3.8 Geology, Soils, and Seismicity

3.8.1 Introduction

This section examines the potential effects associated with geology, soils, and seismicity of the study area as a result of implementation of the proposed Expo Phase 2 project.

Greater detail on Geology, Soils, and Seismicity is contained in the ~~*Geologic/Seismic Conditions and Hazardous Materials*~~*Geology, Soils, and Seismicity Technical Background Report*. Full bibliographic references can be found in Appendix B (Bibliography).

3.8.2 Existing Conditions

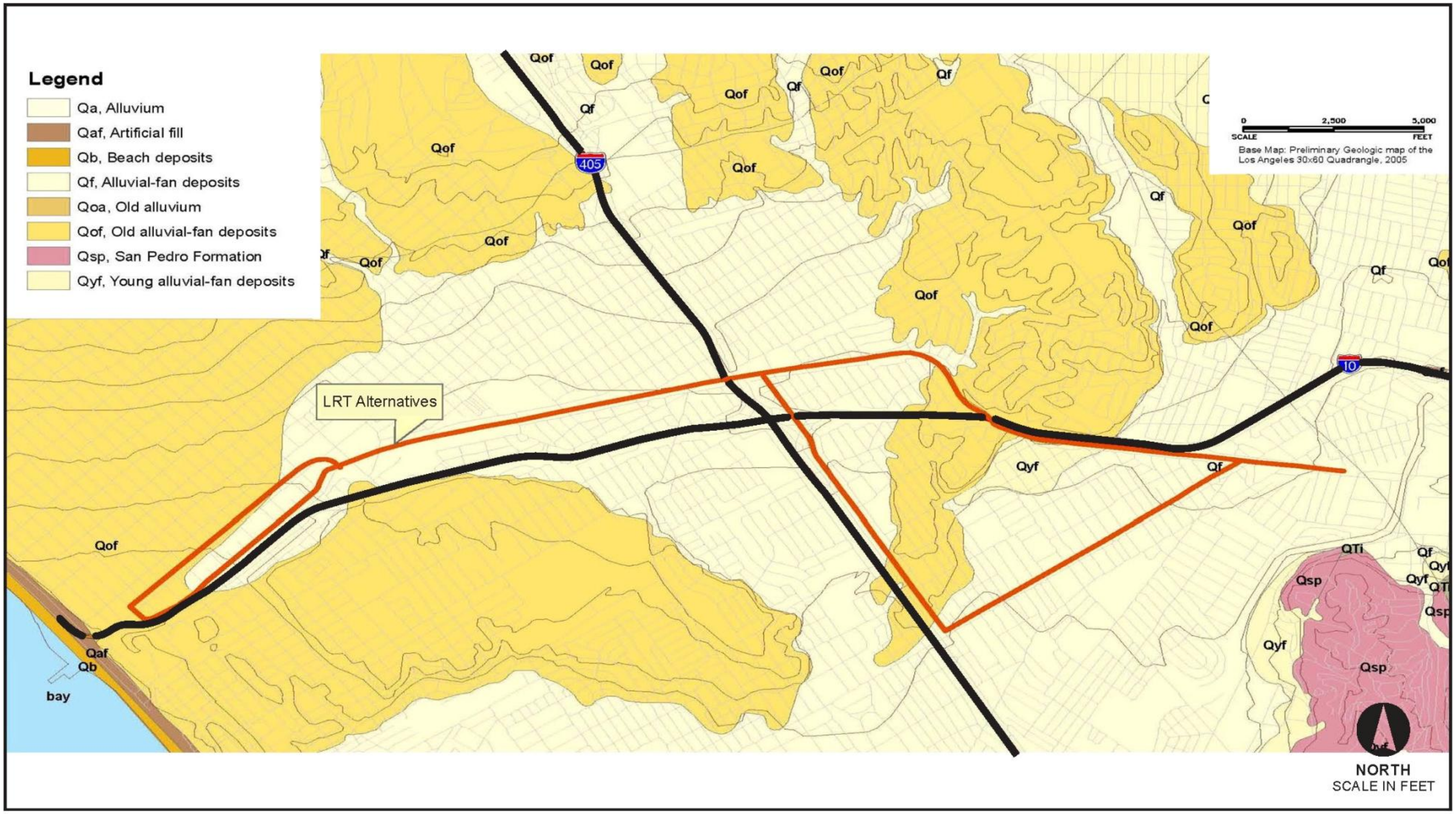
Regional Setting

The geological and seismic hazard study area is located on the west side of Los Angeles County and ~~can be~~ is defined for this section ~~by~~ as the Expo Phase 1 terminus station to the east of Venice and Robertson Boulevards; the Pacific Ocean to the west; the Santa Monica Mountains to the north; and the Baldwin Hills to the south. Mountains and hills generally expose Late Cretaceous to Late Pleistocene-age sedimentary and igneous rocks and bound the great Los Angeles Basin along the north, northeast, east, and southeast (Yerkes 1965). The Los Angeles Basin is a northwest-trending structural trough, alluviated lowland plain, approximately 50 miles long and 20 miles wide. The Expo Phase 2 alignments traverse approximately 6.6 miles of Quaternary- to Pleistocene-age alluvial fan deposits within the southerly portion of the basin. The location of the LRT Alternatives in relation to the geologic formations within the area is shown in Figure 3.8-1 (Geologic Formations Map).

The eastern end of the alignments lies adjacent to a complex system of faults and folds that extend southeast through the Los Angeles Basin identified as the Newport-Inglewood structural zone. This structural zone is a controlling factor of the nearby Baldwin Hills geomorphology. The steep uplifted terrain of the Baldwin Hills is vulnerable to landsliding and erosion, triggered largely by sustained, heavy rains (California Division of Mines and Geology [CDMG] 1982). Other landsliding in the region is largely due to the effects of groundshaking.

Geology and Soils

Anticipated underlying materials within the study area include artificial fill associated with the existing development of Exposition Boulevard and surrounding buildings and utilities. Fill materials are anticipated to be comprised of native alluvial soils. The young, Holocene in age (11,000 years old to recent) native alluvial soils are unconsolidated, detrital sediments consisting of variable amounts of gravel, sand, silt, and clay. Alluvial soils are anticipated to be in excess of 100 feet in depth within this portion of the alignment. Much of the study area is mapped as older Pleistocene age, alluvial sediments and shallow marine sediments are mapped (~~Dibblee 1991~~Leighton Consulting, Inc. 2007). These older sediments are weakly consolidated and are comprised of sand, gravel, and silt (~~Dibblee 1991~~Leighton Consulting, Inc. 2007).



Source: Leighton Consulting Inc.

Figure 3.8-1 Geologic Formations Map

Groundwater

Based on local topography and measured groundwater levels in the Charnock subbasin, which is a sub-basin of the Santa Monica Basin upon which the project is located, depth to groundwater is estimated to be between 110 to 180 feet below ground surface (bgs) along Segment 1 (Expo ROW), and Segment 2 (Sepulveda to Cloverfield); depth to groundwater along Segment 1a (Venice/Sepulveda) is expected to be about 100 feet bgs. Depth to groundwater along Segment 3 (Olympic) and Segment 3a (Colorado) is estimated to be between 60 to 140 feet bgs (SMPCDD 2004, 4.5-41).[64] Groundwater is not expected to be a constraint since the alignments are to be constructed almost entirely at grade with cuts less than 6 feet in depth.

Subsurface Gas

Based on maps from the California Division of Oil, Gas, and Geothermal Resources (DOGGR) (~~Dibblee 1991~~Leighton Consulting, Inc. 2007), the alignment is located south of the Cheviot Hills Oil Field. Common problems associated with oil field properties include methane and hydrogen sulfide soil gas, oil seepage, contaminated soils, leaking wells, and wells not plugged and abandoned to current standards. Site-specific geotechnical investigations have not been initiated.

Portions of Segment 1a are within the City of Los Angeles Methane and Methane Buffer Zones. The location of the LRT Alternatives in relation to oil fields and the City of Los Angeles' Methane and Methane Buffer Zones is presented in Figure 3.8-2 (Oil Fields and Methane Zones Map).

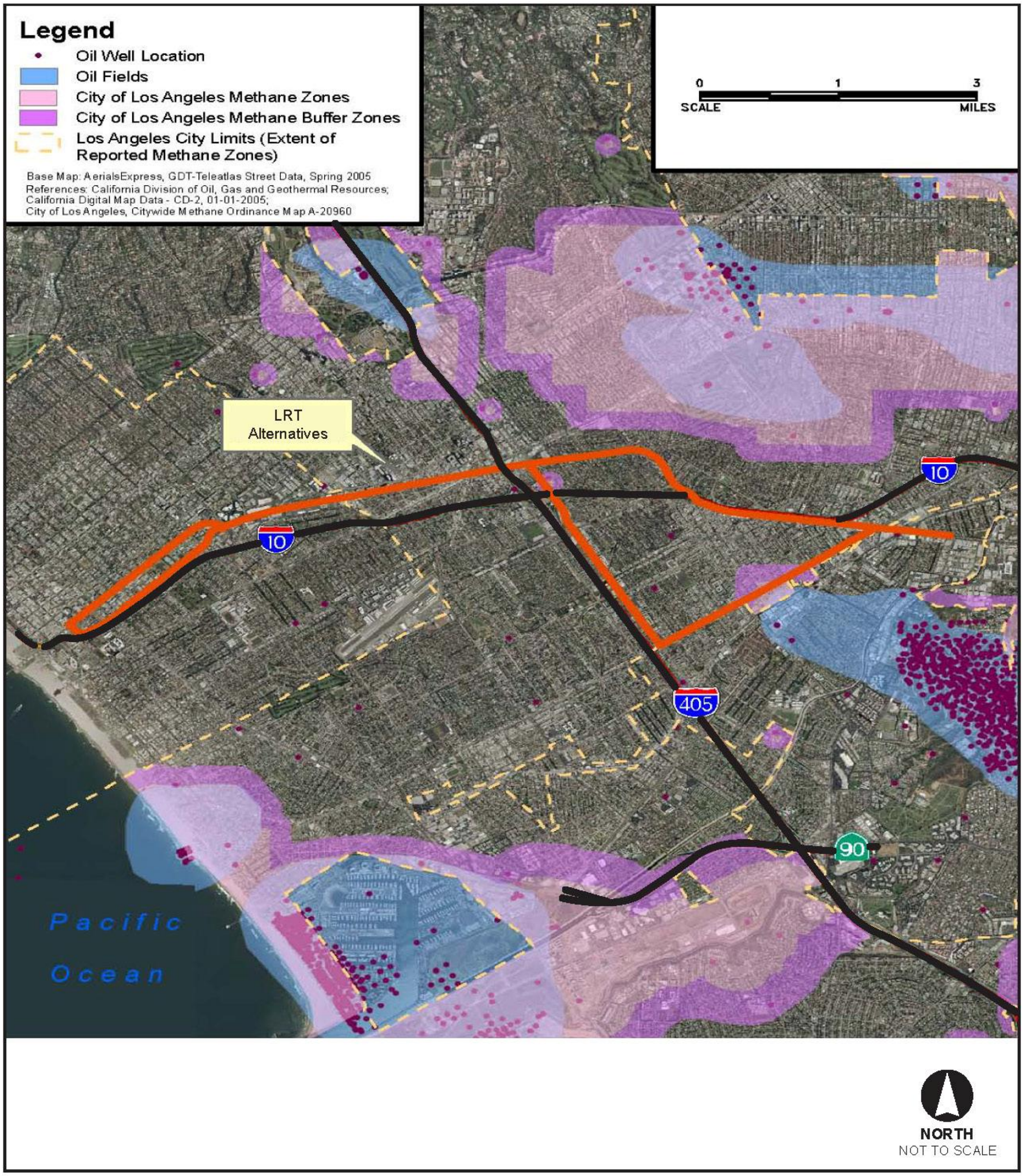
Corrosivity

Based on results of chemical testing performed as part of the previous investigation for Expo Phase 1, which encountered similar non-marine alluvium, subsurface materials along the Expo Phase 2 project are expected to be classified as corrosive to severely corrosive to metals, and moderately deleterious to concrete.

Faults and Seismicity

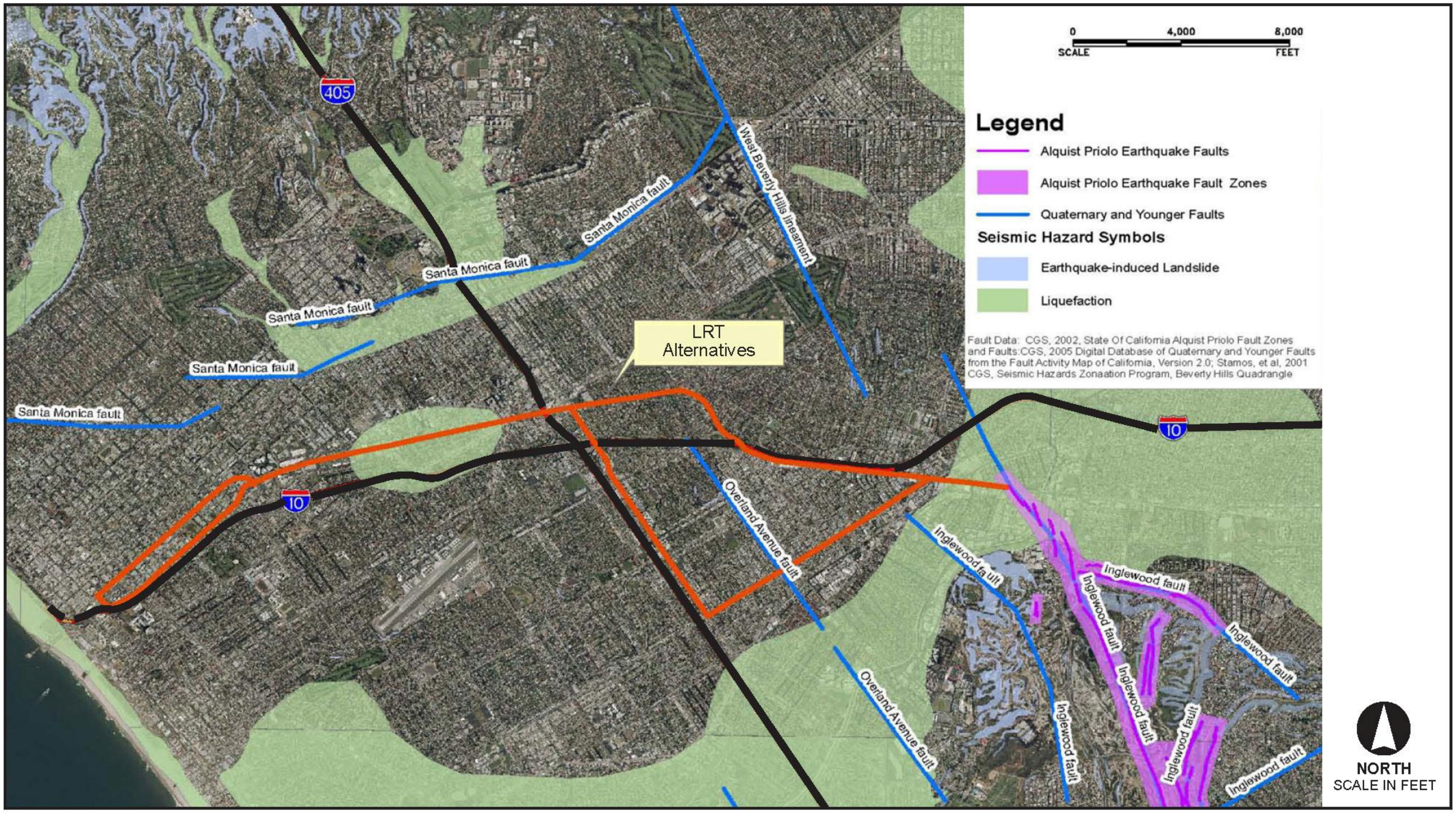
The seismic hazard which is expected to have the highest probability of affecting the alignment is groundshaking resulting from an earthquake occurring along any of several major active and potentially active faults in Southern California. Known regional active faults that could produce substantial groundshaking at the project area include the Newport-Inglewood, Santa Monica, Hollywood, Puente Hills Blind Thrust, Upper Elysian Park Blind Thrust, and Raymond faults, among others. The closest of these is the Newport-Inglewood fault, with a surface projection of potential rupture area located in Segment 1. The probable magnitude of a seismic event on the Newport-Inglewood fault would range from 6.7 to 7.4 on the Richter scale. The probable magnitude of a seismic event on the Santa Monica fault would range from 6.7 to 7.4 on the Richter scale. The location of the LRT Alternatives in relation to known faults and liquefaction zones is shown in Figure 3.8-3 (Seismic Hazards Map).

[64] Depth to groundwater measured for a project near 4th Street in Santa Monica indicated groundwater levels at about 47 to 50 feet bgs.



Source: Leighton Consulting Inc.

Figure 3.8-2 Oil Fields and Methane Zones Map



Source: Leighton Consulting Inc.

Figure 3.8-3 Seismic Hazards Map

Liquefaction

Liquefaction is the loss of soil strength or stiffness due to a build-up of pore-water pressure during severe groundshaking. Liquefaction is associated primarily with loose (low density), saturated, fine- to medium-grained, cohesion-less soils. Effects of severe liquefaction can include sand boils, excessive settlement, bearing capacity failures, and lateral spreading.

A review of the Seismic Hazard Zones Map for Beverly Hills Seismic Hazard Zones Map (CDMG 1999) indicates that portions of all of the proposed project alignments are in an area mapped as being susceptible to liquefaction. However, due to the depth to groundwater of the project site, potential impacts from liquefaction are considered low. Since the risk due to liquefaction is considered low, so also is the risk for lateral spreading considered low.

Landslides

The topography of the alignment is relatively flat. The project area is not mapped as being at risk for landslides. Therefore, the potential for landslides is considered low.

3.8.3 Regulatory Setting

State

Alquist-Priolo Earthquake Fault Zoning Act

The California legislation protecting the population of California from the effects of fault-line ground-surface rupture is the *Alquist-Priolo Earthquake Fault Zoning Act*. This State law was passed in response to the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. At the directive of the Act, in 1972 the State Geologist began delineating Earthquake Fault Zones (called Special Studies Zones prior to 1994) around active and potentially active faults to reduce fault-rupture risks to structures for human occupancy.[65] This Act has resulted in the preparation of maps delineating Earthquake Fault Zones to include, among others, recently active segments of the Newport-Inglewood and San Andreas faults. The Act provides for special seismic design considerations if developments are planned in areas adjacent to active or potentially active faults.[66] The study area is not in a State of California Earthquake Fault Zone. ~~As described in greater detail in Section 3.8.5 (Criteria, Impact Evaluation, and Mitigation Measures) below, t~~The active Newport-Inglewood Fault Zone is approximately ¾-mile southwest of the proposed alignments.

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[65] *Alquist-Priolo Earthquake Fault Zoning Act*, California *Public Resources Code*, Division 2, "Geology, Mines, and Mining," Chapter 7.5 "Earthquake Fault Zones," Sections 2621 through 2630; signed into law December 22, 1972, most recently amended October 07, 1997.

[66] Hart, E.W., and W.A. Bryant. Interim Revision 2007. "Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps." California Division of Mines and Geology, Special Publication 42, 42 p.~~California Geological Survey. 2003. CGS Special Publication 42, Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps. Revised 1997, Supplements 1 and 2, 1999, Supplement 3, 2003. Authors, E.W. Hart and W.A. Bryant.~~

California Building Code (CBC)

The California regulations protecting the public from geo-seismic hazards, other than surface faulting, are contained in the 2007 *California Code of Regulations*, Title 24, Part 2 CBC and California *Public Resources Code*, Division 2, Chapter 7.8 (the *Seismic Hazards Mapping Act*). Both of these regulations apply to public buildings (and a large percentage of private buildings) intended for human occupancy. The *Metro Design Criteria* require conformance with the CBC for all construction.

The 2007 CBC, effective January 1, 2008, is based on the current (2006) *International Building Code* and contains major updates and prominent enhancements of the sections dealing with fire safety, equal access for disabled persons, and environmentally friendly construction.[67] Each jurisdiction in the state may adopt its own building code based on the 2007 CBC. Local codes are permitted to be more stringent than Title 24, but, at a minimum, are required to meet all state standards and enforce the regulations of the 2007 CBC beginning January 1, 2008.

Seismic Hazards Mapping Act

The California *Seismic Hazards Mapping Act* became effective in 1991 to identify and map seismic hazard zones for the purpose of assisting cities and counties in preparing the safety elements of their general plans and to encourage land use management policies and regulations that reduce seismic hazards. The recognized hazards include strong groundshaking, liquefaction, landslides, and other ground failure. The Act has resulted in the preparation of maps delineating Liquefaction and Earthquake-Induced Landslide Zones of Required Investigation. Mapping has been completed for the Newport Beach quadrangle, which contains the study area, and the official map was issued in April, 1997. The study area is in a zone of potential liquefaction.

Caltrans Seismic Design Criteria

The State of California has established construction standards and design criteria for roadways to safeguard life and property. Construction standards and seismic design criteria are contained in such regulatory codes as Caltrans' *Seismic Design Criteria Version 1.2* (Caltrans 2001, December); *Highway Design Manual*, Section 110.6 (Earthquake Consideration) and Section 113 (Geotechnical Design Report) (Caltrans 2001, November); and similar codes adopted by a city for roadway corridor protection. The *Seismic Design Criteria* would apply to any roadway widening required for the project.

State guidelines protecting bridges and overpasses from geo-seismic hazards are contained in Caltrans' Bridge Design Specifications, Bridge Memos to Designers, Bridge Design Practices Manual, and Bridge Design Aids Manual. Bridge design must be based on the "Load Factor Design methodology with HS20 44 live loading" (a procedure to incorporate the estimated weight of the vehicles and/or pedestrians on the bridge with the weight of the bridge for loading calculations). Seismic resistant design is required to conform to the Bridge Design Specifications, and Section 20 of Bridge Memos to Designers, as well as the Caltrans Seismic Design Criteria. The Bridge Design Specifications would apply to the proposed aerial structures.

[67] California Building Standards Commission, *2007 California Building Code*, California Code of Regulations, Title 24, Part 2, Volumes 1 and 2, effective January 1, 2008.

Regional

Los Angeles County Metropolitan Transportation Authority (Metro)

The *Metro Design Criteria* establishes the design criteria for Expo Phase 1 and Expo Phase 2. All new structures shall be designed to resist the earthquake forces (EQ) and the ground displacement stipulated in the criteria.

3.8.4 Analytic Methodology

The method for assessing adverse effects involves examining the Expo Phase 2 project for known geologic hazards. If stations or structures are located within or directly adjacent to geologic hazard areas, there would be the potential for an impact that would require additional geotechnical studies and may require enhanced design to eliminate or mitigate the potential impact. Such additional studies and design ~~would be~~were conducted following preliminary selection of the ~~Locally~~ Recommended Preferred Alternative ~~(LPA)~~ and will be ongoing during the final design process.

The potential effects on geology, soils, and seismicity have been identified from a review of available published and unpublished geotechnical literature pertinent to the proposed project. These include, but are not limited to, the safety elements of the general plans for the city and county of Los Angeles, and the cities of Culver City and Santa Monica; aerial photographs; Official Alquist-Priolo Earthquake Fault Zone Maps; Official Seismic Hazard Zone Maps; geologic and topographic maps; other publications by the California Geological Survey (CGS), the U.S. Geological Survey (USGS), and the DOGGR; and available geotechnical reports pertinent to the project. The analysis of potential geologic and seismic effects along the project LRT alignments was determined specifically from (1) the Los Angeles County Seismic Safety Element (1990); (2) the City of Los Angeles Safety Element (1996); (3) the Seismic Hazard Zone Maps published by the CDMS (1999); (4) Alquist-Priolo Earthquake Fault Zone Maps; and (5) reports prepared for the Expo Phase 2 and for other projects in the vicinity.

3.8.5 Criteria, Impact Evaluation and Mitigation Measures

Criterion	**Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving 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); strong seismic groundshaking; seismic-related ground failure, including liquefaction; or landslides?**

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. However, the only improvement that would change the physical environment in the Expo Phase 2 ROW would be the I-405 Widening project. The No-Build Alternative at the Expo Phase 2 ROW would not be located within an Alquist-Priolo Fault zone or geoseismic risk areas. The No-Build Alternative would result in ***no impact*** associated with faults, groundshaking, ground failure, or landslides.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses and would not be located within an Alquist-Priolo Fault zone or geoseismic risk areas. As with the No-Build Alternative, the TSM Alternative would result in ***no impact*** associated with faults, groundshaking, ground failure, or landslides.

LRT Alternatives

The project site is not in a State of California Earthquake Fault Zone. The active Newport-Inglewood Fault Zone is approximately ¾-mile southwest of the site. Potential impacts as related to groundshaking would occur if the guideway system (including but not limited to rail tracks, aerial structures, and overhead catenary system [OCS]) were affected by ground deformation and/or liquefaction. Inasmuch as the proposed project would be implemented under design standards that have been specifically developed to respond to seismic conditions, implementation of any of the LRT Alternatives would result in a ***less-than-significant*** impact.

FEIR Design Options

As the proposed Sepulveda Grade Separation, Colorado Parking Retention, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not require the expansion of the LRT Alternatives into an Alquist-Priolo Fault zone or geoseismic risk area, impacts with respect to proposed uses in those areas would not occur. Further, development of the contemplated design options would be implemented under the same applicable design standards as for the LRT Alternatives. As such, impacts would be ***less than significant***.

Criterion	Would the project result in substantial soil erosion or the loss of topsoil?

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. However, the only improvement that would change the physical environment in the Expo Phase 2 ROW would be the I-405 Widening project. The improvements to the 405 project in the Expo Phase 2 ROW would be subject to the CBC, relevant plans, codes, and regulations, including the National Pollution Discharge Elimination System (NPDES) permit requirements. As a result, the No-Build Alternative would result in ***no impact***.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. As with the No-Build Alternative, the TSM Alternative would be subject to the CBC and relevant plans, codes, and regulations, including the NPDES permit requirements result in ***no impact***.

LRT Alternatives

The project would include ground-disrupting activities, such as excavation and trenching for foundations and utilities (associated with the transit stations, aerial structures, and maintenance facility) and soil compaction and site grading associated with the implementation of a new track system, all of which would disturb soils. The State Water Resources Control Board (SWRCB)—through its ~~National Pollution Discharge Elimination System (~~NPDES~~)~~ Program—requires erosion and sediment controls for projects with more than 1 acre of land disturbance. Requirements associated with the NPDES Program include preparation and implementation of a Stormwater Pollution Prevention Plan and a Water Quality Management Plan, with permanent erosion and sediment controls; and preparation and implementation of an erosion and sediment control plan, describing permanent erosion and sediment controls. The project would be required to comply with these existing regulations. Adherence to these requirements would prevent substantial on-site erosion and would ensure that the LRT Alternatives would not result in substantial soil erosion or the loss of topsoil; therefore, the proposed project would create a ***less-than-significant*** impact. Refer to Chapter 4 (Construction Impacts) for more discussion on the temporary impacts and mitigation measures associated with erosion and sediment controls.

FEIR Design Options

Development of the Sepulveda Grade Separation, Colorado Parking Retention, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would be conducted in conformance with the same applicable regulatory programs as the LRT Alternatives, such as NPDES requirements with respect to erosion and sediment control. Therefore, impacts would remain ***less than significant***.

Criterion	Would the project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

No-Build Alternative

There would be roadway and transit service improvements associated with the No-Build Alternative. Within the Expo Phase 2 study area, the No-Build Alternative would not involve geologic units, unstable soils, or areas susceptible to lateral spreading, subsidence, liquefaction, or collapse. Therefore, t~~T~~he No-Build Alternative would result in ***no impact***.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses, none of which involve geologic units, unstable soils, or areas susceptible to lateral spreading, subsidence, liquefaction, or collapse. As with the No-Build Alternative, the TSM Alternative would result in ***no impact***.

LRT Alternatives

Portions of the proposed LRT Alternatives are in an area mapped as being susceptible to liquefaction. Liquefiable alluvial soils have been mapped along the eastern end of the alignments, east of Venice Boulevard (Station 500+00). This area is in common with all of the LRT Alternatives. Liquefiable alluvial soils have also been identified between approximately the Expo ROW east of Stewart Street and the Expo ROW at Pico Boulevard (Stations 735+00 to 680+00), which includes the grade separation for Centinela Avenue, Bundy Avenue, and Pico Boulevard along with the retained fill between and after the structures. This area is common to all LRT Alternatives. However, implementation of the LRT Alternatives would not exacerbate these geologic pre-existing conditions. Additionally, the LRT Alternatives would be constructed in compliance with the CBC and *Metro Design Criteria* to ensure that the project would not be adversely affected by liquefiable soils. Therefore, implementation of the LRT Alternatives would not have an effect related to on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; therefore, a ***less-than-significant*** impact would occur.

FEIR Design Options

Development of the Sepulveda Grade Separation, Colorado Parking Retention, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would be conducted in accordance with CBC and *Metro Design Criteria* to insure that potential seismic hazards are minimized as with the LRT Alternatives. Therefore, impacts related to implementation of the design options would be considered ***less than significant***.

Criterion	**Would the project be located on expansive soil, as defined in Table 18 1 A of the CBC (2001), creating substantial risks to life or property?**

No-Build Alternative

There would be roadway and transit-service improvements associated with the No-Build Alternative. Compliance with the CBC and relevant plans, codes, and regulations would ensure that there would be ***no impact***.

Transportation Systems Management (TSM) Alternative

The TSM Alternative would include all of the improvements under the No-Build Alternative and new on-street bus services to directly serve the Expo Phase 2 community transit needs. Those additional improvements would include minor physical modifications such as upgraded bus stops and additional buses. As with the No-Build Alternative, compliance with the CBC, and relevant plans, codes, and regulations, in addition to bus operations safety procedures, would ensure that there would be ***no impact***.

LRT Alternatives

Portions of the proposed project may be located on expansive soil as defined in Table 18 1 A of the CBC (2001). ~~Upon~~ After preliminary selection of the ~~LPA~~Recommended Preferred Alternative, further field investigation ~~would be~~was performed to identify areas where expansive soils may exist. ~~If~~ The location of such soils is reported in the *Geotechnical Exploration Report* prepared in the fall 2009. ~~are found, their existence will be reported in the Final EIR. Regardless~~

~~of the selected LPA,~~ Therefore, compliance with *Metro Design Criteria*, the CBC, and relevant plans, codes, and regulations would ensure that ~~the~~ impacts would be ***less than significant***.

FEIR Design Options

Implementation of the Sepulveda Grade Separation, Colorado Parking Retention, Colorado/4th Parallel Platform and South Side Parking, Maintenance Facility Buffer, or Expo/Westwood Station No Parking design options would not exacerbate pre-existing geologic conditions and would be conducted in accordance with the CBC, *Metro Design Criteria*, and other relevant regulations to insure that potential for expansive soils to affect human health risks and property would be minimized. Therefore, impacts related to implementation of the design options would be considered ***less than significant***.