5.5 GEOLOGY AND SOILS

INTRODUCTION

This section describes effects on geology and soils that would be caused by implementation of the Project. Information from the *Geotechnical Feasibility Study* prepared for the Project site in July 2018 (**Appendix F**)[1] was used to inform this section of the Draft Environmental Impact Report (EIR). The *Geotechnical Feasibility Study* evaluates the background geologic setting in the geologic study area and identifies potential geotechnical constraints that may impact implementation of the Project.

Scoping Issues Addressed

No public or agency comments related to geology or soils were received during the public scoping period for this Draft EIR.

REGULATORY SETTING

Federal

National Earthquake Hazards Reduction Program

The National Earthquake Hazards Reduction Program was established by the US Congress when it passed the Earthquake Hazards Reduction Act of 1977, Public Law 95–124. In establishing the National Earthquake Hazards Reduction Program, Congress recognized that earthquake-related losses could be reduced through improved design and construction methods and practices, land use controls and redevelopment, prediction techniques and early warning systems, coordinated emergency preparedness plans, and public education and involvement programs.

Several key federal agencies contribute to earthquake mitigation efforts. Implementation of National Earthquake Hazards Reduction Program priorities is accomplished primarily through original research, publications, and recommendations to assist and guide state, regional, and local agencies in the development of plans and policies to promote safety and emergency planning.

State

California Code of Regulations

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

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes;

[1] Geocon Consultants, Inc. 2018. *Geotechincal Feasibility Study* – Dublin Boulevard Extension.

- Building standards that have been adopted and adapted from the national model code standards to meet California conditions; and
- Building standards, authorized by the California legislature, that constitute extensive additions not covered by the model codes that have been adopted to address particular California concerns

Alquist-Priolo Earthquake Faulting Act

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

Seismic Hazards Mapping Act

The Seismic Hazard Mapping Act was adopted by the California Legislature in 1990 to reduce public health and safety threats and to minimize property damage caused by earthquakes. The act directs the California Geological Survey to identify and map areas prone to earthquake hazards, such as liquefaction, earthquake induced landslides, and ground shaking. The act requires site-specific geotechnical investigations to identify potential seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy within seismic hazard zones.

Local

City of Dublin

City of Dublin General Plan

The Dublin General Plan, Chapter 8, Environmental Resources Management: Seismic Safety & Safety Element requires that safety measures are implemented to protect the community from any unreasonable risk associated with the effects of seismically induced ground rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction and other seismic and geologic hazards; flooding; and wildland and urban fires.[2] Notably, Implementing Policy 8.2.1.B.1 identifies the following structural and grading requirements:

a) All structures shall be designed to the standards delineated in the Dublin Building Code and Dublin's Grading Ordinance. A "design earthquake" shall be established by an engineering geologist for each structure for which ground shaking is a significant design factor.

[2] City of Dublin, 2017. City of Dublin General Plan. Available: https://www.dublin.ca.gov/DocumentCenter/View/10560/Chapter-12. Accessed: June 5, 2018.

b) Generally, facilities should not be built astride potential rupture zones, although certain low-risk facilities may be considered. Critical facilities that must cross a fault, such as oil, gas, and water lines, shall be designed to accommodate the maximum expected offset from fault rupture. Site specific evaluations shall determine the maximum credible offset.

City of Dublin Municipal Code

The Dublin Municipal Code is a compilation of the applicable ordinances of a municipality, and sets forth Dublin's laws. Chapter 7.16, Grading Regulations, ensures the intended use of a graded site is consistent with the General Plan, any adopted specific plans, and applicable city ordinances, including the zoning ordinance.[3]

Eastern Dublin Specific Plan

Eastern Dublin Specific Plan (EDSP) Section 6.4.1, Geology, Soils, and Grading discusses slope stability, erosion, and relevant policies. The EDSP describes the north-eastern portion of the specific plan study area as particularly susceptible to slope instability and rates potential damage to future development improvements as high unless mitigated. The policies included in the EDSP define the acceptable slope percentages that structures may be built upon and defines at what slope percentages limited grading and repair of landslides is permitted. It also requires new development to provide effective control of soil erosion during construction activities and when altering site drainage characteristics.

Alameda County

Alameda County Safety Element

The Alameda County Safety Element provides regulatory guidance to resolve development issues that arise from known or previously unknown hazards.[4] Chapter 1.2, Seismic/Geologic Hazards, includes descriptive information, analysis and policies pertaining to geologic, seismic, flood and fire hazards within the County. The focus of the Safety Element is to minimize human injury, loss of life, property damage, and economic and social dislocation due to natural and human-made hazards.

Alameda County General Ordinance Code

The Alameda County General Ordinance Code, Chapter 15.36, Grading, Erosion and Sediment Control, regulates grading on private property within unincorporated areas of the county. [5] This Code is intended to:

- Safeguard individuals, property, and public welfare;
- Avoid pollution of watercourses with nutrients, sediments, or other earthen materials generated on or caused by surface runoff on or across the permit area

[3] City of Dublin, 2017. Dublin Municipal Code, Ch. 7.16 Grading Regulations. Available: https://www.codepublishing.com/CA/Dublin/?Dublin09/Dublin0912.html&?f. Accessed: June 5, 2018.
[4] Alameda County Community Development Agency. 2013. Alameda County Safety Element. Amended 2014.
[5] Alameda County Community Development Agency. 2013. Alameda County Safety Element. Amended 2014.

- Ensure that the intended use of a graded site is consistent with the County General Plan, any adopted specific plans, and applicable county ordinances including the zoning ordinance.

Alameda County General Plan, East County Area Plan

The East County Area Plan includes goals and policies pertaining to soil and slope stability, seismicity, and geologic hazards. The following goals and policies apply to the Project:

Goal: To minimize the risks to lives and property due to soil and slope instability hazards.

Policy 307: The County shall encourage Zone 7, cities, and agricultural groundwater users to limit the withdrawal of groundwater in order to minimize the potential for land subsidence.

Policy 308: The County shall not permit development within any area outside the Urban Growth Boundary exceeding 25 percent slopes to minimize hazards associated with slope instability.

Goal: To minimize the risks to lives and property due to seismic and geologic hazards.

Policy 309: The County shall not approve new development in areas with potential for seismic and geologic hazards unless the County can determine that feasible measures will be implemented to reduce the potential risk to acceptable levels, based on site-specific analysis. The County shall review new development proposals in terms of the risk caused by seismic and geologic activity.

Policy 310: The County, prior to approving new development, shall evaluate the degree to which the development could result in loss of lives or property, both within the development and beyond its boundaries, in the event of a natural disaster.

Policy 312: The County shall ensure that major transportation facilities and pipelines are designed, to the extent feasible, to avoid or minimize crossings of active fault traces and to accommodate fault displacement without major damage that could result in long-term disruption of service.

City of Livermore

City of Livermore General Plan

Livermore's General Plan, Public Safety Element, provides information about risks in Livermore due to natural and created hazards.[6] Its policies are designed to protect the community as much as possible from seismic, flood, geologic and wildfire hazards. This element establishes mechanisms to reduce death, injuries, damage to property and to address the negative results from public safety hazards like flooding, fires and seismic events. Said mechanisms are highlighted in the policies and ordinances that are required of development. Policy Objective PS-1.1 of the Livermore General

[6] City of Livermore. 2004. City of Livermore General Plan 2003-2025. Amended December 2014.

Plan's Public Safety element includes policies for new land development in order to prevent the creation of new geologic hazards. Policies under this objective that are relevant to the Project are outlined below

Policy P1. Urban development within earthquake fault zones and areas of high landslide susceptibility, shown in Figure 10-3, shall be conditioned upon the preparation of site-specific geotechnical investigations.

Policy P2. The City shall rely on the most current and comprehensive geologic hazard mapping available to assist in the evaluation of potential seismic hazards associated with proposed new development. Projects proposed in areas identified as being subject to moderate or high geologic hazard shall be required to conduct site-specific geotechnical investigation.

Policy P3. No structure proposed for human occupancy shall be placed across the trace of any active or potentially active fault within the Planning Area. The Greenville fault and Las Positas fault shall be assumed active, and the Livermore fault shall be assumed potentially active, unless and until proven otherwise.

Policy P4. Geologic and engineering studies shall be required for all proposed building projects, per State law, and all critical facilities (schools, hospitals, fire and police stations) within the City so that these facilities can be constructed in a manner that mitigates site-specific geotechnical challenges and will minimize the risk to the public from seismic hazards.

Policy P5. Construction shall be prohibited in areas with severe erosion (slopes over 10 percent), as mapped by the USDA's Natural Resources Conservation Service, unless it can be clearly demonstrated through geotechnical engineering analysis that the project will not contribute to increased erosion, sedimentation or runoff.

Policy P6. Development shall be prohibited in areas susceptible to slope failure (defined as landslide susceptibility areas 3 and 4 on Figure 10-3 or current hazard mapping), per State law, unless site-specific geotechnical investigation indicates that landslide hazards can be effectively mitigated.

Policy P7. Prohibit development on expansive soils which are subject to a high probability of sliding; developments proposed below areas of expansive soils in foothill areas shall be conditioned to avoid damage from potential slide areas.

EXISTING CONDITIONS

Geologic and seismic information for this section is provided in the *Geotechnical Feasibility Study* prepared for the Project (see **Appendix F** of this Draft EIR). The *Geotechnical Feasibility Study* includes relevant information published in geologic maps, aerial photographs, Project plans, in-house documents, and other literature pertaining to faulting hazards. The *Geotechnical Feasibility Study* also included a field reconnaissance to observe the existing conditions at the site. The *Geotechnical Feasibility Study includes* evaluation of geologic features including topography, hydrology, subsurface soils, geologic hazards, and seismic hazards. The geologic study area includes the Project site and areas in its immediate vicinity that could contain geological features or hazards that influence the Project site.

Geologic Setting

The study area is located in the Livermore-Amador Valley, a valley in eastern Alameda County bounded by the foothills of the Diablo Range on the north, east, and south. This range is part of the northwest-trending Coast Ranges Geomorphic Province of mountain ranges and valleys that trend northwest, parallel to the San Andreas Fault. The ranges have been intensely uplifted, folded, and faulted.[7]

The diverse geologic conditions underlying the Livermore-Amador Valley and greater San Francisco Bay Area (Bay Area) are largely defined by the network of major active faults that occur within the region. The San Andreas Fault System is one of the most prominent geologic features in the region; it includes several major fault zones (San Andreas, Hayward, and Calaveras) as well as smaller active and potentially active faults.

The geologic units which comprise the study area consist of Quaternary alluvium, a mixture of loose rocks and loosely consolidated deposits composed of sandstone, shale, and gravel (also known as Livermore Gravel).[8,9] The Quaternary period refers to the current period of geologic time, which began 1.8 million years ago.[10]

The climate in Alameda County is characterized by warm, dry summers and mild, wet winters. Average annual precipitation is 14.18 inches. Cottonwood Creek, the only waterway within the study area, crosses the Project site flowing north-to-southwest direction and discharges into Arroyo Mocho just south of Interstate 580 (I-580). Historic high groundwater levels in the study area range from 10 to 39 feet below ground level. Shallower groundwater levels may

---

[7] Bay Area Rapid Transit Agency, 2017. BART to Livermore Extension Project EIR, Chapter G: Geology, Soils, Seismicity, Mineral, and Paleontological Resources. Available: http://www.bart.gov/sites/default/files/docs/BLVX%20DEIR_Vol%201_0_Cover-TOC.pdf. Accessed November 13, 2018.

[8] Bay Area Rapid Transit Agency, 2017.

[9] USGS. 2018b. California Geologic Map Data. Available: https://mrdata.usgs.gov/geology/state/map-us.html#home. Accessed: June 5, 2018.

[10] USGS. 2006. What is the Quaternary? Available: https://geomaps.wr.usgs.gov/sfgeo/quaternary/stories/what_is.html. Accessed: June 4, 2018.

be present throughout the Project site, particularly at the Cottonwood Creek crossing. Refer to **Appendix F** for additional detailed information about climate, hydrology, and groundwater throughout the study area.

The Project site slopes slightly downward toward the south and features elevations ranging from approximately 370 to 415 feet above mean sea level (AMSL). No natural landmarks or other major geologic features, such as scenic rock outcroppings, occur within the study area.

The *Water Quality Report*[11] includes a Natural Resources Conservation Service (NRCS) Web Soil Survey to identify soils underlying the Project site. The predominant soils within Project site are Diablo Clay[12] and Linne Clay Loam[13]. Soils beneath Cottonwood Creek are Clear Lake Clay[14]. All three soil types have a slow infiltration rate and high runoff potential when thoroughly wet.[15]

Geologic Hazards

Geologic hazards include soil erosion, subsidence, expansive soils, corrosive soils, landslides, and volcanic hazards. These hazards are explained below.

Soil Erosion

Erosion is the detachment and movement of soil material by natural processes, such as wind and water. During a rain event, the rate of soil erosion is dependent on the slope, vegetative cover, and soil properties. Texture, structure, organic matter content, and permeability are specific soil properties that influence the rate of soil erosion. The NRCS Web Soil Survey conducted for the Project indicates soils within the study area have low erosion potential.

Subsidence

Subsidence is the settlement of organic soils and saturated mineral soils of low density following drainage of water out of the soils. According to the U.S. Geological Survey (USGS), the study area is not susceptible to subsidence.[16]

Expansive Soils

Expansive soils have the potential to shrink or swell depending on the moisture content of the soil. This potential for shrinking and swelling is dictated partially by the amount and type of clay

[11] BKF, 2018. Water Quality Report - Dublin Boulevard-North Canyons Parkway Extension Project.
[12] Diablo clay is a soil included in the Diablo series of soils, which generally consist of deep to moderately deep, well-drained, clayey soils on rolling to very steep uplands north and west of the Livermore Valley.
[13] Linne Clay Loam is a soil included in the Linne series of soils, which consist of well-drained, shallow to deep, calcareous soils on rolling to very steep uplands north and east of the Livermore Valley. Linne soils are formed from soft, calcareous, interbedded shale and fine-grained sandstone.
[14] Clear Lake Clay is a soil from the Clear Lake Series. Soils in the Clear Lake series consist of deep, moderately well-drained and imperfectly drained, clayey soils in nearly level basins in the Livermore and Amador Valleys.
[15] The infiltration rate is the velocity or speed at which water enters into the soil. It is usually measured by the depth of the water layer that can enter the soil in one hour.
[16] USGS. 2018a. Areas of Land Subsidence in California. Available: https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html. Accessed: June 4, 2018.

materials present and is measured by finding the percent change of the soil volume. Highly expansive soils present a significant risk to buildings and infrastructure. Expansive soils are common in the Livermore Valley, particularly in soils with high clay content, and may be present at the Project site. As mentioned above, clayey soils such as Diablo Clay, Linne Clay Loam, and Clear Lake Clay were identified on the Project site, and these soils could exhibit expansive properties.[17] Therefore expansive soils have the potential to be present on the Project site.

Corrosive Soils

Various properties of soil, such as moisture content, texture, acidity, electrical conductivity, and sulfate or sodium content can cause soils to corrode uncoated subsurface steel and concrete structures. Over time, the corrosion could weaken the materials, resulting in fatigue and eventual failure of steel or concrete materials. Soil corrosivity is not a visually discernable characteristic and soil sampling and testing to evaluate soil corrosion parameters have not been performed. Though soil sampling to test for corrosive soils has not been performed, clayey soils, such as the soils found on the Project site, are considered to have a high corrosion potential. Therefore, the Project site has the potential for corrosive soils.

Landslides

Landslides are classified as either rapid movement of large amounts of soil or imperceptibly slow movement of soils on slopes. Areas with landslide potential generally have steeper slopes than the soil or rock material forming the slope can support. Topographic variability within the study area suggests history of landslide activity. Landslide susceptibility is prevalent in the hills north of the study area, outside of the Project site. The southern portion of the study area (bordering I-580) is relatively flat with little to no susceptibility to landslides. However, according to the Landslide Inventory Map, there is evidence of previous landslides north of the Project site.[18]

Tsunamis and Seiches

Tsunamis are large sea waves caused by submarine earthquakes, landslides, or volcanic eruptions. A seiche is defined as a wave oscillation on the surface of water in an enclosed basin, such as a lake, which can occur as a result of seismic activity. There is no potential for tsunamis and/or seiches to occur within the study area due to the significant distance between the Project site and the San Francisco Bay (18 miles). Further, the Project site is 370 to 415 feet AMSL, and would therefore have reduced potential to be at risk of tsunamis and seiches, as water would need to climb a significant elevation over a significant distance to reach the Project. No other water bodies near the Project site are large enough to experience a seiche event. These features are considered either too distant or small to create a hazard at the Project site, and are not discussed further in this Draft EIR.

[17] San Francisco Bay Area Rapid Transit District. 2018. BART to Livermore Extension Project Environmental Impact Report.
[18] USGS. 2010. Landslide Inventory Map of Livermore Quadrangle Alameda and Contra Costa Counties, California. Available: ftp://ftp.consrv.ca.gov/pub/dmg/pubs/lsim/LSIM_Livermore.pdf. Accessed: June 4, 2018.

Volcanic Hazards

The closest volcano to the study area is Clear Lake Volcanic Field, located approximately 132 miles away from the Project. This feature is considered too distant to create a hazard at the Project site and therefore is not discussed further within this Draft EIR.

Seismic Hazards

Geologists and seismologists recognize the Bay Area as one of the most seismically-active regions in the United States. The significant earthquakes that occur in the Bay Area are typically associated with movements along well-defined active fault zones that generally trend in a northwesterly direction. **Table 5.5-1** presents approximate distances from the Project site to nearby active faults. Faults in these table and many others in the Bay Area are sources of potential ground motion. However, earthquakes that might occur on other faults within northern California area are also potential generators of significant ground motion and could cause ground shaking at the site.

The site is not located within an Alquist-Priolo Earthquake Fault Zone. A field reconnaissance and review of Caltrans' statewide fault database conducted in 2018 for the *Geotechnical Feasibility Study* did not reveal evidence of active faulting through or near the site.

The Association of Bay Area Governments identifies the Mount Diablo Thrust Fault as the most active thrust fault in the Bay Area.[19] The Caltrans fault database dates the Mt. Diablo Thrust Fault as Late Quaternary age (0.5-1.0 million years) and places the fault approximately 1.75 miles north of the Project site. However, the *Geotechnical Feasibility Study* states that other geologic references place the inferred location of Mt. Diablo Thrust Fault within the Project site, west of Cottonwood Creek.

According to a study of earthquake probabilities for the San Francisco Bay Region conducted by the USGS Working Group of California Earthquake Probabilities, the Mount Diablo Thrust Fault is capable of generating a magnitude 6.7 or greater earthquake with an estimated 3 percent probability of occurrence over the next 30 years. Buried thrust faults typically have fault planes that extend under a wide area and are extremely difficult to identify and characterize. Consequently, regulations such as the Alquist-Priolo Earthquake Fault Zoning Act have not been applied to the Mount Diablo Thrust Fault.[20]

[19] A thrust fault is a break in the Earth's crust, across which older rocks are pushed above younger rocks. It is a dip-slip fault in which the upper block, above the fault plane, moves up and over the lower block. This type of faulting is common in areas of compression, such as regions where one plate is being subducted under another. When the dip angle is shallow, a reverse fault is often described as a thrust fault. (USGS)
[20] Bay Area Rapid Transit Agency, 2017.

Table 5.5-1 Regional Fault Summary

Fault Name	Approximate Distance to Nearest Portion of Project Site (miles)	Maximum Earthquake Magnitude, M_w	Fault Age
Mt. Diablo Thrust	1 ¾	6.7	Late Quaternary (0.5-1.0 million years ago)
Pleasanton	3 ¾	6.6	Holocene (within the last 11,000 years)
Las Positas	5 ½	6.4	Holocene (within the last 11,000 years)
Calaveras (North)	5 ½	6.9	Holocene (within the last 11,000 years)

Source: BKF, 2018

Surface Fault Rupture

During an earthquake, surface rupture occurs when the ground surface is broken as a result of fault movement. Surface rupture is an offset of the ground surface and is mostly found to occur along active fault traces. As noted above, an inferred location of the Mt. Diablo Thrust crosses the Project site near Cottonwood Creek.

Seismic Ground Shaking

During a seismic event, all aspects of motion of the earth's surface caused by the earthquake are generally referred to as seismic ground shaking. Ground shaking is normally the predominant cause of damage during earthquakes, and the extent of the ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. Faults identified in **Table 5.5-1** and many others in the Bay Area are sources of potential ground motion. However, earthquakes that might occur on other faults within northern California area are also potential generators of significant ground motion and could cause ground shaking at the site.

Liquefaction

Liquefaction is a phenomenon in which loose, saturated, and low-cohesion soils beneath the groundwater table lose strength during strong ground motions. Primary factors controlling liquefaction include intensity and duration of ground motion, the subsurface soil characteristics, stress conditions, and depth to groundwater.[21] Most of the study area has a low susceptibility to liquefaction, except for the Cottonwood Creek area which has very high liquefaction susceptibility.[22]

[21] Geological stress conditions refer to the force per unit area that is placed on a rock. There are four types of stresses: confining stress, compressions, tension, and shear. Stress can result in fracture or deformation of the rock, and are seismic hazards.
[22] Geocon Consultants, 2018.

Impacts and Mitigation Measures

Significance Criteria

The following significance criteria for geology and soils were derived from the Environmental Checklist in CEQA Guidelines Appendix G. These significance criteria have been amended or supplemented, as appropriate, to address lead agency requirements and the full range of impacts related to the Project.

An impact of the Project would be considered significant and would require mitigation if it would meet one of the following criteria:

A. Result in soils that are unable to support an on-site wastewater disposal system (septic)

B. Expose people or structures to potential risk of loss or injury where there is high potential for seismically induced ground shaking, landslides, liquefaction, settlement, lateral spreading, and/or surface cracking

C. Expose people or structures to potential risk of loss or injury where there is high potential for earthquake-related ground rupture near major fault crossings

D. Result in triggering or acceleration of geologic processes, such as landslides, substantial soil erosion, or loss of topsoil during construction

E. Expose people or structures to potential risk of loss or injury where corrosive, expansive or other unsuitable soils are present

Methodology

To determine potential impacts, the impact significance criteria identified above were applied to construction and operation of the Project.

Impact Analysis

No Impact Summary

A. A: Result in soils that are unable to support an on-site wastewater disposal system (septic)

No septic systems are proposed, and construction and operation of the Project would not require the use of a wastewater disposal system. Therefore, no impact would occur.

Impacts of the Project

B. Expose people or structures to potential risk of loss or injury where there is high potential for seismically induced ground shaking, landslides, liquefaction, settlement, lateral spreading, and/or surface cracking

<u>Impact GEO-1</u><u>: People and structures may be exposed to risks associated with slope stability, liquefaction, and seismically-induced settlement at or near Project site.</u> **<u>(Less than Significant with Mitigation)</u>**

<u>Slope Stability</u>

The Project would include cuts and fills throughout the Project site which, if not inclined properly, could lack adequate preventative slope stability safety measures. Furthermore, fill slopes constructed of predominantly clayey materials can be prone to surficial slumping, especially when not properly vegetated after grading operations. If existing clayey soils on the Project site would be reused for fill, they could cause slope instability. This represents a potentially significant impact. The design-level geotechnical report required by **Mitigation Measure GEO-1** (described below) would convey the need for selective grading provisions to mitigate the potential for clayey materials in fill slopes. In addition, the design-level geotechnical report will evaluate the suitability of existing soils for re-use as fill material based on the soil characteristics. With implementation of **Mitigation Measure GEO-1**, this impact would be less than significant.

<u>Liquefaction and Seismically-Induced Settlement</u>

Although most of the Project site exhibits low liquefaction susceptibility, the Cottonwood Creek drainage exhibits very high liquefaction susceptibility. This represents a potentially significant impact. The design-level geotechnical report required by **Mitigation Measure GEO-1** shall evaluate liquefaction potential at Cottonwood Creek and recommend foundation designs to reduce liquefaction hazards. Specifically, the design-level geotechnical report would determine the need for foundation elements deeper than those required for structural loading purposes. Therefore, the mitigation measure would effectively determine the extent of the liquefaction hazard and implement a foundation design to counter liquefaction hazards, reducing the risk from liquefaction and settlement. With implementation of **Mitigation Measure GEO-1**, this impact would be less than significant. Additionally, **Mitigation Measure GEO-1** would reduce impacts caused by corrosive soils, expansive soils, and erosion as discussed under **Impact GEO-2** and **Impact GEO-3** below.

<u>Mitigation for Impact GEO-1</u>

> **Mitigation Measure GEO-1:** As part of the final design phase, preparation of a design-level geotechnical and geologic report will be required and will include subsurface field work and laboratory testing. Site specific subsurface soil conditions and slope stabilities within the Project site will be verified during the preparation of this report to determine the appropriate final design for the Project. Recommendations from the design-level report will be incorporated into the Project design.
>
> Future subsurface exploration will include soil borings at approximate 500-foot intervals along the roadway extension. Soil borings will determine the geologic stability of soils underlying the Project site. In addition, borings will specifically be performed for cut slopes over 8 feet, at retaining wall locations, at bridge support locations, and at culvert crossing locations. Additional borings may be necessary for other Project components, at the

discretion of the City of Dublin or the Responsible Agency in their jurisdiction and on the recommendation of professionally qualified specialists. The field investigation will consider Project design details to provide design recommendations. Key considerations shall include the following:

- *Liquefaction.* The design-level geotechnical report shall evaluate liquefaction potential at the Cottonwood Creek crossing to determine the need for foundation elements deeper than those required for structural loading purposes.
- *Slope Stability.* The Project would include cuts and fills throughout the Project site. Cut/fill slopes will be addressed in the design-level geotechnical report to evaluate the need for selective grading provisions to mitigate the potential for clayey materials in fill slopes, which could create slope stability issues. Selective grading provisions, if necessary, will avoid this risk. In addition, the design-level geotechnical report will also evaluate the suitability of existing soils for re-use as fill material. If soils are not suitable to use as fill material, imported fill will be used where needed to ensure stability.
- *Corrosive Soils.* The design-level geotechnical report will investigate for the presence of corrosive soils within the Project site. If corrosive soils are identified at locations where new subsurface facilities are proposed (e.g. bridge foundations, culverts, etc.) specially coated rebar, or alternative pipe culverts will be specified in the contract documents.
- *Expansive Soils.* The design-level geotechnical report will investigate for the presence of expansive soils within the Project site. Depending on the extent of expansive soils and level of expansion potential, supplemental design measures such as lime-treatment, selective grading, or select import fill materials may be necessary.
- *Erosion Potential.* The design-level geotechnical report will characterize the risk of increased erosion as a result of topography, soil characteristics, and Project design.

Less than Significant Impacts

<u>Subsidence</u>

According to the USGS, the study area is not susceptible to subsidence.[23] This impact would be **less than significant**.

[23] USGS, 2018a.

Landslides

Based on geologic mapping, existing landslide distribution, and overall flatness of the Project site, existing landslides hazards would not endanger future users of the Project. The distance between the Project site and the more steeply inclined hills to the north makes the overall risk of landslide at the Project site low. This impact would be **less than significant**.

Groundshaking

The Project site is in proximity to several faults that, during a seismic event, would cause seismic ground shaking. Potential seismic ground shaking hazards would be minimized through application of the Dublin General Plan Implementing Policy 8.2.1.B.1, which requires adherence to structural standards delineated in the Dublin Building Code and Dublin's Grading Ordinance based on a "design earthquake" event for each structure for which ground shaking is a significant design factor. Compliance with the California Building Code is required. The Project would also apply the California Uniform Building Code, as recommended in the Livermore General Plan. Further, Policy 315 of the Alameda County East County Area Plan requires that buildings be designed and constructed to withstand groundshaking forces of a minor earthquake without damage, a moderate earthquake without structural damage, and a major earthquake without collapse of the structure. With implementation of these design criteria, the Project would not expose people or structure to adverse risks associated with seismic ground shaking, and this impact would be **less than significant**.

C. Expose people or structures to potential risk of loss or injury where there is high potential for earthquake-related ground rupture near major fault crossings

There are no Alquist-Priolo zones in the Project vicinity. However, the Project would cross the inferred location of Mt. Diablo Thrust Fault west of Cottonwood Creek. Linear features, such as a roadway or bridge, spanning a surface fault could become offset or deformed during a surface rupture. Therefore, the Project could experience surface fault rupture associated with the Mt. Diablo Thrust.

Although the Project could be susceptible to surface fault rupture at the Mt. Diablo Thrust, this fault is not a major safety consideration for the Project. As a generally linear, flat transportation structure, the Project would not be used for human occupancy, so life hazards would be limited. Potential displacement of the roadway alignment could interfere with roadway operations, but would not cause collapse since the majority of the Project is not elevated. The Cottonwood Creek bridge, however, could be subject to collapse in the event of a surface fault rupture, if not properly designed.

As mentioned above, Implementing Policy 8.2.1.B.1 (a) of the Dublin General Plan requires adherence to structural design standards delineated in the Dublin Building Code and Dublin's Grading Ordinance. Compliance with the California Building Code is required. The project would also apply the California Uniform Building Code, as recommended in the Livermore General Plan. Additionally, Policy 315 of the Alameda County East County Area Plan, which requires that buildings be designed and constructed to withstand groundshaking forces of a minor earthquake without damage, a moderate earthquake without structural damage, and a major earthquake without collapse of the structure. As required by these local regulations, a "design earthquake" shall be established by an engineering geologist for the roadway and bridge over Cottonwood Creek. In addition, Implementing Policy 8.2.1.B.1 (b) of the Dublin General Plan requires site-specific evaluations to determine the maximum credible fault offset, which would be accommodated into Project design. Adherence to these policies would ensure that the proposed roadway alignment and bridge are designed within acceptable margins of safety with regards to surface fault hazards. This impact would be **less than significant**.

D. Result in triggering or acceleration of geologic processes, such as landslides, substantial soil erosion, or loss of topsoil during construction

Impact GEO-2: The Project may result in soil erosion or loss of topsoil during construction. **(Less than Significant with Mitigation)**

The potential for Project construction to result in substantial erosion or loss of topsoil is described in **Section 5.8, Hydrology and Water Quality**. Project construction would involve grading and paving activities that could result in erosion and sedimentation. This is a potentially significant impact. Projects involving construction on sites that are 1 acre or more are required to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) that specifies how the water quality will be protected during construction. These measures include, but are not limited to:

- Design and construction of cut and fill slopes in a manner that will minimize erosion
- Protection of exposed slope areas
- Control of surface water flows over exposed soils
- Limiting soil excavation in high winds
- Construction of berms and runoff diversion ditches
- Use of sediment traps, such as fiber rolls.

As stated above, **Mitigation Measure GEO-1** would include the preparation of a design-level geotechnical report as part of the final design phase that would include subsurface field work and laboratory testing of soil samples. Site specific subsurface soil conditions (including erosion potential) and slope stabilities within the Project site will be verified during the preparation of this report to determine the appropriate final design for the Project. The design-level geotechnical report would characterize the risk of increased erosion as a result of topography, soil characteristics, and Project design. Recommendations from the design-level report would be incorporated into the Project design. With implementation of **Mitigation Measure GEO-1** and a SWPPP, which would reduce erosion potential, this impact would be less than significant.

Mitigation for Impact GEO-2

Mitigation Measure GEO-1 (described above)

Less than Significant Impacts

As discussed above under Existing Conditions, the Project site is not at risk for landslides. As an at-grade roadway Project that would not be placed on unstable slopes, the Project would not exacerbate an existing hazard in relation to landslides. This impact would be **less than significant**.

E. Expose people or structures to potential risk of loss or injury where corrosive, expansive or other unsuitable soils are present

Impact GEO-3: With implementation of the Project, roadway users and the new Cottonwood Creek bridge may be exposed to risks associated with corrosive, expansive, or other unsuitable soils. **(Less than Significant with Mitigation)**

Roadway and bridge infrastructure built atop expansive soils can experience damage when changes in moisture cause soils to shrink and swell. Similarly, bridge footings could be subject to corrosion if placed in corrosive soils. This could indirectly lead to unsafe conditions for travelers on the roadway and bridge structure.

Soil sampling and testing to evaluate the presence or absence of corrosive or expansive soils has not yet been performed within the study area. However, clayey soils, such as those found on the Project site, have the potential to exhibit expansive and corrosive properties. Therefore, the risk of potential loss or injury from the effect of expansive or corrosive soils has the potential to occur. The design-level geotechnical report required by **Mitigation Measure GEO-1** would investigate for the presence of expansive and corrosive soils within the Project site. Depending on the extent of expansive soils and level of expansion potential, design recommendations such as lime-treatment, selective grading or select import fill materials may be necessary and would be documented in the design-level geotechnical report. Design recommendations from the design-level geotechnical report would be incorporated into the final Project design. These design recommendations would reduce the potential for risk associated with expansive and/or corrosive soils. Therefore, with application of **Mitigation Measure GEO-1**, this impact would be less than significant.

Mitigation for Impact GEO-3

Mitigation Measure GEO-1 (described above)

CUMULATIVE IMPACTS

Cumulative impacts arise due to the linking of impacts from past, present, and foreseeable future projects in the region. Other projects in the area include past and planned residential, commercial, and infrastructure development projects in Dublin, Livermore, and elsewhere around the study area (see **Chapter 4.0, Introduction to Environmental Analysis**).

Because geologic impacts are site-specific and highly dependent upon the structural characteristics of individual projects, cumulative geologic hazard and soils impacts are generally confined to the Project site and immediate vicinity.

Most geologic-related impacts from development, if properly designed, would not result in worsening of the environment or public health and safety. Pursuant to Implementing Policy 8.2.1 (b) of Dublin's General Plan, future development would be subject to review by a registered geotechnical engineer. Geotechnical and soils reports for individual projects would include investigation of site-specific conditions and provide design recommendations to minimize exposure to geologic and soils-related risks. Similarly, Policy Objective PS-1.1 of the Livermore General Plan's Public Safety element includes policies for new land development in order to prevent the creation of new geologic hazards. Policies P1 through P7 under this Objective outline specific requirements of new developments. Policy 309 in the Alameda County East County Area Plan stipulates the County will not approve new development in areas with potential for seismic and geologic hazards unless the County can determine that feasible measures will be implemented to reduce the potential risk to acceptable levels, based on site-specific analysis.

Cumulative development would also involve the exposure of an increased number of people and/or structures to risk of earthquakes and their associated geologic hazards. New construction would be required to comply with the most current California Building Code, which establishes building standards to minimize risk based on the geologic and seismic conditions of the region in which a Project is located.

With administration of these requirements, the incorporation of **Mitigation Measure GEO-1**, and adherence to the California Building Code, the Project would not have a cumulatively considerable contribution to cumulative geologic and soils impacts.

REFERENCES

Alameda County Community Development Agency. 2013. Alameda County Safety Element. Amended 2014.

Alameda County. 2018. Alameda County, California - Municipal Code, Ch. 15.36, Grading, Erosion and Sediment Control. Available: https://library.municode.com/ca/alameda_county/codes/code_of_ordinances?nodeId=TIT15BUCO_CH15.36GRERSECO. Accessed: June 5, 2018.

BKF. 2018. Water Quality Report - Dublin Boulevard-North Canyons Parkway Extension Project.

City of Dublin. 2017. City of Dublin General Plan. Available: https://www.dublin.ca.gov/DocumentCenter/View/10560/Chapter-12. Accessed: June 5, 2018.

City of Dublin. 2017. Dublin Municipal Code, Ch. 7.16 Grading Regulations. Available: https://www.codepublishing.com/CA/Dublin/?Dublin09/Dublin0912.html&?f. Accessed: June 5, 2018.

City of Livermore. 2004. City of Livermore General Plan 2003-2025. Amended December 2014.

Geocon Consultants, Inc. 2018. Geotechnical Feasibility Study – Dublin Boulevard Extension.

San Francisco Bay Area Rapid Transit District. 2018. BART to Livermore Extension Project Environmental Impact Report.

USGS. 2006. What is the Quaternary? Available: https://geomaps.wr.usgs.gov/sfgeo/quaternary/stories/what_is.html. Accessed: June 4, 2018.

USGS. 2010. Landslide Inventory Map of Livermore Quadrangle Alameda and Contra Costa Counties, California. Available: ftp://ftp.consrv.ca.gov/pub/dmg/pubs/lsim/LSIM_Livermore.pdf. Accessed: June 4, 2018.

USGS. 2018a. Areas of Land Subsidence in California. Available: https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html. Accessed: June 4, 2018.

USGS. 2018b. California Geologic Map Data. Available: https://mrdata.usgs.gov/geology/state/map-us.html#home. Accessed: June 5, 2018.