
IV. ENVIRONMENTAL IMPACT ANALYSIS

F. GEOLOGY & SOILS

INTRODUCTION

This section of the Draft Environmental Impact Report (DEIR) addresses the subject of geology and soils with respect to the proposed Big Wave Wellness Center and Office Park project (“proposed project”) and includes an assessment of potential impacts associated with the development of the proposed project on the geology and soils of the project site. The following discussion is based, in part, on the findings and conclusions of a third party geotechnical/geological peer review conducted by Treadwell & Rollo, Inc. (T&R). This section is based on the following reports (refer to Appendix F of the DEIR):

- *Geotechnical Investigation, Proposed 5-Acre Commercial Development West Corner of Airport Street and Stanford Avenue, Princeton by the Sea, California*, prepared by Bay Area Geotechnical Group (BAGG), June 13, 2000;
- *Preliminary Geotechnical Engineering Investigation, Proposed 10-Acre¹ Commercial Development South of Airport Street, APN 047-311-060, Princeton by the Sea, California*, prepared by BAGG, May 7, 2002;
- *Third Party Geotechnical Review, Big Wave Office Park and Wellness Center, Princeton by the Sea, California*, prepared by T&R, April 3, 2007;
- *Proposal, Final Geotechnical Investigation, Proposed Big Wave Office Park and Wellness Center Airport Street Northwest of Stanford Avenue, APN 047-311-060 (Office Park) and APN 047-312-040 (Wellness Center), Princeton-By-The-Sea, California*, prepared BAGG, July 10, 2008;
- *Geotechnical Consultation, Proposed Big Wave Office Park and Wellness Center, Airport Street Northwest of Stanford Avenue, APN 047-311-060 (Office Park) and APN 047-312-040 (Wellness Center), Princeton-By-The-Sea, California*, prepared by BAGG, July 11, 2008 (in response to T&R’s April 3, 2007 Third Party Geotechnical Review);
- *Third Party Geotechnical Review, Big Wave Office Park and Wellness Center, Princeton by the Sea, California*, prepared by T&R, April 22, 2009; and
- *Third Party Geotechnical Review, Big Wave Office Park and Wellness Center, Princeton by the Sea, California*, prepared by T&R, May 19, 2009.

¹ *At the time the preliminary investigation was performed, 100-foot-wide set backs from the existing wetlands had been specified, reducing the available building space from 14 acres to approximately 10 acres.*

T&R reviewed the above-listed BAGG reports to verify their adequacy, completeness, and accuracy for use in this EIR. T&R did not perform any additional onsite geologic mapping, drilling borings, laboratory testing, or any type of subsurface exploration for this analysis.

METHODOLOGY

The methodology used to determine the environmental setting and impacts of the proposed project to geology and soils included the following:

- review of previous geologic and geotechnical reports prepared for the site;
- review of local geologic and seismicity data for the site vicinity;
- completion of limited exploration of the subsurface soil and bedrock conditions by excavating 23 test pits on the project site (fourteen on the northern parcel [twelve borings to depths ranging from 17 to 25 feet, and two deep borings to depths of 50 feet] and nine on the southern parcel [to depths ranging from 17.5 to 41.5 feet]);
- evaluation of the engineering characteristics of the subsurface soils by performing laboratory tests and engineering analyses; and
- preparation of report as a summary of findings and to present preliminary conclusions and recommendations.

ENVIRONMENTAL SETTING

Regional and Local Setting

The project site is within the Coast Ranges geomorphic province², which is characterized by northwest trending valleys and ridges. These are controlled by a series of folds and faults that resulted from the collision of the Farallon and North American tectonic plates and subsequent strike-slip faulting along the San Andreas Fault zone. The Coast Ranges can be further divided into the northern and southern ranges, which are separated by the San Francisco Bay. The Southern Coast Ranges run north and south between San Francisco Bay to the north, the Central Valley to the east, Transverse Ranges to the south, and the Pacific Ocean to the west.

The project area is situated on a structural block west of the San Andreas and Pilarcitos faults.³ The Half Moon Bay Terrace Formation underlies the Half Moon Bay Airport, as well as the agricultural fields to the east and west of State Route 1 (SR 1; Cabrillo Highway). This formation consists of unconsolidated deposits of sand, silt, and clay and serves as the principal water-bearing zone in the Moss Beach and El Granada area.

² A geomorphic province is an area that possesses similar bedrock, structure, history, and age.

³ Brady/LSA, 2002, Fitzgerald Marine Reserve Master Plan. Part Two: Environmental Setting. May 2002. Woyshner, M., Hedlund, C., and Hecht, B., 2002, *Ibid.*

Soils within the project area include coarse-grained, older alluvial fan and stream terrace deposits (Qof) of the Pleistocene Age, consisting of poorly consolidated gravel, sand, and silt, coarser grained at heads of old fans and in narrow canyons, and younger (outer) alluvial fan deposits (Qyfo) of the Holocene age, consisting of unconsolidated fine sand, silt, and clayey silt (refer to Figure IV.F-1).

The project site, which is currently used for agricultural purposes, is located to the west of Airport Street, north of the Princeton/Pillar Point Harbor area. The project site encompasses a total of 19.4 acres on two parcels, including: a northern parcel (14.25 acres) and a southern parcel (5.28 acres). A natural drainage swale (intermittent stream) is at a low point between the two parcels and leads to the Pillar Point Marsh, a salt marsh habitat influenced by both tidal action and freshwater runoff from its tributary drainage area. Both portions of the site have a relatively steep topography change at their western edges, which approach the marsh. Steeper topographic changes also exist along the northern edge of the southern parcel and the southern edge of the northern parcel, where the parcels respectively border the drainage swale. Elevations of the northern parcel range from 11.5 to 27.7 feet National Geodetic Vertical Datum (NGVD),⁴ while elevations of the southern parcel range from 8.9 to 18.3 feet NGVD.

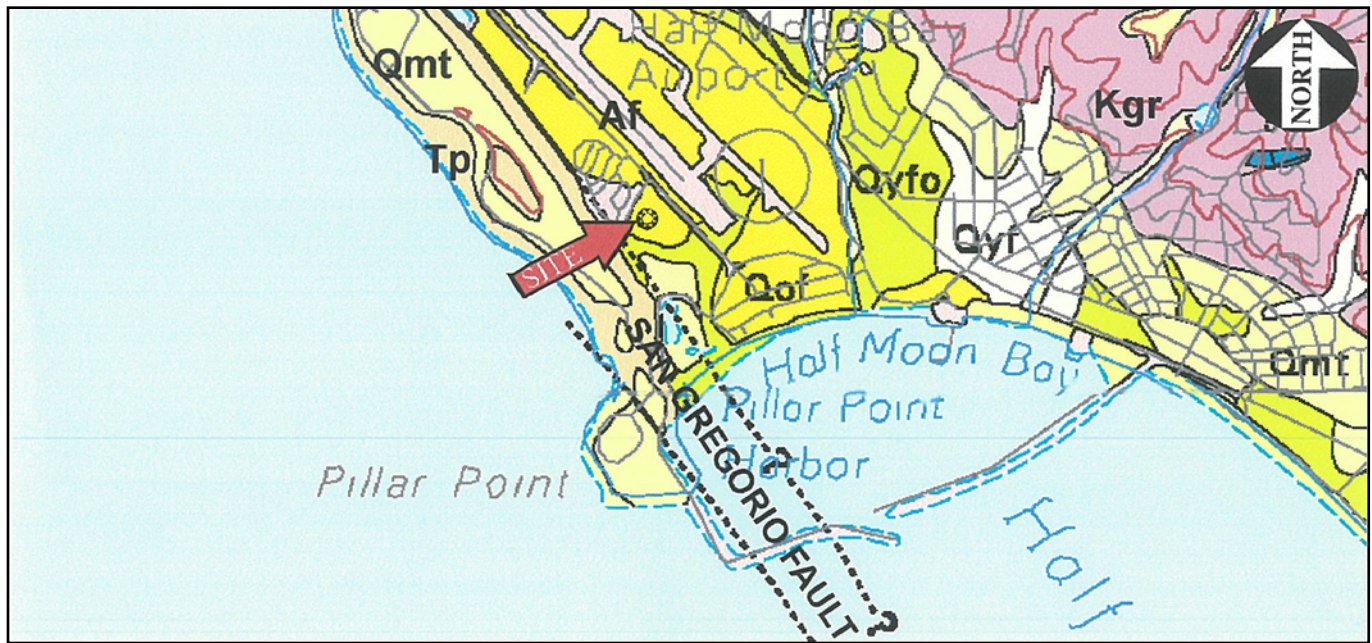
Project Site Geology

According to the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Web Soil Survey⁵ for the County of San Mateo, two soil types underlay the site (refer to Figure IV.F-2): Denison clay loam, “nearly level” (DcA) and Denison clay loam, “nearly level and imperfectly drained” (DdA). Using the NRCS Web Soil Survey, percentages of each soil type on the project site were estimated. The northern parcel contains 96.7 percent DcA and 3.3 percent DdA, with the DdA portions at the low-lying southwest corner and eastern edges near the drainage swale. The southern parcel contains predominantly DdA soils at 75.9 percent; DcA soils comprise 24.1 percent of the site on the eastern edge of the site.

Field exploration was performed at the southern parcel in 2000 and the northern parcel in 2002. The exploration included performing 23 borings on the project site (fourteen on the northern parcel [to depths ranging from 17 to 50 feet below the existing ground surface (bgs)] and nine on the southern parcel [to depths ranging from 17.5 to 41.5 feet bgs]).

⁴ *The topographic elevations are based on Site Topography by MacLeod & Associates dated October 14, 2005 and are benchmarked to the San Mateo County Datum. San Mateo County Datum is identical to the National Geodetic Vertical Datum of 1929 (NGVD 29).*

⁵ *United States Department of Agriculture, Natural Resources Conservation Service, Web Soil Survey, accessed by CAJA Staff at <http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm> on April 29, 2009.*



LEGEND

Qyfo Younger (outer) alluvial fan deposits (Holocene)

Unconsolidated fine sand, silt, and clayey silt.

Qmt Marine terrace deposits (Pleistocene)

Poorly consolidated and poorly indurated well- to poorly-sorted sand and gravel. Thickness variable but probably less than 30 m.

af Artificial fill (Historic)

Loose to very well consolidated gravel, sand, silt, clay, rock fragments, organic matter, and man-made debris in various combinations. Thickness is variable and may exceed 30 m in places. Some is compacted and quite firm, but fill made before 1965 is nearly everywhere not compacted and consists simply of dumped materials.

Qof Coarse-grained older alluvial fan and stream terrace deposits (Pleistocene)

Poorly consolidated gravel, sand, and silt, coarser grained at heads of old fans and in narrow canyons.

Qyr Younger (inner) alluvial fan deposits (Holocene)

Unconsolidated fine- to coarse grained sand, silt, and gravel, coarser grained at heads of fans and in narrow canyons.

Tp Purisima Formation (Pliocene and upper Miocene)

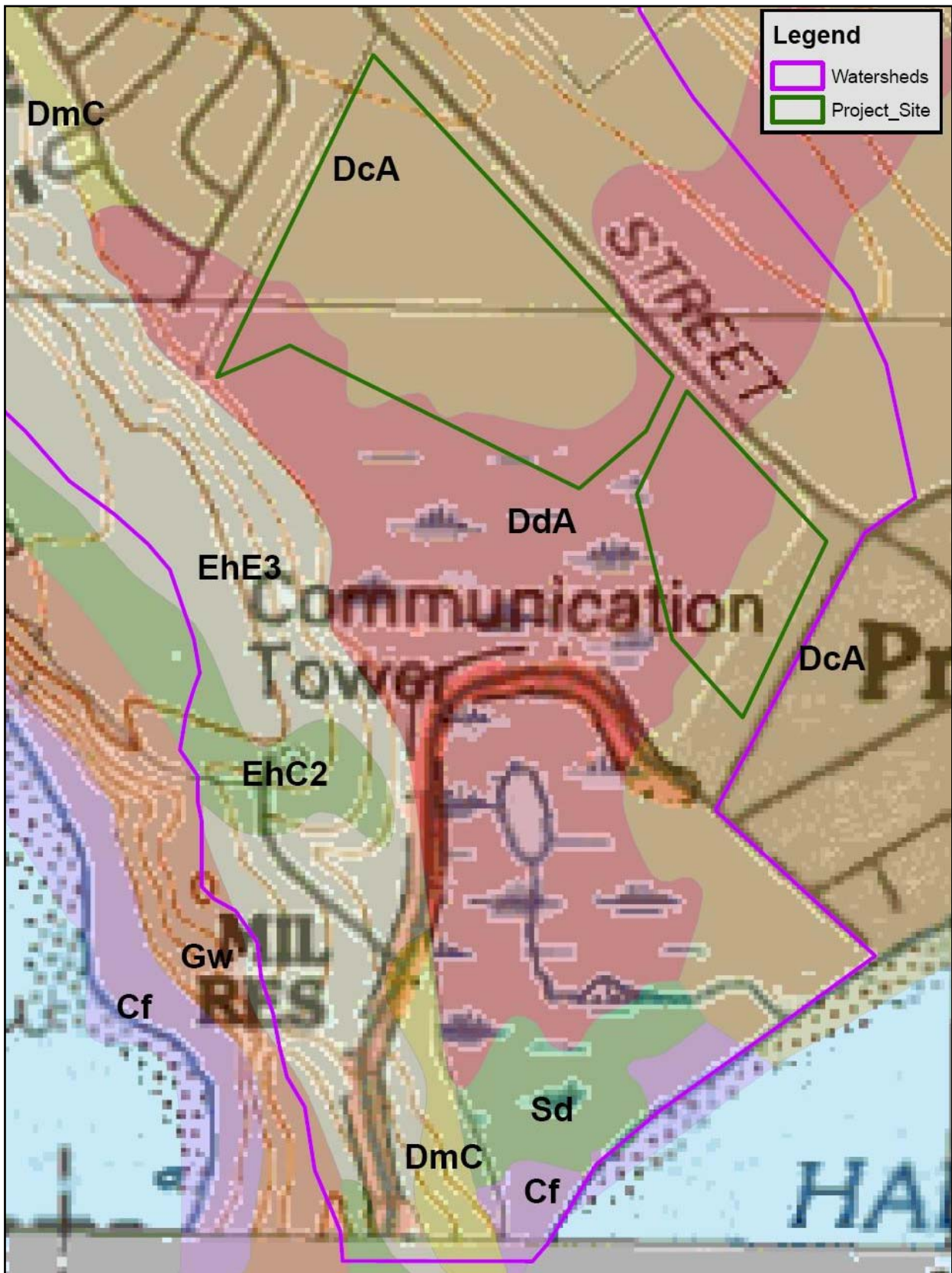
Predominantly gray and greenish-gray to buff finegrained sandstone, siltstone, and mudstone, but also includes some porcelaneous shale and mudstone, chert, silty mudstone, and volcanic ash. West of Portola Valley, this unit consists of fine- to medium-grained silty sandstone.

Kgr Granitic rocks of Montara Mountain

Very light gray to light brown, medium- to coarsely crystalline foliated granitic rock, largely quartz diorite with some granite. These rocks are highly fractured and deeply weathered. Foliation is marked by an alignment of dark minerals and dark dioritic inclusions. Tabular bodies of aplite and pegmatite generally parallel foliation.

REFERENCE: *GEOLOGY OF THE ONSHORE PART OF SAN MATEO COUNTY, CALIFORNIA: A DIGITAL DATABASE, PAMPHLET DERIVED FROM DIGITAL OF98-137*, by Brabb, E.E., Gravmer, R.W., And Jones, D.L. U.S. Geological Survey, 1998.





Source: U.S. Department of Agriculture, Natural Resources Conservation Service, 2006, Soil Survey (SSURGO) database for San Mateo Area, California, ca637, December 14, 2006. USGS, 1993, Montara Mountain, CA, 7.5' Quadrangle Sheet.



CHRISTOPHER A. JOSEPH & ASSOCIATES
Environmental Planning and Research

Figure IV.F-2
Project Site Soils Map

Test borings indicate that several saturated, medium dense, granular soil layers are present at the site and that the project site is underlain by a wide variety of soils and is blanketed by approximately 12 inches of soft and wet soils. The near-surface soil encountered in the test borings at the northern and southern parcels consisted primarily of medium to high plasticity clay and low to high plasticity clay, respectively.

The northern parcel is generally underlain by clay, sand, and gravel, with a fines content ranging from 4 to 15 percent. Test borings indicate that soils at the northern parcel generally consist of extremely heterogeneous lenses of soft to very stiff lean clays, sandy lean clays, lean to fat clays, and loose to very dense clayey sands, silty sands, clayey gravels, and poorly-to well-graded sands with varying fines content, including clay, silt, and gravel.

Soils at the southern parcel generally consist of clay and sand, with a fines content ranging from 4 to 42 percent. Test borings indicate that soils at the southern parcel consist of extremely heterogeneous lenses of soft to very stiff lean clays, sandy lean clays, fat clays, and loose to very dense clayey sands, silty sands, and poorly graded sands.

Groundwater

Groundwater was encountered on the project site during subsurface site drilling, at depths ranging from 5.5 to 7.5 and 3 to 10 feet bgs on the northern parcel and southern parcel, respectively. Groundwater levels fluctuate as a result of seasonal changes.

Seismicity and Seismic Hazards

Seismic hazards include ground motion, ground surface fault rupture, liquefaction, settlement, lateral spreading, and seismically-induced slope instabilities. Seismic hazards, including the potential for fault rupture, cyclic densification, liquefaction, lateral spreading, and sand boils are primary geotechnical concerns for the project site.

The project site is located in the seismically active region of the San Francisco Bay Area and active earthquake faults have been recognized within the immediate site area. This region has the highest rate of seismic moment release per square mile of any urban area in the United States. The numerous faults in the region include active, potentially active, and inactive faults. These major groups are based on criteria developed by the California Geological Survey (CGS), formerly known as the California Division of Mines and Geology, for the Alquist-Priolo Earthquake Fault Zoning Program. By definition, an active fault is one that has had surface displacement within the Holocene epoch (about the last 11,000 years). A potentially active fault is a fault that has demonstrated surface displacement during the Quaternary period (the last 1.6 million years). Inactive faults are faults that have not had any movement in the last 1.6 million years. Earthquake Fault Zones, formerly known as Special Studies Zones, have been established along active known faults in California in accordance with the Alquist-Priolo Earthquake Fault Zoning Act passed in 1972.

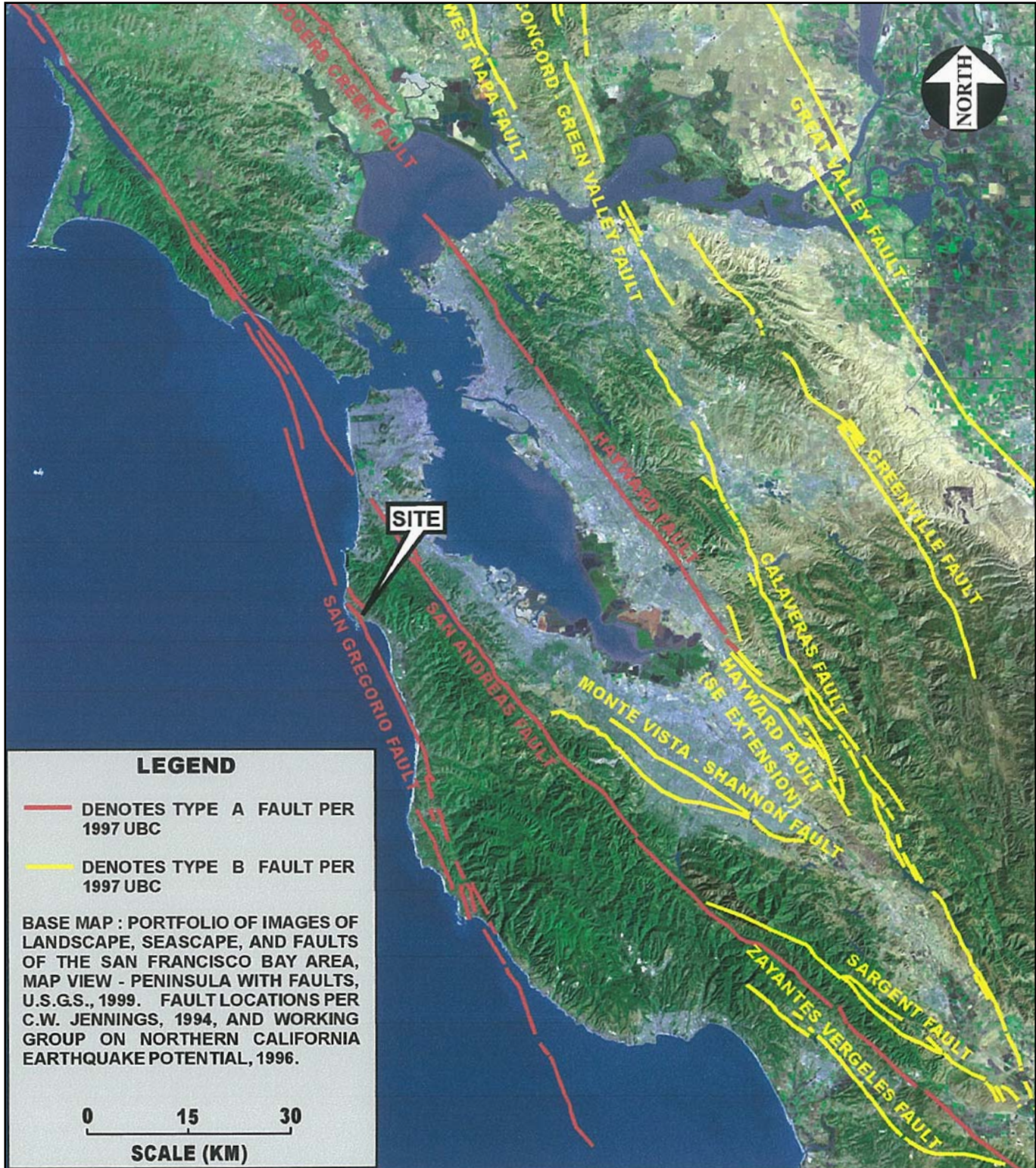
The project site is within a region characterized by the seismically active San Andreas Fault system, which is the principal tectonic element of the North American/Pacific plate boundary in California. Movements along this plate boundary in the Northern California region are primarily translational, resulting in mostly right-lateral strike-slip faulting along the San Andreas Fault system. Seismic and aseismic slip on the San Andreas Fault system is partitioned into subsidiary structures that distribute plate movements across the Coast Ranges province, between the off-shore Continental Shelf areas to the west and the Sacramento Valley to the east.

The nearest major active fault to the project site is the San Gregorio Fault, located approximately 500 feet (0.15 kilometers) to the southwest of the buildable portion of the project site. No subsurface trenching was performed on the project site to locate the San Gregorio fault. Additionally, the San Andreas Fault is located approximately 6.7 miles (10.8 kilometers) northeast of the project site. Many large historical earthquakes have occurred on active faults associated with the regional stress field of the San Andreas Fault Zone. A list of major active faults in the region, including their distances from the project site and maximum moment magnitudes (M_w), is provided in Table IV.F-1. Moment Magnitude is an energy-based scale and provides a physically meaningful measure of the size of a faulting event. Moment magnitude is directly related to average slip and fault rupture area. Other faults in the area, which are generally considered inactive, include the Pilarcitos and San Mateo Creek Faults, located approximately 4.2 miles (6.7 kilometers) and 5.5 miles (8.9 kilometers) northeast of the project site, respectively. Refer to Figure IV.F-3.

**Table IV.F-1
Regional Active Faults and Seismicity**

Fault Name	Distance from Site (km)	Direction from Site	Maximum Moment Magnitude
San Andreas - 1906 Rupture	10.8	Northeast	7.9
San Andreas – Peninsula	10.8	East	7.2
San Gregorio – North	0.15	Southwest	7.3
<i>Source: BAGG 2000, 2002.</i>			

Since 1800, four major earthquakes have been recorded on the San Andreas Fault in the greater San Francisco Bay and Monterey Bay areas. In 1836, an earthquake with an estimated maximum intensity of VII on the Modified Mercalli (MM) scale occurred east of Monterey Bay on the San Andreas Fault. The estimated M_w for this earthquake is approximately 6.25. In 1838, an earthquake occurred with an estimated MM intensity of about VIII-IX, corresponding to a M_w of about 7.25. The San Francisco earthquake of 1906 caused the most significant damage in the history of the San Francisco Bay area in terms of loss of lives and property damage. This earthquake created a 400-kilometer surface rupture along the San Andreas fault from Shelter Cove to San Juan Bautista. It had a maximum MM intensity of XI, a M_w of about 7.9, and was felt 560 kilometers away in Oregon, Nevada, and Los Angeles. The most recent large earthquake to affect the Bay Area was the Loma Prieta earthquake of October 17, 1989 with a M_w of 6.9. The epicenter of this earthquake was in the Santa Cruz Mountains.



In 1999, the Working Group on California Earthquake Probabilities (WGCEP, 1999) at the U.S. Geologic Survey (USGS) predicted a 70 percent probability of a M_w of 6.7 or greater earthquake occurring in the San Francisco Bay Area by the year 2030. The WGCEP revised their estimate in 2003 to a 62 percent probability of a M_w of 6.7 or greater earthquake during the period of 2003 to 2032. WGCEP 2007 was commissioned to develop an updated, statewide forecast, the latest result of which is the Uniform California Earthquake Rupture Forecast (UCERF), Version 2.⁶ Organizations sponsoring WGCEP 2007 include the USGS, CGS, and the Southern California Earthquake Center (SCEC). The comprehensive new forecast builds on previous studies and also incorporates abundant new data and improved scientific understanding of earthquakes.⁷ The WGCEP 2007 estimate predicts a 63 percent probability of a M_w of 6.7 or greater earthquake occurring in the San Francisco Bay Area by the year 2037. More specific estimates of the probabilities for select faults in the Bay Area are presented in Table IV.F-2.

**Table IV.F-2
WGCEP Estimates of 30-Year Probability of a
Moment Magnitude (M_w) 6.7 or Greater Earthquake for Select Faults**

Fault Segment	Probability (WGCEP, 1999) (percent)	Probability (WGCEP, 2003) (percent)	Probability (WGCEP, 2007) (percent)
San Andreas	21	21	21
San Gregorio	10	10	6
<i>Source: USGS, CGS, SCEC. The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2), prepared by 2007 Working Group on California Earthquake Probabilities. Accessed by CAJA Staff at http://pubs.usgs.gov/of/2007/1437/of2007-1437_text.pdf.</i>			

Ground Motion

Ground motion is generated during an earthquake as two blocks of the Earth’s crust slip past each other. In general, ground motion is greatest near the epicenter, increases with increasing magnitude, and decreases with increasing distance. However, the ground motion measured at a given site is influenced by a number of criteria, including depth of the epicenter, proximity to the projected or actual fault rupture, fault mechanism, duration of shaking, local geologic structure, source direction of the earthquake, underlying earth material, and topography.

Earthquake magnitude is a quantitative measure of the strength of an earthquake or the strain energy released by it, as determined by seismographic or geologic observations. Earthquake intensity is a qualitative measure of the effects a given earthquake has on people, structures, or objects, which varies to place to place within the area affected by the earthquake. Earthquake magnitude is measured on the Richter scale or as M_w , and intensity is described by the MM intensity scale. A related form of

⁶ USGS, CGS, SCEC. *The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2), prepared by 2007 Working Group on California Earthquake Probabilities.* 2008. Accessed by CAJA Staff at http://pubs.usgs.gov/of/2007/1437/of2007-1437_text.pdf.

⁷ USGS, CGS, SCEC. *Fact Sheet - Forecasting California’s Earthquakes-What Can We Expect in the Next 30 Years?* 2008. Accessed by CAJA Staff at <http://pubs.usgs.gov/fs/2008/3027/fs2008-3027.pdf>.

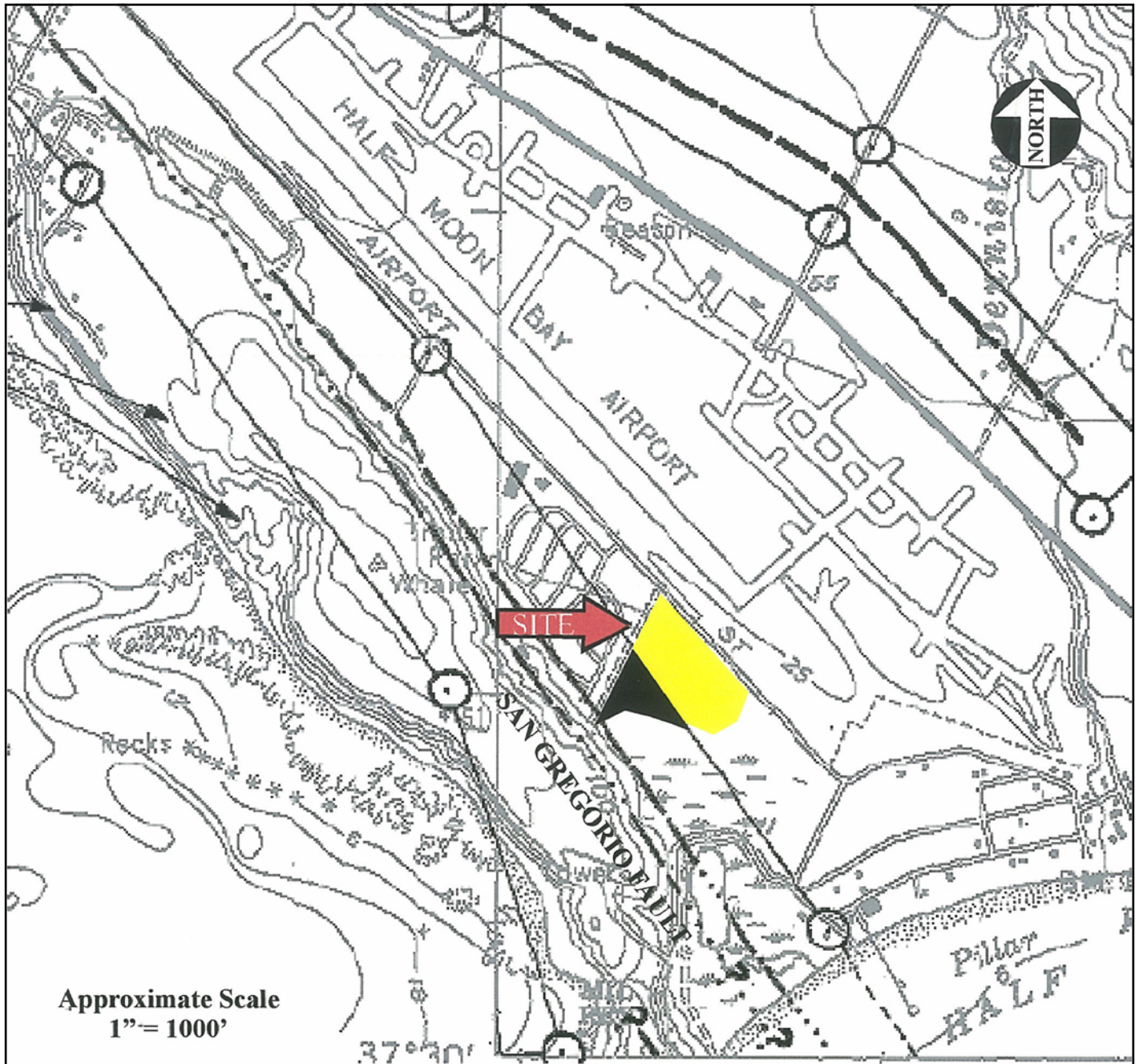
measurement is peak ground acceleration, which is a measure of ground shaking during an earthquake. Peak ground acceleration values are reported in units of gravity (g). Structures founded on thick soft soil deposits are more likely to experience more destructive shaking, with higher amplitude and lower frequency, than structures founded on bedrock. In addition, thick soft soil deposits at far distances from earthquake epicenters may result in seismic accelerations significantly greater than expected in bedrock at the same distance. As a general rule, the severity of ground shaking increases with proximity to the epicenter of the earthquake. The Probabilistic Seismic Hazard Analysis (PSHA) from CGS estimates a peak horizontal ground acceleration at the project site having a 10 percent probability of exceedance in 50 years to be 0.595g.⁸

Ground shaking is a seismic hazard that can cause damage to structures. As described above, several faults exist within close proximity of the project site. Maps prepared by Association of Bay Area Governments (ABAG, 2001) indicate the site will experience a MM Intensity of “X”, which could result in “very violent” shaking and “extreme damage” from a M_w 7.3 earthquake on a nearby portion of the San Gregorio fault. The ABAG maps also indicate that during a M_w 7.9 earthquake on a nearby portion of the San Andreas fault, the site could experience “violent” shaking and “heavy damage”. As such, the project site could be subjected to severe ground shaking in the event of a major earthquake on any of the faults referenced above or other faults in northern California. However, the risk of hazard associated with ground shaking at the project site is comparable to the risk experienced in the project area in general. This is common to virtually all developments in the greater San Francisco Bay Area.

Fault Rupture

Ground surface rupture results when the movement along a fault is sufficient to cause a gap or break along the upper edge of the fault zone on the surface. Damage due to surface rupturing is limited to the actual location of the fault line break, unlike damage from ground shaking, which can occur at great distances from the fault. The northwest corner of the northern parcel is within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act (refer to Figure IV.F-4). No subsurface trenching was performed to locate the San Gregorio fault. The southern parcel is not located within an Earthquake Fault Zone and no known active or potentially active faults exist on this parcel. Since the southern parcel is located within a seismically active area, the remote possibility exists for future faulting in areas where no faults previously existed. However, based on the proximity of the known fault traces, their orientation and trend, and their degree of activity, the potential for fault rupture at the southern parcel is low.

⁸ California Geological Survey. *Probabilistic Seismic Hazards Mapping Ground Motion Page*. Accessed by CAJA Staff at <http://redirect.conservation.ca.gov/cgs/rghm/pshamap/pshamap.asp> on June 15, 2009.



Site shaded black is a wetland zone not to be constructed. In the field wetlands setback line runs very close to the diving line between the black and yellow areas of the site.

REFERENCE: Reproduced with permission, California Division of Mines and Geology CD-ROM 2000-004 (2000), Official Map of Alquist-Priolo Earthquake Fault Zones, Montara Mountain Quad, 1982.



Seismic-Related Ground Failure

In addition to triggering landslides, strong ground shaking caused by large earthquakes can induce ground failures, such as cyclic densification and liquefaction. A site's susceptibility to these hazards relates to the site topography, soil conditions, and/or depth of groundwater, which are discussed above. Potential liquefaction-induced hazards include lateral spreading, ground settlement due to post-liquefaction reconsolidation, and surface manifestations such as sand boils and lurch cracking.

Cyclic Densification

Cyclic densification is a phenomenon in which non-saturated, cohesionless soil is compacted by earthquake vibrations, causing differential settlement. Loose layers of sandy soil above the groundwater table that may densify during a major earthquake are present at the project site. As such, the project site could be subject to differential ground settlement resulting from cycling densification of the loose sandy soils. The settlement analysis performed for the site estimates that differential settlement of the ground surface would be between 0.5 and 3.5 inches at the northern parcel. A preliminary evaluation of cyclic densification at the southern parcel indicates that ground settlement due to cyclic densification would be on the order of approximately 0.25 inches.

Liquefaction

Liquefaction is a phenomenon in which saturated, cohesionless soil experiences a temporary loss of strength due to the buildup of excess pore water pressure, especially during cyclic loading such as that induced by earthquakes. Soils most susceptible to liquefaction are loose, clean, saturated, uniformly graded, fine-grained sands. Silty sands may also be susceptible to liquefaction during strong ground shaking, although to a lesser extent. As stated previously, both parcels are underlain by layers of saturated loose to medium dense, sandy soil that are susceptible to soil liquefaction and liquefaction is likely to occur at the site. It is preliminarily estimated that up to 6 inches of liquefaction-induced ground surface settlement may occur at the northern parcel with differential settlement of about 3 inches across a 50-foot horizontal distance. At the southern parcel, up to approximately 2.5 inches of liquefaction-induced ground settlement is estimated to occur with differential settlement of about 1.5 inches across a 50-foot horizontal distance.

Lateral Spreading

Lateral spreading typically occurs as a form of horizontal displacement of relatively flat-lying alluvial material toward an open or "free" face such as an open body of water, channel, or excavation. Generally in soils, this movement is due to failure along a weak plane, and may often be associated with liquefaction. As cracks develop within the weakened material, blocks of soil displace laterally toward the open face. Cracking and lateral movement may gradually propagate away from the face as blocks continue to break free. Lateral spreading can occur within areas having potential for liquefaction. A preliminary evaluation for the potential for lateral spreading to occur at the site was performed by evaluating the location, thickness, and relative density of the potentially liquefiable soil layers, in addition

to site topography and locations of free-face conditions, such as creek banks. While existing subsurface information indicates liquefaction is likely to occur at the site, based on the thickness and the relative density of the potentially liquefiable soil, the potential for lateral spreading to occur at the project site during seismic events is considered to be low.

Surface Manifestations

Surface manifestations, including sand boils or lurch cracking, are other types of liquefaction-induced ground failure that could potentially occur at the project site. A sand boil occurs when sand and water come out onto the ground surface during an earthquake as a result of liquefaction at shallow depth. Lurch cracking is the cracking of the ground surface in soft, saturated material as a result of earthquake-induced ground shaking. These types of ground failures are dependent on the thickness of the liquefiable soil layer relative to the thickness of the overlying non-liquefiable material. Because the project site's potentially liquefiable soil is relatively shallow, the potential for surface manifestations as a result of liquefaction in the form of sand boils and lurch cracking is high.

Landslides and Slope Instabilities

Steep slopes, shallow soil development, excess water, and lack of shear strength in an area can result in slope instabilities and landslides. Ground shaking during an earthquake may lead to seismically induced landslides, but most slides result from the weight of rain saturated soil and rock exceeding the shear strength of the underlying material.

As previously discussed and provided in Section III (Project Description) of the DEIR, the project site is relatively flat with surface elevations ranging from 9.0 to 27.7 feet National Geodetic Vertical Datum (NGVD), with gentle slopes to the south and west. Pursuant to the Natural Hazards Map of the County's General Plan⁹, the project site is not located within the boundaries of an "Area of High Landslide Susceptibility." Additionally, there are no portions of the project site mapped by the CGS in accordance with the Seismic Hazard Mapping Act as a seismically-induced landslide hazard area.¹⁰ As such, the probability of seismically-induced landslides and slope instabilities affecting the project site is considered to be remote, due to the relatively flat nature of the site and surrounding area.

Expansive Soil

Expansive soil undergoes large volume changes during changes in moisture content (i.e., shrinks when dried and expands when wetted). Clay mineralogy, clay content, and porosity of the soil influence the change in volume. The most common cause of changing soil moisture content is seasonal fluctuation due

⁹ County of San Mateo, Planning & Building Department, *San Mateo County General Plan, General Plan Maps, Natural Hazards*, accessed by CAJA Staff at [http://www.sforoundtable.org/P&B/gp/maps/gp%20natural%20hazards%20\(11x17\).pdf](http://www.sforoundtable.org/P&B/gp/maps/gp%20natural%20hazards%20(11x17).pdf) on June 19, 2009.

¹⁰ State of California, Department of Conservation, *California Geological Survey, Seismic Hazards Zonation Program*, accessed by CAJA Staff at <http://www.conservation.ca.gov/cgs/shzp/Pages/Index.aspx> on June 19, 2009.

to rainfall; however, improper surface drainage or underground water pipe leaks may cause expansive soils to shrink and swell. The shrinking and swelling caused by expansive soil can cause damage to building foundations, concrete slabs, hardscape, pavement, underground utilities, and other surface or near-surface improvements due to differential ground movement induced by changes in soil moisture content.

As previously discussed, the near-surface soil encountered in the test borings at the northern and southern parcels consisted primarily of medium to high plasticity clay and low to high plasticity clay, respectively. The project site is blanketed by about 1.5 to 2.5 feet of potentially expansive clayey soil. The presence of expansive near-surface soil is a primary geotechnical concern for the project site.

Soil Erosion

As discussed above, two soil types underlay the site: Deninson clay loam, “nearly level” (DcA) and Denison clay loam, “nearly level and imperfectly drained” (DdA). Per Section IV.H (Hydrology & Water Quality), based on the moderate slopes and topography onsite, the erosion potential of the above soils is none to slight.

REGULATORY SETTING

Federal

Federal Earthquake Hazards Reduction Act

In 1997, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes through the establishment and maintenance of an effective earthquake hazards and reduction program. To accomplish this, the Act established the National Earthquake Hazards Reduction Program (NEHRP). The agencies responsible for coordinating NEHRP are the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF); and the United States Geological Survey (USGS). In 1990 NEHRP was amended by the National Earthquake Hazards Reduction Program Act (NEHRPA), which refined the description of the agency responsibilities, program goals, and objectives. The four goals of the NEHRP are as follows:

- Develop effective practices and policies for earthquake loss-reduction and accelerate their implementation,
- Improve techniques to reduce seismic vulnerability of facilities and systems,
- Improve seismic hazards identification and risk-assessment methods and their use, and
- Improve the understanding of earthquakes and their effects.¹¹

¹¹ *National Earthquakes Hazards Reduction Program, About Us, Background & History. Accessed by CAJA Staff at <http://www.nehrp.gov/about/history.htm> on May 8, 2009.*

State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act is the State law that focuses on hazards from earthquake fault zones. The purpose of this law is to mitigate the hazard of surface fault rupture by regulating structures designated for human occupancy near active faults. As required by this Act, the California Geological Survey has delineated Earthquake Fault Zones along known active faults in California. The northwestern portion of the northern parcel of the project site is located within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act.

California Building Standards Code¹²

Title 24 of the California Code of Regulations (CCR), known as the California Building Standards Codes or “Title 24”, contains the laws and regulations that govern the construction of buildings in California. The California Building Standards Code applies to all occupancies throughout the State. However, cities or counties may establish more restrictive building standards. The 2007 edition of the California Building Standards Code (Title 24) became effective on January 1, 2008.

Part 2 of Title 24 is the California Building Code (CBC), which contains general building design and construction requirements relating to fire and life safety, structural safety, and access compliance. CBC provisions provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures and certain equipment. Chapter 23 of the CBC addresses seismic safety, and includes regulations for earthquake-resistant design and construction.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (Assembly Bill [AB] 1341) was enacted in 1997 by the California legislature to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This Act requires the State Geologist to map areas subject to seismic hazards, including areas where earthquake-induced liquefaction or landslides could occur. A geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design before development permits will be granted. Additionally, this Act requires a Standardized Natural Hazards Disclosure Statement form be completed by real estate sellers if a property is within one of the designated natural hazards areas.

¹² Department of General Services, State Architect, Title 24 Overview. Accessed by CAJA Staff at <http://www.dsa.dgs.ca.gov/Code/title24.htm> on May 8, 2009.

Regional and Local

San Mateo County General Plan

The specific General Plan policies related to geology and soils that apply to the proposed project are as follows:

Soil Resources

2.17 Regulate Development to Minimize Soil Erosion and Sedimentation

- Regulate development to minimize soil erosion and sedimentation; including, but not limited to, measures which consider the effects of slope, minimize removal of vegetative cover, ensure stabilization of disturbed areas and protect and enhance natural plant communities and nesting and feeding areas of fish and wildlife.

2.23 Regulate Excavation, Grading, Filling, and Land Clearing Activities Against Accelerated Soil Erosion

- Regulate excavation, grading, filling, and land clearing activities to protect against accelerated soil erosion and sedimentation.

2.25 Regulate Topsoil Removal Operations Against Accelerated Soil Erosion

- Regulate topsoil removal operations to protect against accelerated soil erosion and sedimentation through measures which ensure slope stabilization and surface drainage control.

Natural Hazards

15.12 Locating New Development in Areas Which Contain Natural Hazards

- As precisely as possible, determine the areas of the County where development should be avoided or where additional precautions should be undertaken during review of development proposals due to the presence of natural hazards.
- Give preference to land uses that minimize the number of people exposed to hazards in these areas.
- Require detailed analysis of hazard risk and design of appropriate mitigation when development is proposed in these areas.

Geotechnical Hazards

15.19 Appropriate Land Uses and Densities in Geotechnical Hazard Areas

- In urban areas, consider higher density land uses that are compatible with the surrounding pattern of development to be appropriate if adequate site-specific review of geotechnical hazards has been undertaken and appropriate mitigation measures can feasibly be incorporated into development projects.

15.20 Review Criteria for Locating Development in Geotechnical Hazard Areas

- Avoid the siting of structures in areas where they are jeopardized by geotechnical hazards, where their location could potentially increase the geotechnical hazard, or where they could increase the geotechnical hazard to neighboring properties.
- Wherever possible, avoid construction in steeply sloping areas (generally above 30%).
- Avoid unnecessary construction of roads, trails, and other means of public access into or through geotechnical hazard areas.
- In extraordinary circumstances when there are no alternative building sites available, allow development in geotechnically hazardous and/or steeply sloping areas when appropriate structural design measures to ensure safety and reduce hazardous conditions to an acceptable level are incorporated into the project.

ENVIRONMENTAL IMPACTS

Thresholds of Significance

In accordance with Appendix G of the CEQA Guidelines, the proposed project could have a potentially significant impact relating to geology and soils if it would:

- (a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
 - (i) 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 (as shown in Table IV.F-1).
 - (ii) Strong seismic ground shaking.
 - (iii) Seismic-related ground failure, including liquefaction.
 - (iv) Landslides.
- (b) Result in substantial soil erosion or the loss of topsoil.

- (c) 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 onsite or offsite landslide, lateral spreading, subsidence, liquefaction or collapse.
- (d) Be located on expansive soil, as defined in Table 18-1-B of the California Building Code (2001), creating substantial risks to life or property.
- (e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

As discussed in Section V.C (Impacts Found To Be Less Than Significant) of this DEIR, the potential impacts associated with Threshold (a.-iv) listed above were determined to result in a less-than-significant impact. Therefore, only Thresholds (a-i), (a-ii), (a-iii), (b), (c), (d), and (e) listed above are addressed in the following discussion.

Project Impacts and Mitigation Measures

Impact GEO-1 Fault Rupture

Ground surface rupture results when the movement along a fault is sufficient to cause a gap or break along the upper edge of the fault zone on the surface. Damage due to surface rupturing is limited to the actual location of the fault line break, unlike damage from ground shaking, which can occur at great distances from the fault.

The northwestern portion of the northern parcel of the project site is located within an Earthquake Fault Zone, as defined by the Alquist-Priolo Earthquake Fault Zoning Act. However, only a portion of the Office Park parking lot is proposed within the Earthquake Fault Zone and no habitable structures are proposed within the Earthquake Fault Zone. Therefore, project impacts related to fault rupture on the Office Park property would be ***less than significant***.

The southern parcel of the project site is not within an Earthquake Fault Zone and no known or potentially active faults exist on the parcel. Since the project site is located in a seismically active region, the remote possibility exists for future faulting in areas where no faults previously existed; however, based on the proximity of the known fault traces, their orientation and trend, and their degree of activity, the risk of surface faulting and consequent secondary ground failure at the Wellness Center property is considered low. As such, project impacts related to fault rupture on the Wellness Center property would be ***less than significant*** and no mitigation measures are required.

Impact GEO-2 Strong Seismic Ground Shaking

As previously discussed, the project site is located in the seismically active region of the San Francisco Bay Area, which has the highest rate of seismic moment release per square mile of any urban area in the United States. Additionally, active earthquake faults have been recognized within the immediate site area. During the service life of the proposed project, the site is likely to experience at least one moderate

to severe earthquake that could produce potentially damaging ground shaking. Therefore, development of the proposed project would expose future users of the project to seismic ground shaking.

As discussed previously, the probabilistic seismic hazard analysis from the CGS estimates a peak horizontal ground acceleration at the site having a 10 percent probability of exceedance in 50 years to be 0.595g. Further, maps prepared by the ABAG (ABAG, 2001) indicate the project site could experience a MM Intensity of X, which could result in “very violent” shaking and “extreme damage” from a M_w 7.3 earthquake on a nearby portion of the San Gregorio fault, and during a M_w 7.9 earthquake on the on a nearby portion of the San Andreas fault, the project site could experience “violent” shaking and “heavy damage.” Seismic ground shaking could damage the proposed development and associated infrastructure.

However, the project applicant would be required to design and construct the project in conformance with the most recently adopted building code (2007 CBC) design parameters. The CBC specifies that all proposed structures on the project site should be able to: (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage but with some nonstructural damage; and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. In addition, the proposed Office Park and Wellness Center buildings shall be designed to prevent collapse and to maintain reasonable ingress and egress for the Office Park tenants, developmentally disabled (DD) inhabitants of the Wellness Center buildings, and potential emergency response workers (if needed). Therefore, conformance with current CBC requirements would reduce the potential for structures on the project site to sustain damage during an earthquake event, and project impacts related to ground shaking would be *less than significant* and no mitigation measures are required.

Impact GEO-3 Seismic-Related Ground Failure

Strong ground shaking caused by large earthquakes can induce ground failures, such as cyclic densification, liquefaction, lateral spreading, ground settlement due to post-liquefaction reconsolidation, and surface manifestations. A site’s susceptibility to these hazards relates to the site topography, soil conditions, and/or depth of groundwater, as previously discussed.

Cyclic Densification

As discussed previously, the settlement analysis performed for the project site estimates that differential settlement of the ground surface would be between 0.5 and 3.5 inches at the Office Park property. A preliminary evaluation of cyclic densification at the Wellness Center property indicates that ground settlement due to cyclic densification would be on the order of approximately 0.25 inches. Therefore, loose layers of sandy soil above the groundwater table that may densify during a major earthquake are present at the site. Impacts to the project due to differential ground settlement resulting from cyclic densification of the loose sandy soils would be *potentially significant*.

The following mitigation measure would reduce cyclic densification impacts to a *less-than-significant* level:

Mitigation Measure GEO-3a Seismic-Related Ground Failure

The final geotechnical investigation for the project shall evaluate the potential for cyclic densification and develop final mitigation measures, as needed. Potential mitigation measures may include, but are not limited to: (1) overexcavating and replacing loose sandy soil with compacted engineered fill; (2) applying deep soil compaction techniques, such as DDC, RIC, or equivalent soil densification method; and (3) designing building foundations to accommodate total and differential ground settlement resulting from cyclic densification, as well as post-liquefaction settlement and consolidation ground settlement (if applicable).

Liquefaction and Associated Hazards

The liquefaction potential and associated hazards at the Office Park and Wellness Center properties, was reviewed, including the impacts associated with extensive surface water recharge and wastewater disposal/infiltration. As discussed previously, existing subsurface information indicate liquefaction is likely to occur at the site. Potential liquefaction-induced hazards include: lateral spreading, ground settlement due to post-liquefaction reconsolidation, and surface manifestations such as sand boils and lurch cracking.

Lateral Spreading

Based on the thickness and the relative density of the potentially liquefiable soil, the potential for lateral spreading to occur at the site is low and therefore project impacts would be *less than significant* and no mitigation measures are required.

Liquefaction-induced Ground Surface Settlement

The estimate for liquefaction-induced ground surface settlement for the Office Park property is between 0 and 6 inches with differential settlement of about 3 inches across a 50-foot horizontal distance; and for the Wellness Center property is between 0 and 2.5 inches with differential settlement of about 1.5 inches across a 50-foot horizontal distance. Therefore, impact to the proposed project due to liquefaction-induced ground surface settlement is *potentially significant*.

Surface Manifestations

As stated previously, because of the potential for soil liquefaction within relatively shallow soil layers, the impact of surface manifestations of the liquefaction, such as sand boils or lurch cracking, is high at the Office Park and Wellness Center properties and therefore project impacts would be *potentially significant*.

The following mitigation measure would reduce the abovementioned potentially significant liquefaction and associated hazards impacts to a *less-than-significant* level:

Mitigation Measure GEO-3b Seismic-Related Ground Failure

Additional subsurface exploration using rotary-wash drilling methods and/or CPTs shall be performed to better characterize the subsurface conditions at the sites. Based on the results of subsurface investigation, the potential for soil liquefaction and liquefaction-induced ground failures, such as lateral spreading, post-liquefaction reconsolidation, lurch cracking, and sand boils shall be re-evaluated at the site. The final geotechnical investigation report shall provide mitigation measures for liquefaction-induced hazards. Potential mitigation measures may include: (1) improving the soil with deep soil compaction techniques, such as DDC, RIC, or equivalent method, to reduce the liquefaction potential; (2) buildings supported on stiffened shallow foundations (i.e. footings with interlocking grade beams) bearing on a layer of well-compacted fill; (3) buildings supported on deep foundations such as drilled piers, driven piles or proprietary piles (i.e., torque-down piles and auger cast piles); and (4) constructing a structural slab that spans supported between columns.

Impact GEO-4 Total and Differential Settlement

Ground settlement at the project site will include cyclic densification settlement and post-liquefaction reconsolidation settlement (see above discussion), as well as consolidation settlement. Foundation settlement may occur due to the consolidation and compression of weak soil under the weight of new fill and structural loads as a result of the proposed project. The static settlement of soft and loose soil layers due to the placement of fill would range from 0.5 to 3 inches with differential settlement of about 1.25 inches over a 100-foot-distance for the Office Park property; no settlement estimates were provided for the Wellness Center property. There is currently insufficient data available to accurately predict the amount of settlement that would occur at the site due to the weight of new fill and building loads. Therefore, settlement impacts to the proposed project would be *potentially significant*.

The following mitigation measure would reduce total and differential settlement impacts to a *less-than-significant* level:

Mitigation Measure GEO-4 Total and Differential Settlement

Additional subsurface exploration using rotary-wash drilling methods and/or CPTs and consolidation laboratory testing shall be performed to better characterize the subsurface conditions and soil properties at the site. Based on the results of subsurface investigation, total and differential ground settlement due to cyclic densification, post-liquefaction reconsolidation, and consolidation settlement due to building loads and fill placement shall be re-evaluated. The final geotechnical investigation report shall provide mitigation measures for ground settlement. Potential mitigation measures may include: (1) improving the soil with deep soil compaction techniques, such as DDC, RIC, or equivalent method, to reduce the potential for total and differential ground settlement; (2) supporting the buildings on stiffened shallow foundations (i.e. footings with interlocking grade beams) bearing on a layer of well-compacted fill; (3)

supporting the buildings on deep foundations such as drilled piers, driven piles or propriety piles (i.e., torque-down piles and auger cast piles); and (4) constructing a structural slab that spans supported between columns. If deep foundations are selected, they shall be designed to accommodate load conditions resulting from post-liquefaction reconsolidation and consolidation due to the placement of new fill (if applicable).

Impact GEO-5 Soil Erosion or Loss of Topsoil

As discussed in Section IV.H (Hydrology & Water Quality), the proposed project would increase the amount of imperviousness onsite since the site currently has no impervious development. The increase in imperviousness would increase runoff amounts by 80 percent. The drainage plans (refer to Figure III-25 and III-26) propose rain gardens to mitigate the peak flows from the site. Erosion is of greatest potential concern during the construction-phase. After a project has been built and the landscaping has been installed, erosion from residential and commercial development sites is usually minimal, particularly when they are sited on relatively flat slopes. The existing drainage patterns on the project site, as inferred from the site topography, are dispersed overland flow. Some of the overland flow likely flows into the drainage swale between the two parcels of the project site. These drainage patterns will be somewhat altered by the proposed project. Rooftop runoff will be concentrated on the rooftops, collected into the storm drain system, and released to on-site rainwater gardens for detention and percolation.

Erosion control plan sheets have been prepared by the applicant. These sheets only show short- or mid-term controls, such as fiber rolls and jute mesh at the downstream edges of the development. Clear flow paths of stormwater are not shown. Mitigation Measure HYDRO-3 has been included to require a Stormwater Pollution Prevention Plan (SWPPP) meeting the San Francisco Bay RWQCB requirements in order to reduce runoff related erosion impacts during grading and construction phases to a less-than-significant level. Long-term erosion control measures such as landscaping are described in the proposed landscaping plan (refer to Figures III-23 and 24). Proposed landscaping includes wetland and riparian plantings within restored wetland areas and parking areas on both project sites. Also, proposed walkways, trails, and parking lots will be constructed using durable yet pervious surface materials. As proposed and mitigated, soil erosion on newly graded sites would represent a ***less-than-significant*** impact.

Impact GEO-6 Expansive Soil

The near-surface soil encountered in the borings drilled at the Office Park property primarily consisted of medium to high plasticity clay. The near-surface soil encountered in the borings drilled at the Wellness Center property consisted of low to high plasticity clay. The site is blanketed by about 1.5 to 2.5 feet of potentially expansive clayey soil. Therefore, project impacts related to expansive soils would be ***potentially significant***.

The following mitigation measure would reduce expansive soil impacts to a *less-than-significant* level:

Mitigation Measure GEO-6 Expansive Soil

The final geotechnical investigation shall provide an estimate of differential movement associated with the shrinking and swelling of the existing onsite expansive soil at the site. Mitigation measures for expansive soils may include designing the buildings to be supported on: (1) shallow foundations that rest on a layer of non-expansive engineered fill¹³; (2) a deepened spread footing system where the proposed footings gain support at or below the depth of significant seasonal moisture fluctuation and the slab-on-grade floor will be supported on a layer non-expansive fill, as described above; (3) a stiffened foundation system, such as a reinforced concrete or post-tensioned mat, that is capable of resisting the differential movement and soil pressures associated with the expansive soil; or (4) a deep foundation system that transfers the building and slab loads to competent soil beneath the near-surface moderately to highly expansive soil layer.

Impact GEO-7 Pervious Pavements and Other Water/Wastewater Infiltration Systems

Pervious pavements would be utilized for both the Office Park and Wellness Center properties. Additionally, extensive groundwater recharge and wastewater infiltration are proposed. The anticipated water/wastewater loading rate would be approximately 20,000 gallons per day. The near-surface soil consists of moderately to highly expansive clay and one of the proposed import fill materials is proposed to be fine-grained material with a plasticity index (PI) of less than 25; therefore, special subgrade preparation and pavement design recommendations may be required to prevent the near-surface clayey soil from ponding water, and becoming saturated and weak under the proposed traffic loads. Therefore, impacts to the proposed project would be *potentially significant*.

The following mitigation measure is proposed to reduce impacts associated with the permeable pavement system to a *less-than-significant* level:

Mitigation Measure GEO-7 Pervious Pavements and Other Water/Wastewater Infiltration Systems

Considering the near-surface soil may consist of moderately to highly expansive clay, special subgrade preparation, and foundation and pavement design recommendations shall be required to prevent the near-surface clayey soil from ponding water, and becoming saturated and weak under the proposed site loading conditions, such as foundation and traffic loads. Final design recommendations for a pervious pavement system shall allow surface water to percolate through the pavement without causing adverse impacts to new pavements and building foundations due to moisture fluctuations in the near-surface expansive clay. Potential mitigation measures may include: (1) collecting and redirecting surface and subsurface water away from the proposed building foundations; (2) using permeable base material within pavement areas;

¹³ T&R typically defines non-expansive fill as a material with a Plasticity Index (PI) less than 12 and a liquid limit less than 40.

and (3) installing subdrains to collect and redirect water from areas that could adversely impact building foundations and vehicular pavement to a suitable outlet.

Mitigation Measure GEO-8 Review and Approval of Final Grading, Drainage, and Foundation Plans and Specifications

To ensure the applicant's geotechnical consultant is given the opportunity to participate in the final design and construction phases of the project, the applicant's consultant (Registered Geotechnical Engineer and Registered Engineering Geologist) shall review and approve the final grading, drainage, and foundation plans and specifications. Also, upon completion of construction activities, the applicant's consultant shall provide a final statement indicating whether the work was performed in accordance with project plans and specifications, and the consultant's recommendations. All mitigations and final design recommendations shall be reviewed and approved by the County prior to issuance of applicable permits and approval of the Final Map.

CUMULATIVE IMPACTS

Implementation of the project in combination with the related projects (see Table III-1, Related Projects List) would result in the development of mixed-use, residential, commercial, industrial, and park land uses in the County of San Mateo. Geotechnical hazards are site-specific and there is little, if any, cumulative relationship between development of the proposed project and the related projects. The impacts on each related project site would be specific to that site and its users and would not be common or contribute to (or shared with, in an additive sense) the impacts on other sites. As such, construction of the related projects is not anticipated to combine with the proposed project to cumulatively expose people, property, or infrastructure to such geologic hazards as earthquakes, ground shaking, liquefaction, landslides, unstable soils, expansion soils, and/or result in substantial soil erosion or the loss of topsoil. In addition, development on each site would be subject to uniform site development and construction standards that are designed to protect public safety. Therefore, the proposed project's contribution to significant cumulative impacts related to geology and soils would be ***less than significant*** and no mitigation measures are required.

LEVEL OF SIGNIFICANCE AFTER MITIGATION

Implementation of the mitigation measures listed above and compliance with applicable regulations would reduce project impacts related to geology and soils to a ***less-than-significant*** level.