CHAPTER 12
GEOLOGY, SOILS, SEISMICITY AND PALEONTOLOGY

This section addresses the potential impacts of the Castilleja School Project (proposed project) to geologic, soils, and paleontological resources as well as impacts related to seismic safety and soil stability. Site characteristics such as regional and local fault zones and seismic hazards are described based on site-specific information and published technical information. Information in this section is based on a geotechnical investigation prepared for the proposed project by Silicon Valley Soil Engineering, dated January 2017, and peer reviewed by Cornerstone Engineering in February 2017; see Appendix H.

The comments received in response to the Notice of Preparation for this Environmental Impact Report (EIR) identified concerns regarding the adequacy of the geotechnical analysis assessment of the potential for the project to increase seismic hazards in the vicinity, potential for subsidence, the extent of excavation and soil displacement. The Notice of Preparation, Initial Study and comments received are provided in Appendix A.

12.1 EXISTING CONDITIONS

Geology

Regional Setting

The City of Palo Alto lies in the San Francisco Bay Area, which is part of the Coast Ranges geomorphic province. The regional structure is dominated by the northwest-trending Santa Cruz Mountains to the southwest and the Diablo Range across the bay to the northeast. The Santa Cruz Mountains consist of two entirely different, incompatible core complexes, lying side by side and separated from each other by large faults. These two core complexes are Early Cretaceous Granitic intrusions and an Upper Jurassic to Lower Cretaceous eugosynclinal assemblage – the Franciscan formation. These core complexes are blanketed by thick layers of Eocene to Pleistocene marine deposits. Some Miocene volcanic intrusions are also present in the Santa Cruz Mountains southwest of the project site. The core complex of the Diablo Range to the northeast of the project site is comprised of Franciscan formation predominantly covered with Upper Cretaceous and Lower to Middle Pliocene marine deposits. The Quaternary history of the region is recorded by sedimentary marine strata alternating with non-marine strata. The changes of the depositional environment are related to the fluctuation of sea level corresponding to the glacial and interglacial periods. Late Quaternary deposits fill the center of the San Francisco Bay Area and most of the strata are of continental origin characterized as alluvial and fluvial materials.

Project Site Conditions

The project site lies on the east flank of the Santa Cruz Mountains on a thin layer of Holocene alluvial deposits overlying the Merced formation, Lower Pleistocene and Upper Pliocene marine deposits (Appendix H). The site is bounded by Embarcadero Road, Bryant Street, Kellogg Avenue, and Emerson Street. Single-family residences are present to the west, south, and east of the site. The site is irregularly shaped and relatively flat and occupied by the Castilleja School campus.

Soils

Soil type is one criterion used to evaluate potential impacts of development. Soils are typically considered for their resource value in agricultural production or for their potential development characteristics or constraints. Some soils are more stable under varying conditions and are better suited for development, while others are more susceptible to erosion and/or are subject to expansion under certain soil moisture conditions.

Regional Setting

In the City of Palo Alto, the predominant soil types include Urban-Land Stevenscreek, Flaskan, Hangerone, and Clear Lake complexes, and Urban-Land Orthents and Botella soils. Most belong to the Mollisol soil order that is formed on alluvium on slopes of zero to five percent. These soils are typically well to moderately well drained and characterized by low runoff. One exception is the Urban-Land Hangerone complex, which is poorly drained. The Botella complex soils are generally composed of deep or very deep, well-drained clay loams, whereas Urban-Land Orthents are very deep, poorly drained, texturally heterogeneous soils (Palo Alto 2016).

Soils in Palo Alto are known to be expansive in places. A number of widely used treatments are available to mitigate expansive soils, including soil grouting, recompaction, and replacement with a non-expansive material. The California Building Code (CBC) requires that each construction location be evaluated to determine the most appropriate treatment for expansive soils (Palo Alto 2016).

Project Site Conditions

The geotechnical investigation prepared for the project included field investigations and laboratory testing, including exploratory test borings to determine the surface and subsurface soil characteristics at the project site. Based on the laboratory testing results, the native surface soil at the project site has been found to have a moderately high expansion potential when subjected to fluctuations in moisture (Appendix H).

The Standard Penetration Test borings were drilled to a depth of 35 feet below the existing ground surface elevation (bgs). In Boring B-2, from the surface to a depth of 13 feet, a brown, damp, very stiff silty clay layer was encountered. From the depth of 13 feet to the end of the boring at 35 feet, the soil became reddish brown, moist, dense sandy gravel. The gravel was 1.5 inches in maximum diameter, sub-angular, and well graded. Similar soil profiles were encountered in Boring B-5 and Boring B-7. However, in Boring B-5, the sandy gravel layer was encountered from the depths of 16 feet to 30 feet. In Boring B-7, the sandy gravel layer was encountered from the depths of 16 feet to 26 feet.

The Cone Penetration Test (CPT) borings were advanced to the depths of 35 feet and 65 feet bgs. The investigation found sand layers at depths of 23 feet to 30 feet in Boring B-6 and at depths of 23 feet to 41 feet in Boring B-9. In Boring B-1, from the surface to a depth of 14 feet, the CPT sounding interpreted the soil behavior type (SBT) as very dense/stiff sandy silt to silty clay. From the depths of 14 feet to 23 feet, the SBT is silty sand to sand. From the depths of 23 feet to the end of the sounding at 65 feet, the SBT is stiff silty clay. Similar SBT profiles were encountered in other CPTs.

Seismicity

Regional Setting

Palo Alto is located in a seismically active area. The San Andreas Fault—long considered the predominant seismic risk in California—passes through the City. The San Andreas Fault is believed capable of producing a magnitude 8.4 earthquake. This would cause very violent ground shaking in much of Palo Alto, with fault rupture possible along the San Andreas, Monte Vista, and Hermit faults, and other fault traces around the Stanford University campus. The greatest hazards to the City are most likely associated with fault rupture and ground shaking, although liquefaction hazards are significant in the area east of Highway 101 due to the porous nature and high water content of the soil. Liquefaction occurs when ground shaking causes water-saturated soil to become fluid and lose its strength. Settlement and subsidence due to groundwater withdrawal has historically been a problem in the southern and eastern portions of Palo Alto, but more recent groundwater recharge efforts and reduced pumping have reduced these hazards.

Project Site Conditions

There are no known active faults beneath or near the project site. The closest major active faults to the project site are the San Andreas, Hayward, and San Gregorio faults, with main traces mapped approximately 5.2 miles southwest, 13.7 miles northeast, and 15.6 miles southwest, respectively (Appendix H).

Geologic and Seismic Hazards

This section describes the potential for typical geologic and seismic hazards to exist in the vicinity of the project site. According to the State of California Seismic Hazard Zones map, the project site is not located in a liquefaction or earthquake-induced landslide zone (California Department of Conservation 2006). However, the Palo Alto Comprehensive Plan Map S-3 shows the site in an area of moderate liquefaction potential. The site-specific characteristics related to liquefaction potential were evaluated as part of the geotechnical investigation, as discussed in the following liquefaction section.

Landslides

A landslide is the downhill movement of masses of earth material under the force of gravity. The factors contributing to landslide potential are steep slopes, unstable terrain, and proximity to earthquake faults. Landslides may be triggered by oversaturated soils (i.e., after heavy rains) or by earthquakes. Several factors can affect the susceptibility of a slope to failure, including (1) steepness of the slope; (2) strength and bulk density of the soil or bedrock; (3) width, orientation, and pervasiveness of bedrock fractures, faults, or bedding planes; (4) prevailing groundwater conditions; and (5) type and distribution of vegetation. Landslide potential is highest in steeply sloped areas. The project site and surrounding area are relatively flat and do not pose a risk of landslide.

Liquefaction

Liquefaction typically occurs when loose sand and silt that is saturated with water can behave like a liquid when shaken by an earthquake. Earthquake waves cause water pressures to increase in the sediment and the sand grains to lose contact with each other, leading the sediment to lose strength and behave like a liquid. The soil can lose its ability to support structures, flow down even very gentle slopes, and erupt to the ground surface to form sand boils. Many of these phenomena are accompanied by settlement of the ground surface—usually in uneven patterns that damage buildings, roads and pipelines.

Groundwater was encountered at depths between 29 and 31 feet below grade in the geotechnical explorations and rose to static levels ranging of 28 feet to 30 feet at the end of the drilling operation. As described in the geotechnical investigation (Appendix H), based on the California Geological Survey's Seismic Hazard Zone Report 111, the highest expected groundwater level at the project site is approximately 23 feet below ground elevation; therefore, the liquefaction analysis conducted for the project site conservatively used this groundwater level. The geotechnical investigation concluded that the liquefaction potential of the liquefiable soil layers at the project site is low, and there is minimal potential for liquefaction-induced ground surface damage. The liquefaction-induced total maximum settlement at the site is 1.66 inches. The liquefaction-induced maximum differential settlement at the site is 1.098 inches. Conventional foundation systems are expected to tolerate these magnitudes (Appendix H).

Fault Rupture

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 and is intended to mitigate the hazard of surface faulting to structures for human occupancy. The California Geological Survey designates earthquake fault zones around the surface traces of active faults and publishes maps delineating these zones. Each earthquake fault zone extends approximately 200 to 500 feet on either side of the mapped fault trace. Surface rupture during earthquakes is typically limited to those areas immediately adjacent to the fault on which the event is occurring. The project site is not included in an Alquist-Priolo Earthquake Fault zone (Department of Conservation 1974).

Ground Shaking

The most serious direct earthquake hazard is the damage or collapse of buildings caused by ground shaking, which, in addition to property damage, can cause injury or death. Ground shaking is the vibration that radiates from the epicenter of an earthquake. The severity of ground shaking depends on several variables such as earthquake magnitude; hypocenter proximity; local geology, including the properties of unconsolidated sediments; groundwater conditions; and topographic setting. In general, ground-shaking hazards are most pronounced in areas that are underlain by loosely consolidated soil/sediment.

While the project site is not located within a fault zone, it is located in a region with several active faults. The U.S. Geological Survey (USGS) estimates that the Northern San Andreas Fault, which runs west of the cities of San Francisco and Palo Alto, has a 6.4 percent chance of having an earthquake larger than magnitude 6.7 in the next 30 years. However, the San Francisco Bay Area as a whole contains many faults in addition to the San Andreas Fault, including the San Gregorio Fault, the Calaveras Fault, and the Hayward Fault, and has a 72 percent chance of having an earthquake larger than magnitude 6.7 in the next 30 years (USGS 2015).

Earthquakes of this magnitude can create ground accelerations severe enough to cause major damage to structures and foundations not designed to resist the forces generated by earthquakes. In the event of an earthquake on the San Andreas Fault, most parts of Palo Alto southwest of US 101 are expected to experience “very strong” shaking, whereas most parts east of US 101 are expected to experience “violent” shaking (ABAG 2017).

Ground Failure

Seismic related ground failure could include liquefaction and lateral spreading, which occurs in unconsolidated basin deposits (i.e., silt, sand, and gravel) that are under saturated conditions.

Lateral spreading is the most pervasive type of liquefaction-induced ground failure. During lateral spreading, blocks of mostly intact, surficial soil displace downslope or towards a free face along a shear zone that has formed within the liquefied sediment. As described above, the geotechnical investigation (Appendix H) concluded that the liquefaction potential of the liquefiable soil layers at this site is low, and there is minimal potential for liquefaction-induced ground surface damage.

Paleontological Resources

Paleontological resources are the fossilized remains or impressions of prehistoric plants and animals. They are valuable, nonrenewable, scientific resources used to document the existence of extinct life forms and to reconstruct the environments in which they lived. Fossils can be used to determine the relative ages of the depositional layers in which they occur and of the geologic events that created those deposits.

In the context of the California Environmental Quality Act (CEQA), fossils of land-dwelling vertebrates and their environment are considered important (i.e., significant) paleontological resources. Such fossils typically are found in river, lake, and bog deposits, although they can occur in nearly any type of sedimentary deposit. The potential for fossil remains at a location can be predicted based on whether or not previous fossil finds have been made in the vicinity, as well as based on the age of the geologic formations.

The geologic units in the Palo Alto area are part of an alluvial deposit found along the perimeter of the Santa Clara Valley. These units consist of 12 to 15 feet of moderately well sorted, unconsolidated, fine sandy silt and clayey silt overlying at least 6 feet of silty clay. Below that layer, the Santa Clara formation is an older alluvium made up of partially consolidated clay, silt, sand, and gravel deposited more than 11,000 years ago (Palo Alto 2016).

Most of the paleontological resources in the Palo Alto area consist of small marine fossils such as clams and snails. The area also contains old quarries, creek beds, cut slopes and rock outcroppings, which are of geological interest and educational value. Arastradero Road contains good examples of exposed rock formations. The Berkeley Museum has documented four paleontological sites in the area surrounding Stanford University, including the remains of a *Paleoparadoxia* (an extinct marine mammal similar to a hippopotamus), representing the most complete *Paleoparadoxia* found outside of China. The other sites contained *Allodesmus* (an extinct seal-like mammal) remains as well as some parts of other marine mammals. Additionally, fossilized remains of terrestrial fauna from the Pleistocene period were encountered in a deep excavation near the Stanford Medical Center. Finally, various other fossil discoveries have been made in the Palo Alto area including a large mastodon tusk found in the bank of San Francisquito Creek, fragments of petrified mastodon and/or dinosaur bone along Foothill Expressway, and isolated fragments of fossil ribs and lower limbs from late Pleistocene mammals (Palo Alto 2016).

12.2 REGULATORY FRAMEWORK

Federal Regulations

Federal Earthquake Hazards Reduction Act

The Earthquake Hazards Reduction Act was passed by Congress in 1977, and is intended to reduce the risks to life and property from future earthquakes. The act established the National Earthquake Hazards Reduction Program. The goals of National Earthquake Hazards Reduction Program are to educate and improve the knowledge base for predicting seismic hazards, improve land use practices and building codes, and to reduce earthquake hazards through improved design and construction techniques.

Installation of underground infrastructure/utility lines must comply with national industry standards specific to the type of utility (e.g., American Water Works Association for water lines), and the discharge of contaminants must be controlled through the National Pollutant Discharge Elimination System permitting program for management of construction and municipal stormwater runoff. These utility standards contain specifications for installation, design, and maintenance to reflect site-specific geologic and soils conditions.

Clean Water Act

The Clean Water Act, administered by the U.S. Army Corps of Engineers, regulates soil disturbance as it affects wetlands and other waters of the United States. The Clean Water Act prohibits discharges of pollutants, including sedimentation from soil erosion, to waters of the United States unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCBs) issue both general and individual NPDES permits for certain activities that may result in discharges of pollutants to surface waters Construction activities that disturb 1 acre or more of soil must comply with the NPDES Construction General Permit (Order 2009-0009-DWQ) that regulates the flow of stormwater from construction sites. Site owners must notify the State, prepare and implement a Stormwater Pollution Prevention Plan (SWPPP), and monitor the effectiveness of the plan. The SWPPP must include best management practices (BMPs) designed to reduce potential impacts to surface water quality, including erosion and sediment control measures.

State Regulations

Building Codes and Standards

The state regulations protecting structures from geo-seismic hazards are contained in the California Building Code (CBC) (24 CCR, Part 2), which is updated on a triennial basis. The CBC is based on the International Building Code (IBC) used nationwide. The CBC incorporates the IBC and includes numerous more detailed and/or more stringent regulations to reflect conditions specific to the state of California. Where no other building codes apply, the IBC/CBC regulates excavation, foundations, and retaining walls, and regulates grading activities, including drainage and erosion control and construction on expansive soils.

In addition, Section 19100 et seq. of the California Health and Safety Code, State Earthquake Protection Law, requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Chapters 16 and 16A of the 2016 CBC include structural design requirements governing seismically resistant construction, including factors and coefficients used to establish seismic site class and seismic occupancy category for the soil/rock at the building location and the proposed building design. Chapters 18 and 18A include (but are not limited to) the requirements for foundation and soil investigations (Sections 1803 and 1803A); excavation, grading, and fill (Sections 1804 and 1804A); damp-proofing and water-proofing (Sections 1805 and 1805A); allowable load-bearing values of soils (Sections 1806 and 1806A); the design of foundation walls, retaining walls, embedded posts and poles (Sections 1807 and 1807A), and foundations (Sections 1808 and 1808A); and design of shallow foundations (Sections 1809 and 1809A) and deep foundations (Sections 1810 and 1810A). Chapter 33 of the 2016 CBC includes (but is not limited to) requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes (Section 3304).

Construction activities are subject to occupational safety standards for excavation and trenching, as specified in the California Safety and Health Administration regulations (Title 8 of the California Code of Regulations) and in Chapter 33 of the CBC. These regulations specify the measures to be used for excavation and trench work where workers could be exposed to unstable soil conditions. The proposed project would be required to employ these safety measures during excavation and trenching.

As indicated previously, the CBC is updated and revised every three years. The 2019 version of the CBC will be effective January 1, 2020. Each individual construction phase of the proposed Castilleja School Master Plan would use the most current CBC at the time of specific project building activity.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act, codified in California Public Resources Code, Sections 2621–2630, prohibits construction of buildings used for human occupancy on the surface of active faults. This act also requires the State Geologist to establish regulatory zones, known as Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps to be used by local agencies in regulating and planning construction. Earthquake fault zones are designated by the California Geological Survey and are delineated along traces of faults where mapping demonstrates surface fault rupture has occurred within the past 11,000 years.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, codified in California Public Resources Code, Sections 2690–2699.6, addresses non-surface rupture earthquake hazards, including liquefaction, earthquake-induced landslides, and subsidence. The Act requires the California Department of Conservation to identify Seismic Hazard Zones within the state based on the probable seismic shaking exposure and soil conditions in a given area. Areas that may be subject to substantial shaking, or where soil conditions indicate the area may be prone to liquefaction or earthquake-induced landslides, are included in Seismic Hazard Zones. The Act specifies that the lead agency may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

California Public Resources Code

Paleontological resources are afforded protection by environmental legislation set forth under CEQA. Appendix G of the CEQA Guidelines provides guidance relative to significant impacts on paleontological resources, indicating that a project would have a significant impact on paleontological resources if it would disturb or destroy a unique paleontological resource or site. The Guidelines for Implementation of CEQA (California Code of Regulations, Title 14, Chapter 3) defines procedures, types of activities, persons, and public agencies required to comply with CEQA, including potential significant effects to paleontological sites. This code requires mitigation of adverse impacts to a paleontological site from development on public land by construction monitoring.

Section 5097.5 of the California Public Resources Code specifies that a person shall not excavate, remove, or destroy any vertebrate paleontological site, including fossilized footprints, on public lands, except with the express permission of the public agency having jurisdiction over the lands. Public lands include lands owned by, or under the jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any agency thereof.

Local Regulations

Palo Alto Comprehensive Plan

The *City of Palo Alto Comprehensive Plan 2030* (Comprehensive Plan), adopted in November 2017, is the primary tool for guiding the future development of the City by describing long-term goals for the City's future as well as policies to guide day-to-day decisions. Chapter 5, Safety, of the Comprehensive Plan contains goals, policies, and programs to help the City prepare for natural disasters and minimize public exposure to hazards like fire, flood, and earthquake. The following goal, policy, and programs are relevant to geology, soils, and seismicity with respect to the proposed project:

- Goal S-2: Protection of life, ecosystems, and property from natural hazards and disasters, including earthquake, landslide, flooding, and fire.
  - Policy S-2.5: Minimize exposure of people and structures to geologic hazards, including slope stability, subsidence, and expansive soils, and to seismic hazards including ground shaking, fault rupture, liquefaction, and landslides.
    - Program S2.5.1: Periodically review and update the City's Seismic Hazard Ordinance.
    - Program S2.7.1: As part of the construction permitting process for proposed new and redeveloped buildings in areas of identified hazard shown on Map S-2, structures that would affect the most people in a seismic event require submittal to the City of a geotechnical/seismic report that identifies specific risks and appropriate mitigation measures.
    - Program S2.7.2: Review and update, as appropriate, City code requirements for excavation, grading, filling, and construction to ensure that they conform to currently accepted and adopted State standards.

City of Palo Alto Municipal Code

The Palo Alto Municipal Code contains other requirements that pertain to geologic or seismic hazards. Chapter 16.42 describes requirements for buildings that are consistent with California Health and Safety Code Sections 19160 – 19169 and are necessary to implement the Comprehensive Plan's Environmental Resources Policy 14, Program 47. The chapter aims to promote public safety by identifying those buildings in Palo Alto which exhibit structural deficiencies and by accurately determining the severity and extent of those deficiencies in relation to their potential for causing loss of life or injury.

Chapter 16.28 of the City's Municipal Code includes detailed requirements for construction-related grading and erosion and sediment control. The main goal of these requirements is to "provide for safe grading operations, to safeguard life, limb, and property, and to preserve and enhance the natural environment, including, but not limited to, water quality, by regulating clearing and grading on private property." The chapter describes rules and regulations to control land disturbances, land fill, soil storage, and erosion and sedimentation resulting from such activities. It also establishes procedures for issuance, administration, and enforcement of a permit. Per the City's code, each grading permit application shall include a site map and grading plan, interim and final erosion and sediment control and SWPPPs, a soils engineering report, and an engineering geology report.

City of Palo Alto Zoning Ordinance

The City's Zoning Ordinance, Title 18 of the Municipal Code, Chapter 18.40.120, Hazardous Conditions, requires any area within the City identified by the Comprehensive Plan as having high risk due to seismic activity hazard or other geologic hazard to include a geologic report. The building official may require, prior to issuance of a building permit or other permit authorizing new construction, detailed geologic, soils, and engineering data.

12.3 PROJECT IMPACTS

Methods of Analysis

The project setting was developed based on the site-specific geotechnical investigation (Appendix H), and by reviewing available geological documentation for the project area from the California Geological Survey, the USGS, the U.S. Department of Agriculture, the City of Palo Alto Comprehensive Plan, and the Comprehensive Plan EIR. The understanding of potential impacts resulting from the proposed project was based on analysis of these documents.

CEQA requires that the project be analyzed for potential impacts including exposing people or property to risk from seismic events or ground instability, resulting in soil erosion, resulting in the alteration of existing landforms, or destroying paleontological resources. As described in the Initial Study (see Appendix A), the project would not include the use of septic tanks; therefore, no impact would occur with regard to adequate soils to support septic tanks and this criterion is not further evaluated in this EIR.

Significance Criteria

Potential impacts associated with soils, geology, and seismicity have been evaluated using the following criteria, based on Appendix G of the CEQA Guidelines. The proposed project would have a potentially significant impact related to geology, seismicity, and soils if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.
    - Strong seismic ground shaking.
    - Seismic-related ground failure, including liquefaction.
    - Landslides.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result on-site or off-site landslide, lateral spreading, excessive expansion, subsidence, liquefaction, or collapse.
- Result in substantial soil erosion or the loss of topsoil
- Result in substantial alterations to existing landforms.
- Directly or indirectly destroy paleontological resources.

Impact Analysis

IMPACT 12-1:	Exposure to hazards involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure including liquefaction, or landslides
SIGNIFICANCE:	Potentially Significant
MITIGATION MEASURES:	Mitigation Measure 12a
SIGNIFICANCE AFTER MITIGATION:	Less than Significant

The project site is not located on a known earthquake fault; therefore, no impact would occur with regard to rupture of a known earthquake fault. The project site is not located in a liquefaction zone or earthquake-induced landslide zone. As noted in Section 12.1, the project site and surrounding area are relatively flat and do not pose a risk of landslide; and the liquefaction potential of the liquefiable soil layers at the project site is low. Conventional foundation systems are expected to tolerate maximum liquefaction-induced differential settlement at the site (Appendix H).Therefore, impacts associated with seismic-related ground failure including liquefaction or landslides would be less than significant.

The primary geologic hazard at the project site is seismic ground shaking. Given the proximity of the project site to several active earthquake faults, in the event of an earthquake, the project site would have a high potential to experience strong seismic ground shaking which could have adverse effects to people or structures (Appendix H). The proposed project would increase the school's maximum enrollment cap, resulting in approximately 100 additional students on site, thus the project would have the potential to expose additional people to strong seismic ground shaking. This would be a **potentially significant** impact. However, the project would be required to adhere to standard engineering design and seismic safety techniques specified in the CBC as well as protections specified in the City of Palo Alto Seismic Hazards Identification Program (Municipal Code Chapter 16.42) and Zoning Ordinance (Municipal Code Chapter 18.40). In addition, adherence to Mitigation Measure 12a requiring compliance with recommendations provided in the geotechnical investigation (Appendix H) would reduce the potential impact associated with seismic ground shaking to a less-than-significant level. Therefore, impacts associated with seismic ground shaking would be **less than significant**.

IMPACT 12-2:	Location on a geologic unit or soil that is unstable or that would become unstable as a result of the project, and potentially result in on-site or off-site landslide, lateral spreading, excessive expansion, subsidence, liquefaction, or collapse
SIGNIFICANCE:	Potentially Significant
MITIGATION MEASURES:	Mitigation Measure 12a
SIGNIFICANCE AFTER MITIGATION:	Less than Significant

As previously discussed, the project site has minimal potential for liquefaction and landslides. The project site is relatively level, with no free face or sloping ground in the vicinity. Therefore, the potential for lateral spreading would be minimal. Based on the analyses in the geotechnical investigation (Appendix H), the potential for differential seismic settlement would be low. Therefore, the project site is not located on an unstable geologic unit prone to liquefaction, lateral spreading, subsidence, or collapse. However, the project site is known to contain expansive soils, thus the project would have a **potentially significant** impact associated with placing new structures on soil that may be unsuitable to support the structures.

Expansive soils are composed largely of clays, which swell in volume when saturated with water and shrink when dried. Native soils on the project site have a moderately high expansion potential, which would be a potentially significant impact. With proper site preparation, foundation design, and compliance with recommendations from the geotechnical investigation as required by Mitigation Measure 12a, implementation of the project would not create substantial risks to life or property due to expansive soils. Adherence to Mitigation Measure 12a would reduce impacts associated with expansive soil to a **less-than-significant** level.

The Geotechnical Investigation found that the depth to groundwater in the project area is between 23 feet and 31 feet below the ground surface, thus with a maximum depth of excavation of 15 feet it is not expected that groundwater would be encountered during excavation and construction within the project site. In the event that groundwater is encountered during excavation and construction and dewatering becomes necessary, the project would implement the contingency dewatering plan recommended by the Geotechnical Investigation (Appendix H), as required by Mitigation Measure 12a. Further, any dewatering activities would be subject to the City's requirements and standard permit approval conditions. These include requiring that water be collected in trucks for dust suppression on-site, street-sweeping and other city programs. With implementation of Mitigation Measure 12a, if dewatering is necessary during construction, the risks to ground stability would be reduced to a **less-than-significant** level.

IMPACT 12-3:	Substantial erosion or loss of topsoil
SIGNIFICANCE:	Less than Significant
MITIGATION MEASURES:	None Required
SIGNIFICANCE AFTER MITIGATION:	Less than Significant

Soil erosion is a natural process that can be accelerated by construction activities such as grading, vegetation clearing, and earthwork. Project construction would include ground-disturbing activities, including excavation and grading that would expose soils and increase the potential for soil erosion from wind or stormwater runoff. Because the project would disturb more than one acre of soil, the project would be subject to the NPDES Construction General Permit, requiring preparation of a SWPPP including erosion control BMPs, as described above in Section 12.2. Construction activities would also be required to comply with the provisions in CBC Appendix J in regard to grading, excavation, and earthwork construction, as well as the grading and erosion and sediment control measures set forth in the Chapter 16.28 of the Palo Alto Municipal Code. Compliance with these regulations would prevent substantial soil erosion or loss of topsoil and the impact would be **less than significant**.

IMPACT 12-4:	Substantially alter existing landforms
SIGNIFICANCE:	Potentially Significant
MITIGATION MEASURES:	Mitigation Measure 12a
SIGNIFICANCE AFTER MITIGATION:	Less than Significant

The project site is developed with the existing Castilleja School facilities, including above- and below-grade building space, surface parking lots, a pool, the Circle, Spieker Field, two residential buildings, and hardscaped and landscaped areas. The project site is relatively level and, as described in Chapter 3, Project Description, has been developed since the early 1900s and does not contain natural or prominent geologic landforms. As the project site is relatively level, the project would not involve terracing of natural slopes, disturbance to or a change in elevation of steep hillsides, or other major alterations to the existing landform.

The project would involve substantial amounts of excavation to construct the below-grade parking garage, below-grade pool, below-grade areas of the new academic building, and below-grade loading area. Excavation for these features would extend approximately 15 feet below the existing ground surface. In total, approximately 45,800 cubic yards of material would be excavated and exported off site. As noted previously, the Geotechnical Investigation found that the depth to groundwater in the project area is between 23 feet and 31 feet below the ground surface, thus with a maximum depth of excavation of 15 feet it is not expected that groundwater would be encountered during excavation and construction within the project site. In the event that groundwater is encountered during excavation and construction and dewatering becomes necessary, the project would implement the contingency dewatering plan recommended by the Geotechnical Investigation (Appendix H), as required by Mitigation Measure 12a. With implementation of Mitigation Measure 12a, if dewatering is necessary during construction, the potential for dewatering to result in an alteration of landforms would be reduced to a **less-than-significant** level

The proposed construction activities would not alter the existing landform because upon completion of construction, the site would remain relatively flat. The ground surface above the parking garage would be restored to support Spieker Field in its current location and configuration. Therefore, impacts associated with landform alteration would be **less than significant**.

IMPACT 12-5:	Directly or indirectly destroy paleontological resources
SIGNIFICANCE:	Potentially Significant
MITIGATION MEASURES:	Mitigation Measure 12b
SIGNIFICANCE AFTER MITIGATION:	Less than Significant

As described in Section 12.1, there are known paleontological resource sites within the City of Palo Alto. The presence of these known sites indicates that there are likely undiscovered resources within the City. While the entire project area, including the project site, has been heavily disturbed by urban development over the years, intact paleontological resources may be present below ground. If intact paleontological resources are located on site, ground-disturbing activities associated with construction of the proposed project, such as excavation of the below-grade parking garage, pool, and other features, and grading of the site during site preparation would have the potential to destroy undiscovered paleontological resources. This would be a **potentially significant** impact. In the event that paleontological resources are discovered during project construction, implementation of Mitigation Measure 12b, which requires evaluation, protection, and/or documentation of any discovered paleontological resources by a qualified paleontologist, would reduce potential impacts to paleontological resources to **less than significant**.

IMPACT 12-6:	Substantially contribute to cumulative impacts associated with geology, soils, seismicity, and paleontological resources
SIGNIFICANCE:	No Impact
MITIGATION MEASURES:	None Required
SIGNIFICANCE AFTER MITIGATION:	No Impact

Impacts that may result from geologic hazards, potentially unstable soils, and seismic hazards are generally site-specific, rather than cumulative in nature. Each individual project in the cumulative scenario would be subject to uniform site development and construction standards to address the site-specific and project-specific geologic, soil stability, and seismic considerations. In this way, potential cumulative impacts resulting from geological, seismic, and soil conditions would be reduced to less-than-significant levels on a site-by-site basis by modern construction methods and code requirements. As such, there would be no significant cumulative geotechnical impact to which the project could contribute.

It is possible that in a cumulative development scenario there could be a series of impacts to paleontological resources that may be discovered during construction. However, as discussed in Chapter 4, Land Use and Planning, the recently approved and pending projects in the vicinity of the Castilleja School site involve modifications to or demolition and replacement of existing single-family dwelling units. These projects would have similar potential to uncover paleontological resources as the proposed project, and they would be required by State law to evaluate, protect, and/or document any discovered paleontological resources. Thus there would be no cumulative impact to paleontological resources to which the project could contribute.

12.4 MITIGATION MEASURES

Mitigation Measure 12a: Project design and construction shall show compliance with and implement all of the recommendations contained in the geotechnical investigation prepared by Silicon Valley Soil Engineering in January 2017 or provide an acceptable equivalent to these measures to the satisfaction of the Director of Public Works Engineering in order to reduce hazards related to expansive soils and the stability of soil and landforms. These include but are not limited to:

1. the basement foundation system should use a concrete mat slab with a minimum thickness of 12 inches and underlain by 6 inches of ¾-inch clean crushed rock and waterproofed;

2. shoring shall be provided for trenches and excavation in excess of five feet in depth;

3. a geotechnical engineer shall be retained to observe and inspect all earthwork and grading;

4. within construction areas, organic materials shall be stripped from the soil and the soil shall be scarified by machine to a depth of 12 inches and thoroughly cleaned of vegetation and other deleterious matter;

5. soil shall be compacted to not less than 90 percent relative maximum density and moisture conditioned; and

6. a contingency dewatering plan shall be prepared that provides for collection of any surface runoff water and perched groundwater and use of the water as approved by the City and consistent with the City's dewatering requirements, such as for on-site dust suppression, street-sweeping, and other City programs.

Mitigation Measure 12b: A discovery of a paleontological specimen during any phase of the project shall result in a work stoppage in the vicinity of the find until it can be evaluated by a professional paleontologist. Any paleontological resource discovered on site should be either preserved at its location or adequately treated and documented as a condition of removal. Should loss or damage be detected, additional protective measures or further action (e.g., resource removal), as determined by a professional paleontologist, shall be implemented to ensure that the information potential represented by the resource is retained.

12.5 REFERENCES CITED

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