3.8 Geology and Soils

This section describes the geologic and seismic setting of the Commonwealth Corporate Center Project (Project) site (the Commonwealth Site and the Jefferson Site), including regional and local geology, soils, and groundwater; the regulatory framework relevant to the Project; and the potential environmental effects of the Project related to geology and soils. The impacts examined include risks related to geologic hazards, such as earthquakes, landslides, liquefaction, expansive soils, and impacts on the environment related to soil erosion and sedimentation. This section identifies both Project-level and cumulative environmental impacts and explains how compliance with the applicable regulations would reduce or avoid the identified impacts.

A preliminary geotechnical investigation was prepared for the Commonwealth Site. The information and conclusions from this document are incorporated into this section. No preliminary geotechnical analysis was completed for the Jefferson Site because it can be assumed that subsurface geologic and soils conditions are similar to those beneath the Commonwealth Site since the two sites are adjacent. Additional information was obtained from government agency documents and websites.

No comments related to geology and soils were received in response to the Notice of Preparation (NOP) (Appendix 1).

Existing Conditions

Regulatory Setting

Federal

Earthquake Hazard Reduction Act of 1977. Federal laws codified in the U.S. Code Title 42, Chapter 86 were enacted to reduce the risks to life and property from earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards reduction program. Implementation of these requirements are regulated, monitored, and enforced at the state and local level. Key state and local regulations and standards are summarized below.

State

California Building Code. California Code of Regulations (CCR), Title 24, Part 2, the California Building Code (CBC), provides minimum standards for building design in the state. The 2013 CBC, effective January 1, 2014, is the current code and is based on the current International Building Code (IBC).

Each jurisdiction in California may adopt its own building code based on the CBC. Local codes are permitted to be more stringent than the CBC but, at a minimum, are required to meet all state standards and enforce the regulations of the CBC. The City of Menlo Park (City) has adopted the 2010 CBC and, starting January 1, 2014, will adopt the 2013 CBC.

Chapter 16 of the CBC deals with structural design requirements governing seismically resistant construction (Section 1604), including factors and coefficients used to establish seismic site class and seismic occupancy category for the soil/rock at the building location and the proposed building design (Sections 1613.5 through 1613.7). Chapter 18 includes the requirements for foundation and soil investigations (Section 1803); excavation, grading, and fill (Section 1804); allowable load-bearing values of soils (Section 1806); and the design of footings, foundations, and slope clearances (Sections 1808 and 1809); retaining walls (Section 1807); and pier, pile, driven, and cast-in-place foundation support systems (Section 1810). Chapter 33 includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes (Section 3304). Appendix J of the CBC includes grading requirements for the design of excavations and fills (Sections J106 and J107) and for erosion control (Sections J109 and J110). Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in the California Division of Occupational Safety and Health (Cal-OSHA) regulations (CCR, Title 8).

Seismic Hazards Mapping Act. The 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 intent of this act is to protect the public from the effects of strong groundshaking, liquefaction, landslides, ground failure, or other hazards caused by earthquakes. In addition, the California Geologic Survey's (CGS) Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*,[1] provides guidance for the evaluation of earthquake-related hazards for projects in designated zones of required investigations, and for recommending mitigation measures as required by Public Resources Code Section 2695(a). Liquefaction hazards mapping has been prepared for the west side of San Francisco Bay (Bay), including the Menlo Park area.

NPDES Construction General Permit. Under the authority of the federal Clean Water Act Section 402 (National Pollutant Discharge Elimination Program [NPDES]), the State Water Resources Control Board (State Water Board) permits all regulated construction activities under Order No. 2009-0009-DWQ (adopted September 2, 2009). This order requires that, prior to beginning any construction activities, the permit applicant must obtain coverage under the Construction General Permit by preparing and submitting a Notice of Intent (NOI) to State Water Board and preparing and implementing a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the Construction General Permit requirements for all construction activities disturbing one or more acre of land surface. Construction activities subject to the Construction General Permit include clearing, grading, and disturbances to the ground, such as stockpiling or excavating, that result in soil disturbances of at least 1 acre of total land area. The SWPPP has two major objectives: (1) to help identify the sources of sediment and other pollutants that affect the quality of stormwater discharges; and (2) to describe and ensure the implementation of best management practices (BMPs) to reduce or eliminate sediment and other pollutants in stormwater as well as non-stormwater discharges.

Implementation of the permit requirements are necessary (and required) to control erosion during construction activities. Compliance with the state permit is enforced and monitored by the City under Municipal Code Section 7.42 (see below).

[1] California Geological Survey. 2008. Guidelines for Evaluating and Mitigating Seismic Hazards in California. California Department of Conservation. (Special Publication 117A.) Available: <http://www.conservation.ca.gov/cgs/shzp/webdocs/sp117.pdf>. Accessed: May 2013.

Local

City of Menlo Park General Plan. The following policies and implementing program within the Safety Element of the General Plan are relevant to the Project.

> *Policy S1.13:* Geotechnical Studies. Continue to require site-specific geologic and geotechnical studies for land development or construction in areas of potential land instability as shown on the State and/or local geological hazard maps or identified through other means.
>
> *Policy S1.14:* Potential Land Instability. Prohibit development in areas of potential land instability identified on State and/or local geologic hazard maps, or identified through other means, unless geologic investigation demonstrates hazards can be mitigated to an acceptable level as defined by the State of California.
>
> *Implementing Program S1.D:* Require early investigation of Potential Hazard conditions. Require that potential geologic, seismic, soils, and/or hydrologic problems confronting public or private development be thoroughly investigated at the earliest stages of the design process, and that these topics be comprehensively evaluated in the environmental review process by persons of competent technical expertise.

Earthquake Emergency Response. The City is a participant in the Association of Bay Area Governments (ABAG) multi-jurisdictional planning process for natural disaster emergencies. The City has adopted an Emergency Operation Plan that assesses the potential losses associated with earthquakes (among other disasters) and identifies responsibilities for city departments and coordination with San Mateo County and regional emergency response providers.[2] The City has also prepared a Disaster Preparedness Manual that is available to the public that describes actions that residents and businesses can take in the event of an earthquake.

Municipal Code. The following chapters of the Municipal Code pertain to the Project.

> *Building Code.* Chapter 12.06 of the City's Municipal Code implements the 2010 CBC and local amendments thereto.
>
> *Grading and Drainage Control Guidelines.* The City Engineering Division requires a grading and drainage plan whenever more than 500 square feet of the surface of a lot is to be affected by a building project. The basis for the grading and drainage plan requirement is City development policy, Stormwater Ordinance 859 (Chapter 7.42) and the California Regional Water Quality Control Board Municipal Regional Stormwater Permit issued on October 14, 2009 (Order R2-2009-0074, NPDES Permit No. CAS 612008). The focus of these guidelines is to control eroded sediment from construction sites entering waterways.

The City also requires the grading and drainage plan to include "Construction Erosion and Sedimentation Control" notes and plans, which must address timing of grading activities during the dry months, if feasible, and minimization of land disturbance, among other items.

Environmental Setting

Regional Setting

Geology

The Project site is situated along the San Francisco Peninsula, which separates the Bay from the Pacific Ocean. The San Francisco Peninsula is a ridge of rocks and sediments in the Santa Cruz Mountains

[2] City of Menlo Park. 2011. Emergency Operation Plan, Version 2.

portion of the Coast Ranges geomorphic province, which forms a rugged barrier between the Pacific Coast and inland California.[3] (Geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landform.) The Coast Ranges province, which extends approximately 600 miles north from the Santa Ynez River in Santa Barbara County to the Oregon border, owes much of its physiographic character to the San Andreas fault system (in the San Francisco Bay Area [Bay Area]). This fault system is a 44-mile-wide zone of fracturing and folding rock where two adjoining tectonic plates that form the Earth's surface (the Pacific plate on the west and the North American plate on the east) are moving past each other in opposite directions. One result of this tectonic plate movement is the regional rock deformation and the general northwest trend of valleys and ridges throughout the Coast Ranges. The sedimentary rocks that form most of the plate boundary area were deposited during successive geologic intervals as layers of marine and terrestrial sediments between 70 million (Cretaceous Period) and 200 million years ago (Jurassic Period).

Quaternary alluvial sediment derived from the Santa Cruz Mountains overlies older Cretaceous and Jurassic sedimentary rocks. The youngest of this alluvial material consists of Holocene-age (11,000 years or younger) unconsolidated clay interbedded with sand and fine gravel. This unit is generally less than 15 feet thick and forms in poorly drained interfluvial basins, usually at margins of tidal marshlands at the edge of San Francisco Bay, where it interfingers with Bay Mud. Overlying this material is artificial fill, which consists of a combination of gravel, sand, and silt, and rock fragments.

Faults

The San Francisco Bay Area, one of the world's most seismically active regions, is near several active faults. Faults are geologic zones of weakness. Earthquakes are caused by the violent and abrupt release of strain built up along faults. Fault rupture almost always follows preexisting faults. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking. Surface rupture occurs when movement on a fault deep in the earth breaks through to the ground surface.

Figure 3.8-1 shows the locations of regional faults in proximity to the Project site. The closest active and potentially active faults are the Monte Vista–Shannon fault (5.0 miles southwest), the San Andreas fault (6.6 miles southwest), and the Hayward fault (12.9 miles northeast). Other nearby active Bay Area faults include the San Gregorio fault, about 16.0 miles southwest, and the Calaveras fault, about 18.0 miles northeast of the Project site. Potentially active, concealed faults of the Quaternary Palo Alto and Stanford faults are a few miles southwest of the Project site. The trace of the San Jose fault is northeast of the site, in the vicinity of East Palo Alto.[4] These Quaternary faults do not show evidence of recent surface displacements (i.e., during the last 10,000 years) that would cause the State of California to categorize them as active.

Earthquake Magnitude

Earthquakes are classified based on the amount of energy released, using logarithmic scales known as the Richter scale and the Moment Magnitude scale (MM). Each whole number of Richter magnitude represents a tenfold increase in the wave amplitude (earthquake size) generated by an earthquake, as

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[3] California Geological Survey. 2002. California Geomorphic Provinces. California Department of Conservation. (California Geological Survey Note 36.) Available: <http://www.conservation.ca.gov/cgs/information/publications/cgs_notes/note_36/Documents/note_36.pdf>. Accessed: May 2013.

[4] California Geological Survey. 2010. 2010 Fault Activity Map of California. California Department of Conservation. Available: <http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html>. Accessed: May 2013.

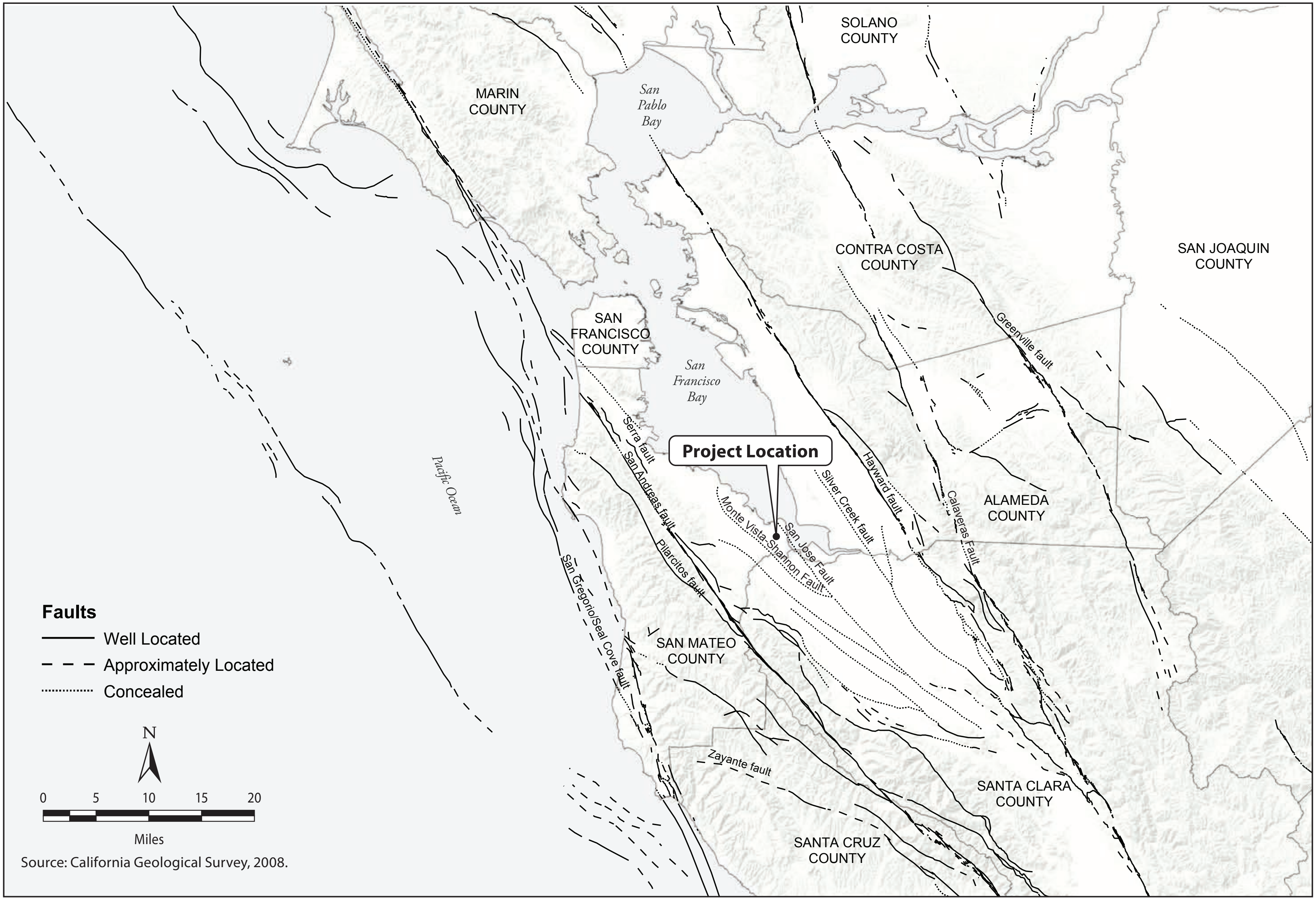

Figure 3.8-1
Regional Faults

well as a 3.16-fold increase in energy released. Thus, a magnitude 6.3 earthquake is ten times larger than a magnitude 5.3 earthquake and releases 31.6 times more energy. In contrast, a magnitude 7.3 event is 100 times larger than magnitude 5.3, and releases 1,000 times more energy. Table 3.8-1 shows the nearby active faults, their maximum credible earthquake expressed in MM, and their distance from the Project site.

Table 3.8-1. Maximum Credible Earthquake for Principal Active Faults in Project Vicinity

Fault	MCE Magnitude[a]	Distance from Project Site
Monte Vista–Shannon	6.2[b]	6.7
San Andreas	7.0–7.9[b]	6.5
Hayward	7.2[b,c]	12.3
Calaveras	6.8–7.5[b,c]	17.9
San Gregorio	7.5–7.7[b,d]	15.5

Note:

a. MCE magnitude is the maximum credible earthquake measured using the Moment Magnitude scale.

Sources:

b. Mualchin, L. 1996. A Technical Report to Accompany the Caltrans California Seismic Hazard Map 1996 (Based on Maximum Credible Earthquakes). Available: <http://www.dot.ca.gov/hq/escearthquake_engineering/Seismology/MapReport.PDF>. Accessed: May 2013.

c. Anderson, L. W., M. H. Anders, and D. A. Ostenaa. 1982. Late Quaternary Faulting and Seismic Hazard Potential, Eastern Diablo Range, California. Pages 197–206 in E. W. Hart, S. E. Hirschfeld, and S. S. Schulz (eds.), Proceedings, Conference on Earthquake Hazards in the Eastern San Francisco Bay Area. (Special Publication 62.) Sacramento, CA: California Division of Mines and Geology.

d. Weber, G.E. and W.R. Cotton. 1981. Geologic Investigation of Recurrence Intervals and Recency of Faulting along the San Gregorio Fault Zone, San Mateo County, California. (U.S. Geological Survey Open File Report 81-263.) Prepared for U.S. Geological Survey. Available: <http://pubs.usgs.gov/of/1981/0263/report.pdf>. Accessed: May 2013.

The U.S. Geological Survey's 2007 Working Group on California Earthquake Probabilities[5] estimated that there is a 63 percent probability that one or more MM 6.7 or greater earthquakes will occur in the Bay Area in the next 30 years. The probability of a MM 6.7 or greater earthquake occurring along individual faults was estimated to be 31 percent on the Hayward fault and 21 percent along the San Andreas fault.[6]

Earthquake Intensity

The Modified Mercalli Intensity Scale is a scale used for describing the intensity of an earthquake. The scale relates an earthquake to its effects on humans, objects of nature, and human-made structures on a scale of I through XII, with I denoting a weak earthquake and XII an earthquake that causes almost complete destruction. Table 3.8-2 (Modified Mercalli Intensity Scale) provides abbreviated definitions of the scale ratings. This scale is not employed by engineers when designing seismic-resistant structures.

[5] 2007 Working Group on California Earthquake Probabilities. 2008. The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2). USGS Open File Report 2007-1437. CGS Special Report 20 Available: <http://pubs.usgs.gov/of/2007/1437/of2007-1437_text.pdf>. Accessed: May 2013.

[6] 2007 Working Group on California Earthquake Probabilities. 2008. The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2). USGS Open File Report 2007-1437. CGS Special Report 20 Available: <http://pubs.usgs.gov/of/2007/1437/of2007-1437_text.pdf>. Accessed: May 2013.

The safety standards to which structures must be designed are set forth in the CBC and take into account numerous factors and criteria. However, this scale is useful in describing earthquake effects for the general public and can serve to interpret earthquake magnitude qualitatively.

Table 3.8-2. Modified Mercalli Intensity Scale

Scale Rating	Description
I	Not felt.
II	Felt by persons at rest, on upper floors, or favorably placed.
III	Felt indoors; hanging objects swing; vibration like passing of light trucks; duration estimated; may not be recognized as an earthquake.
IV	Hanging objects swing; vibration like passing of heavy truck or sensation of a jolt like a heavy ball striking the walls; standing automobiles rock; windows, dishes, doors rattle; wooden walls and frame may creak.
V	Felt outdoors; direction estimated; sleepers wakened; liquids disturbed, some spilled; small unstable objects displaced or upset; doors swing; shutters, pictures move; pendulum clocks stop, start, change rate.
VI	Felt by all; many frightened and run outdoors; persons walk unsteadily; windows, dishes, glassware broken; knickknacks, books, etc., off shelves; pictures off walls; furniture moved or overturned; weak plaster and Masonry D cracked.
VII	Difficult to stand; noticed by drivers of automobiles; hanging objects quiver; furniture broken; weak chimneys broken at roof line; damage to masonry D, including cracks, fall of plaster, loose bricks, stones, tiles, and embraced parapets; small slides and caving in along sand or gravel banks; large bells ring.
VIII	Steering of automobiles affected; damage to Masonry C, partial collapse; some damage to Masonry B; none to Masonry A; fall of stucco and some masonry walls; twisting, fall or chimneys, factory stacks, monuments, towers, elevated tanks; frame houses moved on foundations if not bolted down; loose panel walls thrown out; decayed piling broken off. Branches broken from trees; changes in flow or temperature of sprigs and wells; cracks in wet ground and on steep slopes.
IX	General panic; Masonry D destroyed Masonry C heavily damaged, sometimes with complete collapse; Masonry B seriously damaged; general damage to foundations; frame structures, if not bolted, shifted off foundations; frames racked; serious damage to reservoirs; underground pipes broken; conspicuous cracks in ground and liquefaction.
X	Most masonry and frame structures destroyed with their foundations; some well-built wooden structures and bridges destroyed; serious damage to dams, dikes, embankments; large landslides; water thrown out of banks of canals, rivers, lakes, etc.; sand and mud shifted horizontally on beaches and flat land; rails bent slightly.
XI	Rails bent greatly; underground pipelines completely out of service.
XII	Damage nearly total; large rock masses displaced; lines of sight and level distorted; objects thrown in the air.

Source: Spangle, William E. 1987. Pre-Earthquake Planning for Post-Earthquake Rebuilding.

Notes: Masonry A = Good workmanship and mortar, reinforced designed to resist lateral force.
Masonry B = Good workmanship and mortar, reinforced.
Masonry C = Good workmanship and mortar, unreinforced.
Masonry D = Poor workmanship and mortar and weak materials, like adobe.

Groundshaking

The intensity of the seismic shaking (groundshaking), or strong ground motion, during an earthquake depends on the distance and direction between a particular area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding that area. Earthquakes occurring on faults closest to the Project site probably would generate the strongest ground motions.

An earthquake along the entire San Andreas fault is considered capable of generating a MM 7.9 earthquake (similar to the 1906 San Francisco earthquake). An earthquake of this magnitude would generate strong to very strong seismic shaking (Modified Mercalli Intensity VII and VIII) at the site.[7] Groundshaking of this intensity could result in damage to buildings and can trigger ground failures such as liquefaction, potentially resulting in foundation damage, disruption of utility service, and roadway damage.

Hydrogeology

The Project site is near the boundary between major units of two alluvial deposits, as defined by the California Department of Water Resources: San Francisquito Cone and Niles Cone. The San Francisquito deposits are derived from the Santa Cruz Mountains to the southwest, and the Niles Cone deposits are derived from the Diablo Range along the northeastern boundary of the Bay.[8]

The unconsolidated materials in both units consist of four hydrogeologic zones: shallow aquifer, aquitard, deep aquifer, and sediments below the deep aquifer. The shallow aquifer zone ranges in depth from 5 to approximately 100 feet below ground surface. The zone consists of silt and clay with low permeability interbedded with high-permeability coarse-grained channel deposits.[9]

Project Site

Site Topography

The Commonwealth Site is relatively flat and lies at an elevation of approximately 6.7 to 11.9 feet above mean sea level (msl), sloping in a general northward direction. There are several feet of fill within the building footprints, elevating the interior floor above the surrounding exterior grade.[10] The Jefferson Site is relatively flat and lies at an elevation of approximately 6.6 to 7.4 feet above msl. The onsite surface parking lot and the existing building are at equal grade. However, a gentle slope rises from Jefferson Drive to the front of the building. There are no adjacent hillsides.

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7 Association of Bay Area Governments. 2003. Earthquake Hazard Maps. Available: <http://www.abag.ca.gov/bayarea/eqmaps/s89m.html>. Accessed: June 2013. Last modified: April 18, 2003.

8 San Francisco Bay Regional Water Quality Control Board. 2003. South Bay Basins Groundwater Protection Evaluation. Available: <http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/groundwater/sobayground.shtml>. Accessed: June 2013.

9 San Francisco Bay Regional Water Quality Control Board. 2003. South Bay Basins Groundwater Protection Evaluation. Available: <http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/groundwater/sobayground.shtml>. Accessed: June 2013.

10 Cornerstone Earth Group. 2012. *Preliminary Geotechnical Investigation: Commonwealth Office Complex*. March 142.

Soils

The Project site is near the historic shoreline of the Bay. Soils at the Project site consist of artificial fill, organic silty clay, interbedded clay, and coarse-grained channel deposits that are discontinuous across the site.

Field exploration collected borings to a depth of approximately 50 feet. Alluvial clays and silty clays were generally encountered to a depth of approximately 20 feet. Medium-dense to very dense sands were encountered between 20 and 30 feet below grade. Stiff to very stiff clay was encountered between 30 and 50 feet below grade. It anticipated that there are several feet of fill within the building footprint. However, it is likely that undocumented fill and undocumented underground structures exist at the Project site.

Soils at the Project site also have been mapped by the Natural Resources Conservation Service (NRCS) as primarily Urban land-Orthents, reclaimed complex, 0 to 2 percent slopes. This map unit is generally associated with former tidal flats and marshes. The Urban land category is a description for human-made soils and land, usually already developed and covered by paving and structures, consisting of heterogeneous fills of unknown origin. Neither of these soils is a source of topsoil. The properties and characteristics of these soils are highly variable because of differences in the fill materials present. Below the surface pavements are alluvial clays and silty clays to a depth of approximately 20 feet. The clays are underlain by medium dense to very dense sands to a depth of approximately 30 feet, which are underlain in turn by stiff to very stiff clay deposits to the terminal depth of the cone penetration testing (approximately 50 feet). Several feet of fill are also expected within the building footprint, elevating the interior floor above the surrounding exterior grade. While no preliminary geotechnical analysis was completed for the Jefferson Site, the two adjacent sites are assumed to have similar soil conditions. It is anticipated that pockets of undocumented fill exist throughout the Project site.[11]

Fault Rupture

No known surface expression of fault traces cross the Project site, and the site is neither in an Alquist–Priolo Earthquake Fault Zone nor adjacent to any known active fault.[12] Therefore, fault rupture hazard is not a significant geologic hazard at the Project site.

Groundshaking

Because there are several faults within approximately 15 miles of the Project site, the site would be expected to be subject to strong groundshaking.

Liquefaction

Liquefaction is a phenomenon in which uniformly sized, loosely deposited, saturated, granular soils (usually fine sand) with low clay content lose strength during strong groundshaking, which causes the soil to behave as a fluid for a short time. Liquefaction generally occurs at depths shallower than 50 feet below ground surface. Soils may lose their ability to support structures, and this loss of bearing strength

[11] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

[12] Bryant, W. A. and E. W. Hart. 2007. Fault-Rupture Hazard Zones in California—Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps. (Special Publication 42. Interim Revision) Sacramento, CA: California Geological Survey. Available: <ftp://ftp.consrv.ca.gov/pub/dmg/pubs/sp/sp42.pdf>. Accessed: May 2013.

may cause structures founded on the liquefied materials to tilt or possibly topple over. Light structures such as pipelines, sewers, and empty fuel tanks that are buried in the ground can float to the surface when they are surrounded by liquefied soil. The susceptibility of a site to liquefaction is a function of the uniformity, depth, density, and water content of the granular sediments beneath the site and the magnitude of earthquakes likely to affect the site.

The potential for liquefaction at the Project site is high, based on the soils and depth to groundwater.[13] In addition, the Project site is mapped by the state and the County as being within a seismic hazard zone for liquefaction.[14,15]

Lateral Spreading

Lateral spreading (or lurching) occurs as a form of horizontal displacement of relatively flat-lying material toward an open face, such as an excavation, channel, or body of water. Generally, in soils, this movement is due to failure along a weak plane and may often be associated with liquefaction.

Although liquefaction potential at the Project site is high, there are no significant steep open faces within 200 feet of the site where lateral spreading could occur. Therefore, the potential for lateral spreading to affect the site appears to be low.[16]

Ground Rupture

Ground rupture can occur when the pore water pressure within liquefiable soil layers are great enough to break through the overlying non-liquefiable layer. Because the potential for liquefaction at the Project site is high, ground rupture is possible. However, field testing indicates that the depth of the non-liquefiable soil layer is sufficient to prevent ground rupture at the Project site.[17]

Differential Compaction and Settlement

When near-surface materials vary in composition either vertically or laterally, strong groundshaking can cause non-uniform compaction, resulting in movement of the materials and overlying structures. This can also occur gradually over time. Surficial materials underlying the Project site generally consist of undocumented fill materials and younger sediments. Field testing and site-specific analysis indicate that

[13] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

[14] California Geological Survey. 2006b. Seismic Hazard Zone Report for the Palo Alto 7.5-Minute Quadrangle, San Mateo and Santa Clara Counties, California. California Department of Conservation. (Seismic Hazard Zone Report 111.) Sacramento, California. Available: <http://gmw.consrv.ca.gov/shmp/download/quad/PALO_ALTO/reports/paloa_eval.pdf>. Accessed: May 2013.

[15] San Mateo County. 2012. San Mateo County Hazards Mitigation Maps. Liquefaction. Available: <http://www.co.sanmateo.ca.us/portal/site/planning/menuitem.2ca7e1985b6c8f5565d293e5d17332a0/?vgnextoid=f2356327a3a51210VgnVCM1000001d37230aRCRD&cpsextcurrchannel=1> Accessed: October 31, 2013.

[16] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

[17] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

liquefaction could result in settlement of 0.3 to 2.0 inches, with a differential settlement of approximately 0.75 inch between adjacent footings separated by 30 feet.[18]

Differential settlement can also result from subsidence due to removal of groundwater. Santa Clara Valley was subject to subsidence until the 1960s. However, due to groundwater recharge efforts, subsidence has been halted.[19] Much of Santa Clara Valley, including the Project site, experienced subsidence between 1932 and 1969 as a result of overextraction of groundwater. Since the 1960s, subsidence has been halted through Santa Clara Valley Water District's efforts; less groundwater is extracted, and surface reservoirs created to promote groundwater recharge have raised the water table.[20] The current limited fluctuations in groundwater levels have a low probability to cause structural damage.

Expansive Soils

Expansive soils can undergo significant volume change with changes in moisture content. They shrink and harden when dried, and expand and soften when wetted. Soil plasticity is an indicator of the shrink-swell potential of soil. Field testing indicated that soils at the Commonwealth Site have moderate to high expansion potential under wetting and drying cycles.[21] It can reasonably be assumed that soils at the adjacent Jefferson Site also have moderate to high expansion potential under wetting and drying cycle.

Compressible Surface Soils and Fills

Compressible soils can settle or subside as a result of groundshaking or as a result of the loads placed on top of them. It is suspected that fill exists inside the building at the Commonwealth Site; it is unknown whether this fill has been compacted. Therefore, there is the potential for compressible soils to be present at the Project site.

Landslide Hazards

The topography at the Project site and in the surrounding area is level to nearly level, having 0 to 2 percent slopes. The California Geological Survey[22] classifies this area as having low landslide incidence and susceptibility.

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[18] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

[19] Ingebritsen, S.E. and Jones, D.R. 1999. Santa Clara Valley, California: A Case of Arrested Subsidence. In Galloway, D., D.R. Jones, S.E. Ingebritsen (Eds.), Land Subsidence in the United States. U.S. Geological Survey. (U.S. Geological Survey Circular 1182.) Reston, VA. Available: <http://pubs.usgs.gov/circ/circ1182/>. Accessed: May 2013.

[20] Ingebritsen, S.E. and Jones, D.R. 1999. Santa Clara Valley, California: A Case of Arrested Subsidence. In Galloway, D., D.R. Jones, S.E. Ingebritsen (Eds.), Land Subsidence in the United States. U.S. Geological Survey. (U.S. Geological Survey Circular 1182.) Reston, VA. Available: <http://pubs.usgs.gov/circ/circ1182/>. Accessed: May 2013.

[21] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

[22] California Geological Survey. 2006a. State of California Seismic Hazard Zones, Mountain View Quadrangle. California Department of Conservation. (Official Map, released October 18, 2006.) Available: <http://gmw.consrv.ca.gov/shmp/download/pdf/ozn_mview.pdf>. Accessed: May 2013.

Groundwater

Groundwater at the Project site was estimated from pore pressure dissipation test data at a depth of approximately 10 to 11 feet below current grade, or about -1 or -2 feet msl.[23] The state has mapped historic high groundwater at depths less than 10 feet.[24] Seasonal fluctuations occur in the shallow zone.

Environmental Impacts

This section describes the impact analysis relating to geology and soils for the Project. It describes the methods used to determine the impacts of the Project and lists the thresholds used to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany each impact discussion.

Thresholds of Significance

In accordance with Appendix G of the State CEQA Guidelines, the Project would be considered to have a significant effect if it would result in any of the conditions listed below.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: (1) 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; (2) Strong seismic ground shaking; (3) Seismic-related ground failure, including liquefaction; and (4)Landslides.
- Result in substantial soil erosion or the loss of topsoil.
- 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 an onsite or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems in areas where sewers are not available for the disposal of wastewater.

For the purpose of this Draft EIR, a significant impact would result from soil and/or seismic conditions so unfavorable that they could not be overcome by reasonable design, construction, and maintenance practices.

Methods for Analysis

A preliminary geotechnical analysis was completed for the Commonwealth Site and was used for the analysis of Project site impacts. The preliminary geotechnical assessment provides a summary and compilation of available geotechnical information that was used as part of the analysis of geologic,

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[23] Cornerstone Earth Group. 2012. Preliminary Geotechnical Investigation, Commonwealth Office Complex, 151 Commonwealth Drive, Menlo Park, CA. Sunnyvale, CA. March 14. Prepared for The Sobrato Organization, Cupertino, CA.

[24] California Geological Survey. 2006b. Seismic Hazard Zone Report for the Palo Alto 7.5-Minute Quadrangle, San Mateo and Santa Clara Counties, California. California Department of Conservation. (Seismic Hazard Zone Report 111.) Sacramento, California. Available: <http://gmw.consrv.ca.gov/shmp/download/quad/PALO_ALTO/reports/paloa_eval.pdf>. Accessed: May 2013.

seismic, and geotechnical issues for this Draft EIR. This preliminary geotechnical assessment describes and evaluates geologic and geotechnical conditions at the Project site to support preliminary planning and conceptual-level design during initial phases of Project planning. Design-level geotechnical studies would be completed during development of construction plans, in accordance with the 2010 California Building Code (CBC) and City building permit requirements. While no preliminary geotechnical analysis was completed for the Jefferson Site, it can be assumed that subsurface geologic and soils conditions are similar to those beneath the Commonwealth Site because the site is adjacent to the Commonwealth Site. In addition, since no structures are planned for the Jefferson Site, no need for geotechnical studies is anticipated.

Impacts Not Evaluated In Detail

Fault Rupture. As shown in Figure 3.8-1 and Table 3.8-1, no faults cross the Project site, nor is the site within an Alquist–Priolo Earthquake Fault Zone. Because there would be no impact related to fault rupture, this impact is not further evaluated.

Landslides. The Project site is nearly level and is not adjacent to any hillsides where seismically induced landslides or other downslope movement of rock or soil material that could pose a hazard. In addition, the Project would not cause or exacerbate landslide hazard. Because the Project would not increase exposure of people to landslide hazards, this impact is not further evaluated.

Lateral Spreading. Because there are no steep open faces or bodies of water adjacent to the Project site that could be conducive to lateral spreading, there would be no risk of lateral spreading, and this impact is not further evaluated.

Loss of Topsoil. As discussed above, soils at the Project site are primarily of a soils type that is not a source of topsoil. Because the Project would not result in the loss of topsoil, this impact is not further evaluated.

Impacts on Septic Systems. The Project would not include any septic tanks or leach field systems. Wastewater generated at the Project site would be disposed through the existing sanitary sewer system. Because the Project does not require soils capable of supporting septic systems, this impact is not further evaluated.

Impacts and Mitigation Measures

Impact GEO-1: Strong Seismic Groundshaking and Seismic-Related Ground Failure. The Project would have a less-than-significant potential to expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: (1) Strong seismic ground shaking, and (2) Seismic-related ground failure, including liquefaction. (LTS)

Development of the Project site would involve the construction and occupancy of new buildings in a location where strong seismic groundshaking can be expected to occur over the life of the Project. Based on previous investigations at the site, mapped soil conditions, and the existence of high groundwater, the potential for liquefiable sediments is high. The County Hazards Mitigation Maps and the CGS Seismic Hazard Zone maps both identify the Project site as being potentially subject to liquefaction.

Liquefaction-related phenomena can include loss of bearing strength, vertical settlement from densification (subsidence), buoyancy effects, and flow failures, all of which could cause damage to the proposed structures on the Project site. Damage from liquefaction and lateral spreading is generally most severe when liquefaction occurs within 15 to 20 feet below the ground surface. Foundations for structures and pipelines would be the components most vulnerable to damage from liquefaction-related phenomena. Seismically induced settlement can occur in areas underlain by compressible or poorly consolidated sediments. Some artificial fills are susceptible to mobilization and densification, resulting in earthquake-induced subsidence. Although there are seismic hazards, the preliminary geotechnical investigation for the Site concluded that development of the Project is feasible provided the potential hazards are reduced through the implementation of standard design and construction methods.

Specifically, all structures, roads, and utility lines must meet or exceed design criteria of the adopted CBC for Seismic Zone D. Design and construction of the structures and facilities at the Project Site would be required by the relevant sections of the CBC.

In addition, because the Project site is in a liquefaction Seismic Hazard Zone, the Project Sponsor would be required to comply with the guidelines set by CGS Special Publication 117, which outline the protocol for analysis and treatment of liquefaction-related hazards, including estimates of vertical settlement and lateral spreading. Prediction of liquefaction-related settlement is necessarily approximate, and related hazard assessment and development of recommendations for treatment of such hazards must be performed conservatively, as recommended by CGS Special Publication 117A. A similarly conservative approach is recommended by CGS Special Publication 117A when estimating the amount of localized differential settlement likely to occur as part of the overall predicted settlement: localized differential settlements up to two-thirds of the total settlements anticipated must be assumed until more precise predictions of differential settlements can be made.

The 2010 CBC requires that geotechnical investigations provide design criteria that would minimize impacts associated with strong groundshaking during an earthquake. The 2010 CBC also requires that all foundations and other improvements (e.g., roads, driveways, utilities) be designed by a licensed professional engineer based on site-specific soil investigations performed by a California Certified Engineering Geologist or Geotechnical Engineer to ensure the suitability (especially considering the existence of potentially liquefiable soils at the site) of the subsurface materials for adequately supporting the proposed structures. This would include designing foundations so they are able to tolerate or resist the anticipated total and differential settlement that can be caused by liquefaction. The City and the Project Sponsor would be responsible for ensuring that all recommendations from the investigations are incorporated in the Project, pursuant to state law.

As evidenced by the level of development throughout the Bay Area, successful building construction is possible in a seismically active zone and can be readily accomplished even where seismic hazards are known to exist. The risks to public safety from seismic hazards can be mitigated to the extent required by law with implementation of the proper design and construction methods, which would be within the responsibility of the City and the Project Sponsor to monitor and enforce through its building permit process. In addition, the City, along with other Bay Area jurisdictions, participates in a coordinated planning and emergency response program and has its own Emergency Operation Plan to respond to natural disasters.

Consequently, the Project would not have a significant adverse impact with regard to exposure of people or structures to damage resulting from seismic groundshaking or liquefaction-related hazards. Therefore, impacts would be ***less than significant***.

Impact GEO-2: Soil Erosion. The Project would result in less-than-significant soil erosion impacts. (LTS)

The Project site is nearly level and would not involve development on hillsides that would involve cut-and-fill. Thus, there would be no topographic changes that could alter erosion potential. However, development of the Project site would involve grading to construct building foundations and trenching for utility installations, parking surface, and landscaping. Some minor modifications to allow additional roadway access points would also be implemented. These construction activities could temporarily expose soils to erosive effects from stormwater runoff.

If fill is imported and stockpiled at the Project site, the stockpiles could be eroded by wind or water unless properly protected. Because the Project site exceeds 1 acre in size, the City would require the Project Sponsor to implement a SWPPP, in accordance with Chapter 7.42 of the Municipal Code, to reduce potential erosion and subsequent sedimentation of storm water runoff. This SWPPP would include BMPs to control erosion associated with grading, trenching, and other ground surface-disturbing activities. The Project Sponsor would be required to submit a grading plan to the City before permits would be issued. In addition, the Project Sponsor would be required to prepare and submit a grading and demolition (G&D) plan, along with an Erosion and Sedimentation Control Plan prior to obtaining a grading permit from the City. The Project Sponsor would also be required to implement the specifications in Chapter A33 of the CBC, which regulates grading activities, including drainage and erosion control. Compliance with City requirements and the CBC, which are within the authority of the City to enforce and monitor, would ensure that erosion impacts resulting from Project construction would be less than significant.

After construction, the Project site would be developed with buildings, parking areas, roadways, and landscaping and hardscaping. Stormwater runoff would be managed and collected by a new stormwater drainage and management system which would connect to the City's storm drain system, as described in Chapter 2, *Project Description*. The amount of impervious surface would be reduced from existing conditions from 85 to 72 percent of the Project site, leading to less stormwater runoff than under existing conditions. The impact resulting from erosion under project operation would be ***less than significant***.

Impact GEO-3: Soil Hazards. The Project would not 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 subsidence, liquefaction, or collapse. (LTS)

While subsidence was a concern in Santa Clara Valley in the early part of the twentieth century, it was effectively halted in the 1960s.[25] The risk of subsidence and associated differential settlement is low. However, the preliminary geotechnical investigation anticipates that differential settlement resulting from seismically induced liquefaction may occur. If Project structures are improperly designed and constructed, differential settlement could undermine structural foundation, potentially exposing people onsite, including inhabitants and construction workers, to increased safety risk.

Construction activities, such as excavation, could introduce instability and cause slopes to collapse. Soil collapse is also associated with subterranean voids, such as tunnels or mine shafts, or with excessive loading. Soil collapse could result if utilities, pipes, or tanks currently extant at the Project site are

[25] Ingebritsen, S.E. and Jones, D.R. 1999. Santa Clara Valley, California: A Case of Arrested Subsidence. In Galloway, D., D.R. Jones, S.E. Ingebritsen (Eds.), Land Subsidence in the United States. U.S. Geological Survey. (U.S. Geological Survey Circular 1182.) Reston, VA. Available: <http://pubs.usgs.gov/circ/circ1182/>. Accessed: May 2013.

abandoned in place and not appropriately backfilled, capped, and retrenched. Further, the artificial, undocumented fill and alluvial deposits that underlie the Project site are regarded as potentially weak soils that may be compressible or exhibit other characteristics that would make them unstable (e.g., differential compaction).

The presence of shallow groundwater could affect grading and underground construction by causing wet pavement subgrade, difficulty achieving compactions, and difficult utility installation. Dewatering and shoring of utility trenches may be required for deeper gravity utilities. However, standard engineering practices could be used to reduce potential hazards associated with soils at the Project site, and the preliminary geotechnical investigation concluded that development of the Commonwealth Site is feasible from a geotechnical perspective. The study also concluded that, on a preliminary basis, the planned structures could be supported on conventional shallow spread footings, bearing on natural, undisturbed soil or engineered fill.

As part of the construction permitting process, the City requires completed reports of soil conditions, conducted by registered soil professionals, to identify potentially unsuitable soil conditions. The reports must (a) identify potentially unsuitable soil conditions, and (b) contain appropriate recommendations for foundation type and design criteria that conform to the analysis and implementation criteria described in the City Building Code, Chapters 16, 18, and A33, to eliminate inappropriate soil conditions.

Adherence to the soil and foundation support parameters of the City Building Code, as required by City and state law, ensures the maximum practicable protection available from soil failures under static or dynamic conditions for structures and their associated trenches and foundations. The Project Sponsor would be required to incorporate these recommendations into Project design. In view of these circumstances, hazards related to unstable geologic or soil units at the Project site are considered ***less than significant***.

Impact GEO-4: Expansive Soil. The Project would not be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating a less-than-significant risk to life or property. (LTS)

The preliminary geotechnical investigation for the Commonwealth Site indicates that soils are expected to have a moderate to high shrink-swell potential. Structural damage, warping, and cracking of roads, driveways, parking areas, and sidewalks, and rupture of utility lines may occur if the potential for expansive soils and the nature of the imported fill are not considered during design and construction of improvements. However, standard engineering practices could be used to reduce potential hazards associated with soils at the Project site, and the preliminary geotechnical investigation concluded that development of the Commonwealth Site is feasible from a geotechnical perspective.

As part of the construction permitting process, the City would require completed reports of soil conditions to identify potentially unsuitable soil conditions. The evaluations must be conducted by registered soil professionals. The reports must (a) identify potentially unsuitable soil conditions and (b) contain appropriate recommendations for foundation type and design criteria that conform to the analysis and implementation criteria described in the City Building Code, Chapters 16, 18, and A33, to eliminate inappropriate soil conditions.

Adherence to the soil and foundation support parameters of the City Building Code, as required by City and state law, ensures the maximum practicable protection available from soil failures under static or dynamic conditions for structures and their associated trenches and foundations. The Project Sponsor would be required to incorporate these recommendations into Project design. In view of these circumstances, hazards related to expansive soil units at the Project site are considered ***less than significant***.

Cumulative Impacts

The geographic context for the analysis of impacts resulting from geologic hazards is generally limited to the project site, rather than being associated with other projects in the area. Because each project site has unique geologic considerations that would be subject to uniform site development and construction standards, the potential for cumulative geologic impacts to occur is limited. Therefore, the geographic context for issues related to soil composition (i.e., liquefaction, subsidence, lateral spreading, and landslides) includes only those projects in the immediate vicinity of the Project, which would include Menlo Gateway (Tier 1) and the North Fair Oaks Community Plan and some areas under the Menlo Park Housing Element (Tier 2 projects).

Impact C-GEO-1: Cumulative Seismic Hazards. The Project, in combination with other foreseeable development in the vicinity, would not substantially increase the risk of exposure or people or structures to seismic hazards. (LTS)

Tier 1 and Tier 2

Future population growth in the Bay Area, along with the Project and cumulative development, will increase the number of people and structures exposed to seismic hazards. Given the risk from seismic activity associated with all development in seismically active areas, this impact would be significant if it were not mitigated by building code requirements. Construction in California is strictly regulated by the CBC, as adopted and enforced by each jurisdiction, including the City, to reduce risks from seismic events to the maximum extent possible. Because the City uses and enforces the requirements of the CBC as part of its Building Code, new buildings and facilities in the City are required to be sited and designed in accordance with the most current geotechnical and seismic guidelines and recommendations. Development of cumulative projects would implement all necessary design features recommended by site-specific geotechnical studies (required for all development applications) to reduce the risk from seismic activity, unstable slopes, and soil limitations. Therefore, there would be no significant cumulative impact. The Project would implement the design features recommended by the Project geotechnical studies. With adherence to the City Building Code and related plans, regulations, and design and engineering guidelines and practices, the cumulative impact of the Project would be ***less than significant***.

Impact C-GEO-2: Cumulative Soil Erosion. The Project, in combination with other foreseeable development in the vicinity, would not substantially increase soil erosion potential. (LTS)

Tier 1 and Tier 2

The geographic context for analysis of impacts on development associated with the geotechnical aspects of erosion (i.e., permanent loss in soil or topographic changes that can cause or exacerbate erosion) is generally site-specific, and impacts would not be compounded by additional development. From a watershed perspective, however, erosion can affect water quality by contributing sediment; thus, the geographic context for erosion impacts for the Project would include the Atherton Channel watershed (see Section 3.9, *Hydrology and Water Quality*). However, the Atherton Channel watershed is considered already 99 percent built out, with an estimated 69 percent impervious cover. Consequently, potential growth would likely occur as redevelopment and not extensive new development on vacant land or open space. Nonetheless, development of the cumulative projects could expose soil surfaces and alter soil conditions. To minimize the potential for cumulative impacts that could cause erosion, all cumulative projects in the City are required to conform to the provisions of applicable City ordinances and State regulations pertaining to erosion and sedimentation control. This includes the City's Municipal Code Chapter 7.42 requirements, which implement the federal and state National Pollutant Discharge Elimination System (NPDES) program. Therefore, there is no significant cumulative impact due to soil erosion.

During the construction phase, soil could be exposed to erosion by wind or water because it would involve substantial amounts of soil disturbance, but it would not involve permanent topographic changes that could cause increased erosion. Because the City and the Project Sponsor are responsible for ensuring the Project would be in compliance with applicable NPDES permit requirements, and would implement and maintain the BMPs required by the Project SWPPD, the cumulative impact would be ***less than significant***.

Impact C-GEO-3: Cumulative Soil Hazards. The Project, in combination with other foreseeable development in the vicinity, would not substantially increase soil hazards. (LTS)

Tier 1 and Tier 2

The geographic context for analysis of impacts on development from unstable soil conditions, including expansive soils or other conditions that could cause structural problems, is limited to the site and would not be compounded by additional development. Further, development is required to undergo analysis of geological and soil conditions applicable to the specific individual project, and restrictions on development would be applied in the event that geological or soil conditions pose a risk to safety as a result of site-specific geologic or soils instability, subsidence, collapse, and/or expansive soil. Because the City uses and enforces the requirements of the CBC as part of its Building Code, new buildings and facilities in the City are required to be sited and designed in accordance with the most current geotechnical guidelines and recommendations. There would be no significant cumulative impact with respect to soil hazards. The Project would include all necessary design features recommended by the site-specific geotechnical studies to reduce the risk from seismic activity, unstable slopes, and soil limitations. With adherence to the Building Code and related plans, regulations, and design and engineering guidelines and practices, the cumulative impact of the Project with respect to soil hazards would be ***less than significant***.