5.4 GEOLOGY AND SOILS

INTRODUCTION

This section describes the geology and soils of the project site and analyzes issues such as potential exposure of people and future improvements to geologic and seismic hazards, such as earthquakes, slope instability, and landslides, alterations to terrain, and erosion. This section incorporates information contained in two geotechnical reports prepared by ENGEO Incorporated and a geotechnical report prepared by Kleinfelder, Inc. Copies of all reports are provided in **Appendix 5.4**.

ENVIRONMENTAL SETTING

Regional Geology

The northern portion of Contra Costa County is bordered on the west by the San Francisco Bay, on the north by the Carquinez Straits and Suisun Bay, and on the north and east by Sacramento and San Joaquin Rivers. A majority of the County lies within the Coast Ranges geomorphic province of Central California, which consists of smooth rolling hills and fairly rugged mountains. Folds, thrusts, and faults form a series of nearly parallel, northwest-trending ridges made up mostly of Tertiary age (2 to 65 million years old) marine and non-marine shales, siltstones, sandstones, claystones, and conglomerates that strike roughly east-west and dip to the north. Bedrock at depth is presumed to be Franciscan Complex of Upper Jurassic to Cretaceous age (65 to 140 million years old). Valleys between the ridges are filled with Quaternary alluvium on fans and flood plains. Ridges bordering the San Francisco and Suisun Bays are skirted by terraces and alluvial fans that merge into the tidal flats adjacent to the bays (Kleinfelder 2000).

Local Geology

The hillsides south of Pittsburg are comprised of marine and non-marine sedimentary and volcanic rocks ranging in age from Eocene to Pliocene (about 50 to 2 million years old). Structurally, these rocks form a layered unit of sedimentary materials, which has been tilted about 25 to 45 degrees to the north. The sedimentary rocks are generally sandstone and clay shale with less common beds of volcanic ash (tuff) and diatomaceous rock (Kleinfelder 2000).

From south to north, the sedimentary bedrock consists of the Markely formation (composed of clay shale, which forms the southern ridge along the southern margin of the main project site), the Kirker formation (sandstone intermixed with volcanic ash material, which forms the lower portion of the steep north-facing slope in the southern portion of the main project site), the Cierbo sandstone (coarse, thick beds of sandstone, forming a small ridge in the central portion of the main project site), the Neroly sandstone

(non-marine sandstone, forming the steep south-facing slopes in the northern portion of the main project site and erosion-resistant rock bluffs), and the Lawloff tuff (volcanic ash and pumice, forming the northern ridgeline) (Klienfelder 2000).

The uplifted sedimentary geological unit of the main project site has been eroded by several streams, which have created steep canyons with thin deposits of unconsolidated alluvium in the bottom (Kleinfelder 2000). The clay-rich rocks typically weather more deeply and form gentler slopes than the sandstone and tuff rock. Additionally, the clay-rich rocks typically support thicker soils that are prone to downslope creep and landsliding. The steeper slopes generally cannot support thick soils but are commonly associated with debris flow and rock fall hazards. Large areas of the north-facing slopes in the southern portion of the main project site have been impacted by shallow (2 to 3 feet deep) debris flow failures (Kleinfelder 2000). The south-facing slopes of the northern ridge are underlain with sandstone, and are littered with loose rock indicating that rock-falls are common.

An alluvial valley that drains from west to east traverses the central portion of the main project site. The alluvial deposits extend up into several swales and canyons. The main stream channel has incised into the alluvium to depths of up to 15 feet in the central portion of the main project site. The alluvial material is composed of unconsolidated clayey sand and soil grit with gravel, with a thickness of less than 20 feet. In an apparent effort to reduce erosion along the incised channel, artificial debris and boulders have been dumped along much of the channel alignment (Kleinfelder 2000).

Seepage areas and springs were noted at the foot of the range on the southern portion of the main project site, with marshy conditions surrounding both seepage areas. The marshy conditions and its location at the head of an alluvial fan indicate that it stays relatively fixed throughout the winter and spring (Kleinfelder 2000).

There is a large area of existing fill associated with an abandoned quarry located on the eastern portion of the main project site. It appears that the fill consists of a mixture of on-site soils and bedrock, and construction debris such as concrete, wood, and asphalt (ENGEO 2011).

The bedrock in the off-site detention basin area consists of volcanic tuff and sandstone of the Lawlor Tuff, and non-marine sediments of the Tulare Formation. The dip of bedding in the bedrock formations varies from approximately 20 to 40 degrees to the northeast. The proposed off-site detention basin is located on the contact between the two formations (ENGEO 2012).

Faulting and Seismicity

There are several active faults located throughout the Bay Area region. The nearest active fault is the Concord fault located approximately 6 miles to the west of the project site. The 30-year probability of a magnitude 6.7 or greater earthquake occurring on a known active fault system in the Bay Area is 63 percent (ENGEO 2011).

Ground Rupture

Fault rupture is the displacement of the earth's surface along a fault during an earthquake. Fault rupture can be confined to a relatively narrow zone along some faults while other fault systems have a broad more complex fault rupture zone. The project site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo Zone), and there are no know active faults passing through the project site (ENGEO 2011). As a result, fault rupture is not likely to occur at the site.

Seismic Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking at the site, similar to that which has occurred in the past (ENGEO 2011).

Liquefaction, Lateral Spreading, and Ground Lurching

Liquefaction involves the sudden loss in strength of a saturated, cohesionless soil (predominantly sand) caused by the buildup of pore water pressure during cyclic loading, such as that produced during an earthquake. This increase in pore water pressure can temporarily transform the soil into a fluid mass, resulting in vertical settlement. The increase in pore pressure can also result in lateral spreading, which is a failure within a nearly horizontal soil zone that causes the overlying soil mass to move towards a free face or down a gentle slope. Ground lurching can occur in soft, saturated clays and silts that are subjected to strong ground shaking during earthquakes. Based on existing subsurface data, it appears that the alluvium on the project site, which consists of stiff silty to sand clays, will not be subject to liquefaction, lateral spreading, or ground lurching hazards (ENGEO 2011).

Landslides

Landslide movement can be triggered by changes in groundwater elevation due to rainfall, saturation by leaking utilities or impounded water, stream incision, man-made excavations and fill placement, as well as by seismic ground shaking. Landslide movement can cause large vertical and horizontal ground movements, ground warping and bulging, displacement of large masses of debris from slopes onto roads

and structures, and blocking of stream courses. The City of Pittsburg General Plan (2004) identifies the project site as having moderately unstable soil conditions, and a number of landslides have been identified on north-facing slopes within the greenwall. These landslides have been characterized as relatively shallow surficial earthflows and possible deeper-seated earthflows and rotation slumps (ENGEO 2011). In addition, a deep-seated landslide and a surficial landslide have been identified to the north of the off-site parcel where the detention basin is proposed (ENGEO 2012).

Expansive Soils

Expansive soils tend to expand and contract in response to moisture content. Problems due to expansive soils may include cracking and deterioration of foundations buildings and road surfaces. The clayey soils and claystone units within the bedrock in this region have moderate to high plasticity and moderate to high expansion potential (ENGEO 2011).

REGULATORY FRAMEWORK

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zones Act), signed into law in December 1972, requires the delineation of 1,000 to 2,500-foot-wide zones along active faults in California. The purpose of the Alquist-Priolo Act is to regulate development on or near fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones by, for example, withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement. Surface fault rupture is not necessarily restricted to the area within a Fault Rupture Hazard Zone, as designated under the Alquist-Priolo Act.

California Uniform Building Code

The California Uniform Building Code is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in Title 24 or they are not enforceable.

Published by the International Conference of Building Officials, the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The California Building Code incorporates the

UBC by reference and includes necessary California amendments. These amendments include criteria for seismic design.

Local Regulations

City of Pittsburg General Plan

The Pittsburg General Plan Health and Safety Element includes goals and policies related to geology and seismicity. The goals and policies applicable to the proposed project are listed below.

Geology and Seismicity

Goal 10-G-1 Minimize risk to life and property from geologic and seismic hazards.

Goal 10-G-2 Establish procedures and standards for geotechnical review of projects located in areas of steep slopes, unstable soils, or other geologic or seismic risks.

Goal 10-G-4 Mitigate potential seismic hazards, including landsliding and liquefaction, during the design and construction of new development.

Slopes and Erosion

Policy 10-P-1 Ensure preparation of a soils report by a City-approved engineer or geologist in areas identified as having geological hazards in Figure 10- 1, as part of development review.

Policy 10-P-2 Restrict future development from occurring on slopes greater than 30 percent (as designated in Figure 10-1) over the 900 foot elevation contour, and on major and minor ridgelines (as delineated in Figure 4-2).

Policy 10-P-3 Regulate the grading and development of hillside areas for new urban land uses. Ensure that such new uses are constructed to reduce erosion and landsliding hazards:

- Limit cut slopes to 3:1, except where an engineering geologist can establish that a steeper slope would perform satisfactorily over the long term.
- Encourage use of retaining walls or rock-filled crib walls as an alternative to high cut slopes.

- Ensure revegetation of cut-and-fill slopes to control erosion.
- Ensure blending of cut-and-fill slopes within existing contours, and provision of horizontal variation, in order to mitigate the artificial appearance of engineered slopes.

Policy 10-P-8 During development review, ensure that new development on unstable slopes (as designated in Figure 10-1) is designed to avoid potential soil creep and debris flow hazards. Avoid concentrating runoff within swales and gullies, particularly where cut-and-fill has occurred.

Geologic Hazards

Policy 10-P-9 Ensure geotechnical studies prior to development approval in geologic hazard areas, as shown in Figure 10-1. Contract comprehensive geologic and engineering studies of critical structures regardless of location.

Policy 10-P-11 Form geological hazard abatement districts (GHADs) prior to development approval in unstable hillside areas (as designated in Figure 10-1) to ensure that geotechnical mitigation measures are maintained over the long-term, and that financial risks are equitably shared among owners and not borne by the City.

Seismic Hazards

Policy 10-P-16 Ensure compliance with the current Uniform Building Code during development review. Explore programs that would build incentives to retrofit unreinforced masonry buildings.

Policy 10-P-17 Ensure detailed analysis and mitigation of seismic hazard risk for new development in unstable slope or potential liquefaction areas (as designated in Figure 10-1). Limit the location of critical facilities, such as hospitals, schools, and police stations, in such areas.

City of Pittsburg Grading Regulations

Grading within the City of Pittsburg is regulated by Pittsburg Municipal Code (PMC) section 15.88.060. The regulations provide guidance for setbacks, ground preparation, cut and fill slopes, excavations and embankments, erosion and sediment control, drainage, and wet season work.

ENVIRONMENTAL IMPACTS

Thresholds of Significance

In accordance with Appendix G of the *2013 California Environmental Quality Act (CEQA) Guidelines*, the impact of the proposed project related to geotechnical hazards would be considered significant if it would

- 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. (Refer to Division of Mines and Geology Special Publication 42.)

    ii. Strong seismic ground shaking.

    iii. Seismic-related ground failure, including liquefaction.

    iv. 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 and 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.

CEQA Checklist Items Adequately Addressed in the Initial Study

The analysis in the Initial Study prepared for the proposed project and circulated with the Notice of Preparation (NOP) concluded that further analysis of the following issues was not required in the EIR.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault.

The project site is not located within a State of California Earthquake Fault Zone (Alquist-Priolo), and there are no known faults that pass through the site. The nearest active fault is the Concord fault, located approximately 6 miles west of the project site (ENGEO 2011). There is no potential for fault rupture at the project site. There would be no impact with regard to this criterion.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking.

An earthquake of moderate to high magnitude generated within the San Francisco Bay Region could cause considerable ground shaking on the project site (ENGEO 2011). However, construction of new structures on the main project site, including the proposed water tank, would be subject to compliance with the provisions of the current (at time of building permit issuance) California UBC related to seismic safety, which require buildings and structures, such as the proposed water tank, to be designed and constructed to resist structural damage in the event of a minor or moderate earthquake and collapse during a major earthquake. With required full UBC compliance, a less than significant impact is anticipated with regard to this criterion.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction.

Liquefaction potential is highest among sandy, porous soils with high water content. Sites in Pittsburg with the highest liquefaction potential are generally located in lowland and marsh areas nearest to Suisun Bay. According to the Association of Bay Area Governments (ABAG) Geologic Information Systems (http://gis.abag.ca.gov) Earthquake Liquefaction Susceptibility map, there are some areas on the main project site which generally align with the drainage path in the center of the main project site and the existing creek (Kirker Creek) located immediately east of the main project site that have a low and moderate liquefaction potential; however, per the preliminary geotechnical report (ENGEO 2011), the existing subsurface data for the project site indicates that the alluvium consists of stiff silty to sand clays that would not be subject to liquefaction, lateral spreading or ground lurching hazards. The project site is also not expected to be subject to seismic-related ground failure; therefore, a less than significant impact is anticipated with regard to this criterion.

- 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 proposed project would not involve the installation of septic tanks or alternative wastewater disposal systems. There would be no impact with regard to this criterion.

Impact Analysis

Impact GEO-1 **Implementation of the proposed project could expose people or structures to risks associated with seismic-related ground failure, including landslides.** ***(Potentially significant)***

A number of potential landslides and rock falls have been identified on the northern facing slopes within the greenwall on the southern portion of the main project site and on the northwestern facing slopes on the off-site parcel (ENGEO 2011). The site of the proposed water tank is not located on or near an area with landslide potential. The proposed project includes a series of 20-foot-wide debris benches situated between residential uses and hillsides on the northern and southern portions of the main project site. The debris benches would be designed to catch debris from landslides triggered by seismic events and allow for removal of debris at a later date. However, the debris benches would not entirely prevent damage from identified landslides on the main project site during seismic events. Exposure of future residents and structures, including the off-site detention basin, to landslides and rock falls during seismic events is considered a potentially significant impact. However, implementation of **Mitigation Measure MM GEO-1**, which would require the developer to prepare a design-level geotechnical report for the main project site and off-site detention basin and implement the recommendations of the design-level geotechnical report, would reduce this impact to a less than significant level.

Mitigation Measures

MM GEO 1 Once the construction documents are developed, the developer shall prepare a design-level geotechnical report to provide site-specific geotechnical recommendations for the main project site and off-site detention basin.

For the main project site, the design-level geotechnical report shall include the following:

(1) Detailed site-specific grading plans and recommendations to reduce the risk of landslides, including partial landslide debris removal and buttressing with engineered fill or complete landslide debris removal and replacement of engineered fill. These measures shall be prepared during review of the final 40-scale grading plans.

(2) Recommendations with respect to excavatability of bedrock, and appropriate treatment of oversized-rock fragments;

(3) Site-specific recommendations for moisture conditioning and compaction of fills to reduce potential fill settlements;

(4) Site-specific recommendations for the construction of stable cut and fill slopes; and

(5) Site-specific recommendations for slope stabilization where appropriate.

For the off-site basin, the design-level geotechnical report shall include:

(1) Specific design recommendation for remedial grading including, the removal and replacement of landslide debris, keyways, and sub-drains. These measures shall be prepared during review of the final 40-scale grading plans;

(2) Site-specific geotechnical recommendations for site preparation grading and compaction of engineered fills; and

(3) Corrective grading plans depicting the location and dimensions of required slope buttresses keyways and sub-drains.

All of the recommendations of the design-level geotechnical report shall be implemented in conjunction with the preparation of the project site and construction of the residences and the off-site detention basin.

Residual Impacts after Mitigation

This impact would be reduced to a less than significant level.

Impact GEO-2 **The proposed project could result in substantial soil erosion or the loss of topsoil.** ***(Potentially significant)***

Construction of the proposed project, including the proposed water tank, would require site clearance, grading, and other earthmoving activities, which could subject exposed soils to erosion by water or wind. The disturbance footprint would exceed the 1-acre threshold that triggers the National Pollutant Discharge Elimination (NPDES) requirement to prepare and implement a storm water pollution prevention plan (SWPPP). In compliance with the NPDES requirements, appropriate erosion-control measures would be incorporated into the SWPPP and implemented during site grading and construction. These measures would include but are not limited to control of surface flows over exposed soils and use of sediment traps such as hay bales.

Upon completion of construction, erosion potential would be low because a majority of the main project site would covered by buildings, pavement, and landscaping. In addition, the proposed project includes a series of detention basins that would intercept site runoff and provide for the removal of sediment present in the runoff. However, the graded hillsides on the northern and southern portions of the main project site and the slopes associated with the off-site detention basin on the off-site parcel could be susceptible to erosion. This represents a potentially significant impact. However, implementation of **Mitigation Measure MM AES-2**, which would require the developer to hydro-seed all disturbed, yet

undeveloped, slopes (including those surrounding the proposed off-site detention basin) to encourage the growth of new vegetation on disturbed hillsides, would reduce the impact to a less than significant level.

Mitigation Measures

Implement **Mitigation Measure MM AES-2**.

Residual Impacts after Mitigation

This impact would be reduced to a less than significant level.

Impact GEO-3 **The proposed project could 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-site landslides or slope failure.** ***(Potentially significant)***

Graded slopes for the proposed project could be subject to slope stability issues related to natural soil and groundwater conditions in cut slopes and in foundation soils below fills. The stability of graded slopes is also affected by construction methods such as slope inclination, fill compaction, and the adequacy of subsurface drainage systems (ENGEO 2011). The potential for cut and fill slopes to become unstable and result in on-site landslides represents a potentially significant impact. However, implementation of **Mitigation Measure MM GEO-1**, which requires the preparation of a design-level geotechnical report that would provide detailed, site-specific analyses for proposed slopes, geotechnical recommendations and corrective grading plans prior to the approval of the final grading plan, and the implementation of the report's recommendations would reduce the potential impact to a less than significant level. The proposed project would not affect the stability of hillside slopes facing adjacent existing development to the north as these slopes would not be graded or disturbed as part of the proposed project.

Existing fills associated with the abandoned quarry are located on the main project site. The existing fill may be reused as engineered fill provided the material is deemed suitable for reuse by the City Engineer. It appears that portions of the existing fill contain deleterious material (wood debris) that would need to be segregated from the fill prior to reuse. If the deleterious material is not removed, the fill would become unstable due to the rotting of the wood. This impact is considered potentially significant. **Mitigation Measure MM GEO-3**, which would require that deleterious material been segregated from existing fill prior to use as engineered fill, would reduce the potential impact to a less than significant level.

Mitigation Measures

Implement **Mitigation Measures MM GEO-1**.

MM GEO-3 All deleterious material shall be segregated from existing fill prior to use as engineered fill. The developer shall obtain approval from City Engineer prior to reusing any existing fill on the project site as engineered fill.

Residual Impacts after Mitigation

This impact would be reduced to a less than significant level.

Impact GEO-4 **The proposed project could be located on expansive soils, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life and property.** ***(Potentially significant)***

Clayey soils and claystone units located on the main project site have moderate to high plasticity and moderate to high expansion potential (ENGEO 2011). With regards to the off-site detention basin, the bedrock layers underneath and adjacent to the basin contain moderately to highly expansive clay (ENGEO 2012). Expansive soils shrink and swell as a result of seasonal fluctuation in moisture content which can cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations.

The proposed water tank would be located on bedrock and the foundation for the tank would be designed in conformance with design standards established by the Contra Costa Water District to reduce potential impacts from expansive soils. The proposed residential units would be located on fill soils and due to the expansive soils on the project site, there is potential for uplift, cracking and increased maintenance of floor slabs, lightly loaded foundations, exterior flatwork, and pavements. However, with implementation of **Mitigation Measure MM GEO-1**, which requires the preparation of a design-level geotechnical report and implementation of its recommendations with respect to expansive soils, and **Mitigation Measure MM GEO-4**, which requires the placement of non-expansive granular soil fill under structures, this impact would be reduced to a less than significant level.

Mitigation Measures

Implement **Mitigation Measure MM GEO-1**.

MM GEO-4 Non-expansive granular soil fill shall be placed under structures at depths ranging from at least 1 to 2 feet, for building pads and the immediate perimeter areas, and beneath flatwork and paved areas. Final locations, depths, and dimensions of the non-expansive fill placement shall be determined in accordance with the recommendations in the design-level geotechnical report, as reviewed and approved by the City Engineer. Non-

expansive soils shall also be kept moist by watering for several days before placement of concrete in order to avoid having to remoisturize clayey soils (which would involve excavation, moisture conditions, and recompaction).

Residual Impacts after Mitigation

This impact would be reduced to a less than significant level.

Cumulative Impacts

Impact GEO-5: The proposed project along with other existing and future development in the cities of Pittsburg and Antioch would not result in a significant cumulative impact related to geologic risks. (*Less than significant*)

Geologic impacts associated with this project, such as those related to risk from landslide potential and unstable soils, are site-specific and would not cumulate, as there are no proposed developments immediately adjacent to the site The only exception to this would be the James Donlon Boulevard Extension Project; however, the extension project would be located on the east side of Kirker Pass Road, leaving the roadway to act as a physical barrier between the two projects, thereby significantly decreasing the likelihood that both projects could destabilize the same geologic landform and result in a cumulative geologic impact. In addition, there is no likelihood of a cumulative geologic impact to occur along the northern project edge, between the proposed development and existing development, as the north facing slopes are not proposed to be disturbed as part of the proposed project and the development to the north is existing and no changes in that area are proposed. Therefore, future development associated with the proposed project and other development in the vicinity of the project site in the City of Pittsburg, including Tuscany Meadows, Sky Ranch II and the James Donlon Boulevard Extension Project, and in the City of Antioch, including Black Diamond Ranch, would not result in a significant cumulative impact related to geologic risks.

Mitigation Measures

No mitigation measures are required.

REFERENCES

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