SR 710 North Study

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

Structure Preliminary Geotechnical Report
SR 710 Connector Underpass

Prepared for

Metro

Los Angeles County
Metropolitan Transportation Authority

February 2014

07-LA-710
EA 07-187900
PM 26.7/32.1

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
APS	Advance Planning Study
ASTM	ASTM International (formerly American Society for Testing and Materials)
bgs	below ground surface
BRT	Bus Rapid Transit
Caltrans	California Department of Transportation
CDMG	California Division of Mines and Geology
CIDH	cast-in-drilled-hole
CTM	Caltrans Test Method
ECI	Earth Consultants International
H:V	horizontal to vertical
LRFD	Load and Resistance Factor Design
LRT	Light Rail Transit
Metro	Los Angeles County Metropolitan Transportation Authority
NAVD 88	North American Vertical Datum 1988
ohm-cm	ohm-centimeters
ppm	parts per million
SPGR	Structure Preliminary Geotechnical Report
SR	State Route
TSM/TDM	Transportation System Management/ Transportation Demand Management
USGS	United States Geological Survey

SECTION 1

Introduction

1.1 Scope of Work

The California Department of Transportation (Caltrans), in cooperation with the Los Angeles County Metropolitan Transportation Authority (Metro), proposes to improve mobility and relieve congestion in the area between State Route (SR) 2 and Interstates 5, 10, 210, and 605 in east/northeast Los Angeles and the San Gabriel Valley, through the implementation of various transportation improvement projects. One of these improvement projects involves the SR 710 North Study. Five alternatives are being evaluated for the SR 710 North Study, as part of the transportation enhancement in the area, including a No Build Alternative. The four build alternatives include Transportation System Management/ Transportation Demand Management (TSM/TDM), Bus Rapid Transit (BRT), Light Rail Transit (LRT), and Freeway Tunnel. Figure 1-1 shows a vicinity map for the SR 710 North Study Area.

The TSM/TDM Alternative for the SR 710 North Study will include a new SR 710 Connector roadway between Valley Boulevard and Mission Road in the City of Los Angeles. The roadway would be located in the undeveloped land to the north of the current SR 710 terminus. Where the proposed SR 710 roadway crosses the existing railroad tracks, a new SR 710 Connector Underpass Bridge will be constructed to provide a grade separation between the three railroad tracks and the proposed SR 710 Connector roadway.

As part of the Environmental Studies Documentation Process of the SR 710 North Study, CH2M HILL collected and reviewed geotechnical information for the SR 710 Connector Underpass Bridge, and then used information collected during the review to prepare this Structure Preliminary Geotechnical Report (SPGR). The intent of the SPGR is to provide geotechnical information for the Advance Planning Study (APS). Recommendations for other bridge structures as part of the SR 710 North Study are presented in separate reports.

The scope of work for this SPGR included the following:

- Review available geology maps and documents associated with the project site.
- Conduct a site reconnaissance at the proposed bridge location to review the visible physical characteristics and surficial soil conditions on the site.
- Prepare a summary of geotechnical findings, subsurface soil conditions, and geological constraints at the site based on the available information.
- Provide preliminary recommendations for foundation type, and identify any additional geotechnical investigation necessary for the design of the proposed bridge structure.

1.2 Project Description

The proposed bridge structure is located about 200 to 300 feet south of Mission Road, at approximately latitude 34°04'41.37"N and longitude 118°09'42.38"W. A site location map is provided in Figure 1-2.

At the proposed bridge location, existing railroad tracks are situated atop a fill embankment, roughly 10 to 20 feet higher than the surrounding area. The proposed SR 710 Connector Underpass will be a new bridge structure that maintains the tracks at their current elevation and accommodates a grade separation of the proposed SR 710 Connector and the railroad tracks.

The proposed SR 710 Connector Underpass will be a two-span, steel deck plate with steel plate girder superstructure supported on 24- to 72-inch cast-in-drilled-hole (CIDH) piles. The new bridge will be 90 feet long and 72 feet wide. The existing grade underneath the railroad tracks will be depressed by as much as 26 feet to accommodate two lanes each of the northbound and southbound SR 710 Connector. The general plan for the proposed structure is provided in Appendix A.

1.3 Pertinent Reports and Investigations

Existing maps and other documents were collected and reviewed for this geotechnical study. Pertinent documents included the following:

- California Division of Mines and Geology (CDMG). 1998. *Seismic Hazard Zone Report for the Los Angeles 7.5-minute Quadrangle, Los Angeles County, Seismic Hazard Zone Report 029.*
- CDMG. 1999. *Seismic Hozard Zones Map for the Los Angeles 7.5-minute Quadrangle, Los Angeles County, California.* March 25.
- CH2M HILL. 2010. *Final Geotechnical Summary Report, SR 710 Tunnel Technical Study, Los Angeles County California.* Prepared for Caltrans. EA-07-187900. April.
- United States Geological Survey (USGS). 2005. *Preliminary Geologic Map of the Los Angeles 30' x 60' Quadrangle, Southern California.* Open File Report 2005-1019.

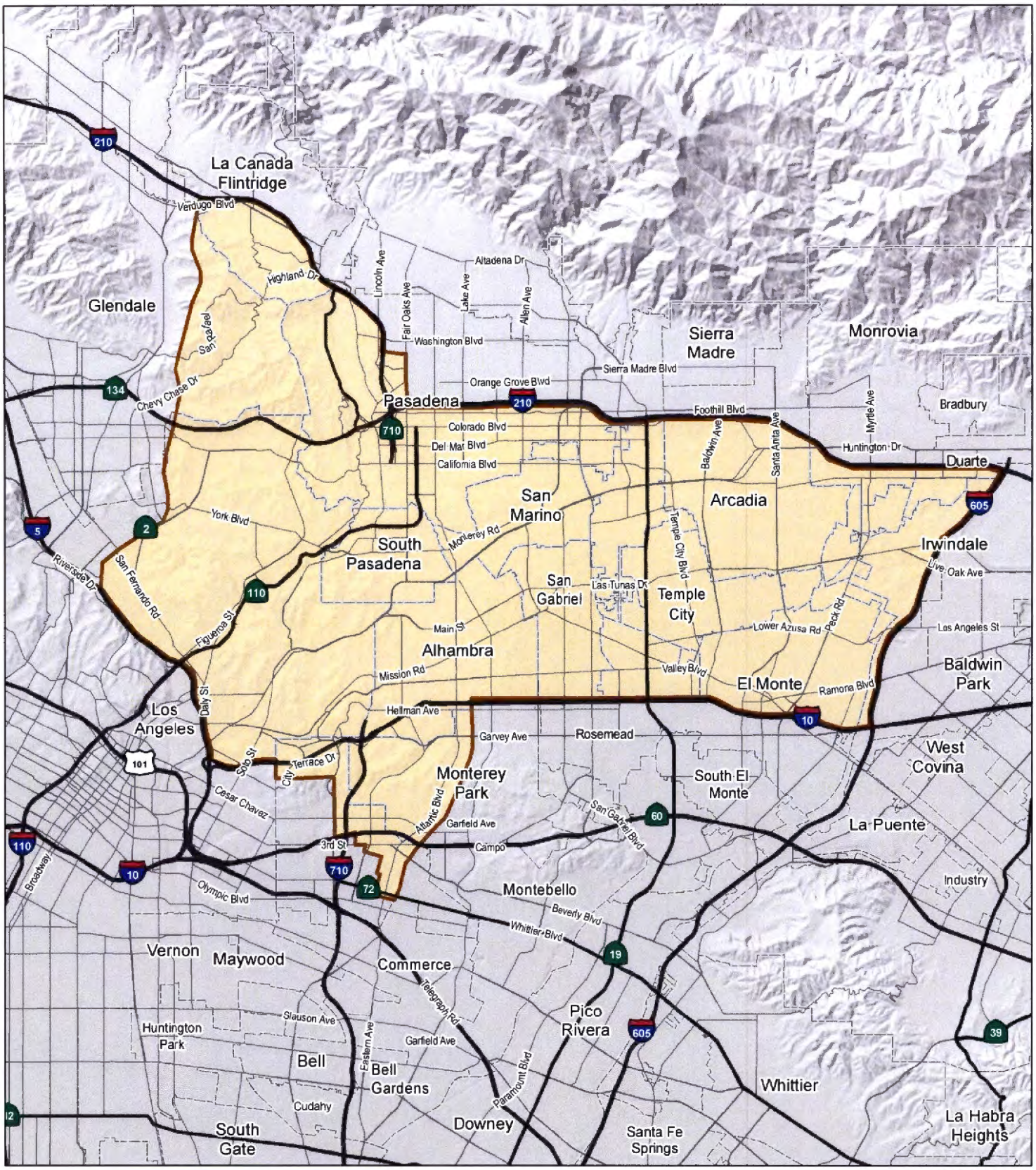
1.4 Limitations

This SPGR was prepared for the exclusive use of the CH2M HILL design team members, Caltrans District 7, and Metro for specific application to the design and Environmental Studies Documentation Process for the project. The report has been prepared in general accordance with Caltrans standards and follows the report outline presented in the *Caltrans Foundation Report Preparation for Bridges* (2009). No other warranty, express or implied, is made.

The preliminary recommendations contained in this report are based on the data obtained from review of a single boring log advanced during the SR 710 Tunnel Technical Study (CH2M HILL, 2010), geological maps and documents for the area, and the site reconnaissance. The boring log indicates subsurface conditions only at the specific boring location and time it was conducted, and only to the depth penetrated. It does not necessarily reflect variations that may exist at other locations and depths, or changes that may take place with time. If variations in subsurface conditions from those described in this report are noted during final design or construction, the recommendations presented in this report must be reevaluated.

If any change in the nature, design, or location of the proposed structure occurs, the conclusions and recommendations of this report should not be considered valid unless such changes are reviewed and the conclusions of this report are modified or verified in writing by CH2M HILL's geotechnical staff. CH2M HILL is not responsible for any claims, damages, or liability associated with the reinterpretation or reuse of the subsurface data in this report by others.

The geotechnical recommendations presented in this report are based on the preliminary general plan prepared for this structure. Other than the APS plans, no other structural plans for the proposed bridge structure were available at the time this report was prepared.



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\GIS\StudyArea.mxd (1/21/2014)

PRE-DELIBERATIVE DRAFT

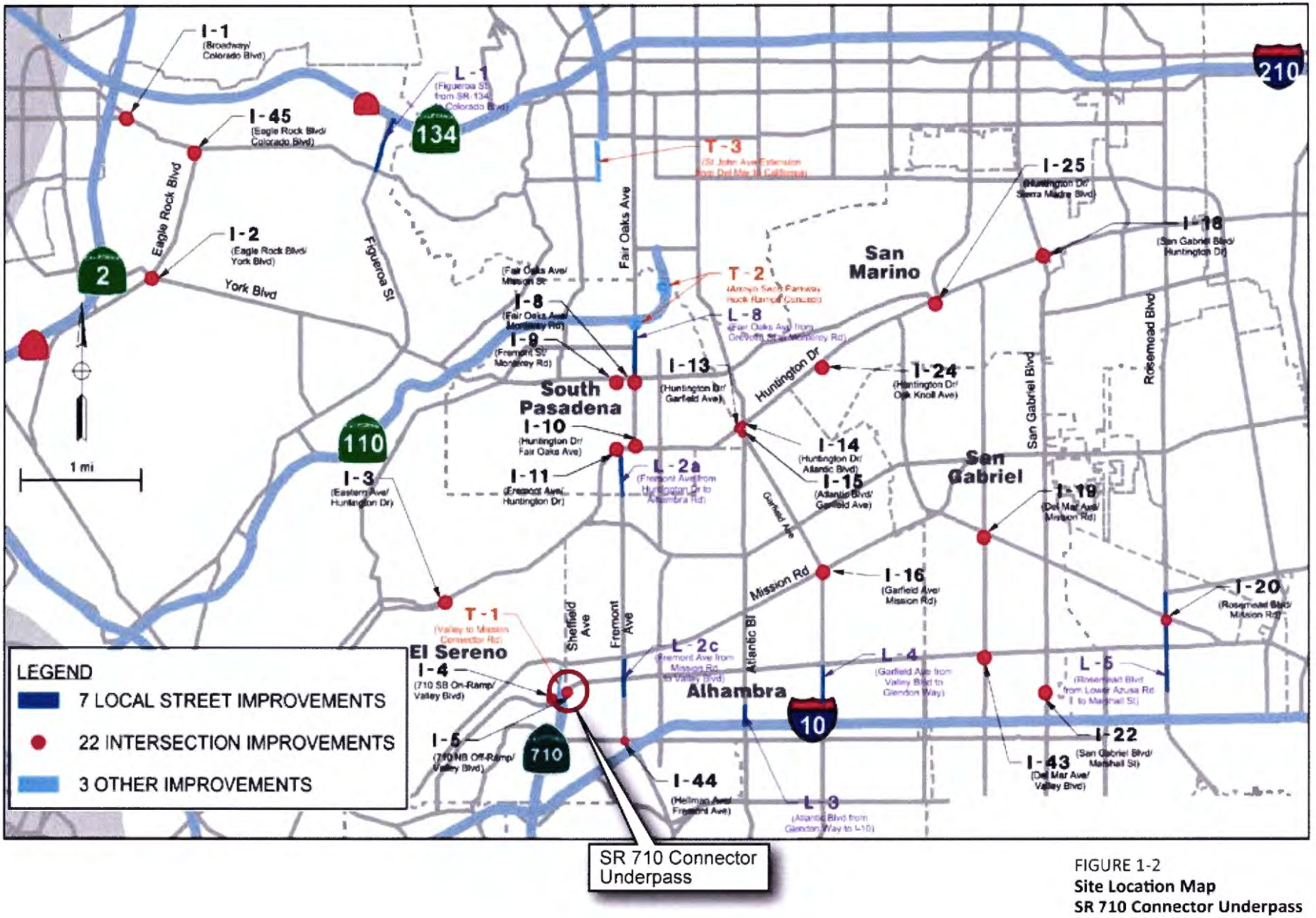


FIGURE 1-2
Site Location Map
SR 710 Connector Underpass
SR 710 North Study
Los Angeles County, California

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SECTION 2

Geotechnical Data

2.1 Field Exploration

No previous geotechnical investigations have been conducted at the proposed bridge site. However, one boring was drilled approximately 250 feet south of the bridge site during the SR 710 Tunnel Technical Study (CH2M HILL, 2010). The boring was drilled by Caltrans Drilling Services and was continuously observed and logged by a Caltrans engineering geologist.

Boring information is summarized in Table 2-1. The boring location is shown in Figure 2-1. A detailed boring log is presented in Appendix B. The preliminary soil stratigraphy for the project site was developed based on this boring log.

TABLE 2-1
Summary of Geotechnical Exploration
SR 710 Connector Underpass

Exploration No.	Year of Exploration	Type of Exploration	Ground Surface Elevation[a] (feet)	Depth of Exploration (feet)	Groundwater Elevation[a] (feet)		
					July 2009	March 2013	September 2013
R-09-Z1B8	2009	Rotary Wash/Wire Line Coring	419.6	200.0	394.6	396.2	395.7

[a] The elevations are based on North American Vertical Datum 1988 (NAVD 88).

2.2 Laboratory Testing

Laboratory testing was performed on representative soil samples collected during the SR 710 Tunnel Technical Study field exploration (CH2M HILL, 2010). Tests included natural moisture content, in-place density, soil and rock classification, strength characteristics, and corrosivity. Leighton and Associates, Inc., and Sierra Testing Laboratories, Inc., under subcontract to CH2M HILL, conducted the laboratory tests. Testing was completed in general accordance with applicable ASTM International (ASTM) standards or the Caltrans Test Method (CTM).

CH2M HILL engineers reviewed the laboratory test results for completeness and reasonableness. The laboratory tests performed are summarized in Appendix C. The detailed laboratory test results will be included in a future-phase foundation report.

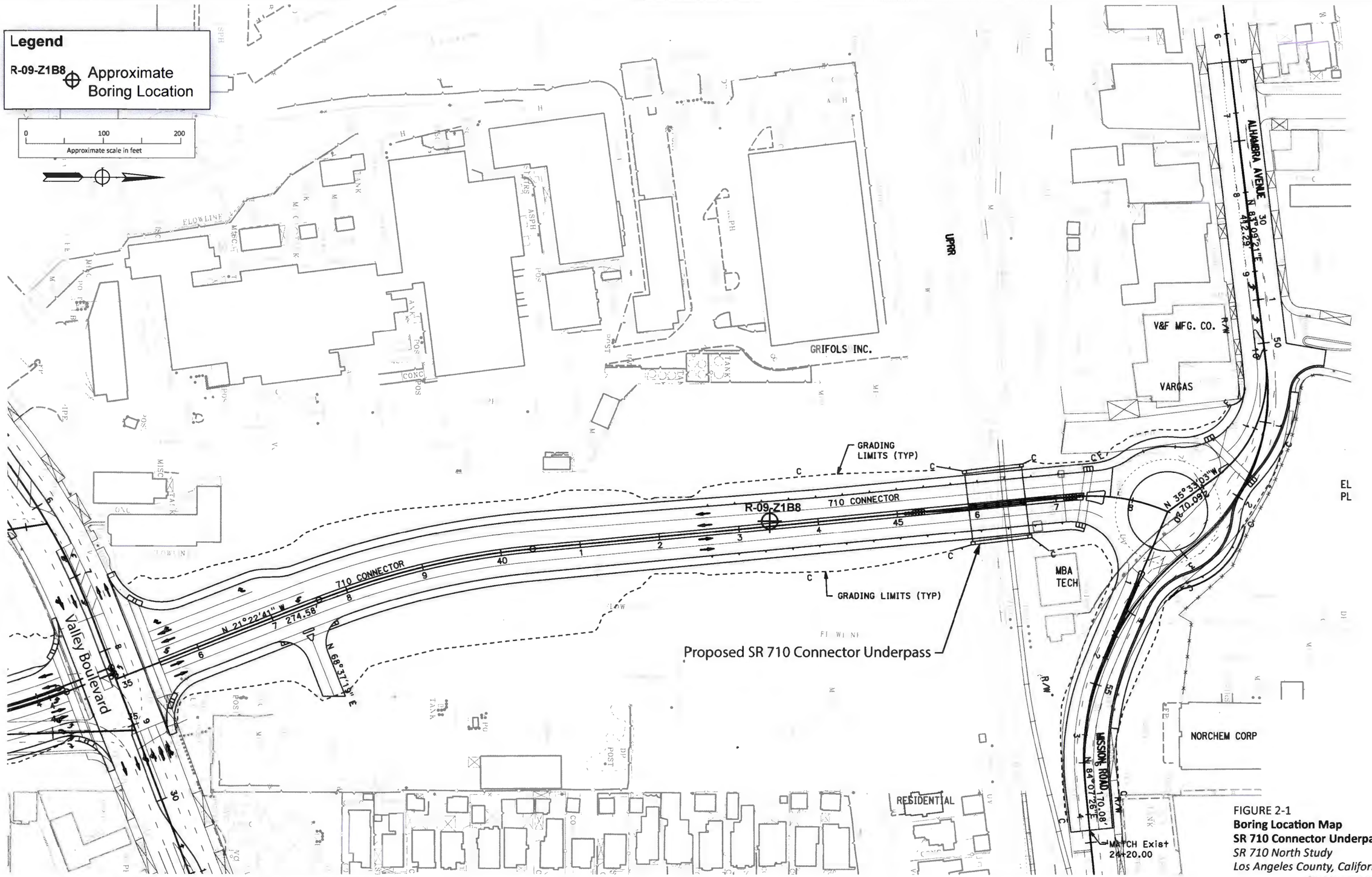

FIGURE 2-1
Boring Location Map
SR 710 Connector Underpass
SR 710 North Study
Los Angeles County, California

SCO428908.02.14.01.01.08 SR710_boringlocation_map.ai 2/14

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SECTION 3

Site Geology and Subsurface Conditions

3.1 Topography

The SR 710 Connector Underpass is located near the northeastern face of the Repetto Hills, at the southwestern edge of the San Gabriel Valley. In the vicinity of the underpass, the existing railroad tracks are situated atop a fill embankment on the order of 10 to 20 feet in height. The embankment side slopes are inclined at an approximate slope of 2:1 (horizontal to vertical [H:V]). The topography surrounding the underpass site is relatively flat.

3.2 Geology

3.2.1 Regional Geology

The SR 710 Connector Underpass is located within the northwest-southeast-trending Peninsular Ranges physiographic/geologic province. The regional geology of the Peninsular Ranges consists of terrestrial and marine sedimentary rocks, as well as older igneous and metamorphic basement rocks. Surficial soils derived from the Repetto Hills and San Gabriel Mountains blanket the San Gabriel Valley and drainages within the Repetto Hills.

The SR 710 Connector Underpass is located in a tectonically active region of southern California. Nearby active and potentially active faults include the Raymond, Alhambra Wash, and San Rafael/Eagle Rock fault zones, among others. Additional details about these active and potentially active faults are described in the technical memorandum titled *Fault Rupture Evaluation for the SR 710 North Study* (CH2M HILL and Earth Consultants International [ECI], 2013).

3.2.2 Site Geology

The SR 710 Connector Underpass is underlain by alluvial soil deposits and Puente Formation bedrock. The composition of the alluvial soil deposits is described in Section 3.2.3.

As observed within boring R-09-Z1B8, the Siltstone Member of the Puente Formation underlies the site. Bedrock was encountered at 42 feet below ground surface (bgs) at the exploration drilled near the underpass site (see Figure 2-1). The bedrock underlying the site has been deformed as a result of regional tectonic forces, and is expected to be moderately sheared and fractured.

3.2.3 Stratigraphy

Based on boring R-09-Z1B8, the subsurface at the site consists of alluvial soils underlain by Puente Formation bedrock. The alluvial soils predominantly consist of loose to medium dense sandy soils with occasional interbedded soft to stiff silty and clayey lenses. The alluvial soils extended from ground surface to a depth of approximately 42 feet bgs (elevation of 377.6 feet).

The Puente Formation bedrock at the bridge site is composed of moderately weathered soft siltstone and mudstone with thin interbeds of fine sandstone to the maximum depth of exploration at 200 feet bgs.

The location beneath active rail tracks means that a potential exists for contaminated soils within the embankment fill and upper zone of alluvial soils. These conditions may require special handling and disposal of material excavated for the underpass, as well as for the construction of CIDH piles that support the bridge. Additional investigation is recommended for this location to determine whether any environmental impact is present in the soil because of the railroad right-of-way (CH2M HILL, 2014).

Additional borings should be drilled at the proposed abutment and center pier locations to supplement the existing subsurface information. Information from the existing and proposed borings should be used for the final foundation design recommendations.

3.3 Groundwater Conditions

Based on the *Seismic Hazard Zone Report 029* (CDMG, 1998), the historically highest groundwater at the bridge site is noted at a depth of 200 feet bgs. However, groundwater was observed within the piezometer installed within boring R-09-Z1B8 at an approximate depth of 23.4 to 25 feet (elevations of 394.6 to 396.2 feet) from July 2009 to September 2013. This groundwater could be perched on the top of underlying bedrock.

A groundwater elevation of 396.2 feet should be used during preliminary design of the proposed underpass foundations. The currently proposed bottom of the pile caps is at an approximate elevation of 397 feet. The bottom of the pile cap may encounter the groundwater table. The depressed roadway grade at the bridge location is at an approximate elevation of 407 feet and the lowest roadway elevation south of the bridge is approximately 403 feet. Both of these locations are above the ground water table based on the currently available groundwater data.

Because the groundwater table can fluctuate as a result of seasonal variations, nearby construction, irrigation, and numerous other human-made and natural influences, the design groundwater elevation should be updated as more information becomes available regarding the maximum and seasonal variation in groundwater. Future groundwater evaluations should specifically determine whether groundwater is also located within the Puente Formation or perched on top of this formation.

3.4 Scour Evaluation

There are no creeks or rivers crossing the site. Therefore, scour is not a concern at the project site.

3.5 Corrosion Conditions

Soil laboratory tests for corrosivity were conducted on two samples collected in the boring drilled adjacent to the bridge site. Soil samples were tested for pH, minimum resistivity, soluble chloride content, and soluble sulfate content using the procedures described in CTM 417, 422, and 643 (Caltrans, 2007, 2013a, and 2013b). The corrosion test results are summarized in Table 3-1.

TABLE 3-1
Summary of Laboratory Test Results for Corrosion
SR 710 Connector Underpass

Boring No.	Sample	Depth (feet)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
R-09-Z1B8	C-26	120.2	Siltstone/ Mudstone	343	6.2	1,156	59
R-09-Z1B8	C-33	159.6	Siltstone/ Mudstone	410	6.3	720	76

ohm-cm – ohm-centimeters
ppm – parts per million

Caltrans (2012) considers a site to be corrosive to structural elements if one or more of the following conditions exist:

- Chloride concentration is greater than or equal to 500 ppm.
- Sulfate concentration is greater than or equal to 2,000 ppm.
- The pH is 5.5 or less.

Based on the above corrosion criteria, the subsurface soils at the bridge site are considered noncorrosive for common construction materials. If this alternative is selected, additional soil corrosion testing should be performed within the alluvial soils and Puente Formation bedrock. During design, a corrosion engineer should review the corrosion data and provide design recommendations for construction materials proposed at the project site.

3.6 Geologic Hazards

3.6.1 Liquefaction

When loose, saturated sand and nonplastic silt deposits are subjected to seismic loading, the deposits can liquefy and lose shear strength if levels of ground shaking are high enough. For this bridge site, the groundwater was encountered at an elevation of 395.7 feet (24 feet below existing ground surface). Based on the subsurface conditions encountered in boring R-09-Z1B8, the soils below groundwater consist of a 5-foot-thick clay layer underlain by a 12-foot-thick medium dense sandy layer, which in turn is underlain by Puente Formation bedrock.

Although clayey soils with medium to high plasticity and the Puente Formation bedrock are not susceptible to liquefaction, the 12-foot-thick medium dense sandy layer may potentially liquefy depending on the intensity of the ground shaking. The *Seismic Hazard Zones Map for the Los Angeles 7.5-Minute Quadrangle* (CDMG, 1999) indicates that the proposed bridge site is not located in an area where historical occurrence of liquefaction or a potential for liquefaction is noted.

Because of the presence of medium dense sandy soils and shallow groundwater conditions, the subsurface material is considered potentially susceptible to liquefaction. The liquefaction potential at the bridge site should be further evaluated using site-specific borings drilled during future field explorations.

3.6.2 Landslides

Based on the *Seismic Hazard Zones Map for the Los Angeles 7.5-Minute Quadrangle* (CDMG, 1999), the proposed SR 710 Connector Underpass site is not within the vicinity of potential landslide areas. Therefore, the potential for land sliding or slope instability from sloping ground conditions at the proposed SR 710 Connector Underpass is considered low during gravity or seismic loading.

3.6.3 Ground Rupture

No faults are mapped crossing the SR 710 Connector Underpass site, and no faults have been mapped in the immediate vicinity of the site (USGS, 2005 and 2010; CDMG, 1977). Therefore, the ground surface rupture hazard associated with known active faults is considered very low at the bridge site.

Additional discussion regarding the overall SR 710 North Study fault rupture potential is presented in the technical memorandum *Fault Rupture Evaluation for the SR 710 North Study* prepared for the project (CH2M HILL and ECI, 2013).

SECTION 4

Foundation Recommendations

4.1 Foundation Recommendations

The proposed SR 710 Connector Underpass structure will be a two-span bridge and will be supported on high-seat cantilever abutments at the ends and 4-foot-diameter columns in the middle.

Based on the subsurface conditions, the proposed SR 710 Connector Underpass can be supported on CIDH piles at the abutments and bent. For advanced planning purposes, 24-inch CIDH and 72-inch CIDH piles are considered at the abutments and bents, respectively. The CIDH piles will be socketed into the Puente Formation bedrock. The depth of the rock socket will have to be sufficient for axial and lateral loading during rail and seismic loading. The potential for encountering natural gas during construction of the drilled shafts for this structure is considered low to moderate. The potential to encounter naturally occurring gases would be addressed during drilled shaft construction if the alternative is selected.

Shallow foundations are not recommended because of the relatively high groundwater elevation present at the site and the associated buoyancy forces, as well as footing size requirements to meet seismic demands. Driven precast concrete and steel piles are not recommended because of high seismic lateral load and uplift demands, in combination with the shallow bedrock depth and the anticipated hard driving conditions. Noise associated with driving piles also would potentially result in significant concerns from nearby residences.

Because groundwater was encountered at an elevation of 396.2 feet (23.4 feet bgs) near the bridge site (boring R-09-Z1B8; see Figure 2-1), temporary dewatering will likely be required during construction of the pile caps for the abutments. During future phases of design, alternate abutment foundations, such as secant pile walls, will be considered to avoid dewatering requirements. These alternate foundations may be particularly beneficial if groundwater contamination occurs in the area.

4.2 Future Investigations

The boring that was drilled near the underpass bridge provides limited coverage for the proposed structure. To provide more design information, additional borings should be drilled and sampled.

According to Section 10.4.2 of *AASHTO LRFD [Load and Resistance Factor Design] Bridge Design Specifications* (American Association of State Highway and Transportation Officials [AASHTO], 2007), a minimum of three borings with depths of 100 feet below the existing ground surface should be planned. Final boring depths should be determined on the basis of the quality of the rock and the depth required to meet gravity and seismic loads.

Soil and rock samples should be collected every 5 feet using the standard penetration test, modified California-driven samplers, and rock coring methods. Selected samples should be tested for soil classification, strength and consolidation characteristics, corrosivity, and expansion potential. Groundwater monitoring piezometers should be constructed in selected borings to adequately characterize the groundwater table in the area of the proposed bridge. The screens for groundwater piezometers should be located in the alluvial soil and in the Puente Formation.

SECTION 5

References

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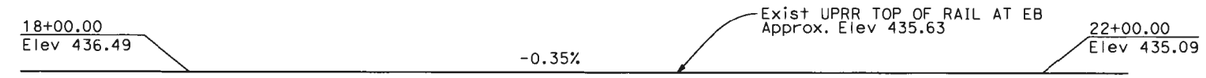
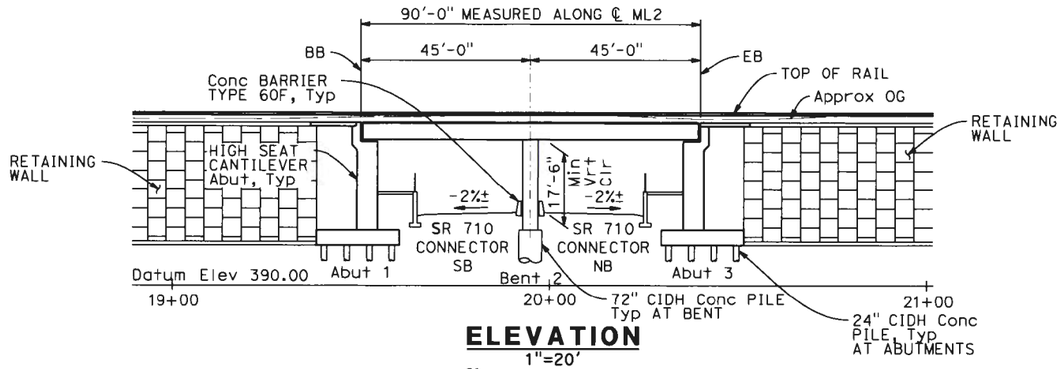
Appendix A
Proposed General Plan

PREPARED FOR THE STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION



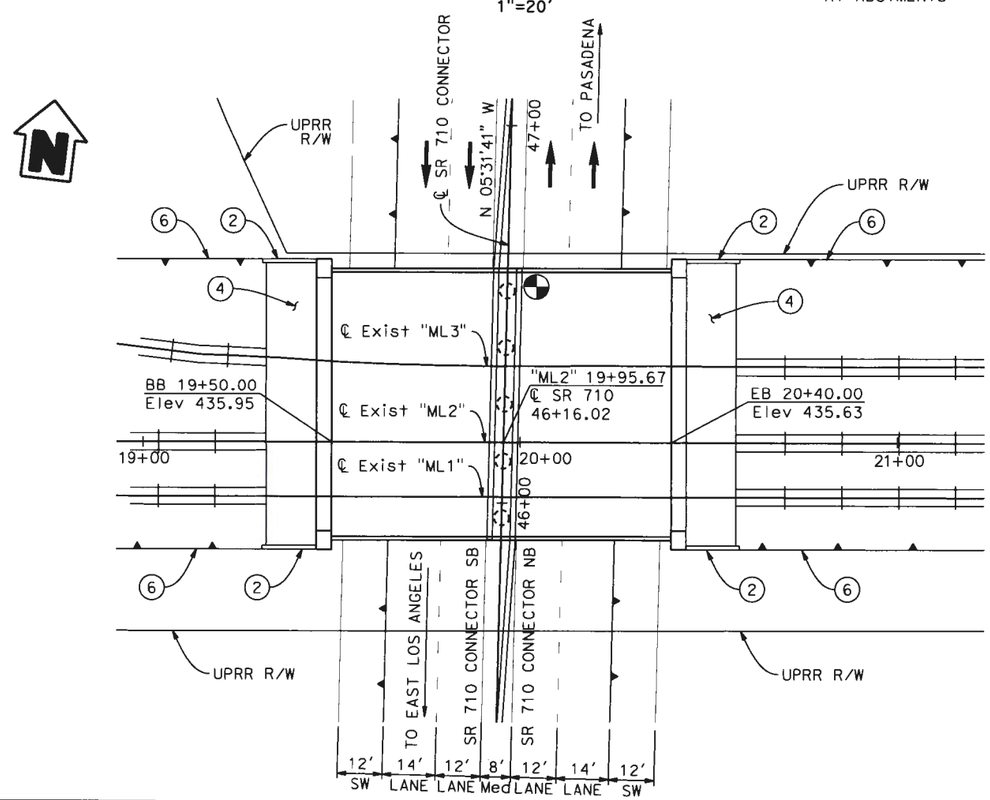
PROFILE GRADE - TOP OF RAIL (ML2)

NO SCALE



ELEVATION

1"=20'



PLAN

1"=20'

LEGEND:

1. Precast Facade Panels
2. Wingwall
3. Walkway
4. Approach Slab
5. Picket Hand Railing
6. Railroad Retaining Wall

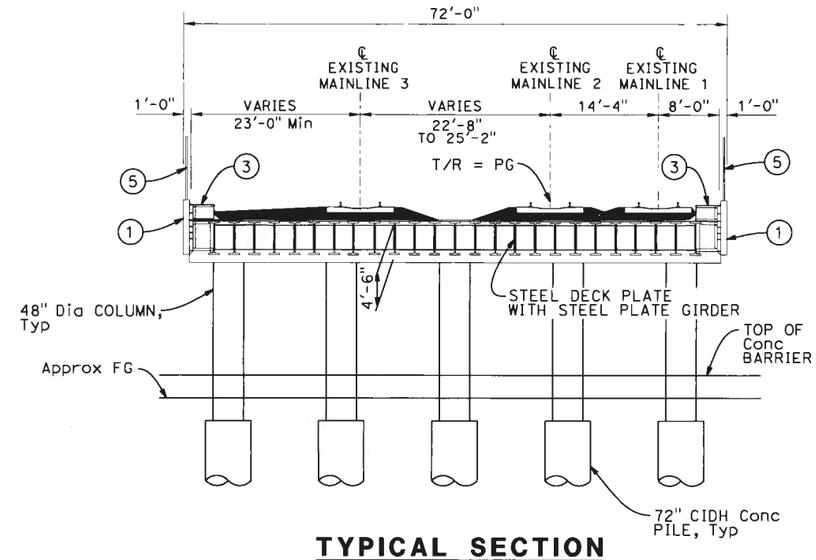
Denotes Point of Minimum Vertical Clearance

Traffic Lane or Direction

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT
7	LA	710	

METRO
ONE GATEWAY PLAZA
LOS ANGELES, CA 90012

CH2M HILL
1000 WILSHIRE BLVD, SUITE 2100
LOS ANGELES, CA 90017



TYPICAL SECTION

1"=10'

ABBREVIATION

T/R TOP OF RAIL
PG PROFILE GRADE

NOTE: SHOOFLY WILL BE REQUIRED TO BUILD THE BRIDGE WHICH IS NOT SHOWN IN THIS PLAN.

DATE OF ESTIMATE	FEBRUARY 2014
BRIDGE REMOVAL	NONE
STRUCTURE DEPTH	4'-6"
LENGTH	90'-0"
WIDTH	72'-0"
AREA	6,480 SF
COST/FT^2 INCLUDING 10% MOBILIZATION & 25% CONTINGENCY	$ 1342
TOTAL COST	$ 8,693,000

DESIGNED BY	A. Issa	DATE	02-17-2014
DRAWN BY	N. Morales	DATE	02-17-2014
CHECKED BY	M. Atiqullah	DATE	02-17-2014
APPROVED		DATE	

M. Atiqullah
PROJECT ENGINEER

PLANNING STUDY

SR 710 CONNECTOR UNDERPASS

BRIDGE NO. TBD	UNIT:
SCALE: 1"-20'	PROJECT NUMBER & PHASE:

DESIGN OVERSIGHT

SIGN OFF DATE

ADVANCE PLANNING STUDY SHEET (ENGLISH) (REV. 7/16/10)

FILE => 710Conn-Bridge.dgn

CONTRACT NO.: X

USERNAME => nmorales DATE PLOTTED => 17-FEB-2014 TIME PLOTTED => 10:30

Appendix B
Boring Log

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic / Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (short-term)
- Static Water Level Reading (long-term)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

REPORT TITLE
BORING RECORD LEGEND

DIST.	COUNTY	ROUTE	POSTMILE	EA
07	LA	710	D/D	07-187900

PROJECT OR BRIDGE NAME
SR-710 Tunnel Technical Study

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
N/A			1 of 3

CONSISTENCY OF COHESIVE SOILS				
Descriptor	**Unconfined Compressive Strength (tsf)**	**Pocket Penetrometer (tsf)**	**Torvane (tsf)**	**Field Approximation**
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 - 0.50	0.25 - 0.50	0.12 - 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 - 1.0	0.50 - 1.0	0.25 - 0.50	Can be penetrated several inches by thumb with moderate effort
Stiff	1.0 - 2.0	1.0 - 2.0	0.50 - 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2.0 - 4.0	2.0 - 4.0	1.0 - 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

APPARENT DENSITY OF COHESIONLESS SOILS	
Descriptor	**SPT N_{60} - Value (blows / foot)**
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

MOISTURE	
Descriptor	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS	
Descriptor	**Criteria**
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

SOIL PARTICLE SIZE		
Descriptor		**Size**
Boulder		> 12 inches
Cobble		3 to 12 inches
Gravel	Coarse	3/4 inch to 3 inches
	Fine	No. 4 Sieve to 3/4 inch
Sand	Coarse	No. 10 Sieve to No. 4 Sieve
	Medium	No. 40 Sieve to No. 10 Sieve
	Fine	No. 200 Sieve to No. 40 Sieve
Silt and Clay		Passing No. 200 Sieve

PLASTICITY OF FINE-GRAINED SOILS	
Descriptor	**Criteria**
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CEMENTATION	
Descriptor	**Criteria**
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

NOTE: This legend sheet provides descriptors and associated criteria for required soil description components only. Refer to Caltrans Soil and Rock Logging, Classification, and Presentation Manual (July 2007), Section 2, for tables of additional soil description components and discussion of soil description and identification.

ROCK GRAPHIC SYMBOLS


IGNEOUS ROCK


SEDIMENTARY ROCK


METAMORPHIC ROCK

BEDDING SPACING

Descriptor	Thickness or Spacing
Massive	> 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8 inches to 1 ft
Thinly bedded	1-1/4 to 3-5/8 inches
Very thinly bedded	3/8 inch to 1-1/4 inches
Laminated	< 3/8 inch

WEATHERING DESCRIPTORS FOR INTACT ROCK

	Diagnostic Features					
	Chemical Weathering-Discoloration-Oxidation		Mechanical Weathering and Grain Boundary Conditions	Texture and Solutioning		
Descriptor	Body of Rock	Fracture Surfaces		Texture	Solutioning	General Characteristics
Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull	Minor to complete discoloration or oxidation of most surfaces	No visible separation, intact (tight)	Preserved	Minor leaching of some soluble minerals may be noted	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty"; feldspar crystals are "cloudy"	All fracture surfaces are discolored or oxidized	Partial separation of boundaries visible	Generally preserved	Soluble minerals may be mostly leached	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation (refer to grain boundary conditions)	All fracture surfaces are discolored or oxidized; surfaces are friable	Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated	Altered by chemical disintegration such as via hydration or argillation	Leaching of soluble minerals may be complete	Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures or veinlets. Rock is significantly weakened.
Decomposed	Discolored of oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay		Complete separation of grain boundaries (disaggregated)	Resembles a soil; partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes".

Note: Combination descriptors (such as "slightly weathered to fresh") are used where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant identifiable zones can be delineated. Only two adjacent descriptors shall be combined. "Very intensely weathered" is the combination descriptor for "decomposed to intensely weathered".

RELATIVE STRENGTH OF INTACT ROCK

Descriptor	Uniaxial Compressive Strength (psi)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

ROCK HARDNESS

Descriptor	Criteria
Extremely Hard	Specimen cannot be scratched with pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows
Very hard	Specimen cannot be scratched with pocket knife or sharp pick; breaks with repeated heavy hammer blows
Hard	Specimen can be scratched with pocket knife or sharp pick with heavy pressure; heavy hammer blows required to break specimen
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure; breaks with moderate hammer blows
Moderately Soft	Specimen can be grooved 1/6 in. with pocket knife or sharp pick with moderate or heavy pressure; breaks with light hammer blow or heavy hand pressure
Soft	Specimen can be grooved or gouged with pocket knife or sharp pick with light pressure, breaks with light to moderate hand pressure
Very Soft	Specimen can be readily indented, grooved, or gouged with fingernail, or carved with pocket knife; breaks with light hand pressure

CORE RECOVERY CALCULATION (%)

$$\frac{\Sigma \text{ Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100$$

RQD CALCULATION (%)

$$\frac{\Sigma \text{ Length of intact core pieces} > 4 \text{ in.}}{\text{Total length of core run (in.)}} \times 100$$

FRACTURE DENSITY

Descriptor	Criteria
Unfractured	No fractures
Very Slightly Fractured	Lengths greater 3 ft
Slightly Fractured	Lengths from 1 to 3 ft, few lengths outside that range
Moderately Fractured	Lengths mostly in range of 4 in. to 1 ft, with most lengths about 8 in.
Intensely Fractured	Lengths average from 1 in. to 4 in. with scattered fragmented intervals with lengths less than 4 in.
Very Intensely Fractured	Mostly chips and fragments with few scattered short core lengths

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

REPORT TITLE: **BORING RECORD LEGEND**

DIST	COUNTY	ROUTE	POSTMILE	EA
07	LA	710	D/D	07-187900

PROJECT OR BRIDGE NAME: SR-710 Tunnel Technical Study

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
N/A			3 of 3

Addendum (including non-standard laboratory test designations) to 2010 SR 710 Tunnel Technical Study (CH2M HILL, 2010) Boring Record Legend

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly graded SAND Poorly graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic / Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CAI	Cerchar Abrasivity Index
CL	Collapse Potential (ASTM D 5333-03)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
EM	Elastic Model with Compressive Strength (ASTM D 7102)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
PTS	Petrographic Thin Section
R	R-Value (CTM 301 - 00)
SG	Specific Gravity (AASHTO T 100-06)
SD	Slake Durability Index (ASTH D 4645)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (short-term)
- Static Water Level Reading (long-term)

CH2MHILL

REPORT TITLE: **BORING RECORD LEGEND**

DIST.	COUNTY	ROUTE	POSTMILE	EA
7	L.A.	710		07-187900

PROJECT OR BRIDGE NAME: **SR 710 North Study**

BRIDGE NUMBER	PREPARED BY	DATE	PLATE NO.
NA			

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
K. Barker	1-6-09	1-12-09	34° 4' 38" / 118° 9' 58" NAD83	R-09-Z1B8
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Caltrans Drilling Services			' Lt Sta Caltrans ROW @ Front St.	419.6 ft NAVD88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wire-Line			CME 85	4 in
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
SPT(1.4"),Punch Core(2.5"),Shelby(2.87"),HQ Core			CME Automatic, 140 lb., 30 inch drop	87%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Piezometer Installed on Completion			READINGS NM / 25.0 ft on 7-1-09	200.0 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0													
	1		SILTY, CLAYEY SAND (SC-SM); medium dense; light olive brown; dry; fine SAND; little low to medium plasticity fines [RECENT ALLUVIUM].		D01			100						This Boring Record was prepared in accordance with the Caltrans Soil & Rock Logging, Classification and Presentation Manual (June, 2007), except as noted in Appendix A.1 of the Final Geotechnical Summary Report, SR-710 Tunnel Technical Study, Los Angeles County, California, dated April, 2010.
417.63	2													
	3													
415.63	4													
	5		At EL. 414.6 ft, contains trace fine GRAVEL.		S02	5 5 17	22	100						Hand Auger 0'-5'
413.63	6													
	7		At EL. 412.6 ft, with olive yellow mottled with light gray.											
411.63	8													
	9													
409.63	10				O03			33						
	11													
407.63	12													
	13													
405.63	14													
	15		At EL. 404.6 ft, becomes black.		S04	3 4 5	9	100		23				PA
403.63	16		SANDY SILT (ML); stiff; dark grayish brown; dry; few GRAVEL; little coarse to fine SAND; mostly low plasticity fines.											
	17													
401.63	18													
	19													
399.63	20		SILTY SAND (SM); loose; dark yellowish brown; medium SAND.		O05			33						
	21													
397.63	22													
	23													
395.63	24													
	25													

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				R-09-Z1B8
DIST.	COUNTY	ROUTE	POSTMILE	EA
07	LA	710	T/T	07-07-187900
PROJECT OR BRIDGE NAME				
SR-710 TUNNEL TECHNICAL STUDY				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
	K.Barker			1 of 7

CALTRANS BORING RECORD MET+ENG FIXED KRIS - SR-710 CALTRANS BORING LOGS WITH REV Z1B4 Z1B8 Z2B3 Z2B4 Z2B5 AND Z3B11 ONLY.GPJ CALTRANS LIBRARY 040808.GLB 3/10/10

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	25													
393.63	26		Lean CLAY (CL); soft; very dark grayish brown slightly mottled with rust staining; medium plasticity fines.		S06	p p 2		100		32				PI
	27													
391.63	28													
	29													
389.63	30		SILTY SAND (SM); very dark grayish brown; fine SAND.		O07			33						
	31													
387.63	32													
	33													
385.63	34													
	35		Poorly graded SAND (SP); medium dense; grayish brown; coarse to medium SAND; weak cementation.		S08	5 7 13	20	100						
383.63	36													
	37													
381.63	38													
	39													
379.63	40		SILTY, CLAYEY SAND (SC-SM); medium dense; grayish brown; trace fine GRAVEL; mostly medium to fine SAND; some low plasticity fines.		O09			17						PA, DS
	41													
377.63	42		SEDIMENTARY ROCK, (SILTSTONE)/MUDSTONE, olive gray, intensely weathered, weak, soft, unfractured, with thin (1") clay lenses. **[PUENTE FORMATION]**							21	110			
	43													
375.63	44													
	45				S10	8 13 20	33	100						
373.63	46													
	47													
371.63	48													
	49													
369.63	50				O11		8	100				TV = 8		UW
	51													
367.63	52									22	109			
	53													
365.63	54													
	55													

(continued)

CALTRANS BORING RECORD MET+ENG FIXED KRIS - SR-710 CALTRANS BORING LOGS WITH REV Z1B4 Z1B8 Z2B3 Z2B4 Z2B5 AND Z3B11 ONLY.GPJ CALTRANS LIBRARY 040808.GLB 3/10/10

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-Z1B8**
DIST.	COUNTY	ROUTE	POSTMILE	EA
07	**LA**	**710**	**T/T**	**07-07-187900**
PROJECT OR BRIDGE NAME				
SR-710 TUNNEL TECHNICAL STUDY				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
	K.Barker			**2 of 7**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	55		At EL. 364.0 ft, contains pebble to cobble. *(continued)*		S12	24 23 20	43	100						
363.63	56													
	57													
361.63	58													
	59													
359.63	60				O13			0						UW
	61													
357.63	62													
	63													
355.63	64													
	65				S14	6 14 18	32	100						
353.63	66													
	67		SEDIMENTARY ROCK, (SILTSTONE)/MUDSTONE, massive, medium dark gray to dark gray, moderately weathered, weak, soft, unfractured.											
351.63	68													
	69													
349.63	70				O15A			0						UW
	71													
347.63	72													
	73													
345.63	74													
	75				U15B			0						
343.63	76													
	77				S15C	12 29 50/5.5"		0						
341.63	78				C16			100	0					**See note at the end of the log regarding RQD.**
	79													
339.63	80				C17			97	47	26	97			PI, PA, UU
	81													
337.63	82													
	83													
335.63	84													
	85													

(continued)

CALTRANS BORING RECORD MET+ENG FIXED KRIS - SR-710 CALTRANS BORING LOGS WITH REV Z1B4 Z1B8 Z2B3 Z2B4 Z2B5 AND Z3B11 ONLY.GPJ CALTRANS LIBRARY 040808.GLB 3/10/10

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-Z1B8**
DIST.	COUNTY	ROUTE	POSTMILE	EA
07	**LA**	**710**	**T/T**	**07-07-187000**
PROJECT OR BRIDGE NAME				
SR-710 TUNNEL TECHNICAL STUDY				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
	K.Barker			**3 of 7**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		*(continued).*		S18	10 18 23	41	100							UW **See note at the end of the log regarding RQD.**
333.63	86														
	87				C19			0	0						
331.63	88														
	89		At EL. 330.6 ft, grades to greenish black.												
329.63	90		At EL. 329.6 ft, becomes slightly fractured, not healed, dipping 60 to 50°.		C20			100	100						
	91														
327.63	92														
	93														
325.63	94														
	95				C21			100	100						
323.63	96														
	97														
321.63	98														
	99														
319.63	100				C22			50	50						
	101		At EL. 318.6 ft, becomes unfractured.												
317.63	102														
	103														
315.63	104														
	105		At EL. 314.6 ft, becomes slightly fractured, not healed, dipping 50°.		C23			100	100						PI, PA, UU
313.63	106														
	107														
311.63	108														
	109									23	103				
309.63	110		At EL. 309.6 ft, becomes unfractured.		C24			83	83						
	111														
307.63	112														
	113														
305.63	114														
	115														

(continued)

CALTRANS BORING RECORD MET+ENG FIXED KRIS - SR-710 CALTRANS BORING LOGS WITH REV Z1B4 Z1B8 Z2B3 Z2B4 Z2B5 AND Z3B11 ONLY.GPJ CALTRANS LIBRARY 040808.GLB 3/10/10

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-Z1B8**
DIST.	COUNTY	ROUTE	POSTMILE	EA
07	**LA**	**710**	**T/T**	**07-07-187900**
PROJECT OR BRIDGE NAME				
SR-710 TUNNEL TECHNICAL STUDY				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
	K.Barker			**4 of 7**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	115				C25										**See note at the end of the log regarding RQD.**
303.63	116														
	117														
301.63	118														
	119														
299.63	120		At EL. 299.6 ft, becomes moderately soft.		C26			100	100	21 16	104				PI, PA, UU, CR
	121														
297.63	122														
	123														
295.63	124														
	125				C27			83	83						
293.63	126														
	127														
291.63	128														
	129														
289.63	130		At EL. 289.6 ft, becomes laminated.		C28			100	100						SD, EM
	131														
287.63	132														
	133														
285.63	134									23	100				
	135				C29			100	100						
283.63	136														
	137														
281.63	138		At EL. 281.6 ft, contains 6" lens of fresh, very strong, very hard.												
	139														
279.63	140				C30			100	0						
	141		At EL. 279.1 ft, becomes medium strong, very slightly fractured, bedding plane separation.												
277.63	142														
	143														
275.63	144														
	145														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE: **BORING RECORD**
HOLE ID: **R-09-Z1B8**

DIST.	COUNTY	ROUTE	POSTMILE	EA
07	LA	710	T/T	07-07-187900

PROJECT OR BRIDGE NAME: **SR-710 TUNNEL TECHNICAL STUDY**

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
	K.Barker		5 of 7

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	145				C31			100	100						**See note at the end of the log regarding RQD.**
273.63	146														
	147														
271.63	148									22	105				PTS, SD, EM
	149														
269.63	150				C32			100	100						
	151														
267.63	152														
	153														
265.63	154														
	155				C33			100	100						UW, PI, CR
263.63	156														
	157														
261.63	158														
	159														
259.63	160		At EL. 259.6 ft, becomes soft.		C34			98	98	22	106				
	161														
257.63	162														
	163														
255.63	164														
	165				C35			95	95						
253.63	166														
	167														
251.63	168														
	169														
249.63	170		At EL. 249.6 ft, with few coarse sand.		C36			100	100						
	171														
247.63	172														
	173														
245.63	174														
	175														

(continued)

CALTRANS BORING RECORD MET+ENG FIXED KRIS - SR-710 CALTRANS BORING LOGS WITH REV Z1B4 Z1B8 Z2B3 Z2B4 Z2B5 AND Z3B11 ONLY.GPJ CALTRANS LIBRARY 040808.GLB 3/10/10

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-Z1B8**
DIST.	COUNTY	ROUTE	POSTMILE	EA
07	**LA**	**710**	**T/T**	**07-07-187900**
PROJECT OR BRIDGE NAME				
SR-710 TUNNEL TECHNICAL STUDY				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
	K.Barker			**6 of 7**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	175				C37			100	100	22	102				SD, EM **See note at the end of the log regarding RQD.**
243.63	176		At EL. 243.1 ft, contains 3" lens of fresh, very strong, very hard.												
	177														
241.63	178														
	179														
239.63	180				C38			100	100						
	181														
237.63	182														
	183														
235.63	184														
	185		At EL. 235.1 ft, contains 6" lens of fresh, very strong, very hard.		C39			93	93						
233.63	186														
	187														
231.63	188														
	189														UU
229.63	190				C40			95	95	25	100				
	191														
227.63	192														
	193														
225.63	194														
	195				C41			100	100						SD, EM
223.63	196									22	102				
	197														
221.63	198														
	199														
219.63	200		Bottom of borehole at 200.0 ft bgs												
	201		Borehole was converted to piezometer at the completion of drilling.												
217.63	202		RQD values provided in the boring logs are based on intact core pieces obtained between two natural discontinuities. Majority of cores obtained in this boring are weak and does not meet the "sound core" definition provided in standard test method for RQD ASTM D 6032. These RQD values should not be used to evaluate the rock mass quality.												
	203														
215.63	204														
	205														

CALTRANS BORING RECORD MET+ENG FIXED KRIS - SR-710 CALTRANS BORING LOGS WITH REV Z1B4 Z1B6 Z2B3 Z2B4 Z2B5 AND Z3B11 ONLY.GPJ CALTRANS LIBRARY 040808.GLB 3/10/10

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-Z1B8**
DIST.	COUNTY	ROUTE	POSTMILE	EA
07	**LA**	**710**	**T/T**	**07-07-187900**
PROJECT OR BRIDGE NAME				
SR-710 TUNNEL TECHNICAL STUDY				
BRIDGE NUMBER	PREPARED BY		DATE	SHEET
	K.Barker			**7 of 7**

Appendix C
Laboratory Test Result Summary

TABLE C-1
SR 710 NORTH STUDY
SUMMARY OF LABORATORY TEST RESULTS

Boring #	Depth (ft)	Sample #	Soil or Rock Description	Sample Type	Recovery (%)	Blow Count/ RQD (%)	Field Moisture Content (%)	Field Dry Density (pcf)	Corrected Expansion Index	Grain Size (G:S:F) (%)	Atterberg Limits			Consolidation Undisturbed		Direct Shear Test		UU Triaxial Test	UC Test	Modulus of Elasticity (ksi)	Cerchar Abrasivity Index	Point Load Test	Slake Durability Index	Corrosivity			
											LL	PL	PI	C_{cc}	C_{rc}	Ult. Cohesion (psf)	Ult. ϕ (deg)	Undrained Shear Strength (psi)	Uniaxial Compression Strength (psi)			Uniaxial Compression Strength (psi) [=24x corr. point load]		pH	Min. Resistivity (ohm-cm)	Sulfate Content (ppm)	Chloride Content (ppm)
R-09-Z1-B8	15.0	S-4	SANDY SILT	SPT		9	23.0			8:22:70																	
R-09-Z1-B8	25.0	S-6	lean CLAY	SPT		25	31.9				31	20	11														
R-09-Z1-B8	42.5	S-9	SILTY CLAYEY SAND	P. Pen	22		21.0	110.2		3:52:45						290	29										
R-09-Z1-B8	52.5	S-11	lean CLAY	P. Pen	100		21.9	109.3																			
R-09-Z1-B8	80.4	C-17	CLAYSTONE	CORE	97	47	25.7	97.2		0:2:98	47	28	19					75.5									
R-09-Z1-B8	109.4	C-23	CLAYSTONE	CORE	100	100	23.1	102.5		0:3:97	47	27	20					103.5									
R-09-Z1-B8	119.8	C-26	SILTSTONE	CORE	100	100	21.4	104.4										161.5									
R-09-Z1-B8	120.2	C-26	CLAYSTONE	CORE	100	100	15.7			0:4:96	48	26	22											6.18	343	1156	59
R-09-Z1-B8	133.6	C-28	MUDSTONE	CORE	100	100	23.0	100.2											299.0	7.9			2.0				
R-09-Z1-B8	148.2	C-31	MUDSTONE	CORE	100	100	21.8	104.9											324.0	10.0			12.9				
R-09-Z1-B8	159.6	C-33	CLAYSTONE	CORE	100	100	21.5	105.7			47	26	21											6.26	410	720	76
R-09-Z1-B8	175.4	C-37	MUDSTONE	CORE	100	100	21.7	102.2											289.0	8.8			0.0				
R-09-Z1-B8	189.6	C-39	SILTSTONE	CORE	93	93	24.2	99.7										122.1									
R-09-Z1-B8	195.6	C-41	MUDSTONE	CORE	100	100	21.7	101.6											361.0	12.1			56.8				

Note:

Type of Sampling:
- S = Split Spoon (includes SPT and Cal Mod)
- C = Core (both rock and soil)

Units:
- pcf = pounds per cubic feet
- psf = pounds per square feet
- ksf = kilo-pounds per square feet
- ohm-cm = Ohm-Centimeter

Atterberg's Limits:
- n LL = Liquid Limit (in %)
- PL = Plastic Limit (in %)
- PI = Plasticity Index (LL - PL, in %)
- NP = Non-Plastic Soil

G:S:F = Gravel:Sand:Fines (in %)

RQD = Rock Quality Designation