic Blvd & Pomona Blvd

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

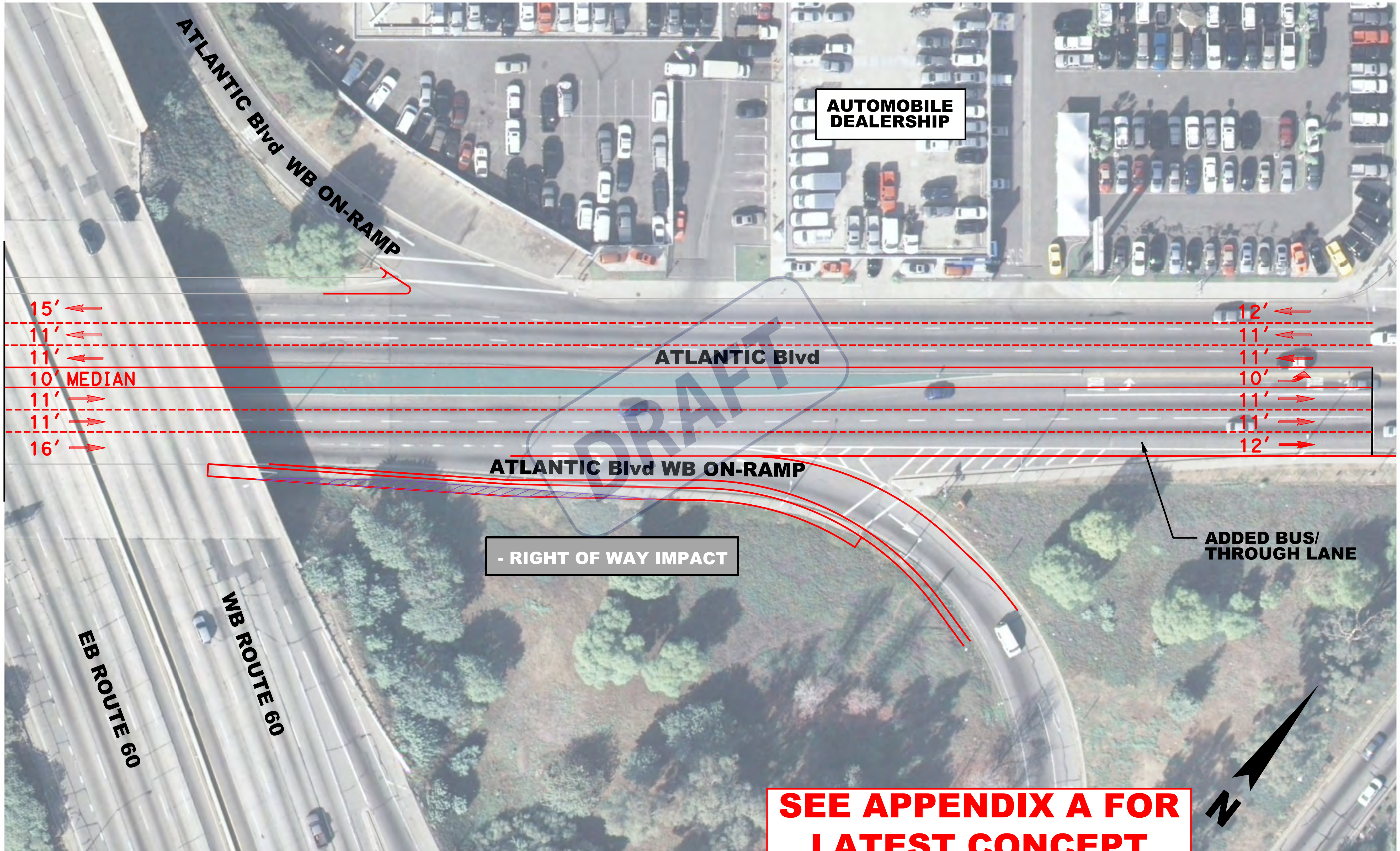
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 4A: Atlantic Blvd & SR-60 Fwy

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

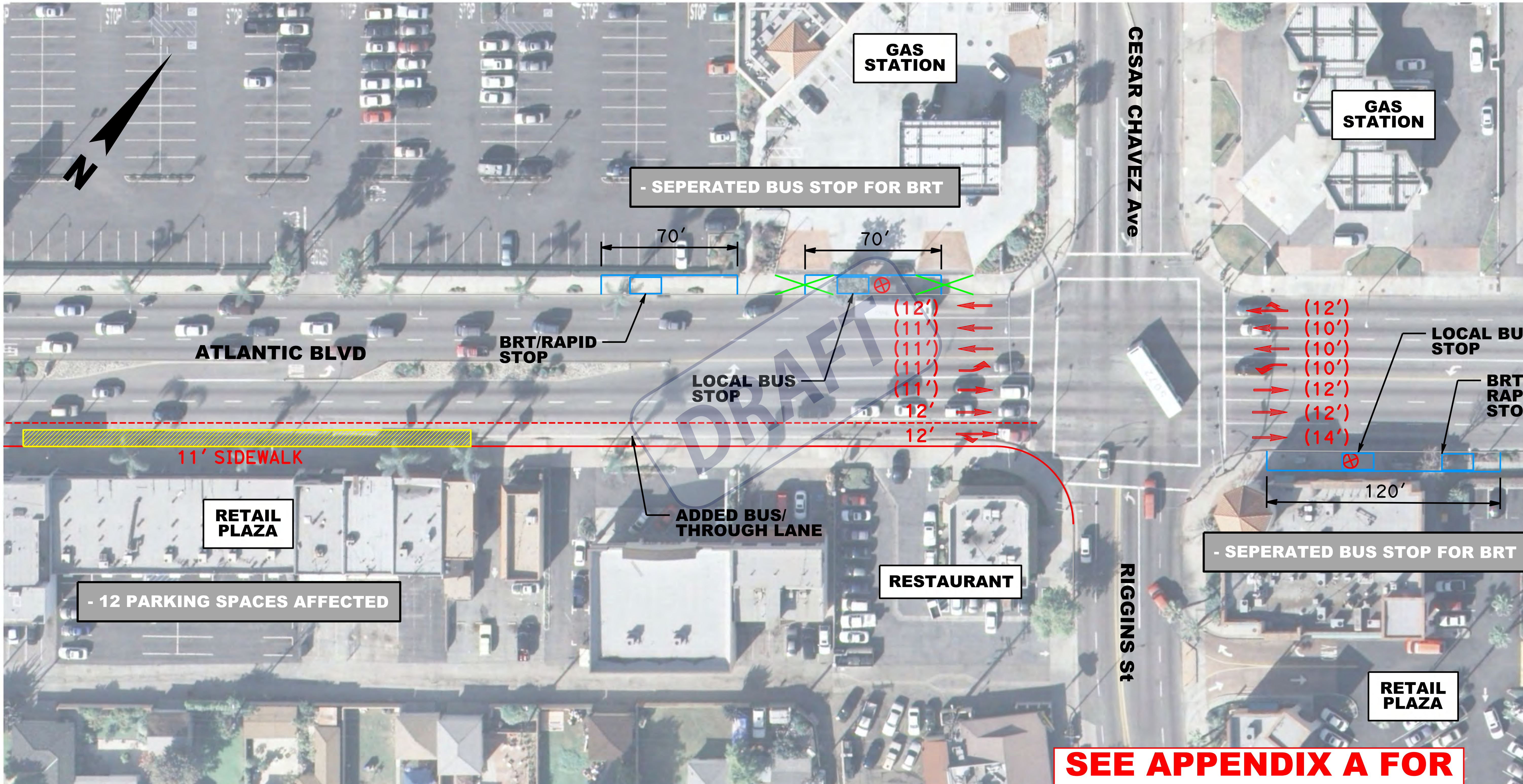
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 4B: Atlantic Blvd & SR-60 Fwy

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

0 25 50 100

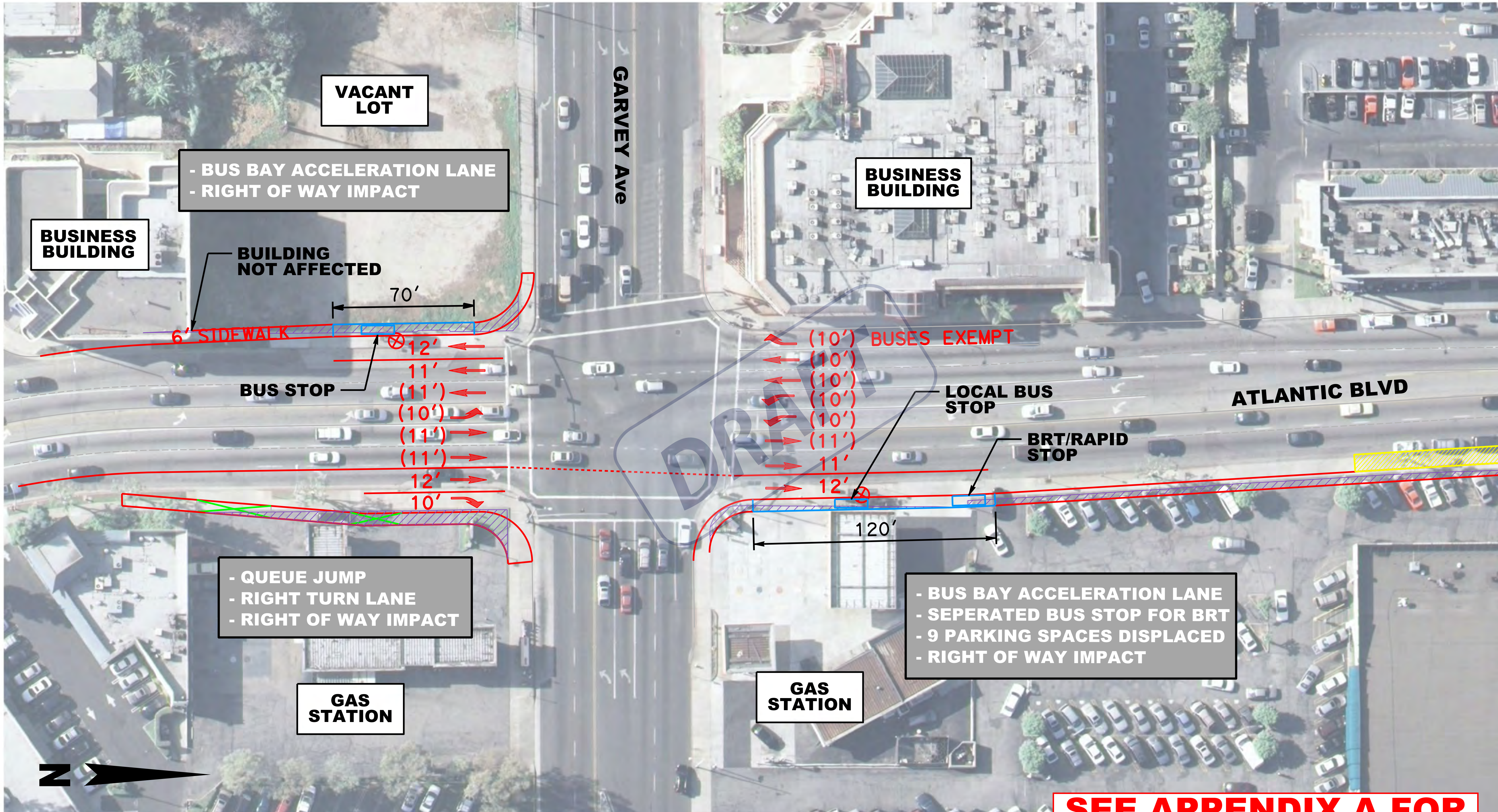
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 5: Atlantic Blvd & Cesar Chavez/Riggin Ave

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

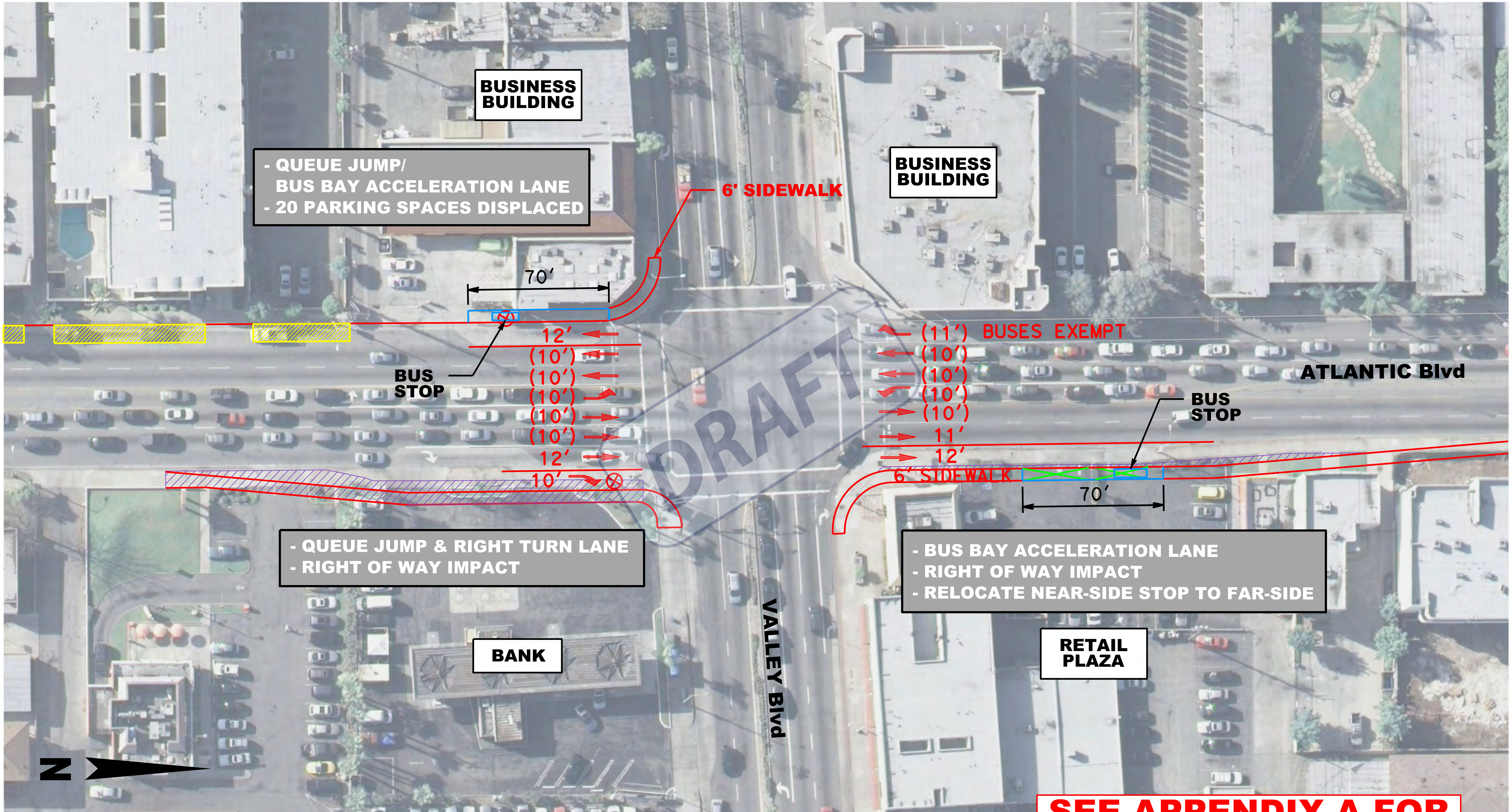
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 6: Atlantic Blvd & Garvey Ave

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

0 25 50 100

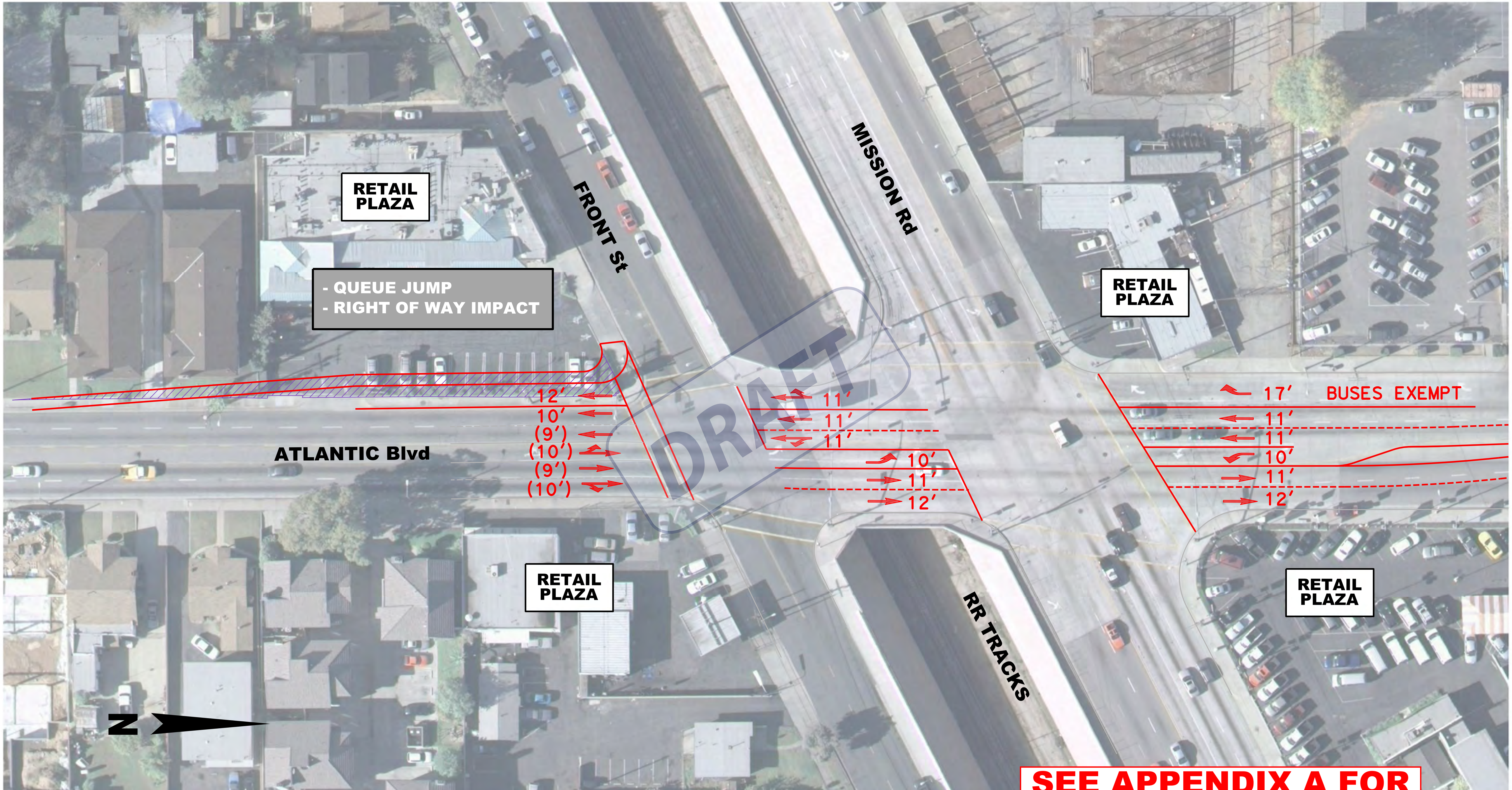
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 7: Atlantic Blvd & Valley Blvd

11 FEBRUARY 2013



LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

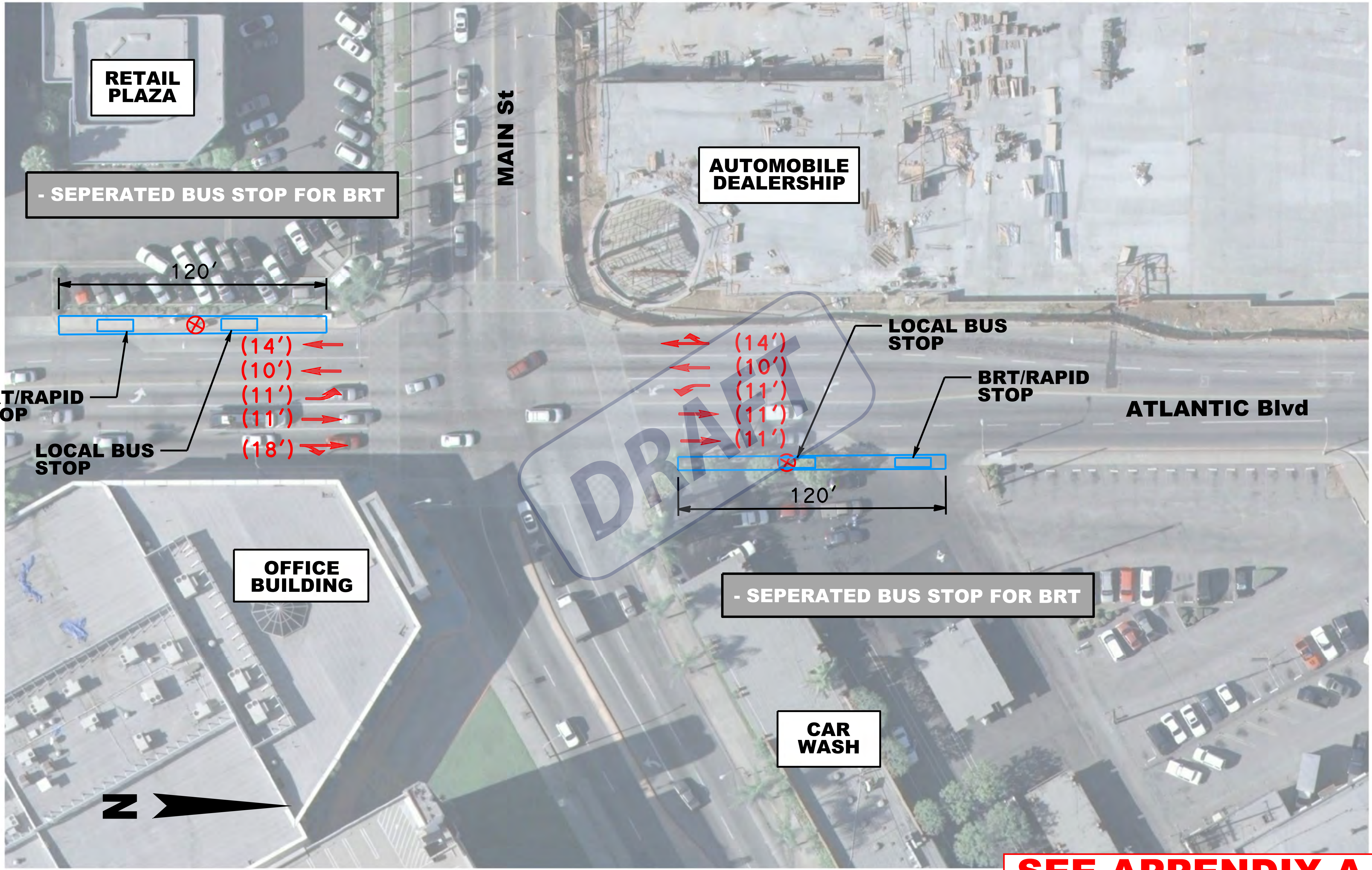
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SEE APPENDIX A FOR LATEST CONCEPT

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN
Intersection No. 8: Atlantic Blvd & Mission Rd/ Front St

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

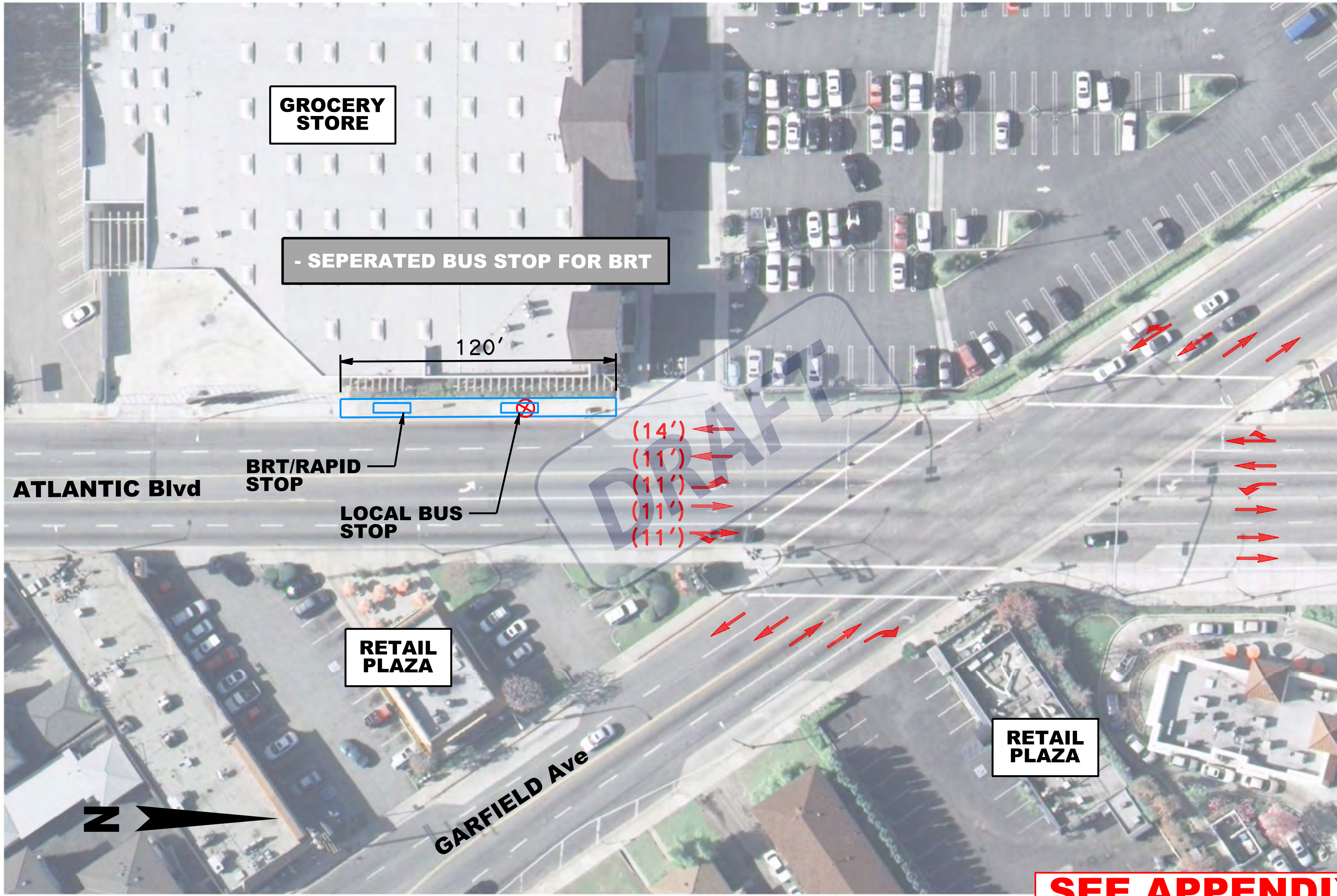
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 9: Atlantic Blvd & Main St

11 FEBRUARY 2013



NOTE: DESIGN TO BE DEVELOPED IN THE TSM/TDM ALTERNATIVE.

SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- AFFECTED ON-STREET PARKING
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

0 25 50 100

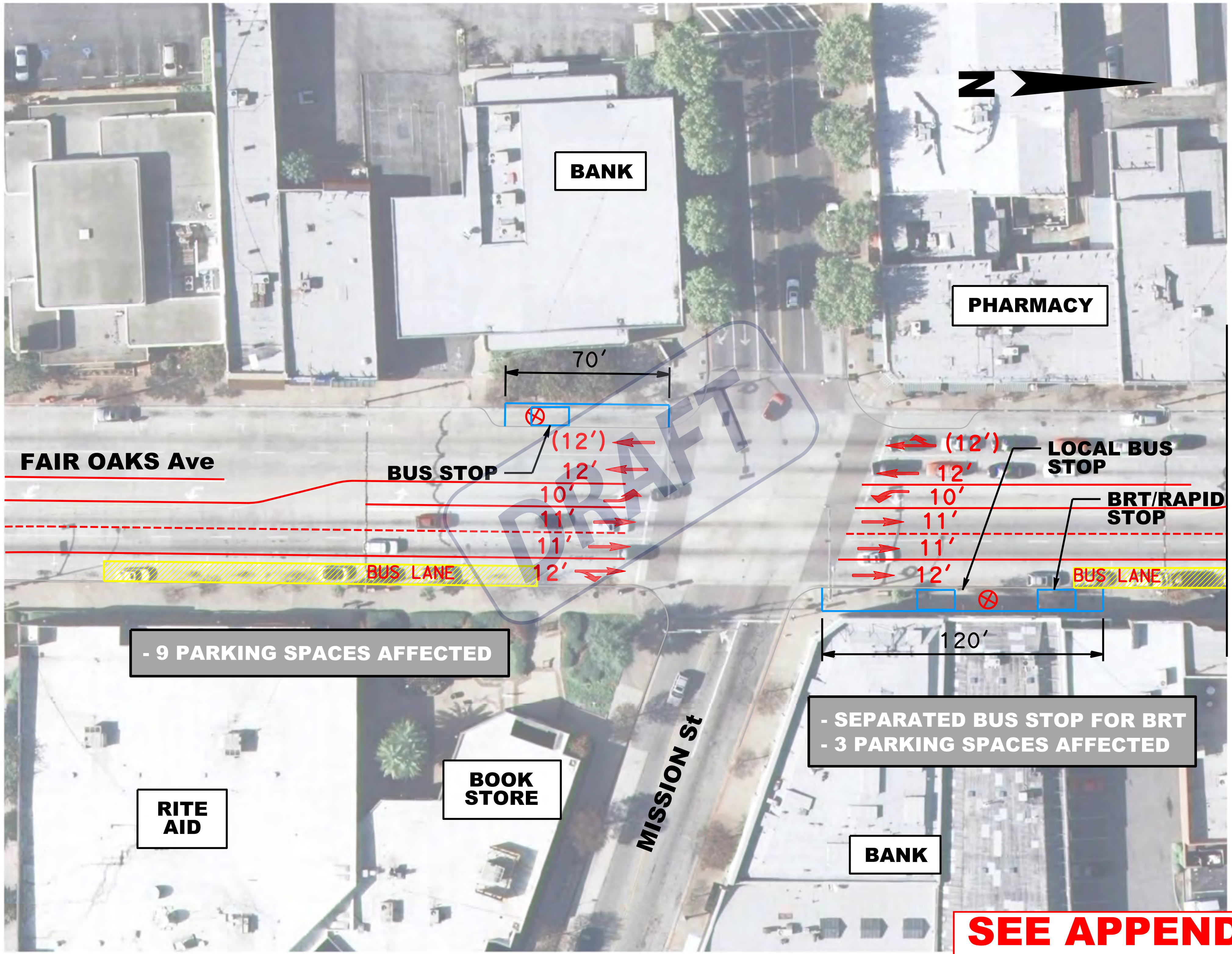
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 10: Atlantic Blvd & Garfield Ave

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- DISPLACED PARKING ON STREET
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX′) EXISTING LANE WIDTH
- XX′ PROPOSED LANE WIDTH
- EXISTING BUS STOP

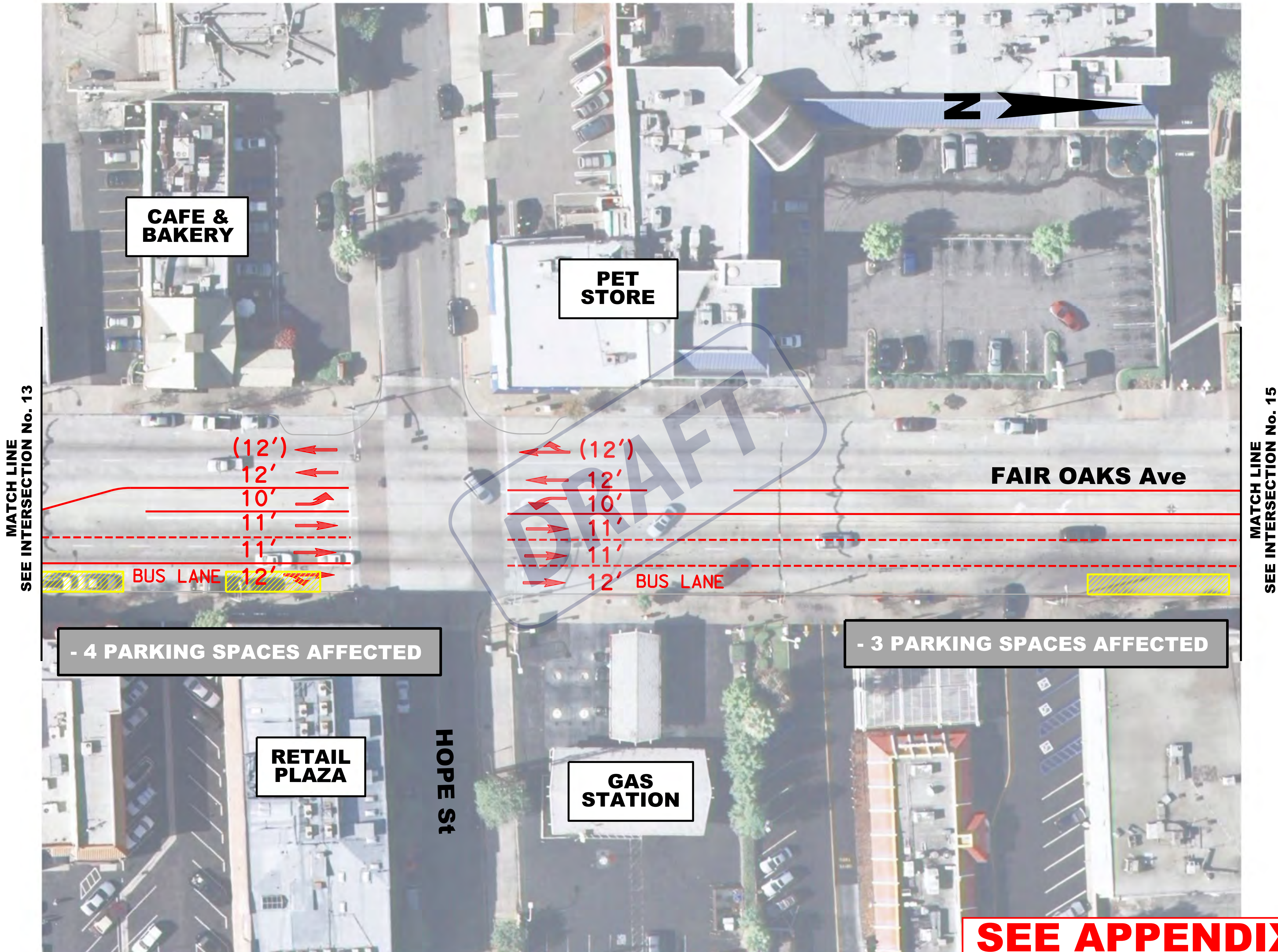
0 25 50 100
SCALE 1" = 50′

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 13: Fair Oaks Ave & Mission St

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- DISPLACED PARKING ON STREET
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

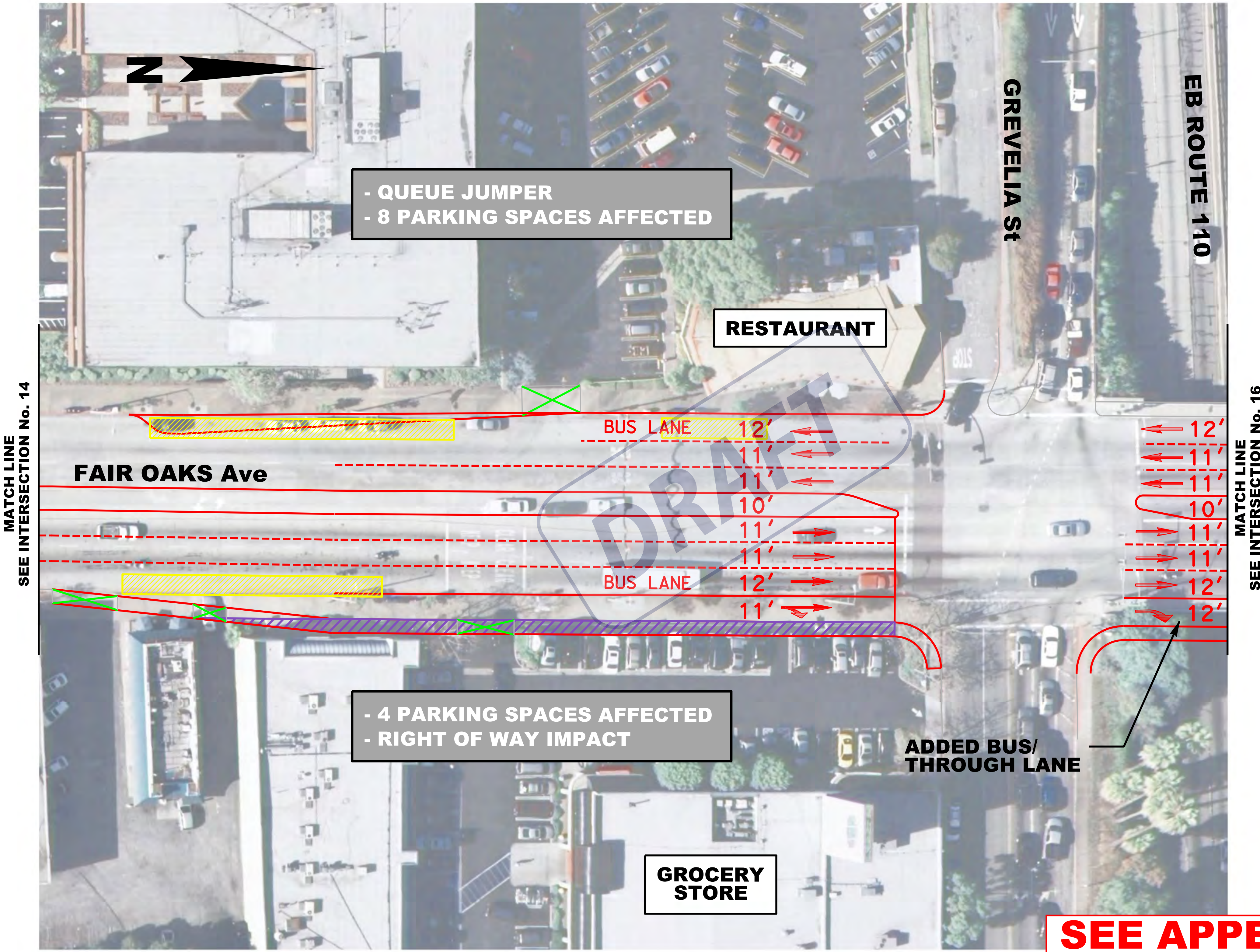
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 14: Fair Oaks Ave & Hope St

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

NOTE: ADDITIONAL IMPROVEMENTS ON SR-110 TO BE DEVELOPED IN THE TSM/TDM AL

LEGEND:

- IMPACTED DRIVEWAYS
- DISPLACED PARKING ON STREET
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

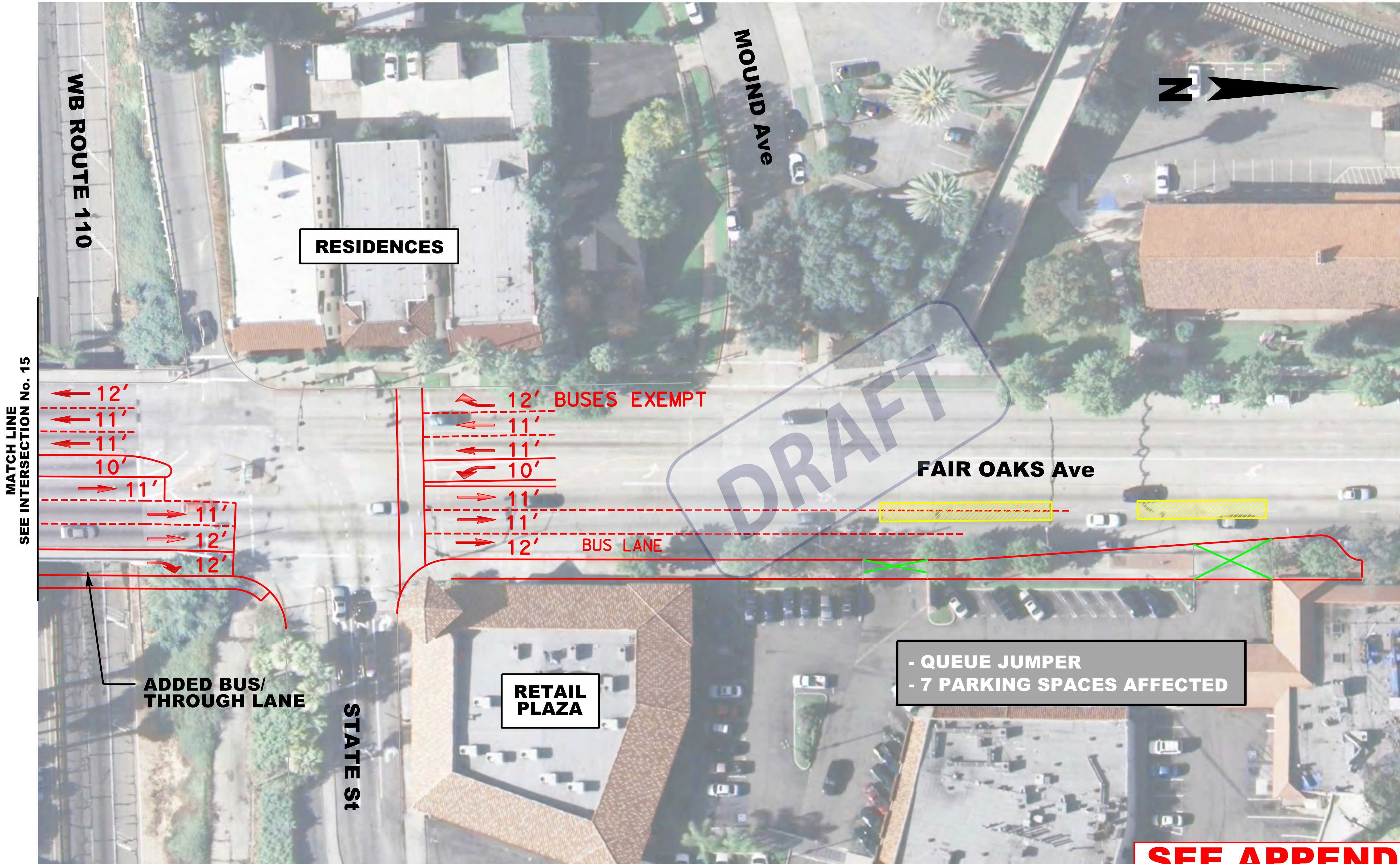
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 15: Fair Oaks Ave & Grevelia St

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

NOTE: ADDITIONAL IMPROVEMENTS ON SR-110 TO BE DEVELOPED IN THE TSM/TDM ALTE

LEGEND:

- IMPACTED DRIVEWAYS
- DISPLACED PARKING ON STREET
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

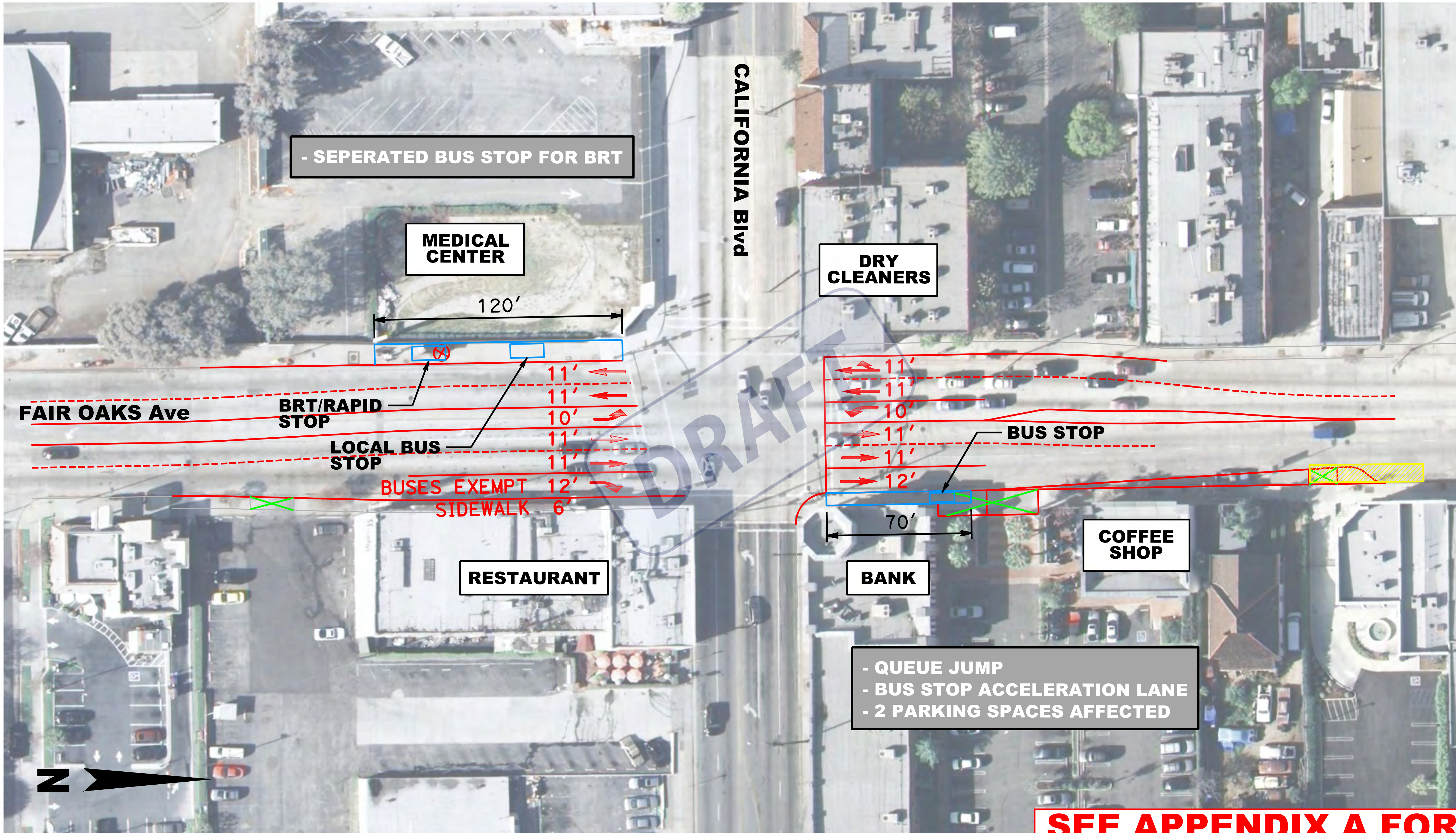
0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 16: Fair Oaks Ave & State St

11 FEBRUARY 2013



SEE APPENDIX A FOR LATEST CONCEPT

LEGEND:

- IMPACTED DRIVEWAYS
- DISPLACED PARKING ON STREET
- PROPOSED BRT STATION
- R/W IMPACTS
- (XX') EXISTING LANE WIDTH
- XX' PROPOSED LANE WIDTH
- EXISTING BUS STOP

0 25 50 100
SCALE 1" = 50'

PRELIMINARY FOR INTERNAL DISCUSSION

SR 710 STUDY - BRT ALTERNATIVE CONCEPTUAL DESIGN

Intersection No. 17: Fair Oaks Ave & California Blvd

11 FEBRUARY 2013

Appendix C
Assessment of BRT Scenarios, Travel Times, and Potential Effects, BRT Alternative Technical Memorandum

DRAFT TECHNICAL MEMORANDUM

Assessment of BRT Scenarios, Travel Times, and Potential Effects; BRT Alternative, SR 710 Study

PREPARED FOR:	Michelle Smith/Metro
COPY TO:	Caltrans Study Team
PREPARED BY:	CH2M HILL Team
DATE:	November 12, 2013
PROJECT NUMBER:	428908

Introduction

The Bus Rapid Transit (BRT) Alternative is one of five alternatives recommended for further evaluation as part of the State Route (SR) 710 Study. This technical memorandum is an assessment of BRT scenarios, travel time, and potential effects. The intent of this memorandum is to assess the travel times among the various BRT scenarios with different options for bus lanes and to understand the potential effects to properties and parking with each BRT scenario. The analyses and data presented are preliminary and subject to change. The various scenarios were studied to provide to provide a comparison to enable refinements to the BRT Alternative. Some of the potential effects that are shown are for scenarios that are not being recommended. This assessment will help support which options should be included in the refined version of the BRT Alternative for further evaluation in preliminary engineering and environmental review.

Background

Overall Study

The review of BRT scenarios, travel times, and potential effects on properties and parking was conducted as a portion of the study of refinements for the BRT Alternative for the SR 710 Study. The SR 710 Study includes an evaluation of transportation alternatives for the study area generally bounded by the Interstate (I)-210 freeway on the north, the I-605 freeway on the east, the I-10 freeway on the south, and the I-5 and SR 2 freeways on the west. The SR 710 Study is composed of three parts:

- Alternatives Analyses (AA)
- Project Report
- Environmental Documentation

The BRT scenarios are being reviewed in the Project Report for BRT Alternative, which was recommended for further evaluation after the AA phase.

Metro

Caltrans

In past studies during the AA Phase, 27 BRT options were considered throughout the study area. The BRT options were identified for potential routes based upon the study Purpose and Need, and the opportunity to connect to major travel destinations. Also the availability of street right-of-way along street corridors was considered. The resulting options were evaluated and refined through a three-step screening process to identify the best performing options that best meet the purpose and need of the study. The factors in the screening process included ridership potential, minimal potential community effects, reduction of local street congestion, and accommodation of regional north-south travel. The screening process identified seven of the initial 27 BRT options to be considered for conceptual engineering and initial evaluation which was presented in the Alternatives Analyses Report. Figure 1 shows the routes of the seven BRT alternatives considered for further development and evaluation.

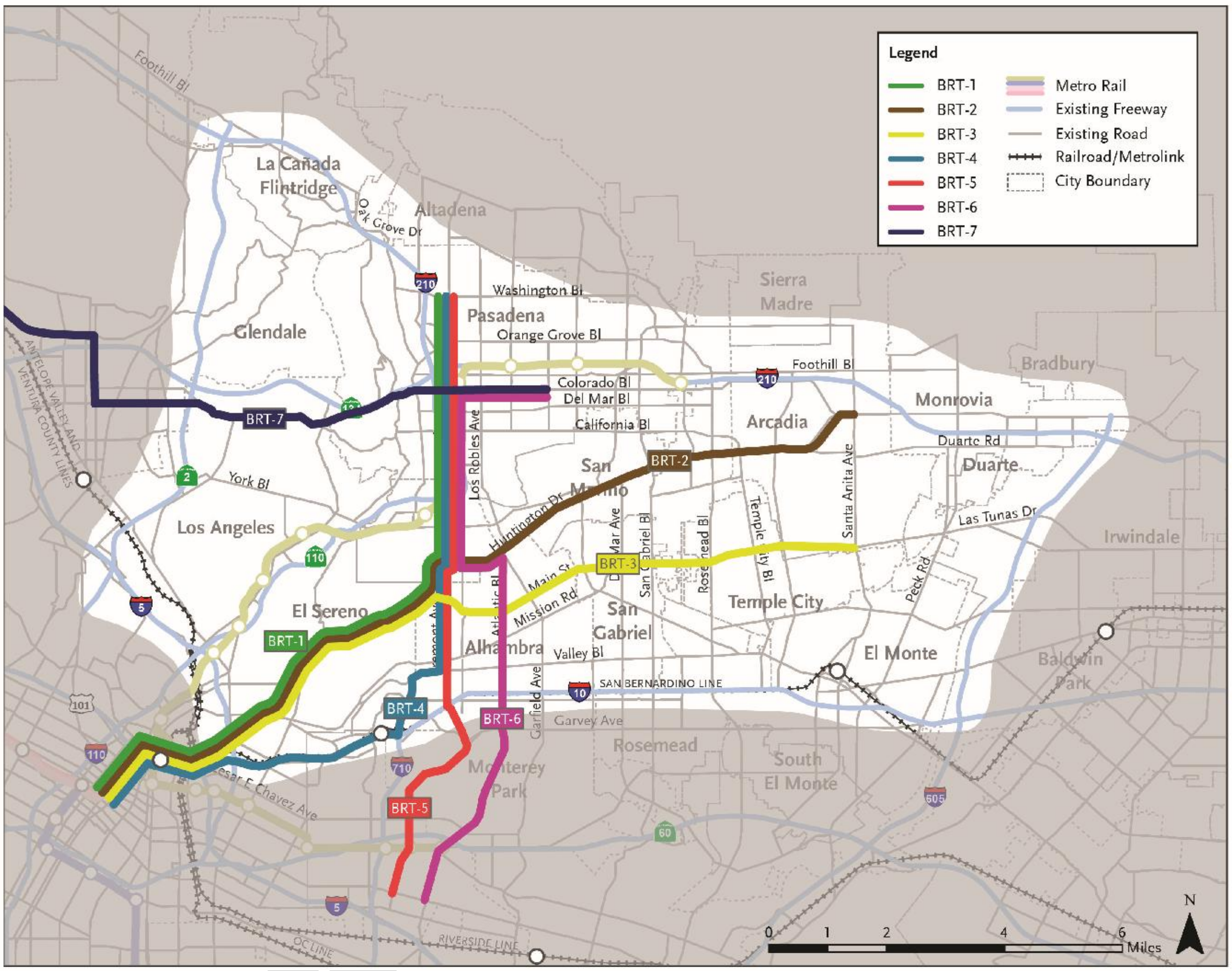


FIGURE 1

Map of the seven BRT alternatives considered for Conceptual Engineering

Alternative BRT-1 would run from Union Station in East Los Angeles to Pasadena and would reduce local street congestion. Alternative BRT-2 would start at Union Station in East Los Angeles and finishes in Santa Anita with minimal potential right-of-way effects. Alternative BRT-3 would run from Union Station in East Los Angeles to El Monte and would have high potential for ridership. Alternative BRT-4 would start from Union Station in East Los Angeles and finishes in La Canada by utilizing part of the existing infrastructure of the El Monte Busway. Alternative BRT-5 would run from the East LA Civic Center Gold Line Station to the Del Mar Gold Line Station with high potential for ridership. Alternative BRT-6 would start from the Atlantic Gold Line Station and finish in Pasadena with high potential for ridership potential and accommodates north-south travel. Alternative BRT-7 would run from downtown Pasadena to downtown Glendale with minimal potential right-of-way effects.

After consideration of projects needs and objectives, service to major destinations, available right-of-way, and maintaining traffic lanes, a total of two BRT alternatives with one additional design variation (developed during the evaluation process) were selected for additional evaluation. These options were then evaluated on factors such as general traffic lanes, on-street parking, sidewalk and median widths, and potential right-of way property effects. In the Alternatives Analysis Report (CH2M HILL, 2012), BRT-6 was identified and recommended as the best performing BRT option for Project Approval/Environmental Documentation (PA/ED).

Description of Alternative BRT-6

Alternative BRT-6, as identified and recommended in the AA phase, would provide BRT service between Atlantic Boulevard at Whittier Boulevard in East Los Angeles, and Pasadena City College (PCC) and the California Institute of Technology (Caltech) in Pasadena. Alignment BRT-6 has been further refined after the AA phase to better serve the community and region. Northbound BRT vehicles would travel north along Atlantic Boulevard to Huntington Drive, then briefly west along Huntington Drive to Fair Oaks Avenue, and then north along Fair Oaks Avenue into Pasadena. Rather than travelling along California Boulevard, the refined BRT alternative would have the BRT vehicles travel along Del Mar Boulevard, making a loop to California Institute of Technology (Caltech) and Pasadena City College (PCC) via Hill Avenue, Colorado Boulevard, and Lake Avenue. The total length of the route would be 13.8 miles. A Figure that illustrates the alignment of Alternative BRT-6 and refined BRT Alternative can be found in Attachment A. Bus stops would be at approximately 0.8-mile intervals, at major activity centers and cross streets, as shown in Table 1.

TABLE 1

Alternative BRT-6 Stop Locations from Whittier Boulevard to Colorado Boulevard

Atlantic Boulevard at Whittier Boulevard
Atlantic Boulevard at Pomona Boulevard
Atlantic Boulevard at Cesar Chavez Avenue/Riggin Street
Atlantic Boulevard at Garvey Avenue
Atlantic Boulevard at Valley Boulevard
Atlantic Boulevard at Main Street
Huntington Drive at Garfield Road
Huntington Drive at Marengo Avenue
Fair Oaks Avenue at Mission Street
Fair Oaks Avenue at Glenarm Street
Fair Oaks Avenue at California Boulevard
Fair Oaks Avenue at Del Mar Boulevard
Del Mar Boulevard at Los Robles Boulevard
Del Mar Boulevard at Lake Avenue
Del Mar Boulevard at Hill Avenue
Colorado Boulevard at Hill Avenue
Colorado Boulevard at Lake Avenue

BRT Scenarios

Alternative BRT-6 was selected as the highest performing BRT Alternative during the AA. Alternative BRT-6 has been further refined to improve performance based upon initial findings in the AA and from input received at TAC and SOAC meetings and general public input. Based on feedback from TAC meetings that followed the AA, analysis to determine the travel time performance and potential effects of the following scenarios are being evaluated:

- No Build 2035
- Mixed-Flow Lanes & Right-Side Bus Lanes

- Continuous Right-Side Bus Lanes
- Continuous Median Bus Lanes

No Build

The No Build 2035 scenario does not include any BRT scenario in the SR 710 corridor study area. The No Build scenario includes all of the projects that are identified in the financially constrained project list of Southern California Association of Government's (SCAG) *2008 Regional Transportation Plan (RTP): Making the Connections*. The No Build scenario also includes currently planned projects in Los Angeles County that are identified in Measure R, as well as those in the "Constrained Plan" of Metro's 2009 Long Range Transportation Plan (through the year 2035). Transit Signal Priority (TSP) will also be implemented along this corridor.

The typical cross section for the no build scenario is depicted in Figure 2, with a typical width range of 90 feet. This cross section is common in the BRT alignment, particularly in the commercial areas along Atlantic Boulevard and Fair Oaks Avenue. The cross sections consist of a four lane roadway with two 11 feet lanes in each direction. There is generally eight feet of on-street parking on both sides of the roadway and the sidewalk width typically varies from six to ten feet. In addition, ten feet of striped median is provided to allow for left turns.

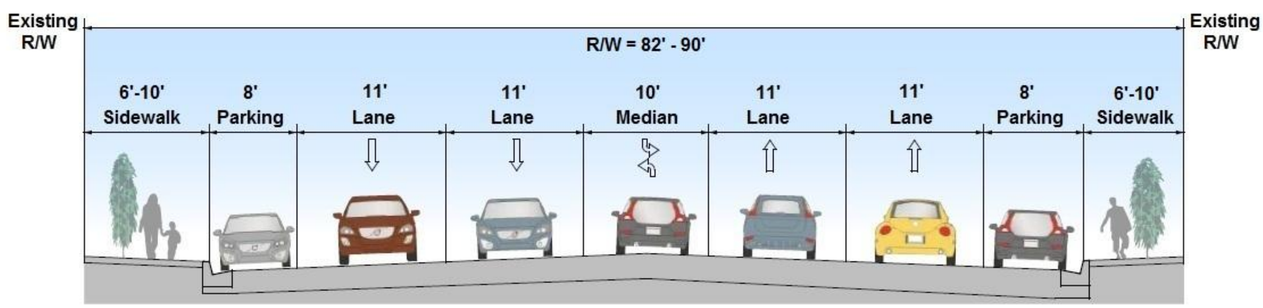


FIGURE 2
Typical Cross Section for the No Build Scenario

Mixed-Flow Lanes & Right-Side Bus Lanes

Mixed-Flow Lanes and Right-Side Bus Lanes BRT Scenario would operate within both exclusive bus lanes and mixed-flow lanes. The BRT vehicles are proposed to operate in exclusive lanes, roughly adjacent to the curb, in the following general areas:

- Atlantic Boulevard from Whittier Boulevard to Beverly Boulevard (northbound only)
- Atlantic Boulevard from Floral Avenue to Harding Avenue
- Atlantic Boulevard from Harding Avenue to Valley Boulevard (southbound only)
- Huntington Drive from Atlantic Boulevard to Fair Oaks Avenue
- Fair Oaks Avenue from Huntington Drive to Columbia Street
- Fair Oaks Avenue from Columbia Street to Del Mar Boulevard (northbound only)

In the remaining portions of the BRT alignment, the BRT vehicles would operate in mixed-flow lanes. The exclusive lanes were proposed within existing right-of-way generally through a variety of methods, including restriping the roadway; prohibiting on-street parking; and narrowing medians, planted parkways, and sidewalks. In some areas, exclusive lanes could not be provided without substantial right-of-way acquisition. In these areas, the buses would share existing lanes with other traffic. The BRT stations for this scenario would be located on the sidewalk and provide curbside passenger loading. Depending on demand levels and available sidewalk widths, BRT stations would feature amenities such as shelters, lighting, variable message sign, etc.

In the mixed-flow lanes and right-side bus lane scenario, right-side bus lanes were added in one or both directions while trying to remain within public right of way. A typical section within the corridor would have a total width ranging from 88 feet to 98 feet. It generally includes a 10 feet median, two 11 -foot mixed flow lanes, and a 14-foot bus lane in one or both directions as shown in Figure 3 and Figure 4. The additional 14 feet bus lane eliminates on-street parking, if any. Sidewalk widths are also reduced and range from six to eight feet in areas with limited right of way. The sidewalk width varies in order to meet the minimum sidewalk width requirement of the American Disabilities Association (ADA) of five feet and the minimum BRT station width requirement of eight feet (for bus front door wheel chair ramp).

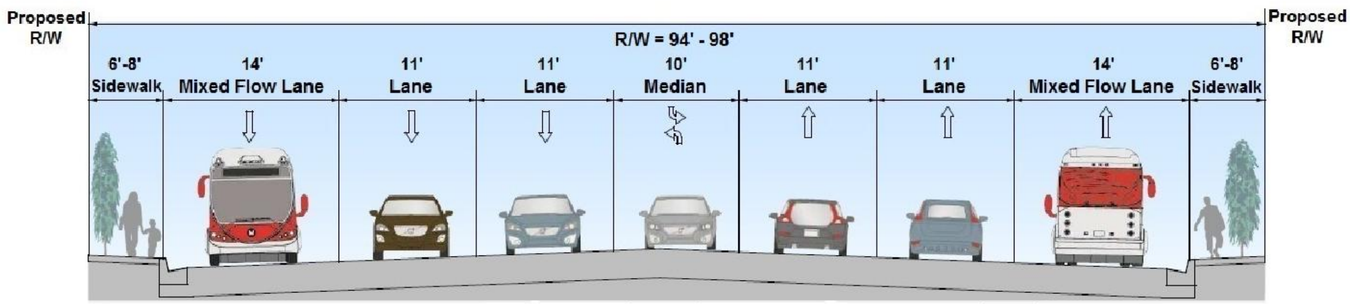


FIGURE 3
Typical Cross Section for the Mixed-Flow Lanes & Right-Side Bus Lanes Scenario with Exclusive Bus Lanes in Both Directions

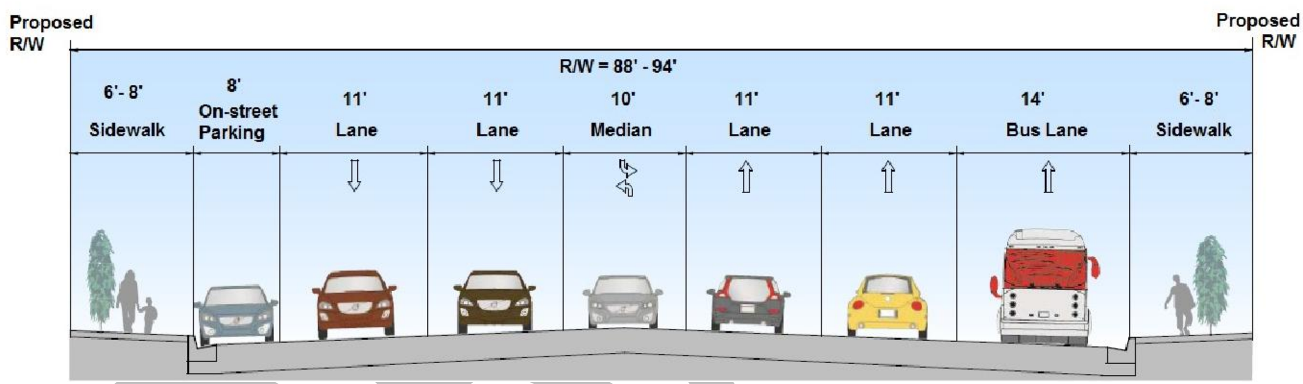


FIGURE 4
Typical Cross Section for the Mixed-Flow Lanes & Right-Side Bus Lanes Scenario with an Exclusive Bus Lane in a Single Direction

Continuous Right-Side Bus Lane

The Continuous Right-Side Bus Lane scenario would have exclusive right-side bus lanes along the entire BRT alignment in both directions of travel. Providing exclusive bus lanes along the entire route would potentially require significant right-of-way acquisition even with roadway improvements to mitigate potential property effects. The BRT stations for this scenario would be located on the sidewalk and provide curbside passenger loading for easy access. Depending on demand levels and available sidewalk widths, BRT stations would feature amenities such as shelters, variable message sign, etc.

The typical section of the Continuous Right-Side Bus Lane would add right-side bus lanes in each direction to the existing condition throughout the entire corridor, similar to the Mixed-Flow and Right-Side Bus Lane scenario with exclusive lanes in both directions as shown in Figure 3. With right-side bus lanes in both directions, the number of potential properties effected increase in comparison to the mixed flow and right-side bus lane scenario where existing right-of-way is limited.

Continuous Median Bus Lane

The Continuous Median Bus Lane BRT scenario would have the vehicles operating in a median bus-way, separated from traffic, along the trunk line of the BRT alignment. However, in the loop at the north end of the BRT alignment, the BRT vehicles would operate in right-side bus lanes, roughly adjacent to the curb. The loop begins and ends north of the intersection of Fair Oaks Avenue and Del Mar Boulevard. The BRT stations in the Continuous Median Bus Lane BRT scenario would be located in the median near intersections to allow for pedestrian access. The BRT station would include a median platform with shelter, lighting, etc. In order to provide median bus-ways separated from traffic throughout the BRT alignment, substantial right-of-way acquisition would be required, especially at intersections. The continuous median bus lane scenario avoids traffic interference and impedance. However, this scenario has a significant interference with left turns and potential problems for pedestrian access.

In the continuous median bus lane scenario, bus lanes are placed at the center of the roadway. At station stops, the range of the total roadway width is 104 to 110 feet. The center of the roadway has two 14-foot bus lanes in opposite directions, a median BRT station, and a two-foot island to separate the bus-way from general traffic. In Figure 4, the BRT station is located on the left side in order to accommodate passenger loading for one direction of travel. The station for the opposite direction of travel will be located on the opposite side of the intersection. Mixed-flow lanes adjacent to the BRT station and sidewalk are 14 feet wide. The remaining mixed flow lanes will be 12 feet wide.

At segments where there are no BRT stations, the total roadway width narrows to a range of 96 to 100 feet. The total roadway width includes two 14-foot mixed flow lanes adjacent to the outside curb, two 12-foot mixed flow lanes, two 14-feet bus lanes, two two-foot islands and a six to eight foot sidewalk in each direction.

In the north loop of the continuous median bus lane scenario, the typical cross section would not feature the 28 feet median bus-way. Instead, the typical cross section of the north loop would appear similar to the typical cross section of the mixed-flow and right-side bus lane scenario in Figure 3.

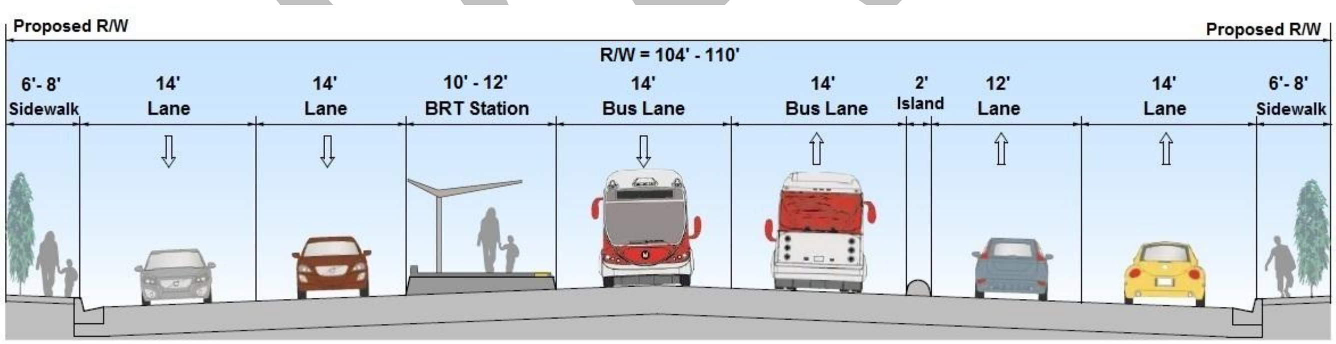


FIGURE 5
Typical Cross Section for the Continuous Median Bus Lane Scenario

Bus Rapid Transit Operation Performance Tool

Metro Rapid Route 762 runs in the same corridor as the proposed BRT Alternative. The team has researched the operating characteristics of Route 762 and other Metro services that use dedicated bus lanes. The data collected was used to develop a spreadsheet tool that can help predict the future BRT travel time with proposed BRT improvements. The Bus Rapid Transit Operational Performance Tool (BRTOPT)was calibrated using the existing bus travel time in the corridor under existing traffic conditions. Once the BRTOPT was calibrated under the existing condition, factors were then applied to estimate the benefits from the Traffic Signal Priority (TSP) improvements being implemented in the corridor, the effects of increased congestion from existing to the future (year 2035), and the benefits from various improvements in each of the three BRT scenarios. The study includes 2013 existing conditions to evaluate the future scenarios mentioned above. The BRTOPT models all of the following:

1) 2013 Existing Conditions
2) 2013 Existing Conditions with Traffic Signal Priority (TSP) Improvements
3) 2035 No Build Condition with TSP Improvements
4) 2035 Future Condition with Mixed Flow & Right Side BRT Lanes with TSP Improvements
5) 2035 Future Condition with Continuous BRT Lanes with TSP Improvements
6) 2035 Future Condition with Median BRT Lanes with TSP Improvements

Methodology:

The BRTOPT is a spreadsheet model that analyzes the BRT corridor in sub-segments defined by bus operating conditions. The conditions include: signalized intersections, approaches to and departures from intersections, mid-block segments, bus stop zones, approaches to and departures from bus stop zones. The BRT corridor consists of the above seven conditions repeated in a manner that is consistent with the existing operating environment, resulting in a total of 337 sub-segments from Atlantic Boulevard at Whittier Boulevard in East Los Angeles to Colorado Boulevard at Hill Avenue in Pasadena.

In general, speeds and delays used in the model for existing condition and existing condition with TSP improvements were based on:

- Actual field observations of Metro Rapid 762 performance;
- Ongoing Metro TSP project for the Atlantic Boulevard and Fair Oaks Avenue corridors;
- 2004 Crenshaw Boulevard Corridor Bus Signal Priority Pilot Project Before/After Study;
- Sample VISSIM analyses from other similar studies with TSP applications.

Scenario 1, 2013 existing condition, was developed to calibrate the BRTOPT to closely match the predicted bus run time with the actual average bus run times on Route 762. The calibration process involves adjusting variables such as the assumed delay at signalized intersections.

Once the model was calibrated, Scenario 2 was developed to determine the time savings from the TSP improvements being implemented by Metro for the Atlantic Boulevard and Fair Oaks Avenue corridors. The 2004 pilot TSP project along Crenshaw Boulevard suggests an average of 12 percent reduction in delays associated with signalized intersections. Assuming that similar benefits on this corridor can be achieved with TSP, the model applies a 12 percent reduction to existing times spent at approaches to intersection, intersection signal, and departure from intersections. In addition, it is assumed that TSP improvements will remain in future conditions. The same reduction factor used in Scenario 2 will be applied to all future scenarios.

Scenario 3, the 2035 no build condition, was the first future scenario to be evaluated. CH2M HILL calculated the expected rate of increase per year using the delay per peak auto commuter data from the Texas A&M Transportation Institute: 2012 Annual Urban Mobility Report. The delays at intersections and bus stops are expected to increase at a rate of 1.3 percent each year without any operational improvements to the corridor. From 2013 to 2035, the estimated accumulative increase in delays is approximately 33 percent which will result in longer bus run times.

Scenario 4, the 2035 future condition with mixed flow and right side BRT lanes, assumes a set of proposed improvements from the current BRT Alternative included in the SR 710 North Study. Improvements in the mixed flow and right side BRT lane scenario include the following:

TABLE 2
Improvements in Mixed Flow and Right Side BRT Lane Scenario

	Improvement Description	Expected Benefits
1	Exclusive Peak Period BRT Lanes in Specified Segments	Intersection Delay Reduction & Increased Speeds Mid-Block Segment Time Reduction
2	Non-Exclusive/Mixed Flow lanes with Queue Jump Lanes	Intersection Delay Reduction
3	Queue jump lanes and exclusive right turn lanes	Intersection Delay Reduction
4	Bus Bay with Acceleration Lane	Bus Stop Delay Reduction and Merging Delay
5	Separated Stops	Bus Stop Delay Reduction
6	Articulated 60-foot Buses with Three Doors with enhanced fare collection technology	Bus Stop Delay Reduction

Different time reduction factors are used in the model to each applicable sub-segment based on the specific proposed improvements to determine total travel time.

In Scenario 5, continuous exclusive right-side bus lanes are proposed along the entire BRT corridor. As a result, an intersection delay reduction factor is applied at every intersection along the corridor. Also, since all of the remaining improvements listed for BRT Scenario 4 are incorporated in this scenario as well, the same reduction factor can be applied to determine the total travel time.

In Scenario 6, continuous exclusive median bus lanes separated from general traffic are considered for the trunk line (Atlantic Boulevard– Huntington Drive – Fair Oaks Avenue) and right-side bus lanes are evaluated for the north loop in Pasadena. With a median bus lane, time savings can be expected from no interruptions from general traffic and increased bus speeds closer to posted speed limits. Other time savings would be identical to Scenario 5.

Average Travel Times

Results of average total one-way bus travel times along the BRT corridor for each scenario using the BRTOPT are shown in Table 3.

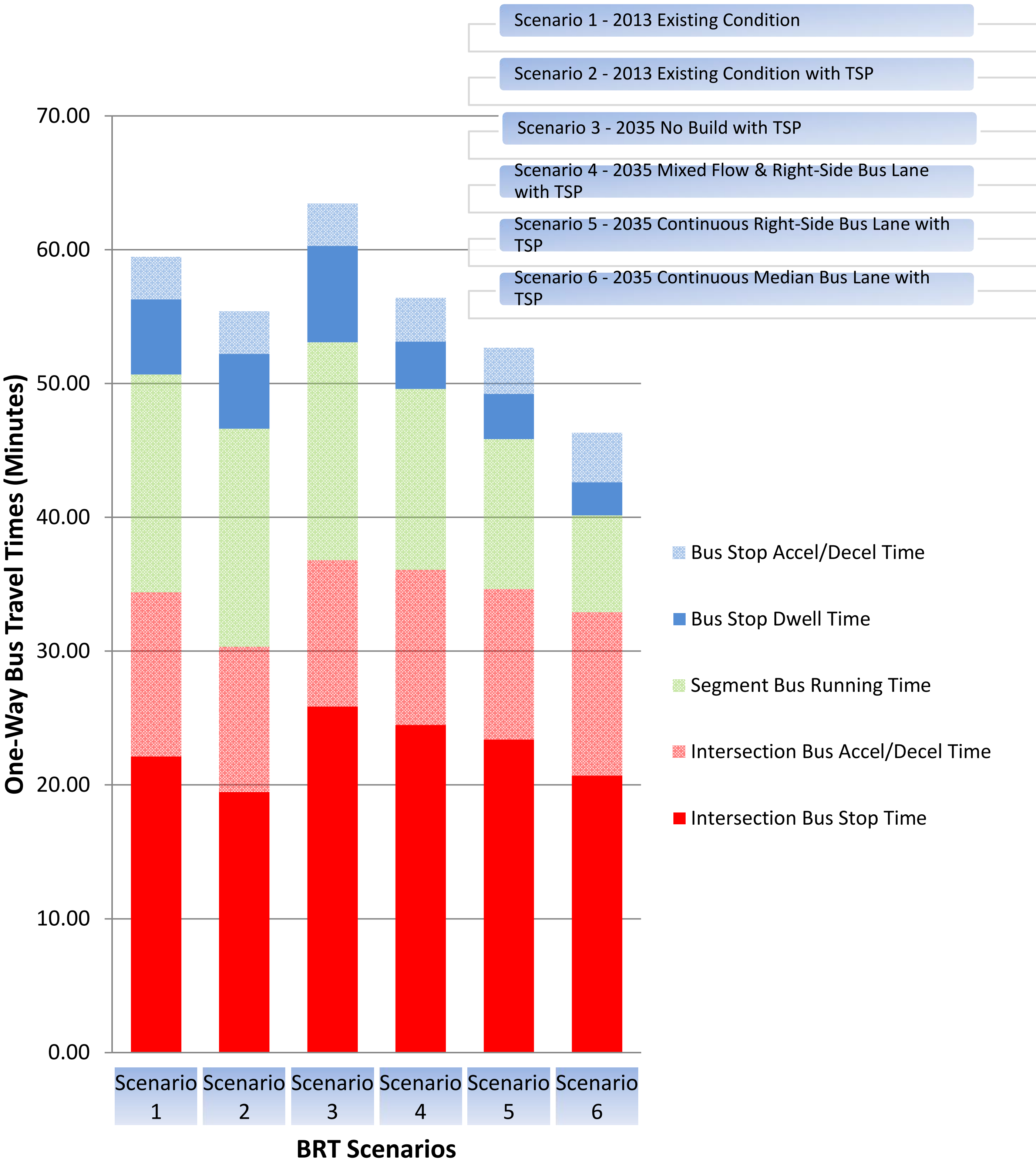
TABLE 3
Average One-Way Bus Travel Times for Each BRT Scenario

	BRT Scenarios	One-Way Bus Travel Times (Minutes)
1	2013 Existing Condition	59
2	2013 Existing Condition with TSP	55
3	2035 No Build with TSP	63
4	2035 Mixed Flow & Right Side Bus Lane with TSP	56
5	2035 BRT Continuous Lane with TSP	53
6	2035 BRT Median Lane with TSP	46

The chart shown on Figure 6 summarizes the total time spent on the different operating conditions. Most of the delay time for the BRT line is at intersections and bus stops and acceleration/deceleration to those intersections and stops.

FIGURE 6

Average One-Way Bus Travel Time for Each Scenario Chart



Potential Effects on Properties for each BRT Scenario

Potential effects on properties were also evaluated for each future scenario. Right-of-way acquisitions were identified and calculated based upon whether or not the newly proposed right-of-way was in conflict with existing right of way boundaries. If the proposed right-of-way spanned across the existing landscape of properties, a partial right-of-way acquisition was suggested. If the proposed right-of-way is in conflict with a building on the property, a full right-of-way acquisition of the property was advised. In cases where there is only one building in conflict on a property where there are several buildings, a partial acquisition of only the building that is being effected was advised. All potential property effects were measured in acres with a 25 percent margin of accuracy. No right-of-way costs were estimated. Figure 6 below shows the type of right-of-way effects to expect from some of the scenarios evaluated.

FIGURE 7

Potential Property Effects with Continuous BRT Scenarios (example for study purposes, not proposed)

A summary of the number of properties being potentially effected and acreage are shown in Table 4. The

Continuous Median Bus Lane scenario would have the greatest potential effect to properties followed by the Continuous Median Bus Lane Scenario. The Mixed-Flow and Right-Side Bus Lane scenario maintains improvements within the existing public right of way, therefore, requiring the least amount of property acquisitions. The number of properties that are partial and full property acquisitions, as well as the acreage that are partial and full property acquisitions for each scenario by cities along the BRT alignment can be found in Attachment C.

TABLE 4

BRT Scenario Potential Property Acquisitions & Acreage by City

BRT Scenario	Number of Properties Effected			Quantity of Acreage Acquired		
	Partial Properties	Full Properties	Total	Partial Properties	Full Properties	Total
Mixed-Flow & Right-Side Bus Lane	34	0	34	0.32	0	0.32
Continuous Right-Side Bus Lane	228	235	463	5.62	58.49	64.11
Continuous Median Bus Lane	301	281	582	7.33	62.14	69.47

Potential Parking Effects for each BRT Scenario

Potential parking effects were evaluated for each scenario and summarized in Table 5. In the Mixed-Flow & Right-Side Bus Lane and Continuous Right-Side Bus Lane BRT scenarios, the bus would only operate in the dedicated bus lanes during peak hours of 7:00-9:00 AM and 4:00 to 7:00 PM during the weekdays. During non-peak hours, right-side bus lanes will be used for parking. Due to the wider footprint of the Continuous Median Bus Lane BRT scenario, in order to minimize the potential effects to properties, parking will be eliminated throughout the entire alignment. Although parking can be provided with additional widening to each BRT Scenario, the potential property effects would greatly increase and is not recommended.

TABLE 5
BRT Scenario Potential Parking Effects

BRT Scenario	No. of AM/PM Parking Spaces Potentially Displaced	No. of Permanent Parking Spaces Potentially Displaced
Mixed-Flow & Right-Side Bus Lane	1,100	70
Continuous Right-Side Bus Lane	1,800	100
Continuous Median Bus Lane	0	1,900

Evaluation

When comparing results shown in Table 6, although Mixed-Flow & Right-Side lane has the slowest average one-way travel times it also has the lowest potential effects to properties and parking. Bus travel times are lower for the other scenarios but have greater potential effects to the commercial and residential communities.

TABLE 6
BRT Scenario Analysis Results

Scenarios	One-Way Bus Travel Times (Minutes)	Total No. of Partial & Full Property Acquisitions	Total Acre of Partial and Full Property Acquisitions	No. of AM/PM Parking Spaces Potentially Displaced	No. of Permanent Parking Spaces Potentially Displaced
Mixed-Flow & Right-Side Bus Lane	56	34	0.32	1,100	70
Continuous Right-Side Bus Lane	53	463	64.11	1,800	100
Continuous Median Bus Lane	46	582	69.47	0	1,900

Although travel times improve with continuous right-side lanes and continuous median bus lanes, the increased footprint would potentially also have other effects. For example, based on the Caltrans future hook ramp project, the historic bridge SR-110 at Fair Oaks Avenue will be restriped to have two 12-foot through lanes and 5 feet sidewalks in each direction. The northbound direction will have a 16-foot right turn lane to access the hook ramps and the southbound direction will have a 10-foot shoulder. If continuous lanes are to be added, the bridge will need to be widened at least 18 feet to accommodate 14 feet continuous bus lanes in each direction through that segment. Due to the close proximity of the Raymond Fault line and the existing structure of the bridge, it would not be feasible to only widen the bridge. The Raymond Fault, approximately 16 miles in length, stretches across the San Gabriel Valley area from Arcadia to Glendale. The fault line crosses Fair Oaks Avenue in South Pasadena, just north of Columbia Street and is approximately 0.4 miles from the historic bridge. The existing bridge would need to be retrofitted or may require a full reconstruction in order to provide continuous bus lanes in each direction as shown in Figure 7.

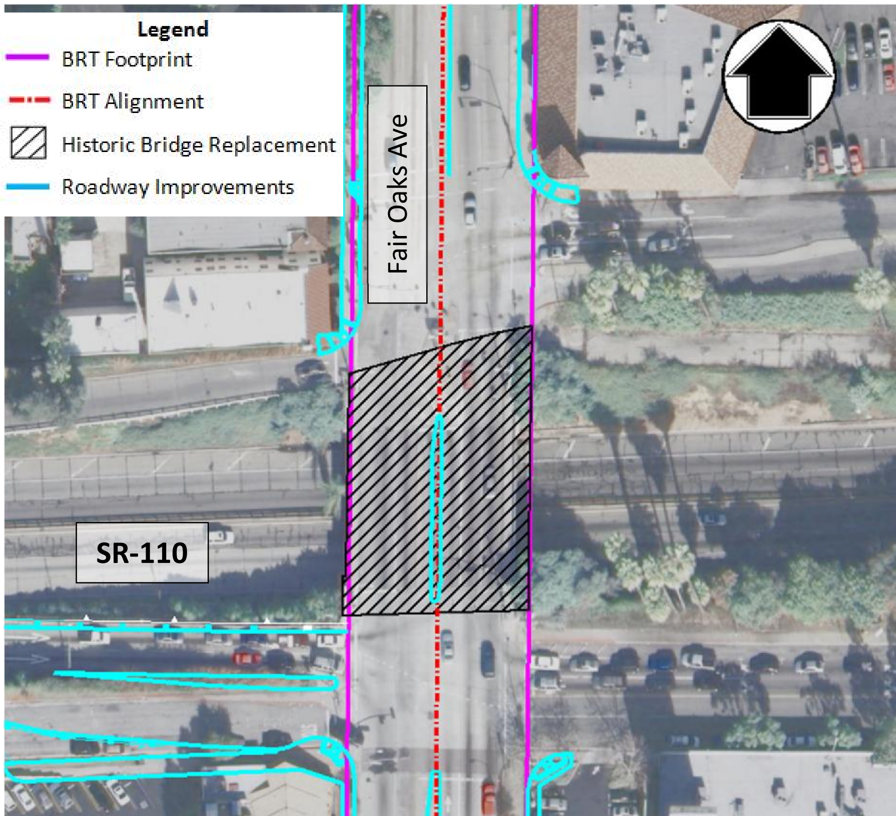


FIGURE 8
SR-110 and Fair Oaks Avenue Historic Bridge

Another example is where I-10 and Metrolink tracks cross over Atlantic Boulevard via two roadway bridges and one rail bridge. There are 4 lanes and sidewalks on both sides on Atlantic Boulevard and the abutment walls are located at the back of sidewalks. To provide an additional bus lane in each direction, all three bridges would need to be lengthened or completely replaced with a longer span over Atlantic Boulevard.

Lengthening of an existing roadway or rail bridge without a full replacement is uncommon and generally not feasible as a concept. Therefore a complete replacement of all three bridges with longer spans is assumed in order to widen Atlantic Boulevard. Demolition of the existing bridges and construction of the new bridges would interrupt vehicular traffic on I-10 and rail traffic on Metrolink. Long term closure of either is likely not acceptable to the public; therefore this study assumes that traffic must be maintained with minimal disruptions due to construction.

Maintenance of vehicular and rail traffic would require construction of temporary bridges (or shoofly for tracks) parallel to the existing bridges to carry and maintain traffic while the existing bridges are demolished and new bridges are replaced. In addition, traffic would need to be temporarily re-routed to the temporary bridges, thus requiring construction of temporary detour alignments. All of the above would require acquisitions of properties since there is little to none available existing right of way to shift traffic.

The scope of work involved in replacing the freeway bridges over Atlantic Boulevard would likely prompt Caltrans to require a detail review of existing deficiencies of the Atlantic Boulevard interchange including ramps. After the team reviewed the aerial mapping and photographs of the interchange with field observations, it became apparent that there are a number of existing traffic and geometric deficiencies with the interchange. A separate comprehensive multi-year study is needed to develop a solution that would address the existing deficiencies.

For the purpose of understanding the potential effects of widening Atlantic Boulevard, the team developed a concept of a solution that involves a different interchange configuration that could solve many of these deficiencies: a single point urban interchange (SPUI). A SPUI is a high capacity interchange that requires less right of way than a conventional Diamond or Partial-Cloverleaf interchange as shown in Figure 8. A SPUI fits well with the context due to the close proximity of residences to the existing interchange ramps and freeway mainline. A SPUI only has one signalized intersection in comparison to two in a diamond interchange, which results in reduced traffic signal delay. Operational advantages of a SPUI are that vehicles making left turn movements in opposing directions will not have to cross paths and will occur at the same intersection. Also, due to the flatter radii and angles, capacity of the ramp is improved. The blue shape shown in the figure below represents an approximate footprint of a SPUI. The team believes that this footprint is sufficiently large to accommodate the temporary widening of I-10 that will be required in order to replace the three bridges over Atlantic Boulevard.

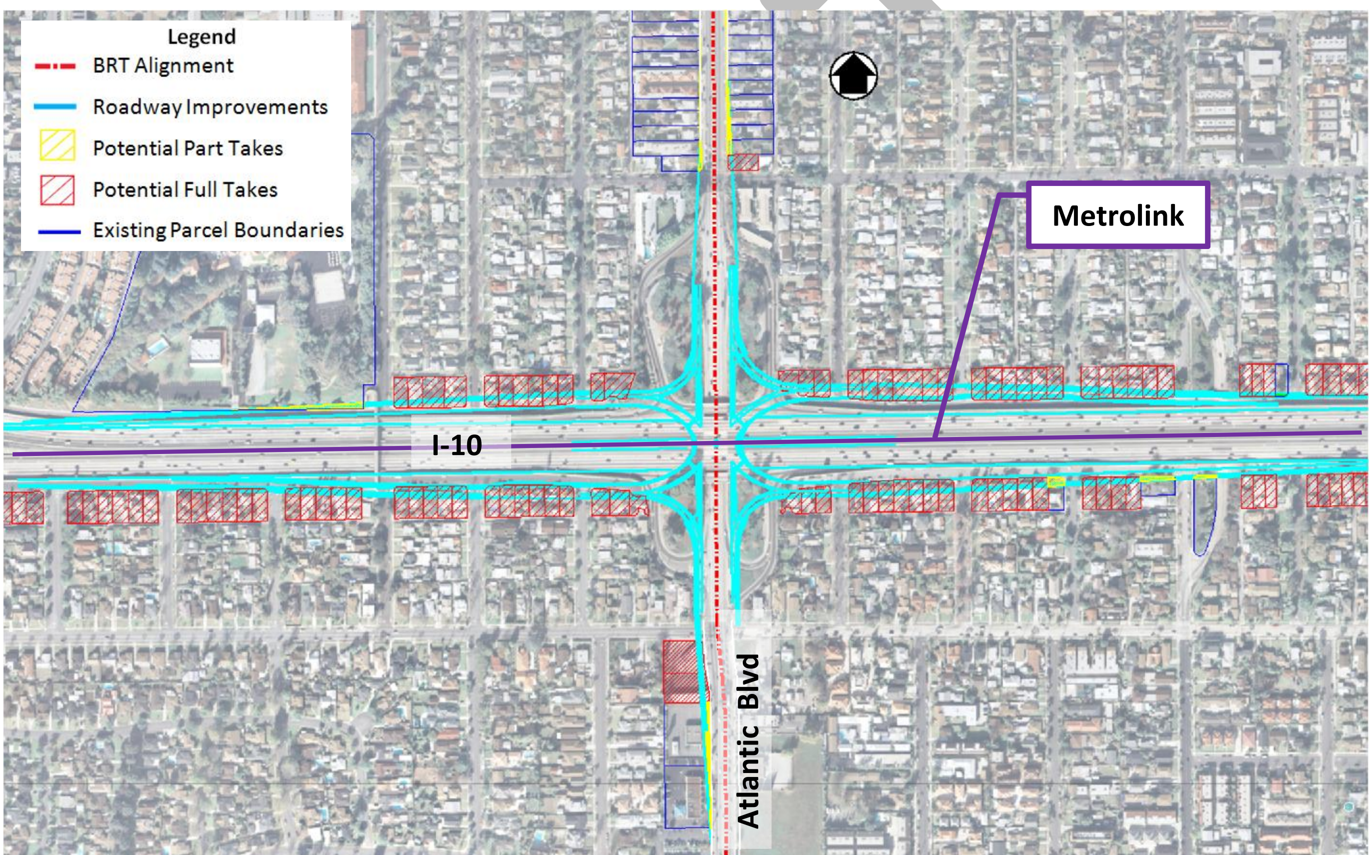


FIGURE 9
Single Point Urban Interchange Concept at I-10 and Atlantic Boulevard (for study purposes only, not proposed)

Conclusion

Although bus travel times from continuous bus lanes are reduced, the mixed flow and right-side bus lane scenario is recommended. The potential effect to parking and properties are minimal compared to the other scenarios while travel time is still improved from the 2035 No Build condition. The BRT improvements of the mixed flow and right-side bus lane will provide enhanced vehicles, amenities, operation and improve the local bus system.

List of Attachments

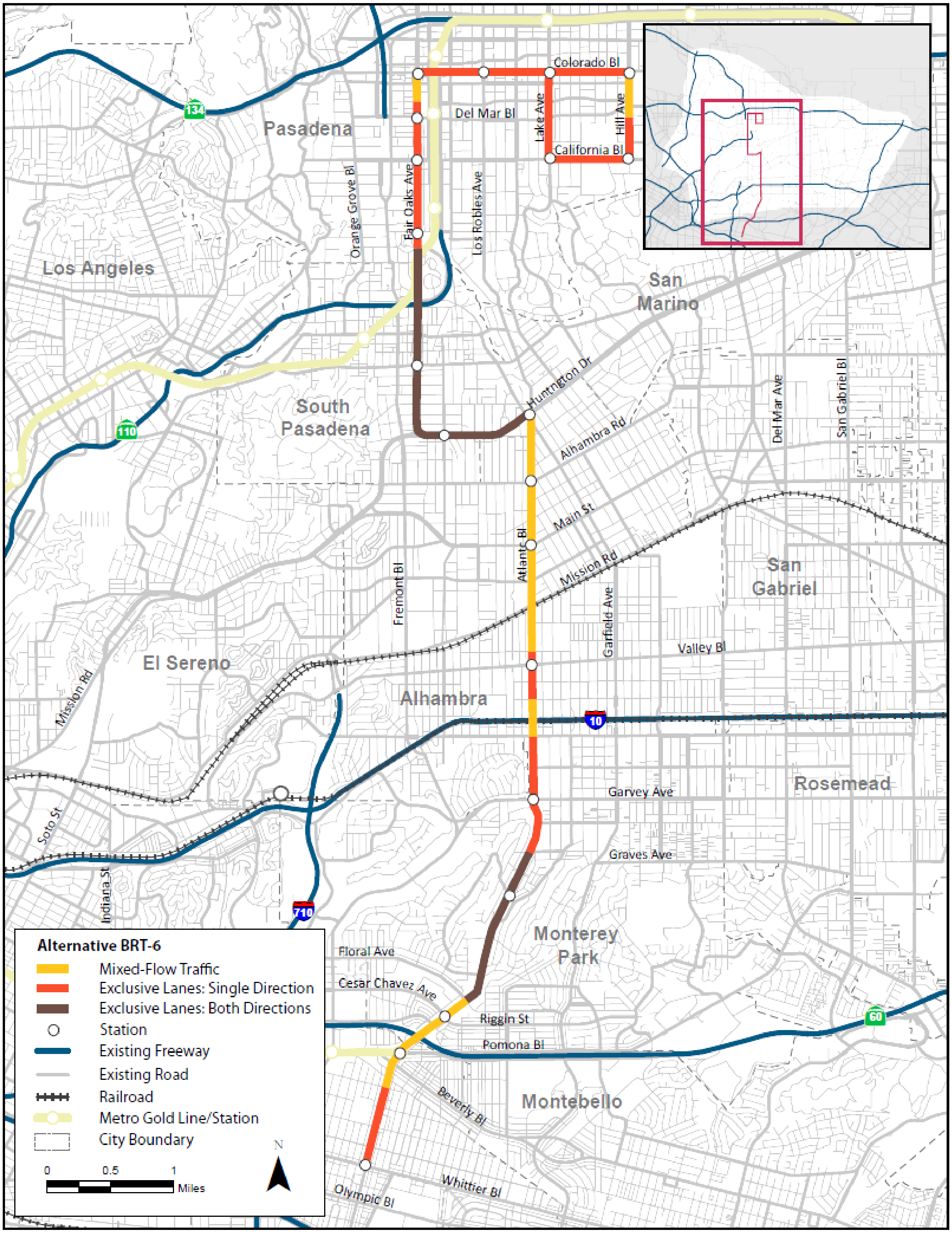
A. Map of BRT Alignment

B. BRTOPT Assumptions and Summary of Results

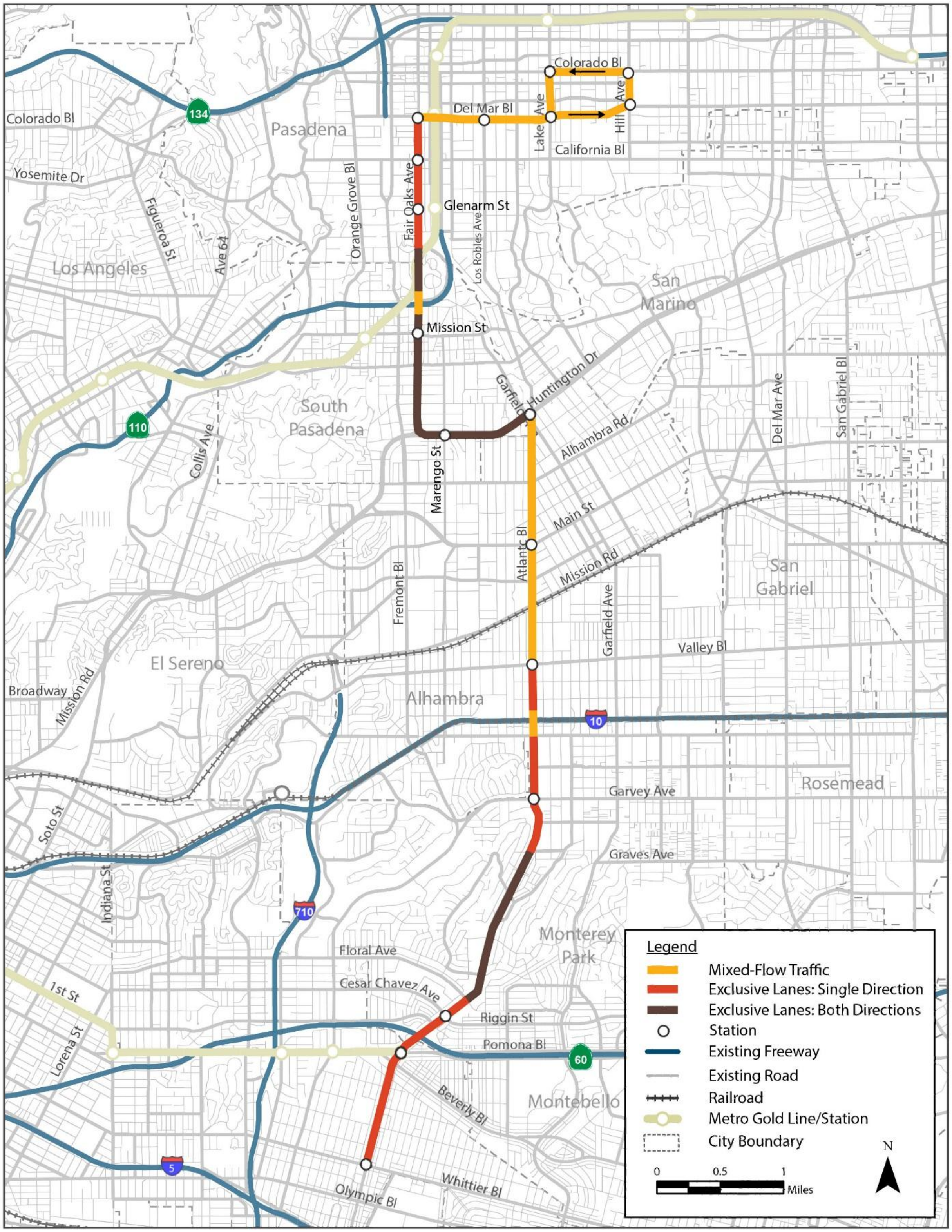
C. Summary of Potential Effects on Properties

Attachment A
Map of BRT Alignment

Alignment of Alternative BRT-6



Alignment of Refined BRT Alternative



Attachment B
BRTOPT Assumptions and Model

Bus Rapid Transit Operational Performance Tool

Data Collected:

Run Times

A total of 12 runs to collect travel time and delay information (6 in the northbound direction and 6 in the southbound direction) were conducted during the morning and evening commute hours (7:00 a.m. to 9:00 a.m., and 4:00 p.m. to 6:00 p.m.) over a period of 4 weekdays in December 2012. During each run, the data collector boarded the bus at an existing 762 bus stop, noted the start time, recorded the amount of delay upon each delay event on the ride, and noted the end time after he/she got off the bus.

On each run, the total run time, observed delays, and nature of each delay event were recorded. Three types of delays are separately recorded:

- Delay due to a red light at the signalized intersection ahead
- Delay due to the bus pulling out to a bus stop serving passengers and merging back with traffic
- Delay due to other reasons such as heavy traffic, extra wait time at stop, etc.

Speed:

The team determined average bus speeds along the corridor by collecting travel speeds on actual Metro Rapid 762 runs and from data collected on general traffic speeds along the corridor where Metro Rapid 762 did not run. Results of the average speed along the corridor are shown in Table 1 and Table 2.

TABLE 1
Average Existing Bus Speeds along Corridor – Northbound Direction

Bus Corridor	Corridor Segment	Northbound Runs
		Average Speed
Atlantic Blvd	Whittier Blvd to Cesar Chavez Ave	**15**
Atlantic Blvd	Cesar Chavez Ave to Garfield Ave	**23**
Garfield Ave	Atlantic Blvd to Huntington Dr	**15**
Huntington Dr	Garfield Ave to Fair Oaks Ave	**30**
Fair Oaks Ave	Huntington Dr to Monterey Rd	**30**
Fair Oaks Ave	Monterey Rd to SR-110	**15**
Fair Oaks Ave	SR-110 to Del Mar Blvd	**30**
Del Mar Blvd	Fair Oaks Ave to Hill St	**20**
Hill St	Del Mar Blvd to Colorado Blvd	**20**

TABLE 2

Average Existing Bus Speeds along Corridor – Southbound Direction

Bus Corridor	Corridor Segment	Southbound Runs
		Average Speed
Colorado Blvd	Hill St to Lake Ave	**20**
Del Mar Blvd	Lake Ave to Fair Oaks Ave	**21**
Fair Oaks Ave	Del Mar Blvd to Huntington Ave	**28**
Huntington Dr	Fair Oaks Ave to Marengo Ave	**28**
Huntington Dr	Marengo Ave to Garfield Ave	**30**
Garfield Ave	Huntington Ave to Atlantic Blvd	**25**
Atlantic Blvd	Garfield Ave to Newmark Ave	**25**
Atlantic Blvd	Newmark Ave to Floral Dr	**40**
Atlantic Blvd	Floral Dr to Pomona Blvd	**15**
Atlantic Blvd	Pomona Blvd to Whittier Blvd	**25**

Bus Stop:

Data collected on stop delay times were from field studies done along the Metro Orange Line BRT and Wilshire BRT. These existing BRT corridors have similar elements to the proposed bus stops and vehicles.

Key Assumptions:

Acceleration/Deceleration:

Using the data collected the team determined the bus' average acceleration rate and deceleration rate. The data collected included the starting speed, bus' constant speed, and time it took the bus to accelerate from starting speed to a constant speed. For uniform acceleration and deceleration the following equation was used:

$$a = \frac{v - v_0}{t}$$

a=bus acceleration rate/deceleration rate
t=time it took bus to accelerate from v0 to v (average time from field study)
v0=bus starting speed (in this case always 0 since it is from a stop)
v=bus final speed (average speed along segment from field study)

The bus acceleration rate used in this model was 2.56 ft/s^2 and a bus deceleration rate of 2.46 ft/s^2.

Signal Delays

The existing and future estimated delays were based on findings of similar studies and applied with an assumed probability of a bus encountering a green light at a signal. Each intersection was assigned a delay time based on the movement of the bus and the classification of the streets intersecting. Signal delays in the 2035 No Build condition used the existing 2013 delay condition with a 1.3% increase in delay per year for future growth. The estimated delays are shown in Table 3.

TABLE 3
Estimated Existing and Future Signal Delays

Street	Cross Street	Movement	2035 Delay (sec)	2035 No Build (sec)
Major	Minor	Left	14	18.6
		Right	2	2.7
		Thru	6	8.0
Major	Major	Left	45.5	60.5
		Right	17.5	23.3
		Thru	31.5	41.9
Minor	Minor	Left	14	18.6
		Right	6	8.0
		Thru	10	13.3
Minor	Major	Left	38.5	51.2
		Right	17.5	23.3
		Thru	31.5	41.9

Future Bus Stop Delays

The estimated future bus stop delays were determined by actual field study and studies on similar bus rapid transit operations with 60' articulated buses, 3 door boarding, off-board fare collection, shared/separated bus stops, high/low patronage volumes, and probability of bus stopping. The estimated delays for each stop are shown in Table 4.

TABLE 4
Estimated Bus Stop Delays

	Continuous Bus Lanes		Median Bus Lanes	
Stop Location	**Northbound**	**Southbound**	**Northbound**	**Southbound**
Whittier Blvd	20.8	16.7	15.0	15.0
Pomona Blvd	25.0	16.7	18.0	15.0
Cesar Chavez/Riggin Ave	20.0	20.0	18.0	18.0
Garvey Ave	20.0	16.7	18.0	15.0
Valley Blvd	25.0	20.0	18.0	18.0
Main St	25.0	20.8	18.0	15.0
Garfield Ave	17.0	11.3	10.0	6.7
Marengo Ave	5.7	8.5	3.3	5.0
Mission St	8.5	14.2	5.0	8.3
Glenarm St	8.5	5.7	5.0	3.3
California Blvd	11.3	11.3	6.7	6.7
Del Mar Blvd	8.5	5.7	5.0	3.3
Los Robles	5.7	5.7	3.3	3.3
Lake Ave	5.7	5.7	3.3	3.3
Hill Ave	5.7	5.7	3.3	3.3
Colorado Blvd	5.7	5.7	3.3	3.3

TSP improvements

Transit Signal Priority is being implemented along this corridor. According to a *Transit Signal Priority Tool by a combination of Dana Woodbury, Joel Falter, KOA transportation consultant, and an article by Selman Altun and Peter Furth and FTA funded Peer-to-Peer Information Exchange on BRT Report*, Metro's rapid and BRT system uses a conditional active transit signal priority system (TSP) based on headways. Implementation of TSP will extend the green time, have the ability to shorten the red signal, hold a green signal until the bus crosses an intersection during non-coordinated (free) option and a phase call typically used for queue jumper operations.

According to a 2004 pilot project implemented by Metro along the Crenshaw Boulevard corridor indicated that bus signal priority improves bus travel time and reduces signal delay. The study revealed that there is an average 12% reduction in red signal delay during AM and PM peak periods. In the BRTOPT model, the team determined a time savings factor that would be applied to intersections, intersection acceleration, and intersection deceleration in the existing condition that would result in a 12% time savings. The same factor is then used for every scenario based on the assumption that TSP will be implemented in the future.

Queue Jump

At signalized intersections that are heavily congested during peak hours, a queue bypass lane (or queue jumper) has been proposed to be installed at several intersection to allow buses to bypass the queue, with an optional separate transit signal phase. It is important to also provide a recovery lane or a bus bay on the far-side of the intersection to enable re-entry of buses to traffic.

In intersections where a queue jumper was proposed a time savings factor that would reduce the intersection delay by 20% was applied. In the scenario 6, a queue jump is applied at all intersections where an exclusive median bus lane is proposed since the bus will always bypass any queue.

Speed

The estimated speeds used in the model were based on actual observed speeds and posted speed limits. In the existing conditions, field study data was used for each segment. Where exclusive bus lanes are proposed in the base condition and continuous lane condition, buses are assumed to travel at 80% of the posted speed limit. However, in some segments buses will travel the same speed as general traffic depending on the surrounding. In the median bus lane condition, buses are assumed to travel at 90% of the posted speed limit since bus drivers will be separated from general traffic by a raised island and therefore any conflicts with other right-turn traffic are eliminated.

Summary of Time Performance for each BRT Scenario **Date: 9/13/2013**

Northbound BRT	Total Travel Time (min)	Running Time (min)	Stop Delay (min)	Intersection (min)	Stop Accel/Decel (min)	Intersection Accel/Decel (min)
2013 Existing Condition	59.86	18.74	5.56	21.00	3.16	11.41
2013 Existing Condition with TSP	56.10	18.74	5.56	18.48	3.16	10.16
2035 No Build with TSP	63.73	18.74	7.11	24.55	3.16	10.16
2035 BRT Base Case with TSP	55.74	14.39	3.59	23.34	3.30	11.12
2035 BRT Continuous Lane with TSP	52.87	11.90	3.59	22.26	3.48	11.64
2035 BRT Median Lane with TSP	46.23	7.63	2.56	19.64	3.74	12.66

Southbound BRT	Total Travel Time (min)	Running Time (min)	Stop Delay (min)	Intersection (min)	Stop Accel/Decel (min)	Intersection Accel/Decel (min)
2013 Existing Condition	59.06	13.84	5.64	23.25	3.20	13.13
2013 Existing Condition with TSP	54.69	13.84	5.64	20.46	3.20	11.56
2035 No Build with TSP	63.19	13.84	7.28	27.18	3.20	11.69
2035 BRT Base Case with TSP	57.23	12.64	3.50	25.64	3.25	12.04
2035 BRT Continuous Lane with TSP	52.48	10.50	3.17	24.50	3.41	10.90
2035 BRT Median Lane with TSP	46.40	6.87	2.38	21.75	3.65	11.76

BRT Northbound & Southbound	Average Total Travel Time (min)	Average Running Time (min)	Average Stop Delay (min)	Average Intersection (min)	Average Stop Accel/Decel (min)	Average Intersection Accel/Decel (min)
2013 Existing Condition	59.46	16.29	5.60	22.13	3.18	12.27
2013 Existing Condition with TSP	55.40	16.29	5.60	19.47	3.18	10.86
2035 No Build with TSP	63.46	16.29	7.20	25.87	3.18	10.93
2035 BRT Base Case with TSP	56.48	13.51	3.54	24.49	3.27	11.58
2035 BRT Continuous Lane with TSP	52.68	11.20	3.38	23.38	3.45	11.27
2035 BRT Median Lane with TSP	46.31	7.25	2.47	20.69	3.69	12.21

Attachment C
Summary of Potential Property Effects on Properties

Assessment of BRT Scenarios Potential Effects on Properties

Potential property effects were evaluated for each future scenario.

In the No Build 2035 scenario no properties would be impacted.

Mixed-Flow & Right-Side Bus Lane Potential Property Takes & Approximate Acreage

Mixed-Flow & Right-Side Bus Lane Location	Number of Properties			Acreage		
	Partial Properties	Full Properties	Total	Partial Properties	Full Properties	Total
East Los Angeles	2	0	2	0.1	0	0.1
Monterey Park	5	0	5	0.1	0	0.1
Alhambra	12	0	12	0.2	0	0.2
South Pasadena	12	0	12	0.1	0	0.1
Pasadena	3	0	3	0.1	0	0.1

Continuous Right-Side Bus Lane Potential Property Takes & Approximate Acreage

Continuous Right-Side Bus Lane Location	Number of Properties			Acreage		
	Partial Properties	Full Properties	Total	Partial Properties	Full Properties	Total
East Los Angeles	29	31	60	0.3	6.8	7.9
Monterey Park	23	14	37	1.2	12.1	13.3
Alhambra	163	167	330	3.1	26.1	29.1
South Pasadena	1	1	2	0.1	0.4	0.4
Pasadena	12	22	34	0.2	13.3	13.4

Continuous Median Bus Lane Potential Property Takes & Approximate Acreage

Continuous Median Bus Lane Location	Number of Properties			Acreage		
	Partial Properties	Full Properties	Total	Partial Properties	Full Properties	Total
East Los Angeles	39	33	72	0.8	7.8	8.6
Monterey Park	34	6	40	1.2	2.1	3.3
Alhambra	185	171	356	4.1	28.1	32.1
South Pasadena	14	12	26	0.1	4.8	4.9
Pasadena	29	59	88	1.1	19.5	20.6

BRT Scenario Potential Property Takes & Approximate Acreage

BRT Scenario	Number of Properties			Acreage		
	Partial Properties	Full Properties	Total	Partial Properties	Full Properties	Total
Mixed-Flow & Right-Side Bus Lane	34	0	34	0.3	0	0.3
Continuous Right-Side Bus Lane	228	235	463	5.6	58.5	64.1
Continuous Median Bus Lane	301	281	582	7.3	62.1	69.5

Appendix D
BRT Bus Travel Times and Potential Effect on Ridership Technical Memorandum

DRAFT TECHNICAL MEMORANDUM

SR 710 North Study – BRT Bus Travel Times and Potential Effect on Ridership

PREPARED FOR:	Michelle Smith/Metro
COPY TO:	Caltrans
PREPARED BY:	CH2M Hill Team
DATE:	November 4, 2013
PROJECT NUMBER:	428908

At the SR710 North Study Technical Advisory Committee (TAC) and Stakeholder Advisory Committee (SOAC) Meetings that were held in September, 2013, there were several questions regarding BRT bus travel times and the affect of bus travel times on transit ridership. At that meeting, the results of a study of BRT bus travel times for various bus lane options was presented. That study of bus lane options used a BRT Operations model to estimate average bus travel times for the BRT Alternative route. This memorandum addresses these questions along with responses. A summary description of the BRT Alternative is attached to this memorandum with supporting graphics.

Question-1: How long would it take for an automobile to drive the BRT route from Whittier Boulevard to end of the North Loop?
The same operations model that was used for the study of BRT bus travel times was used to estimate the travel time for an automobile for the year 2035 analyses year under the No Build Alternative condition. To compute this estimated travel time, adjustments were made to estimate performance for a private automobile versus a public transit bus. The estimated travel time for an automobile for this 11.8-mile trip for the year 2035 would be approximately 49 minutes during the PM peak hour in comparison to the BRT bus average travel time of 56 minutes.

For comparison purposes, travel time estimates are provided in the table below for several scenarios.

PM Peak Travel Time Comparisons for Existing and Future Scenarios		
Travel Time Scenario	Year	Estimated Time
- Existing Automobile Trip	2013	41 minutes
- Existing Bus Trip Without Improvements and Transit Signal Priority	2013	59 minutes
- Existing BRT Bus Trip with all BRT and Transit Signal Priority Improvements	2035	48 minutes
- Future Automobile Trip	2035	49 minutes
- Future BRT Bus Trip with all BRT and Transit Signal Priority Improvements	2035	56 minutes

The BRT buses would benefit from use of the right side bus lanes, queue bypass lanes, and transit signal priority at intersections. Buses would need to stop at up to 17 bus stops for boarding and deboarding passengers along the 12 miles, and also buses have lower acceleration and deceleration rates than automobiles. However, under the BRT Alternative the dwell times at bus stops would be reduced to 20 seconds per stop or less depending upon the boarding volumes at stations. It should be noted that only a portion of all travel in the study area would make this entire trip. Instead many trips would use only a portion of this route. For example, some transit trips may use feeder bus routes running east-west, and then transferring to the BRT line running north-south to get to destinations.

Question-2: How much more ridership would the BRT Alternative attract than what the existing 762 line could attract?
The ridership projections for this comparison will be provided using the SCAG model. The 762 line is part of the No Build transit network and the TSM Alternative network so ridership estimates will be available to make this comparison. The BRT Alternative includes a number of features that would yield improved ridership beyond the 762 line. The BRT alternative will include sections of right side bus lanes, some queue bypass lanes at intersections, enhancements of bus stops, and on-board fare validation to enable 3-door bus access. The total travel time for the BRT alternative in comparison to the 762 line in the year 2035 would be PM peak hour average of 56 minutes in comparison to an average of 63 minutes. The 762 line has a peak frequency of 20 minutes per bus, while the BRT Alternative would have a proposed peak frequency of 10 minutes per bus. Also the BRT Alternative includes additional feeder and connecting bus services and frequencies that will enable transit riders to reduce transfer times and gain access to more destinations. The expected increase in ridership results will be reported once the travel demand modelling is completed.

Question-3: Don't we need continuous median or right side bus lanes for the BRT Alternative to attract greater transit ridership?
A study of peak hour bus travel times for various bus lane options was conducted and summarized in a separate report. That study found that continuous median or right side bus lanes would reduce bus travel times in comparison to the BRT Alternative. The current BRT Alternative design includes right side bus lanes on approximately 77 percent of the 10-mile truck-line and 64 percent of the 12 mile route. Estimates of peak period average bus travel times were prepared for the year 2035 conditions. The peak period average bus travel times were estimated to be 56 minute for the BRT Alternative, 53 minutes for continuous right side bus lanes, and 46 minutes for continuous median running bus lanes. Continuous median lanes would potentially save 10 minutes while continuous right side bus lanes would potentially save 3 minutes for the 12 mile route.

The potential environmental effects to achieve these travel time reductions for both the continuous right side bus lanes and continuous median bus lanes were substantial. Therefore the BRT Alternative as currently designed will be accepted as is and will be the Alternative that is reviewed in the Draft EIR/EIS. Another transportation alternative that is being studied is the Light Rail Transit (LRT) Alternative. That alternative runs in 100 percent exclusive transit ways including tunnels and elevated structures. The transit ridership projections for the LRT Alternative will be available to allow decision making on the importance of exclusive transit ways for affecting transit ridership.

The bus operations speed improvements due to dedicated bus lanes would have a partial affect on ridership. However, it should be noted that there are many factors that affect transit ridership. Based upon research and transit ridership surveys, the factors that affect transit ridership that can be addressed in the development of a BRT alternative include:

1. <u>Transit travel speeds.</u> Bus speeds as affected by the degree of bus to which bus operate on exclusive lanes or running ways on the route.
2. <u>Connectivity/service between origins and destinations.</u> How well the transit network connects origins and destinations in the area and the region so that travelers can get to where they want to go.
3. <u>Service frequencies.</u> How frequent is the service? Is the transit route on a headway-based schedule? A headway based schedule manages headway, with operations would be controlled to maintain a specific headway. As a result, patrons would expect buses to be coming at timed intervals rather than a scheduled exact time. With this type of schedule would travelers count on buses being available every 10 minutes or less?

4. Transfer requirements. The degree to which transfers are easy to make and conveniently located nearby. Also how frequent are the bus lines for transfers? Long waits for transfers affect the desirability of using transit as the mode for travel.
5. Travel time reliability. Does the travel time vary dramatically from one bus trip to another? Bus travel times can be affected by traffic delays, or a ride range in boarding volumes at bus stops.
6. Accessibility to transit. Access to transit can be affected by lack of sidewalks, or difficulty to cross streets and roads.
7. Comfort and convenience. The factors for customer comfort and convenience for using transit include the quality of amenities at bus stops; the level of safety and security; protection for rain, wind, hot sun; availability of a seat at stops; ease/convenience of the fare payment system; quality of the bus ride; availability of seats on the bus.

There are other factors that also affect transit ridership, that are external to the design of a transit alternative. These are: Automobile ownership; cost of parking; cost of transit fare; level of traffic congestion; automobile travel time; trip type.

The relative importance of these factors to potential transit customers depends upon whether or not those potential customers have access to/choice to use an automobile for their travel. For discretionary transit users (those that have a choice to use an automobile or transit) convenience, travel time, and safety are most important. For transit dependent users (those who do not have access to an automobile) transit access to get to destinations is most important.

Based upon surveys of the existing 762 operations, approximately 40 percent of the total travel time during peak hours on the BRT Alternative 10-mile trunk/spine along Atlantic Boulevard/Huntington Drive/Fair Oaks Avenue is stop time. Approximately 60 percent of total bus stop time during peak hours occurs at intersections and another 35 percent of stop time occurs at bus stops. The remaining 5 percent occurs mid block or due to other factors. Providing bus lanes would be beneficial, especially at approaches to intersections. However at mid block areas, traffic is mostly free flow at or near the speed limit. On the 10-mile trunk/spine, bus lanes are included in either one or both directions for 77 percent of the trunk line for the route. Also, capacity improvements are provided at 14 intersections to reduce bus delays.

Bus travel surveys found that delay times at bus stops ranged as high as 100 seconds, due to time for up to 10-to-15 passengers to board through the front door of buses. Other delays at bus stops are sometimes due to inability for buses to re-enter traffic. Additional improvements are proposed at bus stop locations including separation of BRT stops from the local bus line stops. Acceleration lanes downstream from bus stops will be provided where possible. Also 3-door BRT bus boarding is proposed to reduce bus stop dwell times.

The BRT Alternative includes many improvements to transit operations in comparison to the existing 762 line in the study area. The table below identifies improvements included in the BRT Alternative to address each of the factors that affect transit ridership.

Factor Affecting Transit Ridership	BRT Improvements versus 762 Line
1) Transit travel speeds	• Bus lanes in one or both directions 77% of trunk line • Intersection improvements at 14 intersections • Separation of BRT bus stops from local bus stops • More than 10 % total bus travel time reduction in future traffic conditions
2) Connectivity/service between origins and destinations	• New bus feeder services to El Monte and Commerce • Increased bus frequencies on many connecting bus lines
3) Service frequencies	• Increased peak BRT bus frequencies from 20 minutes per bus for the 762 to 10 minutes per bus for BRT
4) Transfer requirements	• Improved bus zones, and way finding to access transfers • Increased bus frequencies for both the BRT line and connecting bus lines reduces transfer times
5) Travel time reliability	• Transit Signal Priority improves schedule reliability • 3-door boarding reduces longer dwell times due to queues at front door of buses so improves schedule reliability
6) Accessibility to transit	• Intersection areas and sidewalk improvements enable easier access to bus stops • Bus shelters and access at stops
7) Comfort and convenience	• Bus shelters, wind screens, seats & lean bars • Transit information signage, including information on transfers to other transit lines • Next bus LED sign providing bus arrival times • Safety and security improvements including tactile warning strips, lighting, marked wheel chair access location

ATTACHMENT

Background on the BRT Alternative

The Bus Rapid Transit (BRT) service was advanced from an evaluation of six candidate corridors, based on its potential to link important trip origins and destinations, carry significant ridership, and improve mobility in the SR 710 study area. The BRT alternative is proposed to operate between East Los Angeles to Pasadena. A figure illustrating the BRT alternative is attached at the end of this memorandum.

The intent of the BRT alternative is to improve on the existing Metro Rapid services in the study area, particularly Metro 762, by providing higher-frequency, faster and more efficient bus service connecting key origins and destinations in the study area. The selected corridor exhibited the greatest potential for travel time savings and preferential bus treatments such as curbside dedicated lanes (i.e., sufficient right-of-way) without significant disruption to existing roadways.

The BRT alternative would enhance the Atlantic Boulevard-Fair Oaks Avenue corridor with additional limited stop, high frequency bus service, enhancements such as dedicated bus lanes, and transit signal priority measures. The route would provide new connectivity from the Atlantic Avenue Corridor to major educational institutions in Pasadena and employment in the Fair Oaks Avenue and East Colorado Boulevard corridors.

BRT service would be provided between Atlantic Boulevard at Whittier Boulevard, south of the Gold Line Atlantic Station, and Pasadena City College (PCC) and the California Institute of Technology (Caltech) in Pasadena. The route would replicate the existing 762 Metro Rapid service for much of its length, with a new eastward connection in Pasadena to PCC and Caltech. The existing 762 Rapid service would be shortened on its northern end and would operate between Compton and East Los Angeles, terminating at East Los Angeles Community College (ELACC). Where the BRT, 762 or other local services overlap, routes would share bus stop locations, with separation of boarding space for BRT and local/Rapid services to ensure efficient interplay between routes.

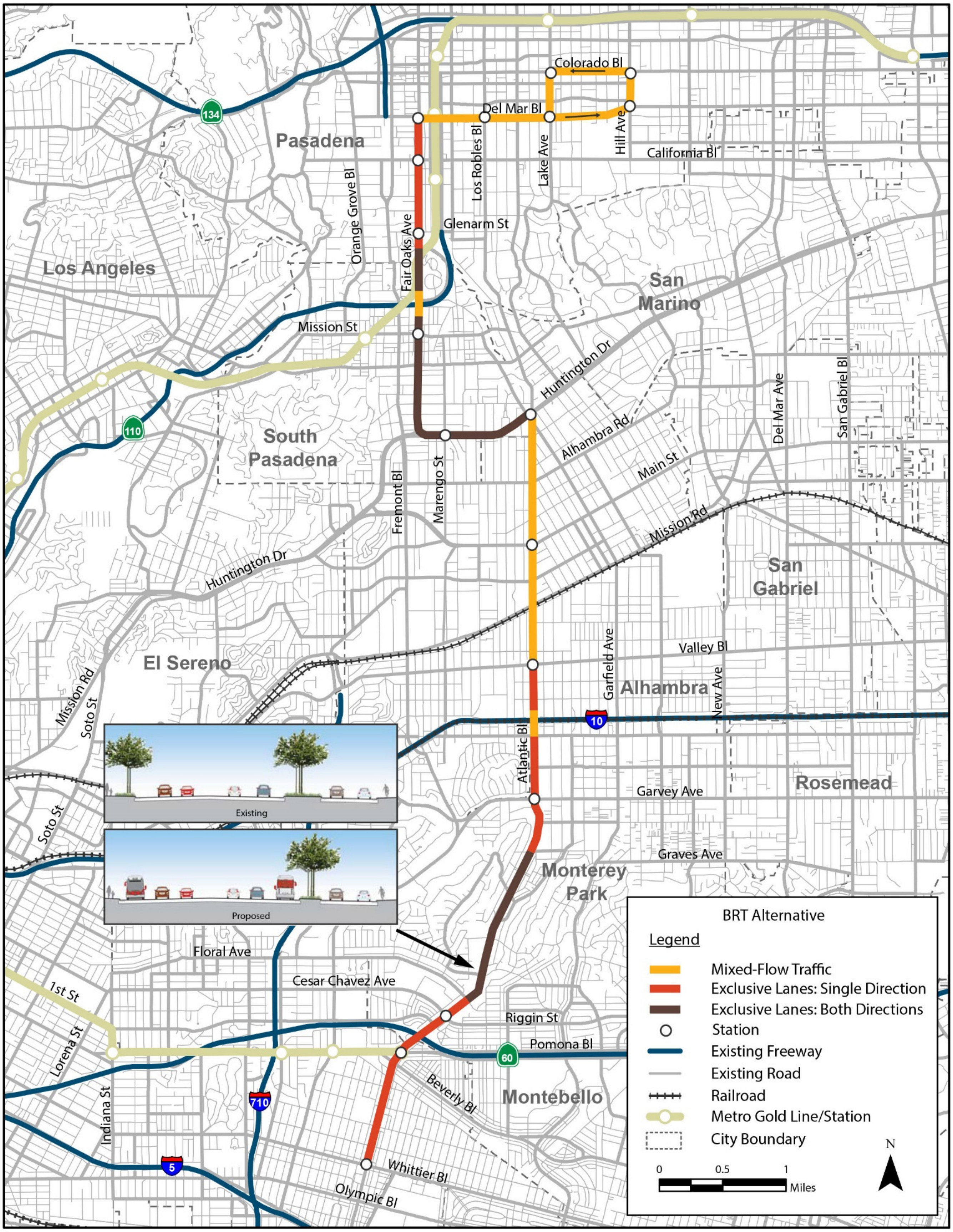
The average one-way length of the route would be 11.8 miles. BRT vehicles would travel along Atlantic Boulevard to Huntington Drive, west along Huntington Drive to Fair Oaks Avenue, then northbound on Fair Oaks Avenue into Pasadena. In Pasadena, the BRT vehicles would travel along Del Mar Boulevard and then make a loop to PCC and Caltech via Lake Avenue, Colorado Boulevard, Hill Avenue and return to Fair Oaks Avenue via Del Mar Boulevard.

BRT service would operate from 5:00 A.M. to 9:00 P.M. on weekdays and 7:00A.M. to 7:00 P.M. on Saturday and Sunday. Local bus routes in the area would continue to operate a longer span than BRT and limited stop services.

The BRT alternative would operate on a peak frequency of every 10 minutes and an off-peak frequency of every 20 minutes. Combined with the 260 (10 minutes peak; 20 minutes off-peak), this frequency of 5 minutes peak and 10 minutes off-peak would provide exceptional levels of service between East Los Angeles and Pasadena.

Bus Rapid Transit service would incorporate modern, articulated buses with low-floor boarding to facilitate passenger entry and exit. Typical articulated buses feature two doors; however, three-door vehicles are becoming more common. Based on an average one-way route length of 11.8 miles and an estimated average travel time of 50.0 minutes, the BRT would require 12 peak vehicles for 10-minute frequency service and 6 off-peak vehicles for 20-minute service.

Bus Rapid Transit service would feature dedicated bus-only lanes for much of the planned alignment as well as transit signal priority (TSP) components to improve both bus and general traffic flow in the corridor. BRT bus stops would be recognizable through distinct branding, shelters, on-board fare card validation, and public information such as real-time arrival displays indicating the proximity of buses to the stop.



Colorado Bl
Del Mar Bl
Hill Ave
California Bl
Lake Ave
Los Robles Bl
Pasadena
Orange Grove Bl
Fair Oaks Ave
Glenarm St
Los Angeles
San Marino
Mission St
Huntington Dr
South Pasadena
Alhambra Rd
Main St
Del Mar Ave
San Gabriel Bl
Marengo St
Fremont Bl
Mission Rd
Huntington Dr
San Gabriel
El Sereno
Valley Bl
Garfield Ave
Alhambra
New Ave
Mission Rd
Soto St
Atlantic Bl
Garvey Ave
Rosemead
Soto St
Existing
Proposed
Graves Ave
Monterey Park
Floral Ave
Cesar Chavez Ave
1st St
Riggin St
Lorena St
Pomona Bl
Indiana St
Beverly Bl
Montebello
Whittier Bl
Olympic Bl
BRT Alternative
Legend
Mixed-Flow Traffic
Exclusive Lanes: Single Direction
Exclusive Lanes: Both Directions
Station
Existing Freeway
Existing Road
Railroad
Metro Gold Line/Station
City Boundary
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1
Miles

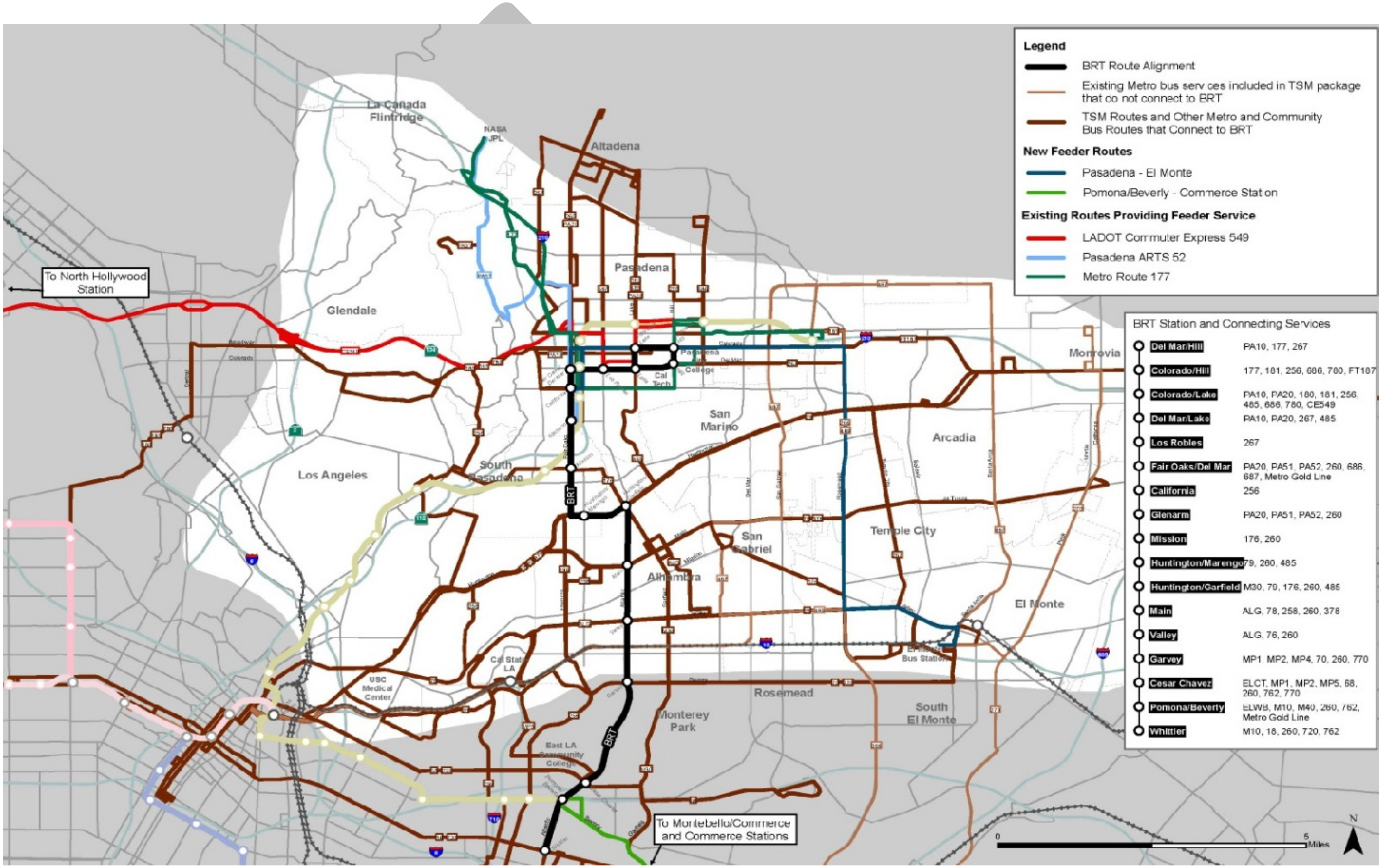
BRT Supporting Bus Services Including Feeder, Connecting, and TSM Alternative Bus Services

Two BRT feeder routes were advanced to support transit access to the BRT Line. The first route, envisioned as a Metro Rapid route, will operate between the El Monte Bus Station and the California BRT Station in Pasadena along Valley Boulevard, Rosemead Boulevard and Colorado Boulevard. The second route, envisioned as a local feeder, would operate between the Commerce and Montebello/Commerce Metrolink Stations and the Pomona/Beverly Station on the BRT in East Los Angeles via Garfield Avenue and Beverly Boulevard.

In addition to these two proposed feeder routes, Metro Rapid Route 762 will continue to serve East Los Angeles Community College (ELACC), its new northern terminus and provide feeder service to the BRT. El Sol operates a shuttle route between ELACC and California State University – Los Angeles (CSULA). The route currently operates every 30 minutes. Although not a formal recommendation for feeder service, an increase in frequency on the El Sol route would create a valuable BRT feeder service for trips to and from CSULA.

The Transportation Systems Management (TSM) alternative includes significant enhancements to existing bus services throughout the study area. These enhancements relate primarily to frequency of service. By providing higher frequency service throughout the study area, local bus transit becomes an increasingly viable alternative to private automobile travel while reducing travel times and enhancing mobility significantly for existing transit users. The TSM alternative would also complement the implementation of one or both of the Bus Rapid Transit alternatives by improving connectivity to and from these major corridors and expanding the reach of transit as a whole.

The TSM alternative focuses on viable frequency enhancements that will increase ridership overall without resulting in significant impacts on productivity or operating costs. Furthermore, it is assumed that Metro will provide TSM alternative levels of service as demand warrants, i.e., the TSM frequencies represent a target based on travel demand forecasting and anticipated demand in the year 2035.


Legend
BRT Route Alignment
Existing Metro bus services included in TSM package that do not connect to BRT
TSM Routes and Other Metro and Community Bus Routes that Connect to BRT
New Feeder Routes
Pasadena - El Monte
Pomona/Beverly - Commerce Station
Existing Routes Providing Feeder Service
LADOT Commuter Express 549
Pasadena ARTS 52
Metro Route 177
BRT Station and Connecting Services
Del Mar/Hill PA10, 177, 267
Colorado/Hill 177, 181, 256, 686, 780, FT187
Colorado/Lake PA10, PA20, 180, 181, 256, 485, 686, 780, CE549
Del Mar/Lake PA10, PA20, 267, 485
Los Robles 267
Fair Oaks/Del Mar PA20, PA51, PA52, 260, 686, 687, Metro Gold Line
California 256
Glenarm PA20, PA51, PA52, 260
Mission 176, 260
Huntington/Marengo 79, 260, 485
Huntington/Garfield M30, 79, 176, 260, 485
Main ALG, 78, 258, 260, 378
Valley ALG, 76, 260
Garvey MP1, MP2, MP4, 70, 260, 770
Cesar Chavez ELCT, MP1, MP2, MP5, 68, 260, 762, 770
Pomona/Beverly ELWB, M10, M40, 260, 762, Metro Gold Line
Whittier M10, 18, 260, 720, 762
To North Hollywood Station
To Montebello/Commerce and Commerce Stations
La Canada Flintridge
NASA JPL
Altadena
Pasadena
Glendale
Monrovia
San Marino
Arcadia
Cal Tech
Los Angeles
South Pasadena
San Gabriel
Temple City
Alhambra
El Monte
Cal State LA
USC Medical Center
Rosemead
South El Monte
Monterey Park
East LA Community College
BRT
N
0
5 Miles

Appendix E
BRT Alternative Construction Staging and Transportation Management Plan Technical Memorandum

MEMORANDUM

TO: Vincent Chio, CH2M Hill

FROM: Steve Itagaki, PE, TE, PTOE

DATE: October 4, 2013

SUBJECT: **SR-710 North Study - BRT Alternative**
Construction Staging and Transportation Management Plan
2011.0056.0002.00

This memorandum briefly discusses construction staging for proposed improvements as part of the Bus Rapid Transit (BRT) alternative which proposes new bus lanes and other roadway modifications, new station amenities, traffic signal and street lighting modifications, utility relocations, drainage modifications, etc.

Construction Staging

Construction staging for the BRT alternative is designed to optimize traffic flow and circulation during construction. Construction staging will involve lane (i.e., outside lane) closures in each direction to avoid complete, alternate route, detours which are impractical due to high traffic volumes, current intersection congestion and potential access impacts to businesses and residents in the study area. Single lane closures will maintain at least one lane per direction along existing arterials during day and nighttime hours. On-street parking is expected to be impacted temporarily during construction activities.

In general, construction of various BRT improvements would occur on one side of the street at a time to the maximum extent feasible. Once one side of the street is complete, work can then commence on the other side. By restricting construction to one side of the street at a time, the area available for travel lanes and on-street parking is maximized.

Construction staging has been customized for the following BRT improvements:

- Roadway and Station Improvements
- Traffic Signal Modifications
- Street Lighting Modifications
- Modifications to On Ramps at SR-60

Construction staging for each BRT improvement is briefly described below.

<u>Roadway and Station Improvements</u>

Roadway and BRT station Improvements will be developed according to three possible scenarios listed below:

- Scenario A – Street widening on one or both sides in mid-block
- Scenario B – Construction of BRT stations
- Scenario C – Intersection widening

Considering that roadway and station improvements will occur within curb lanes and sidewalks, construction staging for these improvements, based on the above scenarios, will generally consist of the construction sequencing described and illustrated in Figures 1 and 2 below:

1. Restripe lanes and shift traffic away from the construction area.
2. Install temporary traffic control devices and close the construction area to traffic.
3. Modify utilities and modify catch basins, if present.
4. Modify existing traffic signals, if present.
5. Construct new pavements, curbs and sidewalks.
6. Provide temporary pedestrian walkways/detours.
7. Construct BRT station amenities, if applicable.
8. Open construction area to traffic.

FIGURE 1 - CONSTRUCTION STAGING (STAGE 1)

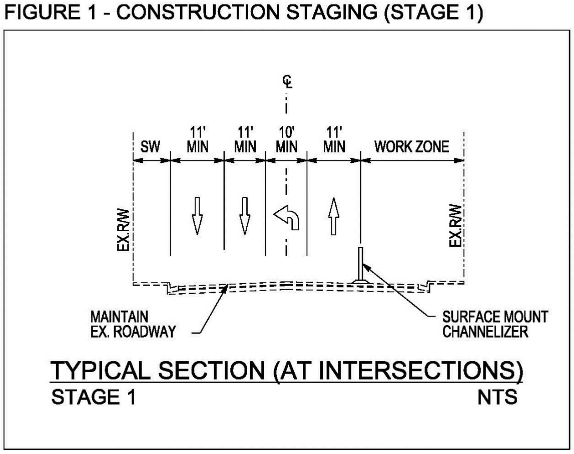
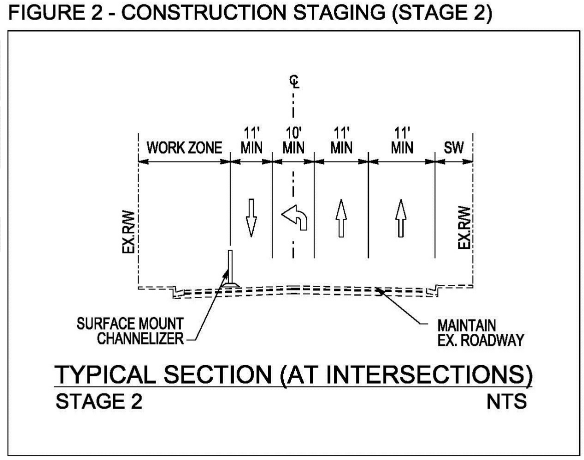


FIGURE 2 - CONSTRUCTION STAGING (STAGE 2)



Traffic Signal Modifications

Traffic signal equipment at existing signalized intersection will need to be modified where roadway widening is proposed or where proposed BRT stations are in conflict with existing signal equipment. The scope of work will include replacement or relocation of existing traffic signal pole(s), traffic signal priority (TSP), emergency vehicle preemption, controller cabinets, and service points, as well as upgrading existing traffic signal equipment that does not meet jurisdictional standards. To avoid impacts to traffic operations, the contractor will need to install proposed traffic signal poles in their ultimate locations before any cut-over in service occurs. Once the new traffic signal poles are installed the contractor will schedule a one day cut-over consisting of the installation of temporary stop signs at all approaches, turning off the existing traffic signal and reactivating within one day.

Traffic signal modifications will occur at intersections and require the following construction sequencing:

Street Lighting Modifications

Street light poles and the associated electrical work along Atlantic Boulevard and Fair Oaks Avenue will need to be modified where widening is proposed. The scope of work will include relocation of street light poles, installation of new wiring, conduits and pull boxes. Street lighting modifications will mostly occur between intersections and require the following construction sequencing outlined below:

1. Relocate street light pole(s) to accommodate street widening and/or station improvements.
2. Replace street light pole(s) and/or luminaire(s) to meet jurisdiction standards, as appropriate.
3. Add new street light pole(s) to meet jurisdiction standards, as appropriate.

Modifications to On-Ramps at SR-60

Temporary ramp closures are anticipated at the SR-60 on-ramps to reconstruct a portion of the ramps necessary to widen and accommodate BRT service on Atlantic Boulevard. The following sequence is proposed for ramp closures.

1. Provide advance notice signs on freeway at arterial to advise motorists of proposed ramp closure periods.
2. Provide detour signs to direct traffic to next available on-ramp.
3. Close each ramp while avoiding the closure of consecutive ramps as much as possible.

General: Construction sequencing described above was provided to demonstrate feasibility. Final sequencing will be determined by the contractor selected to construct the project.

Transportation Management Plan and Traffic Control

Transportation Management Plan

A Transportation Management Plan (TMP) is a program of activities for alleviating or minimizing work-related traffic delays by the effective application of traditional traffic handling practices and an innovative combination of various strategies. These strategies encompass public awareness campaigns, motorist information, demand management, incident management, system management, construction methods and staging, and alternate route planning. Depending on the complexity of the work or magnitude of anticipated traffic impacts, a TMP may provide lane requirement charts, Standard Special Provisions for maintaining traffic, and for a major project, a separate comprehensive report.

Since the proposed alignment of the BRT service follows some of the most heavily traveled urban arterials in the region, notification through public information (television, radio, internet, newspapers, etc.) about construction activities will be necessary. Specific items may include:

1. **Brochures and Mailers.** Brochures and mailers are printed material containing project-related information such as advance notice of the project's start date, schedules, pictures/graphics of the project, a description of the need for the project, alternative routes, alternative modes of transportation, and transit services. These may be disseminated to motorists at key locations, including businesses, rest stops, travel information centers, automobile associations, and through direct mailings to affected businesses and residents in the project area.

2. **Press Releases/Media Alerts.** This strategy provides timely project-related information to the news media, affected businesses, and other affected or interested parties using print and/or electronic media. Examples of these groups include local and cable television newsrooms, traffic navigation systems groups, schools, local major employers and businesses, and emergency services (fire, law enforcement, and ambulance). News media strategies (for example, newspaper, television, and radio press releases) are a no-cost alternative proven to be very effective in notifying travelers of planned roadway work. Various mechanisms fax, e-mail, telephone message, and mailings can be used to communicate information relating to start dates, work schedules, significant traffic pattern changes, transit routes, traffic collisions, and other incidents within the work zone.

3. **Paid Advertisements.** Paid public service announcements of an upcoming major project may be transmitted through newspaper, radio, and television ads, as well as billboards. Paid advertisements can also be used for progress updates or to provide information regarding major changes to the work zone configuration and traffic management strategies. A cost analysis should be conducted to determine the expense of developing a public service announcement against the value of the number of targeted audiences the information will reach.

4. **Public Information Center.** This is a small-scale facility typically located on or near the project site that contains such materials as scale-model displays, maps, brochures, videos describing the project, its potential traffic impacts, and available travel alternatives to minimize those impacts, including available transit routes and transit agency contact information.

5. **Telephone Hotline.** This traveler information strategy provides traffic or travel information for the work zone using a toll-free telephone number. It can include prerecorded messages or real-time, interactive request/response information and a link to 511 (travel information telephone direct line).

6. **Planned Lane Closure Web Site.** The Lane Closure System (LCS) is a statewide Web-based application that allows users to request, review, approve or deny, and monitor planned lane closures on the State Highway System. The purpose of the LCS is to provide California highway workers and motorists with a single source of information on traffic closures on the State's highways. The system operates continuously, providing real-time information on lane closures located in both urban and rural areas. The information is posted to District Web sites listing the routes involved, the type of work being performed, and the closure start and

end dates and times. The LCS information is planned to be incorporated into the statewide 511 travel map.

7. **Project Web Site.** A project Web site provides information for a specific work zone including long-term static information on project plans and progress, as well as real-time interactive information.

8. **Public Meetings.** This strategy involves the presentation of project information to the community and businesses by public relations staff and solicitation of input of potential concerns, impacts, and management strategies. Public meetings often involve the use of videos, slides, and graphical presentations to supplement public announcements and public information center displays.

9. **Community Task Force.** The development of a community task force, which includes various stakeholders (businesses, neighborhood groups, employee transportation coordinators, interested individuals, public officials, or other representatives) that may be impacted by the work zone, can facilitate the dissemination of information related to a transportation project. A task force can also help generate interest and support for a project.

10. **Communication with Selected Stakeholders.** Stakeholders most directly affected can be identified and can receive information during construction on a regular basis through periodic meetings or e-mail and fax notices.

11. **Information Kiosk.** A kiosk is a small information center that can provide handouts and other information to passersby. The kiosk should be located in an area with high foot traffic in the general vicinity of the work location. Sample locations are shopping malls, rest stops, and gas stations.

12. **Construction Zone Enhanced Enforcement Program (COZEEP).**COZEEP is a powerful tool that effectively improves project safety through the use of supplemental California Highway Patrol Units to assist in the management of traffic passing through the construction zone. COZEEP involves the presence of the CHP in certain construction zones to serve as a reminder to the motoring public to slow down, observe construction zone signs, and use care while driving through the work zone. Since closure of mainline freeway lanes are not required, the need for COZEEP is not anticipated.

Traffic Control

Proposed traffic control will meet current California Manual on Uniform Traffic Control Devices (CA MUTCD) guidelines and require local agency approval. Construction will be performed during peak and non-peak hours, and all traffic lanes will remain open during non-construction periods. Traffic control devices will include delineators or channelizers, barricades and drums, as appropriate. Traffic control signage will include advance warning signs, flashing arrow boards, and advance closure message signs. Since construction activities are proposed along the ramps at the SR-60/Atlantic Boulevard interchange, temporary construction area signs and advance notification signs will be provided on the freeway mainline and on Atlantic Boulevard on all approaches to the interchange.

cc: Yoga Chandran/Tom Ionta, CH2M Hill
Juan M. Diaz, JMD

Appendix F
BRT Alternative Traffic Signal and Street Lighting Modifications, Tables and Technical Memorandum

MEMORANDUM

TO: Vincent Chio, CH2M Hill

FROM: Steve Itagaki, PE, TE, PTOE

DATE: October 4, 2013

SUBJECT: **SR-710 North Study - BRT Alternative**
Traffic Signal and Street Lighting Modifications
2011.0056.0002.00

This memorandum briefly describes traffic signal and street lighting modifications as part of the Bus Rapid Transit (BRT) alternative which includes new bus lanes and other roadway modifications, new station amenities, traffic signal and street lighting modifications, utility relocations, drainage modifications, etc.

Traffic Signal Modifications

Traffic signal modifications will be required at most intersections along the BRT alignment to account for proposed street widening which will vary between two feet and eight feet in one direction. Traffic signal modifications will consist of traffic signal equipment relocation, replacement or upgrades.

Traffic signal equipment relocation will be possible at locations where the proposed widening is minor and does not require longer mast arms to maintain existing vehicle heads within existing lanes. It is estimated that widening of about 2 feet may allow existing signal poles with mast arms to be reused and relocated.

Replacement of existing traffic signal poles will be required where the proposed widening is substantial and will require existing mast arms to be lengthened to fall within existing lane lines for proper visibility. It is estimated that the maximum widening proposed for the BRT alternative will result in replacement of traffic signal poles with mast arms.

In some cases, existing traffic signal equipment will need to be upgraded, regardless of the proposed widening, due to the fact that such equipment does not meet local jurisdiction requirements. Such cases include existing mast arms which have not been maintained to meet latest standard requirements as well as conditions where existing traffic signal equipment may need to meet specially designed ornamental fixtures and equipment. In such cases, traffic signal upgrades will be warranted to comply with proposed BRT conditions.

Traffic signal upgrades include re-wiring new signal pole/equipment as well as installing new conduits and new vehicle detection loops (included in Table 1).

Table 1 enclosed provides a list of traffic signal equipment to be relocated, replaced or upgraded.

Transit Signal Priority (TSP)

Metro's Rapid Bust Transit Priority System Expansion Project is being currently implemented and will be installed prior to the improvements proposed in the SR-710 Study. It is anticipated that some of the proposed TSP equipment will be affected by proposed street widening for the BRT Alternative. Metro's TSP Expansion Project includes the installation of traffic signal pole-mounted antennas and traffic signal controller cabinet upgrades. As part of the BRT alternative, the antennas will need to be relocated to new or relocated pole locations. However, relocated controller cabinets will already include the TSP hardware within the cabinet, and will not need to be relocated separately. The only added cost affecting Metro's TSP Expansion Project by the BRT project is the relocation of the antennas. This cost is estimated at $2,000 per location for a total of 18 locations.

Street Lighting Modifications

Street lighting modifications for the BRT alternative will primarily consist of relocation of light poles to a new location at least 18 inches behind the proposed curb face. Replacement of existing poles with new poles with longer mast arms is not anticipated considering that the width of widening will be limited to a maximum of 8 feet. Relocated poles will include decorative poles found in the cities of South Pasadena and Pasadena along Fair Oaks Avenue and Colorado Boulevard, respectively.

Table 2 enclosed provides a list of street light poles to be relocated.

Enclosures

cc: Yoga Chandran/Tom Ionta, CH2M Hill
Juan M. Diaz, JMD

Table 1 - BRT Alternative Traffic Signal Modifications

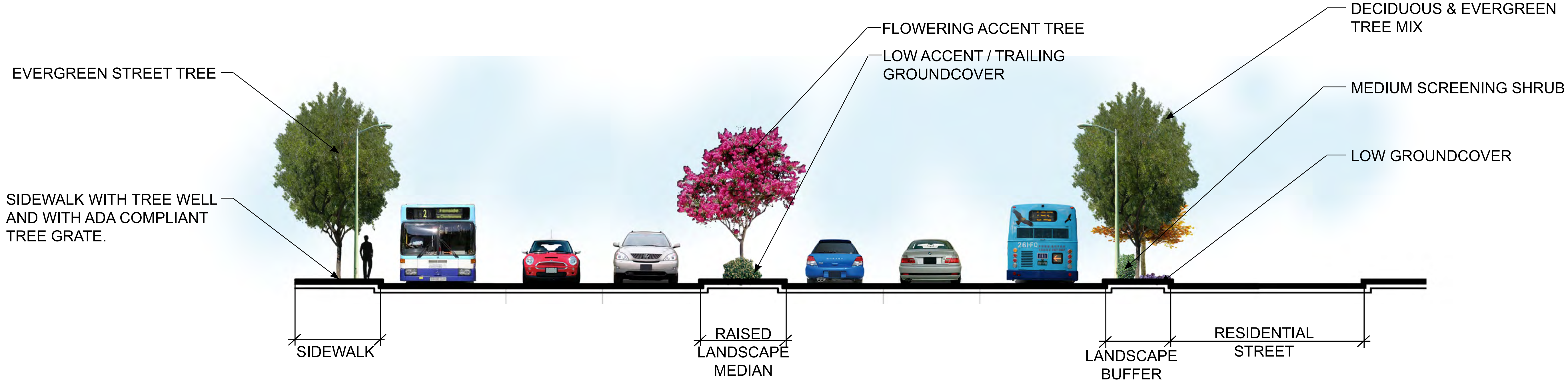
Int. #	Intersection	Traffic Signal																		Total Cost Per Intersection
		Remove Pole (Unit Cost= $3000)		Relocate Pole (Unit Cost= $4000/EA)		Install New Pole (Unit Cost= $10,000/EA)		Relocate Controller Cabinet (Unit Cost= $5,000/EA)		Remove Controller Cabinet (Unit Cost= $2000)		Install New Controller Cabinet (Unit Cost= $15000/EA)		Install New Pull Box (Unit Cost= $400/EA)		Install New Counduit (Unit Cost= $30/LF)		Install New Vehicle Loop (Unit Cost= $800/EA)		
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity (ft)	Cost	Quantity	Cost	
1	Atlantic Blvd, Whittier Blvd	0	$0	3	$12,000	0	$0	0	$0	0	$0	0	$0	3	$1,200	300	$9,000	10	$8,000	$30,200
2	Atlantic Blvd, Hubbard St	0	$0	8	$32,000	0	$0	0	$0	1	$2,000	1	$15,000	8	$3,200	700	$21,000	20	$16,000	$87,200
3	Atlantic Blvd, E 6th St	0	$0	7	$28,000		$0	1	$5,000	1	$2,000	1	$15,000	8	$3,200	750	$22,500	20	$16,000	$89,700
4	Atlantic Blvd, Eagle St	0	$0	8	$32,000	0	$0	0	$0	1	$2,000	1	$15,000	8	$3,200	700	$21,000	20	$16,000	$87,200
5	Atlantic Blvd, E 4th St	1	$3,000	7	$28,000	1	$10,000	0	$0	1	$2,000	1	$15,000	8	$3,200	750	$22,500	20	$16,000	$94,700
6	Atlantic Blvd, E Beverly Blvd	0	$0	2	$8,000	0	$0	1	$5,000	0	$0	0	$0	2	$800	250	$7,500	40	$32,000	$53,300
7	Atlantic Blvd, Pomona Blvd	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	100	$3,000	28	$22,400	$25,400
8	Atlantic Blvd, 60 E/B Off Ramp	0	$0	1	$4,000	0	$0	0	$0	0	$0	0	$0	1	$400	800	$24,000	14	$11,200	$39,600
9	Atlantic Blvd, W 1st St/Pomona Fwy WB Off Ramp	1	$3,000	4	$16,000	1	$10,000	1	$5,000	0	$0	0	$0	5	$2,000	800	$24,000	18	$14,400	$71,400
10	Atlantic Blvd, W Riggin St/Avenida Cesar Chavez	0	$0	5	$20,000	0	$0	1	$5,000	0	$0	0	$0	7	$2,800	850	$25,500	40	$32,000	$85,300
11	Atlantic Blvd, Prado Center Dwy/Atlantic Square Dwy	0	$0	4	$16,000	0	$0	0	$0	0	$0	0	$0	4	$1,600	700	$21,000	15	$12,000	$50,600
12	Atlantic Blvd, W Floral Dr	1	$3,000	5	$20,000	1	$10,000	1	$5,000	0	$0	0	$0	5	$2,000	780	$23,400	28	$22,400	$82,800
13	Atlantic Blvd, Brightwood St	1	$3,000	6	$24,000	1	$10,000	1	$5,000	0	$0	0	$0	7	$2,800	750	$22,500	21	$16,800	$81,100
14	Atlantic Blvd, W El Repetto Dr	3	$9,000	3	$12,000	3	$30,000	1	$5,000	0	$0	0	$0	5	$2,000	700	$21,000	15	$12,000	$82,000
15	Atlantic Blvd, Sevilla St	2	$6,000	5	$20,000	2	$20,000	1	$5,000	0	$0	0	$0	7	$2,800	800	$24,000	23	$18,400	$90,200
16	Atlantic Blvd, Cadiz St/ El Mercado Ave	0	$0	6	$24,000	0	$0	1	$5,000	0	$0	0	$0	7	$2,800	900	$27,000	23	$18,400	$77,200
17	Atlantic Blvd, El Portal Pl	2	$6,000	8	$32,000	2	$20,000	1	$5,000	0	$0	0	$0	9	$3,600	850	$25,500	28	$22,400	$108,500
18	Atlantic Blvd, Harding Ave	1	$3,000	2	$8,000	1	$10,000	1	$5,000	0	$0	0	$0	2	$800	750	$22,500	28	$22,400	$68,700
19	Atlantic Blvd, W Newmark Ave	0	$0	3	$12,000	0	$0	0	$0	0	$0	0	$0	3	$1,200	730	$21,900	23	$18,400	$53,500
20	Atlantic Blvd, Garvey Ave	1	$3,000	5	$20,000	1	$10,000	0	$0	0	$0	0	$0	5	$2,000	820	$24,600	28	$22,400	$79,000
21	Atlantic Blvd, Shopping Center Dwy	0	$0	4	$16,000	0	$0	0	$0	0	$0	0	$0	1	$400	700	$21,000	20	$16,000	$53,400
22	Atlantic Blvd, W. Emerson Ave	0	$0	3	$12,000	0	$0	0	$0	0	$0	0	$0	2	$800	750	$22,500	31	$24,800	$60,100
23	Atlantic Blvd, Parking Lot Dwy	0	$0	3	$12,000	0	$0	1	$5,000	0	$0	0	$0	3	$1,200	850	$25,500	12	$9,600	$53,300
24*	Atlantic Blvd, W Hellman Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
25	Atlantic Blvd, W Glendon Way	8	$24,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
26	Atlantic Blvd, W Valley Blvd	0	$0	6	$24,000	0	$0	1	$5,000	0	$0	0	$0	4	$1,600	800	$24,000	0	$0	$54,600
27*	Atlantic Blvd, W Shorb St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
28	Atlantic Blvd, Front St	1	$3,000	3	$12,000	1	$10,000	0	$0	0	$0	0	$0	4	$1,600	700	$21,000	20	$16,000	$60,600
29*	Atlantic Blvd, W Mission Rd	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
30*	Atlantic Blvd, W Commonwealth Ave.	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
31*	Atlantic Blvd, Washigton St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
32*	Atlantic Blvd, W Main St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
33*	Atlantic Blvd, Woodward Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
34*	Atlantic Blvd, Alhambra Rd	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
35*	Atlantic Blvd, Spruce St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
36*	Atlantic Blvd, Pine St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
37	Atlantic Blvd, Garfield Ave	0	$0	1	$4,000	0	$0	0	$0	0	$0	0	$0	2	$800	900	$27,000	34	$27,200	$59,000
38	Huntington Dr, Garfield Ave	0	$0	3	$12,000	0	$0	0	$0	0	$0	0	$0	6	$2,400	850	$25,500	36	$28,800	$68,700
39*	Huntington Dr, Fletcher Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
40*	Huntington Dr, Marengo Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
41	Huntington Dr, Fair Oaks Ave	2	$6,000	1	$4,000	2	$20,000	0	$0	0	$0	0	$0	2	$800	650	$19,500	0	$0	$44,300
42	Fair Oaks Ave, Oak St	2	$6,000	6	$24,000	2	$20,000	1	$5,000	0	$0	0	$0	8	$3,200	750	$22,500	0	$0	$74,700
43	Fair Oaks Ave, Rollin St	2	$6,000	3	$12,000	2	$20,000	0	$0	0	$0	0	$0	4	$1,600	800	$24,000	7	$5,600	$63,200
44	Fair Oaks Ave, Bank St	2	$6,000	6	$24,000	2	$20,000	1	$5,000	0	$0	0	$0	7	$2,800	800	$24,000	0	$0	$75,800
45	Fair Oaks Ave, Monterey Rd	3	$9,000	5	$20,000	3	$30,000	0	$0	0	$0	0	$0	4	$1,600	900	$27,000	16	$12,800	$91,400
46	Fair Oaks Ave, Oxley St	2	$6,000	6	$24,000	2	$20,000	0	$0	0	$0	0	$0	8	$3,200	700	$21,000	0	$0	$68,200
47	Fair Oaks Ave, El Centro St	2	$6,000	6	$24,000	2	$20,000	0	$0	0	$0	0	$0	8	$3,200	750	$22,500	1	$800	$70,500
48	Fair Oaks Ave, Mission St	3	$9,000	5	$20,000	3	$30,000	0	$0	0	$0	0	$0	5	$2,000	750	$22,500	0	$0	$74,500
49	Fair Oaks Ave, Hope St	2	$6,000	6	$24,000	2	$20,000	0	$0	0	$0	0	$0	5	$2,000	750	$22,500	0	$0	$68,500
50	Fair Oaks Ave, Grevelia St	3	$9,000	1	$4,000	4	$40,000	0	$0	0	$0	0	$0	7	$2,800	800	$24,000	21	$16,800	$87,600
51	Fair Oaks Ave, State St	1	$3,000	6	$24,000	1	$10,000	0	$0	0	$0	0	$0	2	$800	900	$27,000	24	$19,200	$81,000
52	Fair Oaks Ave, Columbia St	1	$3,000	2	$8,000	1	$10,000	0	$0	0	$0	0	$0	4	$1,600	750	$22,500	7	$5,600	$47,700
53	Fair Oaks Ave, Glenarm St	2	$6,000	4	$16,000	2	$20,000	0	$0	0	$0	0	$0	6	$2,400	750	$22,500	3	$2,400	$63,300
54	Fair Oaks Ave, Bellefontaine St	2	$6,000	2	$8,000	2	$20,000	0	$0	0	$0	0	$0	2	$800	750	$22,500	24	$19,200	$70,500
55	Fair Oaks Ave, Fillmore St	1	$3,000	3	$12,000	1	$10,000	1	$5,000	0	$0	0	$0	4	$1,600	700	$21,000	2	$1,600	$51,200
56	Fair Oaks Ave, Congress St	1	$3,000	5	$20,000	1	$10,000	1	$5,000	0	$0	0	$0	4	$1,600	700	$21,000	21	$16,800	$74,400
57	Fair Oaks Ave, California Blvd	1	$3,000	6	$24,000	1	$10,000	1	$5,000	0	$0	0	$0	6	$2,400	750	$22,500	0	$0	$63,900
58	Fair Oaks Ave, Del Mar Ave	0	$0	3	$12,000	0	$0	1	$5,000	0	$0	0	$0	3	$1,200	900	$27,000	0	$0	$45,200
59*	Del Mar Ave, Raymond Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
60*	Del Mar Ave, S Arroyo Pkwy	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
61*	Del Mar Ave, Marengo Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
62*	Del Mae Ave, S Euclid Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
63	Del Mar Blvd, S Los Robles Ave	0	$0	1	$4,000	0	$0	0	$0	0	$0	0	$0	1	$400	750	$22,500		$0	$26,900
64*	Del Mar Ave, S El molino Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
65*	Del Mar Ave, S Oak Knoll Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
66*	Del Mar Ave, S Hudson Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
67*	Del Mar Blvd, S Lake Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
68*	Del Mar Blvd, S Mentor Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
69*	Del Mae Ave, S Wilson Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
70*	Del Mar Ave, S Chester Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
71*	Del Mar Ave, Souther California Ecumenical	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
72*	Hill Ave, Del Mar Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
73*	Hill Ave, Cordova St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
74*	Hill Ave, Green St	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
75*	Colorado Blvd/ Hill Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
76*	Colorado Blvd, N Michigan Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
77*	Colorado Blvd, Michigan Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
78*	Colorado Blvd, Wilson Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
79*	Colorado Blvd, N Catalina Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
80*	Colorado Blvd, Mentor Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
81*	Colorado Blvd, S Lake Ave	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$0
82*	Lake Ave/ Colorado Blvd		$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0		$0	0	$0	$0
	Total	54	$162,000	192	$768,000	47	$470,000	19	$95,000	4	$8,000	4	$60,000	216	$86,400	33930	$1,017,900	741	$592,800	**$3,260,100**

*** No Traffic Signal Improvements Required** **47 Number of Traffic Signage Impacted** **35 Number of Traffic Signage not Impacted**

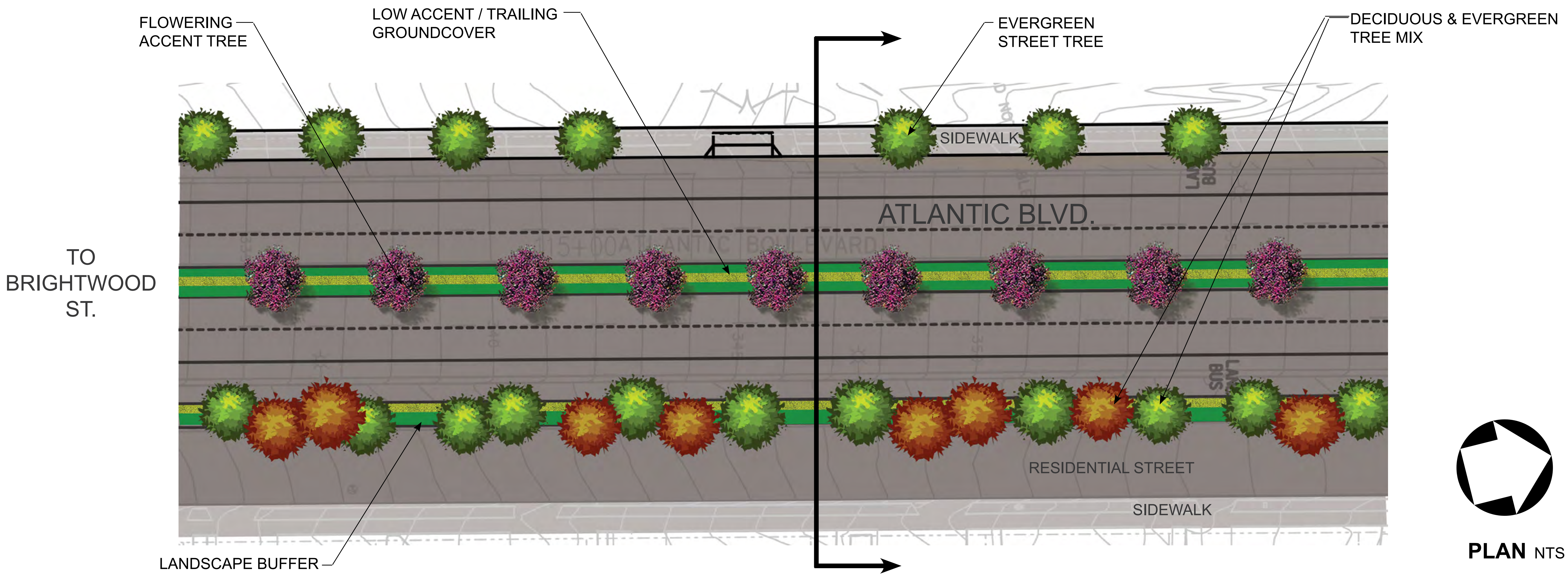
Table 2 - BRT Alternative Street Lighting Modifications

Street Lighting						
Segment	Total # of Poles to be Relocated	Relocate Pole (Unit Cost= $3000/ EA)	Pole Type			
		Cost	Conc	Steel	Dec. Steel	Dec. Conc
Atlantic Blvd (Whittier Blvd - Garfield Ave)	196	$588,000	195	0	0	1
Garfield Ave (Atlantic Blvd - Huntington Dr)	1	$3,000	1	0	0	0
Huntington Dr (Garfield Ave - Fair Oaks Ave)	0	$0	0	0	0	0
Fair Oaks Ave (Huntington Dr - Del Mar Blvd)	136	$408,000	6	81	49	0
Del Mar Blvd (Fair Oaks Ave - Hill Ave)	1	$3,000	1	0	0	0
Hill Ave (Del Mar Blvd - Colorado Blvd)	0	$0	0	0	0	0
Colorado Blvd (Hill Ave - Lake Ave)	1	$3,000	1	0	0	0
Lake Ave (Colorado Blvd - Del Mar Blvd)	0	$0	0	0	0	0
Total	**335**	$1,005,000	204	81	49	1

Appendix G
Landscaping Conditions



SECTION ELEVATION NTS



PLAN NTS

THE PREPARATION OF THIS DRAWING HAS BEEN FINANCED BY THE TAXES OF THE CITIZENS OF LOS ANGELES COUNTY AND OF THE STATE OF CALIFORNIA.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DRAFT

DESIGNED BY
DRAWN BY
CHECKED BY
IN CHARGE
DATE

Metro
LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
1000 WILSHIRE BLVD
SUITE 2100
LOS ANGELES, CA 90017

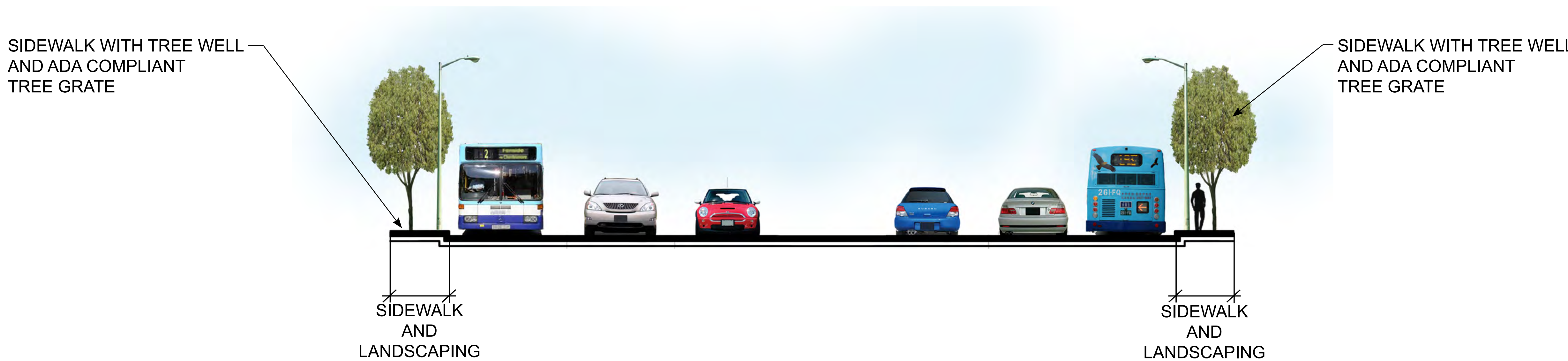
TATSUMI & PARTNERS, INC.
49 DISCOVERY
SUITE 120
IRVINE, CA 92618
949-453-9901

710 NORTH STUDY-BRT

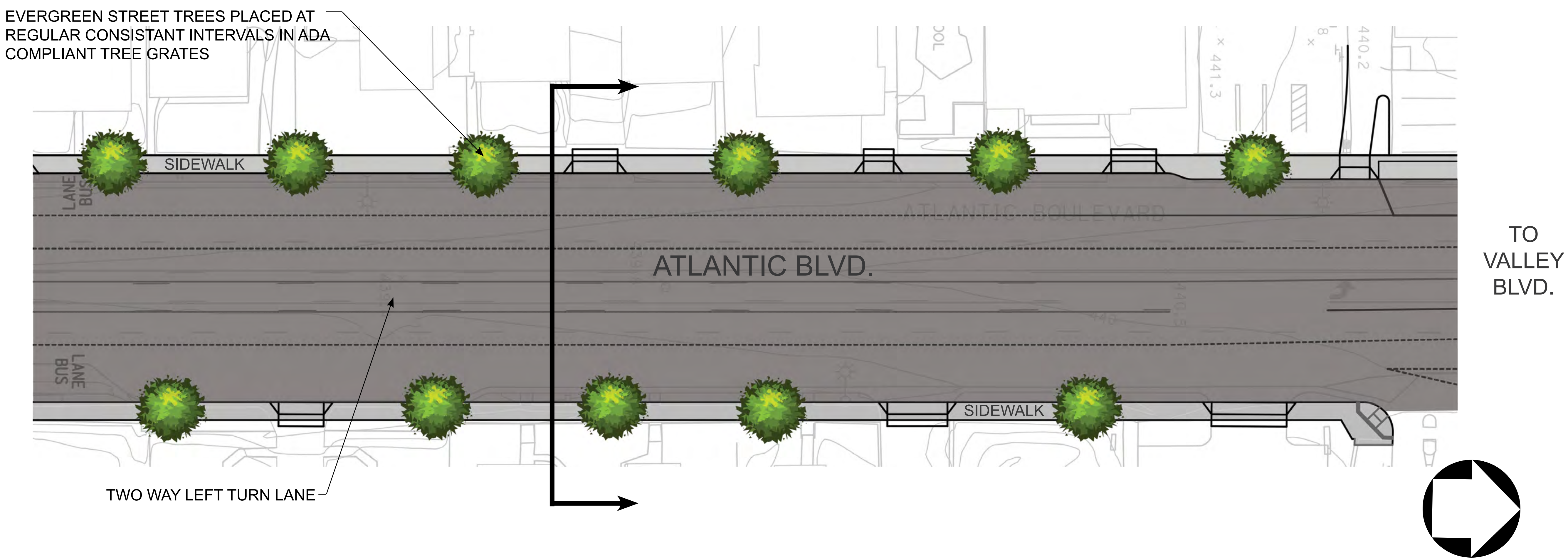
CONDITION 1 - TYPICAL PLANTING TREATMENT

CONTRACT NO
DRAWING NO
REV
SCALE
SHEET NO

Model Name= $MODELNAME$



SECTION ELEVATION NTS



PLAN NTS

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Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

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LOS ANGELES, CA 90017

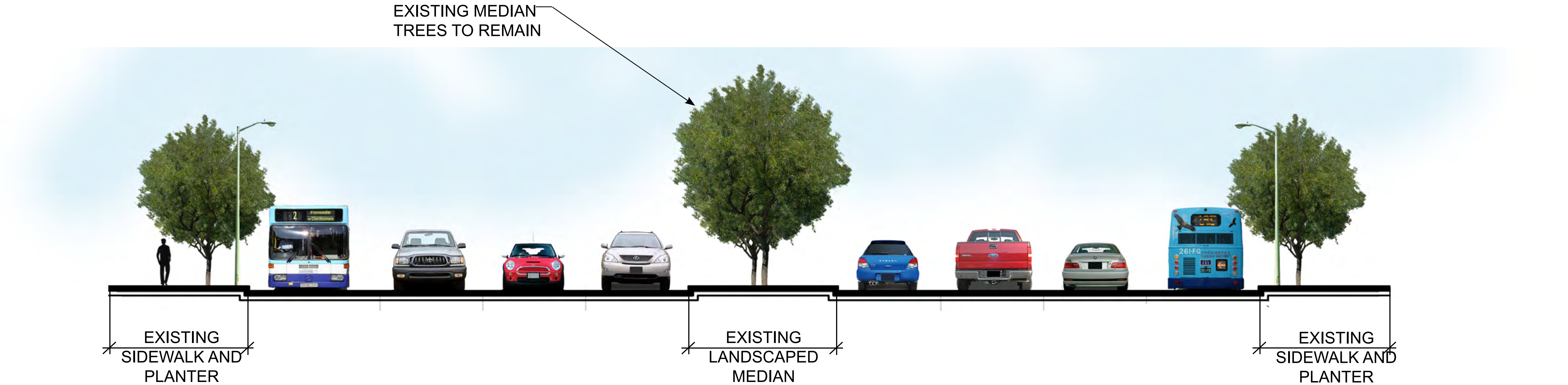
TATSUMI & PARTNERS, INC.
49 DISCOVERY
SUITE 120
IRVINE, CA 92618
949-453-9901

710 NORTH STUDY-BRT
CONDITION 2 - TYPICAL PLANTING TREATMENT

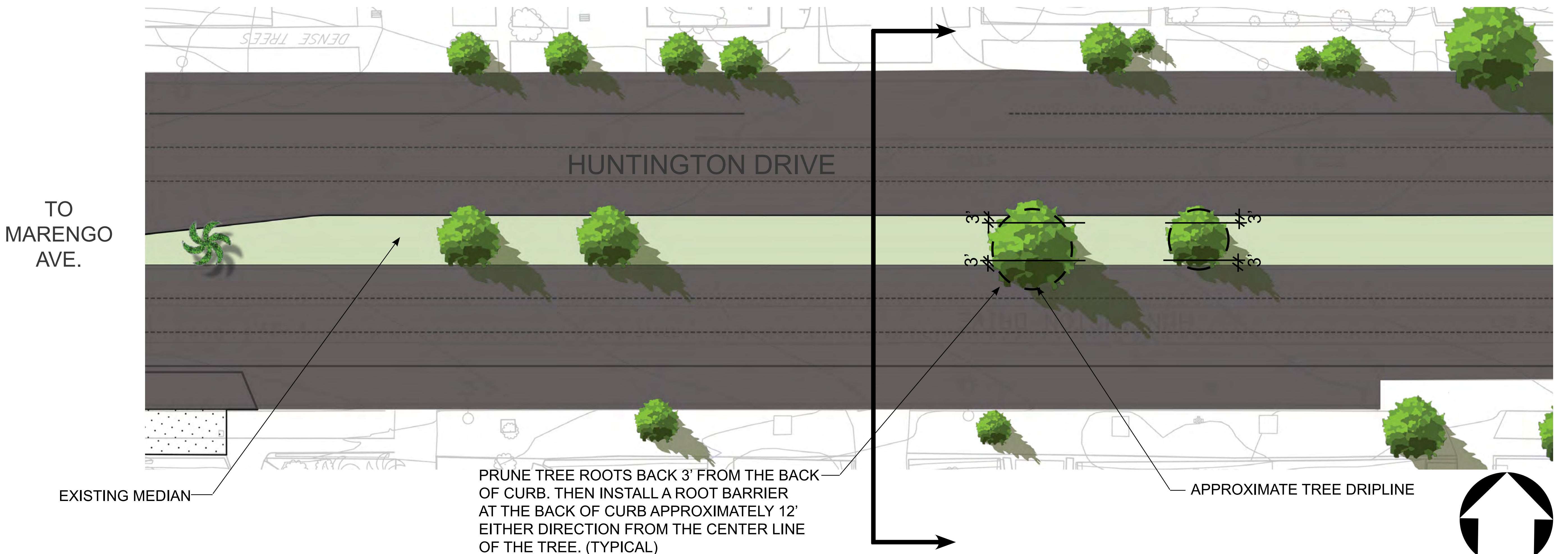
CONTRACT NO
DRAWING NO
REV
SCALE
SHEET NO

Model Name= $MODELNAME$

Pentable=$PENTBLS$
Plot Driver $PLTDRVS$
$FILEA$
$DATE$
$TIME$
$USER$



SECTION ELEVATION NTS



PLAN NTS

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REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DRAFT

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Metro
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METROPOLITAN TRANSPORTATION AUTHORITY

CH2MHILL
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SUITE 2100
LOS ANGELES, CA 90017

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49 DISCOVERY
SUITE 120
IRVINE, CA 92618
949-453-9901

710 NORTH STUDY-BRT

CONDITION 3 - EXISTING TREES TO REMAIN

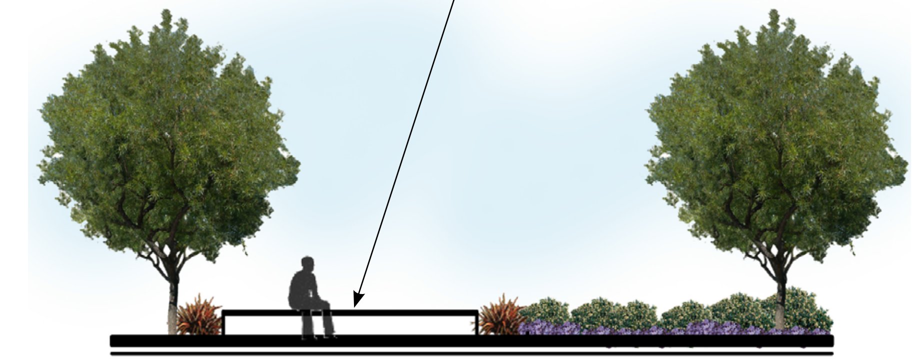
CONTRACT NO
DRAWING NO
REV
SCALE
SHEET NO

Model Name= $MODELNAME$

Pentable=$PENTBL$$
Plot Driver=$PLTDRV$$
$FILEA$
$DATE$
$TIME$
$USER$

STREET TREES TO MATCH EXISTING. IN ADA COMPLIANT TREE WELLS.

OPTIONAL. LOW SEAT WALL OR BENCH. THEMATIC TEXTURE. ACCENT LIGHTING.

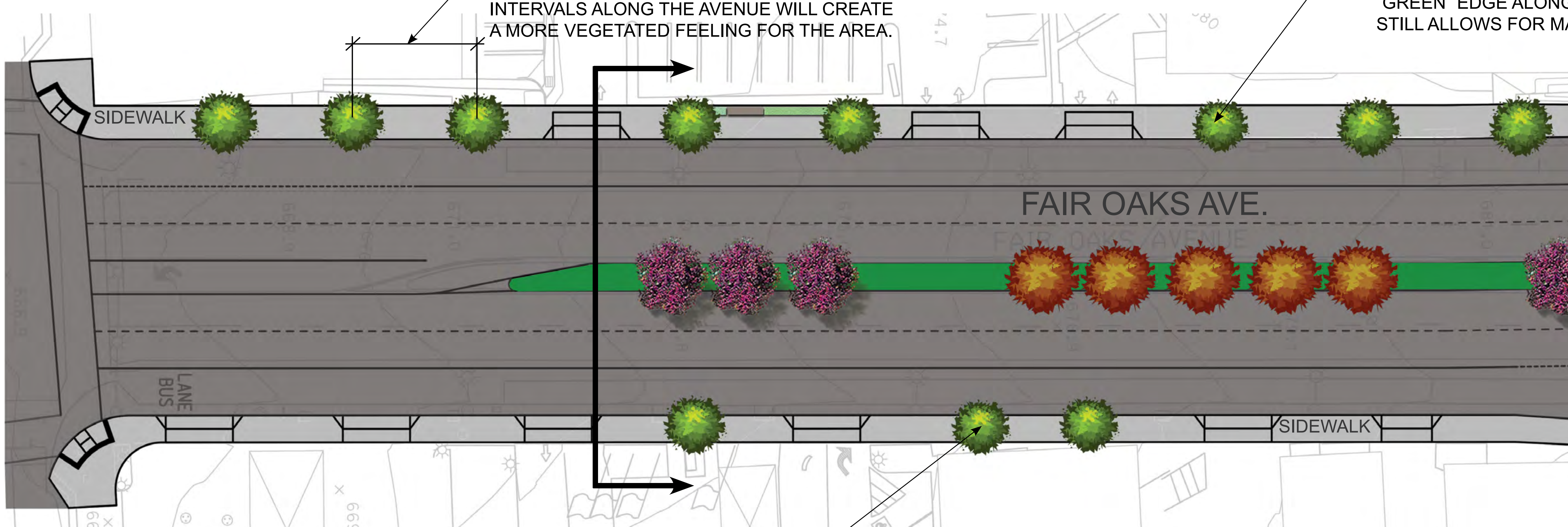


SECTION ELEVATION NTS

GROUP TREES IN PAIRS SPACED @ 30' ON CENTER. THE GROUPS PLACED AT CONSTANT INTERVALS ALONG THE AVENUE WILL CREATE A MORE VEGETATED FEELING FOR THE AREA.

CURB ADJACENT TREE PLANTING UTILIZING TREE GRATES WITH AN ALLOWANCE FOR UNSTORY PLANTING. TO PROVIDE A SOFTER "GREEN" EDGE ALONG THE AVENUE. THAT STILL ALLOWS FOR MAXIMUM PEDESTRIAN

HOPE ST.



PROPOSED STREET TREES TO MATCH EXISTING SPECIES ALONG THE CORRIDOR TO ESTABLISH THE GREEN PATTERN/THEME.

PLAN NTS

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DESIGNED BY
DRAWN
CHECKED BY
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DATE

Metro
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

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SUITE 2100
LOS ANGELES, CA 90017

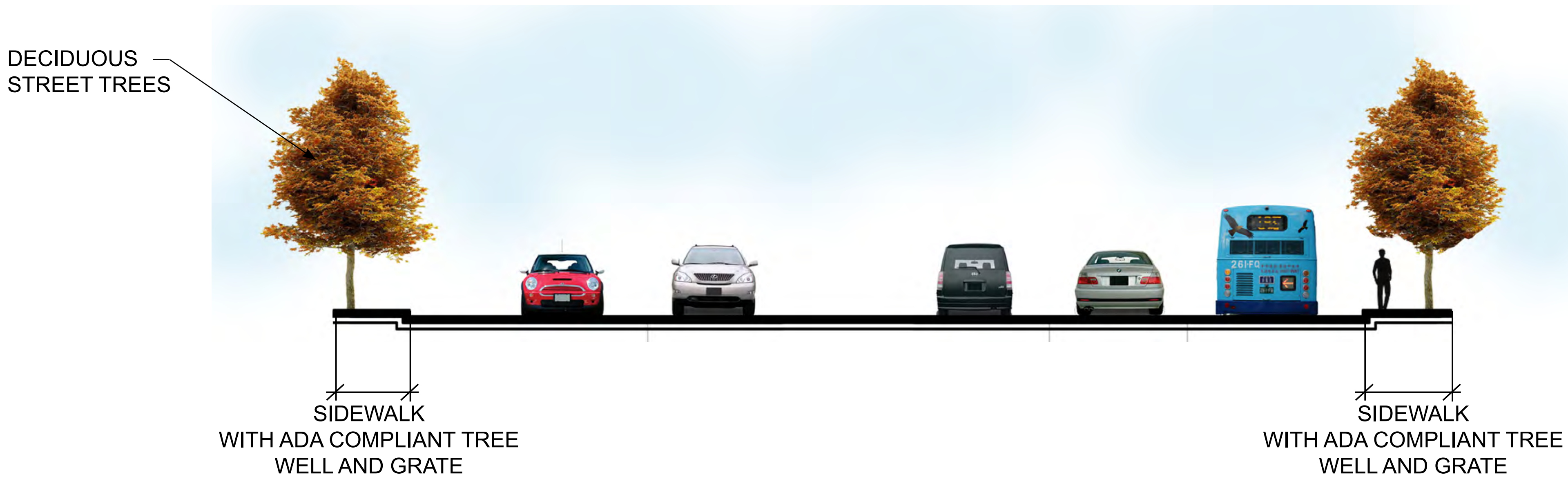
TATSUMI & PARTNERS, INC.
49 DISCOVERY
SUITE 120
IRVINE, CA 92618
949-453-9901

710 NORTH STUDY-BRT

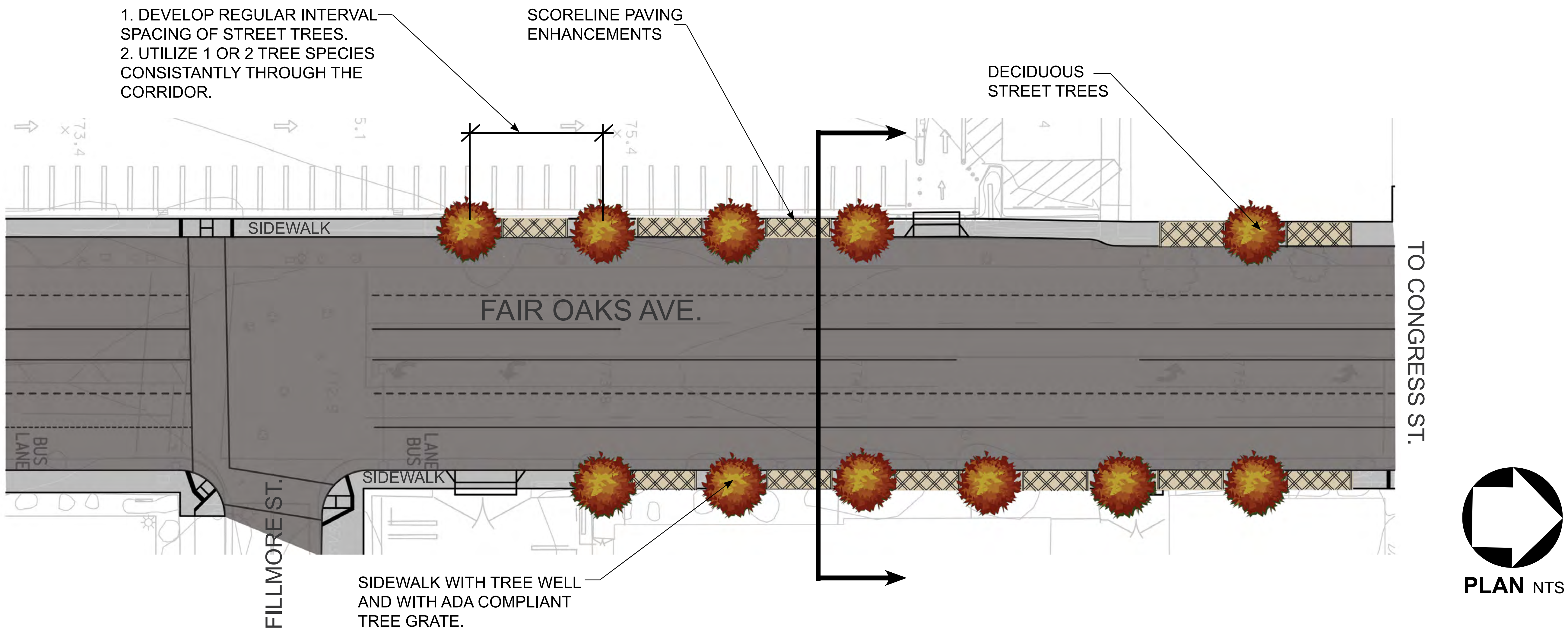
CONDITION 4 - TYPICAL PLANTING TREATMENT

CONTRACT NO
DRAWING NO
REV
SCALE
SHEET NO

Model Name= $MODELNAME$



SECTION ELEVATION NTS



PLAN NTS

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DRAFT

Metro
LOS ANGELES COUNTY
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49 DISCOVERY
SUITE 120
IRVINE, CA 92618
949-453-9901

710 NORTH STUDY-BRT

CONDITION 5 - TYPICAL PLANTING TREATMENT

CONTRACT NO
DRAWING NO
REV
SCALE
SHEET NO

Model Name= $MODELNAME$

DRAFT

Appendix H
Use of BRT Fare Collection Technical Memorandum

710 Study: Use of Bus Rapid Transit Fare Collection

PREPARED BY: CH2M HILL

DATE: Revised June 18, 2013

This memo examines how other U.S. transit agencies utilize off-board fare collection for bus rapid transit (BRT) services, focusing specifically on BRT routes that serve stop locations where other local bus services serve the same stop location. The local bus services may utilize on-board fare payment at the shared stops, which may contribute to communications and operational challenges.

Our research covers the BRT services listed below. Some of these BRT services have off-board fare collection operating on fully or partially dedicated right-of-way (separate from local bus routes); others have off-board fare collection at stops shared with local routes.

- Los Angeles Metro Orange Line (Los Angeles, CA)
- King County RapidRide (Seattle, WA)
- RTC Metropolitan Area Express or MAX (Las Vegas, NV)
- Santa Clara VTA BRT (San Jose, CA: planned)
- Community Transit Swift BRT (Everett, WA)

This memo summarizes the features and relevant issues faced by each agency. The information was provided by agency or consultant staff familiar with each respective BRT service.

In summary, CH2M HILL recommends a fare collection approach that facilitates improved customer convenience, increased boarding capacity, and reduced dwell time while considering fare policy consistency, station constraints, and long-term technological roadmaps. Since the fare collection system may change in coming years, an approach that allows the most flexibility was a key consideration.

Table 1: Summary of BRT Off-Board Fare Collection Systems

	LA Metro Orange Line (Los Angeles, CA)	King County RapidRide (Seattle, WA)	RTC MAX (Las Vegas, NV)	Santa Clara VTA BRT (Santa Clara, CA: planned for early 2015)	Community Transit Swift BRT (Everett, WA)
Fare Media	Contactless Smart Card (TAP Card)	Smart card (Orca), paper transfers, tickets, cash	Ticket Vending Machines and on board farebox	Ticket Vending Machines, on board farebox, smart card (Clipper)	Ticket Vending Machines, two smart card readers (Orca) at each station
Shared Stops for BRT and Local Services?	No. Separate, dedicated alignment	Yes	Yes	Yes	No. BRT stops are about 60 feet away from local stops
Right of Way	Dedicated BRT	HOV lanes, "BAT" lanes, mixed traffic. For Business Access and Transit (BAT) lanes, general traffic is allowed only to access business driveways and to make right turns	Side running dedicated bus lane, mixed with right turning traffic at intersections	Blend of dedicated BRT, HOV lanes, and mixed traffic	Mixed: BAT lanes, and mixed traffic (see King County RapidRide for description of BAT lanes)
BRT Fare Payment and Boarding Method	Off board: ticket vending machines and platform validators All door boarding	Busy zones: Off board Other zones: On board All door boarding - Cash riders always pay at front door; paper transfer riders board at back doors	Off board: ticket vending machines All door boarding	Off board: ticket vending machines. Platform validators or front and rear door smart card readers are also being considered All door boarding	Off board: ticket vending machines and smart card readers All door boarding
Local Bus Fare Payment Method	On board: cash riders and TAP card holders pay at front door	Always front door for all fare media	At stops shared with BRT: Off board with TVMs. At stops not shared with BRT: On board at front door	On board. At stops shared with BRT, patrons could purchase fare media at TVMs for visual display on board	On board at front door

	LA Metro Orange Line (Los Angeles, CA)	King County RapidRide (Seattle, WA)	RTC MAX (Las Vegas, NV)	Santa Clara VTA BRT (Santa Clara, CA: planned for early 2015)	Community Transit Swift BRT (Everett, WA)
Fare Enforcement for BRT Services	Handheld inspection	Portable smart card reader and visual inspection of transfers. All cash/ticket riders receive a paper transfer as proof of payment.	On board visual fare enforcement	To be determined: likely handheld inspection	Handheld and visual inspection
Comments (Benefits/Challenges)	+ High ridership + Similar operation to ungated light rail system - Unlike Metro Rapid/Express lines which can cause confusion	+ Reduced dwell time + Expense of off-board equipment is focused for time savings - Cost for contracted Fare Enforcement Officers - Riders don't change fare payment habits; often go through front door with smart card or transfer when they could use back door - Some areas have less overall smart card use (lower income) so less potential benefit	+ Faster service in a highly transit dependent neighborhood - Some confusion of all door boarding for local route at shared stops - Stops not necessarily at best locations due to land availability and the ability to get easements	Service is not currently in operation	+ Swift has high ridership and is growing the market + End to end travel time has decreased over 30%. Service is reliable + Able to achieve consistent 10-second dwell times at stations - Fare evasion estimated at 6% to 7%
Point of Contact	Stephen Tu Manager, Operations & Service Delivery 213-922-6985 TuS@metro.net	Karen Rosenzweig RapidRide Program Manager 206-263-3103 karen.rosenzweig@ kingcounty.gov	David Swallow MAX Project Manager 702-676-1616 swallowd@RTCsnv.com	Deborah Dagang CH2M HILL 510-587-7591 Deborah.Dagang@ ch2m.com	June Devoll Manager, Swift BRT 425-348-2337 june.devoll@ commtrans.org

Conclusions

While Bus Rapid Transit programs across the country each have unique requirements, common benefits and challenges can help guide new deployments. Features including dedicated right-of-way, traffic signal prioritization (TSP), and off-board fare collection allow BRT systems to operate at high levels of efficiency and reliability compared to traditional local bus services.

No matter what fare collection practices are implemented, these key factors will contribute to success:

- Strong customer communications campaign
- Clear and accessible signage, particularly for occasional riders and tourists
- Encourage use of the TAP card through marketing and retail outlets
- Consistent fare enforcement
- Adherence to existing fare policies and pricing

Agencies that operate BRT services in right-of-way that is shared with local bus services with shared stops face challenges that can be mitigated with technology features, consistent fare policy, and clear customer communication. However, these agencies must make a decision as to whether BRT services should utilize on-board fare collection (e.g., existing Metro Rapid services), or utilize “hybrid” fare collection practices that could involve off-board fare collection for BRT and on-board fare collection for the local services. Agencies that utilize hybrid fare collection practices, including King County Metro in Seattle and RTC in Las Vegas, experience challenges with respect to how some of their patrons use the system. This is due in part to having BRT services and local routes that share the same stops, but have different methods for fare collection that contribute to customer confusion.

The physical constraints of installing and maintaining fare collection equipment (ticket vending machines, standalone validators, fare gates) can be a barrier at bus stops with limited real estate. The infrastructure required for such equipment can be considerable, especially compared to onboard validators which are becoming commoditized and have reduced capital and operational costs. If Metro decides to migrate to a new technology in the future (open payments, mobile payments, etc), the onboard readers can be upgraded or replaced at a much lower cost than fare revenue equipment installed on site.

For Metro BRT services that operate in shared right-of-way with local services and have shared stops, recommended fare collection features are provided below. These recommendations are intended to speed up fare payment on BRT services, facilitate ease and simplicity of the overall fare collection system, and limit the need to procure and install additional fare collection equipment (particularly given space constraints that are often present at bus stop locations):

- Install rear-door TAP validators on BRT vehicles
- For TAP patrons: boarding at any door, validation at TAP validator or farebox
- For cash patrons: boarding at front door, payment at farebox
- Roaming fare inspectors on vehicles to enforce fare payment at rear doors (consistent with current policy)

Benefits of the approach outlined above include:
- Ability to board at any door
- Can be adapted/upgraded to future fare payment technologies at a relatively low cost
- Cash customers pay at fare box, which is consistent with rest of Metro system
- Leverages TAP fare media which Metro has fully migrated to
- Onboard validation provides more detailed ridership data and service planning potential
- Fare enforcement can target inspections on buses with low % of validation

- TAP media available at extensive third party vendor network, expanding customer convenience
- Avoids expensive capital and infrastructure costs associated with fare equipment
- Allows marketing to stay consistent with existing fare policy, minimizing disruption to customer behavior

Transit agencies that implement BRT services in dedicated right-of-way (including the LA Metro Orange Line) have fare collection practices that are similar to light rail service, with off-board fare collection. For Metro BRT services in dedicated right-of-way, recommended fare collection features are as follows:

- Off-board fare payment at platform Ticket Vending Machines
- Boarding at any door
- Smart card patrons tap at platform validators before boarding
- Fare enforcement at BRT platforms or onboard via handheld inspection devices
- Consistent with Metro Orange Line

Appendix I
BRT Operating Plan
Technical Memorandum

TECHNICAL MEMORANDUM

SR 710 Study – BRT Operating Plan

PREPARED FOR: Michelle Smith/Metro

COPY TO: Caltrans

PREPARED BY: CH2M Hill Team

DATE: March 31, 2014

PROJECT NUMBER: 428908

At a June 2010 meeting, the Los Angeles County Metropolitan Transportation Authority (Metro) in coordination with the California Department of Transportation (Caltrans), moved to broaden the search for multimodal solutions for the State Route 710 (SR 710) study area and move forward with the environmental review phase.

More recently, Metro has initiated the SR 710 Alternatives Analysis (AA) process to evaluate alternatives for transportation improvements in the SR 710 study area. A series of project alternatives have been developed, which include a Transportation Systems Management (TSM) alternative, freeway alternatives, Bus Rapid Transit (BRT) alternatives, and Light Rail Transit (LRT) alternatives.

A Bus Rapid Transit (BRT) service was advanced from an evaluation of six candidate corridors, based on its potential to link important trip origins and destinations, carry significant ridership, and improve mobility in the SR 710 study area. The BRT alternative is proposed to operate between East Los Angeles to Pasadena. A figure illustrating the BRT alternative is attached at the end of this memorandum.

The intent of the BRT alternative is to improve on the existing Metro Rapid services in the study area, particularly Metro 762, by providing higher-frequency, faster and more efficient bus service connecting key origins and destinations in the study area. The selected corridor exhibited the greatest potential for travel time savings and preferential bus treatments such as curbside dedicated lanes (i.e., sufficient right-of-way) without significant disruption to existing roadways. This technical memorandum documents the approach used to develop a preliminary operating plan and the operating and maintenance (O&M) cost methodology for the BRT alternative.

Operating Assumptions and Plans

BRT: East Los Angeles to Pasadena

The BRT alternative would enhance the Atlantic Boulevard-Fair Oaks Avenue corridor with additional limited stop, high frequency bus service, enhancements such as dedicated bus lanes, and transit signal priority measures. The route would provide new connectivity from the Atlantic Avenue Corridor to major educational institutions in Pasadena and employment in the Fair Oaks Avenue and East Colorado Boulevard corridors.

Route Alignment

BRT service would be provided between Atlantic Boulevard at Whittier Boulevard, south of the Gold Line Atlantic Station, and Pasadena City College (PCC) and the California Institute of Technology (Caltech) in Pasadena. The route would replicate the existing 762 Metro Rapid service for much of its length, with a new eastward connection in Pasadena to PCC and Caltech. The existing 762 Rapid service would be shortened on its northern end and would operate between Compton and East Los Angeles, terminating at East Los Angeles Community College (ELACC). Where the BRT, 762 or other local services overlap, routes would share bus stop locations, with separation of boarding space for BRT and local/Rapid services to ensure efficient interplay between routes.

The average one-way length of the route would be 11.8 miles. BRT vehicles would travel along Atlantic Boulevard to Huntington Drive, west along Huntington Drive to Fair Oaks Avenue, then northbound on Fair Oaks Avenue into Pasadena. In Pasadena, the BRT vehicles would travel along Del Mar Boulevard and then make a loop to PCC and Caltech via Lake Avenue, Colorado Boulevard, Hill Avenue and return to Fair Oaks Avenue via Del Mar Boulevard.

Stop Locations

BRT stops would be placed at approximately 0.7 mile intervals, at major activity centers and cross streets. Local bus routes would continue to serve their current stop locations.

BRT stops are proposed at the following locations (from south to north):

1. Atlantic Boulevard at Whittier Boulevard
2. Atlantic Boulevard at Pomona Boulevard/Beverly Boulevard
3. Atlantic Boulevard at Avenida Cesar Chavez/Riggin Street
4. Atlantic Boulevard at Garvey Avenue
5. Atlantic Boulevard at Valley Boulevard
6. Atlantic Boulevard at Main Street
7. Huntington Drive at Garfield Road
8. Huntington Drive at Marengo Avenue
9. Fair Oaks Avenue at Mission Street
10. Fair Oaks Avenue at Glenarm Street
11. Fair Oaks Avenue at California Boulevard
12. Fair Oaks Avenue at Del Mar Boulevard
13. Del Mar Boulevard at Los Robles Avenue
14. Del Mar Boulevard at Lake Avenue
15. Del Mar Boulevard at Hill Avenue
16. Colorado Boulevard at Hill Avenue
17. Colorado Boulevard at Lake Avenue

Span of Service

BRT service would operate from 5:00 A.M. to 9:00 P.M. on weekdays and 7:00A.M. to 7:00 P.M. on Saturday and Sunday. Local bus routes in the area would continue to operate a longer span than BRT and limited stop services.

Frequency of Service

The BRT alternative, which is developed within an already transit-rich corridor served by the 260 Metro Local and 762 Metro Rapid buses, would operate on a peak frequency of every 10 minutes and an off-peak frequency of every 20 minutes. The BRT service frequency would replace previous 20 minute peak and 30 minute off-peak frequencies of the 762 Metro Rapid route. Combined with the 260 (15 minutes peak; 30 minutes off-peak), this frequency of 6 minutes peak and 12 minutes off-peak would provide exceptional levels of service between East Los Angeles and Pasadena.

Vehicle Requirements

Bus Rapid Transit service would incorporate modern, 60-foot long articulated buses with low-floor boarding to facilitate passenger entry and exit. Typical articulated buses feature two doors; however, three-door vehicles are becoming more common. Based on an average one-way route length of 11.8 miles and an estimated average travel time of 50.0 minutes, the BRT would require 12 peak vehicles for 10-minute frequency service and 6 off-peak vehicles for 20-minute service. Metro applies a 20 percent spare ratio for the routes that it operates. For the BRT, an additional 3 spare buses will be required bringing the total vehicle requirement to 15 buses.

Service Amenities

Bus Rapid Transit service would feature dedicated bus-only lanes for much of the planned alignment as well as transit signal priority (TSP) components to improve both bus and general traffic flow in the corridor. BRT bus stops would be recognizable through distinct branding, shelters, and public information such as real-time arrival displays indicating the proximity of buses to the stop.

The BRT vehicles would operate in exclusive lanes, generally adjacent to the curb, in the following areas:

- Atlantic Boulevard from Whittier Boulevard to Beverly Boulevard (northbound only)
- Atlantic Boulevard from Floral Avenue to Harding Avenue
- Atlantic Boulevard from Harding Avenue to Valley Boulevard (southbound only)
- Huntington Drive from Atlantic Boulevard to Fair Oaks Avenue
- Fair Oaks Avenue from Huntington Drive to Columbia Street
- Fair Oaks Avenue from Columbia Street to Del Mar Boulevard (northbound only)

Operating Costs

Incremental operating costs for the BRT alternative are calculated based on the revenue vehicle hours of service for the 11.8 mile route and applying a fully-allocated cost rate of $134.70 per revenue service hour from Metro's FY2013 budget. The following table breaks down the hours and days of operation and summarizes operating costs for the BRT.

Also, the reduction in service hours for the truncated 762 Metro Rapid line (approximately 9 miles shorter than the existing route) would be 22,399.6 annually, which would correspond to a $3,017,266 reduction in annual operating costs for the route.

TABLE 1
Estimated Operating Costs – BRT
Total operating costs based on annual revenue hours of service

Weekdays	Daily Revenue Vehicle Hours	Unit Cost/Hour*	Days per Year	Total
Early AM	6	$134.70	255	$206,091
AM Peak	33	$134.70	255	$1,133,501
Midday	36	$134.70	255	$1,236,546
PM Peak	48	$134.70	255	$1,648,728
Evening	12	$134.70	255	$412,182
Subtotal	135	$134.70	255	$4,637,048
Saturdays	**Daily Revenue Vehicle Hours**	**Unit Cost/Hour**	**Days per Year**	**Total**
All Day	72	$134.70	52	$504,317
Sundays and Holidays	**Daily Revenue Vehicle Hours**	**Unit Cost/Hour**	**Days per Year**	**Total**
All Day	72	$134.70	58	$562,507
Annual	**Annual Revenue Vehicle Hours**	**Unit Cost/Hour**	**Days per Year**	**Total**
All Days	42,345	$134.70	365	$5,703,872

[a] FY2012 unit cost per revenue service hour from adopted Metro FY2013 budget, page 45.

Notes:

- Weekday PM peak hours assumes about 1/3 more hours than AM peak hours as AM peak service is assumed to operate from 6AM-9AM and PM peak service is assumed to operate from 3PM-7PM. Additionally, only 11 peak buses will be required for AM peak service based on 2035 travel time models for BRT cycle times.
- Days per year shows approximate number of weekdays, Saturdays, and Sundays/Holidays

Preferred BRT Feeder Alternatives

Based on comments and recommendations from Metro, two BRT feeder routes were advanced as preferred alternatives. The alternatives were selected based on the provision of multi-modal connections, ridership in the selected corridors, and the lack of existing services already providing the connection. The first route, envisioned as a Metro Rapid route, will operate between the El Monte Bus Station and the California BRT Station in Pasadena along Valley Boulevard, Rosemead Boulevard and Colorado Boulevard. The second route, envisioned as a local feeder, would operate between the Commerce and Montebello/Commerce Metrolink Stations and the Pomona/Beverly Station on the BRT in East Los Angeles via Garfield Avenue and Beverly Boulevard.

The El Monte-Pasadena route will provide a relatively fast connection between bus services utilizing the El Monte Bus Station, downtown Pasadena, and the BRT. The route would provide a high quality connection to the BRT for customers east and southeast of Pasadena.

The Pomona/Beverly – Commerce feeder is a combination of two proposed feeder route alternatives, one operating between the Whittier BRT Station and Commerce Metrolink Station and the other operating between the Pomona/Beverly BRT Station and Montebello/Commerce Metrolink Station. The route provides service to the Montebello/Commerce Metrolink Station and Commerce Metrolink Station, connecting the proposed BRT and existing Gold Line with the Orange County and Riverside Metrolink lines. The route will also provide a connection to the BRT for customers in higher ridership corridors.

The feeders will operate 20 minute headways on weekdays between the hours of 5:00 A.M. and 9:00 P.M., when the BRT is in operation. On Saturday and Sunday, only the El Monte – Pasadena feeder route will operate since Metrolink does not provide service to either the Montebello/Commerce Station or Commerce Station on weekends. On weekends, customers along Garfield Avenue and Beverly Boulevard corridors can connect to the BRT by using Metro Route 18 and Montebello Bus Lines Route 40. The El Monte-Pasadena route will provide service every 20 minutes between the hours of 7:00 A.M. and 7:00 P.M. on Saturday and Sunday.

In addition to these two proposed feeder routes, Metro Rapid Route 762 will continue to serve East Los Angeles Community College (ELACC), its new northern terminus and provide feeder service to the BRT. El Sol operates a shuttle route between ELACC and California State University – Los Angeles (CSULA). The route currently operates every 30 minutes. Although not a formal recommendation for feeder service, an increase in frequency on the El Sol route would create a valuable BRT feeder service for trips to and from CSULA.

Vehicle Requirements

The El Monte – Pasadena route is proposed to have a cycle time of 160 minutes which would require 10 buses for operation, including 2 spares. The Pomona/Beverly – Commerce route has a proposed cycle time of 60 minutes and would require 4 buses for operation, including 1 spare bus.

TABLE 2

Estimated Operating Costs – BRT Feeder Routes

Total operating costs based on annual revenue hours of service

Weekdays	**Daily Revenue Vehicle Hours**	**Unit Cost/Hour***	**Days per Year**	**Total**
El Monte-Pasadena	128	$134.70	255	$4,396,608
Pomona/Beverly-Commerce	48	$134.70	255	$1,648,728
Subtotal	165	$134.70	255	$6,045,336
Saturdays	**Daily Revenue Vehicle Hours**	**Unit Cost/Hour**	**Days per Year**	**Total**
El Monte-Pasadena	96	$134.70	52	$672,422
Pomona/Beverly-Commerce	0	$134.70	52	$0
Subtotal	165	$134.70	52	$672,422
Sundays and Holidays	**Daily Revenue Vehicle Hours**	**Unit Cost/Hour**	**Days per Year**	**Total**
El Monte-Pasadena	96	$134.70	58	$750,010
Pomona/Beverly-Commerce	0	$134.70	58	$0
Subtotal	165	$134.70	58	$750,010
Annual	**Annual Revenue Vehicle Hours**	**Unit Cost/Hour**	**Days per Year**	**Total**
All Days	55,440	$134.70	365	$7,467,768

[a] FY2012 unit cost per revenue service hour from adopted Metro FY2013 budget, page 45.

TSM Alternative (Bus Components)

The Transportation Systems Management (TSM) alternative includes significant enhancements to existing bus services throughout the study area. These enhancements relate primarily to frequency of service. By providing higher frequency service throughout the study area, local bus transit becomes an increasingly viable alternative to private automobile travel while reducing travel times and enhancing mobility significantly for existing transit users. The TSM alternative would also complement the implementation of one or both of the Bus Rapid Transit alternatives by improving connectivity to and from these major corridors and expanding the reach of transit as a whole.

The TSM alternative focuses on viable frequency enhancements that will increase ridership overall without resulting in significant impacts on productivity or operating costs. Furthermore, it is assumed that Metro will provide TSM alternative levels of service as demand warrants, i.e., the TSM frequencies represent a target based on travel demand forecasting and anticipated demand in the year 2035.

The TSM alternative was developed in an iterative fashion, beginning first with across-the-board increases to frequencies (reductions to headways) based on existing service levels in the study area. Bus frequencies were generally increased incrementally, whereby a local route with 60 minute headways would be upgraded to 30 minute headways. Thirty minute headways would be improved to 20 or 15 minutes, and 15 minute headways would shift to 10 minutes. These increases were applied to the Metro travel demand forecast model to determine anticipated ridership and productivity levels for the 2035 horizon and were reviewed by Metro. In cases where notably drops in productivity were seen, i.e., too much service was added for insufficient gain in ridership, improvements were scaled back. Where productivity remained relatively constant or improved, the frequency increases were maintained. The following table summarizes the Metro bus routes in the study designated for frequency increases, along with their existing and recommended peak hour headways.

TABLE 3

TSM Bus Improvements

Proposed increases in frequencies for bus routes in the SR 710 study area

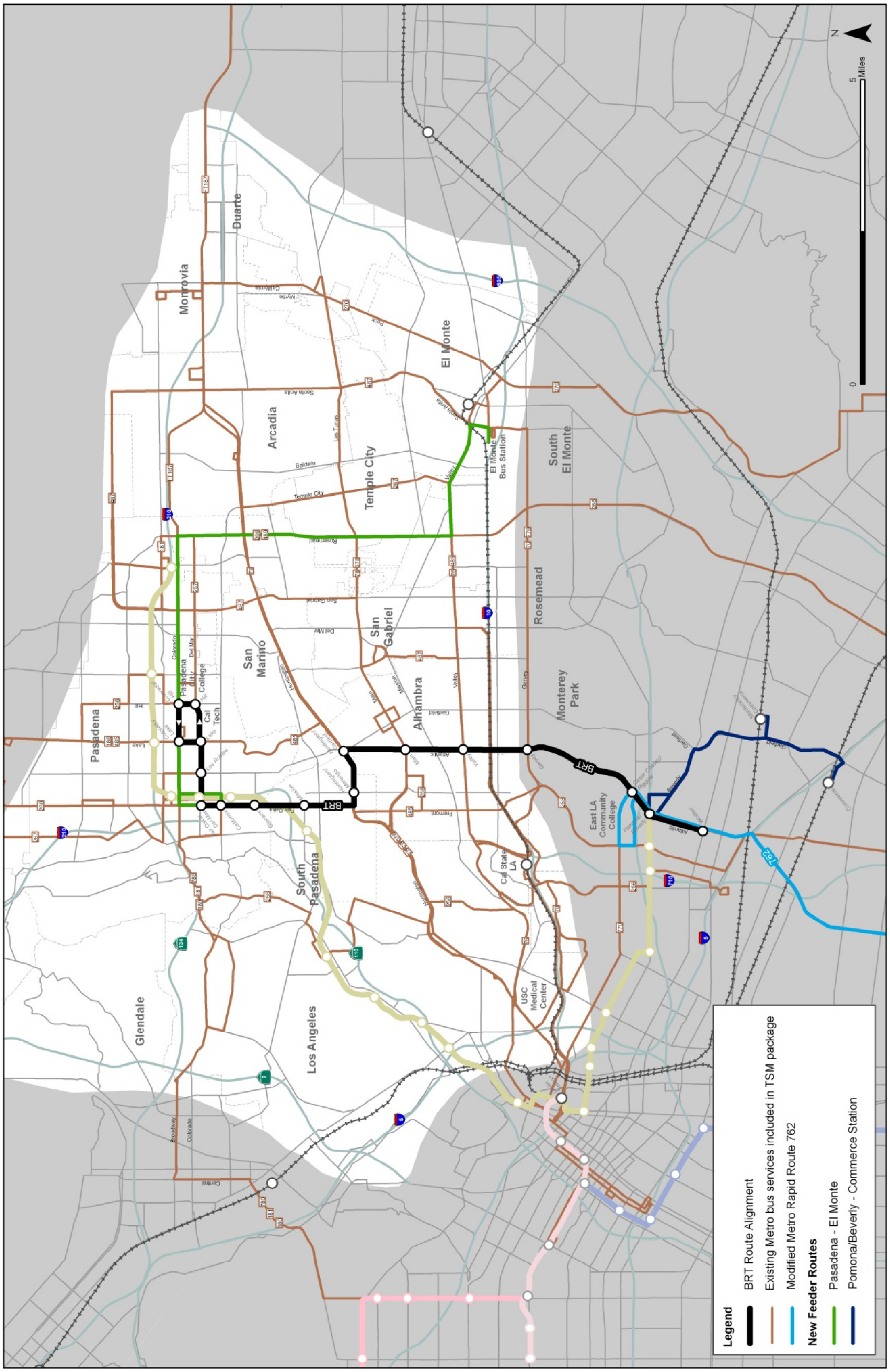
Bus Route	**From/To**	**Current Weekday Peak Frequency (minutes)**	**TSM Peak Frequency (minutes)**
70 (Metro Local)	Downtown LA to El Monte	10-12	10
770 (Metro Rapid)	Downtown LA to El Monte	10-13	10
76 (Metro Local)	Downtown LA to El Monte	12-15	10
78 (Metro Local)	Downtown LA to Irwindale	10-20	10
378 (Metro Limited)	Downtown LA to Irwindale	18-23	20
79 (Metro Local)	Downtown LA to Santa Anita	20-30	15
180 (Metro Local)	Hollywood to Altadena	30	30
181 (Metro Local)	Hollywood to Pasadena	30	15
256 (Metro Local)	Commerce to Altadena	45	30
258 (Metro Local)	Paramount to Alhambra	48	20
260 (Metro Local)	Compton to Altadena	16-20	16-20
762 (Metro Rapid)	Compton to Altadena	25	15
266 (Metro Local)	Lakewood to Pasadena	30-35	30-35
267 (Metro Local)	El Monte to Pasadena	30	15
485 (Metro Express)	Union Station to Altadena	40	40
487 (Metro Express)	Westlake to El Monte	18-30	18-30
489 (Metro Express)	Westlake to East San Gabriel	18-20	15
270 (Metro Local)	Norwalk to Monrovia	40-60	30
780 (Metro Rapid)	West LA to Pasadena	10-15	10-15
187 (Foothill Local)	Pasadena to Montclair	20	15

Vehicle Requirements

As of 2013, there were 198 buses required to operate the Metro routes included in the TSM package during peak service. When the TSM package is executed, more frequency service on almost all routes will require an increase in the number of buses required to operate service overall. Metro will require an additional 37 buses to implement the TSM package, bringing the total number of buses required to operate peak service to 235 buses. The change in bus requirements were calculated based on the percent change in headways. As the 2013 bus requirement numbers include spares, spare bus needs are represented in the TSM bus requirement numbers.

TSM Estimated Operating Costs

An order of magnitude cost estimate was developed for the TSM alternative, focusing on the directly comparable number of revenue vehicle service hours included in the demand forecast model. The model compared the 2006 service levels to the 2035 full implementation of the TSM alternative. Furthermore, vehicle hours were only developed for the weekday AM peak and midday periods; PM peak periods are added by adding an additional hour to the AM peak total. Based on Metro’s unit cost of $134.70 per vehicle service hour, the relative cost increase from the 2035 no build condition to full implementation of the TSM would be $13,258,521 annually for these time periods. This number would increase depending upon service changes in the early morning, evening, and overnight periods, and on Saturday and Sunday.


Legend
BRT Route Alignment
Existing Metro bus services included in TSM package
Modified Metro Rapid Route 762
New Feeder Routes
Pasadena - El Monte
Pomona/Beverly - Commerce Station
Monrovia
Duarte
Arcadia
El Monte
El Monte Bus Station
Temple City
South El Monte
Rosemead
San Gabriel
San Marino
Alhambra
Monterey Park
Pasadena
Pasadena City College
Cal Tech
East LA Community College
Cal State LA
South Pasadena
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Appendix J
Bus Fleet and Maintenance Requirements Technical Memorandum

SR 710 North Study

TECHNICAL MEMORANDUM

Bus Fleet and Maintenance Requirements

PREPARED FOR: Michelle Smith, Metro

COPY TO: Yoga Chandran, CH2M HILL

PREPARED BY: Michael Wallin and Steve Greene, AECOM

DATE: March 31, 2014

PROJECT NUMBER: 428908

This memo looks at bus requirements and bus storage capacity to determine if available capacity can meet the need for proposed increases in bus services.

Several bus transit alternatives have been proposed in the area of the I-710 gap, including a Transportation Systems Management (TSM) plan that would increase frequency on many bus routes in the study area. An additional Bus Rapid Transit (BRT) service, BRT feeder bus routes and a bus route utilizing the I-710 connector tunnel, if constructed, have also been proposed. The TSM plan may be implemented alone or in conjunction with these additional services. The increase in service proposed, in addition to possible new services, will result in a need for more bus storage.

Bus Requirements

The number of additional buses required to operate each alternative (TSM, BRT, BRT feeder bus routes, and tunnel route) are presented in this section. Service details for BRT and the tunnel route options have not been finalized at this time. The memo provides an approximation of the additional number of buses required to operate the service and the corresponding bus storage demand.

TSM

As of 2013, there were 198 buses required to operate the routes included in the TSM package during peak service. When the TSM package is executed, more frequency service on almost all routes will require an increase in the number of buses required to operate service overall. An additional 37 buses will be required to implement TSM bringing the total number of buses required to operate peak service to 235 buses. See Table 1 for TSM bus requirements. The change in bus requirements were calculated based on the percent change in headways. As the 2013 bus requirement numbers include spares, spare bus needs are represented in the TSM bus requirement numbers.

TABLE 1
TSM Bus Requirements

Route	2013 Headway	2013 Bus Requirement	TSM Peak Headway	TSM Bus Requirement	Change
70	12	18	10	21	3
770	12	17	10	20	3
76	14	16	10	23	7
78*	15	7	10	10	3
378*	20	8	20	8	0
79*	25	11	15	16	5
180*	30	7	30	7	0
181*	30	8	15	12	4
256	45	5	30	7	2
258	40	6	20	9	3
260	18	19	18	19	0
762	25	10	15	14	4
266	30	8	30	8	0
267	30	8	15	12	4
485	40	4	40	4	0
487*	24	14	24	14	0
489*	19	6	15	8	2
270	20	6	30	3	-3
780	13	20	13	20	0
Total	-	198	-	235	37

[a] *Bus requirements are grouped for these routes. In order to estimate the current requirement for the individual route, current peak travel time and frequency were used to create a proportion of service allotted to each route sharing numbers for bus requirements. These calculations were used to project the TSM bus requirement.
Source: Ten-Year Bus Fleet Management Plan, October 2012

BRT

If the proposed BRT service is implemented with the TSM package, additional vehicles will be required to operate the service and additional space will be required for bus storage. While the details of BRT service have not been finalized, a 10 minute headway and 120 minute cycle time are assumed at the current time. Given that cycle time estimate of 120 minutes, which includes layover time, 12 vehicles will be needed to operate the service. Applying Metro's 20 percent spare ratio, an additional three spare buses would also be required for BRT operation for a total of 15 buses. See Table 2 for BRT bus requirements.

BRT Feeders

Two new BRT feeder bus routes are proposed to provide connections for riders to the BRT. One route operates between Pasadena and the El Monte Bus Station via Rosemead, and the other operates between Commerce Metrolink Station and the Atlantic Gold Line Station via Garfield and Beverly. Bus requirements for the BRT feeders can be found in Table 2.

Spare buses are accounted for in the bus requirement total. The spare calculation was based on an additional 20 percent added to the number of buses needed to operate service. For example, if 10 buses are needed to operate service on a route, 12 buses would be the bus requirement for the route since 2 buses would be needed for spares.

TABLE 2
BRT Bus Requirements

Route	Proposed Headway	Proposed Cycle Time	Bus Requirement
BRT	10	120	15
El Monte - Pasadena	20	160	10
Commerce – Atlantic Station	20	60	4
Total	-	-	29

Tunnel Route

If a highway tunnel alternative is selected and constructed, a bus route has been proposed that will utilize the tunnel to enhance bus service between East Los Angeles and Pasadena. The route is proposed to operate between the Commerce Metrolink Station and California Institute of Technology in Pasadena. The estimated cycle time for the route is 120 minutes and, during peak hours, the route is proposed to operate every 20 minutes. See Table 3 for the bus requirements of the tunnel route. Spare buses are accounted for in the bus requirement total.

TABLE 3
Tunnel Route Bus Requirements

Route	Proposed Headway	Proposed Cycle Time	Bus Requirement
Tunnel Route	20	120	8

Overall Bus Requirement

This section presents the bus requirements for different service plans alternative combinations. For example, TSM may be implemented alone or in combination with the BRT or tunnel route. The combination of TSM with BRT and BRT feeder bus routes would require the most buses of all the alternatives. See Table 4 for overall bus requirements for each combination of alternatives. To note, the BRT would likely operate 60 foot buses. The overall numbers have been converted into a 40 foot equivalent since Metro uses that measurement for storage capacity purposes. Spare buses are accounted for in the bus requirement total.

TABLE 4
Overall Bus Requirements

Route	Bus Requirement	40' Equivalent
TSM	37	37
TSM + BRT	52	60
TSM + BRT + Feeders	66	74
TSM + Tunnel Route	45	45

Bus Storage Capacity

As of 2012, there are approximately 49 bus storage spaces available at division in the general study area. (This number may be slightly high as Metro did not include six buses in their capacity and utilization counts that are stored in Division 3. Additionally, Division 9 is currently over bus storage capacity by 7 buses.) See Table 5 for bus storage capacities. Based on this number, Metro may have the capacity to store the buses required for some combinations of service proposals, including TSM alone and TSM/Tunnel Route combined proposals.

Metro does not currently have the capacity to store the additional vehicles necessary to operate service proposed in the any combination of alternatives that include BRT. However, Metro approved the construction of a new storage and maintenance facility at Cesar Chavez and Vignes, near Union Station. The new division, Division 13, received FTA funding in FY 2011 and will have the capacity to store 200 40' buses when completed.

TABLE 5
Metro Bus Storage Capacity

Bus Division	2012 40' Bus Storage Capacity	2012 40' Equivalent Utilization	Unused Capacity
3*	210	187	23
9	235	242	+7
10	259	233	26
13	n/a	n/a	200

*Metro did not include 6 42-foot hybrid buses in the calculations.
Source: Ten-Year Bus Fleet Management Plan, October 2012

Conclusion

Based on the preceding analysis, the additional capacity from Division 13 or from capacity in nearby divisions freed up by its opening will be more than enough to store the additional buses required by the increases in bus service proposed in all alternatives. A new facility, therefore, will not need to be identified in the EIR/EIS section of this study.