5.8 GEOLOGY AND SOILS

This Section describes the geologic, soil and seismic setting of the project area, identifies potential impacts associated with the proposed Project, and recommends mitigation measures to reduce the significance of such impacts. Information in this section is based on the *Geology, Soils and Seismicity Report* prepared by Geologist D. Scott Magorien (dated October 2004) and the *Geotechnical Feasibility Study for the Sierra Meadows Dam* prepared by Geomatrix Consultants (dated September 2004). The scope of work performed by Mr. Magorien included a compilation and review of relevant reports, including the *Geotechnical Feasibility Study for the Sierra Meadows Dam* report, and maps that address geotechnical, geologic and hydrogeologic conditions for the project area, and reconnaissance-level geologic mapping. The *Geology, Soils and Seismicity Report* and the *Geotechnical Feasibility Study for the Sierra Meadows Dam* reports are included in Appendix 15.8, *Geology/Soils Analysis*.

EXISTING CONDITIONS

GEOLOGIC SETTING

The Sierra Meadows project area is situated within a transitional area between the rolling foothills and mountain ranges of the Sierra Nevada Mountains. Bedrock exposed across the region surrounding the project area is predominately granitic rock that forms the core of the Sierra Nevada Mountains (i.e., Sierra Nevada batholith). The granitic rock that underlies the project area and surrounding region is identified as early Cretaceous age (approximately 120 million years old) Bass Lake Tonalite. Prebatholithic metamorphic rocks of the Coarsegold roof pendant are exposed across the top of Potter Ridge, located directly south of the project area, and are correlative with rocks of the Western Metamorphic Belt exposed north of Mariposa. The Coarsegold roof pendants include Jurassic age metavolcanic rocks (primarily amphibolite) and surrounding Triassic age slate and phillite with interbedded quartzite and chert. Alluvial deposits occupy the bottoms of the major drainages that flow westerly from the Sierra Nevada Mountains.

Site Conditions

The project site occupies a small upland valley and surrounding ridgelines formed by Miami and Carter Creek and a number of smaller northwest-trending tributary drainages. Elevations within the site range from a low of approximately 1,640 feet near the confluence of Miami and Peterson Creeks, to a maximum of approximately 2,450 feet in the northeastern portion of the project area. Topographically, the majority of the project area is characterized by moderate to deeply incised drainages and relatively broad intervening ridgelines and narrow plateaus. A broad, fairly large alluviated valley associated with the Peterson and Miami Creek drainage occupies a limited portion of the of the project area. Natural slopes adjacent to Miami and Carter creeks and the tributary drainages within the project area display surface gradients of approximately five (5) to 30 percent, except along the margins of the portions of Miami and Carter Creeks, where slopes can vary from 30 percent to near vertical.

GEOLOGIC MATERIALS

Bedrock beneath the project area consists entirely of granite. The majority of the project area is capped by residual soils derived from weathering of the underlying granitic rocks. Recent alluvial deposits occupy the bottom of the many of the natural drainages. Rocky debris, referred to as scree, and accumulations of large stream boulders occupy portions of the two major drainages, namely Miami and Carter creeks. The designations shown below, in parenthesis, correspond to those shown on Exhibit 5.8-1, *Geologic Map*.

Topsoil (Not Designated)

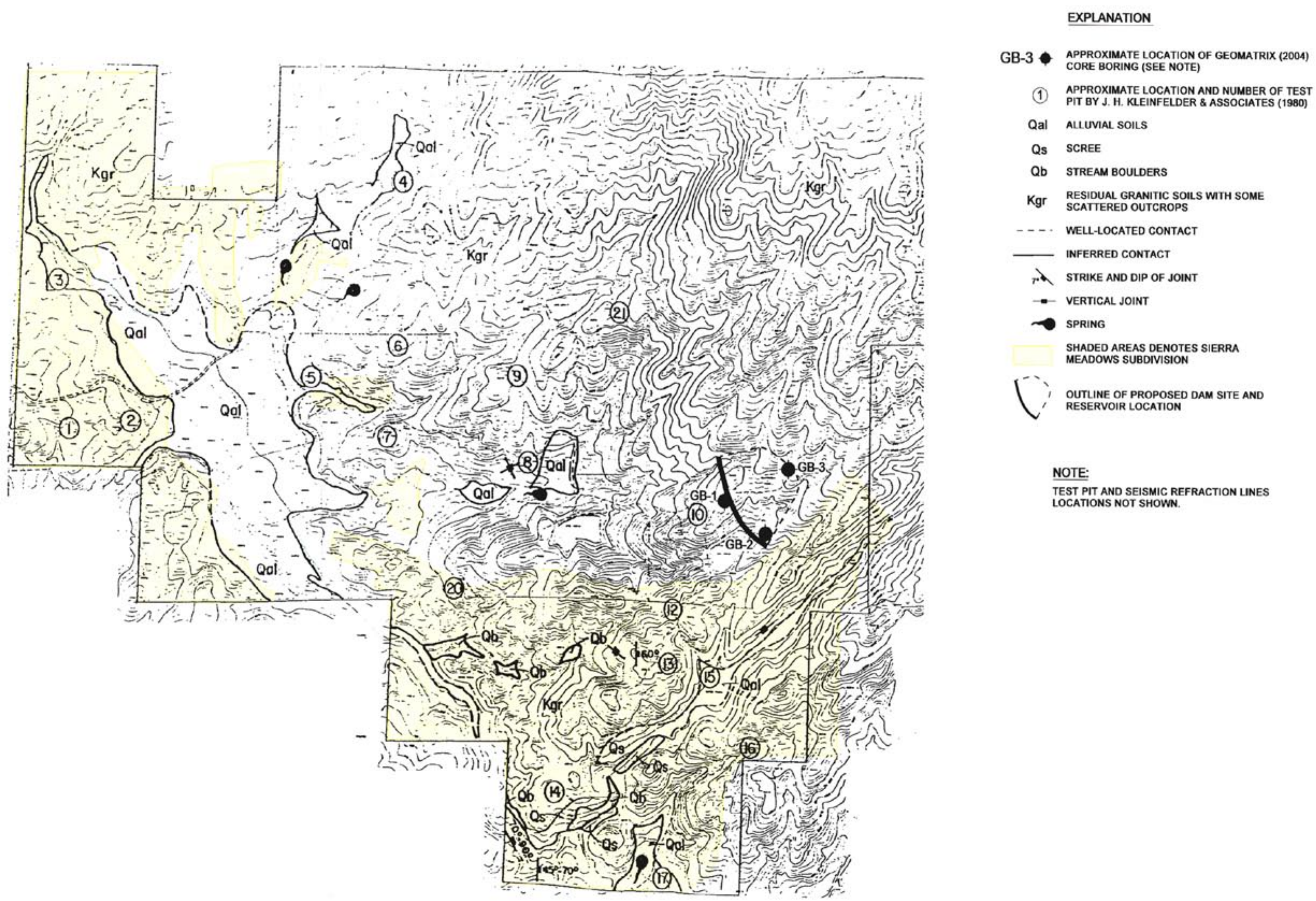
Native topsoil materials in the project vicinity are classified by the U.S. Department of Agriculture Soil Conservation Service (USDA) mostly as Ahwahnee and Auberry (undifferentiated) coarse sandy loams. According to previous studies, there are three general soil layers within the project area. The uppermost layer varies in thickness from several inches to approximately four (4) feet and consists of medium to dark brown silty/micaceous sand that is moist, medium dense and considered to be moderately to highly permeable, and slightly to moderately erodible. The underling soil layer varies from absent to over 10 feet thick and consists of brown to orange-brown and tan silty/micaceous fine to coarse sand, silty sand or clayey sand or sandy clay that is usually slightly moist and dense. The lowermost layer grades into decomposed granite. Overall, these lower residual soils units are considered to be slightly to moderately permeable, and slightly to moderately erodible, depending upon depth below the ground surface. These various soil materials are suitable for use as compacted fill for construction of the proposed dam/ embankment. These soils are also suitable for use as a compacted soil cap for the proposed residential lots.

Alluvium (Qal)

Alluvial soils are those deposited by streams and are found in most of the larger drainages courses. Although not encountered in exploratory test pits previously conducted on the project site, these alluvial soils likely consist primarily of layers and lenses of fine to coarse-grained sand, silty sand and some finer grained layers. Typically, alluvial soils are loose to medium dense, moist to partially saturated, porous, and likely contain varying amounts of organic matter. In such cases, there is a potential for soils to be subject to collapse upon placement of structural loads (i.e. single-family homes and reservoir embankments).

Due to presence of shallow groundwater and potentially looses sandy soils, there is the possibility of seismically-induced settlement and/or liquefaction within portions of Miami and Carter Creek. Current development plans indicate that approximately 10 lots (Lots 264 to 269; and Lots 300 to 303) in the western portion of the project area are underlain by alluvial soils.

Based on exploratory trenching by Geomatrix Consultants, there are limited amounts of alluvial-type soils within the natural drainages in the area of the proposed dam and reservoir. Where encountered, these alluvial soils vary from about 10 to 20 feet thick and are composed of loose to moderately dense silty sand and sand. These soils



Source: D. Scott Magorien, C.E.G. 1290, October 1, 2004.

Not to Scale

RBF CONSULTING

PLANNING ■ DESIGN ■ CONSTRUCTION

05/05 JN 10-102469

ENVIRONMENTAL IMPACT REPORT

SIERRA MEADOWS ESTATES SUBDIVISION

Geologic Map

Exhibit 5.8-1

would be completely removed as part of the foundation excavation for the dam; and from portions of the reservoir area and be used as a source of borrow for the dam/embankment. As such, any settlement and/or collapse of the dam due to unsuitable nature of these soils would not occur.

Scree and Stream Boulders (Qs and Qb)[1]

Locally along Miami Creek and a tributary drainage near the south boundary are bouldery scree and loose boulders (refer to Exhibit 5.8-1). Scree is a deposit of broken rock fragments and/or accumulation of large boulders with little to no matrix (i.e., sand or gravel size particles that would fill the void space) that creeps down steeper slopes. The boulders are derived from steep cliffs and scree slopes and were deposited in the streams in comparatively recent geologic time.[2]

Granitic Bedrock (Kgr)

The entire project area is underlain at relatively shallow depths by granitic rocks that vary in composition from quartz-rich pegmatite to quartz monzonite to more mafic diorite. These variations could not be mapped separately due to very limited exposures of these rocks in the project area. These variations do affect the differences in texture, mineralogy, overlying soil profile and depth of weathering. Typically, the coarser grained the textured rocks, the greater the depth of weathering and the greater ease of excavation. Conversely, the finer grained the rock, there is commonly less residual soil and excavatibility becomes more difficult.

The likelihood of drilling and blasting of the grained granitic rock for excavations of individual lots is considered low. However, the *Geotechnical Feasibility Study* prepared for the proposed dam and reservoir area indicates that the zone of weathering within the granitic rock extends to depths of only a few feet to depths of 37 to 44 feet below ground surface. Based on the current layout of the proposed dam and interior slopes of the reservoir, some amount of drilling and blasting would be necessary in order to achieve the desired reservoir slope configuration. Further field investigation studies have been recommended by Geomatrix to further evaluate the excavatibility of the bedrock in the reservoir area.

However, from the perspective of dam stability, the *Geotechnical Feasibility Study* indicates that the granite would, once the severely weathered (i.e. grussified) material has been removed, make an excellent foundation for the dam embankment.

BEDROCK STRUCTURE

Geologic structure within the granitic bedrock is defined primarily by jointing. Joints are essentially internal planes of weakness (i.e. fractures) that develop within the rock due to internal stress that have developed within the rock mass. As the rock mass becomes uplifted from depth, such as the ongoing uplift of the Sierra Nevada Mountains and/or erosion of the overlying rocks these built up stresses are released, resulting in the creation of joints/fractures. As with most granitic rock terrains, an

[1] Scree is defined as heap of stones or rocky debris lying on a slope or at the base of a cliff.

[2] Scree slopes are formed by an accumulation of rock debris.

orthogonal system of joints often develops. Joints also form the avenues for groundwater flow and connect surface water with the groundwater stored in the joints/fractures within the bedrock.

The pattern of the jointing in the bedrock within and surrounding the project area essentially controls the creation of drainage patterns. Where observed, the joint set includes high angle (50 to 90 degrees) northeast-southwest and northwest-southeast trending joints, as well as nearly flat lying sheet joints that roughly parallel the ground surface. A number of the granitic outcrops often have a rounded dome-like surface due to the process of exfoliation. Typically exfoliation slabs vary in thickness for 0.5 to 3 feet where the outcrops have a rounded surface, but are typically absent where the surface of the outcrop is nearly flat. The high angle joints cutting the granitic rock at the proposed dam site are widely spaced, typically exceeding 20 feet.

In the area of steep natural slopes adjacent to Miami and carter creeks, jointing patterns control the nature and extent of localized “toppling” slope/ block failures. The possibility of joint-controlled toppling failures is increased if the joints become filled with water, such as from precipitation, surface runoff from landscape irrigation and groundwater seepage from the proposed reservoir, and are unable to drain.

GROUNDWATER

Water that is contained within fractures/ joints in the granitic bedrock serves as the principal groundwater aquifer in the area. There are several operating wells in the vicinity of the project that are used to supplement usage of surface water from Miami Creek. No documentation was available for review concerning quality or quantities of groundwater produced from these wells. However, the majority of potable water supply for the project would come from surface water in Miami Creek that would be stored in the proposed reservoir. Groundwater would continue to provide a supplemental source of water during periods of low flow within the creek.

Depth to groundwater beneath the majority of the proposed residential portions of the site is not well documented. In the proposed residential area adjacent to Miami Creek several springs have been mapped in the area (refer to Exhibit 5.8-1) where depth to groundwater is presumed to be relatively shallow and could pose a concern as it relates to potential degradation to water quality from private, onsite sewage disposal and landscape irrigation runoff.

Based on groundwater level information obtained from exploratory drilling, as well as from existing wells in the area of the proposed dam and reservoir, depth to groundwater in the dam/reservoir area varies from about 10 to 40 feet below ground surface. The shallower depths to the groundwater table correspond to the bottom elevations of the two main natural drainage channels that transect the reservoir, from north to south. According to the *Geotechnical Feasibility Study*, the direction of groundwater flow is essentially north to south.

The majority of groundwater recharge to the bedrock aquifer is likely supplied from inflow on Miami Creek, as well as from a number of surface water storage ponds upgradient of the project area. Infiltration of rainfall during the winter months also contributes to groundwater recharge in the upland areas.

MINERAL RESOURCES

There are no economic metallic or non-metallic ore deposits within or directly adjacent to the project area. Historically, Coarsegold Creek was the closest area associated with economic mineral deposits, primarily placer gold mining. The only lode mine with a significant record of gold production is the Texas Flat Mine, a short distance northwest of the town of Coarsegold, which was mined intermittently between 1886 and 1927. The potential for oil and/or gas deposits beneath the site is considered remote.

GEOLOGIC HAZARDS/CONSTRAINTS

Potential geologic/geotechnical constraints within the proposed residential portion of the project area include the following:

- Soil erosion resulting from grading for housing pads and attendant slopes;
- Potentially collapsible and liquefiable alluvial soils within the broad, marshy area of Miami Creek;
- Slope instability along steep, natural slopes adjacent to portions of Miami and Carter Creek, as well as slopes created during grading for individual lots;
- Degradation of water quality due to the use of on-site sewage disposal for 5-acre (+) lots situated along Miami Creek.

Potential geotechnical and geologic constraints/hazards associated with the proposed construction of a 49-foot-high earthen dam/embankment and the attendant 210-acre-foot capacity reservoir, as illustrated in Exhibit 3-5, include the following:

- Availability of suitable onsite soils for construction of the dam/embankment;
- Excavatibility of the hard granitic bedrock associated with construction of the reservoir;
- Compressibility of native soils when subjected to embankment loads;
- Stability of the dam/embankment and cut slopes surrounding the reservoir;
- Dispersive nature of the soils that would be used for construction of the dam, which may be moderately susceptible to surface erosion;
- Potential leakage of water from through the dam, as well as through major fractures (i.e. joints) in the granitic bedrock in the foundation beneath the dam and within the surrounding reservoir; and
- Downstream flooding and resulting inundation of a number of the proposed residential lots due to excessive discharge from the reservoir along the spillway, or a failure of the dam/ embankment.

Although the project area is located within a relatively seismically quiescent area of the State, it is surrounded by seismically active regions of Southern California. Seismically-induced strong ground shaking is not anticipated within the project area due to the relatively large distance to major faults. There are no documented active or potentially active faults transecting or projecting towards the project area. Moreover, there are no documented landslides within the project area.

The project area is situated with the Foothills/ Mountains subregion of the County, as identified in the *Madera County General Plan Final Environmental Impact Report* (dated 1995). This area of the County is known as being underlain by dense soils and competent bedrock that is regarded as relatively safe from damage by ground shaking resulting from seismic activity; and in low risk conditions for damage resulting from liquefaction, subsidence or landslides. The following sections provide analysis of the potential geologic hazards/constraints associated with the project area.

Faulting and Seismicity

Hazards associated with earthquakes include primary hazards, such as ground shaking and surface rupture; and secondary hazards, such as liquefaction, seismically induced settlement, and landsliding, tsunamis, and seiches.

In accordance with the California Geological Survey (formally the California Division of Mines and Geology), a fault is a fracture in the crust of the earth along which rocks on one side have moved relative to those on the other side. Most faults are the result of repeated displacements over a long period of time. An inactive fault is a fault that has not experienced earthquake activity within the last three million years. In comparison, an active fault is one that has experienced earthquake activity in the past 11,000 years. A fault that has moved within the last two to three million years, but not proven by direct evidence to have moved within the last 11,000 years, is considered potentially active. No active or potentially active faults are located within or project towards the project area.

The project area, like most of California is part of a seismically active region. The Alquist-Priolo Act of 1972 (now the Alquist-Priolo Earthquake Fault Zoning Act, Public Resources Code 2621-2624, Division 2, Chapter 7.5) regulates development near active faults so as to mitigate the hazard of surface fault-rupture. Under the Act, the State Geologist is required to delineate “special study zones: along known active faults in California.” The Act also requires that, prior to approval of a project, a geologic study be conducted to define and delineate any hazards from surface rupture. A geologist registered by the State of California, within or retained by the lead agency for the project must prepare this geologic report. A 50-foot setback from any known trace of an active fault is required. The project area is not currently known to be located within an Alquist-Priolo Fault Rupture Hazard Zone, according to the California Geological Survey.

The Modified Mercalli intensity scale was developed in 1931 and measures the intensity of an earthquake’s effects in a given locality, and is perhaps much more meaningful to the layman because it is based on actual observations of earthquake effects at specific places. On the Modified Mercalli intensity scale, values range from

I to XII. The most commonly used adaptation covers the range of intensity from the conditions of "I –not felt except by very few, favorably situate," to "XII – damage total, lines of sight disturbed, objects thrown into the air." While an earthquake has only one magnitude, it can have many intensities, which decrease with distance from the epicenter.

Ground motions, on the other hand, are often measured in percentage of gravity (percent g), where g = 32 feet per second per second (980 cm/sec^2) on the earth. Ground shaking accompanying earthquakes on nearby faults can be expected to be felt within the project area. However, the intensity of ground shaking would depend upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property.

A listing of active faults considered capable of producing strong ground motion at the site, their closest distances to the property, and the maximum expected earthquake along each fault is presented in Table 5.8-1, *Summary of Fault and Generalized Earthquake Information*. Also presented are generalized evaluations of maximum ground shaking on-site for the maximum earthquakes, and generalized predictions of the likelihood of such events occurring.

Table 5.8-1
Summary of Fault and Generalized Earthquake Information

Name	Miles (direction from site)	Maximum Magnitude	Expected Level of Ground Shaking	Likelihood
Foothills Fault System	11 (north)	6.5	Moderate	Moderate
San Andreas	95 (southwest)	7.4	Low	High
Ortigalita	76 (west)	6.9	Low	High
San Joaquin (Great Valley Thrusts)	69 (west)	6.6	Low	High
Hartley Springs	47 (northeast)	6.8	Low	Moderate
Hilton Creek	46 (east)	6.7	Low	Moderate
Owens Valley	76 (southeast)	7.6	Low	Moderate

The greatest amount of ground shaking at the site would be expected to accompany a large earthquake on the Foothills Fault System, namely the Melones or Bear Creek Faults. An earthquake magnitude of 6.5 on either of these two faults could produce Modified Mercallli intensities in the range of IV to VIII within the project area, and maximum horizontal ground acceleration between 0.14g and 0.16g. Insofar as this expected ground acceleration and proposed dam is concerned, the California Department of Water Resources Division of Safety of Dams (DSOD), which serves as the regulatory agency for new dams, requires the minimum design ground acceleration for new dams is 0.2g. Damage from ground rupture on-site is extremely unlikely because no known active faults cross the property.

Secondary earthquake hazards include liquefaction, ground lurching, lateral spreading, seismically induced settlement, tsunamis, and earthquake induced landsliding.

Liquefaction

Seismic ground shaking of relatively loose, granular soils that are saturated or submerged can cause the soils to liquefy and temporarily behave as a dense fluid. Liquefaction is caused by a sudden temporary increase in pore water pressure due to seismic densification or other displacement of submerged granular soils. Liquefaction more often occurs in earthquake prone areas underlain by young alluvium where the groundwater table is higher than 50 feet below the ground surface. Based on the presence of Holocene age alluvium and shallow groundwater within the broad, marshy area of Miami Creek, this portion of the project area could be susceptible to liquefaction. Additionally, loose, granular soils within the drainages where the dam(s) are proposed could be susceptible to liquefaction.

Ground Lurching

Certain soils have been observed to move in a wave-like manner in response to intense seismic ground shaking, forming ridges or cracks on the ground surface. Areas underlain by thick accumulations of colluvium and alluvium appear to be more susceptible to ground lurching than bedrock. Under strong seismic ground motion conditions, lurching can be expected within loose, cohesionless solids, or in clay-rich soils with high moisture content. Generally, only lightly loaded structures such as pavement, fences, pipelines and walkways are damaged by ground lurching; more heavily loaded structures appear to resist such deformation. Ground lurching may occur where deposits of loose alluvium exist on the project site. If alluvial soils prove to be loose (i.e. poorly consolidated), ground lurching may affect structures built on these materials.

Lateral Spreading

Lateral spreading involves the lateral displacement of surficial blocks of sediment as a result of liquefaction in a subsurface layer. Although there may be liquefaction potential within a portion of the project area, the likelihood of lateral spread is considered to be remote.

Seismically Induced Ground Settlement

Strong ground shaking can cause settlement by allowing sediment particles to become more tightly packed, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits are especially susceptible to this phenomenon. Poorly compacted artificial fills may also experience seismically induced settlement. Unconsolidated soils such as near surface alluvial soils are subject to seismically induced ground settlement.

Tsunamis

A tsunami is a seismic sea-wave caused by sea-bottom deformations that are associated with earthquakes beneath the ocean floor. Given the distance from the project site to the Pacific Ocean, the site would not be subject to hazards associated with tsunamis.

Seiching

Seiching involves an enclosed body of water oscillating due to groundshaking, usually following an earthquake. Lakes and water towers are typical bodies of water affected by seiching. The potential for seiching and its impact on dam safety would be assessed during the actual design phase for the dam and reservoir.

Landslides

No landslides are known to exist within the upgradient of the site. Field reconnaissance did not disclose the presence of older, existing landslides within or near the subject property. Aerial photographic analyses performed as part of the geologic study also did not disclose any existing landslides or slumps in the project area. Given the overall character of the granitic bedrock in the vicinity of the proposed reservoir, the potential for landsliding on the internal, 2:1 (horizontal to vertical) slopes bordering the reservoir is considered low.

Expansive Soils

According to the *Geology, Soils and Seismicity Report*, based on the information generated from previous geotechnical studies, there is no indication of expansive soils within the project area.

Soil Erosion

Increased soil erosion is anticipated within the project site due to the following:

- Grading of individual lots, as well as the proposed reservoir, that would disturb the natural soil conditions and expose the contact between granite and the overlying decomposed granite and highly erodable soils;
- Loss of vegetative cover;
- Construction of cut slopes for individual lots, roadways and reservoir slopes that would expose weathered bedrock and overlying soils to accelerated erosion;
- Increased surface water runoff resulting from construction of impermeable surfaces, such as roadways, driveways, and extensive hardscape on individual lots; and
- Channelization of surface water runoff collected from storm drains that discharge into natural drainages.

ON-SITE SEWAGE DISPOSAL

Madera County requirements consider percolation rates between five and 60 minutes per inch of drop in water level (minutes/inch) as an acceptable range for private sewage systems. However, the percolation rate is only one of many factors that affect the suitability of any site for sewage disposal via the use of leach lines. In the absence of the various factors used to evaluate suitability, poorly designed septic systems can create significant impacts to nearby water courses and riparian habitat, as well as degradation of groundwater quality.

Private on-site sewage disposal is planned for 28 five-acre plus lots (all lots within Phase 1), 22 of which border Miami Creek. To date, there has been no specific testing (i.e., percolation tests) within the lots that are planned to use an on-site septic system. Of the 11 percolation tests previously performed in and around the project area, percolation rates varied from a low of 0.8 to 400 minutes/inch within test pits that ranged from 1.6 to 3.5 feet deep. The fastest percolation rate is six times as fast as the fastest acceptable rate, and the slowest rate is 1/6 the slowest acceptable rate. Therefore, the near-surface soils and highly weathered granitic bedrock exhibit a wide range of percolation rates. Many of the lots would be built on fill material that would provide the required percolation. The existing developed lots on the area utilize on-site septic systems that have performed adequately.

IMPACTS

SIGNIFICANCE CRITERIA

Appendix G of the California Environmental Quality Act (CEQA) Guidelines contains the Initial Study Checklist form. The Initial Study Checklist includes questions relating to geology, soils and mineral resources. The issues presented in the Initial Study Checklist have been utilized as thresholds for significance in this Section. Accordingly, a project may create a significant environmental impact if one or more of the following occurs:

- 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 (refer to Impact Statement 5.8-6);
    - Strong seismic ground shaking (refer to Impact Statement 5.8-6);
    - Seismic-related ground failure, including liquefaction (refer to Impact Statement 5.8-5);
    - Landslides (refer to Impact Statement 5.8-1);

- Result in substantial soil erosion or the loss of topsoil (refer to Impact Statement 5.8-3);

- 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 (refer to Impact Statements 5.8-1, 5.8-3 and 5.8-5);

- Be located on expansive soils, as defined in Table 18-1 B of the Uniform Building Code (1994), creating substantial risks to life or property (refer to Impact Statement 5.8-5); and/or

- 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 (refer to Impact Statement 5.8-4).

The level of geotechnical and landform information contained herein is adequate to analyze the potential project effects on earth resources and landforms, and to determine appropriate mitigation measures for the proposed residential development and dam/reservoir. Although there is adequate geologic and geotechnical information relative to the siting and construction of the proposed dam, design-level engineering and geotechnical studies would be required, which would need to be reviewed by and approved by DSOD prior to actual construction of the proposed dam. In addition, the project geotechnical engineer would also need to perform additional testing and review of on-site conditions as part of the final design work for the residential portion of the development. This additional work for both the residential development and proposed dam would further refine details for site/dam design, but is not anticipated to alter the conclusions of significance contained herein. These later additional refinements are not a deferral of mitigation. Rather, it is a design refinement, consistent with the commitment to mitigation included in this EIR.

According to the current residential development plan, a total of 315 individual lots are proposed to be constructed in 12 different phases of grading. Of the 315 lots to be developed, 135 of the lots would be graded. If the housing pads expose a combination of competent bedrock and loose soil, to achieve a uniform foundation for a home, the entire pad would be over excavated a minimum of three feet and replaced with compacted fill. Excavated materials from the housing pads, as well as adjacent cut slopes, would be placed as compacted fill around the edges of the pads/lots. The lots range in size from approximately 7,000 square feet to six acres. All but the 28, five-to six-acre lots in Phase 1 would be tied into a central sewage and treatment system..

Surface water runoff from each lot is planned to be directed away from the fill slopes and sheet flow to shallow earthen or concrete lined swales located within cut portions of the lots. In many cases this surface water runoff from lots and adjacent cut slopes would be directed into nearby natural drainage channels.

In order to supplement water supply during the summer months, the project would include construction of an earthen dam and reservoir that would be filled during the winter months that would hold approximately 210 acre-feet of water. As stated above, there is sufficient geologic, geotechnical and preliminary dam design information available to adequately assess potential impacts associated with the proposed dam and reservoir.

The project would also include a water treatment plant to be located near an existing 150,000-gallon water tank. The treatment plant would be constructed utilizing a factory- assembled metal unit approximately 10 feet wide, 32 feet long and 10 feet high.

There are a number of short- and long-term impacts to the current physical/geological setting that could be generally expected from grading and development activities associated with the proposed residential development and the dam.

Based on the results of the information reviewed for this analysis, earthquake induced strong ground motion, and landsliding (excluding rock fall-type failures) are not considered to represent significant impacts due to the low potential within the project site. Also, there is no indication of the presence of expansive soils within the limits of the project area.

The most significant potential impacts resulting from the proposed residential development and construction of the dam would be caused by changes in existing topography from grading activities, slope stability, erosion of surficial soils and highly weathered granitic bedrock, degradation of surface and groundwater quality from residential septic systems and irrigation runoff, possible collapsible and/or liquefaction-prone alluvial soils, and most certainly any potential failure of the dam.

Potential impacts associated with the project area are discussed below. Mitigation measures are provided to reduce the significance of impacts.

SLOPE STABILITY

5.8-1 *Development of the proposed project could result in slope failures. Implementation of the recommended mitigation measures and compliance with the Madera County Development Code and Uniform Building Code would reduce impacts to less than significant levels.*

RESIDENTIAL DEVELOPMENT

Current project grading plans indicate the construction of 2:1 (horizontal to vertical) cut slopes up to 40 feet high as part of grading for individual lots. Based on the very dense nature of the granitic bedrock, lack of weak zones/layers, and the good performance of existing cut slopes in the residential area and roadways surrounding the project site, surficial and gross stability of cut slopes is not anticipated to be a constraint to residential development. In fact, many of the roadway slopes that have been excavated in similar granitic rocks along SR-41 and SR-49 are as steep as 1/2:1 and are not experiencing signs of instability. All other factors being equal, steeper slopes (i.e., 1½ to 1:1) in sound granitic bedrock are generally less susceptible to surficial instability because of the more limited amount of exposed surface area that is subject to direct contact with rainfall. Additionally, as stated in the Existing Conditions section above, the project area is not subject to impacts from landslides.

To ensure that the proposed project would not result in slope failures, where cut slopes are planned, they should be excavated primarily within granitic bedrock materials at inclinations not exceeding 1.5:1 (horizontal to vertical). Additionally, fill slopes for residential development should be constructed with engineered fill at inclinations no steeper than 2:1. Under the observation of a geotechnical specialist or engineering geologist, periodic inspections during placement of fill materials and compaction testing during excavation of cut slopes would minimize slope stability impacts. Cut and fill slopes would be grossly and surficially stable with implementation of the recommended mitigation measures regarding slope stability and compliance with the construction guidelines set forth in the Madera County Grading Ordinance.

In regards to stability of the steep granitic rock slopes bordering portions of Miami and Carter Creeks, block-and/or toppling-type failures could occur as the result of the stream erosion undermining portions of these slopes and/or the buildup of water within natural joints and fractures due to infiltration of misdirected surface water runoff and/or from effluent from septic systems. Currently, the accumulation of scree deposits along the base of these slopes helps create a natural buttress for these slopes, thereby enhancing their stability. Establishing adequate structural setbacks for homes and septic systems from the steep natural slopes adjacent to Miami and Carter Creeks, and maintaining positive surface drainage away from these steep slopes would provide appropriate mitigation against slope failures.

To minimize project-related impacts regarding slope stability for the construction of residential uses, mitigation measures have been recommended. The recommended mitigation measures include cut and fill slope requirements, providing adequate structural setbacks for homes and septic systems from the steep natural slopes adjacent to Miami and Carter Creeks and providing positive surface drainage directed away from steep natural slopes adjacent to Miami and Carter Creeks. Implementation of the recommended mitigation measures and compliance with Madera County design standards would ensure that all impacts during residential construction regarding slope stability are reduced to less than significant levels.

RESERVOIR CONSTRUCTION

The proposed dam would have crest elevation of 2,440 feet above mean sea level (msl) and crest length of approximately 1,140 feet and would be comprised of a main dam with a length of approximately 780 feet and a saddle dam with a length of approximately 150 feet separated by a 210 foot bedrock cut section. The maximum embankment height would be 49 feet as measured from the dam crest to the lowest downstream toe of the main embankment. The *Geotechnical Feasibility Study* indicates that the embankments may be constructed of suitable earthen materials (i.e. residual soils, alluvium, grussified granite) obtained from the excavations for the embankment foundation and reservoir. Hydraulic conductivity testing performed on remolded bulk soil samples obtained during their field exploration indicates that the on-site soils would be suitable for embankment construction. Based on the proposed reservoir storage capacity of approximately 210 acre-feet, the proposed dam would fall under the jurisdiction of DSOD. As such all aspects of dam design and construction would need to be reviewed and approved by DSOD.

The stability of the proposed dam and cut slopes surrounding the reservoir is of critical importance as it relates to public safety. The upstream and downstream face of the embankment would have slope ratios of 3:1 (horizontal to vertical) and 2:1, respectively. The bedrock cut slopes internal to the reservoir would vary in height from approximately 35 to 60 feet and have slope ratios of 2:1. According to the *Geotechnical Feasibility Study*, the embankment slopes, as well as the cut slopes within the reservoir are expected to have adequate factors of safety (i.e., > 1.5) against failure, both under static conditions and under earthquake loading during a seismic event in the region. From the perspective of overall stability of dam, once the severely weathered granitic bedrock materials have been removed, the remaining granite bedrock would make an excellent, stable foundation for the dam embankment.

Based on the seismic refraction surveys, exploratory trenching and core analysis, the uppermost 17 to 37 feet of highly to moderately weathered (i.e., decomposed) granite should be readily excavatable with conventional heavy earth moving equipment and should provide suitable material for embankment fill when placed and compacted in accordance with the recommendations presented in the *Geotechnical Feasibility Study*. By contrast, the excavatibility of the fresh to little weathered granitic bedrock is considered non-rippable using conventional types of grading equipment and would require blasting in order to excavate. There are several areas within the proposed reservoir where it appears that blasting may be required to create portions of the internal slopes. The *Geotechnical Feasibility Study* recommends that in order to evaluate the depth to which the granite can be readily excavated by typical construction equipment, test excavations using a D 9 bulldozer with ripper shanks should be performed.

Insofar as controlling water seepage from the reservoir through the proposed embankment, a blanket drain at the base of the embankment would be required and a chimney drain may be required depending upon the results of a seepage analyses to be performed during the actual design phase for the project. In order to control seepage through the fractures/joints in the foundation bedrock, a cut off trench has been suggested by the *Geotechnical Feasibility Study*.

Groundwater is anticipated where excavations approach the top of the weathered bedrock, particularly in swales and drainage courses. Dewatering can likely be accomplished by means of sumps and pumps placed at low points in the excavations.

As with similar types of dams, a spillway cut in the bedrock on either the west or eastern abutment would be necessary. To date, no proposed spillway location has been identified. Further investigation of the spillway area would be performed during the design phase for the dam.

To minimize project-related impacts regarding slope stability for the construction of the dams/reservoir, mitigation measures have been recommended. First, similar to residential development, fill slopes would be required to be constructed with engineered fill at inclinations no steeper than 2:1. Mitigation has been recommended that test excavations be performed to determine the excavation depths to which typical granite can be excavated by typical construction equipment. These tests would determine the necessary blasting requirements to excavate the proposed reservoir area. Lastly, mitigation has been recommend that a seepage analysis be performed as part of the actual design phase for the project to determine if a chimney drain is required in addition to a blanket drain at the base of the embankment. Implementation of the recommended mitigation measures and compliance with Madera County and/or DSOD design standards would ensure that all impacts during the reservoir construction regarding slope stability are reduced to less than significant levels.

GROUNDWATER

5.8-2 *Development of the proposed project could result in groundwater recharge that could affect underground utilities and private sewage systems. Implementation of the recommended mitigation measure and compliance with DSOD dam design standards would reduce impacts to less than significant levels.*

As stated in the Existing Conditions section above, there are several operating wells in the vicinity of the project that are used to supplement usage of surface water from Miami Creek. However, no documentation was available for review concerning quality or quantities of groundwater produced from these wells. Although the majority of potable water supply for the project would come from surface water in Miami Creek, groundwater would continue to provide a supplemental source of water during periods of low flow within the creek.

Significant amounts of groundwater recharge could develop with construction of the reservoir, thereby creating elevated groundwater levels in the area surrounding the reservoir. As part of the geotechnical analysis conducted for the project site, permeability (i.e. packer) testing was conducted in three borings to assess in-situ bedrock fracture permeability (hydraulic conductivity). Average hydraulic conductivities were calculated for each 13- to 20-foot depth interval in each of the 80- to 100-foot deep borings, ranging from approximately 7.3 x 10-5 centimeters per second (cm/sec) [6 feet per year (ft/yr)] to 2.9 x 10-4 cm/sec [296 ft/yr]. Based on the location of each of the borings with respect to the proposed embankment and reservoir, the hydraulic conductivity values indicate the granite bedrock displays low to moderate potential for subsurface leakage in the foundation bedrock beneath the dam and from the reservoir, respectively. Per the recommendation of the *Geotechnical Feasibility Study*, to preclude any significant leakage beneath the dam, a “cut-off trench” should be constructed within the foundation of the dam, if necessary, pending the hydrogeologic findings of the design-level studies referenced in Mitigation Measure 5.8-1f.

Implementation of the recommended mitigation measure and compliance with all DSOD design standards would ensure that all potentially significant impacts regarding groundwater recharge are reduced to less than significant levels.

SOIL EROSION

5.8-3 *Development of the proposed project could result in accelerated soil erosion. Project compliance with the Madera County Development Code* *and Uniform Building Code and implementation of the recommended mitigation measures would reduce impacts to a less than significant level.*

The near surface soils and highly weathered bedrock materials within the project area are moderately erodable. Adverse surface drainage across individual lots, on the face of manufactured slopes and from concentrated discharge from storm drains into natural drainage channels could promote accelerated soil erosion that could lead to increased sedimentation. This impact would be considered significant if not mitigated. Additionally, surface erosion aspects associated with construction of the dam would include downstream discharge from the spillway of the dam and surface erosion on the downstream face of the dam due to dispersive soils and/or concentrated surface water runoff. These potential concerns would be addressed during design-level work for the dam.

Mitigation measures, which include establishing vegetative cover in disturbed areas, diverting surface drainage from cut and fill slopes, minimizing the area of disturbance, would reduce potentially significant impacts as a result of soil erosion to less than significant levels.

SEWAGE DISPOSAL

5.8-4 *Development of the on-site sewage disposal systems may impact groundwater quality and soils in the project area. Analysis has concluded that with implementation of recommended mitigation, impacts would be less than significant.*

According to the current site plan, a total of 315 individual lots would be constructed in 12 phases of grading. All but the 28, five-acre plus lots in Phase 1 would be tied into a central sewage and treatment system. Per the analysis conducted in the *Geology, Soils and Seismicity Report*, it is recommended that potential impacts on surface and groundwater quality and slope stability resulting from the proposed on-site sewage disposal systems warrant a comprehensive and detailed study of leach field suitability. Such a study should investigate and evaluate all the factors involved in individual sewage disposal system utilization, including soil types and their depths, permeability, slopes, the locations of springs and depth to seasonal groundwater, drainage, effluent volume, and setbacks to watercourses and other features.

Existing County and State regulations for community water systems require testing the water for coliform bacteria and other possible pollutants at least once a month, and weekly when the systems serve more than 15 connections. This required testing program mitigates the potential for any undiscovered water quality problems. Subject to the approval of the Madera County Health Department, a testing program for coliform bacteria and other possible pollutants would be established for all on-site wastewater systems. At the County's discretion, the testing program may include monitoring of surface water quality in Miami and Carter Creeks and/or groundwater supplies.

Section 5.10, *Public Services and Utilities*, includes a review of wastewater treatment and disposal alternatives for the proposed project. Implementation of the recommended mitigation measures requiring preparation of a leech field study and a testing program for coliform bacteria and other possible pollutants established for all on-site wastewater systems subject to review and approval by the Madera County Environmental Health Department, would reduce potentially significant impacts from sewage disposal to less than significant levels.

COLLAPSIBLE AND/OR LIQUEFACTION-PRONE SOILS

5.8-5 *Development of the proposed project may create substantial risks to life property as a result of collapsible and/or liquefaction-prone soils. Analysis has concluded that with implementation of recommended mitigation, impacts would be less than significant.*

Portions or all of the alluvial soils associated with the major modern drainages, namely Miami and Carter Creeks, are likely to be susceptible to collapse upon placement of structural loads, such as from placement of fill soils or construction of single-family homes. Saturated portions of these soils are also considered potentially susceptible to liquefaction-induced settlement. Additionally, due to presence of shallow groundwater and potentially looses sandy soils, there is the possibility of seismically induced settlement and/or liquefaction within portions of Miami and Carter Creeks. Current development plans indicate that approximately 10 lots (Lots 264 to 269 and Lots 300 to 303) in the western portion of the project area are underlain by alluvial soils. It is also noted that no expansive soils exist within the project area.

The limited amounts of alluvial soils within the natural drainages where the reservoir is proposed would likely be completely removed as part of the foundation excavation for the dam. As such, impacts from settlement/collapse due to unsuitable soils beneath the dam are considered less than significant.

The impact to homes built atop alluvial soils from either soil collapse, or soil settlement resulting from liquefaction would be significant unless mitigated. Typical mitigation concepts would include complete removal and replacement of these soils with engineered fill, performing in-situ densification of collapsible/liquefaction-prone soils, or supporting all future structures that are underlain by these unsuitable soils on piles and grade beams. Geotechnical engineering studies to evaluate collapsible and/or liquefaction-prone soils would be needed where development areas of the project are underlain by alluvial soils. Implementation of the recommended mitigation measures would reduce potentially significant impacts from collapsible and/or liquefaction-prone soils to less than significant levels.

GROUND SHAKING

5.8-6 *Development of the proposed project may increase the number of people/structures exposed to effects associated with seismically induced ground shaking. Compliance with the Madera County Development Code, Uniform Building Code and DSOD dam design standards and implementation of the recommended mitigation would ensure that impacts are less than significant.*

As stated in the Existing Conditions section above, no active or potentially active faults are located within or project towards the project area. Thus, impacts from surface rupture of a fault would not occur in the project area. However, given the highly seismic character of the region, moderate to severe ground shaking can be expected within the project area due to moderate to large earthquakes on the nearby Foothills Fault System, San Andreas, Ortigalita, San Joaquin, Hartley Springs, Hilton Creek, or Owens Valley fault zones. Additionally, it is noted project development may expose people/structures to seiching as a result of significant ground motion related to an earthquake. Seiching involves an enclosed body of water oscillating due to groundshaking, usually following an earthquake. The potential for seiching and its impact on dam safety would be assessed during the actual design phase for the reservoirs. Per Mitigation Measure 5.8-1e, the design-level study prepared for the project that would analyze seismically induced seiching, which would include a determination of the necessary freeboard between the water and crest of the dam to prevent seiching impacts.

Compliance with the with the Madera County Development Code, Uniform Building Code and DSOD dam design standards and implementation of the recommended mitigation measure would ensure that potentially significant ground shaking-related impacts to all structures intended for human occupancy, as well the proposed water reservoir, would be reduced to less than significant levels.

CUMULATIVE IMPACTS

5.8-7 *The proposed project, combined with future development, may result in increased short-term impacts such as erosion and sedimentation, and long-term seismic impacts within the area. Analysis has concluded that impacts would be less than significant.*

According to the Madera County General Plan EIR, with full implementation of the policies and programs in the General Plan, there would be no significant adverse seismic and geologic impacts to development resulting from development under the General Plan. Thus, the General Plan EIR concludes that seismic and geologic impacts are less than significant.

Soils and geologic conditions in the project vicinity may vary by location. Short-term cumulative impacts such as erosion and sedimentation would occur. The only cumulative long-term impact related to geology is the exposure of people and the property in the vicinity of the Foothills Fault System to the potential for seismically induced ground shaking. Implementation of the cumulative projects would incrementally increase the number of people and structures potentially subject to a seismic event. Such exposure can be minimized by adhering to Uniform Building Code standards and requirements. The cumulative effects of increased seismic risk would be addressed on a project-by-project basis in order to determine the need for project specific mitigation. Implementation of the proposed project would not contribute to cumulative geology and soils impacts within the project levels. Thus, cumulative impacts in this regard are concluded to be less than significant.

MITIGATION MEASURES

This section directly corresponds to the identified Impact Statements in the impacts subsection.

SLOPE STABILITY

Residential Development

5.8-1a Where cut slopes are planned, they shall be excavated primarily within granitic bedrock materials at inclinations not exceeding 1.5:1 (horizontal to vertical). A qualified engineering geologist shall conduct periodic inspections and compaction testing during excavation of cut slopes.

5.8-1b Fill slopes shall be constructed with engineered fill at inclinations no steeper than 2:1. A qualified geotechnical specialist shall conduct periodic inspections and compaction testing during placement of fill slope areas.

5.8-1c Adequate structural setbacks for homes and septic systems from the steep natural slopes adjacent to Miami and Carter Creeks shall be established per the findings of the leach field suitability study (refer to Mitigation Measure 5.8-4a). Structural setbacks shall be in compliance with all applicable Madera County Development Code and/or Uniform Building Code setback requirements. The design and locations of all on-site septic systems shall be approved by the Madera County Environmental Health Department.

5.8-1d Surface drainage shall be directed away from steep natural slopes adjacent to Miami and Carter Creeks.

5.8-1e Prior to issuance of Grading Permits, the Project Applicant shall fund site-specific geologic analysis/studies that includes 1) quantitative geotechnical analysis of collapsible and/or liquefaction-prone soils; 2) a design level geotechnical engineering report; 3) a design-level engineering geology report; and 4) analysis of seismically induced seiching. Pending the results of the geologic analysis/studies, site-specific design-level measures shall be developed to address issues relating to slope stability, collapsible and/or liquefaction-prone soils, including alluvial soils, and seiching.

5.8-1f If the housing pads expose a combination of competent bedrock and loose soil, to achieve a uniform foundation for a home, the entire pad shall be over excavated a minimum of three feet and replaced with compacted fill.

Reservoir Construction

Refer to Mitigation Measure 5.1-B. The following mitigation measures are also recommended:

5.8-1f The Project Applicant shall fund design-level geotechnical studies that focus on the various geotechnical and hydrologic aspects for the safe design and construction of the dams. These studies would include, but are not be limited to, an evaluation of the quantity and engineering properties of on-site soils and bedrock materials necessary for construction of the dams, dam foundation characteristics, hydrogeologic conditions within the reservoirs and beneath the dams, hydrology calculations of dams and reservoir, modeling of the potential changes in groundwater levels, and stability of interior and exterior slopes of the reservoir, etc. The information generated from the geotechnical design-level study shall be forwarded to the California Department of Water Resources Division of Safety of Dams for their review and comment prior to the issuance of Grading Permits by Madera County.

5.8-1g Test excavations using a D9 bulldozer with ripper shanks shall be performed to evaluate the depth to which the granite can be readily excavated by typical construction equipment.

5.8-1h A seepage analyses shall be performed during the actual design phase for the project to determine if a chimney drain is required in addition to a blanket drain at the base of the embankment.

GROUNDWATER

5.8-2 To preclude any significant leakage beneath the dam, a "cut-off trench" shall be constructed within the foundation of the dam, if necessary, pending the hydrogeologic findings of the design-level studies referenced in Mitigation Measure 5.8-1f.

SOIL EROSION

5.8-3a Upon completion of grading for each lot, a protective vegetative cover shall be established in all disturbed areas via planting and/or seeding followed by placing a temporary protective cover, such as jute netting, mulch, hay or other non-erodable form of ground cover, until a vegetative cover is established.

5.8-3b Surface drainage shall be diverted from cut and fill slopes via brow ditches, collected in ditches with relatively shallow gradients, and provide a means to inhibit sediment runoff into natural drainages until such time as a protective vegetative cover effectively mitigates further soil erosion. Energy dissipating devices shall be placed in drainages subject to increased runoff.

5.8-3c Grading shall attempt to minimize the area of disturbance and be avoided near natural springs.

5.8-3d Prior to the issuance of Grading Permits, the Project Applicant shall post a Soil Stabilization and Revegetation Bond for the estimated cost of soil stabilization and revegetation of the grading site, for submittal and approval by the Madera County Department of Engineering and General Services.

SEWAGE DISPOSAL

5.8-4a Prior to issuance of Grading Permits, a detailed study of leach field suitability shall be conducted for on-site sewage disposal systems. The study shall investigate and evaluate all the factors involved in individual sewage disposal system utilization, including soil types and their depths, permeability, slopes, the locations of springs and depth to seasonal groundwater, drainage, effluent volume, and setbacks to watercourses and other features. The study shall be reviewed and approved by the Madera County Environmental Health Department.

5.8-4b A testing program for coliform bacteria and other possible pollutants shall be established for all on-site wastewater systems, per the approval of the Madera County Environmental Health Department. The testing program shall include monitoring of surface water quality in Miami and Carter Creeks and/or groundwater supplies, pending County discretion.

COLLAPSIBLE AND/OR LIQUEFACTION-PRONE SOILS

5.8-5 Refer to Mitigation Measure 5.8-1e. No additional mitigation measures are required.

GROUND SHAKING

5.8-6 Refer to Mitigation Measure 5.8-1e. No additional mitigation measures are required.

CUMULATIVE IMPACTS

5.8-7 No mitigation measures are recommended.

LEVEL OF SIGNIFICANCE AFTER MITIGATION

No unavoidable significant impacts related to Geology and Soils have been identified following implementation of mitigation measures and/or compliance with all applicable Madera County, DSOD and Uniform Building Codes design standards.