

## 4.5 GEOLOGY AND SOILS

This section assesses the project's potential to result in or expose people or property to adverse geological conditions or hazards. It is based on geologic and geotechnical analyses prepared by the applicant's geologist (GMU Geotechnical, Inc. [GMU], GMU 2007, GMU 2009, GMU 2011); information from previous environmental documents in the general site area (Padre Associates, 1999); data from City of Goleta (General Plan/Coastal Land Use Plan documents, 2008); and published information for the Goleta-Santa Barbara area (e.g., United States Geological Survey [USGS], 2009). The geotechnical report prepared by GMU was submitted with the project application, and supplemental geotechnical reports were submitted in 2009 and 2011. Prior to the GMU 2011 update Envicom Corporation's certified engineering geologist, Kenneth Wilson, ~~subsequently~~ had reviewed and augmented ~~this~~ the previous study studies through analysis of the reports and available maps.

### 4.5.1 Existing Conditions

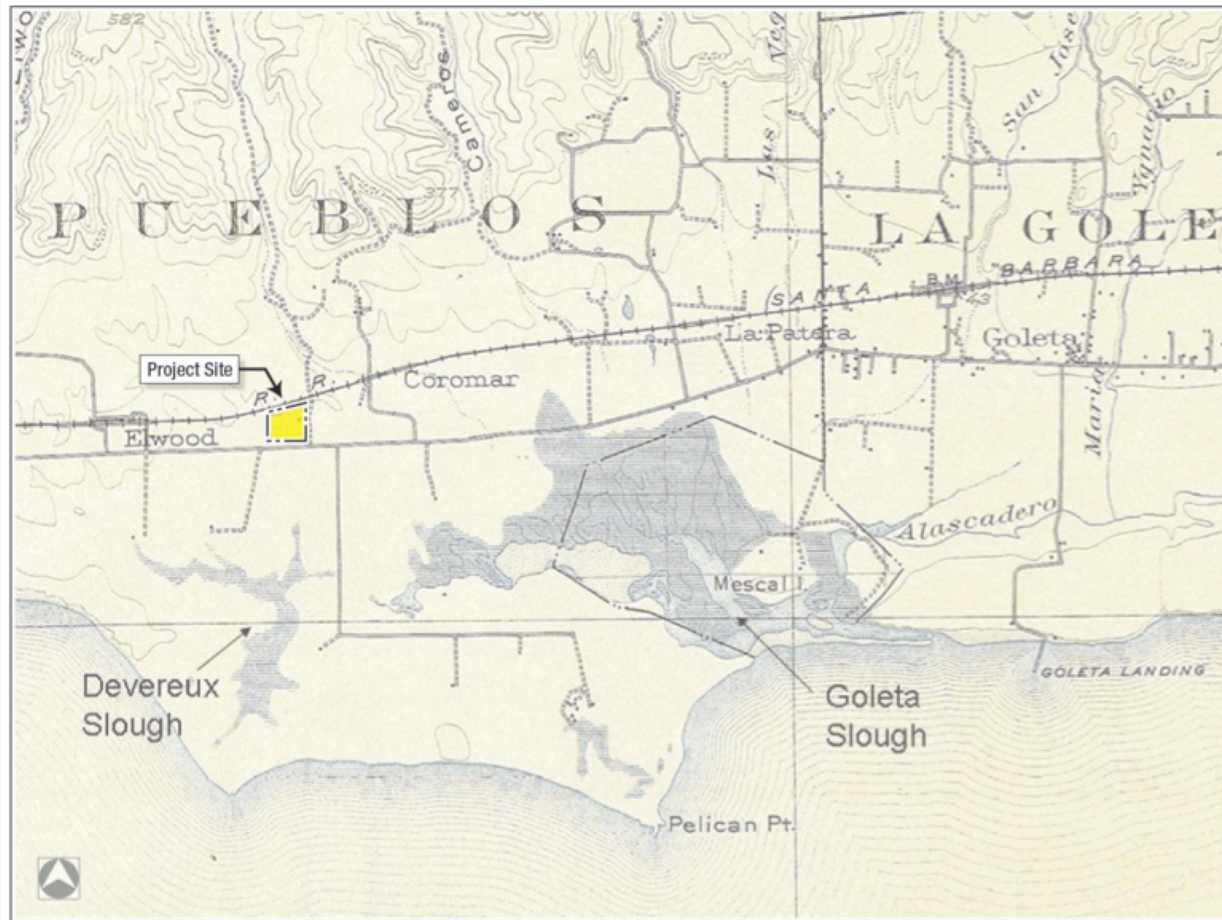
#### Geologic Units and Structure in the Goleta Area

Based on the geologic data sources reviewed for this study, the project site is underlain by predominantly Quaternary marine terrace (intermediate-age alluvium) deposits and possibly young alluvial deposits, with some man-made fill materials. Located on the Goleta-Santa Barbara Coastal Piedmont, the site area uplifted terrain is characterized by elongated, east-west trending folds and faults. Preserved upper Pleistocene marine terrace landforms and deposits include two distinct terrace surfaces age-dated at 47,000 years before the present (ybp) and 58,000 to 60,000 ybp. These terrace surfaces represent preserved "paleo-sea level" useful in dating minimum age of last movement on geologic faults. Geologic units and faults are discussed in more detail below.

#### Site Area Topography, Slope, and Drainage

The topography of the project area prior to grading (UCSB, 2011) was a generally south-southeast sloping surface draining to Devereux Slough. Recent historical grading activities on the project site that have changed the project site's natural topography are related to the construction of the Southern Pacific Railroad cut, the Storke Road / Highway 101 interchange construction, the development of Santa Felicia Drive west of the site, and on-site dirt road crossings. Prior to this grading, the site was crossed by northwest-to-southeast trending drainages that emptied into Devereux Slough to the south. The historic outline of Devereux Slough based on a 1903 topography map (and other historic maps), show that the Slough approached the project area from the south historically, but is believed to have remained well south of Hollister Avenue (University of California Santa Barbara [UCSB], 2011, 1903 USGS map) as shown in **Exhibit 4.5-1**.

**Exhibit 4.5-1**  
**Historical extent of Devereux Slough – 1903**



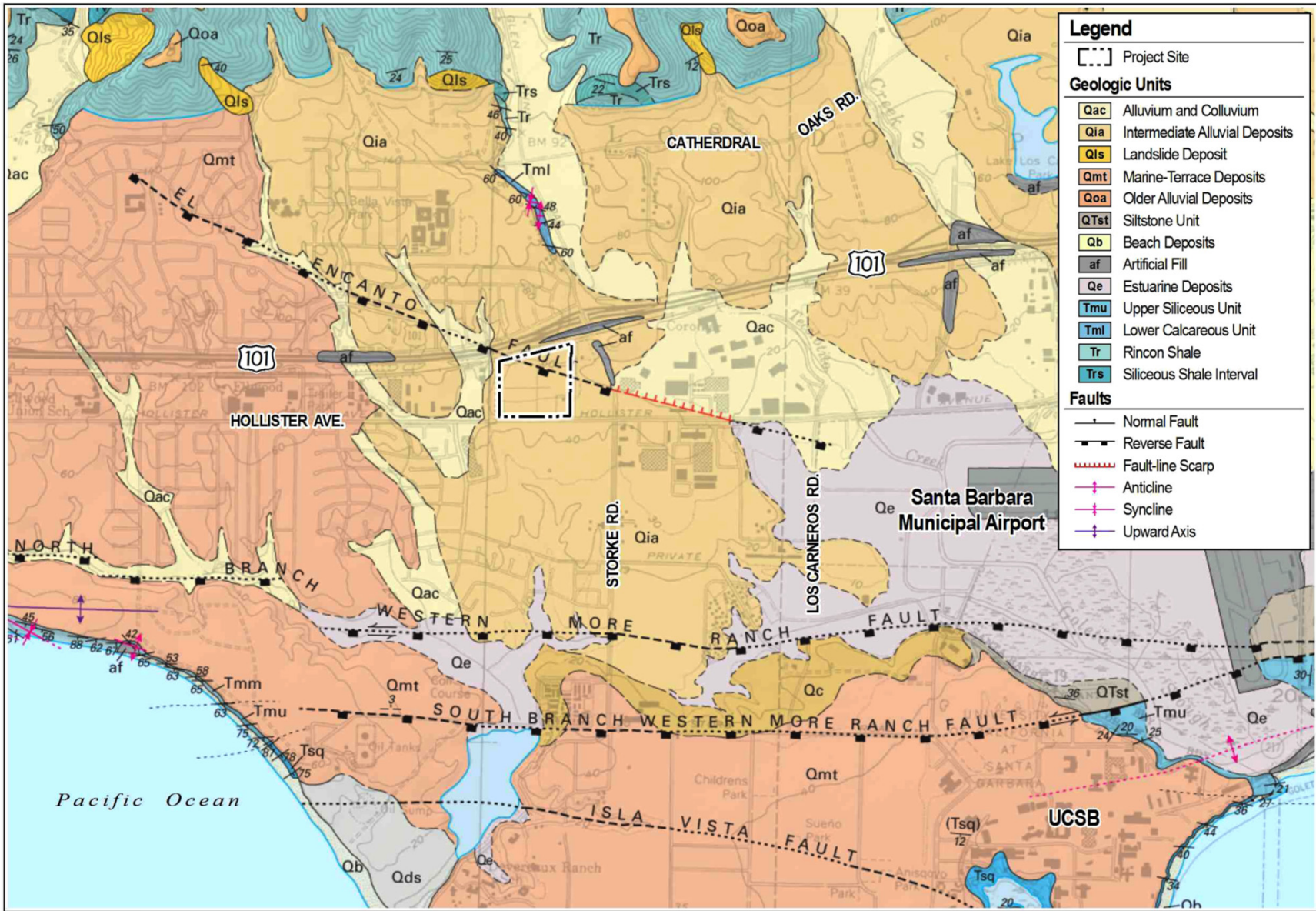
Source: UCSB 1903.

Currently, no large named or blue-line streams are within or immediately adjacent to the project site. Smaller drainage swales exist locally on the west and east edges of the project site. Subsequent minor ground modification appears to have shifted the general slope direction to the south (at one- to two-percent) and lowered the gradient possibly due to excavation along the south edge of the railroad tracks. A berm (maximum height of approximately 14 feet) exists within the northern portion of the project site adjacent to the northern property line that separates the project site and the adjacent railroad right-of-way. Local area slopes approaching 15 percent are found in the northern corners of the site. A man-made drainage feature, lying just south of the railroad right-of-way and bounded by 2:1 (horizontal: vertical) slopes, with an arcuate trend roughly west-to-east across the northern portion of the project site. Elevations across the site range from approximately 71 feet amsl at the northeast corner to about 45 feet amsl at the southwest corner at Hollister Avenue.

### **Project Site Geology Conditions**

Based on regional mapping (Minor, and others, 2009), site-specific geotechnical analysis (GMU, 2009), and historic topographic maps, alluvial formations exposed on the project site include the units summarized in **Table 4.5-1** and depicted in **Figure 4.5-1**.





Source: USGS, Geologic Map of the Santa Barbara Coastal Plain Area, Santa Barbara County, California (2009).

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# Project Area Geologic Formation

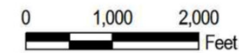


FIGURE 4.5-1

**Table 4.5-1**  
**Artificial Fill and Geologic Formations Exposed Within the Project Site**

<b>Formation</b>	<b>Map Symbol</b>	<b>Age</b>
Artificial Fill <sup>1</sup>	No map symbol	Recent (Historic)
Younger Alluvium <sup>2</sup>	Qa	Holocene and upper Pleistocene
Intermediate-Age Alluvium <sup>2</sup>	Qia	Upper Pleistocene
1. Not mapped, but believed to be present based on grading done within the existing project site. 2. Not mapped, but believed to be present based on historic topographic maps covering the existing project site (UCSB, 2010). Source: Minor, and others, 2009 (see Figure 4.5-1).		

Minor and others (2009) compiled the geologic map using other mapping and original work of the other authors; in particular, they considered the mapping of Dibblee (1987) in the Goleta Quadrangle.

### Artificial Fill

Based on the review of aerial photography dating back to 1938 (Dudek & Associates, 2005), the site has no known history of agricultural use; has been traversed by trails, paths, and dirt roads; has been disturbed by an engineered cut representing the former site of a portion of the Southern Pacific Railroad; has been disturbed from installation of utilities (e.g., the sewer line along the western project boundary) and by imported soils from ground disturbances associated with construction of the Glen Annie Road and/or Storke Road overpasses on U.S. Highway 101 (US 101). In addition, previously existing drainages crossing the site would have been filled to at least several feet deep.

GMU (2009) does not describe the artificial fill within the building areas; however, assuming any fill consists of materials derived on-site, specifically the intermediate-age alluvium (Qia) it would likely be composed of clay and granular material such as medium-grained sand. In general, it is assumed that the characteristics of the artificial fill are:

- Moderately to highly erodible;
- Portions may be suitable if processed for engineered fill;
- Generally stable in low slopes with a gradient shallower than 20 percent;
- Susceptible to slope failures during strong earthquake shaking; and
- Potentially expansive and may have poor foundation characteristics.

It is assumed that any fill masses present were not placed in accordance with current engineering standards and would be unsuitable for the planned development.

### Intermediate-age Quaternary Alluvium (Qia)

Intermediate-age Quaternary (Upper Pleistocene) alluvium mapped by Minor and others (2009) is called marine terrace deposits by GMU (2009, 2011). As shown on Figure 4.5-1, Qia underlies the entire site. Minor and others describe the material as orange-brown, unconsolidated layers of silt, sand, and cobble conglomerate with well-rounded clasts up to about 10 inches long. They conclude that the unit is greater than 20 meters (65 feet) thick



locally (a maximum of 100 feet). GMU (2009, 2011) describes the intermediate-age alluvium from bore hole data as dense, silty fine sand and fine sandy silt, and from the fault trench data as 6-foot-thick Bt soil horizons that are comprised of sandy clay and clayey sand. The clay-rich soils have low to moderate compressibility and generally very high expansion indices (high shrink-swell potential).

Qia engineering properties are likely acceptable, with some modifications, for most construction purposes. Any Saturated medium-dense sandy units may be subject to liquefaction during a strong earthquake. Based on the descriptions from GMU (2009, 2011), some general statements can be made about the potential geologic hazards of the intermediate-age alluvium:

- Moderately erodible;
- Suitable for most construction purposes if processed for engineered fill;
- Generally Potentially unstable on slopes greater than 20 percent;
- Depending on slope height and inclination, Ssusceptible to slope failures during strong earthquake shaking;
- Dense to very dense with a low potential for liquefaction; and,
- Potentially highly to very highly expansive with poor to adequate foundation characteristics.

It is expected that beneath the intermediate-age alluvium, is an old alluvium that in turn overlies the middle Pleistocene Santa Barbara Formation, and the Miocene Monterey Formation (GMU, 2009).

## General Soil Conditions

GMU (2009) excavated and logged six soils borings to depths of 25 feet, confined to two small areas in the northeast and southwest corners of the site where surface water infiltration features are proposed. Limited testing was performed (permeability, blow-counts, moisture content, and dry unit weight), including expansion and corrosivity using one sample in a fault test trench. They concluded that the uppermost 5 feet of soil would be compressible and deeper soils are estimated to have low compressibility. One test indicated severe corrosion potential to ferrous metals, negligible sulfate exposure for concrete, and high expansion potential. Percolation testing indicated low percolation rates in the areas tested.

In June 2011, GMU (report dated July, 2011) conducted additional geotechnical exploration of the project site to assess possible construction design. The exploration consisted of 12 hollow stem auger borings, 5 cone penetration test probes, and 8 backhoe test pits to depths up to 51 feet. Laboratory tests were conducted to determine soil engineering properties, including soil characterization, shear strength, compaction, consolidation, expansion, corrosion, and R-value. Additionally, geotechnical analyses was conducted regarding corrective grading, settlement, seismic design, foundations, liquefaction, retaining walls, and structural pavement.

Geotechnical exploration analyses reconfirmed that the uppermost 5 feet of soil would be compressible and deeper soils are estimated to have low compressibility, that onsite soils should be considered severely corrosive to ferrous metals, that onsite soils have a negligible sulfate exposure for concrete, and that onsite soils should be considered highly expansive. Percolation testing confirmed that native soils that underlie the stormwater storage area have

low infiltration rates, typically less than 0.5 inch/hour. Additionally, it was found that static settlement should not exceed 1.0 inch total and 0.5 inch over 40 feet differential if the recommendations in this report are followed. The geotechnical design report concluded that the proposed grading and improvements and structures are feasible and practical (GMU, July, 2011).

## Geologic Structure

### *Faults, Folds, and Bedding Planes*

#### Regional Faults

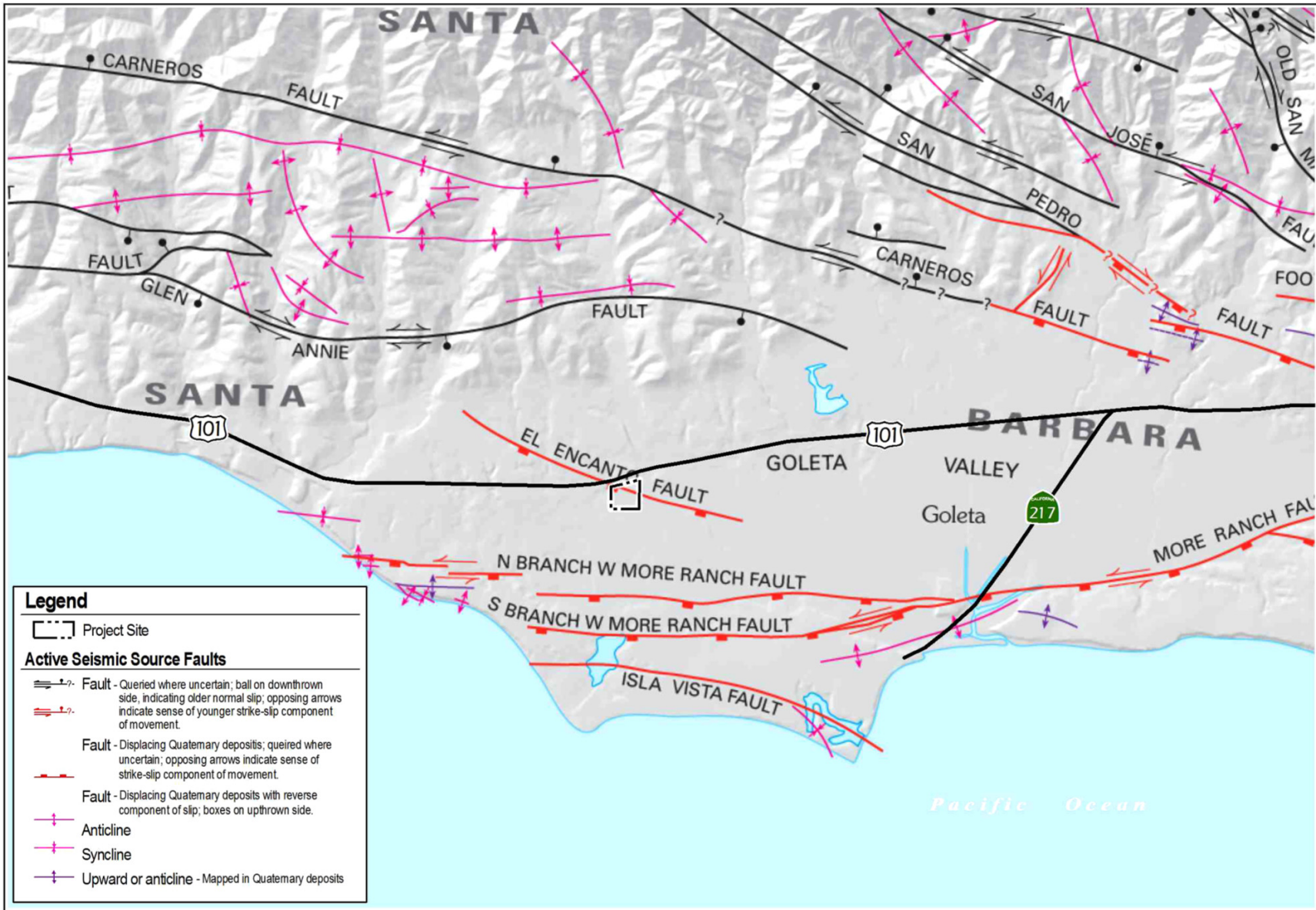
~~A geologic fault is a discontinuity in the earth's crust along which earth materials on one side of the fault have moved vertically or horizontally relative to the other side. The State of California (Alquist Priolo Earthquake Fault Zoning Act, 1972) defines active faults as those where movement within the last 11,000 years (the Holocene epoch) can be demonstrated. Potentially active faults have experienced movement during the last 1.6 million years (the Pleistocene epoch). Inactive faults have no evidence of movement within the last 1.6 million years. The term non-active fault is sometimes used for faults with no evidence of Holocene movement and that are considered unlikely to move during the life of an engineered structure.~~

A geologic fault is a discontinuity in the earth's crust along which earth materials on one side of the fault have moved vertically or horizontally relative to the other side. Based on criteria established by the State Mining and Geology Board (SMGB) in the California Code of Regulations, Title 14, Sections 3600 et seq., and as summarized in the Special Publication 42 Fault Rupture Hazard Zones in California by the State of California Geological Survey (CGS), faults can be classified as active, potentially active, or inactive.<sup>1</sup> The State of California Alquist-Priolo Earthquake Fault Zoning Act (2007), California Public Resources Code Sections 2621 et seq., defines an active fault as one that has had surface displacements within Holocene time (about the last 11,000 years). Initially, faults were defined in the Alquist-Priolo Act as "potentially active", and were zoned, if they showed evidence of surface displacement during Quaternary time (last 1.6 million years). Beginning in 1977, evidence of Quaternary surface displacement was no longer used as a criterion for zoning. Since 1975, the State of California defined the terms "sufficiently active" and "well defined" for application in zoning faults. These two terms constitute the present criteria used by the State Geologist in determining if a given fault should be zoned under the Alquist-Priolo Act. A fault is deemed sufficiently active if there is evidence of Holocene surface displacement. A fault is considered well-defined if its trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface (Alquist-Priolo Earthquake Fault Zoning Act, 2007). Inactive faults have no evidence of movement within the last 1.6 million years. The term non-active fault is sometimes used for faults with no evidence of Holocene movement and that are considered unlikely to move during the life of an engineered structure.

Numerous active and potentially active geologic faults within 45 miles are considered for the potential strong groundshaking affects at the site based on data contained in the City of Goleta General Plan/Coastal Land Use Plan Safety Element Background Report #16 (City of Goleta, 2004)). These are listed in **Table 4.5-2** and mapped on **Figure 4.5-2** (Minor and others, 2009).

The project site is located approximately 4,600 feet north of the More Ranch fault, which is the western 10-mile portion of the 41-mile long active Mission Ridge-Arroyo Parida fault system.

<sup>1</sup> The California Geological Survey was formerly called the California Division of Mines and Geology (CDMG).



Source: USGS, Geologic Map of the Santa Barbara Coastal Plain Area, Santa Barbara County, California Figure 11, <http://pubs.usgs.gov/sim/3001/>.

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## Seismic Source Faults

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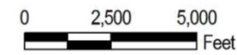


FIGURE 4.5-2



There is disagreement in various databases as to the sense of movement (reverse [Peterson and others, 1996] and left lateral-oblique [Gurrola, 2003 and SCEC, 2011]) and dip direction (north [Peterson and others, 1996] and south [Gurrola, 2003]) of the fault. We conclude that the More Ranch fault (Gurrola, 2003) is a potentially active reverse-left oblique fault dipping to the south that is mostly “blind” (rupture/offset does not penetrate to the ground surface). The City of Goleta Safety Element indicates (see Table 4.5-2) the More Ranch fault has a maximum credible earthquake magnitude of 5.8+. Peterson and others (1996) indicate an estimated average slip rate is 0.2 to 0.6 millimeters per year (mm/yr), an estimated maximum moment magnitude (Mw) earthquake of 6.7, and an annual recurrence interval is 1,076 years (Peterson and others, 1996). It is noted by Minor and others (2009) that no significant deformation has been recognized in the mapped Holocene deposits despite historic earthquake activity and geodetic evidence for active tectonic rotation in the region.

### Local Faults

Minor and others (2009) map a west-northwest trending, south-dipping reverse fault through the site, which they term the El Encanto fault. GMU (2009) reports on their 2007 fault investigation based on the Minor and others 2009 geology and fault map; GMU (2007 and 2009) calls the fault the North Ellwood fault, which is noted in the City of Goleta General Plan/Coastal Land Use Plan (General Plan/Coastal Land Use Plan Figure 5-1, 2008). The site is not within an Alquist-Priolo Earthquake Fault Zone (APEFZ; California Division of Mines and Geology [CDMG], 1997). GMU analyzed the potential for fault hazards on the property using aerial photograph interpretation, surface geophysical methods, and fault investigation trenches.

Minor and others describe the El Encanto fault as follows:

“The El Encanto fault in western Goleta Valley is inferred from a 3.4-km-long northwest-trending geomorphic lineament consisting of aligned linear drainage channels, depressions, and a subdued scarp near its southeast end. The fault is interpreted to have southwest-up, reverse displacement based on slightly higher ground surfaces southwest of the lineament and a northeast-facing apparent fault-line scarp that crosses Hollister Avenue south of U.S. Highway 101. A youthful age for the probable El Encanto fault is suggested by its geomorphic expression in upper Pleistocene deposits (Qia, Qmt).”

**Table 4.5-2**  
**Earthquake Faults and Expected Earthquake Magnitudes/Accelerations within**  
**45 Miles of the Project Site**

<b>Fault Type: Name</b>	<b>Approximate Minimum Distance From Site (Miles)</b>	<b>Maximum Credible Earthquake (Richter Magnitude)</b>	<b>Approximate Peak Ground Acceleration (g = gravity)</b>	<b>Estimated Mercalli Scale Intensity (see Source Table 2)</b>
<b>Active:</b>				
Big Pine	19.0	7.1-7.2	0.24	VII-VIII
Mesa	7.6	5.0+	0.34	VII-VIII
More Ranch	0.6	5.8+	0.51	VIII-X
Nacimiento	25.0	7.6+	0.24	VII-VIII
San Andreas	45.0	8.25	0.16	VII
Santa Ynez	10.0	7.2	0.42	VII-VIII

<b>Fault Type: Name</b>	<b>Approximate Minimum Distance From Site (Miles)</b>	<b>Maximum Credible Earthquake (Richter Magnitude)</b>	<b>Approximate Peak Ground Acceleration (g = gravity)</b>	<b>Estimated Mercalli Scale Intensity (see Source Table 2)</b>
<b>Potentially Active:</b>				
Goleta (San Pedro)	7.5	4.5	0.30	VI-VIII
San Jose	4.2	5.8	0.51	VIII-IX
El Encanto (North Ellwood)	0.0	No estimate	No estimate	No estimate
Source: City of Goleta (2004), Table 1 by RBF Consulting. Distances are modified from Table 1 and the El Encanto fault (Minor and others, 2009) is added.				

Campbell Geo (2007) performed a geologic hazard evaluation for a property at the northwest corner of Cortona Drive and Hollister Avenue (proposed Rincon Hotel), several hundred feet east of the project site. Their evaluation of the El Encanto fault (they called it the North Ellwood fault based on earlier geologic studies) included review of existing data, aerial photograph interpretation, exploratory trenching, and a seismic reflection/refraction geophysical profile. Their study concluded that the fault does offset and disturb upper Pleistocene terrace deposits and is considered potentially active. Although their study concluded that the El Encanto fault is potentially active, in their exploratory trenches they found no fractures, fault gouge, or offsets indicative of a precise fault location, and the study indicates the absence of a surface rupture hazard. They did find post-depositional disturbance of the marine terrace deposits Qia and some gentle warping of the unit contacts at the north end of both trenches. The associated project MND (City of Goleta, 2007) indicates the fault is non-active and that a 50-foot setback for habitable structures is required based on City of Goleta Policy SE 4.4. The geologic analysis for the Cabrillo Business Park EIR (City of Goleta, 2007), a development southeast of the project site, relied upon a fault location investigation conducted by Michael F. Hoover, Consulting Geologist (Hoover, 2007), which found that the El Encanto fault occurred along to the north of the estimated trajectory found depicted in the City General Plan/Coastal Land Use Plan Figure 5-1 (Geologic Hazards Map).

GMU (2007 and 2009) used seismic reflection, seismic refraction, and trenching techniques to characterize the El Encanto fault within the project site. They found that there are three possible faults at depths of about 150 feet at the north end of the seismic reflection profile that may affect the upper Pleistocene deposits and that “the uppermost 150 feet of strata are not noticeably offset by the potential secondary faults”. Also, they “detected no observable faults” in three exploration trenches, one located on the main mapped El Encanto fault and one possible deep fault, and two trenches located at estimated projection points of the other two possible deep faults. GMU (2007 and 2009) concluded, “there are no sufficiently active and well-defined faults present within the site” and “a fault setback is not required per the City of Goleta General Plan/Coastal Land Use Plan because there are no active surface faults on the subject property.” They indicate that the fault is inactive and that the mapped photolineations are attributable to a northside up “topographic step (that) is interpreted to be a denuded paleo-shoreline sea cliff.” Based on the GMU evaluation report, the El Encanto fault is not considered to pose an earthquake risk to the development.

The 2007 and 2009 GMU reports rely on four types of data and analysis to reach their conclusions:

1. Review of available literature,
2. Interpretation of aerial photographs,
3. A seismic reflection geophysical profile, and
4. Logging of exploratory fault trenches.

GMU (2007) used these techniques to characterize the El Encanto fault (Minor and others, 2009). Considering the information provided for the four analysis types, the peer review of this study conducted for this EIR was able to directly review and evaluate items 1 and 3, while items 2 and 4 are not directly available for review. The peer review considered relevant available studies (item 1) and the seismic reflection profile (item 3) for other possible interpretations. The aerial photographs (item 2) were not available, but the description of the findings was reviewed. Only the drafted logs of the fault trenches (item 4) were reviewed.

In addition, the GMU reports refer to the City General Plan/Coastal Land Use Plan Safety Element (adopted October 2006, amended 2008, and republished November 17, 2009), though not to specific passages. The peer review identified two relevant passages (page 5-18):

- **SE 4.2 Potentially Active Faults. [GP/CP]** Potentially active faults shall be subject to the same requirements as active faults unless and until geological or geotechnical studies demonstrate that a given potentially active fault is not active.
- **SE 4.4 Setback from Faults. [GP/CP]** New development shall not be located closer than 50 feet to any active or potentially active fault line to reduce potential damage from surface rupture. Nonstructural development may be allowed in such areas, depending on how such nonstructural development would withstand or respond to fault rupture or other seismic damage.

Following a discussion of the peer review with GMU, they prepared a letter clarifying issues discussed (GMU, February, 2011) and providing additional information not previously available. A summary of the issues and additional information is presented below.

1. The 2007 and 2009 GMU reports indicate that the El Encanto fault likely lies north of the project site. Following submittal of the 2007 fault investigation report, a 2009 update of the Minor and others USGS report (with Dr. Gurrola as one co-author) shows the subject El Encanto fault in the same location. GMU (February, 2011) indicates that the 2007 fault report was not in the public record until 2009; therefore, was not known to Minor and could not have been referenced in the revised USGS report/map. They indicate that Dr. Gurrola was a relatively minor co-author without authority to make such changes on his own had the report been public.
2. Dr. Gurrola (Gurrola and others, 2003) mapped an active fold structure about 0.5 mile northeast of the El Encanto fault and the peer review asked for clarification of the relationship of this or other active folds to the project site. GMU (February, 2011) indicates that the 2007 and 2009 studies were directed at active surface faulting not folding, and that (a) folding of the strata between the interpreted “purple and yellow” buried marine terrace surfaces (geologic contacts) is not readily apparent and (b) movement on this fold, if it were to exist, would not have a significant impact at the ground surface because there is approximately 150 feet of dense terrace deposits above the “yellow” geologic contact (marine terrace surface per GMU, February, 2011).



3. The aerial photograph analysis conducted by GMU (2007) concludes that the photolineament is a “soil tonal color and an apparent topographic step” that characterizes the mapped fault location and “is interpreted to be a denuded paleo-shoreline sea cliff” that “forms during paleo-high sea level stands”. GMU (February, 2011) indicates that there is no indication that the cliff structure in the seismic reflection records because the “feature is very subtle and likely the result of a temporary shoreline within the overall terrace surface. This subtle surface feature is not expected to have a subsurface signature; rather, it was likely notched into the terrace surface at the time of formation.”
4. In the 2007 and 2009 reports, GMU indicates that the geologic interpretation of the seismic reflection record by Advanced Geosciences reflects a normal fault structure, whereas the project area is generally with a compressional (reverse/thrust fault) geologic setting as indicated by Minor and others (2009, as quoted above). In their response to the peer review, GMU indicates that the three possible faults interpreted from seismic surveys may not exist, but it was the most conservative assumption to take for the project “for conservatism, the fault scenario was presented on the seismic reflection profile and used in part to select locations for additional fault trenching.” Also, as mentioned in item 2 above, even if hypothetically a south-dipping reverse fault, possibly a “blind” fault that does not offset the shallow geologic units, were interpreted instead, there is no evidence that it would impact the development.
5. The peer reviewer requested additional details of the trench logging methodology and process, which GMU (February, 2011) provided, along with a copy of the original field logs. No regulatory agency representatives viewed the trench in 2007.
6. The peer review requested clarification on the method used to project the three red-line faults upward 150-feet to the ground surface to locate trenches T-2 and T-3. GMU (February, 2011) indicates the faults were projected along their uppermost trend in the seismic reflection profile and that the trenches were a conservative approach to investigate features unlikely to be faults.
7. In the 2007 and 2009 reports GMU refers to a seismic reflection profile by Advanced Geosciences at a site located at the northwest corner of Cortona Drive and Hollister Avenue; the peer review requested more information about that profile and it was provided (GMU, February, 2011). GMU indicates that the Cortona Drive profile clearly shows what is believed to be the El Encanto fault and that this same seismic signature is not present at the project site, therefore the El Encanto fault is likely to the north of the site.
8. A request was made to clarify the relationship in the stratigraphy between the Cortona Drive site and the project site based on the two seismic reflection profiles. GMU (February, 2011) indicates that the “seismic profile for the subject site correlates well with the southwest end of the seismic profile for the adjacent site. For example, the yellow line on our profile is approximately 6,000 ft/sec and occurs at an elevation of about -60 to -70 feet. This velocity layer correlates approximately with the yellow line on the attached profile from the adjacent investigation, where the line is placed at 5,500 feet/sec at an elevation of about -55 to -60 feet.”
9. The peer review requested that GMU clarify the relationship of their results to the City of Goleta Safety Element Policies SE 4.2 and SE 4.4 quoted above. GMU (February, 2011) indicates that their study has demonstrated that the main trace of the subject fault is not within the site and that any potential secondary faults are inactive, and that this also satisfies the intent of the Alquist-Priolo Act and the City of Goleta General Plan/Coastal Land Use Plan Safety Element 4.4 for setback from active faults. In

addition, they indicate that Safety Element 4.4 applies to an active fault line and associated surface rupture, and therefore does not reasonably apply to folds because there is no fault line or surface rupture.

Conclusions regarding the potential presence of the El Encanto fault at the project site as it relates to the project are provided below in the project impacts discussion (Section 4.5.4 *Project Impacts, Faulting*)

### Folds and Bedding Planes

Strike (the compass direction of a horizontal line on a plane) and dip (slope angle of original sedimentary layering relative to horizontal) are the two measurements used to describe the geometry of a bedding plane or fault. Because no bedrock formations are exposed within or immediately adjacent to the site, there are no bedding plane attitudes to report. The project site is within the western Santa Barbara fold belt (Gurrola, 2004; **Figure 4.5-3**) characterized by northwest trending strike-slip faults (predominantly lateral movement) in the Santa Ynez Mountains and south-dipping reverse-left oblique thrust faults (predominant movement south over north). The reverse faults are considered (or proven to be) active based on earthquake locations mainly in the Santa Barbara Channel and limited onshore examples of dated Holocene faulting and uplift/folding (Gurrola, 2004). No active faults or major folds are considered to be present within or immediately adjacent to the project site (GMU, 2007 and 2009).

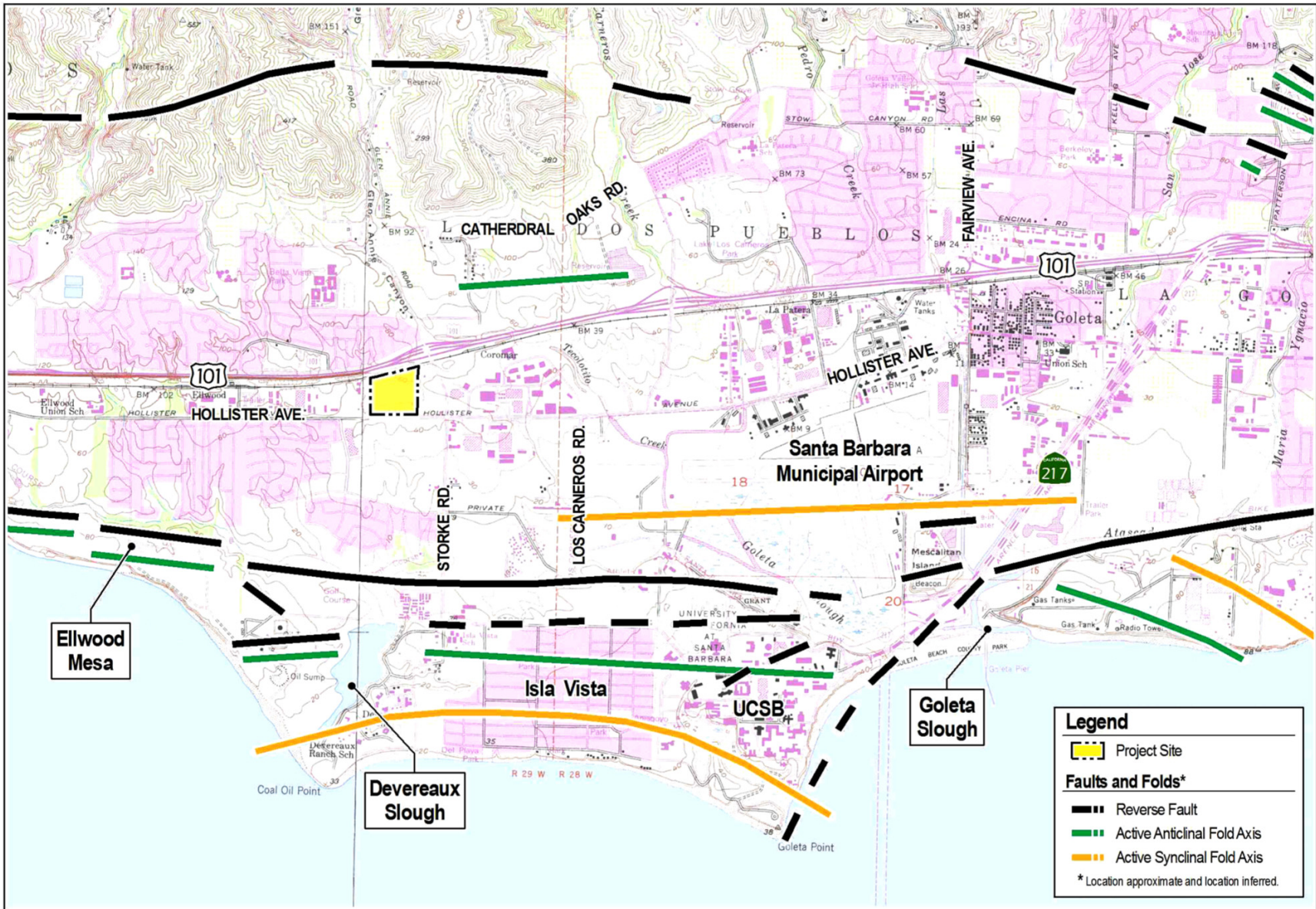
### Co-Seismic Uplift and Active Folds

**Figure 4.5-3** shows the active faults and includes active fold structures mapped within the western Santa Barbara fold belt (Gurrola, 2003). The indication is that from a paleoseismic study of the More Ranch faults (thought to be blind faults not exposed at the surface) they determined that a rupture on the More Ranch segments could produce surficial uplift associated with bending moment faulting along the anticlinal fold crests (the green lines on Figure 4.5-3). Single or multiple segment ruptures could produce uplift on the hanging wall block over the anticlinal crest of approximately 1 to 3 meters and at least 0.5 meter of bending moment faulting. The nearest known active anticline is approximately 0.5-mile north of the project site. If this anticline were the focus for 3 meters of vertical uplift (which is unlikely) the tilt of the ground surface at the site would be less than one percent and cause no damage to the site (beyond the strong earthquake shaking). If such co-seismic uplift were to occur above the El Encanto fault (also very unlikely) the project site could experience lesser uplift and tilt.

### Earthquakes and Ground Motion

Earthquake records in the Santa Barbara area extend from the late 1700's during the time of Spanish mission formation. Three large earthquakes occurred, one each in 1812, 1925, and 1927 (Gurrola, 2003). The 1812 event, based on strong shaking and damage records was likely a magnitude 7 event. The seismic source is unknown, but may have been one of the Santa Barbara fold belt south-dipping reverse faults or a fault farther out in the Channel. The City of Santa Barbara event on June 26, 1925 produced extensive damage to the downtown and surrounding areas with an estimated Modified Mercalli Intensity (MMI) of VII-IX indicating a magnitude of M6.3 to 6.8; the source fault has not been identified. In 1927 the Point Arguello earthquake produced low MMI values in the City from a M7.3 earthquake some 100 miles to the west.

Similar to most of southern California, the project site is subject to some level of damaging ground shaking as a result of movement along the major active (and potentially active) fault



Base Source: USGS Quadrangle. Fault and Fold Source: Gurola, Figure 2, [http://www.larrygurola.com/2003\\_scec\\_guidebookfinal.pdf](http://www.larrygurola.com/2003_scec_guidebookfinal.pdf) (2003).

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## Site Area Faults and Folds

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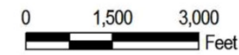


FIGURE 4.5-3



zones that characterize this region. The nearest significant known active or potentially active fault with the potential to produce strong ground shaking at the site is the More Ranch Fault located less than one mile south of the project site per the City's General Plan/Coastal Land Use Plan Safety Element (2008, their Figure 5-1) and Minor and others (2009 Geologic Hazards Map).

Per the geotechnical review (GMU 2007, 2009, 2011) and peer review, the El Encanto Fault is known to exist at the Rincon Palm Hotel site and the Cabrillo Business Park; however, the trajectory of the fault shifts north, northwest of the Rincon Palms Hotel site and continues north of the project site. As such, no known faults are found on the project site or within 50 feet of the project boundaries.

Ground motion values (10 percent probability of being exceeded in 50 years) for the project site have been obtained from the California Geological Survey (CGS; 2011) interactive website. These values are expressed as a fraction of the acceleration due to gravity (g). Three values of ground motion are provided by CGS including peak ground acceleration (PGA), spectral acceleration at moderate (0.2 second) and short (0.1 second) periods. Ground motion values are modified to account for local site soil conditions, in this case ~~soft rock~~ alluvium (or stiff soil) (site category GD as defined by the California Building Code, 2010). The values for the project site are as shown on **Table 4.5-3**.

**Table 4.5-3**  
**Probabilistic Earthquake Site Parameters**

<b>Ground Motion (g = force of gravity)</b>	<b>Firm Rock</b>	<b>Soft Rock</b>	<b>Alluvium</b>
Peak Horizontal Ground Acceleration (PHGA in g)	0.36	0.37	0.40
Spectral Acceleration (0.2 second period)	0.85	0.89	0.96
Spectral Acceleration (0.1 second period)	0.31	0.39	0.48

These values are representative of the ground motion for the surrounding region and are moderate compared to the levels in more seismically active parts of the State.

A deterministic estimate of the potential for strong groundshaking (City of Goleta, 2008) indicates the fault system may be capable of producing approximately 0.49g (equal to 49 percent of the force of gravity) at the site for this maximum earthquake event of magnitude (M) 6.7. Assuming a risk level of 10 percent probability of exceedance in 50 years (i.e., -475 year ARP), GMU (~~2009, July~~ 2011) estimated the peak horizontal ground acceleration (PHGA) is ~~0.59~~ 0.58g.

## Groundwater and Liquefaction

The nearest Goleta Basin groundwater wells are east of the project site near the intersection of Los Carneros Road and Hollister Avenue. The final Goleta Groundwater Basin Management Plan (Bachman, 2010, his Figure 2-2) indicates that in this area groundwater is at elevation 15

to 20 feet amsl (or 25 to 40 feet below ground surface (bgs) at the project site). K-C Geotechnical (1994) states their investigations in 1994 indicate perched groundwater lies at depths ranging from approximately 16 feet bgs near the south side of the site to approximately 44 feet bgs near the north side of the site. GMU (2011) encountered groundwater at 35 to 37 feet below existing site grade (12 to 14 feet amsl). Current groundwater elevations are likely lower than historic high water levels, which could be at least several feet higher.

Two of three elements for potential liquefaction are likely present at the project site, potentially strong earthquake ground shaking and shallow groundwater. However, the Pleistocene age of the intermediate-age alluvium, the presence of clay in the formation, and the relatively high blow-counts (sand units classified as dense to very dense) achieved in the drilling (GMU, 2009, Appendix A) suggest that the liquefaction potential is low in the areas investigated. Additional geotechnical exploration analyses concluded the potential for liquefaction is minimal. Liquefaction-induced seismic settlement is negligible, and lateral spreading is not considered a site hazard (GMU, July 2011).

### ***Other Geologic Hazards***

#### **Flooding, Tsunami and Seismically-Induced Dam Failure Inundation**

Flood and tsunami hazards are presented in the City of Goleta General Plan/Coastal Land Use Plan EIR Figure 5-2 (City of Goleta, 2008). In historic times two tsunamis have had a significant run-up along the Santa Barbara coastline; these were caused by the 1812 and 1927 earthquakes, discussed above. Run-up from each tsunami event was about 6 feet (2 meters), with the 1812 event affecting Santa Barbara directly. The probable 10-foot run-up (not shown) would not reach the site and the 38-foot possible tsunami (shown) would approach the project site falling from 3 to 10 feet in elevation below site elevations based on recent evaluations by the United States Geological Service (USGS) and California Geological Survey (CGS).

With regard to flooding, Penfield & Smith (2010, Attachment A) provide the FIRM map with no indication of flood hazard from the 100-year or 500-year floods.

The only reservoir directly upstream from the site that could fail and produce down stream inundation potential at the site is the Glen Annie Reservoir (USBR, 2011); it is an earthfill dam built in the 1951-1954 period, has a crest length of 240 feet, a height of 135 feet, a maximum reservoir capacity of 470 acre-feet and is located at the outlet of Tecolote Tunnel. The dam is located approximately 2.6 miles north of the site within West Fork (Glen Annie Canyon Creek) and in the event of a dam failure flood water would drain down Glen Annie Creek just west of Glen Annie Road to the north side of US 101 at a point north of the site, where the creek turns east and flows under the freeway into Tecolotito Creek that passes well to the east of the project site on the east. T, therefore the probability for dam inundation flooding at the site is considered very low.

#### **Oil and Gas**

The project site is located at the south end of the Glen Annie Gas Field and east of the Ellwood Oil Field (K-C Geotechnical, 1994). They indicate numerous oil and gas leases have been obtained for the broader historical parcel of which the site was a part; however, there is no indication that oil or gas has been produced in the immediate site area. Available maps indicate that no oil or gas wells have been drilled at the site and that several oil wells have been drilled within a 1/4-mile of the site, the closest is indicated to be located approximately 500 to 600 feet

west of the southwest corner of the site. All of these off-site wells are reportedly plugged and abandoned dry holes.

### Subsidence

There is no indication in the City General Plan/Coastal Land Use Plan Safety Element (2008) or other readily available sources that ground subsidence is occurring in the City. Groundwater levels in the Goleta Basin were at or near historic lows in the 1980s and 1990s (Bachman, 2010, Figures 2-5 through 2-12) without subsequent reports of subsidence. Since there is no oil and gas development in the immediate site area, groundwater extraction is from the relatively well-consolidated Santa Barbara Formation, and the marine terrace deposits (Qia) underlying the site are relatively dense. Subsidence concentrated at the project site is unlikely.

## **4.5.2 Regulatory Framework**

### **Federal Regulations**

The Uniform Building Code (UBC) is a model building code that was published by the International Conference of Building Officials (ICBO). The UBC defines different regions of the United States and ranks them according to their seismic hazard potential. There are four types of these regions, including Seismic Zones 1 through 4, with Zone 1 having the least seismic potential and Zone 4 having the highest seismic potential. The project is within in Seismic Zone 4; accordingly, any future development would be required to comply with all design standards applicable to Seismic Zone 4.

The International Building Code (IBC) is a model building code published by the International Code Council (ICC) that combines three model building codes: the UBC published by the ICBO used on the West Coast and in some of the Midwest, the Building Officials Code Administrators National Building Code (BOCA/NBC) published by the Building Officials Code Administrators International (BOCA) used on the East Coast and in some of the Midwest, and the Standard Building Code (SBC) published by the Southern Building Code Congress International (SBCCI) used in the Southeast. The IBC has no regional limitations and, like the UBC, is published on a triennial basis.

The IBC classifies structures into Seismic Design Categories. Seismic Design Categories includes classifications of A-F and are based on three criteria: (1) probable site ground motions, which is based on Federal Emergency Management Agency maps, the maximum spectral acceleration and the design acceleration response; (2) soil site class, which are based on soil classifications A-F (hard rock, rock, very dense soil/soft rock, stiff soil, soft soil and special soil); and (3) building occupancy use, which is broken down by four types – Type IV (agricultural buildings), Type III (essential buildings), Type II (structures that represent a substantial hazard in the event of a collapse), Type I (all other buildings). The process to determine the applicable Seismic Design Category must be done by an engineer.

### **State Regulations**

#### ***Building Codes***

In 2010, the California Building Standards Commission (CBSC) adopted the 2009 IBC as amended by the CBSC, which became the 2010 California Building Standards Code, California Code of Regulations, Title 24. The 2010 California Building Standards Code is commonly referred to as the 2010 California Building Code and became effective January 1, 2011.

Development in the State of California is governed by the 2010 California Building Code (CBC, 2010), as amended and adopted by each local jurisdiction. These regulations include provisions for site work, demolition, and construction, which include excavation and grading, as well as provisions for foundations, retaining walls and expansive and compressible soils.

The California Seismic Safety Commission was established by the Seismic Safety Commission Act in 1975, California Government Code Sections 8870 et seq., with the intent of providing oversight, review, and recommendations to the Governor and State Legislature regarding seismic issues. The commission's name was changed to Alfred E. Alquist Seismic Safety Commission in 2006. Since then, the Commission has adopted several documents based on recorded earthquakes, such as the 1994 Northridge earthquake, 1933 Long Beach earthquake, the 1971 Sylmar earthquake, etc. Some of these documents are listed below:

- Research and Implementation Plan for Earthquake Risk Reduction in California 1995 to 2000, report dated December 1994;
- Seismic Safety in California's Schools, 2004, "Findings and Recommendations on Seismic Safety Policies and Requirements for Public, Private, and Charter Schools," report dated December 1994;
- Findings and Recommendations on Hospital Seismic Safety, report dated November 2001; and
- Commercial Property Owner's Guide to Earthquakes Safety, report dated October 2006.

### ***Alquist-Priolo Earthquake Fault Zoning Act***

The Alquist-Priolo Geologic Hazards Zone Act, California Public Resources Code Sections 2621 et seq., was enacted by the State of California in 1972 to address the hazard and damage caused by surface fault rupture during an earthquake. The Act has been amended ten times and renamed the Alquist-Priolo Earthquake Fault Zoning Act, effective January 1, 1994, which is the name of the Act today. The Alquist-Priolo Earthquake Fault Zoning Act, California Public Resources Code Sections 2621 et seq., revised in 2007, defines an active fault as one which has had surface displacements within Holocene time (about the last 11,000 years). Initially, faults were defined in the Alquist-Priolo Act as "potentially active", and were zoned, if they showed evidence of surface displacement during Quaternary time (last 1.6 million years). Beginning in 1977, evidence of Quaternary surface displacement was no longer used as a criterion for zoning. Since 1975, the State of California defined the terms "sufficiently active" and "well defined" for application in zoning faults. These two terms constitute the present criteria used by the State Geologist in determining if a given fault should be zoned under the Alquist-Priolo Act, and are defined as follows ((Alquist-Priolo Earthquake Fault Zoning Act, 2007):

"Sufficiently active. A fault is deemed sufficiently active if there is evidence of Holocene surface displacement along one or more of its segments or branches. Holocene surface displacement may be directly observable or inferred; it need not be present everywhere along a fault to qualify that fault for zoning.

"Well-defined. A fault is considered well-defined if its trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The fault may be identified by direct observation or by indirect methods (e.g., geomorphic evidence; Appendix C). The critical consideration is that the fault, or some part of it, can be located in the field with sufficient precision and confidence to indicate that the required site specific investigations would meet with some success."



The Alquist-Priolo Earthquake Fault Zoning Act, California Public Resources Code Sections 2621 et seq., requires the State Geologist to establish “earthquake fault zones” along known active faults in the State. Cities and counties that include earthquake fault zones are required to regulate development projects within these zones.

### ***Seismic Hazards Mapping Act***

The Seismic Hazard Mapping Act of 1990, California Public Resources Code Sections 2690 et seq., was enacted, in part, to address seismic hazards not included in the Alquist-Priolo Act, including strong ground shaking, landslides, and liquefaction. Under this Act, the State Geologist is assigned the responsibility of identifying and mapping seismic hazards zones.

The State of California Geologic Survey (CGS) (previously known as the Division of Mines and Geology (CDMG) and herein called CGS) has also adopted seismic design provisions in Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California on March 13, 1997 and revised and readopted on September 11, 2008. The CGS also provides guidance with regard to seismic hazards under Seismic Hazards Mapping Act; seismic hazard zones are to be identified and mapped to assist local governments in planning and development purposes. The intent of this publication is to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and other hazards caused by earthquakes. In addition, CGS Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California, provides guidance for evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations.

### ***California Environmental Quality Act (CEQA)***

The 1970 California Environmental Quality Act (CEQA) ensures that local agencies consider and review the environmental impacts of projects within their jurisdictions. CEQA requires that an environmental document (e.g., Environmental Impact Report [EIR] or Mitigated Negative Declaration [MND]) be prepared for projects that are judged in an Initial Study (IS) to have potentially significant effects on the environment. Environmental documents (IS, MND, EIR) must consider, and analyze as deemed appropriate, geologic, soils, and seismic hazards. If impacts are considered potentially significant, recommendations for mitigation measures are made to reduce geologic and seismic hazards to less than significant. This allows early public review of development projects and provides lead agencies the authority to regulate development projects in the early stages of planning.

### ***Natural Hazards Disclosure Act***

The Natural Hazards Disclosure Act (effective June 1, 1998), requires:

“That sellers of real property and their agents provide prospective buyers with a “Natural Hazard Disclosure Statement” when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone.”

The Seismic Hazard Mapping Act (SHMA) specifies two ways in which this disclosure can be made:

“c. In all transactions that are subject to Section 1103 of the Civil Code, the disclosure required by subdivision (a) of this section shall be provided by either of the following means:

- 1) The Local Option Real Estate Transfer Disclosure Statement as provided in Section 1102.6a of the Civil Code.
- 2) The Natural Hazard Disclosure Statement as provided in Section 1103.2 of the Civil Code.”

The Local Option Real Estate Disclosure Statement can be substituted for the Natural Hazards Disclosure Statement if it contains substantially the same information and substantially the same warning as the Natural Hazards Disclosure Statement. Both the APEFZ Act and the SHMA require that real estate agents, or sellers of real estate acting without an agent, disclose to prospective buyers that the property is located in an APEFZ or SHMZ.

### ***City of Goleta Regulations***

The City of Goleta Planning and Environmental Services Department and the Community Services Department Engineering Division have the responsibility for land development review and engineering approvals of all private development within the City to ensure compliance with City codes, ordinances and policies, and the preparation and enforcement of conditions of approval for development projects. The City has adopted the CBC to use as its own building code.

The City’s grading regulations (Goleta Municipal Code Title 15, Chapter 15.09) pertain to new grading, excavations, fills, cuts, borrow pits, stockpiling, and compaction of fill, “... where the transported amount of materials... exceeds 50 cubic yards or the cut or fill exceeds 3 feet in vertical distance to the natural contour of the land.”

### **4.5.3 Thresholds of Significance**

The City’s *Environmental Thresholds and Guidelines Manual* (City of Goleta, 2011) assumes that a project would result in a potentially significant impact on geological processes if the project, and/or implementation of required mitigation measures, could result in increased erosion, landslides, soil creep, mudslides, and/or unstable slopes. In addition, impacts are considered significant if the project would expose people and/or structures to major geological hazards such as earthquakes, seismic related ground failure, or expansive soils capable of creating a significant risk to life and property.

The City of Goleta’s *Environmental Thresholds and Guidelines Manual* includes Geologic Constraints Guidelines approved in August 1993 by the Santa Barbara County Board of Supervisors and revised through 2002. These guidelines are reproduced below:

The purpose of these guidelines is to provide preliminary criteria for determining whether a particular activity could have a potentially significant impact on the environment as described in Section 15064 of the State CEQA Guidelines. Because geologic conditions are highly variable within the City, these guidelines are not fixed thresholds upon which a determination of significance would be made. Rather they serve to point out when further study of site-specific conditions is required to assess potential geologic impacts. Upon review of project plans, mitigation measures and site-specific geologic information, the City of Goleta staff (~~in~~in consultation with licensed geologists and engineers, as necessary), determine the level of geologic impacts (i.e., “potentially significant,” “potentially significant but subject to effective mitigation” or “not significant”).

Impacts are considered potentially significant if the development activity, including all mitigation measures, could result in substantially increased erosion, landslides, soil creep, mudslides and unstable slopes (Appendix G, CEQA Guidelines). In addition, impacts are considered potentially significant when people or structures would be exposed to major geologic hazards upon implementation of the project (Appendix G, CEQA Guidelines).

The City of Goleta's *Environmental Thresholds and Guidelines Manual* provides that impacts related to geology have the potential to be significant if the project involves any of the following characteristics:

- 1.a. The project site or any part of the project is located on land having substantial geologic constraints, as determined by the City of Goleta. Areas constrained by geology include parcels located near active or potentially active faults and property underlain by rock types associated with compressible/collapsible soils or susceptible to landslides or severe erosion.
- 2.b. The project results in potentially hazardous geologic conditions such as the construction of cut slopes exceeding a grade of 1.5 horizontal to 1 vertical.
- 3.c. The project proposes construction of a cut slope over 15-feet in height as measured from the lowest finished grade.
- 4.d. The project is located on slopes exceeding 20% grade.

Mitigation measures may reduce impacts to a less than significant level. These measures would include minor project redesign and engineering steps recommended by licensed geologists and engineers subsequent to detailed investigation of the site.

Based on Appendix G of the CEQA Guidelines, the project would further result in a potentially significant impact relating to geologic resources if the project, and/or implementation of recommended mitigation measures, would result in exposure of people or structures to potentially substantial adverse effects, including risk of loss, injury, or death involving the following:

- e. 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 based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42;
- f. Strong seismic ground shaking;
- g. Seismic-related ground failure, including liquefaction;
- h. Substantial soil erosion or the loss of topsoil; or
- i. Located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.

#### 4.5.4 Project Impacts

The project would involve grading of the site, construction of drainage control structures, placement of utilities and roads, and construction of one- to three-story buildings. The following analysis assesses the range of potentially hazardous geologic conditions within the overall setting described above that could expose people or property to associated geologic, seismic,

or soils risks. **Table 4.5-4** summarizes the types of geologic conditions and potential hazards present at the project site.

For purposes of this analysis, geologic, seismic, and soil conditions raising environmental issues that would be addressed through the City's standard geotechnical study/review process and strict compliance with applicable regulations are identified as less than significant impacts. Environmental issues that may involve more comprehensive study and advanced state-of-the-practice assessment, and/or might not be easily mitigated through typical geotechnical engineering measures and compliance with City and state building codes, are considered potentially significant impacts.

**Table 4.5-4**  
**Summary of Project Site Geology/Seismic/Soil Conditions and Potential Hazards**

<b>Geologic/Seismic/Soil Conditions and Potential Hazards</b>	<b>Project Site</b>	<b>Geologic/Seismic/Soil Conditions and Potential Hazards (Continued)</b>	<b>Project Site</b>
<b>A. Geology Units</b> (with Map Symbol Figure 4.5-1)			
<b>Qaf</b> –Artificial fill	Yes	Within or near past liquefaction areas per County or other sources	No
<b>Qia</b> –Marine Terrace deposits (upper Pleistocene)	Yes	Lateral spread landslide conditions	Unlikely
<b>B. Fault and Earthquake Shaking Hazards</b> (Figures 4.5-1, -2, and -3)		<b>D. Landslide Hazards</b>	
Within an Alquist-Priolo Earthquake Fault Zone	No	Past landslides (except lateral spread) in the area	No
One or more faults are within the project site	Yes	Within a defined hillside area	No
Fault is active (A), or potentially active (PA), not active (NA)	PA/NA	<b>E. Oil and Gas Related Hazards</b>	
<u>Potentially tectonic/Co-seismic deformation</u>	<u>Yes</u>		
One or more nearby faults project toward project site	Yes	Within a State-designated major drilling area or oil field	No
Within a fault rupture study area	No	Known abandoned wells	No
Estimated 10% in 50 years Peak Ground Acceleration (g)	<del>0.400</del> .058	<b>F. Flood Hazards</b>	
<b>C. Liquefaction Hazards</b>		FEMA 100-year flood zone	No
Within a defined liquefiable area	No	FEMA 500-year flood zone	No
Within a defined potential liquefiable area	No	Within a City-designated tsunami hazard zone	No
Historically highest groundwater depth range (in feet)	~30 to 50	Within delineated dam-failure flood inundation zone	No

Based on the available reports and public information, site geologic, soils, and seismic constraints include compressible and highly expansive soils, some areas of corrosive soils, low



percolation rates, strong seismic shaking, liquefaction, area-wide co-seismic uplift, erosion and sediment transport associated with site development.

## **Geologic Characteristics/Geotechnical Issues<sup>2</sup>**

***Impact Geo 1: Geologic and geotechnical characteristics associated with surficial geologic units present at the project site may affect the development.***

*Significance Before Mitigation: Less than Significant*

Compressible, expansive, and corrosive soil conditions in the artificial fill and intermediate-age alluvial deposits (e.g., af, Qia), if present throughout the project site, may affect individual structures and infrastructure elements. Based on one sample tested, expansive soils with a medium to high expansion potential and corrosive soils with severe corrosion potential to ferrous metals are developed over the intermediate-age alluvium found within the project site. Local areas of the site may have been graded in association with the engineered cut in the northern portion of the site. Expansion and contraction of clays in these soils can cause substantial damage to building foundations and other structures. Potential impacts associated with expansive and corrosive soils on the building areas are addressed through the standard CBC process by which building permits are issued.

Natural alluvium, soil, and improperly engineered artificial fill materials are subject to consolidation from an increase in overburden pressure (new compacted fill or heavy structures) or earthquake shaking, which can lead to ground cracking, settlement and structural damage. Visual observations (GMU, 2009) indicate the present of collapsible/consolidation-prone soils in local areas of the site. The required geotechnical/foundation reports would provide lot-specific data on consolidation potential for the site soil materials. The foundation designs would be reviewed and approved by the Building & Safety Division of the City's Planning & Environmental Services Department.

Considering the above information, impacts associated with expansive, corrosive and consolidation-prone materials in the building areas are considered less than significant.

## **Faulting<sup>3</sup>**

***Impact Geo 2: The project would be developed in the vicinity of potentially active folds and ~~may be located above or in the vicinity of the potentially active El Encanto fault.~~***

*Significance Before Mitigation: Less than Significant*

There are no Alquist-Priolo mapped earthquake faults or zones within the City of Goleta. No active faults or folds have been identified by GMU (2007, 2009, and 2011) beneath the project site (see below for further discussion). The nearest known active fault is the North More Ranch less than one mile to the south. Surface rupture on the North More Ranch fault would not impact the project site. Potential impacts associated with fault rupture are considered less than significant.

Potential active fold structures have been identified north and south of the site. The fold structure 0.5 mile northeast of the project site could, under the most serious earthquake event

<sup>2</sup> Addresses Thresholds "a", "f", "g", "l."

<sup>3</sup> Addresses Thresholds "a", "e", "f", "g", "l."

for the area, cause one to three meters of uplift just over the crest of the anticline. At the distance from the site the ground tilt would be less than one degree and therefore impacts associated with co-seismic uplift are considered less than significant.

As described above under *Existing Conditions*, the City's General Plan/Coastal Land Use Plan (2009, their Figure 5-1) indicates the named El Encanto fault crosses the site from northwest to southeast. The El Encanto fault is potentially active based on the definitions commonly used for fault investigation in California. GMU (2007, 2009, and 2011) conducted a fault investigation and concluded there are no sufficiently active/potentially active and well-defined faults present within the project site. This conclusion is based upon a review of previous local and regional geology and geomorphology studies, analysis of aerial photography, a site-specific seismic reflection geophysical survey, three fault trench excavations (T-1, T-2, and T-3), and an age-date of marine terrace deposits. With this conclusion, neither an earthquake fault hazard zone nor a fault setback are required because the studies conducted found no active surface fault within the project site and, based on the age of the marine terrace deposits, there has been no surface fault rupture at the site within at least the past 58,000 to 60,000 years, and possibly the past 125,000 years. Through additional geotechnical exploration and analysis, GMU (July, 2011) reconfirmed that "there are no active surface faults within the property. However, the site is located within close proximity to several active faults, and may therefore be subject to strong ground motions in the future."

Based on the technical peer review of the GMU studies and supplemental information (2007, 2009, July 2011) discussed above under Existing Conditions, and the review of other published data, the peer reviewer concludes that:

1. While various elements of the available data may be subject to more than one interpretation, the totality of the available data supports the GMU (July 2011) conclusion that no significant through-going fault affecting the shallowest 150 feet of upper Pleistocene geologic units is evident on the seismic reflection profile. This is consistent with GMU's depictions on the exploratory trench logs. No observations of post-depositional disturbance similar to the Cortona Drive site were made by GMU at the site.
2. The interpretation of possible normal faulting in the Cortona Drive and in the project site seismic reflection profiles does not fit the structural setting for the local area or the reported south side up reverse El Encanto fault reported by Minor and others (2009). However, alternative interpretations of the available data by the peer reviewer suggesting potential blind thrust faulting or co-seismic folding that may have affected the buried marine terrace contact (the "yellow line") at the project site, would (a) be of a relatively small magnitude (approximately 20 feet or so), (b) have a very low probability of occurrence within the useful life of the development, and (c) be unlikely to affect the ground surface considering the 150-foot thick, dense overlying marine terrace deposits.
3. There are similarities and differences between the Cortona Drive investigation (Campbell Geo, 2007) and the GMU investigation, but both indicate that upper Pleistocene geologic contacts/units may have been subject to movements (offset or folding) on secondary faults associated with the main El Encanto fault making it, based on commonly used terminology, a potentially active fault.
4. GMU and its consultant are properly qualified, registered, and certified within the State of California to conduct the fault investigation work, and to make the interpretations and reach the conclusions presented in their reports (GMU, 2007, 2009, and July 2011).

Based on the information available, the main El Encanto fault at the project site may be ~~(1)~~ located off the site to the north, but does not cross the project site as indicated in General Plan/Coastal Land Use Plan Figure 5-1 (Geologic Hazards Map); ~~(2)~~ There may be three possible secondary faults present beneath the site and is not active ~~no~~ fault off-set was identified in seismic records in the upper 150 feet of upper Pleistocene marine terrace deposits. ~~or (3) it is not a fault, but~~ The main El Encanto fault, as previously mapped, may reflect some form of buried erosional channel and/or a surface geomorphic feature (e.g., sea cliff or strand line) associated with past sea level changes. As such, based on the information ~~available~~ referenced herein, the potential for earthquake-related tectonic movements on the main El Encanto fault to affect the site are unlikely and ~~are~~ considered less than significant.

## Seismic Ground Shaking<sup>4</sup>

**Impact Geo 3: Development at the project site would be subject to seismic ground shaking.**

*Significance Before Mitigation: Less than Significant*

Similar to most of southern California and the County of Santa Barbara, the project site is subject to some level of damaging ground shaking as a result of movement along the major active (and potentially active) fault zones that characterize this region. The nearest significant known active fault capable of a moderate to large earthquake that could generate strong groundshaking at the site is the More Ranch Fault located less than one mile south of the project site per the City's General Plan/Coastal Land Use Plan (2006, Figure 5-1) and Minor and others (2009). The performance of residential and commercial structures during earthquake shaking is addressed, and the acceptable level of risk is inherently defined, by CBC requirements. All project construction would be subject to compliance with the seismic safety standards of the 2010 California Building Code which has been adopted by the Goleta Municipal Code ~~City~~. Given CBC earthquake ground shaking construction requirements, strong seismic shaking impacts are considered less than significant.

Strong seismic shaking is one of the mechanisms that triggers landslides. Potential impacts related to landslides/slope failure are discussed below.

## Soils and Slope Stability<sup>5</sup>

**Impact Geo 4: Development within the project site may be subject to soil stability, erosion, and/or slope stability issues.**

*Significance Before Mitigation: Less than Significant*

The site is subject to potentially significant geologic/soils hazards associated with project grading, construction, and operations. At this time it is estimated that project grading would be nearly balanced, with approximately 49,100 cubic yards of cut and 48,800 cubic yards of fill, resulting in the export of 300 cubic yards of cut from the project site. Currently, the project-specific geotechnical data and analyses have considered ~~in an overview fashion~~ collapsible soils, expansive soils, soil permeability, and corrosive materials (discussed under Impact Geo 1, above) and. ~~Both what is known and what is not known about site geotechnical conditions indicate that there could be potentially significant soil stability impacts. A final geotechnical~~

<sup>4</sup> Addresses Thresholds "a", "e", "f", "g", "l."

<sup>5</sup> Addresses Thresholds "a" – "d", "f", "g", "l."

report is required when final project designs are known in order to meet City building code and regulatory requirements.

In general, for residential and commercial construction projects, there is a potential for increased short-term erosion and sedimentation due to construction activities. Associated water quality impacts are discussed in Section 4.8 *Hydrology and Water Quality*.

The south sloping topography of the project site is generally subdued and the underlying geologic formations are not layered in a manner prone to static (non-seismic) landslide activity.

Past studies indicate that the project site has some potential for shallow groundwater, less than fifty feet deep, and a high potential for significant seismic shaking, however the marine terrace deposits (Qia) are dense to very dense where testing has been done. Even with these relatively shallow groundwater depths, the potential for significant liquefaction is low based on the relatively high density of the underlying marine terrace deposits. Lateral spread landslide potential may be present if liquefaction in shallow layers is determined, even with the relatively flat natural slopes. Together this data indicates low potential for liquefaction and possibly low potential for lateral spread landsliding. A determination of the Project site liquefaction potential must however be made through final design geotechnical investigations will allow an assessment of lateral spreading landslide potential. GMU 2011 indicates a maximum of 0.21 inch of liquefaction-induced settlement occurring below a depth of 25 to 30 feet below existing grade. Consequently, seismic settlement at the ground surface is anticipated to be minimal. Liquefaction-induced lateral spreading is considered to be unlikely at the site due to the lack of a significantly sloping ground surface and minimal potential for liquefaction. These issues would be addressed through standard compliance with the CBC seismic standards, and accepted construction standards-of-practice for liquefaction determination can provide geotechnical solutions that would reduce these project impacts to less than significant.

The low cut slope to the north of the site along the railroad tracks would be stabilized using a berm that would vary in height from approximately 3 to 5 feet. All retaining walls, which would be constructed along the western side of the development, and structural foundation designs would be reviewed and approved by the Building & Safety Division of the City's Planning & Environmental Services Department for compliance with the California Building Code for structural stability and safety specifications, which would account for the soil characteristics of the site. Therefore, potential slope stability impacts are considered less than significant.

## Groundwater<sup>6</sup>

### ***Impact Geo 5: Development within the project site may be affected by shallow and/or perched groundwater.***

*Significance Before Mitigation: Less than Significant*

Groundwater can affect semi-subterranean structures if it is within proximity to floors, walls, and foundations. Effects may include nuisance moisture, seepage causing ponding, and structural impacts to foundations. Borings have encountered perched groundwater within 14 to 44 feet below ground surface and historic levels may be several feet higher. GMU (July 2011) encountered groundwater at 35 to 37 feet below existing site grade (12 to 14 feet amsl). Except for some utilities, it is unlikely that excavations would reach these depths based on current plans. Standard geotechnical investigations are required to evaluate shallow water occurrence

<sup>6</sup> Addresses Thresholds "g", "l."



for foundations, semi-subterranean structures, utilities, and various design measures are available to minimize liquefaction or nuisance water effects. Such measures may include ~~deep pile foundations~~, water-proofing, gravel base material, subdrains, or sump-pumps to remove water from beneath structures.

Sewage disposal service for the project would be provided by the Goleta West Sanitary District. Therefore, no potential groundwater and geotechnical hazards posed by the use of septic tanks or alternative wastewater disposal systems would exist.

## **Subsidence<sup>7</sup>**

***Impact Geo 6: Development within the project site may be affected by subsidence.***

*Significance Before Mitigation: Less than Significant*

### ***Subsidence***

The project site is not located within an area of oil or gas development where subsidence can often occur, and groundwater pumping has not produced documented ground surface subsidence in the site vicinity. Therefore, no potential subsidence issues would exist at the project site.

### ***Abandoned Wells and Dry Holes, Shallow Subsurface Gas, and Oil and Gas Reserves***

The project site is not located within an area of active oil or gas development, or natural organic deposits (e.g., peat) where shallow subsurface gas could be produced, where abandoned wells or dry holes would be present, or where oil and gas reserves would be encountered. Therefore, no potential oil and gas related issues would exist at the project site.

## **Flooding and Inundation<sup>8</sup>**

***Impact Geo 7: Development within portions of the Project Area may be subject to flooding, tsunami affects, and/or dam inundation.***

*Significance Before Mitigation: Less than Significant*

The project site is not located within a 100-year flood zone and is not within the path of flooding due to a dam failure at Glen Annie Reservoir. Tsunami impacts result from both the forces of wave run-up and wave retreat, as well as rising water (flooding) without significant wave action. Generally these forces are most significant nearest the shoreline and decrease progressively inland. The Goleta General Plan/[Coastal Land Use Plan](#) (2008) defines a possible tsunami flood risk elevation limit of 40 feet for planning purposes. Finished site elevations at the project site are planned to be approximately 43 to 70-feet in elevation. Therefore, potential flood and inundation impacts are considered less than significant.

### **4.5.5 Cumulative Impacts**

Geologic impacts are typically confined to a project site or within a very localized area and do not affect off-site areas associated with the related projects identified in Section 3.0 *Related Projects* or other growth. Project grading and subsequent slope instability or erosion, however, may contribute to offsite instability, particularly along the northern edge of the site, if not

<sup>7</sup> Addresses Thresholds "a", "g", "l."

<sup>8</sup> Addresses Thresholds "a", "f", "l."

mitigated. This project-specific contribution to cumulative geologic effects would not, however, be substantial based on the following: no significant slopes border the project site to the south; retaining walls would be constructed along the west side of the development and in the interior of the project site, and a berm would be constructed along the north side of the development; and, the application of City-wide implementation of mandated slope stability and erosion control requirements, in particular for the north property slope along the railroad tracks. Therefore, based on the project design and strict compliance with applicable regulations and plan review to verify compliance with applicable regulations, the project would be expected to meet the applicable geology and soils standards and sufficiently reduce its incremental cumulative geology and soil impacts to less than a significant cumulative impact.

#### 4.5.6 Mitigation Measures

***Impact Geo 1: Geologic and geotechnical characteristics associated with surficial geologic units present at the project site may affect the development.***

The project's impacts are anticipated to be less than significant given standard geotechnical study/review process and strict compliance with applicable regulations. However, the following measure is ~~recommended~~ required to further assure that necessary geotechnical measures are incorporated into final plans and implemented during construction.

**GEO 1-1 (~~Recommended~~):** All grading and earthwork recommendations from the project geotechnical and soils reports, including any updates, ~~shall~~ must be incorporated into the final project design, including the Final Grading, Drainage and Erosion Control Plans, or other plans deemed necessary by the Planning and Environmental Services Director, or designee City staff, and shall ~~must~~ ensure they meet the City's building code requirements set forth in ~~Title 15 of the Goleta Municipal Code for construction~~. All grading activities ~~shall~~ must be supervised by a Registered Civil Engineer or Certified Engineering Geologist.

**Plan Requirements and Timing:** Final grading, drainage, and erosion control plans ~~shall~~ must be reviewed and approved by the ~~City Building~~ Planning and Environmental Services Director, or designee, and Community Services Director, or designee, before the City issues a ~~Departments~~ prior to LUP for grading issuance.

**Monitoring:** The Planning and Environmental Services Director, or designee, and Community Services Director, or designee, City staff shall ~~shall~~ must verify compliance during grading and construction activities.

***Impact Geo 2: The project would be developed in the vicinity of potentially active folds and may be located above or in the vicinity of the potentially active El Encanto fault.***

These impacts are less than significant and therefore mitigation measures are not required.

***Impact Geo 3: Development within the project site would be subject to seismic ground shaking.***

With implementation of California Building Code requirements, impacts are less than significant and therefore mitigation measures are not required.

***Impact Geo 4: Development within the project site may be subject to soil erosion, and sedimentation issues.***

This impact is less than significant and therefore mitigation measures are not required. In addition, Section 4.8 *Hydrology and Water Quality* Mitigation Measure WQ1-1 would address erosion control and sedimentation as a water quality concern.

***Impact Geo 5: Development within the project site may be affected by shallow and/or perched groundwater.***

Impacts are less than significant and therefore mitigation measures are not required.

***Impact Geo 6: Development within the project site may be affected by subsidence.***

This impact is less than significant and therefore mitigation measures are not required.

***Impact Geo 7: Development within the project site may be subject to flooding, tsunami affects, and/or dam inundation.***

These impacts are less than significant and therefore mitigation measures are not required.

### **4.5.7 Residual Impacts**

The project's impacts related to geologic characteristics, faulting, seismic shaking, soils and slope stability, would be addressed by implementation of CBC measures and standards-of-practice, and the project location would not be susceptible to impacts related to subsidence, flooding, tsunami affects, and/or dam inundation. As such, the project's residual impacts related to geology and soils issues are considered less than significant (**Class III**).