3.12 Geology and Soils

Environmental Setting

PHYSICAL SETTING

Geology and Soils

Regional Geology

The Planning Area covers approximately 1,138 acres located in the northwestern Livermore Valley. The Livermore Valley is located in the California Coast Ranges Geomorphic Province, a geologically young and seismically active region. Northwest-southeast trending ranges of low mountains and intervening valleys dominate this region. The Livermore Valley is bounded to the north by the Tassajara Hills, to the east by the Greenville Fault and Altamont Hills, to the south by the Las Positas Fault and the central Diablo Range, and to the west by the Amador Valley, which is in turn bounded by the Calaveras Fault. The Livermore Valley is a deep structural basin containing young unconsolidated sedimentary deposits.

Soil Properties

The surface soils in the Planning Area have been mapped by the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) and consist of several soil types (see Table 3.12-1 and Figure 3.12-1). Soils in the Planning Area are mostly low to moderately corrosive to concrete and moderately to highly corrosive to steel, which can constrain foundation and utility construction design. The Planning Area also contains Diablo, Rincon, Linne, and Pescadero clay or clay-loam soils, which are moderately to highly expansive. Expansive soils can shrink and swell in response to the presence of water, causing foundation and wall cracks, heaving sidewalks, and creating flaws in paved areas. Development in areas with expansive soils may require special building foundations or grade preparation, such as the removal of problematic soils and replacement with engineered soils.

Geologic and Soil Hazards

Expansive Soils

Certain types of soil are inherently expansive, meaning they can expand and contract as the water content fluctuates within the soil. This expansion and contraction, also called "shrink-swell," can damage structures that are not appropriately engineered for this activity. The NRCS analyzes the shrink-swell potential of each soil type, and categorizes it as "low," "moderate," "high," or "very high." Where the shrink-swell classification is moderate to very high, shrinking and swelling can damage buildings, roads, and other structures (NRCS n.d.). Diablo, Rincon, Linne, and Pescadero clay or clay-loam soils are moderately to highly expansive. As shown in Figure 3.12-1 and described

in Table 3.12-1, some areas of soil with moderate to high shrink-swell potential are scattered throughout the Planning Area.

Liquefaction

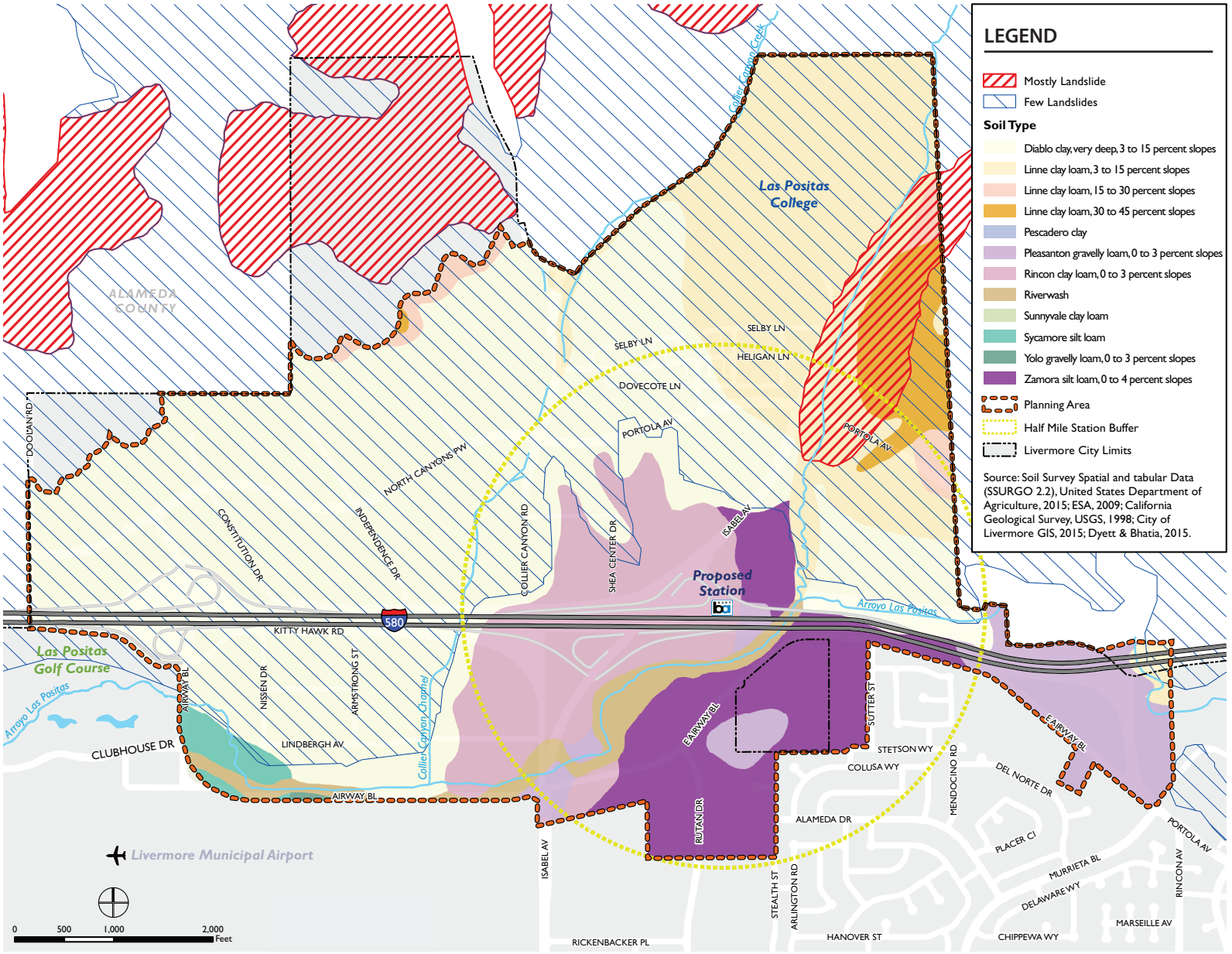
Liquefaction is the temporary transformation of loose, saturated, granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes a temporary loss of strength, which commonly causes ground displacement or ground failure to occur. Since saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths.

As shown in Figure 3.12-2 regional liquefaction hazard mapping (Association of Bay Area Governments, 2017). indicates that the Planning Area includes areas ranging from low to very high liquefaction susceptibility. Areas along the Arroyo Las Positas and the Collier Canyon Channel mapped as having a "very high" susceptibility to liquefaction. Regional mapping is only a general analysis; site-specific analysis would identify specific areas where liquefaction may occur. In addition to the depth to water, the potential for ground shaking also influences liquefaction potential.

Subsidence

Subsidence can occur from immediate settlement, consolidation and secondary compression, shrinkage of expansive soil, and liquefaction. Immediate settlement is the elastic vertical compression of granular soil that occurs immediately after a load is applied to nonsaturated soils. Consolidation settlement occurs in saturated clay over time as a result of the volume change caused by the squeezing out of water from the pore spaces within the soil caused by the application of a load (e.g., a building) onto the soil. Consolidation occurs over a period of time and is followed by secondary compression, which is a continued change in the soil density under the continued application of the load. Subsidence of expansive soil occurs when wet, expanded soils dry out and contract. Subsidence as a result of liquefaction occurs when ground shaking in saturated soils causes pore pressure to be lost. As a result, the soil can move either horizontally or vertically. Saturated clays are present in the Planning Area (Natural Resources Conservation Service, 2017). Therefore, there is potential for each of these forms of subsidence to occur in the Planning Area.

In the Bay Area, subsidence is also caused by excessive groundwater or natural gas withdrawal. Long-term groundwater withdrawals have the potential to cause subsidence if recharge rates are not sufficient to maintain current water table levels. The cities of Pleasanton, Dublin, and Livermore have supplemented their water supply with groundwater obtained from the groundwater basins underlying the cities. The Main Basin, managed by the Zone 7 Water Agency, serves large-capacity municipal production wells and is used to store and distribute high quality imported water through Zone 7's recharge program. Groundwater recharge occurs through natural and artificial recharge from rainfall, releases from the South Bay Aqueduct of Lake Del Valle, and gravel mining recharge to the Arroyo Mocho and Arroyo Del Valle, but the majority of recharge is through artificial recharge and recharge through stream channels. Consequently, potential for groundwater-induced subsidence is considered to be low (PBS&J, 2009).



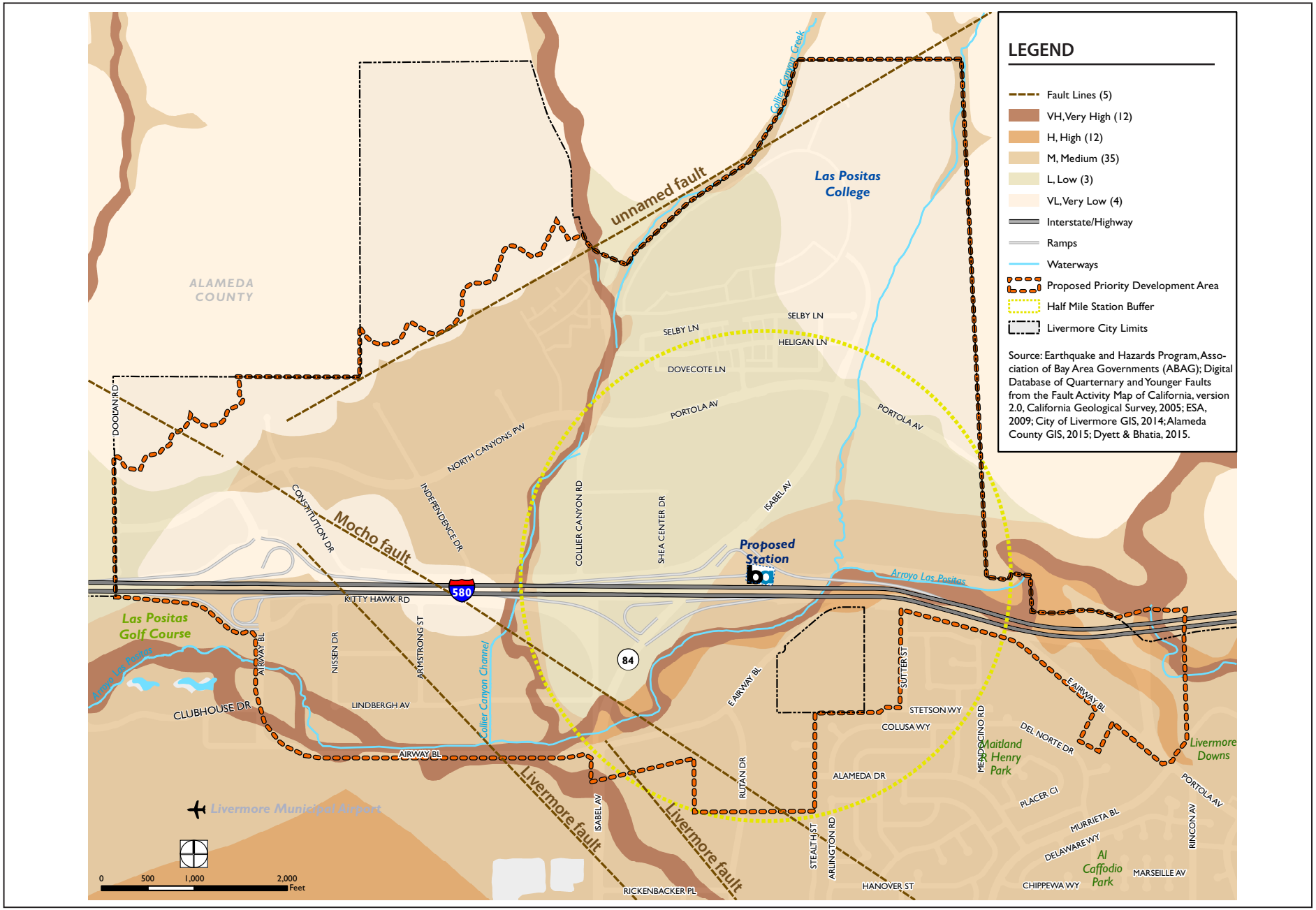
ICF Graphics ... 0021515 (12-20-2017)

Figure 3.12-1
Soils and Geologic Hazards

Table 3.12-1: SURFACE SOILS IN THE PLANNING AREA

Soil Unit	*Slope*	*Rough percentage of Planning Area*	*Portions of Planning Area*	*Corrosive to concrete and steel.*	*Corrosive to concrete*	*Susceptible to expansion/ contraction*	*Susceptibility to water erosion (kw).*
Diablo clay (DvC)	3-15%	46%	Central portion of the site, north and south of North Canyons Parkway to south of I-580	High	Moderate	Highly expansive	Moderate
Linne clay loam (LaC)	3 to 15%	20%	Northeast portion of site; portions of Shea Sage property, eastern side of Las Positas College	Moderate	Low	Moderately expansive	Moderate
Rincon Clay loam (RdA)	0 to 3%	10%	South part of site south of Airway Blvd.	High	Low	Highly expansive	Moderate
Zamora silt loam (Za)	0 to 4%	9%	BART station area and areas along Airway Blvd east of Isabel Ave.	Moderate	Low	Moderately expansive	High
Pleasanton gravelly loam (PgA)	0 to 3%	6%	Along portions of Arroyo Las Positas	Moderate	Low	Moderately expansive	Low
Linne clay loam (LaD)	15 to 30%	3%	Northwestern and northeastern slopes	Low	Low	Moderately expansive	Moderate
Linne clay loam (LaE2)	30 to 45%	3%	Northwestern and northeastern slopes	Moderate	Low	Moderately expansive	High
Riverwash (Rh)	N/A	2%	Along portion of Arroyo Las Positas.	N/A	N/A	N/A	N/A
Sycamore silt loam (So)	N/A	<1%	Small areas along Arroyo Las Positas adjacent to Airway Blvd/Livermore Airport.	Moderate	Low	Moderately expansive	High
Pescadero clay (Pd)	N/A	<1%	Small area along Arroyo Las Positas near Portola Ave. crossing.	High	High	Highly expansive	Moderate
Clear lake clay (CdA)	0 to 2%	<1%	Small areas (unmapped).	Unavailable	Unavailable	Unavailable	Unavailable

Source: Natural Resources Conservation Service, 2017; Soil Survey Spatial and tabular Data (SSURGO 2.2), United States Department of Agriculture, 2015; ESA, 2009; California Geological Survey, USGS, 1998; City of Livermore GIS, 2015; Dyett & Bhatia, 2015.



ICF Graphics ... 0021515 (12-21-2017)

Figure 3.12-2
Liquefaction Hazard

Soil Erosion

Erosion is the weathering of soil and rock by wind, water, or other natural agents. Soils that contain high amounts of loose sand and silt are more easily erodible than soils which are more consolidated. In the Planning Area, areas that are susceptible to erosion are those that would be exposed during grading and earthmoving activities associated with new construction and those along the Arroyo Las Positas and the Collier Canyon Channel. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures, asphalt, or slope protection.

Landslides

Landslides, also referred to as slope failures, include many phenomena that involve the downslope displacement and movement of material, either triggered by static (i.e., gravity) or dynamic (i.e., earthquake or over-saturation) forces. Exposed rock slopes may undergo rock-falls, rockslides, or rock avalanches, while soil slopes may experience shallow soil slides, rapid debris flows, and deep-seated rotational slides. Landslide-susceptible areas are characterized by steep slopes, downslope creep of surface materials, and unstable soil conditions.

Regional landslide mapping of the Planning Area indicates one landslide deposit area, primarily located to the north of Portola Avenue east of Campus Hill Drive, with a portion located south of Portola Avenue east of Isabel Avenue (Figure 3.12-3). The next nearest landslide deposit area is located northwest of and outside the Planning Area, and has steeper slopes as shown on Figure 3.12-3. The other areas north of I-580 are mapped as an area of few landslides, and the area south of I-580 is primarily mapped as relatively flat, with less than 10 percent slope, and not susceptible to landslides.

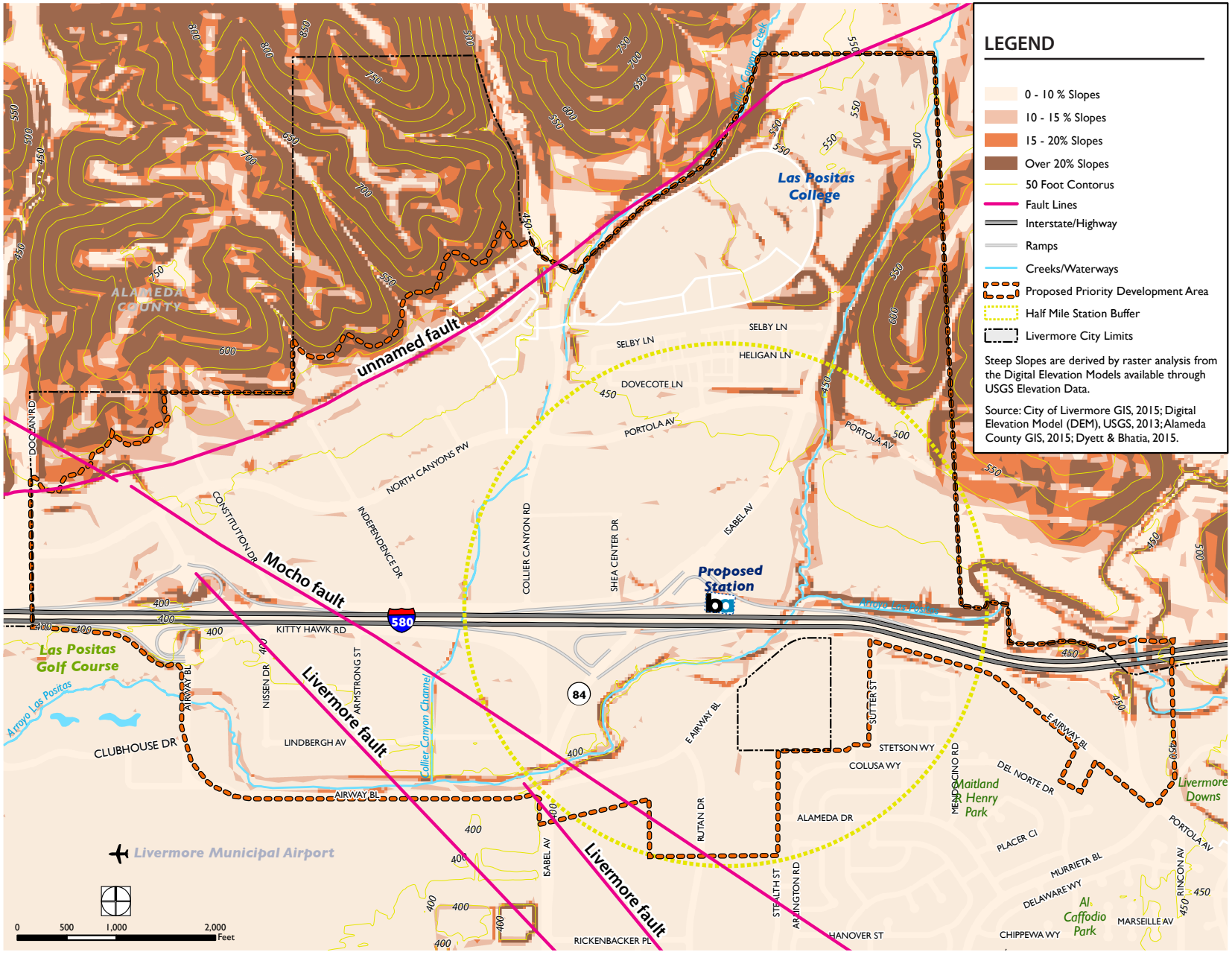
Seismicity

Regional Faults

The entire San Francisco Bay Area is located within the San Andreas Fault System (SAFS), a complex of active faults[1] forming the boundary between the North American and Pacific lithospheric plates. Regional faults are shown in Figure 3.12-4. Movement of the plates relative to one another results in the accumulation of strain along the faults, which is released during earthquakes. Numerous moderate to strong historic earthquakes have been generated in northern California by the SAFS. This level of active seismicity results in a relatively high seismic risk in the San Francisco Bay Area. The California Building Standards Code provides for increasingly stringent construction requirements for projects in areas of high seismic risk.

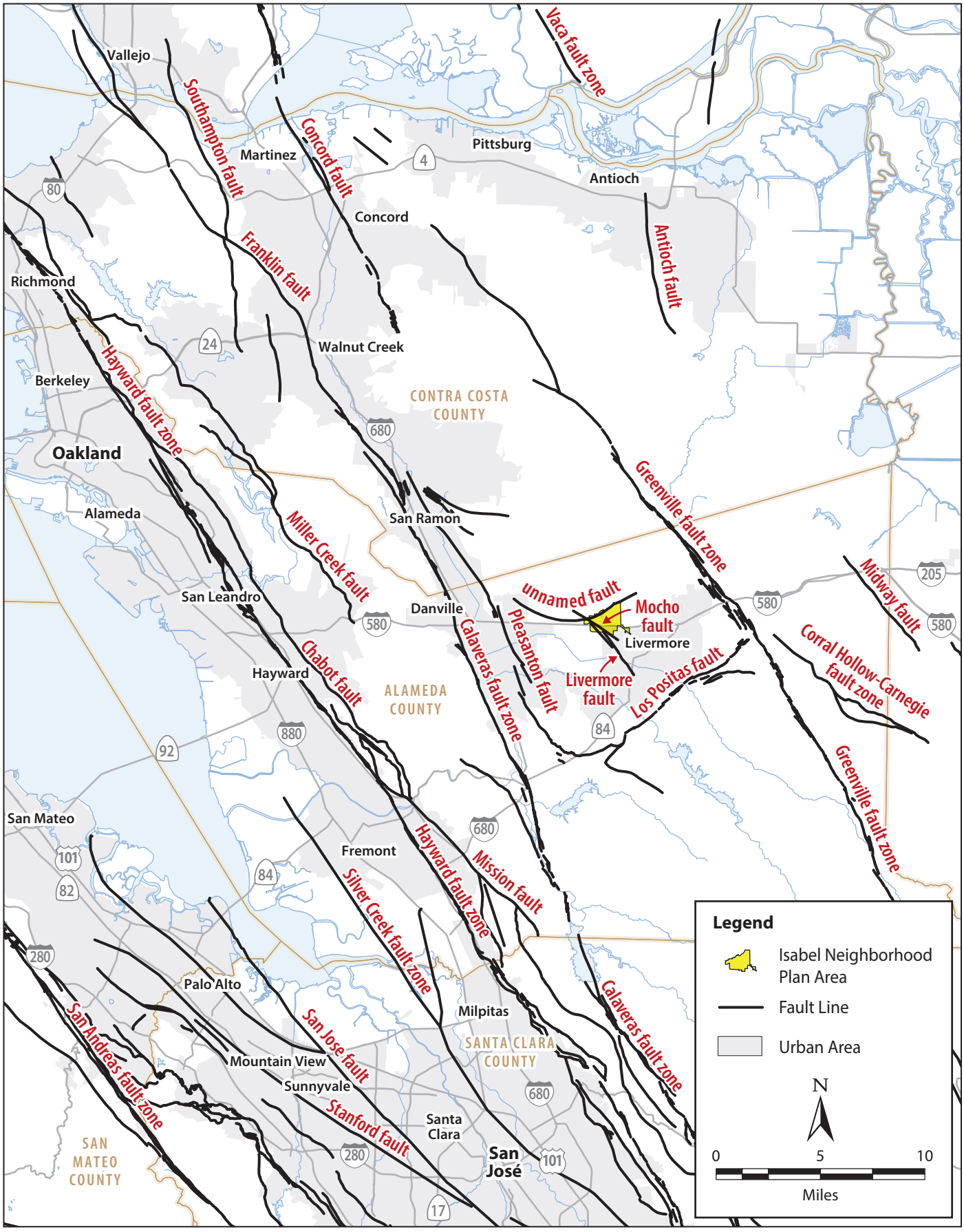
The SAFS includes numerous faults found by the California Geological Survey in the Bay Area under the Alquist-Priolo Earthquake Fault Zoning Act to be "active" (i.e., to have evidence of fault rupture in the past 11,000 years). Active regional faults include the San Andreas, Hayward, Calaveras, Concord-Green Valley, and Greenville faults.

[1] An active fault is defined as a fault that has shown geologic evidence of movement within Holocene time (approximately the last 11,000 years) (Bryant and Hart 1997).



ICF Graphics ... 00215.15 (12-21-2017)

Figure 3.12-3
Steep Slopes and Faults



ICF Graphics ... 00215.15 (12-21-2017)

Figure 3.12-4
Regional Faults

In addition to the known active faults, recent research on the structural geology and tectonics of the region indicates that there is another potential source of large magnitude earthquakes in the region. The Mount Diablo anticline is the largest among the folds and thrust faults mapped in the hills north of the Livermore Valley. Research has interpreted the Mount Diablo anticline to be a large fold developed above a buried ("blind") thrust fault (USGS, 1999). The accumulation of strain on the "blind" Mount Diablo Thrust fault presents the potential for an earthquake along this structure. However, an earthquake on the fault would not be expected to cause fault rupture at the surface and therefore is not included in the Alquist-Priolo Act.

The Coast Range-Sierran Block Boundary (CRSBB) forms the geomorphic boundary of the Coast Ranges with the Central Valley to the east. A seismically active fold and thrust belt underlies this actively deforming boundary. The CRSBB is currently recognized as a potential seismic source capable of generating moderate earthquakes that could affect the Planning Area. Eleven moderate earthquakes (magnitude 5.8 to 6.8) have been documented along the CRSBB zone during the last 150 years, including the 1892 Winters earthquakes. The 1983 Coalinga earthquake (magnitude 6.7) is a recent example of an earthquake that occurred on a blind thrust within the CRSBB zone (City of Livermore, 2015).

The United States Geological Survey's (USGS) Working Group on California Earthquake Probabilities (Field et al., 2015) estimates that there is a 72 percent chance that a magnitude 6.7 or greater earthquake will occur in the San Francisco Bay Area between 2015 and 2045. The probability of a 6.7 magnitude or greater earthquake occurring along individual faults in this time period was estimated to be 6.4 percent along the San Andreas Fault, 14.3 percent along the Hayward-Rodgers Creek Fault, and 7.4 percent along the Calaveras Fault. Major active faults in the vicinity of the Planning Area are listed in Table 3.12-2.

Table 3.12-2: Major Active Faults in the Project Vicinity

Fault	*Distance to Planning Area (miles)*	*Moment Magnitude (MW)[a]*
Northern Calaveras	5.5	6.8
Greenville	6.3	7.25
Hayward-Rodgers Creek	13.7	7.5
Concord/Green Valley	20.5	6.5

Note:

a. A scale used measure the size of an earthquake.

Sources: USGS, 2017; Dyett & Bhatia, 2015; Mualchin, 1996.

Planning Area-Specific Seismicity

A complex interaction of tectonic forces, geologic materials, soils, topography, and groundwater conditions affect the nature of seismic hazards at any site. While faults appear in the Planning Area, they are of Quaternary age and not considered active. The Alquist-Priolo Hazard Zones nearest to the Planning Area are associated with the Calaveras Fault, located approximately 5.5 miles to the southwest of the Planning Area, and the Greenville Fault, located approximately 6.3 miles to the northeast of the Planning Area (USGS, 2017).

In 1980, two earthquakes occurred on the Greenville Fault that exhibited ground rupture and creep at the surface. On January 24, 1980 an earthquake of Magnitude 5.5 (M5.5) on the Richter scale occurred about 9 miles north of the Planning Area. On January 26, 1980 a second earthquake, M5.8, occurred with an epicenter in the vicinity of Frick Lake, approximately 5.2 miles from the Planning Area. The earthquakes caused injuries and property damage in the City of Livermore that included shattered windows, mobile homes knocked off their foundations, swayed and cracked buildings, and snapped gas lines. The overpass of Greenville Road at I-580 was closed for repairs when the roadbed sank 12 inches due to the settlement of fill materials (City of Livermore, 2015).

Ground Shaking

Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the rupture, and local geologic conditions. Intensity is a subjective measure of the perceptible effects of seismic energy at a given point and varies with distance from the epicenter and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the subjective effects of earthquake intensity. The MMI values for intensity of an earthquake event range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage.

Intensity can also be quantitatively measured using accelerometers, or strong motion seismographs, that record ground acceleration at a specific location. Ground acceleration is a measure of force applied to a structure under seismic shaking. Acceleration is measured as a percentage of the acceleration under gravity (g). A rupture of the Northern Calaveras Fault is considered capable of generating a moment magnitude (MW) 6.8 earthquake. An earthquake matching this scenario is estimated to be capable of generating very strong to violent seismic shaking (MMI VIII – IX) in the Planning Area.

REGULATORY SETTING

Federal Regulations

U.S. Geological Survey Landslide Hazard Program

The USGS created the Landslide Hazard Program in the mid-1970s; the primary objective of the program is to reduce long-term losses from landslide hazards by improving our 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. In Alameda County, plans and programs designed for the protection of life and property are coordinated by the Alameda County Sheriff's Office of Emergency Services.

Disaster Mitigation Act of 2000

The Disaster Mitigation Act of 2000 (DMA2K) (Public Law 106-390) amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 to establish a Pre-Disaster Mitigation (PDM) program and new requirements for the federal post-disaster Hazard Mitigation Grant Program (HMGP). DMA2K encourages and rewards local and state pre-disaster planning. It promotes

sustainability and seeks to integrate state and local planning with an overall goal of strengthening statewide hazard mitigation. This enhanced planning approach enables local, tribal, and state governments to identify specific strategies for reducing probable impacts of natural hazards such as floods, fire, and earthquakes. In order to be eligible for hazard mitigation funding after November 1, 2004, local governments are required to develop a Hazard Mitigation Plan that incorporates specific program elements of the DMA2K law.

The California Governor's Office of Emergency Services (Cal OES) has adopted the 2013 Enhanced State of California Multi-Hazard Mitigation Plan (SHMP) (see California Multi-Hazard Mitigation Plan below). In the Bay Area, the Association of Bay Area Governments (ABAG) has adopted a multi-jurisdictional FEMA-approved 2010 Local Hazard Mitigation Plan Update, which cities and counties can adopt and use, in full or in part, in lieu of preparing all or part of a Local Hazard Mitigation Plan themselves (ABAG, 2010). The City is currently preparing the 2017 Tri-Valley Hazard Mitigation Plan with the Cities of Pleasanton and Dublin as partners. This plan will include updated actions and capital improvements for each City to prepare for and mitigate future natural disasters such as landslides, earthquakes, and floods. The Hazard Mitigation Plan is expected to be submitted to California Operation and Emergency Services and the Federal Emergency Management Agency in January 2018. Final approval by City Council is anticipated in Summer 2018.

State Regulations

California Multi-Hazard Mitigation Plan

The State of California Multi-Hazard Mitigation Plan, also known as the State Hazard Mitigation Plan (SHMP), was approved by FEMA in 2013. The SHMP outlines present and planned activities to address natural hazards. The adoption of the SHMP qualifies the State of California for federal funds in the event of a disaster. The SHMP provides goals and strategies which address minimization of risks associated with natural hazards and response to disaster situations. The SHMP notes that the primary sources of losses in the State of California are fire and flooding.

Alquist-Priolo Earthquake Fault Zoning Act (1972)

The Alquist–Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures used for human occupancy. The main purpose of the law is to prevent the construction of buildings used for human occupancy on top of active faults. The law only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as ground shaking or landslides.

The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Alquist–Priolo Zones) around the surface traces of active faults, and to issue appropriate maps. The maps are then distributed to all affected cities, counties and state agencies for their use in planning and controlling new or renewed construction. Generally, construction within 50 feet of an active fault zone is prohibited. The Alquist–Priolo Earthquake Fault Zones nearest to the Planning Area are associated with the Calaveras Fault, approximately 5.5 miles to the southwest, and the Greenville Fault, approximately 6.3 miles to the northeast.

Seismic Hazards Mapping Act, California Public Resources Code Sections 2690–2699.6

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a Seismic Hazard Zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. Geotechnical investigations conducted within Seismic Hazard Zones must incorporate standards specified by the California Geologic Society (CGS) Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards.

California Building Standards Code

The California Building Standards Commission is responsible for coordinating, managing, adopting, and approving building codes in California. The State of California provides minimum standards for building design through the California Building Standards Code (CBC) (California Code of Regulations Title 24). Where no other building codes apply, Chapter 29 of the CBC regulates excavation, foundations, and retaining walls. The CBC applies to building design and construction in the state and is based on the Federal Uniform Building Code (FUBC) used widely throughout the country (generally adopted on a state-by-state or district-by-district basis). The FUBC has been modified for California conditions with numerous more detailed or more stringent regulations.

The State earthquake protection law (California Health and Safety Code Section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. The CBC requires an evaluation of seismic design that falls into Categories A–F (where F requires the most earthquake-resistant design) for structures designed for a project site. The CBC philosophy focuses on "collapse prevention," meaning that structures are designed for prevention of collapse for the maximum level of ground shaking that could reasonably be expected to occur at a site. Chapter 16 of the CBC specifies exactly how each seismic design category is to be determined on a site-specific basis through the site-specific soil characteristics and proximity to potential seismic hazards.

Chapter 18 of the CBC regulates the excavation of foundations and retaining walls. This chapter regulates the preparation of a preliminary soil report, engineering geologic report, geotechnical report, and supplemental ground-response report. Chapter 18 also regulates analysis of expansive soils and the determination of the depth to groundwater table. For Seismic Design Category C, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading. For Seismic Design Categories D, E, and F, Chapter 18 requires these same analyses plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also requires mitigation measures to be considered in structural design. Mitigation measures may include ground stabilization, selection of appropriate foundation type and depths, selection of appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site-specific peak ground acceleration magnitudes and source characteristics consistent with the design earthquake ground motions. Peak ground acceleration must be determined from a site-specific study, the contents of which are specified in CBC Chapter 18.

Finally, Appendix Chapter J of the CBC regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

The CBC has been amended and adopted as Title 15 of the Livermore Municipal Code, which regulates all building and construction projects within the city.

California Department of Transportation (Caltrans) Standards

Jurisdiction of the California Department of Transportation (Caltrans) includes State and interstate routes within California. Any work within the right-of-way of a federal or State transportation corridor is subject to Caltrans regulations governing allowable actions and modifications to the right-of-way. Caltrans standards incorporate the CBC, and contain numerous rules and regulations to protect the public from seismic hazards such as surface fault rupture and ground shaking. In addition, Caltrans standards require that projects be constructed to minimize potential hazards associated with cut and fill operations, grading, slope instability, and expansive or corrosive soils, as described in the Caltrans Highway Design Manual (HDM).

National Pollution Discharge Elimination System Permits

In California, the State Water Resources Control Board (SWRCB) and its Regional Water Quality Control Board (RWQCB) administer the National Pollution Discharge Elimination System (NPDES) program. The NPDES permit system was established as part of the Federal Clean Water Act to regulate both point source discharges and non-point source discharges to surface water of the United States, including the discharge of soils eroded from construction sites.

The NPDES program consists of characterizing receiving water quality, identifying harmful constituents (including siltation), targeting potential sources of pollutants (including excavation and grading operations), and implementing a comprehensive stormwater management program. Construction and industrial activities typically are regulated under statewide general permits that are issued by the SWRCB. Additionally, the SWRCB issues Water Discharge Requirements that also serve as NPDES permits under the authority delegated to the RWQCBs, under the Clean Water Act. See Section 4.9 of this EIR, "Hydrology and Water Quality," for more information about the NPDES.

Local Regulations

City of Livermore General Plan

The City of Livermore General Plan Land Use Element contains a Hillside Conservation (HLCN) designation intended to avoid development in hazardous hillside conditions, among other purposes. This designation establishes a series of performance standards for determining density, based on physical and environmental features such as slope gradient, ridgelines, and existing and potential landslides. Relatively unconstrained sites, those with slopes below 20 percent gradient, will be permitted up to 1 dwelling unit per 20 acres; sites with steeper slopes and additional constraints will be permitted 1 unit per 100 acres. No development is permitted on the steepest slopes or ridgetops.

The City of Livermore General Plan Public Safety Element includes policies to prevent the creation of new geologic hazards. Urban development within areas of high landslide susceptibility

and moderate or high geologic hazard is required to have conducted site-specific geotechnical investigation. All critical facilities to be constructed are required to have conducted site-specific geotechnical investigation.

City of Livermore Grading Ordinance

The City of Livermore has a grading ordinance (Livermore Municipal Code 3.05.300) that promotes public safety by permitting certain grading activities and requiring a conditional use permit for other grading activities that could potentially lead to erosion and ground movement.

City of Livermore Building Code Ordinance

The City of Livermore has adopted the International Building Code, 2015 Edition, as amended and set forth in the California Building Standards Code, Title 24 of the California Code of Regulations, together with Chapter 1, Division II, Scope and Administration, and Appendices Chapters C and J (Livermore Municipal Code 15.02.020), except as set forth in Livermore Municipal Code.

Impact Analysis

SIGNIFICANCE CRITERIA

Implementation of the proposed Plan would have a potentially significant adverse impact if it would:

Criterion 1: 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 or based on other substantial evidence of a known fault,
- Strong seismic ground shaking,
- Seismic-related ground failure, including liquefaction, or
- Landslides.

Criterion 2: Result in substantial soil erosion or topsoil loss;

Criterion 3: 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;

Criterion 4: Be located on expansive soil, as defined in Section 1803.5.3, Expansive Soil, of the California Building Standards Code (2013), creating substantial risks to life or property; or

Criterion 5: Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

METHODOLOGY AND ASSUMPTIONS

This evaluation of geologic and seismic hazard conditions was completed using published geologic, soils, and seismic maps and studies from USGS, CGS, and ABAG. In order to reduce or mitigate potential hazards from earthquakes or other local geologic hazards, implementation of the proposed Plan would ensure that development will continue to be completed in compliance with local and State regulations. These regulations include the CBC, the Seismic Hazard Mapping Act, and the City of Livermore Municipal Code. Policies and implementation measures developed for the Proposed Project include continued conformance with these applicable local and State building regulations.

IMPACTS

Impact 3.12-1 Implementation of the proposed Plan would not 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 or based on other substantial evidence of a known fault; strong seismic ground shaking; seismic-related ground failure, including liquefaction, or; landslides. ***(Less than Significant)***

Fault Rupture

While the City of Livermore is listed as being affected by an Alquist-Priolo Earthquake Fault Zone (California Geological Survey, 2010), no faults zoned under the Alquist-Priolo Earthquake Fault Zoning Act are present within the Planning Area. The Alquist-Priolo Earthquake Fault Zones nearest to the Planning Area are associated with the Calaveras Fault, approximately 5.5 miles to the southwest, and the Greenville Fault, approximately 6.3 miles to the northeast. Because there are no known active faults within the Planning Area, there would be no impact resulting from the rupture of a known earthquake fault.

Ground Shaking

Risks due to seismic ground shaking are legislated for structures intended for human habitation by the Seismic Hazards Mapping Act. In general, ground shaking tends to be more severe in softer sediments such as alluvial deposits than in bedrock materials, because in alluvial deposits surface waves can be amplified causing a longer duration of ground shaking. Areas where bedrock is exposed or located at relatively shallow depth tend to experience surface waves from an earthquake as more of a sharp jolt, compared to other areas. Due to the proximity of the Calaveras and Greenville Faults, locations within the Planning Area could experience considerable ground shaking in the event of an earthquake.

Fault activity has the potential to result in ground shaking, which can be of varying intensity depending on the nature or profile of earthquake activity, proximity to that activity, and local soils and geology conditions. Earthquake damage to structures can be caused by ground shaking. The level of damage at a location resulting from an earthquake depends upon the magnitude of the event, the epicenter distance, the response of geologic materials, and the design and construction quality of structures. Due to the proximity of the Calaveras, Greenville, and Mount Diablo Thrust

fault locations, the Planning Area could experience considerable ground shaking in the event of an earthquake which could bring widespread and serious damage to the City of Livermore.

Development occurring under the proposed Plan would be required to conform to the current seismic design provisions of the most current version of the CBC. The CBC contains the latest seismic safety requirements to resist ground shaking through modern construction techniques, which are periodically updated to reflect the most recent seismic research. Road construction would be required to conform to Caltrans standards and standard industry practices. Compliance with existing CBC requirements, Caltrans standards, and standard industry practices would reduce potential impacts from ground shaking to the greatest extent feasible and impacts would be less than significant.

Liquefaction

Risks due to seismic induced liquefaction are legislated for structures intended for human habitation by the Seismic Hazards Mapping Act. Similarly, Caltrans standards govern risk management for roadways in California. Damage from earthquake-induced ground failure associated with liquefaction could be high in buildings constructed on improperly engineered fills or saturated alluvial sediments that have not received adequate compaction or treatment in accordance with current building code requirements. In addition, damage from earthquake-induced ground failure associated with liquefaction could be high on roadways constructed on improperly engineered fills or saturated alluvial sediments that have not received adequate compaction or treatment in accordance with current Caltrans standards.

As shown in Figure 3.12-2, some locations within the Planning Area are prone to liquefaction hazards. Almost all of the areas bordering the Arroyo Las Positas and Collier Canyon Creek are at very high risk of liquefaction due to the presence of soils that are often saturated or characteristic of wetlands. In addition, a small area in the southeast portion of the Planning Area north of East Airway Boulevard and bounding U.S. I-580 is at high risk of liquefaction (ABAG, 2017). However, the majority of these high-risk areas would be preserved as open space in the proposed Plan and would not be developed with buildings or roadways.

In areas of moderate risk of liquefaction where buildings or roadways would be constructed, impacts from ground failure resulting from liquefaction would be addressed through site-specific geotechnical studies prepared in accordance with CBC requirements or Caltrans standards and standard industry practices. Conformance with CBC requirements or Caltrans standards and standard industry practices, would reduce potential impacts related to ground-failure resulting from liquefaction to a less than significant level.

Seismically Induced Landslides

Risks due to seismically induced landslide are legislated for structures intended for human habitation by the Seismic Hazards Mapping Act. Similarly, Caltrans standards govern risk management for roadways in California. Landslides may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features such as steep slopes or banks, slanted vegetation, and transverse ridges. Landslide-susceptible areas are characterized by steep slopes and downslope creep of surface materials. While the majority of land within the Planning Area is relatively flat, with a slope of 0 to 10 percent, a small area to the north of Portola Avenue and east of Campus Hill Drive may be landslide susceptible due to slopes of 20 percent (see Figure

3.12-3). Most of this area is designated Open Space under the proposed Plan, and a portion is already developed with residential use (Shea Montage Homes). Other nearby landslide-susceptible land is located northwest of the Planning Area, which is designated as Open Space. The remaining areas that are landslide-susceptible land are located outside the Planning Area.

The potential for the development of future structures within the Planning Area to exacerbate existing hazards associated with the potential for the occurrence of landslides would be addressed through site-specific geotechnical studies prepared in accordance with CBC requirements and standard industry practices, which would specifically address landslide hazards located in landslide hazard areas. Development would conform to recommendations in the site-specific geotechnical studies and the current design provisions of the CBC to avoid or minimize losses from landslides. The potential for the development of future roadways within the Plan Area to exacerbate existing hazards associated with the potential for the occurrence of landslides would be addressed through adherence to Caltrans standards and standard industry practice. With compliance with CBC requirements or Caltrans standards and adherence to standard industry practices, the potential for adverse landslide impacts related to proposed changes from implementation of the proposed Plan is considered less than significant.

Mitigation Measures

None required.

Impact 3.12-2 Implementation of the proposed Plan would not result in substantial soil erosion or topsoil loss. (*Less than Significant*)

Construction associated with the proposed Plan would include earthwork activities that could expose soils to the effects of erosion or loss of topsoil. Once disturbed, either through removal of vegetation, asphalt, or an entire structure, exposed and stockpiled soils, if not managed appropriately, could be exposed to the effects of wind and water. Generally, earthwork and ground-disturbing activities, unless below a certain size, require a grading permit from the City or, in the case of roadway construction, adherence to Caltrans standards. The City's grading ordinance requirements (Livermore Municipal Code 3.05.300 Grading Activities), also requires a Conditional Use Permit (CUP) for grading activities within a flood hazard zone or within 150 feet of the top of the bank of any creek, arroyo, or drainage channel or would otherwise The CUP would include measures to protect exposed soils. A CUP for other grading activities that could potentially lead to erosion and ground movement would also be required. Compliance with the grading ordinance or Caltrans standards would minimize erosion impacts.

In addition, construction that disturbs more than one acre would be subject to compliance with a NPDES permit. The NPDES permit requires implementation of best management practices (BMPs) and a storm water pollution prevention plan (SWPPP). BMPs that are required under a SWPPP include erosion prevention measures that have proven effective in limiting soil erosion and loss of topsoil. Projects disturbing less than an acre of ground surface during construction would not be required to prepare a SWPPP, but would be required to implement the construction site control BMPs required by the Alameda County Municipal NPDES permit.

Generally, once construction is complete and exposed areas are revegetated or covered by buildings, asphalt, or concrete, the erosion hazard is substantially eliminated or reduced.

Compliance with applicable codes and regulations would reduce the potential for substantial soil erosion or topsoil loss resulting from implementation of the proposed Plan to be less than significant.

Mitigation Measures

None required.

Impact 3.12-3 Implementation of the proposed Plan would not result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse due to location of structures on a geological unit or soil that is unstable or that would become unstable as a result of the project. (*Less than Significant*)

Areas with underlying materials that include undocumented fills, soft compressible deposits, or loose debris could be inadequate to support development, especially multi-story buildings. Structures, including residential units and commercial buildings, and roadways could be damaged as a result of settlement where structures or roadways are underlain by materials of varying engineering characteristics. Construction of new structures or roadways in the vicinity of relatively steep slopes could provide additional loading, causing landslides or slope failure from unstable soils or geologic units. Slope failure could also occur through earthwork and grading related activities.

As discussed, while the majority of land within the Planning Area is relatively flat, with less than 10 percent slope, a small area to the north of Portola Avenue and east of Campus Hill Drive may be landslide susceptible because of its slopes of 20 percent (See Figure 3.12-3). Other landslide-susceptible land within the City is outside of the Planning Area.

The potential hazards of unstable soil or geologic units would be addressed through the integration of geotechnical information into the planning and design process for future projects within the Planning Area. Geotechnical investigations for specific projects within the Planning Area would be required to thoroughly evaluate site-specific geotechnical characteristics such as subsurface soils and bedrock to assess potential hazards and recommend site preparation and design measures to address any hazards which may be present. These measures would be enforced through compliance with CBC requirements to avoid or reduce hazards relating to unstable soils and slope failure or Caltrans standards. Therefore, with compliance with standard industry practices and State requirements, impacts related to landslides, lateral spreading, subsidence, liquefaction, or collapse resulting from implementation of the proposed Plan would be less than significant.

Mitigation Measures

None required.

Impact 3.12-4 Implementation of the proposed Plan would locate structures on expansive soil, as defined in Section 1803.5.3, Expansive Soil, of the California Building Standards Code (2013), creating substantial risks to life or property. *(Less than Significant)*

As described above, the Planning Area consists of several soil types, including Diablo, Rincon, Linne, and Pescadero clay or clay-loam, which are moderately to highly expansive. Soils that exhibit expansive properties when exposed to varying moisture content over time could result in damage

to foundations, walls, or other improvements. The Planning Area consists mostly of soils which are low to moderately corrosive to concrete and moderate to highly corrosive to steel. Corrosive soils can constrain foundation and utility construction design. Development in areas with expansive and corrosive soils would require compliance with State and local building codes (structures) or with Caltrans standards (roadways). Compliance with these codes or standards would require soil and geologic investigations, which would ensure that the impact resulting from the location of structures on expansive or corrosive soils would be less than significant.

Mitigation Measures

None required.

Impact 3.12-5 Implementation of the proposed Plan would not locate structures on 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. ***(No Impact)***

Future development that may result from implementation of the proposed Plan would not require septic systems or other alternative wastewater disposal systems. Rather, all new construction resulting from the implementation of the proposed Plan would be tied into the City's existing wastewater collection system Therefore, implementation of the proposed Plan would have no impact related to the location of structures on soils incapable of supporting septic tanks or alternative wastewater disposal systems.

Mitigation Measures

None required.

This page intentionally left blank.