SR 710 North Study

Paleontological Identification and Evaluation Report

Prepared for

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

Metro
Los Angeles County
Metropolitan Transportation Authority

March 14, 2014

This page intentionally left blank

DRAFT PALEONTOLOGICAL IDENTIFICATION AND EVALUATION REPORT FOR STATE ROUTE 710 NORTH STUDY

LOS ANGELES COUNTY, CALIFORNIA

CALIFORNIA DEPARTMENT OF TRANSPORTATION DISTRICT 7

E.A. 187900

EFIS 0700000191

07-LA-710 (SR 710)

Reviewed by: ______________________ Date: ____________

Kim Christmann, Senior Engineering Geologist
Division of Environmental Analysis
Hazardous Waste, Air, Noise, and Paleontology Office
California Department of Transportation
1801 30th Street
Sacramento, California 95816

Prepared by: Sarah Rieboldt Date: 3/14/14

Sarah Rieboldt, Ph.D.
Paleontologist
LSA Associates, Inc.
20 Executive Park, Suite 200
Irvine, California 92614

For individuals with sensory disabilities, this document is available in alternative formats. Please call or write to Department of Transportation, Attn: Garrett Damrath, Environmental Planning, 100 South Main Street, Los Angeles, California 90012, or use the California Relay Service TTY number, 711, or 1 800 735-2922.

March 14, 2014

This page intentionally left blank

Abstract

The California Department of Transportation (Caltrans), in cooperation with the Los Angeles Metropolitan Transportation Authority (Metro), proposes the State Route 710 (SR 710) North Study (project) to improve mobility and relieve congestion in the areas between State Route 2 and Interstates 5, 10, 210, and 605 in east/northeast Los Angeles and San Gabriel Valley. This proposed project has five alternatives: (1) the No Build Alternative; (2) the Transportation System Management/Transportation Demand Management (TSM/TDM) Alternative; (3) the Bus Rapid Transit (BRT) Alternative; (4) the Light Rail Transit (LRT) Alternative; and (5) the Freeway Tunnel Alternative. Some of the improvements described in the TSM/TDM Alternative are also part of the BRT, LRT, and Freeway Tunnel Alternatives.

Federal and State regulations require that impacts to paleontological resources be considered during project design and construction, and this report was prepared in order to comply with these regulations. Following the Caltrans Guidelines and recommendations from the Society of Vertebrate Paleontology (SVP), this report identifies and evaluates any potential paleontological resources that may be encountered during development of this project and makes recommendations regarding how to mitigate impacts to those resources. The area studied for each alternative includes all areas in the alternative alignment where project activities will occur, regardless of the type, scale, or result of that activity. The findings in this study are based on the construction methods for each project alternative, definitions of paleontological significance and sensitivity, reviews of geological and paleontological literature, and the results of a paleontological locality search through the Natural History Museum of Los Angeles County.

There are eight geologic units within the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives: Holocene Alluvial Fan Deposits, Young Alluvial Fan Deposits, Young Alluvium, Old Alluvial Fan Deposits, Old Alluvium, the Fernando Formation, the Puente Formation, and the Topanga Group. In addition to these native deposits, there are areas of Artificial Fill, placed during construction of interstates, freeways, and other roads. Artificial Fill does not have the potential to contain scientifically significant paleontological resources because of its disturbed context. The Holocene Alluvial Fan Deposits are too young to produce fossils that would be considered scientifically important. Both of these geologic units have no paleontological sensitivity; however, their thickness is variable and they may overlie other deposits that could contain scientifically important fossils. Although there are no known fossil localities within the boundaries of the project areas, paleontological resources have been recovered near the project areas and elsewhere in the region from the same or similar deposits as the Young Alluvial Fan Deposits, Young Alluvium, Old Alluvial Fan Deposits, Old Alluvium, the Fernando Formation, the Puente Formation, and the Topanga Group. These deposits have high paleontological sensitivity based on their age, composition, and depositional environment, as well as the scientifically significant fossil remains they have produced in other areas. The Young Alluvial Fan Deposits and Young Alluvium may contain scientifically significant fossils in their older sediments and, therefore, are considered to have low sensitivity from the surface to a depth of 10 feet (ft) and high sensitivity below that mark.

Consideration of impacts to paleontological resources must also take into account the project development methods for the alternatives. The No Build Alternative does not include improvements and, therefore, will not affect paleontological resources. The TSM/TDM and BRT Alternatives predominantly consist of improvements to existing streets and interchanges, with a few components that involve larger-scale changes, many of which require some amount of ground disturbance. The LRT Alternative includes excavation for various components, such as support structures for the aerial section, the bored tunnel, and rail stations. Excavation will also occur in portions of the Freeway Tunnel Alternative, for example, the central bored tunnel, cut-and-cover tunnels at the portals, and grade changes to existing right of way. The bored tunnel sections of both the LRT and Freeway Tunnel Alternatives will be excavated using a tunnel boring machine, which prevents access to the rock face and grinds the rock into small particles. Other improvements in the LRT and Freeway Tunnel Alternatives, as well as improvements in the TSM/TDM and BRT Alternatives, will use more traditional excavation methods and equipment, such as scrapers, trackhoes, and bulldozers and/or drilling for Cast-In-Drilled-Hole piles. As a result, development of each Build Alternative has the potential to encounter paleontologically sensitive sediments and may impact scientifically significant, nonrenewable paleontological resources.

To reduce impacts to scientifically significant, nonrenewable paleontological resources, this report recommends the preparation of a Paleontological Mitigation Plan (PMP) for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives. A PMP is not necessary for the No Build Alternative. The PMP should follow the guidelines of Caltrans and recommendations from the SVP and, at a minimum, include the following recommendations:

- A qualified paleontologist or representative will attend the pre-grade conference. At this meeting, the paleontologist will explain the likelihood for encountering paleontological resources, what resources may be discovered, and the methods of recovery that will be employed.
- A preconstruction field survey will be conducted in areas with deposits of high paleontological sensitivity after vegetation and paving have been removed, and any observed surface paleontological resources salvaged prior to the beginning of additional grading.
- In general, a qualified paleontological monitor will initially be present on a full-time basis whenever excavation will occur within the sediments that have a high paleontological sensitivity rating, and on a spot-check basis when excavating in sediments that have a low sensitivity rating. No monitoring is generally necessary in deposits with no paleontological sensitivity, such as Artificial Fill and Holocene Alluvial Fan Deposits. However, the specific monitoring levels and locations will be developed according to the final design plans and take into account the excavation methods and depths, the thickness of any Artificial Fill and/or Holocene Alluvial Fan Deposits present in the project area, and the sensitivity of the deposits underlying those two geologic units.
- Full-time monitoring may be reduced to a part-time or spot-check basis if no resources are being discovered in sediments with a high sensitivity rating (monitoring reductions, when they occur, will be determined by the qualified Principal Paleontologist in consultation with the Resident Engineer). The monitor will inspect fresh cuts and/or spoils piles to recover paleontological resources and/or screen wash for smaller fossils, depending on the material available for inspection. The monitor will be empowered to temporarily divert construction equipment away from the immediate area of the discovery. The monitor will be equipped to rapidly stabilize and remove fossils to avoid prolonged delays to construction schedules. If large mammal fossils or large concentrations of fossils are encountered, heavy equipment will be used to assist in the removal and collection of large materials.

- Native sediments of high and low sensitivity will occasionally be spot-screened on site through 1/8- to 1/20-inch mesh screens to determine whether microvertebrates or other small fossils are present. If small fossils are encountered, sediment samples (up to 3 cubic yards, or 6,000 pounds) will be collected and processed through 1/20-inch mesh screens to recover additional fossils.
- Recovered specimens will be prepared to the point of identification and permanent preservation. This includes the sorting of any washed mass samples to recover small invertebrate and vertebrate fossils, the removal of surplus sediment from around larger specimens to reduce the volume of storage for the repository and storage cost, and the addition of approved chemical hardeners/stabilizers to fragile specimens.
- Specimens will be identified to the lowest taxonomic level possible and curated into an institutional repository with retrievable storage. The repository institutions usually charge a one-time fee based on volume, so removing surplus sediment is important. The repository institution may be a local museum or university with a curator who can retrieve the specimens on request. Caltrans requires that a draft curation agreement be in place with an approved curation facility prior to the initiation of any paleontological monitoring or mitigation activities.
- A Paleontological Mitigation Report will be prepared and submitted to the Lead Agency (Caltrans) to document completion of the PMP.

Implementation of these recommendations will reduce impacts to nonrenewable paleontological resources. Once the alternative is selected, the PMP will be developed concurrently with the final design plans. In this way, more detailed plans for ground disturbance may be integrated into the PMP and used to determine the appropriate level of monitoring for different locations within the project area for the selected alternative.

This page intentionally left blank

Contents

Appendices

Tables

Figures

Acronyms and Abbreviations

ATM	Active Traffic Management
BLM	Bureau of Land Management
BRT	Bus Rapid Transit
Cal State LA	California State University, Los Angeles
Caltrans	California Department of Transportation
CCO	Construction Change Order
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CIDH	Cast-In-Drilled-Hole
CMS	changeable message signs
Corps	United States Army Corps of Engineers
DOE	United States Department of Energy
ESA	Environmentally Sensitive Area
FHWA	Federal Highway Administration
ft	foot/feet
FTA	Federal Transit Administration
FTIP	Federal Transportation Improvement Program
I-5	Interstate 5
I-105	Interstate 105
I-405	Interstate 405
I-10	Interstate 10
I-110	Interstate 110
I-210	Interstate 210
I-605	Interstate 605
I-710	Interstate 710

IEN	Information Exchange Network
LACM	Natural History Museum of Los Angeles County
LRT	Light Rail Transit
LRTP	Long Range Transportation Plan
Ma	million years ago
Metro	Los Angeles County Metropolitan Transportation Authority
mi	mile(s)
mph	miles per hour
MSA	Metropolitan Statistical Area
MSE	mechanically stabilized earth
NALMA	North American Land Mammal Age
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NNL	National Natural Landmark
NPS	National Park Service
O&M	operations and maintenance
PA/ED	Project Approval/Environmental Document
PEAR	Preliminary Environmental Analysis Report
PER	Paleontological Evaluation Report
PIR	Paleontological Identification Report
PMP	Paleontological Mitigation Plan
PMR	Paleontological Mitigation Report
PRC	Public Resources Code (California)
PRIMP	Paleontological Resources Impact Mitigation Program
project	State Route 710 North Study
PRPA	Paleontological Resources Protection Act
PSS	Paleontological Stewardship Summary
ROW	right of way

RTP	Regional Transportation Plan
SCAG	Southern California Association of Governments
SCS	Sustainable Communities Strategy
SER	Standard Environmental Reference (Caltrans)
SR 2	State Route 2
SR 22	State Route 22
SR 57	State Route 57
SR 60	State Route 60
SR 91	State Route 91
SR 110	State Route 110
SR 118	State Route 118
SR 134	State Route 134
SR 710	State Route 710
SVP	Society of Vertebrate Paleontology
TAP	Transit Access Pass
TBM	tunnel boring machine
TCE	temporary construction easement
TSM/TDM	Transportation System Management/Transportation Demand Management
US-101	United States Route 101
US-170	United States Route 170
USC	United States Code
USFS	United States Forest Service
USGS	United States Geological Survey

This page intentionally left blank

1. Project Description

1.1 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 2 (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. The study area for the State Route 710 (SR 710) North Study as depicted on 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. Caltrans is the Lead Agency under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA).

1.2 Purpose and Need

1.2.1 Purpose of the 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 due to accommodating regional traffic volumes.
- Minimize environmental impacts related to mobile sources.

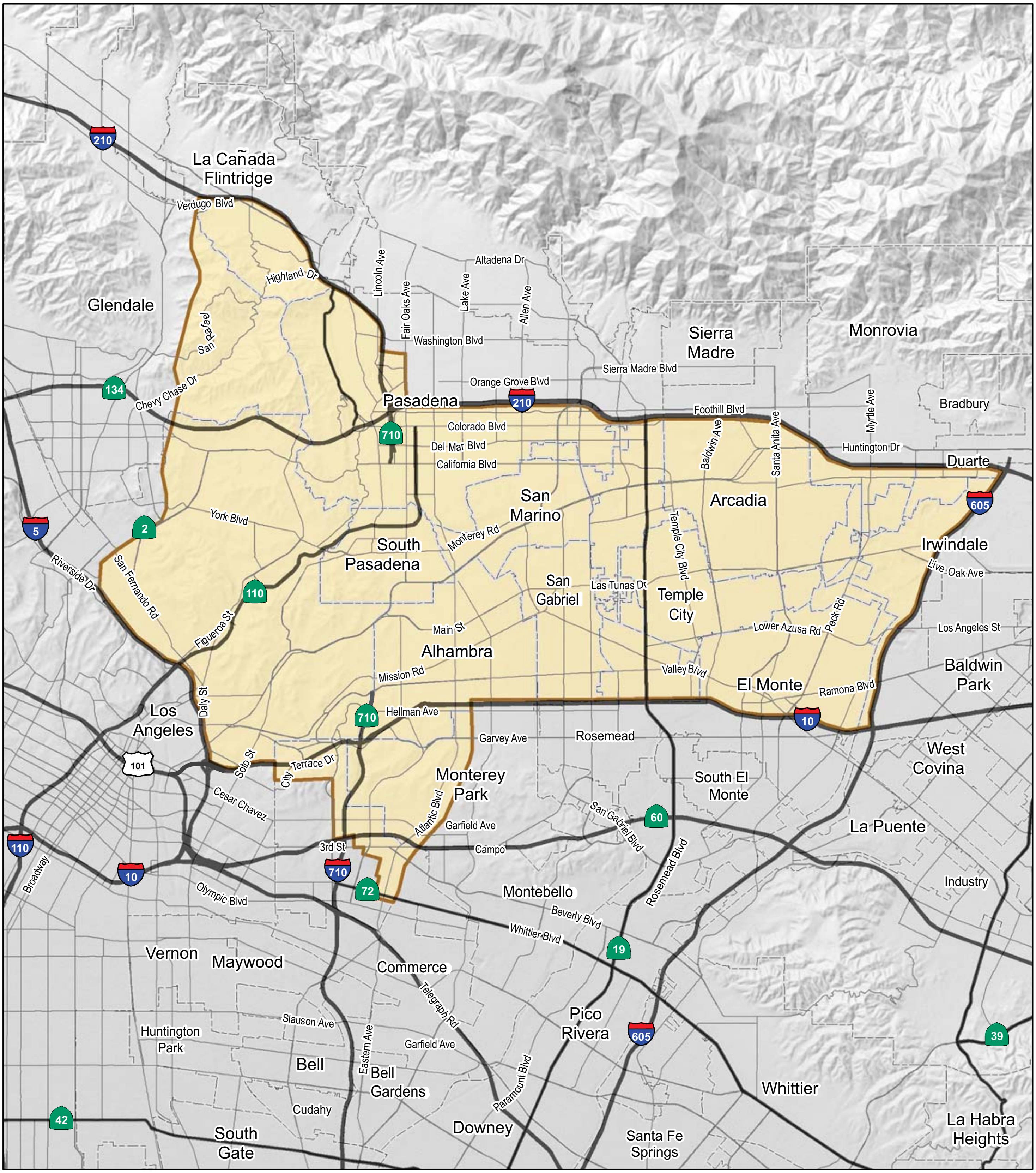
1.2.2 Need for the Project

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)

This page intentionally left blank



LEGEND

SR 710 North Study Area

FIGURE 1-1

N

0 1.25 2.5

MILES

SOURCE: ESRI (2008); LSA (2013)

SR 710 North Study

Project Location

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\G\P&N\Project Location.cdr (10/27/14)

This page intentionally left blank

- 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

1.3 Alternatives

The proposed alternatives include the No Build Alternative, the Transportation System Management/Transportation Demand Management (TSM/TDM) Alternative, the Bus Rapid Transit (BRT) Alternative, the Light Rail Transit (LRT) Alternative, and the Freeway Tunnel Alternative. These alternatives are each discussed below.

1.3.1 No Build Alternative

The No Build Alternative includes projects/planned improvements through 2035 that are contained in the Federal Transportation Improvement Program (FTIP), as listed in the Southern California Association of Governments (SCAG) 2012 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS), Measure R, and the funded portion of Metro's 2009 Long Range Transportation

Plan (LRTP). The No Build Alternative does not include any planned improvements to the SR 710 Corridor. Figure 1-2 illustrates the projects in the No Build Alternative.

1.3.2 Transportation System Management/Transportation Demand Management (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 on Figure 1-3. TSM strategies increase the efficiency of existing facilities (i.e., TSM strategies are actions that increase the number of vehicle trips which a facility can carry without increasing the number of through lanes).

1.3.2.1 Transportation System Management

TSM strategies include Intelligent Transportation Systems (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 1.1. 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.

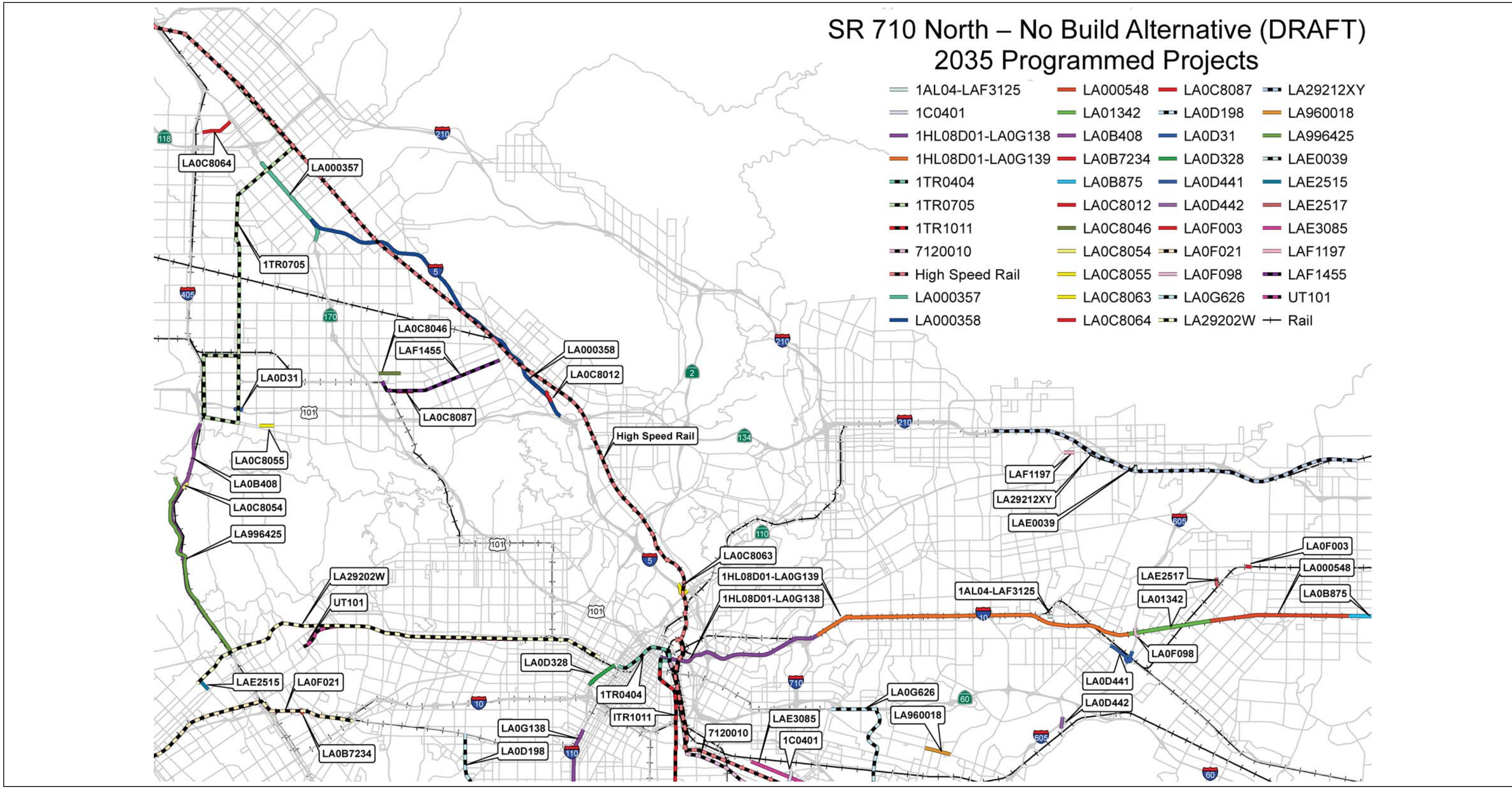


FIGURE 1-2

N

NOT TO SCALE

SOURCE: CH2M HILL (2013)

SR 710 North Study

No Build Alternative

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\G\No Build Alt.cdr (10/27/14)

This page intentionally left blank

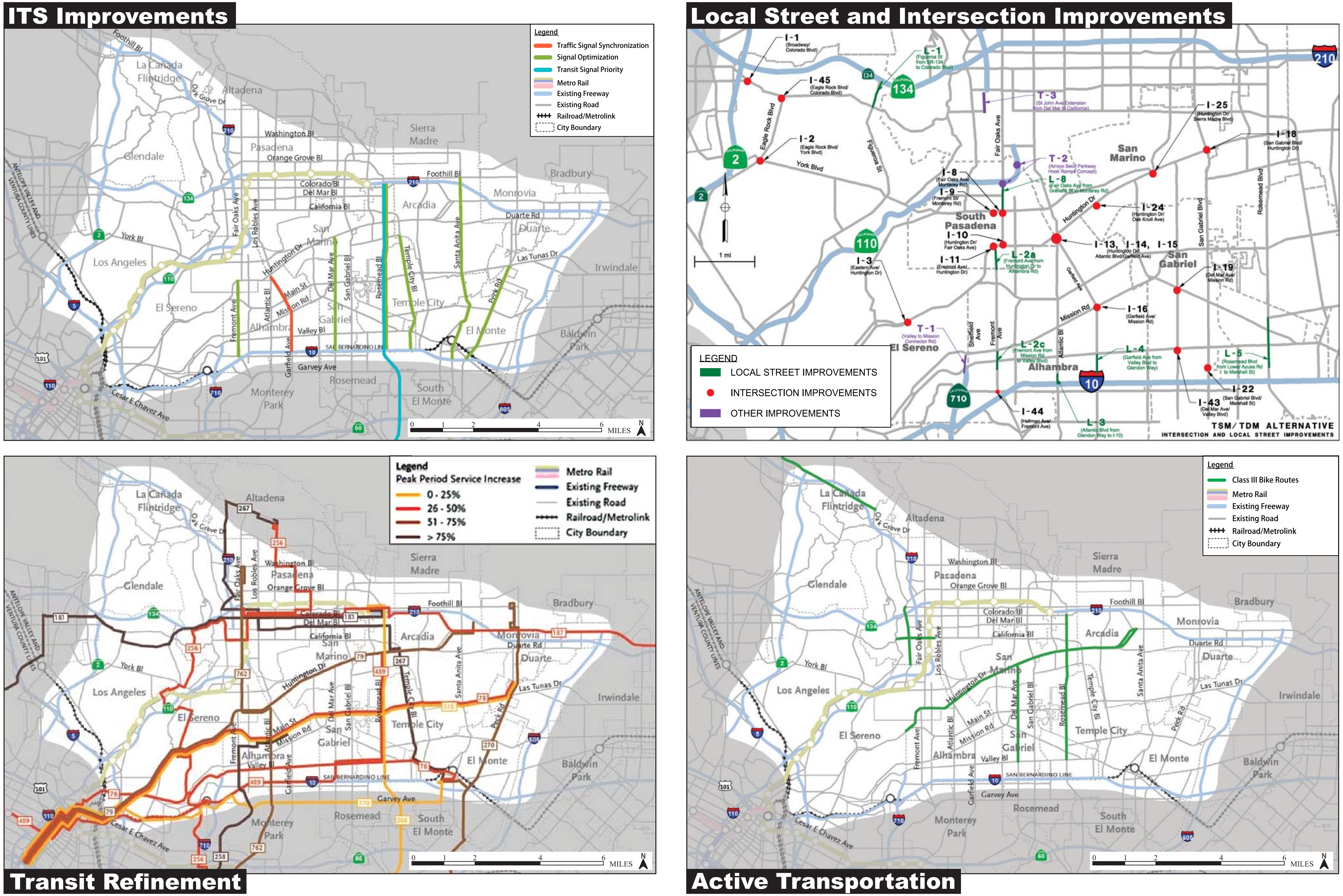


FIGURE 1-3

SR 710 North Study

TSM/TDM Alternative

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

SOURCE: CH2M HILL (2013)

I:\CHM1105\G\TSM_TDM Alt.cdr (10/27/14)

This page intentionally left blank

TABLE 1.1:
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

CMS = changeable message signs
I-10 = Interstate 10
ITS = Intelligent Transportation Systems
SR 110 = State Route 110
TDM = Transportation Demand Management
TSM = Transportation System Management
US-101 = United States Route 101

- **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 1.2 outlines the location of the proposed improvements to local streets, intersections, and freeway ramps as well as two new local roadways.
- **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.

1.3.2.2 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:

TABLE 1.2:
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	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	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/San Marino Avenue	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	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	St. John Avenue Extension between Del Mar Boulevard and California Boulevard	City of Pasadena

I-10 = Interstate 10 SR 110 = State Route 110
I-710 = Interstate 710 SR 134 = State Route 134
NB = northbound TDM = Transportation Demand Management
SB = southbound TSM = Transportation System Management

- **Expanded Bus Service and Bus Service Improvements:** Transit service improvements included in the TSM/TDM Alternative are summarized in Tables 1.3 and 1.4 and illustrated on Figure 1-3. 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 1.4.

TABLE 1.3:
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
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.
BRT = Bus Rapid Transit
Express = Express Bus
Foothill = Foothill Transit
Metro = Los Angeles County Metropolitan Transportation Authority
Rapid = Bus Rapid Transit
TDM = Transportation Demand Management
TSM = Transportation System Management

TABLE 1.4:
Active Transportation and Bus Enhancements of the TSM/TDM Alternative

ID No.	Description	Location
Bus Service Improvements		
Bus-1	Additional bus service	See Table 1.3 and Figure 1-3
Bus-2	Bus stop enhancements	Along routes listed in Table 1.3
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

Metro = Los Angeles County Metropolitan Transportation Authority
TDM = Transportation Demand Management
TSM = Transportation System Management

1.3.3 Bus Rapid Transit (BRT) Alternative

The BRT Alternative would provide high-speed, high-frequency bus service through a combination of new, dedicated, and existing bus lanes, and mixed-flow traffic lanes to key destinations between East Los Angeles and Pasadena. The proposed route length is approximately 12 mi. Figure 1-4 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. BRT includes 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 mi route would begin at Atlantic Boulevard and Whittier Boulevard to the south, follow Atlantic Boulevard, Huntington Drive, Fair Oaks Avenue, 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 from a baseline transit signal priority 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 rights of way (ROW) through a variety of methods that include restriping the roadway, restricted on-street parking during peak periods, 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 available for on-street parking use.

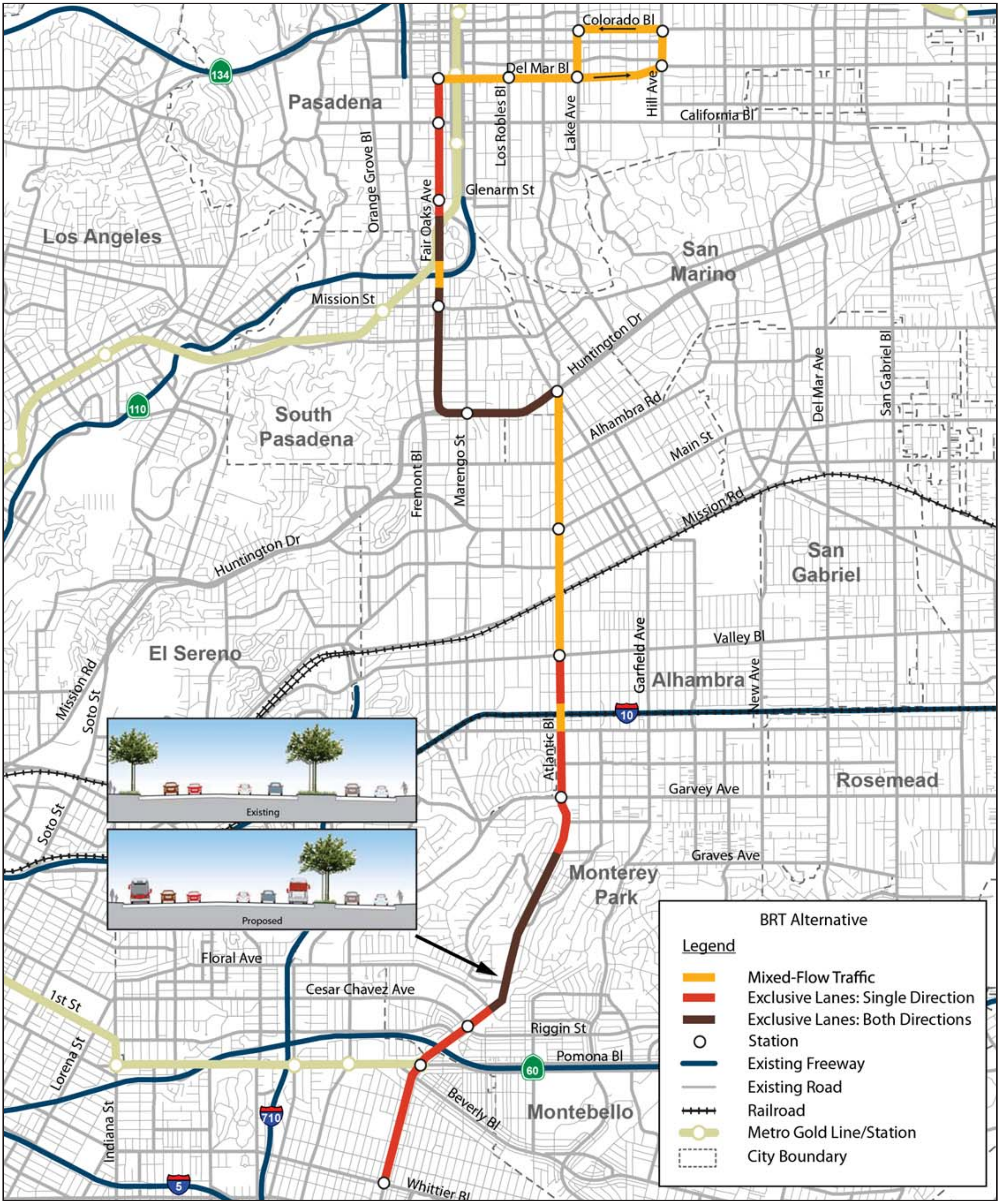
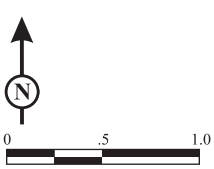


FIGURE 1-4



SOURCE: CH2M HILL (2013)

I:\CHM1105\G\BRT Alternative.cdr (10/27/14)

SR 710 North Study

BRT Alternative

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

This page intentionally left blank

A total of 17 BRT stations with amenities would be placed on average, at approximately 0.8 mi 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 (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 (ft) articulated buses with three doors, and would have the latest 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)

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 City 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 El Sol shuttle improvements are an existing bus service that would be increased in frequency. The headways on the El Sol shuttle "City Terrace/East Los Angeles College (ELAC)" route that connect ELAC to the proposed Floral Station would be reduced from 60 minutes to 15 minutes.

The TSM/TDM Alternative improvements would also be constructed as part of the BRT Alternative, except as noted below. 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. 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.

1.3.4 Light Rail Transit (LRT) 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 1-5 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.

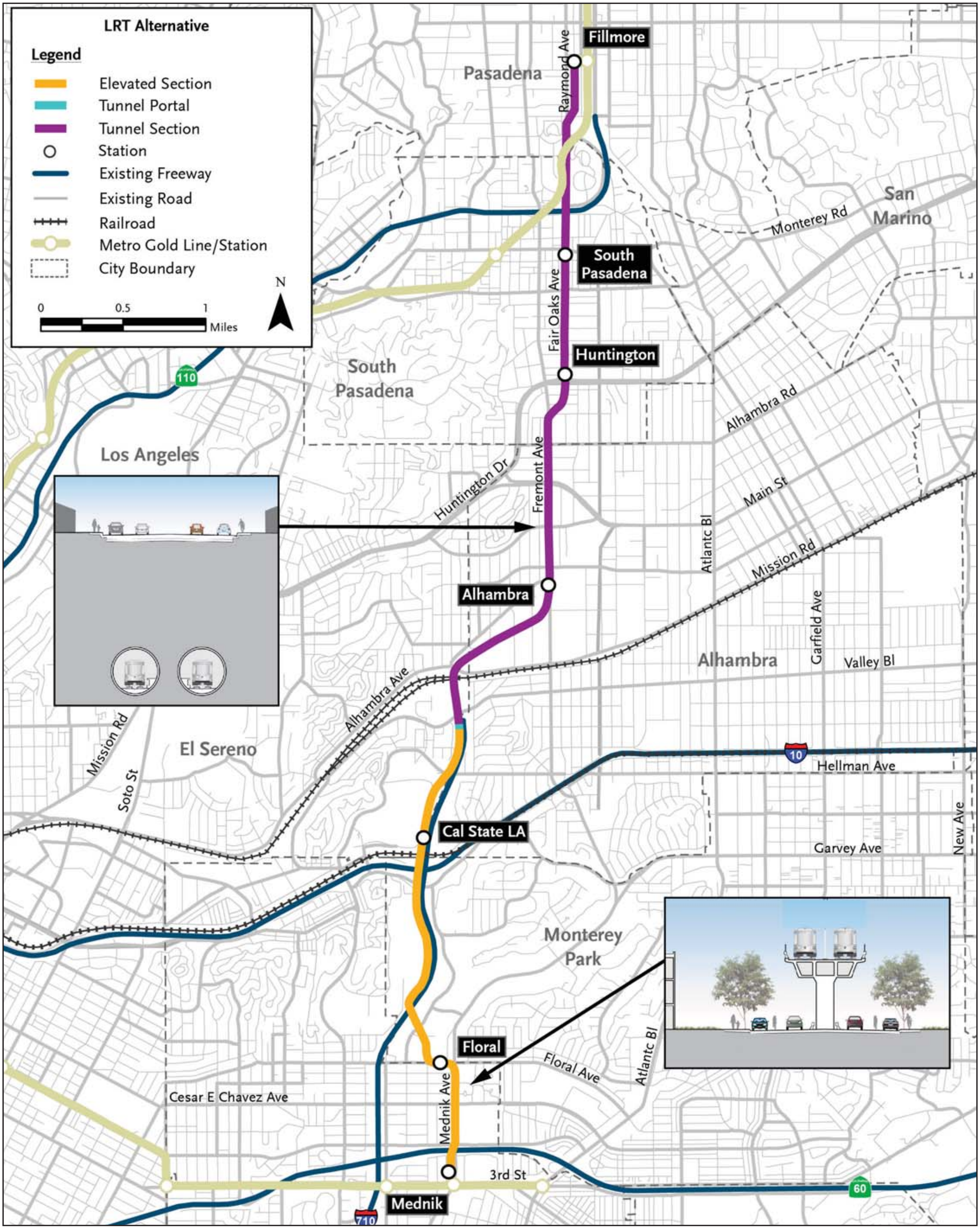


FIGURE 1-5

SR 710 North Study

LRT Alternative

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

0 .5 1
MILES

SOURCE: AECOM (2013)

I:\CHM1105\G\LRT Alternative.cdr (10/27/14)

This page intentionally left blank

As part of the LRT Alternative, the I-710 northbound off-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).

1.3.5 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 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. 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 between Del Mar Boulevard and California Avenue).

1.3.5.1 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. Figure 1-6 illustrates the dual-bore and single-bore tunnel design variations for the Freeway Tunnel Alternative. Each of these design variations is described below.

This page intentionally left blank

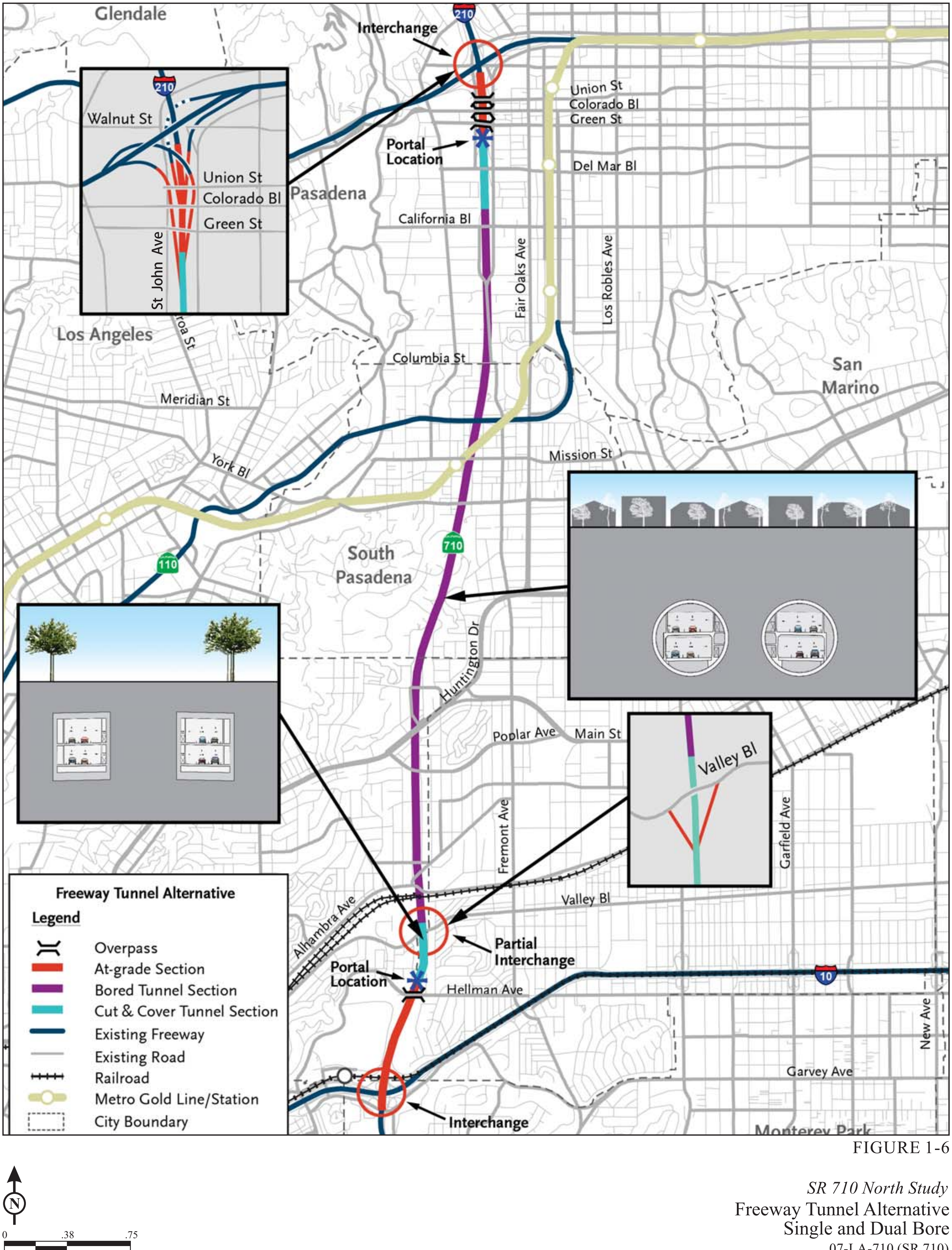


FIGURE 1-6

SR 710 North Study

Freeway Tunnel Alternative
Single and Dual Bore

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

SOURCE: CH2M HILL (2013)

I:\CHM1105\G\Freeway Tunnel Alt Single&Dual Bore.cdr (10/27/14)

This page intentionally left blank

- **Dual-Bore Tunnel:** The dual-bore tunnel design 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 design variation would consist of two side-by-side tunnels (the east tunnel would convey northbound traffic, and the west tunnel would convey southbound traffic). Each tunnel would have two levels with traffic traveling in the same direction. 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 eastern tunnel would be constructed for northbound traffic, and the western tunnel would be constructed for southbound traffic. Each bored tunnel would have an outside diameter of approximately 58.5 ft and would be located approximately 120 to 250 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 1-6 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.

- **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 design 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 58.5 ft and would be located approximately 120 to 250 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 1-7 illustrates the single-bore tunnel variation cross section of the Freeway Tunnel Alternative.

1.3.5.2 Operational Variations

There were three different parameters related to the operational variations of the Freeway Tunnel Alternative:

- **Tolling:** Tolls could be charged for vehicles using the tunnel, or it could be free for all drivers (a conventional freeway).
- **Trucks:** Trucks could be prohibited or allowed.
- **Express Bus:** A dedicated Express Bus could be operated using the tunnel. 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.

This page intentionally left blank

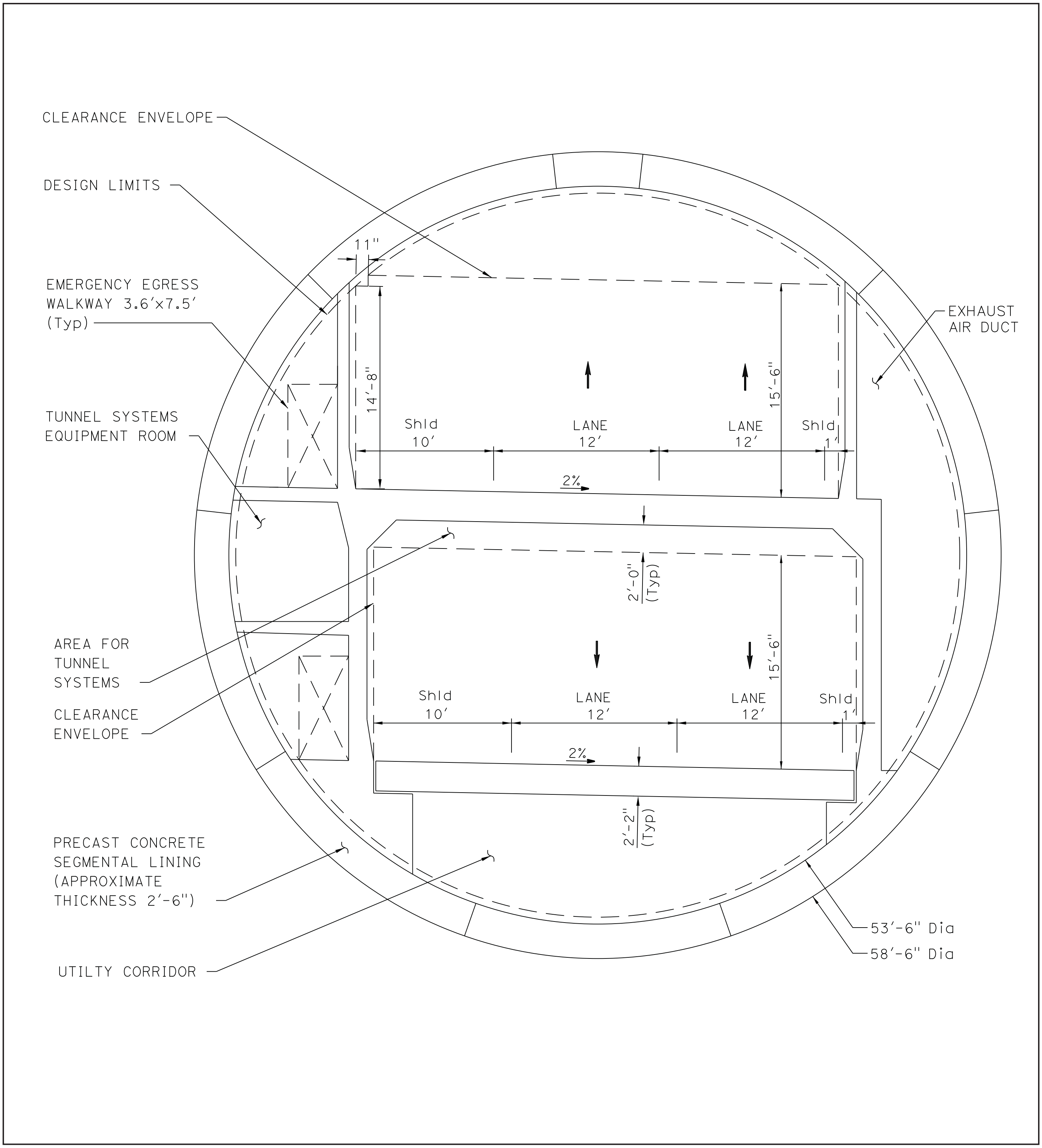


FIGURE 1-7

SR 710 North Study
Freeway Tunnel Alternative
Single Bore Cross Section
07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

SOURCE: CH2M HILL (2014)

I:\CHM1105\G\Single Bore Cross Section.cdr (10/27/14)

This page intentionally left blank

The following operational variations have been studied for the Freeway Tunnel Alternative:

- **Freeway Tunnel Alternative without Tolls:** The facility would operate as a conventional freeway with lanes open to all vehicles. Trucks would be allowed and there would be no Express Bus service. 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. There would be no Express Bus service. Signs would be provided along I-210, SR 134, I-710, and I-10 to provide advance notice of the truck restriction. This operational variation would be considered for the dual-bore tunnel only.
- **Freeway Tunnel Alternative with Tolls:** All vehicles, including trucks, using the tunnel would be tolled. There would be no Express Bus service. This operational variation would be considered for both the dual- and single-bore tunnels described above.
- **Freeway Tunnel Alternative with Trucks Excluded and with Tolls:** The facility would be tolled for all automobiles. There would be no Express Bus service. 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. This operational variation would be considered for the single-bore tunnel only.
- **Freeway Tunnel Alternative with Toll and Express Bus:** The 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. Trucks would be permitted. This operational variation would be considered for the single-bore tunnel only.

1.4 Excavation Parameters

Because paleontological resources may be encountered at or below the surface during development of a project, the depths and methods of any ground-disturbing activities are of particular importance in determining how a project may impact those resources. Therefore, more detailed information regarding the excavation depths and methods for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives was obtained from the engineering teams responsible for their design. This information is summarized below. As mentioned in Section 1.3, some of the improvements listed in the TSM/TDM Alternative are included in the BRT, LRT, and Freeway Tunnel Alternatives. However, to avoid repetition, the excavation methods and equipment for the improvements in the TSM/TDM Alternative are described once. The excavation methods and equipment for the main improvements in the BRT, LRT, and Freeway Tunnel Alternatives are described separately.

1.4.1 Transportation System Management/Transportation Demand Management Alternative

Many of the improvements included in the TSM/TDM Alternative listed in Tables 1-2, and 1-3, such as video detection systems, enhanced bus service, and bike routes, do not involve ground disturbance[1]. However, other improvements, such as the installation of CMS and additional bus stops, as well as the local street and intersection improvements may require ground disturbance for

[1] S. Greene, AECOM, personal communication, September 2013.

their implementation. Excavation and construction for the local street and intersection improvements listed in Table 1-1 involve multiple components, which vary in degree of ground disturbance.[1] Examples of these components include changes to signs and lane striping; rehabilitation of traffic signals; removal of medians; and installation of new medians, sidewalks, pavement, and reversible signal towers. Anticipated depth of excavation for these components ranges from zero to approximately 10 ft. The majority of improvements within this alternative include one or more of these components. In addition to these smaller-scale components, a few improvements in this alternative include more substantial changes, such as new alignments for roads, on-ramps, and off-ramps. These larger-scale changes involve greater levels of ground disturbance with excavation that may reach depths of up to 45 ft.

Traditional excavation equipment, such as scrapers, trackhoes, bulldozers, etc., will be used for most components that involve ground disturbance. For signal poles, cast-in-drilled-hole (CIDH) piles that are 24 to 30 inches in diameter will be used, and the shafts for these piles will be drilled approximately 8 to 10 ft deep using a drill rig equipped with an auger. More precise information on the extent and depth of excavation for each improvement will depend on more detailed geotechnical studies and final design plans.

1.4.2 Bus Rapid Transit Alternative

The current design plans from CH2M HILL (August 2013) indicate that ground disturbance involved in the BRT Alternative is minimal and mainly concentrated in existing ROW. These improvements include widening roadways and sidewalks, modifications to the SR 710/SR 60 interchange, and installation of ancillary structures (e.g., traffic signs, power poles, and small retaining walls).[2] The construction of bus shelters, of which 31 are planned along the route, involves deeper excavation. Anticipated ground disturbance for their installation involves a 3 ft diameter drilled shaft that may extend up to 20 ft below the original ground surface.

Where roadways will be widened, such as along Atlantic Boulevard and Fair Oaks Boulevard, existing surface materials (landscaping, pavements, crushed rock, etc.) would be excavated to a depth of about 12 inches to allow placement of the new pavement section. Similarly, for widening sidewalks, existing material would be removed and replaced; however, excavation would be shallower than 12 inches.

The proposed design for the ramps at the SR 710/SR 60 interchange does not include much change in the vertical profile from the existing alignments.[3] As such, ground disturbance in this area would be minimal and possibly similar to that for widening the roadways.

The installation of smaller features, including traffic signal poles, traffic signs, electrical power poles, light poles, small retaining walls, and drainage facilities would occur in various places along the 12-mile route. These features are similar to those included in the TSM/TDM Alternative improvements and would likely have similar levels of ground disturbance. Excavation for this alternative would use traditional excavation equipment (e.g., scrapers, trackhoes, bulldozers) as well as CIDH piles. More precise information on the extent and depth of excavation will depend on more detailed geotechnical studies and final design plans that will be prepared if this alternative is selected.

1 R. Meza, CH2M Hill, personal communication, August 2013.
2 T. Bevan, CH2M Hill, personal communication, August 2013.
3 Ibid.

1.4.3 Light Rail Alternative

Excavation for the LRT Alternative can be divided into three general categories based on the methods, equipment, and section of the alignment: (1) the bored tunnel section, (2) the aerial section, and (3) the rail stations, cut-and-cover tunnel at the south portal, and other improvements.

It is assumed that the bored tunnel section of this alternative will be excavated using a pressurized-face tunnel boring machine (TBM).[1] This machine has a rotating cutting head at the front that excavates the rock as the machine is pushed through the ground. The excavated material is mixed with water and conditioners and expressed either at the back of the machine or brought to the surface, depending on the type of TBM. This excavation process prevents access to the rock face and grinds the rock into small particles. However, it is possible that a different type of TBM may be used (e.g., one that produces larger, cobble-sized pieces of rock).

Current design plans from AECOM (August 2013) show that most of the aerial section will be supported by CIDH columns that are 8 to 12 ft in diameter. For these columns, a drill rig equipped with an auger will drill a shaft approximately 100 to 125 ft below the ground surface.[2] The columns may extend deeper depending on the final load calculations and properties of the subsurface material. After the shaft is drilled and the soil and rock removed, the shaft will be filled with reinforcement and concrete. In a few areas, the aerial section will be supported by mechanically stabilized earth (MSE), instead of columns.

Traditional excavation equipment (e.g., scrapers, trackhoes, bulldozers) will be used during development of the rail stations and associated parking structures, the portal to the bored tunnel, and other improvements listed below. The tunnel portal and rail stations will be excavated from the surface to the depth of the bored tunnel. Other areas of the LRT Alternative will involve ground disturbance to varying depths in order to implement their respective improvements. Based on current design plans from AECOM[3], these improvements include:

- Widening Mednik Avenue by 20 ft between First Street and Floral Drive;
- Replacing the slope on the north side of Floral Drive with a retaining wall;
- Installing a small retaining wall west of Cal State LA for construction of a sidewalk on the south side of Circle Drive;
- Installing retaining walls and grading the area for the maintenance yard;
- Relocating the I-710 northbound off-ramp to Valley Boulevard; and
- Constructing an embankment and an MSE wall to support the rail line along the I-710 ROW south of the I-10/I-710 interchange.

The depth of excavation for each of these improvements will depend on more detailed geotechnical studies and design plans that will be prepared if this alternative is selected.

1 M. Torsiello, Jacobs Associates, personal communication, August 2013.
2 R. Raveendra, CH2M Hill, personal communication, August 2013.
3 S. Greene, AECOM, personal communication, August 2013.

1.4.4 Freeway Tunnel Alternative

Excavation and ground disturbance for the Freeway Tunnel may also be grouped into three categories based on the methods, equipment, and section, including: (1) the central bored tunnel section, (2) cut-and-cover tunnels at the north and south portals, and (3) other modifications.

It is assumed that the bored tunnel section of this alternative will be excavated using a pressurized-face TBM.[1] This machine has a rotating cutting head at the front that excavates the rock as the machine is pushed through the ground. The excavated material is mixed with water and conditioners and expressed either at the back of the machine or brought to the surface, depending on the type of TBM. This excavation process prevents access to the rock face and grinds the rock into small particles. However, it is possible that a different type of TBM may be used (e.g., one that produces larger, cobble-sized pieces of rock).

The portals at the north and south ends of the central bored tunnel section will be constructed of cut-and-cover tunnels. These cut-and-cover tunnels will be excavated from the surface to the depth of the bored tunnel, approximately 120 to 160 ft below the surface, using traditional excavation equipment (e.g., scrapers, trackhoes, bulldozers).

Other elements of the Freeway Tunnel Alternative will also use traditional excavation methods and equipment for their development; however, the level of ground disturbance would be less extensive than for the cut-and-cover tunnels. These improvements include modifications to surface streets (e.g., Hellman Avenue, Del Mar Boulevard, Saint John Avenue, and Valley Boulevard), on-ramps and off-ramps to and from SR 710, and the interchanges with I-10 and SR 134. In addition, CIDH piles will be used for new signs.

1 M. Torsiello, Jacobs Associates, personal communication, August 2013.

2. Regulatory Environment

2.1 California Department of Transportation Guidelines

Because Caltrans is the Lead Agency, the project is obligated to follow the guidelines specified in Caltrans Standard Environmental Reference (SER). Specifically, the SER Environmental Handbook, Volume 1, Chapter 8 (Caltrans, 2012), deals with paleontology. The guidelines are designed to address impacts to paleontological resources prior to the beginning of construction. In most cases, three documents are required to be prepared: a Paleontological Investigation Report (PIR), a Paleontological Evaluation Report (PER), and a Paleontological Mitigation Plan (PMP). The PIR and PER are often combined into a single document. The PIR and PER must be prepared during the Project Approval/Environmental Document (PA/ED) phase in order to support the conclusions and commitments made in the ED. The PMP must be developed prior to the beginning of construction.

The purpose of the PIR is to identify whether or not paleontological resources may be present within the project area; the purpose of the PER is to evaluate the significance of the resources if it is determined that resources are likely to be present; and the purpose of the PMP is to develop mitigation for scientifically significant resources. Occasionally the PIR/PER will determine that, despite the results of the literature review, it is unlikely that the project will encounter scientifically significant resources during construction. This may be due to the removal of sensitive sediments as a result of previous construction in the area, or to the burying of sensitive sediments with fill deeper than depths that will be encountered during construction related to the project. In these cases, a PMP will not be required, and the reason will be specified in the PIR/PER. At the conclusion of grading, two additional documents may need to be prepared: a Paleontological Mitigation Report (PMR) and a Paleontological Stewardship Summary (PSS).

2.2 Federal Regulations

A project must comply with one or more federal regulations concerning paleontological resources, if (1) the project involves land under the jurisdiction of a federal agency, (2) a federal agency has oversight on the project, and/or (3) a permit, license, authorization, or funding from a federal agency is required to complete the project. A brief discussion of the federal regulations that involve paleontological resources and their applicability to this project are included below.

2.2.1 National Environmental Policy Act of 1969 (NEPA) (42 United States Code [USC] 4321-4375)

NEPA established a national policy for the protection, promotion, enhancement, and understanding of the environment and created the Council on Environmental Quality. As part of this act, Section 101(b)(4) (42 USC 4331) seeks to “preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.” NEPA requires that the environmental effects of a proposed federal project or action be evaluated, and regulations for implementing this evaluation are found in Title 40 of the Code of Federal Regulations (CFR) Section 1500-1508. Because federal agencies (i.e., the Federal Highway Administration [FHWA] and the Federal Transit Administration [FTA]) may have oversight on this project, compliance with NEPA regulations is required.

2.2.2 Archaeological and Paleontological Salvage (23 USC 305)

As part of the Federal-Aid Highway Act of 1956 (23 USC et seq.), this federal law authorizes the appropriation and use of federal funds for paleontological salvage as necessary by the highway department of any state, in compliance with 16 USC 431-433. According to 23 CFR 1.9(a), the use of federal-aid funds must be in conformity with federal and State law. Under this statute, mitigation of impacts to paleontological resources during development of this project may be an eligible federal project cost, provided the necessary documentation is submitted to the FHWA.

2.2.3 The Antiquities Act of 1906 (16 USC 431-433)

This law prohibits appropriating, excavating, injuring, or destroying any object of antiquity situated on federal land without the permission of the Secretary of the Department of the Government having jurisdiction over the land. Fossils are generally considered “objects of antiquity” by federal agencies, including the Bureau of Land Management (BLM), National Park Service (NPS), and United States Forest Service (USFS). Permits to collect fossils on lands administered by federal agencies are authorized under this act. Therefore, projects involving federal lands will require permits for paleontological evaluation and mitigation efforts. No portion of this project crosses lands administered by the federal government. Therefore, this act is not applicable to this project.

2.2.4 Paleontological Resources Preservation Act (PRPA) (16 USC 470aaa et seq.)

This act prohibits the excavation, removal, or damage of any paleontological resources located on federal land under the jurisdiction of the Secretaries of the Interior or Agriculture (e.g., BLM, NPS, and USFS). The statute establishes criminal and civil penalties for fossil theft and vandalism on federal lands. Federal land managing agencies (e.g., the BLM, USFS, NPS, and United States Army Corps of Engineers [Corps]) may issue paleontological permits for conducting project-related investigations, both inventory and mitigation, on lands under their jurisdiction. No portion of this project crosses lands administered by the federal government; therefore, this act is not applicable to this project.

2.2.5 National Natural Landmarks (NNL) Program (16 USC 461-467)

The NNL Program was established in 1962 and is administered under the Historic Sites Act of 1935 (16 USC 461-467). Implementing regulations were first published in 1980 under 36 CFR Section 1212, and the program was re-designated as 36 CFR 62 in 1981. An NNL is defined as “an area designated by the Secretary of the Interior as being of national significance to the United States because it is an outstanding example(s) of major biological and geological features found within the boundaries of the United States or its Territories or on the Outer Continental Shelf.” National significance describes “an area that is one of the best examples of a biological community or geological feature within a natural region of the United States, including terrestrial communities, landforms, geological features and processes, habitats of native plants and animal species, or fossil evidence of the development of life.” Federal agencies and their agents (e.g., Caltrans) should consider the existence and location of designated NNLs, and of areas found to meet the criteria for national significance, in assessing the effects of their activities on the environment under Section 102(2)(c) of NEPA. Because no portion of this project crosses an NNL, the section of NEPA that addresses these does not apply to this project.

2.2.6 Paleontological Resources on Public Lands (43 CFR 8365 et seq.)

These regulations provide for the protection and preservation of public lands and resources, including paleontological resources. Specifically, 43 CFR 8365.1-5(a)(1) states that on public lands, which are defined as lands under the jurisdiction of the BLM (43 CFR 8365.1), no person shall "willfully deface, disturb, remove, or destroy any personal property, or structures, or any scientific, cultural, archaeological, or historic resource, natural object or area," which the BLM interprets to include paleontological resources. This regulation does not apply to this project because the project does not involve lands administered by the BLM.

2.3 State Regulations

Under State law, paleontological resources are protected by both CEQA and Public Resources Code (PRC) Section 5097.5, both of which are discussed in more detail below.

2.3.1 California Environmental Quality Act (CEQA) (PRC 21000 et seq.)

The purpose of CEQA is to provide a statewide policy of environmental protection. As part of this protection, State and local agencies are required to analyze, disclose, and, when feasible, mitigate the environmental impacts of, or find alternatives to, proposed projects.

The State CEQA Guidelines (California Code of Regulations [CCR] 15000 et seq.) provide regulations for the implementation of CEQA and include more specific direction on the process of documenting, analyzing, disclosing, and mitigating environmental impacts of a project. To assist in this process, Appendix G of the State CEQA Guidelines provides a sample checklist form that may be used to identify and explain the degree of impact a project will have on a variety of environmental aspects, including paleontological resources (Section V[c]).

As stated in Section 15002(b)(1-3) of the State CEQA Guidelines, CEQA applies to governmental action, including activities that are undertaken by, financed by, or require approval from a governmental agency. Because this project is undertaken by governmental agencies, CEQA regulations apply.

2.3.2 California Public Resources Code, Section 5097.5

This law protects historic, archaeological, and paleontological resources on public lands within California and establishes criminal and civil penalties for violations.

Specifically, PRC Section 5097.5 states:

> *(a) No person shall knowingly and willfully excavate upon, or remove, destroy, injure or deface any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site, including fossilized footprints, inscriptions made by human agency, or any other archaeological, paleontological or historical feature, situated on public lands, except with the express permission of the public agency having jurisdiction over such lands. Violation of this section is a misdemeanor.*
>
> *(b) As used in this section, "public lands" means lands owned by, or under the jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any agency thereof.*

Because this project involves public lands as defined in Section 5097.5(b), Caltrans and local project proponents are required to comply with this regulation.

2.4 Local Regulations

Caltrans is not required to comply with local ordinances and policies in areas within the State highway system. However, for projects outside their jurisdiction, the agency would comply with local ordinances and policies where feasible. Various cities and counties have passed resolutions related to paleontological resources within their jurisdictions. These resolutions are usually included in the General Plan of the city, community, or county and provide additional guidance on assessment and treatment measures for projects subject to CEQA compliance. Provided below is a summary of any policies and ordinances regarding paleontological resources for the cities, communities, and county involved in this project. Project staff should periodically coordinate with local entities to update their knowledge of local requirements. However, protection of paleontological resources following Caltrans guidelines and CEQA regulations will likely meet and/or exceed paleontological protection guidelines of the cities through which the project passes.

2.4.1 City of Alhambra

The General Plan for the City of Alhambra, which was adopted in November 1986, does not include policies regarding paleontological resources (City of Alhambra, 1986).

2.4.2 City of Arcadia

The General Plan for the City of Arcadia, which was adopted in November 2010, does not include policies regarding paleontological resources (City of Arcadia, 2010).

2.4.3 City of Baldwin Park

The General Plan for the City of Baldwin Park, which was adopted in November 2002, does not include policies regarding paleontological resources (City of Baldwin Park, 2002).

2.4.4 City of Commerce

The City of Commerce 2020 General Plan, which was adopted in January 2008, outlines policies and programs to guide future planning and development in the City (City of Commerce, 2008). Protection of paleontological resources is discussed in one of the programs included in Section 6.4, Chapter 6: Resource Management Element of the General Plan. The Cultural Resource Management Program states, “Should archaeological or paleontological resources be encountered during excavation and grading activities, all work would cease until appropriate salvage measures are established” (p. 151). Under this program, CEQA Guidelines should be followed during monitoring, salvage, and preservation activities.

2.4.5 City of Duarte

The General Plan for the City of Duarte, which was adopted in August 2007, does not include policies regarding paleontological resources (City of Duarte, 2007).

2.4.6 City of El Monte

The General Plan for the City of El Monte, which was adopted in June 2011, does not include policies regarding paleontological resources (City of El Monte, 2011).

2.4.7 City of Glendale

The Open Space and Conservation Element of the General Plan for the City of Glendale was prepared by the Planning Commission in January 1993 and adopted by the City Council in March 1993 (City of Glendale, 1993). This Element outlines 10 policies regarding cultural and natural resources that guide decision-making and future development in the City. The following policy addresses paleontological resources:

- **Policy 3:** Cultural, historical, archaeological, and paleontological structures and sites are essential to community life and identity and should be recognized and maintained.

This policy recognizes the value and contribution to the City that its heritage makes, providing both a bridge to the past and a sense of place through the judicious management of cultural and natural resources.

2.4.8 City of Irwindale

The City of Irwindale 2020 General Plan, which was adopted in June 2008, outlines policies and programs to guide future planning and development in the City (City of Irwindale, 2008). Protection of paleontological resources is discussed in one of the programs included in Chapter 5: Resource Management Element of the General Plan. The Cultural Resource Management Program states, "Should archaeological or paleontological resources be encountered during excavation and grading activities, all work would cease until appropriate salvage measures are established" (p. 120). Under this program, CEQA Guidelines should be followed during monitoring, salvage, and preservation activities.

2.4.9 City of La Cañada Flintridge

The City of La Cañada Flintridge General Plan 2030, which was adopted in January 2013, outlines policies and programs to provide direction and guide future development during the City's planning period through the year 2030 (City of La Cañada Flintridge, 2013). Chapter 4: Conservation Element of this General Plan identifies important natural and cultural resources in the City and provides policies and implementation programs for their protection and utilization. Paleontological resources are identified by the City to be an important resource according to the following excerpt from Section 4.4.5: Cultural, Historical, and Paleontological Resource Conservation (p. 4-14):

> *Cultural, historical, and paleontological resources contribute to La Canada Flintridge's heritage and character. During the planning period the City will undertake actions to assist in conserving these important resources.*

However, the goals, objectives, and policies outlined in Section 4.5 of this Element do not specifically include paleontological resources. Because paleontological resources are considered along with cultural and historical resources, the following objective (p. 4-16) may apply:

- **CNE Objective 3.1:** Mitigate the loss or compromise of scientifically significant archaeological, historical, and other cultural resources within the city.

2.4.10 City of Los Angeles

The Conservation Element of the City of Los Angeles General Plan, which was adopted in September 2001, identifies natural and cultural resources within the City and describes objectives, policies, and programs for their protection, preservation, and management (City of Los Angeles, 2001). Chapter II: Resource Conservation and Management, Section 3: Archaeological and Paleontological discusses protection of paleontological resources and states, in part:

> *Pursuant to CEQA, if a land development project is within a potentially* [scientifically] *significant paleontological area, the developer is required to contact a bona fide paleontologist to arrange for assessment of the potential impact and mitigation of potential disruption of or damage to the site. If* [scientifically] *significant paleontological resources are uncovered during project execution, authorities are to be notified and the designated paleontologist may order excavations stopped, within reasonable time limits, to enable assessment, removal or protection of the resources. (p. II-5)*

This section also indicates that the City is responsible for protecting paleontological resources and outlines the following objective, policy, and program regarding paleontological resources (p. II-5, II-6):

- **Objective:** Protect the City's archaeological and paleontological resources for historical, cultural, and/or educational purposes.
  - **Policy:** Continue to identify and protect [scientifically] significant archaeological and paleontological sites and/or resources known to exist or that are identified during land development, demolition or property modification activities.
    - **Program:** Permit processing, monitoring, enforcement and periodic revision of regulations and procedures.

2.4.11 City of Monrovia

Policies regarding paleontological resources are not included in the Land Use Element, which was adopted in July 1993, Public Service and Conservation Element, adopted in January 1966, or the Recreation and Open Space Element, adopted in January 1966, of the General Plan for the City of Monrovia (City of Monrovia, 1993, 1966a,b).

2.4.12 City of Montebello

The General Plan for the City of Montebello, which was adopted in May 1975, does not include policies regarding paleontological resources (City of Montebello, 1975).

2.4.13 City of Monterey Park

The General Plan for the City of Monterey Park, which was adopted in July 2001, does not include policies regarding paleontological resources (City of Monterey Park, 2001).

2.4.14 City of Pasadena

The Land Use Element of the City of Pasadena Comprehensive General Plan, which was adopted in November 2004, consists of objectives and policies that comprise a unified set of policies for future growth and development of the City (City of Pasadena, 2004). Within this element, the following objective and policy address paleontological resources (p. 21, 22):

- **Objective 19 – Biological, Paleontological and Archaeological Resources:** Protect and enhance areas of the city containing important biological resources; protect and minimize disturbance of any important paleontological and/or archaeological resources that might remain in the city.
  - **Policy 19.3: Paleontological/Archaeological Resources Survey:** Project proponents proposing substantial grading or earthmoving in areas that might contain important paleontological and/or archaeological resources shall conduct a pre-excavation field assessment and literature search to determine the potential for disturbance of paleontological and/or earthmoving activities that shall be monitored by a qualified professional who, if necessary, shall undertake salvage and curation. Any paleontological or archaeological resources recovered shall be documented and archived appropriately. Any human remains recovered shall be treated according to applicable State and federal regulations.

2.4.15 City of Rosemead

The General Plan for the City of Rosemead, which was adopted in April 2010, does not include policies regarding paleontological resources (City of Rosemead, 2010).

2.4.16 City of San Gabriel

The Municipal Code of the City of San Gabriel, which was adopted in May 2004, addresses the protection and preservation of paleontological resources during development. Specifically, Title XV: Land Usage, Chapter 150: Building Regulations, Section 150.002.1 Site Security and Screening Standards states:

> *Prior to application for building, grading, or demolition permits each and every applicant subject to these standards shall be required to provide a site security and screening plan. The contents of the plan shall include at a minimum the following:*
>
> > *(F) Provisions for the protection and recovery of archaeological, paleontological or historical artifacts as may be determined by a historic structures report or inventory, walkover, environmental impact report, conditions of project approval or similar document.*
>
> *No permit shall be issued for construction unless the Building Division has determined satisfactory compliance with these requirements. (City Ordinance 575-C.S, passed 11-20-07)*

Paleontological resources are also addressed in Chapter 11: Cultural Resources of the Comprehensive General Plan of the City of San Gabriel (City of San Gabriel, 2004). In this chapter, the City identifies shortcomings in existing policies and presents new policies and an implementation plan to improve them. The City recognized a “Weak Preservation Ordinance” as one of the shortcomings, and suggested that “The ordinance would be strengthened if it were to address 'pre-history' (archaeological and paleontological resources)" (p. CR-2). In order to improve the preservation of cultural resources, one of the actions listed in the Implementation Plan is to "Establish standards for review of archaeology and paleontology, particularly with respect to State and Federal law requirements." (p. CR-6)

2.4.17 City of San Marino

The General Plan for the City of San Marino, which was adopted in October 2003, does not include policies regarding paleontological resources (City of San Marino, 2003).

2.4.18 City of Sierra Madre

The General Plan for the City of Sierra Madre, which was adopted in June 1996, does not include policies regarding paleontological resources (City of Sierra Madre, 1996).

2.4.19 City of South El Monte

The General Plan for the City of South El Monte, which was adopted in October 2000, does not include policies regarding paleontological resources (City of South El Monte, 2000).

2.4.20 City of South Pasadena

The General Plan for the City of South Pasadena, which was adopted in October 1998, includes goals that describe what the community wants to achieve, as well as policies that provide direction on how to achieve those goals (City of South Pasadena, 1998). The following goal and policies in Chapter 2, Land Use and Community Design Element, of this General Plan may be interpreted to include paleontological resources (p. II-28).

- **Goal 17:** To protect sensitive ecological areas, [scientifically] significant stands of trees and vegetation, geologic features, riparian areas and watercourses from unnecessary encroachment or destruction.
  - **Policy 17.1: Ensure cumulative mapping of resources.** Ensure the mapping of sensitive resources as they become identified, and incorporate this cumulative mapping in the General Plan by reference.
  - **Policy 17.2: Ensure exploration of plan alternatives.** Permit development in sensitive ecological areas only when less-destructive plan alternatives have been exhausted and mitigation is provided.
  - **Policy 17.3: Ensure that sensitive resources be identified.** Ensure that sensitive ecological areas, [scientifically] significant stands of trees and vegetation, and [scientifically] significant topographic, geologic, or hydrologic features in hillside areas be identified on plans submitted for City review.

2.4.21 City of Temple City

The General Plan for the City of Temple City, which was adopted in April 1987, does not include policies regarding paleontological resources (City of Temple City, 1987).

2.4.22 Community of Altadena

Because Altadena is an unincorporated community in the County of Los Angeles, project activities in this area would need to comply with the goals and policies in the County of Los Angeles General Plan (County of Los Angeles, 2012). The Altadena Community Plan, which was adopted in July 1986 by the Los Angeles County Board of Supervisors for the unincorporated community of Altadena, does not include any additional policies regarding paleontological resources (Community of Altadena, 1986).

2.4.23 Community of East Los Angeles

Because East Los Angeles is an unincorporated community in the County of Los Angeles, project activities in this area would need to comply with the goals and policies in the County of Los Angeles General Plan (County of Los Angeles, 2012). The East Los Angeles Community Plan, which was adopted in June 1988 by the Los Angeles County Board of Supervisors for the unincorporated community of East Los Angeles, does not include any additional policies regarding paleontological resources (Community of East Los Angeles, 1988).

2.4.24 County of Los Angeles

The County of Los Angeles General Plan sets forth the goals, policies, and programs the County uses to manage future growth and land use (Los Angeles County, 2012). The Conservation and Natural Resources Element (Chapter 6) of the County's General Plan contains the following goal and policies designed to protect paleontological resources within the County (p. 157):

- **Goal C/NR 14:** Protected historic, cultural, and paleontological resources.
  - **Policy C/NR 14.1.** Mitigate all impacts from new development on or adjacent to historic, cultural, and paleontological resources to the greatest extent feasible.
  - **Policy C/NR 14.2.** Support an inter-jurisdictional collaborative system that protects and enhances the County's historic, cultural, and paleontological resources.
  - **Policy C/NR 14.5.** Promote public awareness of the County's historic, cultural, and paleontological resources.
  - **Policy C/NR 14.6.** Ensure proper notification and recovery processes are carried out for development on or near historic, cultural, and paleontological resources.

This page intentionally left blank

3. Scientific Significance

3.1 Definition of Scientific Significance

If a paleontological resource, such as a rock unit or formation with the potential to contain fossils, cannot be avoided during construction, the scientific significance of the resource must be assessed before mitigation measures are proposed. The scientific significance or importance of a paleontological resource is based on various attributes of that resource, and in the interest of thoroughness, definitions of scientific significance from Caltrans, the Society of Vertebrate Paleontology (SVP), and one additional source are included below.

3.1.1 California Department of Transportation

According to Caltrans (2012), there are two generally recognized types of paleontological significance:

- **National:** A National Natural Landmark eligible paleontological resource is an area of national significance (as defined under 36 CFR 62) that contains an outstanding example of fossil evidence of the development of life on earth. This is the only codified definition of paleontological significance.
- **Scientific:** Definitions of a scientifically significant paleontological resource can vary by jurisdictional agency and paleontological practitioner.

Generally, scientifically significant paleontological resources are identified sites or geological deposits containing individual fossils or assemblages of fossils that are unique or unusual, diagnostically or stratigraphically important, and add to the existing body of knowledge in specific areas, stratigraphically, taxonomically, or regionally. Particularly important are fossils found in situ (undisturbed) in primary context (e.g., fossils that have not been subjected to disturbance subsequent to their burial and fossilization). As such, they aid in stratigraphic correlation, particularly those offering data for the interpretation of tectonic events, geomorphologic evolution, paleoclimatology, the relationships between aquatic and terrestrial species, and evolution in general. Discovery of in situ fossil-bearing deposits is rare for many species, especially vertebrates. Terrestrial vertebrate fossils are often assigned greater scientific significance than other fossils because they are rarer than other types of fossils. This is primarily due to the fact that the best conditions for fossil preservation include little or no disturbance after death and quick burial in oxygen-depleted, fine-grained, sediments. While these conditions often exist in marine settings, they are relatively rare in terrestrial settings. This has ramifications with regard to the amount of scientific study needed to characterize an individual species adequately and therefore affects how relative sensitivities are assigned to formations and rock units.

3.1.2 Society of Vertebrate Paleontology

The SVP provides the following definitions of scientific significance (SVP, 1995):

- **Scientifically Significant Paleontological Resources** are fossils and fossiliferous deposits, here restricted to vertebrate fossils and their taphonomic and associated environmental indicators. This definition excludes invertebrate or botanical fossils except when present within a given vertebrate assemblage. Certain plant and invertebrate fossils or assemblages may be defined as scientifically significant by a project paleontologist, local paleontologist, specialists, or special interest groups, or by Lead Agencies or local governments.

- A **Scientifically Significant Fossiliferous Deposit** is a rock unit or formation that contains scientifically significant, nonrenewable paleontological resources, here defined as comprising one or more identifiable vertebrate fossils, large or small; and any associated invertebrate and plant fossils, traces, and other data that provide taphonomic, taxonomic, phylogenetic, ecologic, and stratigraphic information (ichnites and trace fossils generated by vertebrate animals, e.g., trackways or nests and middens, which provide datable material and climatic information). Paleontological resources are considered to be older than recorded history and/or older than 5,000 years ago.

3.1.3 Other

Eisentraut and Cooper (2002) developed a useful set of criteria for judging whether fossils are scientifically significant. Using their method, fossils can be judged scientifically significant if they meet any of the criteria within the following categories:

- **Taxonomy:** Assemblages that contain rare or unknown taxa, such as defining new (previously unknown to science) species or that represent a species that is the first or has very limited occurrence within the area or formation.
- **Evolution:** Fossils that represent important stages or links in evolutionary relationships or that fill gaps or enhance underrepresented intervals in the stratigraphic record.
- **Biostratigraphy:** Fossils that are important for determining or confining relative geologic (stratigraphic) ages or for use in defining regional to interregional stratigraphic associations. These fossils are often known as biostratigraphic markers and represent plants or animals that existed for only a short and restricted period in the geologic past.
- **Paleoecology:** Fossils that are important for reconstructing ancient organism community structure and interpretation of ancient sedimentary environments. Depending on which fossils are found, much can be learned about the ancient environment from water depth, temperature, and salinity to what the substrate was like (muddy, sandy, or rocky) to even whether the area was in a high energy location like a beach or a low-energy location like a bay. Even terrestrial animals can contain information about the ancient environment. For example, an abundance of grazing animals such as horse, bison, and mammoth suggest more of a grassland environment, while an abundance of browsing animals such as deer, mastodon, and camel suggest more of a brushy environment. Preserved parts of plants can also lend insight into what was growing in the area at a particular time. In addition, by studying the ratios of different species to each other’s population densities, relationships between predator and prey can be determined.

  There is a complex but vital interrelationship among evolution, biostratigraphy, and paleoecology: biostratigraphy (the record of fossil succession and progression) is the expression of evolution (change in populations of organisms through time), which in turn is driven by natural selection pressures exerted by changing environments (paleoecology).
- **Taphonomy:** Fossils that are exceptionally well or unusually/uniquely preserved or are relatively rare in the fossil record. This could include preservation of soft tissues such as hair, skin, or feathers from animals or the leaves/stems of plants that are not commonly fossilized.

3.2 Summary of Scientific Significance

All vertebrate fossils that have contextual information, such as the location and geologic unit from which they were recovered, are considered a scientifically significant, nonrenewable paleontological resource. Invertebrate and plant fossils as well as other environmental indicators associated with vertebrate fossils are considered scientifically significant. Certain invertebrate and plant fossils that are regionally rare or uncommon, or help to define stratigraphy, age, or taxonomic relationships are considered scientifically significant.

This page intentionally left blank

4. Sensitivity

4.1 Definition of Sensitivity

Sensitivity is often stated as "potential" because decisions about how to manage paleontological resources must be based on "potential," as the actual situation cannot be known until construction excavation for the project is underway. Caltrans and the SVP each have a ranking system to describe paleontological sensitivity, both of which are included here.

4.1.1 California Department of Transportation

In accordance with the Caltrans SER guide for paleontology (Caltrans, 2012), the sensitivity of rock units and formations that may contain paleontological resources is assessed on the basis of high, low, or no potential for paleontological resources:

- **High Potential:** Rock units which, based on previous studies, contain or are likely to contain scientifically significant vertebrate, invertebrate, or plant fossils. These units include, but are not limited to, sedimentary formations that contain scientifically significant nonrenewable paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. These units may also include some volcanic and low-grade metamorphic rock units. Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration and ranked as highly sensitive. High sensitivity includes the potential for containing (1) abundant vertebrate fossils; (2) a few scientifically significant fossils (large or small vertebrate, invertebrate, or plant fossils) that may provide new and scientifically significant taxonomic, phylogenetic, ecologic, and/or stratigraphic data; (3) areas that may contain datable organic remains older than Recent, including *Neotoma* (sp.) middens; and/or (4) areas that may contain unique new vertebrate deposits, traces, and/or trackways. Areas with a high potential for containing scientifically significant paleontological resources require monitoring and mitigation.
- **Low Potential:** This category includes sedimentary rock units that (1) are potentially fossiliferous, but have not yielded scientifically significant fossils in the past; (2) have not yet yielded fossils, but possess a potential for containing fossil remains; or (3) contain common and/or widespread invertebrate fossils if the taxonomy, phylogeny, and ecology of the species contained in the rock are well understood. Sedimentary rocks expected to contain vertebrate fossils are not placed in this category because vertebrates are generally rare and found in more localized strata. Rock units designated as low potential generally do not require monitoring and mitigation. However, as excavation for construction gets underway, it is possible that new and unanticipated paleontological resources might be encountered. If this occurs, a Construction Change Order (CCO) must be prepared in order to have a qualified Principal Paleontologist evaluate the resource. If the resource is determined to be scientifically significant, monitoring and mitigation are required.
- **No Potential:** Rock units of intrusive igneous origin, most extrusive igneous rocks, and moderately to highly metamorphosed rocks are classified as having no potential for containing scientifically significant paleontological resources. For projects encountering only these types of

rock units, paleontological resources can generally be eliminated as a concern when the Preliminary Environmental Analysis Report (PEAR) is prepared and no further action taken.

4.1.2 Society of Vertebrate Paleontology

According to the SVP (2010), Paleontological Potential is the potential for the presence of scientifically significant, nonrenewable paleontological resources. All sedimentary rocks, some volcanic rocks, and some metamorphic rocks have potential for the presence of scientifically significant, nonrenewable paleontological resources, and review of available literature may further refine the potential of each rock unit, formation, or facies. The SVP has four categories of potential, or sensitivity: High, Low, None, and Undetermined. If a geographic area or geological unit is classified as having undetermined potential for paleontological resources, studies must be undertaken to determine whether that rock unit has a sensitivity of either High, Low, or None. These categories are described in more detail below.

- **High Sensitivity:** Rock units from which vertebrate or scientifically significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional scientifically significant paleontological resources. Rocks units classified as having high potential for producing paleontological resources include, but are not limited to, sedimentary formations and some volcaniclastic formations (e.g., ashes or tephras), some low-grade metamorphic rocks that contain scientifically significant paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils (e.g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones). Paleontological potential consists of both (a) the potential for yielding abundant or scientifically significant vertebrate fossils or for yielding a few scientifically significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils, and (b) the importance of recovered evidence for new and scientifically significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data. Rock units that contain potentially datable organic remains older than late Holocene, including deposits associated with animal nests or middens, and rock units which may contain new vertebrate deposits, traces, or trackways, are also classified as having high potential.
- **Low Potential:** Reports in the paleontological literature or field surveys by a qualified professional paleontologist may allow determination that some rock units have a low potential for yielding scientifically significant fossils. Such rock units will be poorly represented by fossil specimens in institutional collections, or based on general scientific consensus, fossils are only preserved in rare circumstances; the presence of fossils is the exception, not the rule (e.g., basalt flows or Recent colluvium). Rock units with low potential typically will not require impact mitigation measures to protect fossils.
- **No Potential:** Some rock units have no potential to contain scientifically significant paleontological resources (e.g., high-grade metamorphic rocks [such as gneisses and schists] and plutonic igneous rocks [such as granites and diorites]). Rock units with no potential require no protection nor impact mitigation measures relative to paleontological resources.
- **Undetermined Potential:** Rock units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine whether these rock units have

high or low potential to contain scientifically significant paleontological resources. A field survey by a qualified professional to specifically determine the paleontological resource potential of these rock units is required before a Paleontological Resources Impact Mitigation Program (PRIMP) can be developed. In cases where no subsurface data are available, paleontological potential can sometimes be determined by strategically located excavations into subsurface stratigraphy.

4.2 Summary of Sensitivity

A formation or rock unit has paleontological sensitivity or the potential for scientifically significant paleontological resources if it previously has produced, or is capable of preserving, vertebrate fossils and associated or regionally uncommon invertebrate or plant fossils. All sedimentary rocks, certain volcanic rocks, and mildly metamorphosed rocks are considered to have potential for paleontological resources.

This page intentionally left blank

5. Methods

5.1 Study Area

For this report, the area studied for each alternative is referred to as the "project area." The project area for each alternative includes all areas where project activities will occur, such as new ROW alignments, existing ROW, temporary construction easements (TCEs), and signage. Descriptions of the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives are included below. The No Build Alternative does not contain improvements and, therefore, does not have a project area that was studied for this report. As mentioned in Section 1.3, some of the improvements listed in the TSM/TDM Alternative are included in the BRT, LRT, and Freeway Tunnel Alternatives. However, to avoid repetition, the project area for the TSM/TDM Alternative is described once. The project areas for the main improvements in the BRT, LRT, and Freeway Tunnel Alternatives are described separately.

5.1.1 Transportation System Management/Transportation Demand Management (TSM/TDM) Alternative

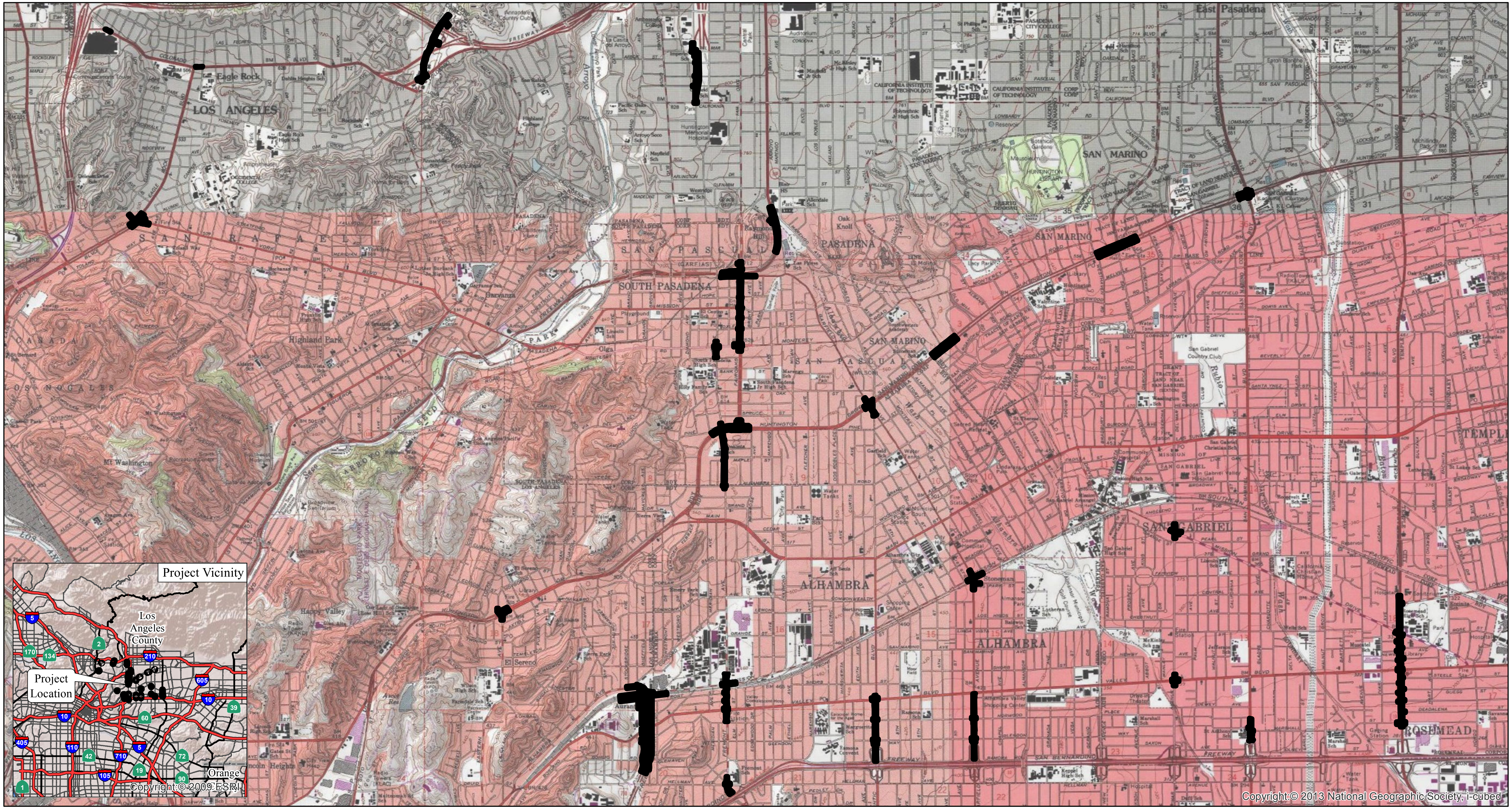
The project area for the TSM/TDM Alternative includes all areas where project activities will occur for the various improvements within this alternative, regardless of the type, extent, or result of the activity. The improvements are listed in Tables 1.1, 1.2, and 1.3 and shown on Figure 1-3 and may include sidewalks, streets, intersections, and highway on- and off-ramps in existing or proposed City and Caltrans ROW.

Improvements listed in Tables 1.2 and 1.3 that are known to not involve ground disturbance (e.g., video detection systems, additional buses, and bike routes) were identified and not studied in more detail. Other improvements in the TSM/TDM Alternative (e.g., CMS signs and bus stops) may require limited ground disturbance, but their locations are unknown at this time. However, the local street and intersection improvements listed in Table 1.1 are likely to require ground disturbance and their locations are known; therefore, these improvements were studied in more detail. Figure 5-1 shows the location and vicinity of the project area for the local street and intersection improvements listed in Table 1.2. The project area is depicted on the *Pasadena, California; Mount Wilson, California; Los Angeles, California;* and *El Monte, California* 7.5-minute United States Geological Survey (USGS) topographic maps within portions of the San Rafael, San Pascual (Garfias), and San Pascual (Wilson) Land Grants, as well as multiple Sections (Sec) in Townships (T) 1 North (N) and 1 South (S) and Ranges (R) 11 and 12 West (W) from the San Bernardino Base Line and Meridian, including T 1 N, R 12 W, Sec 36; T 1 S, R 12 W, Sec 3, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 20, 22, and 24; and T 1 S, R 11 W, Sec 18 and 19.

5.1.2 Bus Rapid Transit (BRT) Alternative

The project area for the BRT Alternative includes all areas (e.g., streets, sidewalks, and intersections) within the existing or proposed City ROW along the planned bus route, whether or not changes to the ROW will occur. From south to north, the proposed bus route begins approximately at the intersection of Louis Place and Atlantic Boulevard, continues along Atlantic Boulevard to Garfield Avenue, to Huntington Drive, to Fair Oaks Avenue, to Del Mar Boulevard, to Hill Avenue, to Colorado Boulevard, to Lake Avenue, and ends at the intersection of Lake Avenue and Del Mar Boulevard.

This page intentionally left blank



LEGEND

TSM/TDM Alternative Local Street and Intersection Improvements Project Area

FIGURE 5-1

0 1650 3300
FEET

SR 710 North Study

TSM/TDM Alternative Local Street and Intersection Improvements Project Area

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

SOURCE: USGS 7.5' Quad - El Monte (1994), Los Angeles (1994), Mt. Wilson (1988), Pasadena (1991), CA

I:\CHM1105\GIS\MXD\PIR_PER\ProjLoc_TSM_TDM.mxd (10/27/2014)

This page intentionally left blank

Also included are areas along this route that involve project activities within Caltrans ROW at highway interchanges, such as Atlantic Boulevard/SR 60 interchange, Atlantic Boulevard/I-10 interchange, and Fair Oaks Avenue/SR 110 interchange.

This project area is shown on Figure 5-2. It is depicted on the *Pasadena, California; Mount Wilson, California;* and *Los Angeles, California* 7.5-minute USGS topographic maps within portions of the San Rafael, San Pascual (Garfias), San Pascual (Wilson), and San Antonio (Lugo) Land Grants, as well as T 1 S, R 12 W, Sec 4, 9, 10, 15, 16, 21, 22, 27, 28, 32, and 33, San Bernardino Base Line and Meridian.

5.1.3 Light Rail Transit (LRT) Alternative

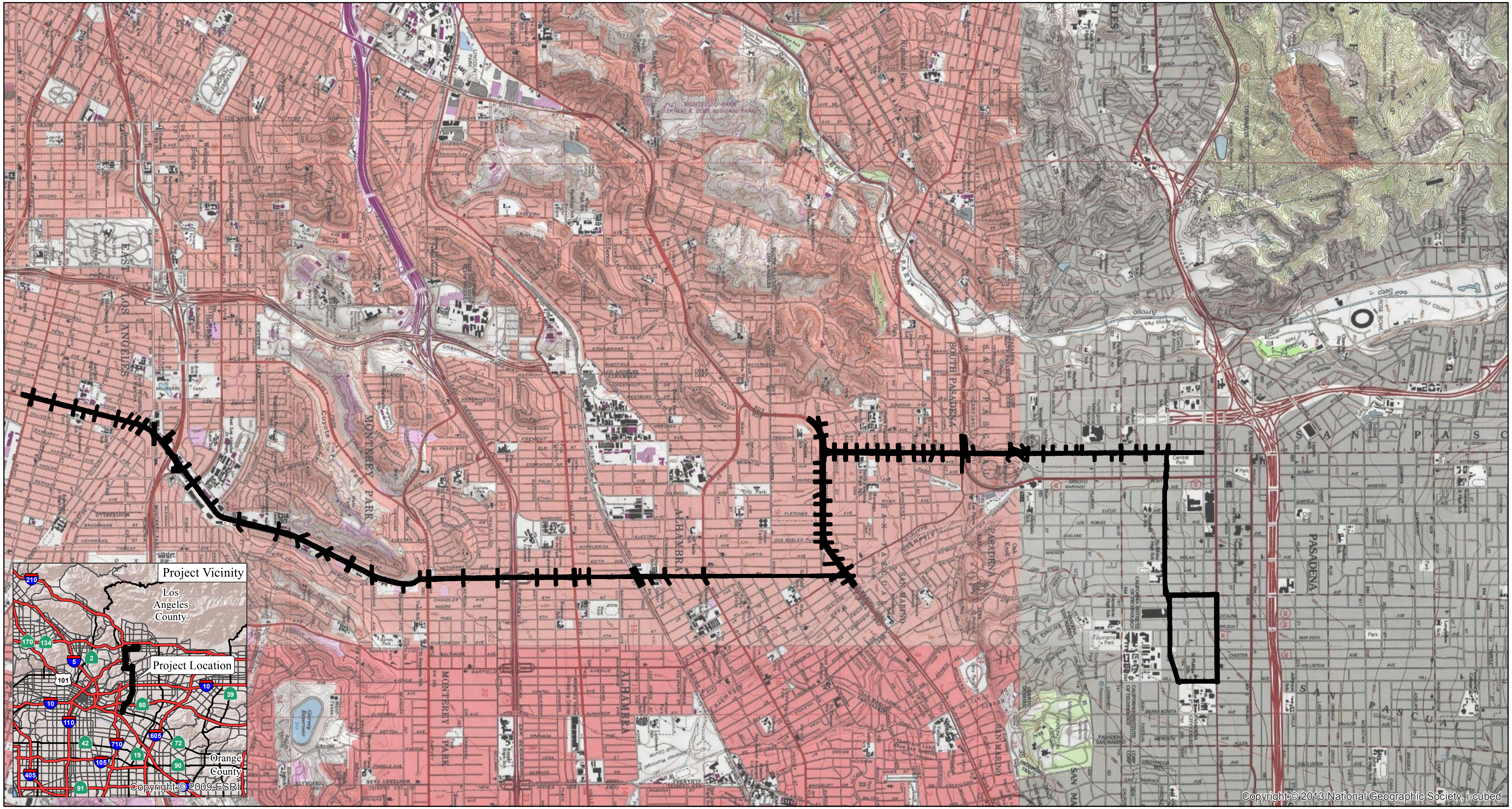
The project area for the LRT Alternative includes all areas within the proposed rail alignment where project activities will occur, regardless of the type, extent, or result of the activity. These areas may be in existing or proposed City, Caltrans, or Metro ROW and may include existing streets, freeways, interchanges, and private property. The alignment contains an aerial section and a tunnel section. From south to north, this alignment begins with the aerial section near the intersection of Third Street and Mednik Avenue, continues along Mednik Avenue to Floral Drive, and then crosses a business park and Corporate Center Drive to reach SR 710. It follows SR 710 to just south of Valley Boulevard, where the aerial section ends and the tunnel section begins. The tunnel section continues north to Mission Road, then shifts east to Fremont Avenue, and continues north on Fremont Avenue to Huntington Drive. Near the intersection of Huntington Drive and Fremont Avenue, the alignment runs north on Fair Oaks Avenue until Glenarm Street, where it shifts east again to continue north on Raymond Avenue, and ends near the intersection of Raymond Avenue and California Boulevard. The project area also includes portions along the alignment where additional project activities would occur, such as construction of the maintenance yard, rail stations, and retaining walls at Cal State LA and Floral Stations. For the tunnel section, the area studied includes the path of the alignment both at and below the surface.

This project area for the LRT Alternative is depicted on Figure 5-3 on the *Pasadena, California* and *Los Angeles, California* 7.5-minute series USGS topographic maps within portions of the San Pascual (Garfias) Land Grant and T 1 S, R 12 W, Sections 4, 8, 9, 16, 17, 19, 20, 21, 29, 32, San Bernardino Base Line and Meridian.

5.1.4 Freeway Tunnel Alternative

The project area for the Freeway Tunnel Alternative includes all areas where project activities will occur for this alternative, regardless of the type, extent, or result of the activity. These areas may be in existing or proposed City or Caltrans ROW and include the main freeway alignment, as well as areas for signage and temporary construction easements. The alignment runs from the southern stub of SR 710 to the northern stub of SR 710 and includes the highway interchanges with I-10 in the south and SR 134 and I-210 in the north. It consists of a central bored tunnel, cut-and-cover tunnels and grade changes at the north and south portals, and modifications to on- and off-ramps at the freeway interchanges and several city streets. Areas for signage and temporary construction easements are located at various places along the alignment, as well as around the SR 710/I-10 and SR 710/SR 134/I-210 interchanges and ramps to/from various city streets. For the tunnel sections, the area studied includes the path of the alignment both at and below the surface.

This page intentionally left blank



LEGEND

BRT Alternative Project Area

FIGURE 5-2

0 1800 3600
FEET

SR 710 North Study

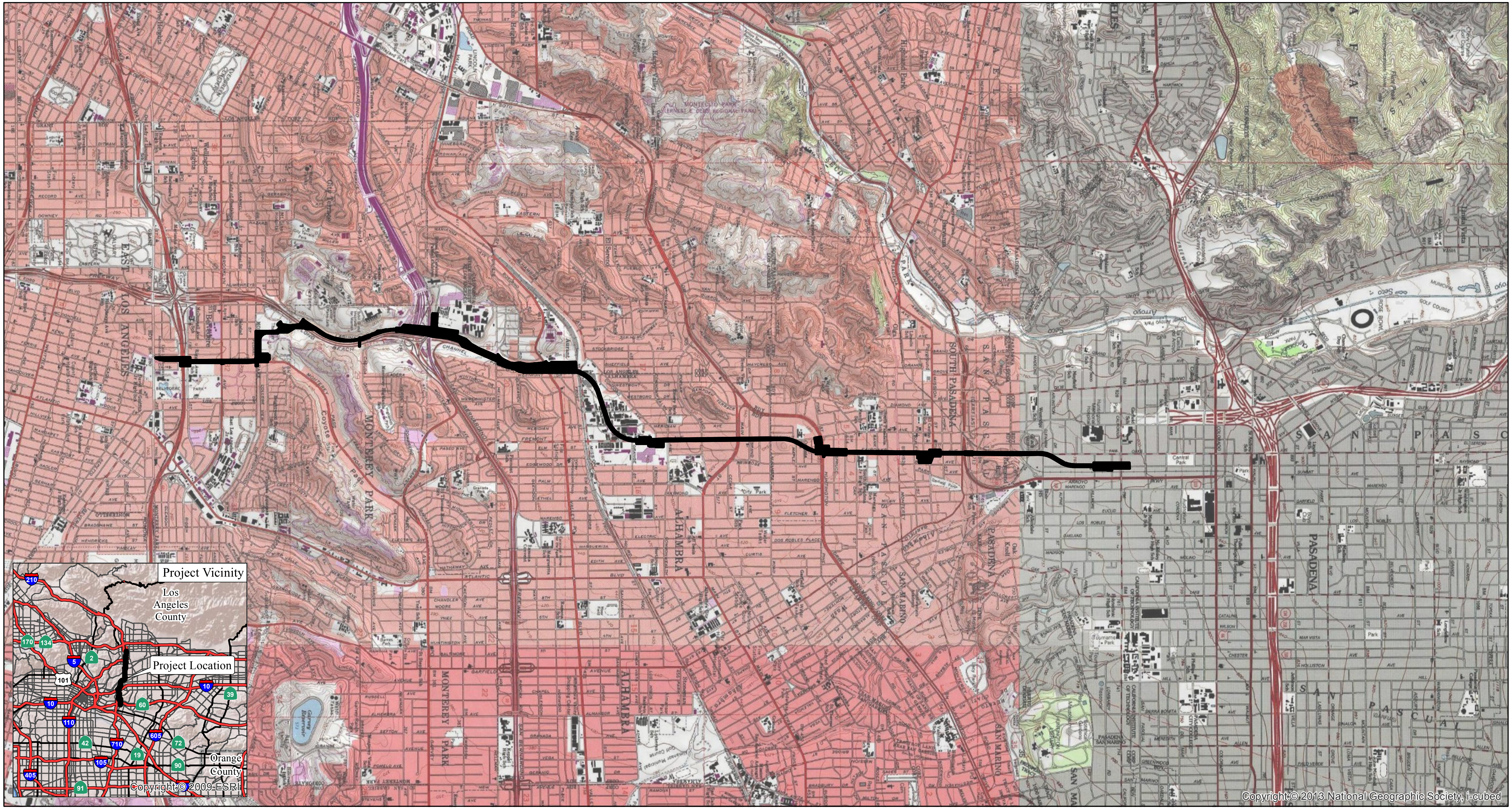
BRT Alternative Project Area

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

SOURCE: USGS 7.5' Quad - El Monte (1994), Los Angeles (1994), Mt. Wilson (1988), Pasadena (1991), CA

I:\CHM1105\GIS\MXD\PIR_PER\ProjLoc_BRT.mxd (10/27/2014)

This page intentionally left blank



LEGEND

LRT Alternative Project Area

FIGURE 5-3

0 1800 3600
FEET

SOURCE: USGS 7.5' Quad - El Monte (1994), Los Angeles (1994), Mt. Wilson (1988), Pasadena (1991), CA

SR 710 North Study

LRT Alternative Project Area

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\ProjLoc_LRT.mxd (10/27/2014)

This page intentionally left blank

The location and vicinity of this project area is shown on Figure 5-4. It is depicted on the *Pasadena, California* and *Los Angeles, California* 7.5 minute series USGS topographic maps within portions of the San Pascual (Garfias) Land Grant and T 1 S, R 12 W, Sections 8, 17, 19, 20, 21, 29, 30, 31, and 32, San Bernardino Base Line and Meridian.

5.2 Literature Review

The literature review included an examination of geologic maps of the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives and a review of relevant geological and paleontological literature to determine which geologic units are present within the project areas and whether fossils have been recovered from those or similar geologic units elsewhere in the region. As geologic units may extend over large geographic areas and contain similar lithologies and fossils, the literature review includes areas well beyond the project area. The results of this literature review include an overview of the geology of the project areas (Section 6.1.1, Geology) and a discussion of the paleontological sensitivity (or potential) of the geologic units within the project areas (Section 6.1.2, Paleontology).

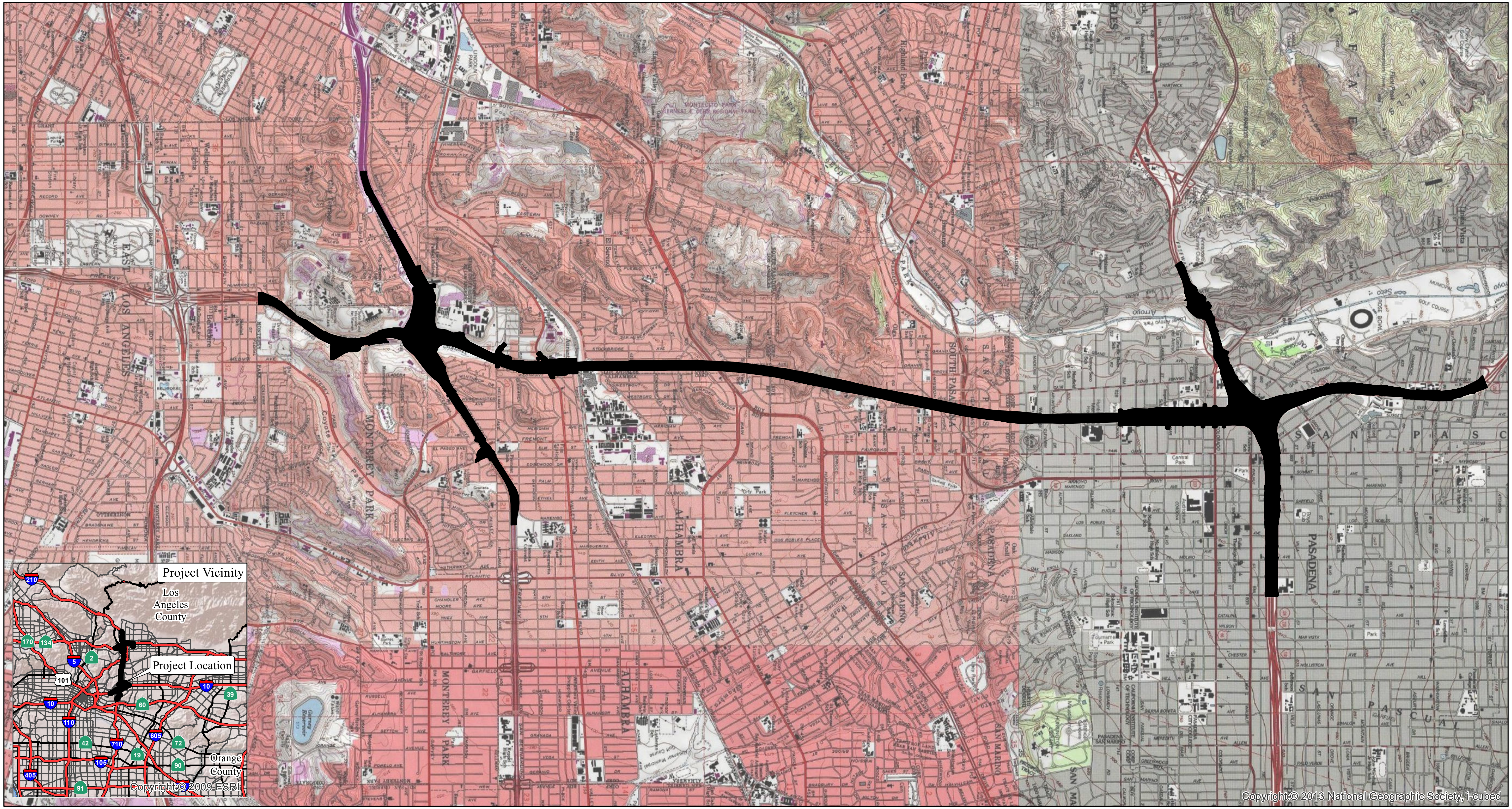
5.3 Locality Search

The purpose of a locality search is to establish the status and extent of previously recorded paleontological resources within and adjacent to the study area for a given project. In June 2013, a locality search was completed through the Natural History Museum of Los Angeles County (LACM). This search identified any vertebrate localities in the LACM records that exist within several miles of the project areas in the same or similar deposits. When available, details of those localities, such as formation, rock type, depth, and species lists were also noted. The locality search results from Dr. Samuel McLeod, Curator of Vertebrate Paleontology at the LACM, are summarized in Section 6.2, and a copy of the letter from the LACM is provided in Appendix A.

5.4 Field Inspection

The purpose of a field inspection is to confirm the accuracy of the geologic mapping and to identify any unrecorded paleontological resources exposed on the surface of a project area. In this way, impacts to existing, unrecorded paleontological material may be mitigated prior to the beginning of ground-disturbing activities and portions of the project area that are more likely to contain paleontological resources may be identified. A field inspection of the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternative project areas was not conducted as part of this report for the following reasons. Within all the project areas, exposures of native deposits are extremely limited because they lie within commercial or residential areas, most of which are either paved or disturbed from previous construction of buildings, streets, or freeways. This is particularly true for the TSM/TDM and BRT Alternative project areas, which involve modifications to existing ROW. For the LRT and Freeway Tunnel Alternatives, large portions of the project areas are underground and not possible to inspect. Other portions at the surface follow active freeway ROW, which is also paved and disturbed from previous construction and is unsafe to inspect.

This page intentionally left blank



LEGEND

Freeway Tunnel Alternative Project Area

FIGURE 5-4

0 1800 3600
FEET

SOURCE: USGS 7.5' Quad - El Monte (1994), Los Angeles (1994), Mt. Wilson (1988), Pasadena (1991), CA

SR 710 North Study

Freeway Tunnel Alternative Project Area

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\ProjLoc_FwyTunnel.mxd (10/27/2014)

This page intentionally left blank

5.5 Personnel

Dr. Sarah Rieboldt, a Paleontologist at LSA Associates, Inc., completed this PIR/PER. Dr. Rieboldt received her Ph.D. from the University of California, Berkeley, and has extensive experience surveying for and collecting paleontological resources; salvaging large fossil specimens; collecting bulk sediment samples; identifying, preparing, and curating fossil material; and writing paleontological assessment reports and final mitigation monitoring reports at the conclusion of construction projects. She has conducted paleontological and geological fieldwork in California, Nevada, Utah, Wyoming, Colorado, Texas, and Alabama and has 5 years of experience working with natural history collections in several museums (Field Museum of Natural History, University of California Museum of Paleontology, and University of Colorado Museum of Natural History). She has worked as a geologist and paleontological consultant on many different projects, including carbon sequestration and astrobiology research programs funded by the United States Department of Energy (DOE) and the National Aeronautic and Space Administration (NASA), respectively, as well as on projects for the State of California Department of Parks and Recreation, Caltrans, and various private developers in California, Nevada, and Utah. Dr. Rieboldt's resume is included in Appendix B.

This page intentionally left blank

6. Results

6.1 Literature Review

The results of the literature review are divided into two sections. Section 6.1.1 provides an overview of the geology of the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives. This summary includes information used to determine the potential to encounter scientifically significant fossil remains in the geologic units found within the project areas. In no way does it represent a geological assessment and should not be used as such. Section 6.1.2, Paleontology, summarizes the paleontological sensitivity (or potential) of the geologic units within the project areas. As discussed in Section 5.1, although the improvements in the TSM/TDM Alternative are also part of the BRT, LRT, and Freeway Tunnel Alternative improvements, to avoid repetition, the project areas for the BRT, LRT, and Freeway Tunnel Alternatives refer only to the main improvements in their respective alternatives (e.g., the bus route, the light rail alignment, and the freeway tunnel). Therefore, in this chapter, the locations where geologic units are encountered in the TSM/TSM Alternative are described once. Any areas where geologic units are encountered in the main improvements in the BRT, LRT, and Freeway Tunnel Alternatives are described separately.

6.1.1 Geology

The project is located in the transition zone between the northern Peninsular Ranges Geomorphic Province and the south-central portion of the Transverse Ranges Geomorphic Province of Southern California (California Geological Survey, 2002). The Peninsular Ranges Geomorphic Province is a 900 mi long northwest-southeast trending structural block that extends from the Transverse Ranges in the north to the tip of Baja California in the south and includes the Los Angeles Basin (Norris and Webb, 1976). This province is characterized by mountains and valleys that trend in a northwest-southeast direction, roughly parallel to the San Andreas Fault. The total width of the province is approximately 225 mi, extending from the Colorado Desert in the east, across the continental shelf, to the Southern Channel Islands (i.e., Santa Barbara, San Nicolas, Santa Catalina, and San Clemente) (Sharp, 1976). It contains extensive pre-Cretaceous (more than 145 million years ago [Ma]) and Cretaceous (145 to 65 Ma) igneous and metamorphic rock covered by limited exposures of post-Cretaceous (less than 65 Ma) sedimentary deposits. The Transverse Ranges Geomorphic Province is characterized by steep mountains and valleys that trend in an east-west direction at an oblique angle to the northwest-southeast trend of the California coast (Norris and Webb, 1976), hence the name “Transverse.” This type of trend is extremely rare elsewhere in the United States. Compression along the San Andreas Fault is squeezing and rotating the Transverse Ranges, making this area one of the most rapidly rising regions on earth (California Geological Survey, 2002). Tectonic activity in this province has also folded and faulted thick sequences of Cenozoic, organic-rich sedimentary rocks, making the area an important source for oil.

Within this larger region, the project borders the western edge of the San Gabriel Valley, running from north to south along the San Rafael Hills and through the Repetto Hills. These low-lying hills rise out of the Los Angeles Basin, separating the San Gabriel Valley from the rest of the basin. They contain exposures of marine sedimentary rocks deposited in the ancient Los Angeles Basin approximately 16 to 2.6 Ma. Combined, these deposits have a maximum thickness of 20,000 ft; however, because they have been uplifted, folded, faulted, and partially eroded, the thickness and amount of exposure of each unit varies throughout the region (Lamar, 1970; Yerkes and Campbell, 2005). It is from these sedimentary rocks that most of the petroleum in the Los Angeles Basin has been produced, and for this reason, oil wells have been drilled throughout the San Rafael and Repetto Hills (Lamar, 1970; Yerkes et al., 1965). Also present within the project area are sediments that eroded from the San Rafael and Repetto Hills and San Gabriel Mountains. These deposits accumulated in the valleys and range from approximately 800,000 to 10,000 years ago.

According to the geologic map prepared by Yerkes and Campbell (2005), eight geologic units may be encountered in the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives of this project: Holocene Alluvial Fan Deposits, Young Alluvial Fan Deposits, Young Alluvium, Old Alluvial Fan Deposits, Old Alluvium, Fernando Formation, Puente Formation, and Topanga Group. In addition, although not mapped by Yerkes and Campbell (2005), Artificial Fill likely occurs within the project areas along existing interstates, highways, and streets, where it was used during construction to adjust for changes in topography and for overpasses and interchanges. Each of these units is described briefly below. Table 6.1 provides a summary of the geologic units found in all the alternatives, including their ages and the map symbols used to abbreviate the geologic units and subunits, if present, in the aforementioned figures. Figure 6-1 provides a legend for the geology maps of the four alternatives shown in Figures 6-2 through 6-5. Because Figures 6-2 through 6-5 include the region surrounding the project area for each alternative, they include additional geologic units not relevant to the project and, therefore, not discussed in the text.

TABLE 6.1:
Geologic Units within the Project Areas for the Alternatives of the SR 710 North Study

Geologic Formation/Unit	Map Symbol		Age (years ago)[1]	Geologic Epoch
Artificial Fill	Af (not mapped)		Less than 100	Holocene
Holocene Alluvial Fan Deposits	Qf		Less than 11,700	Holocene
Young Alluvial Fan Deposits	Qyf (undivided)		Less than 126,000	Late Pleistocene to Holocene
Young Alluvium	Qyaa (undivided, sandy)		Less than 126,000	Late Pleistocene to Holocene
Old Alluvial Fan Deposits	Qof (undivided)		781,000 to 11,700	Middle to Late Pleistocene
Old Alluvium	Qoa (undivided) and Qoaa (undivided, sandy)	Qoa3g (gravelly)	126,000 to 11,700	Late Pleistocene
		Qoa2g (gravelly)	126,000 to 11,700	Late Pleistocene
		Qoa1a (sandy)	781,000 to 126,000	Middle Pleistocene
Fernando Formation	Tf3 (member 3) Tf1 (member 1)		5.333 to 2.588 million	Pliocene
Puente Formation	Tpnz (siltstone)		5.333 to 3.6 million	Early Pliocene
	Tpns (siliceous shale)		5.333 to 3.6 million	Early Pliocene
	Tpna (sandstone)		11.62 to 5.333 million	Late Miocene
Topanga Group	Ttcg (conglomerate) Tta (sandstone) Ttz (siltstone)		15.97 to 11.62 million	Middle Miocene

[1] Age based on International Commission on Stratigraphy (ICS, 2013)
SR 710 = State Route 710

Geology

Reservoir	**Fernando Formation**
Qaf- Artificial Fill	Tf1- Member 1
Qc- Colluvium	Tf2- Member 2
Qls- Landslide Deposits	Tf3- Member 3
Qu- Undifferentiated Surficial Deposits	Tf3?- Member 3?
Qw- Wash Deposits (a-sandy)	Tfl- Lower Member
Qf- Holocene Alluvial Fan Deposits	Tfu- Upper Member
Qyw- Young Wash Deposits (a-sandy, g-gravelly)	Tfuc- Upper Member (c-conglomerate)
Qya- Young Alluvium (a-sandy, g-gravelly)	Tfuf- Upper Member (f-fossiliferous)
Qya2- Unit 2	**Puente Formation**
Qyf- Young Alluvial Fan Deposits (g-gravelly)	Tpna- Sandstone
Qyf1- Unit 1 (g-gravelly)	Tpns- Shale
Qyf2- Unit 2 (g-gravelly)	Tpnz- Siltstone
Qyf3- Unit 3 (a-sandy)	**Topanga Group**
Qyf4- Unit 4	Tt- Undivided
Qoa- Old Alluvium (a-sandy)	Tta- Sandstone
Qoa1- Unit 1 (a-sandy)	Ttcg- Conglomerate
Qoa2- Unit 2 (g-gravelly)	Ttz- Siltstone
Qoa3- Unit 3 (a-sandy, b-bouldery, g-gravelly)	
Qof- Old Alluvial Fan Deposits	Kgr- Cretaceous granitic rocks
Qof1- Unit 1 (g-gravelly)	Mzbhd- Mesozoic biotite-hornblende diorite
Qof2- Unit 2	

FIGURE 6-1

SR 710 North Study

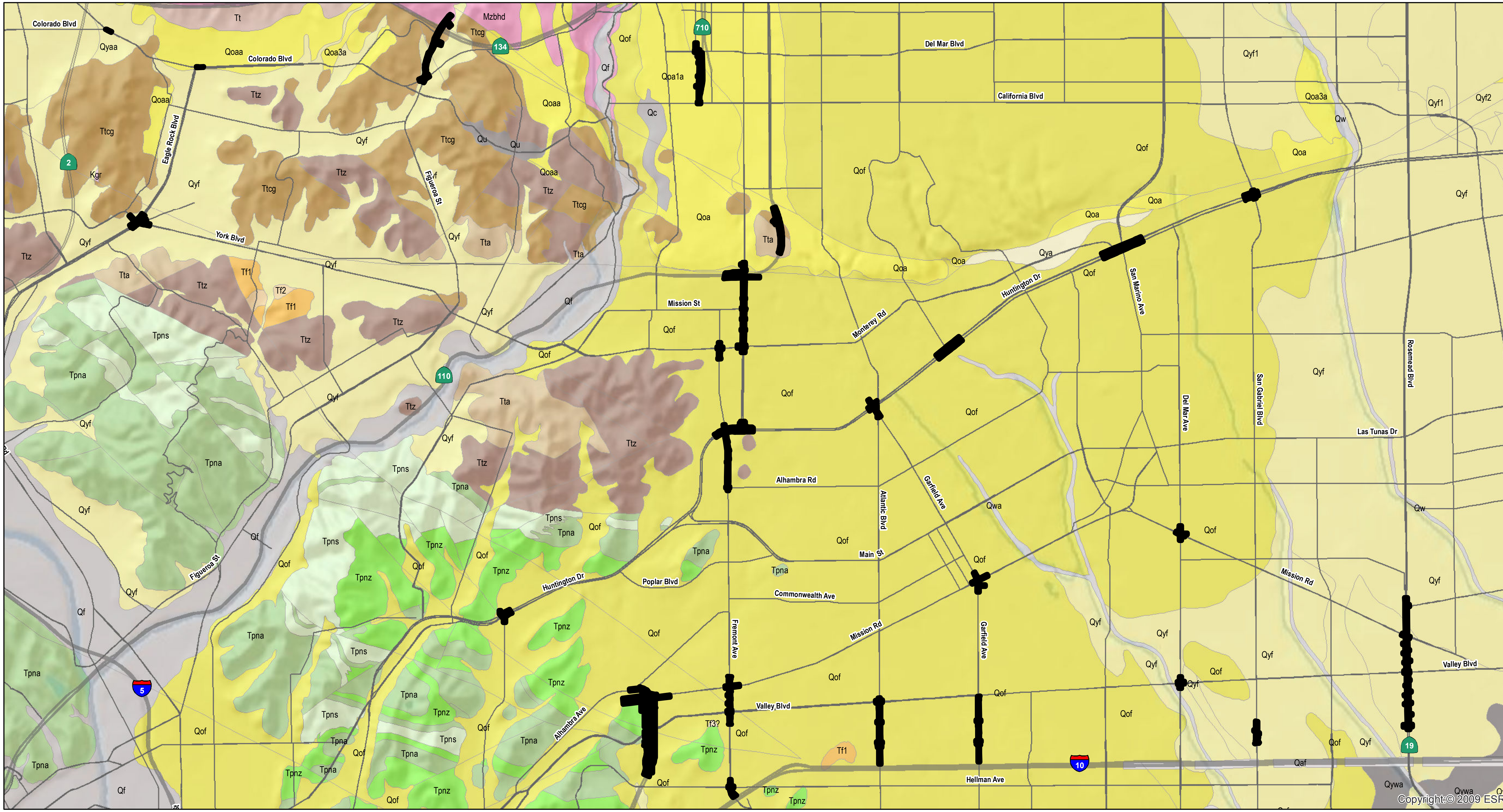
Geology Legend

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

SOURCE: Yerkes and Campbell (2005)

I:\CHM1105\GIS\MXD\PIR_PER\Geology_Legend.mxd (10/27/2014)

This page intentionally left blank



LEGEND

TSM/TDM Alternative Local Street and Intersection Improvements Project Area

SOURCE: ESRI (2008); Yerkes and Campbell (2005)

I:\CHM1105\GIS\MXD\PIR_PER\Geology_TSM_TDM.mxd (10/27/2014)

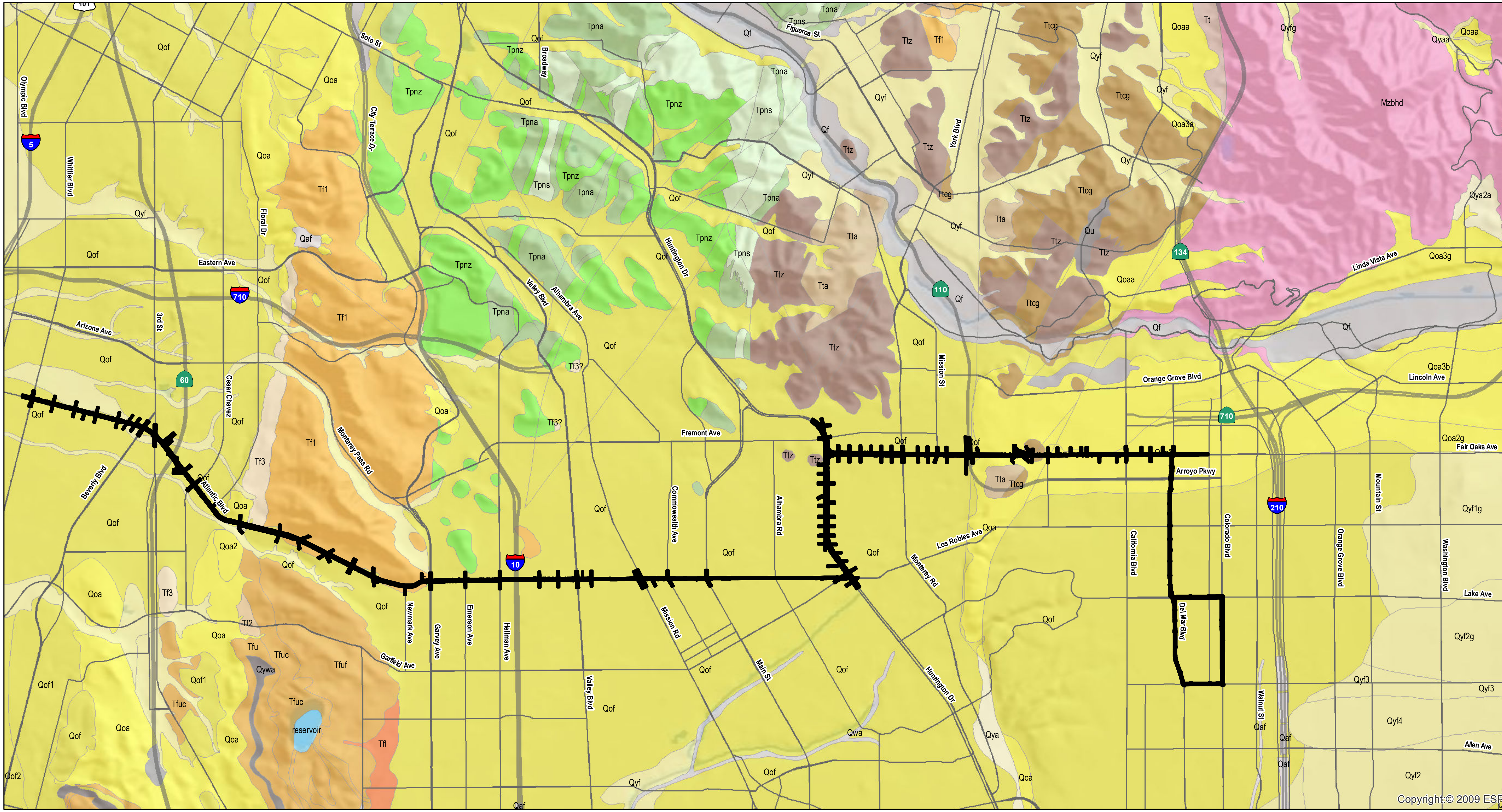
FIGURE 6-2

SR 710 North Study

TSM/TDM Alternative Local Street and Intersection Improvements Project Area Geology

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

This page intentionally left blank



LEGEND

BRT Alternative Project Area

FIGURE 6-3

0 1800 3600
FEET

SOURCE: ESRI (2008);Yerkes and Campbell (2005)

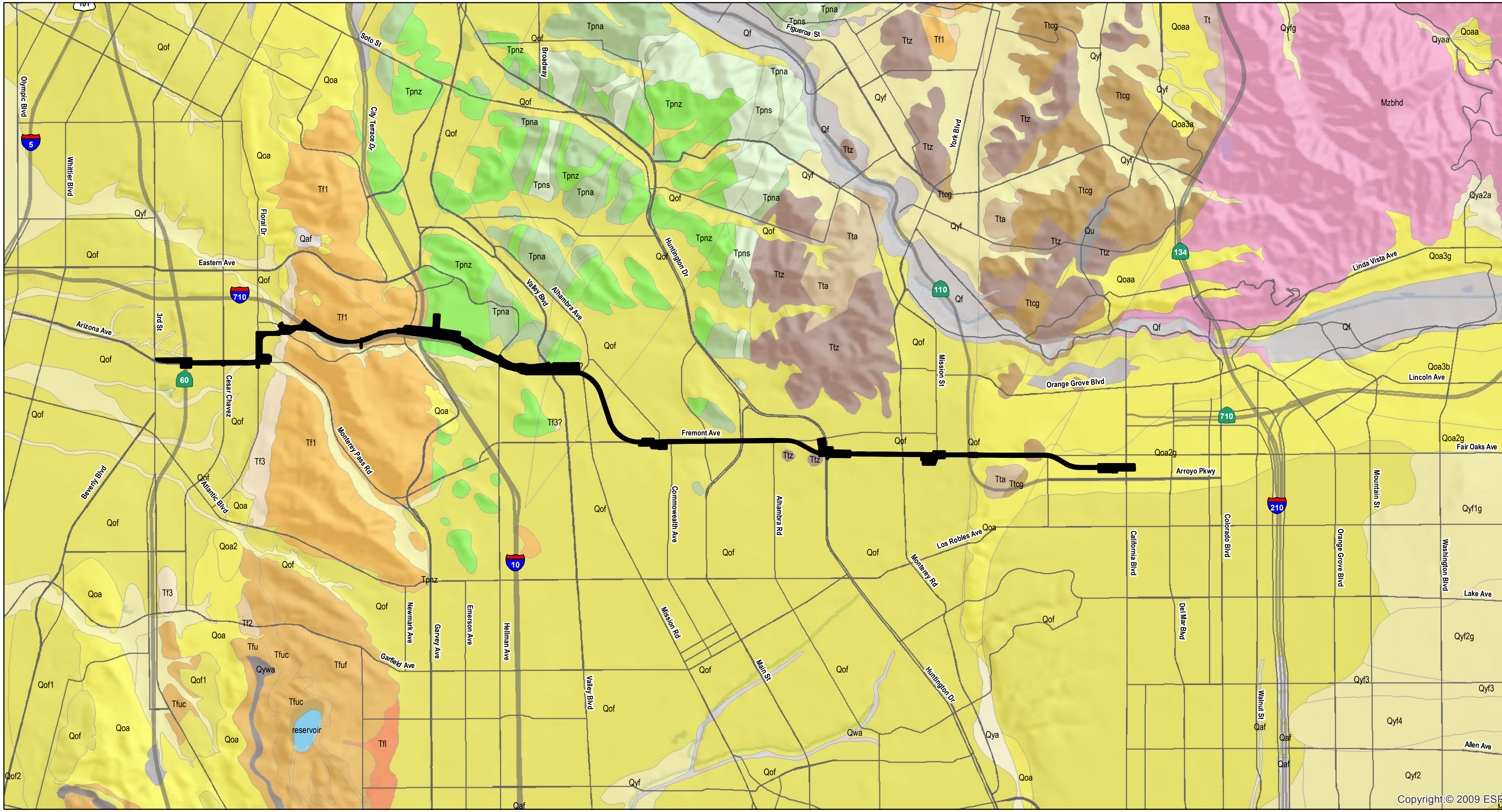
SR 710 North Study

BRT Alternative Project Area Geology

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Geology_BRT.mxd (10/27/2014)

This page intentionally left blank



LEGEND

LRT Alternative Project Area

FIGURE 6-4

0 1800 3600
FEET

SOURCE: ESRI (2008);Yerkes and Campbell (2005)

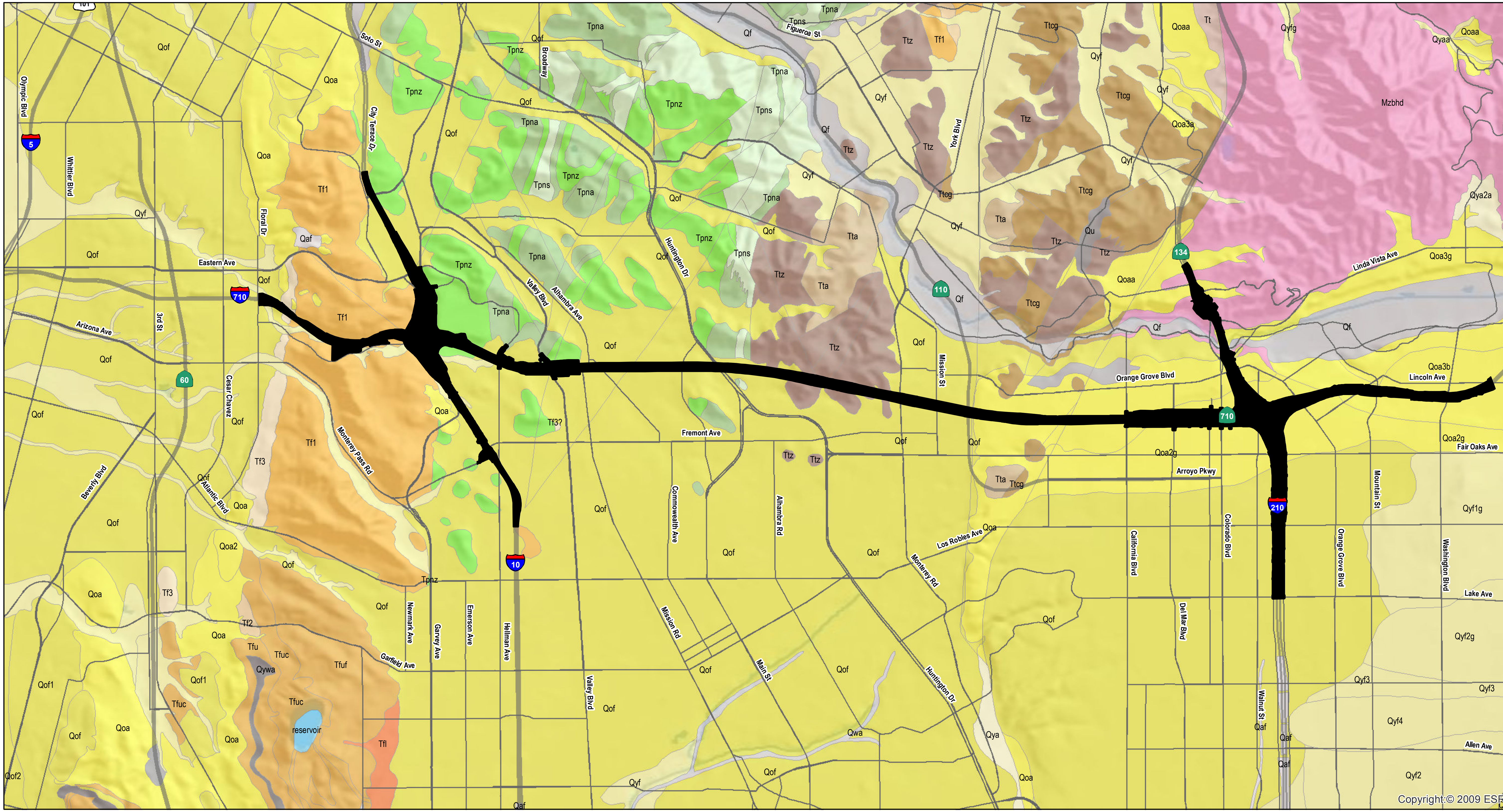
SR 710 North Study

LRT Alternative Project Area Geology

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Geology_LRT.mxd (10/27/2014)

This page intentionally left blank



LEGEND

Freeway Tunnel Alternative Project Area

FIGURE 6-5

0 1800 3600
FEET

SOURCE: ESRI (2008);Yerkes and Campbell (2005)

SR 710 North Study

Freeway Tunnel Alternative Project Area Geology

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Geology_FwyTunnel.mxd (10/27/2014)

This page intentionally left blank

6.1.1.1 Artificial Fill (Af)

Artificial Fill consists of sediments that have been removed from one location and transported to another by humans. The transportation distance can range from a few feet to dozens of miles. Composition is dependent on the source. When it is compacted and dense, it is known as "engineered fill," but it can be unconsolidated and loosely compacted. Artificial Fill will sometimes contain modern debris such as asphalt, wood, bricks, concrete, metal, glass, plastic, and even plant material.

Depending on the area, the thickness of these deposits can range from less than 1 ft to several hundred feet. Yerkes and Campbell (2005) only mapped large areas of Artificial Fill, which are not mapped within the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives. However, Artificial Fill is likely present in portions of the project areas along existing interstates, highways, and streets, where it was used during their construction to adjust for changes in topography and for overpasses and interchanges.

Artificial Fill is likely present at the surface throughout those project areas. The draft geologic cross-section for the freeway tunnel in the Freeway Tunnel Alternative developed by CH2M HILL (2013) indicates that Artificial Fill will be encountered at the southern end of the project area at the SR 710 and I-10 interchange and in the cut-and-cover tunnel around Valley Boulevard. For the LRT Alternative, the draft geologic cross-section (CH2M HILL, 2013) shows Artificial Fill at the surface in the southern part of the project area, below the aerial portion approximately from Kern Avenue to Corporate Center Drive and around the SR 710 and I-10 interchange, as well as in the tunnel portion around Valley Boulevard.

6.1.1.2 Holocene Alluvial Fan Deposits (Qf)

The Holocene Alluvial Fan Deposits formed less than 11,700 years ago and consist of unconsolidated bouldery, cobbly, gravelly, sandy, or silty alluvial deposits on active and recently active alluvial fans and in some channel segments (Yerkes and Campbell, 2005). These sediments were deposited by flooding streams and debris flows coming down from higher elevations and generally form a fan or lobe shape at the base of hills and mountains or in stream channels. These deposits are mapped in the northern portion of the project area for the Freeway Tunnel Alternative along the Arroyo Seco channel (Figure 6-5).

6.1.1.3 Young Alluvial Fan Deposits (Qyf)

The Young Alluvial Fan Deposits are Late Pleistocene to Holocene in age (less than 126,000 years ago) and consist of unconsolidated gravel, sand, and silt with occasional cobbles and boulders near mountain fronts (Yerkes and Campbell, 2005). These sediments were deposited by flooding streams and debris flows coming down from higher elevations and generally form a fan or lobe shape at the base of hills and mountains. In some areas, the surfaces can show slight to moderate soil development.

These deposits are mapped in all the project areas, predominantly in the southern portions. In the TSM/TDM Alternative, these deposits are mapped around the improvements along Figueroa Street from Colorado Boulevard to SR 134, at the intersection of Valley Boulevard and South Del Mar Avenue, and along San Gabriel Boulevard and Rosemead Boulevard just north of I-10 (Figure 6-2). In the project area for the BRT Alternative, they are mapped along Atlantic Boulevard between Brightwood Drive and Floral Drive, as well as between Pomona Boulevard and East Beverly

Boulevard (Figure 6-3). In the project areas for the LRT and Freeway Tunnel Alternatives, these deposits are found along SR 710 from the interchange at I-10 south to Floral Drive (Figures 6-4 and 6-5).

6.1.1.4 Young Alluvium (Qyaa)

The deposits of Young Alluvium are Late Pleistocene to Holocene in age (less than 126,000 years ago) and consist of unconsolidated and generally friable silt, sand, and gravel that was deposited by streams (Yerkes and Campbell, 2005). In some areas, the surfaces of these deposits can show slight to moderate soil development. Young Alluvium is mapped in the project area for the TSM/TDM Alternative around the improvement at the intersection of West Broadway and Colorado Boulevard (Figure 6-2).

6.1.1.5 Old Alluvial Fan Deposits (Qof)

Similar to the Young Alluvial Fan Deposits, the Old Alluvial Fan Deposits consist of gravel, sand, and silt deposited by flooding streams and debris flows coming down from higher elevations (Yerkes and Campbell, 2005). However, these deposits are slightly to moderately consolidated and older, ranging in age from the Middle to Late Pleistocene (781,000 to 11,700 years ago). Some surfaces show increased soil development and are dissected by erosional gullies. These sediments were deposited contemporaneously with the Old Alluvial Fan Deposits but are distinguished by their visible fan or lobe shape near the base of hills and mountains.

These deposits are mapped within the project areas for all the alternatives. Most of the improvements within the project area for the TSM/TDM Alternative are within areas mapped as Old Alluvial Fan Deposits, including improvements in the Cities of South Pasadena, Alhambra, Monterey Park, San Marino, San Gabriel, and Rosemead (Figure 6-2). Similarly, these deposits are mapped within most of the project area for the BRT Alternative, from Pasadena to Monterey Park, including portions of the route along East Colorado Boulevard, Del Mar Boulevard, Fair Oaks Avenue, Huntington Drive, and Atlantic Boulevard (Figure 6-3). Within the project areas for the LRT and Freeway Tunnel Alternatives, these deposits are mapped at the surface roughly from the Arroyo Seco Parkway (SR 110) in the north to Hellman Avenue in the south (Figures 6-4 and 6-5), and they may be encountered at or below the surface at different portions (CH2M HILL, 2013). In the Freeway Tunnel Alternative, the Old Alluvial Fan Deposits may be encountered below the surface in the cut-and-cover tunnel at the south portal near Valley Boulevard and in the bored tunnel from Monterey Road to the Arroyo Seco Parkway (SR 110). In the LRT Alternative, they may be reached during excavation for the maintenance yard; the Mednik, Floral, Alhambra, Huntington, and South Pasadena Stations; the aerial section from East 3rd Street to Floral Drive and Hellman Avenue to Valley Boulevard; the tunnel section from Valley Boulevard to Alhambra Road and Huntington Drive to SR 110 (Arroyo Seco Parkway); and during widening of Mednik Avenue between 1st Street and Floral Drive.

6.1.1.6 Old Alluvium (Qoa, Qoaa, Qoa1a, Qoa2g, Qoa3g)

The Old Alluvium deposits are comprised of unconsolidated to moderately indurated brown to reddish-brown gravel, sand, and silt deposited by streams during the Middle to Late Pleistocene (781,000 to 11,700 years ago) (Lamar, 1970; Yerkes and Campbell, 2005). Surfaces are dissected by erosional gullies and show some soil development, including a distinctive reddish “B” soil horizon that can be recognized in some areas. Yerkes and Campbell (2005) identified and mapped three informal geologic units (Units 1, 2, and 3) to divide these deposits where they could be distinguished based on relative terrace levels. Deposits that could not be easily distinguished are mapped as **Qoa** for undivided Old Alluvium. **Qoa3g** belongs to Unit 3, the youngest of the three subunits where they can be distinguished. It is Late Pleistocene (126,000 to 11,700 years ago) in age and predominantly composed of gravel. **Qoa2g** is also a gravelly unit and dates to the Late Pleistocene (126,000 to 11,700 years ago), but it is older than Unit 3. Unit 1, the oldest of the three subunits, contains the **Qoa1a** deposits, which are mainly sand and were deposited in the Middle Pleistocene (781,000 to 126,000 years ago).

Old Alluvium is mapped within the project areas for all the alternatives. Within the project area for the TSM/TDM Alternative, these deposits are mapped at the intersection of Eagle Rock Boulevard and Colorado Boulevard, along St. John Avenue, and along the Arroyo Seco Parkway (SR 110) (Figure 6-2). In the BRT Alternative, they are mapped in the north along Fair Oaks Avenue from Del Mar Boulevard to the Arroyo Seco Parkway (SR 110) (Figure 6-3). For the LRT Alternative, Old Alluvium is mapped at the surface at the northern end of the project area, from California Boulevard to the Arroyo Seco Parkway (SR 110) (Figure 6-4). It will also be encountered in the subsurface approximately from Fillmore Street to Glenarm Street and during excavation for the Fillmore Street Station (CH2M HILL, 2013). In the Freeway Tunnel Alternative, these deposits are mapped at the northern end of the project area from the SR 710/SR 134/I-210 interchange to the Arroyo Seco Parkway (SR 110) (Figure 6-5), and they would be encountered in the cut-and-cover and bored sections of the tunnel roughly from Del Mar Boulevard to Bellefontaine Street (CH2M HILL, 2013).

6.1.1.7 Fernando Formation (Tf1, Tf3)

The Fernando Formation is mapped in the Monterey Park area of the Repetto Hills and in the hills of the Highland Park area. Its massive siltstone, sandstone, and pebbly conglomerate were deposited in deep to shallow marine environments during the Pliocene (5.333 to 2.588 Ma). This formation is distributed widely in the subsurface of the Los Angeles Basin (Yerkes et al., 1965), and has produced oil in the Puente and Coyote Hills to the southeast (Durham and Yerkes, 1964; Yerkes, 1972). It is exposed in the Santa Ana Mountains and correlates with the Capistrano and Niguel Formations of coastal Orange County (Schoellhamer et al., 1981). In the vicinity of the project areas, three informal members of the Fernando Formation, labeled 1, 2, and 3, were described and mapped by Lamar (1970) and Yerkes and Campbell (2005).

The oldest member (**Tf1**) is a massive, light gray siltstone. The middle member (**Tf2**) is a massive, fine- to medium-grained, brown sandstone. The youngest member (**Tf3**) is a light to reddish-brown, coarse pebble conglomerate. Deposition of these sediments began in a deep marine environment, with water depths greater than 4,000 ft (Lamar, 1970). Over time, this area became progressively shallower, and the coarser-grained sandstones and conglomerates of the upper members were deposited in waters less than 600 ft deep. The formation increases in thickness from west to east, reaching a maximum of 6,000 ft in the Monterey Park area of the Repetto Hills. Only the oldest (**Tf1**-siltstone) and youngest (**Tf3**-conglomerate) members are mapped in the project areas for the BRT, LRT, and Freeway Tunnel Alternatives.

The Fernando Formation is mapped at the surface in a small portion of the southern end of project area for the BRT Alternative along Atlantic Boulevard from West El Repetto Drive to Cadiz Street (Figure 6-3). Within the LRT and Freeway Tunnel Alternatives, this formation is mapped at the surface from the SR 710/I-10 interchange north to Mission Road (Figures 6-4 and 6-5). In the LRT

Alterative, the Fernando Formation may also be encountered in the subsurface during excavation for the aerial section from Corporate Center Drive to the SR 710/I-10 interchange, in the bored tunnel section roughly from Meridian Avenue to Commonwealth Avenue, and for the Alhambra Station (CH2M HILL, 2013). This formation may also be reached at the surface during grading for construction of an MSE embankment that will support the aerial section in the area south of the SR 710/I-10 interchange. In the Freeway Alternative, these deposits may be reached in the subsurface during excavation of the bored tunnel roughly from Norwich Avenue to Huntington Drive (CH2M HILL, 2013).

6.1.1.8 Puente Formation (Tpnz, Tpns, Tpna)

Originally named for exposures in the Puente Hills (Eldridge and Arnold, 1907), the Puente Formation in the Repetto Hills is comprised of over 2,000 ft of marine siltstone, sandstone, and shale deposited during the Late Miocene to Early Pliocene (11.62 to 3.6 Ma) (Lamar, 1970). In the Repetto Hills area, Lamar (1970) used rock type to map four non-sequential, interbedded units, which have not been specifically correlated with formal members identified elsewhere in Los Angeles and Orange Counties (Durham and Yerkes, 1964; Schoellhamer et al., 1981; Yerkes, 1972). Yerkes and Campbell (2005) consolidated these four units into the three (Tpnz, Tpns, and Tpna) that are mapped in the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives.

Rocks mapped as **Tpnz** consist of Early Pliocene (5.333 to 3.6 Ma) well-bedded, light gray siltstone. These beds are thickest in the youngest part of the formation, while older sediments are interbedded with those of the underlying rock type. Also deposited in the Early Pliocene (5.333 to 3.6 Ma) is the light gray, siliceous shales and siltstones labeled **Tpns**, which contain thin, discontinuous beds of fine- to coarse-grained sandstone. Lastly, the brown to light gray, very fine- to very coarse-grained sandstones mapped as **Tpna** contain discoidal concretions in some places and are slightly older, having been deposited in the Late Miocene (11.62 to 5.333 Ma).

Rocks of the Puente Formation in this area show deformation structures typical of slumping and sliding that occurred as they were being deposited, evidence that these sediments formed as part of the southeast lobe of the Tarzana submarine fan recognized in the Santa Monica Mountains (Lamar, 1970). This submarine fan developed as sediments eroded off the coast to the northwest and accumulated at the mouth of a submarine canyon in water several thousand feet deep. After these rocks were deposited, they were uplifted, folded, and faulted, factors that along with their compositional properties have allowed them to trap oil. Oil wells have been drilled into this formation around the Los Angeles Basin (Yerkes et al., 1965) and in the Repetto Hills near the project area (Lamar, 1970), but most of the production has come from the Puente Hills (Durham and Yerkes, 1964; Yerkes, 1972).

Within the project area for the TSM/TDM Alternative, the Puente Formation is mapped at the surface only in a very small portion of the improvement at the SR 710/Valley View intersection (Figure 6-2). Similarly, within the project area for the BRT Alternative, this formation is mapped at the surface in a small area near the intersection of Atlantic Boulevard and West Garvey Avenue (Figure 6-3). These deposits are mapped at the surface in the project areas for the LRT and Freeway Tunnel Alternatives around Cal State LA near the SR 710/I-10 interchange (Figures 6-4 and 6-5), but they may also be encountered in the subsurface during excavation in additional areas. For the LRT Alternative, these additional areas include the aerial section from the SR 710/I-10 interchange north to Valley Boulevard, the Cal State LA Station, and in the tunnel section from Valley Boulevard to

Mission Road and Commonwealth Avenue to Main Street (CH2M HILL, 2013). For the Freeway Tunnel Alternative, the Puente Formation may be reached in the cut-and-cover tunnel around Valley Boulevard and in the bored tunnel roughly from Valley Boulevard to Norwich Avenue and from Huntington Drive to Newtonia Drive (CH2M HILL, 2013).

6.1.1.9 Topanga Group (Ttcg, Tta, Ttz)

The Topanga Group in the project area includes conglomerate, sandstone, siltstone, and shale deposited in a marine environment in the Middle Miocene (15.97 to 11.62 Ma). Kew (1924) first described and mapped the "Topanga Formation" in the Santa Monica Mountains, and it has since been correlated with deposits throughout the Los Angeles Basin, as well as in the Santa Ana Mountains and San Joaquin Hills in Orange County (Campbell et al., 2007).

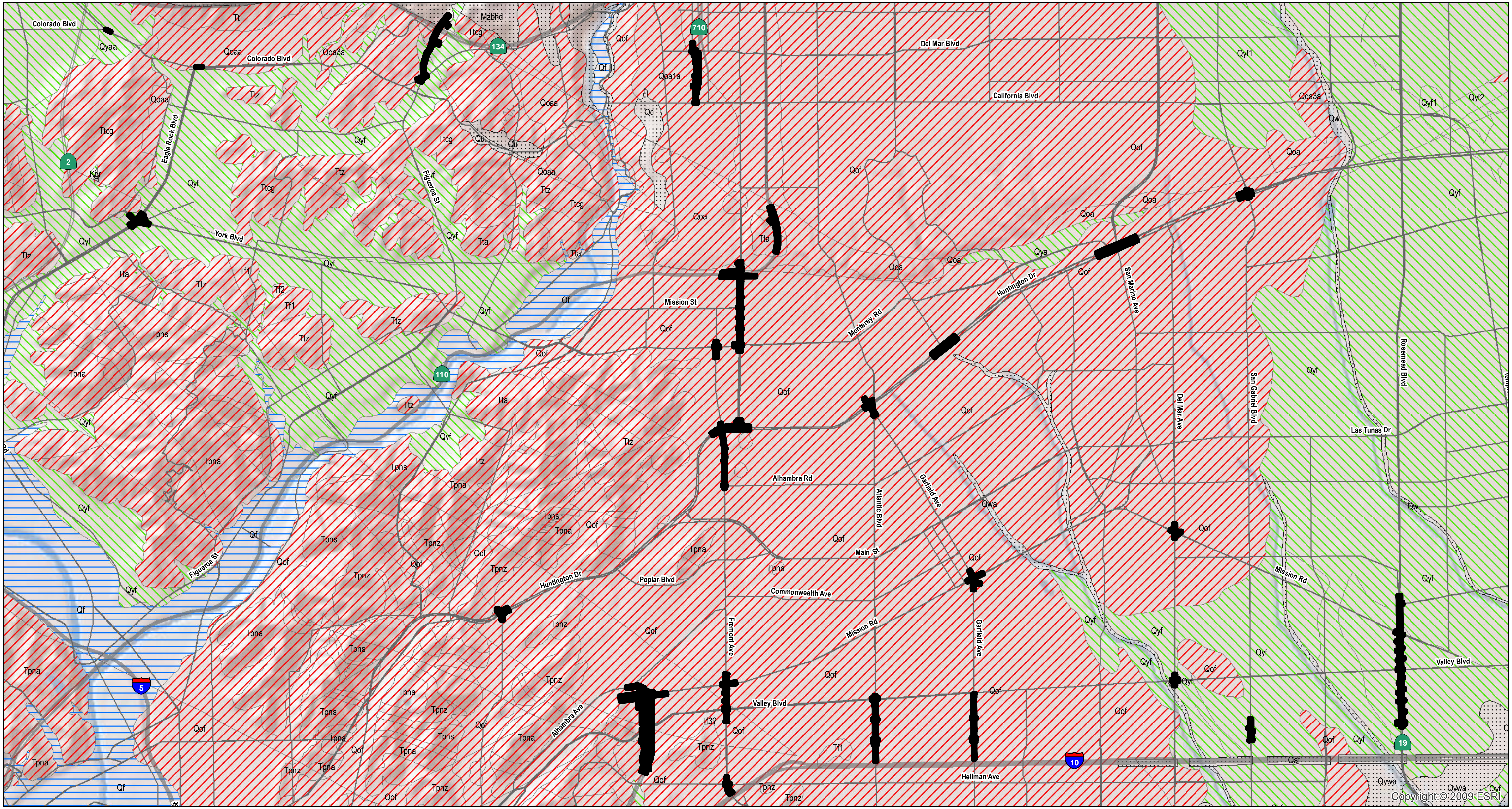
In the Repetto Hills area, Yerkes and Campbell (2005) designated these rocks as the Topanga Group and, following Lamar (1970), mapped three informal subunits based on rock type. The **Ttcg** subunit is a light brown conglomerate that forms distinct beds in the southeast, but is massive and without visible beds in the northwest. Rocks labeled **Tta** consist of light brown and gray, medium- to coarse-grained sandstone that forms visible layers. And **Ttz** designates medium to dark brown siltstone with interbedded sandstone, shale, and chert. All three subunits are composed of sediment carried from land to the northwest and deposited in shallow to deep water on the slopes of the ancient Los Angeles Basin.

Within the project area for the TSM/TDM Alternative, the Topanga Group is mapped along Arroyo Seco Parkway (SR 110) and along Figueroa Street just south of SR 134 (Figure 6-2). Within the project area for the BRT Alternative, these deposits are mapped in small areas off Fair Oaks Avenue, including Mound Avenue, State Street, Raymond Hill Drive, and Grave Walk (Figure 6-3). In the project area for the LRT Alternative, deposits of the Topanga Group are mapped around Huntington Drive and just north of the Arroyo Seco Parkway (SR 110) (Figure 6-4). They also may be encountered in the subsurface during excavation for the Huntington Street Station, as well as in the tunnel section roughly from Main Street north to Huntington Drive and from Arroyo Seco Parkway (SR 110) to Glenarm Street (CH2M HILL, 2013). In the Freeway Tunnel Alternative, these deposits are mapped at the surface from Alhambra Road to Monterey Road (Figure 6-5) and may be reached in the subsurface during excavation for the bored tunnel approximately from Newtonia Drive to Monterey Road and from Arroyo Seco Parkway (SR 110) to Bellefontaine Street (CH2M HILL, 2013).

6.1.2 Paleontology

The paleontological resource sensitivity rating describes the potential to encounter scientifically significant fossil remains in a given geologic unit. The paleontological sensitivities (or potential) of deposits within the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives are summarized in Table 6.2 and described in more detail below. They are also illustrated on Figures 6-6 through 6-9, with the exception of Artificial Fill, which was not mapped in the project areas. These sensitivity (or potential) ratings follow the guidelines of Caltrans (Caltrans, 2012) and the SVP (SVP, 2010) and are based on various aspects of these deposits, including their age, composition, depositional environment, and any scientifically significant fossil remains they have produced in other areas.

This page intentionally left blank



LEGEND

TSM/TDM Alternative Local Street and Intersection Improvements Project Area

Paleontological Sensitivity

- High
- Low - Above a depth of 10 feet, High - Below a depth of 10 feet
- Low
- Not Applicable

N

0 1650 3300
FEET

SOURCE: ESRI (2008); Yerkes and Campbell (2005)

FIGURE 6-6

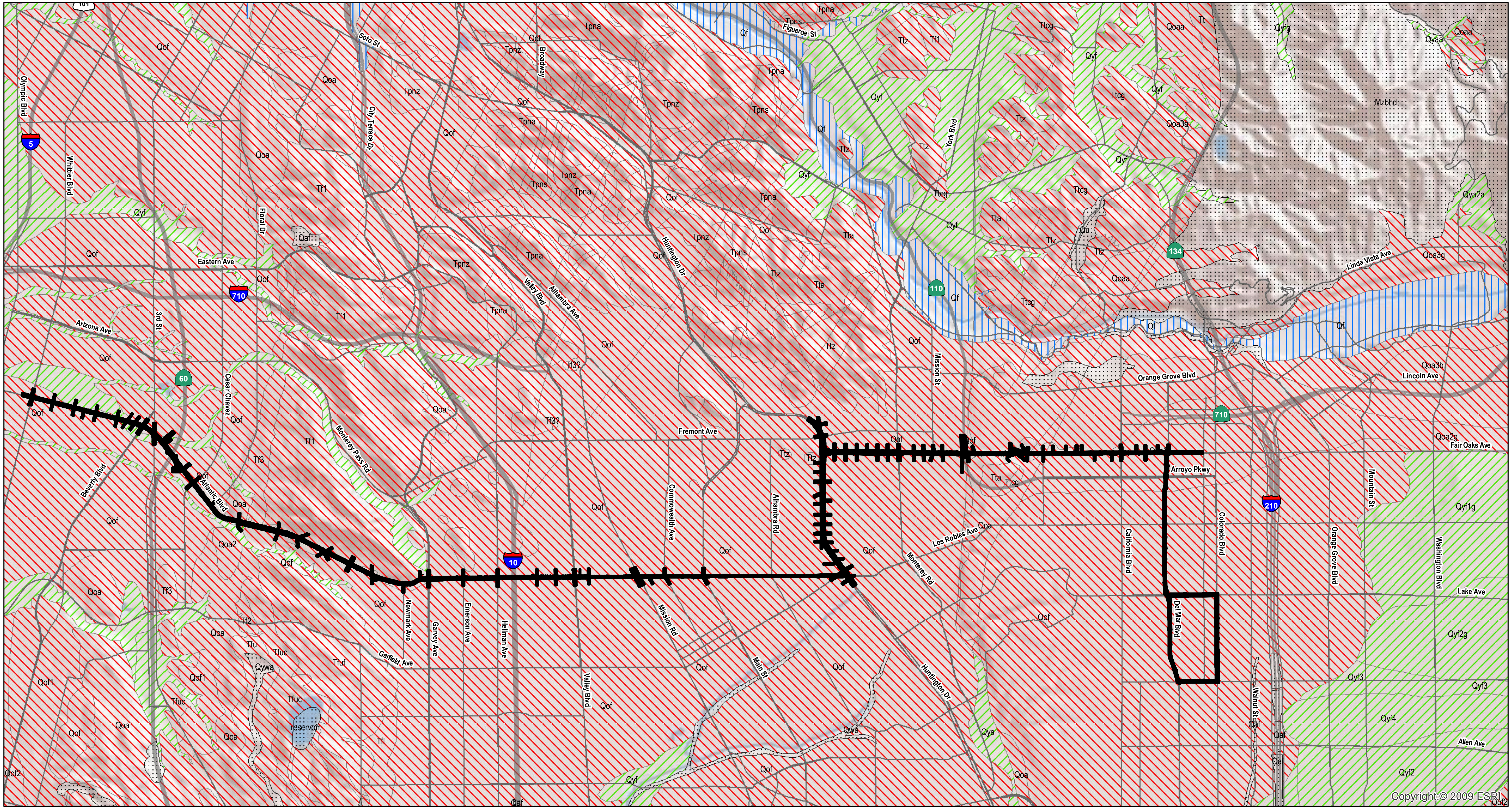
SR 710 North Study

TSM/TDM Alternative Local Street and Intersection Improvements Project Area Paleontological Sensitivity

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Sensitivity_TSM_TDM.mxd (10/27/2014)

This page intentionally left blank



LEGEND

BRT Alternative Project Area

Paleontological Sensitivity

- High
- Low - Above a depth of 10 feet, High - Below a depth of 10 feet
- Low
- Not Applicable

0 1800 3600
FEET

SOURCE: ESRI (2008);Yerkes and Campbell (2005)

FIGURE 6-7

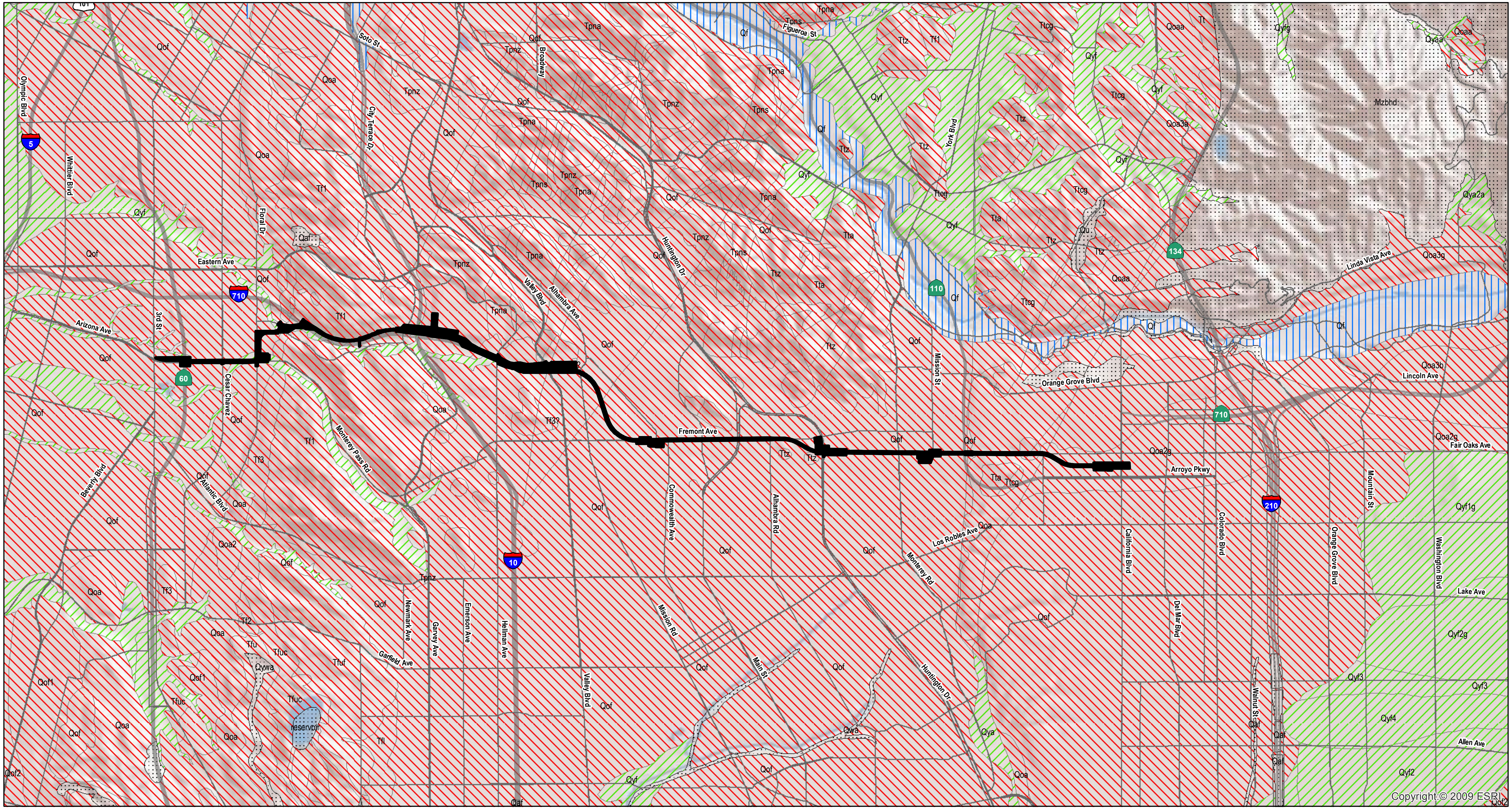
SR 710 North Study

BRT Alternative Project Area Paleontological Sensitivity

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Sensitivity_BRT.mxd (10/27/2014)

This page intentionally left blank



LEGEND

LRT Alternative Project Area

Paleontological Sensitivity

High

Low - Above a depth of 10 feet, High - Below a depth of 10 feet

Low

Not Applicable

0 1800 3600
FEET

SOURCE: ESRI (2008);Yerkes and Campbell (2005)

FIGURE 6-8

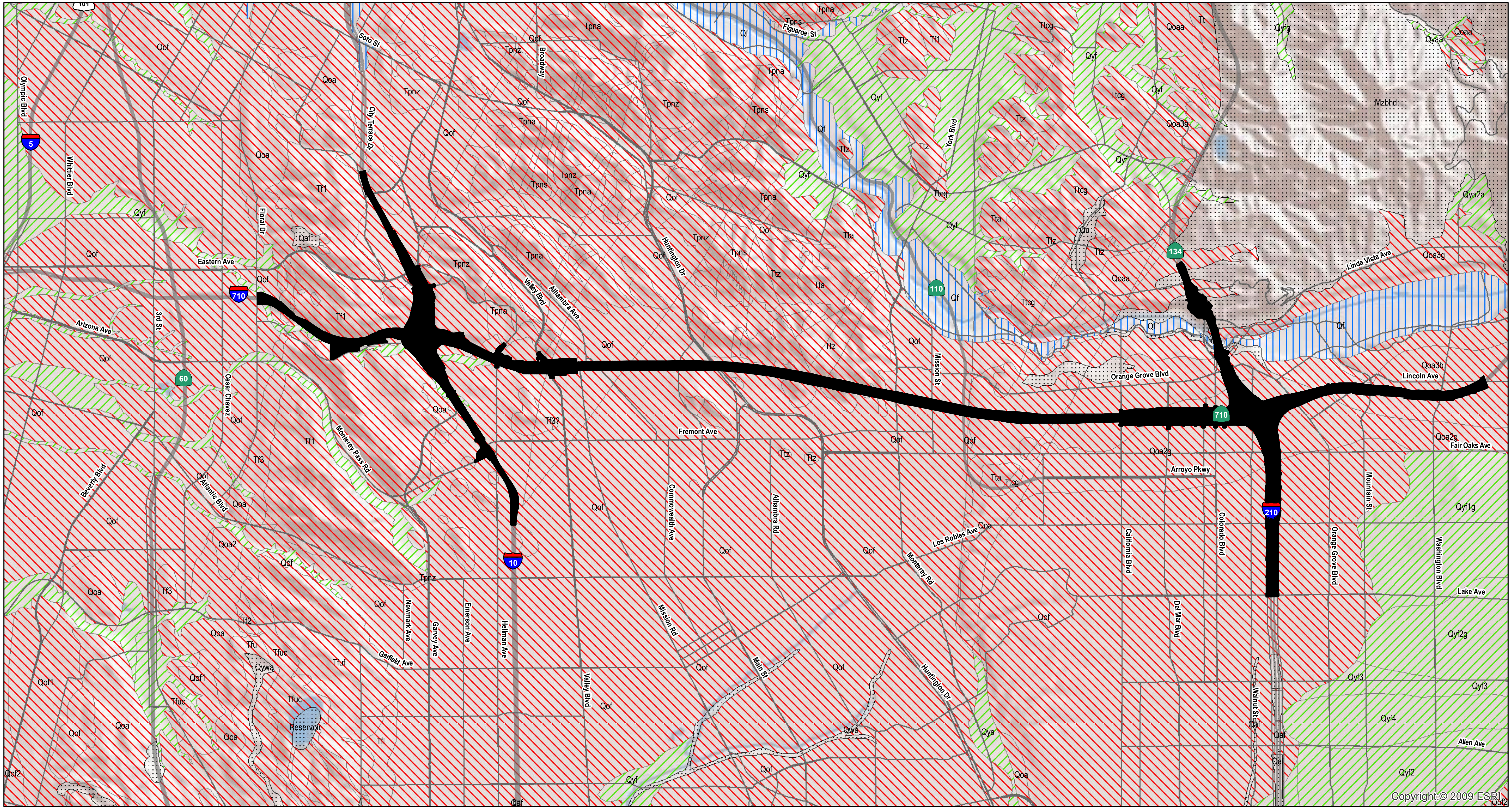
SR 710 North Study

LRT Alternative Project Area Paleontological Sensitivity

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Sensitivity_LRT.mxd (10/27/2014)

This page intentionally left blank



LEGEND

Freeway Tunnel Alternative Alignment

Paleontological Sensitivity

- High
- Low - Above a depth of 10 feet, High - Below a depth of 10 feet
- Low
- Not Applicable

0 1800 3600
FEET

SOURCE: ESRI (2008);Yerkes and Campbell (2005)

FIGURE 6-9

SR 710 North Study

Freeway Tunnel Alternative Project Area Paleontological Sensitivity

07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

I:\CHM1105\GIS\MXD\PIR_PER\Sensitivity_FwyTunnel.mxd (10/27/2014)

This page intentionally left blank

TABLE 6.2:
Paleontological Sensitivity/Potential of Geologic Units within the Project Areas for the Alternatives of the SR 710 North Study

Geologic Unit	Paleontological Sensitivity/Potential
Artificial Fill	No
Holocene Alluvial Fan Deposits	No
Young Alluvial Fan Deposits	Low – Above a depth of 10 ft High – Below a depth of 10 ft
Young Alluvium	Low – Above a depth of 10 ft High – Below a depth of 10 ft
Old Alluvial Fan Deposits	High
Old Alluvium	High
Fernando Formation	High
Puente Formation	High
Topanga Group	High

Source: Guidelines from the Society of Vertebrate Paleontology (2010) and California Department of Transportation (2012).
ft = feet
SR 710 = State Route 710

6.1.2.1 Artificial Fill

Artificial Fill can contain fossils, but these fossils have been removed from their original location. Because these fossils are out of context, they are not considered to be important for scientific study. As a result, Artificial Fill is considered to have no paleontological sensitivity. The thickness of these deposits is variable and unknown in many places. In addition, these deposits may overlie older deposits with high or low paleontological sensitivity. Although not mapped by Yerkes and Campbell (2005), Artificial Fill is likely present at the surface in portions of the all the project areas along existing interstates, highways, streets, and sidewalks. The draft geologic cross-section for the freeway tunnel in the Freeway Tunnel Alternative developed by CH2M HILL (2013) indicates that Artificial Fill will be encountered at the southern end of the project area at the SR 710 and I-10 interchange and in the cut-and-cover tunnel around Valley Boulevard. For the LRT Alternative, the draft geologic cross-section (CH2M HILL, 2013) shows Artificial Fill at the surface in the southern part of the project area, below the aerial portion approximately from Kern Avenue to Corporate Center Drive and around the SR 710 and I-10 interchange, as well as in the tunnel portion around Valley Boulevard.

6.1.2.2 Holocene Alluvial Fan Deposits

The Holocene Alluvial Fan Deposits are less than 11,700 years old (Yerkes and Campbell, 2005). Any fossils recovered from these deposits would be conspecific with modern species and therefore, not considered scientifically significant fossils. As a result, these deposits are identified as having no paleontological sensitivity. The thickness of these deposits is unknown, and they may overlie older deposits with high or low paleontological sensitivity. These deposits are mapped at the surface in the northern end of the project area for the Freeway Tunnel Alternative (Figure 6-9).

6.1.2.3 Young Alluvial Fan Deposits

The Young Alluvial Fan Deposits are Late Pleistocene to Holocene in age (less than 126,000 years ago) (Yerkes and Campbell, 2005), and fossils are known in similar age deposits from scientific research, as well as from excavations for roads, housing developments, and quarries within the Southern California area (Jefferson, 1991a, 1991b; Miller, 1971; Reynolds and Reynolds, 1991). The oldest deposits in this unit span the end of the Rancholabrean North American Land Mammal Age (NALMA), which was named for the Rancho La Brea fossil site in central Los Angeles and dates from 240,000 to 11,700 years ago. The index fossil for the Rancholabrean NALMA is *Bison* sp., but fossils from this time also include other large and small mammals, reptiles, fish, invertebrates, and plants. There is a potential to encounter these types of fossils in the older sediments within this unit below a depth of approximately 10 ft. Any vertebrate, invertebrate, and plant fossils recovered would be considered scientifically significant because they would add to our understanding of the environment in this area over the last 126,000 years, as well as the evolution of the animals and plants that lived here. Therefore these deposits are assigned a low paleontological sensitivity above a depth of 10 ft and a high sensitivity below that mark. These deposits are mapped in the southern portions of the project areas for the TSM/TDM (Figure 6-6), BRT (Figure 6-7), LRT (Figure 6-8), and Freeway Tunnel (Figure 6-9) Alternatives.

6.1.2.4 Young Alluvium

The deposits of Young Alluvium are Late Pleistocene to Holocene in age (less than 126,000 years ago) (Yerkes and Campbell, 2005), and fossils are known in similar age deposits from scientific research, as well as from excavations for roads, housing developments, and quarries within the Southern California area (Jefferson, 1991a, 1991b; Miller, 1971; Reynolds and Reynolds, 1991). The oldest deposits in this unit span the end of the Rancholabrean NALMA, which was named for the Rancho La Brea fossil site in central Los Angeles and dates from 240,000 to 11,700 years ago. The index fossil for the Rancholabrean NALMA is *Bison* sp., but fossils from this time also include other large and small mammals, reptiles, fish, invertebrates, and plants. There is a potential to encounter these types of fossils in the older sediments within this unit below a depth of 10 ft, and any vertebrate, invertebrate, and plant fossils recovered would be considered scientifically significant because they would add to understanding of the environment and biological evolution over the last 126,000 years. Young Alluvium is, therefore, assigned a low paleontological sensitivity above a depth of 10 ft and a high sensitivity below that mark. These deposits are mapped in the project area for the TSM/TDM Alternative on Figure 6-6.

6.1.2.5 Old Alluvial Fan Deposits

The Old Alluvial Fan Deposits formed during the Middle to Late Pleistocene (781,000 to 11,700 years ago) (Lamar, 1970; Yerkes and Campbell, 2005), and fossils are known in similar age sediments from scientific research, as well as from excavations for roads, housing developments, and quarries within the Southern California area (Jefferson, 1991a, 1991b; Miller, 1971; Reynolds and Reynolds, 1991). These deposits span the two youngest NALMAs: the Irvingtonian (1.8 million to 240,000 years ago) and the Rancholabrean (240,000 to 11,700 years ago), which was named for the Rancho La Brea fossil site in central Los Angeles. Mammoths are perhaps the best-known fossil from the Pleistocene epoch, and the index fossil for the Rancholabrean NALMA is *Bison* sp. Deposits in Southern California from both of these NALMAs have yielded fossils of these and other large mammals, such as camels, saber-toothed cats, dire wolves, ground sloths, and horses. Smaller vertebrates like birds, rodents, reptiles, and fish, as well as invertebrates and plants have also been found in Pleistocene sediments and help describe climatic and habitat conditions during this epoch. There is a potential to encounter these types of fossils in the Old Alluvial Fan Deposits in the project areas. Any vertebrate, invertebrate, and plant fossils recovered from these deposits would be considered scientifically significant because they would add to our understanding of the environment of this area during the Pleistocene and the evolution of the animals and plants that lived here. These deposits are mapped within the project areas for TSM/TDM (Figure 6-6), BRT (Figure 6-7), LRT (Figure 6-8), and Freeway Tunnel (Figure 6-9) Alternatives.

6.1.2.6 Old Alluvium

The Old Alluvium deposits accumulated during the Middle to Late Pleistocene (781,000 to 11,700 years ago) (Lamar, 1970; Yerkes and Campbell, 2005). Fossils are known in similar age deposits from scientific research, as well as from excavations for roads, housing developments, and quarries within the Southern California area (Jefferson, 1991a, 1991b; Miller, 1971; Reynolds and Reynolds, 1991). These deposits span the two youngest NALMAs: the Irvingtonian (1.8 million to 240,000 years ago) and the Rancholabrean (240,000 to 11,700 years ago), which was named for the Rancho La Brea fossil site in central Los Angeles. Mammoths are perhaps the best-known fossil from the Pleistocene epoch, and the index fossil for the Rancholabrean NALMA is *Bison* sp. Deposits in Southern California from both of these NALMAs have yielded fossils of these and other large mammals, such as camels, saber-toothed cats, dire wolves, ground sloths, and horses. Smaller vertebrates like birds, rodents, reptiles, and fish, as well as invertebrates and plants have also been found in Pleistocene sediments and help describe climatic and habitat conditions during this epoch. There is a potential to encounter these types of fossils in the Old Alluvium deposits in the project areas, and any vertebrate, invertebrate, and plant fossils recovered from these deposits would be considered scientifically significant because they would add to understanding of the environment and biological evolution during the Pleistocene. These deposits are mapped within the project areas for TSM/TDM (Figure 6-6), BRT (Figure 6-7), LRT (Figure 6-8), and Freeway Tunnel (Figure 6-9) Alternatives.

6.1.2.7 Fernando Formation

The shallow to deep marine siltstones, sandstones, and pebbly conglomerates of the Pliocene (5.333 to 2.588 Ma) Fernando Formation are known to be fossiliferous throughout Los Angeles and Orange Counties. Approximately 1 mi east of the project area, along Atlantic Boulevard in the Repetto Hills, Natland and Rothwell (1954) defined the type section for the earliest Pliocene Repettian stage based on foraminifera. Near Highland Park, a few miles west of the project area, brachiopods, bivalves, and gastropods have been recovered (Lamar, 1970). Farther west in the Santa Monica Mountains, this formation has yielded shark teeth, brachiopods, bivalves, and gastropods (Koch et al., 2004). To the southeast, Eisentraut and Cooper (2002) report that invertebrate and occasional vertebrate fossils have been found in the Fernando Formation in the Santa Ana Mountains and Coyote and Puente Hills. And Schoellhamer et al. (1981) list five localities from the Fernando Formation from the Santa Ana Mountains that contain remains of gastropods, bivalves, and barnacles. The marine sediments of Fernando Formation in the project areas have the potential to yield similar fossils. By producing both vertebrate and invertebrate fossils from shallow to deep marine environments, these deposits provide information for studies on biological evolution, biostratigraphy, and paleoecology of this region. Therefore, these fossils are considered scientifically significant, and because these deposits have the potential to yield scientifically significant paleontological resources, they are given a high sensitivity rating. The surficial deposits of the Fernando Formation are mapped in the project areas for the TSM/TDM (Figure 6-6), BRT (Figure 6-7), LRT (Figure 6-8), and Freeway Tunnel (Figure 6-9) Alternatives; however, additional deposits may be encountered in the subsurface during excavation for the LRT and Freeway Tunnel Alternatives.

6.1.2.8 Puente Formation

Scientifically significant paleontological resources have been recovered from the Late Miocene to Early Pliocene (11.62 to 3.6 Ma) sandstones, siltstones, and shales of the Puente Formation. In the Repetto Hills near the project area, Lamar (1970) reported 12 genera of fish from eight localities, one of which was within 1 mi of the project area. To the southeast in the Puente Hills, this formation has produced scientifically significant fossil remains, including fish, marine mammals (mostly whales), invertebrates, and plants (Eisentraut and Cooper, 2002). The deep-water shales of the Puente Formation in the Peralta Hills in southeastern Anaheim, Orange County, yielded rare fossils of hexactinellid sponges, the first of their kind from the Miocene in California and one of few known from the Miocene in all of North America (Rigby and Albi, 1996). In the Santa Ana Mountains, invertebrates, such as bivalves, gastropods, and barnacles (Schoellhamer et al., 1981), as well as some vertebrates have been recovered. And to the east in Riverside County, these deposits have yielded less commonly preserved invertebrate fossils like shrimp and crabs, in addition to bivalves, microfossils, plants, and marine mammals (Feldmann, 2003).

The marine sediments of the Puente Formation in the project areas are similar to those found in other areas where this formation is mapped and, therefore, have the potential to yield similar fossils, which would be useful for taxonomic, evolutionary, and paleoecological studies. Moreover, because these rocks record depositional and tectonic changes that occurred in the Los Angeles Basin through the Late Miocene to Early Pliocene, fossils recovered from this area could be beneficial for biostratigraphic studies and correlating geologic units across the basin. This information would ultimately present a clearer, more complete picture of the geologic history of Southern California. Because these deposits have the potential to yield scientifically significant paleontological resources, they are considered highly sensitive. The surficial deposits of the Puente Formation are mapped in the project areas for the TSM/TDM (Figure 6-6), BRT (Figure 6-7), LRT (Figure 6-8), and Freeway Tunnel (Figure 6-9) Alternatives; however, additional deposits may be encountered in the subsurface during excavation for the LRT and Freeway Tunnel Alternatives.

6.1.2.9 Topanga Group

The sandstones, siltstones, and shales of the Topanga Group are known to be fossiliferous and record the marine life that existed in the ancient Los Angeles Basin during the Middle Miocene (15.97 to 11.62 Ma). Lamar (1970) reported 15 genera of fish from the Topanga Group in the Repetto and Elysian Hills, six of which were from four localities within 1 mi of the project area. To the southeast, the Topanga Group in the Puente Hills has produced fossil invertebrates, such as bivalves and gastropods, and vertebrates (Durham and Yerkes, 1964; Eisentraut and Cooper, 2002), while in the Santa Ana Mountains, abundant invertebrates, plants, and vertebrates like sharks, whales, sea cows, and sea lions have been recovered from these deposits (Eisentraut and Cooper, 2002). To the west, in the Santa Monica Mountains, rocks from the Topanga Group have yielded foraminifera, plants, bivalves, gastropods, echinoids, barnacles, crabs, fish, whales, and sea lions (Koch et al., 2004).

The marine sediments of the Topanga Group in the project area have the potential to yield invertebrate and vertebrate fossils similar to those found in other areas where this group is mapped. In addition, fossils recovered from this area could be beneficial for biostratigraphic studies and correlating geologic units across the basin, which could ultimately present a clearer, more complete picture of the geologic history of Southern California. As such, fossils from the Topanga Group are considered scientifically significant and give these deposits a high sensitivity rating. The surficial deposits of the Topanga Group are mapped in the project areas for the TSM/TDM (Figure 6-6), BRT (Figure 6-7), LRT (Figure 6-8), and Freeway Tunnel (Figure 6-9) Alternatives; however, additional deposits may be encountered in the subsurface during excavation for the LRT and Freeway Tunnel Alternatives.

6.2 Locality Search

The LACM has no records of vertebrate fossil localities within the boundaries of the project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives. However, they have localities within 5 mi or less of these project areas from the same geologic units. LACM states that all geologic units which the project areas cross have the potential to contain scientifically significant paleontological remains, either at or below the surface.

Scientifically significant vertebrate fossils are not likely to be encountered in the uppermost layers of the younger Quaternary Alluvium, which covers small portions of the project areas for the project alternatives. However, the LACM has four vertebrate localities in older Quaternary Alluvium near the project areas for these four alternatives. The closest locality, LACM 3363, is located south of the San Bernardino Freeway (I-10) between the Long Beach Freeway (I-710) and Monterey Pass Road. It is just south of the TSM/TDM Alternative improvement at Hellman Avenue and Fremont Avenue, less than 1 mi from the project areas for the LRT and Freeway Tunnel Alternatives, and a little over 1 mi from the project area for the BRT Alternative. This locality produced fossil specimens of horse, *Equus.* The next closest vertebrate locality is LACM (CIT) 342, east of the Glendale Freeway (SR 2) and Eagle Rock Boulevard and south of York Boulevard, just south of the improvement at that intersection for the TSM/TDM Alternative and approximately 4.5 mi west of the project areas for the BRT, LRT, and Freeway Tunnel Alternatives. At a depth of 14 ft below the surface, this locality yielded unique and scientifically significant fossil specimens of turkey, *Parapavo californicus,* and mammoth, *Mammuthus,* both of which were published in the scientific literature. The LACM has two vertebrate fossil localities in the City of Commerce near the intersection of Atlantic Avenue and I-710, approximately 1.5 mi south of the BRT Alternative project area, 2.5 mi south of the LRT Alternative project area, 3.5 mi south of the Freeway Tunnel Alternative project area, and 5 mi south of the TSM/TDM Alternative project area. These localities, LACM 7701 and LACM 7702, produced specimens of threespine stickleback (*Gasterosteus aculeatus*), salamander (*Batrachoseps*), lizard, (*Lacertilia*), snake (*Colubridae*), rabbit (*Sylvilagus*), pocket mouse (*Microtus*), harvest mouse (*Reithrodontomys*), and pocket gopher (*Thomomys*) at 11 to 34 ft below the surface.

Within the marine Pliocene Fernando Formation, the LACM records four fossil vertebrate localities in downtown Los Angeles, about 5 mi west of the project areas for the TSM/TDM, LRT, and Freeway Tunnel Alternatives and 6 mi west of the project area for the BRT Alternative. Three of these localities are LACM 3868, LACM 4726, and LACM 6971, all in downtown Los Angeles on both sides of the Harbor Freeway (I-110). These localities produced specimens of eagle ray (*Myliobatis*), bonito shark (*Isurus oxyrinchus*), bull shark (*Carcharhinus*), white sharks (*Carcharodon carcharias, Carcharodon sulcidens, Carcharocles*), and sheephead (*Semicossyphus*). The fourth locality, LACM 7730, is west of Main Street and south of 1st Street, and it yielded many marine vertebrate specimens, including bull shark (*Carcharhinus leucas*), dusky shark (*Carcharhinus obscurus*), hammerhead shark (*Sphyrna*), chimaera (*Chimaeriformes*), six-gilled shark (*Hexanchiformes*), white shark (*Carcharodon*), bonito shark (*Isurus oxyrinchus*), salmon shark (*Lamna ditropis*), stingray

(*Dasyatis*), skate (*Raja*), herring (*Clupeidae*), hake (*Merluccius*), wrasse (*Labridae*), mackerel (*Scomber*), bird (*Aves*), toothed whale (*Odontoceti*), and rorqual whale (*Balaenopteridae*).

The LACM has numerous fossil localities throughout the Los Angeles Basin in the marine Miocene Puente Formation, which may also be referred to as the Modelo or Monterey Formation. The closest vertebrate locality is LACM 1027, located west of SR 710 near the intersection of Valley Boulevard and Highbury Avenue. This locality is adjacent to the TSM/TDM Alternative improvements at the SR 710 and Valley Boulevard intersection, as well as the project areas for the LRT and Freeway Tunnel Alternatives, and about 1 mi west of the project area for the BRT Alternative. This locality produced fossil specimens of the extinct herring, *Xyne grex.* The next locality, LACM 1031, is south of Huntington Drive and Main Street and north of Poplar Boulevard, less than 0.5 mi from the project areas for the LRT and Freeway Tunnel Alternatives and the TSM/TDM improvement at Fremont Avenue and Poplar Boulevard, and about 1 mi from the project area for the BRT Alternative. This locality produced a suite of fossil fish, including moray eel (*Deprandus lestes*), grunion (*Zanteclites hubbsi*), herrings (*Clupea hadleyi*, *Ganolytes cameo,* and *Xyne grex*), sardine (*Ellimma elmodenae*), cods (*Eclipes extensus* and *Merriamina ectenes*), lanternfishes (*Myctophidae*), snake mackerel (*Thyrsocles kriegeri*), porgie (*Plectrites classeni*), deep sea smelt (*Quaesita quisquilia*), and pipefish (*Hipposyngnathus imporcitor*). The pipefish specimens were published in the scientific literature, and of particular scientific importance, one of the fossil herring specimens from this locality is a paratype of *Clupea hadleyi.*

The LACM has one vertebrate locality from the marine deposits of the Miocene Topanga Group: LACM (CIT) 424, located near the intersection of Avenue 64 and Burleigh Drive. This locality is less than 2 mi west of the project areas for the BRT, LRT, and Freeway Tunnel Alternatives and the TSM/TDM Alternative improvement at Figueroa Street and Colorado Boulevard. This locality produced fossils of fish, including herrings (*Ganolytes* and *Etringus*), as well as a snake mackerel (*Thyrsocles*).

The LACM believes that shallow (less than several feet) excavations in the Quaternary Alluvial Deposits found at the surface throughout most of the project area are unlikely to uncover any scientifically significant vertebrate fossils. However, deeper excavations in the Quaternary Alluvial Deposits, as well as any excavations into exposures of the Fernando Formation, Puente Formation, or Topanga Group have the potential to uncover scientifically significant vertebrate fossils. Therefore, the LACM believes that any substantial excavation within these deposits should be monitored by a paleontologist to quickly and professionally recover any fossils that may be encountered while not impeding development during grading within the project area. Any recovered fossils should be placed into an accredited scientific institution for the benefit of current and future generations. A copy of the LACM locality search letter is attached at the end of this report (Appendix A).

6.3 Field Inspection

A field inspection of the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternative project areas was not conducted as part of this report for the following reasons. Within all the project areas, exposures of native deposits are extremely limited because they lie within commercial or residential areas, most of which are either paved or disturbed from previous construction of buildings, streets, or freeways. This is particularly true for the TSM/TDM and BRT Alternative project areas, which involve modifications to existing ROW. For the LRT and Freeway Tunnel Alternatives, large portions of the project areas are underground and not possible to inspect. Other portions at the surface follow active freeway ROW, which is also paved and disturbed from previous construction and is unsafe to inspect.

6.4 Results Summary

The project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives include eight geologic units: Holocene Alluvial Fan Deposits, Young Alluvial Fan Deposits, Young Alluvium, Old Alluvial Fan Deposits, Old Alluvium, Fernando Formation, Puente Formation, and Topanga Group. Artificial Fill is also present in localized areas where it was necessary for previous construction. The locality search through the LACM showed that no previously recorded fossil localities exist within the project area boundaries for any of the alternatives. However, scientifically significant paleontological resources have been recovered nearby and/or within the region from the same or similar geologic units as several of those mapped in the project areas. In particular, the Old Alluvial Fan Deposits, Old Alluvium, Fernando Formation, Puente Formation, and Topanga Group have produced scientifically significant fossils in other areas. Therefore, these geologic units have the potential to contain similarly important paleontological resources within the project areas and are considered to have high paleontological sensitivity. Fossils are also known to occur elsewhere in the older sediments of the Young Alluvial Fan Deposits and Young Alluvium. As such, these units are assigned a low sensitivity rating from the surface to a depth of 10 ft and a high rating below that mark. The Artificial Fill and Holocene Alluvial Fan Deposits do not have the potential to contain scientifically significant fossils and, therefore, have no paleontological sensitivity. However, these two geologic units vary in thickness and may overlie older deposits with high or low paleontological sensitivity.

This page intentionally left blank

7. Recommendations

7.1 Recommendations

Based on the results of this study and consideration of the development methods for each alternative, no special paleontological situations that would require project redesign to avoid critical fossil localities or deposits are anticipated for any of the alternatives. However, the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives include some degree of ground disturbance in paleontologically sensitive sediments. As such, each of these alternatives has the potential to impact scientifically significant, nonrenewable paleontological resources. In order to mitigate this impact and comply with all applicable federal, State, and local regulations, this study recommends that a PMP be prepared if one of these alternatives is selected. Once the alternative is selected, the PMP will be developed concurrently with the final design plans. In this way, more detailed plans for ground disturbance may be integrated into the PMP and used to determine the appropriate level of monitoring for different locations within the project area for the selected alternative. Because the No Build Alternative does not include improvements, it will not affect paleontological resources and, therefore, does not require a PMP.

In general, the level of monitoring recommended in a PMP will vary from project to project and depends on the paleontological sensitivity of the deposits, as well as the method and depth of ground disturbance. For a given project, ground disturbance in deposits with no paleontological sensitivity usually does not require monitoring of any kind, whereas spot-check monitoring and full-time monitoring may be recommended in deposits with low and high sensitivity, respectively. These basic recommendations are more often applicable when traditional excavation methods are used, such as with scrapers, trackhoes, bulldozers, etc. When other excavation methods are employed, such as drilling for CIDH piles and with the TBM, only spot-check monitoring and screen-washing may be required regardless of the sensitivity level of the deposits because these methods prevent access to the rock face, produce fine-grained material, and preclude the recovery of larger fossils. The level of monitoring will also vary according to the depth of excavation, particularly in areas that contain Artificial Fill or Holocene Alluvial Fan Deposits, both of which have no paleontological sensitivity but may overlie deposits that could contain scientifically significant fossils. Portions of a project area underlain by Artificial Fill or Holocene Alluvial Fan Deposits may not be monitored at all if excavation is planned to remain within these geologic units. However, if the thickness of these deposits is unknown or excavation could extend into paleontologically sensitive deposits below them, spot-check monitoring may be required. Of course, if excavation is planned to extend beneath them, full-time or spot-check monitoring may be required, depending on the sensitivity level of the underlying deposits. Using these general conditions, predictions may be made as to the recommendations that may be included in the PMP for each alternative, which are outlined below.

Most of the improvements in the TSM/TDM Alternative consist of modifications to existing ROW. As such, these areas have been previously disturbed for the existing roads, sidewalks, and landscaping and are likely underlain by some amount of Artificial Fill. The PMP for this alternative will need to take into account the method of ground disturbance, depth of excavation, and the presence and thickness of Artificial Fill at each of the improvements. For example, some improvements may not involve any ground disturbance, and the PMP may recommend no monitoring be required regardless of the sensitivity of the underlying deposits. The majority of improvements are in areas mapped with high sensitivity deposits. Depending on the amount of Artificial Fill and the excavation method and depth at each of those improvements, the PMP may recommend no monitoring, only spot-check monitoring, or a combination of spot-check and full-time monitoring during excavation. The same recommendations may also apply to the few improvements that contain deposits with low sensitivity to a depth of 10 ft and high sensitivity below that mark. However, for larger-scale improvements such as T-1 and T-2, the PMP may recommend full-time monitoring because excavation is more likely to reach native deposits, which in these areas are considered to be highly sensitive for paleontological resources.

Most of the improvements in the BRT Alternative occur in areas mapped as having high sensitivity deposits. However, nearly all of the improvements will be in existing ROW, which may contain some amount of Artificial Fill placed during previous construction. These improvements include widening roadways and sidewalks, modifications to the SR 710/SR 60 interchange, and installation of ancillary structures such as bus shelters, traffic signs, and power poles. Therefore, the PMP for this alternative may include spot-check or full-time monitoring for these improvements depending on the presence and thickness of Artificial Fill and the proposed excavation depth. Because some of the TSM/TDM Alternative improvements are also part of the BRT Alternative, the PMP would also include some of the recommendations proposed above for the TSM/TDM Alternative.

The PMP for the LRT Alternative may recommend full-time monitoring during excavation for the southern portal and train stations because these areas will use traditional methods to excavate in high-sensitivity deposits. Because the entire length of the tunnel section passes through high-sensitivity deposits, the PMP may recommend spot-check monitoring and screen washing or full-time monitoring in this area, depending on the type of TBM used. Spot-check monitoring may be recommended during drilling for the CIDH piles that support the aerial section as well. For the other smaller-scale improvements, such as widening Mednik Avenue, retaining walls at the maintenance yard and Floral Station, and the I-710 off-ramp, some degree of monitoring may also be recommended depending on the presence and thickness of Artificial Fill in those areas. Because some of the TSM/TDM improvements are also part of this alternative, the PMP would also include some of the recommendations proposed above for the TSM/TDM Alternative.

For the Freeway Tunnel Alternative, the PMP may recommend full-time monitoring during excavation for the cut-and-cover tunnels at the north and south portals because these areas will use traditional methods to excavate in high sensitivity deposits. Like in the LRT Alternative, the entire length of the bored tunnel section passes through high sensitivity deposits. Therefore, the PMP may only recommend spot-check monitoring and screen washing or full-time monitoring, depending on the type of TBM used. Other improvements in the Freeway Tunnel Alternative (e.g., the I-10 and I-210 interchanges, on-ramps, off-ramps, and some surface streets) may need some degree of monitoring depending on the presence and thickness of Artificial Fill in those areas. Because some of the TSM/TDM Alternative improvements are also part of the Freeway Tunnel Alternative, the PMP would also include some of the recommendations proposed above for the TSM/TDM Alternative.

7.2 Paleontological Mitigation Guidelines

Both Caltrans and the SVP provide guidance on how to mitigate impacts to paleontological resources and develop a mitigation plan, summaries of which are provided in the two next sections. The PMP prepared for the TSM/TDM, BRT, LRT, or Freeway Tunnel Alternative should take this information into consideration and follow the Caltrans guidelines in the SER Environmental

Handbook, Volume 1, Chapter 8 (Caltrans, 2012). Once the PMP has been prepared, the paleontological resource impact minimization measures within it will be incorporated into the plans, specifications, and estimates for whichever project alternative is selected.

7.2.1 California Department of Transportation

Caltrans (2012) has developed the following set of guidelines to reduce impacts to paleontological resources. These recommendations start with avoidance of the resource area by the project and continue with recommendations for impact mitigation measures during construction excavation.

7.2.1.1 Avoidance

Avoidance of project impacts can be achieved by project redesign so that paleontological resources are completely outside the project's impact area (e.g., a different alignment route that misses the resource or a construction approach that does not entail construction excavation that would impact fossiliferous strata). In most cases, however, avoidance is not a viable option because the location of any paleontological resources within a geologic unit is unknown and geologic units can extend for great distances both horizontally and vertically. Therefore, it is unlikely that a project can be redesigned in order to avoid paleontological resources while still meeting the purpose and need of the project.

7.2.1.2 Environmentally Sensitive Areas

A related strategy creates Environmentally Sensitive Areas (ESAs) around paleontological localities. ESAs are a standard part of the Caltrans and FHWA toolkit to protect resources within or adjacent to a project while concurrently delivering the project. Generally, these involve some combination of fencing or cyclic monitoring as an alternative to excavation monitoring. In the event that the special measures prove ineffective for one reason or another, more traditional mitigation is necessary. This fallback sometimes affects delivery schedules and/or total project costs. If viable and properly implemented, however, ESAs can reduce costs and time associated with more extensive traditional mitigation approaches.

ESAs are rarely used for paleontological resources because establishing an ESA around a paleontological resource, such as a fossil locality or fossiliferous area, requires that the presence and location of that paleontological resource be known. However, in most cases, the presence of a paleontological resource within a geologic unit in a given project area is not known prior to excavation, and designating an entire geologic unit an ESA is not a viable option.

7.2.1.3 Paleontological Mitigation Plan

Because the geology of California is diverse and the nature of the fossils that it contains varies from one outcrop to the next, Caltrans does not provide a generic PMP. Instead, Caltrans presents a format for the PMP that can be utilized by the professional project paleontologist who has been retained to manage paleontological resources during project development. A full list of sections of the PMP is included in the Caltrans SER Environmental Handbook, Volume 1, Chapter 8 (Caltrans, 2012). Briefly, the PMP sections are:

- **Introduction:** A brief discussion of the goals of the proposed study, of the construction project effects, and why mitigation is needed (e.g., compliance with CEQA).

- **Background:** Pertinent information should be provided to demonstrate familiarity with the project area and the types of fossils and rock units under study.
- **Description of the Resource:** A description of the rock units, boundaries of the fossiliferous formations, and locations of exposures in the vicinity of the project study area.
- **Proposed Research:** A clear, concise description of why the paleontological resource is scientifically significant or has scientific importance, and how the study is expected to address current gaps in the paleontological data.
- **Scope of Work:** The work plan to mitigate project effects, including all fieldwork and laboratory efforts. This may include:
  - Procedures for interfacing paleontological and construction personnel developed in consultation with the Resident Engineer.
  - Construction monitoring programs should be outlined.
  - Salvage methods should be outlined, from large specimen recovery to collection and processing of microfossils.
  - Recovered specimens should be prepared to a point of identification and stabilized for preservation in conformance with individual repository requirements.
  - All recovered specimens should be cataloged using the format of the proposed curation facility.
  - Not all located fossils need to be recovered. Criteria for the discarding of specific fossil specimens should be made explicit.
- **Decision Thresholds:** How and when fieldwork will achieve the study goals, allowing fieldwork to cease, or any circumstances under which additional effort might be needed to achieve study goals.
- **Schedule:** The schedule for completing the proposed work may appear as text or in graphic form (e.g., a timeline) and include a start date, the duration of fieldwork and laboratory processing, and the time required for report preparation.
- **Justification of Cost Estimate:** Provides narrative support for the cost estimate, including the basis for person-hour estimates, clarification of overhead percentages, and any other costs.
- **Cost Estimate:** This is often presented as an appendix; this documentation should present a tabular summary of costs for the proposed effort and include all proposed numbers and levels of personnel, time, and costs.
- **Bibliography:** The bibliography should include only those references cited in the plan.
- **Curation:** The curation facility should be identified and a draft curation agreement included. A curation agreement with an approved facility must be in place prior to initiating any paleontological monitoring or mitigation activities.

The plan should be prepared by or under the supervision of a qualified Principal Paleontologist and submitted for review sufficiently in advance of an anticipated start-work date so that all involved agencies have time to comment, the Lead Agency has time to adjust the plan to accommodate such input, and the plan may be resubmitted for all necessary approvals. It is imperative that all agencies with jurisdiction over a paleontological site are in agreement as to the level of effort in the mitigation plan, including agreement on the applicability of pertinent laws, regulations, and permit requirements. When properly designed, the PMP serves as a basis for obtaining any necessary permits from other agencies.

Specific interagency issues may include, but are not limited to, health and safety issues; employee access and egress; collection, removal, and stockpiling of fossiliferous sediment; water washing; wet screen processing of fossiliferous sediment and disposal of muddy wastewater; and use of chemicals (kerosene) to break down specific types of indurated fossiliferous sediment. Agency permits that may be needed for access or to conduct the work of monitoring and salvage should be applied for and obtained in advance of the project.

7.2.2 Society of Vertebrate Paleontology

Recommended general guidelines for conformable impact mitigation to scientifically significant nonrenewable paleontological resources have been published by the SVP (1995, 2010), along with conditions of receivership that the repository institution can require when receiving fossils recovered from construction projects (SVP, 1996). Based on these guidelines, in areas determined to have a high potential for scientifically important paleontological resources, an adequate program for mitigating the impact of development should include:

1. An intensive field survey and surface salvage prior to earthmoving, if applicable;
2. Monitoring by a qualified paleontological resource monitor of excavations in previously undisturbed rock units;
3. Salvage of unearthed fossil remains and/or traces (e.g., tracks, trails, and burrows);
4. Screen washing to recover small specimens, if applicable;
5. Preparation of salvaged fossils to a point of being ready for curation (i.e., removal of enclosing matrix, stabilization and repair of specimens, and construction of reinforced support cradles where appropriate);
6. Identification, cataloging, curation, and provision for repository storage of prepared fossil specimens; and
7. A final report of the finds and their scientific significance.

All phases of mitigation must be supervised by a qualified professional paleontologist who maintains the necessary paleontological collecting permits and repository agreements. All field teams will be supervised by a paleontologist qualified to deal with the scientifically significant resources that might be encountered. The Lead Agency must assure compliance with the measures developed to mitigate impacts of excavation. To ensure compliance at the start of the project, a statement that confirms the site's paleontological potential, confirms the repository agreement with an established public institution, and describes the program for impact mitigation must be deposited with the Lead Agency and contractor(s) before any ground disturbance begins. In many cases, it will be necessary to conduct a salvage program prior to grading to prevent damage to known paleontological resources and to avoid delays to construction schedules. The impact mitigation program must include preparation, identification, cataloging, and curation of any salvaged specimens. All field notes, photographs, stratigraphic sections, and other data associated with the recovery of the specimens must be deposited with the institution receiving the specimens. Because it is not professionally acceptable to salvage specimens without preparation and curation of specimens and associated data, costs for this phase of the program must be included in the project budget. The mitigation program must be reviewed and accepted by the Lead Agency. If a mitigation program is initiated early during the course of project planning, construction delays due to paleontological salvage activities can be minimized or even completely avoided.

8. Summary

Caltrans, in cooperation with Metro, proposes this project in order to improve mobility and relieve congestion in the area between SR 2 and I-5, I-10, I-210, and I-605 in east/northeast Los Angeles and the San Gabriel Valley. Federal and State regulations require that impacts to paleontological resources be considered during project design and construction, and this report was prepared in order to comply with these regulations. Following the Caltrans Guidelines and recommendations from the SVP, this report identifies and evaluates any potential paleontological resources that may be encountered during development of this project and makes recommendations on how to mitigate those impacts. The findings in this study are based on the excavation and construction methods for each project alternative, definitions of paleontological significance and sensitivity, reviews of geological and paleontological literature, and the results of a paleontological locality search through the LACM.

This proposed project includes five alternatives: (1) No Build, (2) TSM/TDM, (3) BRT, (4) LRT, and (5) Freeway Tunnel. The No Build Alternative does not include improvements, and therefore, does not involve any ground disturbance. The TSM/TDM and BRT Alternatives mainly consist of modifications to existing ROW, such as widening roads and sidewalks, installing new traffic signals, constructing medians, and relocating light poles. For the most part, these alternatives involve relatively minor ground disturbance, with the exception of a few components in each alternative. The LRT and Freeway Tunnel Alternatives involve more substantial excavation and ground disturbance. For example, the LRT Alternative includes excavation for support structures for the aerial section, a bored tunnel section, and rail stations along the route. The Freeway Tunnel Alternative includes excavation for a central bored tunnel with cut-and-cover tunnels at the portals at both ends. The bored tunnel sections of these alternatives will be excavated using a tunnel boring machine, which prevents access to the rock face and grinds the rock into small particles.

The project areas for the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives are located in a transitional area between the Los Angeles Basin of the Peninsular Ranges Geomorphic Province and the hills of the Transverse Ranges. They cross eight geologic units that were deposited between approximately 16 Ma and the present, including Holocene Alluvial Fan Deposits, Young Alluvial Fan Deposits, Young Alluvium, Old Alluvial Fan Deposits, Old Alluvium, Fernando Formation, Puente Formation, and Topanga Group. Artificial Fill is also present within the project areas where needed during previous construction. Although no paleontological localities are known to exist within the boundaries of the project areas, the Old Alluvial Fan Deposits, Old Alluvium, Fernando Formation, Puente Formation, and Topanga Group all have the potential to contain nonrenewable, scientifically significant paleontological resources and are considered to have high paleontological sensitivity. The Young Alluvial Fan Deposits and Young Alluvium may contain scientifically significant fossils in their older sediments and, therefore, are considered to have low sensitivity from the surface to a depth of 10 ft and high sensitivity below that mark. Although Artificial Fill and Holocene Alluvial Fan Deposits will not contain scientifically important fossils and therefore have no paleontological sensitivity, they vary in thickness and may overlie older deposits that could contain nonrenewable, scientifically significant paleontological resources.

Consideration of the impacts this project would have on paleontological resources must take into account the paleontological sensitivities of the geologic units involved and the project development methods for the alternatives. This study does not anticipate special paleontological situations that would require project redesign to avoid critical localities or strata. The No Build Alternative does not include improvements and, therefore, will not affect paleontological resources. However, the TSM/TDM, BRT, LRT, and Freeway Tunnel Alternatives include some degree of ground disturbance in areas mapped as containing paleontologically sensitive sediments. As such, each of these alternatives has the potential to impact scientifically significant, nonrenewable paleontological resources, and this study recommends that a PMP be prepared if one of these alternatives is selected. The PMP should follow guidelines provided by Caltrans in the SER Environmental Handbook, Volume 1, Chapter 8 (Caltrans, 2012), and, at a minimum, include the following recommendations:

- A qualified paleontologist or representative will attend the pre-grade conference. At this meeting, the paleontologist will explain the likelihood for encountering paleontological resources, what resources may be discovered, and the methods of recovery that will be employed.
- A preconstruction field survey will be conducted in areas with deposits of high paleontological sensitivity after vegetation and paving have been removed, and any observed surface paleontological resources salvaged prior to the beginning of additional grading.
- In general, a qualified paleontological monitor will initially be present on a full-time basis whenever excavation will occur within the sediments that have a high paleontological sensitivity rating, and on a spot-check basis when excavating in sediments that have a low sensitivity rating. No monitoring is generally necessary in deposits with no paleontological sensitivity, such as Artificial Fill and Holocene Alluvial Fan Deposits. However, the specific monitoring levels and locations will be developed according to the final design plans and take into account the excavation methods and depths, the thickness of any Artificial Fill and/or Holocene Alluvial Fan Deposits present in the project area, and the sensitivity of the deposits underlying those two geologic units.
- Full-time monitoring may be reduced to a part-time or spot-check basis if no resources are being discovered in sediments with a high sensitivity rating (monitoring reductions, when they occur, will be determined by the qualified Principal Paleontologist in consultation with the Resident Engineer). The monitor will inspect fresh cuts and/or spoils piles to recover paleontological resources and/or screen wash for smaller fossils, depending on the material available for inspection. The monitor will be empowered to temporarily divert construction equipment away from the immediate area of the discovery. The monitor will be equipped to rapidly stabilize and remove fossils to avoid prolonged delays to construction schedules. If large mammal fossils or large concentrations of fossils are encountered, heavy equipment will be used to assist in the removal and collection of large materials.
- Native sediments of high and low sensitivity will occasionally be spot-screened on site through 1/8- to 1/20-inch mesh screens to determine whether microvertebrates or other small fossils are present. If small fossils are encountered, sediment samples (up to 3 cubic yards, or 6,000 pounds) will be collected and processed through 1/20-inch mesh screens to recover additional fossils.
- Recovered specimens will be prepared to the point of identification and permanent preservation. This includes the sorting of any washed mass samples to recover small invertebrate and vertebrate fossils, the removal of surplus sediment from around larger

specimens to reduce the volume of storage for the repository and storage cost, and the addition of approved chemical hardeners/stabilizers to fragile specimens.

- Specimens will be identified to the lowest taxonomic level possible and curated into an institutional repository with retrievable storage. The repository institutions usually charge a one-time fee based on volume, so removing surplus sediment is important. The repository institution may be a local museum or university with a curator who can retrieve the specimens on request. Caltrans requires that a draft curation agreement be in place with an approved curation facility prior to the initiation of any paleontological monitoring or mitigation activities.
- A PMR will be prepared and submitted to the Lead Agency (Caltrans) to document completion of the PMP.

Implementation of these recommendations will reduce impacts to nonrenewable paleontological resources in compliance with all applicable federal, State, and Local regulations. Once the alternative is selected, the PMP will be developed concurrently with the final design plans. In this way, more detailed plans for ground disturbance may be integrated into the PMP and used to determine the appropriate level of monitoring for different locations within the project area for the selected alternative.

This page intentionally left blank

9. References

California Department of Transportation (Caltrans)

2012 Standard Environmental Reference, Volume 1, Chapter 8 – Paleontology, last updated February 2012. http://www.dot.ca.gov/ser/vol1/sec3/physical/Ch08Paleo/chap08paleo.htm, accessed April 2013.

California Geological Survey

2002 California Geomorphic Provinces, California Geological Survey Note 36. California Department of Conservation.

Campbell, R.H., T.H. McCulloh, and J.G. Vedder

2007 The Miocene Topanga Group of Southern California—A 100-Year History of Changes in Stratigraphic Nomenclature, U.S. Geologic Survey Open File Report 2007-1385, revised 2009, 36 pp.

CH2M HILL

2013 Draft Geologic Cross-Section for the SR 710 North Study, Freeway Tunnel Alternative and Light Rail Transit Alternative. In Geotechnical Report for the State Route 710 North Study. Prepared for Caltrans by CH2M HILL, August 2013.

City of Alhambra

1986 City of Alhambra General Plan, adopted November 10, 1986. Available at Alhambra City Hall, 111 South First Street, Alhambra, CA 91801.

City of Arcadia

2010 City of Arcadia General Plan, adopted November 16, 2010. http://www.ci.arcadia.ca.us/home/index.asp?page=1586, accessed September 2013.

City of Baldwin Park

2002 City of Baldwin Park General Plan, adopted November 20, 2002. http://www.baldwinpark.com/index.php?option=com_docman&task=cat_view&gid=135, accessed September 2013.

City of Commerce

2008 Chapter 6: Resource Management Element, City of Commerce 2020 General Plan, adopted January 2008. http://www.ci.commerce.ca.us/DocumentCenter/Home/View/152, accessed September 2013.

City of Duarte

2007 City of Duarte Comprehensive General Plan 2005–2020, adopted August 14, 2007. http://www.accessduarte.com/?option=com_content&view=article&id=48&Itemid=90, accessed September 2013.

City of El Monte
2011 City of El Monte General Plan, adopted June 7, 2011. http://www.ci.el-monte.ca.us/Government/EconomicDevelopment/Planning.aspx, accessed September 2013.

City of Glendale
1993 Open Space and Conservation Element, City of Glendale General Plan, adopted March 16, 1993. http://www.ci.glendale.ca.us/planning/plangeneralplanelements.asp, accessed September 2013.

City of Irwindale
2008 Chapter 5: Resource Management Element, City of Irwindale 2020 General Plan, adopted June 2008. http://www.ci.irwindale.ca.us/DocumentCenter/View/38, accessed September 2013.

City of La Cañada Flintridge
2013 Chapter 4: Conservation Element, City of La Cañada Flintridge General Plan 2030, adopted January 22, 2013. http://www.lcf.ca.gov/general-plan, accessed September 2013.

City of Los Angeles
2001 Conservation Element, City of Los Angeles General Plan, adopted September 26, 2001. http://cityplanning.lacity.org/, accessed September 2013.

City of Monrovia
1993 Land Use Element, City of Monrovia General Plan, adopted July 20, 1993. Available at Monrovia City Hall, 415 South Ivy Avenue, Monrovia, CA 91016.

1966a Public Service and Conservation Element, City of Monrovia General Plan, adopted January 4, 1966. Available at Monrovia City Hall, 415 South Ivy Avenue, Monrovia, CA 91016.

1966b Recreation and Open Space Element, City of Monrovia General Plan, adopted January 4, 1966. Available at Monrovia City Hall, 415 South Ivy Avenue, Monrovia, CA 91016.

City of Montebello
1975 City of Montebello General Plan, adopted May 27, 1975. http://www.cityofmontebello.com/depts/planning_n_community_development/planning_division/general_plan/default.asp, accessed September 2013.

City of Monterey Park
2001 City of Monterey Park General Plan, adopted July 2001. http://ci.monterey-park.ca.us/index.aspx?page=692, accessed September 2013.

City of Pasadena
2004 Land Use Element, City of Pasadena Comprehensive General Plan, adopted November 8, 2004. http://www.ci.pasadena.ca.us/Planning/CommunityPlanning/General_Plan/, accessed September 2013.

City of Rosemead
2010 City of Rosemead General Plan, adopted April 13, 2010. http://www.cityofrosemead.org/index.aspx?page=88, accessed September 2013.

City of San Gabriel
2004 Comprehensive General Plan of the City of San Gabriel, adopted May 18, 2004. http://www.sangabrielcity.com/index.aspx?NID=404, accessed September 2013.

City of San Marino
2003 City of San Marino General Plan, adopted October 8, 2003. http://www.cityofsanmarino.org/planning.htm, accessed September 2013.

City of Sierra Madre
1996 City of Sierra Madre General Plan, adopted June 11, 1996. http://www.cityofsanmarino.org/planning.htm, accessed September 2013.

City of South El Monte
2000 City of South El Monte General Plan, adopted October, 2000. http://www.ci.south-el-monte.ca.us/CITYDEPARTMENTSSERVICES/CommunityDevelopment/Planning.aspx, accessed September 2013.

City of South Pasadena
1998 Chapter 2: Land Use Element, City of South Pasadena General Plan, adopted October, 1998. http://www.ci.south-pasadena.ca.us/index.aspx?page=120, accessed September 2013.

City of Temple City
1987 City of Temple City General Plan, adopted April 21, 1987. http://www.ci.temple-city.ca.us/planning.asp, accessed September 2013.

Community of Altadena
1986 Altadena Community Plan, adopted July 10, 1986. http://planning.lacounty.gov/view/altadena_community_plan/, accessed September 2013.

Community of East Los Angeles
1988 East Los Angeles Community Plan, adopted June 23, 1988. http://planning.lacounty.gov/view/east_los_angeles_community_plan/, accessed September 2013.

County of Los Angeles
2012 Chapter 6: Conservation and Natural Resources Element, Los Angeles County Draft General Plan 2035. Text-only version May 2012. http://planning.lacounty.gov/generalplan/draft2012, accessed September 2013.

Durham, D.L., and R.F. Yerkes
1964 Geology and Oil Resources of the Eastern Puente Hills Area, Southern California, U.S. Geologic Survey Professional Paper 420-B, 62 pp.

Eisentraut, P., and J. Cooper
2002 Development of a Model Curation Program for Orange County's Archaeological and Paleontological Collections, prepared by California State University, Fullerton, and submitted to the County of Orange Public Facilities and Resources Department/Harbors, Parks, and Beaches.

Eldridge, G.H., and R. Arnold
1907 The Santa Clara Valley, Puente Hills and Los Angeles Oil Districts, Southern California, U.S. Geological Survey Bulletin 309, 266 pp.

Feldmann, R.M.
2003 Decapod Crustaceans from the Puente Formation (Late Middle to Early Late Miocene), California: a Possible Mass Death, Southern California Academy of Sciences Bulletin, Volume 102, Issue 3, p. 107-118.

International Commission on Stratigraphy
2013 International Chronostratigraphic Chart, updated January 2013. http://www.stratigraphy.org/, accessed August 2013.

Jefferson, G.T.
1991a A Catalogue of Late Quaternary Vertebrates from California: Part One, Nonmarine Lower Vertebrate and Avian Taxa. Natural History Museum of Los Angeles County Technical Report No. 5, 60 pp.

1991b A Catalogue of Late Quaternary Vertebrates from California: Part Two, Mammals. Natural History Museum of Los Angeles County Technical Report No. 7, 129 pp.

Kew, W.S.W.
1924 Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California, U.S. Geological Survey Bulletin 753, p. 411–420.

Koch, A.L., V.L. Santucci, and T.R. Weasma
2004 Santa Monica Mountains National Recreation Area Paleontological Survey, Technical Report NPS/NRGRD/GRDTR-04/01.

Lamar, D.L.
1970 Geology of the Elysian Park-Repetto Hills Area, Los Angeles County, California, California Division of Mines and Geology Special Report 101, 45 pp., 1 plate.

Miller, W.E.
1971 Pleistocene Vertebrates of the Los Angeles Basin and Vicinity (Exclusive of Rancho La Brea), Los Angeles County Museum of Natural History Bulletin, Science: No. 10, 124 pp.

Natland, M.L., and W.T. Rothwell, Jr.
1954 Fossil Foraminifera of the Los Angeles and Ventura Regions, California, In R. H. Jahns, ed., Geology of Southern California, California Division of Mines and Geology Bulletin 170, Chapter 3, p. 33–42.

Norris, R.M., and R.W. Webb
1976 Geology of California, John Wiley and Sons, Inc., Santa Barbara, CA, 365 pp.

Reynolds, R.E., and R.L. Reynolds
1991. The Pleistocene Beneath Our Feet: Near-surface Pleistocene Fossils in Inland Southern California Basins, in M. O. Woodburne, R. E. Reynolds, and D. P. Whistler, eds., Inland Southern California: The Last 70 Million Years, Redlands, San Bernardino County Museum Special Publication 38 (3 & 4).

Rigby, J.K., and Y. Albi
1996 An Upper Miocene Hexactinellid Sponge from the Puente Shale, Orange County, California. Journal of Paleontology 70(6):908–913.

Schoellhamer, J.E., J.G. Vedder, R.F. Yerkes, and D.M. Kinney
1981 Geology of the Northern Santa Ana Mountains, California, United States Geologic Survey, Professional Paper 420-D, 109 pp.

Sharp, R.P.
1976 Geology Field Guide to Southern California, Kendall/Hunt Publishing Company, Second Edition, 181 pp.

Society of Vertebrate Paleontology (SVP)
2010 Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources Society of Vertebrate Paleontology. Impact Mitigation Guidelines Revision Committee, p. 1–11.

1996 Conditions of Receivership for Paleontologic Salvage Collections. SVP News Bulletin No. 166:31–32.

1995 Assessment and Mitigation of Adverse Impacts to Nonrenewable Paleontologic Resources: Standard Guidelines. SVP News Bulletin No. 163:22–27.

Yerkes R.F.
1972 Geology and Oil Resources of the Western Puente Hills area, Southern California, United States Geological Survey Professional Paper 420-C, 62 pp.

Yerkes, R.F., and R.H. Campbell
2005 Preliminary Geologic Map of the Los Angeles 30’ x 60’ Quadrangle, Southern California, United States Geological Survey Open File Report 2005-1019. Map Scale 1:100,000.

Yerkes R.F., T.H. McCulloh, J.E. Schoellhamer, and J.G. Vedder
1965 Geology of the Los Angeles Basin California – an Introduction, U.S. Geologic Survey Professional Paper 420-A, 57 pp.

Appendix A: Locality Search Results

This page intentionally left blank

Natural History Museum
of Los Angeles County
900 Exposition Boulevard
Los Angeles, CA 90007

tel 213.763.DINO
www.nhm.org

NATURAL HISTORY MUSEUM
LOS ANGELES COUNTY

Vertebrate Paleontology Section
Telephone: (213) 763-3325
Fax: (213) 746-7431
e-mail: smcleod@nhm.org

21 June 2013

LSA Associates, Inc.
20 Executive Park, Suite 200
Irvine, California 92614

Attn: Sarah Rieboldt, Ph.D., Paleontologist

re: Paleontological Resources Records Search for the proposed State Route 710 Project, LSA Project # CHM1105, Phase C1914P, in the Cities of Pasadena to Monterey Park, Los Angeles County, project area

Dear Dr. Rieboldt:

I have thoroughly searched our paleontology collection records for the locality and specimen data for the proposed State Route 710 Project, LSA Project # CHM1105, Phase C1914P, in the Cities of Pasadena to Monterey Park, Los Angeles County, project area as outlined on the portions of the Pasadena and Los Angeles USGS topographic quadrangle maps that you sent to me via e-mail on 1 May 2013. We have no vertebrate fossil localities that lie directly within the proposed project area, but we do have localities nearby from the same sedimentary deposits that occur within the proposed project area.

Around where the Ventura Freeway (Highway 134) crosses the Arroyo Seco in the northwestern portion of the proposed project area, there are exposures of intrusive igneous rocks that will not contain recognizable fossils.

In the northern portion of the proposed project area south of the Ventura Freeway (Highway 134) and the Pasadena Freeway (I-210), in the southern part of the City of Pasadena and the northern part of the City of South Pasadena, the proposed project may cross exposures of the marine middle Miocene Topanga Formation in the elevated terrain of Grace Hill and Raymond Hill. Our closest vertebrate fossil locality in the Topanga Formation is LACM (CIT) 424, west of this portion of the proposed project area somewhat near the intersection of Avenue

64 and Burleigh Drive, that produced specimens of fossil fish including herrings or anchovies, *Ganolytes* and *Etringus*, as well as snake mackerel, *Thyrsocles*.

Further south in the proposed project area, between the Harbor Freeway (I-110) and the San Bernardino Freeway (I-10), the elevated terrain has exposures of the marine late Miocene Puente Formation [that may also be referred to as the Modelo Formation or the Monterey Formation in this area]. We have numerous vertebrate fossil localities within the Puente Formation scattered throughout the area. Our closest vertebrate fossil locality from the Puente Formation is LACM 1027, immediately west of the Long Beach Freeway (I-710) near the intersection of Valley Boulevard and Highbury Avenue, that produced fossil fish specimens of the extinct herring *Xyne grex*. Our next closest vertebrate fossil locality is LACM 1031, between the two alternative proposed project area routes in Emery Park between Huntington Drive, Main Street, and Poplar Boulevard, that produced a suite of fossil fish including moray, *Deprandus lestes*, grunion, *Zanteclites hubbsi*, herrings, *Clupea hadleyi*, *Ganolytes cameo*, and *Xyne grex*, sardine, *Ellimma elmodenae*, cods, *Eclipes extensus* and *Merriamina ectenes*, lanternfishes, Myctophidae, snake mackerel, *Thyrsocles kriegeri*, porgie, *Plectrites classeni*, deep sea smelt, *Quaesita quisquilia*, and pipefish, *Hipposyngnathus imporcitor*. Specimens of the pipefish *Hipposyngnathus imporcitor* from locality LACM 1031 were published in the scientific literature by L. R. David (1943. Miocene fishes of southern California. Geological Society of America Special Papers, 43:1-193) and R. A. Fritzsche (1980. Revision of the eastern Pacific Syngnathidae (Pisces: Syngnathiformes), including both Recent and fossil forms. Proceedings of the California Academy of Science, 42(6):181-227). Locality LACM 1031 also produced a paratype (a specimen used in describing a species new to science) of the fossil herring *Clupea hadleyi* (D. S. Jordan and J. Z. Gilbert. 1919. Fossil Fishes of Southern California. II. Fossil fishes of the Miocene (Monterey) Formations. Leland Stanford Junior University Publications University Series, pp.13-64).

In the southern portion of the proposed project area, south of the San Bernardino Freeway, the elevated terrain has exposures of the marine Pliocene Fernando Formation. Our closest fossil vertebrate localities in the Fernando Formation are LACM 3868, 4726 and 6971, all directly west of the proposed project area in downtown Los Angeles on both sides of the Harbor Freeway (I-110). These localities produced specimens of fossil eagle ray, *Myliobatis*, bonito shark, *Isurus oxyrinchus*, bull shark, *Carcharhinus*, white sharks, *Carcharodon carcharias*, *Carcharodon sulcidens*, *Carcharocles*, and sheepshead, *Semicossyphus*. A further locality in downtown Los Angeles from the Fernando Formation is LACM 7730, south of 1st Street and west of Main Street, produced a suite of marine vertebrates including bull shark, *Carcharhinus leucas*, dusky shark, *Carcharhinus obscurus*, hammerhead shark, *Sphyrna*, chimaera, Chimaeriformes, six-gilled shark, Hexanchiformes, white shark, *Carcharodon*, bonito shark, *Isurus oxyrinchus*, salmon shark, *Lamna ditropis*, stingray, *Dasyatis*, skate, *Raja*, herring, Clupeidae, hake, *Merluccius*, wrasse, Labridae, mackerel, *Scomber*, bird, Aves, toothed whale, Odontoceti, and rorqual whale, Balaenopteridae.

Most of the proposed project area has surface deposits composed of Quaternary Alluvium, derived either as alluvial fan deposits from the San Gabriel Mountains or hills adjacent to the proposed project area north or as fluvial deposits from the Arroyo Seco drainage.

These deposits typically do not contain significant vertebrate fossils, at least in the uppermost layers. At unknown but possibly relatively shallow depths in the proposed project area, however, there are deposits of older Quaternary Alluvium. Our closest vertebrate fossil localities from these deposits is LACM 3363, in the southern portion of the proposed project area between the Long Beach Freeway (710) and Monterey Pass Road south of the San Bernardino Freeway (I-10), that produced fossil specimens of horse, *Equus*. Our next closest vertebrate fossil locality from these deposits is LACM (CIT) 342, west of the middle portion of the proposed project area east of the Pasadena Freeway (I-110) and Eagle Rock Boulevard just south of York Boulevard, that produced fossil specimens of turkey, *Parapavo californicus*, and mammoth, *Mammuthus*, at a depth of 14 feet below the surface. The fossil turkey specimen from locality LACM (CIT) 342 was published in the scientific literature by L.H. Miller in 1942 (A New Fossil Bird Locality. Condor, 44(6):283-284) and the mammoth specimen was a rare, nearly complete skeleton and was published in the scientific literature by V.L. Roth in 1984 (How Elephants Grow: Heterochrony and the Calibration of Developmental Stages in Some Living and Fossil Species. Journal of Vertebrate Paleontology, 4(1):126-145). From these deposits to the south of the proposed project area, south of the southern terminus of the proposed project area in the City of Commerce near the intersection of Atlantic Avenue and the Long Beach Freeway (I-710), our vertebrate fossil localities LACM 7701-7702 produced fossil specimens of threespine stickleback, *Gasterosteus aculeatus*, salamander, *Batrachoseps*, lizard, Lacertilia, snake, Colubridae, rabbit, *Sylvilagus*, pocket mouse, *Microtus*, harvest mouse, *Reithrodontomys*, and pocket gopher, *Thomomys*, at 11 to 34 feet below grade.

Excavations in the intrusive igneous rocks exposed in the northern portion of the proposed project area will not encounter any recognizable fossils. Shallow excavations in the Quaternary Alluvium found at the surface throughout most of the proposed project area probably will not uncover any significant vertebrate fossils. Deeper excavations in those areas that extend down into older sedimentary deposits, as well as any excavations in the exposures of the Fernando Formation, the Puente Formation, or the Topanga Formation, however, may well uncover significant vertebrate fossils. Any substantial excavations in the proposed project area, therefore, should be monitored closely to quickly and professionally recover any fossil remains discovered while not impeding development. Any fossils recovered during mitigation should be deposited in an accredited and permanent scientific institution for the benefit of current and future generations.

This records search covers only the vertebrate paleontology records of the Natural History Museum of Los Angeles County. It is not intended to be a thorough paleontological survey of the proposed project area covering other institutional records, a literature survey, or any potential on-site survey.

Sincerely,

Samuel A. McLeod

Samuel A. McLeod, Ph.D.
Vertebrate Paleontology

enclosure: invoice

Appendix B: Resume

This page intentionally left blank

SARAH RIEBOLDT, PH.D.

PALEONTOLOGIST

EXPERTISE

Paleontological Mitigation Monitoring Reports

Paleontological Resource Monitoring

Fossil Collection, Salvage, Identification, and Curation

EDUCATION

University of California, Berkeley, Ph.D., Biology, 2005.

University of Colorado, Boulder, B.A., Biology, 1999.

PROFESSIONAL EXPERIENCE

Project Manager, Department of Geological Sciences, California State University, Fullerton, and John D. Cooper Archaeological and Paleontological Center, Santa Ana, California, April 2012–April 2013.

Geologist, Geological Survey of Alabama, Tuscaloosa, Alabama, April 2010–February 2012.

Collections Assistant, Field Museum of Natural History, Chicago, Illinois, February 2009–February 2010.

Science Writer, University of California Museum of Paleontology, Berkeley, California, April 2009–November 2009.

PROFESSIONAL RESPONSIBILITIES

Dr. Rieboldt is a paleontologist at LSA with 13 years of experience in the fields of geology and paleontology. She is responsible for scheduling paleontological monitors on both large- and small-scale projects, and she also prepares paleontological assessment reports and monitoring reports following the completion of paleontological mitigation monitoring.

Dr. Rieboldt's field and laboratory experience includes 13 years working on research projects throughout California, Nevada, Utah, Colorado, Wyoming, Texas, and Alabama. She has 5 years of experience working with natural history collections in museums in California, Colorado, and Illinois, and 5 years of experience as a paleontological consultant in California and Utah monitoring for paleontological resources and writing paleontological resource assessment reports and mitigation plans. Dr. Rieboldt also has experience in monitoring excavation and construction for multiple residential subdivision developments and a natural gas pipeline as well as monitoring drilling and coring operations.

PROJECT EXPERIENCE

Durfee Avenue Grade Separation Project
Pico Rivera, California
LSA is conducting environmental technical studies for the Durfee Avenue Grade Separation Project in the City of Pico Rivera, Los Angeles County. The project proposes to lower Durfee Avenue below the Union Pacific Railroad (UPRR) tracks to improve safety for vehicular, rail, and pedestrian traffic along Durfee Avenue as well as nearby streets and the railroad right-of-way. Project development includes lowering Durfee Avenue, Walnut Avenue, and Stephens Street; raising the UPRR tracks; and relocating various wet and dry utilities. Dr. Rieboldt is preparing the Paleontological Identification Report/ Paleontological Evaluation Report (PIR/PER) for this project.

State Route 60 (SR 60)/Theodore Street Interchange Project
Riverside County, California
LSA is conducting environmental technical studies for air quality and biological, cultural, and paleontological resources for the SR 60/ Theodore Street Interchange Project in Moreno Valley, Riverside County. The proposed project involves reconstruction of the local interchange at SR 60 and Theodore Street in order to reduce congestion, improve traffic flow, and accommodate forecasted traffic demands in and around the City of Moreno Valley. Project development includes removal and replacement of the Theodore Street bridge over SR 60, auxiliary lanes along SR 60, and new entrance and exit ramps from SR 60 to Theodore Street. Dr. Rieboldt is preparing the PIR/PER for this project.

SARAH RIEBOLDT, PH.D.
PALEONTOLOGIST

PROFESSIONAL EXPERIENCE (CONTINUED)

Collections Assistant, Chicago Academy of Sciences, Chicago, Illinois, October 2008–February 2009.Postdoctoral Research Associate, Center for Integrative Planetary Science, University of California, Berkeley, May 2005–December 2005.

Paleontological Consultant, RIC Windmiller Consulting, Auburn, California, June 2000–June 2005.

Graduate Student Researcher, Department of Integrative Biology, University of California, Berkeley, January 2004–December 2004.

Science Writer, University of California Museum of Paleontology, Berkeley, California, June 2003–December 2003.

Paleontological Consultant, California Department of Parks and Recreation, San Francisco, California, and University of California Museum of Paleontology, Berkeley, California, June 2001–December 2002.

Graduate Student Researcher, University of California Museum of Paleontology, Berkeley, California, August 2002–December 2002.

Paleontological Consultant, ECORP Consulting, Inc., Roseville, California, June 2002.

Paleontological Consultant, Jones & Stokes Associates, Sacramento, California, August 2001–January 2002.

Collections Assistant, University of California Museum of Paleontology, Berkeley, California, August 1999–December 1999.

Collections Assistant, University of Colorado Museum of Natural History, Boulder, Colorado, September 1997–May 1999.

PROJECT EXPERIENCE (CONTINUED)

State Route 94 (SR 94)/State Route 125 (SR 125) Interchange Branch Connector Project
San Diego County, California
LSA is conducting cultural and paleontological resources assessments for the SR 94/SR 125 Interchange Branch Connector Project in San Diego County. The proposed project involves the construction of a freeway-to-freeway connector to allow direct south-to-east movement for the SR 94/SR 125 interchange in order to improve regional circulation and reduce traffic on local streets in the Cities of La Mesa and Lemon Grove and in the unincorporated community of Spring Valley. Project development includes construction of a freeway connector between southbound SR 125 and eastbound SR 94, auxiliary lanes on those freeways, and new noise barriers and retaining walls as well as modifications to existing structures. Dr. Rieboldt is preparing the PIR/PER for this project.

Surfside Inn Pedestrian Overcrossing Project
Dana Point, California
LSA conducted cultural and paleontological resources assessments for the Surfside Inn Pedestrian Overcrossing Project in the City of Dana Point, Orange County. The proposed project involves replacement and rehabilitation of the pedestrian overcrossing across the Pacific Coast Highway and Metrolink right-of-way from the Capistrano Surfside Inn to Doheny State Beach. Dr. Rieboldt prepared the paleontological resources assessment for this project.

Adelanto Solar Project
San Bernardino County, California
Dr. Rieboldt prepared a paleontological resources analysis report for the Adelanto Solar Project in San Bernardino County. This report included a summary of the geology and potential paleontological resources of the project area, results from a paleontological locality search through the San Bernardino County Museum, and recommendations for mitigating potential impacts to paleontological resources.

Digital 395 Project
San Bernardino, Kern, Inyo, and Mono Counties, California; Douglas and Washoe Counties and Carson City, Nevada
Dr. Rieboldt prepared the Paleontological Resources Mitigation and Monitoring Plan for the Digital 395 Project, which involved the installation of over 590 miles of fiber-optic line along United States Highway 395 (US-395) on the east side of the Sierra Nevada. Running from Barstow, California, to Reno, Nevada, the project route passed through lands managed by the United States Department of the Interior, Bureau of Land Management; United States Department of Agriculture,

PRESENTATIONS

RECS (Research Experience in Carbon Sequestration) Workshop, (Birmingham, Alabama). June 6, 2011.

Geological Society of America Annual Meeting, (Denver, Colorado), "Taphonomy of Jupiter's Icy Moon Europa." November 7–10, 2004.

Bioastronomy Meeting: Habitable Worlds, (Reykjavik, Iceland), "Life, Past and Present, on Jupiter's Icy Moon, Europa." July 12–16, 2004.

35th Lunar and Planetary Science Conference (Houston, Texas), "Geosciences at Jupiter's Icy Moons: The Midas Touch." March 16, 2004.

Seventh Field Conference of the International Subcommission on Cambrian Stratigraphy: The Cambrian System of South China, (Guiyang, China), "Cambrian Inarticulate Brachiopods from Nevada and Texas." August 2001.

Fourth International Brachiopod Congress (London, England), "Can Oxygen Isotopes from Inarticulate Brachiopods Resolve the Causes of Faunal Turnovers in the Cambrian?" July 10–14, 2000.

Geological Society of America Cordilleran Section Meeting, (Berkeley, California), "Inarticulate Brachiopods from the Pioche Formation (Lower and Middle Cambrian), Nevada and their Relation to the Extinction of the Olenellida." June 2–4, 1999.

TEACHING

Science Specialist, San Roque School, Santa Barbara, California, January 2006–June 2008.

Graduate Student Instructor, Department of Integrative Biology, University of California, Berkeley, August 2000–December 2000, January 2001–May 2001, and January 2003–May 2003.

PROJECT EXPERIENCE (CONTINUED)

Forest Service; United States Department of Defense; the States of California and Nevada; and the lands of several Native American tribes. As such, this project was subject to multiple federal, State, and local regulations and policies regarding paleontological resources.

Stratford Ranch Residential Project
Perris, California
LSA conducted an archaeological and paleontological resources assessment for the Stratford Ranch Residential Project in the City of Perris, Riverside County. The proposed project includes a new residential community with 400 lots and a 15-acre Stockpile Plan on approximately 80 acres in northeastern Perris. Project development involves clearing and grading to prepare the project area, construction of a new road within the area, and installation of on-site storm drains, new water service, new sewer lines, new electric service, new natural gas lines, and a new telecommunication infrastructure system to serve the proposed residential uses. Dr. Rieboldt prepared the paleontological resources section of this assessment.

Kaiser Bellflower East Center Demolition Project
Los Angeles County, California
The proposed project involves the demolition of the existing Administration Building and East Center Wing of the Kaiser Bellflower Medical Center and remodeling of the exterior and lobby of the West Wing of the Medical Center. Excavation activities associated with this project are anticipated to reach 15–20 feet below ground surface. Dr. Rieboldt wrote the paleontological resources memorandum for this project.

North Star Solar Project
Fresno, California
LSA conducted a paleontological resources assessment for the proposed North Star Solar Switching Station and Generation Tie Line (Gen Tie) Project in Fresno County. The purpose of this project is to generate and transmit renewable solar electricity from proven technology at a competitive cost with low environmental impact, and deliver it to market as soon as possible. The project consists of an approximately 1.5-mile-long Gen Tie Line that will tie into a new 115-kilovolt (kV) Switching Station, which is an expansion of the existing Pacific Gas and Electric (PG&E) Mendota substation. Project construction work will involve location preparation, foundation installation, power pole placement, generation line installation, and erection and connection of the Gen Tie Line and Switching Station equipment. Dr. Rieboldt prepared the paleontological resources assessment for this project.

SARAH RIEBOLDT, PH.D.

PALEONTOLOGIST

PUBLICATIONS

Elrick, M., S. Rieboldt, M. Saltzman, and R.M. McKay
2011 Oxygen-isotope trends and seawater temperature changes across the Late Cambrian Steptoean positive isotope excursion (SPICE event). Geology 39(10): 987–990.

Lipps, J.H., and S.E. Rieboldt
2005 Habitats and taphonomy of life on Europa. Icarus 177:515–527.

Parham, J.F., and S.E. Rieboldt
2005 *Contia tenuis* (Sharp-tailed snake): Reproduction. Natural History Note. Herpetological Review 36(4):456.

SELECTED REPORTS

Mount Diablo State Park Paleontological Resources Inventory and Management Recommendations. Prepared for the State of California Department of Parks and Recreation, Bay Area District. December 2002.

Paleontological Resources Assessment for Bayside Covenant Church, Sierra College Boulevard and Cavitt-Stallman Road, City of Roseville, Placer County, California. Prepared for Bayside Covenant Church. June 2002.

Paleontological Resources Assessment for the Riverbend Park Project, Lompoc, California. Prepared for the City of Lompoc. January 2002.

Recommendations for Compliance with Regulatory Requirements and Mitigation Measures for Paleontological Resources for the Mountain Park Community Development Project. Prepared for the Irvine Company. November 2001.

Paleontological Resources Assessment and Mitigation Measures for the Sacramento Regional County Sanitation District 17-Mile Interceptor Project, Sacramento and Yolo Counties, California (co-authored with Jere Lipps, Ph.D.). Prepared for the Sacramento Regional County Sanitation District on behalf of Jones & Stokes Associates, Inc. October 2001.

Scope of Work for Paleontological Investigation Report/Paleontological Evaluation Report for I-680 Northbound Sunol Grade Project. Prepared for Caltrans and Alameda County Congestion Management Agency. August 2001.