4.7 GEOLOGY AND SOILS

This section describes geology and soils at the project site and potential risk associated with known geologic hazards, including seismic activity. Information in this section is based on:

- A Geotechnical Exploration prepared ENGEO in 2013 (see **Appendix I**)
- A Geologic Peer Review by Darwin Meyers Associates, prepared in 2013
- Alquist-Priolo Earthquake Fault Zoning Maps, prepared by the State of California Department of Conservation in 2007
- Custom Soil Resource Report, accessed from the United States Department of Agriculture in 2015
- Soil Survey of Contra Costa County, prepared by the United States Department of Agriculture in 1977
- The Contra Costa County General Plan 2005-2020 (General Plan)

These reports are available for review at the Contra Costa County (County) Department of Conservation and Development, Community Development Division, 30 Muir Street, Martinez, California.

No comments related to the geology and soils were received in response to the Notice of Preparation for this draft environmental impact report.

4.7.1 EXISTING CONDITIONS

Regional Geology

The project site is located within the Coast Ranges Geomorphic Province, which extends 400 miles from Oregon to Southern California. This region is defined by a series of northwest-trending mountain ranges and intervening valleys that parallel geologic structures and major fault systems. Much of this province is composed of marine sedimentary and volcanic rock ranging from 65 to 150 million years old (Metropolitan Transportation Commission and Association of Bay Area Governments, 2013).

The project site lies within the San Ramon Valley, which is a basin surrounded by the East Bay Hills that were formed from younger rocks uplifted between the Hayward and Calaveras fault zones. This region is underlain by Tertiary marine and non-marine sedimentary rocks. The San Ramon Valley fill includes Quaternary-aged

alluvium up to approximately 300 feet thick, and is drained by the San Ramon and South San Ramon creeks, which actively cut into the alluvial surface soils (City of San Ramon, 2010).

Site Geology

The project site is located on the east flank of the Las Trampas Ridge in the Northern San Ramon Valley, approximately 7 miles west of Mount Diablo. Site elevations range from 348 feet above mean seal level (AMSL) near the southeast portion of the property and reach 680 feet AMSL on the hilly, western portions of the project site. The eastern lowlands consist of Quaternary alluvial gravel, sand, and silt, while the western highlands contain Late Miocene Monterey Formation clay shale and sandy siltstone. The western portion of the site sits on broad bedrock spur that extends northeast into the valley.

In the summer of 2008, ENGEO excavated seven test pits (ranging from 2.5 to 10 feet deep) and a 218-foot-long trench (average depth between 10 to 12 feet). The field exploration identified four soil types on the project site: Colluvium, Alluvium, Older Alluvium, bedrock, and artificial fill. These geologic units are discussed below and mapped in **Figure 4.7-1**. Refer to **Section 4.12, Mineral Resources**, for additional descriptions of soil found on the project site. The full results of this geotechnical exploration are included in **Appendix I**.

Colluvium

Colluvium is eroded material carried by sheet wash from ridgelines and slopes into low-lying depressions. Colluvium was identified in test pits 1, 3, 4, and 7 (see **Figure 4.1-1**), and was encountered at depths ranging from 1.5 to 8 feet and in thicknesses between 2 and 4.5 feet. This material consists of brown to dark-brown silty clay, and was moderately stiff to stiff. Based on laboratory results and field observations, these soils are highly to critically expansive when subjected to fluctuations in moisture content. Previous studies also detected colluvium at various locations along the western border of the project site.

Alluvium

Loose, heterogeneous alluvial deposits exist in low-lying areas around the residence and office structures extending to the eastern property limits. A 7-foot-thick deposit of alluvium was encountered at a depth of 3.5 feet at the base of the artificial fill approximately 40 meters east of the existing residence. Based on field tests, these alluvium deposits are a mixture of material types including silty clay, clayey silt, and clayey gravel. The soils range from low to high plasticity and are highly expansive when subjected to fluctuations in moisture content.

Older Alluvium

Older alluvium was encountered in the exploratory trench at depths ranging from 8 to 12 feet. These deposits consisted of clayey silt with variable amounts of gravel and rock fragments. They are very stiff to hard with moderate to low plasticity and moderate expansion potential.

Artificial Fill

Soils around the existing structures experienced significant alteration from previous grading activity. Artificial fill was found in the test pits at depths ranging from 0 to 4 feet and in thicknesses between 1 to 4 feet. The fill typically derived from on-site sources and was free of deleterious debris. Two test pits in the southern portion of site contained substantial quantities of asphaltic concrete and minor nesting of cobble-size sandstone fragments.

Conditions in the test pits suggest that most artificial fills were compacted and experienced little shifting, settling, or movement. However, cracking observed along some of the paved areas suggest that underlying fills may be experiencing slow downward progression known as “creep.” Furthermore, it appears unlikely that the fills were constructed with keyways, benching, or other improvements required for engineered fill to meet current standards.

Bedrock

Bedrock was encountered at five of the seven test pits at depths ranging from two-to-eight feet. This bedrock consists primarily of moderately weathered limestone from the Monterey Formation. The rock varied from moderately strong to very strong and moderately fractured. Bedrock was not encountered in the test trench, but according to the most recent map of Quaternary deposits from the United States Geological Survey, nearly the entire site is underlain by bedrock at relatively shallow depths (ENGEO, 2013).

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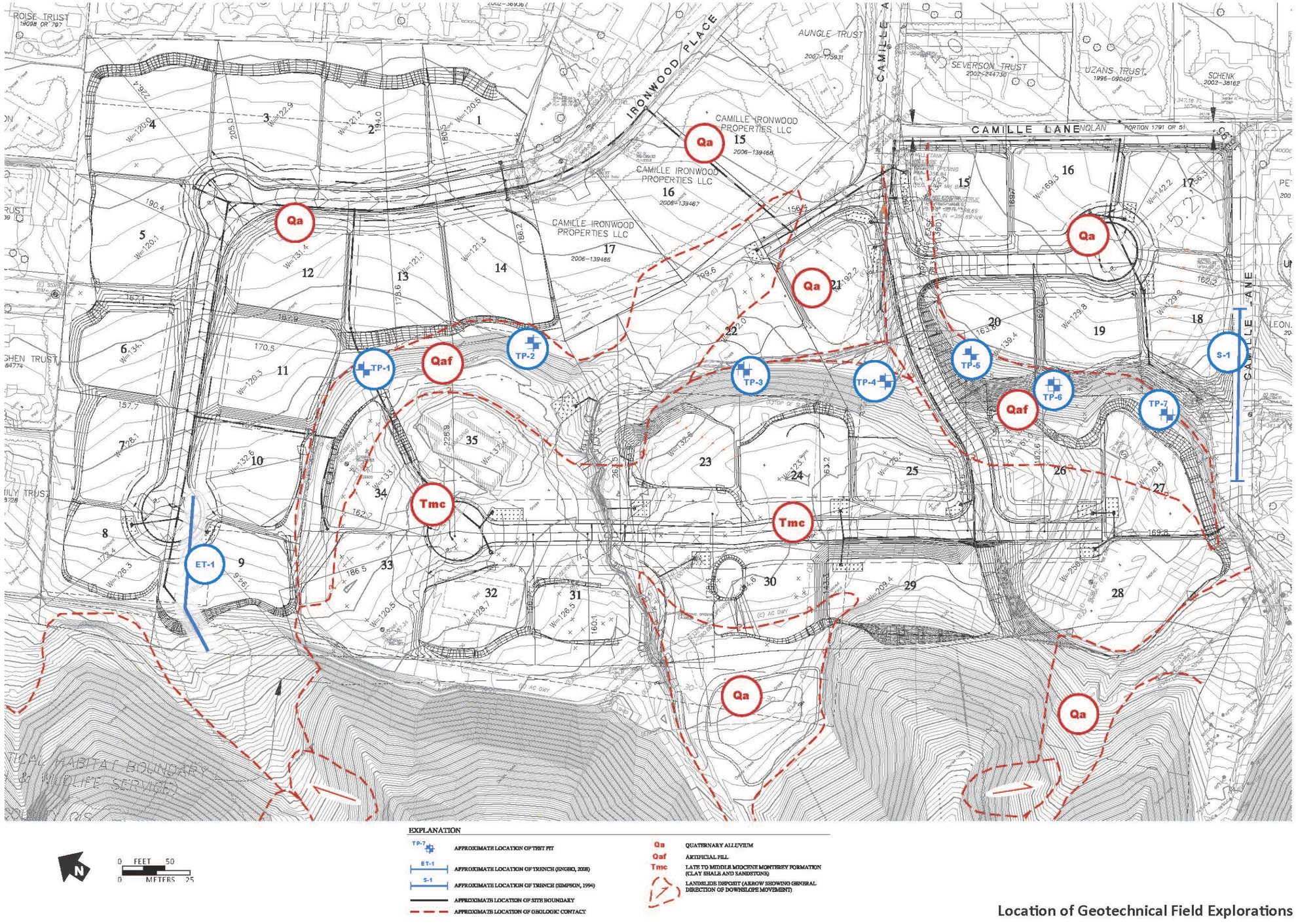

Location of Geotechnical Field Explorations

Figure 4.7-1

Source: ENGEO, 2013.

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Groundwater

Groundwater was not encountered on the project site during the geotechnical exploration, but groundwater fluctuations may occur based on annual variations in precipitation, temperature, irrigation, and other factors (ENGEO, 2013).

Seismic and Geological Hazards

The California Geological Survey (CGS) delineates Alquist-Priolo (A-P) zones along known active faults in California. A-P zones are based on clear evidence of surface fault rupture that occurred during the Holocene time (during the last 10,000 years). No portion of the project site is within an Earthquake Fault Zone (EFZ), as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map (Department of Conservation, 2007).

The ancestral trace of the Calaveras fault passes through the immediate site area. This segment of the Calaveras fault has no proven record of Holocene ground displacement and is not considered to be an active fault by the CGS. However, it may be a potential seismic source.

According to the CGS, the nearest active faults are the Calaveras fault (2.25 miles southeast of the project site), Concord fault (4.75 miles northeast of the project site), and Hayward fault (8.5 miles southwest of the project site). Other nearby faults includes Greenville (9.5 miles east of the project site), and San Andreas (28 miles west of the project site). Potential seismic hazards from a nearby moderate to major earthquake are discussed below.

Surface Rupture

Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. Surface rupture can occur along an active major fault trace. Though a trace of the potentially active Northern Calaveras Fault crosses the project site, the area is not within an EFZ; therefore, the probability of the project site experiencing surface rupture is low.

Ground Shaking

Ground shaking is a general term referring motion of the earth's surface resulting from an earthquake, and is normally the major cause of damage during seismic events. The Modified Mercalli Intensity Scale (MMI) is the most commonly used scale for measurement of the subjective effects of earthquake intensity (**Table 4.7-1**).

Table 4.7-1 **Modified Mercalli Intensity (MMI) Scale**

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

Source: California Geological Survey, 2002.

An earthquake of moderate to high magnitude generated within the San Francisco Bay Area could cause considerable ground shaking at the project site. During a seismic event, the upper portions of the project site could expect Very Strong shaking (VIII MMI), while the lower portions of project site could expect Violent shaking (IXMMI) (Association of Bay Area Governments, 2012). The degree of shaking would be dependent on the magnitude of the event, distance to the seismic source, and local geologic conditions.

The General Plan Safety Element classifies the higher, western portions of the project site as "lowest damage susceptibility." This estimate is for firm bedrock that is of Miocene age or older. The remainder of this site is rated for "moderate damage susceptibility." Sound structures on firm, dry alluvium typically perform satisfactorily, while water saturated areas are potentially hazardous (Contra Costa County, 2005).

Slope Stability and Landslides

Slope failure can occur as either rapid movement of large masses of soil (landslide) or slow, continuous movement (creep). The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock; the height and steepness of the slope; rainfall; and the presence of previous landslide deposits. Clayey soils on steeper natural slopes are subject to creep, so improvements encroaching into these areas may be at risk.

There is landslide evidence in the hillsides west of the proposed residential lots (**Figure 4.7-1**). These landslides consisted of shallow slump-type failures or earth flow failures involving soil over highly eroded bedrock material. Geomorphic features suggest that these landslide deposits range from approximately 10 to 20 feet thick. The nearest landslide is located approximately 200 feet southwest of the proposed residential lots, and exhibited southward displacement away from the project site. Because the slides do not present a risk to the project, corrective grading of the landslides is not warranted.

Soil Liquefaction

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

The United States Geological Survey (USGS) classifies upland portions of the project site with "very low" liquefaction potential due to the presence of bedrock. However, the lower, eastern portions of the site have "moderate" liquefaction

potential (United States Geological Survey, 2000). The General Plan Safety Element also characterizes the lower portions of the project site as “generally high” for liquefaction potential (Contra Costa County, 2005).

Lurching and Lateral Spreading

Lateral spreading is a form of horizontal displacement of soil toward an open channel or excavation boundary. Lateral spreading can result from either the slump of unconsolidated material or, more commonly, by liquefaction of soil or a subsurface layer on a slope, resulting in gravitationally driven movement. Earthquake-induced liquefaction can result in lateral spreading. Based on the soil composition, site topography, and results of the geotechnical exploration, the potential for lateral spreading on the project site is low.

Expansive Soils

Expansive soils contain clay and silt that expand in volume in response to increased water content and shrink in volume upon drying. Highly expansive soils present a significant risk to buildings and infrastructure. Colluvium deposits are highly to critically expansive, and the alluvium mapped in the low lying areas on the project site is highly expansive. The older Alluvium deposits encountered only in the trench excavation are moderately expansive.

Soil Corrosivity

Acidic soils have the potential to corrode steel and concrete building materials, and may result in long-term structural failure. The development area within the project site consists of Millsholm loam, Garretson loam, and Clear Lake clay (United States Department of Agriculture, 2015). Clear Lake clay and Garretson loam exhibit slight acidity, while Milshom Loam exhibits moderate acidity (United States Department of Agriculture, 1977). However, the preliminary geotechnical exploration did not identify any risk from corrosive soils on the project site. Refer to **Section 4.12, Mineral Resources**, for additional descriptions of the soil types on the project site.

4.7.2 REGULATORY SETTING

State

California Building Standards Code

Title 24 of the California Code of Regulations, also known as the California Building Standards Code, sets minimum requirements for building design and construction. The 2016 version of the California Building Standards Code is effective as of January 1, 2017 The California Building Standards Code is a compilation of three types of building standards from three different origins:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes;
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions; and
- Building standards, authorized by the California legislature, that constitute extensive additions not covered by the model codes that have been adopted to address particular California concerns

Project Consistency Analysis

As required by law, the project would be subject to the operative provisions of the most recent California Building Code at the time that building permits are requested. Compliance with building and grading regulations would keep risks within generally accepted limits.

Alquist-Priolo Earthquake Faulting Act

The California Legislature passed the Alquist-Priolo Earthquake Fault Zoning Act in 1972 to mitigate the hazard of surface faulting to structures. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent the construction of buildings used for human occupancy astride the surface trace of active faults, and to require adequate structure setbacks from active faults.

Project Consistency Analysis

The project site is not within an A-P EFZ, and no evidence of active faulting exists. The risk of surface fault rupture at the project area is very low (ENGEO, 2013).

Seismic Hazards Mapping Act

The Seismic Hazard Mapping Act was adopted by the California Legislature in 1990 to reduce public health and safety treats and to minimize property damage caused by earthquakes. The act directs the CGS to identify and map areas prone to earthquake hazards, such as liquefaction, earthquake induced landslides, and ground shaking. The act requires site-specific geotechnical investigations to identify potential seismic hazards and formulate mitigation measures prior to permitting

most developments designed for human occupancy within Zones of Required Investigation.

Project Consistency Analysis

The State of California has not yet issued seismic hazards maps of the County. Consequently, the project site is not within a Zone of Required Investigation, and is not subject to the requirements of the Seismic Hazards Mapping Act.

Local

Contra Costa County Code, Section 94-4.420

Section 94-4.420 of the Contra Costa County Code (County Code) was adopted in 1978 to mitigate the hazards of unstable soils and geological formations to structures. Pursuant to the County Code, the preliminary soil investigation report prepared for a project must be submitted to the County's building inspection department. The report shall indicate the presence of critically expansive soils, unstable geological formations, or any soil problems that may present a hazard to structure, buildings, or other improvements. If soil instability issues arise, a report including the recommended corrective actions taken to prevent structural damage to buildings, structures, or improvements must also be submitted. Upon review of the preliminary soil report, the County Building Official will determine the completeness of the report and the effectiveness of the recommended corrective actions. If approved, the County Building Official shall certify the final map or parcel map and the recommended actions in the report shall become a condition of approval and incorporated into the development.

Project Consistency Analysis

A preliminary geotechnical report was prepared and submitted to the County with the application. Its primary purpose was to characterize site geologic conditions and serve as the primary data source for evaluating the range of potential geologic hazards. A design-level geotechnical report will be required, as outlined in **Mitigation Measures GEO-1** through **GEO-4**, to provide specific criteria and standards to guide the grading, drainage, and foundation depth.

Contra Costa County General Plan

The following policies from the General Plan Safety Element are relevant to geology, soils, and seismicity.

Safety Element

10-3: Because the region is seismically active, structures for human occupancy shall be designed to perform satisfactorily under earthquake conditions.

10-6: Structures of human occupancy, and structures and facilities whose loss would substantially affect the public safety or the provision of needed

services shall not be erected in areas where there is a high risk of severe damage in the event of an earthquake.

10-8: Ground conditions shall be a primary consideration in the selection of land use and in the design of development projects.

10-10: Policies regarding liquefaction shall apply to other ground failures which might result from groundshaking but which are not subject to such well-defined field and laboratory analysis.

10-11: Classify as active those faults which have ruptured the ground surface during Holocene geologic time, roughly the last 10,000 years. Classify as potentially active faults which displace Quaternary geologic units, those formed during approximately the last 2 to 3 million years.

10-13: In areas where active or inactive earthquake faults have been identified, the location and/or design of any proposed buildings, facilities, or other development shall be modified to mitigate possible danger from fault rupture or creep.

10-14: Preparation of a geologic report shall be required as a prerequisite before authorization of public capital expenditures or private development projects in areas of known or suspected faulting.

10-20: Any structures permitted in areas of high liquefaction danger shall be sited, designed, and constructed to minimize the dangers from damage due to earthquake-induced liquefaction.

10-21: Approvals to allow the construction of public and private development projects in areas of high liquefaction potential shall be contingent on geologic and engineering studies which define and delineate potentially hazardous geologic and/or soils conditions, recommend means of mitigations these adverse conditions; and on proper implementation of the mitigation measures.

10-22: Slope stability shall be a primary consideration in the ability of land to be developed or designated for urban uses.

10-23: Slope stability shall be given careful scrutiny in the design of developments and structures, and in the adoption of conditions of approval and required mitigation measures.

10-24: Proposed extensions of urban or suburban land uses into areas characterized by slopes over 15 percent and/or generally unstable land shall be evaluated with regard to the safety hazard prior to the issuance of any discretionary approvals. Development on very steep open hillsides and significant ridgelines throughout the County shall be restricted, and hillsides

with a grade of 26 percent or greater shall be protected through implementing zoning measures and other appropriate actions.

10-26: Approvals of public and private development projects in areas subject to slope failures shall be contingent on geologic and engineering studies which define and delineate potentially hazardous conditions and recommend adequate mitigation.

10-27: Soil and geological reports shall be subject to the review and approval of the County Planning Geologist.

10-28: Generally, residential density shall decrease as slope increases, especially above a 15 percent slope.

10-29: Significant very steep hillsides shall be considered unsuitable for types of development which require extensive grading or other land disturbance.

10-30: Development shall be precluded in areas when landslides cannot be adequately repaired.

10-31: Subdivisions approved on hillsides which include individual lots to be resold at a later time shall be large enough to provide flexibility in finding a stable buildable site and driveway location.

10-32: The County shall not accept dedication of public roads in unstable hillside areas, or allow construction of private roads there which would require an excessive degree of maintenance and repair costs.

Policy Consistency Analysis

Development within the project site would comply with the most recent state seismic requirements and building codes. These measures would ensure the reduction of potential risks to people and property resulting from seismic and geologic hazards. The project would therefore be consistent with the General Plan policies related to geology, soils, and seismicity.

4.7.3 IMPACTS AND MITIGATION MEASURES

Significance Criteria

Appendix G of the CEQA Guidelines identifies environmental issues a lead agency can consider when determining whether a project could have significant effects on the environment. The project would have a significant impact if it would:

- 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.

- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

Discussion of No Impacts

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?

The project site is not located within an A-P EFZ. Therefore, the project would not expose people or structures to potential substantial adverse effects from surface fault rupture of known active faults. No impact would occur.

Would the project 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;

The project site would connect to the Central Contra Costa Sanitary District's sewer system, as discussed in **Section 4.17, Utilities and Service Systems**. Septic tanks or alternative waste water systems would not be required. No impact would occur.

Discussion of Less-Than-Significant Impacts

Would the project result in substantial soil erosion or the loss of topsoil?

The proposed residential portions of the project site (approximately 20 acres) would require intensive earthmoving activities during construction. Excavation of lots,

sidewalks, and roadways on the lower portion of the project site would temporarily increase the amount of exposed (unvegetated) surfaces. Erosion of these surfaces could lead to increased sedimentation in receiving water bodies, such as San Ramon Creek.

As discussed in **Section 4.10, Hydrology and Water Quality**, the project proponent shall submit a Storm Water Pollution Prevention Plan (SWPPP) for review and approval by the Contra Costa County Public Works Department and the Contra Costa County Department of Conservation and Development. The SWPPP would comply with current San Francisco Bay Regional Water Quality Control Board guidelines and would adopt acceptable best management practices (BMP) for control of sediment and stabilization of erosion in the project area. The SWPPP would include acceptable BMPs for the protection of water quality. Application of the SWPPP will ensure that the project would not result in substantial soil erosion or loss of topsoil. This impact would be less than significant.

Discussion of Significant Impacts

Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking?

Impact GEO-1: The project could be subject to strong seismic shaking from regional geologic faults (Less than Significant with Mitigation).

Although the project site is not within an officially designated A-P EFZ, the ancestral trace of the Northern Calaveras fault passes through the immediate project site along the toe of Las Trampas Ridge. This segment of the Calaveras Fault does not fall within an A-P zone because it has no evidence of surface fault rupture during Holocene times (within the last 11,000 years). However, previous geotechnical studies have reported evidence of seismic activity along the Northern Calaveras fault during the Late Quaternary (within the last 35,000 years) in the Walnut Creek area (Darwin Myers Associates, 2013). Though the segment of the Calaveras fault that passes through the project site is not considered an active fault by the CGS, it is a potential seismic source.

In addition, earthquakes along nearby active faults in the region could cause moderate to strong ground shaking at the project site. The ground shaking intensity at the project site during a major earthquake in the San Francisco Bay Area is estimated at MMI level VII or VIII, with the potential to cause violent shaking and significant structure damage. The intensity of the earthquake ground motions and resulting damage would depend on the characteristics of the generating fault, distance to the fault and rupture zone, earthquake magnitude, earthquake duration, and site-specific geologic conditions.

The California Building Code has established seismic structural analysis guidelines for sites located near active seismic sources. As required by law, the project would be designed in conformance with current applicable residential standards for seismic stability as presented in the 2013 California Building Code, or the version in effect at the time of building permit issuance. **Mitigation Measure GEO-1** would address potential impacts related to seismic ground shaking.

> ***Mitigation Measure GEO-1***: The project proponent shall design structures and foundations to withstand expected seismic sources in accordance with the current version of the California Building Code, as adopted by the County. Prior to the issuance of a building permit, the Contra Costa County Department of Conservation and Development shall verify that plans incorporate seismic site categorization and design coefficients in conformance with the most recent version of the California Building Code. The project sponsor shall be required to provide evidence that a qualified geotechnical engineer has reviewed final grading, drainage, and foundation plans for consistency with California Building Code and Uniform Building Code design standards, and verify that all pertinent recommendations of the geotechnical engineer are incorporated into final building plans (see **Mitigation Measure GEO-2**).

Significance after Mitigation: Implementation of **Mitigation Measure GEO-1** would reduce potential adverse impacts resulting from seismic-related ground shaking to a less-than-significant level. Compliance with building and grading regulations would keep risks within generally accepted limits. Peer review of the final design plans and active supervision during installation of the project's seismic components would ensure compliance with all County approved building requirements.

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?

and

Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure or landslides?

Impact GEO-2: Soils on the project site are unstable and could experience soil failure or other geotechnical hazards (Less than Significant with Mitigation).

Artificial Fill

Existing artificial fill on the project site was not constructed in a manner that is consistent with current standards for engineered fill. Furthermore, ENGEO observed downslope movement (creep) of artificial fill within the project site. These

areas represent a potentially unstable geologic unit and a potentially significant impact.

Compressible Alluvial Deposits

Compressible alluvial deposits may exist on site. Placement of engineered fill and structures over on-site colluvial deposits may induce settlement of the underlying compressible alluvial deposits. In general, these soils will settle by approximately 0.25 inch for each foot of engineered fill, in addition to the settlement due to building weight. This is a potentially significant impact.

Corrosive Soil

The soils at the project site may be corrosive to building materials. Structures that contact these corrosive soils may be at risk for long-term damage, which is a potentially significant impact.

Expansive Soil

The expansive nature of the native soil is of significant geotechnical concern in the region. Clayey soils on the project site are highly expansive and susceptible to shrinking and swelling due to variations in moisture content. Expansive soils may cause heaving and cracking of slabs-on-grade, pavement, and foundations, representing a potentially significant impact.

Lurching and Lateral Spreading

Based on the mapped extent of young soils, site topography, and the engineering properties of the surficial deposits on the project site, the risk of lurching and lateral spreading is relatively low.

Liquefaction

Based on subsurface investigation from geotechnical consultants, surficial deposits of the valley floor are too cohesive to liquefy. Furthermore, according to the General Plan Safety Element, portions of the project site have been classified with a “generally high” liquefaction potential. For these reasons, implementation of the project could result in a potentially significant impact associated with liquefaction.

Landslides

Landslide areas shown in **Figure 4.7-1** have a relatively low likelihood of experiencing future instability that would affect the flatter, eastern portions of the project site where the proposed residential lots are located. Nevertheless, the risk of landslides is present at the site to varying degrees depending on the slope conditions and time of year. In addition, many of the soils found in the upland portions exhibit clayey characteristics (see **Section 4.12, Mineral Resources**). Clayey soils on steeper natural slopes are subject to slow, downslope movement that occurs with the annual cycle of wetting and drying under the influence of gravity.

Any encroachment of project improvements into slide areas will require specific remedial grading based on site-specific conditions.

Design-Level Geotechnical Report

The preliminary geotechnical report prepared by ENGEO provided sufficient data to make a preliminary assessment of geological hazards in this draft environmental impact report. However, final design of the project would require future geotechnical analysis and plan review, performed in conjunction with the processing of construction permits. The County Code requires additional geotechnical studies during the processing of final maps, grading permits, and building permits.

Prior to the issuance of building permits, the proponent shall submit a design-level geotechnical report for review by the County and review and approval of the County Building Official. This detailed investigation will also examine the potential hazards posed by artificial fill, compressible native soils, expansive soils, corrosion, liquefaction, and landslides.

Mitigation Measure GEO-2: A design-level geotechnical report shall provide recommendations to address soil stability on the project site. Performance measures shall include, but not be limited to, those described below.

- To reduce the potential for adverse settlement or stability problems, compressible native soils, artificial fill, and any compressible alluvium shall be replaced with engineered fill and/or improvements designed to accommodate the anticipated settlement. To reduce the expansion potential of the fill, moisture conditioning of clayey fill materials to above-optimum moisture content should be anticipated. Detailed fill placement recommendations will be provided based on laboratory testing and analysis performed in conjunction with the design-level geotechnical report.
- Depending on the location and characteristics of compressible native soils and artificial fill, some building pads may require drilled pier and grade beam foundations to achieve the desired level of structural support. This technique entails drilling pier holes below the depth of seasonal moisture changes and into more stable soils below. The pier holes are backfilled with concrete and reinforcing steel rebar, resulting in a structure with low movement risk.
- Most of the existing fill slope located along the rear of Lots 11 through 14 and Lots 18 through 20 will require corrective grading. For existing fills that remain in place, setbacks from the toe of the existing fill slope can be developed based on the findings of the design-level geotechnical exploration. In general, all proposed improvements should be set back from the toe of the slope a distance equal to, or greater than, the height of the existing fill slope.

- If after rough grading, testing of the pad soils determines that soils on the project site are corrosive, the project proponent will provide recommendation for foundations that protect building materials (such as concrete and steel) in contact with the ground surface.
- The design-level geotechnical report will characterize shrink/swell properties of on-site soils. Design-level mitigation will be required to reduce the risk associated with expansive soils, which may include the following.
  - Excavate expansive soils and replace with non-expansive fill
  - Avoid siting structures across soil materials of substantially different expansive properties
  - Extend building foundations below the zone of seasonal moisture change
  - Utilize pier and grade beam foundation system
  - Utilize post-tensioned slabs
  - Prevent accumulation of surface water adjacent to or under foundations
- Depending on the results of the design-level geotechnical report, the potential danger posed by liquefiable soils would be mitigated by appropriate soil and structural stabilization measures, such as compaction grouting and/or designing structures to accommodate anticipated settlement.
- Where development encroaches into the hilly, western areas of the project site, remedial grading will be required to reduce the potential for adverse impacts from slide movement and soil creep. Specific grading measures should be developed on a case-by-case basis where development encroaches into the mapped landslide areas. Measures may include:
  - Benching through the surficial soils during fill placement
  - Drilled pier and grade beam foundation systems to accommodate lateral loads from soil creep
  - Properly engineered cut and fill slopes
  - Stabilization of landslide areas
  - Creation of sufficient buffers between the identified landslide areas and development area
- Maintenance benches should be provided at the toe of major cut slopes (cut slopes higher than 10 feet) or natural slopes that extend upslope of the area of planned development. The width of the bench should be approximately 15 feet wide or as determined necessary by a licensed geotechnical engineer, depending on the height and steepness of the adjacent slope, to

ensure compliance with applicable provisions of the California Building Code.

- A cut slope is planned on the upslope side of proposed Lot 29 that would be about 18 feet high and have a gradient of about 2:1. This proposed cut slope may encounter relatively shallow bedrock. Additional exploration must determine if a 2:1 slope is feasible in this location. If subsurface conditions are such that a 2:1 slope is not feasible, the slope should be flattened to a gradient no steeper than 2.5:1, or reconstructed as an engineered fill slope with an appropriate keyway and subdrainage.

Significance after Mitigation: Mitigation Measure GEO-2, in combination with **Mitigation Measure GEO-1**, would reduce the exposure hazards resulting from artificial fills, compressible native soils, corrosive soils, expansive soils, liquefaction, landslides, and other geotechnical concerns by incorporating site-specific grading and foundation design while ensuring project consistency with the California Building Code. This impact would be less than significant.

Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic-related ground failure, including liquefaction?

Impact GEO-3: The project site could experience hazards related to liquefaction or other seismic-related ground failure (Less than Significant with Mitigation).

Seismic-related ground failure represents a variety of hazards on the project site. A design-level geotechnical exploration is necessary to characterize risks, as described above. Based on this evaluation, **Mitigation Measure GEO-2** would reduce the exposure of people and structures to potential adverse impacts resulting from ground failure by incorporating site-specific stabilization and foundation recommendations into the project design. **Mitigation Measure GEO-1** would ensure that design recommendations are consistent with the California Building Code. Incorporation of these measures would reduce this potentially significant impact to a less-than-significant level.

Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

Impact GEO-4: Evidence of landslide areas in the hills west of the project site suggests that the area experienced landslides in the past (Less than Significant with Mitigation).

The landslide areas shown in **Figure 4.7-1** have a relatively low likelihood of experiencing future instability that would affect the flatter, lower lying portions of the site where the residential lots are proposed. Although the risks of landslides

impacting the proposed residential lots is relatively low, it is potential hazard. Moreover, many of the soils found in the upland portions exhibit clayey characteristics, and may be subject to slow, downslope movement that occurs with the annual cycle of wetting and drying under the influence of gravity. This represents a potentially significant impact.

A design-level geotechnical exploration would be prepared to further refine the assessment of risks related to landslides and soil creep. Based on this evaluation, **Mitigation Measure GEO-2** would apply specific remedial grading measures and foundation design on a case-by-case basis, particularly on the western portions of the development site near the hilly areas. Therefore, **Mitigation Measure GEO-2** would reduce the exposure of people and structures to potential adverse impacts resulting from landslides and soil creep. In addition, **Mitigation Measure GEO-1** would ensure that design recommendations are consistent with the California Building Code. Incorporation of these measures would reduce this potentially significant impact to a less-than-significant level.

Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?

Impact GEO-5: The project site may be located on expansive soils (Less than Significant with Mitigation).

The expansive nature of the native soil is of significant geotechnical concern in this region. Expansive soils may cause structural damage, representing a potentially significant impact. A design-level geotechnical exploration will characterize risks related to soil expansion. Based on this evaluation, **Mitigation Measure GEO-2** would ensure that the risk of expansive soils is reduced through the application of appropriate grading and foundation design measures. In addition, **Mitigation Measure GEO-1** would ensure that design recommendations are consistent with the California Building Code. Incorporation of these measures would reduce the potentially significant impact to a less-than-significant level.

4.7.4 CUMULATIVE IMPACTS

The cumulative context for geology and soils includes any recent or near-future development in the project vicinity. However, geologic conditions within the San Francisco Bay Area and can vary widely, even among short distances. Therefore, seismic hazards related to recent and near-future development in the project vicinity are heavily influenced by site-specific features such as soil composition and slope, and do not have the potential to cumulate.

Due to the seismically active nature of the region, the recent and near-future development within the project vicinity, including the project itself, must conform

to general plan regulations and building codes that ensure adequate performance during a seismic event. Incorporation of these design requirements would avoid cumulative hazards related to regional seismic events.

4.7.5 REFERENCES

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