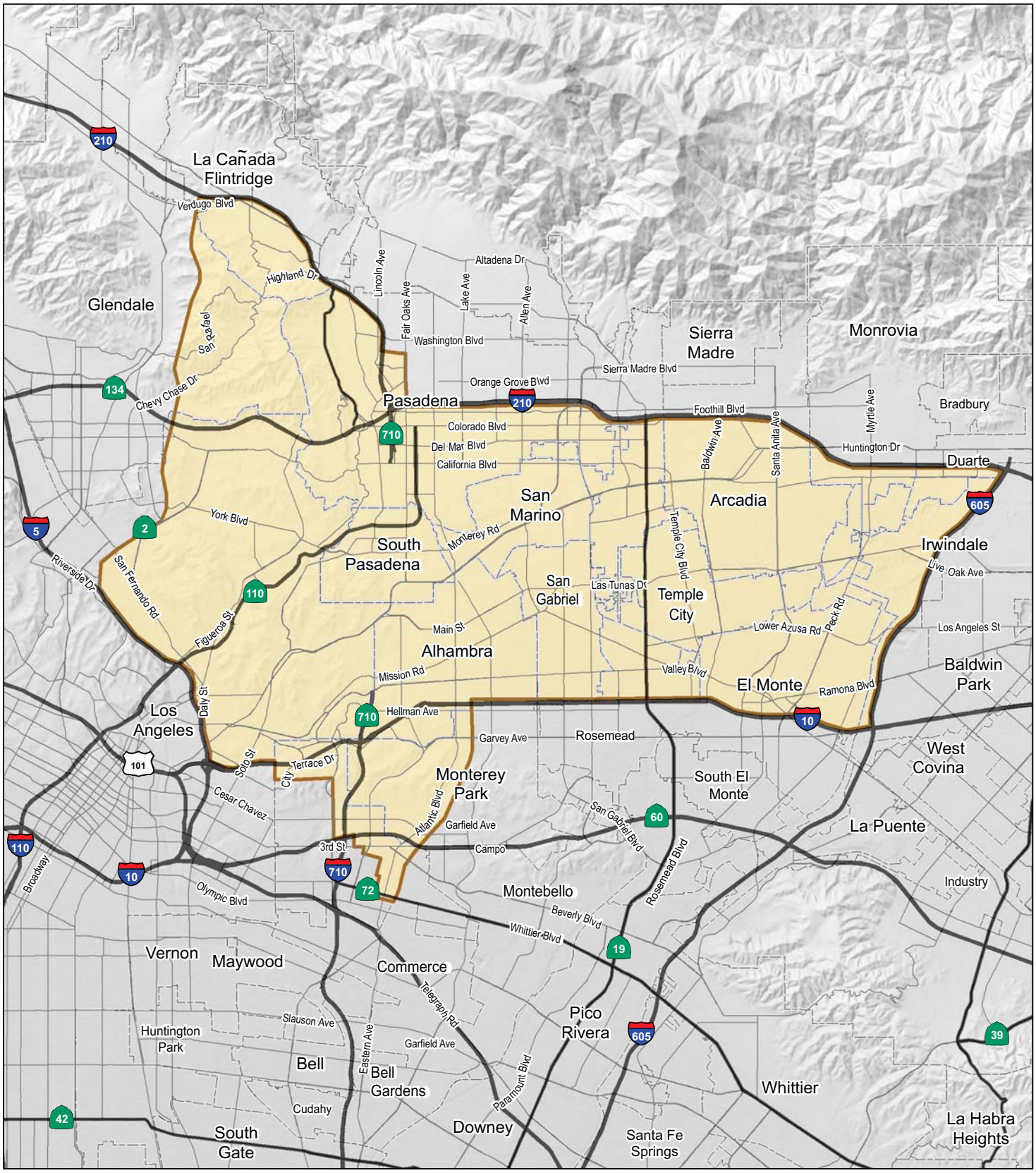


LEGEND

SR 710 North Study Area

FIGURE 1-1

SR 710 North Study
Project Location

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

0 1.25 2.5
MILES

SOURCE: ESRI (2008); LSA (2013)

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

SR 710 North – No Build Alternative (DRAFT)
2035 Programmed Projects

- 1AL04-LAF3125
- 1C0401
- 1HL08D01-LA0G138
- 1HL08D01-LA0G139
- 1TR0404
- 1TR0705
- 1TR1011
- 7120010
- High Speed Rail
- LA000357
- LA000358
- LA000548
- LA01342
- LA0B408
- LA0B7234
- LA0B875
- LA0C8012
- LA0C8046
- LA0C8054
- LA0C8055
- LA0C8063
- LA0C8064
- LA0C8087
- LA0D198
- LA0D31
- LA0D328
- LA0D441
- LA0D442
- LA0F003
- LA0F021
- LA0F098
- LA0G626
- LA29202W
- LA29212XY
- LA960018
- LA996425
- LAE0039
- LAE2515
- LAE2517
- LAE3085
- LAF1197
- LAF1455
- UT101
- Rail

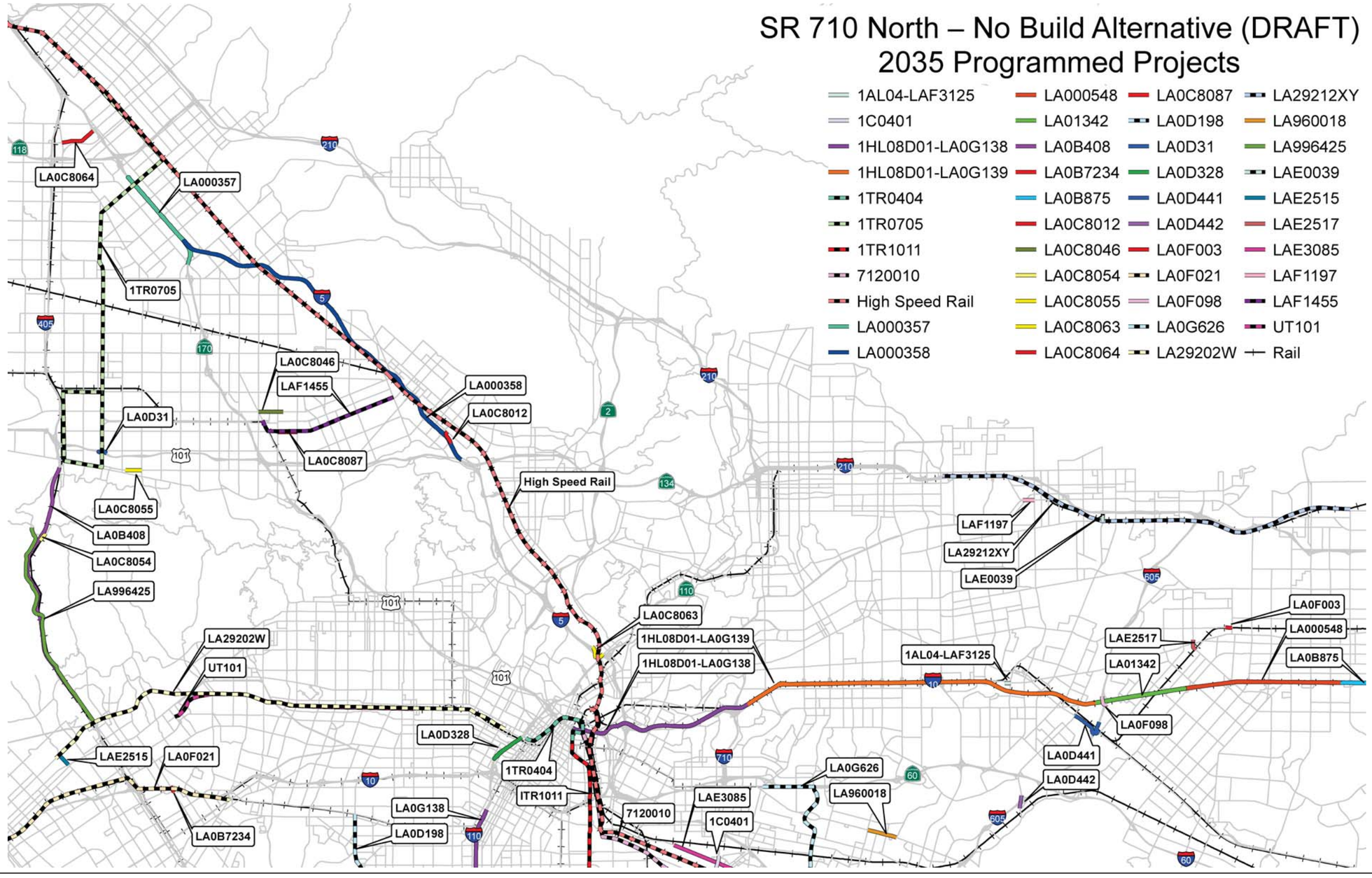


FIGURE 1-2

N

NOT TO SCALE

SOURCE: CH2M HILL (2013)

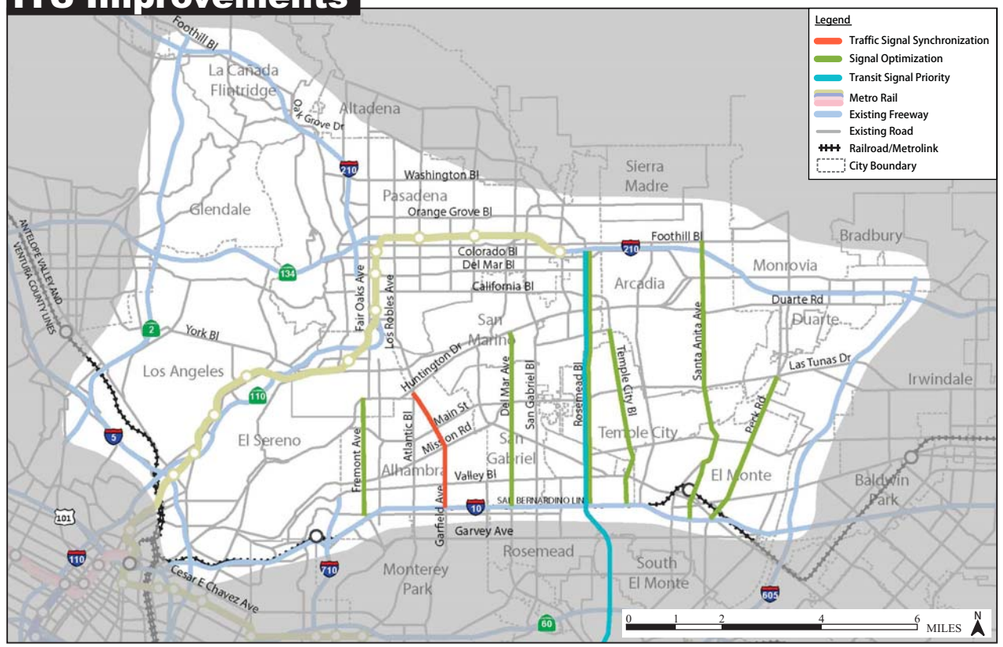
I:\CHM1105\G\No Build Alt.cdr (10/27/14)

SR 710 North Study

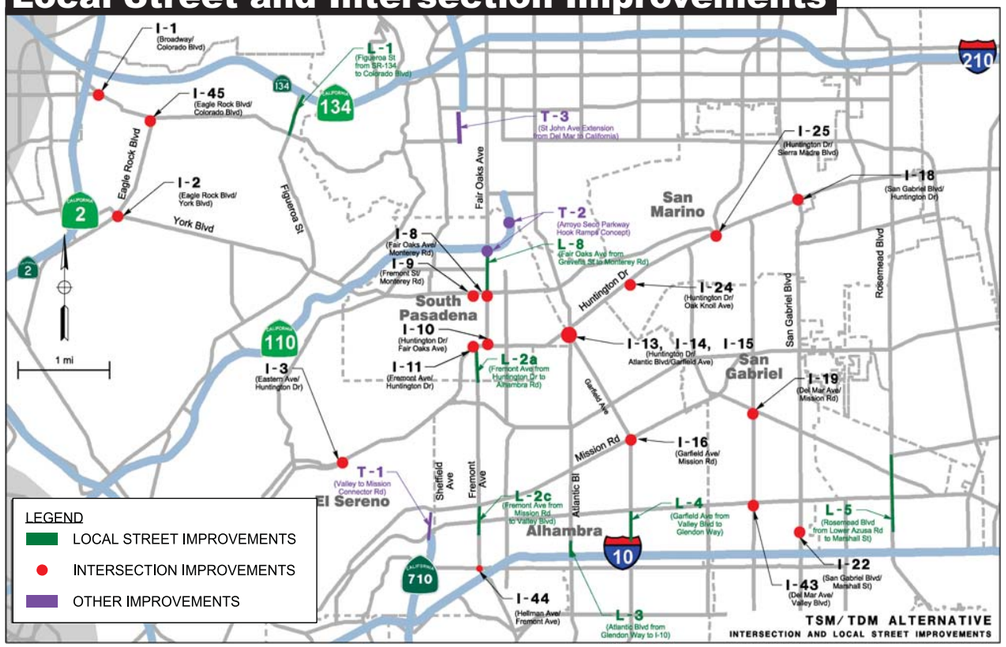
No Build Alternative

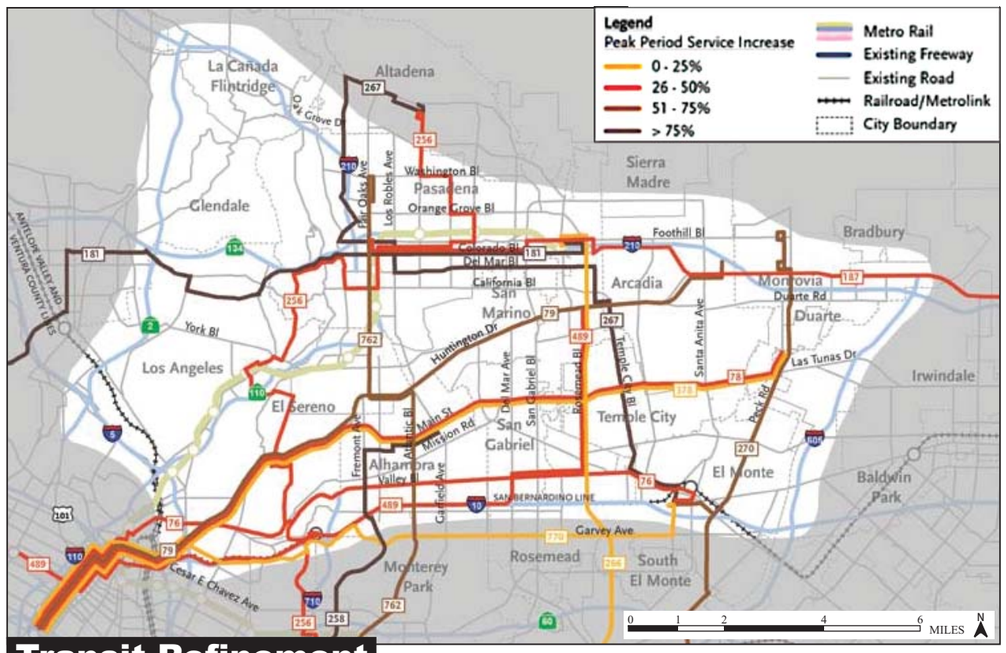
07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

ITS Improvements

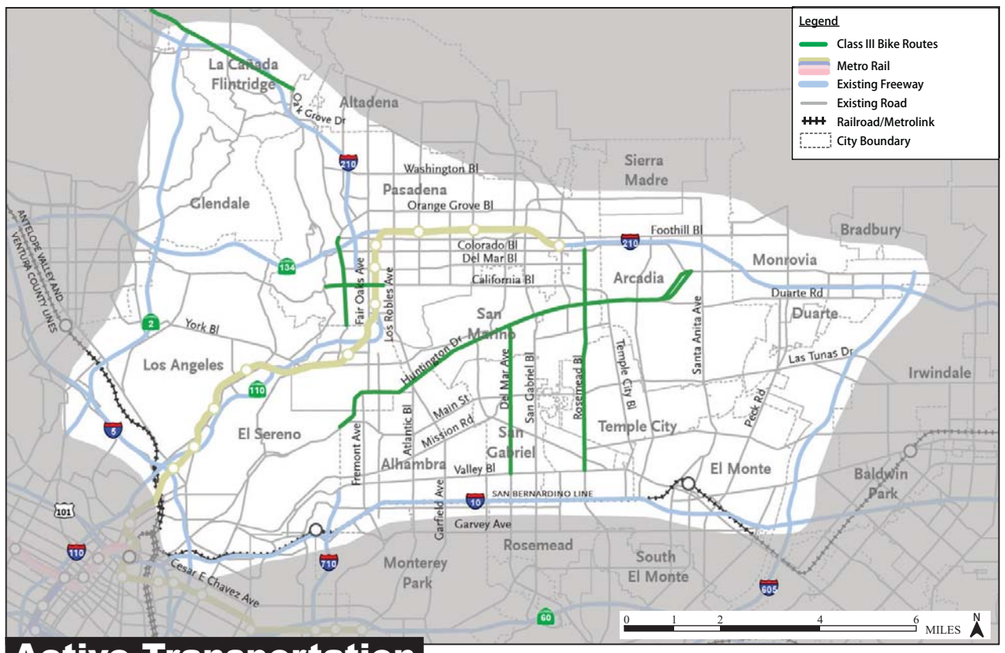


Local Street and Intersection Improvements





Transit Refinement



Active Transportation

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)

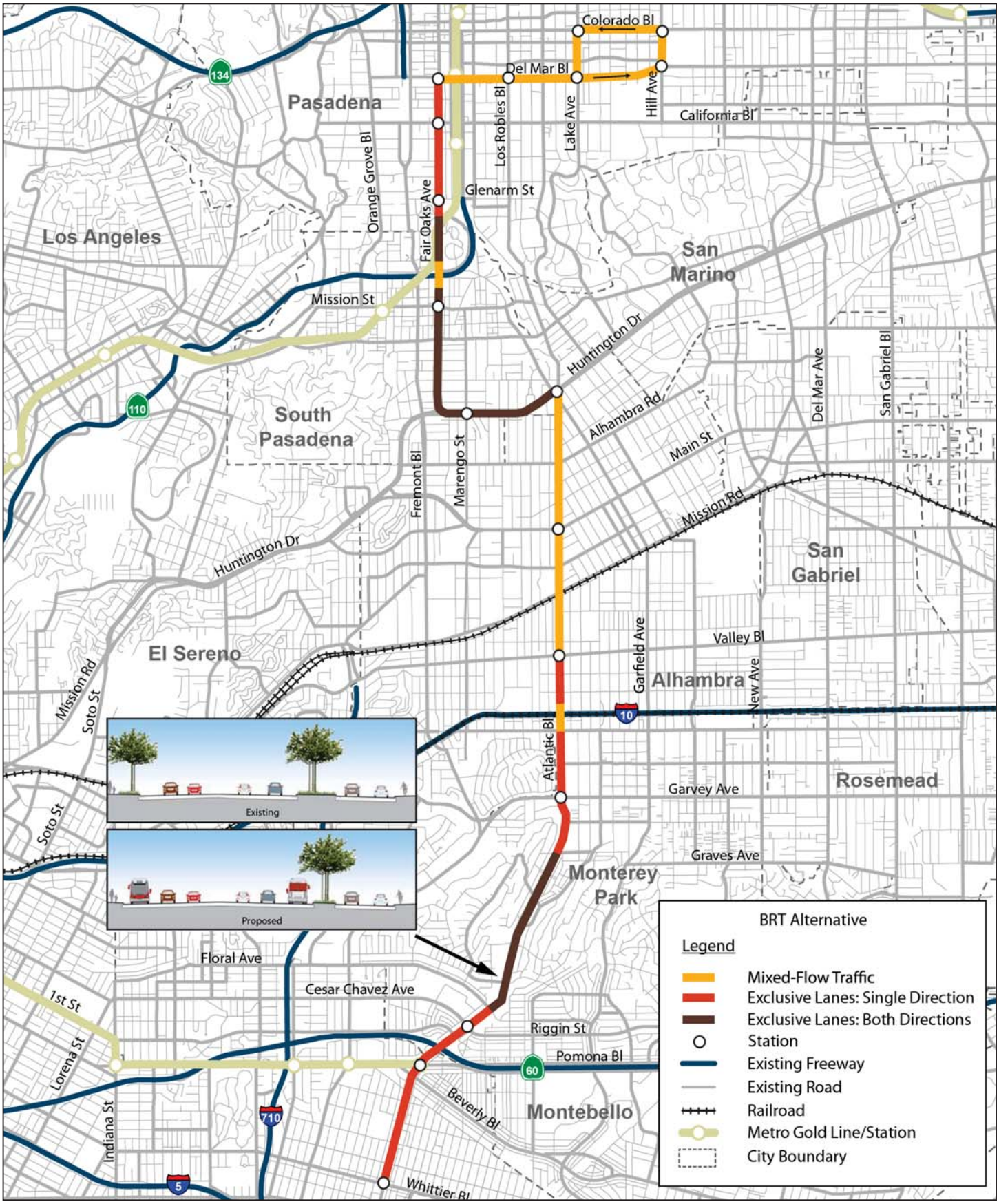


FIGURE 1-4

N

0 .5 1.0

MILES

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

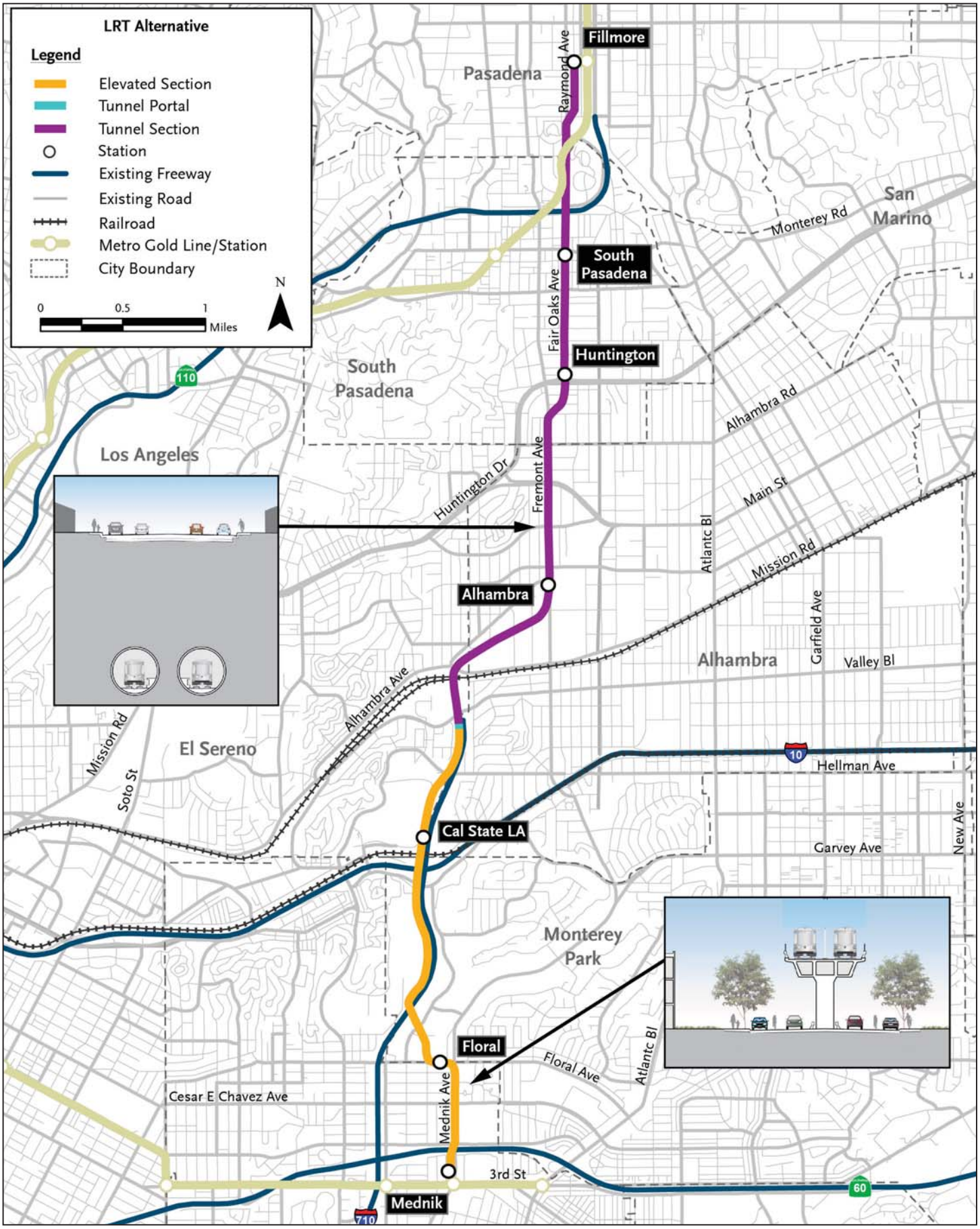


FIGURE 1-5

SR 710 North Study
LRT Alternative
07-LA-710 (SR 710)
EA 187900
EFIS 0700000191

N
0 .5 1
MILES
SOURCE: AECOM (2013)

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

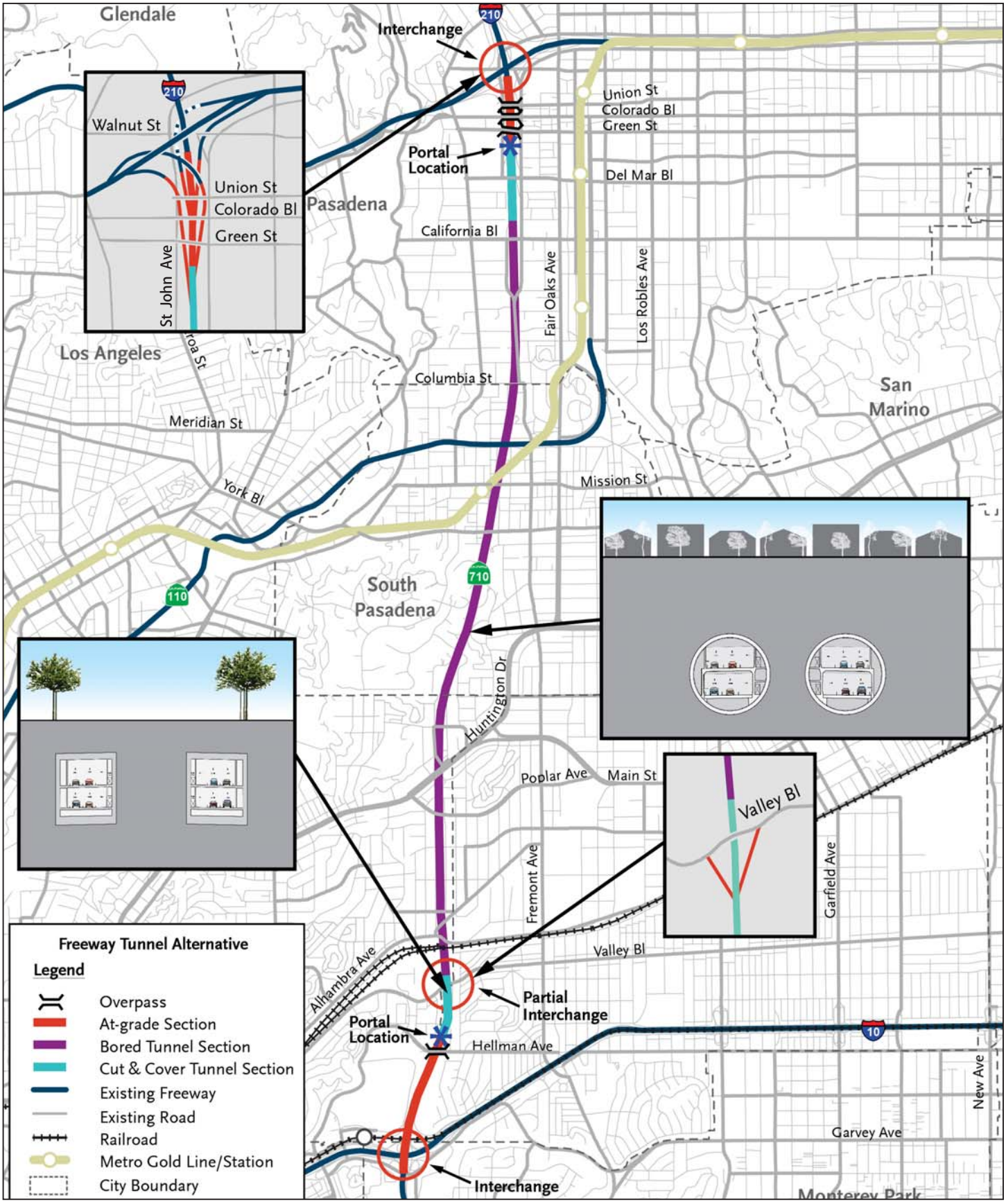


FIGURE 1-6

N

0 .38 .75

MILES

SOURCE: CH2M HILL (2013)

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

SR 710 North Study

Freeway Tunnel Alternative
Single and Dual Bore

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

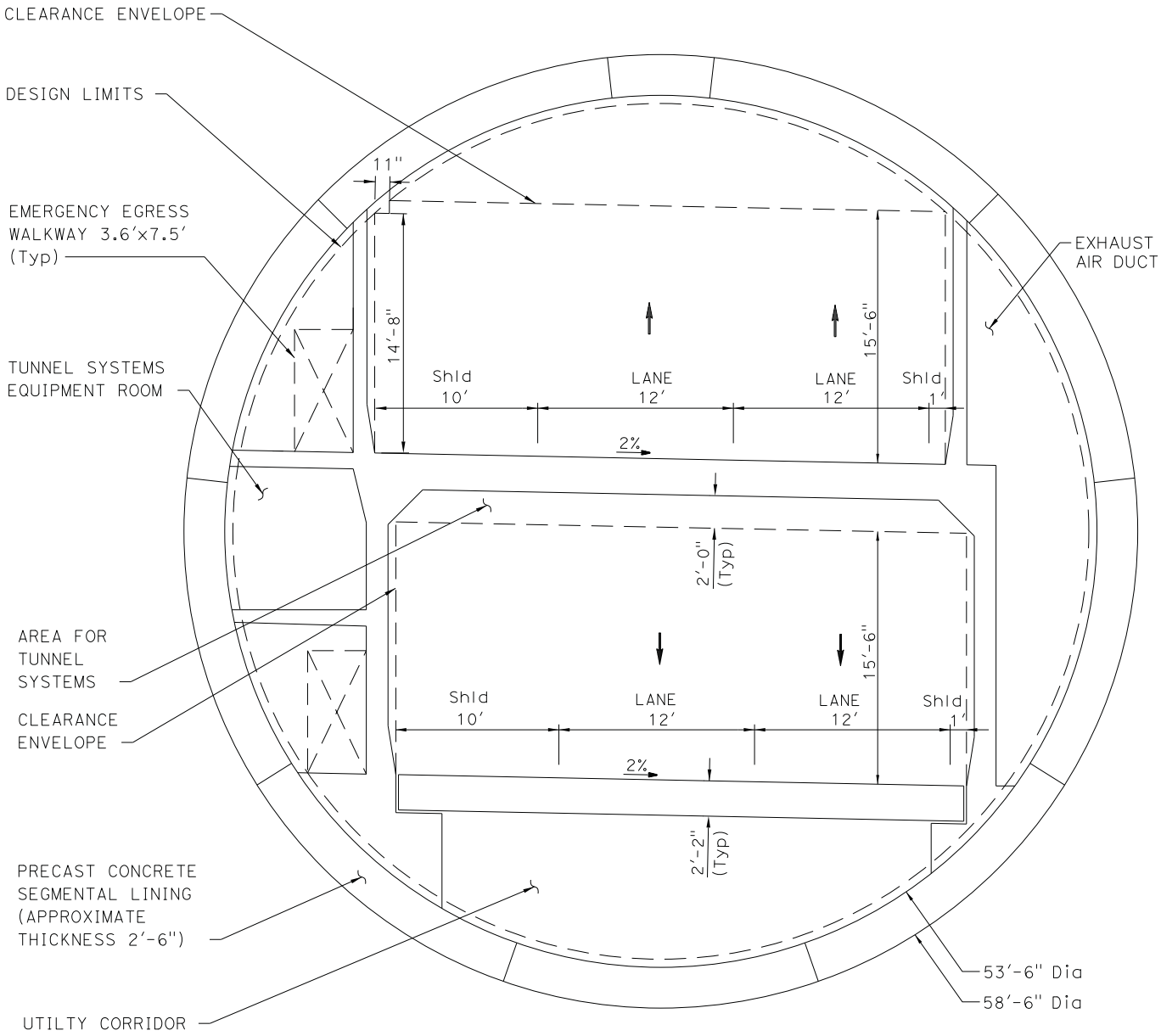


FIGURE 1-7

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)

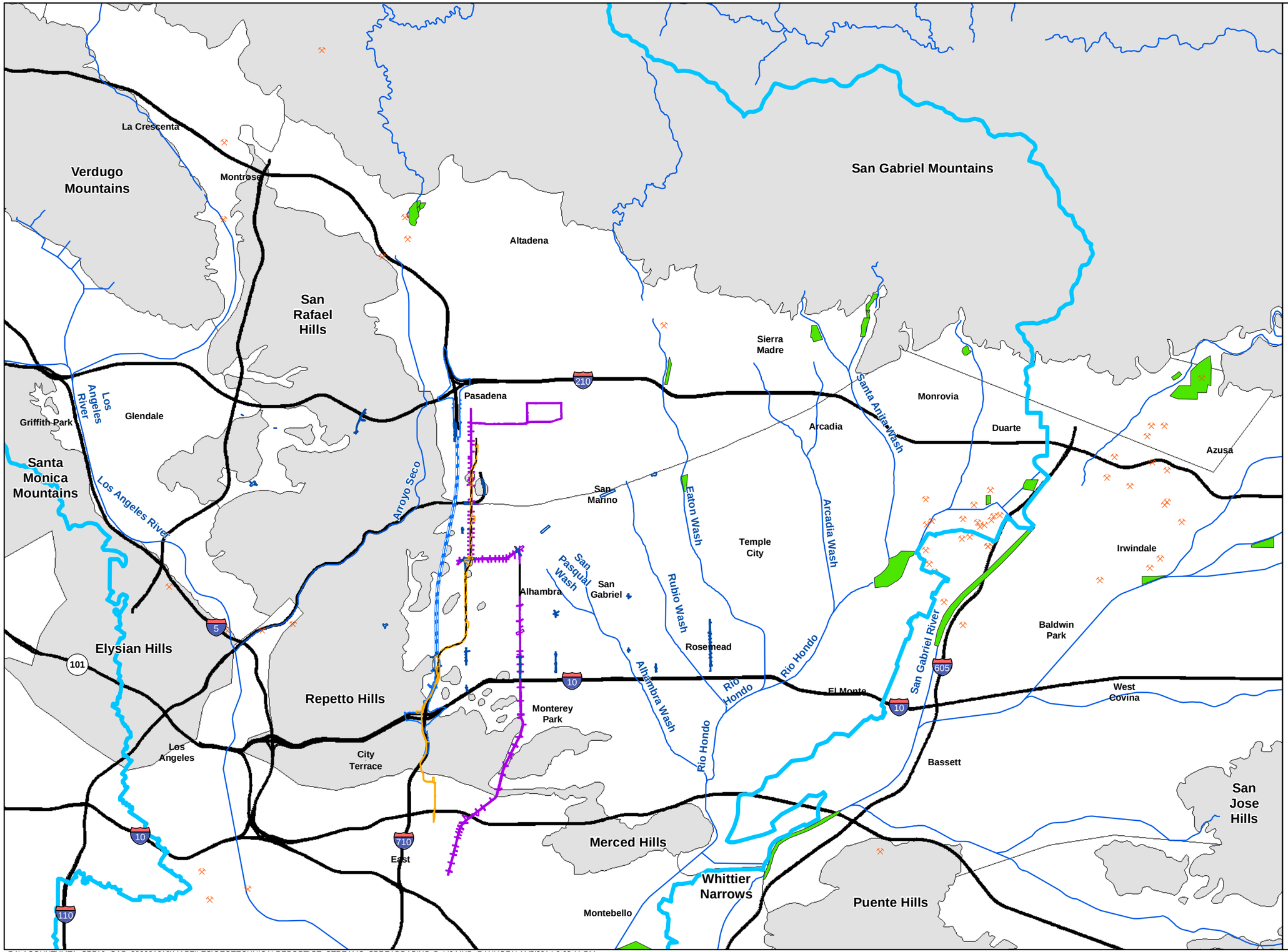
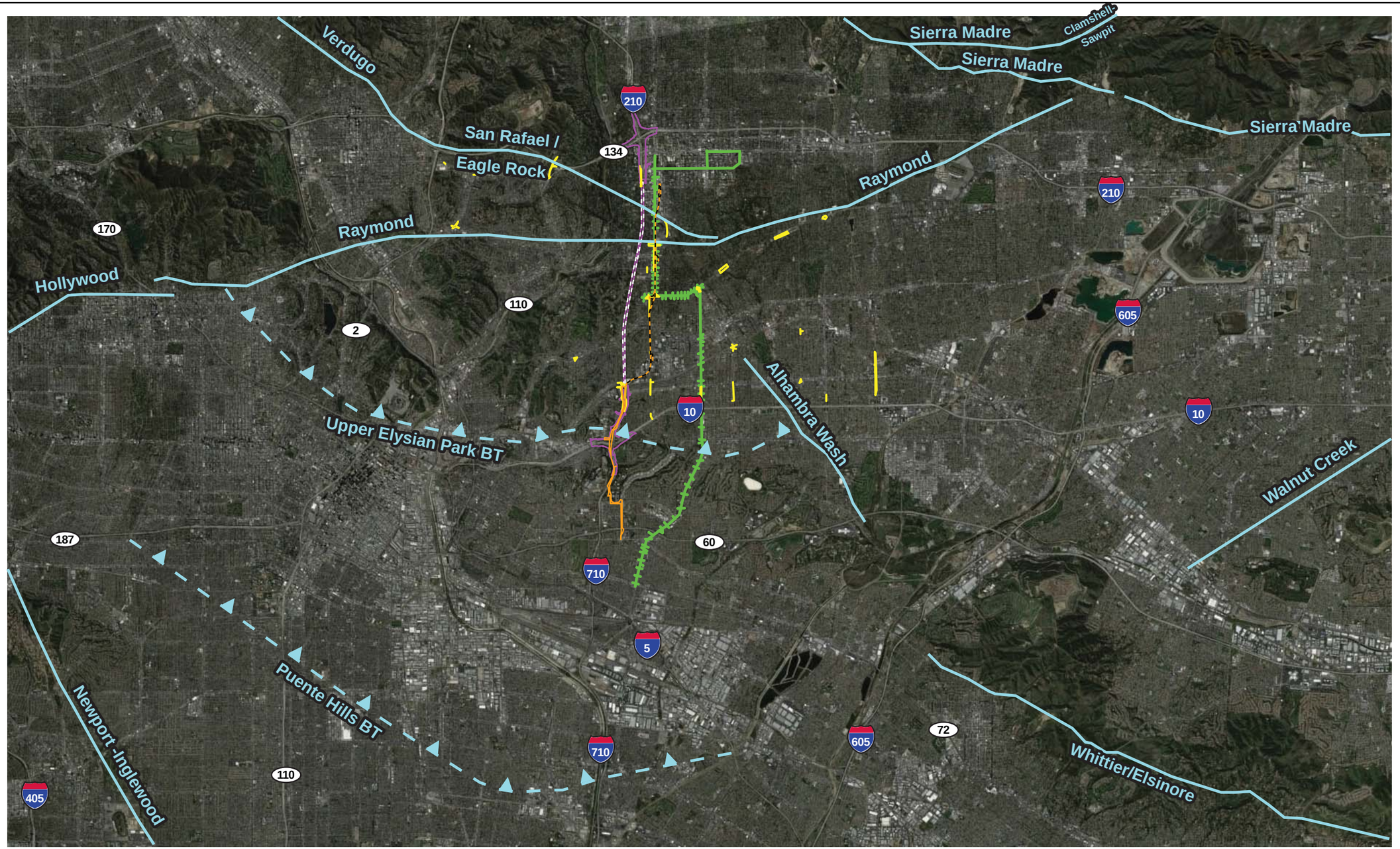


Figure 3-1
Surface Water Features
SR 710 North Study
Los Angeles County, California

R:\LACOUNTYMTA_SR710_GAP_200001218\MAPFILES\GEOTECHNICALREPORT\GT_STREAMS_SPREADBASINS_B_V6.MXD RANHORN 11/5/2014 2:02:11 PM



Aerial image © Google Earth, 2013. Annotation by CH2M HILL, 2013.

LEGEND

- Approximate Fault Location with Name (BT = Blind Thrust, Subsurface Fault, Barbs on Upper Block)
- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

North

0 2.5 5

Approximate scale in miles

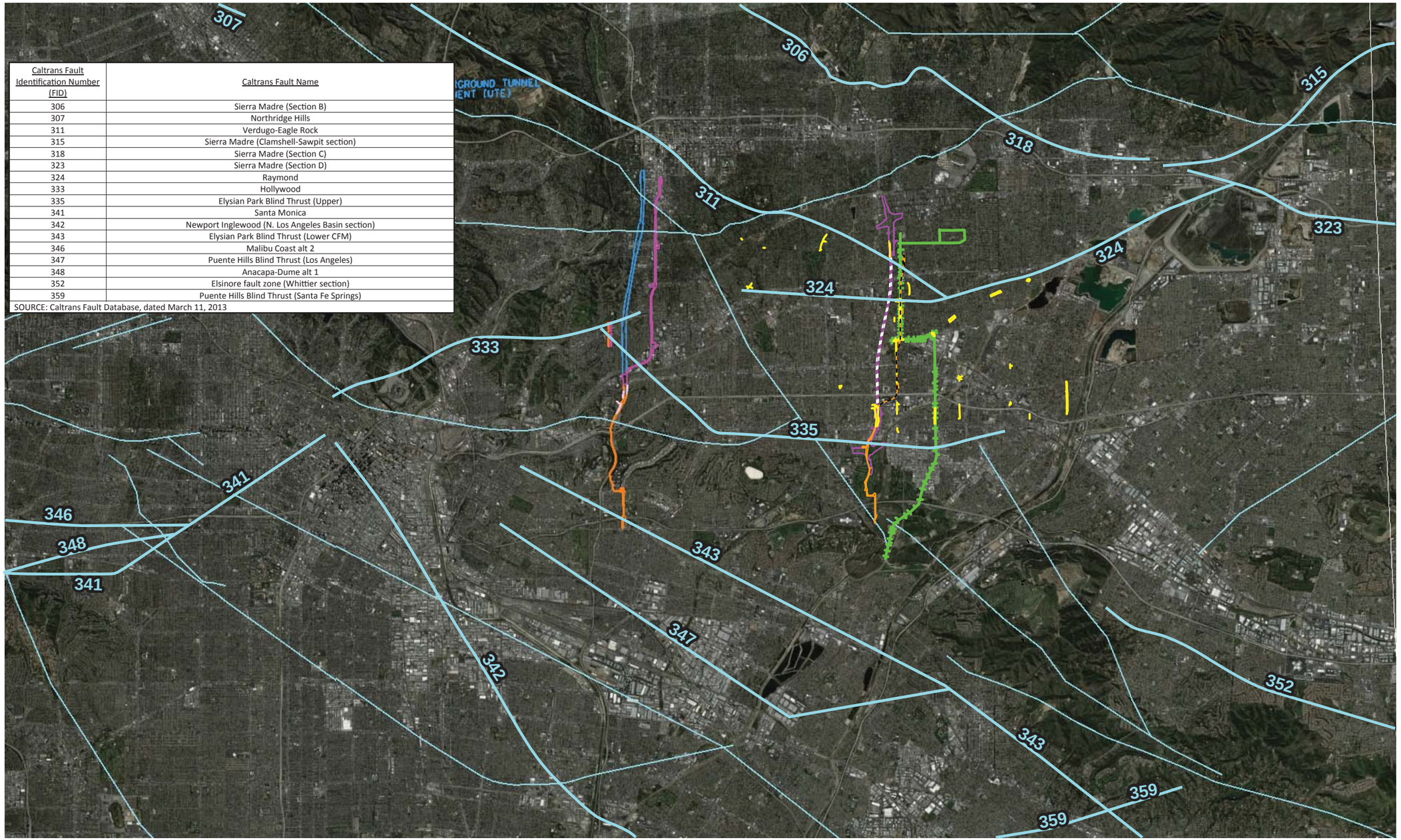
Fault Data from: Plesch et al, 2007 and USGS, 2010; with modifications based on this study.

FIGURE 4-1
FAULT LOCATION MAP
SR 710 North Study,
Los Angeles County, California

CH2MHILL

Caltrans Fault Identification Number (FID)	Caltrans Fault Name
306	Sierra Madre (Section B)
307	Northridge Hills
311	Verdugo-Eagle Rock
315	Sierra Madre (Clamshell-Sawpit section)
318	Sierra Madre (Section C)
323	Sierra Madre (Section D)
324	Raymond
333	Hollywood
335	Elysian Park Blind Thrust (Upper)
341	Santa Monica
342	Newport Inglewood (N. Los Angeles Basin section)
343	Elysian Park Blind Thrust (Lower CFM)
346	Malibu Coast alt 2
347	Puente Hills Blind Thrust (Los Angeles)
348	Anacapa-Dume alt 1
352	Elsinore fault zone (Whittier section)
359	Puente Hills Blind Thrust (Santa Fe Springs)

SOURCE: Caltrans Fault Database, dated March 11, 2013



Aerial image © Google Earth, 2013. Annotation by CH2M HILL, 2013.

LEGEND

- Approximate Fault Location with Caltrans FID (see table above)
- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

North

0 2.5 5

Approximate scale in miles

FIGURE 4-2
REGIONAL FAULT MAP
SR 710 North Study,
Los Angeles County, California

CH2MHILL

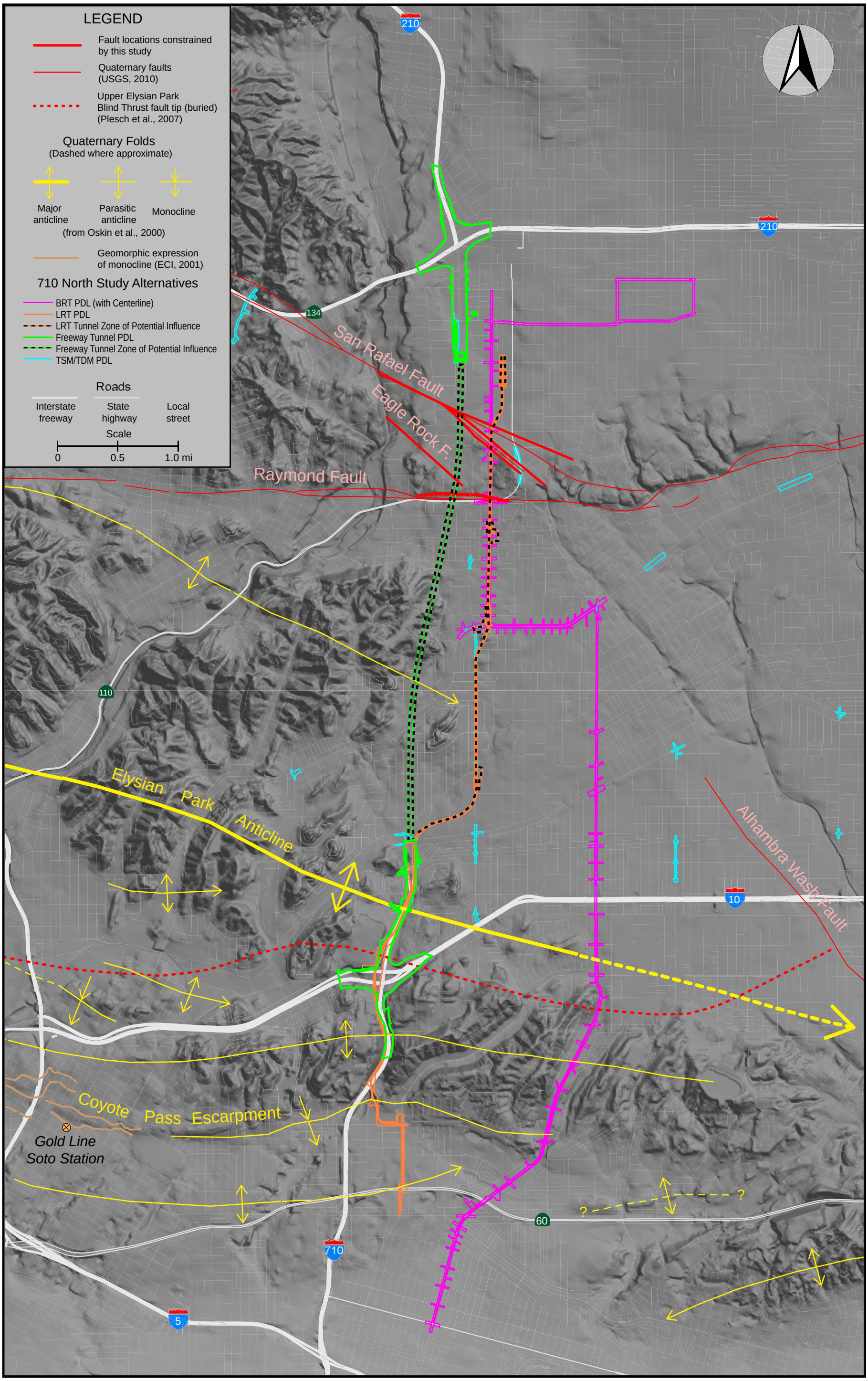


FIGURE 4-3
ELYSIAN PARK BLIND THRUST FAULT AND FOLD MAP
SR 710 North Study,
Los Angeles County, California

CH2MHILL

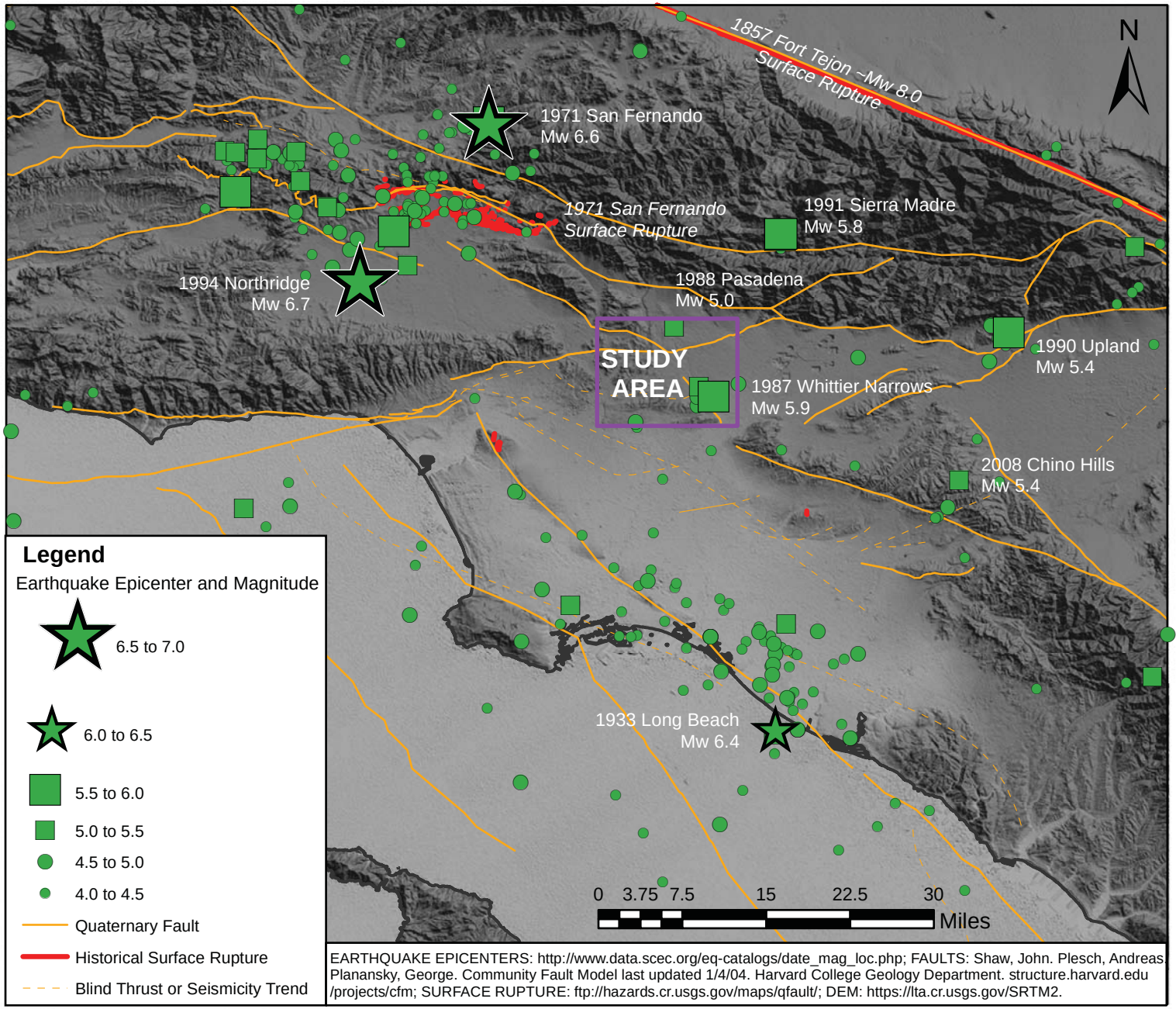


FIGURE 4-4
HISTORICAL SEISMICITY MAP
SR 710 North Study
Los Angeles County, California

CH2MHILL

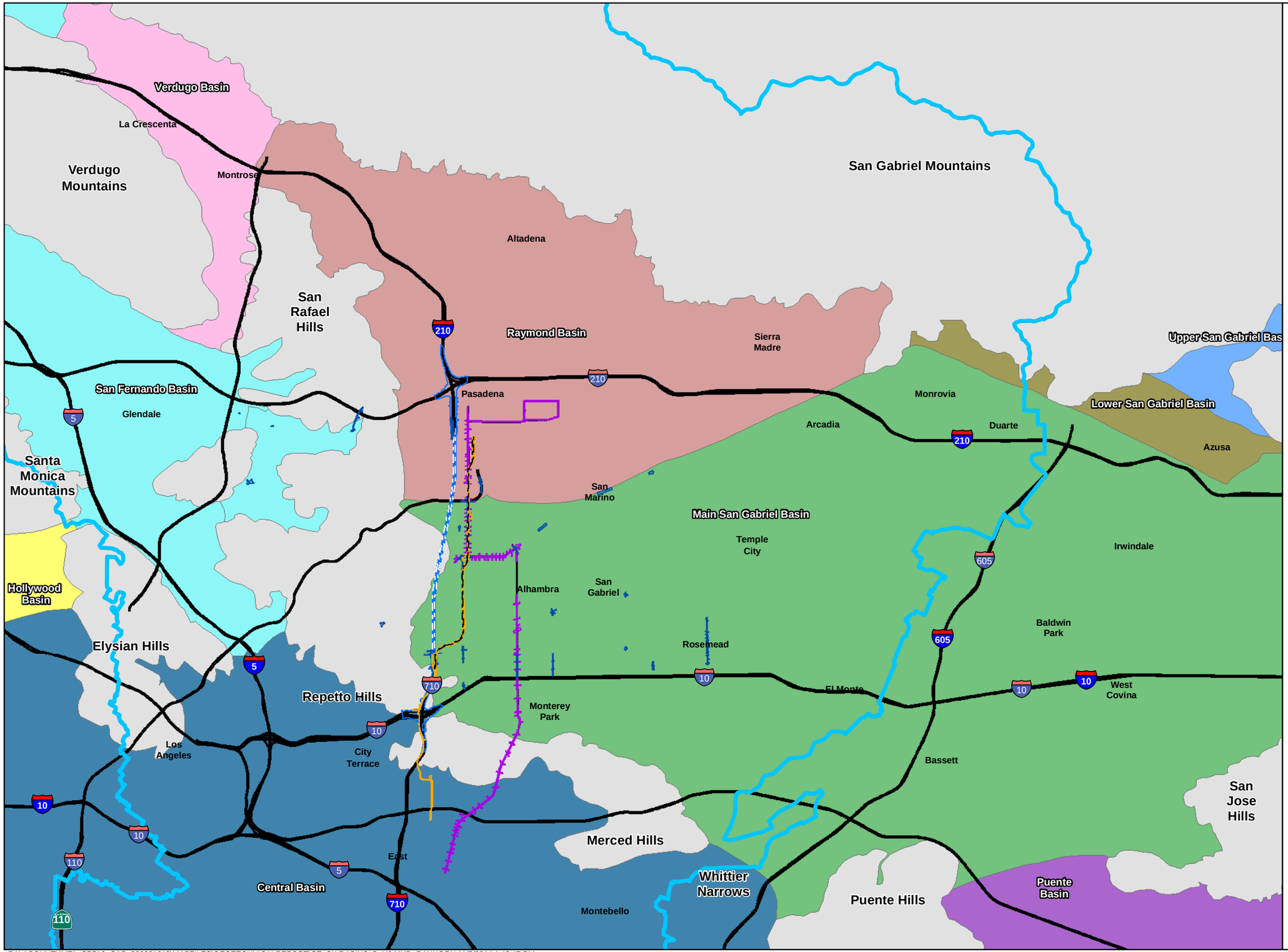


Figure 5-1
Groundwater Basins
SR 710 North Study
Los Angeles County, California

R:\LACOUNTYMTA_SR710_GAP_200001218\MAPFILES\GEOTECHNICALREPORT\GT_GWBASINS_B_V6.MXD RANHORN 11/5/2014 1:43:47 PM

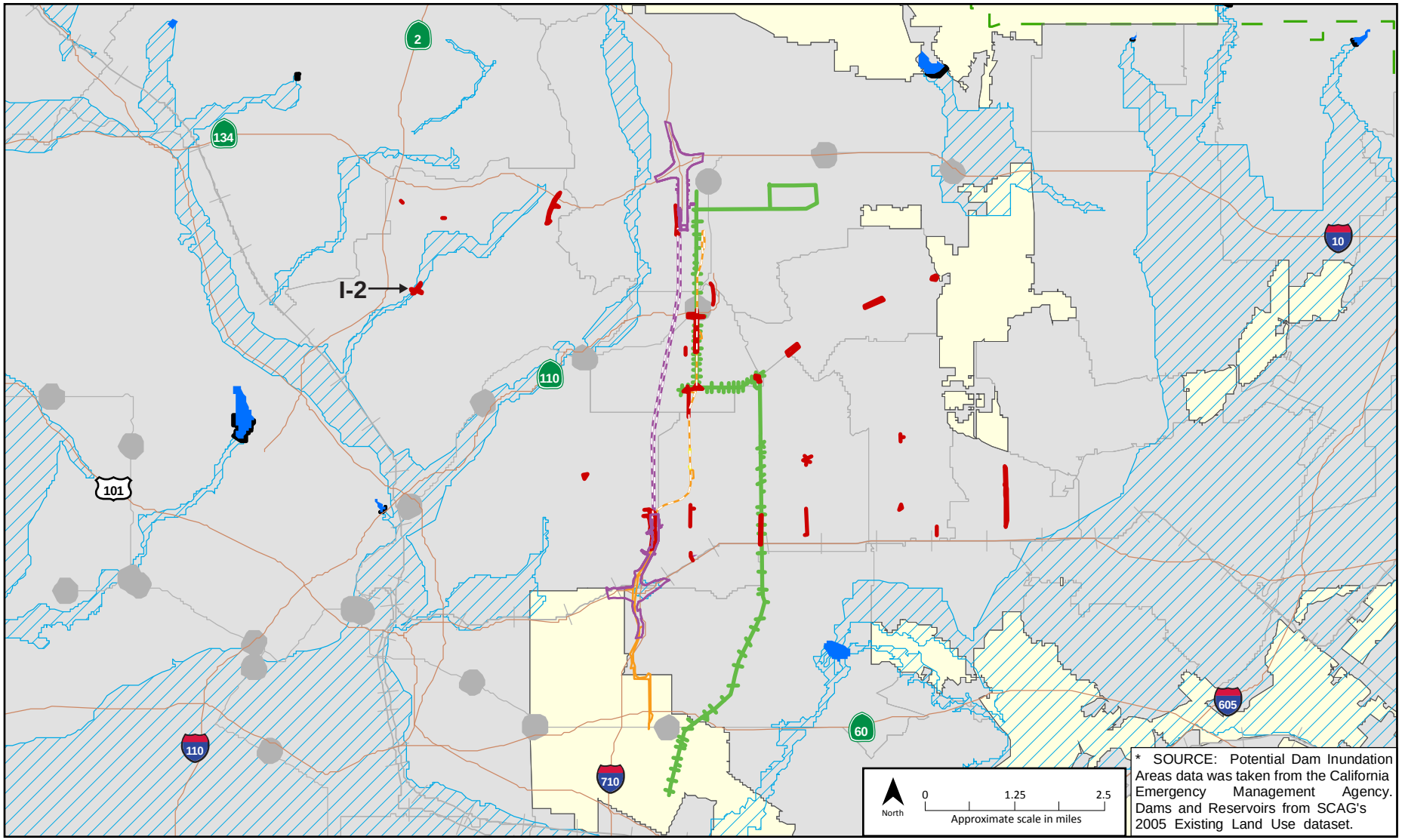
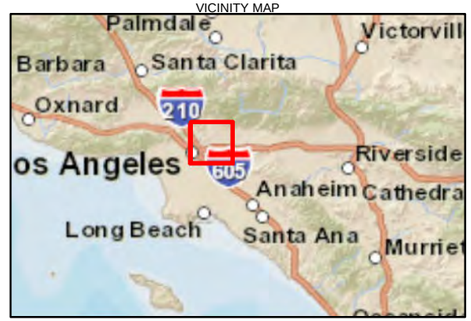


FIGURE 5-2
DAM INUNDATION MAP
SR 710 North Study,
Los Angeles County, California

CH2MHILL

VICINITY MAP



LEGEND

Well Status

- Active
- Buried
- Idle
- New
- Plugged
- Oil Fields

SR 710 North Study Alternative

- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

Sources:
1) Department of Oil, Gas, and Geothermal Resources, 2005, Oil and Gas Field Database. Available at ftp://ftp.consrv.ca.gov/pub/oil/Data_Catalog/Oil_and_Gas/Oil_fields/. Accessed September 17, 2013.
2) Department of Oil, Gas, and Geothermal Resources, 2012, Well Database. Available at http://conservation.ca.gov//dog/maps/Pages/GISMapping2.aspx. Accessed September 17, 2013.

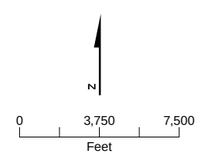
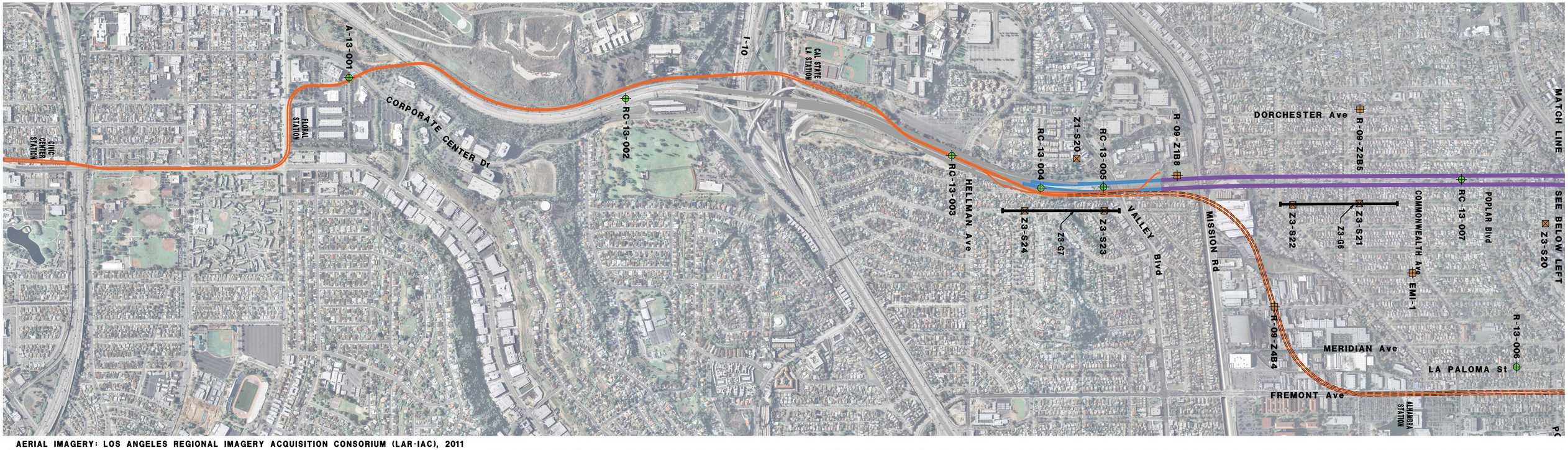
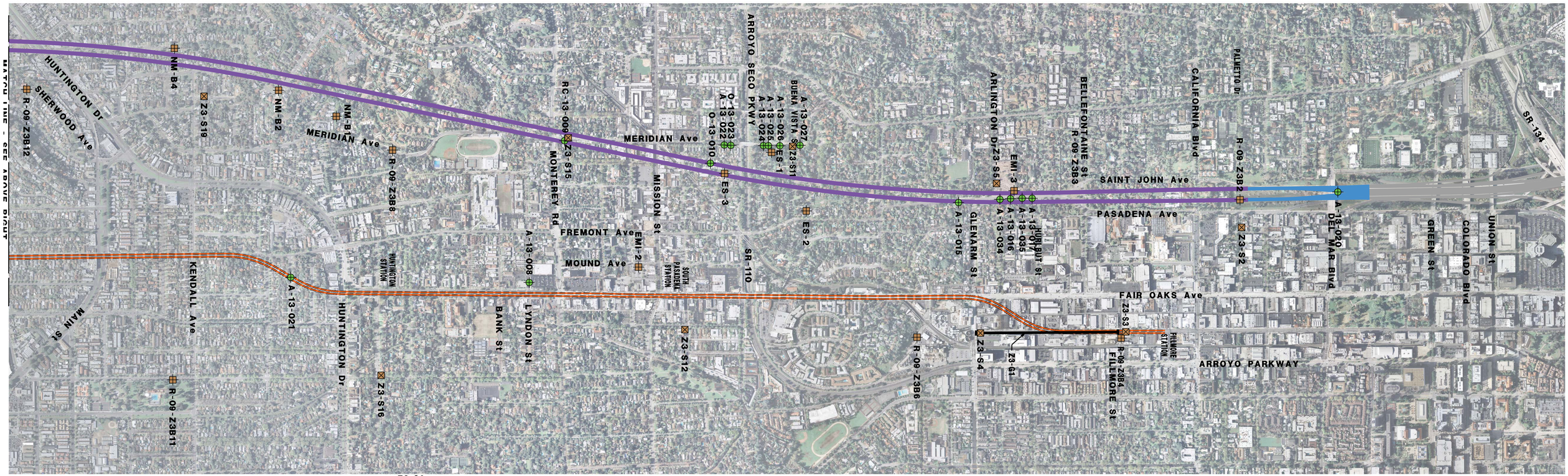


FIGURE 6-1
Oil and Gas Well Location Map
SR 710 North Study
Los Angeles, California

AERIAL IMAGERY: LOS ANGELES REGIONAL IMAGERY ACQUISITION CONSORIUM (LAR-IAC), 2011





LEGEND:

- FREEWAY TUNNEL ALTERNATIVE, CUT & COVER TUNNEL
- FREEWAY TUNNEL ALTERNATIVE, BORED TUNNEL
- FREEWAY TUNNEL ALTERNATIVE, SURFACE
- LRT ALTERNATIVE, ELEVATED
- LRT ALTERNATIVE, TUNNEL

A, R, RC, or O-13-001 — CURRENT BORINGS (CH2M HILL and ECI, 2013)

Z3-G6 — SEISMIC REFLECTION LINE (CH2M HILL, 2010)

Z3-S22 — MULTI-CHANNEL ANALYSIS OF SURFACE WAVES (MASW), (CH2M HILL, 2010)

R-09-Z1B8 — PREVIOUS BORINGS (CH2M HILL, 2010)

NM-B4; EMI-3; ES-2 — PREVIOUS BORINGS (Ninvo and Moore. 1999: Earth Mechanics Inc.. 2006: Caltrans. 1974)

0 600′ 1200′ 1800′

SCALE: 1" = 600′

PLATE 1
BORING LOCATION MAP
SR 710 North Study
Los Angeles County, California

CH2MHILL

Plate 2
Geologic Map
SR 710 North Study
Los Angeles County, California

Legend

SR 710 North Study Alternatives

- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

Explorations

- A-13-001/O-13-010/R-13-006/RC-13-002 — Hollow Stem Auger/Sonic/Rotary Wash/ Continuous Core Boring (this study)
- R-09-Z1B8 — Continuous Core Boring (CH2M HILL, 2010)
- Z3-S3 — Multi-channel Analysis of Surface Waves (MASW), (CH2M HILL, 2010)
- Caltrans As-built LOTB (Caltrans, 1998)
- EMI-1 — Continuous Core Boring (EMI, 2006)
- NM-B1 — Hollow Stem and Bucket Auger Borings (Ninyo and Moore, 1999)
- C-65/C-23f — Small Diameter Boring (Caltrans, 1974a)
- ES-1 — Continuous Core Boring (Caltrans, 1974b)
- Seismic Line (CH2M HILL, 2010)

Symbols

- Eagle Rock, Raymond and San Rafael faults, location based on this study

Base Map:

- Elevation Contour
- Roads
- Stream
- Water Bodies

- anticline, identity and existence certain, location approximate
- anticline, identity and existence certain, location concealed
- overturned anticline, identity and existence certain, location accurate
- syncline, identity and existence certain, location approximate
- syncline, identity and existence certain, location concealed
- contact, identity and existence certain, location accurate
- contact, identity and existence certain, location approximate
- contact, identity or existence questionable, location approximate
- reference contact, identity and existence certain, location concealed
- reference contact, identity or existence questionable, location approximate
- reference contact, identity and existence certain, location approximate
- reference contact, identity and existence certain, location accurate
- fault, identity and existence certain, location accurate
- fault, identity and existence certain, location approximate
- fault, identity and existence certain, location concealed
- fault, identity or existence questionable, location approximate
- fault, identity or existence questionable, location concealed
- reverse fault, identity and existence certain, location approximate
- reverse fault, identity and existence certain, location concealed
- thrust fault, identity and existence certain, location accurate
- thrust fault, identity and existence certain, location approximate
- thrust fault, identity and existence certain, location concealed
- thrust fault, identity and existence certain, location concealed
- water boundary

- af — Artificial Fill - deposits of fill resulting from human construction, mining, or other quarrying activities; includes engineered fill for buildings, roads, dams, airport runways, harbor facilities, and waste landfills
- Qw — Alluvial Wash Deposits - unconsolidated sandy and gravelly sediment deposited in recently active channels of streams and rivers; may contain loose to moderately loose sand and silty sand
- Qf — Alluvial Fan Deposits - uncosolidated boulders, cobbles, gravel, sand, and silt recently deposited where a river or stream issues from a confined valley or canyon; sediment typically deposited in a fan-shaped cone; gravel sediment generally more dominant than sandy sediment
- Qyf — Young Alluvial Fan Deposits - unconsolidated to slightly consolidated, undissected to slightly dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon
- Qya — Young Alluvial Valley Deposits - unconsolidated to slightly consolidated, undissected to slightly dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers
- Qof — Old Alluvial Fan Deposits - slightly to moderately consolidated, moderately dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon
- Qoa — Old Alluvial Valley Deposits - slightly to moderately consolidated, moderately dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers
- Qvoa — Very Old Alluvial Fan Deposits - moderately to well-consolidated, highly dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers; generally uplifted and deformed
- Tss — Coarse-grained Tertiary age formations - primarily sandstone and conglomerate. Includes Fernando (Tf), Puente (Tp) and Topanga (Tt) Formations
- Tsh — Fine-grained Tertiary age formations - includes fine-grained sandstone, siltstone,mudstone, shale, siliceous and calcareous sediments. Includes Fernando (Tf), Puente (Tp) and Topanga (Tt) Formations
- Tv — Tertiary age formations of volcanic origin
- pKm — Cretaceous and pre-Cretaceous metamorphic formations of sedimentary and volcanic origin
- gr — Granitic and other intrusive crystalline rocks of all ages. Includes Wilson Quartz Diorite (Wqd)
- Water

N

0 2,000 4,000 Feet

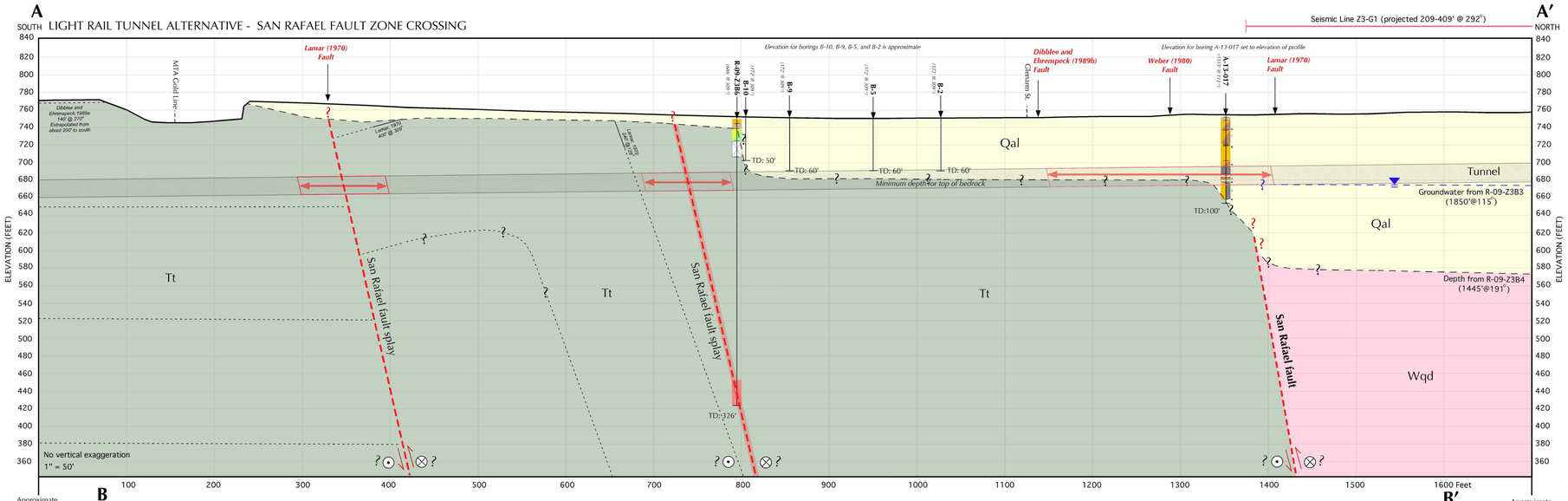
0 750 1,500 Meters

Base map: Modified from CGS, 2012

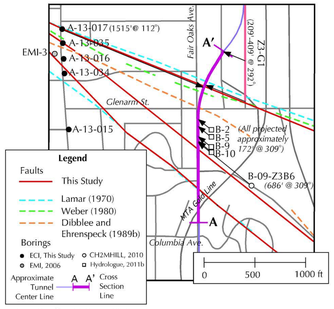
Copyright © 2014 Esri

CH2MHILL

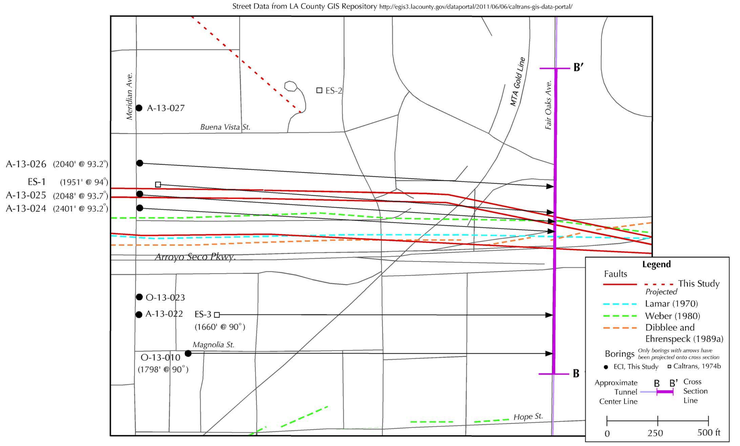
DVR R:\LACOUNTYMTA_SR710_GAP_200001218\MAPFILES\GEOTECHNICALREPORT\GT_GEOTECHNICAL_OVERVIEW_V5.MXD RANHORN 11/5/2014 1:42:11 PM



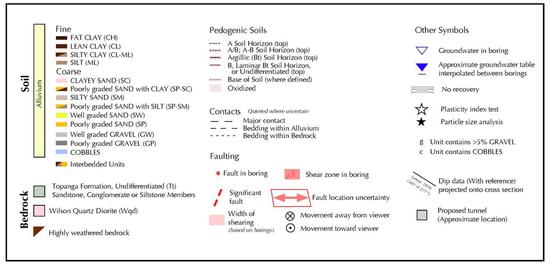
Location Maps



Street Data from LA County GIS Repository http://egis3.lacounty.gov/dataportal/2011/06/06/caltrans-gis-data-portal/



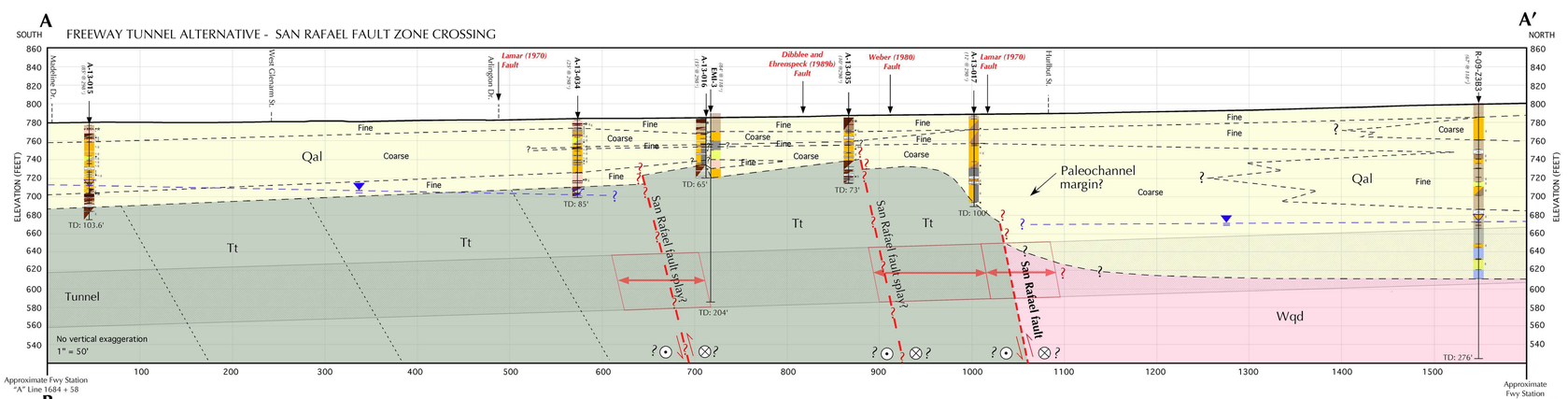
Legend

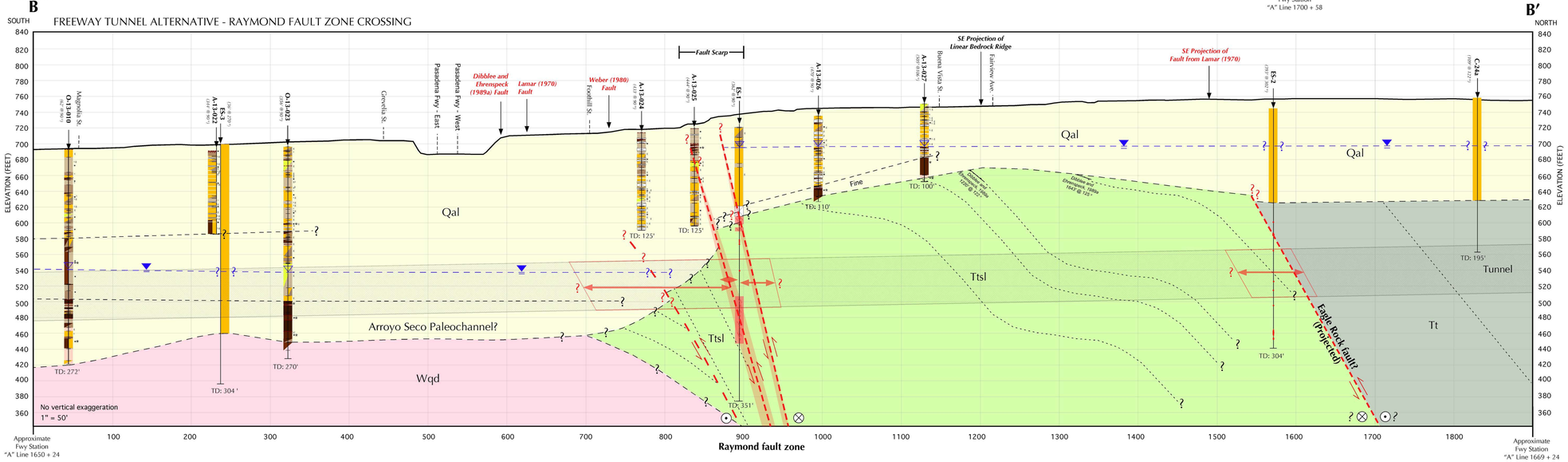


Earth Consultants International
Project No. 3202

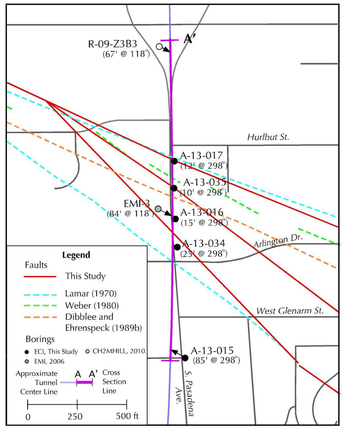
SR 710 North Study Light Rail Transit Alternative Geologic Cross Sections Across the San Rafael and Raymond Fault Zones

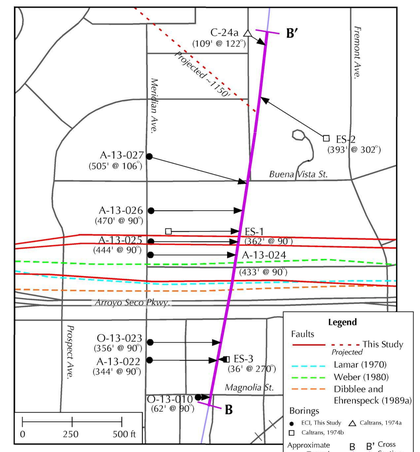
Plate 3





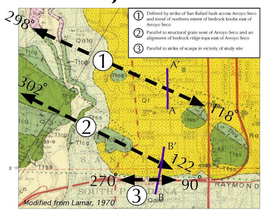
Location Maps



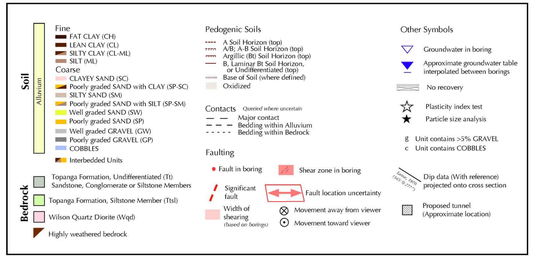


Street Data from LA County GIS Repository http://egis3.lacounty.gov/dataportal/2011/06/06/caltrans-gis-data-portal/

Projections



Legend



Earth Consultants International
Project No. 3202

SR 710 North Study, Freeway Tunnel Alternative, Geological Cross Sections Across the San Rafael, Eagle Rock and Raymond Fault Zones

Plate 4

Legend

SR 710 North Study Alternative

- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

Soils

- 002 - ALTAMONT CLAY LOAM
- 003 - CHINO SILT LOAM
- 004 - DIABLO CLAY LOAM
- 006 - HANFORD FINE SANDY LOAM
- 007 - HANFORD GRAVELLY SANDY LOAM
- 011 - PLACENTIA LOAM
- 013 - RAMONA LOAM
- 014 - RAMONA SANDY LOAM
- 015 - TUJUNGA FINE SANDY LOAM
- 016 - YOLO LOAM
- 017 - YOLO CLAY LOAM

References:
1 - Road base map streamed from ESRI (September, 2014)
2 - Los Angeles County Department of Public Works, 2006. Hydrology Manual. January.
3 - Los Angeles Department of Public Works. 2013. Hydrology Map, A GIS viewer application to view the data for the hydrology manual. http://ladpw.org/wrd/hydrologygis/. Accessed on September 18.

N

0 2,000 4,000 Feet

0 750 1,500 Meters

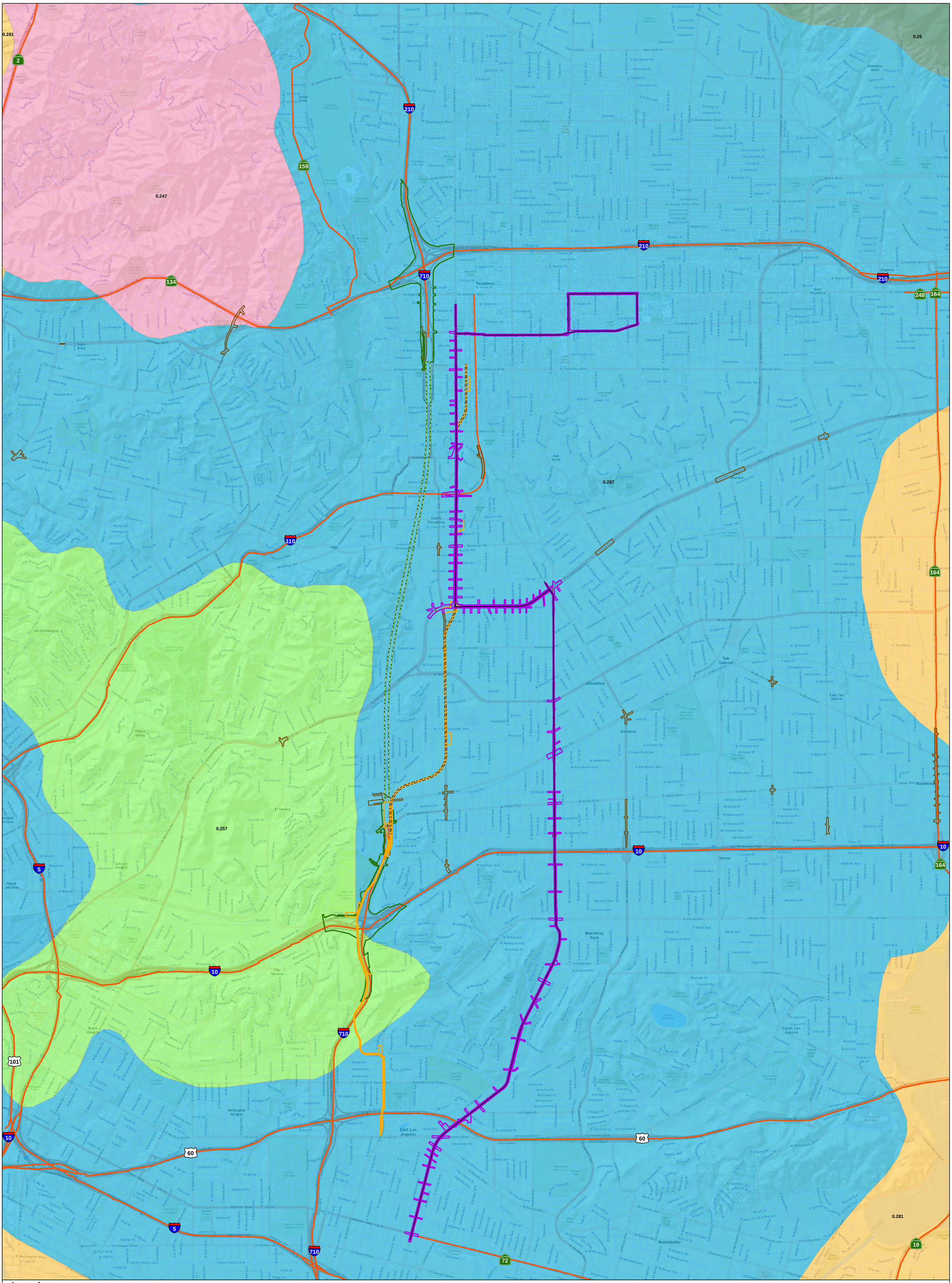
Plate 5
Surficial Soils Map

SR 710 North Study

Los Angeles County, California

CH2MHILL

DVR R:\LACOUNTYMTA_SR710_GAP_200001218\MAPFILES\GEOTECHNICALREPORT\GT_SOILS_OVERVIEW_D_V4.MXD RANHORN 11/5/2014 1:58:29 PM



Legend

SR 710 North Study Alternative

- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

K-Factor

- 0.247
- 0.257
- 0.26
- 0.281
- 0.287

Soil Susceptibility to Erosion	K-Factor
Low	0.05 to 0.20
Moderate	0.20 to 0.40
High	>0.40

References:
1 - NRCS-USDA State Office of Michigan, 2013. Revised Universal Soil Loss Equation (RUSLE) Technical Guide. Available at http://www.iwr.msu.edu/rusle/kfactor.htm. Accessed September 19, 2013
2 - STATSGO- U.S. Department of Agriculture, 1994. Available at http://water.usgs.gov/lookup/getspatial?muid Accessed September 19, 2013
3 - Road base map streamed from ESRI (September, 2014)

N

0 2,000 4,000 Feet

0 750 1,500 Meters

Plate 6
Soil Erodibility Map

SR 710 North Study

Los Angeles County, California

CH2MHILL

DVR R:\LACOUNTYMTA_SR710_GAP_200001218\MAPFILES\GEOTECHNICALREPORT\GT_SOILS_OVERVIEW_D_USGS_KFACT_V4.MXD RANHORN 11/5/2014 1:53:01 PM

L-1

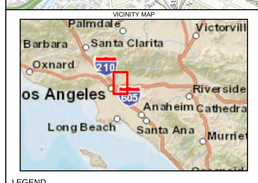
I-2

Raymond Fault

L-5

Alhambra Wash Fault

VICINITY MAP



LEGEND

SR 710 North Study Alternative

- TSM/TDM Alternative, Potential Disturbance Limit (PDL)
- BRT Alternative PDL, with Centerline
- LRT Alternative PDL
- LRT Tunnel Zone of Potential Influence
- Freeway Tunnel Alternative PDL
- Freeway Tunnel Zone of Potential Influence

Fault

- Fault - Certain
- Fault - Inferred
- Fault - Concealed
- Fault Zone
  These are delineated as straight-line segments that connect encircled turning points so as to define special studies zone segments.
- Landslide Zone
  Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required
- Liquefaction Zone
  Areas where historic occurrence of liquefaction,

  or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code
- Elevation Contour

Source:
State of California Department of Conservation, Division of Mines and Geology, Seismic Hazard Zone Maps for the Burbank, El Monte, Hollywood, Los Angeles, Mount Wilson and Pasadena Quadrangles (CDMG, 1977a-b, 1999a-f, and 1991)

0 1,750 3,500
Feet

PLATE 7
Seismic Hazard Zones Map
SR 710 North Study
Los Angeles County, California

CH2MHILL

VE=5X
H:1"=1000'; V:1"=200'

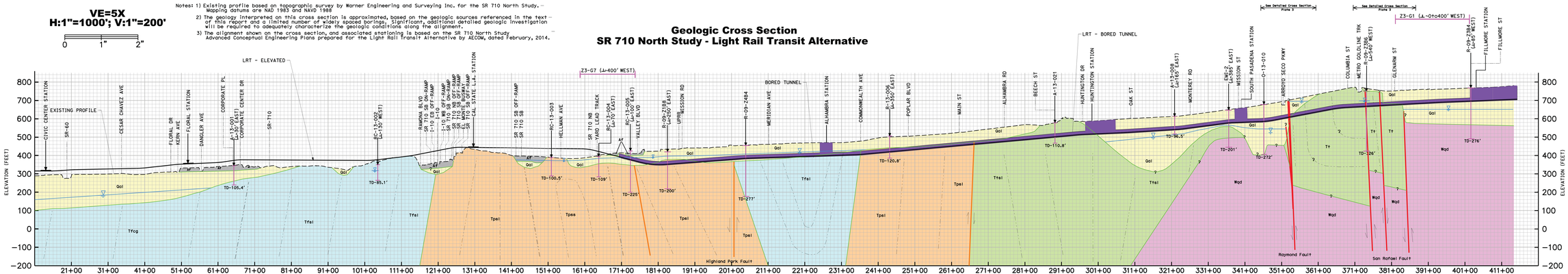
0 1" 2"

Notes: 1) Existing profile based on topographic survey by Warner Engineering and Surveying Inc. for the SR 710 North Study. Mapping datums are NAD 1983 and NAVD 1988

2) The geology interpreted on this cross section is approximated, based on the geologic sources referenced in the text of this report and a limited number of widely spaced borings. Significant, additional detailed geologic investigation will be required to adequately characterize the geologic conditions along the alignment.

3) The alignment shown on the cross section, and associated stationing is based on the SR 710 North Study Advanced Conceptual Engineering Plans prepared for the Light Rail Transit Alternative by AECOM, dated February, 2014.

Geologic Cross Section
SR 710 North Study - Light Rail Transit Alternative



LEGEND

UNITS

Af	ARTIFICIAL FILL
Qal	ALLUVIAL SOIL
Tfcg	FERNANDO FORMATION, CONGLOMERATE MEMBER
Tfsl	FERNANDO FORMATION, SILTSTONE MEMBER
Tpsl	PUENTE FORMATION, SILTSTONE MEMBER
Tpss	PUENTE FORMATION, SANDSTONE MEMBER
Tt	TOPANGA FORMATION, UNDIFFERENTIATED
Ttss	TOPANGA FORMATION, SANDSTONE MEMBER
Ttcg	TOPANGA FORMATION, CONGLOMERATE MEMBER
Ttsl	TOPANGA FORMATION, SILTSTONE MEMBER
Wqd	WILSON QUARTZ DIORITE

SYMBOLS

ALL LOCATIONS ARE APPROXIMATE. QUERIES INDICATE UNCERTAINTY.

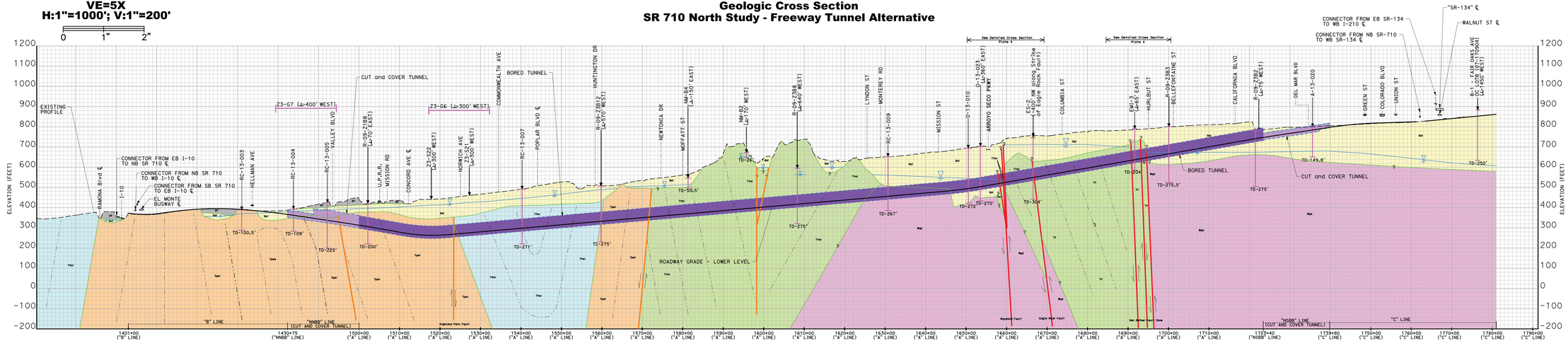
- GEOLOGIC CONTACT
- INACTIVE FAULT
- ACTIVE OR POTENTIALLY ACTIVE FAULT
- INTRAFORMATIONAL CONTACT
- GENERALIZED BEDDING
- ESTIMATED TOP OF GROUNDWATER TABLE
- Z3-G7 SEISMIC LINE (CH2M HILL, 2010), WITH PROJECTION
- 0-13-001 GEOTECHNICAL BORHOLE WITH TOTAL DEPTH AND PROJECTIONS
  - A, R, RC, O-13-001 - CH2M HILL, THIS STUDY
  - R-09-Z1B8 - CH2M HILL, 2010
  - NM-83 - NINYO AND MOORE, 1999
  - EMI-3 - EARTH MECHANICS INC, 2006
  - ES-2 - CALTRANS, 1974
- 0-13-000 TD-148.8'

PLATE 8
LRT ALTERNATIVE GEOLOGIC CROSS SECTION
SR 710 North Study
Los Angeles County, California

CH2MHILL.

SCCH2M08.01.13.01.11 SR710_LRT_plate8_rev2.ai 9/14

Geologic Cross Section
SR 710 North Study - Freeway Tunnel Alternative



Notes:
1) Existing profile based on topographic survey by Warner Engineering and Surveying Inc. for the SR 710 North Study. - Mapping datums are NAD 1983 and NAVD 1988
2) The geology interpreted on this cross section is approximated, based on the geologic sources referenced in the text - of this report and a limited number of widely spaced borings. Significant, additional detailed geologic investigation will be required to adequately characterize the geologic conditions along the alignment.
3) The alignment shown on the cross section, and associated stationing is based on the SR 710 North Study Project - Report prepared for the Freeway Tunnel Alternative Preliminary Project Plans by CH2M HILL, dated February 2014.

LEGEND

UNITS

Af	ARTIFICIAL FILL
Qal	ALLUVIAL SOIL
Tfcg	FERNANDO FORMATION, CONGLOMERATE MEMBER
Tfsl	FERNANDO FORMATION, SILTSTONE MEMBER
Tpsl	PUENTE FORMATION, SILTSTONE MEMBER
Tpss	PUENTE FORMATION, SANDSTONE MEMBER
Tt	TOPANGA FORMATION, UNDIFFERENTIATED
Ttss	TOPANGA FORMATION, SANDSTONE MEMBER
Ttcg	TOPANGA FORMATION, CONGLOMERATE MEMBER
Ttsl	TOPANGA FORMATION, SILTSTONE MEMBER
Wqd	WILSON QUARTZ DIORITE

SYMBOLS

ALL LOCATIONS ARE APPROXIMATE. QUERIES INDICATE UNCERTAINTY.

- GEOLOGIC CONTACT
- INACTIVE FAULT
- ACTIVE OR POTENTIALLY ACTIVE FAULT
- INTRAFORMATIONAL CONTACT
- GENERALIZED BEDDING
- ESTIMATED TOP OF GROUNDWATER TABLE
- Z3-G7 SEISMIC LINE (CH2M HILL, 2010), WITH PROJECTION
- TD-149.8' GEOTECHNICAL BORHOLE WITH TOTAL DEPTH AND PROJECTION: A, R, RC, O-13-001 - CH2M HILL, THIS STUDY; R-09-2188 - CH2M HILL, 2010; NM-B3 - NINYO AND MOORE, 1999; EM1-3 - EARTH MECHANICS INC, 2006; ES-2 - CALTRANS, 1974

PLATE 9
FREEWAY TUNNEL ALTERNATIVE GEOLOGIC CROSS SECTION
SR 710 North Study
Los Angeles County, California

CH2MHILL