4.16 GEOLOGY, SOILS, AND MINERALS

4.16.1 INTRODUCTION TO GEOLOGY, SOILS AND MINERALS

This section describes geology, soils, and mineral resources at and in the vicinity of Pacific Gas and Electric Company's hydroelectric facilities and Project Lands in the five regional bundles. In addition to an overview of regional information, this section describes local geologic and soils conditions at specific project locations and discusses any known or potential geotechnical hazards or issues of concern at project facilities. Also included in this section is a discussion of the types and locations of active mining operations and mineral resources of regional or local significance at and in the vicinity of Pacific Gas and Electric Company's facilities and Project Lands. This section provides an overview of the regulatory framework that addresses geologic hazards and the protection of mineral resources, particularly FERC license conditions, as well as other protection and monitoring measures Pacific Gas and Electric Company takes to protect the integrity of project facilities and operations.

Potential impacts related to geologic hazards, soils, and mineral resources are based on the assumptions described in Chapter 3, Approach to Environmental Analysis. The impact analysis in this section describes the extent to which implementation of the proposed project could be affected by seismic hazards and other geologic hazards such as landslides, erosion, and expansive soils. The analysis also addresses potential effects of the proposed project on mineral resources.

4.16.2 SYSTEM-WIDE REGULATORY CONTEXT

As described in Chapter 3, FERC license conditions provide regulatory oversight over some of the operational activities at the hydroelectric facilities. FERC includes standard terms and conditions for many, but not all, of the project licenses (e.g., requiring Pacific Gas and Electric Company to be responsible for the prevention of soil erosion on lands adjacent to project waterways, or to maintain the projects to protect the integrity of project waters, lands, and facilities associated with certain changes in land use.) The license articles do not identify specific measures or performance standards to achieve article objectives, however. In addition, major construction activities, streambed alterations, and blasting are subject to other regulatory oversight and permitting requirements. These include Section 404 of the Clean Water Act and Federal and State regulations that require an erosion and sedimentation control plan prior to major construction. Pacific Gas and Electric Company also consults with the U.S. Fish and Wildlife Service (USFWS) and local agencies. Timber harvesting is also subject to a number of regulatory requirements, as described in Chapter 3, Timber Harvest Assumptions. A Timber Harvest Plan (THP) includes restoration and site erosion management conditions. Examples include logging only up to a certain grade of slope, installing waterbars on roads, and leaving certain trees or stands of trees intact. Additional information regarding applicable federal and state regulations is presented below.

4.16.2.1 Federal Regulations and Policies

Other than FERC requirements, which address primarily seismic safety issues for dams, the management of geologic, soils, and mineral resources on private lands is administered primarily at the State and local level. Pertinent regulations and standards are summarized below.

4.16.2.2 State Regulations and Policies

The State of California provides minimum standards for building design and site development through the California Building Standards Code (California Code of Regulations [CCR], Title 24). The California Building Code (CBC) is based on the Uniform Building Code (UBC) used widely throughout the United States (generally adopted on a State-by-State or district-by-district basis), and has been modified for California conditions with numerous more detailed and/or more stringent regulations.

Structural and Seismic Safety

Where no other building codes apply, Chapter 18 of the CBC regulates excavation, foundations, and retaining walls, and Appendix Chapter A33 of the UBC regulates grading activities, including drainage and erosion control. The State earthquake protection law (California Health and Safety Code 19100 *et seq*.) requires that buildings be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum seismic safety requirements are set forth in Chapter 16 of the CBC. The CBC identifies seismic factors that must be considered in building design. California includes two seismic zones: Seismic Zone 3 corresponds to an acceleration of 0.3g, and Seismic Zone 4 corresponds to an acceleration of 0.4g, which represents greater hazard.

Installation of underground utility lines must comply with industry standards specific to the type of utility (e.g., National Clay Pipe Institute for sewers and American Water Works Association for water lines). These standards contain specifications for installation and design to reflect site-specific geologic and soils conditions.

As described in more detail in Section 4.9, Hazards and Hazardous Materials, the California Department of Water Resources, Division of Safety of Dams (DSOD) regulates all dams in California that are 25 feet or more in height or that impound 50 acre-feet or more in water storage capacity, including dams within FERC boundaries that are not regulated by FERC. Dams within DSOD's jurisdiction ("jurisdictional dams") are inspected for safety at least once per year, and up to four times per year, based on a hazard rating.

Alquist-Priolo Fault Rupture Hazard Zones

The State of California delineates active faults through the Alquist-Priolo Earthquake Fault Zoning Act of 1994 (previously known as the Alquist-Priolo Special Studies Zones Act of 1972) to reduce the hazards of fault rupture. State law requires that local jurisdictions recognize identified zones in land use planning. Because of the potential for life safety hazard and serious property damage, State regulations mandate that no structure for human occupancy identified as a project (as defined in the Alquist-Priolo Earthquake Fault Zoning Act) be placed across the trace of an active fault. Moreover, the area within 50 feet of an active fault is presumed to be underlain by active branches of the fault unless proven otherwise by a geologic investigation. Further, no change in use or character of occupancy is allowed unless the new use complies with the provisions of the Alquist-Priolo Earthquake Fault Zoning Act. Finally, a geologic report must accompany an application for a development permit for any project within a delineated zone (14 CCR 3603).

If the property is undeveloped, according to State law, a fault study may be required before parcels can be subdivided or structures permitted. If the property is developed, a geologic study would only be required if extensive additions or remodeling of existing structure(s) are proposed. The purpose, scope, and methods of investigation for fault investigations varies on conditions at specific sites and the nature of the projects. The scope also depends on the level of acceptable risk for the proposed structure or development. According to guidelines developed by CDMG, the conclusions of the study should identify the location and type of faults on or adjacent to the site, the nature of anticipated offset, and the probability of or relative potential for future surface displacement. Recommendations to reduce the hazard may include, but would not be limited to, setback distances, structural engineering measures, and risk evaluation. Recommendations, however, may not be totally dependent on geologic factors. The final decision as to whether, or how, a given project should be developed rests with the owner and the governing body that reviews and approves the project (CDMG, 1998). The guidelines establishing the methods for identifying fault rupture hazard are not part of the Policies and Criteria of the State Mining and Geology Board, however.

Mineral Resources Management

Sections 2761(a) and (b) and 2790 of the *Surface Mining and Reclamation Act* (SMARA), enacted in 1975, provide for a mineral lands inventory process termed classification-designation. The California Division of Mines and Geology and the State Mining and Geology Board are the State agencies responsible for administering this process. The primary objective of the process is to provide local agencies, such as cities and counties, with information on the location, need, and importance of minerals within their respective jurisdictions. It is also the intent of this process, through the adoption of general plan mineral resource management policies, that this information be considered in future local land-use planning decisions (Public Resources Code Section 2762). Under SMARA, local land use jurisdictions are the enforcing lead agencies for mineral resource issues, while State agencies guide and regulate city and county enforcement of SMARA.

Mineral resource areas are classified on the basis of geologic factors, without regard to existing land use and land ownership. The areas are categorized into four mineral resource zones (MRZ-1 through MRZ-4). Of the four, the MRZ-2 classification is recognized in land use planning. The MRZ-2 classification adopted by the State Mining and Geology Board is defined as "an area where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood exists for their presence. This zone shall be applied to known mineral deposits where well-developed lines of reasoning, based upon economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high." The classification may be a factor in the discovery and development of mineral deposits that would tend to be economically beneficial to society. The MRZ-2 is relevant to the analysis of the project because divestiture could result in the development of land in containing known mineral resources of significance. The MRZ-1, MRZ-3, and MRZ-4 classifications denote areas with no, undetermined, or unknown mineral resource significance, respectively.

In certain cases, Aggregate Resource Areas (ARAs) have been established by the State Mining and Geology Board as part of the classification process to focus the attention of land use planners and local governments on areas that exceed the State's threshold value for deposits of significant size. ARA resources are categorized into Immediately Significant, Highly Significant, and Significant. These categories are based on a semi-quantitative evaluation of suitable aggregate resources classified as MRZ-2a or MRZ-2b (CDMG, 1990b).

As noted in Section 4.16.2.1, above, FERC license articles govern certain land uses within FERC boundaries. Although significant mineral resources classified by the State may be present within FERC boundaries, new mining on FERC license lands would only be an allowable use if approved by FERC. As noted in Section 3.9.2.2, General Methodology and Assumptions, the potential for significant change in land use and management of lands within the FERC license boundaries is very limited. Such restrictions on mining would not apply to Watershed Lands, however, because they are and would continue to be privately owned. In either case, mining activities are subject to regulation under SMARA, which requires that adverse environmental effects caused by mining, the reclamation of mined lands, and the elimination of public health and safety hazards due to the effects of mining activities be prevented or minimized, and that mined lands are reclaimed to a usable condition that is readily adaptable for alternative land uses (*Public Resources Code* Section 2712[a]). Performance standards, which are designed to attain the objectives of California *Public Resources Code* Section 2712, are codified in Title 14, Division 2, Chapter 8 of the CCR. Specific reclamation requirements that must be addressed in the plan include, but are not limited to, final slope stability and shape, water quality protection, habitat and wildlife protection, soil conditions, and mine waste management. Local agencies (counties) have the authority to issue permits for mining on lands under their jurisdiction and to implement SMARA requirements.

Erosion Control

As noted above, Appendix Chapter A33 of the UBC contains standards pertaining to erosion control and grading. Appendix Chapter A33 requires an engineered grading plan for activities that involve more that 5,000 cubic feet of earth disturbance. The plan is to include the supporting data consisting of a soils engineering and engineering geology report. A liquefaction study is required in cases of shallow groundwater, unconsolidated soils, and high seismic activity areas. Cut and fill slopes must conform to the recommendations in an approved soils engineering or engineering geology report. In absence of such a report, cut slopes must be no steeper than fifty percent.

Horizontal slopes must be constructed on properly prepared ground surfaces and benched when slopes exceed 20 percent or the height of the fill exceeds five feet. Erosion control measures are required on cut and fill slopes.

Other state regulations pertaining to the management of erosion/sedimentation as they relate to forest soils protection, water quality, and habitat are summarized in Section 4.2, Agriculture and Forestry, Section 4.3, Hydrology and Water Quality, and Section 4.5, Terrestrial Biological Resources, respectively, of this EIR. Such regulations include, but are not limited to the National Pollutant Discharge Elimination System (NPDES) program for management of construction and municipal stormwater runoff, which is implemented at the State and local level through issuance of permits and preparation of site-specific plans. Sections 1600 to 1607 of the California Department of Fish and Game Code regulates activities that would alter stream characteristics, including erosion. While the primary purpose of these regulations and standards is the protection of surface water resources from the effects of land development, measures included within such regulations and standards also help to minimize the potential for slope instability due to soil loss. Many counties in which project facilities and watershed lands are located have adopted ordinances requiring erosion control plans and grading permits. Others rely on standard CBC requirements. County-specific information is provided within each regional bundle discussion in Section 4.16.4.

As described in Chapter 3, Timber Harvest Plans, all owners of private timberland in California are required to have an approved timber harvest plan (THP), which must be prepared by a Registered Professional Forester. Timber harvesting operations must adhere to the California Forest Practice Regulations (CFPR), which has the minimization of soil loss as one of its primary objectives. The California Department of Forestry and Fire Protection (CDF) has the responsibility for enforcing these regulations. The CFPR requires a thorough environmental analysis be completed for each proposed timber harvest plan, including harvesting and logging methods, mitigation measures for erosion and slope stability, road design and construction, watercourse and lake protection measures, reforestation and reclamation, and a cumulative impacts assessment. A CDF Forest Practice Inspector must periodically inspect active timber harvest plan operations to ensure that plan conditions and specified mitigation measures are being followed. The number and extent of erosion control measures is dependent upon the site-specific conditions and the judgment of the licensed professional forester. Erosion control measures commonly required in a THP include the placement of silt fencing at the outlets of all culverts and overside road drains, prohibition of the use of heavy equipment on slopes steeper than 65 percent or steeper than 50 percent where the erosion hazard rating is high or extreme, placement of all roads and landings to avoid unstable areas, and the prohibition of harvesting between the logging road or landing and a watercourse to maintain maximum ground cover for filtering silt. For any proposed timber harvest plan, the combination of mitigations required to restrict erosion is based on site-specific conditions and professional judgment of the engineering geologist and registered forester.

Special Site Development Considerations

The proposed project could result in the development of land underlain by bedrock, which could require special methods, such as blasting, for site preparation. Site development or hydroelectric facility maintenance activities that may involve the use of explosives (e.g., dynamite) or explosive mixtures (e.g., fertilizer and diesel) for blasting are subject to requirements specified in Cal-OSHA regulations in the CCR, Title 8, Chapter 4, Subchapter 4, Article 8. While these regulations are designed primarily to protect construction workers, they also serve to minimize potential environmental hazards (e.g., unintended rock slides or fracturing) that could affect people or property. Contractors who perform blasting must also obtain a special license and are subject to blasters' license requirements specified in CCR Title 8, Section 3.2. The storage of explosives must comply with federal Bureau of Alcohol, Tobacco, and Firearms (BATF) regulations and any local jurisdictional requirements (e.g., State Fire Marshal regulations set forth in Title 19 of the CCR). Transport is subject to U.S. Department of Transportation (DOT) hazardous materials transportation regulations as monitored and enforced by the California Highway Patrol. In addition, a permit must be obtained from the local jurisdiction for activities involving the use of explosives in blasting for site development.

Hydroelectric Facility Operational and Maintenance Practices

Operations and maintenance activities at project facilities are subject to applicable regulations identified in Section 4.16.2, above. In addition, Pacific Gas and Electric Company has developed Best Management Practices (BMPs) and Operating Procedures that identify procedures and administrative mechanisms intended to reduce potential effects of routine operations and maintenance activities on Project Lands. The BMPs were developed in coordination with Pacific Gas and Electric Company's Corporate Environmental Policy. BMPs and operating procedures supplement the general requirements set forth in the license articles; however, the performance standards identified in the BMPs and operating procedures are not specifically set forth in the license articles, and are not required to transfer with the title of ownership. While some of these BMPs and operating procedures may have federal or state regulations as the basis for implementation, some may not, and they are performed by Pacific Gas and Electric Company in the interest of protecting facilities and lands necessary for hydroelectric operations. In addition, as described in Chapter 3, Pacific Gas and Electric Company currently has numerous non-binding, or informal agreements with existing agencies and individuals, some of which address environmental resources issues.

Activities at the Pacific Gas and Electric Company hydroelectric facilities that have the potential to affect or be affected by natural geologic and soils conditions include construction, major maintenance, remediation activities or streambed alteration activities that involve soil excavation and earthmoving. Routine maintenance and construction activities include road and bridge abutment repairs, dredging of stream courses and lakes, seismic upgrades of dams, dam-face alteration and construction of coffer dams, and small dams at stream gauge locations. Pacific Gas and Electric

Company uses blasting in the operation of its hydroelectric facilities when rocks fall into the canal system that are too large to extract without diminishing their size. Land management practices that minimize erosion are integrated into facility operations through BMPs and operating procedures (PG&E Co., 1999a).

4.16.3 SYSTEM-WIDE SETTING

4.16.3.1 Geology and Topography

With the exception of Bundle 10 (Potter Valley), all of the project facilities are situated along the western slope of a northwest-trending belt of rocks comprising the Sierra Nevada and within the southern portion of the Cascade Range. The Potter Valley project lies within the Coast Ranges. Figure 4.16-1 illustrates the locations of these physiographic provinces (or “geomorphic provinces”) relative to Project Lands. A generalized geologic map is shown in Figure 4.16-2.

As shown in Figure 4.16-1, the Cascade Range lies to the north of Central Valley and extends into Oregon and gradually rises from the eastern margin of the Great Valley of California. The Cascade Range is dominated by occurrences of oceanic crust, upper mantle, and deep-marine volcanic and sedimentary deposits. The topography of the Cascade Range is dominated by landforms related to volcanic activity, such as mountains, cones, and lava flows composed primarily of rhyolitic and andesitic rocks, breccia, cinder, and pyroclastic deposits (mud and ash flows) (CDMG, 1966b; 1977).

The Modoc Plateau is a transition region between the Basin and Range province to the east and the Cascade Range to the west. The Modoc Plateau is underlain by older, mostly basalt and other volcanic flows, which have been block-faulted into north-trending ranges and large open valleys. The plateau is capped with scattered small cinder cones, which in places are relatively fresh, and basalt flows. Typical features include volcanic breccia, mud and ash flows, lava flows, and cinder cones.

The Sierra Nevada, the largest topographic feature of California, is located east of both the Sacramento and San Joaquin Valleys. The mountain range extends approximately 400 miles, starting in the north at Lassen Peak in the Cascade Range and continuing to the south where it meets the Tehachapi Mountains and is abruptly cut off by the Garlock fault. The Sierra Nevada is 40 to 100 miles wide, and ranges in elevation from 400 feet at the valley edge to over 14,000 feet at its crest in the southern Sierra Nevada. The western slope of the Sierra Nevada gradually rises to peak elevations of about 12,000 feet in the upper reaches of the Mokelumne River watershed. The Sierra Nevada is comprised principally of Cretaceous granitic plutons and remnants of Paleozoic and Mesozoic metavolcanic and metasedimentary rocks, and Cenozoic volcanic and sedimentary rocks. The Paleozoic and Mesozoic metavolcanic and metasedimentary rocks were intruded by the granitic plutons approximately 77 to 225 million years ago, resulting in local uplift and deformation of the overlying older rock. These Mesozoic granitic plutons form the core of the Sierra Nevada and are the predominant rock type. Regional uplift and rapid erosion of most of the overlying metamorphic rocks closely followed intrusion of the plutons, exposing the underlying granitic rocks. Continued uplift and erosion, accompanied by volcanic activity and alpine glaciation resulted in the present pattern of deep-walled valleys which characterize the Sierra Nevada (CDMG, 1966b; Hill, 1975; Durrell, 1987). The ultramafic rocks along the western foothills of the Sierra Nevada (see Figure 4.16-2) may contain asbestos-form minerals, which have received increasing recognition because of potential construction hazards.

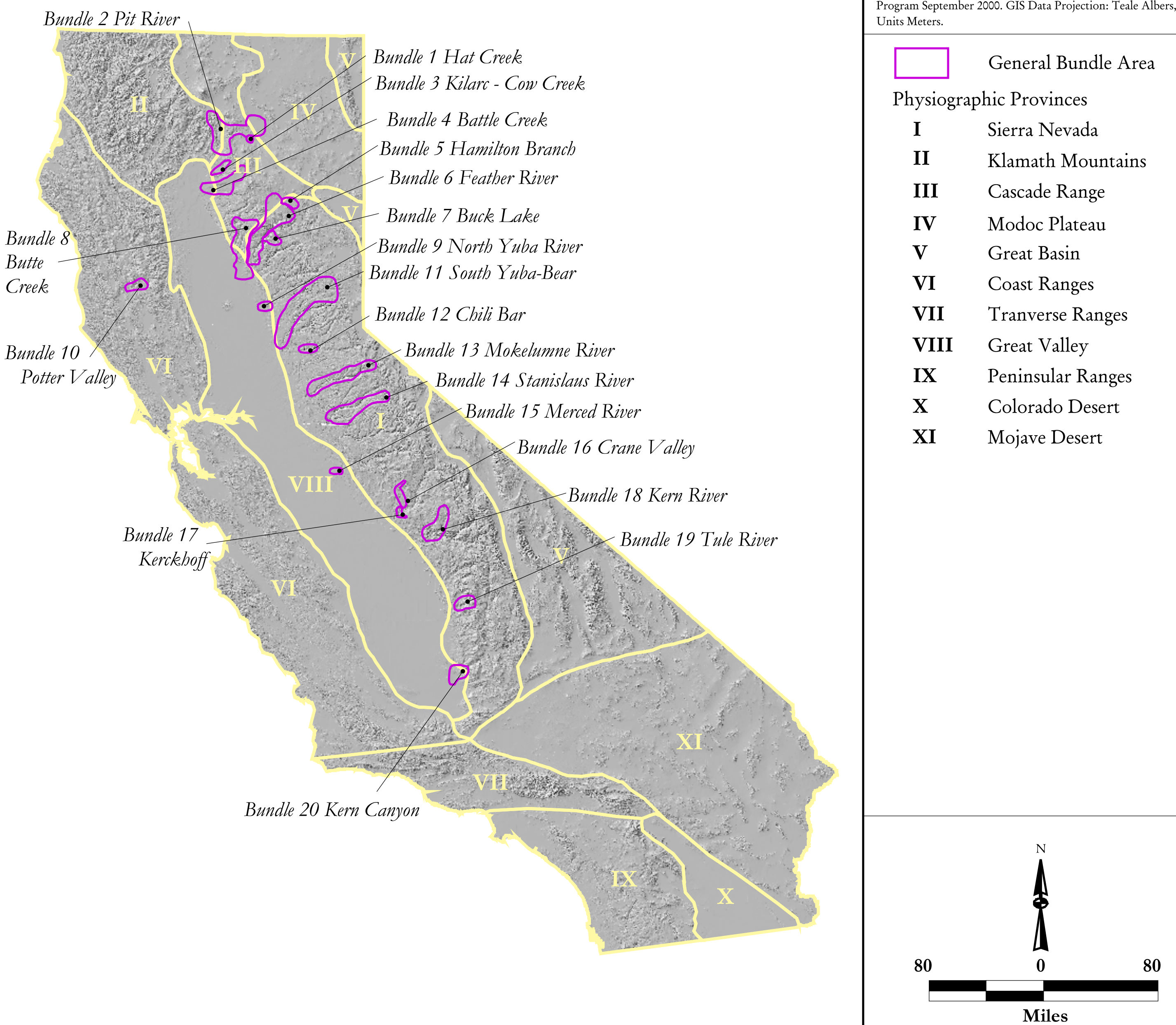
The Coast Ranges geomorphic province is characterized by northwest-trending mountain ranges and alluvial valleys, extending for about 400 miles along the California coast into Oregon. The relief and topography of the Coast Ranges differ significantly from the Sierra Nevada. Highest peaks are about 6,000 feet, and crests average about 2,000 to 4,000 feet in elevation. Most crests in the Coast Ranges are rounded by erosion, as compared to the glaciated, jagged peaks of the Sierra Nevada. The Coast Ranges consist of a complex series of ranges and valleys, of which the Mendocino Range is the highest and longest. Two entirely different core complexes are present in the Coast Ranges. The older is a Jurassic-Cretaceous assemblage ("mélange") comprising sandstone, chert, metamorphic rocks, shale, conglomerate, and volcanic rocks of the Franciscan formation that formed about 136 to 190 million years ago. The Great Valley sequences, consisting of thick deposits of marine sandstone, shale, and conglomerate extends along the east side of the Coast Ranges adjacent to the Franciscan rocks. The other core complex consists of intruded Early Cretaceous granitic intrusive rocks and older metamorphic rocks. Cretaceous and Cenozoic sedimentary rocks cover large parts of the province and are, in many locations, folded and faulted. In the latter part of the early Tertiary (about 10 million years ago), crustal movements began, resulting in volcanic activity and additional uplift and folding (CDMG, 1966b; Oakeshott, 1978). Slopes greater than 30 percent are present in several locations in the project. Steep topography and the geologic properties of slope-forming materials are a primary factor in determining slope stability, as discussed further in Section 4.16.3.4, Other Geologic Hazards.

4.16.3.2 Faulting and Seismicity

Faults

A fault is defined as "a planar or gently curving fracture in the earth's crust across which there has been relative displacement." Movement within a fault causes an earthquake. Generally, earthquakes are associated with faults exposed at the earth's surface.

A fault is classified as "active" if it has had surface displacement with the last 11,000 years or is included in an Alquist-Priolo Earthquake Fault Zone (as established by the California Division of Mines and Geology (CDMG), and potentially active if it has experienced movement within Quaternary time (1.6 million years before the present). Faults that have not moved in the last 1.6 million years are generally considered inactive (CDMG, 1994). This does not mean, however, that faults having no evidence of surface displacement within the last 11,000 years (Holocene) are necessarily inactive. An "inactive fault" shows no evidence of movement in historic or recent



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2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."

Source: Pacific Gas and Electric Company GIS Data Files; Ferc Boundary, Hydrology, Parcels, Public Lands; CA Dept. of Fish and Game, Shaded Relief, February 7, 1997; USGS, Digitized Physical Divisions, January 13, 1992; and EIP Associates GIS Program September 2000. GIS Data Projection: Teale Albers, Units Meters.

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Figure 4.16 - 1

Geomorphic Provinces of California

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Source: CDMG, Generalized Geologic Map of Califonia, Note 17; and EIP Associates GIS Program October 2000. GIS Data Projection: UTM, Units Meters.

General Bundle Area

Quaternary sedimentary deposits

Tertiary sedimentary rocks

Tertiary and Quaternary volcanic rocks

Mesozoic sedimentary rocks

Granitic rock, mostly Mesozoic

Mesozoic and Paleozoic metamorphic rocks; includes some pre-Cambrian metamorphic rocks

Serpentinized ultramafic rocks

N

70 0 70

Miles

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Figure 4.16 - 2

Generalized Geologic Map of California

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geologic time, suggesting that these faults are dormant. Within the last few years, however, geologists have discovered that the filling of a reservoir can induce fault activity and earthquakes, such that an "inactive" fault can become active (USGS, 1996). Recent evidence also suggests that subsurface or "blind" thrust faults can result in earthquakes. Blind-thrust faults can exhibit no surface rupture (Unruh and Moores, 1992).

Regional faults and fault systems in the Sierra Nevada, Cascade Range, Coast Ranges (which includes the San Francisco Bay Area) are capable of affecting all project facilities and watershed lands. Regional faults include the Foothills fault system, Bear Mountain fault zone, Melones fault zone, Eastern Sierra Frontal fault and Owens Valley fault system, and the San Andreas fault. The Foothills fault system includes the Melones and Bear Mountain fault zones. The Foothills fault system is well defined, and includes approximately 25 other mapped but unnamed, smaller faults. According to California Division of Mines and Geology (CDMG) data, these faults have not shown any activity during the last 1.6 million years; however, geologic investigations of the seismic safety of the Auburn dam site suggest these faults are potentially active (USGS, 1996).

Within these fault zones, several potentially active faults have been identified. Smaller, active faults associated with these regional systems are also capable of generating earthquakes that could affect project facilities and watershed lands. Alquist-Priolo Earthquake Fault Zone maps have been published for areas in Shasta and Lake Counties where Project Lands are located. Such maps have not been published for any other areas containing project facilities or watershed lands. Specific faults and their locations (including Alquist-Priolo mapping) relative to project facilities and watershed lands are shown on maps and described in the individual bundle descriptions.

The seismic potential of an active or potentially active fault is generally evaluated by estimating the magnitude of an earthquake that may be expected to occur along the fault. A commonly used measure of a fault's ability to result in displacement is Maximum Credible Earthquake (MCE).[1] Another measure of seismic potential used is the maximum probable earthquake (MPE).[2] MCE and MPE have been used for many years to describe the Richter magnitude of an earthquake that could occur along a particular fault. Recent revisions incorporated by the State into the CBC have eliminated the use of MCE and MPE. The 1997 CBC code revisions require that the moment magnitude (Mw) of the "characteristic earthquake" be used in geotechnical calculations for design purposes.[3]

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1 Maximum credible earthquake (MCE) is defined as "the largest earthquake (measured in magnitude [M] on the Richter Scale) that appears to be reasonably capable of occurring under the presently known geologic framework" (CDMG, 1992).

2 Maximum probable earthquake (MPE) is defined as the largest Richter magnitude seismic event that appears to be reasonably expected within a 100-year period (Greensfelder, 1974).

3 The revisions are based on recommendations identified by the Seismology Committee of the Structural Engineers Association of California. The new criteria for describing the energy release (i.e., the size of the earthquake along a particular fault segment) – moment magnitude (Mw) – was determined by the Seismology Committee to represent

Seismic Hazards

When movement occurs along a fault, the energy generated is released as waves which cause groundshaking. Groundshaking intensity varies with the magnitude of the earthquake, the distance from the epicenter, and the type of rock or sediment through which the seismic waves move. The geological characteristics of an area thus can be a greater hazard than its distance to the earthquake epicenter. The most serious direct earthquake hazard is the damage to or collapse of buildings and other structures caused by groundshaking. All bundles except Bundle 10 (Potter Valley) and Bundle 20 (Kern Canyon) are located in UBC/CBC Seismic Zone 3. Bundles 10 and 20 are in UBC/CBC Seismic Zone 4.

As noted above, the UBC/CBC seismic zone factors are used in the design of structures; however, they do not indicate the probability or potential locations of strong groundshaking. Effects of groundshaking can be characterized by the Modified Mercalli Scale, which measures the intensity of an earthquake by the way it is felt and responded to by humans, and by the amount of damage it does to buildings and structures. The relationship between the Richter Scale and the Modified Mercalli Scale is shown on Table 4.16-1. The Modified Mercalli Scale is presented in Table 4.16-2.

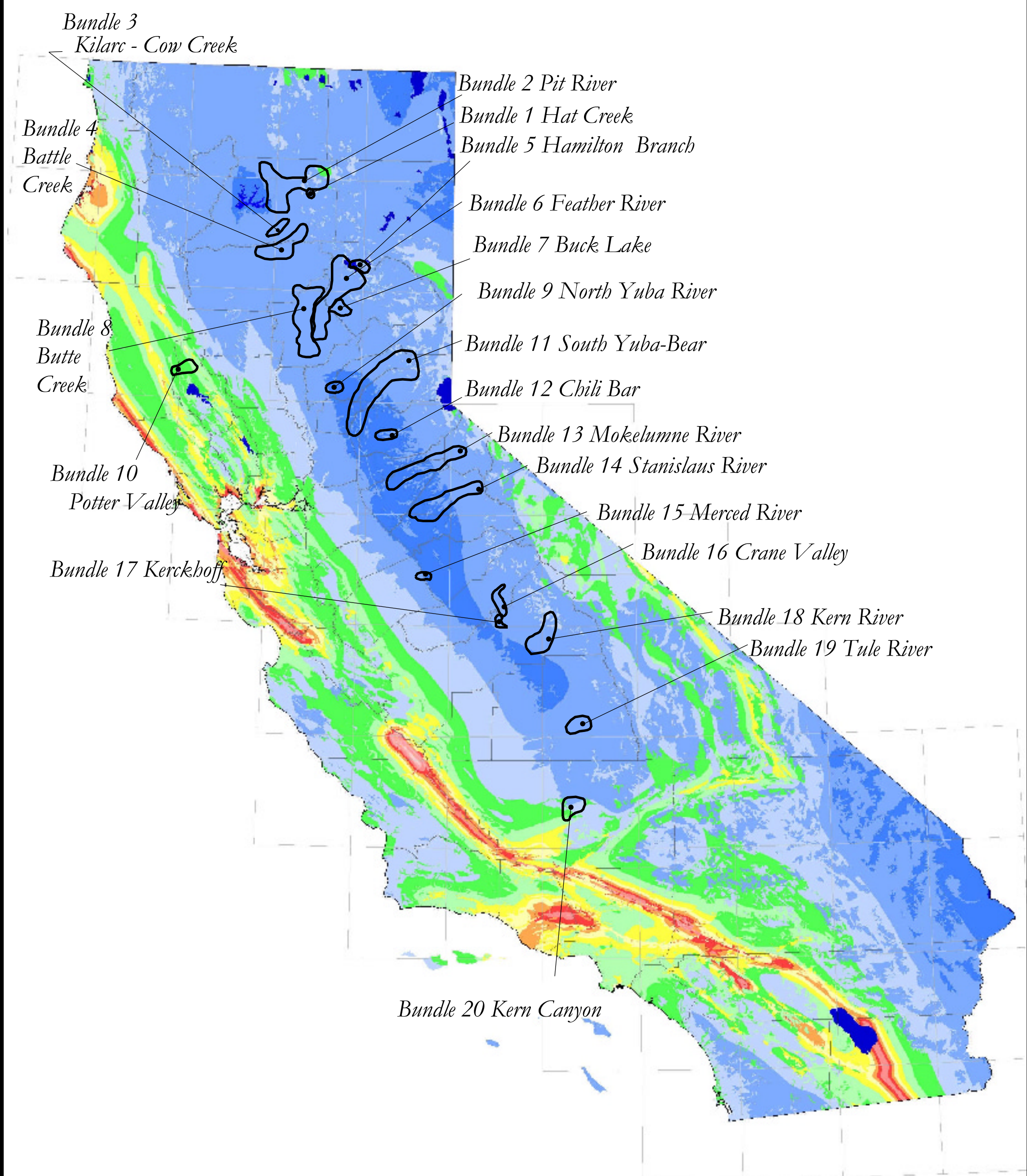
Table 4.16-1 Approximate Relationships Between Earthquake Magnitude and Intensity

Richter Scale Magnitude [M]	Maximum Expected Intensity (MM)[a]	Distance Felt (in approximate miles)
2.0 - 2.9	I – II	0
3.0 - 3.9	II – III	10
4.0 - 4.9	IV – V	70
5.0 - 5.9	VI – VII	90
6.0 - 6.9	VII – VIII	130
7.0 - 7.9	IX – X	240
8.0 - 8.9	XI – XII	360

Source: USGS, 1977. [a] Modified Mercalli Intensity Scale

A more comprehensive groundshaking hazard analysis recently developed by CDMG is based on several factors, including historic activity, slip rates, and acceleration factors (CDMG, 1996; CDMG, 1999c). Figure 4.16-3 illustrates the peak groundshaking hazard within each of the 20 bundles. Based on CDMG mapping, areas shown in blue have a lower probability of experiencing damaging groundshaking effects than the red-shaded areas. Bundle 10 (Potter Valley) is the most susceptible to groundshaking of the 20 bundles.

a more reliable descriptor of future fault activity than the MCE or the MPE. While the moment magnitude value may differ slightly from any MCE or MPE identified in this EIR, the new method for describing future fault activity does not, however, alter the assumptions or conclusions of this EIR because the proposed project would be required by State law and regulation to comply with adopted geotechnical design criteria at the time each structure is designed and constructed.



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2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."

Source: Pacific Gas and Electric Company GIS Data Files; Ferc Boundary, Hydrology, Parcels, Public Lands; CDMG, Peak Ground Shaking Acceleration Map, 1999 and EIP Associates GIS Program October 2000. GIS Data Projection: UTM, Units Meters.

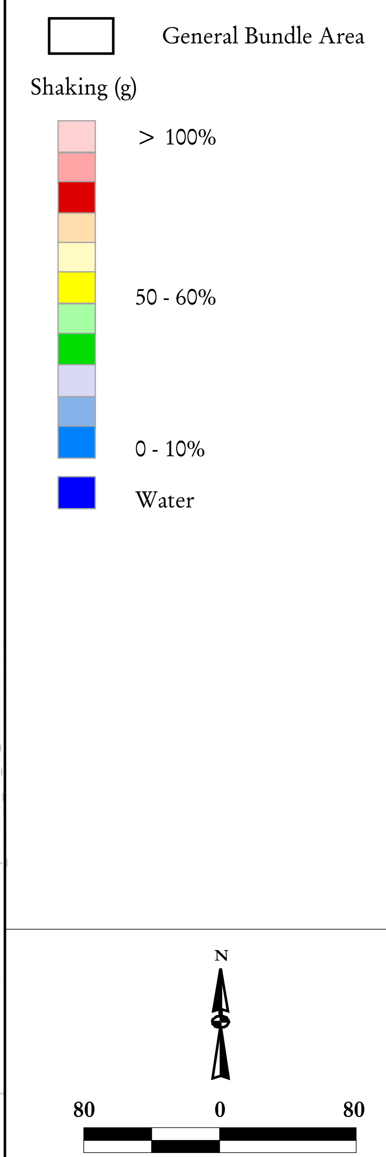

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Figure 4.16 - 3

Peak Groundshaking Acceleration Map of California

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As noted above, there is more than one approach to classifying groundshaking hazard and associated intensity. Various agencies and jurisdictions may rely on one or more classifications (some nearly 30 years old) to assign a relative degree of groundshaking intensity, usually in terms of low, medium (moderate), or high (or strong). The basis for such determinations is often not stated in the literature. As scientific knowledge about seismic activity in California continues to be refined, such classifications may or may not provide an adequate basis to evaluate groundshaking hazard. Therefore, for purposes of the impact analysis in this EIR, "strong" groundshaking is assumed to be that associated with "near-field" effects, as recognized by the CDMG.[4] Any structure in the near-field area is assumed to be subject to significant groundshaking hazards because the lateral and vertical forces could substantially exceed adopted CBC safety standards. However, classifications of severity of groundshaking on Project Lands presented in published documents referenced in Section 4.16.4, Regional and Local Setting and Regulatory Context, are retained for informational purposes

Table 4.16-2 Modified Mercalli Scale Of Earthquake Intensity

Scale	Effects
I.	Earthquake shaking not felt.
II.	Shaking felt by those at rest.
III.	Felt by most people indoors; some can estimate duration of shaking.
IV.	Felt by most people indoors. Having objects swing, windows and doors rattle, wooden walls and frames creak.
V.	Felt by everyone indoors; many estimate duration of shaking. Standing autos rock. Crockery clashes, dishes rattle, and glasses clink. Doors close, open, or swing.
VI.	Felt by everyone indoors and most people outdoors. Many now estimate not only the duration of the shaking, but also its direction and have no doubt as to its cause. Sleepers awaken. Liquids disturbed, some spilled. Small unstable objects displaced. Weak plaster and weak materials crack.
VII.	Many are frightened and run outdoors. People walk unsteadily. Pictures thrown off walls, books off shelves. Dishes or glasses broken. Weak chimneys break at roofline. Plaster, loose bricks, unbraced parapets fall. Concrete irrigation ditches damaged.
VIII.	Difficult to stand. Shaking noticed by auto drivers, waves on ponds. Small slides and cave-ins along sand or gravel banks. Stucco and some masonry walls fall. Chimneys, factory stacks, towers, elevated tanks twist or fall.
IX.	General fright. People thrown to the ground. Steering of autos affected. Branches broken from trees. General damage to foundations and frame structures. Reservoirs seriously damaged. Underground pipes broken.
X.	General panic. Conspicuous cracks in ground. Most masonry and frame structures destroyed along their foundations. Some well-built wooden structures and bridges are destroyed. Serious damage to dams, dikes and embankments. Railroads bent slightly.
XI.	General panic. Large landslides. Water thrown out of banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flatland. General destruction of buildings. Underground pipelines completely out of service. Railroads bent greatly.

4 The design specifications in the CBC provides protection from lateral motion associated with seismically induced groundshaking. Studies of the 1989 Loma Prieta earthquake indicated that in the "near-field" area, lateral motion was greater than 1g, substantially exceeding the lateral forces addressed in the CBC, and that there was also a vertical component greater than 1g that was not addressed in the CBC. The "near-field" area is an oval around the epicenter about one mile wide by two miles long, with the long axis lying on the surface trace of the fault. Structures outside the area would be adequately protected by the provisions of the CBC (McNutt, 1990).

Table 4.16-2 Modified Mercalli Scale Of Earthquake Intensity

Scale	Effects
XII.	General panic. Damage nearly total, the ultimate catastrophe. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.

Source: CDMG, 1973.

Secondary effects from groundshaking include liquefaction, settlement/compaction, lateral spreading, and lurch cracking, which are related to underlying soil and rock characteristics. Earthquake-induced damage or failure of a structure may be result of the building material or design itself, characteristics of the underlying rock or soil, or a combination of the two. Potential hazards related to structural safety and secondary hazards are described below.

Structural Safety of Existing Pacific Gas and Electric Company Hydroelectric Facilities

Because hydroelectric facilities are located in regions subject to seismic activity, Pacific Gas and Electric Company has prepared safety plans and conducts seismic studies for project facilities, as required by FERC. The plans are developed and implemented to protect facilities, workers, and the public from seismic impacts at the facilities. FERC and state inspections, conducted on a regular basis, identify any problems related to long-term stability and seismic safety of many project dams. The potential for earthquake-induced settlement of certain project dams is also evaluated as part of seismic evaluations. For further discussion of these measures, see Section 4.9, Hazards and Hazardous Materials. Pacific Gas and Electric Company has reinforced a number of its dams for seismic safety purposes, and conducts seismic monitoring at many of its facilities (PG&E Co., 1999a). The seismic stability of Pacific Gas and Electric Company dams is presented in this section for informational purposes. As described in Chapter 2, the assets would be transferred "as is."

Unreinforced masonry construction can also present special seismic safety concerns. Buildings one or two stories high of wood-frame construction are considered to be the most structurally resistant to earthquake damage. Older masonry buildings without seismic reinforcement are the most susceptible to the type of structural failure that causes injury or death. The susceptibility of a structure to damage from groundshaking is also related to the underlying foundation material. A foundation of rock or very firm material can intensify short-period motions, which affect low-ridged buildings more than tall, flexible ones. Other potentially dangerous conditions include building architectural features that are not firmly anchored, such as parapets and cornices. As indicated in Section 4.7, Cultural Resources, some of the project powerhouses are 60 to 70 years old. These facilities were constructed prior to the adoption of modern earthquake safety standards. Pacific Gas and Electric Company has not implemented a comprehensive program to evaluate the seismic stability of any of the powerhouses in the regional bundles, and they have not been retrofitted to meet current standards. The seismic stability of Caribou No. 1 Powerhouse was assessed, however, in 1997 following a small earthquake near Quincy, California. The powerhouse sustained some minor cracking, and Pacific Gas and Electric Company is currently working with consultants to determine if modifications are required. The study is scheduled for completion in early 2001 (PG&E, 2000).

Secondary Hazards

Soil-Related Secondary Seismic Hazards. Liquefaction is a response to severe groundshaking that can occur in loose soils. During liquefaction, soil materials are transformed from a solid state to a liquid state (“quicksand”), which can lead to ground settling and landsliding. Earthquake-induced liquefaction affects certain types of alluvium and artificial fill under certain conditions of water saturation. Liquefaction-prone materials are typically characterized by uniformly fine sand or sandy soil; saturated soil conditions - usually where shallow groundwater is present; loose to moderately dense soil compaction; and little or no clay-sized particles. If these conditions occur within about 30 to 40 feet below the ground surface, overlying soils can liquefy. Any structures supported on the soils would be subject to tilting or settlement, which could result in structural damage or failure. Comprehensive mapping of liquefaction hazard has not been prepared by CDMG for areas where the five regional bundles are located. On a regional basis, project facilities and watershed lands are generally located in foothill or mountainous areas underlain by granitic and metamorphic bedrock that are typically not prone to liquefaction. However, there are a few places at lower elevations where it could occur, and the hazard is identified in the discussions for individual bundles where appropriate.

Settlement can occur in poorly consolidated soils during groundshaking. During settlement, the soil materials are physically rearranged by the shaking to result in a less stable alignment of the individual minerals. Settlement of sufficient magnitude to cause significant structural damage is normally associated with rapidly deposited alluvial soils, or improperly founded or poorly compacted fill. On a regional basis, project facilities and watershed lands are generally located in foothill or mountainous areas that are typically not prone to earthquake-induced settlement. However, the results of dam stability seismic evaluations (see Section 4.16.2.1) have indicated some settlement could occur, but the amount is very small. The results of specific evaluations, where published information is available, are summarized in the individual bundle discussions.

Water-Related Secondary Seismic Hazards. Tsunamis (earthquake-induced sea waves) are not a concern in the five regional bundles due to their proximity relative to the Pacific Ocean and intervening topography. Seiches (earthquake-induced waves on closed bodies of water, such as reservoirs) have not been observed or documented at Pacific Gas and Electric Company reservoirs (PG&E, 2000l).

4.16.3.3 Soils

The Natural Resources Conservation Service (formerly the Soil Conservation Service) classifies soil according to various properties. Soil types within the regional bundles vary in physical and chemical properties, reflecting the mineralogy and depth to the rock material from which they were derived and local climate. The potential for erosion, shrink-swell characteristics (expansion potential), and shallow depth to rock are primary considerations when considering land development and potential soils-related hazards. Site-specific geotechnical studies would be required to identify specific hazards.

Natural forces, both chemical and physical, are continually at work breaking down soils. Soil erosion poses two hazards: it removes soils, thereby undermining roads and buildings and producing unstable slopes, and it deposits eroded soil in reservoirs, lakes, drainage structures, and on roads as mudslides. Material eroded from surrounding hills into project reservoirs is the result of activities unrelated to hydroelectric facility operation, but the accumulation of sediment can affect reservoir capacity and outlet operations. The erosion potential for a given area is dependent on several factors, which can be grouped as those pertaining to soil characteristics, topography, climate, and land use and management. In general, soils in many locations are highly susceptible to erosion. Water operations associated with hydroelectric generation have the potential to cause erosion of soils and sediments under some conditions (such as canal overtopping). Erosion and sedimentation problems are addressed by Pacific Gas and Electric Company as normal maintenance activities at project facilities.

Expansive soils are those that greatly increase in volume when they absorb water and shrink when they dry out. Expansion can cause damage to building foundations, floor slabs, underground utility lines such as water and sewer, or roadways if volume changes due to moisture variations occur in the subgrade materials. Soils with high expansion potential (also called shrink-swell potential) are limited to only a few small areas in the five regional bundles. Prior to the issuance of building permits and occupancy, State regulations and local standards require that a geotechnical study be prepared to identify site-specific conditions that could affect site development, including the potential for expansive soils. Where clay soils exist within excavated building pads or within pads at subgrade depth, special treatment such as subexcavation or moisture conditioning of building pads prior to placement of floor slab concrete may be required. However, the effects of expansive soils can be easily managed with mixing of soil with non-expansive materials such as sand or gravel. In some cases, removal of expansive soils would be necessary when building foundations are planned directly over expansive soils. Site-specific recommendations for managing expansive soils and implementation of necessary soils engineering or foundation features to reduce hazards are ensured through the building permit and inspection procedures within the individual counties.

Shallow depth to rock can be a limiting factor for site development. Soils that are shallow over bedrock typically present problems in construction roadways and laying pipelines and could also present severe constraints to landscaping, revegetation, and septic systems.

4.16.3.4 Other Geologic Hazards (Landslides, Volcanic Activity, and Avalanche)

Landslides

Other geologic conditions that can affect project facilities and watershed lands include landslides (including mudslides and other slope stability problems), volcanic activity, and avalanche hazard.

Primary factors affecting slope instability and the potential for landslides of any area are the geologic conditions, drainage characteristics, depth to the groundwater table, slope gradient and configuration, vegetation type and density, and removal of underlying support. Typical slope management techniques identified in geotechnical studies and industry standards to avoid slope instability and mitigate active slide areas include providing adequate drainage, avoiding construction of roads and landing locations on slopes of 65 percent or more, and maintaining root support systems wherever possible. Roads should be located to avoid the crossing of active slides and the undercutting of buttressed slide materials (CDMG, 1997a).

Some of Pacific Gas and Electric Company's canals have been affected by landslides, mudslides, or other slope stability problems. To reduce the potential for damage related to canal failure as a result of such events, Pacific Gas and Electric Company has alarms along the canal system that monitor the level of the canal, allowing Pacific Gas and Electric Company to respond immediately to a high water level warning. Pacific Gas and Electric Company can respond to such alarms by manually or remotely opening spill gates which reduce the flow of water in the canal by diverting it into side conveyances or stream channels that convey the canal water back into a larger waterbody. Pacific Gas and Electric Company generally responds promptly to repair any damage that occurs to maintain the integrity and value of its hydroelectric facilities (PG&E Co., 1999a).

Volcanic Activity

More than 75 volcanic vents in California have been active during the last 10,000 years, and several dozens of volcanoes have erupted. During the past 600 years, Mount Shasta, Lassen Peak and nearby Cinder Cone, volcanoes in the Medicine Lake Highland, and the Mono-Inyo volcanic chain have erupted. Although the eruptions have occurred relatively infrequently, and few, if any, might be expected to occur during a person's lifetime, there is a risk to people and property. The U.S. Geological Survey (USGS) has identified potential hazards from future volcanic eruptions in six regions in California, based on the eruptive behavior of volcanoes in the State during the last 10,000 years, for six areas in California (Miller, 1989). Two of the areas contain lands that are part of the proposed divestiture: Mount Shasta, Medicine Lake Highland, and Lassen Peak Area (Shasta and DeSabla Regional Bundles), and Mono Lake-Long Valley Area (Motherlode Regional Bundle). A third, the Clear Lake Area in Lake County, is several miles southeast of the Potter Valley project. Information regarding the volcanic hazard for the Shasta, DeSabla, and Motherlode Regional Bundles are presented in the individual bundle discussions.

Avalanche

Avalanche hazard areas are generally located on high, mountainous slopes and terrain above 7,000 feet. Snow slab avalanches originate on a wide variety of terrain. Dangerous slab avalanches are most likely to start on slopes ranging from 30 to 45 degrees. For slopes less than 30 degrees, shear stress on the bed surface is not enough to cause shear failure and avalanche (Nevada County, 1995; Placer County, 1999). Avalanche hazard areas have been identified for some locations in the Sierra Nevada and Cascade Range. Site-specific information is presented in the individual bundle discussions, below.

Mineral Resources

Many of Pacific Gas and Electric Company's hydroelectric projects are located in areas containing important mineral resources that were formerly or are currently being mined, most notably gold and aggregate in Bundle 11 (Drum-Spaulding), gold and silver in Bundle 13 (Mokelumne project) along the Sierra Nevada foothills, and diatomaceous earth[5] in the vicinity of Lake Britton in Bundle 2 (Pit River). Mineralization in these areas is closely related to the ancestral seas that covered much of California several hundred million years ago, volcanism and metamorphism, and the mountain-building episodes that resulted in the creation of the Cascade Range, Sierra Nevada and Coast Ranges. Mineral land classification mapping in accordance with SMARA has been published by CDMG on a county-wide basis for Shasta, Nevada, Placer, Merced, and a large portion of Tuolumne counties. Certain portions of those counties, along with some locations in other counties have been mapped at a smaller scale for specific purposes (CDMG, 2000). A few of Pacific Gas and Electric Company's FERC license area and watershed lands have major known mineral deposits classified MRZ-2. Principal resources include sand and gravel, diatomaceous earth, gold (and other metals), quartz, and barite. The locations and nature of MRZ-2 areas and active mines within Project Lands are further described in the discussions of individual bundles, below. For purposes of this analysis, only those lands classified as MRZ-2 are described, as such resources are important to the land use planning process, as noted in Section 4.16.2.

Pacific Gas and Electric Company holds mineral rights on project parcels but does not operate any mines within project boundaries. The specific mineral rights associated with each fee property proposed for divestiture will be identified in conjunction with preparation of formal title reports (PG&E Co., 1999; 2000a; 2000g). There are a few active mining operations conducted by private companies on land leased from Pacific Gas and Electric Company or adjacent to the project (CDMG, 1999). Day-to-day operations and maintenance at Pacific Gas and Electric Company's existing hydroelectric projects do not generally affect in-the-ground mineral resources or mining operations on Project Lands (PG&E Co., 1999; 2000a; 2000g). Potential hazards associated with

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5 Diatomaceous earth (formed from silica-rich skeletal structures of microscopic single-cell water plants) possesses a unique filtering ability, which makes it ideal for use in the food, beverage, chemical, and pharmaceutical industries. It is also used in swimming pool filters, and may be used for fillers, insulating materials, additives, and other industrial processes.

historic or inactive mining operations (e.g., abandoned mines, tailings, or water quality impairment) on Project Lands are described in Section 4.9, Hazards and Hazardous Materials.

In addition to the three permitted mining activities on lands leased from Pacific Gas and Electric Company, numerous mining claims on public lands adjacent to FERC license areas and watershed lands have been filed with the Bureau of Land Management (BLM, 1997). A mining claim is a particular parcel of federal land for which an individual has asserted a right of possession. There are two types of claims, lode and placer. The right is restricted to the extraction and development of a mineral deposit. A claim does not necessarily mean there is active mining, but the current owner is keeping the claim open for possible future use (BLM, 1997). Information regarding active claims is presented in the discussions for the individual bundles.

4.16.4 Regional and Local Setting and Regulatory Context

4.16.4.1 Shasta Regional Bundle

Regional Setting

The Shasta Regional Bundle is located in northeastern California within the geomorphic provinces of the Cascade Range to the west and the Modoc Plateau to the east, and is in the northwestern-most flank of the Sierra Nevada (see Figure 4.16-1). The Cascade Range is a chain of Quaternary volcanoes, which predominantly trend north-south and consist of extensive deposits of volcanic flows, pyroclastic rocks, ash deposits and associated volcanoes which include Lassen Peak and Mount Shasta. Sedimentary deposits of the Great Valley lap on to the flanks of the Cascade foothills. The Modoc Plateau is characterized as a large highland that has been broken by faults into a series of mostly north-south trending block-faulted mountains and valleys. The plateau region also contains extensive volcanic deposits and volcanoes, which dominate the landscape (CDMG, 1966b).

Major faults in the Shasta Regional Bundle include the Hat Creek fault zone and MacArthur fault zone (CDMG, 1994). Alquist-Priolo zone maps were issued in 1991 by the State Geologist for the area north of and including Bundle 1. The southern part of the Cascade Range has a history of mild seismic activity. Several earthquakes have occurred within the region in recent history. A magnitude 5.5 earthquake on March 20, 1950 occurred in the vicinity of Lassen Peak, and a magnitude 6.0 earthquake occurred near Chico on February 8, 1940. The hydroelectric facilities could potentially be subjected to ground motion from earthquakes on these faults. However, maps prepared by the CDMG show the level of seismic shaking that could occur in the region are generally low (CDMG, 1999c).

Shasta County has historically experienced extensive mining activities with diatomite, limestone and aggregate deposits of current economic significance. The diatomite deposits in the Lake Britton area and the concrete-grade alluvial sand and gravel are of special economic importance.

Local Regulations and Policies

Facilities in the Shasta Regional Bundle are located in Shasta and Tehama counties. Relevant portions of planning documents and local standards that apply to discretionary projects in those jurisdictions are summarized in this section. Local ordinances addressing grading and erosion control are identified. It is assumed all counties implement required CBC standards pertaining to seismic safety and SMARA regulations pertaining to mining and mine reclamation.

Bundle 1: Hat Creek -- Hat Creek 1 and 2 (FERC 2661)

Geology and Topography

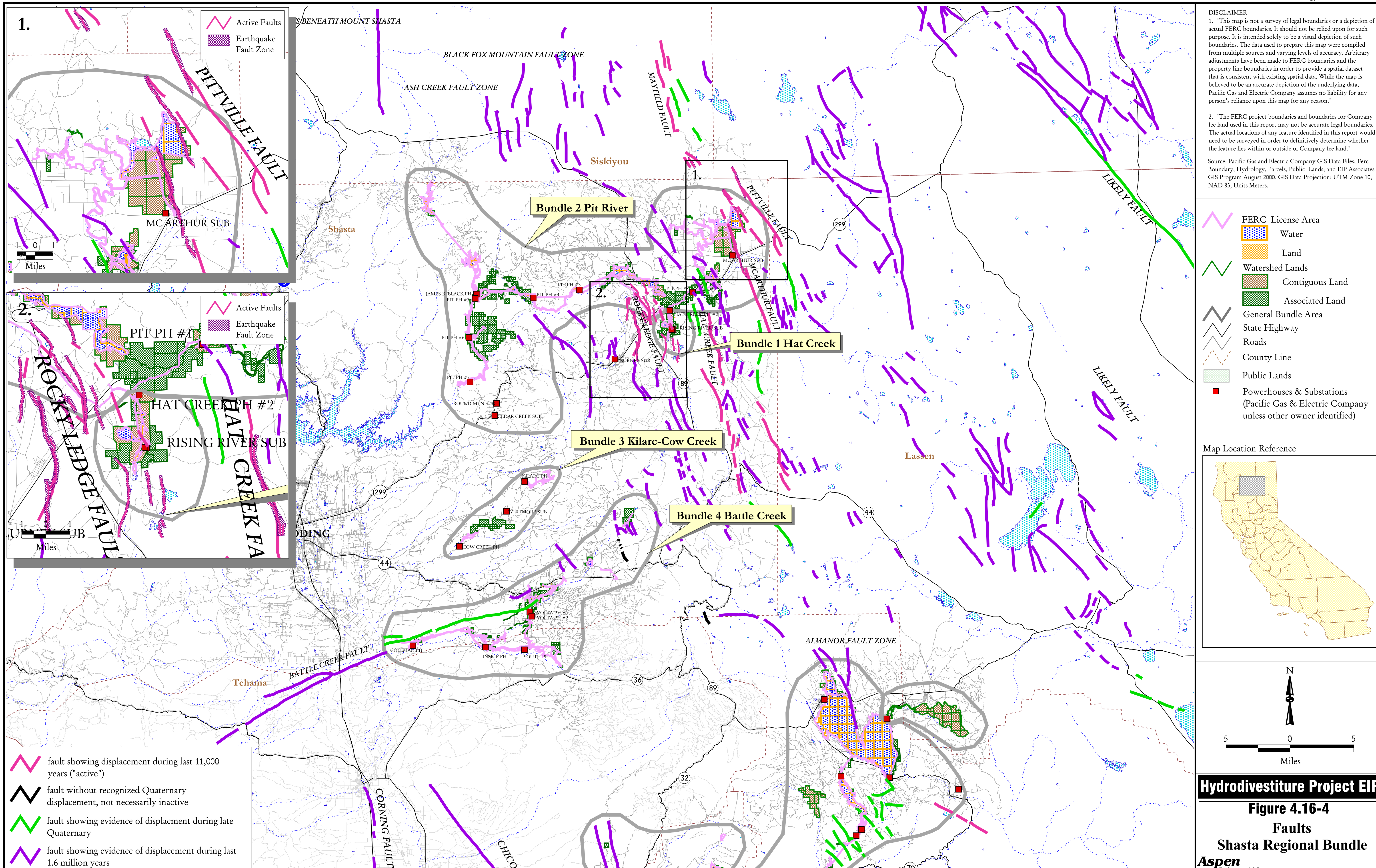
The Hat Creek Valley is located at the boundary between the Modoc Plateau and Cascade Range provinces (see Figure 4.16-1) at an elevation of approximately 2,800 feet, and is bounded on the east by the Hat Creek Rim. Both sides of the valley and the valley floor itself are comprised of basaltic flows of late Pleistocene to Holocene in age, as well as localized deposits of fluvial materials from volcanic rocks, mudflow deposits, floodplain gravels, siltstone, sandstone and conglomerate (see Figure 4.16-2). Stream deposits dominate at the valley's northwestern end beyond the extent of lava flows and in some places are greater than 30 feet deep. Hat Creek rises in small springs on the lower north slope of Lassen Peak and flows through the Hat Creek Valley, where it joins the Pit River at Lake Britton. Springs are very common in the highly fractured lava bed formations and release groundwater that comprises the majority of water which flows down Hat Creek and the Rising River (Cook and Ellis, 1998).

Faulting and Seismicity

Several faults within and near the Project Lands are classified as active faults. One such fault is the Rocky Ledge fault, which extends from Baum Lake north and parallels Hat Creek just west of the creek itself. The McArthur fault, approximately six miles east of Hat Creek, is located near the town of McArthur and trends roughly northwest-southeast. The Hat Creek fault, which parallels the Hat Creek Rim and is where displacement took place that formed the rim itself, is pre-Quaternary in age and is not classified as an active fault. Alquist-Priolo zone maps for faults in the Burney, Burney Falls, Cassel, Dana, Fall River Mills, Hogback Ridge, and Timbered Crater 7.5-minute quadrangles were issued in 1991 by the State Geologist (CDMG, 1997b). Some of these mapped zones extend into Bundle 2. Project facilities may experience moderate groundshaking from earthquakes on these faults. Figure 4.16-4 shows the locations of these faults.

Soils and Erosion

Soils of the Hat Creek Regional Bundle consist of the Loveness-Hunsinger-Lava Flows Soil Association. These soils formed in material derived from lava flows and other extrusive volcanic material and are very similar. Loveness soils consist predominantly of sandy loam and gravelly loam with varying amounts of clay contained in the subsoil layer. Hunsinger soils are very similar,



Hydrodivestiture Project EIR
Figure 4.16-4
Faults
Shasta Regional Bundle

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drained. Major management concerns are the erosion hazard and shrink-swell potential, depending on the slope, vegetation cover and land use (USDA, 2000). Lake deposits of diatomaceous earth are exposed at several localities at the northern end of Hat Creek Valley and are known to underlie some of the volcanic deposits of the valley floor. These deposits may form areas of highly erosive soil.

Subsurface ground water follows sand and gravel units in alluvium and lakebeds, fractured basalt and lava tubes. Springs in the area may be eroding subsurface deposits, adding to sediment problems that are known to occur in Hat Creek (PG&E Co., 1999a).

Other Geologic Hazards

According to Pacific Gas and Electric Company, a landslide appears to form the right abutment of Hat Creek 2 Dam. In response to a previous slide that caused canal overtopping at the Hat No. 2 Flume, Pacific Gas and Electric Company installed automatic intake gate shutoff mechanisms and high/low water alarms. This system has reduced the probability of slide-induced canal overtopping (PG&E Co., 1999a).

The Hat Creek Valley has experienced debris flows due to volcanic activity of Lassen Peak within the relatively recent past. In 1915, an eruption of Lassen Peak caused the rapid melting of snow and ice on the mountain, which resulted in a flow of ice, water, mud and boulders to flow down its northeastern flank, into the Lost Creek drainage, topping over into the Hat Creek drainage and flowing down Hat Creek Valley (Cook and Ellis, 1998). The Hat Creek Bundle is located in an area that could be subject to future volcanic activity associated with Lassen Peak, including lava flows, mudflows, pyroclastic flows, ashfall, and smoke (Miller, 1989).

Mineral Resources

There are no reported active mines on Project Lands in Bundle 1 (CDMG, 1999). A small portion of Watershed Lands in the vicinity of Crystal Lake lies within an MRZ-2 classified zone for cinder resources. There are currently three cinder borrow pits within the MRZ (but not on Project Lands) that actively produce volcanic cinders used for road base aggregate. All three are located on Brush Mountain, which is owned by the BLM. The Shasta County Department of Public Works operates a 24-acre site, Hat Creek Construction operates a 20-acre site, and the third is operated by Packway Materials, Inc. and consists of 40 acres. As shown in Figure 4.16-5, areas of Project Lands located at the northern portion of Hat Creek Valley lie within two MRZ-2 classified zones for diatomite and within one MRZ-2 classified zone for sand and gravel resources suitable for use in portland cement. The significance of the diatomite resource is described in Bundle 2 below, where most of the diatomite is located. An MRZ-3 classified zone for sand and gravel encompasses Baum and Crystal Lakes (CDMG, 1997c).

Bundle 2: Pit River

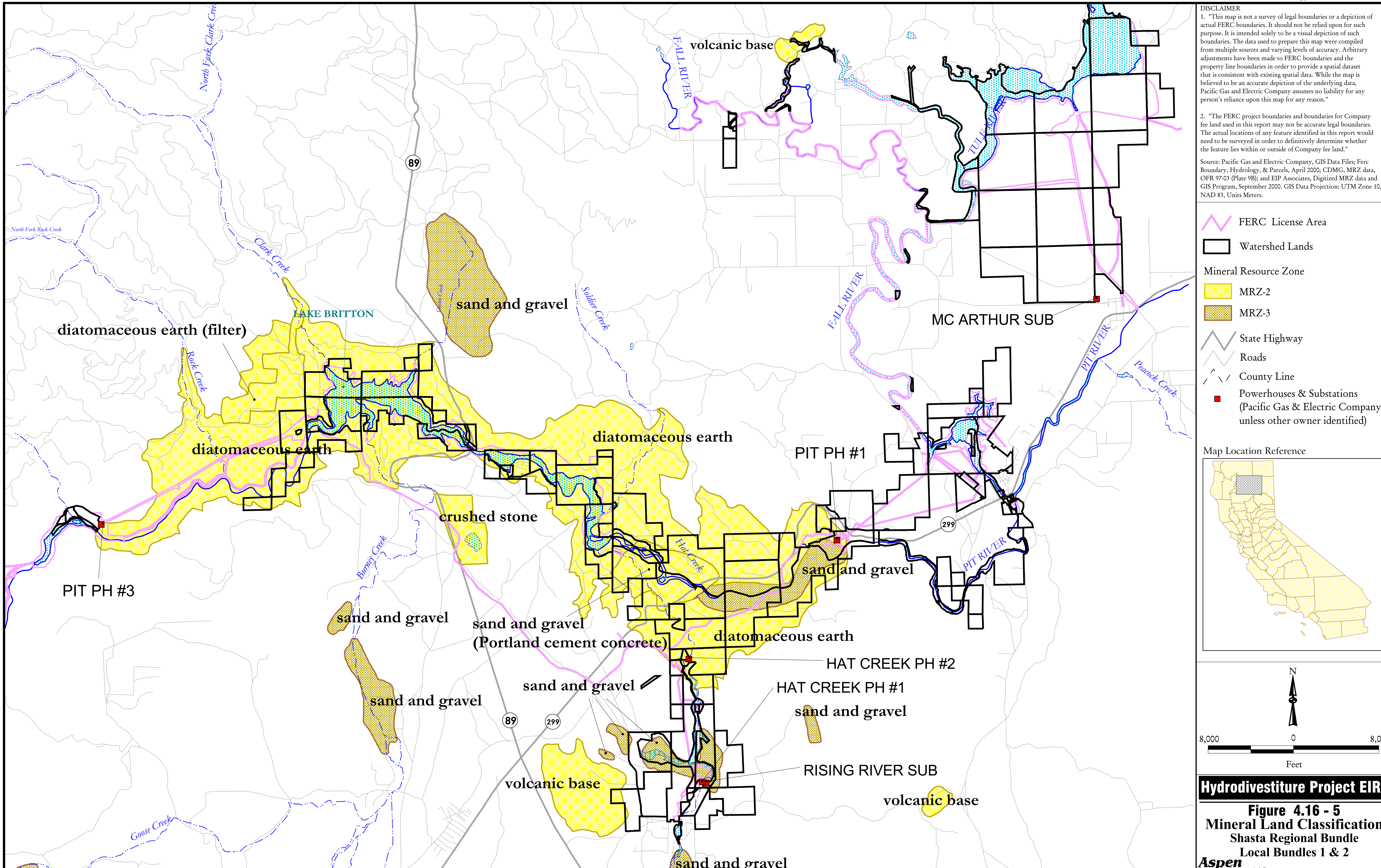
Pit 1 (FERC 2687), Pit 3,4, and 6 (FERC 0233), McCloud - Pit (FERC 2106)

Geology and Topography

Pit 1. The Pit 1 Project is predominantly underlain by basaltic volcanic rocks of lower Pleistocene to Holocene in age at approximately 2,900 feet in elevation. Project Lands in the vicinity of McArthur Swamp and Big Lake are situated on Pleistocene- to Holocene-aged lakebed deposits consisting of mudstone, siltstone and shale (see Figure 4.16-2). Alluvium deposits of similar age underlie the Pit 1 Powerhouse. Relatively minor amounts of non-marine sedimentary deposits occur along and adjacent to the Pit River on Project Lands from Fall River Mills west to the junction of Hat Creek and the Pit River (PG&E Co., 1999a). Fall River Springs, one of the largest spring systems in the U.S., is located within the region. A major source of flow for the springs is the percolation of water from the Pit River channel through the subsurface deposits and into the network of underlying lava tubes (CDM, 1997).

Pit 3, 4, and 5. Pit 3 Powerhouse is situated at approximately 2,400 feet in elevation, Pit 4 Powerhouse is located at 2030 feet in elevation, and the Pit 5 Powerhouse lies at approximately 1415 feet in elevation. Slopes in excess of 30 percent are present on Watershed Lands in the vicinity of Pit 5 and James B. Black Powerhouses and parcels south of Pit 6 Powerhouse. Non-marine sedimentary deposits predominate on Project Lands, with Pleistocene age volcanic basalt flows occupying relatively minor portions of Project Lands farthest away from the Pit River. Including the Pit 3 Powerhouse and to the east, basalt flows of Pleistocene age dominate the landscape (PG&E Co., 1999a). The Lake Britton area has extensive deposits of diatomaceous earth, which is mined in areas northwest of the lake (CDMG, 1997c). The Montgomery Creek Formation, an Eocene sedimentary deposit consisting of sandstones, shales and conglomerates, is found throughout Project Lands east of Big Bend and extending west almost to the Pit River. North of where Iron Canyon Creek joins the Pit River, rock units of the Eastern Klamath terrane are encountered, which include interbedded sequences of volcanic andesites, rhyolites and pyroclastics, and sedimentary deposits of argillites, sandstones, limestones, conglomerates, shales and siltstones. Metavolcanic rocks underlie the vicinity of the Pit 5 Powerhouse. The locations of major geologic formations relative to Project Lands are shown in Figure 4.16-2.

McCloud-Pit. Project facilities in the McCloud-Pit vicinity range in elevation from 1260 feet to 2,650 feet. Slopes in excess of 30 percent cover most Project Lands. Project Lands lie at the juncture between the younger mostly volcanic rocks of the Cascade Range to the east and rock units of the Eastern Klamath terrane to the west, which include interbedded sequences of volcanic andesites, rhyolites and pyroclastics, and sedimentary deposits of argillites, sandstones, limestones, conglomerates, shales and siltstones. Formations of the Eastern Klamath terrane vary in age from Mississippian to Jurassic in age. Most project facilities are situated on the volcanic and sedimentary sequences of the Eastern Klamath terrane. Within Project Lands and on the east side


volcanic base
FALL RIVER
North Fork Clark Creek
North Fork Rock Creek
Clark Creek
89
TULE RIVER
FALL RIVER
MC ARTHUR SUB
sand and gravel
Soldier Creek
LAKE BRITTON
diatomaceous earth (filter)
Rock Creek
diatomaceous earth
diatomaceous earth
PIT PH #1
PIT RIVER
Peacock Creek
crushed stone
299
Hat Creek
sand and gravel
PIT RIVER
PIT PH #3
Burney Creek
sand and gravel
sand and gravel
(Portland cement concrete)
diatomaceous earth
HAT CREEK PH #2
sand and gravel
HAT CREEK PH #1
sand and gravel
sand and gravel
89
299
RISING RIVER SUB
volcanic base
volcanic base
Goose Creek
sand and gravel
DISCLAIMER
1. "This map is not a survey of legal boundaries or a depiction of actual FERC boundaries. It should not be relied upon for such purpose. It is intended solely to be a visual depiction of such boundaries. The data used to prepare this map were compiled from multiple sources and varying levels of accuracy. Arbitrary adjustments have been made to FERC boundaries and the property line boundaries in order to provide a spatial dataset that is consistent with existing spatial data. While the map is believed to be an accurate depiction of the underlying data, Pacific Gas and Electric Company assumes no liability for any person's reliance upon this map for any reason."
2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."
Source: Pacific Gas and Electric Company, GIS Data Files; Ferc Boundary, Hydrology, & Parcels, April 2000; CDMG, MRZ data, OFR 97-03 (Plate 9B); and EIP Associates, Digitized MRZ data and GIS Program, September 2000. GIS Data Projection: UTM Zone 10, NAD 83, Units Meters.
FERC License Area
Watershed Lands
Mineral Resource Zone
MRZ-2
MRZ-3
State Highway
Roads
County Line
Powerhouses & Substations
(Pacific Gas & Electric Company
unless other owner identified)
Map Location Reference
N
8,000
0
8,000
Feet
Hydrodivestiture Project EIR
Figure 4.16 - 5
Mineral Land Classification
Shasta Regional Bundle
Local Bundles 1 & 2
Aspen
Environmental Group

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of the Pit River are sedimentary deposits of the Montgomery Creek Formation, a common rock unit of the Cascades and Eocene in age. The locations of major geologic formations relative to Project Lands are shown in Figure 4.16-2.

Faulting and Seismicity

Pit 1. Figure 4.16-4 shows the locations of faults in Bundle 2. The northern end of the Hat Creek fault underlies the Pit 1 Penstock, while the Pit 1 Powerhouse is situated in between the Rocky Ledge fault to the west and the Hat Creek fault to the east. The McArthur fault runs through the McArthur Swamp and Big Lake. The Pittville fault lies just to the east of Big Lake. As illustrated in Figure 4.16-4, all faults within the area roughly trend northwest to southeast (CDMG, 1994). As discussed in Bundle 1, Alquist-Priolo zone maps for faults in the Burney, Burney Falls, Cassel, Dana, Fall River Mills, Hogback Ridge, and Timbered Crater 7.5-minute quadrangles were issued in 1991 by the State Geologist (CDMG, 1997b). The project vicinity may experience groundshaking from earthquakes on faults of the Rocky Ledge, Hat Creek, Pittville, and McArthur fault systems, which are classified as active.

Pit 3, 4, and 5. The Rocky Ledge fault lies immediately to the south of Lake Britton but does not extend into the lake itself. The Hatchet Mountain fault is classified as a potentially active fault and lies to the south of Big Bend south of the Pit River. The Hat Creek fault lies approximately six to seven miles east of Lake Britton (CDMG, 1994). Pacific Gas and Electric Company has developed an engineering design for a retrofit of the Pit 4 Dam, although it is not known when this retrofit will be implemented (PG&E Co., 1999a). As discussed in Bundle 1, Alquist-Priolo zone maps for faults in the Burney, Burney Falls, Cassel, Dana, Fall River Mills, Hogback Ridge, and Timbered Crater 7.5-minute quadrangles were issued in 1991 by the State Geologist (CDMG, 1997b). The locations of active faults and Earthquake Fault Zones in Bundle 2 are shown in Figure 4.16-4. Seismicity of the Pit 3, 4, and 5 project is similar to the Pit 1 area.

McCloud-Pit. According to fault maps prepared by the CDMG, there are no documented active or Quaternary faults within the McCloud-Pit area. There are several small pre-Quaternary unnamed faults that lie to the east and west of McCloud Reservoir, as well as the pre-Quaternary Willow Springs fault that lies adjacent to and east of Iron Canyon Reservoir. These faults have shown no evidence of displacement during the last 1.6 million years (CDMG, 1994). However, a seismic system at McCloud Dam records strong ground motion from earthquakes (PG&E Co., 1999a). The project vicinity may experience moderate to strong groundshaking from earthquakes on active faults of the nearby Rocky Ledge, Hat Creek, Pittville, and McArthur fault systems found in the Pit 1 and Pit 3, 4, and 5 Projects areas, as well as from the pre-Quaternary faults documented within the McCloud-Pit vicinity. These active fault systems are between 25 and 50 miles distance from McCloud Reservoir. As discussed in Bundle 1, Alquist-Priolo zone maps for faults in the Burney, Burney Falls, Cassel, Dana, Fall River Mills, Hogback Ridge, and Timbered Crater 7.5-minute quadrangles were issued in 1991 by the State Geologist (CDMG, 1994; 1997b). Figure 4.16-4 shows the locations of these faults.

Soils and Erosion. Soils in Bundle 2 consist of four main soil associations: the Ponto-Neer-Neuns association, the Ladd-Dudgen-Graven association, the Jellycamp-Jellico-Splawn association, and the Hunsinger-Lava Flows-Loveness association. All soil associations are derived from lava flows and other extrusive volcanic material, with the Ponto-Neer-Neuns association containing a metamorphic rock material component. Hunsinger-Lava Flows-Loveness soils consist predominantly of sandy and gravelly loams with varying amounts of clay contained in the subsoil layer. Soils of this association are deep and well drained. Major management concerns are the erosion hazard and shrink-swell potential, depending on the slope, vegetation cover and land use. The Ponto-Neer-Neuns association soils are deep and well drained, and are primarily gravelly to sandy loams. Major land use limitations are the slope, coarseness of texture and depth to bedrock. The Ladd-Dudgen-Graven association soils are shallow to moderately deep and are moderately well drained. While the hazard of water erosion is low, the shrink-swell potential is high. The Jellycamp-Jellico-Splawn association is more variable than the other soil associations found on Project Lands. Both Jellico and Splawn soil types are moderately deep and well drained. Land use limitations for all soils are shallow depth to bedrock. Jellico soils exhibit a low shrink-swell potential, while Splawn and Jellycamp soils have high to very high shrink-swell characteristics. The hazard of water erosion ranges from moderate to high in Jellico and Splawn soils, but is low in Jellycamp soils. Slope may also be a land management factor on Splawn soils. Diatomaceous earth deposits are present at certain locales in the Bundle 2 area and are known to underlay surface deposits and strata in some areas. These deposits where exposed may form areas of highly erosive soil (USDA, 2000).

Other Geologic Hazards

Pit 1. Landslides and slumping may occur in the vicinity of Pit 1, as they have in the past near the Pit 1 Powerhouse, due to certain materials on slopes such as talus and colluvium that are prone to mass movement, especially during periods of heavy precipitation. The project vicinity also lies within known active fault systems, as discussed above, which may have provided impetus for landslides in the past. Small localized areas within this region are also subject to moderate to severe erosion, which can affect slope stability (PG&E Co., 1992a). The primary volcanic hazard in the McArthur Swamp land area located northwest of Pit 1 Powerhouse is basaltic lava flows associated with activity in the Medicine Lake Highland or Lassen Peak areas (Miller, 1989).

Pit 3, 4, and 5. This area has been subject to the same types of mass soil movements as mentioned above for the Pit 1 Project. The left abutment of the Pit 4 Dam is near a large ancient landslide, while the Pit 5 Conduit Dam is situated on a large ancient landslide. Due to the history of slides in the area, slopes underlying the area of the Pit 5 Penstocks have been stabilized and monitoring is ongoing. Geotechnical sensors at Pit 5 Powerhouse measure landslide deformation and water level in the slope. Landslides occurred in 1997 in the vicinity of the Pit 5 Powerhouse and stabilization was completed in 1998 (PG&E Co., 1992a). The Pit 3, 4, and 5 and Lake Britton land areas are not situated in areas subject to volcanic hazard (Miller, 1989).

McCloud-Pit. The McCloud-Pit area has experienced landslides in the past and will likely continue to do so, due to factors such as slope gradient, type of materials deposited on slopes, periods of heavy precipitation, and moderate groundshaking due to earthquakes as a result of movement along faults. A landslide in 1986 in the area of the James B. Black Powerhouse caused the penstocks to fail. The landslide was stabilized and penstocks rebuilt during 1986 and 1987. McCloud Reservoir is located in an area subject to volcanic debris flows (mudflows) and pyroclastic flows associated with Mount Shasta (Miller, 1989).

Mineral Resources

Pit 1. As shown in Figure 4.16-5, an area classified as MRZ-2 lies within Project Lands. This area is located to the east of the juncture of Hat Creek and the Pit River and is zoned for the production of high-quality sand and gravel suitable for use in Portland cement. The alluvial resources in this zone have a high possibility of overlying buried diatomite deposits, and for this reason this site has also been classified as an MRZ-2 diatomite resource (CDMG, 1997c). Adjacent to and immediately east of this zone is an MRZ-3 zone for lower quality sand and gravel. Immediately adjacent to Pit 1 FERC license area near the headwaters of Spring Creek on land owned by the U.S. Bureau of Indian Affairs is the Ben Bridge Allotment, also known as the Spring Creek Quarry. As of 1996, this mine consisted of approximately eight acres and produces volcanic cinders used for road base aggregate. Current operations of the project do not affect these mines (PG&E Co., 1999a).

Although there are volcanic areas in the region, there are no geothermal springs or thermal wells on Project Lands (CDMG, 1980).

Pit 3, 4, and 5. The Lake Britton area has extensive deposits of medium- to high-quality diatomaceous earth that has been classified as MRZ-2 for diatomaceous earth, as shown in Figure 4.16-5. This deposit is one of the largest deposits of fresh-water diatomite in the world (CDMG, 1997c; Shasta County, 1998). Three zones contain medium-quality diatomaceous earth deposits. One zone, immediately to the northwest of Lake Britton, is classified as containing high-grade diatomite suitable for use as a filtering agent. A majority of the MRZ zoned lands for diatomaceous earth have also been zoned as MRZ-3 for sand and gravel resources. According to information developed by the CDMG, diatomite resources will continue to be in demand, due to projected population increases in Shasta County and quality of mineral resources. CDMG also notes that aggregate resources along the Pit River are an important resource because of the quality of the material (CDMG, 1997c).

There are currently two active mines on lands leased from Pacific Gas and Electric Company and one near Project Lands. The Burney DE Mine is located just east of Lake Britton on FERC-licensed land owned by Pacific Gas and Electric Company and is leased and operated by the Calaveras Cement Company. The mine consists of 117 acres and produces diatomite suitable as a high-purity silica additive in the manufacture of Portland cement (CDMG, 1997c). The existing mine use permit expires October 2003. It is anticipated the permit will not be renewed because the resource will be depleted by that time. The reclamation plan for the Burney DE Mine includes benching and reshaping to create wildlife habitat, forest, and open space (Shasta County, 2000b). Another active mine is located west of the Pit 1 Powerhouse and north of the Hat Creek Project. Known as the Braden Sand Pit, the mine consists of 19 acres and was operated by Pacific Gas and Electric Company during 1990 and 1991 and is currently under private ownership/operation by Hat Creek Construction on land leased from Pacific Gas and Electric Company (CDMG, 1997c). The Braden Sand Pit is a vested operation, and there is no expiration date on mining operations. A reclamation plan has been prepared, however, which identifies end land uses as open space, wildlife habitat, and watershed protection. To the northwest of Lake Britton (but not on Project Lands) is the Dicalite Quarry operated by the Dicalite Corporation. Consisting of 726 acres, this mine produces superior quality filter-grade diatomite (CDMG, 1997c). Current operations of the Pit 3, 4, and 5 Project do not affect the operations of these mines.

The Shasta County Zoning Code Section 17-88 allows mining activities in the “TP” Timber Production District with a use permit. Mining is also a permitted use in all districts subject to a permit and special conditions. Where not restricted by proximity to existing or future incompatible land uses, all Pacific Gas and Electric Company parcels between Pit 1 Powerhouse and Pit 3 Powerhouse and in the vicinity of Hat Creek 2 Powerhouse in Bundle 1 (Hat Creek) directly south of Bundle 2 are considered subject to potential mining activities. At the urging of Pacific Gas and Electric Company, Shasta County has postponed rezoning Lake Britton a "geologically significant area" for mineral resource extraction until FERC license is complete. On April 16, 1999, Pacific Gas and Electric Company submitted a letter to the Shasta County Planning Department requesting that the county defer any action on establishing a Mineral Resource Overlay Zone for the Lake Britton area. Specifically, Pacific Gas and Electric Company requested deferral at least until Land Management Studies conducted through the relicensing process were complete (PG&E Co., 1999c). As of October 2000, the county has not taken any further action on this issue, and no time frame has been established for further consideration of this matter (Shasta County, 2000b).

Although there is geothermal activity west of Lake Britton in the Big Bend area, there are no geothermal springs or wells on Project Lands (CDMG, 1980).

McCloud-Pit. Project Lands to the west of and including the Pit River are in an MRZ-3 classified zone for limestone (CDMG, 1997c). There are no mines or mining activity in the vicinity of the McCloud-Pit Project (CDMG, 1999).

Bundle 3: Kilarc-Cow Creek (FERC 0606)

Geology and Topography

The Kilarc-Cow Creek Local Bundle is situated in the foothills at the boundary of the Great Valley and Cascade Range provinces (see Figure 4.16-1). Topography ranges from gently rolling hills to narrow steep walled canyons, and project facilities vary in elevation from 1,520 feet in elevation for the Cow Creek Powerhouse to 3,770 feet in elevation for the Kilarc Powerhouse. The Kilarc Powerhouse is situated on a terrace above the streambed of Old Cow Creek, which occupies a narrow channel in a steeply-walled canyon, while the Kilarc Forebay is located on moderately sloping terrain. Rocks exposed at the Kilarc Powerhouse and Forebay are volcanic flows, tuffs and agglomerates of the Tuscan Formation of late Pliocene age and sedimentary shales, sandstones and conglomerates of the Montgomery Creek Formation. The Red Bluff Formation, a thin veneer of Pleistocene continental gravel, occurs as erosional and depositional terraces along the major streams. The Cow Creek Powerhouse is located in Hooten Gulch at the junction of several small tributaries, while the Cow Creek Forebay is located in moderately sloping terrain. The powerhouse is situated on alluvium and the Red Bluff Formation. Volcanic rocks of the Pliocene Tuscan Formation are exposed near Cow Creek Diversion Dam and Forebay (PG&E Co., 1976).

Faulting and Seismicity

As shown in Figure 4.16-4, some faults have been mapped within a few miles of Project Lands, but none have been documented within the Kilarc-Cow Creek Local Bundle. However, the area may experience minor to moderate groundshaking from earthquakes on the Rocky Ledge and Hat Creek faults, which are located approximately 25 to 30 miles east of the bundle and are classified as active faults (CDMG, 1994). No Alquist-Priolo Earthquake Fault Zone maps have been published for the area including Project Lands in Bundle 3 (CDMG, 1997b). The potential for ground rupture within the Bundle is minimal, as is the potential for damage from groundshaking. The Chico and Lassen Peak earthquakes in 1940 and 1950, respectively, did not have any effect or cause damage to any Bundle facilities (PG&E Co., 1999a). As shown in Figure 4.16-3, the probability of strong groundshaking that could occur in the region of the Kilarc-Cow Creek Local Bundle is low, so the potential for liquefaction or differential compaction is considered minimal.

Soils and Erosion

The predominant soil association of the Kilarc-Cow Creek Local Bundle is the Cohasset-Aiken-McCarthy association. Nearly all Project Lands are located on these soils. Soils of this association formed from extrusive igneous rock material. Most soils of this association are deep and well-drained loams but Cohasset soils can contain up to 20 percent of stones and coarse fragments in their composition (USDA, 1974). The Cow Creek Powerhouse is situated on Kilarc-Sites-Myers soils, which formed from sedimentary and metamorphic rock material. Soils are typically well drained loams. All soils in this association have a moderate to high erosion hazard, with Kilarc soils being particularly sensitive to mass movement (PG&E Co., 1976; USDA, 2000a).

Other Geologic Hazards

Due to certain materials on slopes that are prone to mass movement, such as talus and colluvium, landslides and slumping may occur in the area, especially during periods of heavy precipitation. Massive landslide deposits are located on the ridges upstream of the Kilarc Powerhouse, and the

Kilarc Penstock traverses a large ancient landslide. Small landslides have occurred along the penstock just above the Cow Creek Powerhouse, but they have been mitigated (PG&E Co., 1999a). Pyroclastic flows, ashfall, and smoke from volcanic activity at Lassen Peak could affect Bundle 3 (Miller, 1989).

Mineral Resources

There are no reported mines or mining activity in the vicinity of the Kilarc-Cow Creek Project or on Project Lands (CDMG, 1999). There are no areas classified as MRZ-2 (CDMG, 1997c).

Bundle 4: Battle Creek (FERC 1121)

Geology and Topography

Project facilities range in elevation from approximately 920 feet to 3,500 feet in elevation, with the topography varying from gently rolling hills to narrow steep walled canyons. The region encompassing the Battle Creek project facilities and associated lands is dominated by recent volcanic basalt and andesite flows and pyroclastics. Also present in scattered deposits are remnants of Pliocene sedimentary rocks of sandstones, shales, siltstones and conglomerates interbedded with minor volcanic materials, such as ash and tuff. Volcanic strata underlie most project facilities, including Volta 1 and 2 Powerhouses and Penstocks, Lakes Grace and Nora and associated penstocks, and a majority of the canal alignments. Notable exceptions are the Coleman Forebay, which is underlain by a thin veneer of young continental gravel that occurs as erosional and depositional terraces along the major streams. Non-marine sedimentary deposits characterized as colluvium underlie the Coleman Powerhouse. An extensive area of recent alluvial deposits consisting of unconsolidated gravel, sand, silt, and clay, occurs in the vicinity of Macumber Reservoir and Armstrong Nos. 1 and 2 Canals. The alluvial deposits are likely underlain by basaltic rock (PG&E Co., 1999a). Figure 4.16-2 illustrates the general locations of geologic formations relative to Project Lands.

Faulting and Seismicity

The Battle Creek fault trends slightly northeast to southwest and is located just north of the Wildcat Diversion Dam but is classified as inactive. A series of small pre-Quaternary unnamed faults run adjacent to North Battle Creek Reservoir. Other Quaternary faults have been mapped to the east of the area, including the active Hat Creek, Rocky Ledge, and McArthur faults, approximately 15 to 30 miles to the northeast of North Battle Creek Reservoir (CDMG, 1994). The area may experience minor to moderate groundshaking from earthquakes on the above-mentioned faults (see Figure 4.16-3). Figure 4.16-4 shows the locations of these faults. No Alquist-Priolo Earthquake Fault Zone maps have been published for the Bundle 4 vicinity (CDMG, 1997b).

Soils and Erosion

Soils in Battle Creek Project Lands are situated on the Toomes-Supan-Guenoc Soil Association. Most soils of this association are well drained and are formed from volcanic rock material. Depth to bedrock ranges from 15 to 48 inches, with Supan soils being deeper and forming on more gently sloping areas. The erosion hazard for these soils is low to moderate (USDA, 2000a). A small portion of Project Lands north of the Coleman Diversion Dam is found on Tuscan-Inks-Keefers Soil Association soils. These soils are shallow to moderately deep to hardpan, and consist of alluvium material derived from volcanic rock material. Tuscan soils are found on the tops of the old terraces and are cobbly or clay loams with a cemented hardpan usually found at depths less than 20 inches. Inks soils are found on the terrace slopes and consist of cobbly and clay loams over a cemented substratum. The erosion hazard for these soils is none (Tuscan) to low (Inks and Keefers) (USDA, 1967b; 2000a). A portion of Project Lands north of Battle Creek Reservoir is located on the Jiggs-Lyonsville-Chummy Soil. Depth to bedrock ranges from 18 to 60 inches. The erosion hazard ranges from moderate on slopes less than 30 percent, to severe to very severe on slopes greater than 30 percent USDA, 2000a).

Other Geologic Hazards

Deposits prone to landslides, such as unconsolidated materials of alluvium and colluvium, and talus slopes of pyroclastic and other volcanic materials, underlie portions of the Battle Creek Local Bundle (PG&E Co., 1999a). No known significant geologic hazards have been identified by Pacific Gas and Electric Company. However, due to the location of unconsolidated materials prone to movement within the project vicinity, there is the possibility that landslides and slumping may occur in the area, especially during periods of heavy precipitation. Potential hazards associated with volcanic activity at Lassen Peak could affect Project Lands. Hazards include lava and mudflows, pyroclastic flows, tephra, ash fall, and smoke in the easternmost Watershed Lands in the Shingletown land area. Areas to the west could also experience pyroclastic flows, ash, and smoke (Miller, 1989).

Mineral Resources

A portion of Project Lands north of North Battle Creek Reservoir is within an MRZ-3 zone for sand and gravel. A second MRZ-3 zone for sand and gravel is located on Project Lands around and including McCumber Reservoir. A third MRZ-3 zone for sand and gravel is located on Project Lands around and including the Coleman Forebay (CDMG, 1997c). There are no reported mines or mining activity on the Battle Creek Project Lands (CDMG, 1999). Within approximately two miles north of Project Lands, however, is an MRZ-2 zone on Black Butte for volcanic cinders and is where two currently active mines are located. The Black Butte Cinder Pits consist of four pits within an area of 31 acres and is operated by Black Butte Cinders Company. The Cinder Pit is operated by Westside Aggregate and currently consists of ten acres that have been mined as of 1996. Both mines produce volcanic cinders used for roadbase aggregate (CDMG, 1997c). Current operations of the Battle Creek Project do not affect the operations of these mines.

4.16.4.2 DeSabla Regional Bundle

Regional Setting

The DeSabla Regional Bundle is located in northern and northeastern California, beginning at the boundary area between the Modoc Plateau, Cascade Range and Sierra Nevada geomorphic provinces, and extending southward into the Sierra Nevada (see Figure 4.16-1). The Cascade Range is a chain of Quaternary volcanoes, which predominantly trend north-south and consist of extensive deposits of volcanic flows, pyroclastic rocks and ash deposits. The Modoc Plateau is characterized by extensive accumulations of Quaternary basalt and other volcanic flows as well as scattered cinder cones (CDMG, 1966b).

There is an extensive history of volcanic activity and earthquakes within the Regional Bundle vicinity. Lassen Peak's most recent eruption occurred in 1915 and produced a debris flow of mud, ice, water and boulders, resulting in considerable environmental damage to the region north of the peak (CDMG, 1966b). Major earthquakes as recent as 1969, resulted in considerable damage to Oroville in Butte County. In 1940, an earthquake occurred with its epicenter located approximately 13 miles northwest of Rodgers Flat in Plumas County, which had a magnitude of 6.0. There have been no Alquist-Priolo Earthquake Fault Zones maps issued by the California Division of Mines and Geology for any areas within the DeSabla Regional Bundle (CDMG, 1997b).

The vicinity of the Regional Bundle has experienced a rich history of mining activities, which continues to the present. The production of sand and gravel materials is the predominant mineral resource currently produced within the Bundle region (CDMG, 1999). However, no MRZ classifications prepared by the State have been published for any areas within the DeSabla Regional Bundle (CDMG, 2000).

Local Regulations and Policies

Facilities in the DeSabla Regional Bundle are located in Butte, Plumas and Lassen Counties. Relevant portions of planning documents and local standards that apply to discretionary projects in those jurisdictions are summarized in this section. Local ordinances addressing grading and erosion control are identified. It is assumed all counties implement required CBC standards pertaining to seismic safety and SMARA regulations pertaining to mining and mine reclamation.

Bundle 5: Hamilton Branch (non-FERC)

Geology and Topography

The Hamilton Branch Local Bundle is located in Plumas County on the southern margin of the Modoc Plateau (see Figure 4.16-1). Mountain Meadows Reservoir is situated on alluvial deposits formed on terraces, lake beds and streambed materials of early Pleistocene in age. Along the southeast shore, Cretaceous marine sedimentary deposits are exposed, consisting mostly of sandstones but with minor deposits of limestone, shale, chert, and conglomerate. To the north of

Mountain Meadows Reservoir are Quaternary-aged volcanic flow deposits with minor amounts of pyroclastic material. To the west and south are older metavolcanic rocks of Paleozoic and pre-Cenozoic age. The Hamilton Branch Powerhouse and penstocks are located on these volcanic and metavolcanic strata (PG&E Co., 1999a).

Faulting and Seismicity

Several small, unnamed pre-Quaternary faults have been mapped within several miles south of the project, but none have been documented on Project Lands. There are no Alquist-Priolo earthquake fault zones (CDMG, 1997b). The Quaternary Almanor fault zone is approximately eight miles to west. The Holocene Indian Valley fault lies approximately twelve miles southwest of Project Lands (see Figure 4.16-6).

Approximately 30 miles to the north are several active fault zones, consisting of the Hat Creek and McArthur faults (CDMG, 1994). According to Pacific Gas and Electric Company, the area may experience moderate to strong ground motion from earthquakes on local and regional faults (PG&E Co., 1999a).

Soils and Erosion

The majority of the northern shore of Mountain Meadows Reservoir, Mountain Meadows Dam, all the diversion dams, and the Hamilton Branch Powerhouse are located in the Weste-Eagle Lake-Red River Soil Association. Formed from volcanic rock material, the depth to bedrock is approximately 20 to 40 inches. The erosion hazard ranges from moderate to severe depending upon the slope (NCSS, 2000). The northeast shoreline of Mountain Meadows Reservoir predominantly consists of a low-lying marsh or wetland area consisting of soils in the Mountmed-Keddie-Dotta Soil Association. Most soils of this association have a low to moderate shrink-swell potential. Keddie and Mountmed soils have little or no erosion hazard potential; the erosion hazard for Dotta soils ranges from low to moderate. The entire southern and southeastern shore of Mountain Meadows Reservoir is located on the Penstock-Scaribou-Outland Soil Association. Soils of this association are moderately deep to very deep, well drained and have slow to moderate permeability. The erosion hazard ranges from low to moderate to high depending on the slope (NCSS, 2000).

Other Geologic Hazards

Lassen Peak is located approximately 27 miles northwest of Project Lands. In 1915, an eruption of Lassen Peak caused a debris flow that originated on its northeastern flank to flow into the Lost Creek drainage and spill over into the Hat Creek Valley (Cook and Ellis, 1998). Volcanic hazard mapping published for the Lassen Peak area indicates Bundle 5 is within a zone of pyroclastic flows and ashfall (Miller, 1989).

Mineral Resources

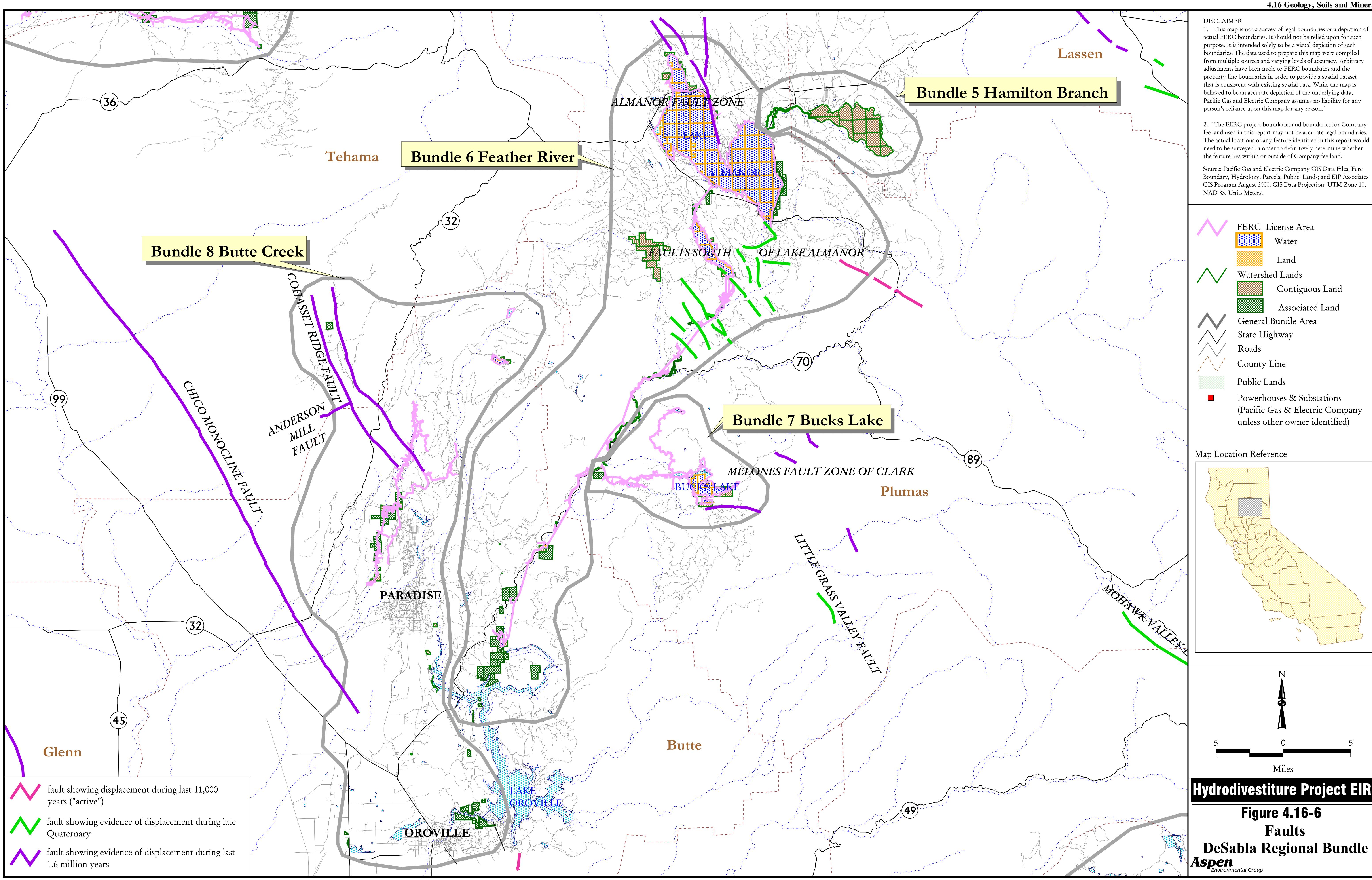
Historically, mining occurred in the project vicinity. However, there are no reported mines or mining activity on Project Lands (CDMG, 1999; PG&E Co., 1999a). Immediately adjacent to the northeast shore of Mountain Meadows Reservoir is a volcanic cinder mine on Round Mountain that produces cinders suitable for use as road base aggregate. The Butler Quarry is approximately seven to eight miles east of Mountain Meadows Reservoir and produces rock and stone (CDMG, 1999). Current operations of the Hamilton Branch Powerhouse do not affect these mines. The area has not been classified as a mineral resource zone by the State Geologist (CDMG, 2000).

Bundle 6: Upper North Fork Feather River -- Upper North Fork Feather River (FERC 2105), Rock Creek-Cresta (FERC 1962), Poe (FERC 2107)

Geology and Topography

Upper North Fork Feather River. All of the facilities of the Upper North Fork Feather River Regional Bundle are located in Plumas County at the margin of the Cascade Range, Modoc Plateau and Sierra Nevada geomorphic provinces, as illustrated in Figure 4.16-1. The North Fork Feather River Canyon, in which the major project facilities are located, is a steep-walled canyon in the northern Sierra Nevada range cut by stream erosion. Project Lands range in elevation from approximately 2,200 to 4,100 feet. Slopes in excess of 30 percent are present on almost all Project Lands along the Feather River downstream of the Caribou Powerhouses to the Poe Powerhouse. The bedrock in this area is generally composed of Cretaceous granitic plutonic and Paleozoic metasedimentary and metavolcanic rocks. The northern, western and southwestern regions surrounding Lake Almanor consist of Tertiary and Quaternary volcanic flows with minor amounts of pyroclastic material. On the northeastern, eastern and southern shores, Paleozoic metasedimentary rocks are exposed, with minor amount of metavolcanics. Alluvial deposits that cover areas of underlying bedrock are found on the northwestern, southern and eastern shorelines of the lake. Butt Valley Reservoir and Powerhouse are underlain by Mesozoic marine metasedimentary and metavolcanic sequences. The Marine metasedimentary deposits extend down into the region of the Belden Forebay and Dam and are also exposed at Caribou 1 and 2 Powerhouses and Oak Flat Powerhouse. Older Paleozoic metasedimentary rocks are found at the Belden Powerhouse. The locations of geologic formations relative to Project Lands is shown in Figure 4.16-2.

Rock Creek-Cresta. The geology of the Rock Creek-Cresta project is similar to that described for the Upper North Fork Feather River project. Cresta and Rock Creek Powerhouses, and Rock Creek Penstock and Tunnel, ranging in elevation from about 1,390 to 1,680 feet, are underlain by Cretaceous granitic plutonic rock of the Bucks Lake and Grizzly Plutons. Exposed granites are massive and moderately to highly jointed where exposed within the canyon. Rock Creek Dam and Reservoir are located where granitic plutionic rock comes in contact with older Paleozoic marine metasedimentary rocks. Cresta Dam and Reservoir are situated at the contact between granitic


Bundle 5 Hamilton Branch
Bundle 6 Feather River
Bundle 7 Bucks Lake
Bundle 8 Butte Creek
ALMANOR FAULT ZONE
FAULTS SOUTH OF LAKE ALMANOR
LAKE ALMANOR
COHASSET RIDGE FAULT
ANDERSON MILL FAULT
CHICO MONOCLINE FAULT
MELONES FAULT ZONE OF CLARK
BUCKS LAKE
LITTLE GRASS VALLEY FAULT
MOHAWK VALLEY
PARADISE
OROVILLE
LAKE OROVILLE
Tehama
Lassen
Plumas
Butte
Glenn
36
32
99
70
89
45
49
fault showing displacement during last 11,000 years ("active")
fault showing evidence of displacement during late Quaternary
fault showing evidence of displacement during last 1.6 million years
DISCLAIMER
1. "This map is not a survey of legal boundaries or a depiction of actual FERC boundaries. It should not be relied upon for such purpose. It is intended solely to be a visual depiction of such boundaries. The data used to prepare this map were compiled from multiple sources and varying levels of accuracy. Arbitrary adjustments have been made to FERC boundaries and the property line boundaries in order to provide a spatial dataset that is consistent with existing spatial data. While the map is believed to be an accurate depiction of the underlying data, Pacific Gas and Electric Company assumes no liability for any person's reliance upon this map for any reason."
2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."
Source: Pacific Gas and Electric Company GIS Data Files; Ferc Boundary, Hydrology, Parcels, Public Lands; and EIP Associates GIS Program August 2000. GIS Data Projection: UTM Zone 10, NAD 83, Units Meters.
FERC License Area
Water
Land
Watershed Lands
Contiguous Land
Associated Land
General Bundle Area
State Highway
Roads
County Line
Public Lands
Powerhouses & Substations
(Pacific Gas & Electric Company unless other owner identified)
Map Location Reference
N
5
0
5
Miles
Hydrodivestiture Project EIR
Figure 4.16-6
Faults
DeSabla Regional Bundle
Aspen
Environmental Group

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plutonic rock and older Paleozoic metavolcanic rocks, which are interbedded with metasedimentary deposits. Unconsolidated gravels and sediments are also present (PG&E Co., 1999a).

Poe. Situated within the North Fork Feather River Canyon at an elevation of approximately 900 feet, the geology of the Poe project is similar to that described for the Upper North Fork Feather River project and Rock Creek-Cresta projects. Bedrock of the Poe Powerhouse area consists of Paleozoic metavolcanic deposits of lava flows, breccia, tuff, pillow lava and greenstone, as well as interbedded metasedimentary of sandstone, shale, limestone, chert, slate, schist, phyllite and quartzite. Outcroppings of serpentine and other ultramafic rocks are scattered within the region. Poe dam is underlain by Cretaceous granitic plutonic rock of the Bucks Lake Pluton (PG&E Co., 1999a).

Faulting and Seismicity

Upper North Fork Feather River. There are various faults and fault systems within proximity of the North Fork Feather River Bundle, and the project facilities may experience moderate to strong ground shaking from earthquakes on local and regional faults (PG&E Co., 1999a). As shown in Figure 4.16-6, the only Holocene fault within the area of project facilities is the Indian Valley fault, which is located approximately six miles southeast of Lake Almanor, and there are no Alquist-Priolo Earthquake Fault zones (CDMG, 1994); CDMG, 1997b). The Quaternary Almanor fault zone runs along the eastern shore of the west lobe of Lake Almanor and traces to the northwest. The Mohawk Valley fault zone and associated faults trend northwest to southeast and extend from Lassen Peak to Lake Tahoe, traversing the western shore of Lake Almanor. Although these faults are pre-Quaternary in age, fault segments within this zone are associated with the alignment of epicenters of known earthquakes, referred to as aligned seismicity. Between Butt Valley Reservoir and the Belden Powerhouse are the Melones fault zone of Clark and Rich Bar fault, both pre-Quaternary in age. To the north of Lake Almanor in the Modoc Plateau region lie the Holocene Rocky Ledge, Hat Creek and McArthur faults (CDMG, 1994; PG&E Co., 1999).

Lake Almanor and Butt Valley Dams were upgraded in 1996 and 1997, respectively, for seismic safety. Both dams have recording systems that record strong ground motion from earthquakes. A dynamic analysis of the Caribou 1 Powerhouse is being conducted, due to cracking that occurred after a 1998 earthquake. The analysis was to have been completed by mid-1999. Preliminary results indicate that building modifications are not warranted (PG&E Co., 1999a).

Rock Creek-Cresta. As mentioned above for the Upper North Fork Feather River project, there are various faults and fault systems within proximity of the North Fork Feather River Regional Bundle, and the project facilities may experience moderate to strong ground shaking from earthquakes on local and regional faults. The faults closest to facilities of the Rock Creek-Cresta project are the Rich Bar fault and Melones fault zone of Clark, which are approximately four miles north of the town of Belden (CDMG, 1994; PG&E Co., 1999a).

Poe. Between the town of Pulga and Poe Reservoir lies a segment of the pre-Quaternary Camel Peak fault. The Big Bend fault is located to the south and crosses the North Fork Feather River Canyon at the town of Big Bend. Similar to the Rock Creek-Cresta and Upper North Fork Feather River projects, facilities of the Poe project may experience moderate to strong ground shaking from earthquakes on local and regional faults (CDMG, 1994; PG&E Co., 1999a).

Other Geologic Hazards

Upper North Fork Feather River. Landslides and slumping may occur in the area, as they have in the past, and impact the water conveyance pipes or other facilities, especially during periods of heavy precipitation. The Caribou project facilities have experienced failure of the Caribou 1 Penstocks in 1984 due to slope failure. The slope that the Caribou 2 Penstock traverses suffered erosion problems during January 1997. Improvements to surface drainage have been made and the moisture content and movement of the slopes are being monitored. Geotechnical sensors at the Caribou Powerhouse monitor the load on anchor bolts installed in the penstock anchor blocks on the lower half of the slope. The slope at the east side of the Belden Siphon has been stabilized with rock bolts. Instrumentation and alarms have been installed at the siphon and the slope is currently being monitored. Also being monitored for movement is the portal area of the west side of the Belden Siphon. The Belden 2 Tunnel has an on-going crack in the tunnel, which is monitored regularly and repaired as needed (PG&E Co., 1999a).

Northernmost parcels in Bundle 6 (north of Lake Almanor) are situated in an area that could be affected by volcanic mudflows, pyroclastic flows, ashfall and smoke. Pyroclastic flows, ashfall, and smoke could affect the Butt Valley Reservoir area (Miller, 1989).

Rock Creek-Cresta. As noted above for the Upper North Fork Feather River project, landslides and slumping may occur in the area, as they have in the past, and impact the water conveyance pipes or other facilities, especially during periods of heavy precipitation (PG&E Co., 1999a). The Plumas County Geologic Hazards Map shows numerous areas of slides, slumps and unconsolidated materials such as talus slopes occurring throughout the North Fork Feather River Canyon. According to the map, slides or talus slopes exist to the north and south of Rock Creek Reservoir but there are no such deposits in the vicinity of the reservoir itself (Plumas County, 1997). However, due to the nature of the bedrock materials and erosion potential, the probability for slides and slumping to occur on Project Lands within the Rock Creek-Cresta project exists (PG&E Co., 1999a). This part of the bundle is outside the mapped hazard zone associated with Lassen Peak volcanic activity (Miller, 1989).

Poe. As noted for the Upper North Fork Feather River and Rock Creek-Cresta projects, landslides and slumping may occur in the area and impact the water conveyance pipes or other facilities, especially during periods of heavy precipitation. Generally, similar geology, topography and erosional characteristics exist in the Poe area as the other two projects of the North Fork Feather River Bundle. The probability for slides and slumping to occur near facilities of the Poe project exists (PG&E Co., 1999a). This part of the bundle is outside the mapped hazard zone associated with Lassen Peak volcanic activity (Miller, 1989).

Soils and Erosion

Upper North Fork Feather River. The northern and eastern shores of Lake Almanor consist of the Weste-EagleLake-RedRiver and Penstock-Scaribou-Outland Soil Associations, previously described above for Bundle 5, Hamilton Branch. The entire southern and southwestern shore of Lake Almanor, Lake Almanor Dam, Butt Valley Powerhouse, Dam, and Reservoir, Caribou Powerhouses 1 and 2, Caribou Afterbay, and Oak Flat Powerhouse are located on the Kinkel-Deadwood-Holland Soil Association. Kinkel and Holland soils are typically deep and well drained and have moderate permeability. Depth to bedrock ranges from 60 to 80 inches. Kinkel soils form from metasedimentary and metavolcanic rock material, while Holland soils form from granitic rock material. The erosion hazard for all soils varies from low to moderate to severe depending upon slope (NCSS, 2000).

In the early 1970s, a report prepared to evaluate the effects of increasing the water surface elevation at Lake Almanor from 4,490 to 4,494 feet noted that fluctuations in lake levels and accompany wave action could contribute to erosion, but that shoreline erosion had also occurred in the past. The report further indicated that the magnitude and patterns of erosion were not expected to be different than those that would ultimately develop under baseline conditions because the topography and soils encountered in the then-proposed lake operating level were the same as those occurring below. Rip-rap was installed at various elevations and locations to reduce potential erosion effects (DWR, 1976). According to Plumas County staff, individual homeowners and homeowners' associations, especially along the eastern shore, have contacted the county with complaints and questions concerning shoreline erosion at the lake. Concerns primarily focus on whether the property affected belongs to individuals or Pacific Gas and Electric Company (Plumas County, 2000). Appendix D indicates that work at Lake Almanor to resolve the issue of shoreline erosion was undertaken in response to a complaint to FERC and subsequent meeting with FERC. However, FERC did not require any follow-up action by Pacific Gas and Electric Company. Although Pacific Gas and Electric Company is working with the Lake Almanor Shoreline Protection Committee, it has not entered into any formal agreements, and county staff is not aware of any additional efforts to further address this issue (Plumas County, 2000).

Rock Creek-Cresta. Rock Creek Dam is located at the margin between the Hollowtree-Kistirn-Deadwood and Chaix-Wapi-Arrastre Soil Associations. Chaix and Arrastre soils are moderately deep to deep, well drained soils that formed from granitic rock material. Wapi soils are shallow, excessively drained soils that formed in eolian sand and volcanic rock material. Wapi soil exposures tend to be short and irregular. All soils are sandy loams, with Chaix soils having a more coarse texture. The erosion hazard is dependent upon slope and varies from none or very low (Wapi) to moderate and high for Arrastre and Chaix soils (NCSS, 2000).

Poe. All project facilities are located within the Aiken-Josephine-Holland Soil Association. Aiken soils consist of loams to clay loams and formed from volcanic rock material. The erosion hazard varies from low to high depending upon slope. Josephine soils are gravelly loams that formed from sedimentary and metasedimentary rock material. With slopes ranging from ten to 70 percent, the erosion hazard varies from slight to high. Holland soils are very deep, well drained soils that formed from granitic rock material. The erosion hazard for these soils varies from slight to high dependent upon slope (USDA, 1967b).

Mineral Resources

Upper North Fork Feather River. Mining has historically occurred in the region of the Upper North Fork Feather River Regional Bundle. The only reported currently active mines within the vicinity of the Upper North Fork Feather River area lie immediately adjacent to and just west of Lake Almanor (CDMG, 1999; Plumas County, 2000). The Feather River Rock quarry lies along the western shore of Lake Almanor south of the Chester Airport and produces sand and gravel. Also producing sand and gravel is the Chester Pit, which is located near the town of Chester just west of Lake Almanor. The Mud Lake Pit is located west-southwest of Lake Almanor on Mud Lake and produces stone and rock material (CDMG, 1999). Current operations of the Upper North Fork Feather River Project do not affect these mines (PG&E Co., 1999a). There are 28 active claims on public lands in the vicinity of Upper North Feather River project facilities and Watershed Lands (BLM, 2000a). None of the Project Lands in Bundle 6 have been classified as a mineral resource zone by the State Geologist (CDMG, 2000).

Rock Creek-Cresta. There are not reported currently active mines on Project Lands in the Rock Creek-Cresta project (CDMG, 1999). Current mining activity in the Rock Creek-Cresta project vicinity includes Tobin Quarry, which produces stone and rock (CDMG, 1999). Tobin Quarry is situated in the North Fork Feather River Canyon near the town of Tobin. The Soper Pit (not on Project Lands) is located in the area east of Rock Creek Reservoir and produces sand and gravel. Current operations of the project do not affect these mines (PG&E Co., 1999a).

Poe. There are no reported currently active mines or mining activity in the vicinity of the Poe project (CDMG, 1999).

Bundle 7: Bucks Creek (FERC 0619)

Geology and Topography

The Bucks Creek Regional Bundle is located in Plumas County at an elevation of approximately 1,770 feet on the western slopes of the Sierra Nevada in the North Fork Feather River Basin. The vast majority of Project Lands are underlain by granitic plutons of Mesozoic age. Bucks Lake, Three Lakes, Lower Bucks Lake and Grizzly Forebay all lie within the Bucks Lake Pluton. The Grizzly Pluton lies to the west of Bucks Lake Pluton and underlies the Bucks Lake Powerhouse. The penstock traverses both of these plutons. A small portion of the southern extension of Bucks

Lake is situated on Paleozoic metasedimentary and to a lesser extent metavolcanic rocks (PG&E Co., 1999a). Although steep slopes (greater than 30 percent) are present on FERC license areas, such slopes are not present around Bucks Lake.

Faulting and Seismicity

The only Holocene fault in the vicinity of Project Lands is the Indian Valley fault, which lies approximately 20 miles to the northeast. All the other faults in the region are Quaternary faults, and there are no Alquist-Priolo Earthquake fault zones (CDMG, 1994; CDMG, 1997b). The Mohawk Valley and related faults that are associated with aligned seismicity as previously described are located along the western flank of Lake Almanor and have been discussed in the Upper North Fork Feather River project description. Near the town of Belden lie the Rich Bar fault and Melones faults, which are several miles east of Three Lakes and approximately eight miles east of Bucks Lake. The Dogwood Peak fault also lies several miles east of Bucks Lake. The region is considered to be moderately seismically active (PG&E Co., 1999a).

Soils and Erosion

Most Project Lands lie within the Chaix-Wapi-Arrastre Soil Association (described above for the Rock Creek-Cresta region), except for Bucks Lake and Dam, Lower Bucks Lake and Dam, and Three Lakes and Dam areas, which are located within the Toem-Cagwin-Toiyabe Soil Association. All soils of this association formed from granitic rock material. Toiyabe and Toem soils are shallow, while Cagwin soils are moderately deep; all are excessively well drained. All soils are classified as gravelly sandy loams, while Toiyabe soils tend to be stony. Erosion hazard for these soils ranges from moderate to high, depending upon slope (NCSS, 2000).

Other Geologic Hazards

Landslides and slumping may occur in the area, as they have in the past, due to certain materials on slopes which are prone to mass movement, especially during periods of heavy precipitation. The conduit that conveys water from Three Lakes to Lower Bucks Reservoir, known as Milk Ranch Conduit, failed during a January 1997 storm, which was caused by a landslide that originated approximately one-half mile uphill of the conduit. The conduit was repaired following the slide. In December 1998, another slide occurred that appears to be related to the earlier January 1997 slide. The conduit is currently out of service. Repairs on the conduit are planned and the slope continues to be monitored (PG&E Co., 1999a). Bundle 7 is outside the mapped hazard zone associated with Lassen Peak volcanic activity (Miller, 1989).

Mineral Resources

Mining has historically occurred and continues to occur in the region of the Bucks Creek project. Currently, there are two active mines within the vicinity of the project but not within Project Lands. The Soper Pit and Spanish Creek Aggregates both produce sand and gravel. Operations of the project facilities do not affect these mines (CDMG, 1999; PG&E Co., 1999). There are no published MRZ-2 classified and mapped areas in Bundle 7 (CDMG, 2000).

Bundle 8: Butte Creek -- DeSabla-Centerville (FERC 0803), Lime Saddle (non-FERC), Coal Canyon (non-FERC)

Geology and Topography

DeSabla-Centerville. All project facilities are located in Butte County except for Round Valley Reservoir, which is in Plumas County. Their elevation ranges from approximately 470 to 2,000 feet. The area surrounding Round Valley Reservoir consists of Paleozoic sedimentary and metasedimentary rock units of sandstone, shale, limestone, conglomerate, slate, honrnfels and quartzite, with minor amounts of volcanic pyroclastic material. Serpentine with minor amounts of other ultramafic rocks are exposed along its north and northwestern shores. Philbrook Reservoir is underlain by Tertiary basalt flows that overlie pre-Cenozoic metavolcanic rocks. The DeSabla Powerhouse and Forebay area are underlain by volcanic rocks of the Pliocene Tuscan Formation, and by Pre-Cretaceous metavolcanic and metasedimentary rocks. The Centerville Powerhouse area is underlain by sandstone, shale and conglomerate of the late Cretaceous Chico Formation. The Toadtown Powerhouse is situated on approximately ten feet of alluvium consisting of silt, clay and sand. Beneath the alluvium are associated sequences of the Tuscan Formation (PG&E co., 1999a). The locations of geologic formations relative to Project Lands are shown in Figure 4.16-2.

Lime Saddle and Coal Canyon. Pre-Cenozoic metavolcanic rocks underlie the Lime Saddle Powerhouse. Younger Pliocene-aged volcanic agglomerates of the Tuscan Formation underlie the penstock, as well as the Upper Miocene Canal. The Coal Canyon Powerhouse is underlain by alluvium consisting of unsorted gravel, sand, silt and clay. Volcanic strata of the Tuscan Formation underlie the penstocks (PG&E Co., 1999a).

Faulting and Seismicity

DeSabla-Centerville. The Project Lands are located in an area of moderate seismicity. Adjacent to the north shore of Round Valley Reservoir is the Holocene Indian Valley fault (see Figure 4.16-6). The Mohawk Valley and related faults that are associated with aligned seismicity as previously described lie to the west of Round Valley Reservoir and have been discussed in the Upper North Fork Feather River project description. The Quaternary Cohasset Ridge fault lies within several miles of Toadtown Powerhouse, and approximately ten miles west and southwest of Philbrook Reservoir and DeSabla Forebay and Powerhouse, respectively. Several miles west of the Centerville Powerhouse is the Chico Monocline fault, which lies at the boundary between the Great Valley and northern Sierra Nevada. Classified a Quaternary fault, displacement that has occurred has been buried by younger rocks. Project facilities could potentially be subjected to ground motion from earthquakes on local and regional faults (PG&E Co., 1999a).

Lime Saddle and Coal Canyon. As shown in Figure 4.16-6, Lime Saddle and Coal Canyon Powerhouses are located approximately 14 and nine miles, respectively, from the Cleveland Hill fault, which experienced an earthquake and surface rupture in 1975. The Cleveland Hills fault has also been associated with aligned seismicity of known epicenters of earthquakes. The facilities are also in close proximity to the Chico Monocline fault system to the northwest (CDMG, 1994). According project facilities may experience minor to moderate groundshaking from earthquakes on the above-mentioned faults (PG&E Co., 1999a).

Other Geologic Hazards

DeSabla-Centerville. Landslides and slumping may occur in the area, as they have in the past, due to certain materials on slopes, which are prone to mass movement, especially during periods of heavy precipitation. Landslides have occurred near many of the DeSabla-Centerville project facilities as well as adjacent to the DeSabla Penstocks, and have severed or plugged canals and flumes. Previous landslides and potential slide areas within the area have been repaired and are being monitored (PG&E Co., 1999a). Bundle 8 is outside the mapped hazard zone associated with Lassen Peak volcanic activity (Miller, 1989).

Lime Saddle and Coal Canyon. The Coal Canyon project area has been subject to the same types of mass soil movements as mentioned above for the DeSabla-Centerville project. Small landslide movements have affected the Coal Canyon Penstock, which crosses an old landslide that has been reactivated, and is being monitored. It is likely that continued slope movements will continue to occur, especially during periods of heavy precipitation (PG&E Co., 1999a).

Soils and Erosion

DeSabla-Centerville. Project Lands in the vicinity of Centerville and DeSabla Powerhouses are situated on the Toomes-Supan-Guenoc Soil Association. Depth to bedrock ranges from 15 to 48 inches, with Supan soils being deeper and forming on more gently sloping areas. The erosion hazard for these soils is low to moderate. Toadtown Powerhouse lies on the Neuns-Cohasset-Aiken Soil Association. Soils of this association formed from extrusive igneous rock material. Most soils of this association are deep and well-drained loams but Cohasset soils can contain up to 20 percent of stones and coarse fragments in their composition. The erosion hazard for this soil association varies from moderate to high depending upon slope (USDA, 1974b). Round Valley Reservoir and Dam, and Philbrook Reservoir and Dam are located in the Sheld-Yallani-Inville Soil Association. All soils are classified as sandy loams with Sheld soils tending to be stony. The erosion hazard for these soils varies from low to moderate depending upon slope (NCSS, 2000).

Lime Saddle and Coal Canyon. Project Lands in vicinity of the Lime Saddle Powerhouse and Kunkel Reservoir are located on the Toomes-Supan-Guenoc Soil Association, which is described above for the DeSabla-Centerville area. Coal Canyon Powerhouse is situated on the Redding-Corning-Pentz Soil Association. The Redding and Corning series consists of gravelly loams that are moderately deep to hardpan, well or moderately well drained soils that formed in alluvium and other mixed rock sources. They are on nearly level or dissected and undulating to hilly high terraces with slopes ranging from zero to 30 percent. Both of these soils have slow permeability. The Pentz series consists of shallow, well-drained loamy soils that formed from volcanic rock material. Permeability is relatively rapid (NCSS, 2000).

Mineral Resources

DeSabla-Centerville. Historically there has been mining activity in the region, particularly in the vicinity of Round Valley and Philbrook Reservoirs. However, there are currently no reported active mines or mining activity in the Project Lands. Mineral lands classification mapping has not been prepared for the Bundle 8 area (PG&E Co., 1999a; CDMG, 1999; CDMG, 2000).

Lime Saddle and Coal Canyon. Mining activity has historically occurred in the region. There are currently, however, no reported active mines or mining activity in the vicinity of the Lime Saddle Powerhouse (PG&E Co., 1999a; CDMG, 1999; CDMG, 2000).

4.16.4.3 Drum Regional Bundle

Regional Setting

As shown in Figure 4.16-1, the Drum Regional Bundle (Bundles 9, 11, and 12) is located principally in the northern and central Sierra Nevada foothills and mountainous area of the western Sierra Nevada. The Potter Valley project (Bundle 10) is geographically isolated from other projects in the Drum Regional Bundle, situated in the Coast Ranges to the west of the Central Valley (see Figure 4.16-1). Chapter 2, Project Description, contains descriptions of the locations and assets in the Drum Regional Bundle.

Local Regulations and Policies

Facilities in the Drum Regional Bundle are located in Nevada, Placer, El Dorado, Yuba, Lake, and Mendocino counties. Relevant portions of planning documents and local standards that apply to discretionary projects in those jurisdictions with respect to geotechnical considerations and mineral resources issues are summarized in this section. Local ordinances addressing grading and erosion control are identified. It is assumed all counties implement required CBC standards pertaining to seismic safety and SMARA regulations pertaining to mining and mine reclamation.

Nevada County Grading and Erosion Control

Nevada County implements the CBC. Appendix Chapter A33 (Site Work, Demolition and Construction) of the UBC/CBC and portions of the county's Land Use and Development Code to regulate grading and erosion control activities in the county. Ordinance Number 1919, adopted in 1996, modifies portions of Chapter 33 of the UBC to make the Code conform to local ordinances and applicable to conditions in the county. The provisions of Section 303, Uniform Administrative Code, are applicable to grading permits. Minor grading is exempt from the requirement for a grading permit, but grading in excess of 5,000 cubic yards requires an engineered grading permit. Erosion control, sediment control; and landscape plans are to be included in the permit application along with a soil/geologic investigation report. An erosion and sediment control plan is required if the graded portion of a site included more than 10,000 square feet of area having a slope greater than ten percent; more than 2,500 square feet will be inadequately protected from erosion during the rainy season.

Placer County Grading and Erosion Control

The Placer County Public Works and Building Department maintains policies and guidelines regarding grading, erosion control, inspection and permitting as they relate to geotechnical considerations. Consistent with the CBC/UBC, a geotechnical engineering report prepared by a California-registered civil engineer or geotechnical engineer is required. The report must identify site-specific geologic and soils conditions and recommendations for seismic conditions, foundations, grading practices, erosion/winterization, slope stability, and any special problems discovered on-site. In addition, all proposed grading must be shown on Improvement Plans, and all work is required to comply with the provisions of Chapter 29 of the Placer County Code, the Grading Ordinance. As described in the Ordinances, the maximum for cut/fill slopes is 50 percent. Erosion control plans must also be prepared in accordance with the Erosion and Sediment Control Guidelines for Developing Areas of the Sierras prepared by the High Sierra Resource Conservation District Council.

El Dorado County Grading and Erosion Control

Grading, erosion and sediment control requirements for development are specified in Chapter 15.14 of the El Dorado County Code. Specific performance standards and permitting requirements designed to minimize environmental damage to earth and water resources as a result of excavation grading, and fill placement and compaction are contained in the Grading, Erosion and Sediment Control Ordinance No. 4071. The El Dorado County Design and Improvement Standards Manual contains amendments to include Hillside Lane Use and Hillside Road Standards, which contain specific provisions regarding grading plans and hillside road construction.

Yuba County Grading and Erosion Control

Yuba County has adopted Appendix Chapter A33, Excavation and Grading, of the UBC to regulate grading and erosion control activities in the county (see Section 4.16.2.2, subsection on Erosion Control).

Lake County Grading and Erosion Control

Lake County has adopted Appendix Chapter A33, Excavation and Grading, of the Uniform Building Code to regulate grading and erosion control activities in the county. A description of Appendix Chapter A33 is summarized in Yuba County, above (see Section 4.16.2.2, subsection on Erosion Control).

Mendocino County Grading and Erosion Control

Mendocino County has adopted Appendix Chapter 33, Excavation and Grading, of the UBC to regulate grading and erosion control activities in the County. Appendix Chapter A33 requirements are summarized under the Yuba County discussion, above (See Section 4.16.2.2 subsection on Erosion Control).

Bundle 9: North Yuba River -- Narrows (FERC 1403)

Geology and Topography

The Narrows project is located on the southeast bank of the Yuba River downstream of the convergence of the South and North Yuba Rivers in the central foothills of the Sierra Nevada at an elevation of approximately 330 to 530 feet. The site is underlain by metavolcanic rock, which is exposed near the surface in many areas (PG&E Co., 1999a).

Faulting and Seismicity

The Narrows project is located within the northeastern portion of the Foothills fault system. Faults active in the late Quaternary in the vicinity of the project include the Spenceville, Swain Ravine, and Cleveland Hills faults, which are located approximately five to ten miles southwest and northwest, respectively, of the project facilities (see Figure 4.16-7). There are no active faults or Alquist-Priolo zones within Bundle 9 lands (CDMG, 1994; CDMG, 1997b). According to data compiled by Pacific Gas and Electric Company, earthquakes on these faults may produce moderate groundshaking at the powerhouse (PG&E Co., 1999a).

Soils and Erosion

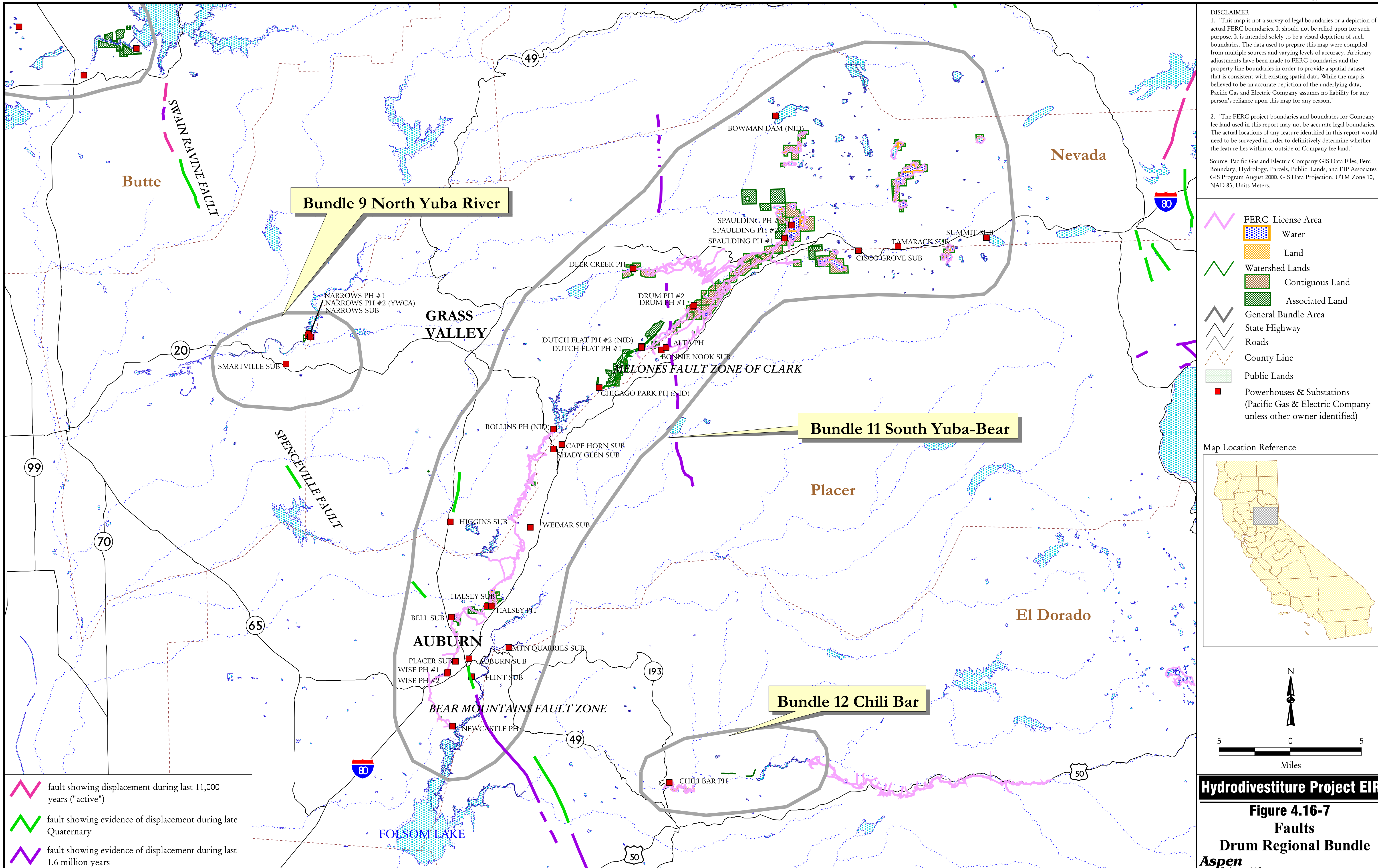
Surface soils at the Narrows project are relatively thin. Soils exhibit low shrink-swell potential and are not prone to erosion (PG&E Co., 1999a). There are no slopes in excess of 30 percent.

Other Geologic Hazards

The project site is not situated in an area prone to landslides, volcanic activity, or avalanche. No known significant hazards resulting in adverse geologic conditions have been identified by Pacific Gas and Electric Company (PG&E Co., 2000i).

Mineral Resources

Englebright Reservoir was created in 1941 by the U.S. Army Corps of Engineers for the purpose of controlling hydraulic mining debris. Since the dam was completed, there has been practically no hydraulic mining activity. Consequently, the reservoir is currently used for recreation and power production. (PG&E Co., 1999a).



Hydrodivestiture Project EIR

Figure 4.16-7
Faults
Drum Regional Bundle

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There is an area classified MRZ-2 for aggregate resources approximately 3,000 feet south of the project and extending to the west. However, there are no MRZ-2 areas or active mines reported within Project Lands, and there are no claims on public lands in the vicinity of project facilities (CDMG, 1988; CDMG, 1999, BLM, 2000b).

Bundle 10: Potter Valley (FERC 77)

Geology and Topography

The Potter Valley project is located within the Northern Mendocino Range in the North Coast Range in the Eel River Basin, which is generally characterized by northwest-trending irregular mountains, ridges, steep slopes, and narrow valleys. Alluvial deposits consisting of clay, silt, sand, and gravel are found in the valleys. The reservoir formed by Scott Dam, known as Lake Pillsbury, is situated in mountainous and moderately forested terrain, extending up to elevations in excess of 7,000 feet. Slopes in excess of 30 percent are scattered throughout the western part of the Lake Pillsbury land area and eastern part of the Van Arsdale Reservoir/Potter Valley area in heavily forested terrain. Scott Dam and Cape Horn Dam are underlain by rocks of the Jurassic to Cretaceous Franciscan Formation (PG&E Co., 1999a).

Faulting and Seismicity

Scott Dam impounds Lake Pillsbury and is located approximately 48 miles east of the San Andreas fault, about 18 miles east of the Maacama fault, and less than 1 mile west of the Bartlett Springs shear zone. A southern segment of the Bartlett Springs fault showing activity within the last 10,000 years (and considered “active”) extends under a contiguous land parcel northeast of Lake Pillsbury, as shown in Figure 4.16-8 (CDMG, 1997b).

An Alquist-Priolo Earthquake Fault Zone has been delineated for the active portion of the Bartlett Springs fault at the north end of Lake Pillsbury (see Figure 4.16-8). Portions of the Bartlett Springs fault active in the early Quaternary are present under the western part of the lake and to the south (see Figure 4.16-8). The maximum credible earthquake has an estimated magnitude of M6.5 on the Bartlett Springs fault. (GEI, 1999b). A seismic monitoring system located at Scott Dam records strong ground motion earthquakes, and geotechnical sensors measure water levels and pressures on the dam. Survey markers and inclinometers provide additional geotechnical data. As reported in the 1999 Seventh Quinquennial Safety Inspection Report, three earthquakes greater than M4.0 occurred within the five-year period of monitoring since the 1994 report, but no events have triggered the seismic system during the last six years. The closest earthquake was approximately 29 miles west-northwest in 1995 (GEI, 1999b).

Scott Dam has a history concerning leakage, erosion, and general foundation instability. Discovery of seismic activity along the Bartlett Springs fault system in the 1980s heightened concerns about dam safety. However, the dam was determined to be stable under seismic loading from an earthquake on this fault. During a 1994 inspection, FERC’s Independent Consultants recommended that Pacific Gas and Electric Company conduct work on the foundation drainage system. Pacific Gas and Electric Company completed this work prior to the 1998-99 rainy season (PG&E Co., 1999a). In the 1999 safety evaluation, field inspection indicated the dam, spillway, and associated facilities are in satisfactory condition and well-maintained. No conditions were observed that require emergency corrective action. There was no evidence of foundation instability beneath the dam, settlement of the dam, or movement of the dam or other structures. Results of seismic stability analysis prepared in 1999 indicated that little or no displacement of the dam would result from the design earthquake. Previous concerns expressed by the DSOD in August 1997 regarding the adequate performance of Scott Dam during the MCE have been resolved, and FERC has also accepted the stability analysis (GEI, 1999b). FERC and State inspections continue to be performed on a regular basis (PG&E Co., 1999a).

Van Arsdale Reservoir is impounded by Cape Horn Dam, which has passed safety inspections and has had no recent need for any corrective actions. No evidence of seismic instability or risk was identified in the most recent safety review prepared in accordance with FERC requirements (PG&E Co., 1999a).

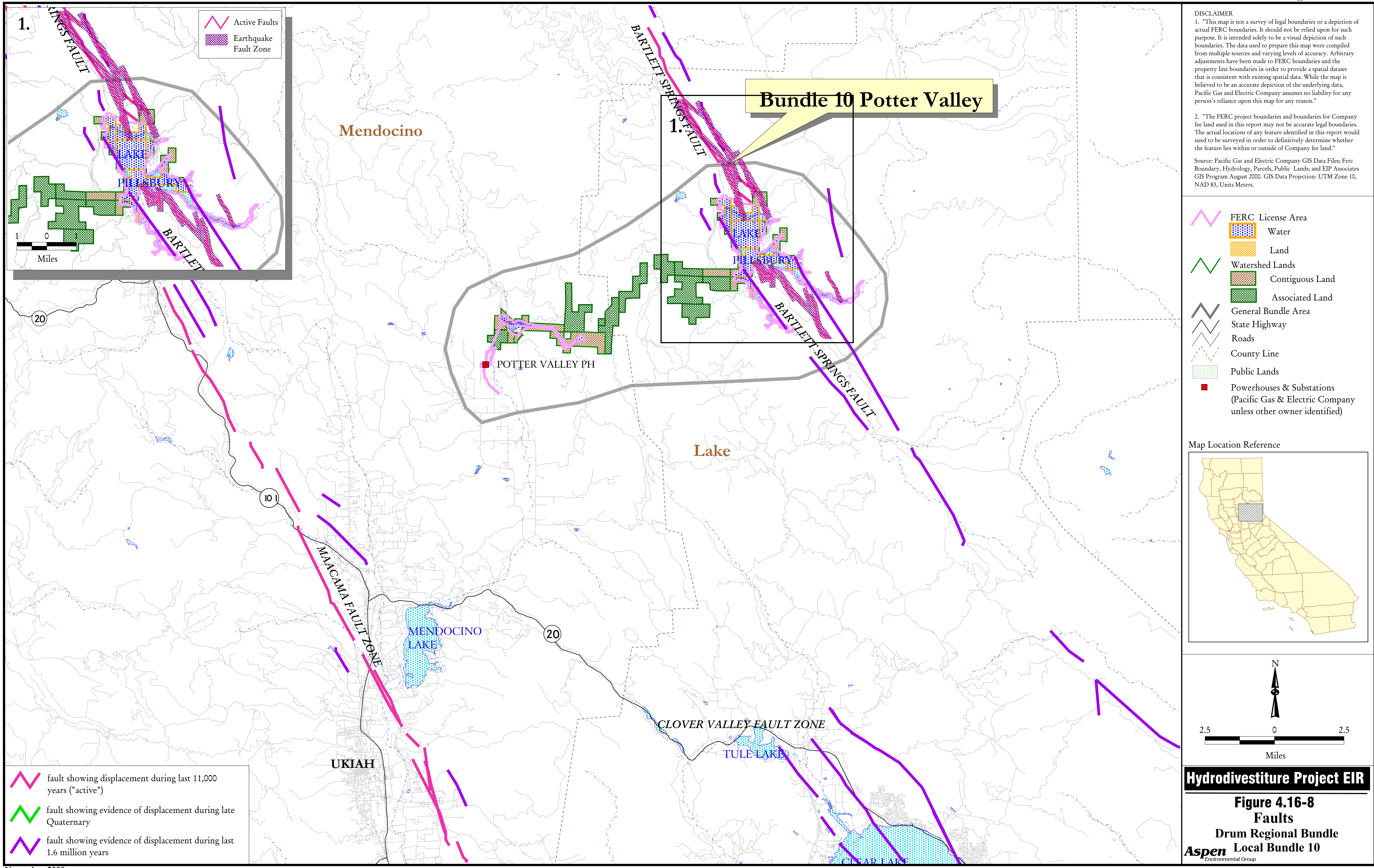
Soils and Erosion

According to a recently published soil survey, soils in the low hills and valleys of the project area are brown gravelly loams of the Pinole gravelly loam, which typically develops on two to eight percent slopes. These soils are described as very deep, and have a slight to moderate erosion hazard. They are classified as silty to clayey gravel with fines that make up 35 to 50 percent of the gravel by weight (PG&E Co., 1999). Soils exhibiting high shrink-swell potential are present only in the vicinity of the powerhouse, and remaining areas are range from low to moderate.

Van Arsdale Reservoir acts as a sediment trap for material eroded from the surrounding watershed and has silted-in considerably since it was constructed. The reservoir's volume has decreased, and the gate valve at the bottom outlet is inoperative as a result of the accumulation of sediment. Lake Pillsbury also accumulates sediment, and finer sediments continue to erode from surrounding hills into the reservoir. (PG&E Co., 1999).

Other Geologic Hazards

Landslides and debris flows may occur in the project area, as they have in the past, and have the potential to affect the water conveyance pipes or other facilities. In mid-February 1999, a landslide occurred at the downstream wood stave section of the Potter Valley penstock, which slightly undermined the outer edge of the footings. The landslide was about 50 feet wide and continued downslope for several hundred feet where it merged and coalesced with other apparent slides terminating at the bottom of a ravine. The slide width adjacent to the penstock was about 20 feet wide. There were several inches of settlement of both the roof structure and penstock in the area of the slide, but the penstock pipe was not damaged by the movement. The ends of three footings


1.
Active Faults
Earthquake Fault Zone
LAKE
PILLSBURY
BARTLETT
SPRINGS FAULT
Miles
Bundle 10 Potter Valley
Mendocino
Lake
POTTER VALLEY PH
BARTLETT SPRINGS FAULT
MAACAMA FAULT ZONE
MENDOCINO LAKE
CLOVER VALLEY FAULT ZONE
TULE LAKE
CLEAR LAKE
UKIAH
20
101
fault showing displacement during last 11,000 years ("active")
fault showing evidence of displacement during late Quaternary
fault showing evidence of displacement during last 1.6 million years
DISCLAIMER
1. "This map is not a survey of legal boundaries or a depiction of actual FERC boundaries. It should not be relied upon for such purpose. It is intended solely to be a visual depiction of such boundaries. The data used to prepare this map were compiled from multiple sources and varying levels of accuracy. Arbitrary adjustments have been made to FERC boundaries and the property line boundaries in order to provide a spatial dataset that is consistent with existing spatial data. While the map is believed to be an accurate depiction of the underlying data, Pacific Gas and Electric Company assumes no liability for any person's reliance upon this map for any reason."
2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."
Source: Pacific Gas and Electric Company GIS Data Files; Ferc Boundary, Hydrology, Parcels, Public Lands; and EIP Associates GIS Program August 2000. GIS Data Projection: UTM Zone 10, NAD 83, Units Meters.
FERC License Area
Water
Land
Watershed Lands
Contiguous Land
Associated Land
General Bundle Area
State Highway
Roads
County Line
Public Lands
Powerhouses & Substations (Pacific Gas & Electric Company unless other owner identified)
Map Location Reference
N
2.5
0
2.5
Miles
Hydrodivestiture Project EIR
Figure 4.16-8
Faults
Drum Regional Bundle
Local Bundle 10
Aspen
Environmental Group

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nearest the slide scarp were undermined or had soft soil beneath them; however, there was no new cracking of the footings. The slide was reported to FERC (PG&E Co., 1999).

Geotechnical evaluations performed in conjunction with repairs (which were initiated immediately) concluded that the ground movement was caused by a relatively shallow pre-existing landslide. When the penstock was constructed, the swale formed by that slide was backfilled with tunnel muck to form a nearly level bench. The slide may have been moving slightly over the years, but not enough to be noticed or to cause distress to the penstock. The recent movements were probably the result of several years of heavier-than-normal winter precipitation. Repairs resulted in the construction of sheet piles and a deep rock fill buttress, which fully penetrate the slide and extend well past the lateral extent of mobilized ground. The penstock was returned to service about two weeks later (Pacific Gas and Electric Company, 1999). Pacific Gas and Electric Company continues to monitor the leakage from the penstock and surface drainage, which will prevent excessive penstock water from entering the slope and causing further movement, and has contracted with a wood stave pipe manufacturer to recommend improvements, if warranted. The site was inspected again in early 2000, and no additional ground movement has been detected (PG&E Co., 2000k).

Movement data for the slide area upstream of the left abutment at Scott Dam indicate the slide continues to move towards the reservoir. Relatively large movements during the period 1994-99 have been attributed to construction activities related to the road of top of the hill above the slide area. However, no direct impact on the dam has been identified (GEI, 1999b).

Mildly explosive volcanic vents active in the last 100,000 to 10,000 years have been identified in the Clear Lake area in Lake County, and a hazard zone has been delineated. However, the hazard zone is approximately 25 miles southeast of Potter Valley (Miller, 1989); therefore, volcanic hazards at the Potter Valley project are not anticipated. Project facilities and lands are situated at relatively low elevations in the Coast Ranges, so there is no avalanche hazard.

Mineral Resources

There are no lands classified as MRZ-2 within or adjacent to project features because mineral lands classification mapping has not been published for Mendocino and Lake counties (CDMG, 2000). Although there are volcanic areas in the region, there are no geothermal springs or thermal wells on Project Lands (CDMG, 1980). There is no reported active mining activity or claims on public lands in the vicinity of the Potter Valley project. (PG&E Co., 1999a; CDMG, 1999; 2000)

Bundle 11: South Yuba River -- Drum-Spaulding (FERC 2310)

Geology and Topography

As illustrated in Figure 4.16-1, the Drum-Spaulding project is in the central part of the Sierra Nevada. Project Lands are situated in a region underlain by Paleozoic and Mesozoic intrusive, granitic rocks and metamorphosed sedimentary and volcanic rocks. Much of the northeastern Project Lands consists of metamorphosed marine sedimentary rocks that transition into metamorphosed pyroclastic volcanic deposits. Bedrock in the southwestern part of the Project Lands consists of metamorphosed marine sedimentary and metavolcanic rock, along with smaller granitic plutons. Most ridges are capped with volcanic agglomerates and sedimentary rocks. Ultramafic rocks, including serpentinite (rock containing asbestos and related minerals) in places, are present in a narrow northwest-trending band along the western foothills of the Sierra Nevada (PG&E Co., 1999a; 2000a).

The hydraulically linked facilities are within the Yuba River, Bear River, Deer Creek, and American River basins. Elevations in Drum-Spaulding range from approximately 300 feet in the west to nearly 8,000 feet at White Rock Lake in the east. Upper portions of the bundle, east of the Rollins Reservoir area, are characterized by mountainous terrain, steep slopes, deeply incised canyons (at the Spaulding Powerhouse, for example), and intermontane lakes and meadows. Central and lower (western) areas of the Drum-Spaulding project are situated in the lower mountains and foothills. Slopes in excess of 30 percent are present in a few locations in the Rock Lake/Lindsay Lakes land area, near the Drum powerhouses, and in Dutch Flat land areas.

Faulting and Seismicity

As shown in Figure 4.16-7, the closest active fault to Drum-Spaulding facilities and lands are unnamed faults in the Truckee area, located approximately 18 miles east of Fordyce Lake (CDMG, 1994). No Alquist-Priolo earthquake fault zones have been delineated for the area comprising the Drum-Spaulding project (CDMG, 1997b). The Foothills fault system traverses Project Lands in the vicinity of the Weimar, Higgins, Halsey, Auburn, Wise, Flint, and Newcastle facilities (see Figure 4.16-7). Data compiled by Pacific Gas and Electric Company indicates the Drum fault crosses the project near the Drum Powerhouse, and the Giant Gap fault ("Melones fault zone of Clark") crosses beneath the Alta penstock (PG&E Co., 1999a). Numerous other potentially active and inactive faults cross Project Lands, as shown in Figure 4.16-7. The probability of strong groundshaking that could affect Project Lands is low, as indicated in Figure 4.16-3. The liquefaction potential at Project Lands is low due to the presence of bedrock, minimal occurrence of floodplain or lake-bed deposits comprised of alluvial sand and silt, and depth to groundwater relative to Project Lands.

Lake Valley Dam was upgraded for seismic purposes in the mid-1970s. Rock Creek Dam was modified to withstand a cross channel earthquake in 1998. Pacific Gas and Electric Company completed a stability analysis for Blue Lake Dam in 1998. As a result of a 1998 inspection, FERC's independent consultants recommended that Pacific Gas and Electric Company pursue remedial actions at Blue Lake Dam (PG&E Co., 1999a). Pacific Gas and Electric Company is currently evaluating several other dam alternatives, including a substantially larger volume earthfill embankment or a concrete gravity dam (PG&E Co., 1999). The State has requested that Pacific Gas and Electric Company develop plans to strengthen Halsey Forebay Dam; upgrades to improve the dam's long-term stability were planned for 1999 (PG&E Co., 1999a). In response to a recommendation in the 1998 safety inspection report, additional analysis of seismic deformation was prepared for Drum Forebay Dam in 1999. Results of the assessment indicated that the dam has adequate stability and that no modification would be required for earthquake loading. (GEI, 1999a; FERC, 2000)

Soils and Erosion

Soils in the Lake Spaulding, Drum, Dutch Flat, and Rollins Reservoir land areas generally consist of Mariposa-Josephine-Sites and Dukabella Rock Outcrop units. The Mariposa-Josephine soils are well drained and shallow to deep over metamorphic rock. The Dukabella soils are well drained and moderately deep stony soil over serpentine. The Mariposa-Josephine and Dukabella soils are moderately to highly erodible. The Auburn-Sobrante soils, which are found on the lower foothills (Halsey and Rock Creek land areas) are well drained and shallow to deep over metamorphic rock and have slight to high erosion hazard, depending on slope and elevation. Steepness of slope and shallow depth to rock are major limitations to building and roadway development and septic tank use in all three units (USDA, 1980; 1993b). Soil units in timber harvest plan areas include Josephine, McCarthy, Cohasset, Crozier, Hurlburt Deadwood, Ledmount, Putt, and Zeibright, which have characteristics similar to those described for the general soil units. Areas of high erosion potential are found southwest of Lake Spaulding and the lower reaches of the Bear River in the Dutch Flat-Bear River land areas. Soils in the Drum-Spaulding project have low to moderate expansion potential, with the exception of a small area located in the Kidd Lakes/Cascade Lakes land area (USDA, 1980; 1993b).

Other Geologic Hazards

Many of the hydroelectric facilities in the Drum-Spaulding project are situated in steep terrain. Debris flows and landslides have affected several Drum-Spaulding project facilities, particularly the flumes and canals. Documented incidents are summarized below.

The Upper Boardman Canal, which provided water to the Alta powerhouse and to water users, was removed from service in 1986 following numerous repairs necessitated by landslides, washouts, and leakage (PG&E Co., 1999a).

In 1992, a slope above Chalk Bluff Canal slid. This caused damage to the canal and hillside, and water from the canal and the slide itself entered Deer Creek. The canal section was rebuilt, and the hillside was re-engineered with fill, a drainage system, and was seeded and strawed (PG&E Co., 2000i).

Approximately 300 feet of the Halsey Penstock backfill eroded away in 1995. The cause was attributed to an uncontrolled release from a water agency treatment plant that had saturated the penstock bedding, eroding the fill and floating sections of the penstock. Also in 1995, approximately 50 feet of the Bear River Canal berm slid down the ravine, flowing through Bear River Campground and into the Bear River (PG&E Co., 2000i)

The Drum Powerhouse, Drum Afterbay and Dutch Flat 1 Powerhouse were affected by severe storms in January 1997. Saturation of an active slide and use of the Pittman Spill channel resulted in a debris flow, which dammed the Bear River, causing sediment to flow into the Drum Powerhouse and Afterbay. The sediment in the Drum Afterbay prohibited operation of the Dutch Flat 1 Powerhouse. Pacific Gas and Electric Company installed upstream erosion control, removed some sediments from the afterbay, restarted operations at Dutch Flat 1 Powerhouse, and removed flood debris and restored all four Drum Powerhouse units to service between 1997 and February 1999. Wise Tunnel 9 and South Tunnel had sinkholes that were subsequently repaired (PG&E Co., 1999a; 2000i).

Facilities and lands in the Drum-Spaulding project are not susceptible to volcanic hazard, as the locations are not within flow or ashfall hazard zones delineated by the USGS for the either the Mount Shasta, Medicine Lake Highland, and Lassen Peak Area to the northwest, or the Mono Lake-Long Valley Area to the southeast (Miller, 1989).

Project facilities or watershed lands in the upper elevations may be subject to heavy snowfall or avalanche hazard. In 1990, heavy snowfall resulted in severe damage to the Towle, South Yuba, Drum, South and Wise Canals, causing mudslides into the Bear River. In 1991, during a heavy snowfall, a large rock and tree slid into a wood box flume on the Towle Canal, causing water to flow downhill onto Interstate 80 (PG&E Co., 2000i). Most of the Drum-Spaulding project facilities and Project Lands are located in Nevada County, which has identified avalanche hazard areas that include Donner Lake, Tahoe-Donner, and Soda Springs areas. The mapping included only currently populated or subdivided areas or locations where domestic or commercial uses are planned. Backcountry or roadless areas were not evaluated. The Nevada County mapping did not identify any areas of avalanche hazard in the vicinity of White Rock Lake, Fordyce Lake, Meadow Lake, or Lake Sterling. Placer County has also identified avalanche hazard areas, but they are a few miles east of Kelly Lake, Lake Valley Reservoir, Peak Lakes, and Kidd Lake (Nevada County, 1995; Placer County, 1992). These upper lake Watershed Land areas are generally inaccessible during periods of highest avalanche potential.

Mineral Resources

Mining activity in western Placer and Nevada Counties, which contain Project Lands, dates back to the mid-1800s, when gold was discovered in the rivers and creeks in the area. Between 1850 and World War II, significant amounts of gold, silver, copper, lead, zinc, and chromite were mined, along with lesser amounts of quartz, limestone, asbestos, and clay (CDMG, 1995). Numerous other active and inactive mines, claims, prospects, and other indications of mineral exploration are present within and in the vicinity of the Drum-Spaulding project. Remnants of historic gold mining in the Drum-Spaulding project area is evidenced by abandoned mine tunnels and shafts and tailings.

Potential hazards associated with these historic, inactive mines in the Drum-Spaulding project are described in Section 4.9, Hazards and Hazardous Materials.

There are no reported active mines within Project Lands in Bundle 11 (CDMG, 1999). However, there are numerous locations in the Drum-Spaulding project classified as MRZ-2 for gold and other metals, aggregate (including sand and gravel), quartz, and barite within and adjacent to some project facilities and watershed lands. ARAs have been established, as described in Section 4.16.2.2, above, for certain mineral lands within Placer and Nevada Counties. Project Lands also contain MRZ-3 and MRZ-4 areas classified for a variety of minerals, and other MRZ-2 areas are also present in the region. Only those MRZ-2 classified areas that are within Project Lands are summarized in this section because of the regulatory importance of the MRZ-2 classification in land use planning.

Aggregate resources in the Bear River/Lake Combie area have been identified as MRZ-2, and ARAs have been delineated for certain areas. In the area between Rollins Reservoir and Lake Putt, sand and gravel resources classified as MRZ-2 are present at four locations where Project Lands are situated, and have been classified as ARAs. ARA-4 (Shady Creek area), ARA-16 (Scott's Flat/Little York area), ARA-25 (Liberty Hill Diggings/Lowell Hill area), and ARA-26 (Omega Diggings area) are all classified as Significant (the amount of material present is one to ten times the threshold amount required for classification. Based on similar deposits in the region, the highest probable use of material is base (CDMG, 1990b). Some Project Lands also contain MRZ-2 areas classified for sand and gravel deposits. The MRZ-2 areas extend from Meadow Vista through Rollins Reservoir and the Bear River upstream from Steephollow Creek confluence (CDMG, 1995). Although the demand for aggregate resources in California remains high and ARAs have been designated (in both Nevada and Placer Counties), county staff have indicated there is a low probability of new aggregate mining operations in areas within or near Project Lands due to access and location. An additional concern noted by staff in El Dorado County (directly south of Placer County) is the presence of asbestos-containing rock formations that extend along the Sierra foothills where many aggregate (as well as other minerals) resources are present (El Dorado County, 2000).

Small areas classified as MRZ-2 for lode and placer gold are also present in scattered locations in the Drum-Spaulding project. One area is situated within a portion of the Gold Run/Dutch Flat District, a group of gold-bearing Tertiary gravel deposits. Although the deposits have been extensively mined, significant amounts of unmined or reworkable material remains within the area. Other parcels are located within the western half of the Lowell Hill Ridge placer gold deposit, which contains significant inferred resources. The placer gold resources contained within Lowell Ridge are estimated to be valued in the low tens of millions of dollars. Some parcels contain the southernmost portion of the Omega Diggings placer gold deposit, which similarly contain significant inferred placer gold resources but with higher estimated value. Lode gold contained in lands on these parcels are also part of the Holbrook Flat Trend, which encompasses a series of mineralized quartz veins in a northerly trending regional structural zone. Parcels to the south (in the

Bear River vicinity midway between Lake Putt and Drum Penstock Forebay) include lands with lode gold associated with the Blue Canyon Area, the southern terminus of a series of northerly trending, gold-bearing veins that extend northward into Nevada County. A small portion of Watershed Land near the South Yuba River is situated within the Graniteville East Trend, a lode gold area comprising a series of mineralized quartz veins cutting northward through the Bowman Lake batholith. Significant indicated and measured gold reserves have been delineated in the Meadow Lake Mine lode gold resource area where Project Lands are located (CDMG, 1990b; CDMG, 1995).

Quartz and barite locations classified as MRZ-2 are also present in the Drum-Spaulding project. Tertiary gravel deposits associated with the Omega Diggins and Holbrook Flat Trend areas contain an abundance of high-grade quartz cobbles of suitable to produce silicon, an elemental material critical in the manufacture of computer chips. Quartz of similar quality is also present in areas mapped as MRZ-2 in the vicinity of Dutch Flat, Alta, and Drum facilities and lands. One small area classified as MRZ-2 for barite, used primarily as a weighting agent in well-drilling mud, is a high-grade deposit contained in lenses north of Dutch Flat. The amount and grade of unmined product is not known, but it is likely additional barite deposits occur beneath Tertiary volcanic rocks that cap Lowell Hill Ridge (CDMG, 1990b; CDMG, 1995).

There are 14 active claims on public lands in the vicinity of Drum-Spaulding project facilities and Watershed Lands (BLM, 2000b).

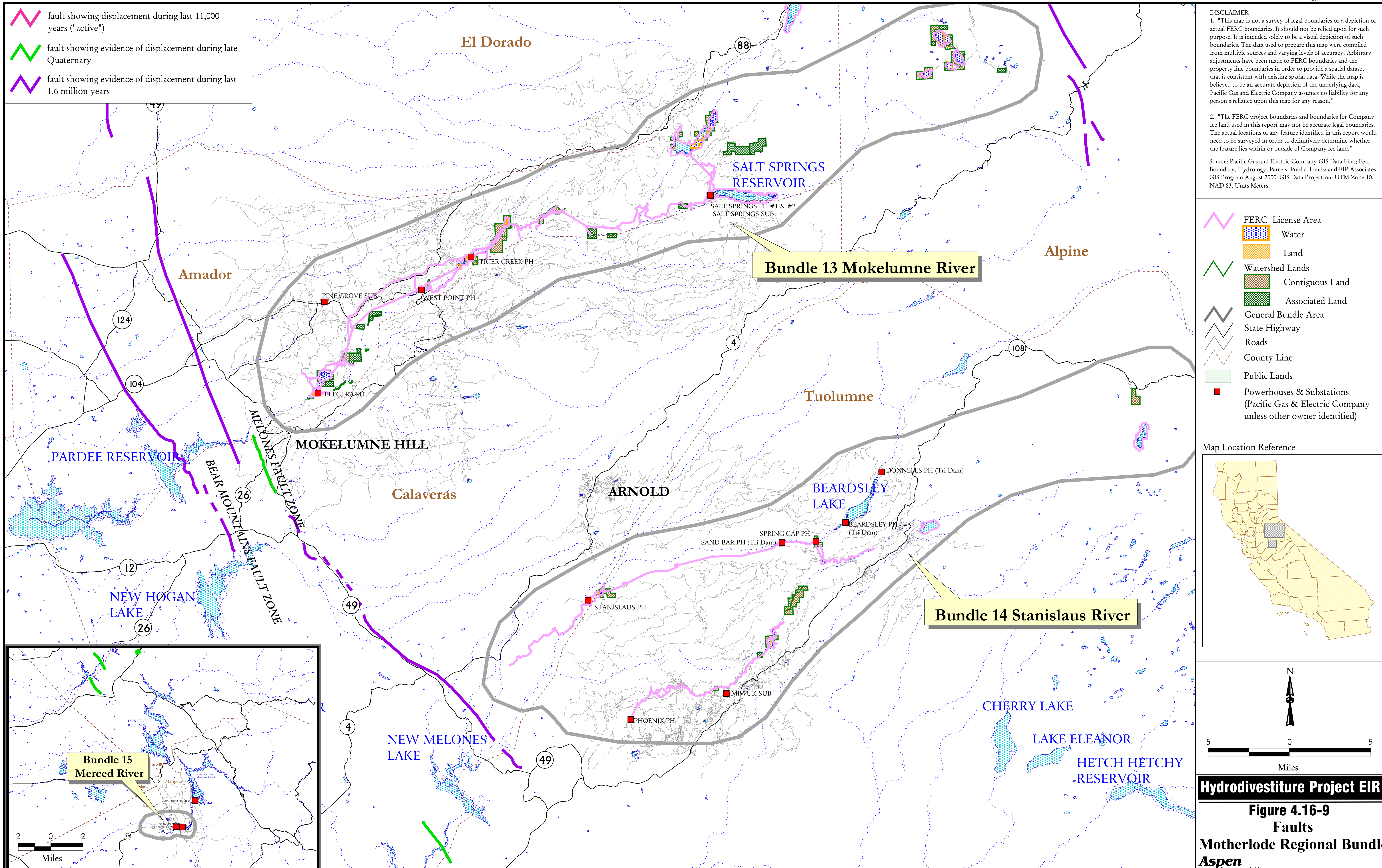
Bundle 12: Chili Bar (FERC 2155)

Geology and Topography

The Chili Bar project is in the northern part of the Sierra Nevada foothills along the South Fork of the American River at an elevation of approximately 940 to 1,000 feet. Slopes adjacent to the dam are relatively steep. Bedrock at the project is metamorphosed marine sedimentary rocks of the Calaveras Complex (PG&E Co., 1999a).

Faulting and Seismicity

There are no active faults or Alquist-Priolo zones delineated at the project site. The Foothills fault system (including the Bear Mountains and Melones fault zones) is situated approximately five miles west of the powerhouse, as illustrated in Figure 4.16-9. The area's seismicity was evaluated in 1994, and there was no evidence of displacement along the Melones fault that would indicate it was a potential seismic source for the dam. According to Pacific Gas and Electric Company, potential earthquakes on regional faults may produce moderate groundshaking at the powerhouse. (PG&E Co., 1999a).



DISCLAIMER

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2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."

Source: Pacific Gas and Electric Company GIS Data Files; Ferc Boundary, Hydrology, Parcels, Public Lands; and EIP Associates GIS Program August 2000. GIS Data Projection: UTM Zone 10, NAD 83, Units Meters.

Hydrodivestiture Project EIR

Figure 4.16-9
Faults
Motherlode Regional Bundle

Aspen Environmental Group

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Soils and Erosion

Project facilities and Watershed Lands are located in areas with soils exhibiting low to moderate shrink-swell potential. Soils on Project Lands consist of Mariposa and metamorphic rock land units. The Mariposa soils are well drained, formed from metasedimentary rock, and have high erosion potential. The metamorphic rock land exhibits slight to moderate erosion hazard (USDA, 1974). Site soils present similar limitations to development as those described for the Drum-Spaulding Project above.

Other Geologic Hazards

According to Pacific Gas and Electric Company, the slopes at Chili Bar Reservoir show no evidence of instability, and inspections have revealed no unusual or unique geologic or seismic features (PG&E Co., 1999a; 2000i). Due to its location in the western Sierra Nevada foothills, the project site is not situated in an area subject to volcanic or avalanche hazard.

Watershed Lands in the vicinity of the powerhouse and FERC License lands extending approximately 1,500 feet east are situated within this MRZ-2 area. The potential for gold mining at the Chili Bar project is considered low, according to El Dorado County staff, for a variety of reasons, including the area's high scenic and recreational values and environmental constraints. There are five active claims on public lands in the vicinity of the Chili Bar project (BLM, 2000).

4.16.4.4 Motherlode Regional Bundle

Regional Setting

The Motherlode Regional Bundle (Bundles 13, 14, and 15) is located on the western slope of the central Sierra Nevada foothills and mountain areas. Chapter 2, Project Description, contains descriptions of the locations and assets of project facilities in the Motherlode Regional Bundle.

Local Regulations and Policies

Facilities in the Motherlode Regional Bundle are located in Amador, Calaveras, Tuolumne, Alpine, Mariposa, and Merced counties. Relevant portions of planning documents and local standards that apply to discretionary projects in those jurisdictions with respect to geotechnical considerations and mineral resources issues are summarized in this section. Local ordinances addressing grading and erosion control are identified. It is assumed all counties implement required CBC standards pertaining to seismic safety and SMARA regulations pertaining to mining and mine reclamation.

Amador County Grading and Erosion Control

Chapter A33 of the Amador County Municipal Code provides regulations for excavation and grading activities. Grading permits that cover excavation and fill and are required under Section 3309.1, along with inspections (Section 3317.1). Performance standards for slopes and cut surfaces are specified in Section 3312.2, and erosion control requirements are specified in Section 3316.1.

Calaveras County Grading and Erosion Control

Calaveras County has adopted Appendix Chapter A33, Excavation and Grading, of the California Building Code to regulate grading and erosion control activities in the county.

Alpine County Grading and Erosion Control

Alpine County has adopted Appendix Chapter A33, Excavation and Grading, of the Uniform Building Code to regulate grading and erosion control activities in the county. Excavations less than two feet deep or fills less than three feet deep generally do not require a grading permit from the County (Alpine County, 1999).

Tuolumne County Grading and Erosion Control

Tuolumne County has adopted a Grading Ordinance (Chapter 12.20 of the Tuolumne County Ordinance Code) which sets limits on grading, cuts and fills, soils engineering requirements, erosion control, drainage, terracing, and permit requirements. The ordinance also addresses excavation, vegetation removal, and site reclamation. The county's Hillside and Hilltop Development Guidelines provide a framework to minimize visible changes, retain vegetation and soils, and reduce grading, among other measures.

These guidelines are applicable when a discretionary permit is required from the county, if the site is on a slope greater than 20 percent or on the crest or ridge of a hilltop, and the site is visible from certain locations specified in the guidelines.

Mariposa County Grading and Erosion Control

Mariposa County has adopted Chapter 15.28, Grading and Excavation, of Title 15 of the Mariposa County Code to regulate grading and erosion control activities with the county. A grading permit is required for any excavation that disturbs more than 5,000 square feet or more than 800 yards of total cut are; disturbs earth within a flood or erosion hazard area; is more than two feet deep or creates a cut slope more than five feet high and steeper than 50 percent. In addition, a grading permit is required for any fill slope that exceeds 50 cubic yards on a lot; is located in a flood or erosion hazard area; has an unsupported height of more than five feet or is more than one foot deep on a steep slope; or is more than three feet deep and is intended to support structures. The plan must include the supporting data consisting of a soils engineering and engineering geology report and an erosion control plan.

Merced County Grading and Erosion Control

Merced County has adopted Appendix Chapter A33, Excavation and Grading, of the Uniform Building Code to regulate grading and erosion control activities in the county.

Bundle 13: Mokelumne River (FERC 137)

Geology and Topography

The Mokelumne River project, which includes Tiger Creek Hydro Service Center, is located in the central Sierra Nevada (see Figure 4.16-1). This part of the range is characterized by Paleozoic to Mesozoic granitic rocks (primarily granodiorite) and metamorphosed sedimentary and volcanic rocks, as shown in Figure 4.16-2. Most of the ridges are capped with volcanic tuff, agglomerate and lava flows. Major formations underlying project facilities and watershed lands include the Calaveras Complex. The Mokelumne project ranges in elevation from approximately 600 feet at the Electra Powerhouse to over 8,000 feet at Upper Blue Lake. Similar to the Drum-Spaulding project, the upper elevations (from approximately Tiger Creek Powerhouse east) are characterized by high peaks, steep slopes and incised valleys, and meadows and lakes. Lower elevations are in the foothills characterized by rolling hills increasing in slope and height to the east. Slopes greater than 30 percent are present throughout most of the Project Lands. The project lies within the North Fork Mokelumne River drainage basin. Many of the storage and diversion reservoirs are located on tributaries that flow south of the North Fork of the Mokelumne River.

Faulting and Seismicity

The closest active fault to Mokelumne project facilities and watershed lands is the Genoa fault and related segments, ranging from about nine to 12 miles east of Blue Lakes (CDMG, 1994). No Alquist-Priolo earthquake fault zones have been delineated for the area comprising the Mokelumne project. The Foothills fault system (including the Bear Mountains and Melones fault zones) is approximately five miles west of the Electra Powerhouse, at the western end of the project bundle, as illustrated in Figure 4.16-9. Pacific Gas and Electric Company has identified several faults in the Foothills system that have displaced Quaternary deposits and are considered potentially active. These include the Gopher Gulch, Poorman’s Gulch, McKays Point, and Douds Landing faults (PG&E Co., 1999a). Approximately 6 miles northeast of Blue Lakes are southern segments of the West Tahoe fault, which is not considered active. As identified by Pacific Gas and Electric Company, other active faults in the Sierra Nevada frontal fault system near the Mokelumne River project include the Waterhouse Peak and the Carson Valley faults. Seismic sensors and recorders have been installed at Salt Springs Dam to record strong ground motion from earthquakes. According to Pacific Gas and Electric Company, although seismic activity in the Mokelumne River area is rare, the project facilities may experience groundshaking from earthquakes on regional faults (PG&E Co., 1999a).

Results of seismic evaluations prepared in 1997 and 1999 indicated that the seismic stability of Salt Springs Dam is adequate, and the spillway and parapet wall are stable under normal and seismic loading cases (Findlay Engineering, 2000a; 2000b; PG&E Co., 2000).

The Upper Bear Dam and Spillway were determined to have adequate seismic stability under the maximum credible design event, according to the most recent seismic analysis prepared in 1998 and 2000. (Findlay Engineering, 2000c; 2000d)

Soils and Erosion

Soils in the Lake Tabeaud, Electra Tunnel/West Point Powerhouse, and Tiger Creek reservoir land areas belong to the Mariposa-Josephine-Sites and Aiken-Cohasset soil associations. The Aiken-Cohasset soils are deep cobbly soils in material derived from volcanic rock. Musick-Holland soils, deep soils from granitic material, are also present in the vicinity of the Tiger Creek land area. The erosion hazard is classified as high to severe for nearly all the soil units within these land areas, with the exception of a few locations on property at the southern terminus of the Electra Tunnel. Soils in the vicinity of Salt Springs Reservoir, Lower Bear Reservoir, and easternmost lakes have not been mapped or classified by the NCRS (USDA, 1993). Project facilities and Watershed Lands are located in areas with soils exhibiting low to moderate shrink-swell potential (USDA, 1993).

Other Geologic Hazards

Landslides and debris flows occur on the steep slopes of the Mokelumne River canyon. A rockslide is mapped near the Salt Springs Penstock, landslides and debris flows are mapped near the Tiger Creek Penstock, and a small landslide is mapped near the Electra Penstock. Landslides have also affected project operation in the past, such as landslides along the canals and soil erosion at spillways and along access roads. Pacific Gas and Electric Company voluntarily conducted an extensive survey of potential and actual erosion sites and landslides throughout the project area, and identified 20 sites in the project area where mitigation measures were implemented to protect environmental resources or project facilities. Most of the sites that have been remediated by Pacific Gas and Electric Company-affected project facilities, such as canal benches or tunnel portals. The remaining sites that were mitigated by Pacific Gas and Electric Company had minor slides along access roads, which were not hampering project operations. Pacific Gas and Electric Company is conducting ongoing slope stability work at the Deer Creek Slide on Salt Springs Road near Station 130+00 of Tiger Creek Canal (PG&E Co., 1999a).

Facilities and lands in the Mokelumne project are not susceptible to volcanic hazard, as the locations are not within hazard zones delineated by the USGS for the Mono Lake-Long Valley Area, the closest active volcanic region to the project, approximately 50 miles southeast of Blue Lakes (Miller, 1989). Amador, Calaveras, and Tuolumne Counties have not identified avalanche hazard potential in planning documents. Project facilities lands situated at higher elevations (e.g., Blue Lakes, Twin Lake, and Meadow Lake) are inaccessible during periods of heavy snowfall when avalanche potential is high.

Mineral Resources

Similar to the Drum-Spaulding project, portions of the Mokelumne project are situated within an area rich with mining history. Historic mining in the region has included the extraction of gold, garnets, tungsten, copper, molybdenum, manganese, and epidote (PG&E Co., 1999a). Potential hazards associated with former mining activities in the Mokelumne project are described in Section 4.9.

There are no reported active mines within or immediately adjacent to Project Lands (CDMG, 1999), but an area of MRZ-2 for gold has been delineated just west of West Point Powerhouse and extending east to the Tiger Creek Powerhouse (CDMG, 1987b). A parcel east of the West Point Powerhouse contains a MRZ-2 mapped area. The MRZ-2 areas are highly mineralized with lode gold occurring along quartz veins. (CDMG, 1987b) FERC and watershed lands also contain MRZ-3 and MRZ-4 areas classified for a variety of minerals, and MRZ-2 areas have been delineated elsewhere in the project area (CDMG, 1987b). There are 29 active claims on public lands in the vicinity of the Mokelumne Project Lands (BLM, 2000).

Although mineral resource locations have identified and mapped, and mining is an allowable use on some Project Lands, Amador and Calaveras County planning staff have indicated low potential for mining in those areas (Amador County, 2000; Calaveras County, 2000).

Bundle 14: Stanislaus River -- Spring Gap-Stanislaus (FERC 2130), Phoenix (1061)

Geology and Topography

Geologic conditions at the Spring Gap-Stanislaus and Phoenix projects are similar to those of the Mokelumne project. Predominant rock types include granitic rocks, principally granodiorite, with metamorphosed sedimentary and volcanic rocks, as illustrated in Figure 4.16-2. The Phoenix project is located at an elevation of approximately 2,600 to 3,800 feet in a transitional area between the Sierra Nevada foothills and mountains. The Spring Gap-Stanislaus project facilities and watershed lands range in elevation from 1,200 feet to over 7,000 feet. Slopes greater than 30 percent are present throughout most of the FERC license areas and Watershed Lands. The Spring Gap-Stanislaus project lies within the Middle Fork and South Fork of the Stanislaus River, one of several large rivers that drain the western slope of the Sierra Nevada.

Faulting and Seismicity

Spring Gap-Stanislaus Project Lands are situated between the Melones fault zone and inactive faults along and within the western Sierra Nevada. The Phoenix project is approximately five to ten miles east of the Melones fault zone and within the Calaveras-Shoo Fly thrust. There are no active faults or Alquist-Priolo zones within Project Lands. The closest active faults to the Spring Gap-Stanislaus and Phoenix projects are located approximately 30 to 40 miles northeast and east of Beardsley Lake. Active faults in the Sierra Nevada frontal fault system near the Spring Gap-Stanislaus project and Phoenix project identified by Pacific Gas and Electric Company include the Relief, Millie

Lake, and West Walker faults (CDMG, 1994; PG&E Co., 1999). According to Pacific Gas and Electric Company, although seismic activity in the Spring Gap-Stanislaus project area is rare, the project facilities may experience groundshaking from earthquakes on regional faults. These include the Rawhide Flat, Moaning Cave, McKays Point, and Douds Landing faults (PG&E Co., 1999a).

Soils and Erosion

Soils in western Tuolumne County, which includes the Stanislaus River and Lyons/Phoenix Reservoir Project Land, are thin, quickly saturated, and are susceptible to erosion during the rainy season (Brown and Caldwell, 1995). Project facilities and Watershed Lands are located in areas with soils exhibiting low to moderate shrink-swell potential (USDA, 1967).

Past soil erosion problems have occurred in the vicinity of Lyons Reservoir. Pacific Gas and Electric Company operated Lyons Lake Resort at the reservoir until 1987. Although all structures were removed by Pacific Gas and Electric Company in 1988, unauthorized recreation use persisted and caused severe erosion problems along the reservoir shoreline. In 1994, Pacific Gas and Electric Company introduced a recreation plan (FERC License Article 410) that proposed mitigation measures for these impacts. The plan called for reducing points of access to the dam, creating a central recreation area with gravel parking lot, and erecting barriers around the parking lot to prevent motorized access to the shoreline. In addition, FERC's Order, dated April 29, 1996, requires Pacific Gas and Electric Company to perform sediment surveys at Lyons Reservoir (PG&E Co., 1999a). FERC License Article 403 requires Pacific Gas and Electric Company to file an erosion control plan with FERC prior to any land-disturbing activities.

Snowfall in the higher elevations has also caused erosion problems. In 1992, ice and snow buildup in the Philadelphia Canal cause overtopping, which resulted in minor erosion on U.S. Forest Service property. The property was seeded, and stabilization measures were implemented on the downhill side. A snowstorm in 1996 toppled a tree into Main Tuolumne Canal J-Flume, resulting in flume failure and spillage onto U.S. Forest Service property. Pacific Gas and Electric Company repaired the flume and revegetated the property (PG&E Co., 2000i).

Other Geologic Hazards

Landslides and debris flows occur on the steep slopes in the project areas and are natural events that can affect project facilities, such as rupturing elevated flume sections or the canal itself, and the uncontrolled spillage resulting in erosion of areas downslope and along adjacent riverbanks. To protect against such occurrences, FERC License Article 401 required Pacific Gas and Electric Company to file a plan for the design and construction of a system that will automatically detect a conduit or penstock failure and immediately shut off flow at the headworks. Pacific Gas and Electric Company submitted a plan, which was accepted by FERC in 1993, and the equipment installed to monitor flow in the conduit or penstocks is required to be tested by Pacific Gas and Electric Company annually (PG&E Co., 1999a).

A rockfall and a rockslide have occurred at the portal to the outlet works below the Main Strawberry and Relief dams; these are being monitored and in part mitigated. Pacific Gas and Electric Company is performing maintenance work on the reservoir side face at Strawberry Dam to address leakage issues raised by DSOD. A filled swale is creeping near the upper end of the Stanislaus Penstock (PG&E Co., 1999a).

In the Spring Gap-Stanislaus project, Relief Reservoir and one parcel to the north and Pinecrest Lake are within a zone of potential ashfall delineated by the USGS for the Mono Lake-Long Valley Area, the closest active volcanic region to the project, approximately 30 miles east-southeast. The estimated thickness of ashfall in the vicinity of Strawberry could be two inches or more, but historic wind directions and windspeeds suggest that most of the ash would be deposited to the east of the eruption or vents (Miller, 1989). The Spring Gap-Stanislaus facilities and lands to the west and the Phoenix project are not within the estimated ashfall radius. As with facilities in the Drum-Spaulding project, avalanche hazard is limited to the higher elevations. However, most of these areas are inaccessible during periods of highest avalanche potential.

Mineral Resources

Although there are some active mines in Tuolumne County, there are no reported mines or mining activity within or adjacent to the Spring Gap-Stanislaus project or the Phoenix project (CDMG, 1999). Mineral land classification maps showing locations of precious metals, carbonate, and aggregate have been published for Tuolumne County, where most of the Spring Gap-Stanislaus facilities and watershed lands are located. Although the area has a history of gold and silver mining, Project Lands are situated in areas mapped as either MRZ-3 or MRZ-4. The closest MRZ-2 location is two small areas classified for lode gold and silver located a few miles south of Lyons Reservoir (CDMG, 1997d). Mining is an allowable use on Project Lands, as identified in County planning documents; however, Tuolumne County staff indicate low potential for mining, with the exception of one parcel (APN 22-11-17) where quartz mining may occur (Tuolumne County, 2000). There are two active claims on public lands in the vicinity of the Phoenix project (BLM, 2000b).

Bundle 15: Merced River -- Merced Falls (FERC 2467)

Geology and Topography

The Merced Falls project is situated in low foothills along the western edge of the south-central part of the Sierra Nevada at an elevation of approximately 350 feet. The project is situated within the lower reaches of the Merced River, as it flows into the San Joaquin Valley. Bedrock in the area is composed of metamorphosed sedimentary and metavolcanic rock. The project is underlain by alluvium, consisting of unconsolidated sands and gravels, with some clays and silts. Outcroppings of slate and shale are common in the upland area, away from the river. The Merced Falls Dam is founded on Paleozoic metasedimentary rock, which is generally slate. (PG&E Co., 1999a)

Faulting and Seismicity

The Merced Falls project is situated at the southern end of the Foothills fault system. As shown on Figure 4.16-2, individual faults within and near the system are known to be active to the north of the project, but none have been identified in the Merced Falls area. There are no Alquist-Priolo earthquake fault zones (CDMG, 1997b). According to Pacific Gas and Electric Company, several strong lineaments, such as Piney Creek and Coulterville, may reflect active faults closer to the dam. Lineaments in the southern end of the Bear Mountain fault zone are about six miles northeast of the project area, and lineaments in the Melones fault zone are located about ten miles northeast of the project area. The controlling seismic source for the Merced Falls Dam is an unnamed segment of the Bear Mountains fault zone approximately five miles from the dam. This segment has an estimated magnitude of 6 to 6.5. Results of a stability analysis and seismic deformation assessment in 1998 concluded there is no possibility of a breach or excessive settlement of the Merced Falls embankment dam under the design earthquake (Arkwright Technical Services, 1998). According to Pacific Gas and Electric Company, the Merced Falls Project facilities may experience groundshaking from earthquakes on regional faults (PG&E Co., 1999a).

Soils and Erosion

Soils in the Merced Falls land area are Hanford, which formed on granitic alluvium on the Merced River bottomland. These soils are considered the best agricultural soils due to their fine texture and moderately high fertility. Erosion hazard is slight (USDA, 1991). Project facilities and lands are located in areas with soils exhibiting low to moderate shrink-swell potential (USDA, 1991).

Other Geologic Hazards

The Merced Falls project is in an area with no known or documented soil instability problems (PG&E Co., 1999; 2000a). Because of its low elevation, there is no risk of avalanche. The project is situated outside any potential ashfall zones associated with the Mono Lake-Long Valley area, approximately 100 miles east (Miller, 1989).

Mineral Resources

There is evidence of mining in the Merced Falls project area by the dredge tailings along the Merced River, directly west of the project area (PG&E Co., 1999a), but there are reported no mines or mining activity on Project Lands (CDMG, 1999). There are no active claims on public lands near project facilities (BLM, 2000b). The channel and floodplain deposits along the Merced River extending west from the Mariposa county line to Snelling Road are classified as MRZ-2b for sand and gravel. An ARA has been established for that reach and is also mapped as an instream resource (CDMG, 1999b).

4.16.4.5 Kings Crane-Helms Regional Bundle

Regional Setting

The Kings Crane-Helms Regional Bundle is located principally on the on the west margin of the central Sierra Nevada structural block, a west-tilted, uplifted block comprised principally of Cretaceous granitic plutons and remnants of Paleozoic and Mesozoic metavolcanic and metasedimentary rocks (CDMG, 1967). The western flank of the central Sierra Nevada gradually rises from the eastern margin of the San Joaquin Valley to the crest and is dissected by deeply cut river canyons.

Regional faults considered most likely to generate earthquakes include faults of the Eastern Sierra Frontal fault system and Owens Valley fault system (see Figures 4.16-10 and 4.16-11).

These faults, as well as other smaller faults noted in the individual bundle discussions below, are part of an active zone of faulting related to the dramatic uplift of the Sierra Nevada structural block and are included in the Alquist-Priolo Fault-Rupture Hazard Zone program administered by the CDMG.

However, no Alquist-Priolo fault hazard zones are present on Project Lands in the Kings Crane-Helms Regional Bundle. The Melones fault zone, part of the Foothills system previously described, is not considered an active fault, but historic fault rupture has occurred on other faults belonging to the Foothills fault system (Oroville, 1975). The San Andreas fault, despite its distance from the project facilities, could produce an earthquake of sufficient magnitude to affect the project area. The principal seismic hazard of the Kings Crane-Helms area is seismically induced groundshaking originating on active faults distant from the project area. Overall, the seismic hazard is considered low to moderate.

Local Regulations and Policies

Facilities in the Kings Crane-Helms Regional Bundle are located in Madera, Fresno, Tulare, and Kern counties. Relevant portions of planning documents and local standards that apply to discretionary projects in those jurisdictions are summarized in this section.

Madera County Grading and Erosion Control

Grading standards in Madera County are set forth in the Madera County Code, Chapter 14.50, Grading and Erosion Control. Earthwork is described in Chapter 11.20 – Excavations.

Fresno County Grading and Erosion Control

The Fresno County Grading Ordinance (Section 7002, March 1991) stipulates safety and environmental control measures for construction practices. The Ordinance sets forth rules and regulations to control excavation, grading, and earthwork construction, including fills and embankments. The Ordinance also establishes the administrative procedure for issuance of permits, and provides for approval of plans and inspection of grading construction. All grading activities are required to be permitted by the County's Building Official with the exception of various kinds of grading that are indicated in the Ordinance. The Ordinance also sets forth other requirements that must be met before any permit is issued. The County requires erosion control measures and inspections to be made by the Building Official.

Tulare County Grading and Erosion Control

Grading Standards in Tulare County are set forth in Part VII of the Ordinance Code of Tulare County. Grading permits that cover excavation and fill and are required and regulated under Chapter 15, Article 7 of the County Ordinance Code.

Kern County (Bakersfield Region) -- Grading and Erosion Control

Grading Standards in Kern County are set forth in the Kern County Code of Building Regulations. Earthwork standards provide regulations for cut and fill slopes, set backs, and tunnels, and are described in Chapter 17.28 – Grading Code.

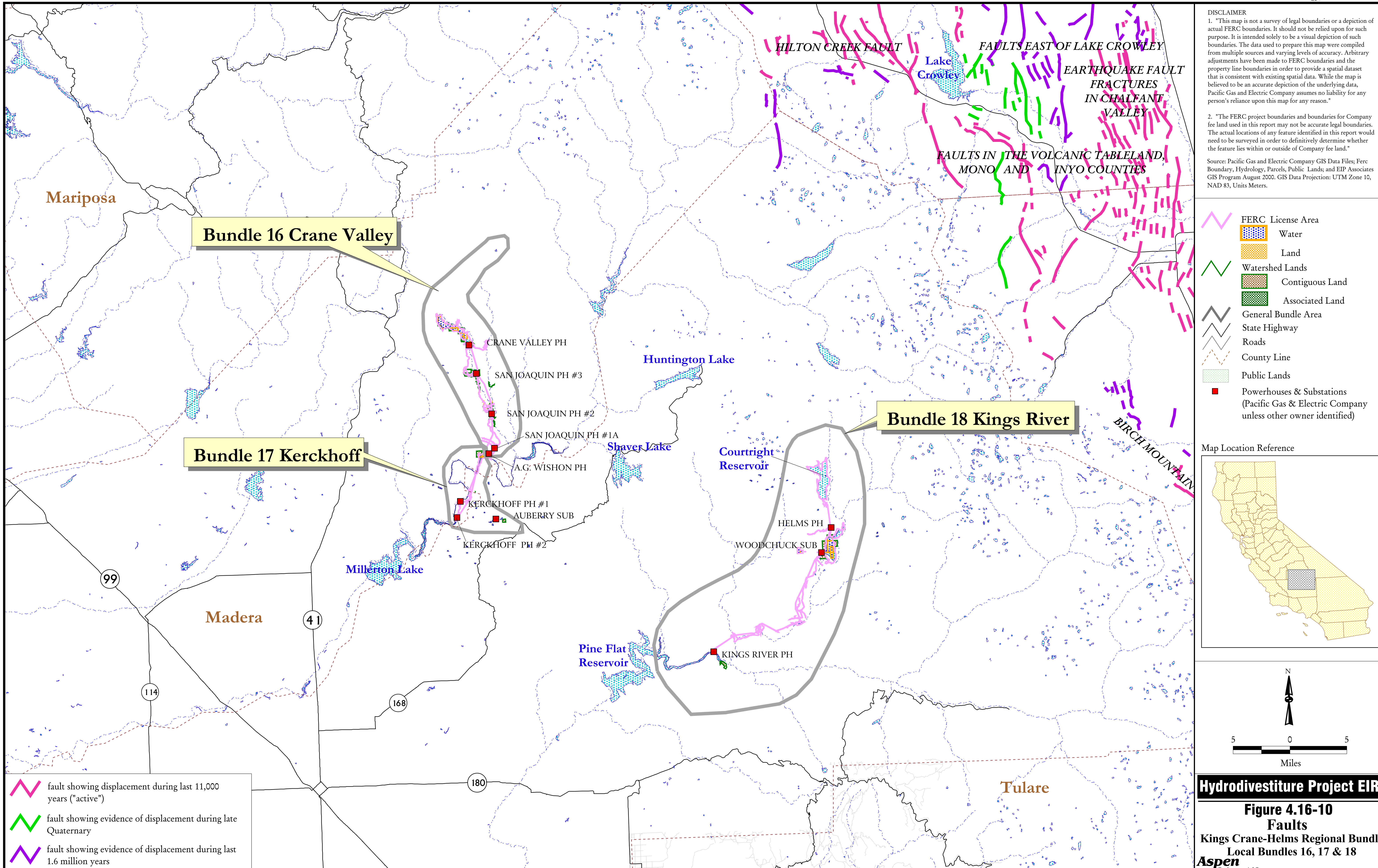
Bundle 16: Crane Valley (FERC 1354)

Geology and Topography

The Crane Valley project is located in Madera County on the west margin of the central Sierra Nevada structural block, a west-tilted, uplifted block comprised principally of Cretaceous granitic plutons and remnants of Paleozoic and Mesozoic metavolcanic and metasedimentary rocks (CDMG, 1967). The predominant rock type in the area is Cretaceous tonalite (Bateman, 1982, 1989). Tonalite is a granitic rock with relatively small amounts of potassium feldspar. All of the Crane Valley project facilities are founded tonalite. Surficial unconsolidated sedimentary deposits found in the area include residual soils formed by decomposition of the underlying tonalite, alluvium deposited along drainages and in valley bottoms, and artificial fills used for road embankments and other structures. Elevation of the Crane Valley project ranges from 1,000 to 3,600 feet.

Faulting and Seismicity

The seismicity of the Crane Valley project area is low to moderate relative to other regions of California. Regional faults considered most likely to generate earthquakes include faults of the Eastern Sierra Frontal fault system and Owens Valley fault system, located approximately 35 to 60 miles east of the project. The Melones Fault Zone, part of the Foothills fault system, is located closer to the Crane Valley project to the northwest. The San Andreas fault, despite its distance from the site, could produce an earthquake of sufficient magnitude to affect the project area. The principal seismic hazard of the project area is seismically induced groundshaking originating from major active faults distant from the project area. Because the project facilities are built and founded on tonalite bedrock, there is no liquefaction hazard.


HILTON CREEK FAULT
Lake Crowley
FAULTS EAST OF LAKE CROWLEY
EARTHQUAKE FAULT FRACTURES IN CHALFANT VALLEY
FAULTS IN THE VOLCANIC TABLELAND, MONO AND INYO COUNTIES
BIRCH MOUNTAIN
Mariposa
Madera
Tulare
Bundle 16 Crane Valley
Bundle 17 Kerckhoff
Bundle 18 Kings River
CRANE VALLEY PH
SAN JOAQUIN PH #3
SAN JOAQUIN PH #2
SAN JOAQUIN PH #1A
A.G. WISHON PH
KERCKHOFF PH #1
AUBERRY SUB
KERCKHOFF PH #2
Huntington Lake
Shaver Lake
Millerton Lake
Courtright Reservoir
HELMS PH
WOODCHUCK SUB
Pine Flat Reservoir
KINGS RIVER PH
99
41
114
168
180
fault showing displacement during last 11,000 years ("active")
fault showing evidence of displacement during late Quaternary
fault showing evidence of displacement during last 1.6 million years
DISCLAIMER
1. "This map is not a survey of legal boundaries or a depiction of actual FERC boundaries. It should not be relied upon for such purpose. It is intended solely to be a visual depiction of such boundaries. The data used to prepare this map were compiled from multiple sources and varying levels of accuracy. Arbitrary adjustments have been made to FERC boundaries and the property line boundaries in order to provide a spatial dataset that is consistent with existing spatial data. While the map is believed to be an accurate depiction of the underlying data, Pacific Gas and Electric Company assumes no liability for any person's reliance upon this map for any reason."
2. "The FERC project boundaries and boundaries for Company fee land used in this report may not be accurate legal boundaries. The actual locations of any feature identified in this report would need to be surveyed in order to definitively determine whether the feature lies within or outside of Company fee land."
Source: Pacific Gas and Electric Company GIS Data Files; Ferc Boundary, Hydrology, Parcels, Public Lands; and EIP Associates GIS Program August 2000. GIS Data Projection: UTM Zone 10, NAD 83, Units Meters.
FERC License Area
Water
Land
Watershed Lands
Contiguous Land
Associated Land
General Bundle Area
State Highway
Roads
County Line
Public Lands
Powerhouses & Substations (Pacific Gas & Electric Company unless other owner identified)
Map Location Reference
N
5 0 5
Miles
Hydrodivestiture Project EIR
Figure 4.16-10
Faults
Kings Crane-Helms Regional Bundle
Local Bundles 16, 17 & 18
Aspen Environmental Group

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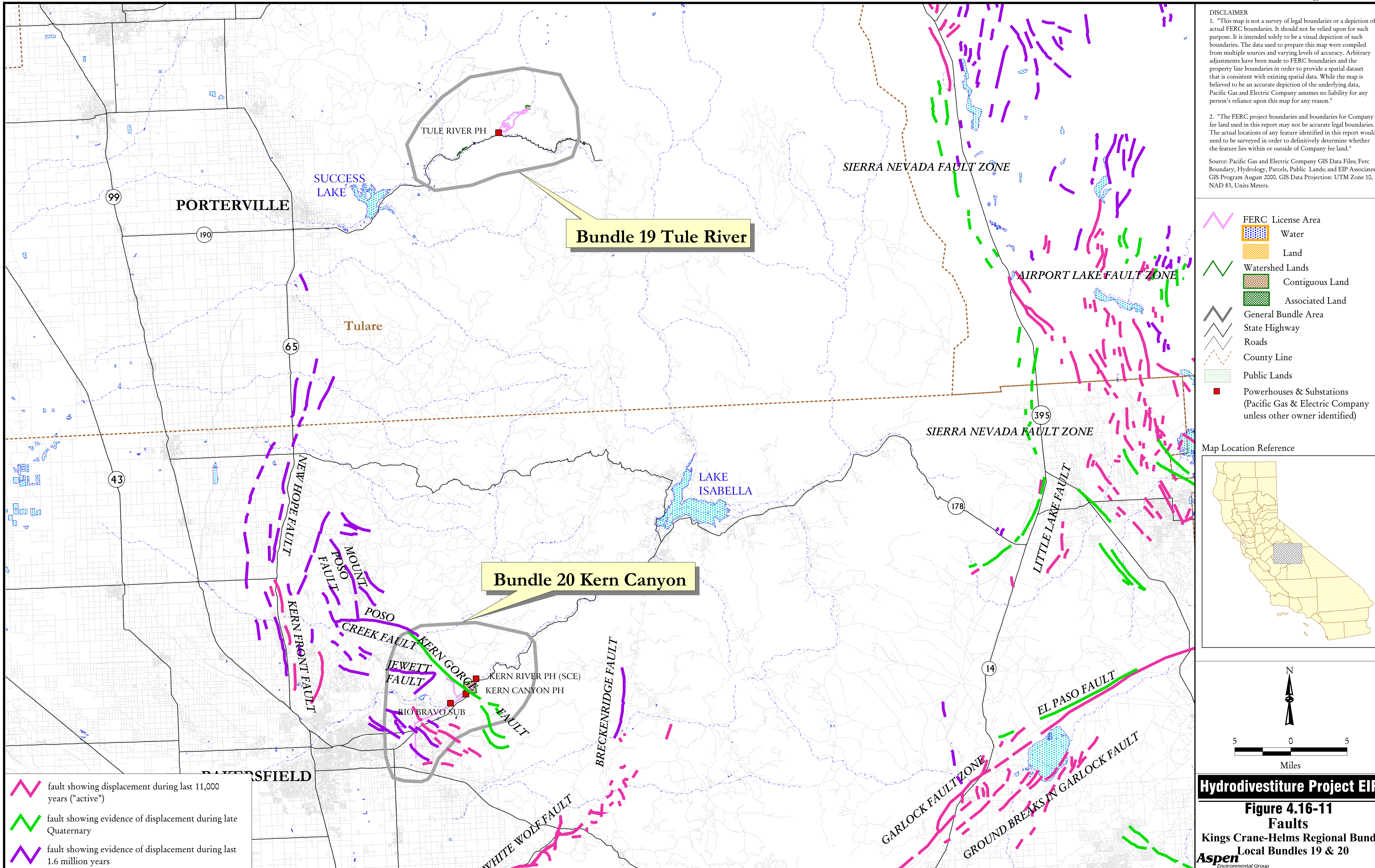

Hydrodivestiture Project EIR

Figure 4.16-11
Faults
Kings Crane-Helms Regional Bundle
Local Bundles 19 & 20

Aspen Environmental Group

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Soils and Erosion

The shoreline of Bass Lake experiences a substantial amount of erosion. According to the Forest Service (USFS, 1981), the extent of shoreline erosion at Bass Lake varies depending on factors such as soil structure, wave action, slope, and stabilizing vegetation. The soils found adjacent to Bass Lake are generally Chawanakee on the north side, and Holland and Josephine on the south. While the Chanwanakee and Josephine soils are relatively stable due to their shallow depth to bedrock and skeletal development, the Holland type is very erodible. Holland soils are deeply weathered granitic material, reaching 20 feet in depth in some places. Subsoil composition varies from 20 to 45 percent clay with a high percentage of mica. Erosion is worst on the south side of Bass Lake owing to the presence of Holland-type soils.

In 1984, Pacific Gas and Electric Company commissioned an intensive investigation to determine the causes of erosion at Bass Lake and to identify mechanisms to control erosion. The results of Pacific Gas and Electric Company's investigation are documented in a report referred to as the Bass Lake Erosion Control Study (1985). The study identified a number of mechanisms, both natural and man-caused, which accelerate the erosion of the shoreline. The dominant factor was wave action resulting from heavy boating use on the reservoir (PG&E Co., 1989).

Based on the findings of the erosion studies, Pacific Gas and Electric Company developed a Bass Lake Erosion Control Action Plan, which was signed in 1987. The erosion control plan applies to all lands owned by Pacific Gas and Electric Company or public lands managed by the U.S. Forest Service within the boundaries of the Crane Valley Project and affected by shoreline erosion at Bass Lake. The action plan, which divided the shoreline into 18 treatment segments, called for each segment to be treated on a priority basis. The most critical segments (priority 1,2, and 3) were treated in the late 1980s. Segments assigned a priority 4 or 5 were monitored to determine if treatment would be needed at a future time. In early 1996, inspections showed that portions of the priority 4 and 5 segments have eroded significantly, and were in need of treatment. To date, these segments have not been treated. Pacific Gas and Electric Company estimates this work to cost $2,000,000 (CVPC, 1997). The Bass Lake Shoreline and Water Surface Management Plan (PG&E Co., 1989) and the Final Phase 1 Agreement for June 27th Ratification (CVPC, 1997) also include commitments by Pacific Gas and Electric Company to restore and protect the Bass Lake shoreline from erosion.

Soils for the remainder of the project area are of three main soil associations: the Holland association, Ahwahnee association, and the Auberry association (USDA, 1962). The Ahwahnee and Auberry soils are generally found at elevations of about 1,000 to 2,800 feet and are very similar. Both soils are derived from the underlying weathered granitic rock, consist predominately of coarse sandy loam, and have a slight erosion hazard. The Auberry soils differ only in that they have more clay. The Holland soils are also similar to the Ahwahnee and Auberry soils in that they are derived from the underlying weathered granitic rock, however they consist predominantly of sandy loams with a moderate to high erosion hazard.

Other Geologic Hazards

Weathering and erosion along rock joint planes can create rounded tonalite “corestones” embedded within a matrix of decomposed rock. These corestones can create a rock topple hazard in areas where they have been exposed by natural erosion or man-made slope cuts. Seismically induced groundshaking of jointed and/or eroded tonalite bedrock or over-steepened slopes may result in rockfalls. Rock topples and falls and small landslides have been noted in the project area and have previously affected project facilities (PG&E Co., 1999). In the winter of 1997/1998 a rock fall blocked the Brown’s Ditch and resulted in an overflow that breached the canal.

Mineral Resources

Madera County has a rich history of mineral extraction, including gold, copper, and granite. Gold extraction in the county is now strictly recreational (gold panning), although gold is occasionally extracted as a by-product in other mineral extraction operations, and copper mining is no longer commercially viable. Three types of minerals are currently commercially mined in Madera County: stone (subbase), dimension stone (granitic), and aggregate (Madera County, 1995). However, no reported active mines or mining claims are located within or near the project area (BLM, 2000c; CDMG, 1999), and the area is not classified by CDMG as a mineral resource zone.

Bundle 17: Kerckhoff (FERC 2735)

Geology and Topography

The Kerckhoff project is located in Fresno and Madera Counties, within the San Joaquin River Basin on the western margin of the central Sierra Nevada, a west-tilted, uplifted block comprised principally of Cretaceous granitic plutons and remnants of Paleozoic and Mesozoic metavolcanic, metasedimentary, and older metamorphosed granitic rocks (CDMG, 1967). The granitic rock in the area consists primarily of granodiorite with dikes and irregular bodies of quartz diorite and older metamorphosed granitic rock with a gneissic texture (FERC, 1979). Kerckhoff Powerhouses #1 and #2 and the southern tunnel segments are founded in the Cretaceous granitic rock; the Kerckhoff Dam and the northern tunnel segments are founded in the older metamorphosed granitic rock.

Irregular outcrops of Tertiary volcanic rocks are located to the east and west of the project. These volcanic rocks are generally more resistant to erosion than the surrounding rocks and form plateaus or tables. Unconsolidated surface deposits include residual soils formed by decomposition of the underlying bedrock, alluvium deposited along drainages and in valley bottoms, and artificial fills used for road embankments and other structures. Elevation of the Kerckhoff project ranges from approximately 900 to 2,200 feet.

The Auberry Service Center is located approximately four miles east of Kerckhoff Powerhouse #2 at the northern end of Big Sandy Valley. Big Sandy Valley is a small tributary drainage to the San

Joaquin River. The principal rock unit in the area is Mesozoic granitics of the Sierran Batholith, with surficial deposits of alluvium, residual soil, and artificial fill.

Faulting and Seismicity

The seismicity of the Kerckhoff project area is low to moderate relative to other regions of California. Regional faults considered most likely to generate earthquakes include faults of the Eastern Sierra Frontal fault system and Owens Valley fault system, located approximately 50 to 75 miles east of the project. The Melones fault zone, part of the inactive Foothills fault system, is located closer to the Kerckhoff project, approximately 25 miles to the northwest. Several small faults that cross and are near the Kerckhoff project have displaced the granitic, older granitic, and metamorphic rocks relative to each other. However, the younger overlying Tertiary volcanic rocks are not offset, indicating these are inactive faults with no movement in the last 1.6 million years. These small faults are most likely part of the Foothills fault system. The principal seismic hazard of the project area is seismically induced groundshaking originating from major active faults distant from the project area. The San Andreas fault, despite its distance from the site, is the most likely to produce an earthquake of sufficient magnitude affect the project area. Because the project facilities are built and founded on granitic and metamorphic bedrock, there is no liquefaction hazard.

Soils and Erosion

Soils of the Kerckhoff project fall into three main soil associations: the Ahwahnee association, the Auberry association and the Coarsegold association (FERC, 1979; USDA, 1971). Both are moderately coarse textured soils derived from the underlying weathered granitic rock, and consist predominately of rocky coarse sandy loam and coarse sandy loam. These soils are mainly undulating to hilly, but do also occur on canyon slopes and steep hill or ridge slopes. Rock outcrops are common. The Auberry soils differ only in that they contain more clay. The Ahwahnee soils are generally found at elevations of about 1,000 to 2,500 feet and the Auberry soils are generally found at elevations of about 1,000 to 3,500 feet. Erosion hazard is generally moderate on low to gentle slopes, however on steep slopes the erosion hazard may be high.

Coarsegold soils are moderately fine-grained soils formed from metasedimentary rocks, and consist predominantly of fine sandy loams. These soils are typically found on steep hills and ridges at elevations ranging from 1,600 to 3,600 feet. Rock outcrops are uncommon. Erosion hazard for this soil is high.

Other Geologic Hazards

Weathering and erosion along fractures or joint planes of exposed bedrock units on the steep slopes within and near the project area could create a rockfall hazard in areas. Poorly consolidated granitic derived soils and talus on steep project area slopes could experience rockslides and small landslides. Seismically induced groundshaking of jointed and/or eroded bedrock or over-steepened slopes may result in rockfalls and or landslides.

Mineral Resources

Fresno and Madera Counties have a long history of mineral extraction, including gold, copper, and granite. Three types of minerals are currently commercially mined in Madera County: stone (subbase), dimension stone (granitic), and aggregate (Madera County, 1995). Fresno County's most significant extractable resources are aggregate and petroleum (Fresno County, 2000). However, no reported active mines or mining claims are located within or near the project area (BLM, 2000c; CDMG, 1999), and the area is not classified by CDMG as a mineral resource zone.

Bundle 18: Kings River -- Helms Pumped Storage (FERC 2735), Haas-Kings River (FERC 1988), Balch (FERC 0175)

Geology and Topography

Helms Pumped Storage. The Helms Pumped Storage project (Helms project), including the Helms Headquarters Service Center, is located in Fresno County on the western slopes of the central Sierra Nevada, about 12 miles west of the regional drainage divide. Elevation of Courtright Lake, the project's upper storage component, is approximately 8,200 feet and Lake Wishon, the lower storage component, is at about 6,550 feet. The geology is typical of the high Sierra, consisting of Mesozoic granitic rock, predominantly granodiorite, with erosional remnants of older metamorphic rock and Pleistocene glacial deposits (CDMG, 1967; PG&E Co., 1976). Pleistocene glaciation strongly affected the topography of the area, scouring the bedrock and carving domes and straight, steep-walled valleys. The resulting barren landscape is rugged and rocky with only patches of soil scattered on the bedrock slopes. All of the project facilities, except the Helms Powerhouse, are founded in the granodiorite bedrock (PG&E Co., 1986). The Helms Powerhouse is constructed on quartzite, a very hard metamorphosed sandstone.

Near the left abutment of Courtright Dam contact relationships between three episodes of granitic intrusions and older metasedimentary rocks are well exposed, and the area has been designated as a Geologic Area in the Sierra National Forest and is known as the Courtright Intrusive Zone (PG&E Co., 1986).

Haas-Kings River. The Haas-Kings River project is located in Fresno County on the western slopes of the central Sierra Nevada, just south of the Helms Project. The project follows the approximate trend of the North Fork Kings River from Lake Wishon to Black Rock Reservoir (Haas), and then from the Balch Afterbay Dam to the Kings River (Kings River). Elevation at the north end of the project, Lake Wishon, is about 6,550 feet and the elevation is approximately 955 feet at Kings River, the southern end. Kellers Ranch is located along the south side of the Kings River is at an elevation of approximately 1,000 feet. The geology of the area is very similar to that of the Helms area, except that there are fewer glacial deposits at these lower elevations and there are several large and small remnants of Quaternary basalt flows to the east of the project (CDMG, 1965). All of the project facilities, with the exception of the southern half of the Kings River Tunnel and the Kings River Powerhouse, are founded in granodiorite bedrock (PG&E Co., 1986a).

The portion of the Kings River tunnel south of Dinkey Creek is founded in Pre-Cretaceous metamorphic rock consisting predominantly of schist, quartzite, and limestone. A part of the Dinkey Creek Siphon and the Kings River Powerhouse are situated on alluvium.

Kellers Ranch is located approximately one mile east of the Kings River Powerhouse on gently sloping terrain underlain by granodiorite. The site is mantled by unconsolidated deposits consisting predominantly of thick colluvial soils and thin stream terrace deposits.

Balch. The Balch project, including the Balch Camp Hydro Service Center, is located between and overlapping the Haas and Kings River portions of the Haas-Kings River project, and thus has very similar geology to the Haas-Kings River project. Elevation at Black Rock Reservoir is approximately 4,100 feet and approximately 1,800 feet at Balch Powerhouses #1 and #2. Elevation of the Balch Camp Hydro Service Center is approximately 1,300 feet. The Balch project area is predominantly underlain by granitics such as granodiorite, quartz diorite and quartz monzonite, with small erosional remnants of metasedimentary rocks throughout the region (CDMG, 1965; PG&E Co., 1986b). Sparse surficial unconsolidated sedimentary deposits are found in the area and include residual soils formed by decomposition of the underlying granitics, talus deposits, colluvium, and alluvium deposited along drainages and in valley bottoms. All of the project facilities, except the penstocks, are located within or upon granitic bedrock. Geologic conditions along the alignment of the penstocks vary between solid bedrock outcrops on the upper and lower ends to thick colluvial materials and decomposed granite in the central, more gently sloped portion.

Faulting and Seismicity

Helms Pumped Storage. The Helms Pumped Storage project is located in an area of low seismic activity. However, the project area may experience minor to moderate groundshaking from earthquakes on faults of the Eastern Sierra Frontal fault system and Owens Valley fault system, located approximately 25 to 40 miles east of the project (CDMG, 1994). Located approximately 25 miles east of the project the Hilton Creek-Round Valley fault is the closest active fault (Blake, 2000). The principal seismic hazard of the project area is seismically induced groundshaking originating from major active faults distant from the project area. The San Andreas fault and the Owens Valley fault, despite their distance from the site, are the most likely to produce an earthquake of sufficient magnitude affect the project area. Because the project facilities are built and founded on granitic and metamorphic bedrock there is no liquefaction hazard.

Haas-Kings River. The seismic character of the Haas-Kings River project area is very similar to the Helms project area. The Hilton Creek-Round Valley fault is also the closest fault, located approximately 30 miles east of the Haas portion of the project and approximately 45 miles east of the Kings River portion of the project. Project facilities that are situated on potentially saturated alluvial deposits may be subject to liquefaction hazards.

Balch. The seismic character of the Balch project area is very similar to the Helms project area. The Hilton Creek-Round Valley fault is also the closest fault, located approximately 35 miles east of Black Rock Reservoir (CDMG, 1994). Because the project facilities are built and founded principally on granitic and metamorphic bedrock, there is no liquefaction hazard.

Soils and Erosion

Helms Pumped Storage. Most of the project area consists of barren granitic exposures with only thin patches of soil. The little soil that is present in the area is typically shallow and poorly developed. Soils are residual, developing in-situ through the decomposition of granitic rock or transported glacial sediments. Soil depths are very irregular and highly dependent on slope steepness, degree of bedrock fracturing, and the underlying rock type (PG&E Co., 1976). Soils formed in the glacial tills are sandy loams with moderate erosion hazard. Soils derived from weathered granitics have a gravelly to cobbly loamy coarse sand texture, and have a high to very high erosion hazard (PG&E Co., 1986).

Haas-Kings River. Soils in the vicinity of the Haas area consist predominately of eight soil families: Chaix, Chawanakee, Gerle, Holland, Shaver, and Cagwin (PG&E Co., 1986). All of these soils are formed in weathered granitics. The Holland and Shaver family soils are deep, sandy to coarse sandy loams with high to very high erosion potential. The Chaix, Gerle, and Cagwin family soils are moderately deep to deep, coarse sandy loams to gravelly coarse sandy loams with moderate to high erosion hazard. The Chawanakee family soils are shallow, coarse sandy loams with high to very high erosion hazard. Areas of rock outcrop are common throughout these soil complexes and associations.

The Kings River area soils are dominated by the Ahwahnee, Auberry, Coarsegold, and Tollhouse families (PG&E Co., 1986). The Ahwahnee and Auberry soils are moderately deep to deep soils derived the underlying weathered granitic rock, consist predominately of coarse sandy loam, and have high to very high erosion hazard in the project vicinity. Auberry soils are also formed in granitic colluvial and alluvial sediments. Tollhouse soils are also derived from the underlying weathered granitics, however they are shallow with a gravelly coarse sandy loam texture and a high erosion hazard. The Coarsegold soils are derived from weathered metasedimentary rocks and consist predominantly of well-drained clay loams with a high to very high erosion hazard.

Balch. Soils in the Balch project area consist predominantly of six soil families mixed with rock outcrops. The soil families include the Auberry, Chaix, Chawanakee, Coarsegold, Holland and Tollhouse families (PG&E Co., 1986b). These soils are described above for the Haas-Kings River project area.

Other Geologic Hazards

Helms Pumped Storage. Isolated rockfalls have occurred throughout the area. Although their occurrence appears to be random in time and location, it is likely that some may be related to groundshaking from distant earthquakes and periods of heavy precipitation. Most rockfalls appear to be from areas that have been affected by erosional processes such as exfoliation and ice wedging. Rockfalls may affect the project facilities. Although the soils in the Helms vicinity have a low to moderate potential for mass soil movement, some soil sloughing has occurred on a limited scale on the shores of Courtright Lake. This shoreline sloughing is predominantly a result of wave erosion.

Haas-Kings River. Mass soil movement may occur in the project area, as they have in the past, and impact the water conveyance pipes or other facilities (PG&E Co., 1999a). Mass soil movement in the project area includes soil erosion, talus slope formation, rockfalls, sloughing and, to a lesser degree, landsliding. The mass movement potential of soils in the project area is predominantly low to moderate, with some area of moderate to high potential (PG&E Co., 1986). Talus deposits have formed at the base of most outcrop slopes in the project vicinity. Isolated rockfalls have occurred throughout the area. Most rockfalls appear to be from areas that have been affected by erosional processes such as exfoliation and ice wedging. Rockfalls may affect the project facilities. Soil sloughing has occurred along some roadcuts in areas of highly weathered rock. Two recognized landslide features are in the vicinity of the Haas-Kings River project; one is located along the eastern slope below the Kings River Penstock and the second is located on the slopes above and immediately upstream of Balch Camp. The landslide above Balch Camp, mapped by Bechtel Corporation for another project, does not pose a hazard to the Haas-Kings River Project or Balch Camp (PG&E Co., 1986).

Balch. The Balch project area is and has been subject to the same types of mass soil movements as mentioned above for the Haas-Kings River project. With the Balch project area, areas of rockfall concentration tend to be located in and below bold outcrop areas such as Patterson Bluffs and the steep-sided North Fork Kings River gorge. Rockfall deposits were removed from the Powerhouse location before construction of Powerhouse #2. Rockfalls and rockslides have been identified on the lower slopes traversed by the Balch Penstocks and are being monitored (PG&E Co., 1999).

Mineral Resources

Helms Pumped Storage. Fresno County has a long history of mineral extraction, including gold, copper, and granite. Currently, Fresno County's most significant extractable resources are aggregate and petroleum (Fresno County, 2000). However, no reported active mines or mining claims are located within or near the project area (BLM, 2000c; CDMG, 1999), and the area is not classified by CDMG as a mineral resource zone. The project area is not located within a recognized oil-producing zone.

Although no reported active mines are located within or near the project area, historic mining, primarily for tungsten, has taken place in the area since the late 1800s (PG&E Co., 1986). A small tungsten mine, the Victory Mine, which has not operated since 1943, is located approximately 1,000 feet east of Lake Wishon.

Haas-Kings River. The distribution of mineral resources and mining history of the Haas-Kings River project is very similar to that of the Helms project due to their close proximity. Regional mineral resources are discussed above for the Helms project. Tungsten has been the primary mineral commodity produced from the project region. Two inactive Tungsten mines are located near the project: the Houghton Brothers and McBride Mines.

Balch. Regional mineral resources are discussed above for the Helms project. Tungsten has been the primary mineral commodity produced from the project region. Two inactive tungsten mines are located near the project: the Garnet Dike and Quigley Mines. The Garnet Dike Mine was one of the five principal mines in the Madera, Fresno, and Tulare tungsten producing area, and operated from 1938 to 1954.

Bundle 19: Tule River (FERC 1333)

Geology and Topography

The Tule River project is located in Tulare County on the western slope of the Sierra Nevada, along the Middle Fork Tule River. Elevation of the project ranges from approximately 2,500 to 4,000 feet. The crest of the Sierra Nevada rises to an elevation of 11,000 feet approximately 40 miles east of the project. Bedrock underlying the Tule River project area consists predominantly of Mesozoic granitic rock. The northeast end of the project is underlain by older, structurally complex metamorphic rock (CDMG, 1965). Overlying the bedrock units are unconsolidated surface deposits including alluvium deposited along the drainages and in the valley bottoms, residual soils formed by decomposition of the underlying bedrock, and artificial fills used for road embankments and other structures.

The granitic terrain along the tributaries of the Middle Fork Tule River has been deeply incised by the streams, resulting in steep slopes with bold outcrops, talus deposits, and decomposed granite exposures. Most of the project facilities are located on the granitic bedrock, including the penstocks, however the powerhouse is located on alluvium deposited from the adjacent Middle Fork Tule River (PG&E Co., 1999a).

Faulting and Seismicity

The Tule River project is located in an area of California with minimal seismic activity. No known active faults cross or are within the immediate vicinity of the project area. The closest active faults to the project area are the Independence and Owens Valley faults, located approximately 40 miles to the east. The Independence fault is part of the Eastern Sierra Frontal fault system and the Owens Valley fault is part of the Owens Valley fault system. Other faults of the Eastern Sierra Frontal and Owens Valley fault systems, the White Wolf and Garlock faults south of the project, and the San Andreas fault zone to the west are also capable of producing groundshaking in the region. The principal seismic hazard of the project area is seismically induced groundshaking originating from major active faults mentioned above. The project facilities that are built and founded principally on granitic and metamorphic bedrock have no potential liquefaction hazard; however, the Powerhouse is founded on alluvium and may be subject to liquefaction hazards. (PG&E Co., 1999a).

Soils and Erosion

The Tule River project area is underlain mainly by soils of three main soil associations: the Chaix, Chawanakee, and Holland. These soil types are described in the section 4.16.4.5 Bundle 18: Kings River Soils. These typically coarse, noncohesive soils are prone to rill and gully erosion in the project area. A 1992 inspection indicated that there may be a need for minor erosion abatement due to erosion effects of the penstock on a nearby drainage swale (PG&E Co., 1999a).

Other Geologic Hazards

A large rockslide and several small debris flows are currently being monitored near the Tule Penstock. Mass wasting and soil movement such as rockfalls, rockslides, landslides, debris flows, and slumps may occur in the project area, as they have in the past, and impact the water conveyance pipes or other facilities (PG&E Co., 1999).

Mineral Resources

The principal economic mineral production in Tulare County is from clay, sand, gravel, and natural gas resources. Significant amounts of tungsten and relatively smaller amounts of other ores were mined in the past. The inactive Travertine Pool Placer mining claim located near the north end of the Tule River Tunnel, formerly mined stone. However, no reported active mines or mining claims are located within or near the project area (BLM, 2000c; CDMG, 1999), and the area is not classified by CDMG as a mineral resource zone (CDMG, 2000).

Bundle 20: Kern Canyon (FERC 0178)

Geology and Topography

The Kern Canyon project is located in Kern County at the edge southern Sierra Nevada, along the Kern River. Elevation of the project area ranges from approximately 700 to 2,600 feet. The crest of the Sierra Nevada rises to an elevation of 9,000 feet approximately 50 miles northeast of the project. A sharp northwest-southeast-trending topographic break, controlled by the Kern Gorge fault, is present at the west end of the project (CDMG, 1994). This topographic break also serves as a sharp transition from the granitic Sierran Batholith to Tertiary and Quaternary sedimentary deposits of the Sierra foothills (CDMG, 1965). Most of the Kern project area is underlain by Mesozoic granitic rock. The granitic terrain along the Kern River has been deeply incised, resulting in steep slopes with bold outcrops, talus deposits, and decomposed granite exposures. Overlying the granitic bedrock units are unconsolidated surface deposits including alluvium deposited along the drainages and in the valley bottoms, residual soils formed by decomposition of the underlying bedrock, and artificial fills used for road embankments and other structures. The Kern Canyon Powerhouse is located on alluvium where the river valley widens as it traverses the more easily eroded Tertiary and Quaternary sedimentary deposits. The associated access road is located on Miocene sandstone and siltstone and Quaternary terrace deposits (CDMG, 1965; PG&E Co., 1999a).

Faulting and Seismicity

The Kern Canyon project is located in an area of moderate seismic activity. The northwest-southeast trending Kern Gorge fault crosses the project site just north of the powerhouse and underlies the penstock. The Kern Gorge fault is a late Quaternary normal dip slip fault, which dips toward the southwest. This fault is not currently considered an active fault and is not included in the Alquist-Priolo Fault-Rupture Hazard Zone program (CDMG, 1997b). The closest active faults to the project are the Kern Front fault and the New Hope fault, located approximately 12 miles to the west. These faults have been creeping since the late 1940s due to fluid removal (oil and water) from the subsurface.

Historically, the project region experienced moderate to strong groundshaking during the Kern County Earthquake of 1952, which was located on the nearby White Wolf fault. This earthquake claimed 12 lives and caused at least $50 million in property damage. Additional damage and deaths resulted from the many strong aftershocks of this earthquake. Regional faults capable of producing moderate to strong groundshaking at project facilities include the White Wolf fault, the Plieto Thrust, the Garlock fault, and the San Andreas fault.

The principal seismic hazard of the project area is seismically induced groundshaking originating from major active faults distant from the project area. The Kern Canyon Powerhouse is situated on alluvial deposits adjacent to the Kern River and may be susceptible to liquefaction resulting from groundshaking (PG&E Co., 1999a).

Soils and Erosion

Most of the project area consists of steep granitic slopes with only thin patches of soil. The little soil that is present in the area is typically shallow and poorly developed. Soils are residual, developing in-situ through the decomposition of granitic rock. Soil depths are very irregular and highly dependent on slope steepness, degree of bedrock fracturing, and the underlying rock type.

Other Geologic Hazards

Although not mapped as an area prone to landslide hazards by the 1981 Kern County General Plan, weathered and fractured granite exposed on steep slopes throughout most of the project making the canyon walls extremely unstable (PG&E Co., 1972). The slopes above the diversion dam intake works and the penstock are prone to rockslides and rock falls. These slopes are currently being monitored (PG&E Co., 1999a).

Mineral Resources

The principal mineral resources under development in region of Kern County near the project are oil, natural gas, sand, and gravel (City of Bakersfield, 1990). Other mineral resources that have been historically mined in the area include gold, uranium, copper, and tungsten (Kern County, 1981). The Kern Canyon project is not located within or near an oil or gas producing region (Kern County, 1981) and there are no reported active mines within or near the project (BLM, 2000c; CDMG, 1999). The Kern River north of the project area is mapped as an area underlain by thermal water of sufficient temperature for direct heat applications; however, there are no mapped geothermal resources in the project area or vicinity (CDMG, 1980).

4.16.5 STANDARDS OF SIGNIFICANCE

For the purpose of this EIR, an impact is considered significant if implementation of the proposed project would:

- Expose people or structures to fault rupture[6] or strong groundshaking[7] associated with active faults;
- Create substantial risks to life or property due to the presence of expansive soils or other soil conditions that could damage structures built as part of new development;
- Expose people or structures to landslides, mudslides, or mass wasting as a result of erosion or development on unstable slopes; or
- Result in the loss of availability of mineral deposits classified as MRZ-2 by the State Geologist or mineral deposits of local value as recognized in the local General Plan.

4.16.6 ANALYTICAL METHODS

4.16.6.1 Sources of Potential Impacts

Geologic conditions can affect or be affected by activities both related to and unrelated to hydroelectric generation and use of Project Lands as well as by natural factors inherent to the remote, mountainous locations of most of the hydroelectric facilities. Hydroelectric facilities in the five regional bundles are located in regions that are underlain by faults, which create the potential for the facilities to be affected by seismic activity. Steep terrain creates an ongoing potential for slides and soil erosion to affect project facilities and lands. Some of Pacific Gas and Electric Company's hydroelectric projects and Project Lands are located in areas known to contain important mineral resources.

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6 As delineated by the State Geologist pursuant to the Alquist-Priolo Earthquake Fault Zoning Act.

7 For purposes of the impact analysis is this EIR, "strong" groundshaking is assumed to be that associated with "near-field" effects, as recognized by the CDMG (see Section 4.16.3.2, Faulting and Seismicty).

4.16.6.2 Establishment of Baseline Conditions and Method of Analysis

Information compiled to establish baseline conditions against which to compare potential effects of the project included a review of published information, site visits, and consultation with knowledgeable personnel. Available technical reports and information published by the California Division of Mines and Geology, the U.S. Geological Survey, and the U.S. Department of Agriculture Natural Resources Conservation Service, information obtained from Pacific Gas and Electric Company in response to specific data requests, geologic reports and related correspondence prepared in accordance with agency requirements regarding geotechnical issues at Pacific Gas and Electric Company facilities, timber harvest plans, land and resource management plans, county general plan documents and background reports, and various monographs were extensively used. In addition, databases managed by the Bureau of Land Management (Geographic Report), U.S. Geological Survey (Minerals Availability System and Mineral Resources Data System), and CDMG (active and inactive mines) were searched to obtain mineral resources information. Other database information reviewed included State Soil Geographic (STATSGO). Data files obtained from CDMG were used to plot the locations of geologic features, faults, mineral resource zones, and mines relative to Project Lands. The locations of such features relative to Project Lands and potential land management scenarios were identified to determine whether resources could be affected by the project, or whether land uses could be exposed to potential hazards.

The standards of significance listed above were used to evaluate project effects. The analysis of geologic and soils impacts is qualitative, and evaluates the extent to which future development of Project Lands (as described in Chapter 3) could affect or be affected by known geologic and soils conditions. The analysis also considers how changes in hydrological operations could affect implementation of existing operating and maintenance procedures that address geotechnical issues. The potential for changes in geologic conditions as a result of fewer non-binding agreements is also evaluated.

4.16.6.3 Potential Effects Considered But Not Evaluated in Detail in the Impact Analysis

Some geotechnical issues were considered for their potential to affect or be affected by the project; however, they are not analyzed in detail in this section because they would not result in any adverse effect. Information to support the conclusions for impacts dismissed from further analysis are provided below.

The development of Project Lands for the uses described in Chapter 3 would not affect local seismicity. Local seismic conditions can, in certain cases, be influenced by human activity such as injection or withdrawal of large amounts of fluids (e.g., petroleum, natural gas, groundwater, or geothermal operations), or impoundment of large volumes of surface water. However, the assumed land use changes would not involve such activities, so there would be no quantifiable risk of affecting local seismic conditions. As a result, the seismic safety of hydroelectric facilities (e.g., dams, powerhouses, and canals) in Project Lands that could be developed for new uses is not likely to be compromised. Therefore, there would be no impact, and this issue is not further evaluated in the EIR.

Pacific Gas and Electric Company dams and penstocks are regularly inspected and evaluated to determine their seismic stability under the design earthquake appropriate to each dam. These reviews, along with seismic safety analyses and emergency response plans, ensure that potential seismic safety hazards are identified and appropriately addressed. Similarly, known erosion or slope stability problems at Pacific Gas and Electric Company facilities in FERC license Areas or on Lands are being managed under the oversight of FERC. As described in Chapter 2, the assets would be transferred “as is.” There are no known aspects of the project that would alter the seismic stability of Pacific Gas and Electric Company dams and penstocks, or create or contribute to known erosion or slope stability problems at the hydroelectric facilities, and these issues are not further evaluated in the EIR.

Pacific Gas and Electric Company has not implemented a comprehensive program to evaluate the seismic stability of any of the powerhouses in the regional bundles, and they have not been retrofitted to meet current standards. As described in Chapter 2, the assets would be transferred “as is.” There are no known aspects of the project that would alter their seismic stability of the powerhouses, and this issue is not further evaluated in the EIR.

Although a few Watershed Lands at higher elevations could be subject to avalanche hazard, these areas are assumed to have minimal development potential, or they are not accessible when avalanche potential is high. Project Lands are not within potential impact zones for tsunamis. These issues are not further evaluated.

Some land areas in the Shasta Regional Bundle and DeSabla Regional Bundle could be affected by lava and mudflows, tephra and pyroclastic debris, ashfall, and smoke that could originate in the Mount Shasta/Medicine Lake-Highland/Lassen Peak volcanic area. The U.S. Geological Survey and the State monitor Lassen Peak and Mount Shasta for potential activity. The State Office of Emergency Services and counties that could be affected (Shasta, Lassen, and Plumas) also have emergency response programs addressing natural hazards. With such mechanisms in place, sufficient advance warning of renewed volcanic activity would be provided by State and local authorities to individuals in the vicinity of potential effects so that appropriate evacuation and/or emergency response procedures are implemented. Therefore, impacts would be less than significant, and this issue is not further evaluated in the EIR.

There is no evidence that changes in consumptive water use would have a direct physical impact to geologic resources, and this issue is not further evaluated in the EIR.

4.16.6.4 Potential Effects Evaluated in Other Technical Sections of this EIR

Related topics addressed in other sections include the effects of erosion and sedimentation on stream channel geomorphology, water quality, and reservoir operations (see Section 4.3, Hydrology and

Water Quality) and hazards associated with historic mining (see Section 4.9, Hazards and Hazardous Materials). Potential environmental effects of mining are evaluated in all other sections of Chapter 4.

4.16.7 INTRODUCTION TO IMPACTS AND MITIGATION MEASURES

Ten impacts have been identified for the geology, soils, and mineral resources analysis.

- Impact 16-1: The project could result in land development that could be subject to surface fault rupture (Significant).
- Impact 16-2: The project could result in land development that could increase the number of people and amount of property exposed to hazards associated with strong groundshaking on active faults (Significant).
- Impact 16-3: The project could result in land development that could result in increased soil erosion or mass wasting during construction or occupancy (Less than Significant).
- Impact 16-4: The project could result in timber harvesting operations that could result in increased soil erosion or mass wasting (Less than Significant).
- Impact 16-5: The project could result in mining operations that could result in increased soil erosion or mass wasting (Less than Significant).
- Impact 16-6: The project could result in land development on or within soils in which shrink-swell (expansion) potential, slope, or shallow depth to rock could damage structures and/or create unstable rock or soil conditions (Significant).
- Impact 16-7: The project could result in a change in hydrological operations that could affect existing informal erosion control plans, which could result in new or exacerbated erosion problems (Significant).
- Impact 16-8: The project could result in development that could limit availability of mineral resources classified as MRZ-2 by the State Geologist or important mineral lands recognized in local land use planning, or the project could cause changes in land use or hydrologic operations could result in termination of existing mining lease agreements which would reduce availability of mineral resources (Significant).
- Impact 16-9: The project could result in land development in areas where significant mineral resources may exist but have not yet been identified, causing the loss of availability of these mineral resources (Significant).
- Impact 16-10: The project could result in a change in hydrological operations and maintenance practices, which could result in new or exacerbated erosion or slope instability problems (Significant).

The following sections first state the impact, then describe its potential to affect or be affected by the proposed project. Significant impacts are identified at the individual, regional, or system-wide level, as appropriate. The justification for grouping potential effects at the regional or system-wide level or eliminating certain individual or regional bundles from further analysis in each impact is presented at the beginning of each impact discussion. Mitigation measures are recommended, if necessary, to reduce significant impacts, and the resulting level of significance is noted.

4.16.8 IMPACT 16-1: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-1: The project could result in land development that could be subject to surface fault rupture (Significant).

Alquist-Priolo Earthquake Fault Zones have been delineated by the State Mining and Geology Board at several locations in the Shasta Regional Bundle (Bundle 1: Hat Creek, and Bundle 2: Pit River Bundles), and in the Drum Regional Bundle (Bundle 10: Potter Valley), as illustrated in Figures 4.16-4 and 4.16-8. The delineation of Earthquake Fault Zones indicates there is a potential for fault rupture because of the presence of an active fault. Alquist-Priolo Earthquake Fault Zones have not been established for any other locations containing Project Lands in the DeSabla, Motherlode, and Kings Crane-Helms Regional Bundles, and no faults classified as active by CDMG occur on Project Lands in those regions. Therefore, there would be no impact related to surface fault rupture in the DeSabla, Motherlode, or Kings Crane-Helms Regional Bundles.

Surface rupture occurs when movement on a fault breaks through to the surface. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Slow surface creep can offset and deform curbs, streets, buildings, and other structures that lie on top of the fault. Sudden displacements are more damaging to structures because they are accompanied by shaking (see also Impact 16-2, below). According to information developed by the CDMG, it is impractical from an economic, engineering, and architectural perspective to design a structure to withstand serious damage from fault rupture. Once a structure is sited on an active fault, the fault-rupture hazard cannot be reduced unless the structure is relocated. Most surface faulting is confined to a relatively narrow zone a few feet to tens of feet wide, making avoidance (i.e., building setbacks) the most appropriate way to mitigate the hazard. However, in some cases, primary fault rupture along branch faults can be distributed across zones hundreds of feet wide or manifested as broad warps, suggesting that engineering strengthening or design may be useful (CDMG, 1998).

The potential hazards associated with the siting of structures in fault-rupture hazard zones can be reduced to less-than-significant levels through the implementation of State regulations (described in Section 4.16.2.2, above) and guidelines addressing the evaluation of surface fault rupture. Recommendations to reduce the hazard identified may include, but would not be limited to, setback distances, structural engineering measures, and risk evaluation, or other appropriate measures identified in the site-specific geologic report that must be prepared.

4.16.8.1 Impact 16-1: Shasta Regional Bundle

Bundle 1: Hat Creek -- Hat Creek 1 and 2 (FERC 2661)

The land development assumptions indicate development could occur at one location in Bundle 1 (Hat Creek land area west of Rising River Lake), as shown in Figure 3-12. An Alquist-Priolo Earthquake Fault Zone has been delineated in one parcel in that land area, as shown in

Figure 4.16-4. Land development could result in the construction of roadways and other infrastructure to support the new uses.

The type and location of development that would occur on parcels where Earthquake Fault Zones have been delineated has not been determined in Bundle 1. The Earthquake Fault Zone mapping does not identify the site-specific hazard, such as the type, potential for displacement, or relative risk. As such, it would be inappropriate to identify site-specific effects, or describe recommended measures to mitigate fault rupture hazard. Therefore, it is assumed that implementation of the project could result in exposure of people and property to hazards associated with fault rupture in Bundle 1 (Hat Creek). This is considered a significant impact.

Bundle 2: Pit River -- Pit 1 (FERC 2687)

The land development assumptions indicate development could occur in Bundle 2 in the McArthur Swamp Land Area, Lake Britton land area, and Hat Creek land area, as shown in Figure 3-12. Alquist-Priolo Earthquake Fault Zones cross one or more parcels in those land areas, as shown in Figure 4.16-4. As with Bundle 1, land development could result in the construction of roadways and other infrastructure to support the new uses. However, as described for Bundle 1, the type and location of development that would occur on parcels where Earthquake Fault Zones have been delineated has not been determined for parcels that could be developed in Bundle 2. Therefore, it is assumed that implementation of the project could result in exposure of people and property to hazards associated with fault rupture in Bundle 2 (Pit River). This is considered a significant impact.

Summary of Impact 16-1: Entire Shasta Regional Bundle

There are four locations in the Shasta Regional Bundle where development could occur that could be subject to surface fault rupture. This is considered a significant impact.

4.16.8.2 Impact 16-1: DeSabla Regional Bundle

There are no Alquist-Priolo zones in the DeSabla Regional Bundle; therefore, there would be no impact.

4.16.8.3 Impact 16-1: Drum Regional Bundle

Bundle 10: Potter Valley (FERC 77)

The land development assumptions indicate development could occur at Lake Pillsbury, where Alquist-Priolo Earthquake Fault Zones are present in some parcels in the Lake Pillsbury land area, as shown in Figure 4.16-4. As described for Bundles 1 and 2, the type and location of development that would occur on parcels where Earthquake Fault Zones have been delineated has not been determined for parcels that could be developed. Therefore, it is assumed that implementation of the project could result in exposure of people and property to hazards associated with fault rupture in Bundle 10 (Potter Valley). This is considered a significant impact.

Summary of Impact 16-1: Entire Drum Regional Bundle

There is one location in the Drum Regional Bundle (Bundle 10: Potter Valley Project at Lake Pillsbury) where development could occur that could be subject to surface fault rupture. This is considered a significant impact.

4.16.8.4 Impact 16-1: Motherlode Regional Bundle

There are no Alquist-Priolo zones in the Motherlode Regional Bundle; therefore, there would be no impact.

4.16.8.5 Impact 16-1: Kings Crane-Helms Regional Bundle

There are no Alquist-Priolo zones in the Kings Crane-Helms Regional Bundle; therefore, there would be no impact.

4.16.8.6 Evaluation of Impact 16-1 to Entire System

As described above, implementation of the project could result in exposure of people and property to hazards associated with surface fault rupture in three bundles, Bundle 1 (Hat Creek), Bundle 2 (Pit River), and Bundle 10 (Potter Valley). This is considered a significant impact. There would be no impact to DeSabla, Motherlode, and Kings Crane-Helms Regional Bundles because there are no faults classified as active by CDMG within Project Lands and no Earthquake Fault Zones delineated by the State Geologist for areas containing Project Lands.

4.16.8.7 Impact 16-1: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

Implement requirements and standards established under the provision of the Alquist-Priolo Earthquake Fault Zoning Act.

Mitigation Measures Identified in this Report

Mitigation Measure 16-1a*:* There shall be no development within the Alquist-Priolo Earthquake Fault Zones in Bundles 1, 2, and 10.

Mitigation Measure 16-1b: Prior to approval of development within Bundle 1, Bundle 2, or Bundle 10, geologic reports shall be prepared and recommendations identified in the geologic report consistent with the then most recent Guidelines for Evaluating the Hazard of Surface Fault Rupture (CDMG Note 49) shall be implemented.

Alternate Mitigation Measure 16-1: As an alternative to Mitigation Measures 16-1a and 16-1b, above, prior to or concurrent with the transfer of title for Bundles 1, 2, or 10, there shall be recorded against the lands within the bundle conservation easements running with the land and (in a form and substance approved by the CPUC) precluding any further land use development, or expansion of timber harvest or mineral extraction activities.

Impact 16-1: Level of Significance After Mitigation

Implementation of Mitigation Measures 16-1a and 16-1b would reduce the impact to a *less than significant level.* Alternatively, implementation of Alternate Mitigation Measure 16-1b would eliminate the impact.

4.16.9 IMPACT 16-2: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-2: The project could result in land development that could increase the number of people and amount of property exposed to hazards associated with strong groundshaking on active faults (Significant).

The project could result in the development of residential, commercial, recreational, or other uses, as described in Chapter 3. Due to their location in California, all of the Watershed Lands are susceptible to groundshaking due to earthquakes on regional or local faults. Some locations, as shown in Figure 4.16-3 may experience more intense groundshaking than others. Effects of groundshaking could range from displacement of small objects, cracking or falling of building materials or walls, to major structural damage or collapse. Small slides or cave-ins along gravel banks are also possible. Landslides or rockfalls in rugged terrain, where steep slopes and highly erodible soils are present (e.g., many locations in the five bundles) or rupture of underground utility lines could also occur. Secondary effects, such as liquefaction or lurch cracking, could also occur, which could result in damage or injury.

Land use changes would increase the number of people and property exposed to groundshaking. The magnitude of the potential effect within each individual bundle or regional bundle would vary depending on the intensity and kind of land development (and the additional number of people and property at risk) and the estimated groundshaking hazard at each location. Prior to the issuance of building permits and occupancy, State regulations and local standards require that a geotechnical study be prepared to identify site-specific seismic conditions that could affect site development, and that buildings, structures, and facilities be designed in accordance with applicable CBC criteria for the location and types of structures. These studies would also identify the potential for liquefaction, settlement, lurch cracking or other secondary hazards. Implementation of such measures would reduce the potential for life safety and property hazards to new development as a result of groundshaking.

4.16.9.1 Impact 16-2: Shasta Regional Bundle

The two bundles that have areas where potential development could be affected by strong groundshaking are addressed below.

Bundle 1: Hat Creek -- Hat Creek 1 and 2 (FERC 2661)

The land development assumptions indicate development could occur at one location in Bundle 1 (west of Rising River Lake). Alquist-Priolo Earthquake Fault Zones cross one or more parcels in that land area, as shown in Figure 4.16-4 (see also Impact 16-1). The location of such development has not been determined relative to the location of the active fault, so new development could, therefore, be subject to strong groundshaking associated with near-field effects. This is considered a significant impact.

Bundle 2: Pit River -- Pit 1 (FERC 2687)

The land development assumptions indicate development could occur at three locations in Bundle 2 (Lake Britton, Horr Pond, and Big Lake). Alquist-Priolo Earthquake Fault Zones cross one or more parcels in that land area, as shown in Figure 4.16-4 (see also Impact 16-1). As with Bundle 1, development could be exposed to strong groundshaking. This is considered a significant impact.

Summary of Impact 16-2: Entire Shasta Regional Bundle

There are four locations in the Shasta Regional Bundle where development could occur that could be subject to strong groundshaking. This is considered a significant impact.

4.16.9.2 Impact 16-2: DeSabla Regional Bundle

There are no active faults in the DeSabla Regional Bundle that could result in strong groundshaking. As discussed in section 4.16.4.2, the DeSabla Regional Bundle has been subjected to recent and intense seismic activity including the eruption of Lassen Peak in 1915 and major earthquakes as recently as 1969. Although Project Lands could be subject to groundshaking effects from seismic activity on nearby faults or volcanic, groundshaking is not expected to be strong, based on current scientific knowledge of identified faults, seismicity, and tectonic framework of California. Measures implemented in accordance with the CBC would be sufficient to mitigate potential hazards on Watershed Lands that could be developed. Therefore, impacts would be less than significant for Bundles 5 through 8.

4.16.9.3 Impact 16-2: Drum Regional Bundle

There are no active faults in Bundles 9, 11, or 12. Although Project Lands could be subject to groundshaking effects from seismic activity on nearby faults, groundshaking is not expected to be strong, based on current scientific knowledge of identified faults, seismicity, and tectonic framework of California. Measures implemented in accordance with the CBC would be sufficient to mitigate potential hazards on Watershed Lands that could be developed. Therefore, impacts would be less than significant for Bundles 9, 11, and 12.

Bundle 10: Potter Valley -- Potter Valley (FERC 0077)

As discussed in Impact 16-1, above, the active Bartlett Springs fault extends into a portion of Watershed Lands at the north end of Lake Pillsbury, where the land use assumptions indicate some development could occur. Development within that area could be subject to strong groundshaking. This is considered a significant effect.

Summary of Impact 16-2: Entire Drum Regional Bundle

There is one location in the Drum Regional Bundle where development could occur that could be subject to strong groundshaking. This is considered a significant impact.

4.16.9.4 Impact 16-2: Motherlode Regional Bundle

There are no active faults in the Motherlode Regional Bundle. Although Project Lands could be subject to groundshaking effects from seismic activity on nearby faults, groundshaking is not expected to be strong, based on current scientific knowledge of identified faults, seismicity, and tectonic framework of California. Measures implemented in accordance with the CBC would be sufficient to mitigate potential hazards associated with land development that could occur on Watershed Lands. Therefore, impacts would be less than significant for Bundles 13, 14, and 15.

4.16.9.5 Impact 16-2: Kings Crane-Helms Regional Bundle

There are no active faults in the Kings Crane-Helms Regional Bundle. Although Project Lands could be subject to groundshaking effects from seismic activity on regional active faults, groundshaking is not expected to be strong, based on current scientific knowledge of identified faults, seismicity, and tectonic framework of California. Measures implemented in accordance with the CBC and local County regulations would be sufficient to mitigate potential groundshaking hazards to people and property on Watershed Lands that could be developed. Therefore, impacts would be less than significant for Bundles 16 through 20.

4.16.9.6 Evaluation of Impact 16-2 to Entire System

As described above, implementation of the project could result in exposure of people and property to hazards associated with strong groundshaking in three bundles, Bundle 1 (Hat Creek), Bundle 2 (Pit River), and Bundle 10 (Potter Valley). This is considered a significant impact. There would be no impact to DeSabla, Motherlode, and Kings Crane-Helms Regional Bundles because there are no faults classified as active by CDMG within Project Lands that are assumed to generate near-field groundshaking effects.

4.16.9.7 Impact 16-2: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

Implement seismic safety requirements set forth in the California Building Code.

Mitigation Measures Identified in This Report

Mitigation Measure 16-2: New development in Bundles 1,2 and 10 shall not be sited in areas subject to near-field effects, or to other such locations that may be subject to strong groundshaking and related secondary effects as identified through site-specific geotechnical studies prepared in accordance with UBC/CBC standards.

Alternate Mitigation Measure 16-2: As an alternative to Mitigation Measure 16-2, above, prior to or concurrent with the transfer of title for Bundles 1, 2, and 10, there shall be recorded against the lands within the bundle conservation easements running with the land and (in a form and substance approved by the CPUC) precluding any further land use development, or expansion of timber harvest or mineral extraction activities.

Impact 16-2: Level of Significance After Mitigation

Implementation of Mitigation Measure 16-2 would reduce the impact to a less than significant level. Implementation of Alternate Mitigation Measure 16-2 would eliminate the impact altogether.

4.16.10 IMPACT 16-3: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-3: The project could result in land development that could result in increased soil erosion or mass wasting during construction or occupancy (Significant).

The project could result in the development of Project Lands for residential, commercial, recreational or other uses, within all five bundles, as described in Section 3.9.2, Future Land Development Assumptions. The following discussion provides an overview of the potential effects. Site-specific issues are presented for each regional bundle.

Grading and removal of vegetation for construction of roads and building pads would leave soil exposed to erosional processes during construction activities. Runoff from construction sites could contain soils and sediments. During storm events, erosion could occur at accelerated rates. Wind could also transport loose, exposed sediments from the construction areas. The increased erosion potential could result in short-term water quality impacts if sediments were carried to waterways. Unstabilized slopes would be subject to increased erosion, which could lead to increased risk of slides that could damage property and present a life safety risk. Short-term erosion effects during construction could be mitigated to less-than-significant levels through the preparation of required stormwater pollution prevention and water quality management plans, and implementation of structural and non-structural best management practices (BMPs) consistent with local grading and erosion control requirements. Examples of temporary BMPs utilized during construction are sediment traps and barriers, soil stabilizers, erosion control geotextiles, and dust control.

Post-construction erosion could create an increase in volume and velocity of surface runoff. Replacement of exposed ground with impervious surfaces such as roads, building roofs, and parking areas would reduce stormwater infiltration, allowing more runoff over potentially erodible soils. Increased travel on new and current unpaved roads for recreational uses could result in roadbed erosion and wind-born dust and sediment. As with construction, such effects could occur regardless of ownership as lands are converted to new uses. Implementation of permanent erosion control BMPs such as sediment traps and barriers, soil stabilizers, erosion control geotextiles, and seeding and planting of stabilizing vegetation would help minimize effects. Proper management of cut and fill slopes in accordance with UBC/CBC requirements and local requirements would also reduce the potential for erosion that could lead to slope stability problems.

4.16.10.1 Impact 16-3: Shasta Regional Bundle

Soils in all four bundles in the Shasta Regional Bundle are characterized as having moderate to high erosion hazard. Erosion and mass wasting could result throughout the Shasta Watershed but would have the highest occurrence potential in Bundles 1 and 2, particularly Project Lands associated with the Hat Creek Watershed Lands in the Pit 3, 4, and 5 FERC License, and around Lake Britton. These areas have the highest potential for erosion impacts because of the amount of land that could be disturbed to accommodate the number of Equivalent Dwelling Units (EDUs). This is considered a significant impact.

4.16.10.2 Impact 16-3: DeSabla Regional Bundle

Similar to the Shasta Regional Bundle, erosion and mass wasting could result throughout the DeSabla Regional Bundle, but would have the highest occurrence potential in Bundles 5, 6, and 7, particularly in the Lake Almanor/Mountain Meadows and Hamilton Branch Watershed Lands in Bundles 5 and 6, and around Bucks Lake. Similar to the Shasta Regional Bundle, the amount of land disturbance to accommodate the intensity of development would result in a risk of erosion. Implementation of Shasta and Tehama County grading and erosion control ordinances applicable to discretionary projects, combined with construction and post-construction BMPs (as defined in Mitigation Measure 16-3) would reduce potential impacts to less-than-significant levels.

4.16.10.3 Impact 16-3: Drum Regional Bundle

Moderate to highly erosive soils are present throughout Project Lands in the Drum Regional Bundle where land development could occur. The potential for mass wasting, i.e. landslides and rockslides, could be increased by construction of new developments and associated infrastructure in areas already susceptible to mass wasting by increasing the amount of soil exposed to erosive conditions. Increased vehicle activity on unpaved roads in new or expanded recreational facilities, if any, could also increase erosion potential. The amount of land that could be disturbed in Bundle

11 (South Yuba-Bear) to accommodate potential development could result in an increased magnitude of this effect, as compared to Bundles 9, 10, and 12, where less development is assumed. This impact is potentially significant but implementation of Nevada, Placer, El Dorado, Yuba, Lake, and Mendocino County grading and erosion control ordinances applicable to discretionary projects, combined with construction and post-construction BMPs (as required in Mitigation Measure 16-3) would reduce potential impacts to less-than-significant levels.

4.16.10.4 Impact 16-3: Motherlode Regional Bundle

Moderate to highly erosive soils are present throughout Project Lands in the Kings Crane-Helms Regional Bundle. However, the amount of land that could be disturbed compared to the number of EDUs that could be constructed is relatively limited. Although localized effects could occur (primarily as a result of construction), it would not be of substantial magnitude. Impacts are potentially significant but could be mitigated to less than significant levels through BMPs (Mitigation Measure 16-3) and implementation of local grading and erosion control requirements adopted by Amador, Calaveras, Tuolumne, Alpine, Mariposa, and Merced Counties.

4.16.10.5 Impact 16-3: Kings Crane-Helms Regional Bundle

Moderate to highly erosive soils are present throughout Project Lands in the Kings Crane-Helms Regional Bundle. However, the assumptions in Chapter 3, indicate that based on factors such as steep topography, remote locations, and limited access, areas of potential significant development are limited. Impacts are potentially significant impacts but could be mitigated to less than significant levels through BMPs (Mitigation Measure 16-3) and implementation of local grading and erosion control requirements established at the County level.

Evaluation of Impact 16-3 to Entire System

Land development that could occur in the five regional bundles has the potential to result in significant impacts from erosion during construction and occupancy. Potential effects could be reduced to less than significant levels through implementation of Mitigation Measure 16-3 (BMPs) and County grading and erosion control requirements.

4.16.10.6 Impact 16-3*:* Mitigation Measures

Mitigation Measures Proposed as Part of the Project

Implement county ordinances pertaining to grading and erosion control.

Mitigation Measures Identified in This Report

Mitigation Measure 16-3: Prior to the transfer of title for any bundle, Pacific Gas and Electric Company shall demonstrate that the new owner has received and reviewed the existing Best Management Practices (BMPs) of Pacific Gas and Electric Company for that particular bundle that relate to erosion control, geotechnical procedures, and slope stability, and the new owner shall either (i) commit in writing to adhere to those pertinent all such existing BMPs, or (ii) submit to the CPUC for its review and approval, and obtain approval of, substitute Best Management Practices that are protective of the environment to an equal or greater degree then Pacific Gas and Electric Company's existing BMPs.

4.16.10.7 Impact 16-3: Level of Significance After Mitigation

Less than significant.

4.16.11 IMPACT 16-4: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-4: The project could result in timber harvesting operations that could result in increased soil erosion or mass wasting (Less than Significant).

4.16.11.1 Evaluation of Impact 16-4 to Entire System

The timber harvest assumptions in Chapter 3 indicate that the project could result in the increased production of timber in all five regional bundles. Of the five bundles, the Kings Crane-Helms Regional Bundle is assumed to have the least amount of timber harvesting. Because timber harvesting is assumed to occur in all five bundles, and because of the regulatory framework in place to regulate such operations (which apply throughout the five bundles), this impact is discussed at the system-wide level. It is not any more or less likely that the significance level of timber harvesting erosion effects would be greater in one regional bundle than another, although the magnitude of the effect would vary depending on the acreage disturbed and the methods used to harvest (i.e., selective harvesting or clear-cutting).

Similar to erosion effects described above, the removal of vegetation and grading for construction of logging roads, landing sites, and other logging practices would leave soil exposed to erosional processes during timber harvesting activities. During periods of heavy precipitation and storm events, erosion could occur at accelerated rates. Destablized slopes from construction or timber harvesting methods could be subject to increased erosion, which could lead to an increased risk of slides. Reactivation of previous landslides could also occur if such areas are undermined. Runoff from exposed slopes within the harvesting site could contain soils and sediments, which could result in short- or long-term water quality effects if soils and sediments were carried to waterways.

All timber harvesting operations must adhere to the California Forest Practice Regulations, which require identification of erosion hazards, methods of removal that account for site-specific soils and slope conditions, mitigation measures for erosion and slope instability, road design and construction, and measures to prohibit sedimentation and erosion near watercourses. Periodic inspections by CDF would also ensure plan conditions and control measures are implemented. Furthermore, the amount of timber harvesting that could occur on divested lands compared to the amount of timber production that occurs State-wide is assumed to be minimal. As discussed in Chapter 3, it is assumed that all timber harvesting as projected for the next five years would comply with Forest Practice Rules. Implementation of adopted regulations, standards, and practices, which are summarized in Section 4.16.2.2, would minimize the erosional effects of timber harvesting to the extent required by State laws and regulations.

Therefore, timber harvesting that could occur with the project would not expose people or structures to landslides or mass wasting as a result of erosion or disturbance of unstable slopes, and impacts would be less-than-significant for the entire system.

4.16.11.2 Impact 16-4: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

Implement regulations and standards established under the Forest Practices Act (CCR Title 14).

Mitigation Measures Identified in this Report

None proposed.

4.16.11.3 Impact 16-4: Level of Significance After Mitigation

Less than significant.

4.16.12 Impact 16-5: Impact, Analysis, and Mitigation

Impact 16-5: The project could result in mining operations that could result in increased soil erosion or mass wasting (Less than Significant).

The assumptions in Chapter 3 indicate mining could occur in two locations: Bundles 1 and 2 and Bundle 14. Similar to timber harvesting, mining has the potential to cause erosion and slope stability problems, which are described below. As described in Chapter 3, no mining is assumed for the Drum Regional Bundle (Bundles 9 through 12), Motherlode Regional Bundle (Bundles 13 and 15), and Kings Crane-Helms Regional Bundle. Therefore, there would be no impact for these individual bundles.

4.16.12.1 Impact 16-5: Shasta Regional Bundle

Bundle 1: Hat Creek -- Hat Creek 1 and 2 (FERC 2661)

The assumptions in Chapter 3 indicate the proposed project could include mining on northernmost Project Lands in Bundle 1. As illustrated in Figure 4.16-5, the most likely commodity that could be mined is diatomaceous earth. The diatomaceous earth deposits that could be mined may be present on hillsides (such as in the vicinity of Lake Britton) or subsurface. Depending on the type of mining, amount of overburden requiring removal, and local geologic and soils conditions, extraction operations could increase the potential for hillside erosion, which could increase the risk for slope instability. Subsurface excavation with cut slopes, if any, could undermine the integrity of adjacent land. Existing or future land uses could be subject to these potential adverse effects.

Following extractive activities, unreclaimed slopes and excavations could present additional hazards.

However, as described in Section 4.16.2.2 above, mining activities in California are subject to the mining and reclamation requirements set forth in Title 14 of the California Code of Regulations, which require that adverse effects of mining be prevented or minimized. Performance standards set forth in State mining regulations, which must be implemented at the local level in Shasta County, include erosion control and slope stabilization. Shasta County General Plan policies also provide a comprehensive framework for ensuring mining activities are managed in an environmentally sound manner. This would ensure mining operations would not expose people or structures to unstable soil or geologic conditions.

Given the regulatory system in place governing mining, potential effects from mining would not expose people or structures to landslides or mass wasting as a result of erosion or disturbance of unstable slopes. Therefore, the impact is considered less than significant for Bundle 1.

Bundle 2: Pit River -- Pit 1 (FERC 2687)

FERC license areas and Watershed Lands between Pit 1 Powerhouse and Pit 3 Powerhouse are classified as MRZ-2 for diatomaceous earth. The assumptions in Chapter 3 indicate all of the parcels could be mined. Although the specific locations and volume of material that could be mined have not been determined, it is assumed mining activities would be similar to those described for Bundle 1. Potential effects would be similar to those described for Bundle 1 but could be greater in magnitude, as the land area that could be mined is considerably larger. Nonetheless, because of the regulatory system in place that is intended to reduce the environmental effects of mining, the impact is considered less than significant for Bundle 2 for the reasons described above.

Summary of Impact 16-5: Entire Shasta Regional Bundle

Based on the assumptions presented in Chapter 3, mining could occur in several locations in Bundles 1 and 2. The potential effects of mining on erosion and potential slope stability problems would be reduced to less-than-significant levels through implementation of an existing regulatory framework administered at the local level.

4.16.12.2 Impact 16-5: DeSabla Regional Bundle

No mining is assumed for the DeSabla Regional Bundle, so there would be no impact.

4.16.12.3 Impact 16-5: Drum Regional Bundle

No mining is assumed for the Drum Regional Bundle, so there would be no impact.

4.16.12.4 Impact 16-5: Motherlode Regional Bundle

Bundle 14: Stanislaus River

The assumptions in Chapter 3 indicate that Parcel APN 22-11-17 (Tuolumne County) could include quartz mining. Quarrying activities for quartz could include hillside extraction or subsurface extraction. Similar to Bundles 1 and 2, potentially significant effects could be reduced to less-than-significant levels through implementation of State and local requirements applicable to mining.

Summary of Impact 16-5: Entire Motherlode Regional Bundle

Mining is assumed to occur at one parcel in Bundle 14. The potential effects of mining on erosion and potential slope stability problems would be reduced to less-than-significant levels through implementation of the existing regulatory framework, as described above.

4.16.12.5 Impact 16-5: Kings Crane-Helms Regional Bundle

No mining is assumed for the Kings Crane-Helms Regional Bundle, so there would be no impact.

4.16.12.6 Evaluation of Impact 16-5 to Entire System

Based on the assumptions in Chapter 3, mining could occur in the Shasta Regional Bundle and in the Motherlode Regional Bundle. The potential effects of mining on erosion and potential slope stability problems would be reduced to less-than-significant levels through implementation of the existing regulatory mechanisms at the State and local levels.

4.16.12.7 Impact 16-5: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

Implement regulations and standards established under the Surface Mining and Reclamation Act (SMARA, California Code of Regulations, Title 14, Division 2, Chapter 8)

Mitigation Measures Identified in this Report

None proposed.

Impact 16-5: Level of Significance After Mitigation

Less than significant.

4.16.13 Impact 16-6: Impact, Analysis, and Mitigation Measures

Impact 16-6: The project could result in land development on or within soils in which shrink-swell (expansion) potential, slope, or shallow depth to rock could damage structures and/or create unstable rock or soil conditions (Significant).

The project could result in the development of Project Lands for residential, commercial, recreational, timber harvesting, mining, or other uses, within all five bundles, as described in Chapter 3. The following discussion provides an overview of the potential effects related to adverse soils conditions. Site-specific issues are presented for each bundle.

Expansive Soils (Shrink-Swell Potential). Development on Watershed Lands in locations where expansive soils are present can expose structures and future occupants to hazards associated with expansive soils. Expansive soils are those that greatly increase in volume when they absorb water and shrink when they dry out. Expansion can cause damage to building foundations, floor slabs, utility lines such as water and sewer, or roadways if volume changes due to moisture variations occur in the subgrade materials. Prior to the issuance of building permits and occupancy, CBC and local standards require that a geotechnical study be prepared to identify site-specific problems with expansive soils and that project construction and design incorporate appropriate measures to minimize risk.

Slope. Most of the Watershed Lands that could be developed are situated in rugged terrain in the mountains and foothills. Consequently, slopes greater than 30 percent are present in many locations in Project Lands. Development of Project Lands involving construction on steep slopes could result in increased erosion potential, and structures could be subject to greater damage potential associated with slope instability or failure during earthquakes or as a result of water infiltration. Application of large amounts of water to lawns, shrubs, and other plants, such as that which could occur for a large housing development, could cause groundwater to accumulate in the subsurface, causing land slippage, particularly in the case of steeper slopes. Development of Project Lands for future uses such as housing or recreational facilities would be subject to review and approval by local planning and building departments as part of building permit issuance and submittal of geotechnical reports required by the CBC.

Shallow Depth to Rock. Shallow depth to rock can be a limiting factor for site development on Watershed Lands. Soils that are shallow over bedrock typically present problems in construction roadways and laying pipelines. Shallowness of soils, combined with very slow to moderate permeability throughout soils at a site, could also present severe constraints to landscaping and revegetation, and reduce the effectiveness of septic systems. Depending on the extent of the problem, erosion could occur unless new sloped areas are stabilized by vegetative material or other protective devices. Blasting could be necessary to remove bedrock, which could result in unintended fracturing of nearby or off-site rock materials or cause slides. Site-specific problems and recommended construction and design methods to effectively manage shallow soil conditions would be identified as part of required geotechnical studies required by the CBC.

4.16.13.1 Impact 16-6: Shasta Regional Bundle

Summary of Impact 16-6: Entire Shasta Regional Bundle

Major site development soils concerns in the Shasta Regional Bundle are shrink-swell potential, erosion hazard (depending on the slope), and vegetation cover. In addition to erosion hazard and high shrink-swell potential, slope, coarse texture and shallow depth to bedrock have been identified as additional potential site development soils concerns in Bundle 2, where the assumed density of development could require a moderate amount of earth-disturbing activity or siting of structures in locations where potential soils- and slope-related hazards could exist. Diatomaceous earth deposits where exposed may form areas of highly erosive soil in these two bundles. Although slopes in excess of 30 percent are not present in land areas that could be developed, some soils in Bundle 3 are particularly sensitive to mass movement. Soil characteristics could increase the potential for soils- and slope-related problems that could be created by cut-and-fill slopes and grading associated with new development, or development could be exposed to potential slope instabilities. Therefore, this is considered a significant impact for the entire regional bundle.

4.16.13.2 Impact 16-6: DeSabla Regional Bundle

Summary of Impact 16-6: Entire DeSabla Regional Bundle

Erosive or expansive soils characteristics, unstable slopes, and shallow depth to rock could increase the potential for geologic hazards at development sites in the DeSabla Regional Bundle, which is considered a significant impact. It should be noted, however, areas where soils constraints have been identified would not involve a substantial amount of new development relative to the amount of acres that could be disturbed, so the magnitude of the effect would be limited.

4.16.13.3 Impact 16-6: Drum Regional Bundle

Bundle 9: North Yuba River -- Narrows (FERC 1403)

Moderately expansive soils are present at the Narrows-Lake Englebright land area, which can be adequately managed through implementation of UBC/CBC requirements and building codes. There are no slopes exceeding 30 percent in lands that could be developed in Bundle 9. Although surface soils are thin, development potential is assumed to be limited in the FERC license area, so minimal effects related to shallow depth to bedrock would occur. Therefore, this is considered a less-than-significant impact.

Bundle 10: Potter Valley (FERC 0077)

Soils with low to moderate expansion potential are present in some locations in Bundle 10 where development could occur, primarily assumed to be in the Lake Pillsbury area. As with Bundle 9, expansive soils would be managed as part of regular site development. Slopes in excess of 30 percent are scattered throughout the western part of the Lake Pillsbury land area and eastern part of the Van Arsdale Reservoir/Potter Valley area in heavily forested and steep terrain, where development would be unlikely to occur. Shallowness of soils has not been identified as a constraint to development. The low number of units relative to the large amount of acreage that could be disturbed in any of the land areas where such conditions are present suggest that the potential magnitude of these soils-related effects would be limited. Therefore, impacts would be less than significant.

Bundle 11: South Yuba River -- Drum-Spaulding (FERC 2310)

Soils in the Kidd Lake/Cascade Lakes land area have high expansion potential. All other areas in the South Yuba-Bear Bundle have low to moderate expansion potential. In any case, implementation of UBC/CBC requirements would mitigate potential hazards related to expansive soils. Slopes in excess of 30 percent are present in a few locations near the Drum powerhouses and Dutch Flat land areas. Depth to bedrock could affect site development. The land use assumptions indicate a higher density of development could occur in these areas, as compared to other locations in the Drum Regional Bundle, resulting in increased opportunities for construction in areas with potential hazards. Site-specific information has not been determined, so methods to control potential hazards have not been identified. This could create substantial risks to life or property due to the presence of expansive soils or other soil conditions that could damage structures built as part of new development. Therefore, this is considered a significant impact.

Bundle 12: Chili Bar -- (FERC 2155)

Soils in the Chili Bar project exhibit low to moderate expansion potential. Although slopes are steep and bedrock is near-surface, minimal development that could increase the risk of adverse soils effects are expected. Therefore, impacts are considered less than significant.

Summary of Impact 16-6: Entire Drum Regional Bundle

Development in Bundle 11 (South Yuba-Bear) could result in significant effects related to development on soils with high expansion potential, steep slopes, or shallow depth to rock. Although some site development could occur in Bundles 9, 10, and 12, potential effects are expected to be minimal due to the amount of development relative to the amount of land that could be disturbed where soil constraints may exist.

4.16.13.4 Impact 16-6: Motherlode Regional Bundle

Bundle 13: Mokelumne River (FERC 137)

Soils exhibit low to moderate expansion potential in Mokelumne Project Lands. Similar to Drum Regional Bundle, implementation of standard UBC/CBC requirements pertaining to expansive soils would reduce potential hazards. Slopes in excess of 30 percent are present in the majority of FERC license areas and Watershed Lands, and shallow depth to rock has been identified as a development constraint. The low number of units relative to the large amount of acreage that could be disturbed in any of the land areas where such conditions are present suggest that the potential magnitude of these soils-related effects would be limited. Further, implementation of Amador County requirements pertaining to grading, slopes, and cut surfaces, as established in adopted ordinances, would also help minimize effects. Therefore, impacts are considered less than significant.

Bundle 14: Stanislaus River -- Stanislaus River (FERC 2130) and Phoenix (FERC 1061)

Similar to Bundle 13**,** soils exhibit low to moderate expansion potential. Although slopes exceeding 30 percent are present in Project Lands, such slopes are not generally present in Watershed Lands where development could occur. The low number of units relative to the large amount of acreage that could be disturbed in any of the land areas suggest that the potential magnitude of the soils-related effects, if any, would be limited. Implementation of Tuolumne County grading standards would help reduce potential effects. Therefore, impacts are considered less than significant.

Bundle 15: Merced River -- Merced Falls (FERC 2467)

There are no significant soil geotechnical constraints identified for Project Lands in the Merced River Bundle. The amount of development would be limited. Therefore, impacts would be less than significant.

Summary of Impact 16-6: Entire Motherlode Regional Bundle

Development in Bundle 13 (Mokelumne River) could result in significant effects related to development on soils with high expansion potential, steep slopes, or shallow depth to rock. Although some site development could occur in Bundles 14 and 15, potential effects are expected to be minimal due to the amount of development relative to the amount of land that could be disturbed where soil constraints may exist, or because soil constraints are minimal. The overall impact to the Motherlode Regional Bundle would be less than significant.

4.16.13.5 Impact 16-6: Kings Crane-Helms Regional Bundle

Soils in the Kings Crane-Helms Regional Bundle primarily have a low expansion potential. Soils with moderate expansion potential are locally present in Bundles 16 and 18. However, no potentially developable Project Lands are located within these areas of moderate soil expansion potential. Although not expected, any expansive soils encountered during site development could be managed as part of regular site development. Slopes in excess of 30 percent are common throughout the Kings Crane-Helms Regional Bundle. However, based on assumptions in Chapter 3, no or little potential development would occur in these areas. Shallowness of soils has not been identified as a constraint to development. The limited amount and area that could be potentially developed relative to the large amount of acreage that could be disturbed in any of the land areas where such conditions are present suggest that the potential magnitude of these soils-related effects would be limited. Therefore, impacts would be less than significant for Bundles 16 through 20.

4.16.13.6 Evaluation of Impact 16-6 to Entire System

Development in all five bundles could result in significant effects related to development on soils with high expansion potential, steep slopes, or shallow depth to rock. This is considered a significant impact.

4.16.13.7 Impact 16-6: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

Implement County grading and erosion control ordinances, CBC standards pertaining to expansive soils, and applicable State and local requirements pertaining to use of explosives for blasting.

Mitigation Measures Identified in This Report

Mitigation Measure 16-6: In Bundles 1 through 8, 11, and 13, avoid development of new structures and associated infrastructure on slopes in excess of 30 percent unless it can be demonstrated through geotechnical engineering studies prepared in accordance with State regulations and local standards that development will not adversely affect site conditions. Development on unstable or steep slopes shall not occur unless appropriate cut-and-fill methods and slope stabilizing measures have been identified, and approved by the local building authority. All grading shall be prepared in accordance with local grading and erosion control ordinances.

Alternate Mitigation Measure 16-6: As an alternative to Mitigation Measure 16-6, above, prior to or concurrent with the transfer of title for Bundles 1 through 8, 11 and 13, there shall be recorded against the lands within the bundle conservation easements running with the land and (in a form and substance approved by the CPUC) precluding any further land use development, or expansion of timber harvest or mineral extraction activities.

4.16.13.8 Impact 16-6: Level of Significance After Mitigation

Implementation of Mitigation Measure 16-6 would reduce the impact to a less than significant level. Alternatively, implementation of Alternate Mitigation Measure 16-6 would eliminate the impact altogether.

4.16.14 IMPACT 16-7: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-7: The project could result in a change in hydrological operations that could affect existing informal erosion control plans, which could result in new or exacerbated erosion problems (Significant).

As indicated in Chapter 3, continued implementation of informal practices are not assumed as a condition of the project. One program, which is currently not mandated by license articles or other regulatory mechanism, has been established by Pacific Gas and Electric Company to work cooperatively to manage geotechnical-related erosion effects at Bass Lake (Bundle 16: Crane Valley). Pacific Gas and Electric Company is also working with a local organization addressing shoreline erosion at Lake Almanor (Bundle 6: Feather River). Similar agreements or participatory mechanisms have not been established for the remaining bundles. Therefore, there would be no impact to the Shasta, Drum, and Motherlode Regional Bundles.

4.16.14.1 Impact 16-7: Shasta Regional Bundle

Non-binding (informal) agreements to manage the geotechnical aspects of erosion in the Shasta Regional Bundle have not been established. Therefore, there would be no impact.

4.16.14.2 Impact 16-7: DeSabla Regional Bundle

Bundle 6: Feather River -- Upper North Fork Feather River (FERC 2105)

Results of the hydrologic modeling indicate a potential increase in lake elevation above modeled baseline conditions (up to the maximum elevation allowed by the FERC license) under the WaterMax Scenario for all four water-year conditions for Lake Almanor. An increase in lake levels could alter erosion patterns by inundating more shoreline. As noted in Section 4.16.4.2, DeSabla Regional Bundle, the potential for erosion due to fluctuations or increases in lake levels to elevation 4,494 feet has been evaluated in the past. Previous studies concluded the magnitude and patterns of erosion were not expected to be different at higher lake levels because the topography and soils in the higher lake operating interval were similar to those occurring at lower elevations. It is unlikely that significant impacts would result.

However, individuals have expressed concern about erosion problems at the lake. While the Lake Almanor Shoreline Protection Committee has been established, Pacific Gas and Electric Company has not entered into any informal or formal agreements to address erosion issues at Lake Almanor. Therefore, while it is unlikely that a significant impact would result, further coordination could ensure this.

4.16.14.3 Impact 16-7: Drum Regional Bundle

Non-binding (informal) agreements to manage erosion in the Drum Regional Bundle have not been established. Therefore, there would be no impact.

4.16.14.4 Impact 16-7: Motherlode Regional Bundle

Non-binding (informal) agreements to manage erosion in the Drum Regional Bundle have not been established. Therefore, there would be no impact.

4.16.14.5 Impact 16-7: Kings Crane-Helms Regional Bundle

Bundle 16: Crane Valley -- (FERC 1354)

The original license for the Crane Valley Project expired on April 25, 1989. Since then, the project has been operating under annual licenses. It is not clear when a new license might be issued or what conditions might be attached to the license. The Forest Service has developed Draft 4(e) conditions that would be attached to the project license. However, the Draft 4(e) conditions do not contain provisions regarding the continued maintenance of erosion control measures nor do they require the more aggressive (priority 4 and 5) erosion control treatments. Without implementation of these measures, potentially significant erosion could continue at Bass Lake. The FERC license is not expected to contain specific provisions regarding erosion control at Bass Lake. In the absence of such a program, erosion problems could be exacerbated. Therefore, this is considered a significant impact.

4.16.14.6 Evaluation of Impact 16-7 to Entire System

The potential for erosion at Lake Almanor (Bundle 6) and the potential for loss of erosion control measures at Bass Lake (Bundle 16: Crane Valley) would be significant effects.

4.16.14.7 Impact 16-7: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

None identified.

Mitigation Measures Identified in This Report

Mitigation Measure 16-7a: Prior to the transfer of title for Bundle 6, the new owner shall consult with the Lake Almanor Shoreline Protection Committee and shall develop appropriate measures to minimize erosion that could result from changes in operation of project facilities. The new owner shall by binding written instrument agree to comply with such measures.

Mitigation Measure 16-7b: Prior to the transfer of title for Bundle 16, the new owner shall by binding written instrument agree to honor the commitments Pacific Gas and Electric Company made in the Final Phase 1 Agreement and in the Bass Lake Shoreline and Water Surface Management Plan.

4.16.14.8 Impact 16-7: Level of Significance After Mitigation

Less than significant.

4.16.15 Impact 16-8: Impact, Analysis, and Mitigation Measures

Impact 16-8: The project could result in development that could limit availability of mineral resources classified as MRZ-2 by the State Geologist or important mineral lands recognized in local land use planning, or the project could cause changes in land use or hydrologic operations could result in termination of existing mining lease agreements which would reduce availability of mineral resources (Significant).

Mineral resources classified by the State Geologist as MRZ-2 are present in Project Lands in Bundles 1, 2 in the Shasta Regional Bundle, in Bundles 11 and 12 in the Drum Regional Bundle, and in Bundles 13 and 15 in the Motherlode Regional Bundle. MRZ-2 areas are of special significance in land use planning because of their potential value as a commodity. Because the specific locations of land that could be developed have not been determined, it is unknown whether MRZ-2 locations could be affected. Therefore, land development in areas classified as MRZ-2 could restrict or eliminate the availability of those resources in those bundles.

MRZ-2 areas have not been mapped or are not present at the following locations: Bundles 3 and 4 in the Shasta Regional Bundle, all of DeSabla Regional Bundle, Bundles 9 and 10 in Drum Regional Bundle, Bundle 14 in the Motherlode Regional Bundle, and all of Kings Crane-Helms Regional Bundle. Therefore, there would be no impact in those bundles related to MRZ-2 resources.

Changes in ownership could also affect existing mining leases on Watershed Lands. A new owner could terminate the lease to use the land for alternate purposes (e.g., new recreation opportunities or changes in hydrologic operations) such that mining operations could cease. Although the economic effects of lease termination would not result in a physical impact, the loss of the mined resource itself and its availability to consumers could be a concern. In such cases, the commodity may need to be obtained from other existing mines (which might need to be expanded to accommodate increased demand resulting from mine closure), or the product might involve additional trips or hauling distances to recover, process, or deliver the commodity. A new mine might also need to be operated. If new mining were to occur at other locations where no mining currently exists to make up for the loss of the mineral resource, it could occur in an area where surrounding land uses and residents have become accustomed to an environment that does not include ongoing mining operations. If permitted by the local land use authority, new mining operations would likely result in environmental effects on these surrounding land uses (e.g., noise, dust, loss of biological values, and visual impacts arising from the expansion of the quarry site), and mining could also be incompatible with adjacent existing and approved planned development.

4.16.15.1 Impact 16-8: Shasta Regional Bundle

Bundle 1: Hat Creek -- Hat Creek 1 and 2 (FERC 2661)

The land development assumptions indicate development of land for residential, commercial, recreational, or other uses could occur in the Hat Creek land area**.** As illustrated in Figure 4.16-5, the northernmost parcel contains an area mapped as MRZ-2 for diatomaceous earth, and one parcel in the southwest contains some land mapped as MRZ-2 for volcanic (base) material.

Major construction or facility modifications are not anticipated as part of the ownership transfer. Minor construction could occur to separate Pacific Gas and Electric Company-retained property from transferred property at some locations. However, this construction is unlikely to involve large or deep excavations that would reduce the availability of mineral deposits classified as MRZ-2 beyond the limits that existing powerlines or easements may impose. Therefore, there would be no adverse impact related to construction and maintenance of hydroelectric facilities.

Shasta County staff have indicated mining is an allowable use on Project Lands through land use and zoning designations. However, if the proposed project resulted in the conversion of lands to other uses other than mining where land classified as MRZ-2 is present, the conversion of land to developed uses could preclude access to or availability of known mineral resources through the development of building and structures, roadways, or other improvements to serve the intended use, or through the establishment of open space, buffers, or easements. It should be recognized that the presence of mineral deposits of regional or local value and whether such resources would be mined (regardless of location) is market-driven. The activity must be economically viable, and is highly regulated through permitting, planning, and monitoring processes in local jurisdictions who implement applicable federal and State regulations and standards. In many cases, the geographic location, topography, and access may be a limiting factor, regardless of the availability. Access to mineral resources for the purposes of future extraction could be considered to be primarily an economic issue. According to Section 15131(a) of the CEQA Guidelines, purely economic impacts are not considered physical environmental impacts. Notwithstanding this, it is assumed for this analysis that future development on Project Lands could result in the loss in availability of known mineral resources that would be of value, particularly where such areas have been classified as MRZ-2 by the State and/or recognized by the local planning jurisdiction, as is the case in Shasta County. This is considered a significant impact.

Bundle 2: Pit River -- Pit 1 (FERC 2687)

The land development assumptions indicate development of land for residential, commercial, recreational, or other uses could occur in four land areas in Bundle 2. As illustrated in Figure 4.16-5, areas classified as MRZ-2 for diatomaceous earth are present in many of the land areas that could be developed.

As described for Bundle 1, construction activities associated with ownership transfer of hydroelectric facilities are not expected to significantly affect the availability of mineral resources; however, development of residential, commercial, or recreational land uses could affect availability. In addition, some areas are assumed for timber harvesting. However, as described for Bundle 1, the loss of availability of the diatomaceous earth deposits in Bundle 2 would be a significant impact.

Summary of Impact 16-8: Entire Shasta Regional Bundle

The diatomaceous earth deposits in the vicinity of Lake Britton in the Shasta Regional Bundle are classified as MRZ-2, and the demand for the product is expected to continue. Two active mines are present on Project Lands, and the extensions of those leases in the future could be eliminated if use of Project Lands changes. Shasta County staff have indicated a high potential for future mining in that area. Loss of availability of these resources (which could result from the loss of existing leases) is considered a significant impact.

4.16.15.2 Impact 16-8: DeSabla Regional Bundle

There would be no impact to the DeSabla Regional Bundle because no MRZ-2 areas have been identified and there are no leases for mining operations of Project Lands.

4.16.15.3 Impact 16-8: Drum Regional Bundle

Bundle 11: South Yuba River -- Drum-Spaulding (FERC 2310)

Areas classified as MRZ-2 are present in Watershed Lands in Bundle 11,. The assumptions in Chapter 3 indicate land development could occur at locations containing mineral resources classified as MRZ-2; however, the locations of such development have not been identified. For the reasons described above, the potential loss of availability of such resources is considered a significant impact.

Bundle 12: Chili Bar -- Chili Bar (FERC 2155)

One MRZ-2 area is present on Project Lands in the vicinity of the Chili Bar Powerhouse. Although the land use assumptions described in Chapter 3 indicate minimal development could occur, the location of such development has not been determined. Because MRZ-2 areas could be affected, this is considered a significant impact.

Bundle 15: Merced River -- Merced Falls (FERC 2467)

Changes in land use at the Merced Falls project could occur in areas classified as MRZ-2. This is considered a significant impact.

Summary of Impact 16-8: Entire Drum Regional Bundle

The potential loss of availability of areas classified by the State Geologist as MRZ-2 due to land development in the Drum Regional Bundle would be a significant impact.

4.16.15.4 Impact 16-8: Motherlode Regional Bundle

Bundle 13: Mokelumne River -- Mokelumne River (FERC 137)

According to the land use assumptions, land development could occur in an area classified MRZ-2 in the vicinity of West Point and Tiger Creek Powerhouses. As described in the introduction to this impact, above, such development could limit availability of the resource. This is considered a significant impact.

Summary of Impact 16-8: Entire Motherlode Regional Bundle

The potential loss of availability of areas classified by the State Geologist as MRZ-2 due to land development in the Motherlode Regional Bundle would be a significant impact.

4.16.15.5 Impact 16-8: Kings Crane-Helms Regional Bundle

There would be no impact to the Kings Crane-Helms Regional Bundle, as described in the introduction to this impact, above.

4.16.15.6 Evaluation of Impact 16-8 to Entire System

Land development could occur in areas classified by the State Geologist MRZ-2 in three regional bundles (Shasta, Drum, and Motherlode) or where active mines are present (Shasta Regional Bundle). The potential loss of these mineral resources is considered a significant impact.

4.16.15.7 Impact 16-8*:* Mitigation Measures

Mitigation Measures Proposed as Part of the Project

None identified.

Mitigation Measures Identified in this Report

Mitigation Measure 16-8: Land development proposals shall identify and consider the location and proximity of areas classified as MRZ-2 by the State Geologist or any special mineral resource land use or zoning designations adopted by the local jurisdiction with approval authority of discretionary projects, and development shall avoid identified MRZ-2 areas to the extent feasible. If such areas cannot be avoided, any change in land use that could affect the availability of MRZ-2 resources shall be subject to the applicable requirements of the Public Resources Code Section 2762 in consultation with the local planning jurisdiction.

Alternate Mitigation Measure 16-8: As an alternative to Mitigation Measure 16-8 above, prior to or concurrent with the transfer of title for bundles with areas classified as MRZ-2, there shall be recorded against the lands within the bundle conservation easements running with the land and (in a form and substance approved by the CPUC) precluding any further land use development, or expansion of timber harvest or mineral extraction activities.

4.16.15.8 Impact 16-8: Level of Significance After Mitigation

Implementation of Mitigation Measure 16-8 would reduce the impact to a less than significant level. Alternatively, implementation of Alternate Mitigation Measure 16-8 would eliminate the impact entirely.

4.16.16 IMPACT 16-9: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-9: The project could result in land development in areas where significant mineral resources may exist but have not yet been identified, causing the loss of availability of these mineral resources (Significant).

4.16.16.1 Evaluation of Impact 16-9 to Entire System

The proposed project could result in the development of Project Lands for residential, commercial, recreational or other uses, within all five bundles, as described in Chapter 3. As noted in Section 4.16.3 and in Impact 16-8, above, not all locations containing FERC license areas and Watershed Lands have been comprehensively evaluated for mineral resources. In particular, the presence of active and inactive mines in the vicinity of Project Lands, combined with geologic conditions favorable for mineralization along the western Sierra Nevada foothills and mountains, suggest additional mineral resources may be present in Bundles 3 and 4 in the Shasta Regional Bundle and in the DeSabla, Drum, and Motherlode Regional Bundles beyond those identified in current mapping. Because the total acreage of land that could be developed in the Kings Crane-Helms Regional Bundle would not be as great as that in the other four regional bundles and known mineral resource locations are limited with respect to Project Lands, this would not be as great a concern.

If development were to occur in locations where the presence or extent of extractive mineral resources has not been clearly delineated (e.g., areas where CDMG has not mapped mineral resource zones or where local jurisdictions have not independently identified such resources), access to those minerals could also be inadvertently restricted or eliminated as a result of land development in those bundles. For the reasons described in Impact 4.16-8, above, this is considered a significant impact for all five bundles.

4.16.16.2 Impact 16-9: Mitigation Measures

Mitigation Measures Proposed As Part of the Project

None identified.

Mitigation Measures Identified in this Report

Mitigation Measure 16-9: Prior to approval of any proposed new development on Project Lands where MRZ-2 areas classified by the State Geologist have not been identified, geologic and minerals resources maps and databases prepared by CDMG and USGS, and available at the time of proposed development, shall be reviewed to determine the potential for significant mineral resources. The review, which shall identify the type and extent of mineral deposits, shall be used to site proposed development, to the extent feasible, to avoid potential mineral lands conflicts. If such areas cannot be avoided, any change in land use that could affect the availability of identified resources shall be subject to the applicable requirements of the Public Resources Code (Section 2762) and in consultation with the local planning jurisdiction.

Alternate Mitigation Measure 16-9: As an alternative to Mitigation Measure 16-9 above, prior to or concurrent with the transfer of title for any bundles, there shall be recorded against the lands within the bundle conservation easements running with the land and (in a form and substance approved by the CPUC) precluding any further land use development, or expansion of timber harvest or mineral extraction activities.

4.16.16.3 Impact 16-9: Level of Significance After Mitigation

Implementation of Mitigation Measure 16-9 would reduce the impact to a less than significant level. Alternatively, implementation of Alternate Mitigation Measure 16-9 would eliminate the impact entirely.

4.16.17 IMPACT 16-10: IMPACT, ANALYSIS, AND MITIGATION MEASURES

Impact 16-10: The project could result in a change in hydrological operations and maintenance practices, which could result in new or exacerbated erosion or slope instability problems (Significant).

4.16.17.1 Evaluation of Impact 16-10 to Entire System

Routine activities performed at project facilities include periodic maintenance of roadways and watercourses conducted to protect the integrity of facilities and ensure safe and efficient operations. In addition, Pacific Gas and Electric Company uses blasting in the operation of its hydroelectric facilities when rocks fall into canal systems that are too large to extract without first reducing their size. Construction activities related to ongoing maintenance that can affect geology and soils include road and bridge abutment repairs, dredging of stream courses and lakes, seismic upgrades of dams, dam-face alteration and construction of coffer dams, and small dams at stream gauge locations. Most of these activities occur in and near water courses or lakes. As described in the Setting, Pacific Gas and Electric Company has developed BMPs and Operating Procedures that identify methods and procedures to control erosion, inspect flume and canal facilities, and implement timely repairs for identified problems. Pacific Gas and Electric Company also voluntarily inspects some facilities and cooperates with local agencies to identify and manage erosion. Some of these BMPs and operating procedures may not have an underlying regulatory framework to ensure their implementation but are performed by Pacific Gas and Electric Company in the interest of protecting facilities. Further, while key elements of project facilities (e.g., dams and penstocks) are routinely inspected and repaired or upgraded as required under FERC or applicable DSOD regulations, other features (e.g., canals and conveyances) are not subject to such stringent requirements. Some dams are not within DSOD jurisdiction and, therefore, not subject to annual inspection or reporting. As indicated in the “Soils and Erosion” and “Other Geologic Hazards” discussions within each individual bundle, various types of geologic and soils problems have occurred from time to time at some of the hydroelectric facilities. While the causes of such problems were attributable to conditions outside Pacific Gas and Electric Company control, voluntary inspections and prompt corrective actions reduced the potential for worsened conditions that could affect non-Pacific Gas and Electric Company lands.

Although FERC license articles impose general requirements to reduce the potential for project facilities to affect or be affected by geologic conditions, the actual methods to reduce such hazards are not specifically set forth in the license or through applicable regulations. At the outset, the new owner may not have a comprehensive program in place to effectively identify or manage geologic hazards that could pose a risk to project facilities or the environment to the extent such measures are implemented by Pacific Gas and Electric Company. As a result, there would be a potential for: increased slope instability problems in areas containing highly erodible soils; damage or failure to flumes or canals from landslides; or unidentified settling or downslope movement of dams not subject to DSOD reporting and inspection requirements. In the absence of specific license requirements mandating such programs and procedures, the proposed divestiture could increase or exacerbate erosion, which could lead to problems with slope stability. This is considered a significant impact.

4.16.17.2 Impact 16-10: Mitigation Measures

Mitigation Measures Proposed as Part of the Project

None identified.

Mitigation Measures Identified in This Report

Mitigation Measure 16-3 would reduce this impact to a less than significant level.

4.16.17.3 Impact 16-10: Level of Significance After Mitigation

Less than significant.

4.16.18 REFERENCES

Amador County. 2000. Personal communication between Wendy Katagi (EIP Associates) and Steve Branco, Planning Department. July 13.

Arkwright Technical Services, Inc.. 1998. Merced Falls Project Embankment Dam Seismic Assessment. Letter from Davis, Alton, P., Independent Consultant, to Ron Adhya, Senior Civil Engineer, Pacific Gas and Electric Company. August 4.

Bateman, P.C. 1982. *Geologic Map of the Millerton Lake Quadrangle, West-Central Sierra Nevada, California*, Scale 1:62,500, U.S. Geological Survey Geologic Quadrangle Map GQ-1548.

____. 1989. *Geologic Map of the Bass Lake Quadrangle, West-Central Sierra Nevada, California*, Scale 1:62,500, U.S. Geological Survey Geologic Quadrangle Map GQ-1548.

Blake, T.F. 2000. A Computer Program for the Estimation of Peak Horizontal Acceleration From 3-D Fault Sources, v. 3.0.

BLM (Bureau of Land Management). 1997. *Mining Claims and Sites on Federal Lands*.

____. 2000a. Data Search for Active Mining Claims for Shasta and DeSabla Regional Bundles FERC License Lands.

____. 2000b. Data Search for Active Mining Claims for Drum and Motherlode Regional Bundles FERC License Lands.

____. 2000c. Data Search for Active Mining Claims for Kings Crane-Helms Regional Bundle FERC License Lands.

Brown and Caldwell. 1995. Stanislaus River Watershed Sanitary Survey Final Report.

Butte County. 2000. Website http://www.buttecounty.net. September.

CDMG (California Department of Conservation, Division of Mines and Geology). 1958. *Geologic Atlas of California, Alturas Sheet*, Scale 1:250,000.

____. 1960. *Geologic Atlas of California, Westwood Sheet*, Scale 1:250,000.

____. 1965. *Geologic Atlas of California, Bakersfield Sheet*, Scale 1:250,000.

____. 1966a. *Geologic Atlas of California, Fresno Sheet*, Scale 1:250,000.

____. 1966b. *Geology of Northern California*. Edited by Edgar H. Bailey. Bulletin 190.

____. 1967. *Geologic Atlas of California, Mariposa Sheet*, Scale 1:250,000.

____. 1973. *Urban Geology Master Plan for California*. Bulletin 198.

____. 1977. *Geologic Map of California*, Scale 1:750:000. Compiled by Charles W. Jennings. Geologic Data Map No.2.

____. 1980. *Geothermal Resources of California*, Scale 1:750,000. Geologic Data Map No. 4.

____. 1983a. *Mineral Land Classification of the Joe Chevreaux Company Property for Portland-Cement-Concrete-Grade Aggregate, Nevada and Placer Counties, California.* Prepared by Don L. Dupras. DMG Open-File Report 83-28.

____. 1983b. *Mineral Land Classification of the Georgetown 15' Quadrangle El Dorado and Placer Counties, California.* Prepared by Susan Kohler. DMG Open-File Report 83-35.

____. 1984. *Mineral Land Classification of the Auburn 15' Quadrangle, El Dorado and Placer Counties, California*. Prepared by Susan Kohler. DMG Open-File Report 83-37.

____. 1987a. *Geologic Map of the Sacramento Quadrangle*, Scale 1:250,000. Compiled by D.L. Wagner and others. Regional Geologic Map Series Map No.1A.

____. 1987b. *Mineral Land Classification of the Camino and Mokelumne Hill 15-Minute Quadrangles, El Dorado, Amador, and Calaveras Counties, California.* Prepared by Ralph Loyd and Susan Kohler. DMG Open-File Report 87-2.

____. 1988. *Mineral Land Classification: Portland Cement Concrete-Grade Aggregate in the Yuba City-Marysville Production-Consumption Region*. Prepared by R.S. Habel and L.F. Campion. Special Report 132.

____. 1990a. *The Loma Prieta (Santa Cruz Mountains), California, Earthquake of 17 October 1989*. Prepared by S.R. McNutt and R.H. Sydnor, editors. Special Publication 104.

____. 1990b. *Mineral Land Classification of Nevada County, California.* Prepared by Ralph Loyd and John Clinkenbeard. Special Report 164.

____. 1992. *Geologic Map of the Chico Quadrangle,* Scale 1:250,000. Compiled by G.J. Saucedo and D.L. Wagner. Regional Geologic Map Series Map No.7A.

____. 1992. *Peak Acceleration From Maximum Credible Earthquakes In California (Rock and Stiff-Soil Sites).* Prepared by L. Mualchin and A.L. Jones. DMG Open-File Report 92-01.

____. 1994. *Fault Activity Map of California and Adjacent Areas, With Locations and Ages of Recent Volcanic Eruptions*. Compiled by Charles W. Jennings. Geologic Data Map No.6.

____. 1995. *Mineral Land Classification of Placer County, California.* Prepared by Ralph Loyd. DMG Open-File Report 95-10.

____. 1996. *Probabilistic Seismic Hazard Assessment for the State of California*. Prepared by M.D. Peterson and others. DMG Open-File Report 96-08/USGS Open-File Report 96-706.

____. 1997a. *Factors Affecting Landslides in Forested Terrain.* DMG Note 50.

____. 1997b. *Fault-Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps.* Prepared by E.W. Hart and W.A. Bryant. Special Publication 42, revised 1999.

____. 1997c. *Mineral Classification of Alluvial Sand and Gravel, Crushed Stone, Volcanic Cinders, Limestone, and Diatomite Within Shasta County, California.* DMG Open-File Report 97-03.

____. 1997d. *Mineral Land Classification of a Portion of Tuolumne County, California, for Precious Metals, Carbonate Rock, and Concrete-Grade Aggregate.* Prepared by Chris T. Higgins. DMG Open-File Report 97-09.

.____. 1998. *Guidelines for Evaluating the Hazard of Surface Fault Rupture*. DMG Note 49.

____. 1999. *Mines and Mineral Producers Active in California*. Prepared by L.G. Youngs and others. Special Publication 103.

CDMG. 1999b. *Mineral Land Classification of Merced County, California*. DMG Open-File Report 99-08.

CDMG. 1999c. *Seismic Shaking Hazard Maps of California*. DMG Map Sheet MS048.

____. 2000. *List of Publications Available from the Division of Mines and Geology*. August.

CVPC (Crane Valley Project Committee). 1997. Final Phase 1 Agreement for June 27th Ratification, Preamble to the Phase 1 Agreement of the Crane Valley Project Committee.

Calaveras County. Personal communication between Wendy Katagi (EIP Associates) and Julie Russell, Planning Aid, and Ray Waller, Planning Director. July 14.

Camp Dresser and McKee, Inc.. 1997. Phase 1 Environmental Site Assessment, Pit 1 Hydroelectric Generating Facility, Highway 229, Shasta County, California, November.

Cook, Jeffrey D. and Maria J. Ellis. 1998. Assessment of Erosion and Sedimentation in the Hat Creek Project Vicinity, Hat Creek Project (FERC No. 2661), Shasta County, California. April.

DWR (California Department of Water Resources). 1976. *Environmental Impact Report Lake Almanor Project.*

Durrell, Cordell. 1987. *Geologic History of the Feather River Country, California.* University of California Press; Berkeley, CA.

El Dorado County. 2000. Personal communication between EIP Associates and Kevin Blake, Planner, Bianca Foster, Planner, Pierre Rivas. July 12.

FERC (Federal Energy Regulatory Commission). 1979. Office of Electric Power Regulation. *Final Environmental Impact Statement Kerckhoff Project No. 96-California.*

____. 2000. Letter from Goris, James, P.E., Acting Regional Director, Federal Regulatory Commission, to Michael A. Katz, Lead Manager, Pacific Gas and Electric Company Hydro Generation, regarding Drum Forebay Dam. February 15.

Findlay Engineering. 2000a. Review of Salt Springs Dam, Stability Analysis Under Seismic Loading FERC Project No. 137-CA. Letter from Findlay, R. Craig, Independent Consultant, to Ron Adhya, Pacific Gas and Electric Company. February 28.

____. 2000b. Review of Stability Analysis and Seismic Assessment, Salt Springs Dam Spillway and Parapet Wall. Letter from Findlay, R. Craig, Independent Consultant, to Ron Adhya, Pacific Gas and Electric Company. February 28.

____. 2000c. Review of Stability Analysis and Seismic Assessment Upper Bear Dam Spillway FERC Project No. 137-CA. Letter from Findlay, R. Craig, Independent Consultant, to Mohammed Aslam, Pacific Gas and Electric Company. March 20.

____. 2000d. Review of Upper Bear River Dam Stability Analysis Under Seismic Loading FERC Project No. 2106-CA. Letter from Findlay, R. Craig, Independent Consultant,., to Ron Adhya, Pacific Gas and Electric Company. January 11.

Fresno County. 1980. *The Zoning Division of the Fresno County Ordinance Code*.

____. 2000. *Public Review Draft Policy Document*, General Plan.

GEI Consultants, Inc.. 1999a. Drum Forebay Dam Stability Analysis Under Seismic Loading. Letter from Davis, Alton P., Independent Consultant, to Ron Adhya, Senior Civil Engineer. December 7.

____. 1999b. *Seventh Quinquennial Safety Inspection, Scott Dam.* Prepared for Pacific Gas and Electric Company. December.

Greensfelder, R.W. 1974. *Maximum Credible Rock Acceleration from Earthquakes in California.* California Division of Mines and Geology Map Sheet 23, Scale1:2,500,000.

Hill, Mary. 1975. *Geology of the Sierra Nevada.* University of California Press; Berkeley, CA.

Kern County. 1981. *Year 2000 General Plan. Land Use Element, Open Space Element, Conservation Element*, Master Environmental Assessment/Master Environmental Impact Report (MEIR). Bakersfield CA.

____. 1994. *Metropolitan Bakersfield 2010 General Plan*.

____. 1999. *Zoning Ordinance*.

Kubik, Tom. 2000. Placer County Planning Department. Personal communication to Alice Tackett, EIP Associates, August 16.

Lassen County. 1998. *Draft Lassen County General Plan*.

Lake County. 2000. Personal communication between Curtis Cash (EIP Associates) and Danielle Zalusky, Associate Planner. July 13.

Madera County. 1995. *Policy Document, Final Environmental Impact Report (FEIR) Vol.1-2.* Background Report, Madera County General Plan.

____. 1999. *Zoning Ordinance*.

Mariposa County. 2000. Personal communication between Wendy Katagi (EIP Associates) and Todd Lewis, Mapper/Planner. July 13.

Mendocino County. 2000. Personal communication between Curtis Cash (EIP Associates) and Dennis Chaty, Planner, and Leaf Farr, Mapper/Demographer. July 14 and July 21.

Miller, C. Dan. 1989. *Potential Hazards from Future Volcanic Eruptions in California.* U.S. Geological Survey Bulletin 1847.

NCSS (National Cooperative Soil Survey). 2000. Accessed Internet website http://www.statlab.iastate.edu/soils/ncssc.html.

Nevada County. 1995. *Nevada County General Plan, Volume 2: Background Data and Analysis.*

Nevada County. 2000. Personal communication between EIP Associates and Karry Przepiorski, Planner. July 17.

Oakeshott, Gordon. 1978. *California's Changing Landscape, A Guide to the Changing Geology of the State*. McGraw-Hill Book Company, New York.

Plumas County. 2000. Personal communication between Kim Mauch (North State Resources) and Steve Allen, Planner, Plumas County. October 11.

PG&E Co. (Pacific Gas and Electric Company). 1966. *Report to the Federal Power Commission on the Bucks Creek Hydroelectric Project, FPC Project No. 619.*

____. 1972. *Kern Canyon Project. FERC 178, Exhibit W Environmental Impact Statement*, Application For New License.

____. 1976. Application of Pacific Gas and Electric Company for New License, Kilarc-Cow Creek. Vol. II of II.

____. 1976a. *Application for License and Amendment of License, Helms Pumped Storage Project*, Exhibit W Environmental Report.

____. 1976b. *Final Environmental Impact Report, Helms Pumped Storage Project*, Chapter 4.

____. 1979. *Rock Creek-Cresta Project, FERC No. 1962, Application of PG&E for New License, Exhibit E6.*

____. 1985. *Bass Lake Erosion Control Action Plan*.

____ 1986a. *Balch Project FERC 175, Report E6 Geological and Soil Resources*, Amendment to License Application, Vol. II of III.

____. 1986b. *Crane Valley Project. FERC 1354 Application for New License. Vol. II of III.* Report E1, E3, and E4.

____. 1986c. *Haas-Kings River Project FERC 1988, Report E6 Geological and Soil Resources*, Amendment to License Application, Vol. III of III.

____. 1987a. *San Joaquin Hydro Generation Bass Lake Erosion Control Project, Bass Lake Erosion Control Action Plan*. San Francisco, CA.

____. 1987b. *Upper North Fork Feather River Development, FERC No. 2105, Application of PG&E for Amendment of License, Exhibit E.*

____. 1989a. *Bass Lake Shoreline and water surface Management Plan*.

____. 1989b. *Bass Lake Shoreline and Water Surface Management Plan*.

____. 1999a. Proponent's Environmental Assessment for Application No. 99-09-053. Volumes 3 through 13. October 29.

____. 1999b. Potter Valley Project, FERC No. 77, Small Landslide at Wood Stave Section of Penstock. Letter from Shiffman, Rhonda, Senior License Coordinator, Pacific Gas and Electric Company, to Noel Folsom, Regional Director, Federal Energy Regulatory Commission. March 30.

____. 1999c. Letter from Michael P. Drury, FERC Land Planning Analyst, to Bill Walker, Shasta County Department of Resources Management. April 16.

____. 2000a. Proponent's Environmental Assessment for Application 99-09-053. Volumes 14 through 16. March 27.

____. 2000b. Errata to Proponent's Environmental Assessment Submitted October 29, 1999 for Application 99-09-053. March 29.

____. 2000c. Response to Energy Division Deficiency Report of April 26. Volume 18. May 18.

____. 2000d. Additional Errata to Proponent's Environmental Assessment for Application No. 99-09-053. Volume 19. June 8.

____. 2000e. Letter from Lee, Wing H., Facility Safety Coordinator, Pacific Gas and Electric Company, to James Goris, Acting Regional Director, Federal Energy Regulatory Commission, regarding Part 12D – Salt Springs Dam. March 2.

____. 2000f. Letter from Lee, Wing H., Facility Safety Coordinator, Pacific Gas and Electric Company, to James Goris, Acting Regional Director, Federal Energy Regulatory Commission. March 23.

____. 2000g. Letter from Wikle, Lessly to Christine Nota, US Forest Service. May 31.

____. 2000h. Letter from Wikle, Lessly, Pacific Gas and Electric Company, Principal Project Manager, to Suzanne Ness, EIP Associates. August 4.

____. 2000i. Letter from Wikle, Lessly, Pacific Gas and Electric Company, Principal Project Manager, to John Kessler.

____. 2000j. Letter from Wikle, Lessly, Pacific Gas and Electric Company, Principal Project Manager, to Alice Tackett, EIP Associates. August 23.

____. 2000k. Letter from Wikle, Lessly, Pacific Gas and Electric Company, Principal Project Manager, to Alice Tackett, EIP Associates. August 28.

____. 2000l. Letter from Wikle, Lessly, Pacific Gas and Electric Company, Principal Project Manager, to Alice Tackett, EIP Associates. September 13.

Placer County Planning Department. 1992. *Placer County General Plan Background Report*.

Placer County Planning Department. 1999. *Draft Environmental Impact Report, Village at Squaw Valley USA.*

Placer County Planning Department. 2000. Personal communication between EIP Associates and James Michaels, Planning Technician, July 12 and July 19.

Shasta, County of, Planning Division. 1998. *Shasta County General Plan.* October.

Shasta, County of, Planning and Building Division. 1995. *Shasta County Code, Chapter 12.12.* April.

Shasta County. 2000. Personal communication between Kim Mauch (North State Resources) and Bill Walker, Shasta County Department of Resources Management. August 16.

Shasta County. 2000b. Personal communication between Kim Mauch (North State Resources) and Bill Walker, Shasta County Department of Resources Management. October 11.

Tehama, County of, Community Development Group. 1983. *Tehama County General Plan.* March.

Tulare County. 1972. *Environmental and Resources Management Element, Open Space, Recreation, Conservation*, General Plan.

____. 1992. *Zoning Ordinance.*

Tuolumne County. 2000. Personal communication between Wendy Katagi (EIP Associates) and Brad Michalk, Senior Planner, and Bev Shane, Planning Director. July 13.

Unruh, J.R. and E.M. Moores. 1992. Quaternary Blind Thrusting in The Southwestern Sacramento Valley, California. *Tectonics*. 11:192-203.

USDA (United States Department of Agriculture,, Soil Conservation Service/Natural Resources Conservation Service). 1962a. *Soil Survey Of Madera Area, California*. Reissued 1990.

____. 1962b. *Soil Survey of Merced Area, California*. Reissued 1992.

____. 1967a. *Report and General Soil Map, Western Tuolumne County, California.*

____. 1967b. *Soil Survey of Tehama County, California.*

____. 1971. *Soil Survey, Eastern Fresno Area, California*.

____. 1974a. *Soil Survey of El Dorado Area, California*

____. 1974b. *Soil Survey of Shasta County Area, California.*

____. 1975. *Soil Survey of Nevada County Area, California.*

____. 1980. *Soil Survey of Placer County, California.*

____. 1982. *Soil Survey Of Tulare County, California, Central Part*.

____. 1993a. *Soil Survey, Amador Area, California.*

____. 1993b. *Soil Survey of Nevada County Area, California.*

____. 2000a. *Soil Survey of Intermountain Area, California, Parts of Lassen, Modoc, Shasta and Siskiyou Counties.*

____. 2000b. Website http://www.ca.nrcs.usda.gov/mlra/sstatus.html. September.

USFS (U.S. Forest Service). 1981. *Bass Lake Shore Erosion Report. (Report 026.11-81.9).*

USGS (U.S. Geological Survey). 1977. *Earthquake Intensity Zonation and Quaternary Deposits.* Miscellaneous Filed Studies Map 9093.

USGS (United States Geological Survey). 1996. *Review of Seismic-Hazard Issues Associated with the Auburn Dam Project, Sierra Nevada Foothills, California*. Prepared by USGS Auburn Project Review Team. USGS Open File Report 96-0011.

Yuba County Planning Department. Personal communication between Curtis Cash (EIP Associates) and Peter Calarco, Principal Planner. July 17.