North Hollywood to Pasadena Bus Rapid Transit (BRT) Corridor Planning and Environmental Study

GEOLOGY AND SOILS TECHNICAL REPORT

Prepared For:

Metro™

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ACRONYMS AND ABBREVIATIONS

AASHTO LRFD	Association of State Highway Transportation Officials' Load and Resistance Factor Design
BRT	Bus Rapid Transit
Caltrans	California Department of Transportation
CBC	California Building Code
CEQA	California Environmental Quality Act
CGS	California Government Code
CWA	Clean Water Act
DMA	Disaster Mitigation Act
EIR	Environmental Impact Report
EOO	Emergency Operations Organization
EPA	Environmental Protection Agency
famsl	Feet Above Mean Sea Level
FEMA	Federal Emergency Management Agency
LAMC	Los Angeles Municipal Code
Metro	Los Angeles County Metropolitan Transportation Authority
NEHRP	National Earthquake Hazards Reduction Program
NPDES	National Pollution Discharge Elimination System
PGA	Peak Ground Acceleration
PI	Plasticity Index
ROW	Right-of-Way
SHMA	Seismic Hazards Mapping Act
SR	State Route
TSP	Transit Signal Priority
U.S.	United States
UBC	Uniform Building Code
USCS	Unified Soil Classification System
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey

1. Introduction

The Los Angeles County Metropolitan Transportation Authority (Metro) is proposing the North Hollywood to Pasadena Bus Rapid Transit (BRT) Corridor Project (Proposed Project or Project) which would provide a BRT service connecting several cities and communities between the San Fernando and San Gabriel Valleys. Specifically, the Proposed Project would consist of a BRT service that runs from the North Hollywood Metro B/G Line (Red/Orange) station in the City of Los Angeles through the Cities of Burbank, Glendale, the community of Eagle Rock in the City of Los Angeles, and Pasadena, ending at Pasadena City College. The Proposed Project with route options would operate along a combination of local roadways and freeway sections with various configurations of mixed-flow and dedicated bus lanes depending on location. A Draft Environmental Impact Report (EIR) is being prepared for the following purposes:

- To satisfy the requirements of the California Environmental Quality Act (CEQA) (Public Resources Code (PRC) Section 21000, et seq.) and the CEQA Guidelines (California Code of Regulations, Title 14, Chapter 3, Section 15000, et seq.).
- To inform public agency decision-makers and the public of the significant environmental effects of the Proposed Project, as well as possible ways to minimize those significant effects, and reasonable alternatives to the Proposed Project that would avoid or minimize those significant effects.
- To enable Metro to consider environmental consequences when deciding whether to approve the Proposed Project.

This Geology and Soils Technical Report is comprised of the following sections:

1. Introduction
2. Project Description
3. Regulatory Framework
4. Existing Setting
5. Significance Thresholds and Methodology
6. Impact Analysis
7. Cumulative Analysis
8. References
9. List of Preparers

2. Project Description

This section is an abbreviated version of the Project Description contained in the Draft EIR. This abbreviated version provides information pertinent to the Technical Reports. Please reference the Project Description in the Draft EIR for additional details about the Proposed Project location and surrounding uses, project history, project components, and construction methods. The Draft EIR also includes a more comprehensive narrative description providing additional detail on the project routing, station locations, and proposed roadway configurations. Unless otherwise noted, the project description is valid for the Proposed Project and all route variations, treatments, and configurations.

2.1 PROJECT ROUTE DESCRIPTION

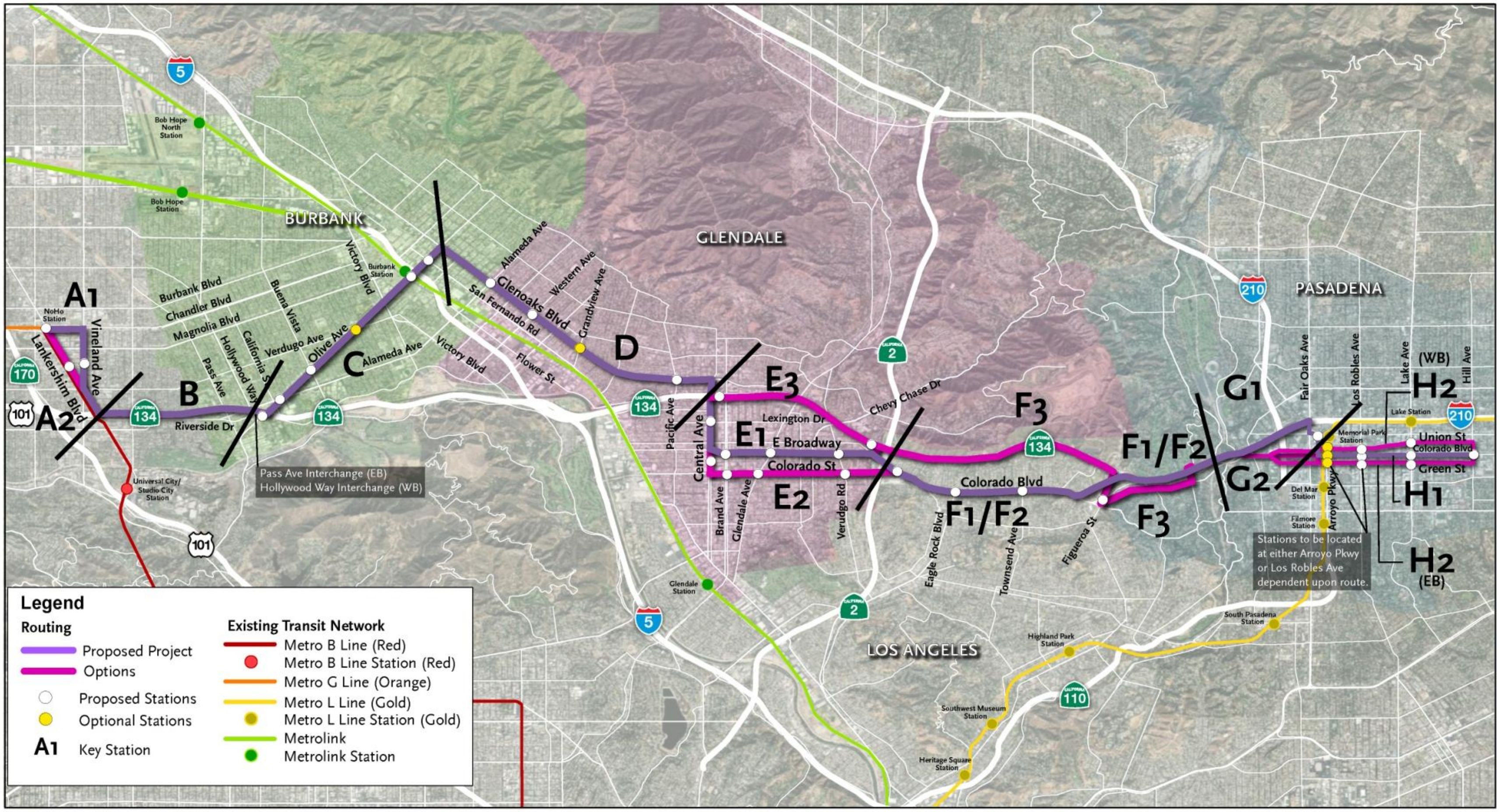
Metro is proposing the BRT service to connect several cities and communities between the San Fernando and San Gabriel Valleys. The Proposed Project extends approximately 18 miles from the North Hollywood Metro B/G Line (Red/Orange) Station on the west to Pasadena City College on the east. The BRT corridor generally parallels the Ventura Freeway (State Route 134) between the San Fernando and San Gabriel Valleys and traverses the communities of North Hollywood and Eagle Rock in the City of Los Angeles as well as the Cities of Burbank, Glendale, and Pasadena. Potential connections with existing high-capacity transit services include the Metro B Line (Red) and G Line (Orange) in North Hollywood, the Metrolink Antelope Valley and Ventura Lines in Burbank, and the Metro L Line (Gold) in Pasadena. The Study Area includes several dense residential areas as well as many cultural, entertainment, shopping and employment centers, including the North Hollywood Arts District, Burbank Media District, Downtown Burbank, Downtown Glendale, Eagle Rock, Old Pasadena and Pasadena City College (see **Figure 1**).

2.2 BRT ELEMENTS

BRT is intended to move large numbers of people quickly and efficiently to their destinations. BRT may be used to implement rapid transit service in heavily traveled corridors while also offering many of the same amenities as light rail but on rubber tires and at a lower cost. The Project would provide enhanced transit service and improve regional connectivity and mobility by implementing several key BRT elements. Primary components of the BRT are further addressed below and include:

- Dedicated bus lanes on city streets
- Transit signal priority (TSP)
- Enhanced stations with all-door boarding

Figure 1 – Proposed Project with Route Options



2.3 DEDICATED BUS LANES

The Proposed Project would generally include dedicated bus lanes where there is adequate existing street width, while operating in mixed traffic within the City of Pasadena. BRT service would operate in various configurations depending upon the characteristics of the roadways as shown below:

- **Center-Running Bus Lanes**: Typically includes two lanes (one for each direction of travel) located in the center of the roadway. Stations are usually provided on islands at intersections and are accessible from the crosswalk.
- **Median-Running Bus Lanes**: Typically includes two lanes (one for each direction of travel) located in the inside lane adjacent to a raised median in the center of the roadway. Stations are usually provided on islands at intersections and are accessible from the crosswalk.
- **Side-Running Bus Lanes**: Buses operate in the right-most travel lane separated from the curb by bicycle lanes, parking lanes, or both. Stations are typically provided along curb extensions where the sidewalk is widened to meet the bus lane. At intersections, right-turn bays may be provided to allow buses to operate without interference from turning vehicles and pedestrians.
- **Curb-Running Operations**: Buses operate in the right-most travel lane immediately adjacent to the curb. Stations are located along the sidewalk which may be widened to accommodate pedestrian movement along the block. Right-turning traffic merges with the bus lane approaching intersections and buses may be delayed due to interaction with right-turning vehicles and pedestrians.
- **Mixed-Flow Operations**: Where provision of dedicated bus lanes is impractical, the BRT service operates in lanes shared with other roadway vehicles, although potentially with transit signal priority. For example, where the service transitions from a center-running to side-running configuration, buses would operate in mixed-flow. Buses would also operate in mixed-flow along freeway facilities.

Table 1 provides the bus lane configurations for each route segment of the Proposed Project.

Table 1 – Route Segments

Key	Segment	From	To	Bus Lane Configuration
A1 (Proposed Project)	**Lankershim Blvd.**	**N. Chandler Blvd.**	**Chandler Blvd.**	**Mixed-Flow**
	Chandler Blvd.	**Lankershim Blvd.**	**Vineland Ave.**	**Side-Running**
	Vineland Ave.	**Chandler Blvd.**	**Lankershim Blvd.**	**Center-Running**
	Lankershim Blvd.	**Vineland Ave.**	**SR-134 Interchange**	**Center-Running Mixed-Flow[1]**
A2 (Route Option)	Lankershim Blvd.	N. Chandler Blvd.	SR-134 Interchange	Side-Running Curb-Running[2]
B (Proposed Project)	**SR-134 Freeway**	**Lankershim Blvd.**	**Pass Ave. (EB) Hollywood Wy. (WB)**	**Mixed-Flow**
C (Proposed Project)	**Pass Ave. – Riverside Dr. (EB) Hollywood Wy. – Alameda Ave. (WB)**	**SR-134 Freeway**	**Olive Ave.**	**Mixed-Flow[3]**
	Olive Ave.	**Hollywood Wy. (EB) Riverside Dr. (WB)**	**Glenoaks Blvd.**	**Curb-Running**
D (Proposed Project)	**Glenoaks Blvd.**	**Olive Ave.**	**Central Ave.**	**Curb-Running Median-Running[4]**
E1 (Proposed Project)	**Central Ave.**	**Glenoaks Blvd.**	**Broadway**	**Mixed Flow Side-Running[5]**
	Broadway	**Central Ave.**	**Colorado Blvd.**	**Side-Running**
E2 (Route Option)	Central Ave.	Glenoaks Blvd.	Colorado St.	Side-Running
	Colorado St. – Colorado Blvd.	Central Ave.	Broadway	Side-Running
E3 (Route Option)	Central Ave.	Glenoaks Blvd.	Goode Ave. (WB) Sanchez Dr. (EB)	Mixed-Flow
	Goode Ave. (WB) Sanchez Dr. (EB)	Central Ave.	Brand Blvd.	Mixed-Flow
	SR-134[6]	Brand Blvd.	Harvey Dr.	Mixed-Flow
F1 (Route Option)	Colorado Blvd.	Broadway	Linda Rosa Ave. (SR-134 Interchange)	**Side-Running** Side-Running Center Running[7]

Key	Segment	From	To	Bus Lane Configuration
F2 (Proposed Project)	**Colorado Blvd.**	**Broadway**	**Linda Rosa Ave. (SR-134 Interchange)**	**Side-Running**
F3 (Route Option)	SR-134	Harvey Dr.	Figueroa St.	Mixed-Flow
	Figueroa St.	SR-134	Colorado Blvd.	**Mixed-Flow**
	Colorado Blvd.	Figueroa St.	SR-134 via N. San Rafael Ave. Interchange	**Mixed-Flow**
G1 (Proposed Project)	**SR-134**	**Colorado Blvd.**	**Fair Oaks Ave. Interchange**	**Mixed-Flow**
	Fair Oaks Ave.	**SR-134**	**Walnut St.**	**Mixed-Flow**
	Walnut St.	**Fair Oaks Ave.**	**Raymond Ave.**	**Mixed-Flow**
	Raymond Ave.	**Walnut St.**	**Colorado Blvd. or Union St./Green St.**	**Mixed-Flow**
G2 (Route Option)	SR-134	Colorado Blvd.	Colorado Blvd. Interchange	Mixed-Flow
	Colorado Blvd. or Union St./Green St.	Colorado Blvd. Interchange	Raymond Ave.	Mixed-Flow
H1 (Proposed Project)	**Colorado Blvd.**	**Raymond Ave.**	**Hill Ave.**	**Mixed-Flow**
H2 (Route Option)	Union St. (WB) Green St. (EB)	Raymond Ave.	Hill Ave.	Mixed-Flow

Notes:
[1]South of Kling St.
[2]South of Huston St.
[3]Eastbound curb-running bus lane on Riverside Dr. east of Kenwood Ave.
[4]East of Providencia Ave.
[5]South of Sanchez Dr.
[6]Route continues via Broadway to Colorado/Broadway intersection (Proposed Project F2 or Route Option F1) or via SR-134 (Route Option F3)
[7]Transition between Ellenwood Dr. and El Rio Ave.

2.4 TRANSIT SIGNAL PRIORITY

TSP expedites buses through signalized intersections and improves transit travel times. Transit priority is available areawide within the City of Los Angeles and is expected to be available in all jurisdictions served by the time the Proposed Project is in service. Basic functions are described below:

- **Early Green**: When a bus is approaching a red signal, conflicting phases may be terminated early to obtain the green indication for the bus.
- **Extended Green**: When a bus is approaching the end of a green signal cycle, the green may be extended to allow bus passage before the green phase terminates.
- **Transit Phase**: A dedicated bus-only phase is activated before or after the green for parallel traffic to allow the bus to proceed through the intersection. For example, a queue jump may be implemented in which the bus departs from a dedicated bus lane or a station ahead of other traffic, so the bus can weave across lanes or make a turn.

2.5 ENHANCED STATIONS

It is anticipated that the stations servicing the Proposed Project may include the following elements:

- Canopy and wind screen
- Seating (benches)
- Illumination, security video and/or emergency call button
- Real-time bus arrival information
- Bike racks
- Monument sign and map displays

Metro is considering near-level boarding which may be achieved by a combination of a raised curb along the boarding zone and/or ramps to facilitate loading and unloading. It is anticipated that BRT buses would support all door boarding with on-board fare collection transponders in lieu of deployment of ticket vending machines at stations.

The Proposed Project includes 21 proposed stations and two “optional” stations, and additional optional stations have been identified along the Route Options, as indicated in **Table 2**. Of the 21 proposed stations, four would be in the center of the street or adjacent to the median, and the remaining 17 stations would be situated on curbs on the outside of the street.

Table 2 – Proposed/Optional Stations

Jurisdiction	Proposed Project	Route Option
North Hollywood (City of Los Angeles)	North Hollywood Transit Center (Metro B/G Lines (Red/Orange) Station)	
	Vineland Ave./Hesby St.	Lankershim Blvd./Hesby St.
City of Burbank	Olive Ave./Riverside Dr.	
	Olive Ave./Alameda Ave.	
	Olive Ave./Buena Vista St.	
	Olive Ave./Verdugo Ave. (optional station)	
	Olive Ave./Front St. (on bridge at Burbank-Downtown Metrolink Station)	
	Olive Ave./San Fernando Blvd.	
City of Glendale	Glenoaks Blvd./Alameda Ave.	
	Glenoaks Blvd./Western Ave.	
	Glenoaks Blvd./Grandview Ave. (optional station)	
	Central Ave./Lexington Dr.	Goode Ave. (WB) & Sanchez Dr. (EB) west of Brand Blvd.
		Central Ave./Americana Way
	Broadway/Brand Blvd.	Colorado St./Brand Blvd.
	Broadway/Glendale Ave.	Colorado St./Glendale Ave.
	Broadway/Verdugo Rd.	Colorado St./Verdugo Rd.
		SR 134 EB off-ramp/WB on-ramp west of Harvey Dr.
Eagle Rock (City of Los Angeles)	Colorado Blvd./Eagle Rock Plaza	
	Colorado Blvd./Eagle Rock Blvd.	
	Colorado Blvd./Townsend Ave.	Colorado Blvd./Figueroa St.
City of Pasadena	Raymond Ave./Holly St. [1] (near Metro L Line (Gold) Station)	
	Colorado Blvd./Arroyo Pkwy. [2]	Union St./Arroyo Pkwy. (WB)[2] Green St./Arroyo Pkwy. (EB)[2]
	Colorado Blvd./Los Robles Ave. [1]	Union St./Los Robles Ave. (WB)[1] Green St./Los Robles Ave. (EB)[1]
	Colorado Blvd./Lake Ave.	Union St./Lake Ave. (WB) Green St./Lake Ave. (EB)
	Pasadena City College (Colorado Blvd./Hill Ave.)	Pasadena City College (Hill Ave./Colorado Blvd.)

[1]With Fair Oaks Ave. interchange routing
[2]With Colorado Blvd. interchange routing

2.6 DESCRIPTION OF CONSTRUCTION

Construction of the Proposed Project would likely include a combination of the following elements dependent upon the chosen BRT configuration for the segment: restriping, curb-and-gutter/sidewalk reconstruction, right-of-way (ROW) clearing, pavement improvements, station/loading platform construction, landscaping, and lighting and traffic signal modifications. Generally, construction of dedicated bus lanes consists of pavement improvements including restriping, whereas ground-disturbing activities occur with station construction and other support structures. Existing utilities would be protected or relocated. Due to the shallow profile of construction, substantial utility conflicts are not anticipated, and relocation efforts should be brief. Construction equipment anticipated to be used for the Proposed Project consists of asphalt milling machines, asphalt paving machines, large and small excavators/backhoes, loaders, bulldozers, dump trucks, compactors/rollers, and concrete trucks. Additional smaller equipment may also be used such as walk-behind compactors, compact excavators and tractors, and small hydraulic equipment.

The construction of the Proposed Project is expected to last approximately 24 to 30 months. Construction activities would shift along the corridor so that overall construction activities should be of relatively short duration within each segment. Most construction activities would occur during daytime hours. For specialized construction tasks, it may be necessary to work during nighttime hours to minimize traffic disruptions. Traffic control and pedestrian control during construction would follow local jurisdiction guidelines and the Work Area Traffic Control Handbook. Typical roadway construction traffic control methods would be followed including the use of signage and barricades.

It is anticipated that publicly owned ROW or land in proximity to the Proposed Project's alignment would be available for staging areas. Because the Proposed Project is anticipated to be constructed in a linear segment-by-segment method, there would not be a need for large construction staging areas in proximity to the alignment.

2.7 DESCRIPTION OF OPERATIONS

The Proposed Project would provide BRT service from 4:00 a.m. to 1:00 a.m. or 21 hours per day Sunday through Thursday, and longer service hours (4:00 a.m. to 3:00 a.m.) would be provided on Fridays and Saturdays. The proposed service span is consistent with the Metro B Line (Red). The BRT would operate with 10-minute frequency throughout the day on weekdays tapering to 15 to 20 minutes frequency during the evenings, and with 15-minute frequency during the day on weekends tapering to 30 minutes in the evenings. The BRT service would be provided on 40-foot zero-emission electric buses with the capacity to serve up to 75 passengers, including 35-50 seated passengers and 30-40 standees, and a maximum of 16 buses are anticipated to be in service along the route during peak operations. The buses would be stored at an existing Metro facility.

3. Regulatory Framework

This section summarizes the federal, state, and local regulations related to geology and soils applicable to the Proposed Project.

3.1 FEDERAL REGULATIONS

3.1.1 National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program (NEHRP) was established by the United States (U.S.) Congress when it passed the Earthquake Hazards Reduction Act of 1977. In establishing NEHRP, Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use and redevelopment controls, prediction techniques and early-warning systems, coordinated emergency preparedness plans, and public education and involvement programs.

The four basic NEHRP goals are:

- Develop effective practices and policies for earthquake loss reduction and accelerate their implementation;
- Improve techniques for reducing earthquake vulnerabilities of facilities and systems;
- Improve earthquake hazards identification and risk assessment methods, and their use; and
- Improve the understanding of earthquakes and their effects.

Several key federal agencies contribute to earthquake mitigation efforts. The four primary NEHRP agencies are:

- National Institute of Standards and Technology;
- National Science Foundation;
- U.S. Geological Survey (USGS); and
- Federal Emergency Management Agency (FEMA).

Implementation of NEHRP priorities is accomplished primarily through original research, publications, and recommendations to assist and guide state, regional, and local agencies in the development of plans and policies to promote safety and emergency planning.

3.1.2 National Engineering Handbook

The National Engineering Handbook was prepared by the U.S. Department of Agriculture (USDA) in 1983. Chapter 3 (Erosion) of Section 3 (Sedimentation) states that in planning programs, to reduce erosion and sediment yield, it is most important that the various types of erosion be thoroughly investigated as sources of sediment. Proper conservation practices and land stabilization measures can then be planned and applied.

3.1.3 Federal Soil Protection Act

The purpose of the Federal Soil Protection Act is to protect or restore the functions of the soil on a permanent sustainable basis. Protection and restoration activities include prevention of harmful soil changes, rehabilitation of the soil of contaminated sites and of water contaminated by such sites, and precautions against negative soil impacts. If impacts are made on the soil, disruptions of its natural functions and of its function as an archive of natural and cultural history should be avoided, as far as practicable. In addition, the requirements of the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) through the National Pollution Discharge Elimination System (NPDES) permit provide guidance for protection of geologic and soil resources.

3.1.4 USGS Landslide Hazard Program

The USGS created the Landslide Hazard Program in the mid-1970s. According to USGS, the primary objective of the Landslide Hazards Program is to reduce long-term losses from landslide hazards by improving understanding of the causes of ground failure and suggesting mitigation strategies. The federal government takes the lead role in funding and conducting this research, whereas the reduction of losses due to geologic hazards is primarily a state and local responsibility.

3.1.5 Clean Water Act

According to the Environmental Protection Agency (EPA), the Clean Water Act (CWA, 1972) establishes the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. “Clean Water Act” became the Act’s common name with amendments in 1972. Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. EPA has also developed national water quality criteria recommendations for pollutants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA’s NPDES permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

3.2 STATE REGULATIONS

3.2.1 California Environmental Quality Act

CEQA requires state and local agencies within California to follow a protocol of analysis and public disclosure of environmental impacts of proposed projects and adopt all feasible measures to mitigate those impacts. The purpose of CEQA is to:

- Disclose to the public the significant environmental effects of a proposed discretionary project.
- Prevent or minimize damage to the environment through development of project alternatives, mitigation measures, and mitigation monitoring.
- Disclose to the public the agency decision-making process utilized to approve discretionary projects through findings and statements of overriding consideration.
- Enhance public participation in the environmental review process through scoping meetings, public notice, public review, hearings, and the judicial process.
- Improve interagency coordination through early consultations, scoping meetings, notices of preparation, and State Clearinghouse review.

3.2.2 California Building Standards Code

According to the Department of General Services, the California Building Standards Code is a compilation of three types of building standards from three different origins: 1) Building standards that have been adopted by state agencies without change from building standards contained in national model codes; 2) Building standards that have been adopted and adapted from national model codes to address California's ever-changing conditions; and 3) Building standards, authorized by the California legislature, that constitute amendments not covered by national model codes, that have been created and adopted to address particular California concerns. All occupancies in California are subject to national model codes adopted into Title 24, and occupancies are further subject to amendments adopted by state agencies and ordinances implemented by local jurisdictions' governing bodies. The 2019 California Building Code (CBC), California Code of Regulations, Title 24 was published July 1, 2019, with an effective date of January 1, 2020.

3.2.3 California Government Code

The California Government Code (CGC) requires that planning agencies of all cities and counties prepare comprehensive, long-term general plans for physical development within their jurisdictions. These plans are referred to as "City General Plans." The plans should provide objectives and policies addressing public health and safety, including protection against the impacts of seismic ground motions, fault ruptures, and other geological and soils hazards.

As stated in Section 6302 (g) (1) of the CGC, a general plan shall include:

> *"A safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body; flooding; and wildland and urban fires. The safety element shall include mapping of known seismic and other geologic hazards. It shall also address evacuation routes, military installations, peakload water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards."*

Chapter 7.8 (Section 2690) of Division 2 of the PRC, referred to above, is known as the Seismic Hazards Mapping Act (SHMA), and is also described below.

3.2.4 California Stormwater Best Management Practices Handbook

The California Stormwater Quality Association develops four Best Management Practices Handbooks (i.e., construction, industrial and commercial, municipal, and new development and redevelopment) generally matched to the three NPDES permit types (i.e., municipal separate storm sewer systems, construction activities, and industrial activities) offering stormwater runoff management support.

3.2.5 Southern California Catastrophic Earthquake Response Plan

The Southern California Catastrophic Earthquake Response Plan (OPLAN, 2010) provides a coordinated state/federal response to a catastrophic earthquake in southern California. Planning assumptions are based on the CGS and the USGS's ShakeOut Scenario of 2008. The mission of the unified effort of local, state, tribal, and federal emergency response is to support the needs of the impacted community by saving and sustaining human life, minimizing suffering, stabilizing and restoring critical infrastructure and setting conditions for recovery. The Southern California Catastrophic Earthquake Response Plan reflects the intent to employ a joint state/federal Unified Coordination Group, using Incident Command System concepts and principles consistent with the National Incident Management System and the Standardized Emergency Management System, to accomplish response activities consistent with the priorities of the Governor, sovereign tribal nations, the local governments and the objectives set forth in the Southern California Catastrophic Earthquake Response Plan.

3.2.6 Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA) of 1990 directs the CGS Department of Conservation to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides and amplified ground shaking. The purpose of the SHMA is to reduce the threat to public safety and to minimize the loss of life and property by identifying and mitigating these seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake.

The SHMA requires the State Geologist to establish regulatory zones (Zones of Required Investigation) and to issue appropriate maps (Seismic Hazard Zone maps). These maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling construction and development. Single-family frame dwellings up to two stories and not part of a development of four or more units are exempt from the state requirements. However, local agencies can be more restrictive than state law requires.

3.2.7 Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted as the Special Studies Zones Act in 1971 to prevent land development and construction of structures for human occupancy directly across the trace of active faults.

The law required the State Geologist to delineate approximately one quarter mile-wide zones along surface traces of active faults. The act defines an active fault as one that has ruptured the ground surface within the past 11,000 years. Prior to approving construction of structures for human occupancy, permit authorities must require a project’s applicant to submit a fault investigation report for review and approval by the local jurisdiction. Although the Alquist-Priolo Act does not regulate transit or transportation projects, it provides relevant information about areas that would be susceptible to ground rupture from an earthquake.

3.2.8 Natural Hazards Disclosure Act

The Natural Hazards Disclosure Act came into effect on June 1, 1998 and requires sellers and their listing agents to provide prospective buyers with a Natural Hazards Disclosure statement that designates whether the home they are selling is located in a hazard area. Hazard areas include flood, fire, earthquake fault, and seismic hazard zones.

3.3 LOCAL REGULATIONS

As stated in previous sections, the CGC requires that planning agencies of all cities and counties prepare comprehensive, long-term general plans for the physical development within their jurisdictions. The plans should provide objectives and policies addressing public health and safety, including protection against the impacts of seismic ground motions, fault ruptures, and other geological and soils hazards. The legislative bodies of all California cities and counties must adopt general plans that include the following elements related to geology, soils, seismicity, and paleontological resources:

- Conservation Element, which addresses the following topics relevant to soils and paleontological resources:
    - Reclamation of land and waters;
    - Soil erosion prevention, control, and correction;
    - Location, quantity and quality of rock, sand, and gravel resources; and
    - Preservation of Paleontological resources.

- Safety Element, which addresses the protection of the community from any unreasonable risks associated with the effects of the following seismic and geologic hazards and which is required to include mapping of such known hazards:
  - Seismically-induced surface rupture;
  - Ground shaking;
  - Ground failure;
  - Slope instability leading to mudslides and landslides;
  - Subsidence due to fluid or gas withdrawal;
  - Liquefaction;
  - Other seismic hazards identified pursuant to California PRC Chapter 7.8 (commencing with Section 2690) of Division 2; and
  - Other geologic hazards known to the legislative body.

This section includes, among other pertinent regulations, relevant excerpts of the General Plans for the Cities of Los Angeles, Burbank, Glendale, and Pasadena.

3.3.1 City of Los Angeles

General Plan

The City of Los Angeles General Plan (Chapter III of the Safety Element) describes goals, objectives, policies and programs that are broadly stated to reflect the comprehensive scope of the Emergency Operations Organization (EOO). The EOO is the only program that implements the Element. The Safety Element's policies outline administrative considerations which are addressed by EOO procedures, including its Master Plan, or which are observed in the carrying out of the Plan. All City of Los Angeles agencies are part of the EOO. All City of Los Angeles emergency preparedness, response and recovery programs are integrated into EOO operations and are reviewed and revised continuously. Because City codes and regulations contain standards for water, streets, etc., the Safety Element programs generally do not contain specific standards. **Table 3** shows relevant goals, objectives, and policies.

Table 3 – City of Los Angeles Relevant General Plan Goals, Objectives, and Policies

Goal/Objective/ Policy	Description
Goal 1	A City where potential injury, loss of life, property damage and disruption of the social and economic life of the City due to fire, water related hazard, seismic event, geologic conditions or release of hazardous materials disasters is minimized.
Objective 1.1	Implement comprehensive hazard mitigation plans and programs that are integrated with each other and with the City's comprehensive emergency response and recovery plans and programs.
Policy 1.1.1	Coordination. Coordinate information gathering, program formulation and program implementation between City agencies, other jurisdictions and appropriate public and private entities to achieve the maximum mutual benefit with the greatest efficiency of funds and staff.
Policy 1.1.2	Disruption reduction. Reduce, to the greatest extent feasible and within the resources available, potential critical facility, governmental functions, infrastructure and information resource disruption due to natural disaster.

Goal/Objective/ Policy	Description
Policy 1.1.3	Facility/systems maintenance. Provide redundancy (back-up) systems and strategies for continuation of adequate critical infrastructure systems and services so as to assure adequate circulation, communications, power, transportation, water and other services for emergency response in the event of disaster related systems disruptions.
Policy 1.1.4	Health/environmental protection. Protect the public and workers from the release of hazardous materials and protect City water supplies and resources from contamination resulting from accidental release or intrusion resulting from a disaster event, including protection of the environment and public from potential health and safety hazards associated with program implementation.
Policy 1.1.5	Risk reduction. Reduce potential risk hazards due to natural disaster to the greatest extent feasible within the resources available, including provision of information and training.
Policy 1.1.6	State and federal regulations. Assure compliance with applicable state and federal planning and development regulations, e.g., Alquist-Priolo Earthquake Fault Zoning Act, State Mapping Act and Cobey-Alquist Flood Plain Management Act.

SOURCE: City of Los Angeles, *Safety Element of the Los Angeles General Plan*, 1996.

City of Los Angeles Municipal Code

Chapter IX (Building Regulations) of the City of Los Angeles Municipal Code of 2020 was prepared to safeguard life, limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures erected or to be erected within the City, and by regulating certain grading operations within the City. Section 91.1804 (Excavation, Grading, and Fill) adopts Section 1804 of the CBC.

3.3.2 City of Burbank

General Plan

The goals and policies contained in the Safety Element (Chapter 7) of the Burbank 2035 General Plan of 2013 provide a framework for keeping residents, businesses, and visitors safe from natural and human hazards. They also provide increased safety for the emergency response personnel. **Table 4** shows relevant goals and policies.

City of Burbank Municipal Code

Article 1 (Grading, Fills and Excavations) of Chapter 7 (Excavations) of the City of Burbank Municipal Code of 2007 was prepared to safeguard life, health, property and the public welfare by establishing minimum requirements for grading, fills and excavations and the prevention of environmental and other damage, and to prescribe procedures by which these requirements may be enforced.

Table 4 – City of Burbank Relevant General Plan Goals and Policies

Goal/Policy	Description
Goal 5	Seismic Safety: Injuries and loss of life are prevented, critical facilities function, and property loss and damage is minimized during seismic events.
Policy 5.1	Require geotechnical reports for development within a fault area that may be subject to risks associated with surface rupture.
Policy 5.2	Require geotechnical reports for new development projects in areas with the potential for liquefaction or landslide.
Policy 5.3	Enforce seismic design provisions of the current California Building Standards Code related to geologic, seismic, and slope hazards.
Policy 5.4	Encourage and facilitate retrofits of seismically high-risk buildings to reduce risks from seismic ground shaking.
Policy 5.5	Facilitate the retrofitting of bridges and highway structures in the City to reduce risks associated with seismic ground shaking.

SOURCE: City of Burbank, *Burbank 2035 General Plan,* February 19, 2013.

3..3.3 City of Glendale

General Plan

The goals and policies contained in Safety Element of the City of Glendale General Plan of 2003 provides an assessment of the natural and manmade hazards in the City, including, but not limited to, earthquakes, landslides, fire, flood, dam, inundation, hazardous materials incidents, terrorism, and vector control and provides a framework by which safety considerations are introduced into the land use planning process and the redevelopment process. Section 3.1 of Chapter 3 covers seismic and geologic hazards. **Table 5** shows relevant goals and policies.

Table 5 – City of Glendale Relevant General Plan Goals and Policies

Goal/Policy	Description
Goal 1	Reduce the loss of life, injury, private property damage, infrastructure damage, economic losses and social dislocation and other impacts resulting from seismic hazards.
Policy 1-1	The City shall ensure that new buildings are designed to address earthquake hazards and shall promote the improvement of existing structures to enhance their safety in the event of an earthquake.
Policy 1-2	The City shall enforce the provisions of the Alquist-Priolo Earthquake Fault Zoning Act and the Seismic Hazards Mapping Act, with additional local provisions.
Policy 1-3	The City shall ensure to the fullest extent possible that, in the event of a major earthquake, essential structures and facilities will remain safe and operational. Essential facilities include hospitals, police stations, fire stations, emergency operation centers, communication centers, generators and substations, reservoirs and “lifeline” infrastructure (as defined in Section 1.8.3 of the Technical Background Report). The vulnerability of some of these critical facilities is summarized in Table 1 (at the end of this document).

Goal/Policy	Description
Policy 1-4	The City shall ensure that current seismic and geologic knowledge and State-certified professional review are incorporated into the design, planning and construction stages of a project, and that site-specific data are applied to each project.
Policy 1-5	The City shall ensure that all residents and business owners in the City have access to information regarding seismic and geologic hazards.
Goal 2	Reduce the loss of life, injury, private property damage, infrastructure damage, economic losses and social dislocation and other impacts resulting from geologic hazards.
Policy 2-1	The City shall avoid development in areas of known slope instability or high landslide risk when possible and will encourage that developments on sloping ground use design and construction techniques appropriate for those areas.

SOURCE: City of Glendale, *Safety Element of the Glendale General Plan*, 2003.

City of Glendale Municipal Code

Chapter 15 (Grading in Hillside Areas and Excavation Blasting) of the City of Glendale Municipal Code was prepared to safeguard life, health, property, public welfare and preservation of the environment by establishing minimum requirements for regulating hillside grading and excavations in addition to the grading requirements in Appendix Chapter 33 of the Glendale Building and Safety Code which adopts the latest version of the CBC.

3.1.6 City of Pasadena

General Plan

Section 5 (Implementation) of the Safety Element of the City of Pasadena General Plan of 2002 addresses a variety of natural and man-made hazards and provides goals and policies aimed at reducing the risk associated with these hazards. Seismic hazard goals and policies are covered under Goal S-1 and Policy S-1 through S-7. Geologic hazard goals and policies are summarized under Goal G-1 and Policy G-1 and G-2. Relevant Safety Element goals and policies related to geology and soils are shown in **Table 6**.

Table 6 – City of Pasadena Relevant General Plan Goals and Policies

Goal/Policy	Description
Goal S-1	Seismic Hazards: Minimize injury and loss of life, property damage, and other impacts caused by seismic shaking, fault rupture, ground failure, earthquake-induced landslides, and other earthquake-induced ground deformation.
Policy S-1	The City will monitor development or re-development within the Fault Hazard Management Zones identified for both the Sierra Madre and Raymond fault.
Policy S-2	The City will ensure that current geologic knowledge and State-certified professional review are incorporated into the design, planning and construction stages of a project, and that site-specific data are applied to each project.
Policy S-3	The City will strive to ensure that the design of new, and the performance of existing structures, address the appropriate earthquake hazards.

Goal/Policy	Description
Policy S-4	The City will ensure to the fullest extent possible that, in the event of a major disaster, essential structures and facilities remain safe and functional, as required by current law. Essential facilities include hospitals, police stations, fire stations, emergency operation centers, communication centers, generators and substations, and reservoirs.
Policy S-5	The City will continue earthquake strengthening and provisions for alternate or back-up essential services, such as water, sewer, electricity, and natural gas pipelines and connections throughout the City. First priority for this program should be for the essential services within the identified fault hazard management zones.
Policy S-6	The City will ensure to the fullest extent possible that, in the event of a major disaster, dependent care and high-occupancy facilities will remain safe.
Policy S-7	The City will educate the public on the hazards that can pose a risk to the City and its residents and will describe loss reduction strategies that can be used to mitigate the specific hazards identified.
Goal G-1	Geologic Hazards: Minimize the risk to life or limb, and property damage, resulting from soil and slope instability.
Policy G-1	Whenever possible, mitigation of geologic hazards will be conducted without violating the property owners' rights to modify or improve their investment, along with preserving the aesthetic or natural conditions of the area through minimal grading. When these goals are in conflict, protection of life and property will take precedence.
Policy G-2	The City will continue to participate in regional programs designed to protect the groundwater resources of the Raymond Basin while protecting the area from the hazard of regional ground subsidence.

SOURCE: City of Pasadena, *Safety Element of the Pasadena General Plan*, 2002.

City of Pasadena Municipal Code

Chapter 14.05 (Excavation and Grading in Hillside Areas) of the City of Pasadena Municipal Code was prepared to regulate excavation and grading within hillside districts and excavation and grading on a slope any portion of which is greater than 15 percent in order to: a) Safeguard life, limb, property and public welfare; b) Protect streams, lakes, reservoirs, and any other water bodies from pollution with chemicals, fuels, lubricants or any other harmful materials associated with construction or grading activities; c) Avoid pollution of the water bodies described above with nutrients, sediment materials, or other earthen or organic materials generated on or caused by surface runoff on or across the permit area; d) Preserve the contours of the natural landscape and land forms; and e) Prevent erosion and control sedimentation.

4. Existing Setting

This section describes the topography, climate, geologic and soil conditions along the Project corridor based on published geologic/geotechnical reports, data, and maps within the Project Area. This section also assesses potential impacts from ground shaking and surface-fault rupture; liquefaction, lateral spreading, and seismically-induced slope failure; groundwater; expansive, corrosive, collapsible, and erodible soils; consolidation settlements; areas of difficult excavation; shallow landslides and debris flow; natural slope stability; and land subsidence.

The approximate minimum search distance for specific Project-related data in this section is 1,000 feet. For regional geology and seismicity, the approximate minimum search distance is 60 miles. Specific areas are referred to by Route Options (namely A1, A2, B, C, D, E1, E2, E3, F1, F2, F3, G1, G2, H1, H2, and H3) as shown in **Figure 2**.

4.1 TOPOGRAPHY

Most of the Proposed Project topography is relatively flat with elevated areas along the southern San Rafael Hills. The eastern third of the Proposed Project route lays on an alluvial plain (alluvium: a deposit of clay, silt, sand, and gravel left by a flowing stream in a valley or delta) of the San Fernando Valley transitioning to alluvial fans emanating from creeks and canyons draining the south-west aspect of the Verdugo Mountains and Verdugo Canyon. The Proposed Project section with the most topographic relief lays along the southern San Rafael Hills before descending onto the alluvial plain of Pasadena.

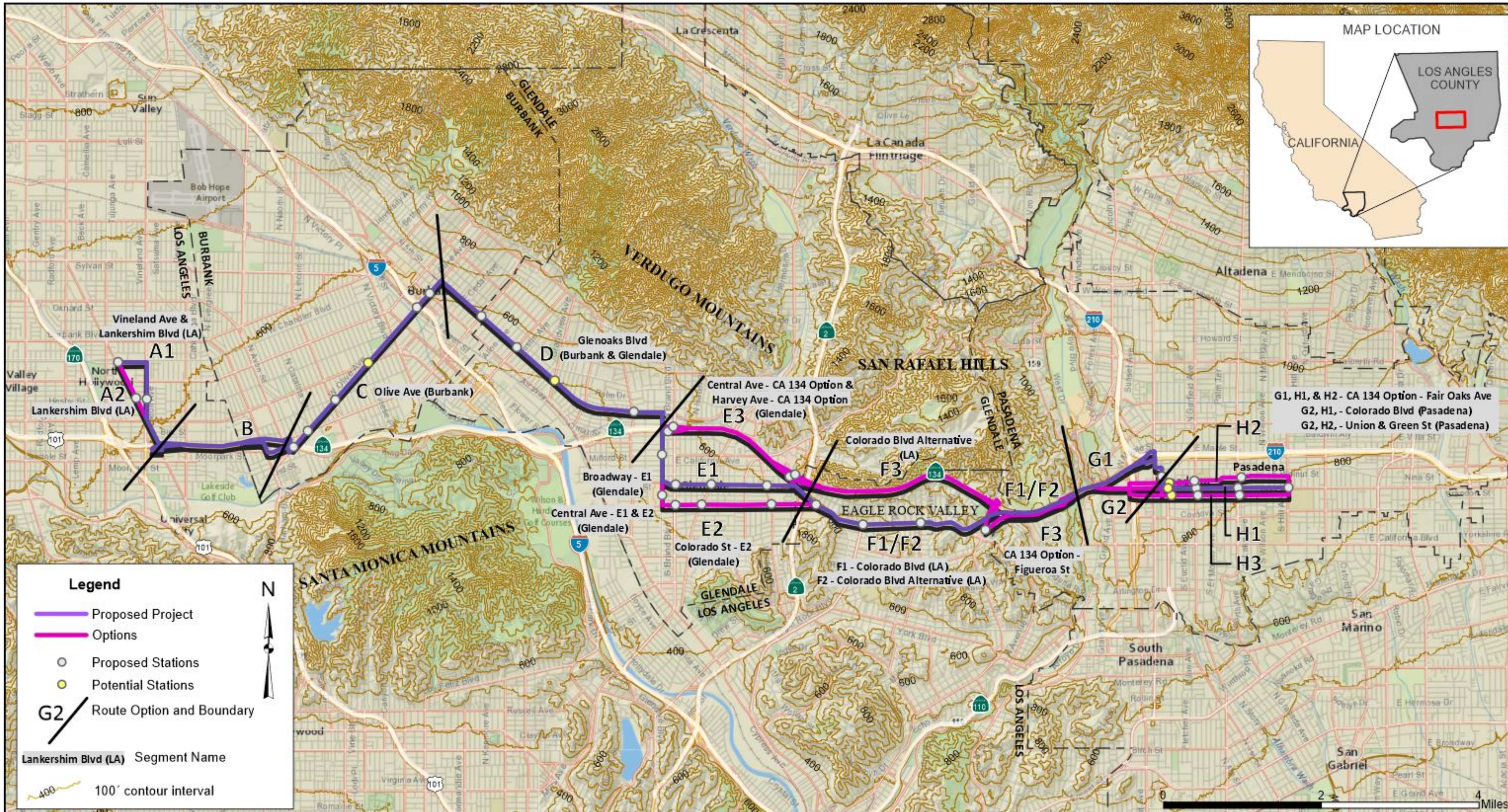
Figure 2 shows the topography of the Project Area. Generally, the western third of the Proposed Project lays at around 600 feet above mean sea level (famsl), gradually increasing to 800 famsl at the Brand Boulevard/Broadway intersection and elevation 1,000 famsl at the Brand Boulevard/State Route (SR) 134 interchange, and descends to elevation 800 famsl onto the alluvial plain of Pasadena.

4.2 CLIMATE

The Los Angeles area has a Mediterranean climate, characterized by warm, dry summers and cool, moist winters. Most of the annual rainfall occurs between November or December and April or May with the hills and mountains generally receiving higher rainfall than the alluvial plains. Microclimatic variation is common. The highest rainfall of the Project Area occurs in the San Rafael Hills and Verdugo Mountains with an annual mean of 21.3 inches and a range of 17.5 to 26 inches. The alluvial plains of the Project Area average about 17 inches of annual rainfall with a range between about 15 and 19 inches annually. The frost-free period is typically 359 to 365 days, except at the higher elevations in the mountains and foothills.

Temperatures across the Project Area vary with distance from the coast and elevation with the alluvial plains averaging about 67 degrees Fahrenheit and the higher elevations of the San Rafael Hills and Verdugo Mountains averaging about 67 degrees Fahrenheit.

Figure 2 – Project Location and Topographic Map



4.3 GEOLOGY AND SOILS

4.3.1 Regional Geology

The Proposed Project is located within the North-Western Block of the Los Angeles Basin in the geologically complex and seismically active Transverse Ranges Geomorphic Province. The Transverse Ranges Geomorphic Province is an anomalous east-west trending set of mountain ranges and valleys composed of a variety of rocks and ages, running from Point Conception in the west, 300 miles into the Mojave and Colorado desert in the east. Proterozoic granitic and metamorphic rocks comprise the San Gabriel and San Bernardino Mountains. Jurassic-Cretaceous Franciscan Complex rocks are found in the western section of the province with Cenozoic sedimentary and volcanic rocks occurring throughout the ranges.

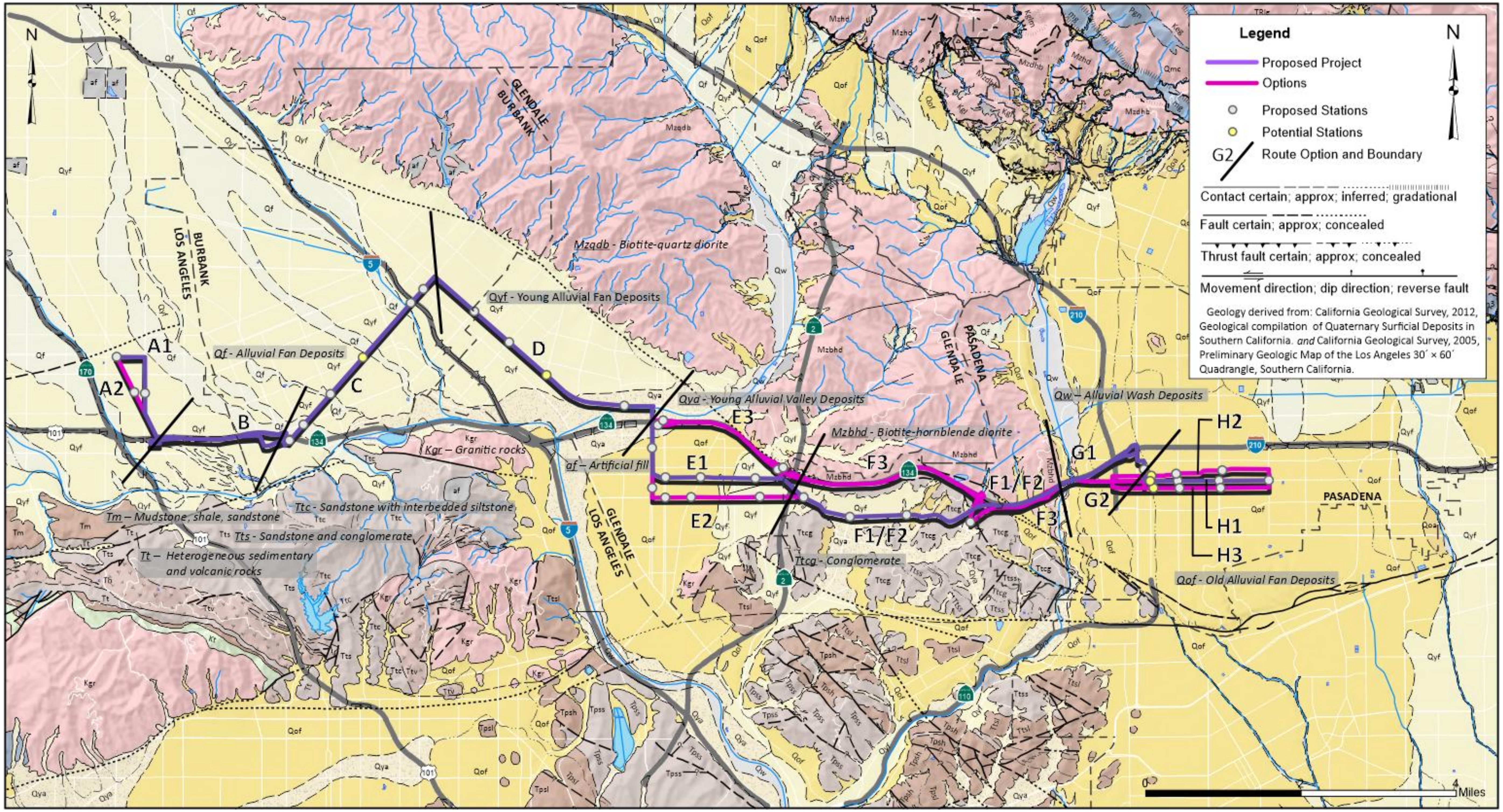
The Los Angeles Basin is a large, relatively flat, low-lying, coastal plain that is bound to the north by the Santa Monica Mountains, the Elysian, Repetto, and Puente Hills; to the east and south-east by the Santa Ana Mountains and San Joaquin Hills. The western margin of the basin is open to the sea except at the Palos Verdes Hills. The floor of the basin slopes gradually southwesterly along the margins of the surrounding hills to sea level along the coastline. The generally flat-lying nature of the Los Angeles Basin is disrupted by an alignment of northwest-southeast trending, low-elevation hills extending from the Beverly Hills area to the Newport Beach area. The areas on either side of these aligned hills are essentially flat and comprise the Downey-Tustin plain on the northeast and the Torrance Plain on the southwest. Major rivers within the basin are the Los Angeles, San Gabriel, and Santa Ana rivers that enter the basin through gaps in the surrounding mountains and drain southerly across the basin floor. The natural form of the basin floor and drainage has been modified by agricultural, urban, and commercial development, and the natural stream channels are now largely confined within concrete-lined or rip-rap lined aqueducts.

The North-Western Block of the Los Angeles Basin, where the Proposed Project is located, consists of late Cretaceous to Pleistocene clastic marine sediments with subordinate middle Miocene volcanics. According to the CGS, the Proposed Project spans the Van Nuys, Burbank, Pasadena, and Mount Wilson 7.5-minute Quadrangles. **Figure 3** shows the regional geology in relation to the Proposed Project.

4.3.2 Site Geology

Figure 3 shows the geology of the Proposed Project which consists of various Quaternary sedimentary deposits, Tertiary sedimentary rocks, and older basement rocks. The Proposed Project itself is mostly underlain by Quaternary deposits, with only minor occurrences of Tertiary and older basement rocks. The following describes bedrock and Quaternary units found within 1,000 feet of the Proposed Project (**Figure 3**). The percentages quoted are for the 1,000-foot search area around the Project corridor.

Figure 3 – Regional and Site Geology Map



Metro

<u>Quaternary</u>

- af – Artificial Fill; fill; deposits resulting from construction, mining, or quarrying activities; include engineered fill for buildings, roads, dams, airport runways, harbor facilities, and waste landfills. This unit underlies approximately 1 percent of the Project along sections of Interstate 5 and SR 134 in Route Options A1, B and C, with a small section adjacent to the eastern end of Route Option F1/F2.
- 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. This unit makes up 0.1 percent of the corridor at Arroyo Seco in Route Option G1 and G2.
- Qf – Alluvial Fan Deposits; unconsolidated 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; gravelly sediment generally more dominant than sandy sediment. This unit underlies approximately 4.4 percent of the corridor and is located in Route Options A through C. The unit is visible in historical aerial photos from the 1920s appearing as shallow and wide braided stream beds.
- 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. This unit underlies about 38 percent of the corridor occurring in broad swathes between drainages containing Qf and in drainages emanating from the San Rafael Hills. Located in Route Options A through F.
- 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. This unit covers about 12.1 percent of the corridor and underlies portions of Route Options D through G.
- 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. The unit occupies about 30 percent of the corridor underlying most of Route Option E, parts of F, and all of G and H.
- 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. Occupies about 1 percent of the corridor and underling small areas of Route Options E3, F1, and F2.

<u>Tertiary</u>

- Ttcg – Topanga Group, conglomerate; conglomerate, massive to well-bedded. Comprises about 5.7 percent of the corridor and occupying low hills in Route Options F1, and F2.

<u>Mesozoic</u>

- Mzbhd – Granitic rocks; various plutonic igneous rocks occurring in the San Rafael Hills. Occupies about 7.7 percent of the corridor in Route Options E3, F1, F2, G1, and G2.

4.3.3 Subsurface Soil Conditions

Subsurface soil conditions were evaluated based on data from previous explorations performed along the Project corridor, more specifically at the location of major arterial street crossings with SR 134, SR 2, and Interstate 210 within the Project Area. **Table 7** shows the soil types encountered along the Project corridor in the west-east direction.

Using the Unified Soil Classification System, the previous explorations listed in **Table 7** encountered mostly coarse-grained cohesionless soils (sand, silty sand, gravel) with cobbles and boulders. Interbedded fine-grained cohesionless and cohesive soils (sandy silt, sandy silty clay, clay) are also present. Conglomeratic sandstone of the Topanga Group conglomerate (Ttcg) was encountered in the Eagle Rock Valley (i.e., intersections of Colorado Boulevard and Figueroa Street with SR 134). Granitic rock (Mzbhd) was encountered at shallow depths at the intersection of Arroyo Seco and the SR 134.

4.3.4 Soil Use

Soils along the Project corridor were mostly used for small ranching and farming operations prior to the completion of the Southern Pacific Railroad in 1885 after which soils became used to produce grains, fruit, vegetable crops, vineyards, and extensive citrus orchards. Soils became used more frequently for urban uses following the great population expansion of the area starting in the early 1900s. Information presented in this section describes the dominant soil conditions but does not eliminate the need for Project specific investigations.

The Proposed Project covers several soil types as shown in **Figure 4**. Soil descriptions and distributions are taken from the USDA (USDA, 2017). The brief descriptions below include the main soil components comprising the map units shown in **Figure 4**. Only those units that are found within the Proposed Project 1,000-foot minimum search area are listed.

- Unit 1002, Urban land-Palmview-Tujunga complex, 0 to 5 percent slopes – This unit comprises about 47 percent of the Project Area with the main components being:
  - Urban Land (45 percent)
  - Palmview (25 percent)
  - Tujunga (20 percent)

- Unit 1012, Urban land-Tujunga-Typic Xerorthents, sandy substratum complex, 0 to 2 percent slopes – This unit comprises about 10.3 percent of the Project Area with the main components being:
  - Urban Land (45 percent)
  - Tujunga (35 percent)
  - Typic Xerorthents, sandy substratum (15 percent)

Table 7 – Subsurface Soil Conditions along the Project Corridor (West-East Direction)

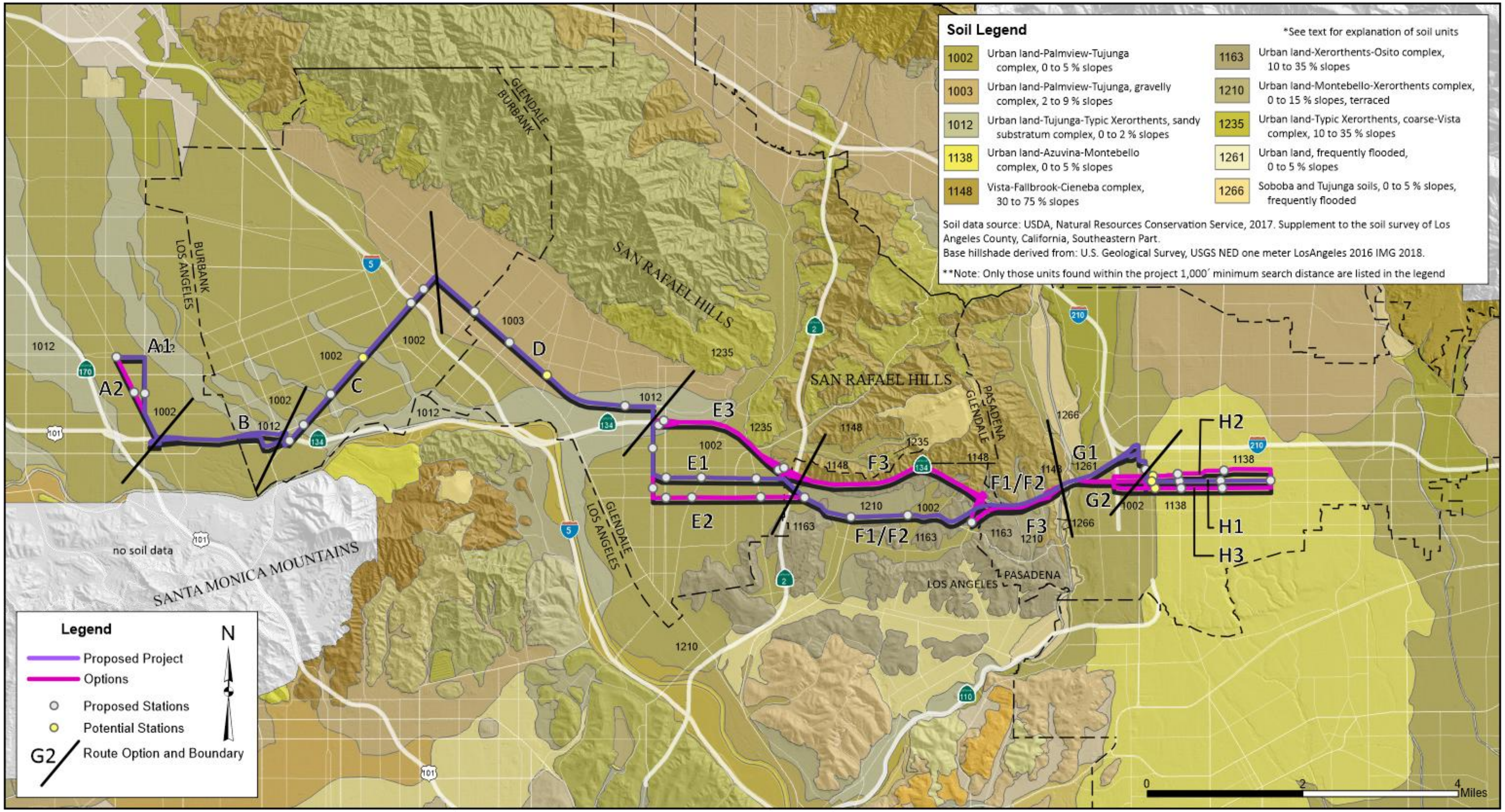
ID	Approximate Location	Caltrans Bridge No.	Subsurface Soil Conditions
1	Vineland Ave. @ SR 134	53-1272	- 23.0 to 30.8 feet of loose to slightly compact, silty fine sand and sand. - Underlain by dense to very dense sandy gravel up to 45.8 feet.
2	Cahuenga Ave. @ SR 134	53-1274L	- 13.8 to 14.8 feet of slightly compact silty fine sand underlain by 13 feet of compact to dense gravelly sand. - Underlain by very dense sands and gravels up to 50.8 feet.
3	Ledge Ave. @ SR 134	53-1275	- 30 to 36 feet of medium dense and occasionally loose to dense sandy silt interbedded with silty sand, fine sand, and minor medium stiff sandy silty clay. - Underlain by 30 feet of dense to very dense silty sand with gravel, coarse sand, gravel, and minor stiff to very stiff lean clay and silt with sand.
4	Pass Ave. @ SR 134	53-1278	- Alternating layers of silty sands, sandy silts, sands, clays and gravels. - 3 to 10 feet of fill (gravels, silty sands and sands) encountered at two locations.
5	Forman Ave. @ SR 134	53-1276	- 13.0 feet of very loose to loose, very fine to medium grained, silty sand and sandy silts. - Underlain by 13.0 feet of compact, very fine to medium grained, silty sand and sand with interbedded lenses of silt. - Underlain by 7.0 feet of stiff, slightly plastic, fine, sandy, clayey silt. - Underlain by 11.0 feet of dense, fine to coarse, sand to gravelly sand with layers of gravel and scattered cobbles.
6	Hollywood Way @ SR 134	53-1279	- 5 feet of fill soils (gravel) overlying native alluvium. Alluvial sediments consist of alternating layers of silty sands, clayey sands and gravels.
7	Olive Ave. @ SR 134	53-1280	- 11.0 feet of loose to slightly compact, fine clean to silty sand. - Underlain by 9 feet of compact, clean fine to medium sand. - Underlain by 8 feet of slightly compact to dense, fine to medium sand with silt. - Underlain by 9 feet of loose to slightly compact silt and compact fine silty sand. - Underlain by 17 feet of very dense, sand and gravel.
8	Harvey Dr. @ SR 134	53-1884G	- Alluvial sands, gravelly sands and bouldery sands.
9	Colorado Blvd. @ SR 2	53-2137	- Slightly compact sand to dense silty sand overlying conglomeratic Sandstone at varying locations.
10	Figueroa St. @ SR 134	53-21518	- Quaternary-age alluvium (Qal) consisting of sands, gravelly sands and silty sands. The alluvium is underlain by conglomeratic sandstone of the Tertiary-age Topanga Formation.
11	Arroyo Seco @ SR 134	53-166	- Alluvial soils described as slightly compact to very dense sand with gravel and cobbles. At depths ranging from 2 to 60 feet, granitic bedrock was encountered. - In general, the granite was most shallow (ranges from 2 to 20 feet below ground surface) between Abutment 1 and Bent 10 and became deeper at Bent 11 and Abutment 12 (ranges from 45 to 60 feet below ground surface).
12	Orange Grove Blvd. @ SR 134	53-2269S	- Silty and gravelly sands; gravel and possible cobbles.
13	Maple St. @ I-210	53-2254	- Granular alluvium consisting of interbedded poorly sorted sand, silty and gravelly sand, occasional cobbles, and thin lenses of sandy silt.

ID	Approximate Location	Caltrans Bridge No.	Subsurface Soil Conditions
14	Lake Ave. @ I-210	53-2276	- At Lake Ave., I-210 has been constructed in a road cut which extends about 25 to 30 feet below the Lake Ave. grade. The natural soils are Pleistocene age terrace deposits which consist of well consolidated sand and gravel, silty sand, and silt with varying amounts of cobbles and boulders. The uppermost soils were found to be loose, while the soils below depths of 10 to 15 feet were compact, and dense to very dense. The Pleistocene age terrace deposits are estimated to extend to a depth of approximately 1,600 feet beneath the site where they overlie granitic basement rocks.
15	Hill Ave. @ I-210	53-2084 R/L and 53C-359	- I-210 has been constructed on an artificial fill embankment which extends up to about 25 feet above the spur grade. The fill materials consist of fine to coarse silty sand with about 10 to 20 percent gravel and cobbles. The fill embankment overlies Pleistocene age terrace deposits which consists of silty sand and sandy silt with varying amounts of gravel and cobbles. Deeper terrace deposits consist of fine to medium, dense to very dense sand and gravel with varying amounts of cobbles and boulders. The Pleistocene materials are estimated to extend to a depth of approximately 1,100 feet beneath the site where they overlie Tertiary age sedimentary rocks. The sedimentary rocks overlie granitic basement rocks at a depth of approximately 1,500 feet.

SOURCES:

1) Caltrans, *File No. 07-LA-134-KP 0.0/3.4 07-061741*, November 29, 2001.
2) Caltrans, *File No. 07-LA-134-KP 0.0/3.4 07-061741*, January 24, 2002.
3) Caltrans, *File No. 07-LA-134-PM 1.11 07-260301*, May 28, 2010.
4) Geobase, *Caltrans Soundwalls and Retaining Walls. Project No. P.315.11.00*, January 2003.
5) Caltrans, *File No. 07-LA-134-KP 0.0/3.4 07-061741*, January 24, 2002.
6) Geobase, *Caltrans Hollywood Way Bridge Lengthening. Project No. P.315.09.00*, February 2003.
7) Tejima and Associates, Inc., *Report of Geotechnical Consultation, Seismic Retrofit Study, Olive Avenue Overcrossing. Job No. 1169-14-04*, April 15, 1994.
8) Caltrans, *File No. 07-LA-134-8.7 07204 117310. Retrofit Project No. 38*, August 2, 1990.
9) Caltrans, *File No. 07-LA-134-8.7/11.4 07-11649G. Retrofit Project No. 16*, February 22, 1990.
10) Caltrans, *File No. 07-LA-134-11.3 07204 117310. Retrofit Project No. 38*, February 25, 1991.
11) The LKR Group, Inc., *Geotechnical Information for Seismic Retrofit Strategy Analysis SR 134 Arroyo Seco Bridge. Project No. LKR 95-1024*, November 17, 1995.
12) Caltrans, *File No. 07-170901*, July 13, 1994.
13) Caltrans, *File No. 07-LA-210-24.86 07262 170901*, June 26, 1995.
14) Law/Crandall, Inc., *Geotechnical Summary Lake Avenue Overcrossing, Foothill Freeway - Interstate 210. Project No. L92045.AE4*, May 17, 1995.
15) Law/Crandall, Inc., *Geotechnical Summary, Hill Avenue Undercrossing and Underpass, Foothill Freeway - Interstate 210. Project No. L92045.AE4*, July 28, 1993.

Figure 4 – Soil Unit Map



Metro

- Unit 1138, Urban land-Azuvina-Montebello complex, 0 to 5 percent slopes – This unit comprises about 10.3 percent of the Project Area with the main components being:
    - Urban Land (45 percent)
    - Azuvina (25 percent)
- Montebello (20 percentUnit 1148, Vista-Fallbrook-Cieneba complex, 30 to 75 percent slopes – This unit comprises about 7.6 percent of the Project Area with the main components being:
    - Vista (45 percent)
    - Fallbrook (25 percent)
    - Cieneba (15 percent)
- Unit 1163, Urban land-Xerorthents-Osito complex, 10 to 35 percent slopes – This unit comprises about 7.3 percent of the Project Area with the main components being:
    - Urban Land (35 percent)
    - Osito (25 percent)
- Unit 1210, Urban land-Montebello-Xerorthents complex, 0 to 15 percent slopes, terraced – This unit comprises about 5.8 percent of the Project Area with the main components being:
    - Urban Land (40 percent)
    - Montebello (25 percent)
    - Xerorthents, coarse fill (20 percent)
- Unit 1235, Urban land-Typic Xerorthents, coarse-Vista complex, 10 to 35 percent slopes – This unit comprises about 0.6 percent of the Project Area with the main components being:
    - Urban Land (45 percent)
    - Typic Xerorthents, coarse (30 percent)
    - Vista (15 percent)
- Unit 1261, Urban land, frequently flooded, 0 to 5 percent slopes – This unit comprises about 0.1 percent of the Project Area with the main components being:
    - Urban Land, frequently flooded (95 percent)
- Unit 1266, Soboba and Tujunga soils, 0 to 5 percent slopes, frequently flooded – This unit comprises about 0.4 percent of the Project Area with the main components being:
    - Soboba (60 percent)
    - Tujunga (25 percent)

4.4 FAULTING AND SEISMICITY

4.4.1 Faulting

Special Publication 42 (CGS, 2018) defines a fault as a shear or zone of closely associated shears across which earth materials on one side have been displaced with respect to those on the other side because of tectonic forces. A fault is distinguished from those fractures or shears caused by landsliding or other gravity-driven surficial failures.

Faults are classified into three categories on the basis of the absolute age of their most recent movement, as follows:

1) *Holocene-active faults:* Faults that have moved during the past 11,700 years. Also known as "Active faults."
2) *Pre-Holocene faults:* Faults that have not moved in the past 11,700 years, thus do not meet the criteria of "Holocene-active fault" as defined in the Alquist-Priolo Act and State Mining and Geology Board regulations. This class of fault may be still capable of surface rupture but is not regulated under the Alquist-Priolo Act.
3) *Age-undetermined faults:* Faults where the recency of fault movement has not been determined. Faults can be "age-undetermined" if the fault in question has simply not been studied in order to determine its recency of movement. Faults can also be age-undetermined due to limitations in the ability to constrain the timing of the recency of faulting.

The Proposed Project is located in a seismically active region containing several historic (<200 years), numerous Holocene (<11,700 years), and potentially active (<1.6 million years) faults. **Table 8** and **Figure 5** list and show active faults (Historic and Holocene) within about 40 miles of the Project Area.

Table 8 – Active Faults within 40 Miles of the Proposed Project

Fault Name	Age	Approximate Distance (miles)	Maximum Moment Magnitude (M_{max})
Verdugo fault	Holocene	0.0	6.8
Raymond fault	Holocene	1.3	6.7
Hollywood fault	Holocene	2.0	6.6
East Montebello fault	Holocene	6.2	Not determined
Santa Monica fault	Holocene	6.5	7.0
Newport-Inglewood-Rose Canyon fault zone	Historic/Holocene	9.4	7.2
San Gabriel fault	Holocene	18.1	7.2
Palos Verdes fault	Holocene	18.7	7.2
Redondo Canyon fault	Holocene	22.6	6.2
Malibu Coast fault zone	Holocene	22.9	6.6
Sierra Madre fault zone	Historic/Holocene	25.4	7.2
San Cayetano fault	Holocene	26.2	7.2
Elsinore fault zone	Holocene	26.6	6.6
San Andreas fault zone	Historic	27.5	7.9
Cabrillo fault	Holocene	30.2	6.5
Llano fault	Holocene	31.1	Not determined
Etiwanda Avenue fault	Holocene	33.0	6.2
Bardsdale fault	Holocene	34.6	Not determined
Simi-Santa Rosa fault zone	Holocene	36.1	6.8
San Jacinto fault zone	Holocene	36.4	7.7

SOURCE: Fault locations are derived from: Jennings & Bryant, *Fault Activity Map of California,* 2010. Magnitudes are derived from: Caltrans Fault Database V2a, 2012.

The primary geological structures of the Proposed Project area are Holocene and late Quaternary faults as listed in **Table 8** and shown in **Figure 5**. Lithological contacts between units are shown in **Figure 3**.

Foliation in the Mesozoic granitic rocks (Mzbhd) at Route Options E3, F1, F2, G1, and G2, are parallel to and dip steeply into the hillside. Bedding in the Topanga Group (Ttcg) is mapped to dip moderately to the north and into the hillside in the vicinity of the Project corridor at Route Options F1 and F2.

Descriptions of the active faults occurring within the Project area are described below.

Verdugo Fault

The Verdugo Fault intersects and parallels the Project corridor along the SR 134 from mid of Route Options E3 to its transition into the Eagle Rock and San Rafael Faults. Holocene movement is marked by south-west facing scarps 6 to 10 feet high in alluvial fan deposits along the south-west edge of the Verdugo Mountains (Weber, et al., 1981). The probable magnitude is estimated to be 6.0 to 6.8 (SEDC, 2013). The fault is not designated with an Earthquake Fault Zone by the CGS.

Raymond Fault

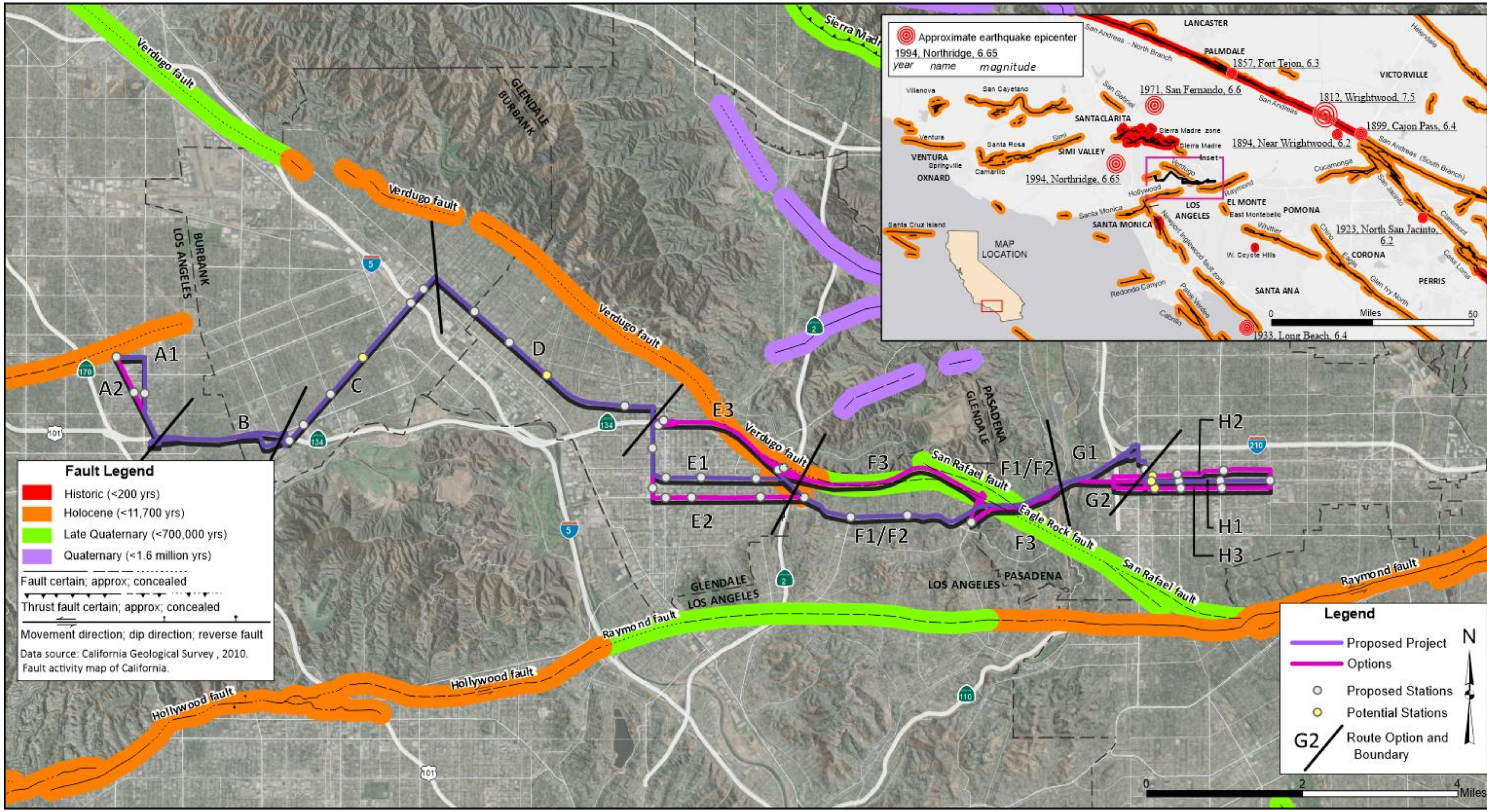
The Raymond Fault, along with the Hollywood Fault described next, lies within the Santa Monica-Hollywood-Raymond Fault system of oblique, reverse and left-lateral faults. The fault system is collectively part of a greater than 125-mile-long west-trending system of oblique, reverse and left-lateral faults that separate the Transverse Ranges geomorphic province of California on the north, from the Peninsular Ranges province on the south. The fault does not intersect the Project corridor, running roughly parallel and approximately 1.4 to 1.7 miles to the south. The fault shows evidence of Holocene surface rupture and is listed as an Alquist-Priolo fault and has an associated Earthquake Fault Zone.

Hollywood Fault

The Hollywood Fault trends east-northeast for about 10.5 miles through densely populated areas, including the cities of Beverly Hills, West Hollywood, and the community of Hollywood within the City of Los Angeles, trending eastward to the Los Angeles River Valley. Recent detailed geologic and geotechnical studies in the cities of West Hollywood and Los Angeles have reported Holocene faulting at a number of sites along the Hollywood Fault (Hernandez & Treiman, 2014). The fault does not intersect the Project corridor, running roughly parallel and approximately 1.8 to 3.5 miles to the south. The fault is listed as an Alquist-Priolo fault and has an associated Earthquake Fault Zone.

Potential earthquakes generated from any of these faults may result in permanent offsets reflected at the ground surface along the fault trace and may directly impact the Proposed Project.

Figure 5 – Fault and Historical Earthquakes (M_{max} > 6) Map



4.4.2 Seismicity

The Proposed Project lies in an area that has experienced significant damaging seismic events. Approximately 60 earthquakes have occurred in the Los Angeles region since the late 1700s. Many faults within the Project Area and region are capable of producing significant seismic events.

Historic earthquakes, exceeding a magnitude 6.0, within the greater Los Angeles are listed in **Table 9** and shown in **Figure 5**. Two earthquake examples from the Project Area, the Northridge (1994) and San Fernando (1971), are briefly described herein.

Table 9 – Historical Earthquakes within 60 Miles of the Proposed Project

Name / Location	Year	Fault	Magnitude
Wrightwood	1812	San Andreas	7.5 estimated
Fort Tejon	1857	San Andreas	6.3 approximately
Near Wrightwood	1894	San Andreas (probable)	6.2 estimated
Cajon Pass	1899	San Andreas	6.4 roughly
North San Jacinto	1923	San Jacinto	6.2
Long Beach	1933	Newport-Inglewood fault zone	6.4
Kern County	1952	White Wolf	7.5
San Fernando	1971	San Fernando fault zone	6.6
Northridge	1994	Northridge Blind Thrust	6.7

SOURCE: National Geophysical Data Center / World Data Service (NGDC/WDS): Significant Earthquake Database.

The Northridge Earthquake occurred on a blind thrust near Reseda about 9.5 miles west north-west of the Project corridor. The earthquake produced the strongest ground motions ever recorded in an urban setting in North America resulting in extensive damage to freeways, parking structures, and all manner of buildings. The death toll was 57 with approximately 8,700 injured and caused about $13-50 billion worth of damage. Legislative and regulatory changes due to the earthquake included the formation of the California Earthquake Authority, updates to the California Building Code, and amendments to the Alfred E. Alquist Hospital Facilities Seismic Safety Act.

The San Fernando Earthquake occurred on a thrust fault of the San Fernando Fault Zone with a surface rupture of approximately 19 miles and maximum slip up to six feet. Over $500 million in property damage and 65 deaths occurred as a direct consequence. The earthquake led directly to the enactment of the Alquist-Priolo Earthquake Fault Zoning Act.

4.5 GEOTECHNICAL CONSIDERATIONS

4.5.1 Seismic Hazards

Primary seismic hazards include ground shaking and surface fault rupture. Secondary seismic effects resulting from soil responses to ground shaking includes liquefaction. These hazards may cause deformation of man-made structures. These hazards are discussed in the following paragraphs.

Primary Seismic Hazards

Ground Shaking
Earthquake-induced ground-shaking is a seismic hazard that can result in liquefaction, lurching and lateral spreading of soils, and landslide of soil and rock as well as dynamic oscillation of man-made structures. Differential settlements can occur at the ground surface due to subsurface liquefaction and densification caused by strong ground-shaking.

Most of the structures referenced in **Table 7** were designed for a Peak Ground Acceleration (PGA) ranging between 0.55g and 0.7g. Using the coordinates of the center point of the Project corridor, preliminary calculations of the PGA using California Department of Transportations (Caltrans) ARS Online web tool (Version V3.0.2) yield a value of about 0.7g. Hence, the earthquake shaking potential at the Project site is considered high.

Surface Fault Rupture
Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture generally can be assumed to be along an active major fault trace. **Figure 6** shows faults in relation to the Proposed Project that are considered active as defined by the Alquist-Priolo Earthquake Fault Zoning Act and include the Holocene Hollywood and Late Quaternary Raymond Faults. **Figure 6** also shows the respective Earthquake Fault Zones in relation to the Proposed Project. The boundaries of these zones encompass active faults that constitute a potential hazard to structures from surface faulting or fault creep such that avoidance as described in PRC Section 2621.5(a) would be required. Rupture of the ground surface along the trace of an active fault can be expected to occur during seismic events that originate on such faults.

Figure 6 – Alquist-Priolo Earthquake Fault Map

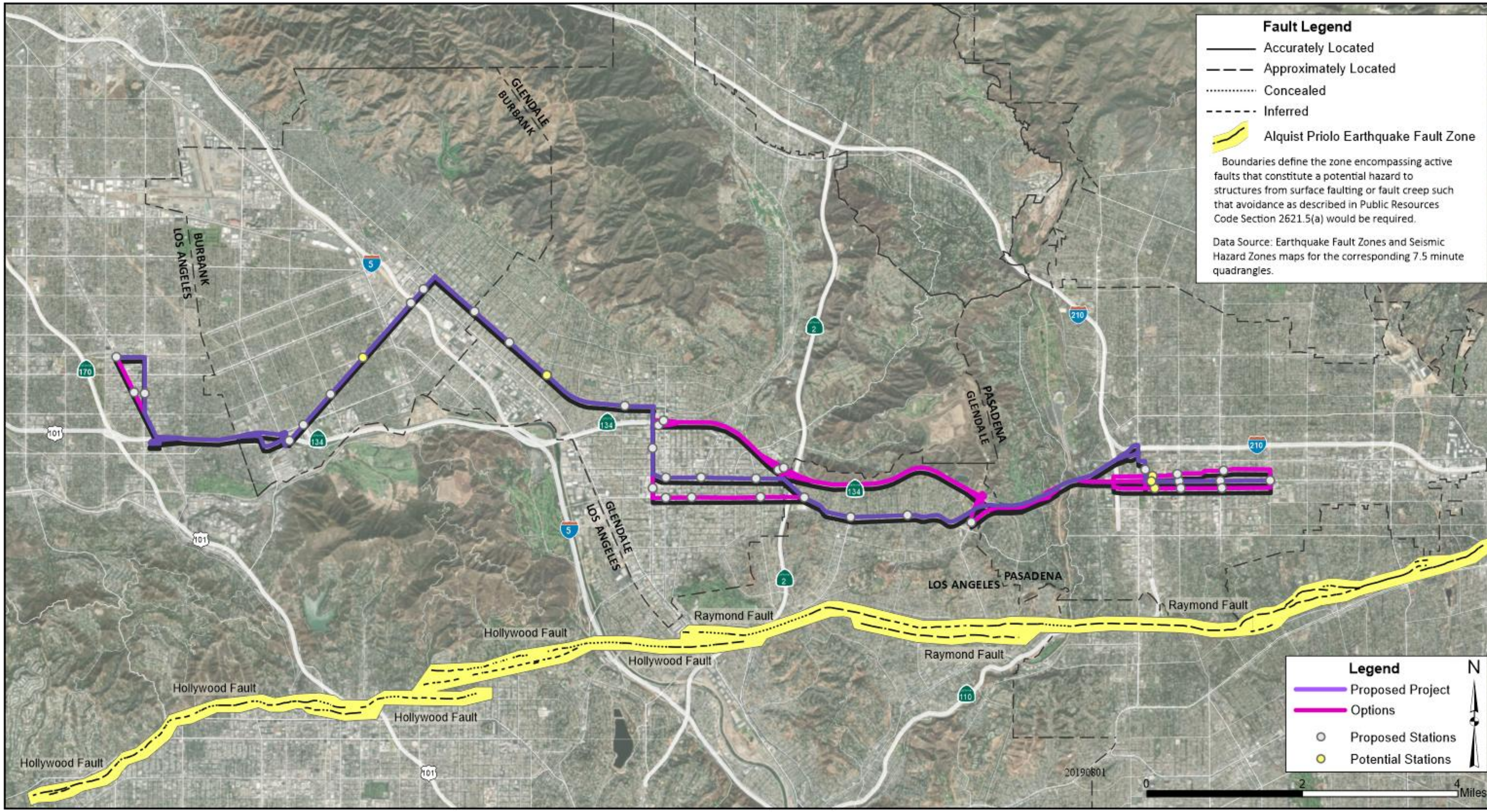


Table 10 lists data for faults shown on **Figure 5** and **Figure 6**. Distance to faults are the closest intercept to the Project corridor and are derived from Bryant (2005). Fault ages are <11,700 years and <700,000 years for Holocene faults and late Quaternary faults, respectively. Note that not all faults listed in **Table 10** are included as Alquist-Priolo Faults; this distinction is determined by the State Geologist as per Section 2622 of the Alquist-Priolo Act.

Table 10 – Data for Faults Laying within 10 miles of the Proposed Project

Fault	Age	Approx. distance (miles; closest intercept)	Maximum Moment Magnitude (M_{max})	Alquist-Priolo Fault
Verdugo	Holocene; Late Quaternary	0	6.8	no
San Rafael	Late Quaternary	0	6.8	no
Eagle Rock	Holocene	0	6.8	no
Raymond	Holocene	1.8	6.7	yes
Hollywood	Holocene	2.5	6.6	yes
Sierra Madre	Late Quaternary	5.5	7.2	yes
East Montebello	Late Quaternary	8.5	Not determined	yes

SOURCE: Bryant, *Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California*, 2005.

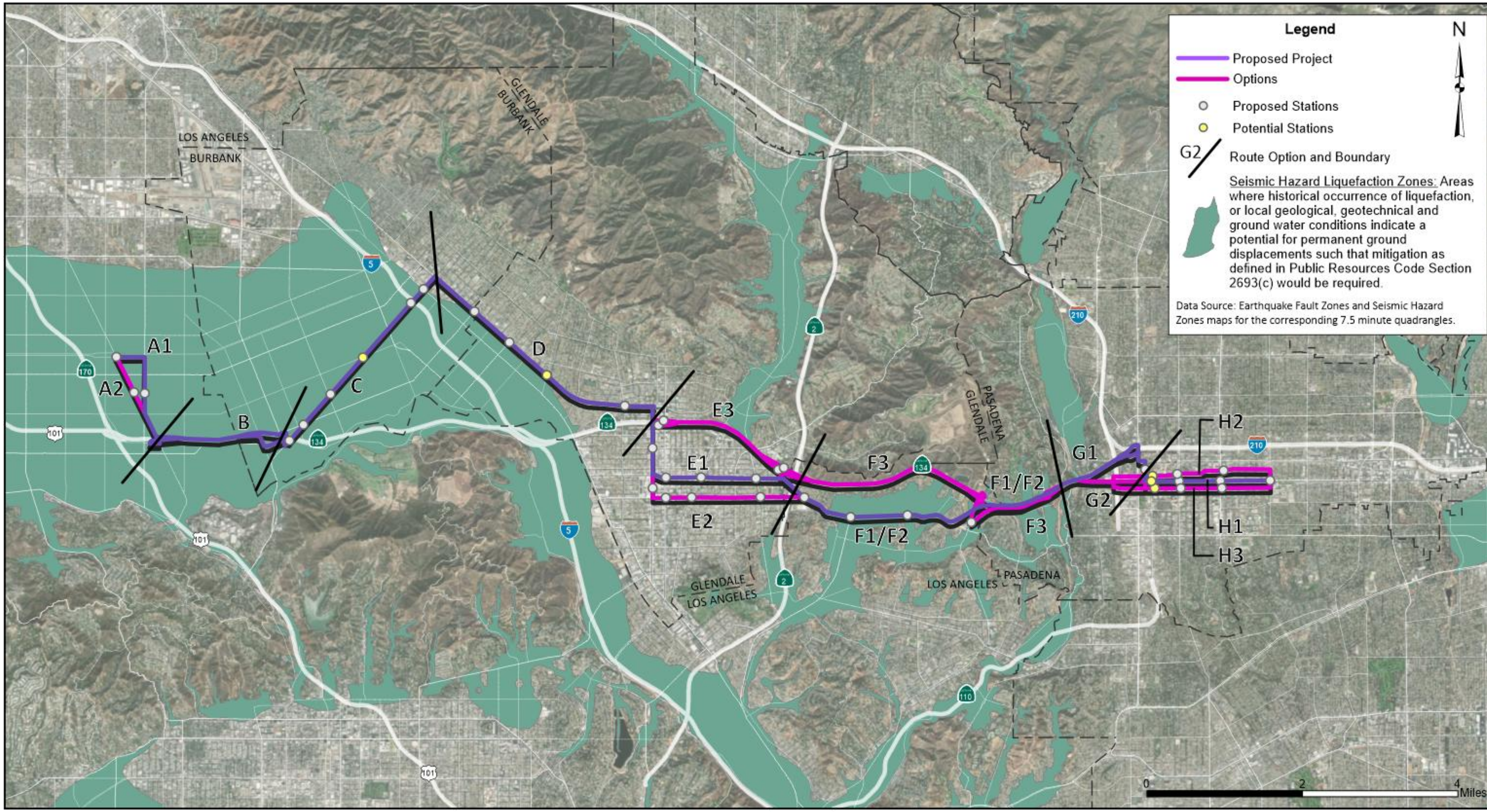
According to the corresponding quadrangle Earthquake Fault Zones and Seismic Hazard Zones maps, no part of the Project or the Project search distance intersects an active fault trace or earthquake fault zone as defined by the Alquist-Priolo Act. Therefore, the potential for fault rupture along the Proposed corridor is very low. The Alquist-Priolo Act only applies to structures for human occupancy; however, it provides relevant information and delineation of areas that would be susceptible to ground rupture from an earthquake.

<u>Secondary Seismic Hazards</u>

Liquefaction

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged cohesionless sands and silts of low relative density are the type of soils which usually are susceptible to liquefaction. Clays are generally not susceptible to liquefaction. As shown in **Figure 7**, according to the Van Nuys(a), Burbank(b), Pasadena(c), and Mount Wilson(d) 7.5-minute Quadrangle Seismic Hazard Zone maps (CGS, 2005a, 2006b, 2006c, and 2006d), with the exception of Route Options E1, E2, H1, H2, and H3, most of the Project corridor is located within or adjacent to liquefaction-prone designated areas.

Figure 7 – Liquefaction Susceptibility Map



Metro

The "Guidelines for Evaluating and Mitigating Seismic Hazards in California" Special Publication 117A of the CGS (CGS, 2008) suggest evaluating liquefaction potential of a site considering at least the upper 50 feet of subsurface soils. For this reason, due to the deep groundwater expected along the Project corridor (50 feet below ground surface (bgs) and deeper) as shown in the Groundwater section of this report, liquefaction is unlikely to happen and may only occur at isolated areas along the Project corridor (i.e., within the Eagle Rock Valley along Route Options F1/F2 and F3). The proposed improvements are mostly surficial, and settlements could be more aerial type and therefore surface manifestation from such settlements may be low. However, seismically-induced settlements (dry settlements) are a potential hazard due to mostly granular soil deposits and expected high PGA at the Project site.

Lateral Spreading

One of the consequences of seismic liquefaction in sloping ground areas is lateral spreading, which refers to the translation of ground laterally after the loss of support due to liquefaction. For this to occur, the liquefied area must be relatively near a free face, a vertical, or sloping face such as a road cut or stream/riverbank. Considering that the liquefaction potential hazard at the Proposed Project area is low due to the absence of groundwater, and if liquefaction occurred, that the potential liquefied area must be relatively near to a free face, a vertical, or sloping face such as a road cut or stream/riverbank, the potential for lateral spreading is low along the Project corridor.

Seismically-Induced Slope Failure

Slope failure can occur when the force of gravity overcomes the strength of the soil or rock within a hillside or built embankment. The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, slope geometry (height and steepness), rainfall, and groundwater. Excavation or erosion of material at the toe of a slope can destabilize the slope above it. Slope failure can be initiated or exacerbated by seismic movements. Earthquake-induced ground-shaking can cause activation of new or previously existing landslides and other slope instabilities, especially during periods of high groundwater.

According to the Van Nuys, Burbank, Pasadena, and Mount Wilson 7.5-minute Quadrangle Seismic Hazard Zone maps prepared by CGS, **Figure 8** shows that small areas of the Project corridor east of SR 2 are located within earthquake-induced landslide areas. Most specifically along Route Options F1/F2, F3, G1, and G2. Hence, the potential for earthquake-induced landslides is high for the Project corridor located within those areas.

4.1.1 Groundwater

According to the groundwater map for the Van Nuys(a), Burbank(b), Pasadena(c), and Mount Wilson(d) 7.5-minute Quadrangles (CGS, 2005a, 2006b, 2006c, and 2006d), **Figure 9** shows that the historical highest groundwater depth along the Project corridor varies between 10 and 30 feet bgs along Route Options A1, A2, B, C, and a portion of D; between 40 and 80 feet bgs at the easternmost portion of Route Option D and along Route Options E1, E2, and E3; about 20 feet bgs along Route Options F1/F2 and F3; and about 100 feet bgs along Route Options G1, G2, H1, H2, and H3.

Figure 8 – Earthquake-Induced Landslide Zones Map

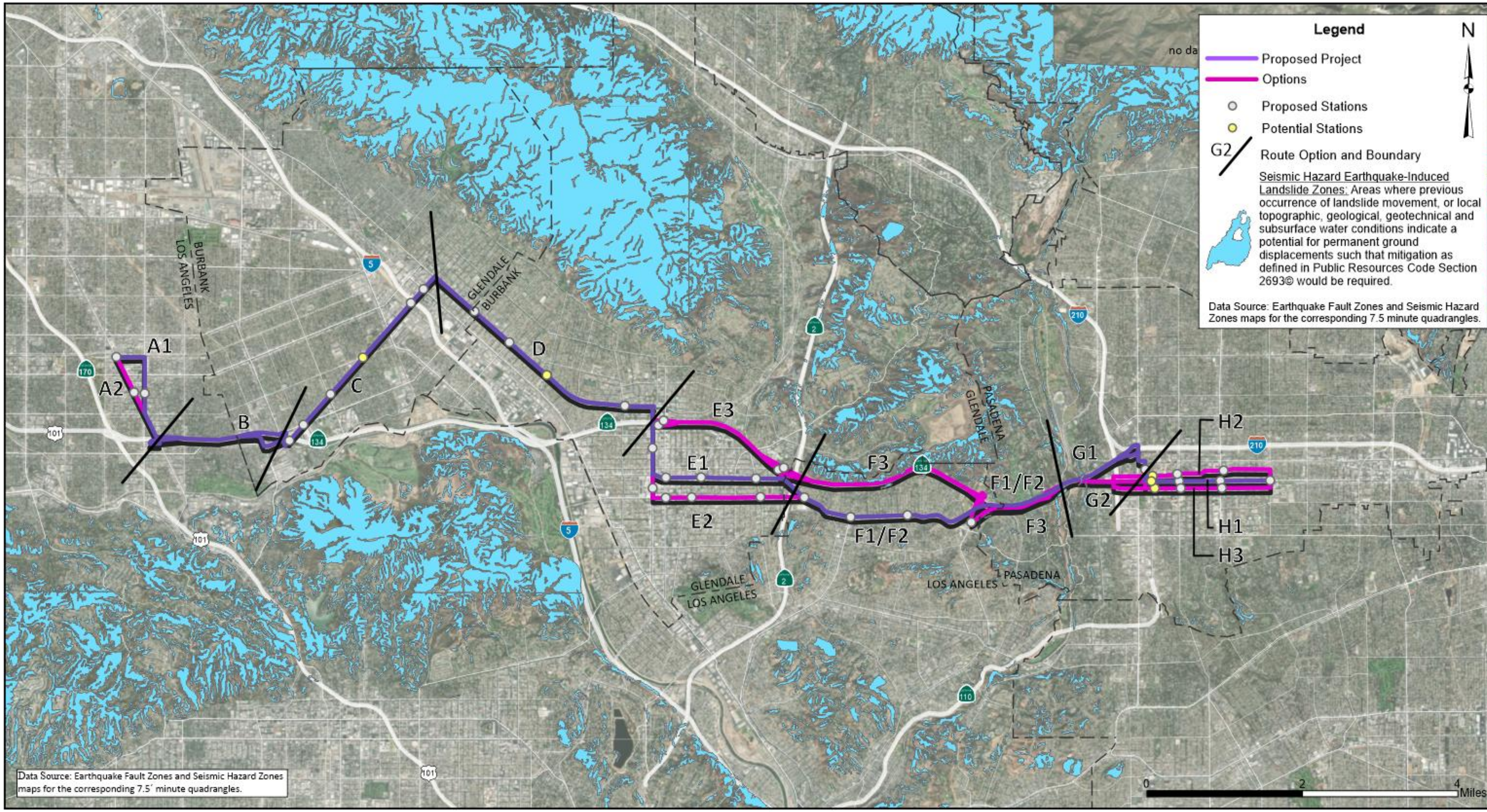
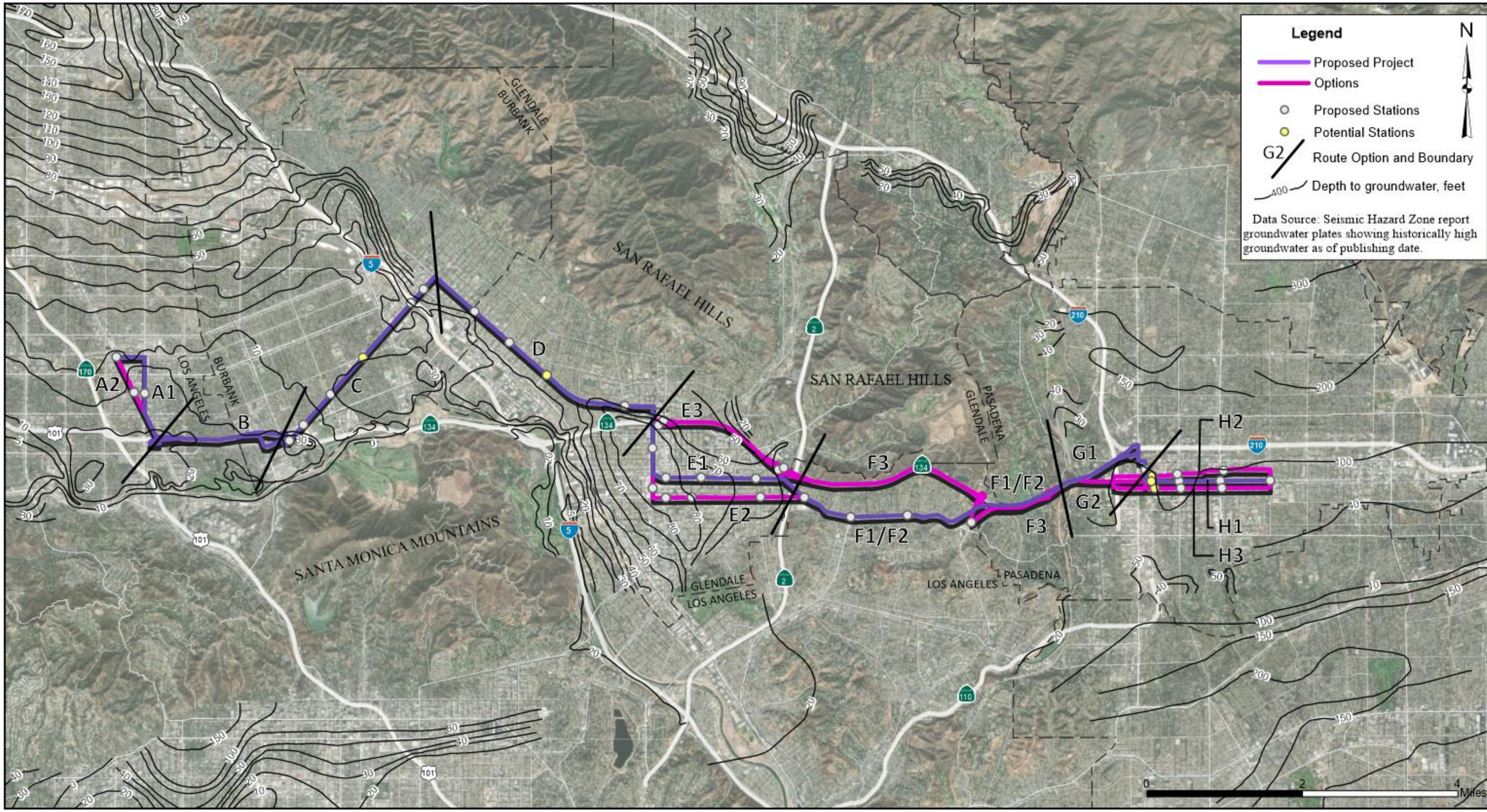


Figure 9 – Historical Groundwater Contours Map



The geotechnical report at the intersection of Pass Avenue and SR 134 (Geobase, 2003) indicates that groundwater high levels were recorded in the 20th century before the valley was developed (urbanized), water extraction was minimal, and surface streams flowed naturally. The report (Geobase, 2003) also states that in 1934 groundwater was at a depth of approximately 15 feet of proximity of the site (Eckis, 1934), by 1944 the water depth had declined to approximately 45 feet of depth (California State Water Rights Board, 1961), and in 1975 the water level was down to 180 feet of depth (Los Angeles County Flood Control, 1977); since then, groundwater from the basin aquifers has been the main supplemental source for water supply in the region besides to the Los Angeles Aqueduct. Even though there has been a shut-down of wells due to contamination and a water table recovery is evident, it is very doubtful that groundwater would rise much more than it is now in the foreseeable future (Geobase, 2003).

The prior statement about the lowering of the groundwater depth (Geobase, 2003) has been corroborated with recorded groundwater depths data from previous explorations performed along the Project corridor, most specifically at the location of major arterial street crossings with SR 134, SR 2, and I-210 within the Project Area. **Table 11** shows the groundwater depths encountered along the Project corridor in the west-east direction.

Based on **Table 11**, groundwater is not expected within the upper 50 feet below ground surface along the Project corridor, with localized exceptions within the Eagle Rock Valley (i.e., intersection of Figueroa Street and SR 134) along Route Options F1, F2, and F3.

The deep groundwater statement should be further investigated during the design phases of the Proposed Project because it directly influences geologic, soils and seismic hazards such as shallow landslides and debris flow, natural slope instability, expansion and collapse potentials, and liquefaction.

It should be noted that potential perched water can be encountered at discrete locations along the Project corridor. Also, groundwater depths may vary due to irrigation, season, and anthropogenic and natural influences.

4.5.2 Expansive Soils

The shrink-swell potential is a reflection of the ability of some soils with high clay content to change in volume with a change in moisture content. Shrink-swell potential poses a less significant hazard where soil moisture is relatively constant (either always wet or always dry). Shrink-swell potential poses a significant hazard to sites, which undergo seasonal variation in soil moisture content, such as on hillsides or flatlands with a seasonally fluctuating water table.

The best way to characterize the soil expansion potential is by performing Expansion Index tests. Alternatively, the Plasticity Index (PI) (obtained during the performance of Atterberg Limits tests) is used to infer the potential of soils to swell when wetted and shrink when dried. Risks associated with expansive soils are ranked low if the PI of the soil is very low or low (PI between 0 and 15), moderate if the PI is medium (PI between 15 and 25), and high if the PI is high (PI between 25 and 35).

Table 11 - Subsurface Soil Conditions Along the Project Corridor (West-East Direction)

ID	Approximate Location	Groundwater Depth (GW) (feet)	End of Boring (feet)
1	Vineland Ave. @ SR 134	Not Encountered	45.8
2	Cahuenga Ave. @ SR 134	Not Encountered	50.8
3	Ledge Ave. @ SR 134	Not Encountered	81.5
4	Pass Ave. @ SR 134	49.0	81.5
5	Forman Ave. @ SR 134	Not Encountered	44.0
6	Hollywood Way @ SR 134	Not Encountered	81.5
7	Olive Ave. @SR 134	Not Encountered	55.0
8	Harvey Dr. @ SR 134	Not Encountered	Not Available
9	Colorado Blvd. @ SR 2	Not Encountered	Not Available
10	Figueroa St. @ SR 134	Between about 24.0 and 42.0 GW reported at EL 797.9 famsl. Surface between about EL 822 and EL 840 famsl (Google Earth)	Not Available
11	Arroyo Seco @ SR 134	---	Not Available
12	Orange Grove Blvd. @ SR 134	Not Encountered	Not Available
13	Maple St. @ I-210	Not Encountered	Not Available
14	Lake Ave. @ I-210	Not Encountered	61.0
15	Hill Ave. @ I-210	Not Encountered	50.0

SOURCES:

1) Caltrans, *File No. 07-LA-134-KP 0.0/3.4 07-061741*, November 29, 2001.
2) Caltrans, *File No. 07-LA-134-KP 0.0/3.4 07-061741*, January 24, 2002.
3) Caltrans, *File No. 07-LA-134-PM 1.11 07-260301*, May 28, 2010.
4) Geobase, *Caltrans Soundwalls and Retaining Walls. Project No. P.315.11.00*, January 2003.
5) Caltrans, *File No. 07-LA-134-KP 0.0/3.4 07-061741*, January 24, 2002.
6) Geobase, *Caltrans Hollywood Way Bridge Lengthening. Project No. P.315.09.00*, February 2003.
7) Tejima and Associates, Inc., *Report of Geotechnical Consultation, Seismic Retrofit Study, Olive Avenue Overcrossing. Job No. 1169-14-04*, April 15, 1994.
8) Caltrans, *File No. 07-LA-134-8.7 07204 117310. Retrofit Project No. 38*, August 2, 1990.
9) Caltrans, *File No. 07-LA-134-8.7/11.4 07-11649G. Retrofit Project No. 16*, February 22, 1990.
10) Caltrans, *File No. 07-LA-134-11.3 07204 117310. Retrofit Project No. 38*, February 25, 1991.
11) The LKR Group, Inc., *Geotechnical Information for Seismic Retrofit Strategy Analysis SR 134 Arroyo Seco Bridge. Project No. LKR 95-1024*, November 17, 1995.
12) Caltrans, *File No. 07-170901*, July 13, 1994.
13) Caltrans, *File No. 07-LA-210-24.86 07262 170901*, June 26, 1995.
14) Law/Crandall, Inc., *Geotechnical Summary Lake Avenue Overcrossing, Foothill Freeway - Interstate 210. Project No. L92045.AE4*, May 17, 1995.
15) Law/Crandall, Inc., *Geotechnical Summary, Hill Avenue Undercrossing and Underpass, Foothill Freeway - Interstate 210. Project No. L92045.AE4*, July 28, 1993.

A representative sample of Expansion Index and Atterberg Limits tests was not encountered during review of the available information. This is most likely due to the granular nature of the site soils. Discrete Atterberg Limits tests performed within the upper 25 feet at the intersection of Pass Avenue and SR 134 show PI results ranging between 15 and 22, which lead to classify the tested soils as “low to moderate” expansive.

This is consistent with the data presented in **Figure 10** (USDA, 2017), in which most of the Project corridor lies within “low expansion” prone areas. Localized areas of the Proposed Project south of the San Rafael Hills and within the alluvial plain of Pasadena are located within “low to moderate expansion” prone areas. Hence, the shrink-swell potential of the soils along the Project route is generally low.

Please note that laboratory testing during the field investigation phases of the Project would be required to identify expansive soils.

4.5.3 Corrosive Soils

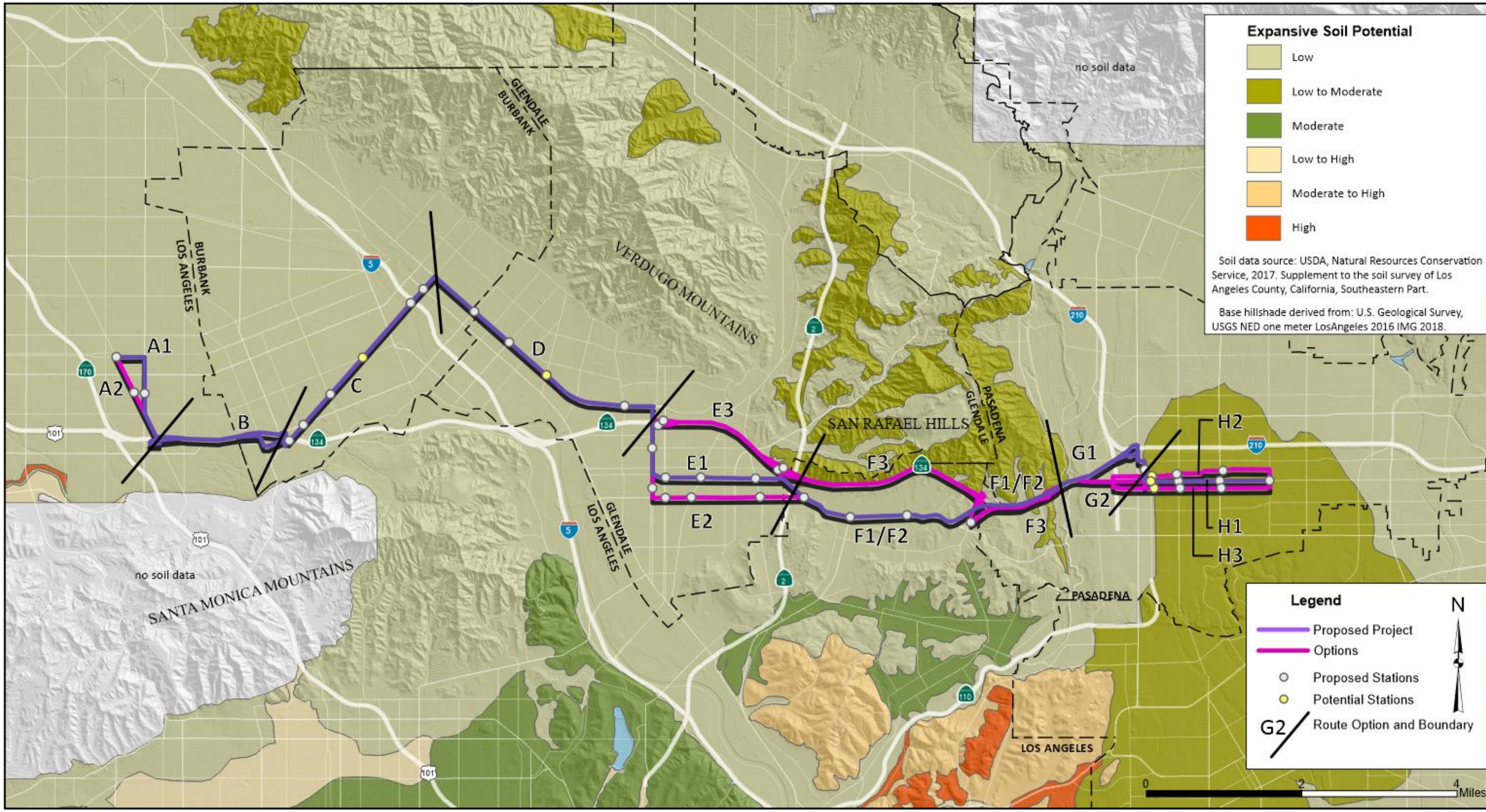
Soil corrosivity involves the measure of the potential of corrosion for steel and concrete caused by contact with some types of soil. Knowledge of potential soil corrosivity is often critical for the effective design parameters associated with cathodic protection of buried steel and concrete mix design for plain or reinforced concrete buried project elements. Several factors (including soil composition, soil and pore water chemistry, moisture content, and pH) affect the response of steel and concrete to soil corrosion. Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts content are most corrosive. In general, sandy soils have high resistivity and are the least corrosive. Clayey soils, including those that contain interstitial salt water, can be highly corrosive. A summary of the available corrosion test results along the Project corridor is provided in **Table 12**.

Table 12 – Corrosion Data Along the Project Corridor

Location	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
Ledge Ave @ SR 134 (Bridge No. 53-1275)	1,300 - 5,800	9.8 - 10.1	10 - 57	32 - 313
Pass Ave @ SR 134 (Bridge No. 53-1278)	700 - 6,497	8.6 - 9.1	45 - 329	29 - 267
Hollywood Way @ SR 134 (Bridge No. 53-1279)	3,037 - 3,431	8.4 - 8.5	129 - 183	74 - 82

SOURCES:
1) Caltrans, *File No. 07-LA-134-PM 1.11 07-260301*, May 28, 2010.
2) Geobase, *Caltrans Soundwalls and Retaining Walls. Project No. P.315.11.00*, January 2003.
3) Geobase, *Caltrans Hollywood Way Bridge Lengthening. Project No. P.315.09.00*, February 2003.

Figure 10 – Expansive Soil Potential Map



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According to the Caltrans Corrosion Guidelines, March 2018 (Version 3.0) and subsequent changes from the 2015 to the 2018 Corrosion Guidelines Memorandum dated July 2008, the soils along the Project corridor as summarized in **Table 7** are considered non-corrosive since the chloride contents are less than 500 ppm, sulfate contents are less than 1,500 ppm, and the pH results are greater than 5.5.

The Caltrans Corrosion Guidelines, March 2018 (Version 3.0) state that a minimum resistivity value for soil and/or water less than 1,100 ohm-cm indicates the presence of high quantities of soluble salts and a higher propensity for corrosion. Furthermore, Caltrans Memo to Designers (MTD) 3-1 and California Amendments to the American Association of State Highway Transportation Officials' Load and Resistance Factor Design (AASHTO LRFD) Bridge Design Specifications (6^{th} Edition) identify a site with a minimum resistivity of 1,000 ohm-cm or less as an indicator of potential corrosion to buried metals. Based on the available corrosion test results summarized in **Table 7**, the soils along the Project corridor are not corrosive when considering these criteria (only a single value yielded a value less than 1,100 ohm-cm).

Please note that laboratory testing during the field investigation phases of the Project would be required to identify soils susceptible to corrosion.

4.5.4 Collapsible Soils

Collapsible soils are soils that undergo volume reduction or settlement upon the addition of water, which weakens or destroys soil particle bonds of loosely packed structure, reducing the bearing capacity of the soil. Other mechanisms for soil collapse include the sudden closure of voids in a soil, whereby the sudden decrease in volume results in loss of the soil's internal structure, causing the soil to collapse. Specific soil types, such as loess and other fine-grained aeolian soils, are most susceptible to collapse, although certain coarser-grained, rapidly deposited alluvial soils can also be susceptible.

Despite the fact that some of the soil deposits encountered during our review of literature (**Table 7**) classify within the soil descriptions mentioned above (i.e., coarser-grained, rapidly deposited alluvial soils), soil collapse in unlikely to happen due to the deep groundwater at the Project corridor (Section 4.5.2). Isolated cases may occur at very localized areas along the Project corridor should unexpected water pipe ruptures occur.

Please note that laboratory testing during the field investigation phases of the Project would be required to identify soils susceptible to collapse potential.

4.5.5 Erodible Soils

The National Engineering Handbook (USDA, 1983) defines erosion as a series of complex and interrelated natural processes that loosen or dissolve and move earth or rock material. The land surface is worn away through the detachment and transport of soil and rock materials by moving water, wind, or other geologic agents. Erosion can be divided into two categories according to the conditions under which it occurs. The first category is normal (geologic) erosion, which has been occurring at variable rates, depending on climatic and terrestrial conditions, since the first solid materials formed on earth. The second category is accelerated erosion caused by the activities of man.

The Proposed Project is underlain by mostly coarse-grained cohesionless soils (sand, silty sand, gravel) with cobbles and boulders, which can be susceptible to erosion. However, the majority of the Project is to be constructed within urbanized areas covered by impervious surfaces. Hence, the potential for soil erosion is low as onsite soils are unlikely to be exposed without erosion-protection measures for a long period of time.

4.5.6 Consolidation Settlement

Consolidation settlement occurs when a fine-grained soil (silt or clay) is loaded with the weight of new fill or of improvements such as structures or fills. New loads cause increases in soil pore water pressure. As the excess pore pressures dissipates, the soil volume decreases, and water is expelled slowly. Settlement rate depends on the soil permeability and layer thickness. Thick layers of clay with low permeability can take years for pore pressures to fully dissipate.

There is no evidence of thick clay layers along the Project corridor. It is expected that most of the sporadic cohesive soil lenses underlying the Project Area be normally consolidated under the load of the structures and buildings. However, this should be evaluated during the field investigation phases of the Project.

4.5.7 Areas of Difficult Excavation

Deep structures are not planned at this time and deep excavations are not anticipated. However, due to the granular nature of the soils along the Project corridor, the Project soils can be excavated by conventional heavy-duty earthmoving equipment, even at the locations where cobbles and boulders may be encountered. Areas of difficult excavations along the Project corridor are not expected to be widespread and the hazard is ranked moderate. Potential hard conditions may be locally encountered in areas where the Topanga Canyon Formation (Tts) and Granitic Rock (Mzbhd) are present.

4.5.8 Shallow Landslides and Debris Flows

Debris flows are a common and widespread phenomenon during periods of intense winter rainfall in Southern California. Most debris flows occur during winters with above normal rainfall, especially during “El Niño” winters. They can cause considerable damage and result in loss of life. Debris flows can occur as isolated flows, in small numbers or can number in the tens of thousands during a single “triggering” rainfall event. These debris flows originate as small, shallow landslides, commonly referred to as soil slips. Most soil slips initiate as debris slide blocks with a form of an elliptical-shaped slab. Debris slide blocks are a form of translational slides. Most soil slips disaggregate into debris flows, fluid slurries of soil and rock detritus that commonly converge in stream channels, where they flow down channel at various speeds for various distances.

These areas are rugged with relatively steep hillsides with a southern aspect. **Figure 11** is a soil-slip susceptibility map derived from Morton et. al., (2003), identifying those natural slopes most likely to be the sites of soil slips during periods of intense winter rainfall. Areas most susceptible to shallow landslides and debris flows within the Project area are shown on and include the southern San Rafael Hills in Route Options E, F1, F2, G1, and G2. Landslide susceptibility was determined using spatial analysis of geology, slope and aspect. Project areas outside the view of **Figure 11** are considered to have no landslide/debris flow risk as per the data source (Morton et. al., 2003).

4.5.9 Natural Slope Instability

Landslides occur when shear stress in a soil or rock mass exceeds their shear strength. Shear stresses can be increased by adding to the weight of soil or rock mass through saturation or loading. Shear strength can be reduced by a rise of groundwater, erosion or grading at the toe of a slide mass. Slope failure can be caused by an increase in shear stress or a decrease in shear strength. Zones of low shear strength often are associated with the presence of expansive clay soils and weak bedrock units.

Landslides can be of several types: falls, slides, slumps, or flows, and can move very rapidly (within seconds or minutes), or slowly (over days or years). Landslide movements often result in significant deformation of ground surfaces, producing open cracks with vertical and horizontal displacements measured in a few inches to multiple feet. All or portions of an existing landslide can be reactivated by any of the causes discussed above. New landslides can occur on slopes with geologic conditions similar to those within existing landslides. Past landslides can be a guide to understanding the potential for slope failures in a given area.

An analysis of one-meter resolution digital elevation data obtained from the USGS indicates that the majority of the Project corridor lays on areas with a slope of less than 1 degree. The SR 134 lays adjacent to slopes varying from about 25 to 40 degrees. These slopes also coincide with the Earthquake-Induced Landslide Zones as described in previous sections and shown on **Figure 8**.

4.5.10 Land Subsidence

Land subsidence is a form of ground settlement that usually results from change in fluid content within soil or rock. The volume change can result from localized dewatering of peat, organic soils, or soft silts and clay. This type of ground settlement is often associated with construction activities when groundwater is lowered to allow construction below the groundwater table. The other form of land subsidence is from a regional withdrawal of groundwater, petroleum, or geothermal resources. Regional subsidence can also result from vertical fault movement. Although the mechanism is different, another cause of land subsidence is the ongoing decomposition of organic-rich soils.

Figure 12 shows the identified subsidence areas of concern in Southern California. The Project corridor is not located within those areas. Unless there is a change in agency policies, there is little susceptibility of large-scale land subsidence along the Project corridor. There is, however, a moderate susceptibility of small, localized areas of subsidence, or settlement, from construction-related dewatering of excavations.

Figure 11 – Landslide Susceptibility Map

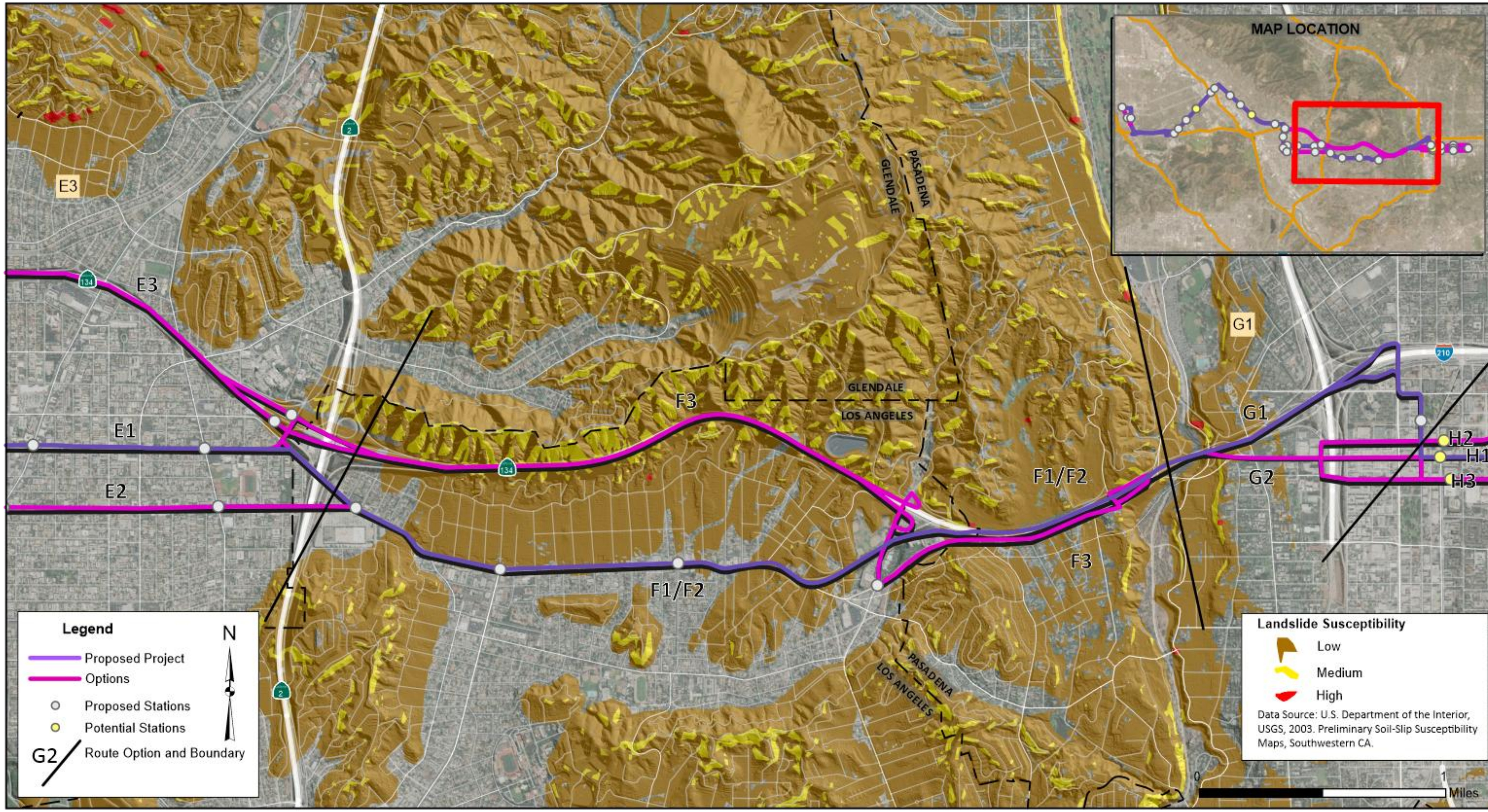
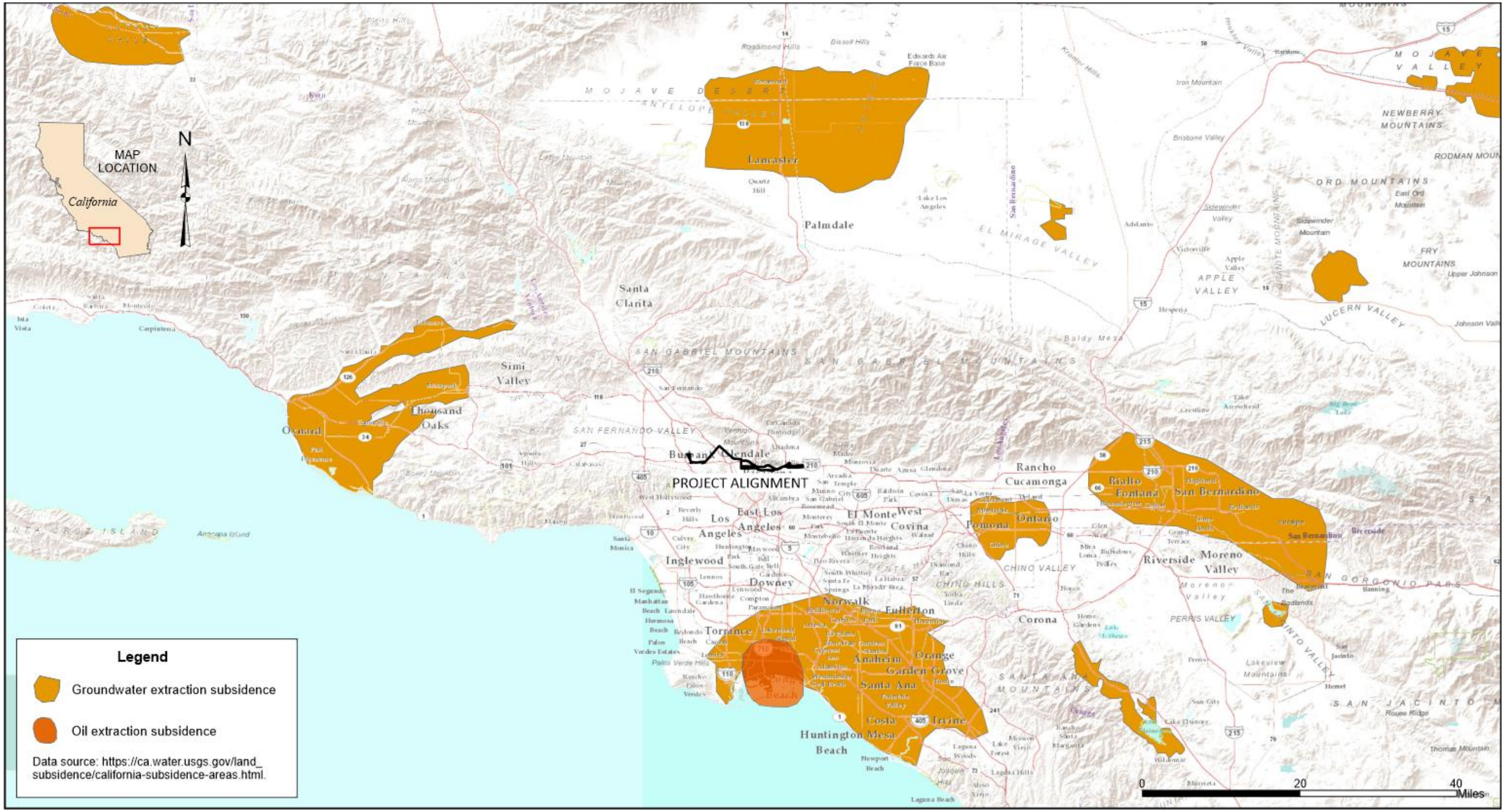


Figure 12 – Land Subsidence Map



5. Significance Thresholds and Methodology

5.1 SIGNIFICANCE THRESHOLDS

In accordance with Appendix G of the State CEQA Guidelines, the Project would have a significant impact related to geology and soils if it would:

a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving:
   I. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault. Refer to division of Mines and Geology Special Publication 42.
   II. Strong seismic ground shaking.
   III. Seismic-related ground failure, including liquefaction.
   IV. Landslides.
b) Result in substantial soil erosion or the loss of topsoil;
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potential result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
d) Be located on expansive soil as defined in Table 18-1-B of the Uniform Building Code (UBC, 1994), creating substantial direct or indirect risks to life or property;
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of waste water; and/or
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

Significance Threshold f) related to paleontological resource is addressed in the Archaeological and Paleontological Resources Technical Report.

5.2 METHODOLOGY

The methodology used to evaluate the potential environmental impacts of and on the Proposed Project associated with geology, soils, and seismicity included a review of published maps, professional publications, and reports pertaining to the geology, soils, and seismicity of the Project Area. The analysis focuses on the potential of the Proposed Project to increase the risk of personal injury, loss of life, and damage to property as a result of existing geologic conditions in the Project Area. The information included available sources such as USGS, CGS, Caltrans, NRCS, and USDA as well as information compiled and evaluated by the Cities of Los Angeles, Burbank, Glendale, and Pasadena.

Figures 1 through **11** show the Project corridor overlaid on the geologic, soil, and seismic conditions. Exposure to each condition was ranked low, moderate, or high as follows:

- Strong ground shaking was classified as high hazard when the PGA is at least 0.2g which correlates to a "very strong perceived shaking" with "moderate potential damage" for an earthquake with an intensity of VII per the Modified Mercalli Intensity scale according to the USGS.
- Fault rupture was classified as high hazard if an Alquist-Priolo fault crossed the Project corridor at any point.
- Liquefaction potential was classified as high hazard if a segment of the Project corridor was mapped within a liquefaction-prone area. This hazard evaluated in conjunction with the presence of shallow groundwater. Lateral spreading was classified as high hazard whenever liquefaction occurs and the liquefied area was relatively near a free face, a vertical, or sloping face such as a road cut or stream/riverbank. Earthquake-induced settlements were classified as high hazard when dry granular soils were present and strong ground shaking was expected.
- Expansive soils potential was ranked low if the PI of the soil is very low or low (PI between 0 and 15), moderate if the PI is medium (PI between 15 and 25), and high if the PI is high (PI between 25 and 35).
- Corrosion potential of soils was ranked corrosive or non-corrosive. Corrosive soils are those with chloride contents greater than 500 ppm, sulfate contents greater than 1,500 ppm, and pH less than 5.5. This includes a minimum resistivity value for soil and/or water less than 1,100 ohm-cm.
- Soils erosion was ranked low or high based on the granular nature of the soils and the soils susceptibility of exposure to the effects of water and/or wind.
- Areas of difficult excavation were ranked moderate if shallow excavation would be somewhat limited and high if shallow excavation would be very limited.
- Landslides and earthquake-induced landslides were classified as high hazard if landslides have been mapped along a segment of the Project corridor, moderate if a segment of the Project corridor is in hilly terrain where landslides might occur, and low if a segment of the Project corridor is in flat terrain where landslides are unlikely to occur.
- Subsidence was classified as high if any segment of Project corridor was mapped within subsidence-prone areas.

6. Impact Analysis

The following section includes the impact analysis, mitigation measures (if necessary), and significance after mitigation measures (if applicable). The potential for the Proposed Project to result in an impact to geology and soils is independent of the specific alignment and Project components. The following impact conclusions are valid for the Proposed Project and all route variations, treatments, and configurations.

Impact a) Would the Proposed Project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving:

i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to division of Mines and Geology Special Publication 42.
ii. Strong seismic ground shaking?
iii. Seismic-related ground failure, including liquefaction?
iv. Landslides?

Construction

No Impact. The impact analysis involves assessing if the location of the Proposed Project would result in impacts related to seismic activities, including landslides. Other than potential risks of landslides, the potential for an impact is not related to construction activities. The Project corridor crosses earthquake-induced landslide areas as shown in **Figure 7**, most specifically along Route Options F1/F2, F3, G1, and G2. Construction activities would not involve substantial earthmoving along slopes, such that existing landslide risks would be worsened or exacerbated. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

Ground Shaking
Less-Than-Significant Impact with Mitigation. The Proposed Project is located within the seismically active Southern California region. Hence, ground shaking as a result of earthquake generated from nearby faults is anticipated. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by ensuring that the latest federal, state, local, and Metro seismic and environmental requirements are implemented for the Proposed Project. As required by Mitigation Measure **GEO-1**, the final design of the Project would comply with the latest versions of local and State building codes and regulations in order to construct seismically-resistant structures that help counteract the adverse effects of ground shaking and reduce this potential impact to less than significant.

Surface Fault Rupture

No Impact. The Proposed Project is not intersected by designated Alquist-Priolo Earthquake Fault Zones and surface rupture is not expected to occur. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Liquefaction

Less-Than-Significant Impact with Mitigation. The Project corridor crosses liquefaction-prone designated areas as shown in **Figure 6**. However, due to the deep groundwater expected along the Project corridor (50 feet bgs and deeper) as shown in the Groundwater section of this report, liquefaction is unlikely to happen and may only occur at isolated areas along the Project corridor (i.e., within the Eagle Rock Valley, along Route Options F1, F2 and F3). However, seismically-induced settlements (dry settlements) are a potential hazard due to mostly granular soil deposits, deep groundwater, and expected high PGA at the Project site. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by ensuring that seismic risk solutions shall be incorporated into final design (e.g., deep foundations, ground improvement, remove and replace, among others) for those areas where liquefaction potential may be experienced. This measure would also ensure the Project is designed to satisfy the most recent latest federal, state, local and Metro seismic environmental requirements.

Seismically-Induced Slope Failure and Landslides

Less-Than-Significant Impact with Mitigation. The Project corridor crosses earthquake-induced landslide areas as shown in **Figure 8**, most specifically along Route Options F1/F2, F3, G1, and G2. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by ensuring that seismic risk solutions shall be incorporated into final design. Therefore, without mitigation, the Proposed Project would result in a significant impact related to operational activities.

Mitigation Measures

Ground Shaking, Liquefaction, and Seismically-Induced Slope Failure

GEO-1 The Proposed Project shall be designed based on the latest versions of local and State building codes and regulations in order to construct seismically-resistant structures that help counteract the adverse effects of ground shaking. During final design, site-specific geotechnical investigations shall be performed at the sites where Project-related structures are proposed within liquefaction-prone designated areas. The investigations shall include exploratory soil borings with groundwater measurements. Groundwater measurements are a key factor in this case. The exploratory soil borings shall be advanced, as a minimum, to the depths required by local and State jurisdictions to conduct liquefaction analyses. Similarly, the investigations shall include earthquake-induced settlement analyses of the dry substrata (i.e., above the groundwater table). The investigations shall also include seismic risk solutions to be incorporated into final design (e.g., deep foundations, ground improvement, remove and replace, among others) for those areas where liquefaction potential may be experienced. The investigation shall include stability analyses of the slopes along the Project corridor located within earthquake-induced landslides areas and provide appropriate slope stabilization measures (e.g., retaining walls, slopes with shotcrete faces, slopes re-grading, among others). The geotechnical investigations and design solutions shall follow the "Guidelines for Evaluating and Mitigating Seismic Hazards in California" Special Publication 117A of the CGS (CGS, 2008), as well as Metro's Design Criteria and the latest federal and state seismic and environmental requirements.

Surface Fault Rupture
No mitigation measures are required.

Significance of Impacts after Mitigation

Implementation of Mitigation Measure **GEO-1** would confirm that the Proposed Project would be adequately designed to limit potential impacts related to ground shaking, liquefaction, lateral spreading, and seismically-induced slope failure. Therefore, the Proposed Project would result in a less-than-significant impact with implementation of Mitigation Measure **GEO-1**.

Impact b) Would the Proposed Project result in substantial soil erosion or the loss of topsoil?

Construction

No Impact. The majority of the Project is to be constructed within urbanized areas covered by impervious surfaces. The BRT would operate on existing paved roadways and construction would involve minimal work around exposed soils. The Project would be designed based on the latest versions of local and State building codes and regulations in order to counteract the adverse effects of erosion. During construction, earthwork activities for street lanes, stations, and utility trenches along the Project corridor would be conducted based on local and state regulations and appropriate permits, and during the period of the year designated for those activities to be undertaken. There is no potential for the surface-running BRT to result in substantial soil erosion or the loss of topsoil. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

No Impact. The surface-running BRT would operate on existing roadways. There is no potential for operations to result in substantial soil erosion or loss of topsoil. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.

Impact c) Would the Proposed Project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potential result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

Construction

No Impact. The impact analysis involves assessing the potential risk related to operating the Proposed Project on unstable soils. The potential for an impact is not related to construction activities. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

Groundwater

Less-Than-Significant Impact. Deep groundwater is expected along the Project corridor (50 feet bgs and deeper), as shown in the Groundwater section of this report, with isolated cases of shallower groundwater depth (i.e., between 24 and 42 feet bgs) within the Eagle Rock Valley, along Route Options F1, F2 and F3). Shallow groundwater (i.e., less than 10 feet bgs) is not expected and would not affect construction of the Proposed Project as planned. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

The deep groundwater indicated in this report should be further investigated during the design phases of the Proposed Project because it directly influences geologic, soils and seismic hazards such as shallow landslides and debris flow, natural slope instability, expansion and collapse potentials, and liquefaction.

Corrosive Soils

Less-Than-Significant Impact. Soils along the Project corridor are mostly noncorrosive. Soil corrosivity tests are normally conducted during the field investigation phases of the Project. Regardless, it is not anticipated that the existing surface streets are located on corrosive soils. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

Collapsible Soils

Less-Than-Significant Impact. Collapsible soils may be present along the Project corridor, but the relatively deep groundwater conditions substantially reduce the potential for collapse. Collapse tests are normally conducted during the field investigation phases of the Project. Regardless, it is not anticipated that the existing surface streets are located on collapsible soils. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

Consolidation Settlement

Less-Than-Significant Impact. There is no evidence of thick clay layers along the Project corridor. It is expected that most of the sporadic cohesive soil lenses underlying the Project Area would be normally consolidated under the load of the structures and buildings. Consolidation tests are normally performed during the field investigation phases of the Project. Regardless, it is not anticipated that the existing surface streets have problems with consolidation settlement. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

Areas of Difficult Excavation

Less-Than-Significant Impact. Soils along the Project corridor are mostly granular in nature and expected to be excavated by conventional heavy-duty earthmoving equipment. Potential hard conditions may be locally encountered in areas where the Topanga Canyon Formation (Tts) and Granitic Rock (Mzbhd) are present, but the excavations at the Project area are expected to be shallow. Therefore, the Proposed Project would result in a less-than-significant impact related to operational activities.

Shallow Landslides and Debris Flows

Less-Than-Significant Impact with Mitigation. Areas most susceptible to shallow landslides and debris flows within the Project area are shown on **Figure 11** and include the southern San Rafael Hills in Route Options E, F1, F2, G1, and G2. The Project Area may be affected by landslides and debris flow. Therefore, without mitigation, the Proposed Project would result in a potentially significant impact related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by requiring final design to include appropriate slope stabilization measures (e.g., retaining walls, slopes with shotcrete faces, slopes re-grading, among others) and by ensuring that the Proposed Project is designed in a manner that meets all federal, state, local, and Metro seismic and environmental requirements.

Lateral Spreading

Less-Than-Significant Impact. The Proposed Project is not expected to experience lateral spreading since liquefaction is not likely to occur at the Project site. Furthermore, the liquefied area must be relatively near a free face, a vertical or sloping face such as a road cut or stream/riverbank, which is unlikely to occur (or may be limited to very specific areas) along the Project corridor. Therefore, the Proposed Project would not result in a potentially significant impact related to operational activities. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by requiring, during final design, stability analyses of slopes located within earthquake-induced landslides areas and requiring appropriate slope stabilization measures (e.g., retaining walls, slopes with shotcrete faces, slopes re-grading, among others) and ensuring the Project is designed to satisfy the most recent latest federal, state, local and Metro environmental requirements.

Natural Slope Instability

Less-Than-Significant Impact with Mitigation An analysis of one-meter resolution digital elevation data obtained from the USGS indicates that the majority of the Project corridor lays on areas with a slope of less than 1 degree. The alternative corridor along the SR 134 lays adjacent to slopes varying from about 25 to 40 degrees. These slopes also coincide with the Earthquake-Induced Landslide Zones as described earlier and shown on **Figure 8**. The Project Area may be affected by slope instability. Implementation of Mitigation Measure **GEO-1** would reduce this impact to less than significant by ensuring that seismic risk solutions shall be incorporated into final design. Therefore, without mitigation, the Proposed Project would result in a significant impact related to operational activities.

Land Subsidence
No Impact. The Project corridor is not located within the areas of subsidence identified in **Figure 11**. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Mitigation Measures

Shallow Landslides and Debris Flows and Natural Slope Instability and Lateral Spreading
No mitigation measures required beyond Mitigation Measure **GEO-1** as outlined above.

Groundwater, Corrosive Soils, Collapsible Soils, Consolidation Settlements, and Areas of Difficult Excavation
No mitigation measures are required.

Significance of Impacts after Mitigation

Mitigation Measure **GEO-1** would ensure that the Proposed Project would be designed to limit potential impacts related to landslides. Therefore, the Proposed Project would result in a less-than-significant impact with implementation of Mitigation Measure **GEO-1**.

Impact d) Would the Proposed Project be located on expansive soil as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

Construction

No Impact. The impact analysis involves assessing the potential risk to life or property related to operating the Proposed Project on expansive soils. The potential for an impact is not related to construction activities. Therefore, the Proposed Project would not result in a significant impact related to construction activities.

Operations

No Impact. The surface-running BRT would operate on existing roadways. Soils along the Project are mostly granular in nature and lay within “low expansion” and “low to moderate expansion” prone areas as shown in **Figure 12**. The roadway network in the Project Area is not prone to expansive soil. Field research indicates that the existing roadway network to be utilized by the Proposed Project is not affected by expansive soils. In addition, the final design would be performed in accordance with Metro’s Design Criteria, the latest federal and state seismic and environmental requirements, and state and local building codes. Therefore, the Proposed Project would not result in a significant impact related to operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.

Impact e) Would the Proposed Project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

Construction and Operations

No Impact. Neither construction nor operation of the BRT would require use of a septic tank or alternative wastewater disposal systems. Therefore, the Proposed Project would not result in a significant impact related to construction or operational activities.

Mitigation Measures

No mitigation measures are required.

Significance of Impacts after Mitigation

No impact.

7. Cumulative Analysis

CEQA Guidelines Section 15355 defines cumulative impacts as two or more individual actions that, when considered together, are considerable or would compound other environmental impacts. CEQA Guidelines Section 15130(a) requires that an Environmental Impact Report (EIR) discuss the cumulative impacts of a project when the project's incremental effect is "cumulatively considerable." As set forth in CEQA Guidelines Section 15065(a)(3), "cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects. Thus, the cumulative impact analysis allows the EIR to provide a reasonable forecast of future environmental conditions to more accurately gauge the effects of multiple projects.

In accordance with CEQA Guidelines Section 15130(a)(3), a project's contribution is less than cumulatively considerable if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact. In addition, the lead agency is required to identify facts and analysis supporting its conclusion that the contribution would be rendered less than cumulatively considerable.

CEQA Guidelines Section 15130(b) further provides that the discussion of cumulative impacts reflects "the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the effects attributable to the project alone." Rather, the discussion is to "be guided by the standards of practicality and reasonableness and should focus on the cumulative impact to which the identified other projects contribute." CEQA Guidelines Sections 15130(b)(1)(A) and (B) include two methodologies for assessing cumulative impacts. One method is a list of past, present, and probable future projects producing related or cumulative impacts. The other method is a summary of projections contained in an adopted local, regional, or statewide plan, or related planning document that describes or evaluates conditions contributing to the cumulative effect. Such plans may include a general plan, regional transportation plan, or plans for reducing greenhouse gas emissions. The cumulative effect on geology and soils in the Project Area is best addressed through consideration of Related Projects.

Related Projects that are considered in the cumulative impact analysis are those projects that may occur in the Project Site's vicinity within the same timeframe as the Proposed Project. In this context, "Related Projects" includes past, present, and reasonably probable future projects. Related Projects associated with this growth and located within half a mile of the Project Site are depicted graphically in **Figures 13a** through **13c** and listed in **Table 13**. The figures do not show Eagle Rock as no related projects have been identified in the Project Area. Related projects of particular relevance to the Proposed Project are discussed below.

Figure 13a – Cumulative Impact Study Area

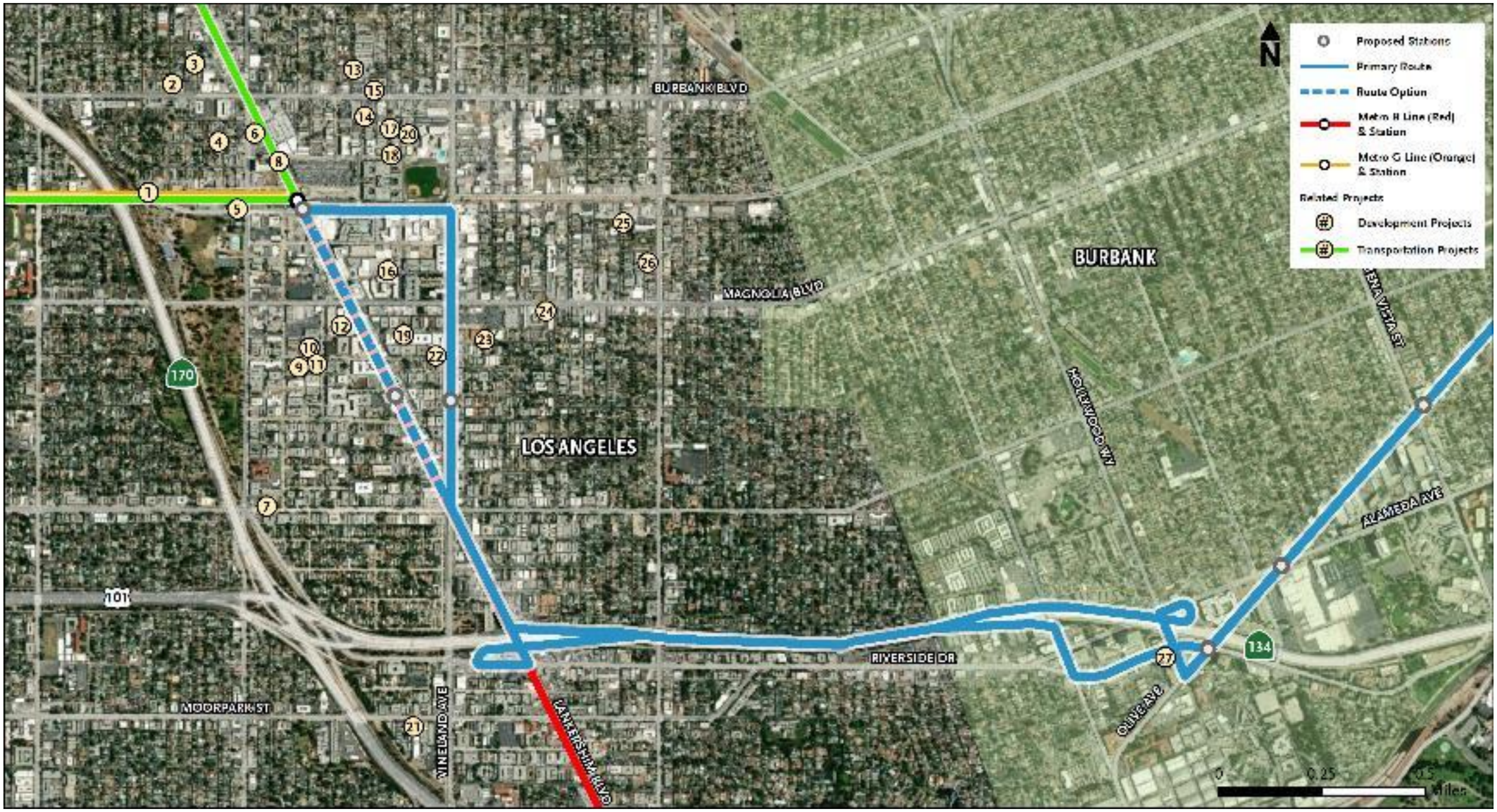


Figure 13b – Cumulative Impact Study Area

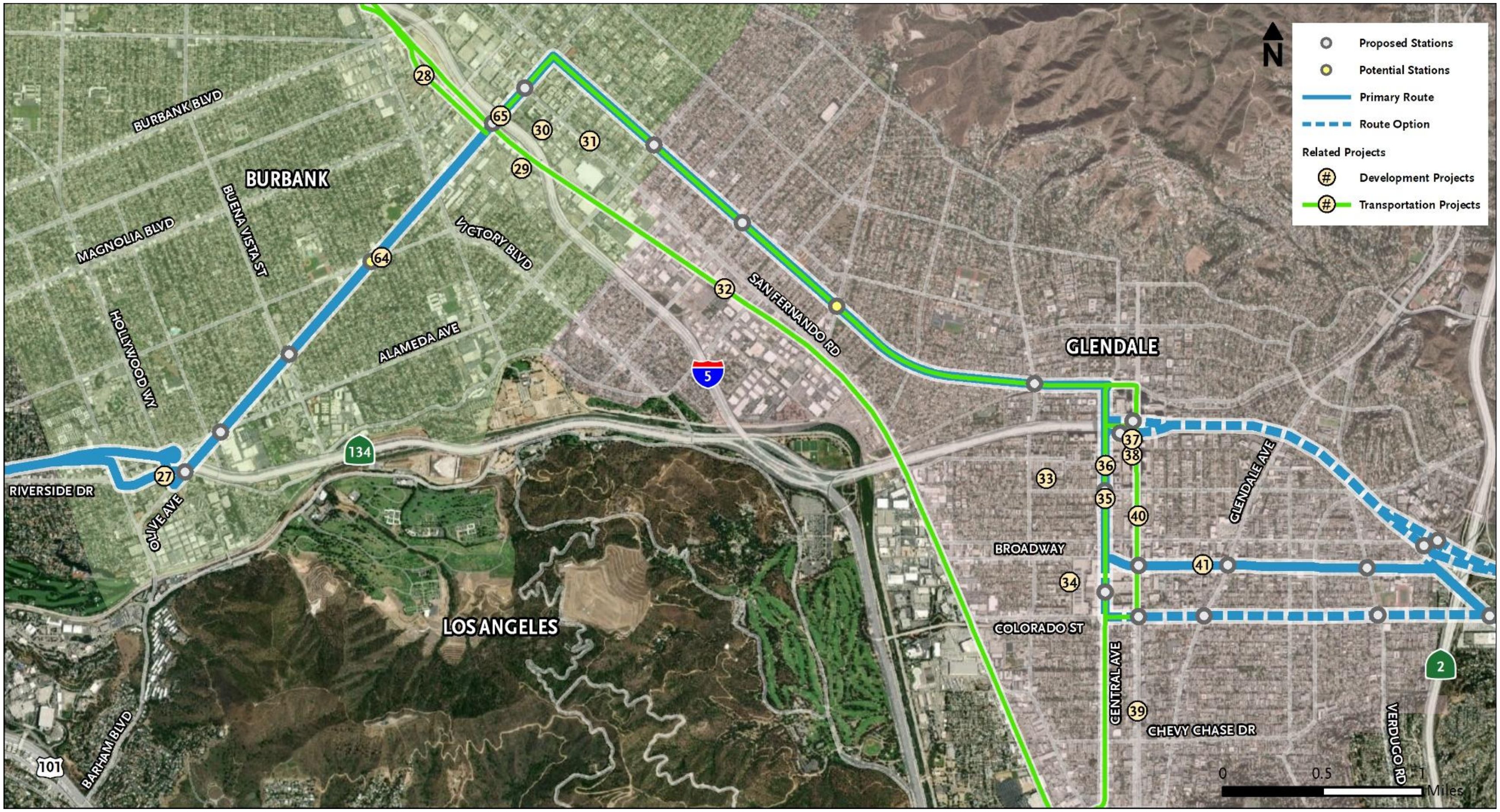


Figure 13c – Cumulative Impact Study Area

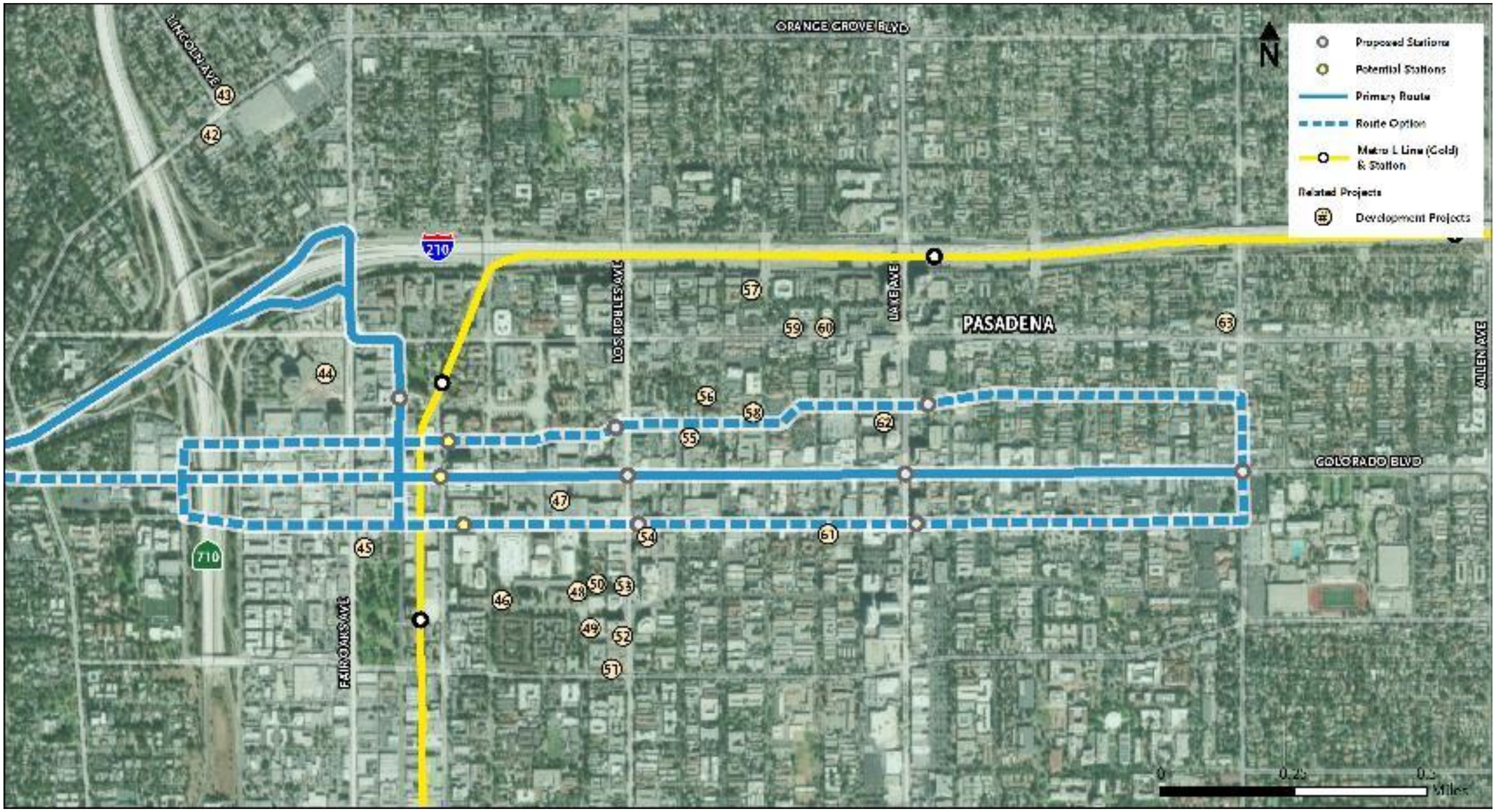


Table 13 – Related Projects

Map ID	Project Name	Location	Description	Status
REGIONAL				
N/A	NextGen Bus Plan	Los Angeles County	The NextGen Bus Plan will revise the existing Metro bus network to improve ridership and make bus use more attractive to current and future riders. The Plan will adjust bus routes and schedules based upon existing origin/destination ridership data with a phased approach to future infrastructure investments in transit convenience, safety, and rider experience.	Implementation early 2021
N/A	East San Fernando Valley LRT Project	San Fernando Valley	New 9-mile LRT line that will extend north from the Van Nuys Metro G Line (Orange) station to the Sylmar/San Fernando Metrolink Station.	Planning
8	North San Fernando Valley BRT Project	San Fernando Valley	New 18-mile BRT line from North Hollywood B/G Line (Red/Orange) Station to Chatsworth.	Planning
32	Los Angeles – Glendale-Burbank Feasibility Study	Amtrak corridor from Los Angeles Union Station to Bob-Hope Airport	Metro is studying a 13-mile transit corridor between Los Angeles Union Station and the Hollywood Burbank Airport. A range of options are under study including both light rail and enhanced commuter rail.	Planning and feasibility
BURBANK				
27	Mixed-Use Development	3700 Riverside Dr.	49-unit residential condominium and 2,000 sq. ft. of retail	Active Project Submission
28	San Fernando Bikeway	San Fernando Blvd. Corridor	Three-mile Class I bike path along San Fernando Blvd. near the Downtown Metrolink Station in the City of Burbank. This project will complete a 12-mile long regional bike path extending from Sylmar to the Downtown Burbank Metrolink Station along the San Fernando Blvd. rail corridor	Planning

Map ID	Project Name	Location	Description	Status
29	Commercial Development	411 Flower St.	Commercial building (size unknown)	Active Project Submission
30	Mixed-Use Development	103 Verdugo Ave.	Two mixed-use buildings (size unknown)	Active Project Submission
31	Mixed-Use Development	624 San Fernando Blvd.	42-unit, 4-story mixed-use building with 14,800 sq. ft. of ground-floor commercial	Active Project Submission
64	Olive Ave./Sparks St./Verdugo Ave. Intersection Improvements	Olive Ave./Sparks St./Verdugo Ave.	Various intersection improvements.	Planning
65	Olive Ave. Overpass Rehabilitation	Olive Ave. over Interstate 5	Improvements to operational efficiency, pedestrian safety, and bicycle connections.	Planning
GLENDALE				
33	Multi-Family Development	452 Milford St.	15-unit building	Active Project Submission
34	Multi-Family Development	401 Hawthorne St.	23-unit building	Active Project Submission
35	Commercial Development	340 Central Ave.	14,229 sq. ft. office	Active Project Submission
36	Multi-Family Development	520 Central Ave.	98-unit building	Active Project Submission
37	Commercial Development	611 Brand Blvd.	Hotel (857 hotel rooms and 7,500 sq. ft. of restaurant/retail)	Active Project Submission
38	Multi-Family Development	601 Brand Blvd.	604 units in 3 buildings	Active Project Submission
39	Commercial Development	901 Brand Blvd.	34,228 sq. ft. parking structure for car dealership	Active Project Submission
40	Glendale Streetcar	Downtown Glendale	Streetcar connecting the Larry Zarian Transportation Center with Downtown Glendale	Planning and feasibility
41	Commercial Development	517 Broadway	Medical/office/retail building (size unknown)	Active Project Submission
LOS ANGELES				
N/A	Orange Line Transit Neighborhood Plan	North Hollywood, Van Nuys, and Sepulveda BRT Stations	Develop regulatory tools and strategies for the areas around these three Orange Line stations to encourage transit ridership,	Undergoing Environmental Review

Map ID	Project Name	Location	Description	Status
			enhance the urban built environment, and focus new growth and housing in proximity to transit and along corridors	
N/A	Take Back The Boulevard Initiative	Colorado Blvd.	The mission of the Take Back the Boulevard initiative is to serve as a catalyst for the community-drive revitalization of Colorado Boulevard in Eagle Rock. The Take Back the Boulevard initiative seeks to utilize broad community feedback and involvement to make this central corridor through Eagle Rock a safe, sustainable, and vibrant street in order to stimulate economic growth, increase public safety, and enhance community pride and wellness.	Active Initiative
1	Multi-Family Development	11525 Chandler Blvd.	60-unit building	Active Building Permit
2	Multi-Family Development	5610 Camellia Ave.	62-unit building	Active Building Permit
3	Multi-Family Development	5645 Farmdale Ave.	44-unit building	Active Building Permit
4	Multi-Family Development	11433 Albers St.	59-unit building	Active Building Permit
5	Mixed-Use Development	11405 Chandler Blvd.	Mixed-use building with residential and commercial components (size unknown).	Active Building Permit
6	Mixed-Use Development	5530 Lankershim Blvd.	15-acre joint development at the North Hollywood Metro Station. Includes 1,275-1,625 residential units (275-425 affordable units), 125,000-150,000 sq. ft. of retail, and 300,000-400,000 sq. ft. of office space	Active Project Submission
7	Mixed-Use Development	11311 Camarillo St.	Mixed-use building (size unknown)	Active Building Permit
9	Multi-Family Development	11262 Otsego St.	49-unit building	Active Building Permit
10	Multi-Family Development	11241 Otsego St.	42-unit building	Active Building Permit
11	Multi-Family Development	11246 Otsego St.	70-unit building	Active Building Permit
12	Mixed-Use Development	5101 Lankershim Blvd.	297 units in a mixed-use housing complex	Active Building Permit

Map ID	Project Name	Location	Description	Status
13	Multi-Family Development	5630 Fair Ave.	15-unit building	Active Building Permit
14	Multi-Family Development	5550 Bonner Ave.	48-unit building	Active Building Permit
15	Commercial Development	11135 Burbank Blvd.	4-story hotel with 70 guestrooms	Active Building Permit
16	Commercial Development	11115 McCormick St.	Apartment/Office building (size unknown)	Active Building Permit
17	Multi-Family Development	5536 Fulcher Ave.	36-unit building	Active Building Permit
18	Multi-Family Development	11111 Cumpston St.	41-unit building	Active Building Permit
19	Multi-Family Development	11050 Hartsook St.	48-unit building	Active Building Permit
20	Multi-Family Development	5525 Case Ave.	98-unit building	Active Building Permit
21	Multi-Family Development	11036 Moorpark St.	96-unit building	Active Building Permit
22	Multi-Family Development	11011 Otsego St.	144-unit building	Active Building Permit
23	Multi-Family Development	10925 Hartsook St.	42-unit building	Active Building Permit
24	Multi-Family Development	10812 Magnolia Blvd.	31-unit building	Active Building Permit
25	Multi-Family Development	5338 Cartwright Ave.	21-unit building	Active Building Permit
26	Multi-Family Development	5252 Willow Crest Ave.	25-unit building	Active Building Permit
PASADENA				
42	Mixed-Use Development	690 Orange Grove Blvd.	48-unit building with commercial space	Active Project Submission
43	Multi-Family Development	745 Orange Grove Blvd.	35-unit building	Active Project Submission
44	Mixed-Use Development	100 Walnut St.	Mixed-use planned development: office building, 93-unit apartment building, and a 139-unit building	Active Building Permit
45	Multi-Family Development	86 Fair Oaks Ave.	87-unit building with commercial space	Active Project Submission
46	Commercial Development	190 Marengo Ave.	7-story hotel with 200 guestrooms	Active Project Submission
47	Multi-Family Development	39 Los Robles Ave.	Residential units above commercial space (size unknown)	Active Building Permit

Map ID	Project Name	Location	Description	Status
48	Mixed-Use Development	178 Euclid Ave.	42-unit building with 940 sq. ft. of office space	Active Building Permit
49	Multi-Family Development	380 Cordova St.	48-unit building	Active Building Permit
50	Mixed-Use Development	170 Euclid Ave.	42-unit building with 10,000 sq. ft. of commercial space	Active Project Submission
51	Multi-Family Development	399 Del Mar Blvd.	55-unit building	Active Building Permit
52	Multi-Family Development	253 Los Robles Ave.	92-unit building	Active Project Submission
53	Mixed-Use Development	171 Los Robles Ave.	8-unit building	Active Project Submission
54	Commercial Development	98 Los Robles Ave.	school of medicine building	Active Building Permit
55	Multi-Family Development	530 Union St.	55-unit building with retail space	Active Building Permit
56	Multi-Family Development	119 Madison Ave.	81-unit building	Active Building Permit
57	Multi-Family Development	289 El Molino Ave.	105-unit building	Active Building Permit
58	Multi-Family Development	99 El Molino Ave.	40-unit building	Active Building Permit
59	Commercial Development	711 Walnut St.	Mixed-use building with condominiums, commercial space, food facility, parking structure (size unknown)	Active Building Permit
60	Commercial Development	737 Walnut St.	42-unit building with commercial space	Active Project Submission
61	Mixed-Use Development	740 Green St.	273-unit building	Active Project Submission
62	Mixed-Use Development	83 Lake Ave.	54-unit building with office space	Active Project Submission
63	Multi-Family Development	231 Hill Ave.	59-unit building	Active Project Submission

SOURCE: Terry A. Hayes Associates Inc., 2020.

North San Fernando Valley (SFV) Bus Rapid Transit (BRT) Project. The North SFV BRT Project is a proposed new 18-mile BRT line that is intended to serve the portions of the San Fernando Valley that are north of the Metro G Line (Orange) service area. The project would provide a new, high-quality bus service between the communities of Chatsworth to the west and North Hollywood to the east. The project would enhance existing bus service and increase transit system connectivity.

Joint Development - North Hollywood Station Project. The Joint Development - North Hollywood Station project would construct facilities at the North Hollywood B/G Line (Red/Orange) Station that would be shared by the Proposed Project. The project has been identified in the Measure M Expenditure Plan, with a projected opening date between Fiscal Year 2023-25 and $180 million of funding.

NextGen Bus Plan. In January 2018, Metro began the NextGen Bus Plan aimed at reimagining the bus network to be more relevant, reflective of, and attractive to the diverse customer needs within Los Angeles County. The NextGen Bus Plan will realign Metro’s bus network based upon data of existing ridership and adjust bus service routes and schedules to improve the overall network. The Proposed Project would be included in the Plan and replace some select bus services in the region. The NextGen Bus Plan is anticipated to begin implementation in the beginning of 2021.

East SFV Light Rail Transit (LRT) Project. The East SFV LRT Project will be a 9-mile LRT line that will extend north from the Van Nuys Metro G Line (Orange) station to the Sylmar/San Fernando Metrolink Station. Light rail trains will operate in the median of Van Nuys Boulevard for 6.7 miles to San Fernando Road. From San Fernando Road, the trains will transition onto the existing railroad right-of-way that’s adjacent to San Fernando Road, which it will share with Metrolink for 2.5 miles to the Sylmar/San Fernando Metrolink Station. The project includes 14 at-grade stations. The Draft EIR/Environmental Impact Statement (EIR/EIS) was published in August 2017 and the Final EIR/EIS is currently being prepared by Metro.

There is an existing cumulative impact in the Project Area related to geology and soils. The cumulative setting for geology and soils is the areas of potential disturbances and the roadway surface. The seismic context is an important consideration because the ground shaking forces are regional in nature. The potential for a seismic event is the primary cumulative consideration for geology and soils. The Proposed Project combined with past, present, and reasonably probable future projects could contribute to the existing cumulative impact. The cumulative effect is best addressed through consideration of Related Projects.

Regarding construction activities, the Proposed Project would not involve substantial earthmoving along slopes, such that existing landslide risks would be worsened or exacerbated. Therefore, no construction impact would occur related to seismic activities, including landslides. The Proposed Project would be designed based on the latest versions of local and State building codes and regulations in order to counteract erosion. There is no potential for the surface-running BRT to result in substantial soil erosion or the loss of topsoil or risk from expansive soils. Therefore, Proposed Project construction activities would not contribute to the existing cumulative impact.

Regarding operational activities, the Proposed Project would be located in a seismically active region. There is potential for operational activities to be influenced by earthquakes and related effects, such as ground shaking and liquefaction. Mitigation Measure **GEO-1** would mitigate inadvertent impacts to geology and soils during construction activities by ensuring the Proposed Project is designed to limit potential seismic impacts. Effects to geology and soils would not be significant with mitigation. Therefore, Proposed Project operational activities would not contribute to the existing cumulative impact.

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