5.4 Geologic Hazards and Resources

5.4.1 Introduction

The Applicant proposes to develop a solar energy project called the Ivanpah Solar Electric Generating System (Ivanpah SEGS). It will be located in southern California's Mojave Desert, near the Nevada border, to the west of Ivanpah Dry Lake. The project will be located in San Bernardino County, California, on federal land managed by the Bureau of Land Management (BLM). It will be constructed in three phases: two 100-megawatt (MW) phases (known as Ivanpah 1 and 2) and a 200-MW phase (Ivanpah 3). The phasing is planned so that Ivanpah 1 (the southernmost site) will be constructed first, followed by Ivanpah 2 (the middle site), then Ivanpah 3 (the 200-MW plant on the north), though the order of construction may change. Each 100-MW site requires about 850 acres (or 1.3 square miles); the 200-MW site is about 1,660 acres (or about 2.6 square miles). The total area required for all three phases, including the Administration/Operations and Maintenance building and substation, is approximately 3,400 acres. The Applicant has applied for a right-of-way grant for the land from BLM. Although this is a phased project, it is being analyzed as if all phases are operational.

The heliostat (or mirror) fields focus solar energy on the power tower receivers near the center of each of the heliostat arrays (the 100-MW plants have three arrays and the 200-MW plant has four arrays). In each plant, one Rankine-cycle reheat steam turbine receives live steam from the solar boilers and reheat steam from one solar reheater—located in the power block at the top of its own tower. The solar field and power generation equipment are started each morning after sunrise and insolation build-up, and shut down in the evening when insolation drops below the level required to keep the turbine online.

Ivanpah 1, 2 and 3 will be interconnected to the Southern California Edison (SCE) grid through upgrades to SCE's 115-kilovolt (kV) line passing through the site on a northeast-southwest right-of-way. These upgrades will include the construction by SCE of a new 220/115-kV breaker-and-a-half substation between the Ivanpah 1 and 2 project sites. This new substation and the 220-kV upgrades will be for the benefit of Ivanpah and other Interconnection Customers in the region. The existing 115-kV transmission line from the El Dorado substation will be replaced with a double-circuit 220-kV overhead line that will be interconnected to the new substation. Power from Ivanpah 1, 2 and 3 will be transmitted at 115 kV to the new substation. SCE plans to add three new 115-kV lines to increase capacity to the existing El Dorado-Baker-Cool Water-Dunn Siding-Mountain Pass 115-kV line heading southwest. The timing of this upgrade depends upon the development of wind projects ahead in the queue, and is not affected by the Ivanpah SEGS project.

Each phase of the project includes a small package natural gas-fired start-up boiler to provide heat for plant start-up and during temporary cloud cover. The project's natural gas system will be connected to the Kern River Gas Transmission Line, which passes less than half a mile to the north of the project site. Raw water will be drawn daily from one of two onsite wells, located east of Ivanpah 2. Each well will have sufficient capacity to supply water for all three phases. Groundwater will go through a treatment system for use as boiler make-up water and to wash the heliostats. To save water in the site's desert environment, each plant will use a dry-cooling condenser. Water consumption is, therefore, minimal

(estimated at no more than 100 acre-feet/year for all three phases). Each phase includes a small onsite wastewater plant located in the power block that treats wastewater from domestic waste streams such as showers and toilets. A larger sewage package treatment plant will also be located at the Administration Building/Operations and Maintenance area, located between Ivanpah 1 and 2. Sewage sludge will be removed from the site by a sanitary service provider. No wastewater will be generated by the system, except for a small stream that will be treated and used for landscape irrigation. If necessary, a small filter/purification system will be used to provide potable water at the Administration Building.

This section evaluates the effect of geologic hazards and resources that might be encountered on the project site and associated linear facilities. The objective of this analysis is to evaluate potential project impacts resulting from construction or operation of the project. This section presents a summary of the relevant laws, ordinances, regulations and standards (LORS); the project setting; environmental effects; and proposed mitigation measures affecting geological resources. In addition, required permits and permitting agencies are identified.

Section 5.4.2 describes the relevant LORS for geologic hazards. Section 5.4.3 describes the affected environment including the regional and local geology, seismicity, and hazards. Section 5.4.4 assesses the project's impacts, and Section 5.4.5 provides mitigation measures to reduce significant impacts from geologic hazards and to geologic resources. Section 5.4.6 addresses relevant agencies, and Section 5.4.7 lists required permits. Section 5.4.8 lists references used in preparing this section.

5.4.2 Laws, Ordinances, Regulations, and Standards

The LORS that apply to geologic resources and hazards are summarized in Table 5.4-1.

TABLE 5.4-1
Laws, Ordinances, Regulations, and Standards Applicable to Ivanpah SEGS Geologic Hazards and Resources

LORS	Requirements/ Applicability	Administering Agency	AFC Section Explaining Conformance
Federal			
Uniform Building Code (UBC	Design criteria for excavations and structures under static and dynamic loading conditions	San Bernardino County	Section 5.4.2.1
State			
California Building Code (CBC), 2007 as amended by the County of San Bernardino	Acceptable design criteria for structures with respect to seismic design and load-bearing capacity.	California Building Standards Commission, State of California, and County of San Bernardino	Section 5.4.2.2
Alquist-Priolo Earthquake Fault Zoning Act Title 14, Division 2, Chapter 8, Subchapter 1, Article 3, California Code of Regulations.	Identifies areas subject to surface rupture from active faults.	California Building Standards Commission, State of California, and County of San Bernardino	Section 5.4.2.2

TABLE 5.4-1
Laws, Ordinances, Regulations, and Standards Applicable to Ivanpah SEGS Geologic Hazards and Resources

LORS	Requirements/ Applicability	Administering Agency	AFC Section Explaining Conformance
The Seismic Hazards Mapping Act Title 14, Division 2, Chapter 8, Subchapter 1, Article 10, California Code of Regulations.	Identifies non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.	California Building Standards Commission, State of California, and County of San Bernardino	Section 5.4.2.2
Local			
County of San Bernardino General Plan	Compliance with the Safety Element of the General Plan.	County of San Bernardino	Section 5.4.2.3

5.4.2.1 Federal LORS

Acceptable design criteria for excavations and structures for static and dynamic loading conditions are specified by the Uniform Building Code (1997). The project will comply with the UBC by ensuring design and construction criteria for Seismic Zone 3.

5.4.2.2 State LORS

5.4.2.2.1 California Building Code

The CBC provides specific and acceptable design criteria for excavations and structures for static and dynamic loading conditions. The project will comply with the CBC by ensuring design and construction criteria for Seismic Zone 3.

5.4.2.2.2 Alquist-Priolo Earthquake Fault Zoning Act

The main purpose of the Alquist-Priolo Earthquake Fault Zoning Act is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. Although the project is subject to the Alquist-Priolo Earthquake Fault Zoning Act, the project features are not located within areas identified as subject to surface rupture from active faults.

5.4.2.2.3 Seismic Hazards Mapping Act

The purpose of the Seismic Hazards Mapping Act is to protect public safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and other hazards caused by earthquakes. The program and actions mandated by the Seismic Hazards Mapping Act closely resemble those of the Alquist-Priolo Earthquake Fault Zoning Act (which addresses only surface fault-rupture hazards). The project will conform to this act by conducting an analysis for potential seismic hazards at the project site.

5.4.2.3 Local LORS

5.4.2.3.1 County of San Bernardino General Plan

The Safety Element of the County General Plan is intended to protect the public from the effects of natural geologic hazards. According to the San Bernardino County Planning and Building Department, there are no specific local LORS regarding geologic hazards that

would be applicable to the proposed activities at the project site, other than grading and building permit review process.

5.4.3 Affected Environment

The proposed Ivanpah SEGS project site is near Ivanpah Dry Lake in San Bernardino County, California. The site is in the Mojave Desert near the California–Nevada border on land that is managed by the BLM and lies in the eastern part of the Mojave Desert physiographic province of California in the Ivanpah Valley. The Ivanpah Valley is an elongated north-south trending alluvial valley located near the California–Nevada border. The Mojave Desert physiographic province exhibits characteristics similar to the Basin and Range province to the north as well as the Colorado Desert province to the south. The general area is dominated by broad alluviated basins that are mostly aggrading surfaces receiving non-marine continental deposits from adjacent uplands (Norris and Webb, 1990). The proposed power plant site is on a gently sloping site (approximate elevation between 3,000 feet on the west and 2,800 feet on the east) on the west flank of the Ivanpah Valley. The Ivanpah Valley Basin is a north-trending valley and is bounded by non water-bearing rocks of the Clark Mountains on the northwest, the Ivanpah Range on the west, and by the New York Mountains on the southeast (DWR, 2004). This area is underlain by Quaternary age alluvial sediments (Jennings, 1961). The site area is not within a highly active seismic region.

5.4.3.1 Regional Geology and Structure

The geology of the area near the proposed Ivanpah SEGS project is not significantly complex. The alluvial sediments present at the site were deposited from erosion of the surrounding mountains and highlands. From a regional perspective, the Mojave Desert area presumably formed as a result of large-scale tectonic activity between the San Andreas Fault to the west and the Garlock Fault to the northwest. Locally, numerous relatively small faults are present in the area and include the Ivanpah Fault as well as the Stateline Fault.

5.4.3.2 Local Geology

The local geology is composed of deposits of recent quaternary age alluvium underlain by bedrock deposits. Figure 5.4-1 shows the geology within a 2-mile radius of the Ivanpah SEGS project site. Note that given the large size of the project site, approximately 5.25 square miles, the scale of Figure 5.4-1 has been changed beyond the standard 1;24,000 scale to accommodate illustration on an 11x17 sheet. This current scale adequately displays the site geology within a 2-mile buffer of the project site.

The geologic deposits in the project site area were derived from alluvial fan facies (Jennings, 1961). A description of the deposits are as follows:

Qal – Quaternary Alluvial Deposits. Recent alluvium. Stream and valley alluvial fan deposits. Mantle of detrital material derived from granular disintegration of the granitic rock of Cima Dome.

Ql – Quaternary Lake Deposits. Playa deposit.

Pls – Paleozoic Limestone or Dolomite. Goodspring Dolomite – thick-bedded limestone and dolomite with thin beds of shale and sandstone.

CM – Carboniferous Mississippian. Marine sedimentary and metasedimentary rocks. Monte Cristo limestone and dolomite.

ePC – early PreCambrian. Metamorphic rocks. Undifferentiated gneiss, schist and granite. Granitic augen gneiss cut by gabbro pegmatite dikes and silicic dikes.

5.4.3.3 Seismic Setting

The project site lies within the eastern part of San Bernardino County in a part of California considered not to be seismically active. Although there are numerous relatively small faults in the area, most do not exhibit recent activity. According to Blake (2004), the nearest major fault is the Garlock Fault, which is located approximately 52 miles to the west of the project site. The Garlock fault is a major fault that has exhibited earthquake activity during recent Holocene time (Jennings, 1994). The State Line Fault, located approximately 5 miles east of the site on the California-Nevada border has been classified as an older fault that has exhibited early Quaternary activity (movement within the last 1.6 million years) (Jennings, 1994). The Ivanpah Fault is located about 0.5 mile west the site. This fault trends in a northwest-southeast orientation and is approximately 33 miles long. Most of the Ivanpah Fault is buried beneath Quaternary alluvium and no surface expression of this fault is present in the vicinity of the project site. The Ivanpah Fault is considered an inactive fault not having earthquake activity within the last 1.6 millions years (Jennings, 1994).

The Ivanpah SEGS site is within Seismic Zone 3 as defined by the 2007 CBC. The site is not located within an area designated by the Alquist-Priolo Special Studies Zone Act of 1972.

5.4.3.4 Geologic Hazards

The following subsections discuss the potential geologic hazards that might occur in the project area based on a literature search and preliminary analysis for the site. The hazards that could be significant include: seismic ground shaking; ground rupture; liquefaction; subsidence and settlement; and seiches/tsunamis. An initial geotechnical report has been prepared and is included as Appendix 5.4A. Additional information will be available following preparation of an amendment to the geotechnical report, which will be provided to the CEC upon request.

5.4.3.4.1 Seismic Ground Shaking

During an earthquake, seismic waves are produced that emanate in all directions from the fault rupture. Seismic waves can produce strong ground shaking that is typically strongest near the fault and attenuates as the waves move away from the source. The severity of ground shaking is controlled by the interaction of magnitude, distance, and the type, thickness, and condition of underlying geologic materials. Areas underlain by unconsolidated, recent alluvium, or fill may amplify the strength and duration of strong ground motion.

Strong ground motion is the most significant geologic hazard at the project site. Blake (2004) estimates a deterministic moment magnitude (Mw) 7.5 earthquake as a result of the Garlock Fault located approximately 52 miles away from the site. According to Blake (2004), this event could produce a peak bedrock acceleration (PBA) of up to 0.054g based on the attenuation relationship by Sadigh et al. (Sadigh et al., 1997) for a rock outcrop site. This would generally have minor impacts to the plant site and proposed transmission line

connection to the SCE transmission system. However, cross referencing with the most current California Department of Transportation (Caltrans) Seismic Hazard Map (CSHM) (Mualchin, 1996) indicates a deterministic PBA of approximately 0.39g produced from the Pahrump-Stateline Fault located approximately 5 miles northeast from the site. This acceleration is interpolated from acceleration contours shown on the map and was compared with the attenuation relationship by Sadigh et al. (Sadigh et al., 1997) for a rock outcrop site, which indicates a PBA of approximately 0.33g. This would affect the plant site and proposed transmission line connection to the SCE transmission system.

The PBA discrepancies between Blake (2004) and the CSHM are related to fault activity. Data used by Blake (2004) are based on the latest California Geologic Society data for 2002 active earthquake faults. These faults are defined as being active from generally the late Pleistocene to Holocene times or approximately 126,000 years (± 5,000 years) ago to present. The CSHM faults consider activity during the late Quaternary Period or approximately 700,000 years ago to present. An assessment of which criteria to consider will need to be conducted before final design of the facilities.

The potential for strong seismic ground shaking to occur at the site is considered low to medium.

5.4.3.4.2 Ground Rupture

The site is not located within a special study zone, as delineated by the Alquist-Priolo Special Studies Zone Act of 1972. One fault has been noted to exist beneath the project site, but does exhibit evidence of recent activity (Jennings, 1994). The potential for ground rupture to occur at the project site or along the project linears is low.

5.4.3.4.3 Liquefaction

During strong ground-shaking, loose, saturated, cohesionless soils can experience a temporary loss of shear strength. This phenomenon is known as liquefaction. Liquefaction is dependent on grain size distribution, relative density of the soils, degree of saturation, and intensity and duration of the earthquake. The potential hazard associated with liquefaction is seismically induced settlement and lateral spreading. The depth to groundwater at the project site is relatively deep, estimated at greater than 100 feet below ground surface (DWR, 2004). Because of the lack of significant potential seismic activity and deep ground water, the project site area has a low potential for liquefaction to occur. In addition, the County of San Bernardino has not identified liquefaction to be a significant geologic hazard in the project area (San Bernardino County, 2007).

5.4.3.4.4 Slope Stability

Slope instability depends on steepness of the slope, underlying geology, surface soil strength, and pore pressures in the soil. Significant excavating, grading, or fill work during construction might introduce temporary slope stability hazards at either the project site or along linear facility routes. Because the project site and linear corridors are relatively flat and no significant and permanent vertical excavations or fills are planned during site construction, the potential for direct impact from landslides or mass wasting is considered low.

5.4.3.4.5 Subsidence

Subsidence can be caused by natural phenomena during tectonic movement, consolidation, hydrocompaction, liquefaction settlement as described above, or rapid sedimentation. Subsidence can also result from human activities, such as withdrawal of water and/or hydrocarbons in the subsurface soils and construction of new facilities such as mass fills and new structures or buildings. Without proper and site-specific geotechnical assessment relative to the proposed facilities, subsidence potential could be high. A site-specific geotechnical investigation is being conducted and will determine the level of subsidence potential for the site and provide recommendations to mitigate impacts, if significant.

A copy of the geotechnical investigation report will be provided upon request.

5.4.3.4.6 Expansive Soils

Expansive soils are clay-rich soils that have the ability to shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations. The project site and linears are primarily underlain by sandy, granular soil intermixed with silt and clay. These silts and clays, though intermixed with granular soil, could have expansion potential. A site-specific geotechnical investigation is being conducted and will determine the level of expansion potential for the site.

5.4.3.4.7 Tsunami/Seiche

Tsunamis are waves typically generated offshore or within large bodies of water during a subaqueous fault rupture or a subaqueous landslide event. Seiches are waves generated within a large body of water caused by the horizontal movement of an earthquake. Due to lack of proximity of the project site to large bodies of water, there is a no potential for the project site to be impacted by a tsunami or seiche.

5.4.3.5 Geologic Resources of Recreational, Commercial, or Scientific Value

Geologic resources of recreational, commercial, or scientific value in the project vicinity that could be affected include mineral resources. No known scientific or recreational geologic resources were identified in the vicinity of the project site. No known oil or gas reserves were identified to be present in the project vicinity (CDOGGR, 2007). Commercial resources of value are discussed in the next paragraph.

5.4.3.5.1 Mineral Resources

According to the State of California Geological Survey, the mineral land classification for the area within a 2-mile buffer of the site is primarily MRZ-4 (California Division of Mines and Geology, 1985). This designation is defined as an "[a]rea where geologic information does not rule out either the presence or absence of mineral resources." The small limestone outcrop (northwest of the site) has been classified as MRZ-3. This designation is defined as an "[a]rea underlain by geologic terrace within which undiscovered industrial mineral resources similar to known deposits in the same producing district or region may be reasonably expected to exist" (California Division of Mines and Geology, 1985). These resources are shown on Figure 5.4-2.

5.4.4 Environmental Analysis

5.4.4.1 Generating Facility

5.4.4.1.1 Geologic Hazards

Ground shaking presents the most significant geologic hazard to the proposed Ivanpah SEGS site and project linears. Based on the analysis in Section 5.4.3, Table 5.4-2 summarizes the geologic hazards associated with the Ivanpah SEGS project site and linear facilities that have at least a moderate potential to occur.

TABLE 5.4-2
Summary of Potential Geologic Hazards at the Proposed Ivanpah SEGS

Project Component	Area of Potential Concern	Geologic Hazards of Potential Concern
Proposed generating facility site (about 5.25 square miles)	Entire site	Seismic ground shaking
Transmission linears	Entire site	Seismic ground shaking

5.4.4.1.2 Geologic Conditions and Topography

Construction will require minor grading and excavation, thereby altering the terrain of the proposed Ivanpah SEGS power plant site. Impacts on the geologic conditions involve minor changes in drainage, cuts, and fills. Since the site has a fairly gentle slope from west to east (approximately 5 percent), any minor site grading is not expected to adversely impact the geologic environment.

5.4.4.2 Geologic Resources of Recreational, Commercial, and Scientific Value

No known natural resources occur in the Ivanpah SEGS project site area other than the limestone outcrop, classified as MRZ-3, that is located immediately northwest of the project site. It is not anticipated that the project will have an adverse impact to this speculative resource.

5.4.5 Cumulative Effects

A cumulative effect refers to a proposed project's incremental effect together with other closely related past, present, and reasonably foreseeable future projects whose impacts may compound or increase the incremental effect of the proposed project (Pub. Resources Code § 21083; Cal. Code Regs., Title 14, §§ 15064(h), 15065(c), 15130, and 15355). Cumulative projects are described in Section 5.6.7 and include the Desert Xpress Rail Line, improvements to Interstate 15, Las Vegas Valley Water District Pipeline, Southern Nevada Supplemental Airport (Ivanpah Valley Airport), and Table Mountain Wind Generating Facility. Although environmental analyses for most of the cumulative projects have not been completed at the time of preparation of this Application for Certification, standard engineering practices are expected to reduce the potential for impacts due to geological hazards that could result from implementation of these projects.

As described above, the project would not affect geologic resources, and thus would not contribute to a cumulative impact when considered in combination with the cumulative projects. As described below, mitigation measures have been identified to reduce impacts

from geologic hazards. With implementation of these measures, the Ivanpah SEGS would not result in adverse geologic hazards impacts. Therefore, the project would not combine cumulatively with other closely related past, present, and reasonably foreseeable future projects and result in cumulative considerable geologic hazards impacts.

5.4.6 Mitigation Measures

The following subsections describe mitigation measures that could be used to reduce impacts from geologic hazards.

5.4.6.1 Ground Rupture

No active faults cross the Ivanpah SEGS project site or project linears (Jennings, 1994). Therefore, no mitigation measures are required to reduce the hazard from surface faulting rupture.

5.4.6.2 Ground-Shaking

The Ivanpah SEGS project site and project linears will need to be designed and constructed to withstand earthquake-shaking as specified in the 2007 CBC for Seismic Zone 3, in accordance with County of San Bernardino construction standards. A site-specific geotechnical investigation (forthcoming) will aid in the development of the seismic design criteria.

5.4.6.3 Liquefaction

A site-specific geotechnical investigation currently being conducted will aid in the assessment of liquefaction potential and lateral spreading. Mitigation for liquefaction may include grouting, deep-dynamic compaction, stone columns, geopiers, or deep foundations such as piles or drilled shafts.

5.4.6.4 Subsidence

A site-specific geotechnical investigation is being conducted and will determine the level of subsidence potential for the site and provide recommendations to mitigate impacts, if significant.

5.4.6.5 Expansive Soils

Expansive soils can be mitigated by removing the soil and backfilling with non-expansive soil, instituting chemical stabilization of the soil, or constructing a foundation treatment that resists uplift of the expansive soil. Soil types present in the general site vicinity likely do not exhibit expansion potential. A site-specific geotechnical investigation is being conducted and will determine the level of expansion potential for the site and present mitigation recommendations.

5.4.7 Involved Agencies and Agency Contacts

No permits are required for compliance with geological LORS.

5.4.8 Permits Required and Permit Schedule

Compliance of building construction with CBC standards is covered under engineering and construction permits for the project. There are no other permit requirements that specifically address geologic resources and hazards. However, excavation/grading and inspection permits may be required prior to construction and will be included in the overall project license (see Section 5.6, Land Use).

5.4.9 References

Blake, T. F. 2004. EQFAULT, A Computer Program for the Deterministic Prediction of Peak Horizontal Acceleration from Digitized California Faults, User's Manual. 79 pp.

California Building Standards Commission. 2007. *20071 California Building Code.* California Code of Regulations, Title 24, Part 2, Volume 2.

California Division of Mines and Geology. 1985. *Mineral Land Classification of the Northern Kingman 1º x 2º Sheet.* San Bernardino County, California.

California Department of Transportation (Caltrans). *California Seismic Hazard Map*. 1996.

California Division of Oil, Gas, and Geothermal Resources (CDOGGR). 2007. O*il and Gas* Field Maps. http://www.consrv.ca.gov/dog/maps/d1_index_map1.htm

California Department of Water Resources (DWR). 2004. *Ground Water Occurrence,* South Lahontan Hydrologic Region, Ivanpah Valley Groundwater Basin. Bulletin No. 118. 135 p.

Jennings, C. W. 1994. *Fault Activity Map of California and Adjacent Areas*. Division of Mines and Geology.

Jennings, C. W. 1961. *Geologic Map of California, Kingman Sheet. 1:250,000 scale*. Division of Mines.

Mualchin, L. 1996. A *Technical Report to Accompany the Caltrans California Seismic Hazard Map.* Prepared for Caltrans by the Office of Earthquake Engineering. July.

Norris, R. M. and R. W. Webb. 1990. *Geology of California.* Second Edition. John Wiley and Sons. New York.

Sadigh, K., and C.Y. Chang, J.A. Egan, F. Makdisis, and R.R. Youngs. Attenuation Relationships for Shallow Crustal Earthquakes Based on California Strong Motion Data, Seismological Research Letters. Volume 68, No. 1.

San Bernardino County. 2007. *Safety Element of the San Bernardino General Plan*. Prepared by URS Corporation for the San Bernardino County Planning Department.

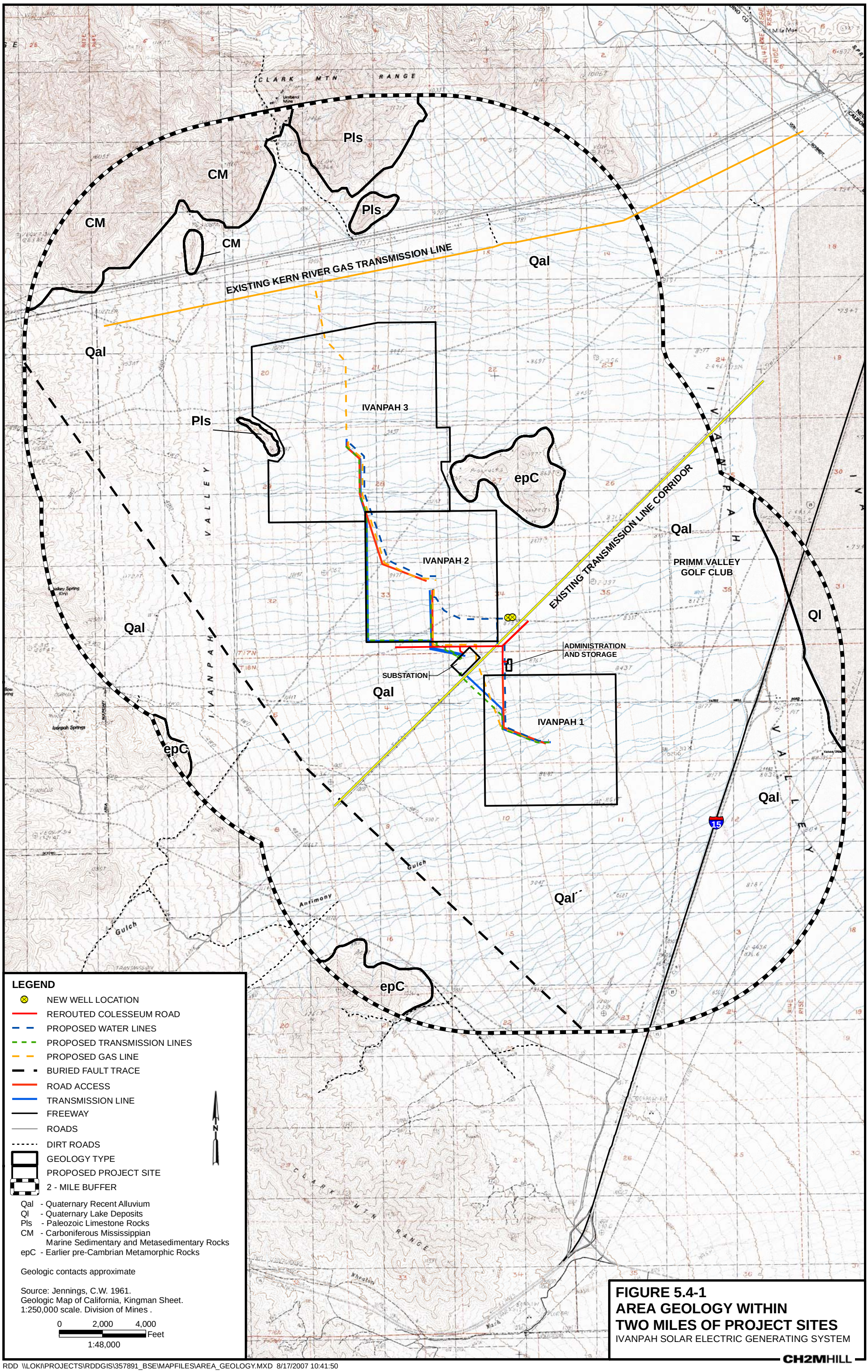

FIGURE 5.4-1
AREA GEOLOGY WITHIN TWO MILES OF PROJECT SITES
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM

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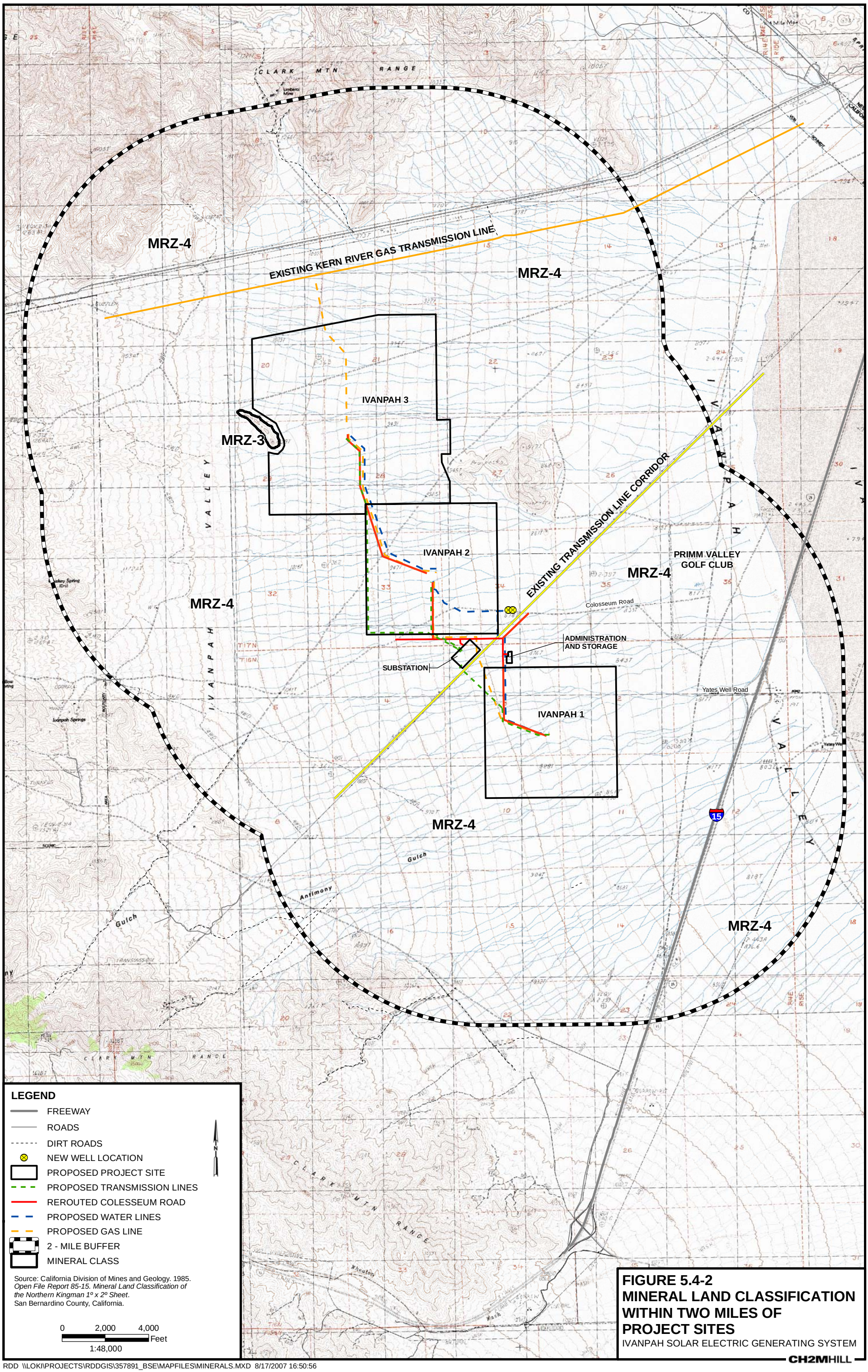

FIGURE 5.4-2
MINERAL LAND CLASSIFICATION WITHIN TWO MILES OF PROJECT SITES
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM

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