4.5 GEOLOGY, SOILS, AND SEISMICITY

This chapter describes potential impacts associated with the implementation of the proposed Serramonte Shopping Center Expansion Project (Project) that may be related to geology, soils, and seismicity. This chapter also describes the environmental setting of the Project, including the regulatory framework, existing conditions, and policies and mitigation measures that would prevent or reduce significant impacts.

4.5.1 ENVIRONMENTAL SETTING

The State of California as well as the City of Daly City have enacted laws and developed regulations that pertain to geology, soils, and seismicity. There are no federal laws or regulations related to geology, soils, and seismicity that are applicable to the Project. The following laws and regulations are relevant to the California Environmental Quality Act (CEQA) review process for the Project.

4.5.1.1 REGULATORY FRAMEWORK

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface fault rupture to structures used for human occupancy.[1] The main purpose of the Act is to prevent the construction of buildings used for human occupancy on top of the traces of active faults. It was passed into law following the February 1971 M_w 6.5 San Fernando (Sylmar) Earthquake that resulted in over 500 million dollars in property damage and 65 deaths.[2] Although the Act addresses the hazards associated with surface fault rupture, it does not address other earthquake-related hazards, such as seismically induced ground shaking, liquefaction, or landslides.

This Act requires the State Geologist to establish regulatory zones, formerly known as Special Studies Zones and now referred to as Earthquake Fault Zones (i.e., "EFZs"), around the mapped surface traces of active faults, and to publish appropriate maps that depict these zones.[3] For the purposes of the Alquist-Priolo Act, an "active" fault is defined by the State Mining and Geology Board as one which has "had surface displacement within Holocene time (about the last 11,000 years)."[4] EFZ maps are made publicly available and distributed to all affected cities, counties, and State agencies for their use

[1] Originally titled the *Alquist-Priolo Special Studies Zones Act* until renamed in 1993, Public Resources Code Division 2, Ch. 7.5, Sect. 2621.

[2] Southern California Earthquake Data Center, 2014, http://www.data.scec.org/significant/sanfernando1971.html, accessed on November 17, 2014.

[3] California Geological Survey (USGS), 2014, Alquist-Priolo Earthquake Fault Zones, http://www.conservation.ca.gov/cgs/rghm/ap/Pages/Index.aspx, accessed on November 18, 2014.

[4] California Geological Survey (USGS), 2007. Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones, Special Publication 42, Interim Revision 2007.

in planning and controlling new or renewed construction. In general, the law prohibits construction within 50 feet of an active fault trace.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, which was passed by the California legislature in 1990, addresses earthquake hazards related to liquefaction and seismically induced landslides. Under the Act, seismic hazard zones are mapped by the State Geologist in order to assist local governments in land use planning. The Act states "it is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety."[5] Section 2697(a) of the Act states that "cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard."[6]

California Building Code

The California Building Code (CBC), known as the California Building Standards Code, is included in Title 24 of the California Code of Regulations. The CBC incorporates the International Building Code, a model building code adopted across the United States. Current State law requires every local agency enforcing building regulations, such as cities and counties, to adopt the provisions of the CBC within 180 days of its publication. The publication date of the CBC is established by the California Building Standards Commission. The most recent building standard adopted by the legislature and used throughout the state is the 2013 version of the CBC, which took effect on January 1, 2014. The CBC, as adopted by local cities or counties, is often modified with more restrictive amendments that are based on local geographic, topographic, or climatic conditions. These codes provide minimum standards to protect property and public safety. They regulate the design and construction of excavations, foundations, building frames, retaining walls, and other building elements, and thereby mitigate the effects of seismic shaking and adverse soil conditions.[7] The codes also regulate grading activities, including drainage and erosion control.

Local Regulations

City of Daly City 2030 General Plan

The Safety Element of City of Daly 2030 General Plan (2030 General Plan), adopted on March 25, 2013, includes goals, policies, and programs that are intended to reduce the risks associated with geology, soils, and seismic hazards. Table 4.5-1 lists these goals, policies, and programs.

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[5] California Public Resources Code, Division 2, Chapter 7.8, Section 2691(c).
[6] California Public Resources Code, Division 2, Chapter 7.8, Section 2697(a).
[7] California Building Standards Commission, http://www.bsc.ca.gov/codes.aspx, accessed on August 20, 2014.

TABLE 4.5-1 CITY OF DALY CITY GENERAL PLAN GOALS, POLICIES, AND PROGRAMS RELEVANT TO GEOLOGY, SOILS, AND SEISMICITY

Goal/Policy/Program Number	Goal/Policy/Program
Safety Element Goal	"Promote a safe environment which minimizes the potential risks from manmade and natural disasters, informs and educates the public on appropriate procedures to follow during emergencies, and integrates data from these disasters to identify hazardous areas and mitigation measures."
Policy SE-1.1	Continue to investigate the potential for seismic and geologic hazards as part of the development review process and maintain this information for the public record. Update Safety Element maps as appropriate.
Policy SE-1.2	Require site-specific geotechnical, soils, and foundation reports for development proposed on sites identified in the Safety Element and its Geologic and Hazard Maps as having moderate or high potential for ground failure.
Policy SE-1.3	Permit development in areas of potential geologic hazards only where it can be demonstrated that the project will not be endangered by, nor contribute to, the hazardous condition on the site or on adjacent properties. All proposed development is subject to the City's Zoning Ordinance and Building Codes.
Policy SE-1.4	Prohibit development - including any land alteration, grading for roads and structural development - in areas of slope instability or other geologic concerns unless mitigation measures are taken to limit potential damage to levels of acceptable risk.
Policy SE-1.5	Design and improve all critical care facilities and services to remain functional following the maximum credible earthquake. Avoid placement of critical facilities and high-occupancy structures in areas prone to violent ground shaking or ground failure.
Policy SE-1.6	Work with San Mateo County, California Water Service Company, and the San Francisco Water Department to ensure that all water tanks and San Francisco's main water pipeline are capable of withstanding high seismic stress.
Policy SE-5.3	Continue to analyze the significant seismic, geologic and community-wide hazards as part of the environmental review process; require that mitigation measures be made as conditions of project approval.
Program S-1	Grading and Erosion Control Ordinance. Adopt ordinance which ensures that new construction, on-going businesses, and municipal maintenance will preserve storm water runoff which flows to the ocean and bay.
Program S-2	Implementation of Erosion Control Program. Inspection and monitoring of construction activities to ensure compliance with the erosion and grading ordinance.
Program S-3	Establishment of a Geological Sensitive Zone. This program involves identifying geologically sensitive areas throughout Daly City. These areas could include land subject to landslides, erosion, and areas with steep slopes. The first phase of program will identify these areas. The second phase will include these areas in a combining district and preparation of performance standards to be included in Zoning Ordinance.

Source: City of Daly City, Daly City 2030 General Plan, adopted March 25, 2013.

Municipal Code

The City of Daly City Municipal Code contains all adopted ordinances for the city. The Municipal Code is organized by Title, Chapter, and Section. The current Municipal Code is codified through Ordinance No. 1382, which was passed on August 11, 2014.

The City of Daly City has adopted the 2013 CBC, by reference, as the basis for the City's Building Code. The provisions of the Building Code are set forth in Title 15, Chapter 15.08 of the City of Daly City Municipal Code.[8] A number of additions, amendments, or deletions were made to the CBC as it was adopted in the Municipal Code, although none appeared to be relevant to hazards associated with geology, soils, and seismicity.

Chapter 15.10.150 of the Municipal Code does contain requirements for seismic reinforcement that are applicable to certain residential structures. Chapter 15.62 entitled "Grading, Erosion, and Sediment Control" contains a number of rules and regulations that govern site clearing, vegetation disturbances, backfilling, excavations, and related activities that have the potential to cause sediments and other pollutants to enter public drainages. The chapter sets forth regulations, permit requirements, and enforcement protocols to effectively control these activities.

4.5.1.2 EXISTING CONDITIONS

This section includes a discussion of the existing geologic, soil, and seismic conditions in the vicinity of the Project.

Geology

The Project site is located within the United States Geological Survey's (USGS's) San Francisco South, California 7.5-minute topographic quadrangle map (see Figure 4.5-1). From a geomorphology perspective, the Project site and the surrounding parts of Daly City lie in the San Francisco Peninsula which is set within the Coast Ranges Geomorphic Province. The San Francisco Peninsula lies north of the Santa Cruz Mountains where it is flanked by the Pacific Ocean and San Francisco Bay to the west and east, respectively. The Coast Ranges Geomorphic Province is typified by northwest-southeast trending mountain ranges that stretch from the Oregon border to the north to Point Conception to the south. In the San Francisco Bay area, most of the Coast Ranges are underlain by tectonically complex, Jurassic- to Cretaceous-age bedrock of the Franciscan Complex.

The topography in the immediate vicinity of the Project site is typified by undulating hills. Ground surface elevations near the Project site generally range from 200 to 500 feet above mean sea level (amsl), whereas the San Bruno Mountains to the northeast locally attain elevations in excess of 1,300 feet amsl.[9] Much of the runoff in the Project vicinity flows east to Colma Creek, whose southeast-trending drainage eventually discharges to San Francisco Bay.

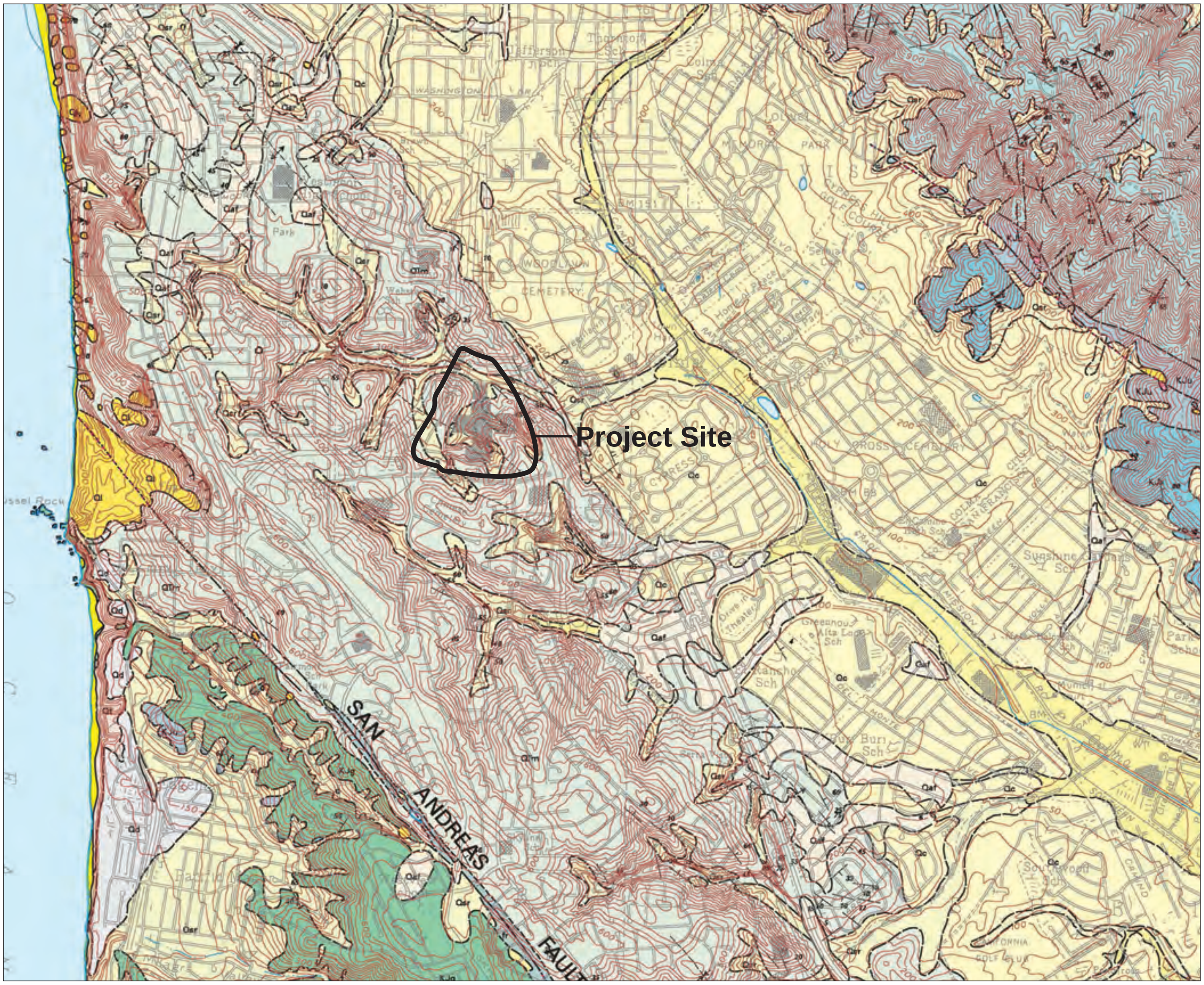
Based on the geologic mapping conducted by the USGS, the Project site is immediately underlain by clastic sediments of the Pliocene to Pleistocene age (i.e., 5 million to 10,000 years before present) Merced Formation, described as medium-grey to yellowish orange, friable to firm sand, silt, and clay with minor amounts of gravel, lignite, and volcanic ash.[10] The Merced Formation crops out in a broad, fault-bounded trough that is partially exposed along the coastal bluffs northwest of the

[8] City of Daly City Municipal Code, https://www.municode.com/library/ca/daly_city/codes/code_of_ordinances, accessed on November 18, 2014.

[9] US Geological Survey (USGS), 1995, San Francisco South Quadrangle, California, 7.5-Minute Series (Topographic), scale 1:24,000.

[10] US Geological Survey (USGS), 1998, Preliminary Geologic Map of the San Francisco South 7.5' Quadrangle and Part of the Hunter's Point 7.5' Quadrangle, San Francisco Bay Area, California, by M. G. Bonilla, Open-File Report 98-354.

GEOLOGY, SOILS, AND SEISMICITY



Source: US Geological Survey, Preliminary Geologic Map of the San Francisco South 7.5' Quadrangle and Part of the Hunter's Point 7.5' Quadrangle, San Francisco Bay Area, California, M. G. Bonilla, Open-File Report 98-354, 1998.

water

QUATERNARY
Holocene

Qaf Artificial fill
Clay, silt, sand, rock fragments, organic matter, and man-made debris.

Qaf/tf Artificial fill over tidal flat
Clay, silt, sand, rock fragments, organic matter, and man-made debris, placed over tidal flats.

Qafs Artificial fill, Native American shellmound
Dark silty to sandy soil containing shell fragments and rare intact shells.

Ql Landslide deposits
Composition and structure depend on the geologic formation involved and type of landslide.

Qal Alluvium
Mostly sand and silt but locally contains clay, gravel, or boulders; generally gray to brown.

Qb Beach Deposits
Predominantly well sorted medium-grained loose gray sand; locally consists of sand, gravel and cobbles.

Qm Bay mud
Soft (moist) to firm (dry) clay and silt, locally contains shell fragments, plant remains, and thin beds of sand.

Qd Dune sand
Well sorted fine-grained sand, gray and loose in most places, grayish orange to reddish brown and firm in a few places. Age extends into Pleistocene

TERTIARY AND QUATERNARY
Pleistocene and Pliocene

QTm Merced Formation
Friable to firm sand, silt, and clay; minor amounts of gravel, lignite, and volcanic ash, medium gray to yellowish orange.

CRETACEOUS AND JURASSIC
Franciscan Complex and associated rocks

KJs Sandstone and shale
Interbedded sandstone and shale, hard where fresh and intact, soft where weathered or sheared. Commonly medium dark gray where fresh, olive gray to yellowish brown where moderately weathered, and yellowish orange to yellowish gray where highly weathered.

KJsk Sandstone and shale
Sandstone generally containing more than two percent potassium feldspar.

KJc Chert
Hard chert interbedded with firm shale; chert layers generally two or three inches thick, shale layers less than one inch thick; generally grayish red.

KJg Greenstone
Altered volcanic rocks, fine grained, mostly basalt; hard where fresh, but weathered and firm to soft in most exposures; commonly grayish olive to moderate olive gray where moderately weathered, dark yellowish orange to light brown where highly weathered.

KJm Metamorphic rocks
Hard to firm, fine- to coarse-grained schistose, gneissose, or granulose metamorphic rocks; dark gray, dark greenish gray, or dark bluish gray.

sp Serpentine
Hard to soft, generally greenish gray; contains small bodies of grabbro and diabase.

KJu Sheared rocks
Small to large fragments of hard rock in matrix of sheared rock. Matrix generally coherent and firm, but soft in places, especially where weathered. Dark gray where fresh, yellowish brown where weathered. Derived mostly from shale and sandstone of Franciscan Complex and serpentine.

0 1
Scale (Miles)

Pleistocene

Qt Marine terrace deposits
Predominantly friable well sorted fine-grained yellowish-orange to gray sand; includes alluvial gravel and colluvial clay.

Qsr Slope debris and ravine fill
Stony silty to sandy clay; locally silty to clayey sand or gravel; yellowish orange to medium gray, unstratified or poorly stratified. Where it overlies the Merced or Colma Formation it is commonly a silty to clayey sand, or gravel.

Qc Colma Formation
In northwest and central parts of area, friable well sorted fine to medium sand containing a few beds of sandy silt, clay, and gravel. In southeast part of area, mostly sandy clay and silty sand; yellowish orange to gray.

Qu Sedimentary deposits, undifferentiated

fr Fault rocks
Zone of gouge, breccia, fractured and sheared rock along the San Andreas fault. Gradational contact with surrounding rocks. Limits poorly known. Age extends into Holocene.

Figure 4.5-1
Geologic Map

Project site. The Merced Formation, in turn, lies stratigraphically below the Late Pleistocene age (125,000 to 10,000 years old) Colma Formation, which is composed of sandy, near-shore and beach deposits, as well as Recent dune sands.

Soils

Web-accessible soil mapping data compiled by the United States Department of Agriculture's (USDA) Natural Resources Conservation Service (formerly, the Soil Conservation Survey) was used to identify the major soil types within the vicinity of the Project (see Figure 4.5-2). The dominant soil types include the Orthent and Urban-Orthent soil complexes, with lesser areas of Urban Land soil complex.[11] These soils are formed on slopes of varying steepness, generally ranging from flat (i.e., 0 percent slope) to slopes as steep as 75 percent.

The soils of the dominant Orthent and Urban-Orthent complexes are typically formed on alluvial fans, terraces, and hills. According to the USDA, these soils are often well drained, although their properties and characteristics can be variable. Susceptibility to runoff is described as medium, and erosion hazards are moderate. These soils reportedly include undisturbed loamy material on coastal terraces; areas that have been graded for residential and other urban uses; smoothed areas on alluvial fans and plains; and reclaimed areas near San Francisco Bay.[12]

In general, expansive soils in the City of Daly City are not prevalent. Nevertheless, customary geotechnical investigations prior to development could indicate their presence, in which case, a wide range of treatments are available to mitigate these soils. Potentially applicable techniques include: soil grouting, recompaction, and replacement with a non-expansive material.

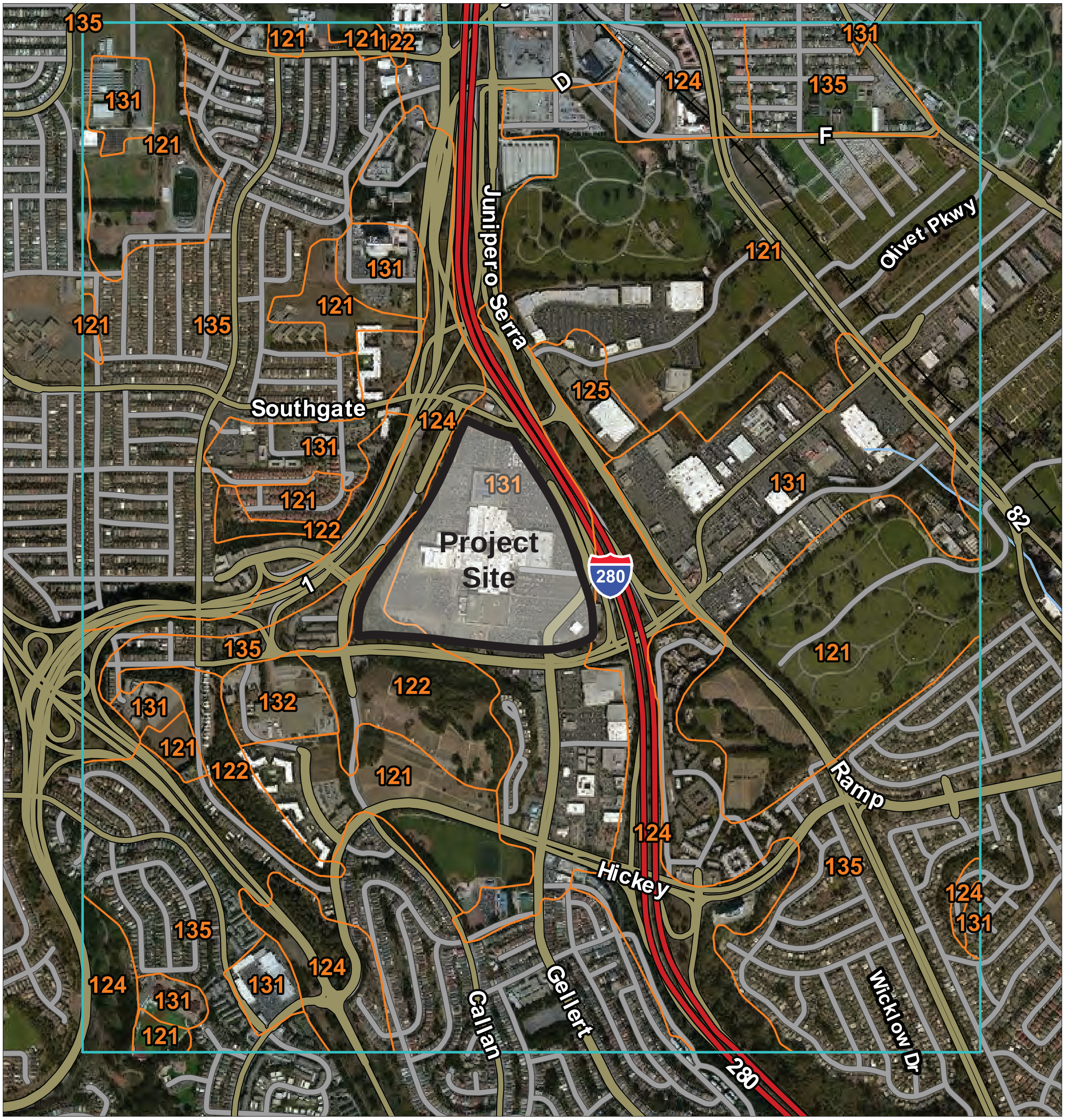
Regional Faulting, Seismicity, and Related Seismic Hazards

The Earth's crust is comprised of tectonic plates that collide with or slide past one another along plate boundaries. California is particularly susceptible to such plate movements, notably, the largely horizontal or "strike-slip" movement of the Pacific Plate as it impinges on and slides past the western margin of the North American Plate. In general, earthquakes occur when the accumulated stress along a plate boundary or fault is suddenly released, resulting in seismic slippage. The amount (i.e., distance) of slippage can vary widely, ranging in scale from a few millimeters or centimeters, to tens of feet.

The performance of man-made structures during a major seismic event varies widely due to a number of factors: location with respect to active fault traces or areas prone to liquefaction or seismically-induced landslides; the type of building construction (i.e., wood frame, unreinforced masonry, non-ductile concrete frame); the proximity, magnitude, and intensity of the seismic event itself; and many other factors. In general, evidence from past earthquakes shows that wood frame structures tend to perform well, especially when their foundations are properly designed and anchored. Older, unreinforced masonry structures, on the other hand, do not perform as well, especially if they have not undergone appropriate seismic retrofitting. Applicable building code requirements, such as those found in the CBC, include seismic

[11] US Dept. of Agriculture, Natural Resources Conservation Service, 2014, Custom Soil Resource Report for San Mateo County, Eastern Part, and San Francisco County, California, dated November 24, 2014.

[12] US Dept. of Agriculture, Soil Conservation Service, 1991, Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California, dated May 1991.



	Map Unit Name
121	Orthents, cut and fill, 0 to 15 percent slopes
122	Orthents, cut and fill, 15 to 75 percent slopes
124	Orthents, cut and fill-Urban land complex, 5 to 75 percent slopes

125	Pits and Dumps
131	Urban land
132	Urban land-Orthents, cut and fill complex, 0 to 5 percent slopes
135	Urban land-Orthents, smoothed complex, 5 to 50 percent slopes

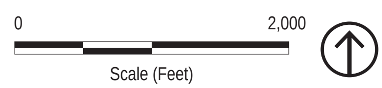


Figure 4.5-2
Soil Types

requirements that are designed to ensure the satisfactory performance of building materials under prescribed seismic conditions.

Seismic potential in the Daly City area is dominated by the nearby San Andreas Fault System that lies as close as 0.9 miles southwest of the Project site. The faults that comprise this system are typified by right-lateral, strike-slip movement. Other active earthquake faults in the region include the Hayward and Calaveras Faults that lie roughly 18 to 24 miles to the east of the Project site, respectively, and the San Gregorio Fault, which passes as close as 8 miles to the southwest (see Figure 4.5-3).[13] Based on maps published by the California Geological Survey (CGS), the only Alquist-Priolo Earthquake Fault Zone that has been mapped in the immediate vicinity of the Project is the zone that flanks the San Andreas Fault. This zone does not cross the Project site.

A number of significant earthquakes have been recorded on the San Andreas Fault since 1800. The 1906 San Francisco Earthquake, with an estimated magnitude between M_W 7.7 and 8.3, caused the most significant damage and loss of life in the recorded history of the region. The surface rupture along the San Andreas Fault extended approximately 270 miles producing ground surface offset of more than 20 feet in some locations. The earthquake was felt as far away as Oregon, Nevada, and Los Angeles.

Another smaller, but locally notable earthquake on the San Andreas Fault occurred on March 22, 1957.[14] The epicenter of this M_w 5.4 earthquake was located close to Mussel Rock, less than two miles west of the Project site. Although the event was of a relatively short duration (approximately five seconds of strong shaking), it triggered landslides along the banks of Lake Merced and slope failures along State Route 1.

Approximately 25 years ago, the M_W 6.9 Loma Prieta earthquake of October 1989 on the San Andreas Fault caused significant damage throughout the San Francisco Bay Area, although no deaths were reported in San Mateo County. The epicenter of the Loma Prieta event was located more than 40 miles southeast of the Project site.[15]

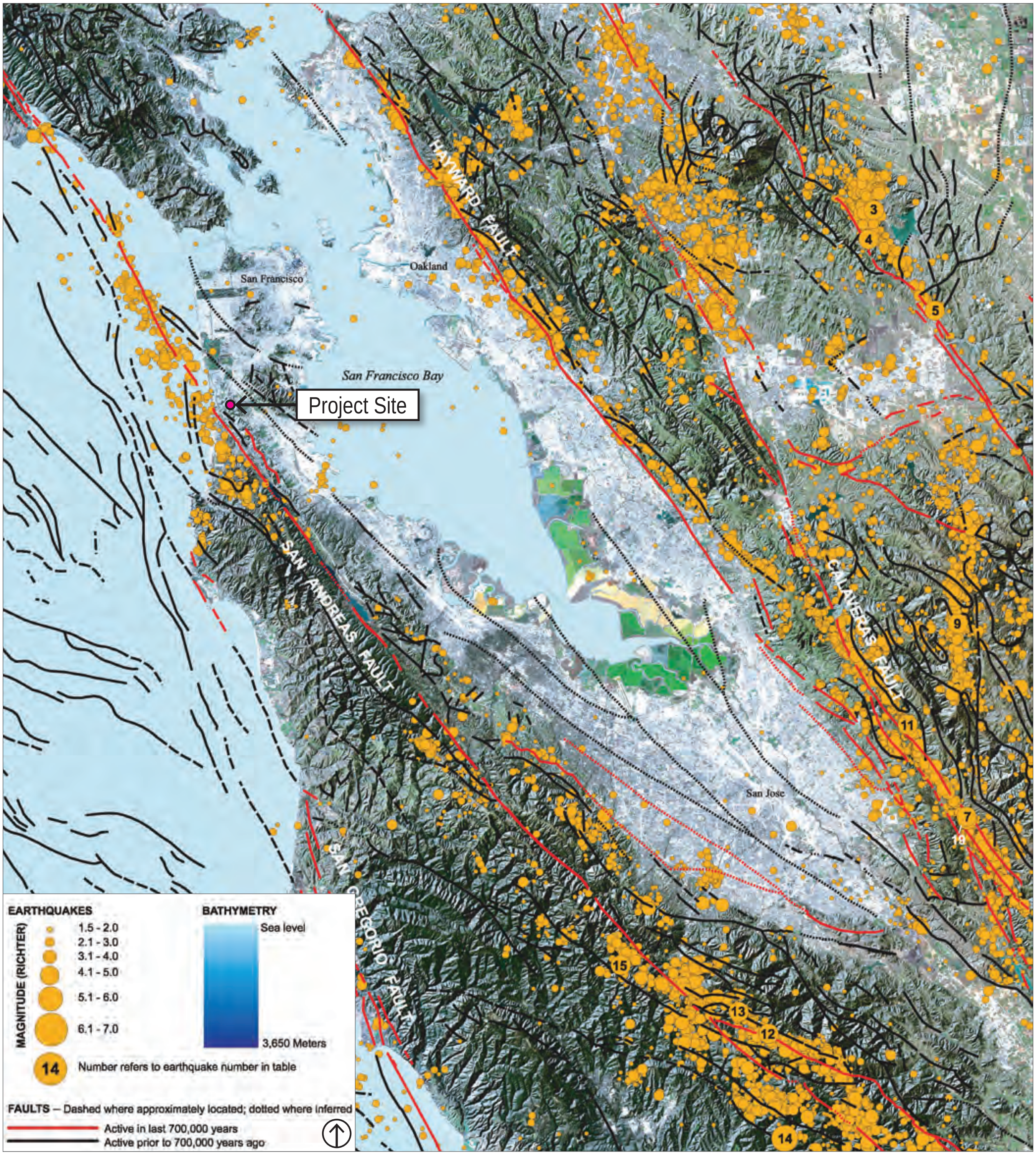
Most recently, the August 24, 2014 M_W 6.0 Napa earthquake, located near the City of Napa roughly 39 miles northeast of the Project site, underscored the regional seismic hazards in the San Francisco Bay Area.[16] This earthquake represented the largest regional seismic event since Loma Prieta, and it resulted in the destruction of more than 70 structures and approximately one billion dollars in total damage.

[13] US Geological Survey (USGS), 2004, Earthquakes and Faults in the San Francisco Bay Area (1970-2003), Scientific Investigations Map 2848.

[14] US Geological Survey (USGS), 1971, Geology of the San Francisco North Quadrangle, California, Geological Survey Professional Paper 782, by Julius Schlocker.

[15] Univ. of California, Berkeley Seismological Laboratory, 2014, Loma Prieta: Remembering the Past, Planning for the Future, http://seismo.berkeley.edu/seismo/loma_prieta_25.html, accessed on December 8, 2014.

[16] US Geological Survey, 2014, Earthquake Hazards Program, http://earthquake.usgs.gov/earthquakes/eventpage/nc72282711#summary, accessed on August 26, 2014.



Source: US Geological Survey, 2004;
Earthquakes and Faults in the San Francisco Bay Area (1970-2003);
Scientific Investigations Map 2848.

Figure 4.5-3
Earthquakes and Faults in the San Francisco Bay Area

GEOLOGY, SOILS, AND SEISMICITY

Ground Shaking

The severity of seismic ground shaking depends on many variables, such as earthquake magnitude, hypocenter proximity, local geology (including the properties of unconsolidated sediments), groundwater conditions, and topographic setting. In general, ground-shaking hazards are most pronounced in areas that are underlain by loosely consolidated soil/sediment.

When earthquake faults within the San Francisco Bay Area's nine counties were considered, the USGS estimated that the probability of a M_W 6.7 or greater earthquake prior to year 2036 is 63 percent, or roughly a two-thirds probability over this timeframe.[17] Individually, the forecasted probability for a given earthquake fault to produce a M_W 6.7 or greater seismic event by the year 2036 is as follows: 31 percent for the Hayward Fault, 21 percent for the San Andreas Fault, 7 percent for the Calaveras Fault, and 6 percent for the San Gregorio Fault, as shown in Figure 4.5-4. Earthquakes of this magnitude can create ground accelerations severe enough to cause major damage to structures and foundations not designed to resist the forces generated by earthquakes. Underground utility lines are also susceptible where they lack sufficient flexibility to accommodate the seismic ground motion. In the event of an earthquake of this magnitude, the seismic forecasts presented on the Association of Bay Area Governments' website (developed by a cooperative working group that included the USGS and the CGS) suggest that the Project site is expected to experience "violent" shaking (i.e., Modified Mercalli Intensity [MMI] IX). [18]

Landslides

Landslides are gravity-driven movements of earth materials that can include rock, soil, unconsolidated sediment, or combinations of such materials. The rate of landslide movement can vary considerably; some move rapidly, as in a soil or rock avalanche, while other landslides creep or move slowly for extended periods of time. The susceptibility of a given area to landslides depends on many variables, although the general characteristics that influence landslide hazards are widely acknowledged. Some of the more important factors that can impact the likelihood of landslides are:

- **Slope Material:** Loose, unconsolidated soil and weakly indurated or highly fractured bedrock are more prone to landslides.
- **Slope Steepness:** Most landslides occur on moderate to steep slopes.
- **Structural Geometry:** The orientation of planar elements in soil or bedrock and their relationship to the ground surface can affect landslide probability.
- **Moisture:** Increased moisture, as it may be present in subsurface soil, bedrock pores, or bedrock fractures, can increase the likelihood of a landslide due to decreased internal friction and increased weight of the earth materials.
- **Vegetation:** Well-established vegetation, and the associated root structures, help promote slope stability.

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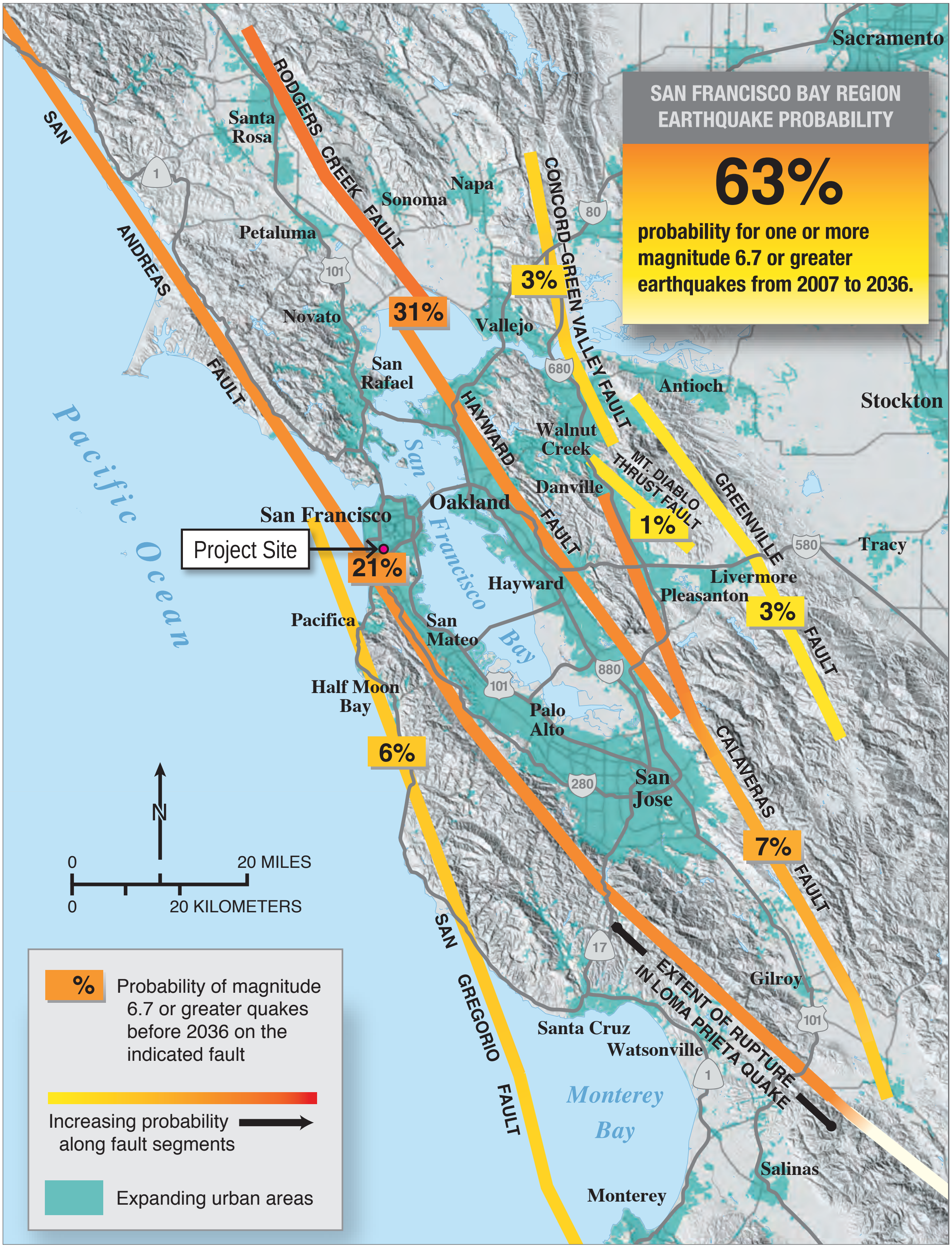
[17] US Geological Survey(USGS), 2014, 2008 Bay Area Earthquake Probabilities, http://earthquake.usgs.gov/regional/nca/ucerf/, accessed on August 25, 2014.

[18] Association of Bay Area Governments, 2014, San Mateo County Earthquake Hazards, http://resilience.abag.ca.gov/earthquakes/sanmateo/, accessed on November 21, 2014.



Source: US Geological Survey, 2008 Bay Area Earthquake Probabilities, 2014.

Figure 4.5-4
Bay Area Earthquake Probabilities

- **Eroded Slopes or Man-made Cuts:** Proximity to eroded faces in soil or bedrock, as well as proximity to cut (i.e., excavated) slope faces can increase landslide potential.
- **Seismic Shaking:** Strong seismic shaking can trigger landslides in otherwise stable slopes or loosen the slope materials such that they are more prone to landslides in the future.

Due to the prevailing gently rolling topography and lack of steep slopes, earthquake-induced landslides are unlikely to occur at the Project site. This is consistent with the maps prepared by the CGS that do not show any seismically induced landslide hazard zones at the Project site.

Liquefaction

Liquefaction generally occurs in areas where moist, fine-grained, cohesionless sediment or fill materials are subjected to strong, seismically induced ground shaking. Under certain circumstances, the ground shaking can temporarily transform an otherwise solid, granular material to a fluid state. Liquefaction is a serious hazard because buildings in areas that experience liquefaction may subside and suffer major structural damage. Liquefaction is most often triggered by seismic shaking, but it can also be caused by improper grading, landslides, or other factors. In dry soils, seismic shaking may cause soil to consolidate rather than flow, a process known as densification.

Recent USGS studies of liquefaction in the greater San Francisco area concluded that the liquefaction potential at the Project site and in its vicinity is "very low."[19] The USGS interpretation is consistent with regional liquefaction potential maps compiled by the Association of Bay Area Governments (ABAG).

Unstable Geologic Units

Expansive soils can change dramatically in volume depending on moisture content. When wet, these soils can expand; conversely, when dry, they can contract or shrink. Sources of moisture that can trigger this shrink-swell phenomenon include seasonal rainfall, landscape irrigation, utility leakage, and/or perched groundwater. Expansive soil can develop wide cracks in the dry season, and changes in soil volume have the potential to damage concrete slabs, foundations, and pavement. Special building/structure design or soil treatment are often needed in areas with expansive soils. Expansive soils are typically very fine-grained with a high to very high percentage of clay. The clay minerals present typically include montmorillonite, smectite, and/or bentonite.

Previous USDA soil surveys in the northwest part of San Mateo County contained very little soil test data for the soils of the Orthent and Urban-Orthent complexes that dominate the Project site. A 2005 geotechnical investigation of a neighboring property to the south of the Project site addressed potential hazards due to expansive soil (or bedrock). Due to its proximity and comparable geologic setting, this investigation is deemed relevant.[20] That study found that although most

[19] US Geological Survey (USGS), 2006, Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California, Open File Report 2006-1037, by Robert C. Witter, Keith L. Knudsen, Janet M. Sowers, Carl M. Wentworth, Richard D. Koehler, and Carolyn E. Randolph.

[20] Kleinfelder, 2005, Draft Supplemental Geologic and Geotechnical Report for Serramonte 200 Condominium Project, Daly City, California, dated August 12, 2005.

of the underlying bedrock of the Merced Formation consisted of sandy sediments with low expansion potential, local beds of clayey siltstone/sandstone with moderate to high expansion potential were locally present. The report recommended careful observation during grading, so that these highly plastic sediments can be identified and segregated, to preclude their on-site reuse as engineered fill.

4.5.2 STANDARDS OF SIGNIFICANCE

Prior to the development of this document, an Initial Study was prepared for the Project (see Appendix A). Based on the analysis contained in the Initial Study, it was determined that development of the Project would not result in significant environmental impacts for certain significance criteria. Consequently, the following significance criteria are not discussed in this chapter.

- 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.

The Initial Study determined that the Project would have a significant impact with regard to geology, soils, and/or seismicity if it would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
   - Surface rupture along a known active fault, including those faults identified on recent Alquist-Priolo Earthquake Fault Zoning Maps issued by the State Geologist, or active faults identified through other means (i.e., site-specific geotechnical studies, etc.).
   - Strong seismic ground shaking.
   - Seismic-related ground failure, including liquefaction.
   - Landslides.
2. Result in substantial soil erosion or the loss of topsoil.
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 landsliding, lateral spreading, subsidence, liquefaction, or collapse.
4. Be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code, creating substantial risks to life or property.

4.5.3 IMPACT DISCUSSION

This section analyzes potential impacts to geology, soils, and seismicity.

GEO-1	**The Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: surface rupture along a known active fault; strong seismic ground shaking; seismic-related ground failure, including liquefaction; and landslides.**

To date, no Alquist-Priolo Earthquake Fault Zones have been mapped at the Project site. Protections afforded by the Alquist-Priolo Act, as well as the CBC, which requires detailed geotechnical reports in areas of suspected geological hazards, suggest that the potential for ground rupture would be adequately mitigated for development of the Project. Nevertheless, in the event of a large, M_W 6.7 or greater, seismic event on the nearby San Andreas Fault, the Project site is expected to experience "violent" ground shaking according to seismic forecasts developed by a cooperative working group that included the USGS and the CGS. Based on published studies and maps of the Project site, the potential for seismically induced liquefaction and seismically inducted landslides appears to be low to very low.

CBC requirements, as adopted in the City of Daly City Municipal Code, require detailed soils and/or geotechnical studies in areas of suspected geological hazards. The protections afforded by these ordinances suggest that the potential for seismically induced liquefaction and seismically induced landslides would be adequately mitigated for development of the Project.

In addition to the safeguards discussed above, development of the Project would be subject to the following policies in the Safety Element of the City's General Plan:

- Policy SE-1.2: Require site-specific geotechnical, soils, and foundation reports for development proposed on sites identified in the Safety Element and its Geologic and Hazard Maps as having moderate or high potential for ground failure.
- Policy SE-1.3: Permit development in areas of potential geologic hazards only where it can be demonstrated that the project will not be endangered by, nor contribute to, the hazardous condition on the site or on adjacent properties. All proposed development is subject to the City's Zoning Ordinance and Building Codes.
- Policy SE-5.3: Continue to analyze the significant seismic, geologic and community-wide hazards as part of the environmental review process; require that mitigation measures be made as conditions of project approval.

Adherence to CBC requirements, applicable City ordinances and regulations, and General Plan policies would ensure that impacts are *less than significant*.

Applicable Regulations:

- Daly City General Plan
- Daly City Municipal Code (Title 15, Chapter 15.08)
- Daly City Municipal Code (Chapter 15.10.150)

Significance Before Mitigation: Less than significant.

GEO-2	**The Project would not result in substantial soil erosion or the loss of topsoil.**

Substantial soil erosion or loss of topsoil during construction could undermine structures and minor slopes, and this could be a concern during Project development. However, compliance with existing regulatory requirements, such as the implementation of grading erosion control measures specified in the CBC and Chapter 15.62 of the City of Daly City's Municipal Code, would reduce impacts from erosion and the loss of topsoil. Examples of these control measures are Best Management Practices (BMPs) such as hydroseeding or short-term biodegradable erosion control blankets; vegetated swales, silt fences, or other forms of protection at storm drain inlets; post-construction inspection of drainage structures for accumulated sediment; and post-construction clearing of debris and sediment from these structures. Chapter 15.62 of the Municipal Code, also known as the "City of Daly City Grading, Erosion and Sediment Control Ordinance," contains rules and regulations that control site clearing, vegetation disturbances, landfills, land excavations, soil storage, and other activities that can cause sediments and other pollutants to enter the storm drain system. The ordinance also includes permit requirements, as well as procedures for the administration and enforcement of permits to appropriately control these development-related activities.

In addition to the safeguards discussed above, future development at the Project site would be subject to the following proposed programs in the Safety Element of the City's General Plan:

- Program S-1: Grading and Erosion Control Ordinance - Adopt ordinance which ensures that new construction, on-going businesses, and municipal maintenance will preserve storm water runoff which flows to the ocean and bay.
- Program S-1: Implementation of Erosion Control Program - Inspection and monitoring of construction activities to ensure compliance with the erosion and grading ordinance.

Adherence to the aforementioned requirements would ensure that impacts associated with substantial erosion and loss of topsoil during the development allowed by the Project would be *less than significant*.

Applicable Regulations:

- Daly City General Plan
- Daly City Municipal Code (Chapter 15.62)

Significance Before Mitigation: Less than significant.

GEO-3	**The Project would not result in a significant impact related to development on unstable geologic units and soils or result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.**

Unstable geologic units are not known to be present at the Project site, and recent USGS studies in the greater San Francisco area concluded that the liquefaction potential at the Project site is very low. This interpretation is consistent with regional liquefaction potential maps compiled by ABAG. Compliance with CBC requirements, which require site-specific soils and/or geotechnical studies for land development or construction in areas of potential geologic instability, as well as adherence to General Plan Policy SE-1.2, would reduce the potential impacts associated with Project development to a *less-than-significant* level.

Applicable Regulations:

- Daly City General Plan
- Daly City Municipal Code (Title 15, Chapter 15.08)

Significance Before Mitigation: Less than significant.

GEO-4	**The Project would not be located on expansive soil, creating substantial risks to life or property.**

In general, expansive soils in Daly City are not prevalent. Based on available USDA Natural Resources Conservation Service soil maps, expansive soils in the vicinity of the Project are not prevalent.[21][22] Therefore, potential risks associated with expansive soils are considered to be low, and the impact is *less than significant*.

Applicable Regulations:

- US Department of Agriculture

Significance Before Mitigation: Less than significant.

4.5.4 CUMULATIVE IMPACTS

GEO-5	**The Project, in combination with past, present, and reasonably foreseeable projects, would result in less than significant cumulative impacts with respect to geology and soils.**

This EIR takes into account the projected growth due to Project development, together with projected growth in the rest of the City of Daly City, as forecast by ABAG. Potential cumulative geological impacts could arise from a combination of Project development, together with future development in the immediate vicinity.

Considering the fact that no active earthquake faults have been mapped by the State of California at or immediately adjacent to the Project site, the risk of primary fault rupture to occupied buildings is considered to be low. Furthermore, development allowed by the Project would be subject to CBC and Municipal Code requirements. Compliance with these

[21] US Department of Agriculture, Natural Resources Conservation Service, 2014, Custom Soil Resource Report for San Mateo County, Eastern Part, and San Francisco County, California, dated November 24, 2014.

[22] US Department of Agriculture, Natural Resources Conservation Service, 1991, Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California, dated May 1991.

requirements would, to the maximum extent practicable, reduce cumulative, development-related impacts that relate to seismic shaking, seismically induced landslides and liquefaction, and expansive soils. Similarly, compliance with the General Plan policies and programs, as well as the City's Ordinances pertaining to construction-related excavation and grading (i.e., Municipal Code Chapter 15.62), would minimize the cumulative impacts associated with soil erosion and loss of topsoil to the maximum extent practicable.

The Project would not result in a significant impact with respect to geology, soils, and seismicity and would not significantly contribute to cumulative impacts in this regard. Therefore, the cumulative impacts associated with development of the Project, together with anticipated growth in the immediate vicinity of the Project site, would result in a *less-than-significant* cumulative impact with respect to geology, soils, and seismicity.

Applicable Regulations:

- Daly City General Plan
- Daly City Municipal Code (Title 15, Chapter 15.08)
- Daly City Municipal Code (Chapter 15.10.150)

Significance Before Mitigation: Less than significant.

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