# 4.6 GEOLOGY AND SOILS

This section describes the soils, geologic, and seismic environment in the vicinity of the project site; discusses the federal, State, and local regulations pertinent to soils, geology, and seismicity; assesses the potential impacts related to geology and soils that would occur as a result of project implementation; and identifies mitigation measures, where appropriate, to address those impacts.

The evaluation in this section is based on information obtained from the Geotechnical Investigation[1] (refer to Appendix D) prepared for the project and geologic reports and maps from the United States Geological Survey (USGS) and California Geological Survey (CGS), among others.

## 4.6.1 Setting

The existing geologic, soil, and seismic conditions and potential for paleontological resources at the project site and vicinity are discussed below. The regulatory framework related to geology, seismicity, soils and building safety, and paleontological resources is also discussed.

### 4.6.1.1 Geologic Conditions

The topography, geology, and soil and groundwater conditions for the project site and its vicinity are described below.

**Topography.** The project site is generally level. The existing ground surface elevation of the project site ranges from approximately 30 to 40 feet referenced to the North American Vertical Datum of 1988 (NAVD 88), and generally slopes gently down towards the east.[2]

**Geology.** The project site is located within the Coast Ranges geomorphic province,[3] which is a relatively geologically young and seismically active region.[4] The Coast Ranges are mountain ranges (approximately 2,000 to 4,000 feet, and in some areas 6,000 feet, in elevation above sea level) and valleys that trend northwest, approximately parallel to the San Andreas Fault, from near the Oregon border to southern California. The only major break in the Coast Ranges is the depression containing the San Francisco Bay region within which the project site is located.[5] Geologic mapping indicates that the project site is underlain by Holocene alluvium and Franciscan Complex mélange.[6]

**Soils and Groundwater Conditions.** The project site was developed by cutting into a steep ridge that was present on the western side of the project site. The excavated material was then placed as fill to level the eastern portion of the project site. Therefore, the western portion of the project site is predominantly underlain by shallow bedrock, while the eastern portion of the project site is

[1] Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

[2] Ibid.

[3] A geomorphic province is a naturally defined geologic region that displays a distinct combination of features based on geology, faults, topography, and climate. Eleven geomorphic provinces are recognized in California.

[4] Norris, Robert M., and Robert W. Webb. 1976. *Geology of California*, 2nd Edition. J. Wiley & Sons, Inc.

[5] California Geological Survey (CGS). 2002a. California Geomorphic Provinces, Note 36.

[6] Graymar et al. 2006. Geologic Map of the San Francisco Bay Region.

underlain by areas of fill material up to 20 feet thick. It is not known whether fill material was placed on the project site in a compacted (engineered) manner; therefore, it is considered "undocumented." The thicknesses of undocumented fill ranges from approximately 2 to 20 feet and generally consists of medium to very stiff clay with varying amounts of sand and gravel with interbedded layers of medium dense to very dense sand and gravel with varying fines contents. The clayey fill is low to moderately expansive.[7]

The undocumented fill is underlain by native soil characterized as alluvial deposits and residual soil[8] that varies in thickness from 1 to 22 feet where present. Alluvial deposits generally consist of medium stiff to hard clays with varying amounts of sand. However, areas of medium dense clayey silty sand and soft clay were encountered below the undocumented fill in the southeast and northeast portions of the project site. Residual soil consisting of very stiff sandy clay was encountered at various depths below the project site.[9]

Bedrock was encountered beneath the project site at depths ranging from approximately 1 to 41 feet and generally consists of interbedded shale and sandstone, shale, sandstone, siltstone, and claystone. Bedrock beneath the project site is predominantly crushed to closely fractured, low to moderate hardness, friable to moderately strong, little to deeply weathered, and oxidized.[10]

Groundwater has been encountered at depths ranging between approximately 11 feet and 33 feet beneath the project site during previous geotechnical investigations. Seasonal fluctuations in rainfall influence groundwater levels and may cause several feet of variation.[11] Groundwater was encountered at depths as shallow as approximately 7 to 10 feet in the southeast portion of the project site during groundwater sampling activities performed in June 2017.[12]

### 4.6.1.2 Seismic Conditions

The entire San Francisco Bay region is located within the San Andreas Fault Zone, a complex of active faults. Numerous historic earthquakes have been generated in northern California by the San Andreas Fault Zone. This level of active seismicity results in relatively high seismic risk in the San Francisco Bay region.

The project site is vulnerable to seismic activity based on the presence of several active faults in the region. An active fault is one that has experienced displacement within the last 11,700 years[13] and is

7 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California.* December 22.
8 Soil formed from highly weathered rock.
9 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California.* December 22.
10 Ibid.
11 Ibid.
12 TŌR Environmental, Inc. 2017. *Limited Phase II Soil, Soil Gas, and Groundwater Assessment, Sears at Northgate Mall, 9000 Northgate Drive, San Rafael, California*. August 22.
13 California Geological Survey (CGS). 2018. Special Publication 42, *Earthquake Fault Zones, A Guide for Government Agencies, Property Owners/Developers, and Geoscience Practitioners for Assessing Fault Rupture Hazards In California*.

expected to move again at some point in the future. The Hayward and San Andreas Faults are the major active faults closest to the project site.

The Working Group on California Earthquake Probabilities and the USGS have predicted a 33 percent probability of a Moment Magnitude ($M_W$)[14] 6.7 or greater earthquake on the Hayward Fault between 2014 and 2043, a 22 percent chance on the San Andreas Fault, and a total probability of 72 percent that an earthquake of $M_W$ 6.7 or greater will occur on one of the regional San Francisco Bay Area (Bay Area) faults during that time.[15]

### 4.6.1.3 Seismic and Geologic Hazards

Seismic hazards are generally classified in two categories: primary seismic hazards (i.e., surface fault rupture and ground shaking) and secondary seismic hazards (i.e., liquefaction and other types of seismically induced ground failure). Each of these hazards are discussed below.

**Surface Rupture.** Surface rupture occurs when the ground surface is broken due to fault movement during an earthquake. Surface rupture generally can be assumed to occur along an active or potentially active major fault trace. Areas that are most susceptible to fault rupture are delineated by the CGS Alquist-Priolo Earthquake Fault Zones. The project site is not located within or adjacent to an Alquist-Priolo Earthquake Fault Zone. The nearest Alquist-Priolo Earthquake Fault Zone to the project site is the Hayward Fault, which is located about 9.5 miles east of the project site.[16] No known active or potentially active faults exist on the project site.[17]

**Ground Shaking.** Ground shaking is a general term referring to all aspects of motion of the earth's surface resulting from an earthquake and is normally the major cause of damage in seismic events. The extent of ground shaking is controlled by the magnitude and intensity of the earthquake, distance from the epicenter, and local geologic conditions. The Modified Mercalli Intensity (MMI) Scale is the most commonly used scale for measurement of the subjective effects of earthquake intensity (Table 4.6.A). The MMI values range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from VI to XII can cause moderate to significant structural damage.[18]During a major earthquake, strong to very strong ground shaking is expected to occur at the project site.[19]

[14] $M_W$, as opposed to Richter Magnitude, is now commonly used to characterize seismic events. $M_W$ is determined from the physical size (area) of the rupture of the fault plane, the amount of horizontal and/or vertical displacement along the fault plane, and the resistance to rupture of the rock type along the fault.

[15] United States Geological Survey (USGS). 2016. Earthquake Outlook for the San Francisco Bay Region 2014–2043, USGS Fact Sheet 2016-3020, revised August.

[16] California Geological Survey (CGS). 2023. Earthquake Zones of Required Investigation. Website: https://maps.conservation.ca.gov/cgs/EQZApp/app/ (accessed March 8, 2023).

[17] Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

[18] California Geological Survey (CGS). 2002b. How Earthquakes and Their Effects are Measured, Note 32.

[19] Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

## Table 4.6.A: Modified Mercalli Scale

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

Source: California Geologic Survey (CGS). 2002b. How Earthquakes and Their Effects are Measured, Note 32.

**Liquefaction, Lateral Spreading, and Seismic Settlement.** Liquefaction is the temporary transformation of loose, saturated granular sediments from a solid state to a liquefied state as a result of seismic ground shaking. In the process, the soil undergoes transient loss of strength, which commonly causes ground displacement or ground failure to occur. Because saturated soils are a necessary condition for liquefaction, soil layers in areas where the groundwater table is near the surface have higher liquefaction potential than those in which the water table is located at greater depths. The potential for liquefaction-induced ground failure (e.g., loss of bearing strength, ground fissures, sand boils) depends on the thickness of the liquefiable soil layer relative to the thickness of the overlying non-liquefiable material. The project site is located in an area where liquefaction hazards have not been mapped by CGS.[20] The materials below the groundwater table at the project

20 California Geological Survey (CGS). 2023. Earthquake Zones of Required Investigation. Website: https://maps.conservation.ca.gov/cgs/EQZApp/app/ (accessed March 8, 2023).

site level are predominantly clayey or bedrock; therefore, the potential for liquefaction settlement at the project site is low.[21]

Lateral spreading is a form of horizontal displacement of soil toward an open channel or other "free" face, such as an excavation boundary. In a lateral spread failure, a layer of soil at the surface is carried on an underlying layer of liquefied material over a nearly flat surface toward a river channel or other bank. The lateral spreading hazard tends to mirror the liquefaction hazard for a site, assuming a free face is located nearby. Because the potential for liquefaction at the project site is low, the potential for lateral spreading to occur at the project site is also low. [22]

Seismic settlement (also referred to as cyclic densification or differential compaction) can occur when non-saturated, cohesionless sand or gravel soil is densified by earthquake vibrations. When the degree of cyclic densification varies based on variations in soil types, differential (i.e., unequal) settlement may occur that can result in greater damage to improvements compared to relatively equal settlement. The materials above the groundwater table at the project site are sufficiently cohesive and/or dense such that the potential for cyclic densification at the project site is low.[23]

**Static Settlement and Differential Settlement.** Static settlement is the lowering of the land surface elevation as a result of loading (i.e., placing heavy loads, typically fill or structures), which often occurs with the development of a site. Differential settlement could occur if buildings or other improvements are built on variable low-strength foundation materials (including imported, non-engineered fill) or if improvements straddle the boundary between different types of subsurface materials (e.g., a boundary between native material and fill). Static settlement and differential settlement generally occur slowly enough that their effects are not dangerous to inhabitants, but they can cause significant building damage over time.

The western portion of the project site is generally underlain by shallow bedrock, while the eastern portion of the project site is underlain by undocumented fill and native soil above bedrock. Where explored, the undocumented fill appears to be comprised of relatively stiff clay; however, it cannot be confirmed that the fill was placed in an engineered fashion across the entire project site.[24] Based on the presence of varying thicknesses of undocumented fill and native soil, the project site could be susceptible to static settlement and differential settlement under new loads.

**Subsidence or Collapse.** Subsidence is the lowering of the land-surface elevation. Subsidence or collapse can result from the removal of subsurface water resulting in either catastrophic or gradual depression of the ground surface elevation. The mechanism for subsidence is generally groundwater pumping that lowers groundwater elevations and subsequent consolidation of loose aquifer sediments and/or drying of expansive clayey soil. The primary hazards associated with subsidence are increased flooding hazards and damage to underground utilities as well as above-ground structures. Other effects of subsidence include changes in the gradients of stormwater and sanitary

[21] Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

[22] Ibid.

[23] Ibid.

[24] Ibid.

sewer drainage systems in which the flow is gravity driven. Areas of the project site that are underlain by undocumented fill and/or native soils that are clayey and/or loose could be subject to subsidence due to the removal of groundwater.

**Expansive Soils.** Expansion and contraction of soil volume can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly. Shrink-swell potential is influenced by the amount and type of clay minerals present and can be measured by the percent change of the soil volume. Shrink-swell potential is also influenced by the location of the soils; soils below the groundwater table maintain a steady moisture content and would therefore not be subject to shrink-swell effects. As a consequence of volume changes due to expansive soils, structural damage to buildings and infrastructure can occur if potentially expansive soils are not considered in project design and during construction. The clayey fill soil at the project site has been found to be low to moderately expansive.[25]

**Landslides.** Slope failure can occur as either rapid movement of large masses of soil (landslide) or slow, continuous movement (creep) on slopes of varying steepness. Areas susceptible to landslides are characterized by steep slopes and downslope creep of surface materials. Slope failures can be triggered by seismic events, heavy rainfall, or grading/excavation activities. Seismically induced landslide hazards have not been mapped by CGS for the project site and surrounding areas.[26] The project site is generally level and therefore would not be subject to landslides. There is a steep slope located adjacent to the west of the project site across Northgate Drive. This steep slope has been graded, benched, and planted with trees, and much of the slope has exposed bedrock. Based on these characteristics, this adjacent slope does not appear to be at risk of significant soil creep or slope failures that could affect the project site; however, there are some boulders present on the ground surface along the base of this slope that suggest rockfall hazards could be present at the base of this slope. Because this slope has been benched, which significantly reduces rockfall hazards, and the project site is approximately 100 feet away from the base of this slope, potential rockfall from this slope would not be expected to affect the project site.

### 4.6.1.4 Paleontological Conditions

Paleontological resources include fossilized remains or traces of organisms, including plants, vertebrates (animals with backbones), invertebrates (e.g., starfish, clams, ammonites, and marine coral), and microscopic plants and animals (microfossils) as well as their imprints from a previous geological period. Collecting localities and the geologic formations containing those localities are also considered paleontological resources because they represent a limited, non-renewable resource that once destroyed cannot be replaced. The Society of Vertebrate Paleontology (SVP) has established guidelines for the identification, assessment, and mitigation of adverse impacts on non-renewable paleontological resources. The SVP has helped define the value of paleontological resources and, in particular, states that significant paleontological resources are fossils and fossiliferous deposits consisting of identifiable vertebrate fossils, large or small, uncommon

25 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

26 California Geological Survey (CGS). 2023. Earthquake Zones of Required Investigation. Website: https://maps.conservation.ca.gov/cgs/EQZApp/app/ (accessed March 8, 2023).

invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information. Paleontological resources are considered to be older than recorded human history and/or older than middle Holocene (i.e., older than about 5,000 years).[27]

A search of paleontological localities in the fossil collections database maintained by the University of California Museum of Paleontology identified 369 fossil localities within Marin County, including plants, invertebrates, vertebrates, and microfossils. The precise locations of the fossil localities are not provided in the database, and for many of the localities there is no information provided to infer even the general location within Marin County; however, based on the available information, it appears there are several localities potentially near the project site, including the following:[28]

- An invertebrate fossil locality identified as "San Rafael" of Quaternary age
- An invertebrate fossil locality identified as "San Rafael quad" of possible Triassic age
- An invertebrate fossil locality identified as "San Quentin" of Quaternary age
- An invertebrate fossil locality identified as "San Pedro Point" of Quaternary age
- Two invertebrate fossil localities identified as "China Camp" of Quaternary age

The fill materials underlying the project site would not be expected to contain paleontological resources because fossils are not generally preserved in fill materials due to the highly disturbed nature of fill materials. Based on the presence of many previously discovered paleontological resources in Marin County and potentially near the project site, the native soils and bedrock underlying the project site could potentially contain paleontological resources.

### 4.6.1.5 Regulatory Framework

Federal, State, and local regulations and programs related to geology, seismicity, soils, and building safety that are applicable to the project are also described below.

**Federal Regulations.** Federal regulations applicable to the proposed project include the National Earthquake Hazards and Reduction Program, as described below.

***National Earthquake Hazards Reduction Program.*** The National Earthquake Hazards Reduction Program (NEHRP) was established by the United States Congress when it passed the Earthquake Hazards Reduction Act of 1977, Public Law 95–124. In establishing the NEHRP, 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. The four basic NEHRP goals are:

27 Society of Vertebrate Paleontology (SVP). 2010. Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources.

28 University of California Museum of Paleontology. 2023. Collections Database, Locality Search. Website: https://ucmpdb.berkeley.edu/loc.html (accessed March 15, 2023).

1. Develop effective practices and policies for earthquake loss reduction and accelerate their implementation.
2. Improve techniques for reducing earthquake vulnerabilities of facilities and systems.
3. Improve earthquake hazards identification and risk assessment methods, and their use.
4. Improve the understanding of earthquakes and their effects.

Implementation of NEHRP 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 Regulations.** State regulations applicable to the proposed project include the Alquist-Priolo Earthquake Fault Zoning Act, the Seismic Hazards Mapping Act, and the California Building Code, as described below.

***Alquist-Priolo Earthquake Fault Zoning Act.*** The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972, and its main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active earthquake faults. The Alquist-Priolo Earthquake Fault Zoning Act requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of known active faults and to issue appropriate maps. "Earthquake Fault Zones" were called "Special Studies Zones" prior to January 1, 1994. The maps are distributed to all affected cities, counties, and State agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. As mentioned above, the project site is not located within an area mapped as subject to surface rupture under the Alquist-Priolo Earthquake Fault Zoning Act, and no known active or potentially active faults cross the project site.

***Seismic Hazards Mapping Act.*** The Seismic Hazards Mapping Act of 1990 (Public Resources Code [PRC], Sections 2690-2699.6) directs the CGS to identify and map areas prone to liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the Seismic Hazards Mapping Act is to minimize loss of life and property through the identification, evaluation, and mitigation of seismic hazards. The Seismic Hazards Mapping Act was passed by the legislature following the 1989 Loma Prieta earthquake. As a result, CGS geologists gather existing geological, geophysical, and geotechnical data from numerous sources to produce the Seismic Hazard Zone Maps. They integrate and interpret this data regionally in order to evaluate the severity of the seismic hazards and designate areas prone to ground rupture, liquefaction, and earthquake-induced landslides as Zones of Required Investigation. Cities and counties are then required to use the Seismic Hazard Zone Maps in their land use planning and building permit processes. The Seismic Hazards Mapping Act requires site-specific geotechnical investigations be conducted within Zones of Required Investigation to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy. The CGS has completed seismic hazard mapping for the portions of California most susceptible to liquefaction, ground rupture, and landslides (primarily the Bay Area and the Los Angeles basin). The project site is located in an area where liquefaction hazards and seismically induced landslide hazards have not been mapped by CGS.[29]

***California Building Code.*** The 2022 California Building Code, which refers to Part 2 of the California Building Standards Code in Title 24 of the California Code of Regulations (CCR), is based on the 2021 International Building Code, and is the most current State building code. The 2022 California Building Code covers grading and other geotechnical issues, building specifications, and non-building structures. The design of the proposed project would be required to conform to the current California Building Code at the time of plan review, which is currently the 2022 California Building Code (which went into effect on January 1, 2023).

The California Building Code requires that a site-specific geotechnical investigation report be prepared by a licensed professional for proposed developments of one or more buildings greater than 4,000 square feet to evaluate geologic and seismic hazards. Preparation of a geologic engineering report is also required for buildings less than or equal to 4,000 square feet except for one-story, wood-frame, and light-steel-frame buildings that are located outside of the Alquist-Priolo Earthquake Fault Zones or Seismic Hazard Zones mapped by the CGS. The purpose of the geotechnical investigation is to identify seismic and geologic conditions that require project mitigation (e.g., ground shaking, liquefaction, differential settlement, and expansive soils). Based on the conditions of the site, the California Building Code requires specific design parameters to ensure construction of buildings that will resist collapse during an earthquake and damage from adverse soil conditions. These design parameters do not protect buildings from all earthquake-shaking hazards but are designed to reduce hazards to a manageable level. Requirements for the geotechnical investigation are presented in Chapter 16 "Structural Design" and Chapter 18 "Soils and Foundation" of the 2022 California Building Code.

**Local Regulations.** The City of San Rafael (City) General Plan and Municipal Code requirements related to geology and soils are described below.

***San Rafael General Plan 2040.*** The City's General Plan 2040[30] contains goals, policies, and programs pertaining to geology and soils that would be applicable to the project, as listed below.

**Goal CDP-5: Protection of Cultural Heritage.** Protect and maintain San Rafael's historic and archaeological resources as visible reminders of the city's cultural heritage.

**Policy CDP-5.15: Paleontological Resource Protection.** Prohibit the damage or destruction of paleontological resources, including prehistorically significant fossils, ruins, monuments, or objects of antiquity, that could potentially be caused by future development.

**Program CDP-5.15A: Paleontological Resource Mitigation Protocol.** Prepare and adopt a list of protocols in accordance with Society of Vertebrate Paleontology

[29] California Geological Survey (CGS). 2023. Earthquake Zones of Required Investigation. Website: https://maps.conservation.ca.gov/cgs/EQZApp/app/ (accessed March 8, 2023).

[30] City of San Rafael. 2021. San Rafael General Plan 2040. August 2.

standards that protect or mitigate impacts to paleontological resources, including requiring grading and construction projects to cease activity when a paleontological resource is discovered so it can be safely removed.

**Goal S-2: Resilience to Geologic Hazards.** Minimize potential risks associated with geologic hazards, including earthquake-induced ground shaking and liquefaction, landslides, mudslides, erosion, sedimentation, and settlement.

**Policy S-2.1: Seismic Safety of New Buildings.** Design and construct all new buildings to resist stresses produced by earthquakes. The minimum level of seismic design shall be in accordance with the most recently adopted building code as required by State law.

**Program S-2.1A: Seismic Design.** Adopt and enforce State building codes which ensure that new or altered structures meet the minimum seismic standards set by State law. State codes may be amended as needed to reflect local conditions.

**Program S-2.1B: Geotechnical Review.** Continue to require soil and geologic hazard studies and peer review for proposed development as set forth in the City's Geotechnical Review Matrix. These studies should determine the extent of geotechnical hazards, optimum design for structures and the suitability and feasibility of proposed development for its location, the need for special structural requirements, and measures to mitigate any identified hazards. Periodically review and update the Geotechnical Review Matrix to ensure that it supports and implements the Local Hazard Mitigation Plan by identifying potentially hazardous areas. Consider removing the procedures from the General Plan and instead adopting them as part of the Zoning Ordinance or through a separate resolution.

**Program S-2.1C: Earthquake Hazard Study.** As recommended by the Local Hazard Mitigation Plan, complete an Earthquake Hazard Study that examines geologic hazards in the city.

**Policy S-2.2: Minimize the Potential Effects of Landslides.** Development proposed in areas with existing or potential landslides (as identified by a Certified Engineering Geologist, Registered Geotechnical Engineer, or the LHMP) shall not be endangered by, or contribute to, hazardous conditions on the site or adjoining properties. Landslide mitigation should consider multiple options in order to reduce potential secondary impacts (loss of vegetation, site grading, traffic, visual). The City will only approve new development in areas of identified landslide hazard if the hazard can be appropriately mitigated, including erosion control and replacement of vegetation.

**Program S-2.2A: Landslide Mitigation and Repair Projects.** Undertake landslide hazard mitigation and repair projects, as outlined in the LHMP. These projects include a landslide identification and management program, repair of the Fairhills Drive landslide, and repair of the Bret Harte sewer easement.

**Policy S-2.3: Seismic Safety of Existing Buildings.** Encourage the rehabilitation or elimination of structures susceptible to collapse or failure in an earthquake. Historic buildings shall be treated in accordance with the Historic Preservation Ordinance and Historic Building Code (see also Program CDP-5.5A).

**Program S-2.3A: Seismic Safety Building Reinforcement.** Enforce State and local requirements for reinforcement of existing buildings, including the city's remaining unreinforced masonry (URM) buildings.

**Policy S-2.4: Post-Earthquake Inspections.** Require post-earthquake inspections of critical facilities and other impacted buildings and restrict entry into compromised structures as appropriate. Following a major earthquake, inspections shall be conducted as necessary in conjunction with other non-City public agencies and private parties to ensure the structural integrity of water storage facilities, storm drainage structures, sewer lines and treatment facilities, transmission and tele-communication facilities, major roadways, bridges, elevated freeways, levees, canal banks, and other important utilities and essential facilities.

**Program S-2.4A: Inspection List.** Develop and maintain a list of facilities that would be inspected after a major earthquake, including City-owned essential or hazardous facilities. Facilities on the list should be prioritized for inspection-scheduling purposes.

**Policy S-2.5: Erosion Control.** Require appropriate control measures in areas susceptible to erosion, in conjunction with proposed development. Erosion control measures should incorporate best management practices (BMPs) and should be coordinated with requirements for on-site water retention, water quality improvements, and runoff control.

**Program S-2.5A: Erosion and Sediment Control Plans.** Require Erosion and Sediment Control Plans (ESCPs) for projects meeting the criteria defined by the Marin County Stormwater Pollution Prevention Program, including those requiring grading permits and those with the potential for significant erosion and sediment discharges. Projects that disturb more than one acre of soil must prepare a Stormwater Pollution Prevention Plan, pursuant to State law.

**Program S-2.5B: Grading During the Wet Season.** Avoid grading during the wet season due to soil instability and sedimentation risks, unless the City Engineer determines such risks will not be present. Require that development projects implement erosion and/or sediment control measures and runoff discharge measures based on their potential to impact storm drains, drainageways, and creeks.

Appendix F of the San Rafael General Plan 2040 outlines geotechnical review requirements for development projects and requires various geotechnical reports that are based on different types of proposed land uses and geologic/seismic characteristics of a site to be submitted to the City at different stages of project review. The types of geotechnical reports that may be required include a Preliminary Geotechnical Report, a Geotechnical Investigation Report, Construction Observation Report, and Geotechnical Review. A Preliminary Geotechnical Report and/or Geotechnical Investigation Report are required during the planning and permitting stages of projects. A Geotechnical Review by the City's Geotechnical Review Consultant is required during the planning and permitting stages for certain projects that have higher geologic/seismic risks due to the proposed land use and/or geologic/seismic characteristics of a site. A Construction

Observation Report is required prior to the City issuing an Occupancy Permit or Notice of Completion for projects.

***Municipal Code.*** Section 9.30.140 of the Municipal Code requires construction-phase Best Management Practices (BMPs) to include erosion and sediment controls and pollution prevention practices. Erosion control BMPs may include, but are not limited to, scheduling and timing of grading activities, timely revegetation of graded areas, the use of hydroseed and hydraulic mulches, and installation of erosion control blankets. Sediment control may include properly sized detention basins, dams, or filters to reduce entry of suspended sediment into the storm drain system and watercourses, and installation of construction entrances to prevent tracking of sediment onto adjacent streets. Section 9.30.150 of the Municipal Code requires an Erosion and Sediment Control Plan for any construction subject to a grading permit or that may have the potential for significant erosion. A Stormwater Pollution Prevention Plan (SWPPP) required by the Construction General Permit may be provided in lieu of the Erosion and Sediment Control Plan provided it meets the City's requirements.

Section 12.100 of the Municipal Code adopts the 2022 California Building Code, Chapters 2 through 28, 30, 31, 32, 33, and 35, and Appendices C, H, I, N and O. Section 12.100.020 of the San Rafael Municipal Code indicate that the local seismic design category is D/D2. Minor City-specific amendments to the California Building Code are contained in Section12.200.

Section 14.16.170 of the Municipal Code requires geotechnical reports to be submitted with development applications consistent with the geotechnical report requirements in San Rafael General Plan 2040. The reports must assess hazards such as seismic hazards, liquefaction, landslides, mudslides, erosion, sedimentation and settlement, and hazardous soils conditions to determine the optimum location for structures. The geotechnical reports must also advise of special structural requirements and evaluate the feasibility and desirability of a proposed facility in a specific location.

## 4.6.2 Impacts and Mitigation Measures

The following describes the potential impacts of the proposed project related to geology and soils. This section begins with the criteria of significance that establish the thresholds for determining whether an impact is significant. The latter part of this section presents the impacts associated with the proposed project and identifies mitigation measures, as necessary.

### 4.6.2.1 Significance Criteria

Implementation of the proposed project would have a significant impact related to geology and soils if it would:

**Threshold 4.6.1:** Directly or indirectly cause a substantial risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zones Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;

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|---|---|
| **Threshold 4.6.2:** | Directly or indirectly cause a substantial risk of loss, injury, or death involving the construction of new buildings for human occupancy or other infrastructure or structures that would not comply with the most recently adopted California Building Code seismic standards applicable to ground shaking events; |
| **Threshold 4.6.3:** | Result in the construction of new buildings for human occupancy or other infrastructure or structures within areas subject to seismic-related ground failure or collapse, liquefaction, or expansive soils and would not comply with the most recently adopted California Building Code standards; |
| **Threshold 4.6.4:** | Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse; or |
| **Threshold 4.6.5:** | Directly or indirectly destroy or substantially damage a unique paleontological resource or site or unique geologic feature. |

Potential impacts associated with soil erosion or loss of topsoil during project construction is addressed in Section 4.7, Hydrology and Water Quality. The proposed project does not include the use of alternative wastewater systems and would connect to existing and planned sewer infrastructure. Therefore, these topics are not addressed in this section.

### 4.6.2.2 Project Impacts

The following section discusses potential impacts related to geology and soils associated with development of the proposed project based on the significance thresholds described above in Section 4.6.2.1. Impacts that would occur with implementation of Phase 1 (2025 Master Plan) and Phase 2 (2040 Vision Plan) would not differ by phase and therefore are not differentiated in this section.

**Threshold 4.6.1: Surface Rupture.** The project site is not located within or adjacent to an Alquist-Priolo Earthquake Fault Zone,[31] and no known active or potentially active faults exist on the project site.[32] Therefore, there would be **no impact** related to surface fault rupture.

**Threshold 4.6.2: Ground Shaking.** During a major earthquake, strong to very strong ground shaking is expected to occur at the project site.[33] The risk to structures and improvements from ground shaking impacts is reduced through adherence to the design and materials standards set forth in the California Building Code and recommendations in a site-specific geotechnical report, which is required for the proposed project by the California Building Code, the San Rafael General Plan 2040, and the San Rafael Municipal Code.

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[31] California Geological Survey (CGS). 2023. Earthquake Zones of Required Investigation. Website: https://maps.conservation.ca.gov/cgs/EQZApp/app/ (accessed March 8, 2023).

[32] Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

[33] Ibid.

The Geotechnical Investigation recommends that the proposed buildings be designed using seismic Site Class C or D depending on the thickness of fill in the vicinity of the structure. The Geotechnical Investigation indicates that seismic Site Class C should be used for the western portion of the project site, which has shallower fill and bedrock, and seismic Site Class D should be used for the eastern portion of the project site, which has deeper fill and bedrock. The Geotechnical Investigation provides recommended seismic design parameters for the different site classes, including the Risk-Targeted Maximum Considered Earthquake ($MCE_R$), Site Coefficients, $MCE_R$ spectral response acceleration parameters, Design Earthquake (DE) spectral response acceleration parameters, and peak ground acceleration. The Geotechnical Investigation also indicates that the project structural engineer would need to determine if site-specific spectra response analysis[34] would be required during the design-level geotechnical study of the project.[35]

The required design and construction of the proposed project in accordance with the recommendations of the Geotechnical Investigation and requirements of the California Building Code, San Rafael General Plan 2040, and San Rafael Municipal Code would ensure that potential impacts related to seismic ground shaking would be **less than significant**.

**Threshold 4.6.3: Seismic-Related Ground Failure or Collapse, Liquefaction, or Expansive Soils.** Potential impacts associated with the construction of new buildings for human occupancy or other infrastructure or structures within areas subject to seismic-related ground failure or collapse, liquefaction, or expansive soils that would not comply with the most recently adopted California Building Code standards are discussed below.

***Liquefaction.*** The Geotechnical Investigation indicates that the materials below the groundwater table at the project site level are predominantly clayey or bedrock; therefore, the potential for liquefaction settlement at the project site is low. The Geotechnical Investigation recommends that foundations for the proposed structures consist of shallow foundations on bedrock, shallow foundations on ground improvement[36] bearing solely in either competent native soil or bedrock (for each individual structure, the ground improvement should extend to similar material), or deep foundations (consisting of auger-cast-in-place piles) to bedrock. Considering the variable depths to bedrock within portions of the project site, a combination of these foundation types, all bearing in bedrock, may be used across a single building footprint.

Construction of foundations in accordance with the recommendations of the Geotechnical Investigation (additional details on ground improvement and foundation recommendations are discussed under Threshold 4.6.4 below) is required by the California Building Code and the City's General Plan 2040 and Municipal Code, and would ensure that proposed structures would not be susceptible to liquefaction-induced settlement because building loads would bear on

34 Site-specific spectra response analysis involves regional seismic hazard analyses and site-specific soil conditions and response analyses for defining seismic actions on a structure.

35 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

36 Ground improvement involves increasing the density and strength of soil. The Geotechnical Investigation indicates that the most appropriate methods to perform ground improvement at the project site would include compacted aggregate piers or drilled displacement columns.

improved ground, competent native material, or bedrock, which would not be susceptible to liquefaction-induced settlement. Therefore, potential impacts related to liquefaction would be **less than significant**.

***Seismic Settlement/Collapse.*** Seismic settlement can result in collapse of the ground surface in areas where subsurface materials above the groundwater table are loose and not cohesive. The materials above the groundwater table at the project site are sufficiently cohesive and/or dense such that the potential for seismic settlement at the project site is low.[37] Project grading activities would include compaction of any new fill materials in accordance with the recommendation of the Geotechnical Investigation, which would ensure that the new fill materials would not be subject to seismic settlement. In addition, construction of foundations in accordance with the recommendations of the Geotechnical Investigation and California Building Code would ensure that proposed structures would not be susceptible to seismic settlement because building loads would bear on improved ground, competent native material, or bedrock, which is not susceptible to significant seismic settlement. Therefore, potential impacts related to seismic settlement/collapse would be **less than significant**.

***Expansive Soil.*** The clayey fill soil at the project site has been found to be low to moderately expansive.[38] Expansive soils have the potential to damage proposed foundations/floor slabs, utilities, and pavements due to moisture fluctuations if appropriate engineering is not incorporated into the project design. Potential causes of moisture fluctuations in soil could include drying during construction and subsequent wetting from rain, capillary rise, landscape irrigation, poor drainage, and type of plant selection.

The Geotechnical Investigation includes recommendations to address expansive soils (including the selection, placement, and compaction of engineered fill beneath proposed improvements) and maintaining surface drainage so that runoff would be collected in lined ditches or drainage swales and would not pond adjacent to foundations, roadways, pavements, retaining walls, or slabs. The Geotechnical Investigation indicates that excavated on-site soil is generally not suitable from a geotechnical perspective for reuse as engineered fill or backfill due to the moderate expansion potential of the soil; however, this soil may be used as general fill outside of building footprints if at least 12 inches of material that meets geotechnical requirements (which includes low to moderate expansion potential) is placed over it.[39]

Implementation of the recommendations from the Geotechnical Investigation would ensure that structures and other improvements would be designed and constructed to account for potentially expansive soils. The project design currently includes the reuse of a large quantity of excavated on-site soil to backfill the basement area of the RH Outlet building, and the proposed Residential 2 building is planned to be constructed over a portion of this basement area. Although the Geotechnical Investigation indicates that that the on-site soil should not be used as engineered fill or backfill within new building footprints, the project's Geotechnical Engineer

37 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

38 Ibid.

39 Ibid.

later indicated that they would allow the use of existing on-site soil in the basement backfill provided at least 12 inches of engineered fill is placed over it.[40] The Preliminary Stormwater Control Plan for the project indicates that stormwater bioretention planters would be lined with concrete on their sides; however, the bottoms of the planters would not be lined,[41] which could conflict with the recommendation of the Geotechnical Investigation that runoff should be collected in lined ditches or drainage swales and could therefore result in damage to proposed and existing improvements due to expansive soil conditions. This would be a **potentially significant** impact.

**Impact GEO-1 Proposed and existing improvements could be damaged due to expansive soil conditions. (S)**

In order to control the risk of damage to proposed and existing improvements due to expansive soil conditions, the project sponsor shall implement Mitigation Measure GEO-1.

**Mitigation Measure GEO-1** **Lining of Bioretention Planters.** The project geotechnical engineer shall review the proposed bioretention planter designs for the project to determine whether the designs meet the geotechnical recommendations regarding lining of stormwater drainage swales to address expansive soil conditions. If the project geotechnical engineer indicates that any of the bioretention planters should include bottom liners to address expansive soil conditions, the bioretention planter designs shall be modified in accordance with the geotechnical engineer's recommendations. Modifications to bioretention planter designs shall account for potential increases in stormwater discharges that could occur from lining the bottoms of planters to ensure that the project would not increase stormwater discharges compared to existing conditions at the project site. Such modifications may include increasing the size/depth of bioretention planters, adding infiltration devices in areas that would not adversely affect proposed or existing improvements, or additional stormwater retention features such as bioswales or underground cisterns with metered outlets. The geotechnical review and potential modifications to project designs discussed above shall occur prior to the City of San Rafael (City) issuing grading or building permits for the project. (LTS)

Implementation of Mitigation Measure GEO-1 would ensure that potential impacts of the project related to expansive soils would be avoided through the use of fill materials that are able to support building loads and other infrastructure and that are not susceptible to expansion. Therefore, this impact would be **less than significant with mitigation**.

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40 Merlone Geier Partners. 2023. Email correspondence between Barron Caronite of Merlone Geier Partners and Jeff Ballantine of the City of San Rafael. May 4.

41 Merlone Geier Partners. 2022. Northgate Town Square, Redevelopment Plan, Resubmittal Application. March 9.

**Thresholds 4.6.4: Unstable Soils.** Potential impacts associated with the construction of new buildings for human occupancy or other infrastructure or structures within a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off- site landslide, lateral spreading, subsidence, liquefaction or collapse are discussed below.

***Lateral Spreading.*** Lateral spreading hazards tend to mirror the liquefaction hazard for a site, assuming a free face is located nearby. There are free faces located in some areas along the perimeter of the project site where the grade changes between the project site and surrounding streets. These free faces consist of relatively small, landscaped slopes with retaining walls in areas with larger grade changes. The project would not substantially alter the existing grades of the project site and therefore would not create any new significant free faces. Because the potential for liquefaction at the project site is low, the potential for lateral spreading to occur at the project site is also low.[42] Therefore, potential impacts related to lateral spreading would be **less than significant**.

***Landslides.*** The project site is relatively flat and therefore would not be subject to landslides. As discussed under Section 4.6.1 above, the large slope adjacent to the west of the project site does not appear to be at risk of significant slope failures or rockfall hazards that could affect the project site. In addition, the project would not include any activities that would modify or destabilize this off-site slope and therefore alter the risk of slope failures or rockfall hazards. Therefore, the project would have **no impact** related to landslides.

***Settlement, Subsidence, or Collapse of Unstable Soil.*** Based on the presence of varying thicknesses of undocumented fill and native soil throughout the project site, static settlement and differential settlement could occur under new loads at the project site. The foundation types recommended by the Geotechnical Investigation would not be susceptible to significant static settlement because they would extend through the undocumented fill materials and compressible native soils on the site and would bear on improved ground, competent native soil, or bedrock.

The Geotechnical Investigation provides recommendations for the design and construction of shallow foundations, including footings and mats, and deep foundations consisting of auger-cast-in-place piles. These foundation recommendations include the depth of installation, bearing capacity, sizing, and lateral load resistance of foundation features, and a test pile program for deep foundations. The Geotechnical Investigation indicates that settlement of properly installed shallow foundations bearing in bedrock should be less than 0.5 inch, and differential settlement should be no more than 0.5 inch between any adjacent deep foundation columns, provided all foundations extend into bedrock. The Geotechnical Investigation also provides recommendations for preparation of subgrade, engineered fill placement and compaction, and construction of floor slabs and pavements, and indicates that although the near-surface soil over

42 Merlone Geier Partners. 2022. Northgate Town Square, Redevelopment Plan, Resubmittal Application. March 9.

large portions of the project site is undocumented fill, it is adequate to support new building slabs-on-grade.[43]

The Geotechnical Investigation indicates that the most appropriate methods to perform ground improvement would include compacted aggregate piers (CAPs) or drilled displacement columns (DDCs); however, these systems are installed under design-build contracts by specialty contractors, and as such the Geotechnical Investigation does not provide specific design recommendations or settlement estimates for these systems. The Geotechnical Investigation provides guidelines for ground improvement, which includes: (a) extending the ground improvement at least 1 foot into the native soil or bedrock; (b) requiring ground improvement elements for a single structure to bear in the same material (i.e., competent native soil or bedrock); (c) using a qualified, design-build, specialty contractor who has previously successfully performed ground improvement in similar subsurface soil conditions to design and perform the ground improvement; (d) designing the ground improvement to provide a bearing capacity factor of safety of at least 2.0 under dead plus live loads; (e) performing at least two compression load tests per building on ground improvement elements prior to production installation; and (f) performing at least one load test in tension per building if DDCs would be used to resist uplift loads.[44]

As discussed above, the Geotechnical Investigation does not provide specific design recommendations or settlement estimates for ground improvement systems. If ground improvement would be performed, then site-specific ground improvement design recommendations and associated settlement estimates must be developed for proposed building foundations/structures to be properly designed to withstand estimated settlement amounts. The Geotechnical Investigation also does not provide estimated settlement amounts that could occur due to loads from placement of new fill materials on the project site. Depending on the thickness of new fill materials and the compressibility of underlying soil, settlement due to new loads from placement of fill materials could result in damage to existing improvements (e.g., buildings, streets, sidewalks, and utilities) or proposed improvements. In addition, the Geotechnical Investigation indicates that during ground improvement and/or deep foundation pre-production test programs and throughout construction, the project would cause vibrations that could cause settlement of fill materials, which could adversely affect nearby improvements. The Geotechnical Investigation recommends that (a) vibration monitoring should be performed to check for vibrations and evaluate the attenuation with distance from the construction activities, and (b) the vibration monitoring program should be reviewed by the geotechnical engineer, the general contractor, and their ground improvement/foundation subcontractors to assess whether modifications need to be made to the construction activities to reduce the potential for damage to nearby improvements. The Geotechnical Investigation recommends that the conditions of buildings and improvements within 150 feet of the project

43 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

44 Ibid.

site should be photographed and surveyed to document existing conditions prior to the start of construction and then monitored periodically during construction.[45]

The project would include excavation for construction of one level of underground parking at the proposed Residential 3 structure (which is in the area where groundwater was previously encountered at depths of approximately 7 to 10 feet[46]) and two levels of underground parking at the proposed Residential 4 structure (which is in an area where groundwater has been encountered at depths of approximately 11 to 15 feet[47]). Excavation activities would extend below the groundwater table; therefore, dewatering of excavations would be required. Excavation dewatering could lower the groundwater table in areas adjacent to excavations, which could result in subsidence and settlement-related damage to existing improvements near excavations. Shoring of excavations would also be required to laterally restrain the sidewalls of excavations to ensure they would not collapse and to limit the movement of adjacent improvements (e.g., public streets, sidewalks, and utilities). The amount of excavation dewatering that would be required can vary depending on the type of shoring system that would be utilized. If appropriate shoring is not designed and installed, the movement or collapse of excavation sidewalls could result in damage to adjacent improvements. The Geotechnical Investigation did not discuss the excavations, shoring, and dewatering that would be required for proposed underground parking structures.

Based on the discussion above, the project could result in subsidence, settlement, and differential settlement that could impact the integrity of nearby buildings and other improvements (e.g., roadways and utilities) in addition to potential settlement-related impacts to existing and proposed on-site improvements. This would be a **potentially significant** impact. Also refer to Section 4.12, Noise, for additional discussion regarding construction vibration.

**Impact GEO-2** **Placement of new loads on the project site, vibration-generating construction activities, and excavation and dewatering activities could result in subsidence, settlement, or differential settlement that could adversely affect the proposed and existing structures and other improvements. (S)**

In order to control the risk of subsidence, settlement, and differential settlement, the project shall implement Mitigation Measure GEO-2.

**Mitigation Measure GEO-2** **Preparation of a Design-Level Geotechnical Report.** The project sponsor shall define the extent of engineered fill that would be placed on the project site and extent of excavation that would occur for subsurface parking structures in the project plans. The project sponsor shall hire a qualified Geotechnical Engineer to prepare a

45 Langan Engineering and Environmental Services, Inc. 2021. Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California. December 22.

46 TŌR Environmental, Inc. 2017. *Limited Phase II Soil, Soil Gas, and Groundwater Assessment, Sears at Northgate Mall, 9000 Northgate Drive, San Rafael, California*. August 22.

47 Langan Engineering and Environmental Services, Inc. 2021. *Updated Geotechnical Investigation, Northgate Town Square, San Rafael, California*. December 22.

design-level geotechnical report for the project that shall include the following:

- A design-level analysis of total and differential settlement that may occur for shallow foundations installed over areas of ground improvement, if ground improvement would be performed. This analysis must be based on site-specific design recommendations for ground improvement prepared in accordance with the recommendations of the 2021 Geotechnical Investigation for the project.

- A design-level analysis of potential total and differential settlement associated with the placement of defined amounts of fill material, ground improvement activities, construction of other improvements, and dewatering activities on the project site. The settlement analysis shall define buffer distances away from construction activities within which settlement could occur as a result of the project and shall describe the settlement amounts that could occur within these buffer distances.

- Allowable settlement estimates for planned and existing improvements both on the project site and within the buffer distances described above that shall account for estimated settlement amounts developed for existing and planned improvements on surrounding properties.

- Recommendations to minimize the amounts of subsidence/settlement and differential settlement that would result from the project (e.g., minimizing placement of fill, use of lightweight fill, and shoring systems that would limit the movement of adjacent improvements and minimize the amount of excavation dewatering required, such as interlocking sheet piles or soil-cement cut-off walls).

- Recommendations to mitigate potential damage to proposed and existing improvements (e.g., structures, pavement surfaces, roadways, underground parking structure, and utilities), both on and off the project site, that could result from settlement of existing unstable soil on and near the project site as a result of the project. Such recommendations could include installation of bracing/underpinning, installation of flexible utility couplings, or relocation of utilities.

- If the settlement analysis indicates that existing off-site improvements could be adversely affected by settlement as a result of the project, a pre-construction survey (e.g., crack survey) and settlement monitoring program shall be developed and implemented before and during construction for existing improvements that may be affected by the project. This survey shall be used as a baseline to evaluate any damage claims and also to assist the contractor in assessing the performance of shoring systems. The pre-construction survey shall record the elevation and horizontal position of all existing installations within the buffer distance determined by the settlement analysis as described above, and shall consist of, but not be limited to, photographs, video documentation, and topographic surveys. The settlement monitoring program shall include installation of inclinometers and groundwater monitoring wells within a distance of 5 to 15 feet from excavations for below-grade parking and toward existing improvements. Settlement surveys shall be performed on a weekly basis during excavation for below-grade parking and on a monthly basis starting approximately 1 month after the excavation has been completed and continuing for a period of at least 2 years after the completion of construction activities (or other frequency and duration as recommended by the Geotechnical Engineer of Record).

The project plans and design-level geotechnical report shall be submitted to the City for review and approval prior to the City issuing grading or building permits. The project sponsor shall repair damages to existing or planned improvements if settlement monitoring identifies obvious damage or exceedance of allowable settlement amounts. The repair of damage shall be performed prior to the City issuing a certificate of occupancy for the project. (LTS)

Implementation of Mitigation Measure GEO-2 would ensure that potential impacts of the project related to static settlement, subsidence, or collapse of unstable soil would be minimized to the extent feasible through compliance with site-specific construction and engineering practices to be detailed in a design-level geotechnical report. Compliance with these measures would ensure that impacts are reduced to below a level of significance and consistent with accepted practices throughout the State. Therefore, this impact would be **less than significant with mitigation**.

**Threshold 4.6.5: Paleontological Resources and Unique Geologic Features.** There are no unique geologic features at the project site, therefore the project would have no impacts related to unique geologic features. As discussed under Section 4.6.1 above, paleontological resources could be present in the native soil and bedrock of the project site. The project would include excavation activities for construction of foundation features and utilities, which could potentially encounter and damage or destroy paleontological resources. Although *Program CDP-5.15A: Paleontological*

*Resource Mitigation Protocol* of the General Plan indicates the City will prepare and adopt a list of protocols in accordance with SVP standards that protect or mitigate impacts to paleontological resources, adoption of a list of such protocols has not occurred in the City's Municipal Code. The potential for damage or destruction of paleontological resources during construction of the project is therefore a **potentially significant** impact.

**Impact GEO-3 The project could directly or indirectly destroy a unique paleontological resource or site. (S)**

In order to control the risk of damaging or destroying a unique paleontological resource or site, the project shall implement Mitigation Measure GEO-3.

**Mitigation Measure GEO-3** **Paleontological Resource Protection.** Before the start of any excavation activities, the project sponsor shall retain a qualified paleontologist, as defined by the Society of Vertebrate Paleontology (SVP), who is experienced in training construction personnel regarding paleontological resources. The qualified paleontologist shall train all construction personnel who are involved with earthmoving activities, including the site superintendent, regarding the possibility of encountering fossils, the appearance and types of fossils that could be seen during construction, and proper notification procedures should fossils be encountered. Should any paleontological resources be encountered during construction activities, all ground-disturbing activities within 50 feet of the find shall cease, and the City and project sponsor shall be notified immediately. The project sponsor shall immediately notify the qualified paleontologist and request that they assess the situation per SVP standards, consult with agencies as appropriate, and make recommendations for the treatment of the discovery if found to be significant. If construction activities cannot avoid the paleontological resources, adverse effects to paleontological resources shall be mitigated. Mitigation may include monitoring, recording the fossil locality, conducting data recovery and analysis, preparing a technical report, and providing the fossil material and technical report to a paleontological repository, such as the University of California Museum of Paleontology. Public educational outreach may also be appropriate. Upon completion of the assessment, a report documenting methods, findings, and recommendations shall be prepared and submitted to the City for review. (LTS)

Implementation of Mitigation Measure GEO-3 would reduce the level of the potential impact through the identification of paleontological resources during construction, the evaluation of unanticipated discoveries, and the recovery of significant paleontological data from those resources that warrant such investigation. This process would recover scientifically consequential information from at-risk resources to offset their potential loss. Therefore, with implementation of Mitigation Measure GEO-3, this impact would be reduced to **less than significant with mitigation**.

### 4.6.2.3 Cumulative Impacts

This section evaluates cumulative impacts on geology and soils. This cumulative analysis examines the effects of the project in the relevant geographic area in combination with other current projects and probable future projects. Cumulative impacts are addressed only for those thresholds that would result in a project-related impact, whether it be less than significant or less than significant with mitigation. If the project would result in no impact with respect to a particular threshold, by definition, it would not contribute to a cumulative impact. Therefore, no analysis would be required.

Potential impacts related to geology, soils, and paleontological resources generally do not extend far beyond an individual development's boundaries because each development may have unique geologic and paleontological considerations. Therefore, the potential for cumulative impacts is generally limited to individual development sites and adjacent sites. For this reason, potential impacts are typically confined to discrete spatial locations and do not combine to create a significant cumulative impact. The exception to this generalization would occur where larger-scale geologic events, such as a large landslide or regional subsidence/settlement that might affect surrounding areas. As discussed under *Landslides* above, the project would have no impacts related to landslides. Potential impacts related to seismic hazards, soil erosion, collapse of unstable soil, expansive soils, and paleontological resources would be specific to the project site and would not combine with other projects to create a cumulative impact. The geographic context for the analysis of potential cumulative impacts related to settlement and subsidence of unstable soil is the project site and adjacent properties.

Potential cumulative impacts associated with settlement or subsidence of unstable soil could occur if cumulative projects adjacent to the project site caused settlement from new loads, vibration-generating construction activities, or subsidence from dewatering that could impact existing and proposed improvements, including structures, pavement/roadways, and utilities. Cumulative projects located adjacent to the project site may include excavation dewatering or placement of fill materials that could result in settlement or subsidence of areas on or adjacent to these cumulative projects. Settlement or subsidence of areas on or adjacent to these cumulative projects could combine with settlement or subsidence from the project, which could contribute to damaging existing or planned improvements. However, there are no current or probable future projects under City review within the vicinity of the project site.

The project would not make a cumulatively considerable contribution to settlement- and subsidence-related impacts because there are no cumulative projects within San Rafael with which the proposed project impacts could combine to result in a cumulatively considerable impact. Furthermore, through the duration of General Plan buildout, measures similar to Mitigation Measure GEO-1 would be required for individual development projects. Mitigation Measure GEO-1 would ensure that: (1) the potential for settlement (which includes potential subsidence) from the project would be evaluated in the design-level geotechnical report and geotechnical recommendations to address potential settlement that would be incorporated into the design of the project, which would account for estimated settlement amounts developed for existing and planned improvements on surrounding properties; (2) settlement monitoring would be performed during and following construction of the proposed project, as necessary; and (3) if excessive settlement occurs, corrective measures (e.g., repair of damages) would be implemented. Therefore, cumulative impacts related to settlement or subsidence of unstable soil would be **less than significant**.