4.5 GEOLOGY, SOILS, AND SEISMICITY

This chapter addresses the subject of geology, soils, and seismic hazards, and mineral resources with respect to the construction of the proposed Project. The information and analysis in this chapter is primarily based on a third party peer review by Alan Kropp & Associates of the following documents prepared for the Project applicant, which are included in Appendix M, Geological Data, of this Draft EIR:

- *Preliminary Geotechnical Feasibility, The Terraces of Lafayette, Lafayette, California* prepared by ENGEO Incorporated on March 18, 2011.
- *Geotechnical Exploration: The Terraces of Lafayette* prepared by ENGEO Incorporated on August 18, 2011 and revised September 2, 2011.
- *Existing Site Conditions (with regards to existing soil and topographic conditions)* by ENGEO Incorporated on September 2, 2011.

As described in the Initial Study prepared for the Project on July 15, 2011 (see Appendix A of this Draft EIR) there are no known mineral resources in Lafayette. The review of historic records indicates the Project site operated as quarry between 1967 and 1970. It is likely the quarry was used as a source of borrow material for the local road and highway improvements. Accordingly, the Project would not result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan. No further discussion of the Project's potential impacts to mineral resources will be included in this chapter.

A. Regulatory Framework

This section summarizes key federal, State, and local regulations, policies, and programs pertaining to geology, soils, and seismic hazards in the vicinity of the Project site.

1. Federal Regulations

There are no Federal regulations pertaining to geology, soils, and seismic hazards that apply to the Project.

2. State Laws and Regulations

The State of California has established a variety of regulations and requirements related to seismic safety and structural integrity, including the California Building Code, the Alquist-Priolo Earthquake Fault Zoning Act, and the Seismic Hazards Mapping Act.

a. Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed by the California Legislature in 1972 to mitigate the hazard of surface faulting to structures. Its intent is to increase safety and minimize the loss of life during and immediately following earthquakes by facilitating seismic retrofits to strengthen buildings against ground shaking.[1] The Act addresses only surface fault rupture; it is not directed toward other earthquake hazards. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, the City or County with jurisdiction must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults.

b. California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Sections 2690-2699.6) addresses seismic hazards other than surface fault rupture, such as liquefaction and seismically-induced landslides.[2] The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures incorporated into project plans to reduce hazards associated with seismicity and unstable soils.

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[1] California Department of Conservation, http://www.conserv666ation.ca.gov/cgs/rghm/ap/Pages/chp_7_5.aspx, accessed on October 12, 2011.

[2] California Department of Conservation, http://www.consrv.ca.gov/CGS/shzp/Pages/article10.htm, accessed on October 12, 2011.

c. California Building Code

The California Building Code (CBC) is included in Title 24 of the California Code of Regulations and is a portion of the California Building Standards Code. Under State law, all building standards must be centralized in Title 24 or they are not enforceable. Through the CBC, the State provides a minimum standard for building design and construction. The CBC contains specific requirements for seismic safety, excavation, foundations, retaining walls, and site demolition. It also regulates grading activities, including drainage and erosion control.

The earthquake protection law (California Heath and Safety Code Section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum standards for seismic safety and structural design to meet earthquake protection requirements are set forth in Chapter 16 of the CBC.

3. Local Regulations and Policies

a. City of Lafayette General Plan

The Safety Element, Chapter VI, of the City's General Plan addresses the protection of the community from unreasonable risks associated with the effects of earthquakes, landslides, slope instability, subsidence, flood, fire, and other geologic hazards. In particular, the goals and policies relating to the geologic and soil conditions of the Project area are contained in Table 4.5-1.

b. City of Lafayette Municipal Code

Title 3, Chapter 3-304 of the Lafayette Municipal Code adopts the 2010 California Building Code, based on the 2006 International Building Code, as the building code of the City. Appendix A, Title 3 of the Lafayette Municipal Code adopts by reference the Building Regulations of the Contra Costa County Grading Ordinance. Section 716-2.604 of the County regulations prohibits any person from grading, whether or not a permit is required, so that dirt, soil, rock, debris, or other material washed, eroded, or moved from the property by natural or artificial means does not create a public nuisance or hazard. Section 716-4.802 dictates that the county building official may

TABLE 4.5-1 **GENERAL PLAN GOALS AND POLICIES RELATED TO GEOLOGY AND SOILS**

Goal/Policy Number	Goal/Policy Content
Goal S-1	*Minimize risks to Lafayette residents and property from landslides and other geologic hazards.*
Policy S-1.1	Consider slope and soil stability when reviewing future projects. Development proposals in areas with landslide hazards shall be reviewed by an engineering geologist to determine whether the proposed development is feasible, and to define the required construction standards and mitigation measures.
Policy S-1.2	Limit building in areas with significant risk potential. Intensity of development shall be minimal in areas of high risk. Consider potential seismic or geologic hazards when determining building density and in siting dwellings.
Goal S-2	*Minimize risks to Lafayette residents and property from earthquakes.*
Policy S-2.1	New development, including subdivisions, new construction, and remodels or expansions of existing structures, shall minimize exposure to seismic hazards through site planning and building design.
Policy S-2.2	Locate construction of high density residential and other critical, high-occupancy or essential services buildings outside high risk zones.

Source: Lafayette General Plan, 2002, http://www.ci.lafayette.ca.us, accessed on November 1, 2011

require an engineering geologist's investigation and report, based on the most recent site plan. This geological report shall include an adequate description of the geology of the site and conclusions and recommendations regarding the effect of geologic conditions on the proposed development. In addition, Section 716-4.804 designates that a soil investigation and report may also be required. This report shall be prepared by a soil engineer and indicate the presence of critically expansive soils, or other soil problems, which if not corrected would lead to defects in structures, buildings or other improvements.[3]

[3] City of Lafayette Municipal Code, http://library2.municode.com/default-now/home.htm?infobase=16435&doc_action =whatsnew, accessed on November 12, 2009.

B. Existing Conditions

1. Regional Seismicity

Lafayette, like most of California, is vulnerable to seismic activity due to the location of several faults within the region. In recent geologic time, earthquakes experienced in the region have caused structural damage.[4] Although seismic risk is assumed by the residents of Lafayette, the City's General Plan identifies no active faults within the City limit. According to the State of California, a fault is considered to be "active" if it has had identifiable movement within the last 11,000 years; the time period for a "potentially active fault" is 2 million years. There are also no Alquist–Priolo Special Study Zones within Lafayette.[5] However the General Plan does acknowledge that significant damage could occur in Lafayette due to earthquakes originating from faults in nearby areas or independent movement along the local faults.[6]

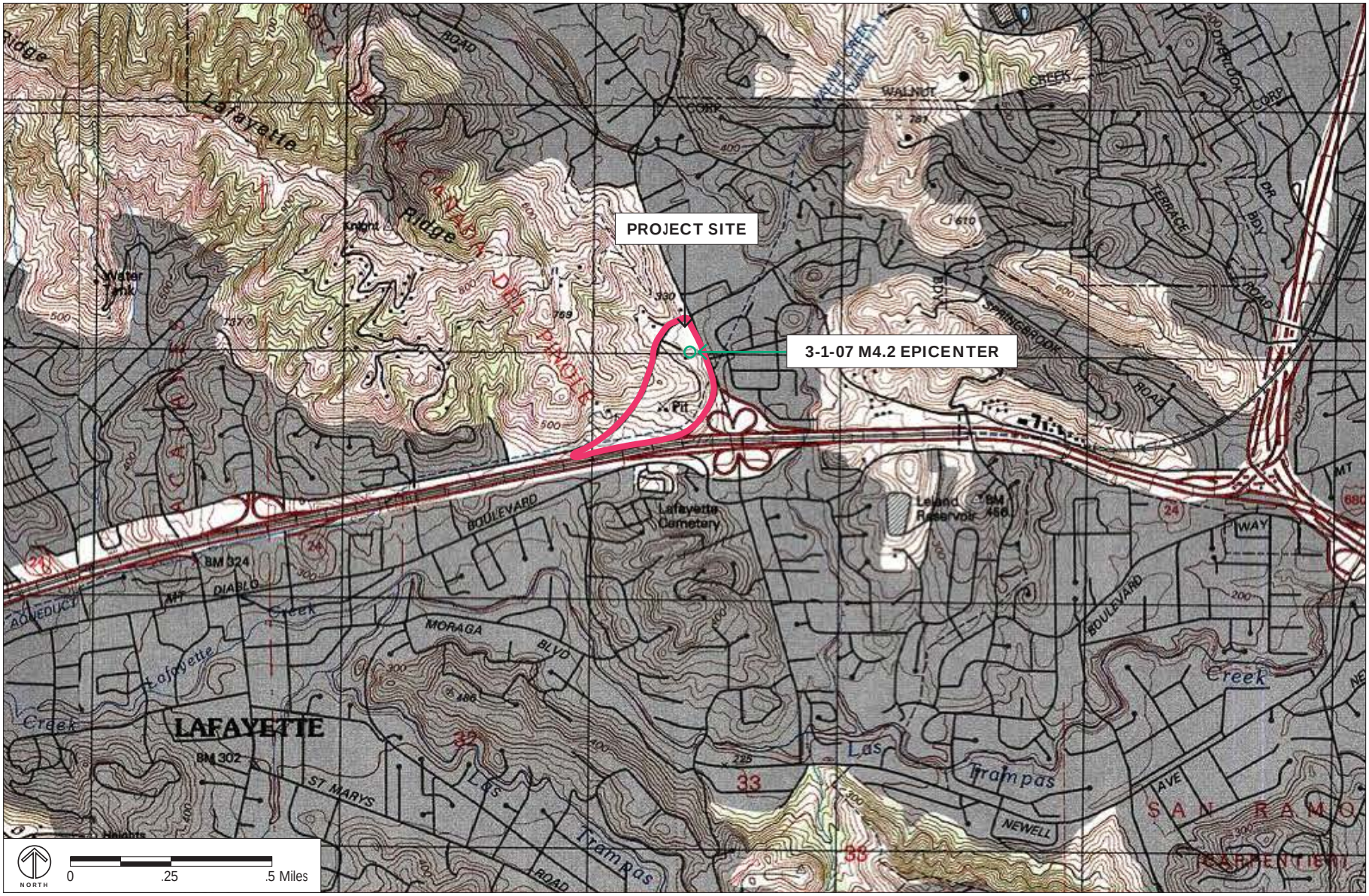
As shown on Figure 4.5-1, a notable 4.2 magnitude quake originated from the Project site on March 2, 2007 and was not attributable to any specific fault.[7] The earthquake epicenter (the point on the earth's surface directly above the actual earthquake location) was estimated to be in the northeast corner of the Project site, near the intersection of Deer Hill Road and Pleasant Hill Road. The earthquake focus (the actual earthquake location within the earth) was estimated to be approximately 10.3 miles below the ground surface. This was the most recent significant earthquake in the Walnut Creek – Lafayette area. Ground shaking intensity in the Lafayette – Walnut Creek area was moderate and minor or very light property damage was reported in the Walnut

[4] City of Lafayette, 2002, Lafayette General Plan, Chapter VI, page 4.

[5] California Department of Conservation, 1999. Cities and Counties Affected by Alquist-Priolo Earthquake Fault Zones as of January 2010, http://www.conservation.ca.gov/cgs/rghm/ap/Pages/affected.aspx, accessed on November 21, 2011.

[6] City of Lafayette, 2002, Lafayette General Plan, Chapter VI, page 4.

[7] Berkeley Seismological Laboratory, M4.2 Near Lafayette, CA, http://seismo.berkeley.edu/eqw/eqw_03.01.07.html, accessed on November 1, 2011.



Source: 2009 National Geographic; 2005 Tele Atlas Rel 8/2005.

FIGURE 4.5-1

2007 EARTHQUAKE EPICENTER

Creek – Lafayette area. Peak ground acceleration in the Project site vicinity was less than 10 percent of g (g is the acceleration due to gravity), which is considered moderate ground shaking.

The active faults nearest to the Project site are the Calaveras, Concord Green-Valley, and Hayward faults.[8] In 1999, ABAG predicted that these faults would be most likely to affect Lafayette in the next 30 years. These faults are shown in Figure 4.5-2 and are described below.[9]

- **Calaveras.** This fault, located 1.4 miles south of the Project site, is the closest active fault to the Project. It is considered an active major strike-slip fault that is part of the larger San Andreas fault system. The fault zone extends for approximately 93 miles from the San Ramon area southeast to approximately 18 miles south of the City of Hollister.[10] Its last damaging earthquake occurred in 1861, and its estimated maximum probable earthquake magnitude within a 100-year time period is 6.5.[11]
- **Concord-Green Valley.** This fault is located approximately five miles to the east of the Project site. This fault extends from Suisun Bay south to the northwestern slope of Mt. Diablo. The fault has three sections including the Avon and Concord sections near the Project area.[12] Its last

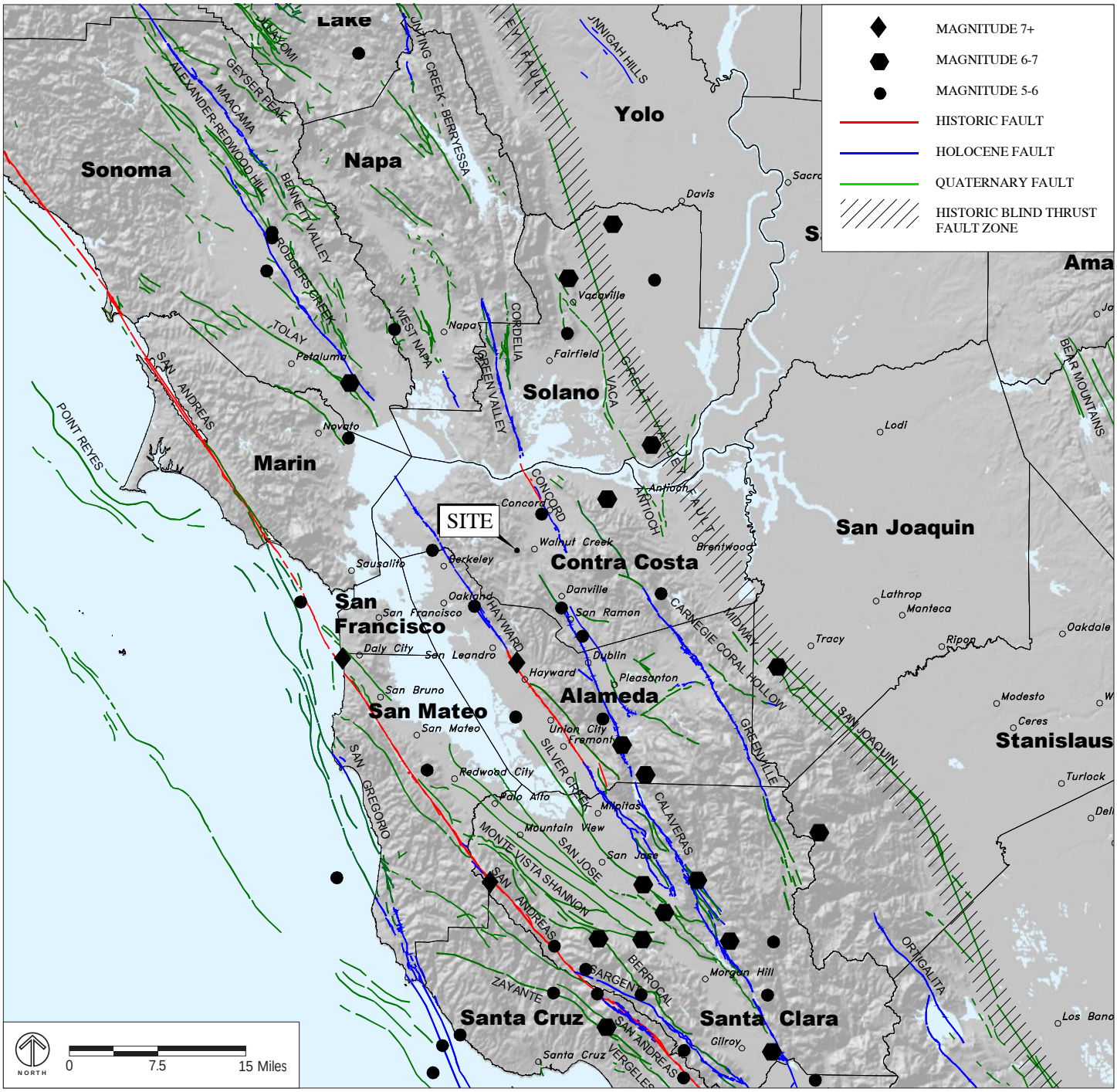
[8] Alan Kropp & Associates, 2011, Draft Memorandum to Terri McCracken, The Planning Center | DC&E, Re: Geologic and Geotechnical Impact Evaluation (Revised).

[9] ENGEO Inc., 2011. *Geotechnical Exploration: The Terraces of Lafayette*, page 5.

[10] United States Geological Survey, Brief Report for Calaveras fault zone, Northern Calaveras section (Class A) No. 54a, http://geohazards.usgs.gov/cfusion/qfault/qf_web_disp.cfm?disp_cd=B&qfault_or=1306&ims_cf_cd=cf, accessed on November 1, 2011.

[11] Contra Costa County, 2005. *Contra Costa County General Plan 2005-2020*, page 428.

[12] United States Geological Survey, Report for Concord fault, Avon section, http://gldims.cr.usgs.gov/webapps/cfusion/Sites/qfault/qf_web_disp.cfm?qfault_or=1274&ims_cf_cd=cf&disp_cd=C, accessed on November 1, 2011.



BASE MAP SOURCE:
U.S.G.S. 1-ARC SECOND S.R.T.M. DATABASE
U.S.G.S. QUATERNARY FAULT DATABASE, MARCH, 2006
U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800-2000)

FIGURE 4.5-2

REGIONAL FAULTING AND SEISMICITY

damaging earthquake was recorded in 1955, and its estimated maximum probable earthquake magnitude within a 100-year time period is 5.5.[13]

- **Hayward.** This fault, located approximately eight miles to the west of the Project site, stretches along the western base of the hills that ring the east side of San Francisco Bay southeastward, roughly parallel to the San Andreas Fault. The main fault runs through many densely populated urban areas, including the Cities of Richmond, Berkeley, Oakland, Fremont, and San Jose.[14] The Hayward – Rodgers Creek Fault has a 31 percent probability of producing a 6.7 magnitude or higher earthquake within the next 30 years, making it the fault most likely to produce an earthquake with such a magnitude in the next 30 years.[15]

Two faults considered inactive by the State of California, have been mapped in close proximity of the Project site. The Las Trampas fault, also referred to as the Lafayette fault, is located approximately 200 feet west of the western tip of the Project site. This fault can be seen on Figure 4.5-3. The unnamed, but informally referred to Reliez fault, is located approximately 100 feet east of the site beneath Pleasant Hill Road. Neither the Las Trampas fault nor the Reliez fault crosses the Project site. As described above, the epicenter of an earthquake on March 2, 2007 was estimated to be in the northeast corner of the Project site, near the intersection of Deer Hill Road and Pleasant Hill Road. Although the faults nearest the Project site are not considered to be active, the faults may accommodate slip on the Northern Calaveras Fault located approximately 4.5 miles south of the Project site.

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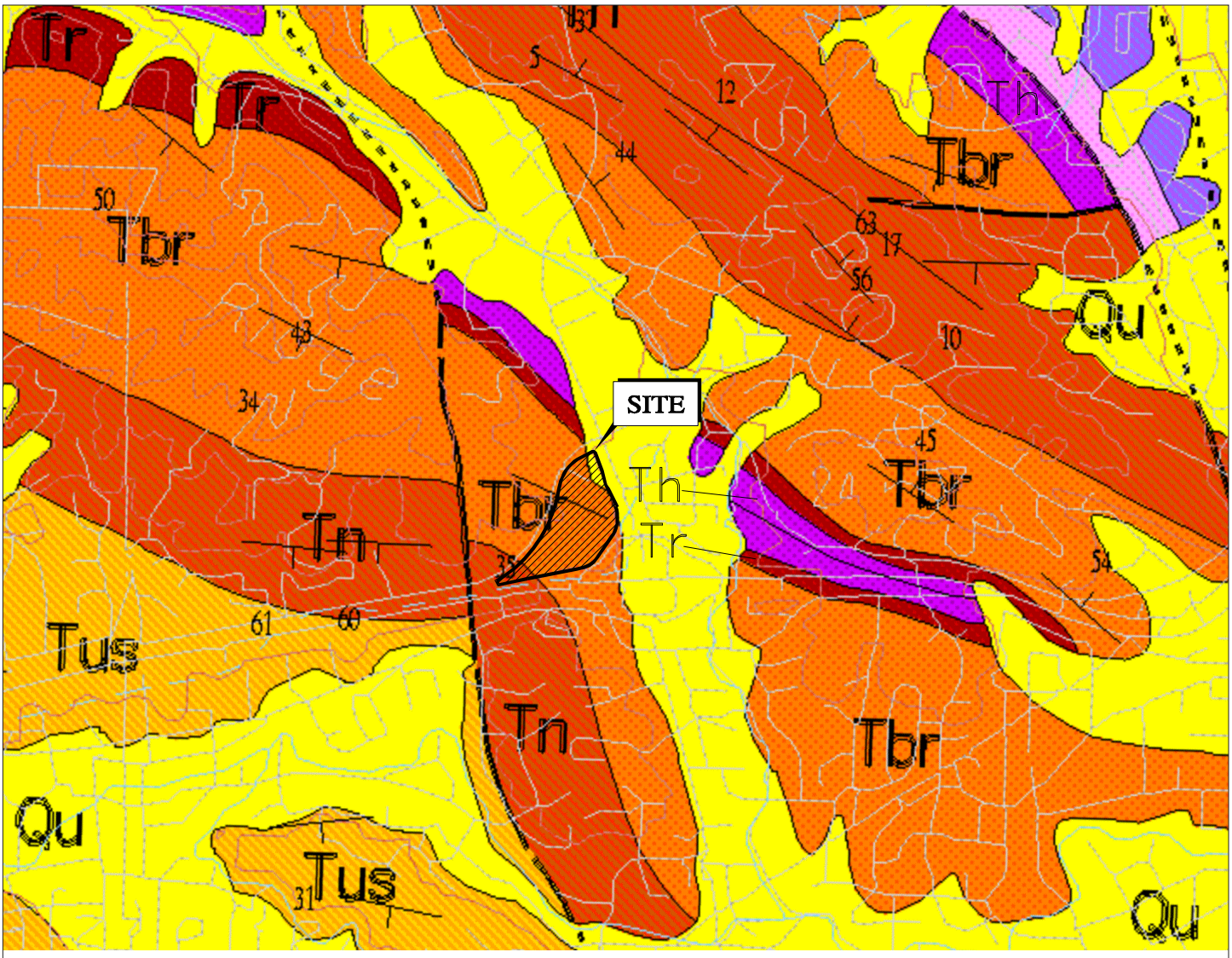
[13] Contra Costa County, 2005. *Contra Costa County General Plan 2005-2020*, page 428.

[14] Working Group on California Earthquake Probabilities, 2003. *Summary of Earthquake Probabilities in the San Francisco Bay Region: 2003 – 2032*, http://earthquake.usgs.gov/regional/nca/wg02/results.php, accessed on November 1, 2011.

[15] United States Geological Survey. *Fact Sheet 2008-3027*, page 4.



Source: Graymer, 1994.

FIGURE 4.5-3

REGIONAL GEOLOGIC MAP

2. Geology and Soils

In addition to the proximity of major active faults, the topography and type of soil that underlies a Project site also determines the extent to which the Project site is subject to seismic hazards.

a. Topography

Overall topography on the Project site is characterized as four relatively flat-lying areas (terraces) separated by slopes that vary from inclinations of 1.5:1 to 4:1 (horizontal:vertical). Current elevations range from a high of about 463 feet above mean sea level (msl) on the northernmost terrace adjacent to Deer Hill Road to a low of about 330 feet above msl at the drainage near Pleasant Hill Road at the eastern edge of the site.

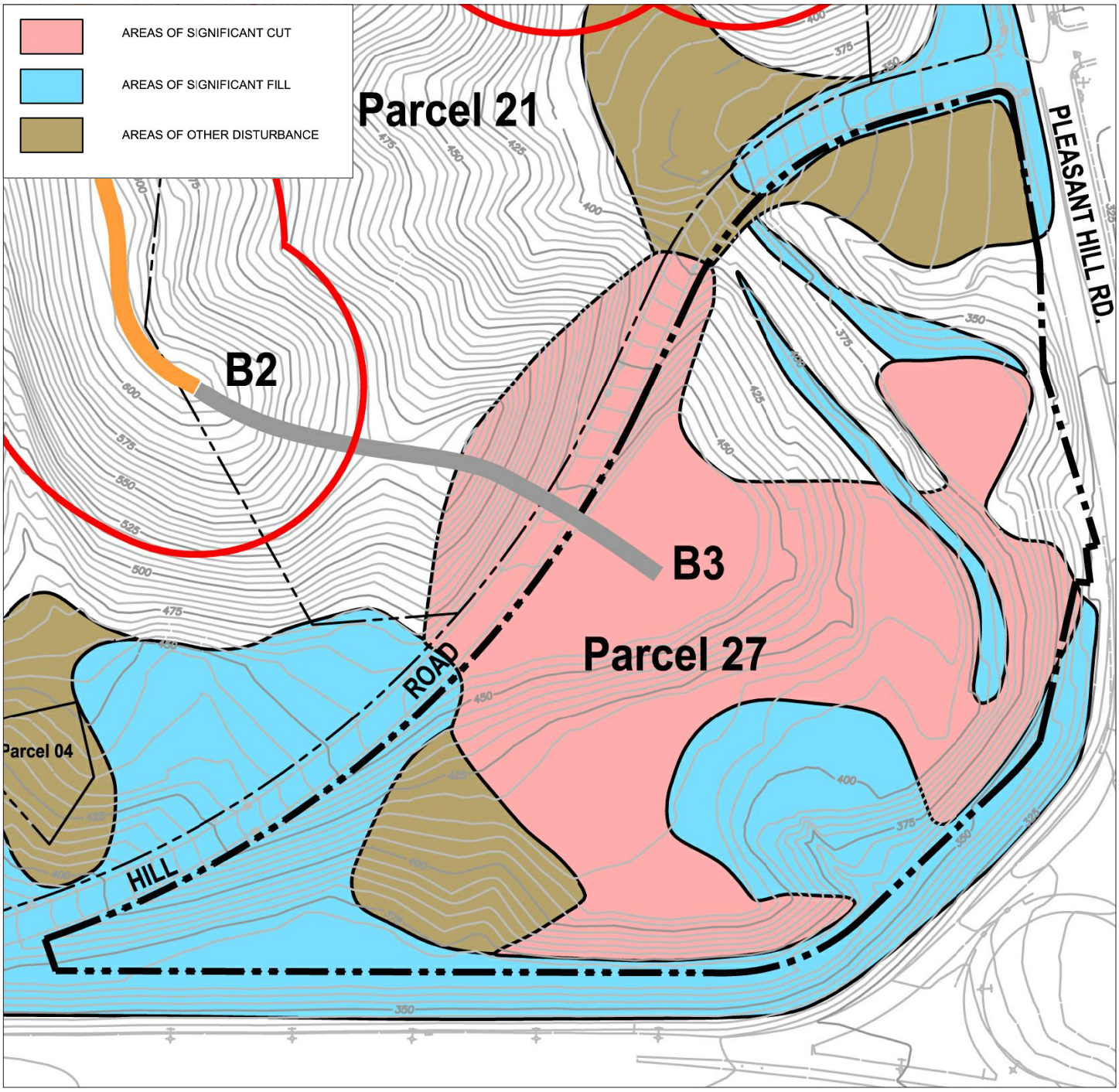
b. Soils

The Project's surface soils are primarily loams of the Diablo, Lodo, and Tierra Series. However, these soils have been removed or buried within most of the site. As illustrated on Figure 4.5-4 and Figure 4.5-5, the site has been subject to previous cut, fill, and other disturbance and accordingly the soil at the Project site includes artificial fill and fill in addition to the landslide debris, colluvium, and alluvial deposits from the Quaternary period, and rodeo shale, briones sandstone, and neroly formation from the Tertiary period.[16] These soils are described below.

i. Existing Fill (Qaf)

Existing undocumented fill (Qaf) is present in the two former swales at the southern portion of the site. This fill appears to have been placed during grading for State Highway 24 in the late 1960s. In general, the existing fill consisted of moist, very stiff to hard, silty clay and sandy clay with angular gravel-sized sandstone fragments, and few cobble-sized sandstone fragments. Fill in these areas displayed horizontal layering indicative of fill placement in lifts. Fill thickness in the swales is approximately 15 feet.

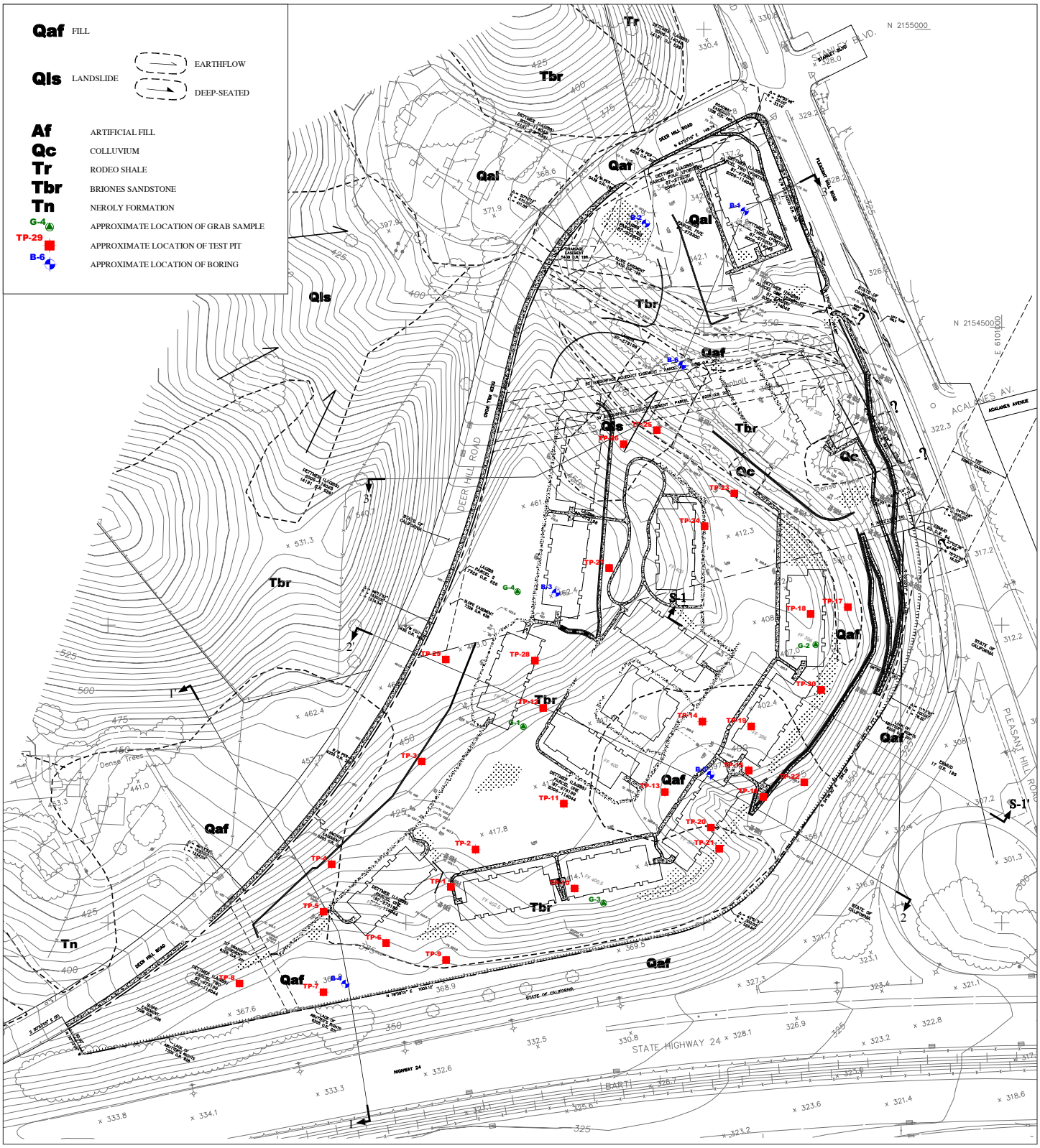
[16] ENGEO, Inc., *Geotechnical Exploration: The Terraces of Lafayette*, September 2, 2011, pages 3 to 4.



Source: 2011 By ENGEO Incorporated.

FIGURE 4.5-4

AREAS OF GRADING DISTURBANCE



Source: Engeo Incorporated, 2011.

NORTH 0 80 160 Feet

FIGURE 4.5-5

SITE PLAN AND GEOLOGIC MAP

Undocumented fill is also present in the southwestern portion of the site in an existing 2:1 fill slope associated with the grading for Deer Hill Road in the late 1960s. In general, the fill is bedrock derived and consists of dense, silty gravel and sandy gravel. Fill in this area also displayed horizontal layering indicative of fill placement in lifts.

In the northeastern portion of the site, minor amounts of fill associated with the access roads to the existing residence and the mid-level terrace are present. This fill generally comprises 3 to 5 feet of very stiff, moist silty clay with gravel-sized sandstone fragments.

In addition to the existing fills described above, the mid-slope, level terrace is blanketed by a 6- to 12-inch layer of road grindings. These were likely placed at some point following the quarry operation at the site.

ii. Landslide Debris (Qls)

Previous landslide mapping shows roughly four landslides at the site. There is one possible earthflow in the northeastern portion of the site. Previous grading and quarrying operations at the site have removed most of the landslides and others were determined to be deposits of colluvium (described below). The earthflow is approximately 15 feet in depth and comprises silty clay. The earthflow exhibited no signs of recent activity through cracking or displacement near the head scarp or additional sloughing of surficial soils.

iii. Colluvium (Qc)

Where not stripped away by previous grading and quarrying activities, colluvial deposits are present below fills placed in the two swales located in the southern portion of the site. Colluvium has also been mapped in two smaller swales located in the northeastern portion of the site. In general, the colluvium consists of moist, very stiff, silty clay.

iv. Pleistocene-age Alluvial Deposits (Qal)

Pleistocene-age alluvial deposits (Qal) are present in the relatively flat lying northeastern area of the site near the intersection of Deer Hill Road and

Pleasant Hill Road. In general, the alluvium is fine-grained consisting of stiff to very stiff silty clay and sandy clay.

v. Miocene Briones Formation (Tbr)

The Project site is underlain by late to middle Miocene marine sedimentary rock primarily consisting of sandstone, and by marine sandstone, clay shale/siltstone of the Monterey Formation. Bedrock underlying the majority of the site comprises the Briones Formation (Tbr – Miocene) with Neroly Formation (Tn) underlying the westernmost corner of the Project site. The bedrock at the site consists primarily of Miocene Briones Formation sandstone with some siltstone interbeds. Bedding within the bedrock units generally strikes west–northwest to east-northeast and dips 30 to 60 degrees towards the south. This sandstone can be described as weak to medium strong, closely fractured and moderately weathered.

3. Groundshaking

Ground shaking has the potential to produce various types of ground failure, including liquefaction, settlement, lateral spreading, lurch cracking, and earthquake-induced landslides. These phenomena are described in greater detail below:

- Liquefaction refers to the loss of soil strength when subjected to stresses caused by earthquake ground shaking resulting from seismic forces acting on water-saturated granular soils. This weakening of the soil can make the soil act like quicksand. According to the General Plan Geologic and Seismic Safety Element, the mapping of liquefiable soils shows there are "virtually none" for most of the Project site and they are "probably absent" in a small area along its southwestern boundary.[17] Additionally, recent test borings and pits indicate some alluvial deposits on the Project site are largely composed of clay and the remaining portions of the site

[17] City of Lafayette, 2002, *Revised Draft Environmental Impact Report for Lafayette General Plan Revision*, Figure 10: Liquefaction Potential Map.

are underlain by Briones Formation bedrock, which combined represent a low liquefaction risk.[18]

- Settlement or subsidence refers to the compaction of soils and alluvium as a result of ground shaking. Compaction typically occurs in places that are underlain by soft water-saturated low-density alluvial material. There is a potential for moderate settlement associated with the Project.[19]
- Lateral spreading is the horizontal movement or spreading of soil toward a stream bank, the open side of a fill embankment, the side of a levee or another open face. Areas most likely to be affected are artificial fill areas that were not properly engineered or that have steep and unstable embankments.
- Lurch cracking refers to fractures, cracks, and fissures stemming from ground shaking, settling, compaction of soil, and sliding. Lurch cracking is most likely in areas where the water table is high.
- Earthquake-induced landslide is slope failure caused directly by ground shaking or indirectly by ground shaking triggering the loosening of soil and rapid introduction of water.[20]

4. Landslides and Slope Stability

Landslides are the rapid movement of soil, rock, and rock debris down a slope. The risk for landslides usually increases when a number of factors are present. These factors include steep slopes where extensive grading or vegetation removal has occurred, weak or shallow soils, water saturation, and active earthquake faults. As noted above, there were approximately four landslides identified at the Project site, but evidence of these landslides has been re-

[18] ENGEO, Inc., 2011. *Geotechnical Exploration: The Terraces of Lafayette*, pages 8 to 9.

[19] ENGEO, Inc., 2011. *Geological Exploration: The Terraces of Lafayette*, pages 10 to 11.

[20] United States Geologic Survey, 2004. *Landslide Types and Processes Fact Sheet*, http://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html, accessed on November 1, 2011.

moved though grading and quarrying activities over the years.[21] As shown on Figure 4.5-5, currently, there is one confirmed landslide on the Project site.[22]

5. Groundwater

Groundwater was encountered in the two northeasternmost borings at a depth of approximately 13 to 14 feet below existing grades. Groundwater was also encountered at a depth of 4 feet in the southwest corner of the site. Fluctuations in groundwater levels occur seasonally and over a period of years because of variations in precipitation, temperature, irrigation, and other factors.

C. Standards of Significance

Geology and soils impacts associated with the Project would be considered significant if the Project would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    a. 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.
    b. Strong seismic ground shaking.
    c. Seismic-related ground failure, including liquefaction.
    d. Landslides.
2. Result in substantial soil erosion or the loss of topsoil.

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[21] ENGEO, Inc., *Geological Exploration: The Terraces of Lafayette*, September 2, 2011, page 4.

[22] ENGEO, Inc., *Geotechnical Exploration: The Terraces of Lafayette*, September 2, 2011, page 4.

3. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.
4. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.
5. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

D. Impact Discussion

This section analyzes potential geological impacts for the Project site. This discussion is organized by and responds to each of the potential impacts identified in the Standards of Significance.

1. Would the Project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault, strong seismic ground shaking, seismic-related ground failure, including liquefaction, landslides.

The Project would have a significant environmental impact if it would expose people or structures to major geological hazards, including rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure, or landslides.

a. Rupture of a Known Earthquake Fault

None of the faults mapped within the City of Lafayette meet the requisite of being active or potentially active, defined by the City's General Plan as having recorded earth movement or displacement within the last 10,000 years.[23]

[23] City of Lafayette, 2002, Lafayette General Plan, page VI-4.

In addition, the California Geological Survey does not include Lafayette on its list of cities that are affected by Alquist-Priolo Fault Zones.[24] The two faults closest to the Project site, the Las Trampas fault and the Reliez fault, are not considered to be active and do not cross the Project site. The closest active fault to the site with the potential for surface fault rupture is the Calaveras fault, located 1.4 miles south of the Project site, is the closest active fault to the Project and is not considered a potential source of fault surface rupture at the site. Based on the available geologic data, active faults with the potential for surface fault rupture are not known to be located directly beneath or projecting toward the site. Therefore, the potential for surface rupture due to fault plane displacement propagating to the surface at the site during the design life of the Project is considered low. Accordingly, seismic hazards impacts associated with the rupture of a known earthquake fault would be *less than significant.*

b. Strong Seismic Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking in the Project area. The effects of earthquake-related ground shaking could include damage to structures, changes in groundwater levels, and damage to streets and utilities.

Groundshaking from future earthquakes similar to the 4.2 magnitude earthquake in 2007 would not pose a risk of significant structural damage or loss a life for the Project. As required by the State of California, new construction of proposed structures must be designed to meet the latest CBC requirements at a minimum, taking into consideration the proposed use of the structures to be constructed. Based on these requirements, structures 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

[24] California Department of Conservation, 1999, Cities and Counties Affected by Alquist-Priolo Earthquake Fault Zones as of January 2010, http://www.conservation.ca.gov/cgs/rghm/ap/Pages/affected.aspx, accessed on November 21, 2011.

major earthquakes without collapse but with some structural as well as non-structural damage. The seismic design requirements of the CBC are based on the maximum earthquake considered probable within the region during the life of the Project, including the possibility of large earthquakes (i.e. greater than a 6.7 magnitude) occurring on either the Calaveras or Hayward faults. Large earthquakes on these faults could cause ground shaking at the site much stronger than the 2007 earthquake. Because the Project would be designed in accordance with the seismic design requirements of the CBC it is very unlikely that an earthquake similar to 2007 earthquake would cause significant damage to the proposed Project. Implementation of the seismic provisions of the mandatory CBC would ensure that major damage is avoided from earthquakes such as the 4.2 magnitude earthquake in 2007 as well as much larger earthquakes occurring on the nearby Calaveras and Hayward faults. Compliance with the mandatory CBC requirements would deem any impacts associated with ground shaking to *less-than-significant* levels.

c. Seismic-Related Ground Failure, Including Liquefaction

Ground failures associated with soil liquefaction include post-liquefaction reconsolidation, lateral spreading, and loss of bearing support. The Project would have a significant environmental impact if it would locate people or structures on soils prone to liquefaction-induced lateral spreading.

The area of the Project site near the intersection of Pleasant Hill Road and Deer Hill Road is susceptible to liquefaction; however, soils encountered during test pit drilling located stiff to very stiff clay to the depth explored, and subsequently, the potential for liquefaction at the site is therefore low.[25] As previously described, areas most likely to be affected by lateral spreading are artificial fill areas that were not properly engineered or that have steep and unstable embankments. Due to the low potential for liquefaction at the site, the potential for lateral spreading is also considered low. Therefore, strong ground shaking associated with a large earthquake on a nearby fault would

[25] ENGEO, Inc., 2011. *Geological Exploration: The Terraces of Lafayette*, pages 8 to 9.

not trigger soil liquefaction and associated ground failures on the Project site, and impacts would be *less than significant*.[26]

d. Landslides

Landslides are also a hazard during a seismic event. However, there is a low potential for an earthquake-induced landslide at the Project site and no evidence of past deep-seated landslides or slope instability were observed on the site.[27] While the probability of an earthquake induced landslide is low, exposed soil on steeper slopes is susceptible to instability resulting in landslides, as a result of heavy rains or excavation. Therefore, considering this and the fact a landslide area has been identified on the Project site, impacts resulting from landslides or slope instability would be *significant*.

2. Would the Project result in substantial soil erosion or the loss of topsoil.

The Project would have a significant environmental impact if it would cause substantial soil erosion or loss of topsoil, which would hinder proper drainage and stormwater management. Erosion control, particularly during grading, is necessary to avoid downstream sedimentation and flooding. Typically, erosion impacts are greatest in the first two years after construction, the time generally required to reestablish a good vegetation cover on areas of disturbed soil.

New construction activities under the proposed Project would involve grading and excavation that could result in erosion of soils and the sloping topography of the Project site could increase the potential for erosion. However, the City's Stormwater Pollution Prevention Plan (SWPPP) contains Best Management Practices that control erosion and sediment dispersion from new construction. Found in Chapter 5-4 of the City's Municipal Code, the pur-

[26] Alan Kropp & Associates, 2011, Draft Memorandum to Terri McCracken, The Planning Center | DC&E, Re: Geologic and Geotechnical Impact Evaluation (Revised).

[27] ENGEO, Inc., 2011. *Geological Exploration: The Terraces of Lafayette*, page 9.

pose of the provisions is to protect the health and safety of Lafayette's citizens by protecting and enhancing the quality of the City's watercourses. Many of these measures, such as Section 5-409 requiring construction sites to implement an approved SWPPP, would reduce soil erosion and the loss of topsoil during construction and operation of the proposed Project.[28] This issue is discussed in Chapter 4.8, Hydrology and Water Quality. As described in Chapter 4.8, prior to the issuance of grading permits, the Project applicant would submit a SWPPP to the State Water Resources Control Board and a Stormwater Control Plan, hydrology/hydraulic report, grading plan, and erosion control plan to the City of Lafayette's Engineering Services Division. Accordingly, impacts associated with the loss of topsoil or soil erosion during construction would be *less than significant*.

3. Would the Project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

There are no unique geologic features in the vicinity of the site. The potential for liquefaction and lateral spreading, and landslides is addressed above under section D.1.c and D.1.d, respectively. Site preparation and grading activities to prepare the Project site for construction of the proposed buildings would consist of excavation and recompaction of on-site soils, and foundation settlement could 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 Project includes fill up to approximately 40 feet thick with the majority of the fill to be placed over bedrock. Approximately 10 feet of fill would be placed over alluvium at the northern end of the Project site. As a result the majority of settlement would occur during fill placement and would not affect the proposed buildings. However, locations with existing fill have the

[28] City of Lafayette Municipal Code, http://library2.municode.com/default-now/home.htm?infobase=16435&doc _action=whatsnew, accessed on November 12, 2009.

potential for moderate settlement or ground cracking to occur. Furthermore, as groundwater was encountered as shallow as 4 feet below existing grade at the southwest corner of the site. As a result, relatively shallow groundwater is present at the site at times during the year. No below grade levels are anticipated for any of the structures; however, excavations to mitigate potential hazards or for planned cuts or utilities may encounter groundwater, depending upon the time of year of construction. Therefore, soil instability impacts associated with fill and shallow groundwater would be *significant*.

4. Would the Project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.

The Project would have a significant environmental impact if it would locate people or structures on expansive soils. Expansive soils undergo a significant volume change as a result of wetting or drying and this volume change can cause damage to improperly designed foundations and pavements.

The geotechnical investigation of the site found the soils and bedrock to vary from low to high shrink/swell potential with variations in moisture content, which can result in damage to slab-on-grade, pavements, and structures founded in shallow foundations.[29] However, since moderately expansive soils are present on the site, the impacts would be *significant*.

5. Would the Project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

The Project site is served by the Contra Costa County Sanitary District and its wastewater facilities. No septic tanks or alternative wastewater disposal systems would be required to serve new development. Therefore, there would be *no impact.*

[29] ENGEO, Inc., *Geological Exploration: The Terraces of Lafayette*, September 2, 2011, page 11.

6. Cumulative Impacts

This section analyzes potential impacts related to geology and soils that could occur from a combination of the Project with other reasonably foreseeable projects in the surrounding area as outlined in Table 4-1 in Chapter 4 of this Draft EIR. Cumulative impacts would occur if development associated with the Project together with other projects in Lafayette would expose people or structures to substantial risk of injury, damage, or death related to seismic activity, soil erosion, or unstable soils.

Currently, there are six other proposed developments in the area; four are condominium or townhouse projects, one is a senior housing project, and the sixth is an independent/assisted living project with a small (6,000 square feet) retail space. As discussed above, the Project is not in close proximity to a major active fault line or in areas prone to erosion or landslides. Additionally, any new construction associated with the Project or in the City overall would be required to meet the latest standards set forth in the CBC. The CBC requirements, along with the aforementioned policies and programs of Lafayette's General Plan, ensure that any development on unstable soil or expansive soil is regulated to minimize potential hazards. Moreover, in combination with foreseeable development in the surrounding area, implementation of the Project would not change the geology or soil characteristics of the city as a whole. Therefore, there would be a *less-than-significant* cumulative impact related to geology and soils.

E. Impacts and Mitigation Measures

Impact GEO-1: Implementation of the proposed Project could result in hazards as a result of slope instability, existing fill conditions, expansive soils, and shallow groundwater.

> Mitigation Measure GEO-1: Prior to issuance of the grading permits, development of the final grading plans shall be coordinated with a City approved Geotechnical Engineer and Engineering Geologist in order to tailor the plans to accommodate known soil and geologic hazards and to

improve the overall stability of the site. The final 40-scale grading plans for the Project shall be reviewed by the City-approved Geotechnical Engineer. Grading operations shall meet the requirements of the Guide Contract Specifications included in Appendix D of the *Geotechnical Exploration: The Terraces of Lafayette*, prepared by ENGEO Incorporated on August 18, 2011 and revised September 2, 2011, and shall be observed and tested by the City-approved Geotechnical Engineer.

Significance after Mitigation: *Less than Significant.*