4.6 GEOLOGY AND SOILS

4.6.1 INTRODUCTION

This section evaluates the potential impacts related to geology and soils from the implementation of the proposed Scott Ranch project. It also presents potential impacts to geology and soils from the construction and operation of the proposed regional park trail that would extend offsite from the western boundary of the Scott Ranch project site to the existing Ridge Trail on the Helen Putnam Regional Park (see **Section 4.6.4.4** below).

4.6.2 ENVIRONMENTAL SETTING

4.6.2.1 Site Description

The project site is made of two parcels that are separated by Windsor Drive. Land elevation ranges from 100 feet above mean seal level (amsl) in the eastern portion of the project site to 380 feet amsl near the southwestern corner of the project site. A relatively flat alluvial plain occupies the central portion of the site and is bordered by moderately steep bedrock slopes to the north and south. The alluvial plain is associated with Kelly Creek which crosses the project site in an east-west direction and flows off site to the east via an existing box culvert under D Street. Two ephemeral drainages cross the central plain of the project site in a northerly direction and drain into Kelly Creek. In addition, an unnamed tributary, which crosses the eastern portion of the project site in a north-south direction, also drains into Kelly Creek; this tributary is called the D Street tributary. In addition, a stock pond and berm are located in a drainage swale south of Kelly Creek. The berm is approximately 15 feet high with a low "levee" of fill used to grade and control potential overflow from the pond. This fill directs pond overflow toward an existing swale, i.e., a shallow trough-like depression that carries water mainly during rainstorms and drains into Kelly Creek.

4.6.2.2 Regional Geologic Overview

Geology

The project site is situated along the southwestern margin of the Petaluma River Valley. This valley is part of the Coast Ranges geomorphic province of California, which is characterized by northwest-southeast trending valleys and ridges. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon and North American plates and subsequent predominantly strike-slip faulting along the San Andreas Fault system. As shown in **Figure 4.6-1, Regional Geology**, this portion of the Coast Ranges province is underlain by bedrock of the Franciscan Complex deposited during the late

Jurassic and Cretaceous age (approximately 65 to 208 million years old). In addition, tertiary age (10.6 to 65 million years old) volcanic rocks are present in scattered patches throughout the region.

Seismicity

The coastal areas of Northern California are seismically active, and the project site can be expected to experience periodic minor or major earthquakes (Moment magnitude 7 or greater) on one of the nearby active faults during the life of the proposed project.

The seismicity in the site vicinity is related to activity on the San Andreas Fault system. The faults in this system are characterized by right-lateral, strike-slip movements (movement is predominantly horizontal). The nearest major active fault is the Rodgers Creek fault located approximately 6.5 miles northeast of the project site. Other major active faults in the area are the San Andreas, West Napa, Maacama, and Hayward faults. These and other faults of the region are shown in **Figure 4.6-2, Major Faults and Epicenters in the San Francisco Bay Area**. A list of major active faults in the region, including the distance from the project site and estimated maximum Moment magnitudes of probable earthquakes on each of these faults are summarized in **Table 4.6-1, Regional Active Faults and Seismicity**.

Table 4.6-1
Regional Active Faults and Seismicity

Fault Name	Approximate Distance from Project Site (miles)	Direction from Project Site	Maximum Moment Magnitude[1]
Rodgers Creek	6.5	Northeast	7.0
San Andreas-1906 Rupture	13.5	Southwest	7.9
Hayward, Total Length	18	Southeast	7.1
San Gregorio	23	South	7.3
Point Reyes	22	Southwest	6.8
West Napa	17	East	6.5
Maacama - South	20	North	6.9

Source: Berlogar 2015
Notes:
[1] *Moment Magnitude is the measure of total energy released by an earthquake. It is not based on instrumental recordings of a quake, but on the area of the fault that ruptured in the quake; thus, describes something physical about an earthquake. It is calculated in part by multiplying the area of the fault's rupture surface by the distance the earth moves along the fault.*

Reference: Blake et al. (1974)

Explanation

Qal Alluvium: sand, gravel, silt, and clay
Qmf Marine and marsh deposits
Tme Merced (?) Formation: sandstone
Tsv Sonoma Volcanics: rhyolite, andesite, basalt, and tuff

Franciscan Complex
KJfs Melange with discrete masses of:
sp serpentinite
ch chert with shale interbeds
gs greenstone
mgs greenstone grading to blueschist
KJfm Metamorphic rocks
KJgr Greenstone

— – Geologic contact, dashed where approximately located
Fault, dashed where approximately located, dotted where concealed queried where uncertain

0 0.5 1 1.5 2
Scale (Miles)

SOURCE: Treadwell & Rollo, 2009

FIGURE **4.6-1**

Regional Geology

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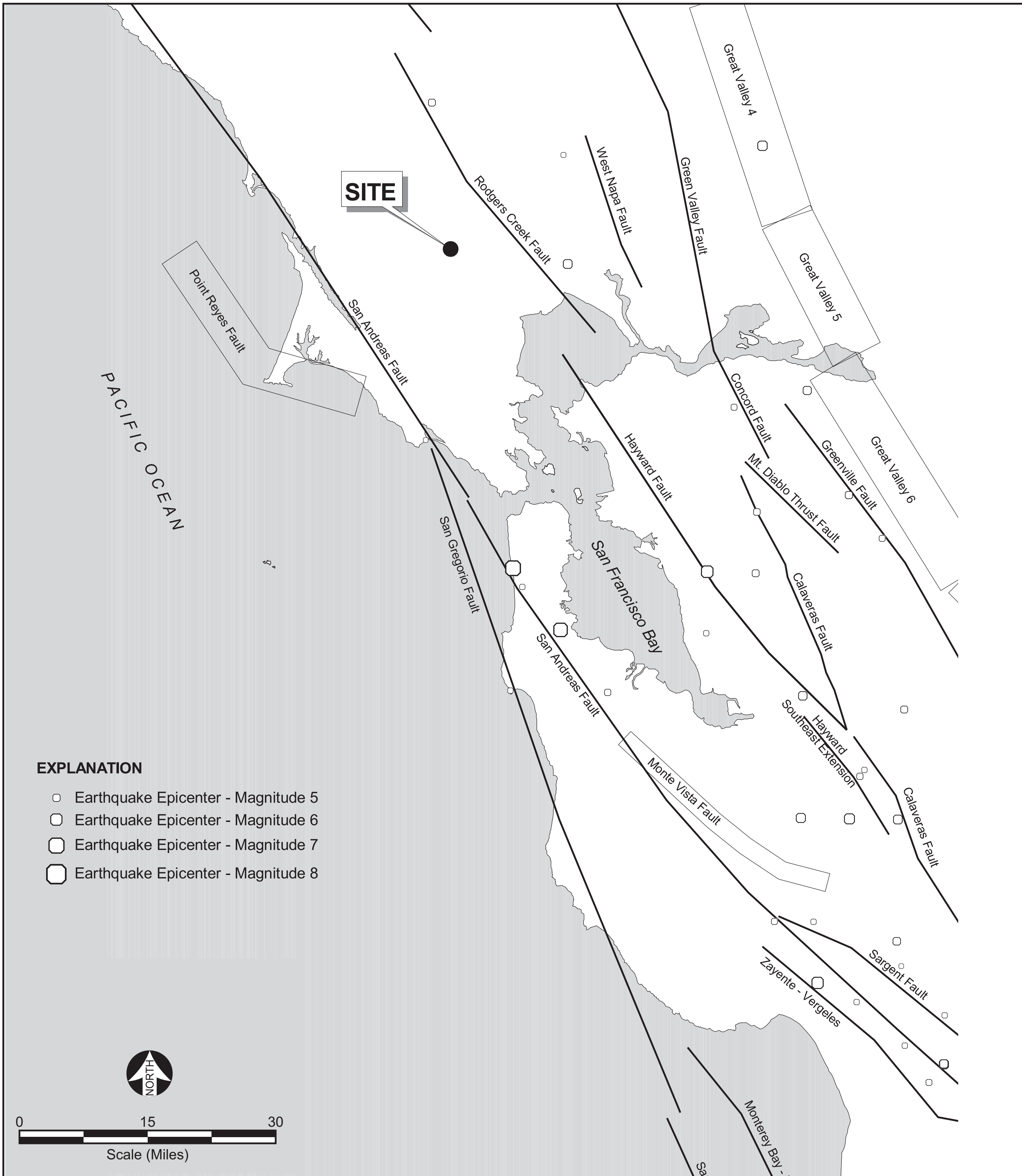

NOTES:
Digitized data for fault coordinates and earthquake catalog was developed by the California Department of Conservation Division of Mines and Geology. The historic earthquake catalog includes events from January 1800 to December 2000.

SOURCE: Christopher A. Joseph & Associates, and Treadwill and Rollo, 2016

FIGURE **4.6-2**

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Major Faults and Epicenters in the San Francisco Bay Area

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Since 1800, three major earthquakes have been recorded on the San Andreas fault system. In 1836 an earthquake with an estimated magnitude intensity of VII on the Modified Mercalli (MM) scale and an estimated Moment magnitude (M_w) of 6.25 occurred east of Monterey Bay on the San Andreas fault. In 1838, an earthquake with an estimated intensity of approximately VII-IX on the MM scale and a M_w of 7.5 also occurred on the San Andreas fault. The third major earthquake on the San Andreas fault occurred in 1906. The San Francisco earthquake of 1906 had a maximum intensity of XI (MM), a Mw of 7.9 and caused the most significant damage in the history of the Bay Area in terms of loss of lives and property damage. The Loma Prieta earthquake of 1989, which also occurred on the San Andreas Fault system, with its epicenter located in the Santa Cruz Mountains and a M_w of 6.9, affected the greater Bay Area.

The most recent earthquake to affect the San Francisco Bay Area occurred on 24 August 2014 and was located on the West Napa fault— approximately 17 miles east of the project site with a M_w of 6.0.

4.6.2.3 Project Site Geology

The geology of the project site has been evaluated by several consultants in anticipation of development, starting in 2002, as listed below.

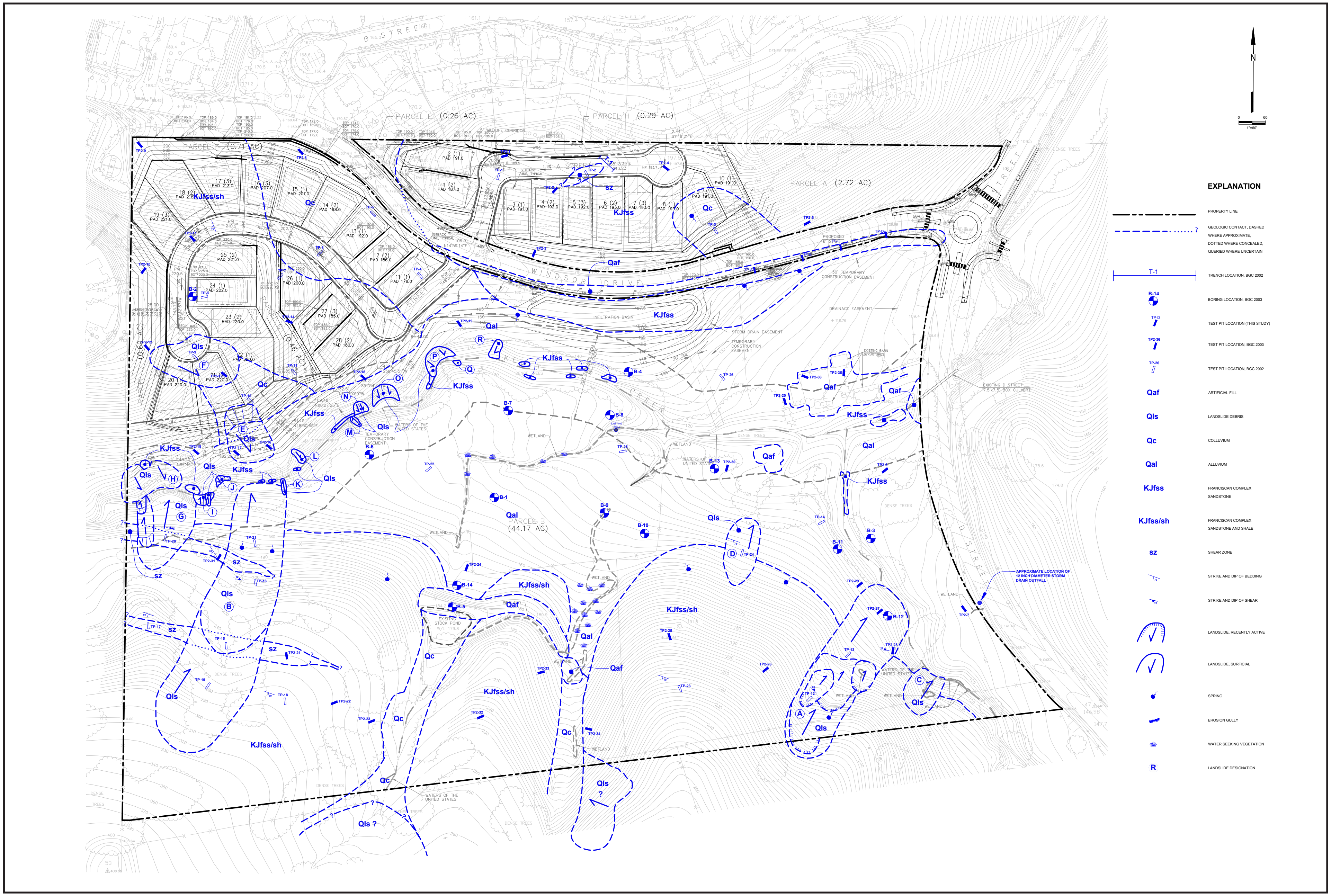
- *Geotechnical Feasibility Investigation Report for the UOP Property* by Berlogar Geotechnical Consultants (March 7, 2002).
- *Design-level Geotechnical Investigation Report for the UOP Property* by Berlogar Geotechnical Consultants (September 22, 2004).
- *Third Party Geotechnical/Geological Review – Davidon Homes EIR*, by Treadwell & Rollo (November 23, 2004).
- *Response to Geotechnical Peer Review Comments, Plus Supplemental Recommendations – UOP Property*, by Berlogar Geotechnical Consultants (December 16, 2004).
- *Third Party Geotechnical/Geological Review – Davidon Homes EIR* by Treadwell & Rollo (December 20, 2004).
- *Geologic Site Review Update, Davidon Homes Administrative Draft EIR Comments, UOP Property D Street, Petaluma, California* by Gilpin Geosciences, Inc. (October 30, 2012).
- *Design-level Geotechnical Investigation Option A – 66 Lots Option B – 63 Lots Scott Ranch* by Berlogar Stevens & Associates (Berlogar) (April 28, 2014).
- *Third Party Geotechnical/Geological Review – Davidon Homes EIR* by Haley & Aldrich (October 11, 2014).
- *Grading Exhibit Review, Scott Ranch, Petaluma, California* by Berlogar Stevens & Associates (Berlogar) (July 3, 2018).
- *Geologic Map, Scott Ranch, 28 Lots, Petaluma, California (Plate 2)* by Berlogar Stevens & Associates (Berlogar) (July 12, 2019).

Berlogar was retained by the applicant to prepare a geotechnical investigation of the project site in 2004. Treadwell & Rollo prepared a third-party peer review of the 2004 geotechnical report. Gilpin Geosciences, Inc. (Gilpin Geosciences) assisted Treadwell & Rollo in a reconnaissance of the site on August 12, 2004. Gilpin Geosciences revisited the site on October 29, 2012 to review site conditions that they originally mapped on August 12, 2004. Gilpin Geosciences found no significant changes in the state of the site slope stability or level of erosion at the site compared to their surveys in 2004. Berlogar prepared an updated geotechnical report for the project site in 2014, and Haley & Aldrich prepared a third-party peer review of the 2014 geotechnical report. Haley & Aldrich also reviewed historical aerials of the project site and identified several landslides on the hill slopes. C2Earth, Inc. (C2) assisting Haley & Aldrich revisited the site on September 10, 2014. Based on peer review comments from Haley & Aldrich, Berlogar updated and reissued the geotechnical report in June 2015. In 2018, Berlogar reviewed the grading plan for the Davidon (28-Lot) Residential Project component to compare it to the 2004 geotechnical report. In 2019, Berlogar prepared a geologic map for the Davidon (28-Lot) Residential Project component. The base drawing for the geologic map was a drawing titled "Revised Project – 28 Lots Proposed Grading Plan," prepared by BKF dated February 11, 2019. The information presented below is based on a review these geotechnical investigations.

Bedrock and Site Geology

Five types of soil/bedrock were encountered on the project site in on-site borings and test pits: artificial fill (Qaf), landslide deposits (Qls), colluvium (Qc), alluvium (Qal), and Franciscan bedrock (KJf). Isolated areas of artificial fill were encountered in three main areas: (1) beneath and around existing buildings, (2) adjacent to the stock pond, and (3) along the downslope (south) side of Windsor Drive. The fill generally consists of dense sandy silt and gravel and stiff to very stiff silty clay. The central half of the site along Kelly Creek is covered with alluvium and the adjacent swales are covered with colluvium. Alluvium, consisting of sandy clays and clayey sands with various amounts of gravel is located in relatively flat areas bordering drainage courses and at the down-slope end of the swales. Colluvium, consisting of stiff to very stiff clay with minor amounts of gravel is present in the lower portions of the site. The colluvium at the site is moderately expansive. Two types of Franciscan bedrock were identified on the site. Sandstone (KJfss) is present along most of the northern edge of the site and in scattered outcrops in the channel of Kelly Creek. Sandstone and shale (KJfss/sh) are present on the majority of the upland portions of the project site (Haley & Aldrich 2014).

Three bedrock shear zones were identified on the project site: two in the southwestern portion of the project site and a third short zone was identified in the northern portion of the project site, as shown in **Figure 4.6-3, Site Geology.** C2 indicates that topographic evidence of the three bedrock shear zones mapped by Berlogar



SOURCE: Berlogar Stevens & Associates

FIGURE **4.6-3**

Site Geology

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was not visible on the surface of the site during the site reconnaissance on September 10, 2014. In the area of the shear zone that Berlogar mapped in the southwestern corner of the property, C2 observed outcrops of indurated sandstone and possibly silica-carbonate rock (Haley & Aldrich 2014).

Project Site Soils

Soils mapping by the Natural Resources Conservation Service (NRCS) shows five soil units on the project site, including Cotati fine sandy loam (9 to 15 percent slopes), Goulding clay loam (15 to 30 percent slopes), Los Osos clay loam (15 to 30 percent slopes), Los Osos clay loam, thin solum (30 to 50 percent slopes), and Pleasanton loam (2 to 9 percent slopes) (USDA NRCS 2014). Cotati fine sandy loam is moderately well drained with slow to rapid runoff and moderately rapid to very slow permeability. Goulding clay loam is somewhat excessively drained with medium to very rapid runoff and moderate permeability. Los Osos clay loam is well drained with very high runoff and slow permeability. Pleasanton loam is well drained with slow to medium runoff and moderately slow permeability (USDA NRCS 2014).

Expansive soils shrink or swell with changes in moisture content. Clay mineralogy, clay content, and porosity of the soil influence the change in volume. The shrinking and swelling caused by expansive clay-rich soil can result in damage to overlying structures. As shown in **Figure 4.6-3**, soils encountered on portions of the project site underlain by colluvium or alluvium deposits were found to be moderately expansive (Haley & Aldrich 2014).

Seismicity

Fault Rupture

The project site is not located within an Alquist-Priolo Earthquake Fault Zone. No active faults or extensions of active faults are mapped on the site, and surficial indications of faulting on the project site were not identified. The nearest mapped active fault to the project site is the Rodgers Creek fault, approximately 6.5 miles to northeast of the site. The potential for fault rupture at the site is therefore low (Berlogar 2015).

Seismic Hazards

Strong ground shaking caused by large earthquakes can induce ground failures, such as liquefaction,[1] lateral spreading,[2] and cyclic densification.[3] A site's susceptibility to these hazards relates to the site topography, soil conditions, and/or depth to groundwater (Berlogar 2015).

Material susceptible to liquefaction or significant dynamic densification was not encountered on the project site. Furthermore, the soil at the project site has sufficient fines and/or density to resist liquefaction and cyclic densification. Therefore, the potential for liquefaction, seismically induced differential settlement, and lateral spreading to occur at the site is very low. Additionally, seismic events may trigger landslides in areas of moderate to steep slopes underlain by thick soils, weak or fractured rock (i.e., much of the Franciscan melange bedrock), previously existing landslides, or loose fill. Landslides on the project site are further discussed below.

Landslides

There are 18 landslides, designated as landslides A through R in **Figure 4.6-3**. Landslides A, B, C, D, and G are located on the flanks of the hillsides in the southern portion of the site. Landslides E, F, and H are located on the flank of the large bedrock knob in the northwest portion of the site. The remaining landslides (Landslides I through R) are located along the banks of Kelly Creek and are the result of typical creek bank oversteepening. Of the landslides, eight are large (Landslides A through H) and the remaining (Landslides I through R) are small landslides on the oversteepened banks along the riparian corridor of Kelly Creek. The landslides on the project site are generally shallow, with depths ranging from 3 to 5 feet for landslides along Kelly Creek and 4 to 12 feet for landslides in the rest of the project site (Berlogar 2015).

Haley & Aldrich assisted by C2 conducted a reconnaissance of the project site on September 10, 2014 to observe the site conditions and geology. During this visit, C2 mapped the geology of the site and reviewed the geologic mapping prepared by Berlogar and confirmed the presence of all but three of the landslides mapped by Berlogar. C2 could not confirm the presence of landslides B, F, and a portion of landslide G, as described in the Berlogar report. Berlogar explored landslide B by excavating and logging four test pits, one of which was located in a mapped shear zone. Based on C2's review, the logs of these pits do not

1 Liquefaction is a phenomenon in which saturated, cohesionless soil experiences a temporary loss of strength due to the buildup of excess pore water pressure, especially during cyclic loading such as that induced by earthquakes. Soil most susceptible to liquefaction is loose, clean, saturated, uniformly graded, fine-grained sand; however, low plasticity silts and clay can also liquefy.

2 Lateral spreading is a phenomenon in which surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. Upon reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces.

3 Cyclic densification is a phenomenon in which non-saturated, cohesionless soil is densified by earthquake vibrations, causing ground surface settlement.

indicate the presence of landslide materials or a basal landslide plane. Berlogar explored landslide F by excavating and logging two test pits, one of which identified a "sharp basal contact, possible slide plane" with an 18-degree dip (direction not specified). If landslide F exists, the lack of surficial evidence defining the limits of the deposit indicates that it has not moved in several years. Berlogar explored landslide G by excavating one test pit, where they encountered a 1/4-inch-thick, slicken-sided clay slide plane. However, the test pit was excavated in the middle of a mapped shear zone; therefore, it is difficult to determine if the slicken-sided plane is associated with a landslide or is an inherent feature of the shear zone (Haley & Aldrich 2014).

Debris Flow and Sedimentation

The potential for debris flow was noted to be low across most of the project site, but was identified in the southwestern drainage courses (Central and Stock Pond Drainages) (Berlogar 2015).

Erosion

Site reconnaissance and aerial photography review indicate erosion is occurring along the incised channels of Kelly Creek and in the Central and Stock Pond Drainages. The presence of bedrock in the floors of these two channels indicates that downcutting is relatively slow along these seasonal streams, and lateral erosion of unconsolidated materials in the channel banks appears to be the main mode of erosion. In addition, a small erosional gully is located in the alluvium across the very gently northeast-sloping valley bottom north of the stock pond (Haley & Aldrich 2014).

4.6.2.4 Paleontological Resources

Paleontological resources (fossils) are the remains and/or traces of prehistoric plant and animal life exclusive of human remains or artifacts. Fossil remains such as bones, teeth, shells, and wood are found in the geologic deposits (rock formations) in which they were originally buried. Fossils represent a limited, non-renewable, sensitive scientific and educational resource. The potential for fossil remains at a location can be predicted through previous correlations that have been established between the fossil occurrence and the geologic formations within which they are buried. For this reason, knowledge of the geology of a particular area and the paleontological resource sensitivity of particular rock formations make it possible to predict where fossils will or will not be encountered. The project site is underlain by the Franciscan Formation, which is the oldest known sedimentary unit in the project area and consists of fossil-bearing marine sediments.

4.6.3 REGULATORY CONSIDERATIONS

4.6.3.1 Federal Laws

Clean Water Act

The Federal Water Pollution Control Act of 1972, often referred to as the Clean Water Act, empowers the US Environmental Protection Agency (US EPA) with regulation of wastewater and stormwater discharges into surface waters by using National Pollutant Discharge Elimination System (NPDES) permits and pretreatment standards. At the state level, these permits are issued by the Regional Water Quality Control Boards, but the US EPA may retain jurisdiction at its discretion. The Clean Water Act's primary relevance for geology and soils is with respect to the control of soil erosion during construction.

Earthquake Hazards Reduction Act

The Earthquake Hazards Reduction Act of 1977 (Public Law 95-124) established the National Earthquake Hazards Reduction Program which is coordinated through the Federal Emergency Management Agency (FEMA), the U.S. Geological Survey (USGS), the National Science Foundation, and the National Institute of Standards and Technology. The purpose of the Program is to establish measures for earthquake hazards reduction and promote the adoption of earthquake hazards reduction measures by federal, state, and local governments; national standards and model code organizations; architects and engineers; building owners; and others with a role in planning and constructing buildings, structures, and lifelines through (1) grants, contracts, cooperative agreements, and technical assistance; (2) development of standards, guidelines, and voluntary consensus codes for earthquake hazards reduction for buildings, structures, and lifelines; and (3) development and maintenance of a repository of information, including technical data, on seismic risk and hazards reduction. The Program is intended to improve the understanding of earthquakes and their effects on communities, buildings, structures, and lifelines through interdisciplinary research that involves engineering, natural sciences, and social, economic, and decisions sciences.

Disaster Mitigation Act (2000)

The federal Disaster Mitigation Act (DMA; Public Law 106-390) provides the legal basis for FEMA mitigation planning requirements for state, local, and Indian Tribal governments as a condition of mitigation grant assistance. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by repealing the previous mitigation planning provisions and replacing them with a new set of requirements that emphasize the need for state, local, and Tribal entities to closely coordinate mitigation planning and implementation efforts. The requirement for a state mitigation plan is continued as a condition of disaster assistance, adding incentives for increased coordination and integration of mitigation activities at the state level through the establishment of requirements for two different levels of state plans. DMA 2000 also established a new requirement for local mitigation plans and authorized up to 7 percent of Hazard Mitigation Grand Program funds available to a state for development of state, local, and Tribal mitigation plans.

4.6.3.2 State Laws and Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Section 25523(a); 20 CCR 1752(b) and (c); 1972 [amended 1994]) was passed in 1972 to regulate development on or near active fault traces to reduce the hazards associated with surface faulting. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to ensure public safety by prohibiting the construction of most structures used for human occupancy across traces of active faults that constitute a potential hazard to structures from surface faulting or fault creep. For projects proposed within Alquist-Priolo Earthquake Fault Zones, site-specific geologic investigations must be performed prior to permitting, and must demonstrate that a proposed building would not be constructed across active faults. If an active fault is found, any structures for human occupancy must be set back from the fault, generally 25 to 50 feet.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act addresses seismically induced hazards, including liquefaction and landsliding (slope instability). Seismic hazard zones, which show areas where there is potential for ground shaking, liquefaction, landsliding, and other types of ground failure, have been developed to better regulate development in hazard-prone areas. For sites located within a seismic hazard zone, geotechnical investigations must be conducted to assess if a hazard exists, and the investigations must provide options for mitigation if any hazards are identified. Geotechnical investigations within seismic hazard zones should be conducted following guidelines specified by California Geological Survey (CGS) Special Publication 117, "Guidelines for Evaluating and Mitigating Seismic Hazards." The California Public Resources Code Chapter 7.8, 1990 Seismic Hazards Mapping Act, allows the lead agency to withhold permits until geologic investigations are conducted and mitigation measures are incorporated into plans.

California Building Standards Code

The State of California's minimum standards for structural design and construction are given in the California Building Standards Code (CBSC) (CCR Title 24). The CBSC is based on the federal Uniform Building Code (International Code Council 1997), which is used widely throughout United States (generally adopted on a state-by-state or district-by-district basis) and has been modified for California conditions with numerous, more detailed or more stringent regulations. The CBSC provides standards for various aspects of construction, including, but not limited to: excavation, grading, and earthwork construction; fills and embankments; expansive soils, foundation investigations, and liquefaction potential; and soil strength loss.

4.6.3.3 Local Plans and Policies

City of Petaluma 2025 General Plan

The City of Petaluma General Plan 2025 contains goals and policies relating to geology and soils. General Plan goals and policies relevant to the proposed project are as follows:

Chapter 10 Health and Safety

10.1 Natural Hazards

Policy 10-P-1: Minimize risks of property damage and personal injury posed by natural hazards.

A. Require geotechnical studies prior to development approval in geologic and/or seismic hazard areas. Require or undertake comprehensive geologic and engineering studies for critical structures regardless of location.

B. On sites with slopes greater than 30 percent, require all development to be clustered outside of the 30 percent slope areas (and preferably on land less than 15 percent in slope) where possible.

C. Regulate the grading and development of hillside areas for new urban land uses, by instituting a Hillside Overlay or other similar mechanism in the Development Code. Ensure that new development on hillsides is constructed to reduce erosion and landslide hazards and in compliance with any City hillside regulations, including, but not limited to:

- 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. Plant materials for revegetation should not be limited to hydro-seeding and mulching with annual grasses. Trees add structure to the soil and take up moisture while adding color and diversity.

- 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.
- Ensure structural integrity of sites previously filled before approving redevelopment.

D. Adopt and amend as needed updated versions of the California Building Code (CBC) so that optimal earthquake-protection standards are used in construction and renovation projects.

E. Explore programs that would encourage, assist, or provide incentives to property owners to retrofit their buildings for seismic safety, such as the successful Unreinforced Masonry (URM) program.

Policy 10-P-2: Protect the community from risks associated with seismically induced surface ruptures, ground-shaking, ground failure, slope instability leading to mudslides and landslides, subsidence, liquefaction, and other seismic, geologic, and fire hazards.

4.6.4 IMPACTS AND MITIGATION MEASURES

4.6.4.1 Standards of Significance

The impacts of the proposed project related to geology and soils would be considered significant if they would exceed the following Standards of Significance, in accordance with Appendix G of the *State CEQA Guidelines*:

- Directly or indirectly cause 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; and
  - landslides;
- result in substantial soil erosion or the loss of topsoil;
- be located on a geologic unit or soil that is unstable or would become unstable as a result of the project, and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse;

- be located on expansive soil, as defined in Section 1803.5.3 of the California Building Code (2019), creating substantial direct or indirect 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; or
- directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

4.6.4.2 Methodology

This section analyzes the potential impacts on geology and soils associated with the proposed project, based on the project description (**Section 3.0, Project Description**), site visit, and geotechnical investigations prepared for the project site and listed above under **Section 4.6.2.3, Project Site Geology**. Impacts are also analyzed within the context of local, state, and federal regulations.

4.6.4.3 Project Impacts and Mitigation Measures

Impact GEO-1: **The proposed project would not directly or indirectly cause potential substantial adverse effects related to fault rupture but would cause potential substantial adverse effects related to seismic ground shaking and/or seismic-related ground failure. (*Potentially Significant; Less than Significant with Mitigation)***

The proposed project is not located within an Alquist-Priolo Fault Zone and there are no known active, potentially active, or inactive faults that transect the project site. The potential for fault rupture is considered to be low and the impact related to fault rupture would be less than significant.

Strong ground shaking caused by large earthquakes can induce ground failures, such as liquefaction, lateral spreading, and cyclic densification. Based on the geotechnical reports, material susceptible to liquefaction or significant cyclic densification was not encountered at the project site. Because the potential for liquefaction to occur at the site is low, the potential for ground failures associated with liquefaction (i.e., lateral spreading, post-liquefaction reconsolidation, and loss of bearing support) is also low. However, due to the project site's proximity to the Rodgers Creek fault which is located approximately 6.5 miles northeast of the site, the project would likely experience strong ground shaking (the site modified peak ground acceleration, PGA_M, for the site is estimated at 0.65g) which could affect the proposed residential structures and result in seismically-induced landslides and ground movement in areas of moderate to steep slopes underlain by thick soils, weak or fractured rock (i.e., much of the Franciscan melange bedrock), or loose fill. Therefore, the proposed project has the potential to expose people or structures to hazards from seismic activity. This impact would be potentially significant.

State law (California Health and Safety Code 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. While there are no absolute guarantees when considering acts of nature such as earthquakes, the proposed project would comply with building requirements set forth in the CBC, which have been designed to reduce the likelihood of damage as a result of ground shaking. In addition, **Mitigation Measures GEO-1a** and **GEO-1b**, which require the preparation of a project-specific geotechnical report and the implementation of recommendations identified in the report in relation to seismic ground shaking and associated ground failure would reduce the potential for structures on the project site to sustain damage during an earthquake event. With implementation of **Mitigation Measures GEO-1a and GEO-1b**, the potential for seismically induced landslides and fill slope movements associated with the proposed project would be less than significant.

Mitigation Measures:

GEO-1a The project Applicants shall submit for City's approval a preconstruction design-level geotechnical report for the Davidon (28-Lot) Residential Project component and the Putnam Park Extension Project component. The report shall include all applicable geologic report standards, reconnaissance and subsurface exploration data, laboratory test results, and conclusions and recommendations, including, but not limited to, those pertaining to: 1) site preparation, excavation, fill placement and compaction, temporary and permanent cut and fill slope inclinations (including whether slopes steeper than 3:1 can be used at the site), slope stability, slope erosion mitigation, and landslide movement mitigation; 2) surface and subsurface drainage systems, including drainage associated with grading for landslide movement mitigation and new cut and fill slopes; 3) foundations and floors for planned residential structures; 4) foundations for planned site improvements, including, but not limited to restrooms, barn, pedestrian bridges, and other structures; 5) settlement and swell estimates for planned residential structures and site improvements, including those bearing of engineered fill; 6) foundations, back-drains, and lateral earth pressures for site retaining walls; 7) seismic design parameters for the planned residential structures, site improvements, and site retaining walls; 8) pavement design for driveways, parking lots, pathways and trails, where applicable; 9) utility trench backfill, including check dams and trench drainage, if appropriate; 10) geologic/geotechnical construction monitoring, testing, and certification requirements; and 11) loop trail construction and long-term maintenance requirements, including criteria for inspecting and maintaining pedestrian bridges, culverts, and pathway surfaces, as appropriate.

The geotechnical report shall include measures, as necessary, to reduce the potential for static and earthquake-induced slope movements that may adversely impact the Davidon

(28-Lot) Residential Project component and the Putnam Park Extension Project component including areas currently underlain by mapped landslides. Engineering analyses shall estimate the factors of safety against slope movements within the planned development area and estimates of the magnitude and location of earthquake-induced slope deformation.

GEO-1b: As determined by the City Engineer and/or Chief Building Official, all recommendations outlined in the preconstruction design-level geotechnical report for the Davidon (28-Lot) Residential Project component and the Putnam Park Extension Project component, as described under **Mitigation Measure GEO-1a,** are herein incorporated by reference and shall be adhered to in order to ensure that appropriate measures are incorporated into the design and construction of the project. Nothing in this mitigation measure shall preclude the City Engineer and/or Chief Building Official from requiring additional information be provided to determine compliance with applicable standards. The project geotechnical engineer shall review the project plans and specifications and submit a letter certifying to the City that the project plans and specifications have been prepared in accordance with the geotechnical recommendations for the project. The project geotechnical engineer or personnel under their direct supervision shall inspect the construction of geotechnical and/or geologic aspects of the project and shall submit a letter certifying to the City that prior to issuance of a certificate of occupancy, the geotechnical and geologic aspects of the project plans and specifications have been appropriately constructed at the site and are acceptable to the project geotechnical engineer.

Significance after Mitigation: Implementation of **Mitigation Measures GEO-1a** and **GEO-1b** would reduce impacts associated with seismically induced structural damage to a less than significant level.

Impact GEO-2: The proposed project would result in substantial soil erosion or the loss of topsoil. *(Potentially Significant; Less than Significant with Mitigation*)

The Davidon (28-Lot) Residential Project component would result in ground disturbance on approximately 15 acres of the project site. The Putnam Park Extension Project component would be located on the remaining 44 acres of the project site and include a multi-use trail network of approximately one mile extending from D Street on the east to Helena Putnam Regional Park on the west and aligned along both the north and south sides of Kelly Creek. It would also include a Class I trail that runs north/south parallel to D Street and improvements to the barn complex. The construction of the Putnam Park Extension Project component would result in ground disturbance along the planned pathways and trails, and at parking lots, driveways, and site structures , such as the barn, restrooms, and pedestrian bridge foundation and abutment locations.

Construction Impacts

The proposed Davidon (28-Lot) Residential Project component would require grading and earthwork leaving bare earth that could result in soil erosion and loss of topsoil on the project site. Of particular concern are newly cut and filled slopes, which are potentially susceptible to surface soil erosion due to: 1) the presence of poorly compacted fill, which can be easily eroded by surface runoff, 2) poor grading which can concentrate and/or redirects surface water to localized portions of the slope, 3) loss of surface vegetation as a result of grading, and 4) insufficient inspection and maintenance of BMPs to ensure that the exposed soil on the slopes is adequately protected until permanent erosion protection, such as deep-rooted plants, can be established on the newly graded slopes.

Mitigation Measures GEO-2a is identified below to address erosion impacts during construction that are related to geotechnical aspects of the project. **Mitigation Measures GEO-2a** would reduce the impact associated with erosion of poorly compacted soil by ensuring that geotechnical recommendations associated with mitigating surface soil erosion are properly implemented during construction.

In addition, as discussed in detail in **Section 4.7, Hydrology and Water Quality**, because the project would disturb more than one acre of land, the Applicants are required to prepare a SWPPP, per NPDES general construction permit requirements through the SWRCB. The SWPPP would address potential erosion and sedimentation issues through a project-specific erosion control plan, as well as other BMPs to reduce the potential for spills and other contamination from on-site construction activities. However, as the details of the project-specific SWPPP are not available at this time, the plan cannot be evaluated to determine whether it includes the appropriate permanent erosion control measures that would minimize erosion once the project is constructed. Therefore, impact related to erosion is considered potentially significant. **Mitigation Measure HYD-1a** is identified, under **Section 4.7, Hydrology and Water Quality**, to guide the SWPPP development process and ensure that surface-water quality impacts during construction are minimized.

With the implementation of **Mitigation Measure GEO-2a** and **Mitigation Measure HYD-1a,** project's impacts associated with erosion during construction activities would be less than significant.

Operation Impacts

As part of the Putnam Park Extension Project component, the existing stock pond and the areas of head-cut/ephemeral drainages stabilization would be fenced from livestock (as described in **Section 3.0, Project**

Description), reducing the potential for surface soil disturbance and erosion in those areas. However, stormwater runoff from the proposed trails could result in soil erosion and discharge of sediment into the creek. **Mitigation Measure GEO-2b** is identified to ensure that the geotechnical recommendations associated with mitigating surface soil erosion through BMPs and a maintenance program of the planned cut and fill slopes are properly incorporated into the SWPPP and/or a project specific operations and maintenance plan. As discussed in **Section 4.7, Hydrology and Water Quality, Mitigation Measure HYD-1d** would address this potentially significant impact, which requires that trail paths be designed to drain runoff into pervious areas not susceptible to erosion.

There are existing areas of ongoing erosion along the incised channels of Kelly Creek and along the central and stock pond drainages. These areas of existing erosion would continue to erode and could be exacerbated by fast-flowing water from upstream stormwater drainage and if not properly controlled would result in a potentially significant impact. **Mitigation Measure HYD-3** would address this impact by guiding the design of stormwater outfalls and by incorporating geomorphic erosion mitigation techniques, such as planting native vegetation, repairing overly steep head cuts, modifying grades, and repairing spillway to reduce this potential impact to a less-than-significant level.

With the implementation of **Mitigation Measure GEO-2b, Mitigation Measure HYD-1d, and Mitigation Measure HYD-3** project's impacts associated with erosion during operation would be reduced to less than significant levels.

Mitigation Measures:

GEO-2a The preconstruction design level geotechnical report, identified in **Mitigation Measure GEO--1,** shall include specific recommendations to mitigate surface erosion. The project geotechnical engineer or personnel under their direct supervision shall inspect the construction of geotechnical and/or geologic aspects of fill placement and compaction and surface drainage systems of cut and fill slopes to ensure that the geotechnical recommendations associated with mitigating surface soil erosion are properly implemented during construction. At a minimum, 1) slope inclinations shall be no steeper than 3:1 (horizontal to vertical), unless the project engineering geologist specifically indicates that a steeper slope would perform satisfactorily over the long term, 2) fill slope requirements shall include a process of overbuilding the fill on the slope and shaving it back to expose a well compacted fill surface that is less susceptible to surface erosion, and 3) the project civil engineer shall check the final grading of the site and the elevations of the surface drainage systems to confirm that the grading contractor graded the site and constructed surface improvement in accordance with the approved grading plans. If the project engineering geologist elects to use a slope design that is steeper than 3:1, a slope stability analysis shall be prepared to show that a suitable factor of safety will be achieved with the proposed design. The acceptance of the slope stability analysis shall be subject to the review and approval of the City Engineer and/or Chief Building Officials.

GEO-2b The project geotechnical engineer shall review the geotechnical aspects of the SWPPP and, where applicable, shall provide comments to the Qualified SWPP Developer (QSD) to ensure that the geotechnical recommendations associated with mitigating surface soil erosion through BMPs and a long term monitoring and maintenance program of the planned cut and fill slopes are properly incorporated into the SWPPP and/or a project specific operations and maintenance plan. As a minimum, the geotechnical aspects of the SWPPP shall include a requirement to check the condition of the slope at the beginning of the first rainy season after the completion of grading and periodic inspections until surface vegetation has been fully established on the exposed slopes.

Significance after Mitigation: Implementation of the project-specific SWPPP and **Mitigation Measure GEO-2a, Mitigation Measure GEO-2b, Mitigation Measure HYD-1a, Mitigation Measure HYD-1d**, and **Mitigation Measure HYD-3** would reduce short-term and long-term soil erosion impacts to a less than significant level.

Impact GEO-3: The proposed project would directly or indirectly cause substantial adverse effects from landslides and unstable slopes. (*Potentially Significant; Less than Significant with Mitigation*)

Landslides, earthslips, mudflows, and soil creeps are soil instabilities caused by steep slopes, shallow soil development, excess water, and lack of soil shear resistance in the area. Erosion of supporting material at the foot of constructed slopes is another major cause of sliding. There are 18 landslides, designated as landslides A through R in **Figure 4.6-3**. Landslides A, B, C, D, and G are located on the flanks of the hillsides in the southern portion of the site. Landslides E, F, and H are located on the flank of the large bedrock knob in the northwest portion of the site. The remaining landslides (Landslides I through R) are located along the banks of Kelly Creek and are the result of typical creek bank oversteepening. Of the landslides, eight are large (Landslides A through H) and the remaining (Landslides I through R) are small landslides. Two of the large landslides (Landslides E and F) are located within the limits of residential grading. Three of the large landslides (Landslides B, G, and H) and four of the small landslides (Landslides L, N, O, and R) are located within, or very close to, the limits of grading for the loop trail. The rest of the landslides are outside the grading limits of the Davidon (28-Lot) Residential Project component and the Putnam Park Extension Project component. Of the two landslides (Landslides E and F) that are within grading limits of the Davidon (28-Lot) Residential Project component, previous design-level geotechnical investigations have recommended that both landslides should be removed in conjunction with the design grading in that portion of the site. With regards to large Landslides G and H, movement of these landslides could have an adverse impact on the foundations of the proposed footbridge that would cross Kelly Creek at the western edge of the property. Other landslides (Landslides B, L, N, O, and R) could adversely impact the proposed loop trail, potentially resulting in damage to the paved surface and non-compliance with ADA requirements. With respect to the other large landslides (Landslides A, C, and D) located outside of the limits of grading, previous design-level geotechnical investigations recommended remediating Landslides A and D to reduce their potential for future movement and no remediation measures were recommended for the large Landslide C or the remaining small landslides (Landslides I, J, K, M, P, and Q).

With the exception of two ephemeral drainages on the south side of the project site, the potential for debris flow to negatively impact the project site is low. Should debris flows occur in these two ephemeral drainages, the runout (distance of debris flow) is expected to be short and would not affect any of the proposed project's components.

No evidence has been identified to indicate that adverse bedding conditions exist at the locations of the proposed cut slopes. However, due to folding and shearing of the bedrock, localized areas of adverse bedrock structure or other zones of geologic weakness could be exposed during grading of cut slopes. As such, any adverse bedding which is uncovered during grading of cut slopes would increase the potential for landslides, which represents a potentially significant impact. In addition, cut and fill slopes, if not properly designed and constructed could also result in slope instability, which would also represent a potentially significant impact.

Accordingly, the proposed project could expose people, or structures to potential adverse effects from destabilization of existing landslides, cut and fill slopes, or areas of weak bedrock that are exposed during grading of cut slopes. This would be a potentially significant impact. **Mitigation Measures GEO-1a** and **GEO-1b**, identified above, would require the preparation and implementation of the recommendations of an updated geotechnical report that would address project impact associated with landslides and cut and fill slopes. In addition, **Mitigation Measures GEO-3a** and **GEO-3b** are set forth below, which require specific analysis and monitoring of measures to address the impacts related to the landslides present at the project site as well as cut and fill slopes. With implementation of **Mitigation Measures GEO-3a** and **GEO-3b,** the impacts from landslides and slope instability would be reduced to less than significant.

Mitigation Measures:

GEO-3a Landslide Remediation

Where landslide mitigation is required under **Mitigation Measure GEO--1a**, the project geotechnical engineer or personnel under their direct supervision shall inspect the excavation and grading associated with the landslide removal and/or stabilization work to ensure that the geotechnical recommendations associated with mitigating landslide hazards are properly implemented during construction. As a minimum, the project geotechnical engineer shall provide project specific design-level recommendations for the removal of Landslides E and F, which are located within the Davidon (28-Lot) Residential Project component. The recommendations shall include, but shall not be limited to, 1) a cross-section(s) showing the limits of landslide debris, depths of planned excavation, planned toe key and benches, and configuration of planned engineered fill, 2) design criteria for surface and subsurface drainage systems, including the locations of subdrain clean-outs and drain outlets, 3) fill placement and compaction requirements, including recommendations for overbuilding, then shaving back the fill to expose a well-compacted slope surface, and 4) geologic/geotechnical observation and testing requirements during site grading activities. Where cut or fill slopes over 30 feet in height are planned, intermediate surface benches shall be incorporated into the slope design as described below, unless the project geotechnical engineer provides alternative project specific recommendations for the design of surface benches on graded slopes. The benches shall be spaced no more than 25 feet vertically on the slope. The benches shall be a minimum of 8 feet wide and include a concrete lined V-ditch to intercept surface water runoff.

The project geotechnical engineer shall evaluate other landslides (Landslides B, G, H, L, N. O, and R), which have a potential to adversely impact the foundations of footbridges and/or the loop trail pavement. As a minimum, the project geotechnical engineer shall establish an inspection and maintenance program to ensure that any damage to the planned footbridge foundations and loop trail improvements due to landslide movements are identified and repaired.

GEO-3b Cut and Fill Slopes

The project geotechnical engineer, project engineering geologist, or personnel under their direct supervision shall inspect all cut slopes focusing on evidence of potential instability. If areas of adverse bedrock structure are encountered, then the project geotechnical engineer and/or project engineering geologist shall develop remedial measures for these slopes and the grading contractor shall implement the remedial activity, under the direction and supervision of project geotechnical engineer and/or engineering geologist, and acceptable by the City engineer.

Significance after Mitigation: The implementation of **Mitigation Measure GEO-1a**, which requires all recommendations of the project-specific Geotechnical Reports be implemented, and **Mitigation Measures GEO-3a** and **GEO-3b** would reduce the significant impact resulting from existing landslides and slope instability to a less than significant level.

Impact GEO-4: **The proposed project would be located on a geologic unit that could become unstable as a result of the project, and on expansive soils creating direct or indirect risk to life or property. (*Potentially Significant; Less than Significant with Mitigation*)**

As described in **Section 4.6.2.3, Project Site Geology**, the project site contains bedrock shear zone, areas with artificial fill, areas in the lower portion of the site and some areas where soils are noted to be moderately expansive. The potential for these existing site conditions to affect the proposed project is evaluated below.

Bedrock Shear

According to bedrock shear assessment by Berlogar, the project site contains three potential bedrock shear zones (**Figure 4.6-3)** that represent ancient shearing within the Franciscan Complex that occurred during its emplacement onto the North American continent, of which one would intersect the proposed development area. Because of the age of the shearing, Berlogar concluded that the risk of future surface displacement along the shear zones is very low. On September 10, 2014, C2 conducted a site reconnaissance and concluded that topographic evidence of the three potential bedrock shear zones, as previously identified by Berlogar, was not visible at the site. Based on the above, the risk of surface displacement as a result of bedrock shear is considered low and the risk of adverse effects to people or structures is also low.

Settlement

As noted earlier, artificial fill was encountered in four areas on the site: beneath and around the existing buildings, the stock pond berm, downslope side of Windsor Drive, and in low areas along D Street. Portions of the Putnam Park Extension Project component would lie within mapped areas of artificial fill. The presence of artificial fill could result in settlement of the proposed structures and site improvements. Accordingly, the proposed project could expose people and structures to potential adverse effects from settlement of the artificial fill layer and this would be a potentially significant impact. Mitigation measures are set forth below to mitigate this impact.

Berlogar indicated for the previously proposed development at the project site that seventy percent of the estimated total settlement of the fill would occur during mass grading. Therefore, the maximum post-grading settlement was predicted to be less than 1 inch. The maximum fill slope height planned for the previous project was approximately 30 feet as measured from top of slope to toe of slope. The maximum depth as measured vertically at the top of fill slope was approximately 15 feet. Settlement of 1 inch measured vertically over the 15 feet fill depth was 0.6 percent of the fill depth (Berlogar 2015). This amount of settlement for the previously proposed development was found not to significantly affect structures. Based on the current grading plan for the Davidon (28-Lot) Residential Project component, this amount of settlement for the proposed project is expected to be similar to the amount of settlement for the previously proposed development. As such, the amount of settlement of compacted fill for the proposed project would not significantly affect the planned structures. However, as previously discussed, earthquake-induced ground shaking can also cause movement of fill slopes and this potential hazard would be reduced to a less than significant level by implementing **Mitigation Measures GEO-1a and GEO-1b**, as described under **Impact GEO-1a** above.

Fill and bedrock materials have different expansion and settlement potentials. Therefore, structures and foundations constructed across the transition line between cut and fill could experience significant differential expansion and/or settlement on the project site. Cracked or damaged foundations could pose a danger to the structures or future occupants on the project site, resulting in a potentially significant impact. **Mitigation Measures GEO-4a** and **GEO-4b** are set forth below to address potentially significant impacts associated with bedrock shear zones and settlement to a less than significant level.

Expansive Soils

Soils located on the project site were identified as moderately expansive. However, the actual amount of swell ultimately depends on the total thickness of fill, material in the fill and in-place moisture content and density. According to the geotechnical report previously prepared for the project site, the maximum swell (expansion) that would occur would be insignificant. However, **Mitigation Measures GEO-4a and GEO-4b** would further reduce the impact associated with the potential soil swelling.

Mitigation Measures:

GEO-4a A preconstruction geotechnical report shall be prepared for the Davidon (28-Lot) Residential Project component and the Putnam Park Extension Project component, as previously discussed in **Mitigation Measure GEO-1a**. Specific to site geology, bedrock shear, settlement, and expansive soil, the project geotechnical engineer shall confirm that the conclusions and all applicable recommendations previously presented in the 2015 design-level geotechnical report are still applicable for the design and construction of the Davidon (28-Lot) Residential Project component and the Putnam Park Extension Project component.

GEO-4b As a minimum, cut lots that have subgrades exposing bedrock shall be over-excavated and recompacted to a minimum depth of three feet, and backfilled as described below, unless the project geotechnical engineer provides project specific alternative recommendations to mitigate the potential for differential settlement associated with variable settlement and swell behavior between bedrock and compacted engineered fill. The exposed surface shall be scarified to a depth of about 12 inches, moisture-conditioned to not less than three percent over optimum moisture content and compacted to at least 90 percent relative compaction.

Excavation deeper than the above recommendations may be required to expose competent material under conditions where soft or saturated soil is encountered. The excavation depth will be determined in the field as part of the geotechnical analysis required under **Mitigation Measure GEO-1a**.

Project site grades shall be designed to slope away from the proposed structures, and water from roof drains shall be directed to suitable outlets. Fill slopes comprised of low to moderately expansive soil shall be evaluated for stability (see **Mitigation Measures GEO-1a and GEO-3a**). Additional mitigations to reduce the impact of expansive soils on the proposed residences shall include:

a. Moisture conditioning and re-compacting low to moderately expansive soil.

b. Placing non-expansive fill beneath the homes and rigid surface improvements.

c. Designing foundations to resist or tolerate differential movement of moderately expansive soil.

Significance after Mitigation: With the implementation of **Mitigation Measure GEO-4a**, which requires all applicable recommendations of the 2015 revised geotechnical investigation and any associated addenda report be incorporated into the preconstruction geotechnical investigation report required under **Mitigation Measure GEO-1a**, and implementation of **Mitigation Measure GEO-4b**, which reduce the potential for differential settlement of residential building that underlain the transition zones between engineered fill and shallow bedrock, the potential impact associated with bedrock shear zones and settlement would be reduced to a less than significant level.

Impact GEO-5: **The proposed project would not have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. (*No Impact*)**

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.

Mitigation Measures: No mitigation measures are required.

Impact GEO-6: **The proposed project could directly or indirectly destroy a unique paleontological resource or site or unique geologic features. (*Potentially Significant; Less than Significant with Mitigation*)**

Paleontological resources are mineralized or fossilized remains of prehistoric plants and animals as well as mineralized impressions or trace fossils that provide indirect evidence of the form and activity of ancient organisms. Geologic units on the project site include the Franciscan Formation, which is the oldest known sedimentary unit in the project area and consists of fossil-bearing marine sediments. Therefore, it is possible that undiscovered resources could be present. Without proper care during the grading and excavation phases on the proposed project, unknown paleontological resources could be damaged or destroyed. Project impacts to unknown paleontological resources would be potentially significant. **Mitigation Measures GEO-6a through GEO-6c,** set forth below, would reduce potential impact to paleontological resources to a less than significant level.

Mitigation Measures:

GEO-6a The project Applicants shall identify a qualified paleontologist prior to any demolition, excavation, or construction. The City shall approve the selected project paleontologist prior to issuance of the demolition permit. The paleontologist shall attend the pre-grading meeting to inform the contractor(s) how to recognize paleontological resources in the soil during grading activities. The prime construction contractor and any subcontractor(s) shall be informed on the legal and/or regulatory implications of knowingly destroying paleontological resources or removing paleontological resources from the project site.

GEO-6b If paleontological resources are encountered during the course of site development activities, work in that area shall be halted and the selected project paleontologist, as outlined in **Mitigation Measure GEO-6a** above, shall be notified of the find to determine the significance of the find and to recommend appropriate mitigation measures. Recommendations shall be presented for City approval in a Treatment and Recovery Plan. The selected project paleontologist shall have the authority to temporarily divert or redirect grading to allow time to evaluate any exposed fossil material.

GEO-6c If the selected project paleontologist determines that the resource is significant, then any scientifically significant specimens shall be properly collected by the project paleontologist. During collecting activities, contextual stratigraphic data shall also be collected. The data will include lithologic descriptions, photographs, measured stratigraphic sections, and field notes.

Scientifically significant specimens shall be prepared to the point of identification (not exhibition), stabilized, identified, and offered for curation to a suitable repository that has a retrievable storage system, such as the University of California, Berkeley, Museum of Paleontology.

The selected project paleontologist shall prepare a final report at the end of the earth-moving activities. The report shall include an itemized inventory of recovered fossils and appropriate stratigraphic and locality data. The project paleontologist shall send one copy of the report to the City of Petaluma Community Development Department; another copy should accompany any fossils, along with field logs and photographs, to the designated repository.

Significance after Mitigation: Implementation of **Mitigation Measures GEO-6a** through **GEO-6c** would reduce potential impacts to paleontological resources to a less than significant level.

4.6.4.4 Regional Park Trail Impacts and Mitigation Measures

Environmental Setting

The topography of the regional park trail alignment is similar to that of the proposed project with moderately steep slopes, also situated along the southwestern margin of the Petaluma River Valley. Drainage features along the proposed trail alignment include the Kelly Creek corridor, several ephemeral tributary drainages, and scattered seeps which are generally associated with the ephemeral drainages.

To the west of the project site and within Helen Putman Regional Park, the south-facing slopes on the north side of Kelly Creek were observed to be recently disturbed, having no visible vegetative cover, suggesting either recent shallow landsliding or erosion. West of Helen Putnam Regional Park, moderate-size fans from possible debris flows were observed emanating from north-facing drainage area of the current development along Cambridge Lane (Haley & Aldrich 2014).

Impacts and Mitigation Measures

RPT Impact GEO-1: The implementation of the proposed regional park trail project could directly or indirectly cause substantial adverse effects related to landslides and cut slopes; however, it would not result in substantial adverse effects related fault rupture, seismic ground shaking, seismic-related ground failure, or existing geologic conditions. Regional park trail project implementation would also not result in substantial soil erosion or have soils incapable of adequately supporting the use of septic tanks. (*Potentially Significant: Less than Significant with Mitigation*)

Fault Rupture and Seismic–Related Ground Failure

The proposed regional park trail is not located within an Alquist-Priolo Fault Zone and there are no known active, potentially active, or inactive faults that transect the proposed regional park trail alignment. The potential for fault rupture is considered to be low and the impact would be less than significant. The potential for liquefaction and related ground failure to occur along the regional park trail alignment is low. The proposed regional park trail project would not expose occupied structures to hazards from seismic activity from Rodgers Creek fault, since the regional park trail project would not construct any structures or buildings.

Erosion

Exposed soil in the construction area would be seeded and a number of erosion control features such as a rock rip rap area, drainage lenses, and armored dip would be constructed along the regional park trail to control erosion at the locations where the regional park trail would cross or be close to drainages. Additionally, areas disturbed during construction would be hydroseeded with native grasses to help reestablish the vegetation and avoid erosion. Therefore, erosion impacts would be less than significant.

Landslides

Although the proposed regional park trail alignment is in an area with known landslides, the project would not contain permanent residences or any structures. However, if the regional park trail becomes damaged and inaccessible to pedestrian traffic, the risk of injury would persist unless the regional park trail is closed to the public and/or until the regional park trail is repaired and accessibility is restored. **Mitigation Measure RPT-GEO-1** set forth below requires periodic inspection and repair of the regional park trail to reduce impact associated with landslide movement. With implementation of **Mitigation Measure RPT GEO-1**, the potential impacts associated with regional park trail damage from earthquake-induced landslides would be less than significant.

Unstable Geologic Unit

Due to close proximity, the proposed regional park trail site would have similar characteristics of the Kelly Creek trail alignment and would exhibit a very low risk of surface displacement along shear zones (Haley & Aldrich 2014). If shear zones of soft or saturated soil are encountered during site preparation, the applicant's engineering geologist would evaluate these conditions and confirm that the risk of adverse effects to the proposed regional park trail alignment is low. Because no structures are proposed at the regional park trail site, this would be a less than significant impact.

There would be no mass grading for the proposed regional park trail, thus impacts from settlement would be less than significant. Moderately expansive earth materials are known to be present within the proposed regional park trail alignment. However, moisture-conditioning and re-compacting these materials would be adequate to address expansive soils. Besides no structures would be built on the regional park trail site that could be affected by expansive soils.

Septic Tanks

There would be no septic tank use along the regional park trail alignment, therefore there would be no impacts with regards to septic tanks.

Mitigation Measure:

RPT GEO-1 To reduce the potential risks of regional park trail damage as a result of earthquake-induced landslide movement, the project geotechnical engineer shall develop and submit to the Sonoma County a long-term maintenance plan, including criteria for inspecting and maintaining the planned regional park trail improvements.

Significance after Mitigation: Implementation of **Mitigation Measure RPT GEO-1** would reduce the potential impacts associated with regional park trail damage from earthquake-induced landslides to a less than significant level.

RPT Impact GEO-2: The proposed regional park trail could directly or indirectly destroy a unique paleontological resource or site or unique geologic features. (*Potentially Significant; Less than Significant with Mitigation*)

There would be no mass grading for the proposed regional park trail. In addition, the regional park trail would not require deep excavation as no structures would be built. Excavation for the regional park trail would be limited to the removal of the topsoil for stabilization purposes. Therefore, the potential to encounter paleontological resources during the construction of the proposed regional park trail is low. Although the potential to encounter paleontological resources during construction is low, **Mitigation Measure RPT GEO-2** shall be implemented to ensure that impacts to paleontological resources would be less than significant.

Mitigation Measure:

RPT GEO-2 If paleontological resources are encountered anywhere in the project site, all work should be halted in the vicinity and a paleontologist consulted immediately.

Significance after Mitigation: Implementation of **Mitigation Measure RPT GEO-2** would reduce the potential impacts associated with regional park trail impacts on paleontological resources to a less than significant level.

4.6.4.5 Cumulative Impacts and Mitigation Measures

The geographical cumulative context for the evaluation of cumulative impacts related to geology and soils includes the immediate vicinity of the project site and regional park trail alignment. This study area is defined based on the fact that a number of geology and soils-related impacts do not cumulate and tend to be site-specific.

Cumulative Impact GEO-1: **The proposed Scott Ranch project and the regional park trail project, in conjunction with other past, present and reasonably foreseeable future development, would not result in significant cumulative geology and soils impacts. (*Less than Significant*)**

Implementation of the proposed Scott Ranch project and the regional park trail project, in conjunction with the projects listed in **Table 4.0-1, Approved and Pending Projects**, would result in the continued development within the project area. Geotechnical hazards are typically site-specific and there is little, if any, cumulative relationship between development of the proposed project and the related projects.

Furthermore, there are no related projects bordering the proposed project that could create a cumulative impact. A few homeowners that live on Oxford Court within the adjacent Victoria Subdivision have expressed concern that the proposed project could result in slope stability impacts to homes on Oxford Court. However, provided the mitigation measures listed above are adequately implemented, monitored, and enforced, the proposed project would not result in any significant geology and soils impacts to off-site properties. Similar to the proposed project, development of other approved and pending projects in the City of Petaluma would be subject to uniform site development and construction standards that are designed to protect public safety. As discussed above, the proposed regional park trail project would not create any significant impacts and construction of other trails or improvements at Helen Putnam Regional Park, if it was to occur would be required to comply with construction standards and therefore would not considerably contribute to a cumulative impact associated with geology and soils. Therefore, cumulative geology and soil impacts would be less than significant.

Mitigation Measures: No mitigation measures are required.

4.6.5 REFERENCES

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