D. GEOLOGY, SOILS AND SEISMICITY

This section describes the project site's geologic environment based on a site reconnaissance, published and unpublished geologic reports and maps, and site-specific technical reports. This section also assesses potential impacts from seismically-induced fault rupture, strong ground shaking, liquefaction, slope failure, lateral slope deformation, differential settlement and unstable or expansive soils. Mitigation measures for the identified significant impacts are provided, as appropriate.

1. Setting

The site's existing conditions related to geology and seismic conditions are described below.

a. Geologic Conditions. The geology, topography, and soils of the project site and vicinity are described below.

(1) Geology. The project site is located within the Coast Ranges Geomorphic Province, a geologically young and seismically-active region on the western margin of the North American plate. In general, the Coast Ranges are composed of sedimentary bedrock with layers of recent alluvium filling the intervening valleys.[1] The project site is underlain by Quaternary-aged coarse-grained older alluvial fan and stream terrace deposits (consisting mostly of poorly consolidated sand, gravel, and silt).[2]

During the geotechnical investigation conducted on the project site, four exploratory borings were drilled to depths ranging from 30 to 50 feet below ground surface (bgs). The borings were drilled in paved areas covered by about 2 inches of asphalt concrete. The explorations encountered from 2 to 6.5 feet of loose to medium dense clayey sand and medium stiff to very stiff sandy clay fill. This layer was underlain by predominantly stiff to very stiff, low to moderate plasticity clays with interbedded layers of medium dense to very dense sands, with variable quantities of clayey and silty fines, to the maximum exploration depth of 50 feet. Plasticity Index (PI) tests were performed on representative soil samples from a depth of 9.5 feet. PI test results were 16 and 18, indicating moderate plasticity and expansion potential. Groundwater was not encountered in the borings to their maximum depth of 50 feet; however, groundwater in wells at an adjacent site was identified at about 35 to 41 feet bgs.[3]

(2) Topography. The approximately 3.4-acre project site is located within a relatively flat urbanized area. The existing ground surface elevation is approximately 65 to 70 feet above mean sea level. No open creek or stream channels cross the site.[4]

(3) Soils. The soils underlying the site have been mapped as approximately 88 percent Urban Land and 12 percent Urban Land – Orthents Complex by the Natural Resources Conservation Service (NRCS). The Urban Land category is a description for man-made soils and land, usually already developed and covered by paving and structures, consisting of heterogeneous fills of (generally)

[1] California Geographic Survey (CGS), 2002. *California Geomorphic Provinces, Note 36.*

[2] Brabb, E.E., Pampeyan, E.H., 1983. Geologic Map of San Mateo County, California, USGS Miscellaneous Investigation Series Map I-1257-A.

[3] TRC Lowney, 2006. *Geotechnical Investigation, Mixed Use Development, 1300 El Camino Real, Menlo Park, CA.* Report No. 228-3, Prepared for: Sand Hill Property Group. March 23.

[4] USGS, 1968 Revised 1973. *Palo Alto Quadrangle, California.* 7.5' Series Topographic Map.

unknown origin. Orthents refers to poor-quality disturbed shallow soils lacking the usual soil horizons. The NRCS does not assign capability classification values for describing engineering constraints for the Urban Land – Orthents Complex type.[5]

b. Seismic Conditions. The following describes seismic conditions in and around the project site.

(1) Regional Seismicity. The entire San Francisco Bay Area is located within the San Andreas fault zone (SAFZ), a complex of active faults forming the boundary between the North American and Pacific lithospheric plates. Movement of the plates relative to one another results in the accumulation of strain along the faults, which is released during earthquakes. Numerous moderate to strong historic earthquakes have been generated in northern California by the SAFZ. The level of active seismicity has resulted in classification of the area as seismic risk Zone 4 (the highest risk category) in the California Building Code. The SAFZ includes numerous faults found by the California Geological Survey under the Alquist-Priolo Earthquake Fault Zoning Act (A-PEFZA) to be "active" (i.e., to have evidence of fault rupture in the past 11,000 years). Regional active faults are shown on Figure IV.D-1.

The U.S. Geological Survey's Working Group on California Earthquake Probabilities estimated that there is a 62 percent probability that one or more Moment Magnitude (M_w) 6.7 [6] or greater earthquakes will occur in the San Francisco Bay Area between 2002 and 2031. The probability of a M_W 6.7 or greater earthquake occurring along individual faults was estimated to be 21 percent along the San Andreas fault, 10 percent along the San Gregorio fault and 27 percent on the Hayward fault. In addition, there is a cumulative 14 percent chance of a background (other earthquake source, either mapped or undiscovered) event occurring. When predictions are expanded to 100 years it is estimated that about three M_W 6.7 or greater events could occur during that time. Thus the probability of at least one M_W 6.7 or greater earthquake rises to the near certainty of about 96 percent when calculated for a 100-year span.[7]

(2) Site-Specific Seismicity. The project site is not within an Alquist-Priolo Earthquake Fault Zone.[8] The project site is about 5 miles northeast of the Peninsula segment of the San Andreas fault, 14 miles northeast of the San Gregorio fault, and 13 miles southwest of the Hayward fault.[9] The San Andreas, San Gregorio and Hayward faults are each right lateral strike-slip faults with northwest-southeast trending axis.[10]

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[5] Natural Resources Conservation Service (NRCS), 2007. Web Soil Survey Website: websoilsurvey.nrcs.usda.gov.

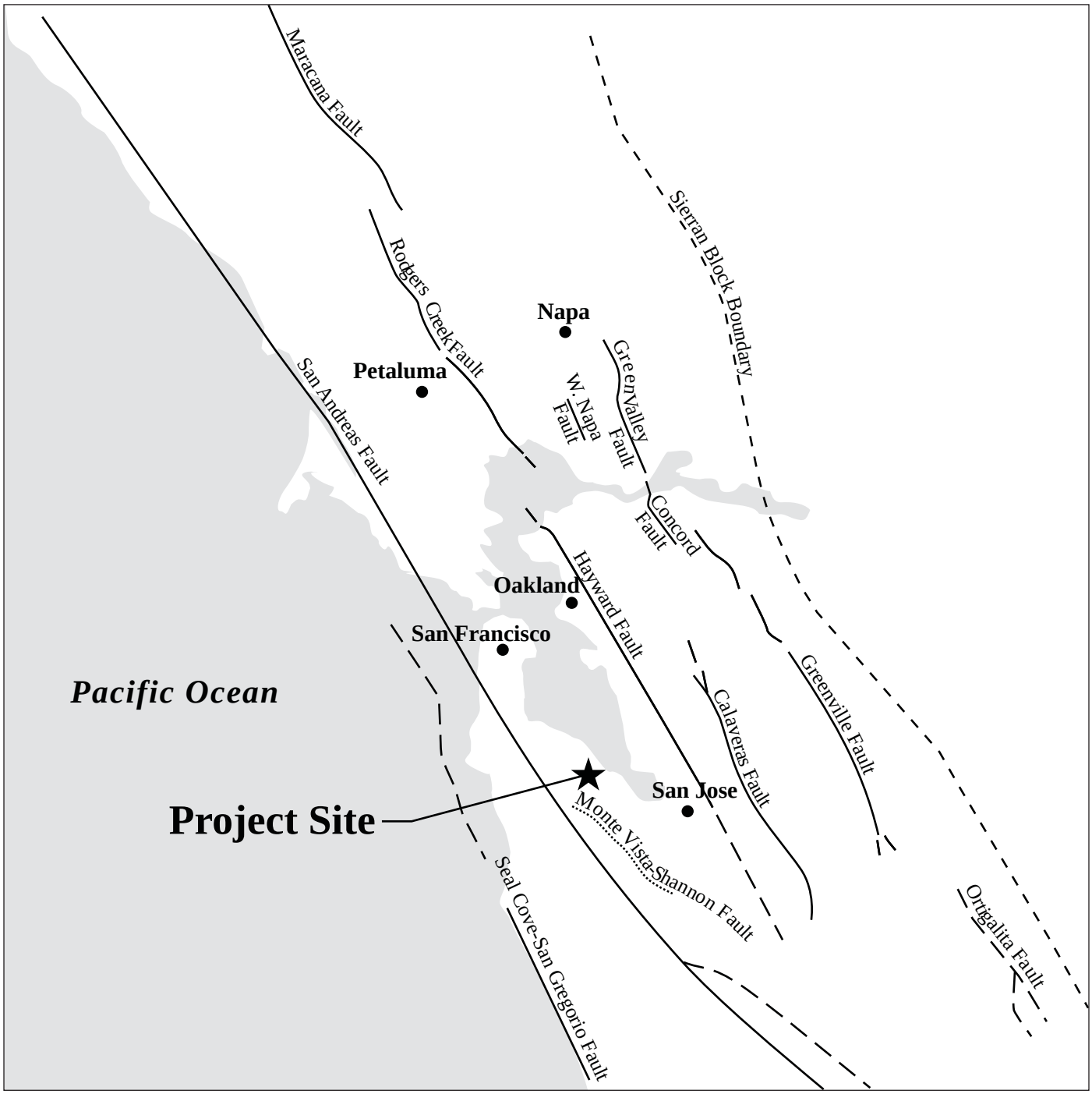
[6] Moment magnitude (M_W) is now commonly used to characterize seismic events as opposed to Richter magnitude. Moment magnitude is determined from the physical size (area) of the rupture of the fault plane, the amount of horizontal and/or vertical displacement along the fault plane, and the resistance to rupture of the rock type along the fault.

[7] Working Group on California Earthquake Probabilities (Working Group), 2003. *Earthquake Probabilities in the San Francisco Bay Region: 2002 to 2031*, USGS Open File Report 03-214.

[8] California Department of Conservation, 2007. Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act, California Geological Survey, Special Publication 42, Interim Revision 2007.

[9] California Division of Mines and Geology (CDMG), 1974. *State of California Special Studies Zones, Palo Alto Quadrangle Map.*

[10] Right-lateral: if the trace of the fault were viewed while standing on one side during an event, it would appear that the ground on the other side of the fault moved to the right. Strike-slip: the sides are moving laterally relative to each other with little or no vertical movement.



LSA

FIGURE IV.D-1

Legend

Active Fault - Fault has evidence of surface displacement within the past 11,000 years (dashed where inferred)

Potentially Active Fault - Fault has evidence of surface displacement in the past 1.6 million years, but not within the past 11,000 years

N

0 10 20
MILES

1300 El Camino Real Project EIR
Regional Faults

SOURCE: BASELINE, 2004

I:/CMK0601 1300 el camino/figures/Fig_IVD1.ai (11/6/07)

The project site is not located within a California Department of Conservation Seismic Hazard Zone for liquefaction or landslide as defined by the Seismic Hazards Mapping Act,[11] although it is rated as an area of moderate hazard for liquefaction by the Association of Bay Area Governments (ABAG).[12]

c. Seismic and Geologic Hazards. The following section describes potential seismic and geologic hazards that could affect the project site.

(1) Surface Rupture. Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. The location of surface rupture can generally be assumed to be along an active or potentially active major fault trace. No active faults have been mapped at the project site. Therefore, potential for fault rupture at the site is negligible.

(2) Ground Shaking. Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the subjective effects of earthquake intensity (Table IV.D-1). A related concept, acceleration, is measured as a fraction or percentage of the acceleration under gravity (g).

Estimates of peak ground acceleration have been made for the Bay Area based on probabilistic models that account for multiple seismic sources. Under these models, consideration of the probability of expected seismic events is incorporated into the determination of the level of ground shaking at a particular location. The expected peak horizontal acceleration (with a 10 percent chance of being exceeded in the next 50 years) generated by any of the seismic sources potentially affecting the project area, including the project site, is estimated by the California Geological Survey as 0.52.[13] This level of ground acceleration at the project site is a potentially significant hazard.

The closest active fault to the project site is the San Andreas fault, located approximately 5 miles to the southwest. Other potentially damaging seismic sources are located in the vicinity of the project site, including the Seal Cove-San Gregorio, Hayward, and Calaveras faults. The Monte Vista-Shannon fault, which is located approximately 3.5 miles to the southwest of the site, is considered a potentially active fault. Potentially active faults are defined as those for which there is evidence of surface displacement within the Quaternary period (that is, within about the past 1.6 million years) but show no surface displacement within the past 11,000 years. The San Andreas fault is considered capable of generating a moment magnitude (M_W) 7.9 earthquake (similar to the 1906 San Francisco quake).[14] An earthquake of this magnitude on the San Andreas fault would generate very strong seismic shaking (MMI VIII) at the project site.[15]

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[11] California Geological Survey (CGS), 2006. *State of California Seismic Hazard Zones*, Palo Alto Quadrangle Official Map. October 18.

[12] Association of Bay Area Governments (ABAG) Earthquake Program, 2001. *Liquefaction Hazard Map*. Website: www.abag.ca.gov.

[13] California Geological Survey (CGS), 2002 revised 2003. *Probabilistic Seismic Hazards Mapping Ground Motion Page*. Website: www.consrv.ca.gov/cgs/rghm/pshamap/pshamap.asp.

[14] Working Group, 2003, op. cit.

[15] ABAG, Earthquake Program 2004. Earthquake Shaking Scenario. June. Website: www.abag.ca.gov.

Table IV.D-1: Modified Mercalli Intensity Scale

I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted.

Source: California Geological Survey, 2002. *How Earthquakes and Their Effects are Measured.*

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

As mentioned above, the project site is rated as a moderate liquefaction hazard area by Association of Bay Area Governments (ABAG) studies.[16] The site-specific geotechnical report analyzed the condi-

[16] ABAG, 2001. op. cit.

tions at the site, including through a screening of granular soil layers from the current and previous investigation in accordance with the California Department of Mines and Geology (DGM) Special Publication SP117, and concluded that the potential for liquefaction to affect the proposed development during earthquake-induced shaking would be low. Similarly, liquefaction-induced lateral spreading would not be expected to damage development on the site.

(4) Expansive Soils. Expansion and contraction of volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. As a consequence of such volume changes, structural damage to buildings and infrastructure may occur if the potentially expansive soils were not considered in project design and during construction. The site is mapped as approximately 88 percent Urban Land and 12 percent Urban Land – Orthents Complex, as described above. Urban Land (man-made fill) can be composed of varying amounts of natural soil materials, construction debris, dredging materials, municipal solid waste, and other fill. The site-specific geotechnical report makes no specific recommendation regarding potential expansive soil hazards; however, it notes that the excavation proposed for the below-grade garage portion of the project would remove most if not all fill from the site and the remaining subsurface materials are stiff to very stiff medium to dense lean sandy clays.

(5) Slope Stability. Slope failure can occur as either rapid movement of large masses of soil ("landslide") or slow, continuous movement ("creep"). The primary factors influencing the stability of a slope are: 1) the nature of the underlying soil or bedrock; 2) the geometry of the slope (height and steepness); 3) rainfall; and 4) the presence of previous landslide deposits. Regional mapping shows that the project area is mapped as Category 1: "Stable areas of zero to five percent slope that are not underlain by landslide deposits."[17] Therefore, the project site is not susceptible slope instability.

(6) Settlement and Differential Settlement. Differential settlement or subsidence could occur if buildings or other improvements were built on low-strength foundation materials (including imported non-engineered fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material and fill). Although differential settlement generally occurs slowly enough that its effects are not dangerous to inhabitants, it can cause significant building damage over time. Portions of the project site that may contain loose or uncontrolled (non-engineered) fill may be susceptible to differential settlement.

At least a portion of the project site was developed by 1916[18] and "casual" or non-engineered fill is present on the project site.[19] The site-specific geotechnical report noted that most if not all fill would be removed by the excavation of the proposed garage, and recommended that any additional fill encountered during construction be over-excavated, and that engineered fill be used to minimize opportunities for differential settlement.

[17] USGS, 1979. *Relative Slope Stability and Land-use Planning in the San Francisco Bay Region, CA.* Professional Paper 944.

[18] EFI Global, 2005. *Phase I Environmental Site Assessment, 1300 El Camino Real, Menlo Park CA.* Prepared for Sand Hill Property Company, EFI Project No. 98520-00-0260. July 7.

[19] TRC Lowney, 2006. op. cit.

d. Menlo Park General Plan Policies. The following policies from the Menlo Park Open Space and Conservation Element (OSCE) and the Seismic Safety and Safety Element (SSSE) pertain to the proposed project.

- OSCE Policy 9: Discourage, and in some cases prohibit, urban development in hazardous areas. These areas include geologic and earthquake hazards, flood hazards, and fire hazards.[20]
- SSSE Policy 11: Require submission of geologic, seismic, and/or soils reports prior to taking action on development proposals for locations identified as potential problem areas in this element.
- SSSE Policy 12: Prohibit structural development in areas where hazards cannot be mitigated by accepted methods to a level of acceptable risk.
- SSSE Policy 13: Require that all new development incorporate adequate hazard mitigation measures to reduce risks from natural hazards
- SSSE Policy 15: 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 Impact Report for each project, by persons of competent geological expertise.

2. Impacts and Mitigation Measures

The analysis of the impacts related to geology, soils, and seismicity that could result from implementation of the proposed project is presented below. This section begins with criteria of significance, which establish the thresholds for determining whether a project impact is significant. The latter part of this section presents the potential geotechnical impacts associated with the proposed project. Mitigation measures are provided as appropriate.

a. Criteria of Significance. The above criteria were adapted from the *CEQA Guidelines* Environmental Checklist. A criterion regarding septic tanks and alternative wastewater disposal systems is not included since the proposed project would be connected to the City's wastewater treatment facilities.

The project would have a significant geology, soils, and seismicity impact if it would:

- Expose people or structures to substantial risk of loss, injury, or death involving:
  - Rupture of a known active or potentially active fault;
  - Strong seismic ground shaking;
  - Seismic-related ground failure, including liquefaction; or
  - Landslides (*Geology, Soils and Seismicity Criterion A*).
- Result in substantial soil erosion or loss of topsoil (*Geology, Soils and Seismicity Criterion B*).
- 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 on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse (*Geology, Soils and Seismicity Criterion C*).

[20] OSCE Policy 9 has been updated as Policy I.H-9 of the Land Use Element: "Urban development in areas with geologic and earthquake hazards, flood hazards, and fire hazards shall be regulated in an attempt to prevent loss of life, injury, and property damage."

- Be located on expansive or corrosive soils, which could cause substantial damage to building foundations, pavements, utilities, and/or other improvements (*Geology, Soils and Seismicity Criterion D*).

For the purpose of this EIR, significant geologic hazards would pertain to soil and/or seismic conditions so unfavorable that they could not be overcome by reasonable design, construction, and maintenance practices; in addition, exposing an increased number of people to a risk of seismic-related injury would constitute a significant impact.

b. Less-than-Significant Impacts. Implementation of the proposed project would not be affected by slope instability. The project would not be expected to contribute to regional subsidence or long-term erosion hazards *(Criterion B)*.

c. Significant Impacts. Development of the proposed project could result in two significant impacts related to seismic hazards *(Criterion A)* and soil stability *(Criteria C and D*), as discussed below.

<u>Impact GEO-1</u>: Project occupants would be subject to seismic hazards. (S)

All structures in the Bay Area could be affected by ground shaking in the event of an earthquake. The amount of ground shaking depends on the magnitude of the earthquake, the distance from the epicenter, and the type of earth materials between the receptor and the epicenter. Very strong to violent ground shaking is expected at the project site during predicted earthquakes on the San Andreas and other regional active faults. This level of seismic shaking could cause extensive non-structural damage in buildings at the site. In addition, limited structural damage could occur. Implementation of the following mitigation measure would reduce this impact to a less-than-significant level:

> <u>Mitigation Measure GEO-1</u>: Prior to the issuance of any site-specific grading or building permits, a design-level geotechnical investigation shall be prepared and submitted to the City of Menlo Park Building Division for review and confirmation that the proposed development fully complies with the California Building Code. The report shall determine the project site's surface geotechnical conditions and address potential seismic hazards such as liquefaction and subsidence. The report shall identify building techniques appropriate to minimize seismic damage. In addition, the following requirement for the geotechnical and soils report shall be achieved:
>
> - The analysis presented in the geotechnical report shall conform to the California Division of Mines and Geology recommendations presented in the *Guidelines for Evaluating Seismic Hazards in California*.[21]
> - All mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report shall be implemented as a condition of project approval. (LTS)

It is acknowledged that seismic hazards cannot be completely eliminated, even with a site-specific geotechnical investigation and advanced building practices (as provided in the mitigation measure

[21] California Division of Mines and Geology (CDMG), 1997. *Guidelines for Evaluating Seismic Hazards in California*, CDMG Special Publication 117, 74 p.

above). However, exposure to seismic hazards is a generally accepted part of living in the earthquake-prone San Francisco Bay Area and therefore the mitigation measure described above would reduce the potential hazards associated with seismic activity to a less-than-significant level.

Impact GEO-2: Damage to structures or property related to shrink-swell soils and/or settlement of non-engineered fill soils could occur. (S)

The geotechnical report for the project site indicates that, based on one plasticity test of representative near-surface soils, site soils have a moderate shrink-swell potential. Actual conditions revealed during grading may vary relative to observations made of the soil borings. Shrink-swell potential may be moderate to high in some locations (the soils have not been mapped for shrink-swell potential by NRCS). In addition, non-engineered near-surface fills have been identified in soil borings associated with the site-specific geotechnical investigation. Structural damage, warping, and cracking of roads, driveways, parking areas and sidewalks, and rupture of utility lines may occur if the potential expansive soils and the nature of the imported fill are not considered during design and construction of improvements. Implementation of the following mitigation measure would reduce this impact to a less-than-significant level:

> Mitigation Measure GEO-2: In locations underlain by expansive soils and/or non-engineered fill, the designers of proposed building foundations and improvements (including sidewalks, roads, driveways, parking areas, and utilities) shall consider these conditions and design the project to prevent associated damage. The design-level geotechnical investigation (required in Mitigation Measure GEO-1) shall include measures to ensure that potential damage related to expansive soils and non-uniformly compacted fill is minimized. Mitigation options may range from removal of the problematic soils, and replacement, as needed, with properly conditioned and compacted fill, to design and construction of improvements to withstand the forces exerted during the expected shrink-swell cycles and settlements. All mitigation measures, design criteria, and specifications set forth in the geotechnical and soils report shall be implemented to reduce impacts associated with problematic soils to a less-than-significant level. (LTS)