IV. ENVIRONMENTAL SETTING, IMPACTS AND MITIGATION

A. GEOLOGY, SOILS AND SEISMICITY

1. Setting

The following information is primarily derived from a geologic report of the project area prepared by Huffman and Associates, Inc., consultants in geology.[1]

a. Geology and Soils. The George Ranch is underlain by rocks of the Sonoma Volcanics of Upper Pliocene age (2.9 to 5.3 million years before present).

The rocks have been divided into two units (Figure 4). Unit Tsa consists predominantly of andesite lava flows, tuff breccias and agglomerates. The latter are air-deposited blocks and fragments in an ash matrix. Beds of lithified volcanic ash (tuff), sedimentary claystone, siltstone and sandstone with interbedded pebble gravels and tuffacious detritus are present in lesser quantities. Unit Tsfd consists predominantly of sedimentary rocks and tuff, with lesser quantities of interbedded lava flows. The rocks are similar to those in unit Tsa.

Strata in both geologic units trend dominantly northwesterly. In unit Tsa they are inclined 15 to 30 degrees to the northeast. Unit Tsfd is more deformed, as evidenced by

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[1]A copy of this report is on file and available for review at the Sonoma County Planning Department, Administrative Center, 2555 Mendocino Avenue, Santa Rosa, California.

varied direction and degree of inclination; the dominant inclination is 30 to 80 degrees to the southwest.

Land forms are controlled by differentiated erosion on hard and weak strata. The resistant lava flows and related rocks of unit Tsa underlie the steeper, higher terrain of the western and southern sectors of the property and form relatively stable slopes. Small valleys and zones of landslides have formed on weaker interbedded sedimentary rocks and tuffs.

The moderate-to-gentle slopes of the northeastern section of the property have formed on unit Tsfd due to the dominance of weak strata. Landslides and soil creep are dominant processes on these slopes, and expansive clay soils are widespread.

b. Landslides and Soil Creep. The term landslide applies generally to discrete, deep-seated slope movements in the George Ranch. In contrast, soil creep is shallow and relatively slow downslope movement of the soil mantle. The soil creep is attributable to expansion and shrinkage of soils resulting from wetting and drying, respectively. The movement manifests itself in surface tension cracks when dry. On the Ranch, zones of soil creep often grade into more stable soils, or landslides.

The dominant landslide type on the George Ranch is rotational slump-earth flow, consisting characteristically of fine grained sedimentary rocks and clayey soils with lava flow boulders. The slumps move as semicoherent masses forming topographic benches and depressions. Earth flows form where materials have become disintegrated by movement, resulting in irregular hummoky topography.

Other slope movements include a large debris slide which lies on slopes of an upland canyon on George Ranch, and consists of lava flow boulders and fragments. "Old" slump-earthflows have a subdued morphology which reflects a period of dormancy during which soil creep and surface wash modified characteristic landslide features.

A large "ancient" landslide, which caused "scarp and bench" topography characteristic of rotational slumps, is located on the east central slopes of the property. A developed recreation pond, located at midslope, occupies a closed depression created by the mass movement.

c. Seismicity. The San Andreas, Rodgers Creek, Maacama, Hayward and Calaveras Faults as well as other active faults in the Bay Region are capable of generating moderate to strong ground motion on the George Ranch.

The two geologic units, Tsa and Tsfd, are separated by a fault that trends north and northwesterly in the northeastern section of the property (Figure 4). A branch of this fault was identified to extend southerly through the central section of the property. These faults are part of a regional fault system that extends at least 12 miles northwest of the George Ranch. Quaternary age (past 2,000,000-3,000,000 years) movement was identified on the northernmost segment of the fault system.

Two northeast-trending faults are present on the southwestern slopes of the property. These appear to be part of a group that branch from the active Rodger's Creek Fault, located within one mile west of the western boundary of the property.

No evidence of active faulting was identified on the George Ranch.

2. Impacts

a. Geology, Soils and Slope Stability. The George Ranch was subdivided into four zones of increasing landslide susceptibility by Huffman and Associates. Two zones (A and B in the report) are of low constraint to construction; one zone contains gentle slopes (generally less than 15%) without evidence of landsliding or underlying conditions conducive to landslides; the other zone contains moderate-to-steep slopes, also without evidence of landsliding and is not directly affected by conditions conducive to landsliding. Two other zones (C and D in the report) reveal greater constraints; one zone contains no direct evidence of landslides but may be underlain by geologic factors conducive to landsliding, it is considered an area of Moderate Constraint to construction (Figure 4); the other zone and areas of overall High Constraint contain recent and old landslides, areas of soil creep, upper portions of the ancient landslide, fault zones, streams and springs (Figure 4).

The relative landslide susceptibility interpretation is based upon the premise that future slope movements are most likely to occur, both naturally and under the impact of land use, where landslides have occurred in the past and where geologic conditions conducive to landsliding have been identified.

Some hazards may pose unacceptably high risks of costly irreparable damage to dwellings. These risks are not readily eliminated by conventional engineering geology and engineering. The hazards may, however, represent acceptably low risks to roads and other repairable facilities, with adequate planning and site investigations to minimize the risks. To minimize the adverse impacts on inhabitants and structures of the proposed project, planning includes maximizing of dwelling sites on areas of low constraint while minimizing location of streets and utilities in areas of Moderate and High Constraints.

Further impacts exist and are not precisely determined. Areas of landslides and potential instability may have gone unrecognized in the study by Huffman. Future movement would have a major impact on dwellings and septic systems. Because there are many causes of landslides, which typically act in combination to produce slope movement, their identification and quantification are difficult. Weak geologic materials are an important underlying cause of slope movement and clearly control the location of landslides on the George Ranch. Steeper slopes tend to be relatively more susceptible to landslides.

Natural or human-induced high moisture contents often contribute to landslides. This is because high moisture content increases the buoyancy and decreases the shearing strength of geologic materials.

Water plays a major role in the geologic processes acting through time, which alter the landslide susceptibility of slopes. Weathering, stream bank erosion, and other natural processes increase the landslide susceptibility of slope forming materials.

The process may take years to induce landsliding, but movement can be manifested in a short amount of time.

Land uses may have similar time-dependent effects, and may accelerate processes begun naturally. Therefore, the apparent lengthy stability of a slope cannot be used solely to judge its landslide susceptibility, as conditions may be unrecognized and/or may change, possibly in the lifetime of a land development and use such as the proposed project.

Land uses may be a major cause of landsliding, particularly when combined with inherent instability. Cumulative impacts of site development may aggravate erosion and maintenance problems on marginally stable materials. Cuts for roads and structures may remove support from unstable slope materials; fill and structures may overload marginally stable slopes. Discharge from septic systems and site drainage may increase the moisture content in unstable geologic materials to critical levels. These conditions have been known to trigger landslides, as they have done to a certain extent on the adjacent Diamond A Subdivision (Huffman and Associates, p. 19).

The George Ranch development would consist of grading activities to widen and stabilize roads, and creation of a new major roadway, driveways and emergency access. Structures will include a house of 2,000 to 3,500 square feet for each residential site; buildings to contain cars, boats, trailers, horse stables and swimming pools are all possibilities.

Grading activities would alter the current condition of the Ranch. In two locations on the site plan, road widening is not desired for aesthetic and feasibility reasons, so a divided road is proposed. It is not yet determined whether proposed cutting would remove support from possible weak slopes above or whether the road would place a critical load on slopes below. Driveways could cause similar such impacts, as well as horse trails on a smaller scale.

Although new road construction would largely follow the existing road pattern, several sections may entail cross slopes and a cut of more than 3 feet. These areas may include the driveways for lots #1, #2, and #3, a corner section of the main road at lots #7, #10 and #9, and parts of the main road and driveways for lots #34 through #42. Some fill would be added for the main road along portions of lots #44, #45, and #25.

In their review of the site plans, Huffman and Associates identified the following impact areas. For the Preliminary Development Plan:

- Access roads to building lots #17, #22, #32, #33, #44, #45, and #51 are not shown. The main road alignment crossing lot #4 (old landslide) is partially in a zone of High Constraint as is the road south of lot #51 which follows a probable fault for several hundred feet. The road alignment south of lot #17 passes through a small zone of Moderate Constraint (possible old landslide).

- Building lots #47, and #27 are partially in zones of High Constraint, i.e., a creep area and old landslide, respectively. The building site of lot #7 is partially in a zone of Moderate Constraint, and building lot #32 is in a slight swale, or shallow watercourse.

b. Seismicity. Based upon regional earthquake history and geology, it is estimated that potentially damaging earthquake groundshaking should occur somewhere in Sonoma County once every 20 to 30 years on the average.[1] The great San Francisco earthquake of 1906 (estimated Richter magnitude 8.3) caused severe damage and landslides in central Sonoma County. Numerous landslides which moved in light, porous tuff of the Sonoma Volcanics, included one which temporarily dammed Maacama Creek in north central Sonoma County. The inclination of the strata, as well as the weak materials, controlled the location of the slide. The moderate Santa Rosa earthquakes of 1969 (Richter magnitudes 5.6 and 5.7) produced locally severe damage in Santa Rosa. They are inferred to have been generated on the northern extensions of the Rodgers Creek Fault.

Three conclusions are drawn from the seismic setting of the George Ranch: (1) there is a reasonable likelihood that potentially damaging earthquake groundshaking would occur during the useful life of the structures; (2) strong earthquake groundshaking would increase the potential for the occurrence of landslides on less stable areas of the property; (3) there is a low-level hazard that sympathetic fault rupture could occur along faults on the George Ranch as a result of a major earthquake, with accompanying surface slippage along the nearby Rodgers Creek Fault.

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[1]Greensfelder, R.W., 1974. Seismicity, Groundshaking and Liquefaction Potential, in Geology for Planning in Sonoma County, California Division of Mines and Geology.

In addition, there is seismic risk associated with potential liquefaction. Liquefaction-induced landsliding occurs when saturated low-density strata of sand and silt are shaken by earthquakes. The strata form slip zones on which the overlying soil moves, even on gentle slopes. This form of landsliding occurs where surficial materials have recently been deposited in alluviated basins. There is a possibility that such materials have been deposited in the upper valleys on the property, however, no evidence of such deposits was noticed and this may be considered a low-level hazard. There is, however, liquefaction potential where abundant seepage indicates high near-surface moisture.

3. Mitigation

A detailed engineering geology/soils investigation should be required for each holding site prior to filing of the final map. It should demonstrate the existence of a stable site for dwellings and adjunct facilities under recommended conditions of location, grading and drainage.

Where dwelling sites and septic systems are located in zones of Low Constraint, soils engineering investigations should be required prior to issuance of building permits to establish criteria for grading, foundation design, and site drainage. Further, should unusual conditions be found by the soils engineer, an engineering geologist should be consulted, and a coordinated site-specific study should be done.

Where street alignments are located in zones of High and Moderate Constraint, including the emergency access road, engineering geology and soils engineering investigations should be conducted to identify potential instability and recommend corrective measures. This mitigation should apply to roadways (especially those requiring cuts exceeding 3 feet), dwelling sites and septic systems in zones of Moderate Constraint, and areas of Low Constraint that may be adjacent and/or impact higher constraint areas. In addition, further investigations should use the findings and criteria of Huffman and Associates

Grading should be minimized to reduce potential destabilization effects of cuts and fills on the slopes. Cut slope inclinations and stabilization measures should be established with consideration of site-specific geologic factors. For example, an alignment might be chosen so that it intersects the stratification at a high angle where this would provide for weaker zones to be supported by more resistant strata.

Some improvements in the site plan that would mitigate impacts as identified in a review of the plans by Huffman and Associates, follow. For the Preliminary Development Plan:

- Access roads to building lots #17, #22, #32, #33, #44, #45, and #51 should be located in Low Constraint areas if possible. Grading and inclination of roads should be minimized. The road alignment of the Alternative Plan through lot #4 is preferable. The road south of lot #51 should be located south or north of the proposed alignment to reduce exposure to the hazard of siting on a probable fault. Slight realignment of the road south of lot #17 would prevent location on the possible old landslide.

- Slight modification in the planned sighting of lots #47, #27, #7 and #32 would remove them from High and Moderate Constraint zones.

Further investigations are critically important, because interpretations and recommendations to date are limited by the scope of investigation. Small areas of unstable surficial materials may have gone undetected. Subsurface exploration was not conducted therefore, it is possible that potentially unstable subsurface structures exist. Further investigations should identify most such hazards. Risks from geologic hazards cannot practically be entirely reduced.

Low Geologic Constraint

Moderate Geologic Constraint

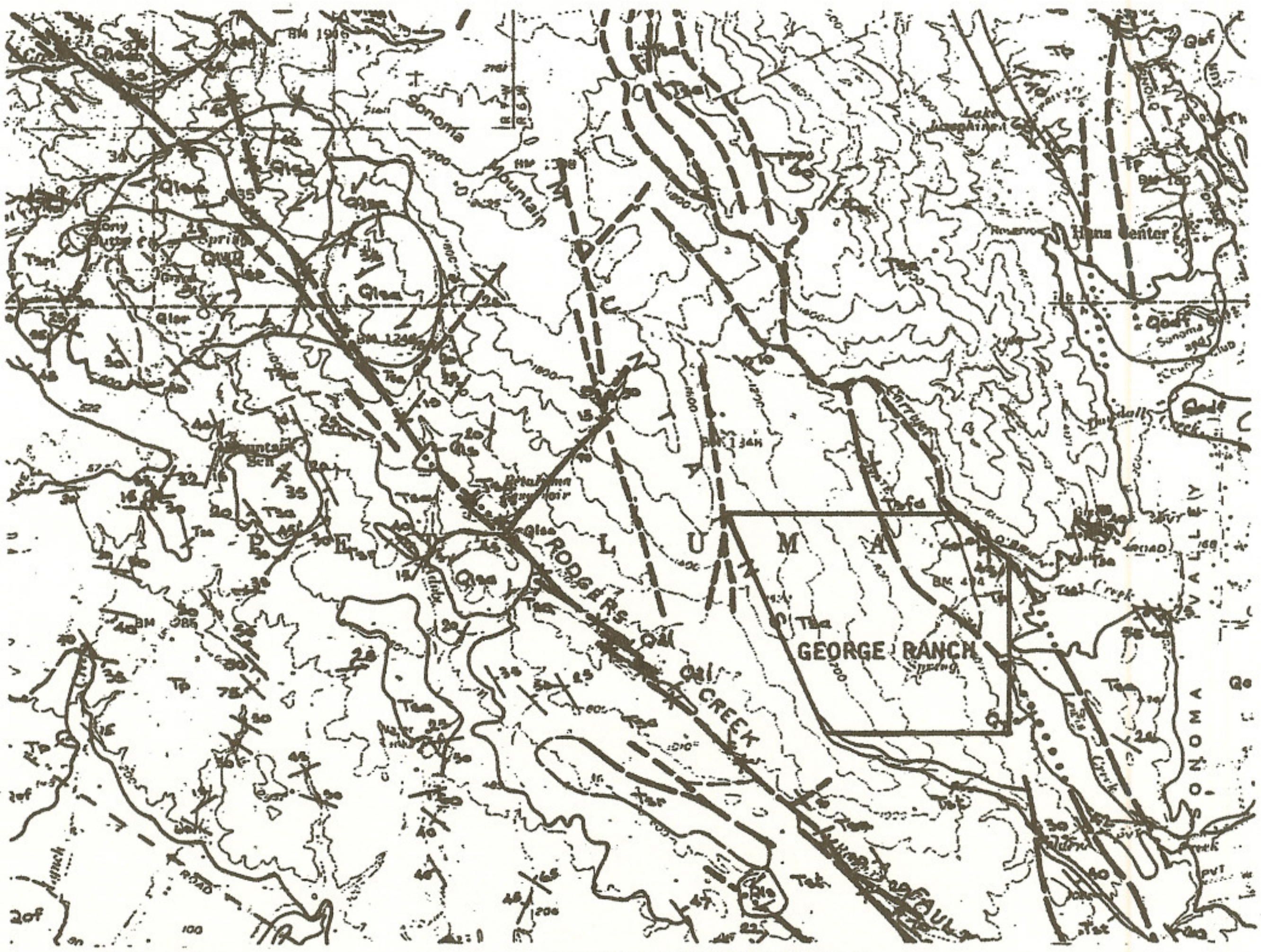
High Geologic Constraint

Fz - Fault Zone
p - pond
st - stream
S - Spring

Geologic Constraints Map

Figure No. 4

0 400 800 1600



Quaternary Units

Qls, Qlsa, Qlsr: Landslide deposits.

Qal: Alluvium.

Qyfo, Qof, Qodf: Alluvial fan deposits.

Quaternary-Tertiary (Plio-Pleistocene) Units

QThg: Huichica and Glen Ellen Formations — sedimentary rocks and tuff.

Tertiary (Pliocene) Units

Tsa: Sonoma volcanics — andesitic to basaltic lava flows.

Tsfd: Sonoma volcanics — lava flows, diatomite, sedimentary rocks.

Tst: Sonoma volcanics — tuff.

Tp: Petaluma Formation — sedimentary rocks, diatomite, tuff.

Symbols

General direction of landslide movement.

10 Strike and dip of flow banding.

70 Strike and dip of bedding.

vertical

160 top of beds known

40 Fault: dashes and dots indicate relatively less certainty of location. Arrow and numeral indicate direction and amount of dip in degrees.

Contact between units: dashes indicate relatively less certainty of location.

Recently active fault: dashes and dots indicate relatively less certainty of location.

TITLE: FIGURE 1. Geologic Setting of the George Ranch (from Fox, et. al., 1973)		HUFFMAN AND ASSOCIATES, INC 105 FITCH STREET - HEALDSBURG CA 95448	
DRAWN BY: E.T.S.	DATE: 6/25/80	SCALE: 1: 62,500	DRWG. NO.