

## **5.7 GEOLOGY AND SOILS**

## 5.7 GEOLOGY AND SOILS

---

### **Geology and Soils – Environmental Setting**

This section describes existing geology, soils, and seismicity at and near the *Wolf House Inn* project site. Included is a discussion of existing conditions and the constraints to development that these particular geologic, soils, and seismic conditions pose.

#### **REGIONAL SEISMICITY**

The project site lies in the tectonically active Coast Ranges Geomorphic Province of Northern California, in the valley of Sonoma Creek, also known as the Valley of the Moon. Northwest trending ridges and valleys are common in the area and their orientation is often structurally controlled by active tectonics along the boundary between the North American and Pacific Tectonic Plates. Active deformation is expressed along this boundary margin through discrete movement along faults of the San Andreas Fault System, movement that generates earthquakes.

Within Sonoma County, faults are characterized by both strike-slip or horizontal displacement, and dip-slip or vertical displacement. Most faults strike northwest to southeast, and may include many fault strands in a broad zone, or a single, actively creeping identifiable fault. Horizontal and vertical movement is distributed on the various fault traces within a fault zone. Over long periods, the fault traces accommodating movement and active deformation within a fault zone may change; some traces become inactive while other traces develop. However, over the short period of human history, the activity of certain fault traces may be constrained by ascertaining the date of historic and prehistoric ruptures to predict the probability of future earthquakes.

Fault maps <sup>1</sup> show four major active faults located within 30 miles of the project site: Rodgers Creek (five miles southwest), San Andreas (25 miles southwest), Maacama (19 miles northeast), and Hayward faults (27 miles south). Each of these faults could produce a large earthquake that would result in strong seismic shaking of the project site. Lesser active faults near the project site include the West Napa (16 miles southeast) and the Green Valley (17 miles east) faults.

Major seismic events in the region that have resulted in moderate to strong ground shaking at the project site include the 1868 Hayward earthquake (estimated magnitude 7.0), the great 1906 San Francisco earthquake (at least magnitude 7.9), and the 1989 Loma Prieta Earthquake (magnitude 6.9). A September 3, 2000 earthquake of magnitude 5.2 on the West Napa fault, near the town of Yountville, reportedly caused between 15 and 70 million dollars in losses, mostly in Napa, while little or no damage was reported in Glen Ellen.

---

<sup>1</sup> *Fault Activity Map of California*, California Division of Mines and Geology, 1994.

## **REGIONAL GEOLOGY**

Geology and soils in Sonoma County are mainly a consequence of the long history of active tectonics near the margin between the Pacific and Tectonic Plates, patterns of climate change, and changing land use and vegetation patterns. The Geologic Map of the Santa Rosa Quadrangle<sup>2</sup> illustrates regional geology. The project site is located within the Sonoma Mountains, an active geological area known for hydrothermal systems and *microseismicity*.<sup>3</sup> Outcrops of volcanic rocks in the area are evidence of relatively recent volcanism. In the project area, the Sonoma Volcanics have been dated to the Pliocene age, occurring between five and two million years before the present. Across hillsides in the project vicinity, there are deposits of the Sonoma Volcanics, including basalt, andesite, rhyolite, and tuff. The Sonoma Volcanics apparently intruded through older Franciscan Complex rocks that are common in the coastal mountains west of Santa Rosa and along some of the higher ridges in the Sonoma Mountains.

The Franciscan Complex is composed of weakly to strongly metamorphosed greywacke (i.e., sandstone), argillite, limestone, basalt, serpentinite, chert, and other rocks. This rock accreted onto the edge of the North American continent during the long period of active subduction of the Pacific Plate beneath the North American Plate. The formation is derived from Jurassic oceanic crust and pelagic (i.e., open ocean) deposits overlain by Late Jurassic to Late Cretaceous sedimentary deposits.

Due to its complex geologic history, there is a wide variety of volcanic and sedimentary rocks in this region that have been metamorphosed to various degrees. These units are often juxtaposed along ancient fault contacts and the structure is complicated by not only ancient deformation, but by active fault deformation. Imprinted on this geology is the drainage pattern of the Sonoma Creek Watershed. Underlying the project area, Pleistocene age deposits of the Huichica formation are mapped that is likely eroded from the older Sonoma Volcanics. This includes gravel, sand, silt, and clay with interbedded tuff. These deposits can be seen in the banks of Sonoma Creek below the project site, while the actual channel bed is armored with more recently deposited cobbles and boulders eroded from underlying rock or transported from upstream.

## **PROJECT SITE**

### **Geologic Units and Soils**

The Sonoma County Soil Survey<sup>4</sup> shows Spreckels Loam underlies the project site with slopes ranging from nine to 15 percent. These slopes have been cut and filled to form the existing level parking area. However, general soils characteristics beneath the layer of fill should be similar to that of Spreckels Loam, consisting of well-drained loams with clay subsoil that are underlain by volcanic tuff mixed with uplifted river sediments and weathered basic igneous rock. A typical surface profile consists of grayish brown loam and light brownish gray clayey loam in the upper 18 inches underlain by an 18-inch thick layer of brown and pale brown clay. According to the Sonoma County Soil

---

<sup>2</sup> *Geologic Map of the Santa Rosa Quadrangle (Scale 1:250,000)*, California Division of Mines and Geology, 1982.

<sup>3</sup> *Microsismicity* includes smaller magnitude earthquakes, generally less than Richter Magnitude 3.0.

<sup>4</sup> *Soil Survey of Sonoma County*, United States Department of Agricultural (USDA), 1972.

Survey, runoff rates from these soils are considered medium and soils have a moderate erosion hazard. These soils have a moderate shrink / swell potential indicating that they are moderately expansive.<sup>5</sup>

Geologic maps<sup>6</sup> show the site vicinity underlain by a unit of the Sonoma Volcanic consisting of Tertiary age pumice ash flow tuff that is locally welded or partially welded and contains intercalated and bedded agglomeratic tuff, andesitic or basaltic lava flows, tuff breccia, bedded tuff, and pumicitic tuff. Maps indicate the bedrock structure dips moderately steeply towards the west, or away from Sonoma Creek.

Site-specific information is available from the Geotechnical Investigation Report completed by Bauer Associates in 1990 (*1990 Geotechnical Investigation Report*) for the proposed Jack London Village Inn.<sup>7</sup> The geotechnical investigation found the project site underlain at depth by tuff breccia (i.e., volcanic ash) that was described as moderately hard and moderately strong.

The surface layer was found to be a variable density fill comprised of clayey gravel with isolated layers of cobbles. This fill was reported to penetrate to as deep as seven feet below the ground surface and overlie a stiff to very stiff, sandy clay and dense to very dense, silty sand.

During hand auguring of eight holes in December of 2005 clayey gravel was also found to underlie the existing gravel parking lot, but was found to penetrate to a depth typically no greater than about three feet below ground surface. Beneath this layer, brown sandy clay was encountered that appears similar to that encountered during the geotechnical investigation. This was found to extend to the bottom of the holes that were dug to a depth no greater than about four feet below ground surface. Fill appeared to be river gravel that may have been borrowed from a nearby site.

### **Slope Stability**

Slope steepness is generally the dominant factor governing slope stability, along with drainage, and soil and bedrock conditions. Steep slopes that exceed 50 percent are especially prone to landslides in areas of weak soil and / or bedrock. Debris flows and shallow slope failures are known to occur on very steep slopes with shallow soils.

Slope failure occurs when the shear stress of a soil or rock mass exceeds its shear strength. Shear stress can be increased by adding to the weight of the soil or rock mass through saturation or loading. Shear strength can be reduced by erosion or grading at the toe of a slide mass. Failure can occur due to either an increase in shear stress or a decrease in shear strength. Zones of low shear strength are often associated with the presence of expansive clay soils and weak bedrock units or structural features susceptible to failure. Sandy soils on steep slopes can experience failure during periods of intense rainfall when loading of the soil with water exceeds the rate at which the soil can drain. These types of failures are generally termed debris flows or mudflows when finer material is involved. Landslides

---

<sup>5</sup> *Soil Survey of Sonoma County*, United States Department of Agricultural (USDA), 1972.

<sup>6</sup> *Preliminary Geologic Map of Eastern Sonoma County and Western Napa County, California*, United States Geological Survey, K.F. Fox, Jr., J.D. Sims, J.A. Bartow and E.J. Helley, 1973 (USGS MF-483); *Geology for Planning in Sonoma County, California* Division of Mines and Geology (CDMG), 1980. *Geologic Map of the Santa Rosa Quadrangle*, California Division of Mines and Geology, 1982.

<sup>7</sup> *Geotechnical Investigation Jack London Village Inn*, Bauer Associates, October 25, 1990

involve the discrete or coherent motion of a block of material and frequently occur along fault traces or structural discontinuities.

Geologic maps show that no landslides threaten the project site. The nearest mapped landslides are shown approximately one-half mile upstream on either side of Asbury Creek, while about 1,000 feet west of the site there is an area of potentially unstable soil and rock.<sup>8</sup> According to the Association of Bay Area Governments (ABAG), the actual project area is within a zone of few landslides and the site and the project is located in an area not threatened by debris flows.<sup>9</sup> The *1990 Geotechnical Investigation Report* mentioned no active landslides of consequence to the proposed development. However, the report concluded this based upon a 50-foot setback from the top of bank above Sonoma Creek. This setback is designed to protect structures from potential slope instability near the top of bank, where slope stability is questionable.

The existing gravel lot on the northern parcel is nearly level, with a slight slope of about two percent toward the south-southeast. The steepest slopes are along the bank of Asbury Creek below the footbridge, where there is a vertical wall and nearly vertical slopes across from the old water wheel; and near the northeast corner of the proposed development, where the south bank of the small tributary drainage is overhanging for about 50 feet upstream of the confluence with Sonoma Creek. The banks along Sonoma Creek are typically between 40 and 50 percent in steepness. There are a few nearly vertical or vertical banks along Sonoma Creek, but these are within the scour line of the active channel and well below the top of bank. Moderate slopes occur along the embankment between Arnold Drive and the subject property, where slopes range from approximately 15 to 25 percent. Nearly all the bank tops are subject to potential slope instability, at least in the form of minor sloughing or soil creep over the edge.

#### **Primary Seismic Hazards- Surface Fault Rupture**

A number of active and potentially active faults are present in the region. According to criteria of the State of California Geological Survey, active faults have experienced surface rupture within the last 11,000 years. The Alquist-Priolo Earthquake Fault Zoning Act of 1972 initiated a program of mapping active and potentially active faults (faults with displacement within Quaternary time- the last 1.6 million years). According to the program, active faults must be zoned and development projects within the Earthquake Fault Zones investigated to establish the location and age of any faulting across the development site.

Active and potentially active faults in Sonoma County have undergone extensive investigation in the past. ABAG has summarized results from many of these studies to quantify the potential impact to certain areas, while the California Geological Survey has established Earthquake Fault Zone (EFZ) boundaries. According to these maps, the proposed development is not located within an EFZ. The nearest EFZ for the Rodgers Creek Fault is located approximately 4.5 miles southwest of the site.<sup>10</sup> The nearest fault trace is of an unnamed fault oriented in a general north-south traverse approximately

---

<sup>8</sup> Geology for Planning in Sonoma County, California Division of Mines and Geology, Special Report 120, 1980

<sup>9</sup> ABAG Debris Flow Source Maps, Association of Bay Area Governments, accessed online at: <http://www.abag.ca.gov/bayarea/eqmaps/landslide/index.html>

<sup>10</sup> *Glen Ellen 7.5 minute Quadrangle Alquist-Priolo (A-P) Earthquake Fault Zone Map*, California Division of Mines and Geology, 1983.

800 feet west of the site. According to the *1990 Geotechnical Investigation Report*, this fault is not considered active but has shown evidence of movement during the Quaternary Period or last 2 million years. Since no faults are mapped as crossing the site on any published maps and no other evidence of active faulting was documented, the geotechnical consultant concluded the risk of ground rupture within the project site boundaries was low.

### **Secondary Seismic Hazards**

#### *Ground Shaking*

The San Francisco Bay Area is a seismically active region and experts consider it likely that the site would be subject to at least strong seismically induced ground shaking within the design life of the development. According to a recent study completed by the Working Group on California Earthquake Probabilities (WGCEP),<sup>11</sup> which assesses the probability of earthquakes in the San Francisco Bay Area, there is a 62 percent probability that a major earthquake of Richter Magnitude 6.7 or greater will strike the region during the next 30 years.

The intensity of ground shaking will vary with the distance and magnitude of the earthquake causing the ground shaking. There is likely to be at least strong shaking of the site due to a major earthquake along the Rodgers Creek, San Andreas, Hayward, or other faults. Such shaking would be roughly equivalent to a Modified Mercalli intensity level of VII. Peak ground accelerations for the site with a 10 percent probability of being exceeded in a 50-year period are estimated to be from 40 to 60 percent of the acceleration due to gravity (g). Actual ground motions resulting from ground acceleration may be amplified or dampened depending on the underlying geologic materials. Deep soft soils tend to amplify waves whereas shallow soils overlying hard bedrock tends to dampen shaking intensity. The site is underlain by shallow soils overlying hard bedrock.

#### *Seismically Induced Liquefaction*

Liquefaction is the temporary transformation of saturated, cohesionless soil into a viscous liquid as a result of ground shaking. According to maps summarized through ABAG and Sonoma County,<sup>12</sup> soils at the site have either very low or low susceptibility to liquefaction. The *1990 Geotechnical Investigation Report* indicated no soil conditions were encountered that would be favorable to liquefaction, such as shallow groundwater and soils with little or no cohesion. While soils encountered underneath the proposed inn site were not found to be prone to liquefaction, sediments within the channels of Asbury and Sonoma Creeks are potentially liquefiable, including loose sands.

#### *Seismically Induced Densification*

Dynamic densification or ground subsidence can occur when dry cohesionless soils collapse as a result of seismic shaking. This may be particularly true of unconsolidated sandy fill, or ground overlying hollow areas due to caves, mines, or areas with excessive groundwater removal. These conditions were not found during the geotechnical investigation, as existing soils were typically dense. Therefore the risk of future densification is considered low.

---

<sup>11</sup> California Geological Survey, available online at <http://www.consrv.ca.gov/CGS/rghm/pshamap/pshamain.html>.

<sup>12</sup> Sonoma County Department of Emergency Services Map available through [http://www.sonoma-county.org/des/em\\_map.htm](http://www.sonoma-county.org/des/em_map.htm)

### *Seismically Induced Lurch Cracking and Ridgetop Fissuring and Shattering*

*Lurching* is the sudden swaying, rolling, or spreading of the ground during a strong earthquake. *Lurch cracking* is the development of fissures or cracks on slopes overlain by weak soils. According to the 1990 *Geotechnical Investigation Report*, soils present at the site were typically dense silty sands or stiff to very stiff, clayey soils not susceptible to lurch cracking. Areas where lurch cracking would be the greatest concern would be at the top of the creek banks.

A related phenomenon is ridgetop fissuring and shattering, thought to be the result of intense amplification or focusing of seismic energy due to local topographic features. Linear fault-like fissures and shattering of surface soils on the crests of steep, narrow ridgelines occurred during the 1989 Loma Prieta and 1994 Northridge earthquakes. This phenomenon can result in severe structural damage, particularly if it occurs on high, narrow ridges flanked by slopes steeper than about 2.5:1 (horizontal: vertical). As this is not the geometry of the project site topography, ridgetop fissuring and shattering is not considered a hazard.

### *Seismically Induced Slope Failure*

Seismically induced slope failure is another secondary seismic hazard. During earthquake-induced ground shaking, unstable slopes can fail, causing landslides and debris flows. The property is not known to be located within an earthquake induced landslide zone. However, very steep slopes greater than 50 percent adjacent to the creek may be subject to some type of slope failure as a result of violent ground shaking.

Closely related to general seismic slope failure is the potential for deformation of “side hill fills”. Side hill fills are artificial fill wedges typically constructed on natural slopes to create roadways or level building pads. Strong ground shaking may result in cracking at the cut and fill contact area, differential settlement in the fill wedge, and bulging on the slope face. This phenomenon has occurred most often in relatively thin fills of 30 feet or less placed near the tops of narrow ridges. This phenomenon was not specifically investigated during the geotechnical investigation, but may be limited, since apparent fill soils are very similar to native soils and are not expected to have differential settlement. Moreover, fill has generally been evenly spread across the site, rather than pushed to the top of the bank, thereby reducing the likelihood of failure.

## **REGULATORY SETTING**

### ***Sonoma County Hazard Mitigation Plan***

The Sonoma County Hazard Mitigation Plan (SCHMP) was designed to identify areas where people or structures may have higher vulnerability to earthquakes, flood, wildland fires, and other natural hazards. The plan identifies policies and actions that may be implemented by the County to reduce the potential for loss of life and property damage in these areas based on an analysis of the frequency of earthquakes, floods, wildland fires and landslides in terms of frequency, intensity, location, history, and damage effects. The plan serves as a guide for decision-makers as they commit resources to reduce the effects of natural hazards.

### ***Sonoma County General Plan, Health and Safety Element***

The intent of the Health and Safety Element is to identify and evaluate natural and human-made hazards that are present or potentially present in the community, and to establish goals, policies and

actions necessary to reduce those hazards to acceptable levels. Hazards discussed in the element include seismic hazards, such as earthquakes, and soil erosion and landslide hazards.

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

The Alquist-Priolo Earthquake Fault Zoning Act was passed by the California Legislature in 1972 to mitigate the hazard of surface faulting to structures. The act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. Local agencies must regulate most development in fault zones established by the State Geologist. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, the city or county with jurisdiction must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults.

***California Seismic Hazards Mapping Act***

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Sections 2690-2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and seismically induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

***California Building Code***

The California Building Code (CBC) has been adopted by most jurisdictions in California to oversee construction. The County has modified some portions of the California Building Code as shown in Section 7-13 of Chapter 7 of the Sonoma County Code. The CBC defines four Seismic Zones in California, which are ranked according to their seismic hazard potential. Zone 1 has the least seismic potential and Zone 4 has the highest seismic potential. The Bay Area is located in Seismic Zone 4 and thus development is required to comply with all design standards applicable to Seismic Zone 4.

***California Health and Safety Code***

The earthquake protection law (California Health and Safety Code section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum standards for seismic safety and structural design to meet earthquake protection requirements are set forth in Chapter 16 of the CBC.

---

## **Geology and Soils – Significance Criteria**

The geology and soils analysis uses criteria from the *State CEQA Guidelines*. According to these criteria, the project would have a significant geologic, soils, and seismic impact if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;
  - Strong seismic ground shaking;
  - Seismic-related ground failure, including liquefaction; or
  - Landslides.
- Result in substantial soil erosion or the loss of top soil; (see *Impact 5.5-1 Soil Erosion from Grading and construction Activities* in **Section 5.5 Hydrology and Water Quality**)
- 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 landslide, lateral spreading, subsidence, liquefaction, or collapse; or
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

According to *CEQA Guidelines*, exposure of people or structures to major geological hazards is considered a significant adverse impact. The potential geologic, soils, and seismic effects of the proposed project can be considered from two points of view: (1) construction impacts; and, (2) geologic hazards to people or structures. The basic criterion applied to the analysis of construction impacts is whether construction of the project would create unstable geologic conditions that would last beyond the short-term construction period. The analysis of geological hazards is based on the degree to which the site geology could produce hazards to people or structures from earthquakes, ground shaking, ground movement, fault rupture, or other geologic hazards, features or events.

---

## Geology and Soils – Impacts and Mitigation Measures

### LESS-THAN-SIGNIFICANT IMPACTS

Based on the findings of the Initial Study (*Appendix A Initial Study*) together with additional analyses completed as a part of this EIR it has been determined that the proposed *Wolf House Inn* would have no or less-than-significant impacts for the following significance criteria:

- *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;*

The site is not located within an Alquist-Priolo earthquake fault zone (EFZ), and no fault trace is mapped across the site. The *1990 Geotechnical Investigation Report* found no evidence of active faulting on the property. Therefore, no impact would occur.

- *Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.*

The proposed project would be required to connect to the local sewer system managed by the Sonoma Valley Sanitation District. Use of septic tanks or alternative wastewater disposal systems is not proposed as part of the project.

### IMPACT ANALYSIS

#### Introduction

Typical geologic and soils related constraints to development within Sonoma County are strong seismic shaking; slope instability that may cause landslides, mudflows, and other types of slope failure; and basic soil instability, including settlement, shrinking and swelling of soil, and fissuring or cracking of the ground. These constraints are interrelated and may be exacerbated by periodic heavy rains causing soil erosion, saturation of the ground, and flooding.

Certain conditions, such as weak or erosive soils, may be practically mitigated through suitable grading, foundation engineering, drainage controls, and other measures; while the often unpredictable nature of geologic hazards, such as strong or violent seismic shaking from an earthquake, may only be mitigated to an acceptable standard or level of risk.

Although projects can have impacts on the local geologic environment through induced slope instability and soil erosion, most projects (other than perhaps large reservoirs or geothermal projects) do not affect the regional geologic environment. However, projects can be affected by regional and area wide geologic conditions. Many seismic events, particularly large magnitude earthquakes, are felt regionally. Injury, damages and property loss tend to occur along and near linear earthquake fault zones of regional extent and in areas of soil and geologic conditions susceptible to rapid ground motion, settlement, or instability.

Most seismic experts agree that for planning and project evaluation purposes, a large, damaging earthquake event should be anticipated to occur within the design life of all projects in the San Francisco Bay Area. Regional and local geologic hazards that could substantially impact the project would primarily be damage to infrastructure (e.g., utilities, roads, etc.).

**Impact 5.7-1 Seismic Ground Shaking**

*Strong seismic ground shaking is expected to occur at the project site some time during the design life of the proposed Wolf House Inn that would expose people or structures to substantial adverse effects, including the risk of loss, injury, or death. This would be a significant impact.*

The proposed project would result in the construction of a three-story, 44,978-square foot condominium hotel. As described in the setting section, there are several seismic sources located in the site region, including the Rodgers Creek and San Andreas faults. The Working Group on California Earthquake Probabilities have estimated strong seismic ground shaking from a magnitude 6.7 or greater earthquake has a 62 percent chance of occurring during the next 30 years.<sup>13</sup> The intensity of the ground motion experienced at the project site would depend on the characteristics of the generating fault, the distance to the earthquake epicenter, the earthquake magnitude and duration, site-specific soil conditions, and the response of structures to the seismic forces. Strong seismic ground shaking can cause direct effects to soil fill, building foundations, and structures.

Development of the proposed project would expose future occupants and structures to substantial adverse affects such as injury (e.g., from falling objects), death or loss of property (i.e., damage or collapse of structures). Therefore, this would be a significant impact.

**Mitigation Measure 5.7-1** In order to reduce the impact to residents and structures from strong seismic ground shaking to an acceptable level, the following measures would be required:

- *Compliance with California Building Code.* Project development shall meet requirements of the California Building Code as adopted by the County of Sonoma. Incorporation of seismic construction standards would reduce the potential for catastrophic effects of ground shaking (e.g., complete structural failure) but would not completely eliminate the hazard of seismically induced ground shaking. Seismic design parameters used at the project site shall be identified using California Building Code Chapter 16 by the Geotechnical Engineer of record and implemented in project design by the Structural Engineer of record.
- *Compliance with a Design Level Geotechnical Investigation Report Prepared by a Registered Geotechnical Engineer and with Structural Design Plans as Prepared by a Registered Structural Engineer.* Foundation engineering, design, and construction shall be in accordance with recommendations of a licensed geotechnical engineer and a licensed structural engineer shall prepare structural design plans. The existing geotechnical report shall be updated to confirm recommendations, or a new geotechnical investigation shall be prepared by the Geotechnical Engineer of record. The design professionals (engineers) or their representatives shall monitor all construction, and documentation of the construction process will be provided to the Building Official. The structural engineering design shall incorporate seismic parameters as outlined in the California Building Code Chapter 16.

---

<sup>13</sup> *Earthquake Probabilities in the San Francisco Bay Region, 2002-2031*, Working Group on California Earthquake Probabilities, United States Geological Survey, Open-file report 03-214, 2003.

- *Complete Final Design Review and Obtain a Building Permit.* Final Design Review shall be performed by a licensed civil / structural engineer for adherence to the seismic design criteria for residential structures in Sonoma County and structural design shall be in accordance with the requirements of the California Building Code.

**Significance After Mitigation** Implementation of Mitigation Measure 5.7-1 would ensure the proposed project meets the ordinance criteria and safety guidelines for Sonoma County. The basic requirement is that new structures should withstand ground movement from a minor earthquake without damage; from a moderate earthquake without structural damage; and from a major earthquake without collapse. Therefore, incorporation of seismic construction standards would reduce adverse effects of strong seismic ground shaking to a less-than-significant impact.

**Responsibility and Monitoring** The applicant and building contractor would be responsible for obtaining necessary permits following design review that comply with the California Building Code. Construction inspection and testing to ensure compliance would be the responsibility of both the applicant and County. The applicant shall keep copies of approved design plan sheets and permits on the site throughout construction.

**Impact 5.7-2 Seismic Related Ground Failure, Including Liquefaction**

*Soils at the project site are not unstable or prone to liquefaction and the risk of seismic related ground failure is considered minimal. This would be a less-than-significant impact.*

Since the project site is subject to strong seismic ground shaking, there is a risk of seismic related ground failure. However, since the *1990 Geotechnical Investigation Report* indicated that site soils are stable and not prone to liquefaction the risk of this hazard to the proposed project would be minimal.

The greatest risk of seismic related ground failure at the project site is along slope breaks (i.e., where level ground slopes downward) such as bank tops. However, the proposed 50-foot setback from creek banks would avoid adverse affects to proposed buildings. Therefore, seismic related ground failure, including liquefaction, would be a less-than-significant impact.

**Mitigation Measure 5.7-2** No mitigation would be required.

**Impact 5.7-3 Landslides and Slope Instability**

*Grading or other disruption of soils near bank tops for the proposed creek walk, swimming pools and other features, could result in slope failure, particularly from sloughing and minor slides along the steepest slopes. This would be a significant impact.*

Nearly vertical banks along Asbury Creek, overhanging banks along the northern drainage way, and slopes exceeding 50 percent along Sonoma Creek are all potentially unstable and prone to at least minor sloughing. While the proposed project includes a 50-foot setback of buildings from creek banks, grading or other disruption of soils near bank tops for the proposed creek walk, swimming pools and other features, could result in slope failure, particularly from sloughing and minor slides along the steepest slopes.

This would be a significant impact. The following mitigation would therefore be required.

**Mitigation Measure 5.7-3(a)** The proposed *Wolf House Inn* shall be constructed in accordance with geotechnical recommendations inside and outside the 50-foot creek setback.

- Maximum cut and fill slopes shall be no steeper than 2:1 (i.e., two horizontal to one vertical). A Civil Engineer shall develop an Erosion Control Plan for all disturbed slopes located within the 50-foot creek setback, including the area adjacent to the proposed creek walk;
- All retaining walls shall include permanent subsurface drains to prevent buildup of hydrostatic pressure behind the walls; and
- Drainage measures shall be designed to prevent soil erosion on slopes, including v-ditches or berms located at the top of bank to prevent uncontrolled runoff from parking areas onto slopes.

**Mitigation Measure 5.7-3(b)** The project applicant shall adopt and implement a Long-Term Slope Stability Plan within the 50-foot creek setback. This plan shall consider all proposed elements within the setback such as the creek walk, swimming holes, waterfalls, and all other planned elements. This plan shall include, but not be limited to the following:

- Long-term slope stability analysis for existing and post development conditions along banks within the setback, including analysis of bank stability and potential undercutting of bank toes by forecasted creek flows. Analysis should also consider potential erosion of banks on neighboring property;
- Slope stability analysis for proposed retaining walls, slope protection measures, and drainage controls within the setback;
- At a minimum, slope stabilization details for any vertical banks on the property with drops of more than four feet. This shall include stabilization of vertical banks along the creek walk downstream of the Asbury Creek pedestrian bridge and overhanging bank near the northeast corner of the property, where swimming holes and waterfall are planned;
- Implementation of a monitoring and maintenance program for slope improvements; and
- Design approval for any structural elements within the setback shall be in accordance with design approval for the entire project. A licensed Civil Engineer shall complete design approval including contingency for inspections during construction.

**Significance After Mitigation** Implementation of Mitigation Measures 5.7-3(a) and 5.7-3(b) would reduce adverse effects from landslides and slope failure to a less-than-significant impact.

**Responsibility and Monitoring** The applicant would be responsible for development, completion, and implementation of an approved slope stability plan for design elements within the 50-foot creek setback. Construction inspection and testing would be the responsibility of the applicant and contractor who would also need to complete a work schedule prior to the start of work and notify County inspectors and local officials when construction work would be completed. County staff or a representative engineer would be responsible for approving each phase of construction in accordance with results of inspection and testing.

**Impact 5.7-4 Unstable Geologic Unit or Soils**

*Unstable fill underlies portions of the project site where development would occur. This would be a significant impact.*

Up to ten feet of fill of variable density and quality underlie portions of the project site planned for development. The 1990 *Geotechnical Investigation Report* concluded that existing fill and any weak natural soils are unsuitable for support of fills, foundations, pavements, and concrete slabs in the condition encountered in 1990. Bauer Associates recommended that the soils be upgraded by removal and recompaction for the full depth of the fill. Within proposed pavement areas, Bauer Associates recommended that soils be excavated and recompacted to depths of 18 inches. The existing fill soils have not been evaluated since 1990.

Based on the conditions at that time, site fill soils may be unstable and subject to effects of settlement, expansion, and contraction of clay soils, or otherwise potentially unstable. In addition, the Limitations section of the 1990 *Geotechnical Investigation Report* requires the report be updated if the project was not constructed within two years or if the project is modified. The proposed development plan for the *Wolf House Inn* differs from the project as originally proposed.

Site development on unstable soil would be a significant impact. The following mitigation would be required.

**Mitigation Measure 5.7-4** The proposed *Wolf House Inn* shall be designed and constructed in accordance with updated geotechnical recommendations to be provided by a licensed Geotechnical Engineer retained by the project applicant. The updated geotechnical recommendations shall take into account the current existing conditions of fill soils present on the project site. It is anticipated that the revised geotechnical recommendations shall include the following mitigation measures:

- In structural foundation areas, site fill soils shall be excavated and recompacted to their full depth;
- All fills shall be keyed and benched into bedrock or firm natural materials under the direction of a licensed Geotechnical Engineer;
- Soil shall be recompacted to a minimum of 90 percent of the maximum dry density at moisture contents above the optimum in accordance with ASTM Test Method D 1557 and under the direction of a licensed Geotechnical Engineer;
- On-site soils shall be suitable for re-use as fill provided that:
  - The materials can be dried to near optimum moisture content;
  - All rocks or lumps greater than six inches in longest dimension shall be removed;
  - The soil materials are non-expansive; and
  - The fill materials are approved by the Geotechnical Engineer of record prior to use.
- All fill shall be placed under the observations and testing of the licensed Geotechnical Engineer of record or designated representative.

**Significance After Mitigation** Implementation of Mitigation Measure 5.7-4 would reduce adverse effects of development on unstable soils to less-than-significant impact.

**Responsibility and Monitoring** The applicant would be responsible to design and construct the *Wolf House Inn* in accordance with recommendation made by a qualified Geotechnical Engineer. The County or representative engineer shall be responsible for review prior to issuance of grading permit.

**Impact 5.7-5 Expansive Soils**

*Expansive soils may be encountered during project grading and construction activities. Development on such soils could result in damage to foundations, slabs, or pavements. This would be a significant impact.*

Soils with moderate or high expansion potential are susceptible to shrinking and swelling due to fluctuations in moisture content, and are a common cause of foundation deterioration, especially cracking of concrete slabs. According to the *1990 Geotechnical Investigation Report*, certain clayey soils are considered to have low to moderate expansion potential and may be susceptible to at least minor shrinking and swelling.

The *1990 Geotechnical Investigation Report* included laboratory testing on soils collected in Borehole No. 1. Soils were found to have low to moderate plasticity, which is indicative of soils with a low to moderate expansion potential. Soils with a low to moderate expansion potential could cause damage to proposed foundations, concrete slabs, retaining walls, and pavements during seasonal shrinking and swelling. This would be a significant impact.

**Mitigation Measure 5.7-5** Expansive soils shall be mitigated by the following measures in conformance with recommendations of a licensed Geotechnical Engineer. These recommendations can be from the existing *1990 Geotechnical Investigation Report*, provided the report is updated to confirm recommendations, or a new geotechnical investigation shall be performed. Recommended mitigations for expansive soils from the *1990 Geotechnical Investigation Report* that are considered minimum standards to be implemented include:

- Clearing and grubbing of all areas to be graded. Excavation of weak soils, old fills and at least 18-inches of existing subgrade underneath pavement, slabs on grade, and within five feet of perimeter foundations
- Engineered fill replacing excavated soils shall meet the following criteria:
  - Soils shall be compacted to a minimum of 90 percent relative compaction at moisture contents above the optimum in accordance with ASTM D1557;
  - Be free of stones or hard lumps exceeding six-inches in diameter;
  - Be free of organic material;
  - Be non-expansive in accordance with recommendations of the Geotechnical Engineer of record.;
  - Meet the following gradation:

<b>Sieve Size</b>	<b>Percent Passing</b>
6-Inch	100
4-Inch	90-100
No. 200	15-60

- Have a liquid limit less than 40 and plasticity index less than 15 in accordance with ASTM D 4318-84 or other approved method;
- Be able to be finished to a smooth unyielding base for slabs and pavement; and
- Results of soil testing and construction observations shall be approved by the licensed Geotechnical Engineer of record prior to completion of the foundation to ensure design standards are met.

**Significance After Mitigation** Implementation of Mitigation Measure 5.7-5 would reduce adverse effects of expansive soils to development to less-than-significant impact.

**Responsibility and Monitoring** The applicant and construction contractor would be responsible for construction in accordance with geotechnical recommendations. The applicant's Geotechnical Engineer shall complete construction observation and testing. The County or representative engineer shall be responsible for inspections.