APPENDIX B

Geotechnical Reports

B.1 Preliminary Geotechnical Constraints Evaluation

B. 2 Preliminary Geotechnical Investigation Report

APPENDIX B.1

Preliminary Geotechnical Constraints Evaluation

PRELIMINARY GEOTECHNICAL/GEOLOGIC CONSTRAINTS EVALUATION PROJECT BEACON KERN COUNTY, CALIFORNIA

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Kleinfelder Project No.86405

September 21, 2007

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September 21, 2007
File No. 86405

Mr. Geoffrey Baxter, PE
Project Manager
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2330 East Bidwell Street, Suite 150
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Subject: Preliminary Geotechnical/Geologic Constraints Evaluation
Project Beacon
Kern County, California

Dear Mr. Baxter:

Kleinfelder West, Inc. (Kleinfelder) is pleased to present this report summarizing geologic and geotechnical conditions within the study area, and potential geologic and geotechnical constraints associated with the site. The project is located within the Fremont Valley area north of California City, unincorporated Kern County, California.

The purpose of this investigation was to identify and evaluate geologic and geotechnical constraints that could affect development of the project. In general, the primary geologic and geotechnical constraints associated with the project include the potential for fault rupture; moderate to severe seismic shaking; subsidence and ground failure related to groundwater withdrawal; local flooding; and expansive and/or collapsible alluvial soils. This report describes these conditions and presents preliminary recommendations for planning and further studies.

We appreciate the opportunity to be of service on this project. If you have any questions, comments, or require additional information, please do not hesitate to contact our office.

Respectfully submitted,

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1.0 INTRODUCTION

1.1 GENERAL

Kleinfelder West, Inc. (Kleinfelder) was retained by WorleyParsons to conduct geologic and geotechnical services in support of the proposed Project Beacon Power Plant in Fremont Valley, Kern County, California. The location of the project site is shown on Plate 1, Site Location Map. The scope of our services was presented in our proposal entitled *Proposal to Conduct Geotechnical Engineering Investigation, California City Solar Project, California City, California,* dated June 21, 2007. The purpose of this study is to provide preliminary geological and geotechnical engineering information for use by the design engineer for further planning, design and economic evaluations of the project.

1.2 PROJECT DESCRIPTION

We understand that the proposed power project site will be located on approximately 2,300 acres land area, north of California City along Highway 14 in the Mojave Desert, approximately 10 miles north of Highway 58. The proposed power plant will generate approximately 250 to 500 MW of power using solar panels.

Based on a review of preliminary site plans prepared by WorleyParsons and discussions with you, we understand that the project will include a solar array field distributed over approximately two square miles in the eastern portion of the site and a power block within solar array field. The power block will include a cooling tower and steam turbine and an unspecified number of other lightly loaded structures. The project will also include water ponds in the northeast portion of the site and an administration building and warehouse in the western portion adjacent to Highway 14.

1.3 PURPOSE AND SCOPE

The purpose of this study was to research and evaluate the existing geotechnical and geologic conditions within the project study area and to identify potential geologic and geotechnical constraints that could impact planning, design and construction.

The study entailed a literature search, review of available engineering documents, interaction with the planning and design team, review and interpretation of available

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aerial photographic maps, geologic reconnaissance mapping, compilation and analysis of the collected data, and the preparation of this report. Reconnaissance surface geology was compiled on USGS 7.5 minute topographic base maps (1:24,000 scale) and aerial photographs covering the project area. Geologic data collected during our literature search were also compiled on the base maps and modified based on the results of our geologic reconnaissance. The collected data and results of our site reconnaissance were evaluated to identify geologic hazards and geotechnical constraints.

Subsurface exploration and laboratory testing were not performed as part of this investigation. Future detailed site-specific investigations are recommended for the various project components.

1.4 PREVIOUS STUDIES AND PERTINENT REPORTS

Geologic and geotechnical literature reviewed included reports, maps, and other documents prepared by the California Geological Survey, the U. S. Geological Survey, and other agencies. We also reviewed the Work Plan for Investigation of Groundwater Resources for the project prepared by ENSR. A list of maps, reports and documents reviewed as part of this study is presented below.

- *Areal geologic map of the Western Mojave Desert, California*, 1967, U.S. Geological Survey Professional Paper 522.

- *Map showing recently active breaks along the Garlock and associated faults, California*, 1973, U.S. Geological Survey Miscellaneous Investigations Map I-741.

- *Log of trench in the Garlock fault zone, Fremont Valley, California*, 1979, U.S. Geological Survey Miscellaneous Filed Studies Map MF-1028.

- *Subsidence cracking and subsequent erosional fissuring in Fremont Valley, California*: 1978 and 1983, June 1984, Naval Weapons Center Technical Memorandum 5268.

- *Modern ground failure in the Garlock fault zone, Fremont Valley, California*, 1988, Geological Society of America, v.100, May 1988.

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- *Ground cracks along the Garlock fault zone in Fremont Valley, Kern County, California*, 1989, California Division of Mines and Geology, Fault Evaluation Report FER-197.

- *State of California Special Studies Zone, Cantil Quadrangle, Revised Official Map*, 1990, California Division of Mines and Geology.

- *State of California Special Studies Zone, Cinco Quadrangle, Revised Official Map*, 1990, California Division of Mines and Geology.

- *State of California Special Studies Zone, NE ¼ Mojave Quadrangle, Official Map*, 1976, California Division of Mines and Geology.

- *Work plan for Investigation of groundwater resources, Project Beacon, Kern County, California*, August 2007, ENSR.

- *Geologic Map of California, Trona Sheet*, 1963, California Division of Mines and Geology.

- *Geologic Map of California, Bakersfield Sheet*, 1965, California Division of Mines and Geology.

Pertinent findings and information contained within these maps and reports are discussed within the body of this report.

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2.0 SITE CONDITIONS

2.1 SITE DESCRIPTION

The project is located within the Fremont Valley area north of California City, in unincorporated Kern County, California. The approximate project boundaries are shown on Plate 1, Site Location Map. The site is located within Sections 3, 4, 7, 8, and 9 of Township 30 South, and Range 37 East. The approximate center of the site is located at approximate Latitude 35.2564° N and Longitude 118.0189° W.

The site encompasses approximately 2,300 acres of essentially vacant land. According to a work plan report prepared by ENSR for the project (ENSR, 2007) and other research (Pampeyan, 1988), the site was previously used for alfalfa farming. Farming was discontinued in 1988. Remnant hay storage facilities are located in the southern portion of the property. Approximately 14 groundwater wells are scattered throughout the property. An abandoned storage or detention basin is located near the center of the site. Surrounding developments include the Southern Pacific Railroad to the west, a small cluster of buildings easterly and adjacent to Highway 14 west of the site, and several abandoned structures northeast of the site.

Topography across the site is characterized as an area of low relief. The area is part of the Fremont Valley, a deep northeast trending alluvial-filled basin. The valley floor in the project area slopes gently to the northeast. Elevations range from approximately 2,260 feet above mean sea level (msl) in the southwest portion of the site to approximately 2,020 msl at the northeast corner. Overall relief on the site is on the order of 240 feet. An approximate 15- to 25-foot high northeast trending eroded escarpment trends through the middle of the site. This escarpment coincides with the mapped trace of the Cantil Valley fault. A more detailed discussion of the fault is provided in Section 3 of this report. A relatively well-defined north- to northeast-trending drainage channel crosses through the site in the area of the proposed solar array field and power block. The channel ranges from approximately 25 to 70 feet wide and includes near vertical banks up to approximately 2 to 4 feet high. Several other drainage channels also cross the western, southern and northeastern portions of the site.

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Surface drainage throughout the study area is via sheetflow runoff over the contour of the land. Offsite drainage from the south is also directed onto the site via the natural drainage channel near the middle of the site. Drainage flows to the northeast towards Koehn Lake, a closed depression within Fremont Valley that receives drainage from the northeast and southwest. Koehn Lake is a dry lake, or playa, formed at the lowest elevation within Fremont Valley. The formation of the lake is associated with formation of the valley and is not likely a result of regional subsidence.

2.2 GROUNDWATER CONDITIONS

The project study area is located within the Fremont Valley Groundwater Basin, which is divided into several sub-basins including the Koehn Lake sub-basin. The project site is located within the Koehn Lake sub-basin. A more detailed description of the Fremont Valley groundwater Basin and the Koehn Lake sub-basin is presented in the *Work Plan for Investigation of Groundwater Resources, Project Beacon, Kern County, California* prepared by ENSR (2007).

Much of the groundwater information provided in this report is based on review of the above referenced report prepared by ENSR, which in turn is based on State database information, published reports on groundwater, and information provide by the property owner's representative. Additional information has been derived from publications from the U.S. Geological Survey and the California Geological Survey.

Data on groundwater beneath the site is based on 14 wells that were installed on the site over 25 years ago. Well information provided in the ENSR report indicates groundwater depths beneath the site ranged from 304 to 487 feet beneath the ground surface (bgs) in February 1981. More recent information in the California DWR database for two wells on the site indicates groundwater levels on the order of 270 to 313 feet bgs (ENSR). The cause for the apparent recent rise in groundwater is unknown, but may be related to regional recharge and the discontinuation of well pumping after 1985.

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Additional information on groundwater from the California Geological Survey and the U.S. Geological Survey indicate pumping of groundwater within the Fremont Valley area has occurred in the past for crop irrigation. Groundwater level declines associated with pumping for irrigation may be associated with past land subsidence and ground failures. A more detailed discussion of groundwater, subsidence and ground failure is presented in Section 3 of this report.

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3.0 GEOLOGIC AND GEOTECHNICAL CONDITIONS

3.1 REGIONAL GEOLOGIC SETTING

Regionally, the project study area is located within the northwestern portion of the Mojave Desert Geomorphic Province of California. The Mojave Desert Province is characterized as a broad interior region of isolated mountain ranges separated by broad alluvial basins. The province is wedged between the northeast-trending Garlock fault, on the north and the northwest-trending San Andreas fault on the south.

Locally, the study area is located within what is known as the Fremont Valley, a deep northeast trending alluvial-filled basin. The basin is bounded on the northwest by the southern Sierra Nevada Mountains and the El Paso Mountains, and on the east by the Rand Mountains. The valley is underlain by approximately 5,000 feet of low-density unconsolidated alluvial sediments (Pampeyan and others, 1988). Within the study area, the valley has formed as a deep structural depression or pull-apart basin formed between two strands of the Garlock fault – the East Strand and the West Strand.

The most significant geologic feature in the project area is the Garlock fault. The Garlock fault extends from its junction with the San Andreas fault near Gorman on the west to the Death Valley fault zone on the east. The fault is a left-lateral strike-slip fault with approximately 40 miles of offset (Smith, 1962). In the project area, the Garlock fault consists of two strands referred to as the East Strand and the West Strand. These two faults are an example of a classic left-stepping en echelon fault system (Pampeyan and others, 1988). The East Strand bounds the northwest side of Koehn Lake and Fremont Valley. North of Koehn Lake, this fault is the main branch of the Garlock fault. The West Strand bounds the southeast side of Koehn Lake and extends southwestward through the study area. The West Strand is also referred to as the Cantil or Cantil Valley fault. Within the study area the Garlock fault includes both strands, with the West Strand beginning near Koehn Lake and the East Strand dying out or joining with the West Strand just south of the study area near Pine Tree Canyon.

Lithologically, the study area is underlain primarily by recent alluvium, Holocene lacustrine (lake) and playa deposits near the surface, and older alluvium at depth. The recent and older alluvial deposits are comprised or various mixtures, layers and lenses

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of sand, silt and gravel. The lacustrine and playa deposits are comprised of finer-grained sands, silts and clays. Basement rocks comprised of granitic and/or metamorphic rocks are believed to underlie the unconsolidated alluvial soils at depth. Regional geologic conditions are shown on Plate 2.

3.2 STRATIGRAPHY

Geologic conditions in the project area have been regionally mapped or compiled by several authors including Jennings, Burnett, and Troxel (1962), Smith (1964), Dibblee (1967), and Jennings (1977). Geologic units and contacts shown on maps prepared by these authors were reviewed and field-checked during our site reconnaissance mapping. Units exposed at the surface within the study area include artificial fill; Quaternary alluvium: Quaternary lake deposits and Pleistocene older alluvium.

The majority of the site is underlain by recent alluvium and or Quaternary lake (lacustrine) deposits. Minor artificial fill is also present on the site in areas of past disturbance including roads, hay storage facilities, water wells, and detention basins. Following are brief descriptions of the soil and geologic units in order of increasing age.

3.2.1 Fill

Artificial fill is present in portions of the project study area, in association with existing developments such as roads and structures. The extent and depth of fill on the site is unknown but is estimated to be minor based on the limited extent of disturbance to the site in the past. Fill soils present on the site are likely generated from native soils and are anticipated to be composed of various mixtures of sands, silt and gravel. Dump fill is also present locally on the site. The dump fill consists of local piles of wood and concrete rubble, tires, and various amounts of trash. For engineering purposes, artificial fills are generally required to meet certain specifications related to grain size, composition, and compaction. The degree of compliance with such standards for fills in the study area is unknown.

3.2.2 Younger Alluvium

Holocene-age alluvium underlies the majority of the site. The alluvium in the project area consists of unconsolidated mixtures of sand, silt and gravel with local cobbles.

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Where exposed onsite, the alluvium is crudely stratified with alternating layers and lenses of sand, silt and gravel. The thickness of the alluvial soils beneath the site is unknown. However, previous researchers indicate unconsolidated and moderately consolidated deposits in the Fremont Valley area are more than 5,000 feet thick (Pampeyan, 1988). This includes younger and older alluvial deposits, and sediments of the Pliocene Ricardo Formation. Within the Koehn Lake sub-basin the unconsolidated deposits including the younger alluvium reportedly ranges up to 1,900 feet in thickness (ENSR, 2007). The alluvial sediments should be expected to be relatively high in permeability, loose to moderately dense near the surface, and increasing in density with depth. Portions of the alluvial soils are likely subject to collapse and consolidation upon loading and wetting.

3.2.3 Lake Deposits

Holocene lake deposits have been mapped underlying Koehn Lake and the surrounding dry lake area within Fremont Valley. The lake deposits have been mapped by others as far south as the northern portion of the project area (Dibblee, 1967, Smith 1964) and were observed during our site reconnaissance on August 20, 2007. The aerial extent of the lake deposits on the subject property was not mapped as part of this study. However, the lake deposits were observed during our site reconnaissance in the northern portion of the study area and, where observed, the lake deposits consist of a mixture of silt and clay soils. The lake deposits exhibit numerous polygonal desiccation cracks at the ground surface suggesting these soils have potential for expansion and shrinkage upon wetting and drying.

3.2.4 Older Alluvium

Pleistocene-age older alluvium exists beneath the recent alluvium and is mapped locally at the surface along the margins of Fremont Valley. The older alluvium is similar in composition and origin to the younger alluvial deposits but is generally more consolidated. The older alluvium generally consists of poorly-graded sand, silt, gravel and clay with finer grained and well graded deposits toward the center of the valley (ENSR, 2007 based on Weir et al. 1965, Bloyd, 1967, and DWR 2003).

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The overburden thickens, depths of recent alluvium and lake deposits and areal distribution and engineering properties of the various soil types underlying the site can be evaluated during future design-level geotechnical investigations.

3.3 LANDSLIDES AND SLOPE STABILITY

No known landslides have been mapped along or adjacent to the study area. We did not identify any active or inactive landslides in the study area during our site reconnaissance or review of aerial photographs.

3.4 FAULTING AND SEISMICITY

3.4.1 Fault Rupture

As discussed earlier, the most significant geologic feature in the project area that could affect the project is the Garlock fault. This fault is one of the major fault systems in southern California and is also a major physiographic boundary between the Mojave Desert Geomorphic Province on the south and the Sierra Nevada and Basin-Ranges Provinces on the north. As discussed in Section 3.1, the Garlock fault includes two strands in the project area – the East Strand and the West Strand. The West Strand is referred to interchangeably in the literature as the Garlock West Strand, the Cantil fault and the Cantil Valley fault.

Both the strands of the Garlock fault are considered active and are included within an Alquist-Priolo Earthquake Fault Zone associated with the Garlock fault zone, as designated by the State of California (Hart, 1997). The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures planned for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures.

The Cantil Valley fault has been mapped by the State of California as crossing the project area through the proposed solar array field and near the proposed power block (see Plate 3, Site Fault Map). Some available maps reviewed indicate the fault is buried beneath recent alluvial soils (Smith, 1964) while other maps indicate the fault shows evidence of past surface rupture at the surface (Jennings, 1977, Dibblee, 1967, Pampeyan, 1988).

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On aerial photographs, the main projection of the fault is recognized as a long lineal tonal expression, trending approximately N57E through the project area. Reconnaissance field mapping performed on August 24, 2007 by the undersigned geologists verified the approximate location and orientation of this fault. The fault location was checked using a handheld Trimble (GPS) unit to obtain accurate coordinates at three locations along the fault (field points 1, 2, and 9, Plate 3). In the field, the fault is expressed primarily as an escarpment trending approximately N55-60E, with approximately 15 to 25 feet of relief across the fault. The sense of displacement is northwest side down relative to the southeast side. This sense of displacement is consistent with that described in the literature reviewed (Wills, 1989). The escarpment is well eroded and evidence of ground cracks or other offsets were not observed during our site reconnaissance. The Cantil Valley fault is shown on geologic maps prepared by the State as a series of discontinuous discrete breaks along the escarpment (Wills, 1988). To the northeast, the Cantil Valley fault diverges into several northeast to northwest trending splays.

Other north to northwest-trending faults have been mapped in the northern and northwest portions of the site in the area of the proposed solar array field and water ponds areas (see Plate 3). These faults are also included within an Alquist-Priolo Earthquake Fault Zone associated with the Garlock fault zone. These faults are oriented in a conjugate orientation with respect to the main trend of the Garlock fault. These faults likely originated during formation of the pull-apart basin formed by the left step of the Garlock fault from the East Strand to the West Strand. These faults are not considered seismogenic faults (capable of generating an earthquake) but rather are more likely to display sympathetic movement or activity in response to activity and movement on a nearby major fault such as the Garlock fault.

Like the main trace of the Cantil fault, some of these north to northwest trending faults are visible as tonal lineaments and aligned drainages on aerial photographs. We were not able to verify many of the lineaments in the field. However, several well defined erosional features, ground cracks, and aligned depressions were mapped during our site reconnaissance. The mapped features are coincident with one set of previously mapped faults by others (field points 4-8, Plate 3). The locations of these features were documented using a handheld Trimble GPS unit and are shown on Plate 3.

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Many of the north to northwesterly trending fault features have been recently associated with ground failure as a result of past pumping of groundwater for irrigation and subsidence as a result of the pumping. A detailed discussion is provided in Section 3.6 of this report. Koehn Lake to the northeast has no relationship to the north to northwesterly trending fault features.

3.4.2 Seismicity and Ground Motion

As described earlier, the project study area is located in the highly seismic, southern California region within the influence of several fault systems, which are considered to be active or potentially active. An active fault is a fault that has experienced seismic activity during historic time (since roughly 1800) or exhibits evidence of surface displacement during Holocene time (Hart and Bryant, 1997). The definition of "potentially active" varies. A generally accepted definition of "potentially active" is a fault showing evidence of displacement that is older than 11,000 years (Holocene age) and younger than 1.7 million years (Pleistocene age). However, "potentially active" is no longer used as criteria for zoning by the California Geologic Survey (CGS). The terms "sufficiently active" and "well-defined" are now used by the CGS as criteria for zoning faults under the Alquist-Priolo Earthquake Fault Act. A "sufficiently active fault" is a fault that shows evidence of Holocene surface displacement along one of more of its segments and branches, while a "well-defined fault" is a fault whose trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The definition "inactive" generally implies that a fault has not been active since the beginning of the Pleistocene Epoch (older than 1.7 million years old). These sufficiently active and well defined faults are capable of producing seismic shaking at the site that could potentially be damaging to buildings and appurtenant structures. It is anticipated that the study area will periodically experience ground acceleration as the result of moderate to large magnitude earthquakes.

The closest major active faults capable of generating ground motions that could affect the project during a seismic event are the Garlock and Lenwood-Lockwood-Old Woman Springs fault zones. Previous studies by others indicate the Garlock fault near the project area has a slip rate of 5-11 mm/year (Pampeyan and others, 1988; Peterson and Wesnousky, 1994). Other literature suggests the recurrence interval for large earthquakes on the Garlock fault is about 1,000 years.

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Faults are also classified as A, B, or C types for Near-Source Zone ground motion by both State and International Conference of Building Officials (ICBO). In the 1997 Uniform Building Code (UBC), Table 16-U, faults are classified according to parameters of known slip rate and maximum earthquake magnitude. Generally, a "Type A" fault has a magnitude, M, greater than or equal to 7.0 and a slip rate (SR) greater than or equal to 5mm/yr. A "Type B" fault has a magnitude M>7.0 and SR<5mm/yr and SR>2mm/yr., or M>6.5 and SR<2mm/yr. A "Type C" fault has a magnitude, M, less than 6.5 and a slip rate of less than 2mm/yr., or is unrated under the current knowledge.

We have performed a computer-aided search of the known sufficiently active and well defined faults within a 62-mile radius of the site and researched available literature to assess the maximum magnitude earthquakes expected to be generated on each fault. Table 1, Significant Faults, summarizes the parameters for six out of the twenty known active and well defined faults within the searched radius of the site that, in our opinion, will have the greatest impact upon the site. Selection of the faults was based on their proximity to the site and their potential to generate strong ground motion on the site.

Table 1 was generated using, in part, the EQFAULT computer program (version 3.00b) developed by Blake (2000) as modified using the fault parameters from DMG Open File Report 96-08 and the 1997 UBC fault maps (ICBO, 1997). This table does not identify the probability of reactivation or the on-site effects from earthquakes occurring on any of the other faults in the region.

Table 1
Significant Faults

Fault Name	Approximate Distance from Middle of Site mi.	km	Maximum Event (Moment Mag.)	Fault Seismic Source Type (ICBO)
Garlock – West	<0.2	<0.3	7.3	A
Garlock – East	1.0	1.6	7.5	A
Lenwood – Lockwood-Old Woman Springs	14.7	23.7	7.3	A
Southern Sierra Nevada	18.0	29.0	7.1	A
White Wolf	21.6	34.7	7.2	A
Gravel Hills – Harper Lake	31.9	51.3	6.9	B

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Since a number of moderate earthquakes have occurred in the vicinity of the project site in past years, we conducted a historic earthquake search. The parameters used to define the limits of the historical earthquake search included geographical limits (within 100 km [62 miles] of the site), dates (1800 through 2006), and magnitude (magnitudes above M 4.0). A summary of the results of the search is presented below in Table 2, Summary of Historic Earthquake Search.

Table 2
Summary of Historic Earthquake Search

Time period (1800 to 2006)	207 years
Maximum Historical Magnitude within 62 mi. radius (July 21, 1952, Tehachapi event)	7.7
Approximate distance to nearest historical earthquake, with a Magnitude greater than M4.0	6.7 km (4.2 mi.)
Number of events exceeding magnitude M4.0 within the search area	456

Under the current understanding of regional seismo-tectonics, the largest maximum credible event to impact the site may be generated by the Garlock fault-East Strand, which is considered to be capable of generating a moment magnitude M7.5 earthquake.

Based on review of preliminary information the peak ground acceleration (PGA) at the site may be on the order of 0.4 g (CGS PSHA website). Peak ground acceleration is a measure of the maximum acceleration experienced at the site during an earthquake event. A more detailed seismic design evaluation should be performed as part of a design level geotechnical investigation.

3.5 LIQUEFACTION POTENTIAL AND SEISMICALLY INDUCED SETTLEMENT

Liquefaction is a phenomenon that may occur because of earthquake shaking at locations where loose sandy soils are present and groundwater levels are shallow. Potential liquefaction hazards are estimated to be low due to deep groundwater beneath the site.

Seismically induced settlement occurs where earthquake shaking causes densification of relatively loose sediments. Sediments that are sufficiently loose are subject to such densification, which can cause surface settlement and damage to surface and near-surface structures. Geotechnical investigations, which will be completed to support

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project design and construction, should evaluate areas that may be subject to seismically induced settlement. Standard design and construction techniques can then be used to mitigate the potential for damage due to seismically induced settlement. Typical mitigation may include removal and recompaction of relatively loose soils.

3.6 FLOOD HAZARDS

Based on the Flood Hazard Maps available through the Federal Emergency Management Agency (FEMA) website, indicate the Northeast trending wash on the site is located within a flood hazard zone prone to a 100-year frequency of flooding.

3.7 SUBSIDENCE AND GROUND FAILURE

Recent studies suggest that ground failures within Fremont Valley have developed as a result of past pumping of groundwater for crop irrigation. These findings are presented in more detail in papers published for the Naval Weapons Center, and by the California Geological Society and the Geological Society of America. These studies indicate that some of the subsidence related features coincide with some of the northwest trending secondary faults identified northwest of the proposed power block and in the area of the proposed water ponds. A summary of the research is presented below.

A report to the Naval Weapons Center (NWC) in 1984 (Roquemore and Zellmer, 1984), indicates that ground cracks were identified in the Fremont Valley area following heavy rains in 1978. The ground cracks were documented using aerial photography followed by field mapping and plotting of the cracks on topographic maps. Additional heavy rains in 1983 resulted in additional reports of ground cracks in the Fremont Valley and a second reconnaissance study was performed by the NWC. According to the report prepared for the NWC (Roquemore and Zellmer, 1984), the most extensive ground cracking was observed in the area of "Rancho Seco" which is located just north of the northwest property corner. Some the ground cracks documented in 1978 and 1983 are shown on Plate 3 of this report near Rancho Seco. The cracks displayed "normal-slip displacement with the west side down." Approximately 4.5 to 10 cm (1.8 to 3.9 inches) of vertical displacement was documented as well as damage to a house, trailer, water line and irrigation channel, and formation of "collapse features, tunnels and fissures." Speculation on the causes of the ground cracks included tectonic strain and fault creep, and non-tectonic desiccation, piping, hydro-compaction, broad subsidence, groundwater over draft and slope failure.

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Pampeyan, Holzer, and Clark (1988) presented a more detailed study on the ground failure within Fremont Valley. The report concentrated on the ground failures southwest of Koehn Lake. Ground failures observed included erosionally enlarged tension cracks (earth fissures) to dip-slip displacement of the land surface along pre-existing fault traces.

According to Pampeyan and others, ground failure was first noted in the Fremont Valley in 1971 and was noted as open cracks along Holocene scarps. By 1976, ground failure was reportedly found on both sides of Neuralia Road and along Munsey Road to Koehn Lake. Additional new collapse features were noted following the heavy rains in 1978. These features are likely coincident with those report by Roquemore and Zellmer (1984).

In addition to documenting areas of ground cracking, Pampeyan's research also included a review of groundwater levels and groundwater usage in the valley. Water levels have reportedly declined approximately 88 meters (289 feet) between 1954 and 1980 due to pumping for alfalfa irrigation. Areas of groundwater usage and decline include the subject property. Groundwater withdrawal rates were not included in Pampeyan's research. Areas of ground failure began after the water level decline, and the failures are reportedly restricted to areas affected by the decline. The pumping of the groundwater for irrigation has resulted in up to 0.9 m (3 feet) of subsidence between 1977 and 1985 (Pampeyan and others, 1988). In addition, the valley's land surface was reportedly subsiding at an annual rate of 111 mm/yr (4.4 inches/yr) at the time of the study due to compaction of the aquifer system due to water-level decline. The current rate of subsidence in the valley is not known.

In summary, Pampeyan and others have concluded that groundwater withdrawal within Fremont Valley has resulted in ground failure, but mostly along pre-existing faults. Regional subsidence is also reported to be a result of past groundwater withdrawal. We did not find any other data that suggests the subsidence is related to other factors such as seismic shaking or seismically induced settlement of loose alluvium.

In view of the plan to develop groundwater resources for use on the power plant, the effect of groundwater withdrawal on future land subsidence should be considered in the overall site development plan. The overall effect of changes in groundwater levels on

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subsidence has not been evaluated. Additional analysis is recommended to evaluate the effect of groundwater withdrawal and changes in groundwater level on subsidence, and the effect of subsidence on the proposed development. Future evaluations would include research and review of past drawdown and pumping rates, well records, and groundwater modeling.

3.8 COLLAPSIBLE SOIL CONDITIONS

A collapsible soil is generally defined as a soil that will undergo a sudden decrease in volume when its internal structural support is lost. The internal support is considered to be a temporary strength and is derived from any number of sources, including capillary tension, cementing agents (e.g. iron oxide and calcium carbonate), clay-welding of grains, silt bonds, clay bonds and clay bridges. Soils found to be most susceptible to collapse include loess (fine-grained, wind-deposited soils) deposits, valley alluvium deposited within a semi-arid to arid climate, and residual soil deposits.

The project site is located in a geologic environment that may be prone to a collapsible soil problem. Based on review of numerous geotechnical reports in similar areas and conditions and our experience in the area, the collapse potential for the majority of on-site soil alluvial deposits ranges from moderate to high. Geotechnical investigations should be completed to support project design and construction, evaluate areas that may be subject to collapsible soils, and evaluate the collapse potential beneath the site. Standard design and construction techniques can then be used to mitigate the potential for damage. Typical mitigation for collapsible soils is remedial grading to remove and recompact soils that are susceptible to collapse potential. Site-specific geotechnical investigations for the various components of the improvements should be performed to evaluate the depth of removal or alternative remedial techniques, and to develop appropriate recommendations.

3.9 EXPANSIVE SOILS

Expansive soils are characterized by their ability to undergo significant volume change (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from rainfall, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors, and may cause unacceptable settlement or heave of structures, concrete slabs supported-on-grade, or pavements supported by these materials. Depending on the extent and location below finished subgrade,

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expansive soils can have a detrimental effect on structures. Based on our experience with the project site and the nature of lake soil deposits underlying the northern portion of the site, we believe that the expansion potential of the on site soils within the northern portion of the site is high. Residual soils in other areas may be expansive. Geotechnical investigations are recommended to evaluate and verify the expansion potential of the native soil deposits.

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4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

The purpose of this investigation was to identify and evaluate geologic and geotechnical constraints that could affect development of the project. Based upon the findings of this research, geologic reconnaissance, and data evaluation, the primary geologic and geotechnical constraints associated with the project include the potential for fault rupture; moderate to severe seismic shaking; subsidence and ground failure related to groundwater withdrawal; local flooding; and expansive and/or collapsible alluvial soils. These conditions and their constraints on the proposed development are summarized below.

- The northeast trending Cantil Valley fault, also referred to as the Garlock fault. West Strand, crosses near the area of the proposed power block and through the area of the solar array field. This fault is capable of generating a M7.5 earthquake. Previous studies by others indicate the Garlock fault has a slip rate of 5-11 mm per year and the recurrence interval for large earthquakes on the Garlock fault is about 1,000 years. Other north to northwest trending faults have been mapped through the areas of the proposed solar array field and water ponds areas. The Cantil Valley fault and other north to northwest trending faults are included within an Alquist-Priolo Earthquake Fault Zone and are considered active by the State of California. Although the provisions of the State Earthquake Fault Zoning act do not apply to the proposed power plant, we do not recommend locating critical structures such as the power block across active or well defined faults. We also do not recommend locating the proposed water ponds across active faults due to the potential for leakage of undesirable fluids into the subsurface upon fault rupture. The solar panels within the solar array field are considered non-critical structures and may be located within the fault zones provided the owner understands the risk of fault rupture damage in the event of an earthquake event and the risk is acceptable to the owner and the local regulatory agencies.

- The site is located in the highly seismic, southern California region within the influence of several fault systems, including the Garlock fault systems, which are considered to be active or potentially active. These active and potentially active

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faults are capable of producing seismic shaking at the site that could potentially be damaging to buildings and appurtenant structures. It is anticipated that the study area will periodically experience ground acceleration as a result of moderate to large magnitude earthquakes. A detailed seismic design evaluation was not performed as part this evaluation and beyond the scope of work for this phase of the project. However, appropriate seismic design recommendations may be provided during the design phase of the project. In general, peak ground accelerations at the site may be on the order of 0.4g based on preliminary information (CGS PSHA website).

- As discussed in the preceding sections of this report, subsidence and related ground failure have been documented in and around the project site in the past. The subsidence and ground failure are reportedly associated with past pumping of groundwater for irrigation purposes and flooding. Up to 0.9m (3 feet) of subsidence has been reported between 1977 and 1985 due to groundwater withdrawal. Ground failure documented at the ground surface is reportedly along pre-existing features. The impact of subsidence and ground failure on the project is very difficult to assess. Since areas of ground failure related to subsidence have been documented and preliminary conclusions associate the failures with pre-existing fault features, the risk of damage to structures may be mitigated by relocating proposed structures away from these features. We also understand that groundwater pumping may be reestablished to provide water for operation of the plant. The impact of further groundwater withdrawal has not been evaluated. The correlation between subsidence and groundwater pumping will require additional analysis including review of previous groundwater pumping rates, and well records, and groundwater modeling.

- The site is located within a flood hazard zone a flood hazard zone associated with the primary drainage channel crossing the site. Improvements in these areas will be subject to the potential for flood hazard. Project planning, design, and construction can reduce the potential hazard due to periodic flooding. Geotechnical investigations should be completed to support project design and construction and to evaluate the scour potential associated with periodic flooding.

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- Lake deposits underlie the northern portion of the site. Where observed during our site reconnaissance, the lake deposits consist of a mixture of silt and clay soils and exhibit numerous polygonal desiccation cracks at the ground surface suggesting these soils have potential for expansion and shrinkage upon wetting and drying. Based on our experience with the project site and the nature of lake soil deposits underlying the northern portion of the site, we believe that the expansion potential of the on site soils within the northern portion of the site is high. Design-level geotechnical investigations are recommended to evaluate and verify the expansion potential of the native soil deposits.

- The project site is located in a geologic environment that may be prone to collapsible soils. Based on our experience, the collapse potential for the site ranges from moderate to high. Geotechnical investigations should be completed to evaluate areas that may be subject to collapsible soils and provide appropriate recommendations to reduce the risk associated with collapsible soils.

The following sections discuss the geotechnical and geologic issues described above and other potential geologic and geotechnical constraints common throughout the project area. Preliminary recommendations are provided for further planning, design and economic evaluations.

4.2 RECOMMENDATIONS

The primary constraint for site development is the potential for surface rupture across the site. As discussed above, we recommend locating critical structures away from known active faults and State recognized fault zones. Based on our preliminary evaluation and discussions with you, we have identified a location for the proposed power block. The recommended location is near the center of the solar array field north of the Alquist-Priolo Earthquake Fault Zone for the Cantil Valley fault, and between the two sets of north to northwest trending secondary faults. The recommended location of the power block is shown on Plate 3. We also recommend locating the evaporation ponds outside of the Earthquake Fault Zone. The recommended location for the evaporation ponds is also shown on Plate 3. The recommended locations of the power block and evaporation ponds as shown on Plate 3 are acceptable from a geologic and geotechnical perspective based on our preliminary evaluation.

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Depending on the requirements of the regulatory agencies, and the level of risk that the owner is willing to take for the project, additional fault trenching should be performed in the area of the proposed power block to confirm the presence or absence of faulting beneath the site. The location of fault trenching can be marked once a location for the power block is confirmed. In general, the trenching should be oriented in a northwesterly direction to intercept northeast trending faults and should cover the entire power block.

A more detailed study of the potential for subsidence-related ground failure is also recommended. This may include a review of pervious groundwater records including drawdown rates, groundwater usage, and other groundwater and well records. Groundwater modeling will be required to quantify the amount of anticipated future settlement.

Finally, design-level geotechnical investigations are recommended for future development of the site.

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5.0 STANDARD DESIGN AND CONSTRUCTION PRACTICES

5.1 GEOTECHNICAL INVESTIGATIONS

Implementation of standard design and construction practices will reduce the project's potential to induce geologic hazards. Such practices include detailed geologic and geotechnical studies. We recommend that site-specific, detailed geotechnical studies be performed on all project components prior to final design. Those studies will likely include a variety of investigation methods, such as detailed geologic mapping, geophysical surveys, borings, and trenching to evaluate site-specific geologic and geotechnical conditions. Additional, site-specific designs for foundations, soil conditions, and seismicity should be developed.

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6.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The conclusions and recommendations submitted in this report are based, in part, upon the data obtained from the field reconnaissance; review of pertinent geologic reports, and past experience. The nature and extent of variations from observed conditions may not become evident until detailed geotechnical and geologic studies of the site are performed or during construction. If variations then appear evident, it will be necessary to reevaluate the conclusions and recommendations of this report. The conclusions and recommendations in this report are preliminary and additional field exploration and engineering analyses should be performed.

In the event of any change in the assumed nature of the proposed project, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing. This report is issued with the understanding that it is the responsibility of the Client or their representatives, to ensure that the information and recommendations contained in this report are called to the attention of architects and engineers for the project.

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7.0 REFERENCES

Blake, Thomas F., 2000, EQFAULT and EQSEARCH, Computer Programs for calculating the site to fault distances, Deterministic peak horizontal ground accelerations for a Maximum Magnitude Earthquake, and historic seismicity for an area from selected known faults in the southern California region (Rev. 2001).

Burke, D.E., 1979, Log of a trench in the Garlock fault zone, Fremont Valley, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1028, Scale 1:20.

California Division of Mines and Geology, 1976, Guidelines for Geologic/Seismic Considerations in Environmental Impact Reports, CDMG Note 46.

California Geological Survey, 1990, Special Studies Zones, Cinco Quadrangle, Revised Official Map, Effective January 1, 1990, Scale 1:24,000.

California Geological Survey, 1990, Special Studies Zones, Cantil Quadrangle, Revised Official Map, Effective January 1, 1990, Scale 1:24,000.

California Geological Survey, 1976, Special Studies Zones, NE ¼ Mojave Quadrangle, Official Map, Effective January 1, 1976, Scale 1:24,000.

Clark, M.M., 1973, Map showing recently active breaks along the Garlock and associated faults, California, U.S. Geological Survey Miscellaneous Geological Investigation Map 1-741, scale 1:24,000.

Design Manual 7.01 and 7.02, 1986, Naval Facilities Engineering Command.

Dibblee, T.W., Jr., 1967, Areal geology of the western Mojave Desert, California: U.S. Geological Survey Professional Paper 522, p. 153.

ENSR CORP., 2007, Work Plan for Investigation of Groundwater Resources, Project Beacon, Kern County, California, August 2007.

FEMA/ESRI Hazard Information and Awareness (web site).

Hart, Earl W., and Bryant William A., 1997, Fault Rupture Hazard Zones in California, Division of Mines and Geology, Special Publication 42.

International Conference of Building Officials, 1997, Uniform Building Code, Volume 2.

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International Conference of Building Officials, 1998, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada for the 1997 Uniform Building Code.

Jennings, Charles W., 1994, Fault Activity Map of California and Adjacent Areas, California Division of Mines and Geology, Geologic Data Map No. 6.

Jennings, C.W., Burnett, J.L., and Troxel, B.W., 1963, Geologic Map of California, Trona Sheet, California Division of Mines and Geology, Scale 1:250,000.

Pampeyan, C.H., Holzer, T.L., and Clark, M.M., 1988, Modern ground failure in the Garlock fault zone, Fremont Valley, California, in Geological Society of America Bulletin, v. 96, p. 1037-1042, August 1985.

Petersen, Mark D., et al., 1996, Probabilistic Seismic Hazard Assessment for the State of California, 1996, California Division of Mines and Geology, Open File Report, 96-08.

Petersen, M.D., and Wesnousky, S.G., 1994, Fault slip rates and earthquake histories for active faults in Southern California, Bulletin of the Seismological Society of America, Vol. 84, No. 5, p. 1608-1649.

Petersen, Mark D., et al., 1999, Seismic Shaking Hazard Maps of California, California Division of Mines and Geology, Map Sheet 48.

Roquemore, G.R., and Zellmen, J.T., 1984, Subsidence cracking and subsequent erosional fissuring in Fremont Valley, California: 1978 and 1983, Naval Weapons Center Technical Memorandum 5268, June 1984.

Smith, A.R., 1965, Geologic Map of California, Bakersfield Sheet, California Division of Mines and Geology, Scale 1:250,000.

Smith, G.I., 1962, Large lateral displacement on Garlock fault, California, as measured from offset dike swarm: American Association of Petroleum Geologists Bulletin, v. 46, p. 85-104.

USGS, 1999, National Seismic Hazard Mapping Project (web site).

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Wills, C. J., 1989, Ground Cracks Along the Garlock Fault Zone in Fremont Valley, Kern County, California, California Division of mines and Geology, Fault Education Report FER-197, March 17, 1989.

Working Group on California Earthquake Probabilities, 1995, Seismic Hazards in southern California: Probable Earthquakes, 1994 to 2024, Bulletin of the Seismological Society of America, Vol. 85, No. 2, pp. 379-439.

Roquemore, G.R., Zellmen, J.T., and Blackerby, B.A., 1985, Modern tectonic cracking near the Garlock fault, California, Geological Society of America Bulletin, v. 96, p. 1037-1042, August 1985.

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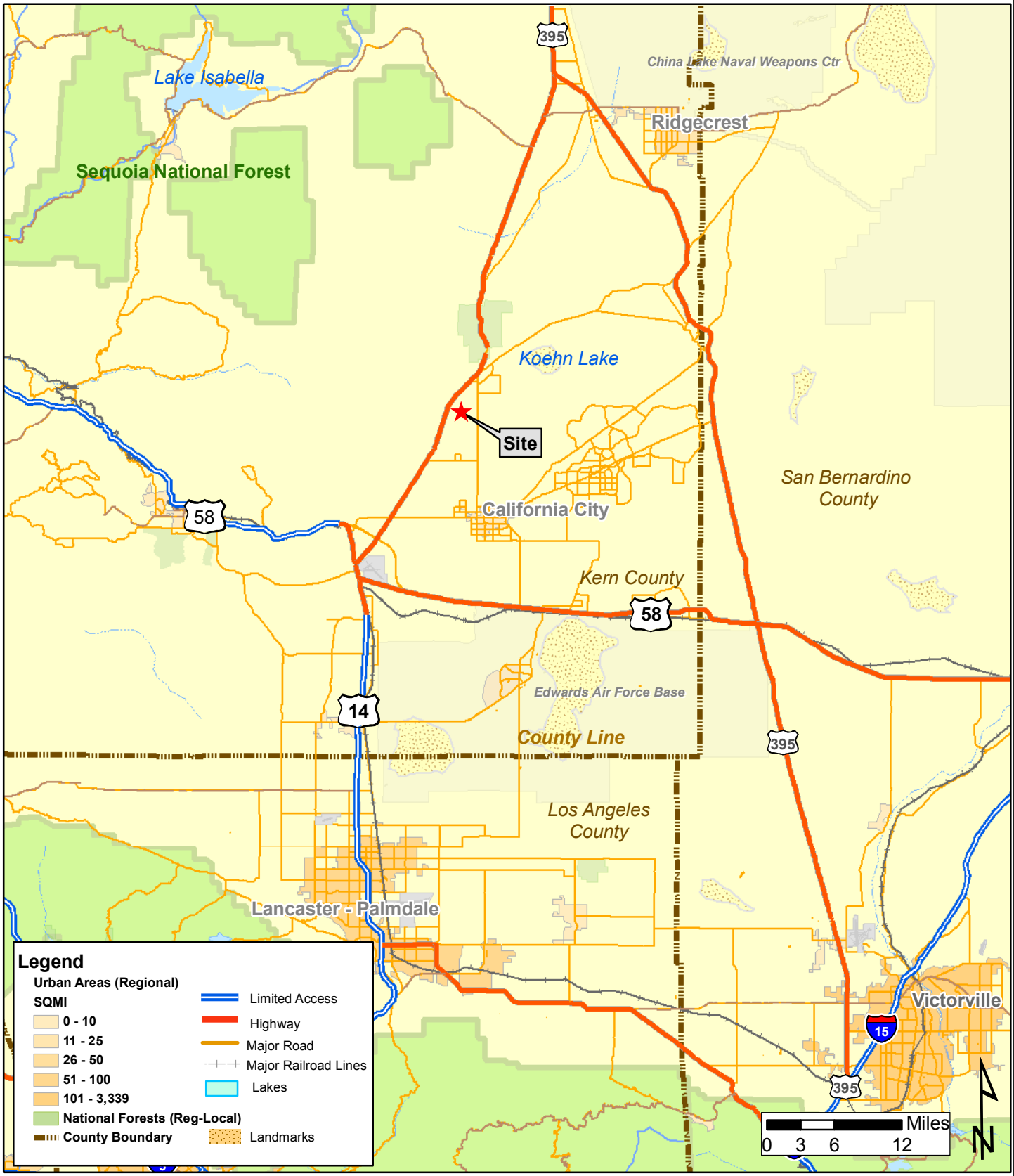
PLATES



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APPROVED BY:

Site Vicinity Map

PRELIMINARY GEOTECHNICAL/GEOLOGIC
CONSTRAINTS EVALUATION
PROJECT BEACON
KERN COUNTY, CA

PROJECT NO: 86405

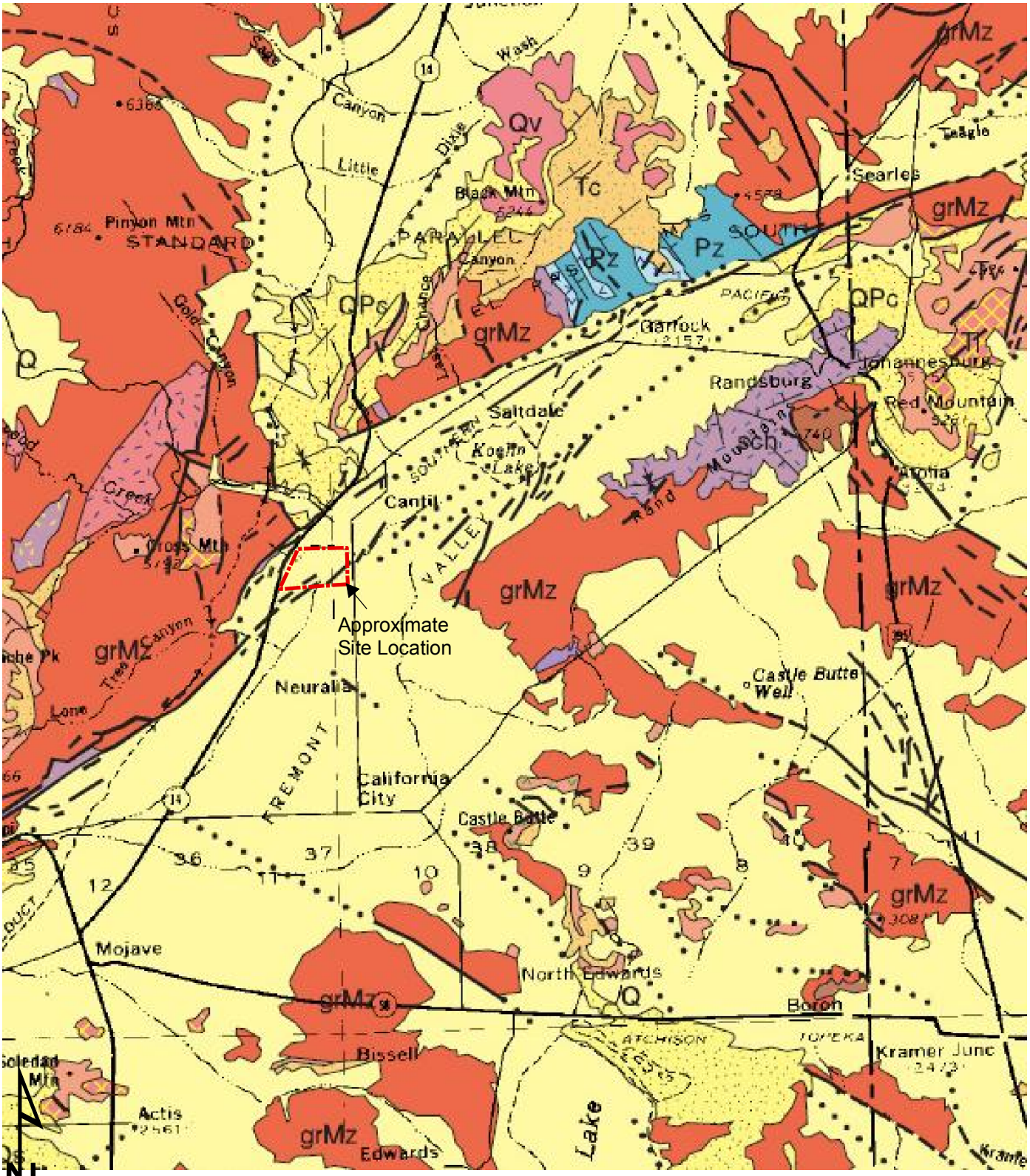
FILE NAME: Site Vicinity Map.mxd

September 21, 2007

DRAFTED BY: V. Prast

CHECKED BY: R. Escandon

PLATE: 1



1 inch = Approximately 14 miles

Reference: CGS, 2000

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Regional Geologic Map

PRELIMINARY GEOTECHNICAL/GEOLOGIC
CONSTRAINTS EVALUATION
PROJECT BEACON
KERN COUNTY, CA

PROJECT NO: 86405

FILE NAME: Plate 2 - Regional Geologic Map.mxd

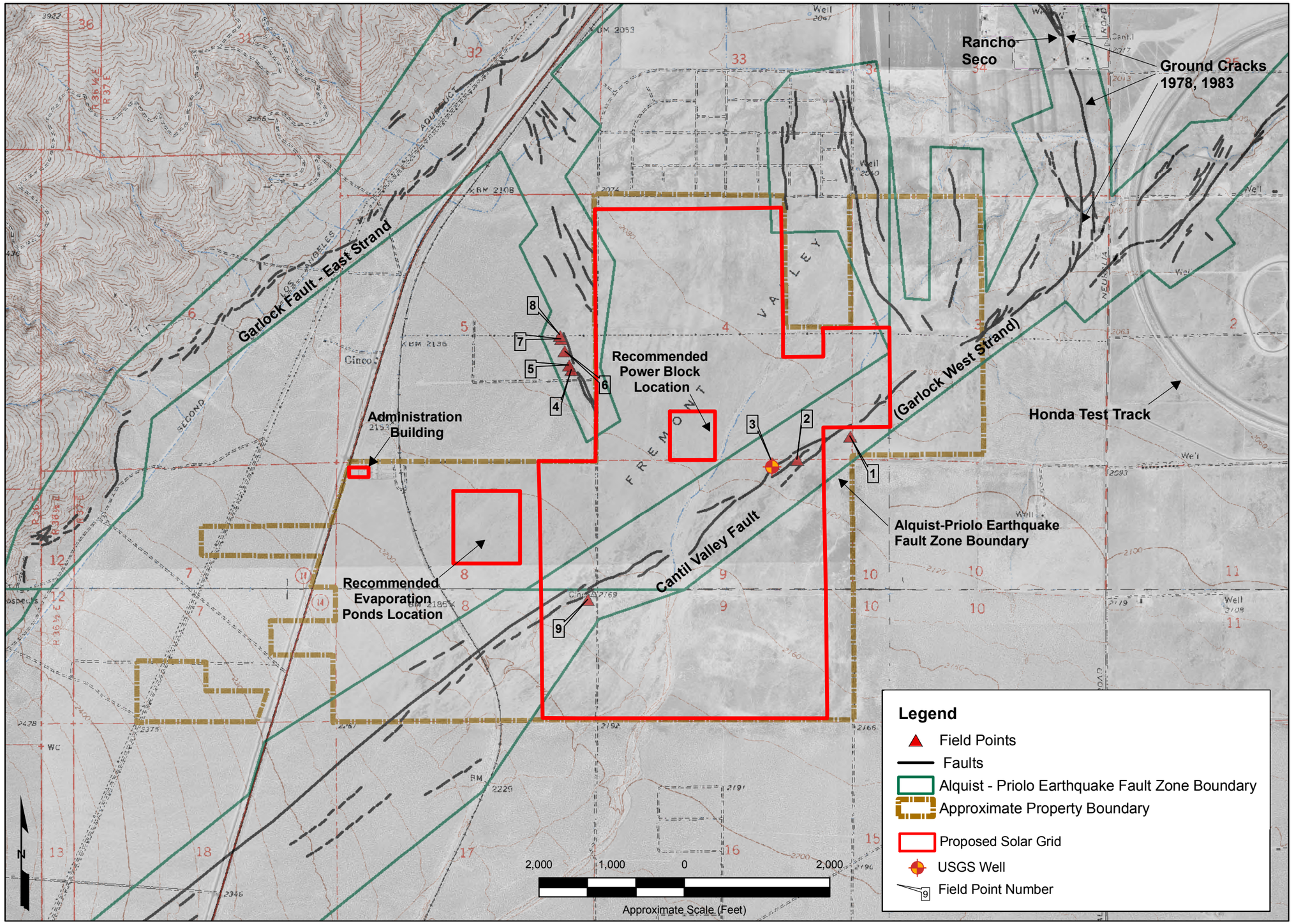
September 21, 2007

REVISED:

DRAFTED BY: V. Prast

CHECKED BY: R. Escandon

PLATE: **2**



NO.	REVISION	BY	DATE
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Site Fault Map

PRELIMINARY GEOTECHNICAL/GEOLOGIC CONSTRAINTS EVALUATION
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GIS FILE Fault Map.mxd
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CHECKED BY: R. Escandon
DESIGNED BY:

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS

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DATE: September 21, 2007

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PLATE: 3

3 OF 3 SHEETS

DRAWING PLOTTED: Friday, Aug 24, 2007, 10:52am

APPENDIX B.2

Preliminary Geotechnical Investigation Report

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February 26, 2008
File No. 86405.GEO2

Mr. Geoffrey Baxter, P.E.
Project Manager
WorleyParsons
2330 E. Bidwell Street, Suite 150
Folsom, California 95630

Subject: Preliminary Geotechnical Investigation Report
FPL Energy Proposed 250MW Solar Plant
Highway 14
California City, California

Dear Mr. Baxter:

Kleinfelder is pleased to present this report summarizing the findings of the preliminary geotechnical investigation for the referenced project. The project site is located along Highway 14 in the Mojave Desert, approximately 10 miles north of Highway 58.

The purpose of the preliminary geotechnical investigation was to evaluate the suitability of the subsurface conditions for construction of the proposed subject project. Based on the present information, it is Kleinfelder's professional opinion that the proposed site is geotechnically suitable for construction of the proposed project. The recommendations presented in this report could be incorporated into the project conceptual design.

We appreciate the opportunity to be of service on this project. Please do not hesitate to contact the undersigned if you have any questions, comments, or require additional information.

Respectfully submitted,
KLEINFELDER

Neva M. Popenoe, EIT
Staff Engineer

Josue A. Montes, PE
Senior Engineer

NMP:JAM:lf

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PRELIMINARY
GEOTECHNICAL INVESTIGATION REPORT
FPL ENERGY PROPOSED 250MW SOLAR PLANT
HIGHWAY 14
KERN COUNTY, CALIFORNIA

February 26, 2008

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WorleyParsons

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Folsom, California 95630

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT
FPL ENERGY PROPOSED 250MW SOLAR PLANT
HIGHWAY 14
KERN COUNTY, CALIFORNIA

Kleinfelder Job No.: 86405.GEO2

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February 26, 2008

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Appendix A Field Exploration
Appendix B Laboratory Testing

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EXECUTIVE SUMMARY

This report presents the results of the geotechnical investigation program for the proposed FPL Energy 250MW Solar Plant (referred to as the Project in this report), located north of California City, California. This project is also known as the Beacon Project. The purposes of this investigation were to evaluate the general subsurface soil conditions, seismicity and other geologic hazards for the site, and to provide recommendations for design of the foundations for the proposed structures.

Subsurface conditions at the locations for the proposed solar facility were explored by excavating 20 exploratory borings. A laboratory testing program was performed on selected representative soil samples obtained from the borings to assess the geotechnical and corrosivity characteristics of the subsurface soils. Geologic trenching is scheduled to evaluate the potential presence of seismic/subsidence related to ground fissuring.

Based on the results of the subsurface investigation, the project site is underlain by Holocene alluvial deposits. The site surface and near surface soils encountered in the field exploration generally consist of two basic soil types in two primary areas. The north area (B-1 through B-6) has expansive fine grained clayey soils, and the remainder of the site has non-expansive granular materials (B-7 through B-20). In general, soils were comprised of alternating layers of sandy silt with some clay, silty sand, sand, and sand with silt.

No groundwater was encountered within the maximum boring depth of 101 feet below the existing ground surface. Based on well information in a report entitled "Work Plan for Investigation of Groundwater Resources, Project Beacon, Kern County, California", prepared by ENSR (dated August 2007), groundwater depths beneath the site ranged from 304 to 487 feet below ground surface (bgs).

A portion of the site is located within an Alquist-Priolo Earthquake Fault Zone associated with the Garlock Fault zone, as designated by the State of California. The

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Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures planned for human occupancy and other critical structures. A separate report prepared by Kleinfelder, entitled "Preliminary Geotechnical/Geologic Constraints Evaluation, Project Beacon, Kern County, California" (dated September 21, 2007) was submitted. The purpose of the geotechnical/geologic constraints study was to evaluate available published data regarding geotechnical and geologic conditions within the Project site and identify potential geotechnical and geologic constraints that could impact planning, design, and construction. In addition to the geotechnical borings, some subsurface trenching was performed to further evaluate subsurface soils and geologic conditions.

The site is located within the seismically active Fremont Valley in California. The primary seismic hazard at the site is a potential for moderate to severe shaking. The computer program EZ-FRISK version 7.20 (Risk Engineering, 2006) using a probabilistic analysis 2% and 10% in 50 years indicates a PHGA of 0.84 and 0.45g, respectively, for the site. The 2006 International Building Code (IBC) Maximum Considered Earthquake (MCE) (2% probability of exceedance in 50 years) and design earthquake (about 5% probability of exceedance in 50 years) PHGAs are 0.78g and 0.52g, respectively. It is understood that the proposed structures will be designed and constructed in accordance with the requirements of the International Building Code (2006). Recommendations for seismic design parameters are presented in Section 3.2, Faulting and Seismicity. Based on subsurface information and groundwater data, the potential for liquefaction and liquefaction induced settlement at the site is considered low.

At this stage of the project, partial information regarding structural loads is available. Solar panels are anticipated to be light, on the order of 2,500 pounds (DL + LL). The power block will consist of several components supported on mat foundations. Preliminary foundation recommendations include data for both shallow spread and mats foundations, and pier foundations. Recommendations for foundation design are presented in Section 5.0.

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The upper soils are generally unsuitable for support in their present condition due to desiccation, wind deposition, and/or agricultural activity. This potentially adverse condition appears to be limited to the upper 1.5 to 2 feet of the site soil. Expansive soils were encountered in the north portion (approximately one-third area) of the proposed solar array area. It is anticipated the on-site soils encountered during the investigation, excluding organics, debris, and/or other deleterious materials, are considered suitable for use as engineered fill. Site preparation should be performed in accordance to Section 5.10.

The executive summary presented herein briefly summarizes the results of the geotechnical investigation for the subject project and should be used only in conjunction with recommendations presented in the attached report.

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1.0 INTRODUCTION

1.1 GENERAL

The proposed FPL Energy 250MW Solar Plant (referred to as the Project in this report) facility is located north of the Highway 58 along Highway 14, near California City, Kern County, California. The Project is also known as Beacon Project. Kleinfelder West, Inc. (Kleinfelder) was retained by WorleyParsons Group, Inc. (WP) to provide geotechnical engineering services for the proposed project. The proposed plant site is shown on Plate 1, Site Vicinity Map. The scope of Kleinfelder's services was based on a WP document entitled "FPL Energy 250MW Solar Plant, Specification FPLS-0-TS-02010, Revision 0, For Geotechnical Investigation".

This report includes recommendations related to the geotechnical aspects of project design. Conclusions and recommendations presented in this report are based on subsurface conditions encountered at the locations of the exploration, as well as the provisions and requirements outlined in the "Additional Services" and "Limitations" Sections of this report. Recommendations presented herein should not be extrapolated to other areas or used for other projects without prior review.

1.2 PROJECT DESCRIPTION

The proposed Project consists of approximately 2,300 acres of land, approximately 10 miles north of Highway 58, along Highway 14. The project plans to generate approximately 250 Mega Watts of power using solar power technology.

It is understood that the Project will include a solar array field distributed over approximately two square miles. A power block will be located within the solar array field. The power block will include a cooling tower, expansion storage tanks, water tanks, steam turbine, and several other smaller components. The steam turbine/generator (STG) will have a total weight of approximately 1,269 kips (generator is 511 kips; turbine is 758 kips). The STG will be supported on a 7-foot thick mat foundation with dimensions of approximately 50 feet by 120 feet. It is assumed the

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larger components will be supported by mat foundations. The water storage tanks will be about 140 feet in diameter and have a capacity of 2MG.

Other structures outside the power block area will include water ponds, a high-voltage transmission line, administration building and warehouse, and a switch yard. An existing creek on site will be rerouted; however, it is not a part of this preliminary investigation.

Solar panels are anticipated to be supported by drilled piers. Preliminary information indicates that maximum downward loads will be about 2.5 kips (DL + LL) on each drilled pier. It is assumed the solar panels will be situated about 5 to 6 feet above grade. A lateral deflection of ½ inch is considered for lateral load evaluation.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this preliminary geotechnical investigation program was to explore the subsurface conditions at the proposed site and to provide evaluations and recommendations for design of the proposed power generating facilities. Kleinfelder's scope of services for this project consisted of:

Task 1 – Field Exploration

- Contacted Underground Service Alert (USA) to identify potential conflicts between planned geotechnical boring locations and existing underground utilities.
- Retained a drilling subcontractor to perform hollow stem auger borings. Approximate boring locations are shown on Plate 2. Twenty (20) borings were excavated.
- Participated, together with the drilling subcontractor staff, in a bio-awareness teleconference with ENSR.
- Provided full time supervision of the drilling operation by Kleinfelder field staff. The Kleinfelder representative maintained logs of subsurface materials encountered and obtained samples for visual classification and laboratory testing. Inspection of areas was performed as per bio-awareness prior to commencing drilling.

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- Performed a series of field resistivity tests at the proposed power block location.

Task 2 – Laboratory Testing

- Laboratory testing was performed on selected representative samples to evaluate the geotechnical characteristics and corrosion potentials of the subsurface materials encountered during subsurface exploration.

Task 3 – Analysis and Report

Conducted an engineering evaluation and prepared this report, which includes the following:

- A general description of the project.
- Discussion of the regional geologic settings, geologic features and hazards including potential of ground rupture due to surface faulting, liquefaction potential, and seismically induced settlement.
- Description of the subsurface investigation program, laboratory testing program, subsurface soil conditions, and groundwater conditions.
- Discussion of the potential for collapsible soil at the site. Upper 4 to 5 feet of soils were observed in test pits during trenching investigation to evaluate collapse potential.
- Recommendations for seismic design parameters based on 2006 International Building Code.
- Preliminary foundation recommendations for shallow spread and mat foundations and deep or pier foundations, including bearing and potential settlement.
- Static and dynamic soil parameters for vibrating machine foundations.
- Recommendations for earthwork, including site preparation, engineered fill, guidelines for temporary excavations, pipe bedding and trench backfill.
- Presentation of corrosion test results.
- Presentation of field resistivity test results.
- Plates including Site Vicinity Map and Boring Location Plans for proposed solar facility.
- Appendices including boring logs and laboratory testing results.

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2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

The field exploration, conducted on October 2 through 5, 2007, consisted of drilling twenty (20) exploratory test borings and a site reconnaissance. The test borings were drilled using a CME 55 truck mounted drill rig using hollow-stem auger drilling techniques. The borings were advanced to depths ranging from 31.5 to 101 feet below the existing ground surface. The approximate locations of the test borings are indicated on the Site Plan, Plate 2. Sixteen (16) borings were drilled in solar panel areas, two (2) in the power block area, one (1) in the proposed stormwater basin, and one (1) in administration building west of Highway 14. Surface elevations indicated on the boring logs are estimates only, based on a USGS topographic map.

The soils encountered in the test borings were visually classified in the field and a continuous log was recorded. Relatively undisturbed samples were collected from the borings at selected depths by driving a 2.5-inch I.D. split barrel sampler containing brass liners into the undisturbed soil with a 140-pound automatic hammer free falling a distance of 30 inches. The 2.5-inch sampler is in general conformance with ASTM D3550. Relatively undisturbed soil samples may experience some minor disturbance due to hammer impact, retrieval, and handling. In addition, a 1.4-inch I.D. standard penetrometer (SPT) was driven at selected depths in general accordance with American Society of Testing Materials (ASTM) D1586 test procedures. The SPT sampler was used without liners. Resistance to sampler penetration was noted as the number of blows per foot over the last 12 inches of sampler penetration on the boring logs. The blow counts listed in the boring logs have not been corrected for the effects of overburden pressure, rod length, sampler size, or hammer efficiency. Bulk samples were also obtained from auger cuttings at several of the boring locations. Rock was not encountered in any of the borings. Each soil sample was classified in accordance with the Unified Soil Classification (USCS) system. Logs of the borings are attached in Appendix A, Field Exploration.

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Two test pits and several geologic trenches were excavated. The side walls of the excavation were observed by the geotechnical engineer. Geotechnical logs of the test pits and one location in a geologic trench (TP-3) are attached. These logs were typical of the geotechnical observation in all of the trenching.

2.2 FIELD AND LABORATORY TESTING

SPT penetration rates, determined in general accordance with ASTM D1586, were used to aid in evaluating the consistency, compression, and strength characteristics of the foundation soils. Penetration rates obtained using the 2.5-inch I.D. split barrel sampler could be converted to an unlined SPT value by multiplying the recorded blow count by 0.75. This conversion is based on penetration energy, sampler dimensions correlations indicated by Winterkorn and Fang.

Field resistivity tests were performed in the proposed power block area. The testing method is discussed and test results are presented in Section 5.12 Field Resistivity Testing.

Kleinfelder performed laboratory tests on selected samples to evaluate certain physical characteristics. The following laboratory tests were used to develop the design geotechnical parameters:

- Unit Weight (ASTM D2937)
- Moisture Content (ASTM D2216)
- Soluble Sulfate Content (California Test Method No. 417)
- Soluble Chloride Content (California Test Method No. 422)
- pH and Minimum Resistivity (California Test Method No. 532)
- Direct Shear (ASTM D3080)
- Sieve Analysis (ASTM D422)
- Consolidation (ASTM D2435)
- Amount of Material in Soils Finer than No. 200 Sieve (ASTM D1140)

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- Plasticity Index (ASTM D4318)
- Resistance Value (California Test Method No. 301)
- Maximum Density/Optimum Moisture (ASTM D1557)

Test specimens for unit weight and moisture content, direct shear, consolidation and collapse tests consisted of relatively undisturbed 2.5-inch I.D. samples. The dry density and moisture content test results are shown on the boring logs in Appendix A. The soluble sulfate, soluble chloride, pH, and minimum resistivity results are presented in Section 5.13 ("Corrosion Potential"). The remaining test results are provided in Appendix B.

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3.0 GEOLOGIC CONDITIONS

3.1 REGIONAL GEOLOGY

The site is located in the northwestern portion of the Mojave Desert Geomorphic Province of California. The Mojave Desert Province occupies approximately 25,000 square miles and consists of broad alluvial basins, in-filled by approximately 3,500 feet of alluvial deposits from nearby. The province is wedged between the northeast-trending Garlock fault, on the north, and the northwest-trending San Andreas Fault on the south.

Based on published information, the study area is located within what is known as the Fremont Valley, a deep northeast trending alluvial-filled basin. The Fremont Valley has more than 5000 feet of Holocene, Pleistocene, and Pliocene sediments. Within the Fremont Valley is the Koehn Lake sub-basin which has alluvial sediment reportedly ranging up to 1900 feet in thickness. (Description of soils encountered during this site-specific investigation is presented in Section 4.2 and Appendix A.) The basin is bounded on the northwest by the southern Sierra Nevada Mountains and the El Paso Mountains and on the east by the Rand Mountains. The valley has formed as a deep structural depression or pull-apart basin formed between two strands of the Garlock fault – the East Strand and the West Strand.

The most significant geologic feature in the Project area is the Garlock fault. This fault extends from its junction with the San Andreas Fault near Gorman on the southwest to the Death Valley fault zone on the northeast. The fault is a left-lateral strike-slip fault with approximately 40 miles of offset (Smith, 1962). In the Project area, the Garlock fault consists of the two strands referred to as the East Strand and the West Strand. These two faults are an example of a classic left-stepping en echelon fault system (Pampeyan and others, 1988). The East Strand bounds the northwest side of Koehn Lake and Fremont Valley. North of Koehn Lake, this fault is the main branch of the Garlock fault. The West Strand bounds the southeast side of Koehn Lake and extends southwestward through the study area. The West Strand is also referred to as the

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Cantil or Cantil Strand beginning near Koehn Lake and the East Strand dying out or joining with the West Strand just south of the study area near Pine Tree Canyon.

Lithologically, the Project area is underlain primarily by Holocene alluvium, lacustrine (lake) and playa deposits near the surface, and older alluvium at depth. The recent and older alluvial deposits are comprised of various mixtures, layers, and lenses of sand, silt and gravel. The lacustrine and playa deposits are comprised of finer-grained sands, silts and clays. Basement rocks comprised of granitic and/or metamorphic rocks are believed to underlie the alluvial soils at significant depth.

3.2 FAULTING AND SEISMICITY

3.2.1 Fault Rupture

As discussed in the Preliminary Geotechnical/Geologic Constraints Evaluation report, the most significant geologic feature in the project area that could affect the project is the Garlock fault. This fault includes two strands in the project area – the East Strand and the West Strand. The West Strand is also referred to as the Garlock West Strand, the Cantil fault, and the Cantil Valley fault.

Both the East and West strands of the Garlock fault are considered active. Both are included within an Alquist-Priolo Earthquake Fault Zone, as designated by the State of California (Hart, 1997). The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures planned for human occupancy. This state law was a direct result of the 1971 San Fernando earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures.

The Cantil Valley fault was mapped as crossing the project site through the proposed solar array field and near the proposed power block. The Preliminary Geotechnical/Geologic Constraints Evaluation report should be used as reference for more information on fault rupture.

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3.2.2 Seismicity and Ground Motion

The Project site is located in a highly seismic region. The site is within the influence of several fault systems, which are considered to be active or potentially active. An active fault is a fault that has experienced seismic activity during historic time (since roughly 1800) or exhibits evidence of surface displacement during Holocene time (Hart and Bryant, 1997). The definition of "potentially active" varies. A generally accepted definition of "potentially active" is a fault showing evidence of displacement that is older than 11,000 years (Holocene age) and younger than 1.7 million years (Pleistocene age). However, "potentially active" is no longer used as criteria for zoning by the California Geologic Survey (CGS). The terms "sufficiently active" and "well-defined" are now used by the CGS as criteria for zoning faults under the Alquist-Priolo Earthquake Fault Act. A "sufficiently active fault" is a fault that shows evidence of Holocene surface displacement along one or more of its segments and branches, while a "well-defined fault" is a fault whose trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The definition "inactive" generally implies that a fault has not been active since the beginning of the Pleistocene Epoch (older than 1.7 million years old). These sufficiently active and well defined faults are capable of producing seismic shaking at the site that could potentially be damaging to buildings and appurtenant structures. It is anticipated that the Project site will periodically experience ground acceleration as the result of moderate to large magnitude earthquakes.

Previous studies by others indicated the Garlock fault near the Project site has a slip rate of 5-11 mm/year (Pampeyan and others, 1988; Peterson and Wesnousky, 1994). Other literature suggests the recurrence interval for large earthquakes on the Garlock fault is about 1,000 years.

A computer program EQFAULT (version 3.00b) was used to search known sufficiently active and well defined faults within a 62-mile radius of the proposed power block site. Table 3.2-1, Significant Faults, summarizes the parameters for six of the twenty known active and well defined faults within the searched radius of the site that, in our opinion, will have the greatest impact upon the site. Selection of the faults was based on their

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proximity to the proposed power block site and their potential to generate strong ground motion on the site. This table does not identify the probability of reactivation or the on-site effects from the earthquakes occurring on any of the other faults in the region.

Table 3.2-1
Sufficiently Active and Well-Defined Faults at Site and Vicinity

Fault Name	Approximate Distance from Middle of Site	Maximum Event (Moment Magnitude)
Garlock – West	<0.5 mi.	7.3
Garlock – East	2.0 mi.	7.5
Lenwood-Lockwood-Old Woman Springs	14.7 mi.	7.3
Southern Sierra Nevada	18.0 mi.	7.1
White Wolf	21.6 mi.	7.2
Gravel Hills-Harper Lake	31.9 mi.	6.9

Evaluation using the computer program EZ-FRISK version 7.20 (Risk Engineering, 2006) resulted in a Peak Horizontal Ground Acceleration (PHGA) with 10% probability of exceedance in 50 years of 0.45g for the site. The PHGA for a 2% probability of exceedance in 50 years was 0.84g. The PHGA for the IBC Maximum Considered Earthquake (MCE) would be 0.78g. The IBC design earthquake would have a PHGA of 0.52g. Site specific deterministic attenuation methods by Sadigh (2007) for deep soil indicate a PHGA of 0.56g. It is recommended that the IBC design earthquake PHGA of 0.52g be used in design.

3.2.3 IBC Seismic Design Parameters

For a code-based design, the estimated Maximum Considered Earthquake (MCE) mapped spectral accelerations for 0.2 second and 1 second periods (S_S and S_1) and associated soil amplification factors (F_a and F_v) based on 2006 IBC are presented in Table 3.2-2. The site modified spectral accelerations (S_{MS} and S_{M1}) and corresponding design spectral accelerations (S_{DS} and S_{D1}) are also presented in Table 3.2-2. The site soil profile would be Class D.

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TABLE 3.2-2
IBC SEISMIC DESIGN PARAMETERS

Parameter	Value
S_S	1.944g
S_1	0.834g
F_a	1.0
F_v	1.5
S_{MS}	1.944g
S_{M1}	1.251g
S_{DS}	1.296g
S_{D1}	0.834g

3.3 OTHER GEOLOGIC HAZARDS

Collapsible soil deposits can exist in arid regions adjacent to mountains and/or drainage courses. Collapsible soils are generally defined as soils that have potential to suddenly decrease in volume upon increase in moisture content, even without increase in external loads. Soils susceptible to collapse include loess, weakly cemented sands and silts where the cementing agent is soluble (e.g. soluble gypsum, halite), valley alluvial deposits within semi-arid to arid climate, and certain granite residual soils. Based on the geotechnical data (soil density and collapse testing) and observation of the soil profile exposed in test pits, geologic trenches, and vertical banks of drainage courses, collapsible soil is not considered present on the site.

Shallow trenching performed to evaluate fissures at the site did not reveal any indication of fissures in the area of the power block. Fissures may be a concern in other areas of the site. Further subsurface investigation is recommended during the detailed design of the project.

Based on the Flood Hazard Maps provided by the Federal Emergency Management Agency (FEMA) website, the northeast trending wash on the site is located within a flood hazard zone prone to a 100-year frequency of flooding. A 100-year flood is defined as the flood elevation that has 1 percent probability of being equaled or exceeded each year.

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Liquefaction is a phenomenon that may occur because of earthquake shaking at locations where loose sandy soils are present and groundwater levels are shallow. Based on the subsurface investigation program, the proposed site is generally underlain by medium dense to very dense sand and silty sand deposits. Groundwater was not encountered within the depth of the exploration (to 100 feet below the existing ground surface). The available information indicates ground water is deeper than 300 feet. The absence of shallow groundwater would preclude the occurrence of liquefaction.

Dynamic compaction can occur where earthquake shaking is sufficient to cause densification of relatively loose unsaturated sediments. The sediments are sufficiently dense to preclude dynamic compaction. Consequently, the potential for damage due to seismically induced compaction is considered low at the proposed site.

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4.0 SITE AND SUBSURFACE CONDITIONS

4.1 SURFACE CONDITIONS

The proposed Project site is mostly vacant, relatively flat, and undeveloped. The site has an approximate land area of about 2,300 acres, as shown on Plate 1. Most of the site is east of Highway 14 and the Southern Pacific Railroad. The Project site is located within Sections 3, 4, 7, 8, and 9 of Township 30 South and Range 37 East. The approximate center of the site and center of the power block are located at approximate Latitude 35.2564°N Longitude 118.0189°W, and Latitude 35.2575°N Longitude 118.0132°W, respectively.

The site was used for alfalfa farming until 1988. Remnant hay storage facilities, a ponding basin, a trailer home site, and some abandoned structures are present within the site. Also, approximately 14 groundwater wells are scattered throughout the property. A topographic map indicates surface elevations ranging from 2260 feet in the southwest portion of the site to approximately 2020 feet in the northeast corner. Overall topographic relief is on the order of 240 feet. An approximately 14- to 25-foot high northeast trending eroded escarpment trends through the middle of the site, coinciding with the mapped trace of the Cantil Valley fault.

A north to northeast trending drainage channel traverses the site in the area of the proposed solar array field and power block. The channel ranges from approximately 25 to 70 feet wide and includes near vertical banks up to 2 to 4 feet high. Several other drainage channels also cross the western, southern and northeastern portions of the site.

4.2 SUBSURFACE SOIL CONDITIONS

The following description provides a general summary of the subsurface conditions encountered during the field exploration and further verified by the laboratory testing program. For a more thorough description of the actual conditions encountered at specific boring locations, refer to the boring logs presented in Appendix A (Plates A-1

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through A-20). All soils have been classified in general accordance to the Unified Soil Classification System (ASTM D2487).

The encountered earth materials are Holocene age deposits overlying older alluvium. Generally, the older alluvium is considered to be deeper than 50 to 80 feet. The penetration rates of boring B-20 (switching yard) may be indicative of older alluvium as shallow as 14 feet. The near surface soil profile is generally grouped in (1) fine grained sandy silt and clay and (2) silty sand and sand.

Surface and near surface soils in north area (most of Section 4 and the NW half of Section 3) of the Project site generally consists of 4 to 9 feet highly plastic sandy silt with clay (borings B-1 through B-6). In the middle and south areas of the Project site, near surface soil generally consists of silty sands and sands (borings B-7 through B-20). The average field blow count (corrected for sampler type) in the upper 5 feet for fine grained silt is 11. The average field blow count in the upper 5 feet for the sands is 12. This correlates to a relative density greater than 70%.

The near surface soils are underlain by laterally discontinuous layers of silty sand, sandy silt, and sand to the depth of exploration. Some fine to coarse gravel was encountered in some of the borings. The sandy silt was medium stiff to very stiff. The granular soils generally have a relative density of medium dense to very dense.

Typical to arid climates, the soil moisture is relatively low. The degree of saturation ranged from 6% to 59%, with the average saturation being 17%.

4.3 GROUNDWATER

At the time of the investigation, groundwater was not encountered within the exploratory borings, which ranged in depth from 31.5 feet to 101 feet below the existing ground surface. Based on the ENSR groundwater report, the depth to groundwater ranged from 304 to 487 feet (February 1981).

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5.0 PRELIMINARY EVALUATIONS AND RECOMMENDATIONS

5.1 GENERAL

The site foundation soils encountered in the field exploration generally consists of two basic units: (1) expansive fine-grained soils, and; (2) non-expansive granular materials. The fine grained soil is generally confined to the low lying drainage (small dry lake bed). The upper soils (1.5 to less than 2 feet) are in a looser state as a result of desiccation, wind deposition or agricultural activity. This condition will require removal of the upper 1.5 feet and replacement as engineered fill in areas to receive fill or under structure foundations.

5.2 SHALLOW FOUNDATIONS

Generally two geotechnical issues determine the design bearing pressure for conventional spread footing or mat foundations: (1) available soil bearing capacity based on the strength of the soil and foundation geometry and/or (2) tolerable settlement. For moderate to large or deep spread foundations, the available shear bearing capacity is very large and settlement considerations or necessary foundation geometry will govern the design bearing.

5.2.1 Spread Footings and Mat Foundations

The available gross bearing capacity of the foundation soil is dependent upon the effective foundation width and depth of embedment and the shear strength of the soil. Table 5.2-1 provides the expressions for the available allowable bearing capacity for static loading (D+L loads) and total combined loading (D+L+transient loads). Also provided is the ultimate (unfactored) capacity for use with Load Factor Design. In these expressions, B represents the effective foundation width (least dimension), and D is the total foundation embedment below the lowest adjacent grade. There are no geotechnical considerations which would necessitate specific minimum foundation dimensions or embedment. Therefore, foundation depths and dimensions need only

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satisfy structural and constructability considerations. Use of code minimums (e.g. 1 foot wide and 1 foot deep) would be satisfactory.

TABLE 5.2-1
AVAILABLE VERTICAL BEARING CAPACITY

Loading Conditions	Available Bearing Capacity (psf)
Static	750B + 1600D
Total Combined	1500B + 3200D
Ultimate	2250B + 4800D

5.2.2 Ringwall Footings

Table 5.2-2 presents the allowable bearing capacities for static (D.L. + any L.L.) and the total combined (D.L. + L.L. + dynamic) loading conditions on ringwall footings. Bearing capacity is influenced by the confining effect of the stored product. Consequently, bearing capacity data is provided for the tank empty and the tank full.

TABLE 5.2-2
RINGWALL FOOTING

Tank Condition	Allowable Bearing Capacity (psf)	
	Static Loads	Total Combined Loads
Empty	750B + 1600D	1125B + 2400D
Full	1500B + 3200D	2350B + 4800D

For tanks that have a fixed roof with column supports, the available bearing capacity of the column bearing plates will be dependent upon plate thickness, which will limit the effective bearing width, and the confining effect of the product load. As an example, a 1.0-inch thick bearing plate on a 0.25-inch bottom plate, results in a maximum effective bearing width of about 2.5 feet. Table 5.2-3 provides the allowable available bearing capacities for column bearing plates.

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TABLE 5.2-3
COLUMN BEARING PLATES

Tank Condition	Allowable Bearing Capacity (psf)	
	Static Loads	Total Combined Loads
Empty	600B	900B
Full	1200B	1800B

5.3 ESTIMATED SETTLEMENT

As can be seen from the bearing capacity expressions in Table 5.2-1, deep or large foundations can have extremely high available bearing capacity. The design of such foundations would normally be governed by tolerable settlement. The foundation soil is considered to have relatively low compression characteristics.

5.3.1 Spread Footing and Mat Foundations

Table 5.3-1 provides the estimated settlement for assumed loading on conventional footing foundations and equipment mat foundations. A range of design bearing pressures has been assumed to provide designers an indication of the variability in settlement. Settlement evaluation is based on methods by Schmertmann. If furnished with information on foundation loads and geometry, additional data can be provided regarding foundation settlement.

Due to the granular nature of the underlying foundation soil, the estimated settlements are anticipated to occur very rapidly with load application.

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TABLE 5.3-1
ESTIMATED SETTLEMENT – SPREAD/MAT

Plant Component	Dimension (feet)	Foundation Load	Estimated Contact Pressure (psf)	Estimated Settlement (inch)
Structure Footings	---	4 kips/ft	2000	0.25
		6 kips/ft	3000	0.3
		25 kips	3000	0.25
			4000	0.3
		50 kips	3000	0.4
			4000	0.5
		100 kips	3000	0.6
			4000	0.7
Cooling Tower (mat)	40 x 580	---	650	0.3
			1150	0.7
Steam Turbine/Generator (mat)	50 x 120		1300	0.4
Expansion Storage Tanks (mat)	100 x 170	---	400	Less than 0.25
			650	0.3

5.3.2 Tanks

Table 5.3-2 provides the estimated settlement for tank structures with ringwall foundations. Settlement evaluation is based on methods by Schmertmann.

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TABLE 5.3-2
ESTIMATED SETTLEMENT – TANKS ON RINGWALL

Plant Component	Tank Diameter (feet)	Estimated Contact Pressure (psf)	Estimated Settlement (inch)	
			Edge	Center
Storage Tanks	140	1100	0.25	0.4
		1500	0.4	0.6
		2500	1.0	1.6

It is estimated the settlement for a 2-foot wide ring footing and 2.5-foot column plate will be about 0.25 inch per 2000 psf of long-term (static) bearing. The anticipated settlement associated with transient loading is about 0.1 inch per 2000 psf of transient bearing. Settlement of the ringwall footing or column plate is based on loads applied to the footing (i.e. shell and roof and surge), exclusive of the static product load.

5.4 LATERAL EARTH PRESSURES

Table 5.4-1 provides the lateral earth pressures against buried structures and retaining walls. Data are presented for active, braced and at-rest conditions for structures/walls supporting level ground surface. Lateral earth pressures are strain related. The active pressure would be applicable for walls capable of rotating 0.0005 radian. The braced values are for walls restrained at specific points from translation, but are capable to rotate 0.0005 radian at the midpoint between restraints (e.g., a 10-foot high wall restrained at the top and bottom, but capable to deflect 0.03 inch at its midpoint would be designed for the braced pressure). The at-rest pressures are applicable to walls fully fixed against translation or rotation. The at-rest pressures include the Jaky solution for normally consolidated soil plus consideration for the locked-in pressure associated with the pre-stressing due to backfill compaction (over-consolidation).

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TABLE 5.4-1
LATERAL EARTH PRESSURES AGAINST RETAINING STRUCTURES

Condition	Lateral Pressure Static
Active (psf/ft)	32
Braced (psf)	20.5H
At-Rest (psf/ft)	75

Note: H is the retained height in feet

Where design considers seismic effects, the dynamic increment for the active, braced and at-rest conditions, which would be added to static values, is 22 psf/ft of depth. The resultant force determined for the dynamic increment should be applied at 0.6H above the bottom of the wall. To evaluate the stress distribution along the wall, the dynamic increment pressure diagram can be considered an inverted triangle. The Project site proximity to the Garlock fault which in turn results in relatively high design PHGA, results in the relatively high dynamic active increment.

The uniform lateral pressure against a retaining structure due to a uniform surcharge can be determined by multiplying the surcharge pressure by 0.26.

5.5 RESISTANCE TO LATERAL LOADS

5.5.1 Foundations

Lateral loads applied to foundations can be resisted by a combination of lateral bearing and frictional resistance. Table 5.5-1 provides the ultimate and allowable passive pressure and frictional coefficient for use in evaluating resistance to lateral loading on structures.

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TABLE 5.5-1
LATERAL RESISTANCE PARAMETERS

	Allowable		Ultimate
	Static	Total Combined	
Frictional Coefficient	0.48	0.58	0.73
Passive Pressure (psf/ft)	400	540	800
Lateral Translation Necessary to Develop Passive Pressure	0.005D	0.008D	0.022D

Note: D is the foundation depth below lowest adjacent grade. Lateral translation will be in the same units as D.

The static values are for use with D+L loads and the total combined values are for resistance of D+L+transient loads other than seismic. The allowable parameters include a safety factor and, as such, can be used for direct comparison of driving and resisting loads. If design approaches use a prescribed ratio of resisting loads to driving loads greater than unity, ultimate values can be used. Passive resistance is strain related (deformation necessary to mobilize shear resistance). If the translation necessary to develop the passive pressure is within structure tolerance, the frictional resistance and passive pressure can be used in combination without any reduction. Otherwise, passive pressure needs to be reduced to be compatible with tolerable deformation.

Table 5.5-2 provides the passive dynamic increment. When considering seismic effects, this dynamic increment should be subtracted from the total combined or ultimate values in Table 5.5-1.

TABLE 5.5-2
DYNAMIC PASSIVE PRESSURE

Condition	Passive Dynamic Increment (psf/ft)
Total Combined	300
Ultimate	450

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5.5.2 Tank Bottom

Lateral loads on the base of tanks can be resisted by friction between the tank bottom plate and supporting soil. The allowable frictional coefficients for static (D+L) and total combined (D+L+ transient) loads are provided in Table 5.5-3.

TABLE 5.5-3
FRICTIONAL RESISTANCE AT BOTTOM OF TANK

Base Material	Allowable Frictional Coefficient		Ultimate Frictional Coefficient
	Static Loads	Total Combined Loads	
Steel Tank Bottom on On-Site Soil or Imported Sand	0.22	0.26	0.32
Steel Tank Bottom on Imported Gravel	0.25	0.30	0.38

5.6 DYNAMIC SOIL PARAMETERS

The dynamic soil parameters tabulated below were based in borings B-8 and B-9. These borings are at the proposed power block will be constructed in this area, where vibrating equipment will be installed.

TABLE 5.5-2
DYNAMIC SOIL PARAMETERS

Mass Density, lb-sec^2/ft^4	Poisson's Ratio	Shear Modulus (ksf)		Material Damping Ratio		Modulus of Elasticity (ksf)	Shear Wave Velocity (ft./sec)
		$\epsilon=10^{-3\%}$	$\epsilon=10^{-5\%}$	$\epsilon=10^{-3\%}$	$\epsilon=10^{-5\%}$		
3.8	0.3	1260	1400	0.02	0.05	3640	600

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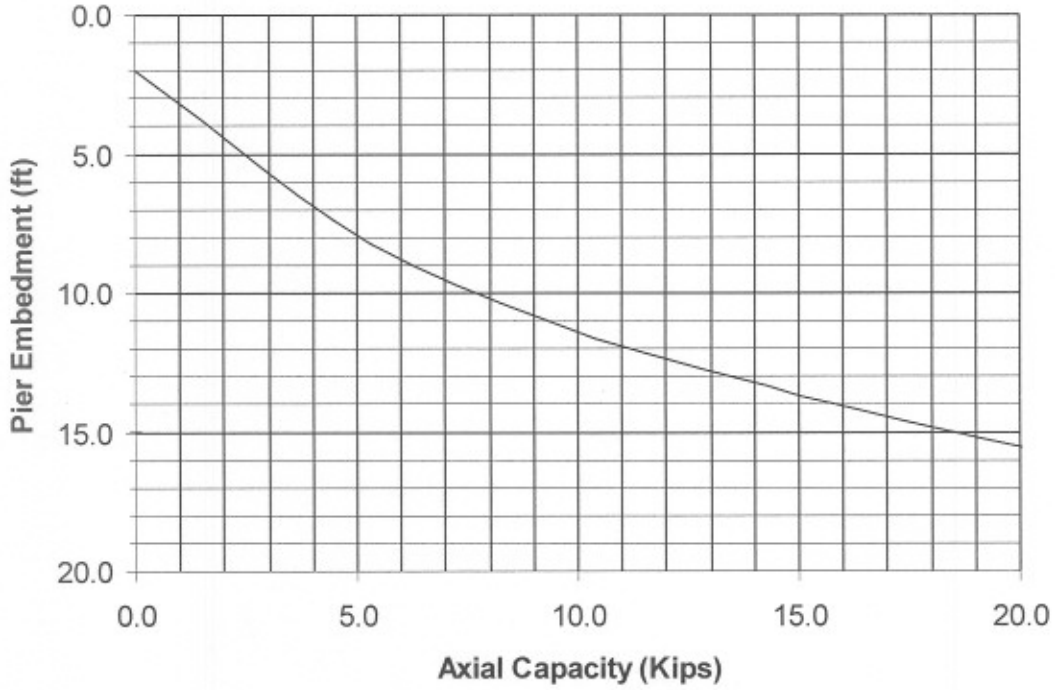
5.7 CIDH FOUNDATION PIERS

5.7.1 Axial Capacities

Cast-in-drilled hole (CIDH) pier foundations may be considered for support of pipe racks or solar panels. Analysis, based on the "alpha" method (NAVFAC DM7, Bowles, Coduto, Das), considers axial capacity based on side friction only. Figure 5.7-1 provides axial compressional capacity versus depth of embedment of a 24-inch diameter CIDH pier. The capacity of other pier diameters would be proportional to the pier diameter. Uplift capacity may be used as 70 percent of the compressive frictional capacity plus the dead weight of the concrete pier. If groups of piers are necessary, the pier spacing should be a minimum of 3 pier diameters, center to center. If closer spacing is required, a capacity reduction for group effect will be required.

FIGURE 5.7-1
Allowable Axial Capacity vs Pier Depth
24-inch Diameter CIDH Concrete Pier



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5.7.2 Lateral Pier Capacity

The lateral response of pier foundations were evaluated using LPILE Plus Version 4.0 for Windows (computer software developed by *Ensoft Inc.*). The geotechnical parameters summarized in Table 5.7-1 can be used for evaluation of lateral loading of piles.

Table 5.7-1
Soil Input Parameters for LPILE

Depth Below Original Grade (ft)		p-y	K	γ'	ϕ	c
From	To	Curve	(pci)	(pci)	(°)	(psf)
0	14	Sand	150	0.060	36	0
14	19	Sand	160	0.058	40	0
19	32	Sand	120	0.061	40	0
32	49	Sand	110	0.061	40	0

Figure 5.7-2 provides the lateral load versus embedment depth for a pier hear deflection of 0.5 inch. Data are presented for a free head condition with the lateral load applied at the ground surface. Data can be provided for a partially embedded pier, if the point of load application above the ground surface or the shear and moment at the ground surface is provided.

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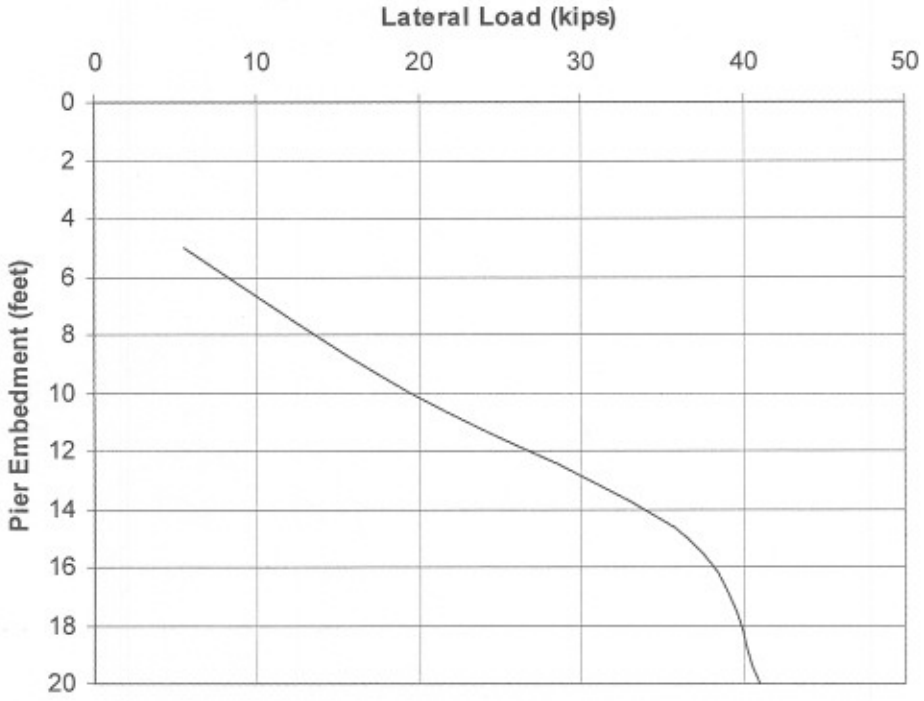
Figure 5.7-2
Lateral Load Curve for 24" Diameter CIDH Pier



Curves displaying the moment, shear, and displacement distribution along the pier can be provided for the final loading and pier geometry.

When considering the lateral capacity of a pier group, it will be necessary to reduce the single pier capacity of trailing piles. The reduction in capacity due to the effects of shaft interaction will be dependent upon the center-to-center (CTC) pier spacing. It is recommended that the capacity of individual trailing piers in a laterally loaded group be reduced according to the data in Table 5.7-3.

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TABLE 5.7-3
GROUP AFFECT FOR LATERALLY LOADED PILE

CTC Spacing (In-line Loading)	Ratio of Lateral Resistance of Trailing Pile in Group to Isolated Single Pile
2B	0.4
3B	0.6
4B	0.8
5B	1.0

5.7.3 Pier Construction Considerations

Foundation soils are anticipated to be predominately sandy silt and silty sand. Some zones of relatively clean sand will also likely be encountered. Care will be necessary to avoid over-crowding and wobbling the drilling auger. Under cutting the pier boring wall could cause caving.

5.8 CONCRETE SLABS-ON-GRADE

5.8.1 Subgrade Preparation

Slabs-on-grade should be supported on at least 30 inches of non-expansive (PI<9). If slabs are to be located in areas containing expansive soil, the subgrade should be over-excavated and replaced with non-expansive engineered fill placed as described in Section 5.10.5 of this report. The slab subgrade, to a depth of at least 12 inches, should have a moisture content of at least optimum immediately prior to pouring the slab or placing a vapor retarding membrane.

5.8.2 Capillary and Moisture/Vapor Break

Considering the depth to ground water and the soil types, a capillary break (i.e. clean sand or gravel layer) is not necessary.

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In buildings where equipment or other components are moisture-sensitive, it is recommended that the slab subgrade be covered by vapor retarding membrane, such as 10-mil polyorfin. If design should incorporate a gravel subgrade layer, the membrane should have a minimum thickness of 15-mil. As an added precaution, consideration could be given to extending the vapor retarding membrane around the footings to provide a more complete vapor barrier. The subgrade surface should be smooth and care should be exercised to avoid tearing, ripping, or otherwise puncturing the vapor retarding membrane. If the vapor retarding membrane becomes torn or disturbed, it should be removed and replaced or properly patched. It is recommended consideration be given to placing concrete directly on the vapor retarding membrane. If desired by designers, the vapor retarding membrane could be covered with approximately 1 to 2 inches of saturated surface dry (SSD), relatively clean sand to protect it during construction. Concrete should not be placed if sand overlying the vapor barrier has been allowed to attain moisture content greater than about 5% (due to precipitation or excessive moistening). Excessive water beneath interior floor slabs could result in future significant vapor transmission through the slab, adversely affecting moisture-sensitive floor coverings or equipment and the indoor environment.

It should be noted that, although the slab support discussed above is currently the industry standard, this system might not be completely effective in preventing floor slab moisture vapor transmission problems. This system will not necessarily assure that floor slab moisture transmission rates will meet any component standards and that indoor humidity levels will not inhibit mold growth. A qualified specialist(s) with knowledge of slab moisture protection systems, flooring design and other potential components that may be influenced by moisture, should address these post-construction conditions separately. The purpose of a geotechnical study is to address subgrade conditions only, and consequently, it does not evaluate future potential conditions.

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5.8.3 Conventional Slab Design

Slab concrete should have good density, a low water/cement ratio, and proper curing to promote a low porosity. It is recommended that the water/cement ratio not exceed 0.45, to minimize vapor transfer.

The thickness and reinforcement of slabs-on-grade should be determined by structural considerations and should be designed by the project structural engineer.

5.9 PIPE DESIGN

5.9.1 Vertical Loading

Pipe zone (bedding, haunching and initial backfill) backfill compaction and material should be compatible with the pipe type and tolerable deformation. Randomly excavated site soil would result in a Class III backfill material as described in ASTM D2321. Table 5.9-1 provides estimated values for soil stiffness modulus (E^I_b and E^I_n) of the trench wall and pipe zone backfill and backfill density for use in evaluating initial pipe deflection and pipe zone backfill criteria that is compatible with pipe types.

TABLE 5.9-1
PIPE DESIGN PARAMETERS

Type of Soil	Soil Stiffness Modulus (psi)			Backfill Density (pcf)	
	E^I_n (trench wall)	E^I_b (backfill)		85% Compaction	90% Compaction
		85% Compaction	90% Compaction		
Silty Sand	3000	900	1350	116	123
Sandy Silt	2500	700	1000	110	116

E^I_n represents the modulus for the undisturbed natural soil and is based on the relative density and data by Howard (1996). E^I_b is the modulus for backfill derived from excavation of on-site soil and is based on data by Hartley and Duncan (1982) and Watkins and Anderson (2000). The design E^I will be dependent upon the pipe diameter

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and trench width, which dictates the relative influence of E'_n and E'_b. Methods by Howard (1996) are suggested for evaluating the design E'.

In evaluating the maximum load (W_c) on pipes, a Ku' of 0.19 (K=0.26 and u'=0.73 can be used in determining the load coefficient C_d.

5.9.2 Resistance of Lateral Loads

The lateral thrust on pressurized pipelines can be resisted by friction between the pipe and pipe zone backfill and lateral bearing on thrust blocks. Table 5.9-2 provides the recommended frictional resistance and lateral bearing for sustained loading and test loading conditions.

TABLE 5.9-2
LATERAL RESISTANCE FOR PIPES

Resistance Mode	Sustained Loading	Test Loading
Frictional Coefficient		
Smooth Pipe (plastic, steel)	0.22	0.26
Rough Pipe (corrugated, cement)	0.42	0.51
Lateral Bearing		
Shallow Thrust Block (1)	400 psf/ft	540 psf/ft
Deep Thrust Block (2)	3000H psf (3)	4500H psf(3)

Notes: (1) Shallow thrust block has a height greater than 70% of the depth to the center of the pipe.
(2) Deep thrust block has a height less than 70% of the depth to the center of the pipe
(3) H is height of the thrust block in feet

The horizontal deflection associated with developing the allowable lateral bearing on shallow thrust blocks is about 0.005D for sustained loading and 0.008D for test loading. D represents the depth below the ground surface to the base of the thrust block. The

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estimated horizontal deflection associated with the lateral bearing on deep thrust blocks is about 0.25 inch per 2000 psf of lateral bearing.

5.10 SITE EARTHWORK

5.10.1 Stripping and Grubbing

At the time of the field exploration, light to moderately heavy growth of brush and seasonal weeds occupied the site. The density of surface vegetation varies significantly and could change substantially prior to the time of grading. All surface vegetation and any miscellaneous surface obstructions should be removed from the project area, prior to any site grading. It is anticipated stripping of brush and seasonal vegetation could involve the upper 2 to 3 inches. Grubbing should include removal of bush root-balls and isolated roots greater than 0.5 inch in diameter. Surface strippings should not be incorporated into fill unless they can be sufficiently blended to result in an organic content less 3 percent by weight (ASTM D2974).

5.10.2 Disturbed Soil, Undocumented Fill and Subsurface Obstructions

Initial site grading should include a reasonable search to locate any disturbed soil, undocumented fill soils and abandoned underground structures that may exist within the area of construction. Any obstructions should be removed from the project area. Any disturbed soil, void spaces created by burrowing animals or undocumented fill, which are encountered, should be excavated to approved firm native material.

5.10.3 Over-excavation

Observation of exposures in test pits, geologic trenches and erosional channel banks indicate the upper 1.5 to less than 2 feet are unsuitable for support of fill or structures due to desiccation, wind deposition, and agricultural activity. It will be necessary to over-excavate and recompact these soils beneath areas to receive fill or where structure foundations or pavement subgrade do not extend more than 2 feet below

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existing grade. The grading should result in any required over-excavation extending beyond the perimeter of foundations or paving subgrade to a minimum of 5 feet.

Over-excavation should extend to a depth of 1.5 feet below the existing ground surface. Representatives of the project geotechnical engineer or project geologist should determine the exposed soils are suitable for receiving compacted fill.

The depth of over-excavation may be modified if grading utilizes equipment (e.g. Rex 760 open-hub compactor) which is capable of efficient deeper in-place compaction.

5.10.4 Scarification and Compaction

Following site stripping, grubbing and/or any required over-excavation, it is recommended:

1) **Granular soil (PI<9)** areas to receive engineered fill or to be used for support of shallow foundations, concrete slabs, and pavements be scarified to a minimum depth of 8 inches, uniformly moisture-conditioned to at, or above, optimum moisture content, and compacted to at least 90 percent of the maximum dry density.

2) **Expansive soil (PI≥9)** areas to receive fill or to be used for support of shallow foundations, concrete slabs, and pavements should be scarified to a depth of 8 inches and moisture conditioned to at least 4% above optimum and compacted to at least 88%, but not more than 92%, of the maximum density.

Reference to maximum dry density and optimum moisture is in accordance to ASTM (American Society for Testing and Materials) Test Method D1557.

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5.10.5 Engineered Fill

5.10.5.1 Materials

All engineered fill soils should be nearly free of organic or other deleterious debris and less than 3 inches in maximum dimension. The native soil materials, exclusive of debris, may be used as engineered fill provided they contain less than 3 percent organics by weight (ASTM D2974).

Recommended requirements for any imported soil to be used as engineered fill, as well as applicable test procedures to verify material suitability are provided on Table 5.10-1.

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TABLE 5.10-1
IMPORT SOIL MATERIALS

Gradation		Test Procedures	
Sieve Size	Percent Passing	ASTM[1]	Caltrans[2]
76 mm (3 inch)	100	C136	202
19 mm (¾ inch)	80 – 100	C136	202
No. 4	60 - 100	C136	202
No. 200	20 – 50	C136	202
Plasticity			
Liquid Limit	Plasticity Index		
< 25	<9	D4318	204
Soluble Sulfates			
< 1500 ppm		-	417
Soluble Chloride			
<300 ppm		-	422
Resistivity			
>1000 ohm-cm		-	643

Notes:
[1] American Society for Testing and Materials Standards (latest edition)
[2] State of California, Department of Transportation, Standard Test Methods (latest edition)

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Any imported materials to be used for engineered fill should be sampled and tested by a representative of the project Geotechnical Engineer prior to being transported to the site.

5.10.5.2 Compaction Criteria

Expansive Soils (PI≥9)

Required moisture conditioning and compaction will be based on the expansive nature of the soil encountered. Due to the possible variability in expansion potential, the required level of moisture conditioning and compaction will have to be determined during grading. During grading for the project, Plasticity Index (PI) tests should be conducted with each maximum density curve conducted.

Soils used for engineered fill should be uniformly moisture-conditioned to at least the percentages above optimum indicated in Table 5.10-2, placed in horizontal lifts, and compacted to the required percent relative compaction indicated Table 5.10-2. Disking and/or blending may be required to uniformly moisture-condition soils used for engineered fill. The thickness of lifts should be sufficiently thin to result in uniform compaction throughout the lift (e.g., Rex 760 open-hub compactor could use 18-inch lifts, whereas a Cat 815 should use about 8-inch lifts and hand tampers should use 3 to 4-inch lifts).

The general intent is to bring the expansive material to about 80% to 85% saturation at the time of construction. Preliminary design should consider criteria for the PI of16 to 25 for fill generated from the clay soil.

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TABLE 5.10-2
EXPANSIVE SOIL CONDITIONING

Expansion Potential of Soils	RELATIVE COMPACTION (MIN – MAX)	Minimum Moisture Conditioning (Over Optimum)
PI		
9 to 15	90-95%	+3%
16 to 25	88-92%	+4%
> 25	88-92%	+5%

Granular Soils (PI<9)

Soils used for engineered fill should be uniformly moisture conditioned to at, or above, optimum moisture, placed in horizontal lifts, and compacted to at least 90 percent relative compaction. Disking and/or blending may be required to uniformly moisture-condition soils used for engineered fill. Lift thicknesses should be compatible with the compaction equipment to produce uniform compaction throughout the lift.

5.10.6 Volume Loss

A volume loss will be experienced from cut to compacted fill yardage. Based on the limited number of in-place density samples obtained, the average volume loss for soil excavated from a depth of about 2 to 5 feet below existing grade will be about 15%. The loss in soil excavated from the upper 2 feet will be greater. No specific data is available for this upper 2 feet. Based on observation of test pits at geologic trenching, it is anticipated the loss in the upper 2 feet could be on the order of 25%.

It must be recognized that the available sample volume is less than one millionth of one percent ($6x10^{-7}$%) of the anticipated grading volume. Consequently, available data is a very limited representation of the potential volume loss. Better representation of the potential volume loss would require extensive testing of in-place density.

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5.10.7 Construction Considerations

Site soil has relatively low natural moisture content. It should be anticipated significant quantities of water will be necessary to facilitate compaction.

If construction is performed during dry, hot or windy weather, it may be necessary to periodically apply surface watering to counter evaporative loss or re-establish moisture prior to continuing fill operations after an interruption or constructing improvements.

Should site grading be performed during or subsequent to wet weather, surface soils may be significantly above optimum moisture content. These conditions could hamper equipment maneuverability and efforts to compact site soils to the recommended compaction criteria. Disking to aerate, chemical treatment, replacement with drier material, stabilization with a geotextile fabric or grid, or other methods may be required to reduce excessive soil moisture and facilitate earthwork operations. Any consideration of chemical treatment (e.g. lime) to facilitate construction would require additional soil chemistry evaluation and could affect landscape areas or some building materials.

5.11 TEMPORARY EXCAVATIONS

5.11.1 General

All excavations must comply with applicable local, state, and federal safety regulations including the current the Occupational Safety & Health Administration (OSHA) Excavation and Trench Safety Standards. Construction site safety generally is the responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. Kleinfelder is providing the information below solely as a service to the client. Under no circumstances should the information provided be interpreted to mean that Kleinfelder is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

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5.11.2 Temporary Slopes

Near-surface soils encountered during the field investigation consisted predominantly of sandy silt and silty sand with some interbeds of poorly graded sand. These soils would be considered as a Type C soil with regard to OSHA regulations. According to OSHA regulations, the maximum allowable slopes for Type C soil is 1.5:1 (horizonal:vertical) for excavations less than 20 feet deep. Use of higher or steeper cut slopes for temporary excavations will require specific evaluation of strength, moisture content, and homogeneity of the soils and associated stability analysis.

5.11.3 Shoring

Shoring may be required where space or other restrictions do not allow for an adequately sloped excavation. A braced or cantilevered shoring system maybe used. A temporary cantilevered shoring system should be designed to resist an active earth pressure of 32 psf/foot of depth. Braced excavations should be designed to resist a uniform horizontal soil pressure of 20.5H psf, where 'H' is the excavation depth in feet. The values assume a level ground surface adjacent to the top of the shoring and no surcharging.

Equipment or spoil placed within a horizontal distance equal to the shoring height may result in a lateral surcharge load. Twenty-five percent of a uniform areal surcharge placed adjacent to the shoring may be assumed to act as a uniform horizontal pressure against the shoring. Special cases such as combinations of slopes and shoring or other surcharge loading geometry would require specific evaluation to determine the surcharge effect. These conditions should be evaluated on a case-by-case basis.

Shoring must extend to a sufficient depth below the excavation bottom to provide the required lateral resistance. The allowable passive pressure against solid shoring, which extends below the level of excavation is 540 psf/foot of depth. It is recommended that required embedment depths for cantilevered shoring be determined using methods for evaluating sheet pile walls and based on the principles of force and moment equilibrium. Isolated soldier piles with a spacing greater than 3D, where 'D' is the width of the shaft,

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may be designed for an allowable passive pressure of 800 psf/foot of depth. This value already considers arching. Consequently, no additional increases should be considered. The Contractor should be responsible for the structural design and safety of all temporary shoring systems.

5.12 PRELIMINARY PAVEMENT SECTIONS

5.12.1 General

The potential subgrade soil is anticipated to be silty sand. Should pavement will be constructed in areas of expansive subgrade soil, excavated on-site granular soil (e.g from evaporation ponds) should be used to replace the upper 12 inches of fine grained soil. The subgrade Resistance-value (R-value) for the granular on-site soil was evaluated in the laboratory. The test results indicated R-values of 66 and 63 by exudation, from B-11 and B-20, respectively. Considering very high R-values can be significantly affected by subtle variations in gradation and fines content, a design R-value of 50 is recommended. The laboratory testing was in conformance with Caltrans Test Method 301.

5.12.2 Asphalt Concrete Pavement

Specifications indicated using HS20-44 loading for pavement areas. Detailed frequency information is not available for this project. Therefore, it was assumed that an average daily truck traffic (ADTT) of one HS 20-44 vehicle for a 20-year design period. The assumption translates to 18-kip ESAL (Equivalent Single Axle Loading) design repetitions of 163,907, which is equivalent to a Caltrans Traffic Index (TI) of 7.5. This traffic design assumption should be reviewed for compatibility with the actual development, and revised pavement sections developed, if necessary. For non-truck pavement areas, a design TI of 4.5 has been used. This TI would represent an average of about 200 vehicles under a GVW of 7,000 pounds per day.

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The flexible pavement design recommendations presented are based upon the Caltrans procedures. The flexible pavement sections associated with the estimated T.I.'s and a design R-value of 50 are summarized in Table 5.12-1.

TABLE 5.12-1
RECOMMENDED PRELIMINARY PAVEMENT SECTIONS
ON GRANULAR (SANDY) SUBGRADE

Traffic Index	Asphalt Concrete	Aggregate Base (Min. R-value: 78)
4.5	2.5"	4.0"
7.5	4.5"	5.0"

The flexible pavement should conform to, and be placed in accordance with, current Caltrans Standard Specifications, May 2006. The aggregate base (Class 2) should comply with the specifications in Section 26. The aggregate base should be compacted to a minimum of 95 percent relative compaction as determined by the ASTM D1557 test procedures. The upper 12 inches of pavement subgrade should be moisture conditioned to at, or above, optimum and compacted to at least 90%.

5.12.3 Portland Cement Concrete Pavement

Design recommendations for PCCP are based on standard guidelines developed by the Portland Cement Association. For a T.I. of 4.5 (ESAL of 2960) it is recommended rigid pavement consist of 5.75 inches of PCCP. For a TI of 7.5 (ESAL of 164,000), the rigid pavement would be 7.0 inches of PCCP. If desired, a design analysis could be performed based on actual truck volumes and axial loading. PCCP should be placed on at least 12 inches of non-expansive (PI<9) granular soil compacted to at least 90% of maximum density.

The concrete mix design should provide a 28-day compressive strength of at least 4,000 pounds per square inch. The concrete mix should also be designed for a slump

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not exceeding 4 inches. Thickened edges should be used along outside edges of concrete pavements. Edge thickness should be at least 2 inches greater than the concrete pavement thickness and taper to the actual concrete pavement thickness 36 inches inward from the edge. Integral curbs may be used in lieu of thickened edges.

Continuous sections of concrete pavement should have construction or control joints in an approximately 12-foot square grid system or less. If a square system is impractical, rectangular panels having a maximum dimension of 12 feet can be used. All longitudinal or transverse control joint should be constructed by saw-cutting, hand forming or placing pre-molded fillers, such as zip strips. Longitudinal or transverse construction joints should be keyed or doweled to mitigate against differential movement. Expansion joints should be used to isolate fixed objects abutting or within the pavement area. The expansion joints should extend the full depth of the pavement. Joints should run continuously and extend through integral curbs and thickened edges. It is recommended that joint layout be adjusted to coincide with the corner of objects and structures.

5.12.4 Moisture Considerations

The pavement design should consider both the vehicular loading, as well as the environmental factors. The vehicular loading will depend on the amount and type of traffic anticipated for the pavement design life. Environmental factors include the potential for moisture variations beneath the pavement structural section. It is recommended that all pavement areas conform to the following criteria:

1. All trench backfill, including utility and sprinkler lines, should be properly placed and adequately compacted to provide a stable subgrade.
2. Adequate drainage should be provided to prevent ponding of surface water which could saturate the subgrade soil.
3. A periodic maintenance program should be incorporated to include sealing cracks and other measures.
4. All concrete curbs separating pavement and landscaped areas should extend to the subgrade.

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5.12.5 Construction Considerations

In the event unstable (pumping) subgrades are encountered within planned pavement areas, we recommend a heavy, rubber-tired vehicle (typically a loaded water truck) be used to test the load/deflection characteristics of the finished subgrade materials. This vehicle should have a minimum rear axle load (at the time of testing) of 16,000 pounds with tires inflated to at least 65 psi pressure. If the tested surface shows a visible deflection extending more than 6 inches from the wheel track at the time of loading, or a visible crack remains after loading, corrective measures should be implemented. Such measures could include disking to aerate, chemical treatment, replacement with drier material, or other methods. It is recommended Kleinfelder be retained to assist in developing which method (or methods) would be applicable for this project.

5.13 FIELD RESISTIVITY TESTING

The resistivity of the soil was measured at the site to assist designers in evaluation of a potential grounding system. Soil resistivity was measured using the Wenner four-electrode method and a Model 4620 Ground Resistance Tester, manufactured by AEMC, Inc. The Wenner method involves the use of four metal probes or electrodes driven into the ground, along a straight line, an equal distance from each other. An alternating current from the soil resistance meter is induced into the soil. The current creates a voltage gradient that is proportional to the average resistance of the soil mass to a depth equal to the distance between probes. The resistivity of each layer of soil was then calculated using the Megger Method as follows:

$$\rho = A\, 2\, \pi\, R$$

where;

ρ= soil resistivity at depth (ohm-cm)
A = distance between the electrodes (cm)
R = resistance of soil layer from a to b (ohms)
π= constant 3.1416

Two resistivity test lines were performed at the project site. The tests were performed in the proposed location of power block (as shown on Plate 2). One resistivity line was taken in an east-west direction and one in a north-south direction. Resistance

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measurements were conducted with probe spacing of 5, 10, 20, and 30 feet at the project site.

The result of the field resistivity testing is provided in Table 5.13-1.

TABLE 5.13-1
FIELD RESISTIVITY TEST RESULTS

ORIENTATION	SPACING, ft.	RESISTIVITY, ohm-cm
North-South	5	24,991
	10	29,874
	20	31,406
	30	12,639
East-West	5	21,831
	10	19,725
	20	37,917
	30	27,0012

The average resistivity of a layer in ohm-cm is the average resistivity of soil to a depth equal to the pin spacing (i.e. a 10-foot spacing is a 10-foot thick layer).

5.14 CORROSION POTENTIAL

Chemical analyses were performed on five samples of near surface soils to estimate pH, resistivity, soluble sulfate, and chloride contents in general accordance with Caltrans Standard Test Methods 643 (pH and resistivity), 417 (sulfates), and 422 (chlorides). The results of the corrosivity testing are provided in Table 5.14-1.

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TABLE 5.14-1
CORROSION TEST RESULTS

Sample ID	Sulfates	Chloride	pH	Minimum Resistivity
B-1 @ 0-5 ft.	486	37.8	7.8	750
B-8 @ 0-5 ft.	24.4	21	7.9	5640
B-9 @ 0-5 ft.	21.9	2.1	8.1	4790
B-11 @ 0-5 ft.	18.3	38.3	---	---
B-15 @ 0-5 ft.	20.7	2.1	8.1	5540

The test results suggest that relatively low levels of soluble sulfate content and low levels of soluble chloride content are present in on-site soils. Normal Type II cement is anticipated to be adequate in foundation concrete that comes in contact with the foundation soils.

The minimum electrical resistivity is generally representative of an environment that could normally be moderately to severely corrosive to buried unprotected metals. Corrosion is dependent upon a complex variety of conditions, which are beyond the geotechnical practice. Kleinfelder does not practice corrosion engineering. It is recommended that a competent corrosion engineer evaluate the corrosion potential of the site to the proposed project, to recommend further testing as required, and to provide specific corrosion mitigation methods appropriate for the project. It is recommended that specific testing be performed once site-grading activities are near completion to provide a better assessment of the actual soils present in the areas of interest.

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6.0 ADDITIONAL GEOTECHNICAL INVESTIGATIONS

6.1 PLANS AND SPECIFICATION REVIEW

It is recommended Kleinfelder be retained to review preliminary foundation and earthwork plans and specifications. It has been Kleinfleder's experience that this service provides an opportunity to review whether or not the recommendations have been properly interpreted and to correct possible misunderstandings of the recommendations prior to the start of construction. In the event Kleinfelder is not retained to perform this recommended review, Kleinfelder will assume no responsibility for misinterpretation of the recommendations.

6.2 CONSTRUCTION OBSERVATION AND TESTING

It is recommended that Kleinfelder, Inc. be retained to provide observation and testing services during site earthwork and construction of foundations. This will allow us the opportunity to compare actual subsurface soil conditions with those encountered during the field exploration and, if necessary, to provide supplemental recommendations, if warranted due to unanticipated subsurface conditions.

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7.0 LIMITATIONS

Recommendations contained in this report are based on the field observations, subsurface explorations, laboratory tests, and present knowledge of the proposed construction, as described in this report. It is possible that soil conditions vary between or beyond the points explored. If soil or groundwater conditions are encountered during construction that differ from those described herein, Kleinfelder should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction changes from that described in this report, the recommendations should also be reviewed. Kleinfelder has not reviewed the final grading plans or foundation plans for the Project.

Corrosion recommendations are preliminary. Kleinfelder is not a corrosion engineering consultant. Specific recommendations for corrosion protection should be obtained from a corrosion specialist.

Kleinfelder has strived to present the findings, conclusions and recommendations in this report in a manner consistent with the standards of care and skill ordinarily exercised by members of this profession practicing under similar conditions in Kern County, California, and at the time the services were performed. No warranty, express or implied, is made. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by Kleinfelder during Project construction in order to evaluate compliance with the recommendations and/or to provide supplemental recommendations, as needed, if anticipated subsurface conditions are encountered.

This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance, but in no event later than one year (without review) from the date of the report. Land use, site conditions or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of

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these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party, and client agrees to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

The scope of the geotechnical services did not include any environmental site assessment for the presence or absence of hazardous/toxic materials. Kleinfelder will assume no responsibility or liability whatsoever for any claim, damage, or injury which results from pre-existing hazardous materials being encountered or present on the project site, or from the discovery of such hazardous materials.

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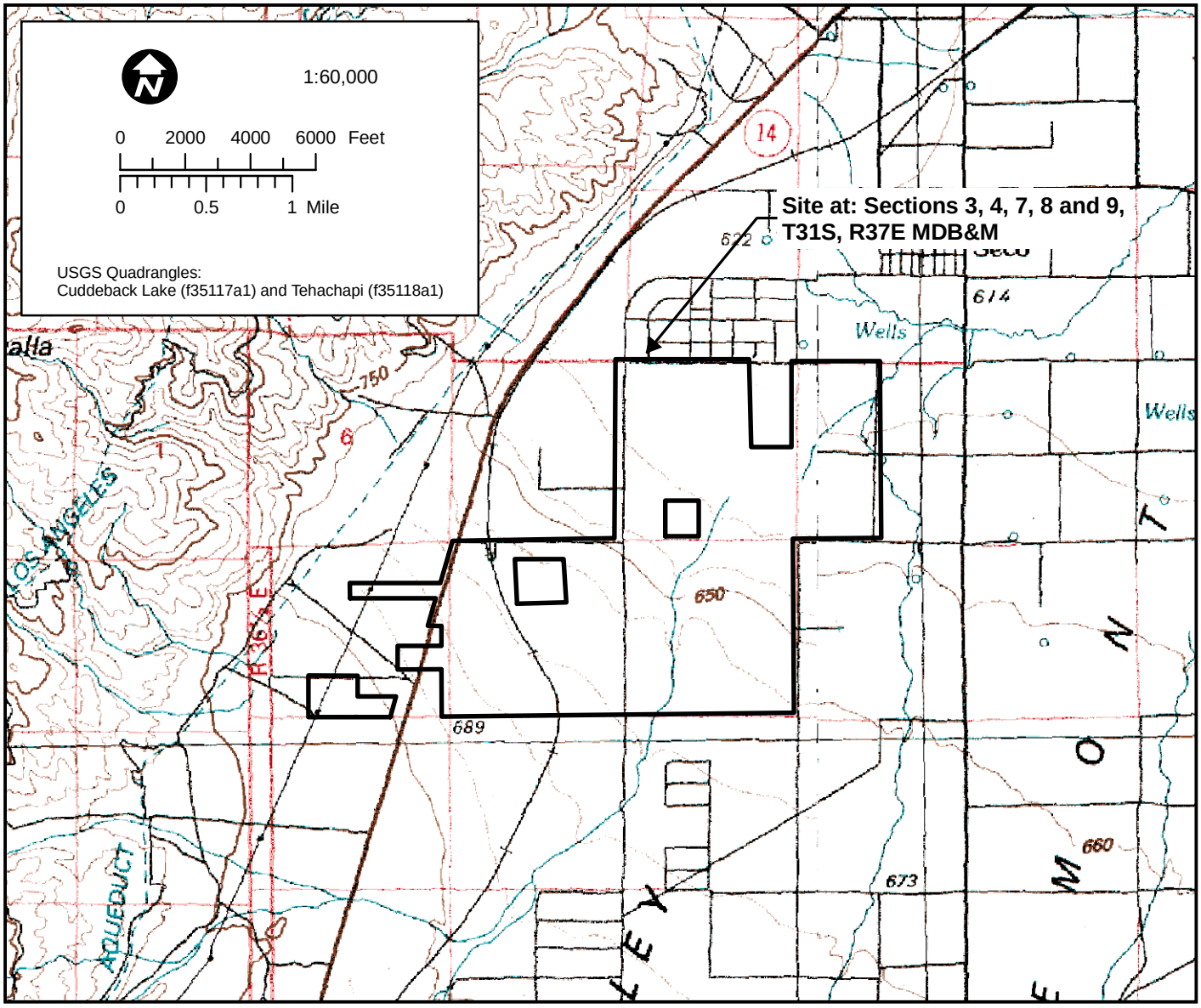

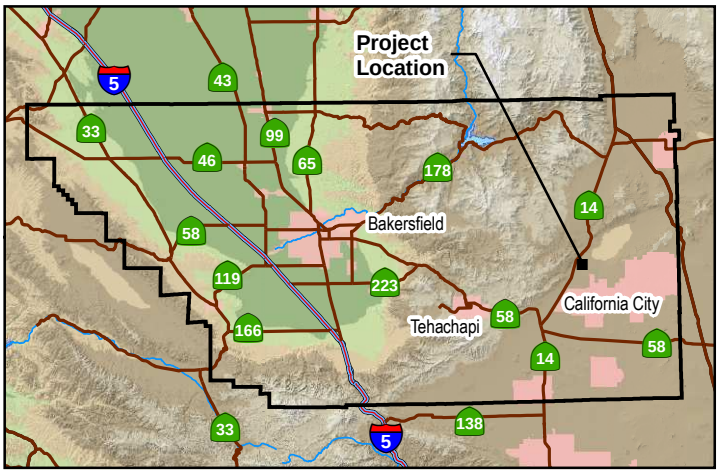

KLEINFELDER
1410 F Street, Fresno, California, 93706
(559) 486-0750 • Fax: (559) 442-5081

Project Number: 86405 | Date: October 10, 2007

SITE VICINITY MAP

FPL Energy 250MW Solar Plant
HWY 14
California City, Kern County, California

PLATE 1

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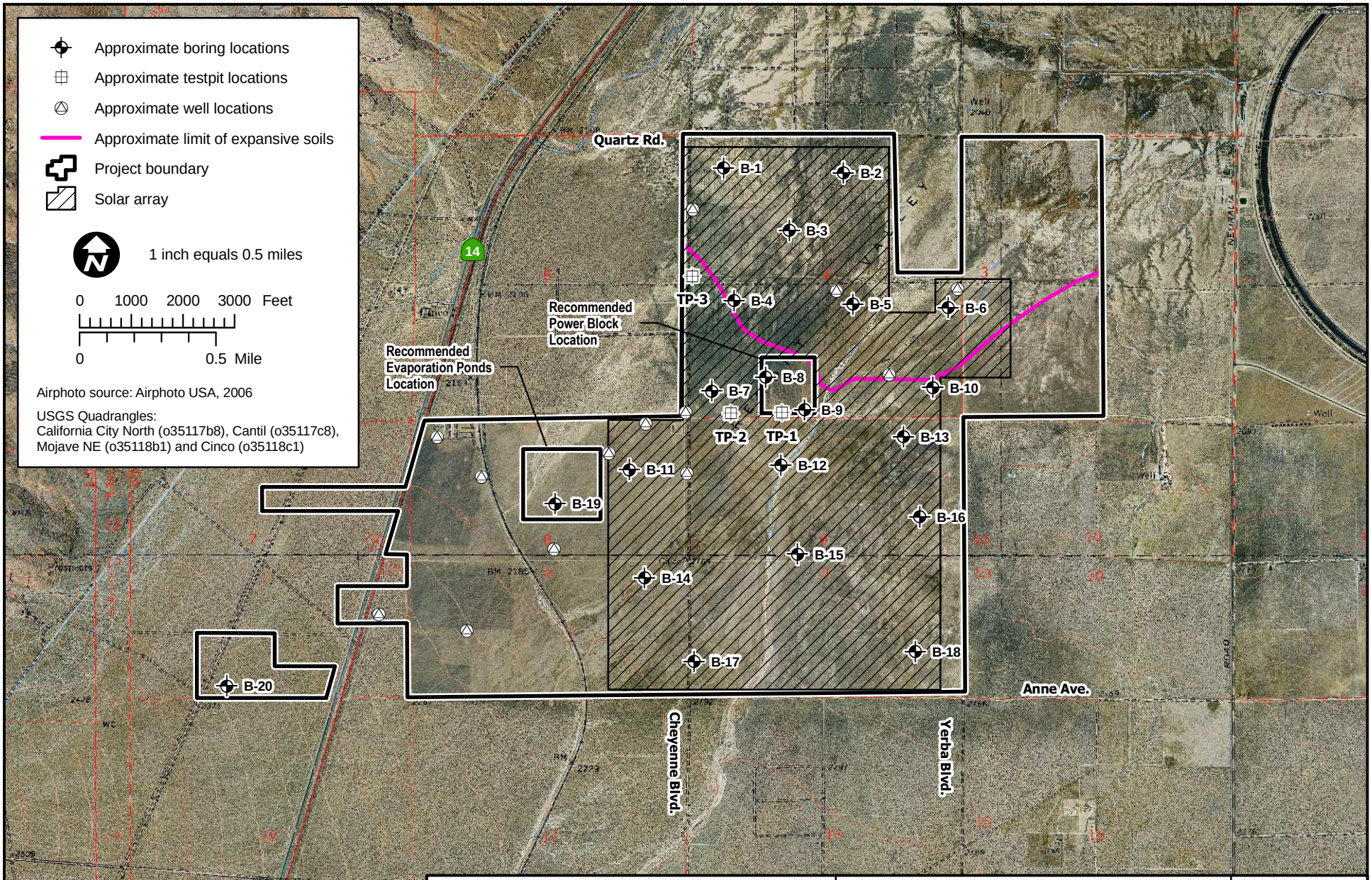

KLEINFELDER

1410 F Street, Fresno, California, 93706
(559) 486-0750 • Fax: (559) 442-5081

Project Number: 86405 | Date: January 24, 2008

SITE PLAN

FPL Energy 250MW Solar Plant
HWY 14
California City, Kern County, California

PLATE 2

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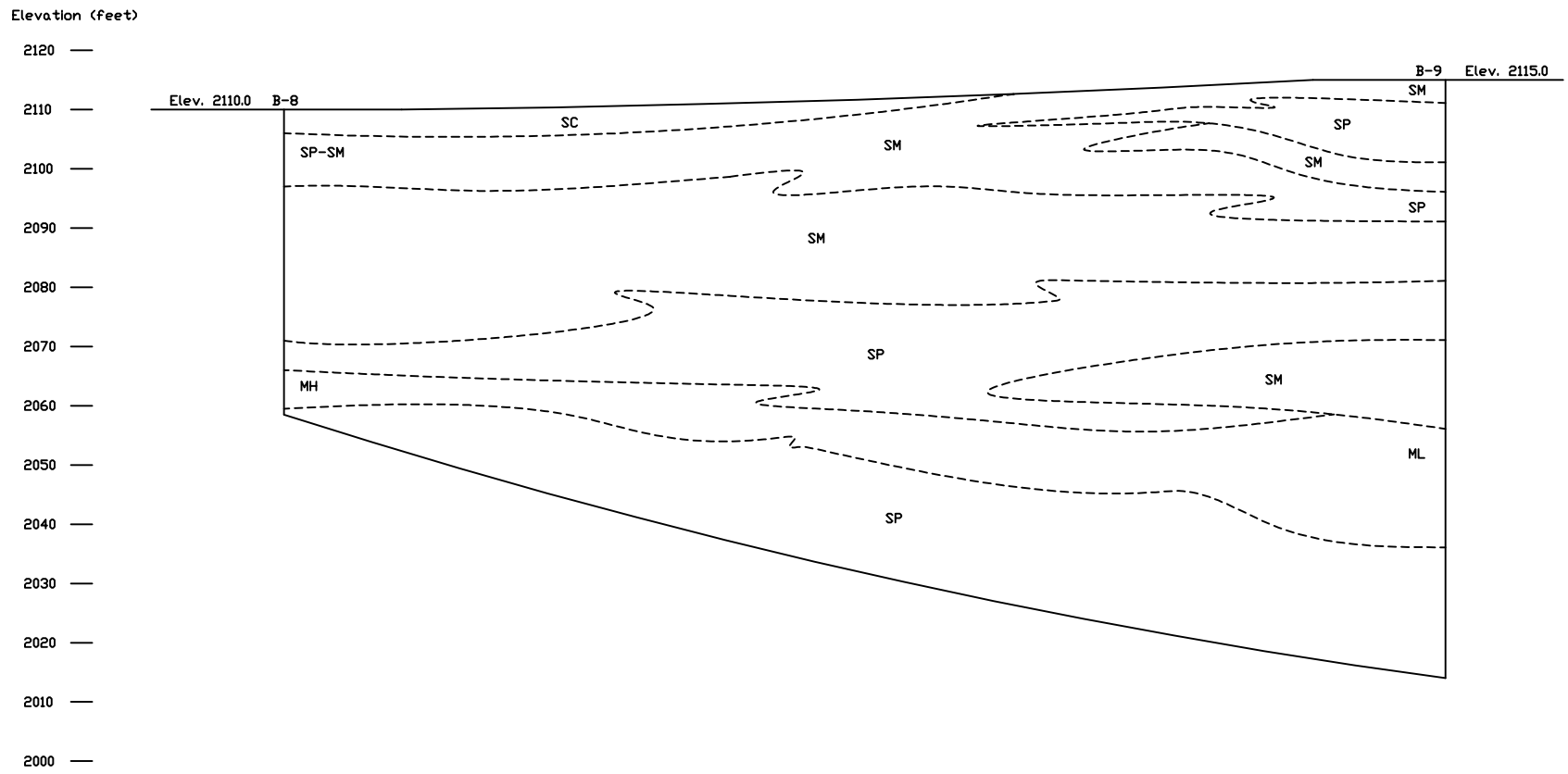

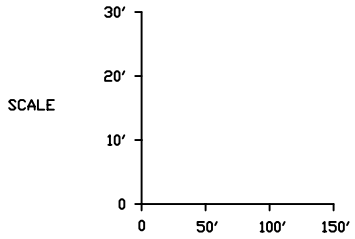

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NORTHWEST-SOUTHEAST PROFILE AT POWER BLOCK SITE

FPL ENERGY
PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

DRAWN BY: S. KAPOOR
REVISED BY:
CHECKED BY: J. MONTES
PLATE **3**

DRAWN: 02/18/08 | APPROVED BY:_____ | PROJ_NO 86405.GEO2 | FILE NAME: 86405_P3.DWG

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LOG SYMBOLS

☒	BULK / BAG SAMPLE	-4	PERCENT FINER THAN THE NO. 4 SIEVE (ASTM Test Method C 136)
■	MODIFIED CALIFORNIA SAMPLER (2-1/2 inch outside diameter)	-200	PERCENT FINER THAN THE NO. 200 SIEVE (ASTM Test Method C 117)
▮	CALIFORNIA SAMPLER (3 inch outside diameter)	LL	LIQUID LIMIT (ASTM Test Method D 4318)
◥	STANDARD PENETRATION SPLIT SPOON SAMPLER (2 inch outside diameter)	PI	PLASTICITY INDEX (ASTM Test Method D 4318)
▮	NX SIZE CORE BARREL	EI	EXPANSION INDEX (UBC Standard 18-2)
		COL	COLLAPSE POTENTIAL
▯	CONTINUOUS SAMPLER (3 inch outside diameter)	UC	UNCONFINED COMPRESSION
▼	WATER LEVEL (level after completion)	MC	MOISTURE CONTENT
▽	WATER LEVEL (level where first encountered)	NFGWE	NO FREE GROUND WATER ENCOUNTERED
≈	SEEPAGE		

GENERAL NOTES

1. **Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.**
2. **No warranty is provied as to the continuity of soil conditions between individual sample locations.**
3. **Logs represent general soil conditions observed at the point of exploration on the date indicated.**
4. **In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.**
5. **A temporary benckmark for relative elevation was located at:**

KEYLOGG 86405.GPJ 12/5/07

KLEINFELDER		LOG KEY FPL ENERGY 250MW PROPOSED SOLAR PLANT CALIFORNIA HIGHWAY 14 CALIFORNIA CITY, CALIFORNIA	PLATE A
Drafted By:	Project No.: 86405.GEO2		
Date:	File Number:		

Copyright Kleinfelder, Inc. 2007

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2082.0
		8	101.4	3.6	15.0			**SANDY SILT (MH)** - light brown, moist, soft to stiff, some clay.
5		9						**SILTY SAND (SM)** - light brown, moist, loose to medium dense, fine to medium grained
10		6						
15		17	98.4	2.1	8.0			... fine to coarse grained.
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B - 1

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
								... fine to medium grained.
		13						
25								
		20						
30								
		15						
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/4/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B - 1

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 0.0
		14						**SANDY SILT (MH)** - light brown, moist, medium dense, fine grained sand.
5		17						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
10		27						
15		12						
20								**SANDY SILT (ML)** - light brown, moist, medium dense, fine grained sand.

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B - 2

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A2

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		17						
25		26						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
30		28						**SANDY SILT (ML)** - light brown, moist, medium dense, fine grained sand.
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/4/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B - 2
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 51.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2078.0
		11						**SANDY SILT (MH)** - light brown, moist, medium stiff, fine grained sand.
5		9						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
10		11	98.6	8.5	33.0			
15		8						
20								**POORLY GRADED SAND (SP)** - red brown, moist, medium dense, fine to coarse grained.

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 3

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		21						
								SANDY SILT (ML) - light brown, moist, medium dense, fine to medium grained.
25		26						
30		16	88.6	7.8	24.0			
								SILTY SAND (SM) - light brown, moist, medium dense, fine to medium grained.
35		18						
40		19						

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 3

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
45		29						
50		53						
55								
60								
65								

Notes:
1.) Bottom of boring at 51.5 feet.
2.) No free groundwater encountered.
3.) Boring backfilled with soil cuttings 10/4/07.

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PROJECT NO. 86405

LOG OF Boring B - 3
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE 3 of 3

A3

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2100.0
		12						**SANDY SILT (MH)** - light brown, moist, medium stiff, with clay.
5		10						
10		6						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
15		15	90.1	3.5	11.0			
20								

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 4

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		17						
25								
		25						
30								
		17						
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/4/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B - 4

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2055.0
								SANDY SILT (MH) - light brown, moist, medium stiff.
		9	86.9	3.9	11.0			
5								
		10						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
10								... red brown, fine to coarse grained.
		14	84.2	7.5	21.0			
15								
		10						
20								

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 5

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A5

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
			97.3	4.4	17.0			
		18						
25								
		24						
30								
		18						
35								
40								

Notes:
1.) Bottom of boring at 31.5 feet.
2.) No free groundwater encountered.
3.) Boring backfilled with soil cuttings 10/4/07.

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 5
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2070.0
		16	87.8	7.4	22.0			**SANDY SILT (MH)** - light brown, moist, medium stiff.
5		17						
								SILTY SAND (SM) - light brown, moist, medium dense, fine to medium grained
10		31						
15		12						
20								

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 6

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A6

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		13						
25		20						
								SANDY SILT (ML) - light brown, moist, medium dense, fine grained sand.
30		25						
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/4/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B - 6

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2120.0
		6	88.3	5.2	16.0			**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
5		11						
10		13						
15		25	97.7	2.7	10.0			**POORLY GRADED SAND (SP)** - red brown, moist, medium dense, fine to medium grained.
20								**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 7

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A7

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		10						
25		15						
30		21						
35								
40								

Notes:
1.) Bottom of boring at 31.5 feet.
2.) No free groundwater encountered.
3.) Boring backfilled with soil cuttings 10/4/07.

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B - 7
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE 2 of 2

A7

Date Completed: 10/2/07

Logged By: C. Davis

Total Depth: 51.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2110.0
		12	93.9	2.7	9.0			**CLAYEY SAND (SC)** -light brown to brown, moist, medium dense, fine grained
5		14						**POORLY GRADED SAND WITH SILT (SP-SM)** - light brown, moist, medium dense, fine to medium grained.
10		15						
15		21						**SILTY SAND (SM)** - light brown, moist, medium dense, fine grained
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B - 8

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
			94.9	4.2	15.0			
		20						
25								
		20						
30			97.3	3.6	14.0			
		28						
35								
		29						
								POORLY GRADED SAND (SP) - light brown, moist, medium dense, fine to medium grained.
40			100.9	1.9	8.0			
		45						

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 8
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
45		20						**SILT (MH)** - light brown, moist, medium dense, trace of fine grained sand.
50		28						**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine to medium grained.
55								Notes: 1.) Bottom of boring at 51.5 feet. 2.) No free groundwater encountered. 3.) Boring backfilled with soil cuttings 10/2/07.
60								
65								

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PROJECT NO. 86405

LOG OF Boring B - 8
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE 3 of 3

A8

Date Completed: 10/2/07

Logged By: C. Davis

Total Depth: 101.0 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2115.0
		14	102.0	2.5	11.0			**SILTY SAND (SM)** - light tan, moist, medium dense, fine grained.
5		36	105.6	3.2	15.0			**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine to medium grained
10		40						
15		23	114.5	2.0	12.0			**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained, some fine grained gravel.
20								**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine grained.

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PROJECT NO. 86405.GEO2

LOG OF Boring B - 9

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		12						
								SILTY SAND (SM) - light brown, moist, medium dense, fine to medium grained.
25		10						
								POORLY GRADED SAND (SP) - light brown, moist, medium dense, fine grained.
30		14	94.9	4.1	15			
35		33						
40		14						

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B - 9

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
45		26						
50		23	94.5	16.6	59			**SILTY SAND (SM)** - light brown, moist, medium dense, fine grained.
55								
60		24						**SANDY SILT (ML)** - light brown, moist, medium dense, fine grained sand.
65								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B - 9

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
70		24						
75								
								POORLY GRADED SAND (SP) - light brown, moist, medium dense, fine to medium grained
80		31						
85								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B - 9
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
90								
		50/5						
95								
100								
		50/4						
								Notes: **1.) Bottom of boring at 100 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/2/07.**
105								
110								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B - 9

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/5/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2100.0
								SILTY SAND (SM) - light brown, moist, medium dense, fine grained.
		10	99.0	1.6	6.0			
5		13						
10		10						
15		11						... fine to medium grained.
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B-10

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A10

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		17						
25		21						
30		28						
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/5/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-10
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/3/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2160.0
		6	92.7	5.2	18.0			**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
5		11						
10		31	96.3	4.3	16.0			
15		10						
20								**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine to medium grained.

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PROJECT NO. 86405.GEO2

LOG OF Boring B-11

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		26						
25		12						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
30		11						
35								**Notes:** **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/3/07.**
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-11
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/4/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 0.0
								SILTY SAND (SM) - light brown, moist, medium dense, fine to medium grained.
		9						
5		12						
10		15						
								POORLY GRADED SAND (SP) - light brown, moist, medium dense, fine to medium grained.
15		19						
								SILTY SAND (SM) - light brown, moist, medium dense, fine to medium grained.
20								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-12

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		14						
25		15						
30		21						
35								
40								

Notes:
1.) Bottom of boring at 31.5 feet.
2.) No free groundwater encountered.
3.) Boring backfilled with soil cuttings 10/4/07.

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-12
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE 2 of 2

A12

Date Completed: 10/5/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 0.0
		10						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to coarse grained.
5		16						
10		18						
15		7						
20								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-13

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A13

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		16						
25		11						
30		28						**POORLY GRADED SAND (SP)** - light bron, moist, medium dense, fine to medium grained.
35								**Notes:** **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/5/07.**
40								

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PROJECT NO. 86405

LOG OF Boring B-13

FPL ENERGY 250MW PROPOSED SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 2 of 2

A13

Date Completed: 10/3/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2177.0
		16	107.0	3.1	15.0			**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained, trace of fine grained gravel.
5		22						
10		13						
15		15						
20								

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PROJECT NO. 86405.GEO2

LOG OF Boring B-14

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A14

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		12						
25		11						
30		37						... Fine to coarse grained, trace of fine grained gravel.
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/3/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-14
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/3/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2165.0
								SILTY SAND (SM) - light brown, moist, medium dense, fine to medium grained.
		13						
5		14						
10		32	101.9	3.0	13.0			
15		18						
20								

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PROJECT NO. 86405.GEO2

LOG OF Boring B-15

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		28						
25		37						
30		55						**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine to coarse grained.
35								**Notes:** **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/3/07.**
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-15
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/5/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2130.0
								SILTY SAND (SM) - light brown, moist, medium dense, fine grained.
		18						
5			95.4	10.4	38.0			
		23						
10								
		33						
								POORLY GRADED SAND (SP) - red brown, moist, medium dense, fine to coarse grained, trace of fine grained gravel.
15								
		34						
								SILTY SAND (SM) - brown, moist, medium dense, fine to coarse grained.
20								

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PROJECT NO. 86405.GEO2

LOG OF Boring B-16

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		26						
25		28						
30		57						
35								
40								

Notes:
1.) Bottom of boring at 31.5 feet.
2.) No free groundwater encountered.
3.) Boring backfilled with soil cuttings 10/5/07.

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PROJECT NO. 86405

LOG OF Boring B-16
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/3/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2189.0
		32	105.3	2.0	9.0			**SILTY SAND (SM)** - reddish brown, moist, medium dense, fine to medium grained.
5		19						
								POORLY GRADED SAND (SP) - light brown, moist, medium dense, fine to coarse grained.
10		22	113.5	3.8	22.0			
15		21						
20								**SILTY SAND (SM)** - red brown, moist, medium dense, fine to coarse grained.

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PROJECT NO. 86405.GEO2

LOG OF Boring B-17

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

PLATE 1 of 2

A17

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		19						
25		39						**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine to coarse grained.
30		42						
								Notes: **1.) Bottom of boring at 31.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/3/07.**
35								
40								

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-17
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/5/07

Logged By: C. Davis

Total Depth: 31.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2167.0
		24						**SANDY SILT (MH)** - light brown, moist, medium dense, fine grained sand.
5		24						
10		24						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to medium grained.
15		28	108.6	2.1	11.0			
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B-18

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		22						
25		22						
30		36						
35								
40								

Notes:
1.) Bottom of boring at 31.5 feet.
2.) No free groundwater encountered.
3.) Boring backfilled with soil cuttings 10/5/07.

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-18
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/3/07

Logged By: C. Davis

Total Depth: 51.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2170.0
								POORLY GRADED SAND WITH SILT (SP-SM) - light brown, moist, medium dense, fine to coarse grained.
		14	104.3	3.3	15.0			
5		15						
10		36						
15		23						
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B-19

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		9						
25		21						
								SANDY SILT (ML) - brown, moist, medium dense, fine grained sand.
30		6						
								SILTY SAND (SM) - light brown, moist, medium dense, fine to coarse grained.
35		19						
40		20						

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B-19
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
45		17						**SILT (ML)** - light brown, moist, medium dense, trace of fine grained sand.
50		12						
55								**Notes:** **1.) Bottom of boring at 51.5 feet.** **2.) No free groundwater encountered.** **3.) Boring backfilled with soil cuttings 10/3/07.**
60								
65								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B-19
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Date Completed: 10/3/07

Logged By: C. Davis

Total Depth: 51.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: CME 55 Auger Type: 6" H.S.

Groundwater: No free groundwater encountered.

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet): 2280.0
		19	105.8	2.7	13.0			**SILTY SAND (SM)** - light brown, moist, medium dense, fine to coarse grained.
5		41						
10		51						**POORLY GRADED SAND (SP)** - light brown, moist, medium dense, fine to medium grained, trace of silt.
15		54						**SILTY SAND (SM)** - light brown, moist, medium dense, fine to coarse grained.
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Boring B-20

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD Sample	FIELD Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
		50/5"						
25		53						... some fine grained gravel.
30		55						
35		48						
40		70						

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-20
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

Depth, ft	FIELD: Sample	FIELD: Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								(Continued from previous plate)
45		78/10"						
50		99/10"						
55								
60								
65								

Notes:
1.) **Bottom of boring at 51.5 feet.**
2.) **No free groundwater encountered.**
3.) **Boring backfilled with soil cuttings 10/3/07.**

KLEINFELDER

PROJECT NO. 86405

LOG OF Boring B-20
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE 3 of 3

A20

Date Completed: 12/10/07

Logged By: J. Montes

Total Depth: 4.5 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: Backhoe Auger Type: NA

Groundwater:

Depth, ft	FIELD: Sample	FIELD: Blows/ ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet):
								SILTY SAND (SM) - brown, silty sand, fine to coarse with rootlets, friable at 1 to 1.5 ft ... fine to medium grained, with interbedded layers of sand, some gravel
5								**Notes:** **1.) Bottom of test pit at 4.5 feet.** **2.) No free groundwater encountered.** **3.) Test pit backfilled by others.**
10								
15								
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Test Pit TP-1

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Date Completed: 12/10/07

Logged By: J. Montes

Total Depth: 4.0 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: Backhoe Auger Type: NA

Groundwater:

Depth, ft	FIELD Sample	FIELD Blows/ ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Approx. Saturation %	LABORATORY Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet):
								SILTY SAND (SM) - brown, moist, fine to coarse grained, with some gravel, friable silty sand, some rootlets ... interbedded layers of thin silt to 3.75 feet
5								**Notes:** **1.) Bottom of test pit at 4.0 feet.** **2.) No free groundwater encountered.** **3.) Test pit backfilled by others.**
10								
15								
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

LOG OF Test Pit TP-2

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

Date Completed: 12/10/07

Logged By: J. Montes

Total Depth: 5.0 feet

Surface Conditions: Open Desert, Scattered Rock, Sparse Vegetation

Rig Type: Backhoe Auger Type: NA

Groundwater:

Depth, ft	FIELD: Sample	FIELD: Blows/ ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Approx. Saturation %	LABORATORY: Other Tests	Pen, tsf	DESCRIPTION
								Approximate Surface Elevation (feet):
								SILTY SAND (SM) - brown, fine to medium grained, with rootlets and roots
								SANDY SILT (ML) - brown, fine to medium grained
								SILTY SAND (SM) - brown, fine to medium grained, some friable thin layers
5								
								Notes: **1.) Bottom of test pit at 5.0 feet.** **2.) No free groundwater encountered.** **3.) Test pit backfilled by others.**
10								
15								
20								

KLEINFELDER

PROJECT NO. 86405.GEO2

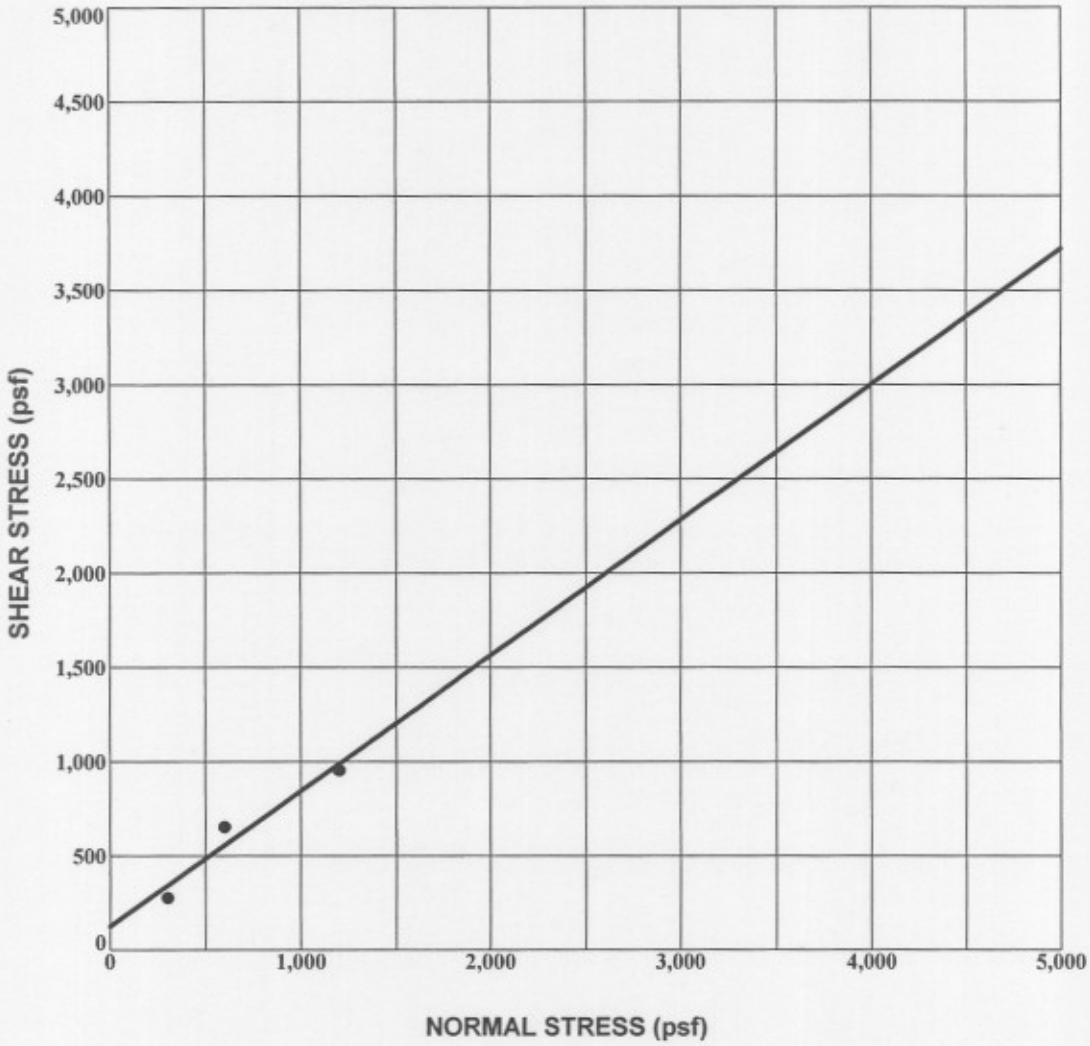
LOG OF Test Pit TP-3

FPL ENERGY PROPOSED 250MW SOLAR PLANT

CALIFORNIA HIGHWAY 14

CALIFORNIA CITY, CALIFORNIA

DIRECT SHEAR



Source:	**B - 1** (Relatively Undisturbed)	**Friction Angle =**	**36 deg**
Depth:	**2.0 ft**	**Cohesion =**	**124 psf**
Test Type:	**Consolidated - Drained**		
Soil Description:	**SANDY SILT (ML)**		

Dry Density (pcf)	101.4	101.4	101.4
Initial Water Content (%)	3.6	3.6	3.6
Final Water Content (%)	23.5	24.0	24.6
Normal Stress (psf)	300	600	1200
Shear Stress(psf)	275	653	954

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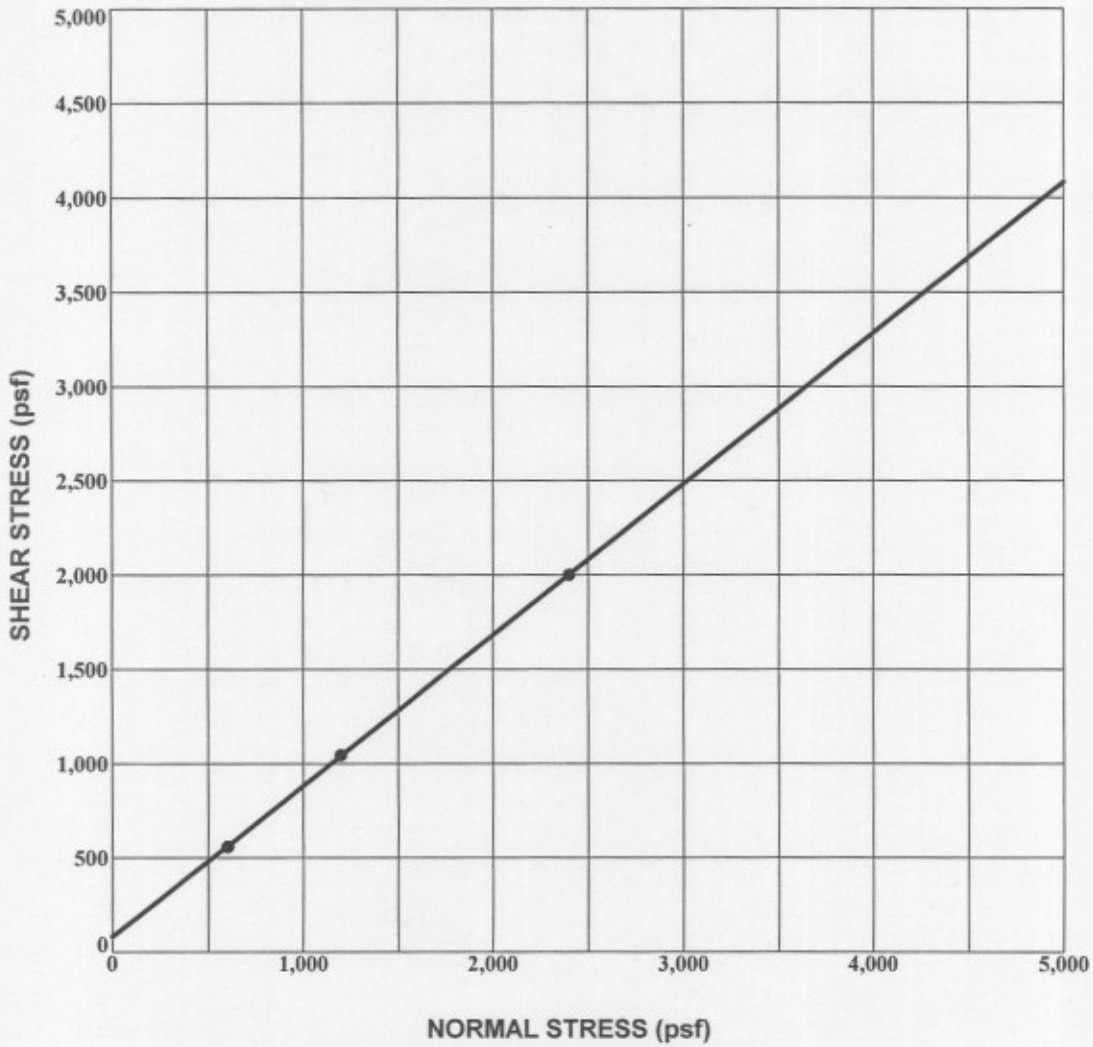
DIRECT SHEAR TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-1

DIRECT SHEAR



Source:	B - 3 (Relatively Undisturbed)	Friction Angle =	39 deg
Depth:	10.0 ft	Cohesion =	80 psf
Test Type:	Consolidated - Drained		
Soil Description:	SILTY SAND (SM)		

Dry Density (pcf)	98.6	98.6	98.6
Initial Water Content (%)	8.5	8.5	8.5
Final Water Content (%)	24.7	24.0	24.5
Normal Stress (psf)	600	1200	2400
Shear Stress(psf)	558	1045	2000

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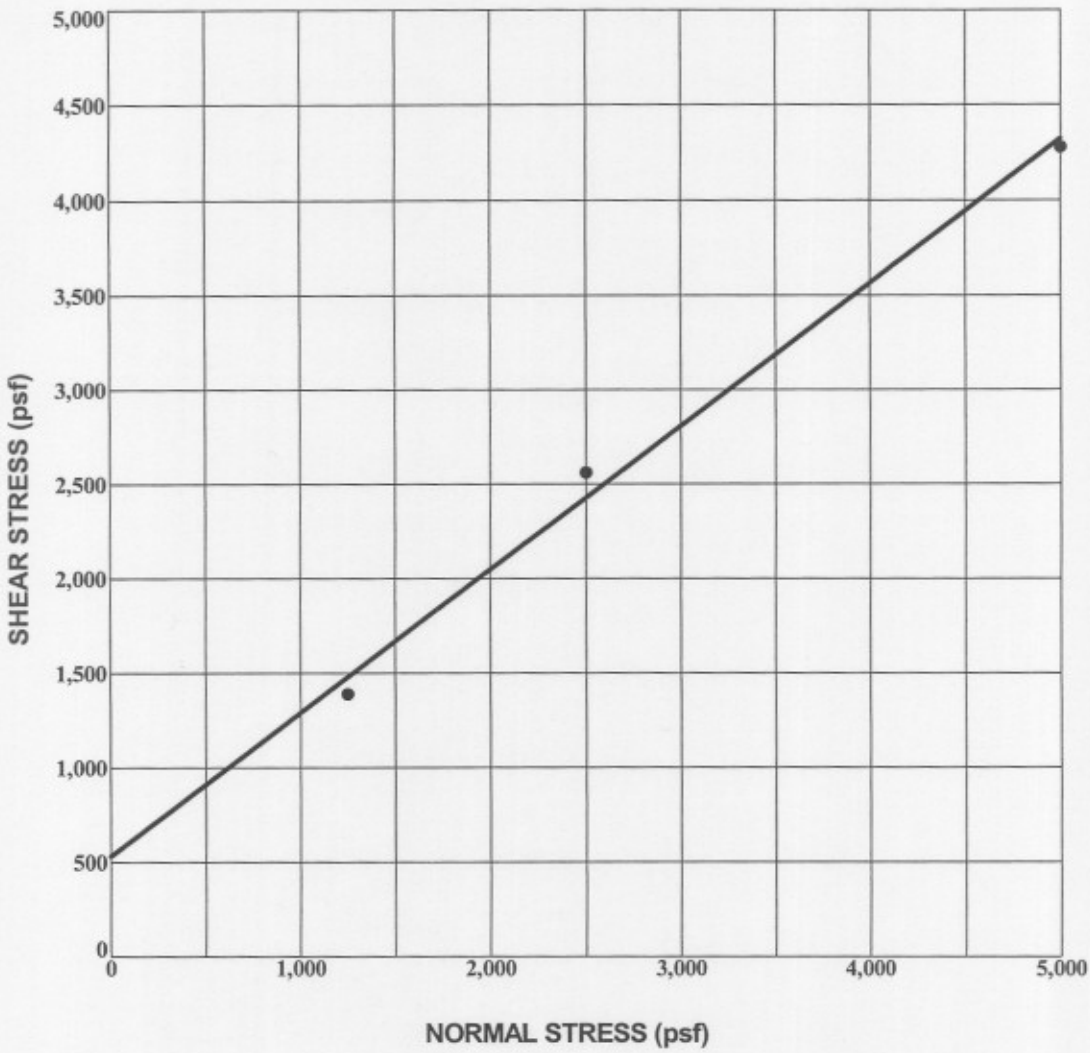
PROJECT NO. 86405.GEO2

DIRECT SHEAR TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE
B-2

DIRECT SHEAR



Source:	**B - 5** (Relatively Undisturbed)	**Friction Angle =**	**37 deg**
Depth:	**20.0 ft**	**Cohesion =**	**530 psf**
Test Type:	**Consolidated - Drained**		
Soil Description:	**SILTY SAND (SM)**		

Dry Density (pcf)	**97.3**	**97.3**	**97.3**
Initial Water Content (%)	**4.4**	**4.4**	**4.4**
Final Water Content (%)	**23.7**	**22.0**	**18.9**
Normal Stress (psf)	**1250**	**2500**	**5000**
Shear Stress(psf)	**1388**	**2558**	**4276**

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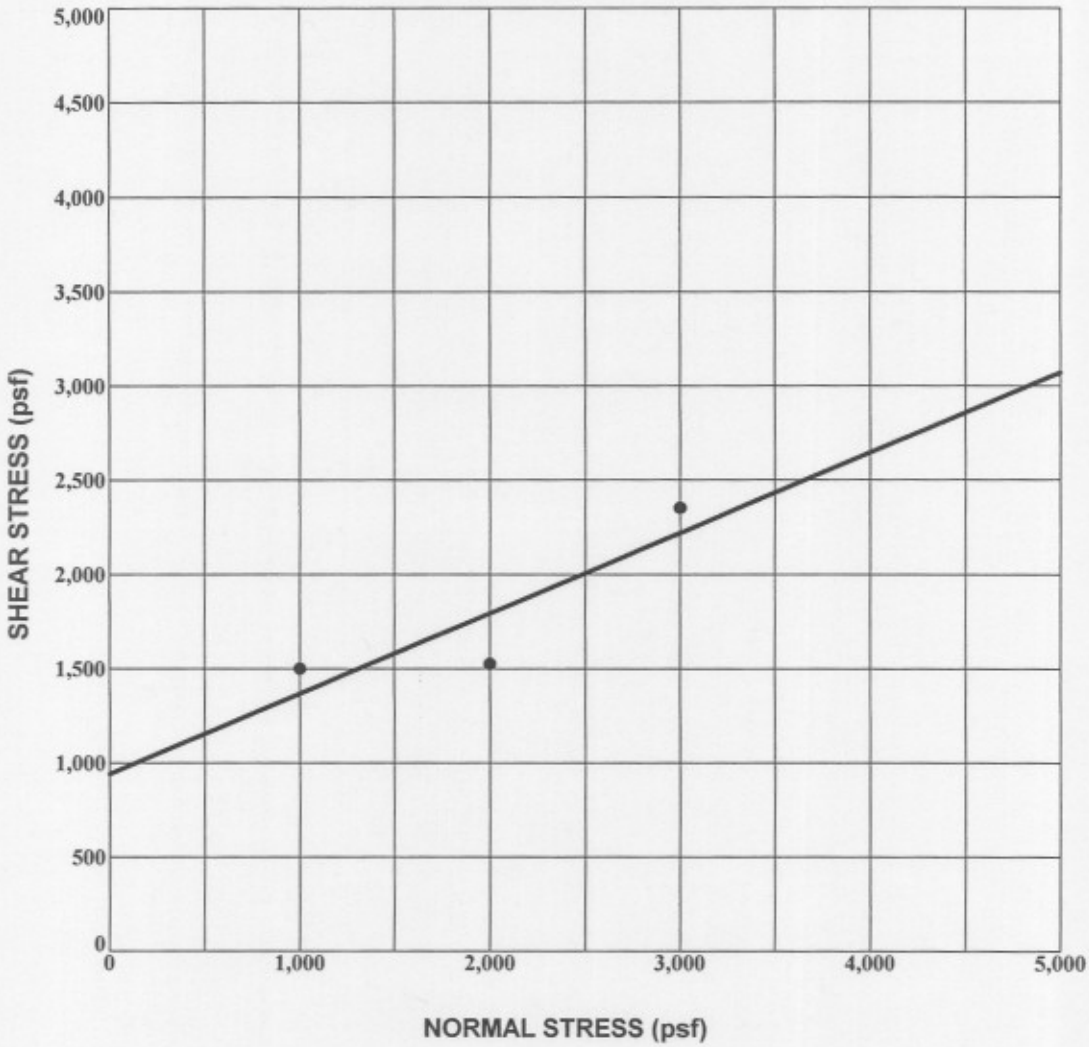
DIRECT SHEAR TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-3

DIRECT SHEAR



Source:	B - 8 (Relatively Undisturbed)	Friction Angle =	23 deg
Depth:	2.0 ft	Cohesion =	940 psf
Test Type:	Consolidated - Drained		
Soil Description:	CLAYEY SAND (SC)		

Dry Density (pcf)	93.9	93.9	93.9
Initial Water Content (%)	2.7	2.7	2.7
Final Water Content (%)	30.7	29.7	29.7
Normal Stress (psf)	1000	2000	3000
Shear Stress(psf)	1500	1526	2352

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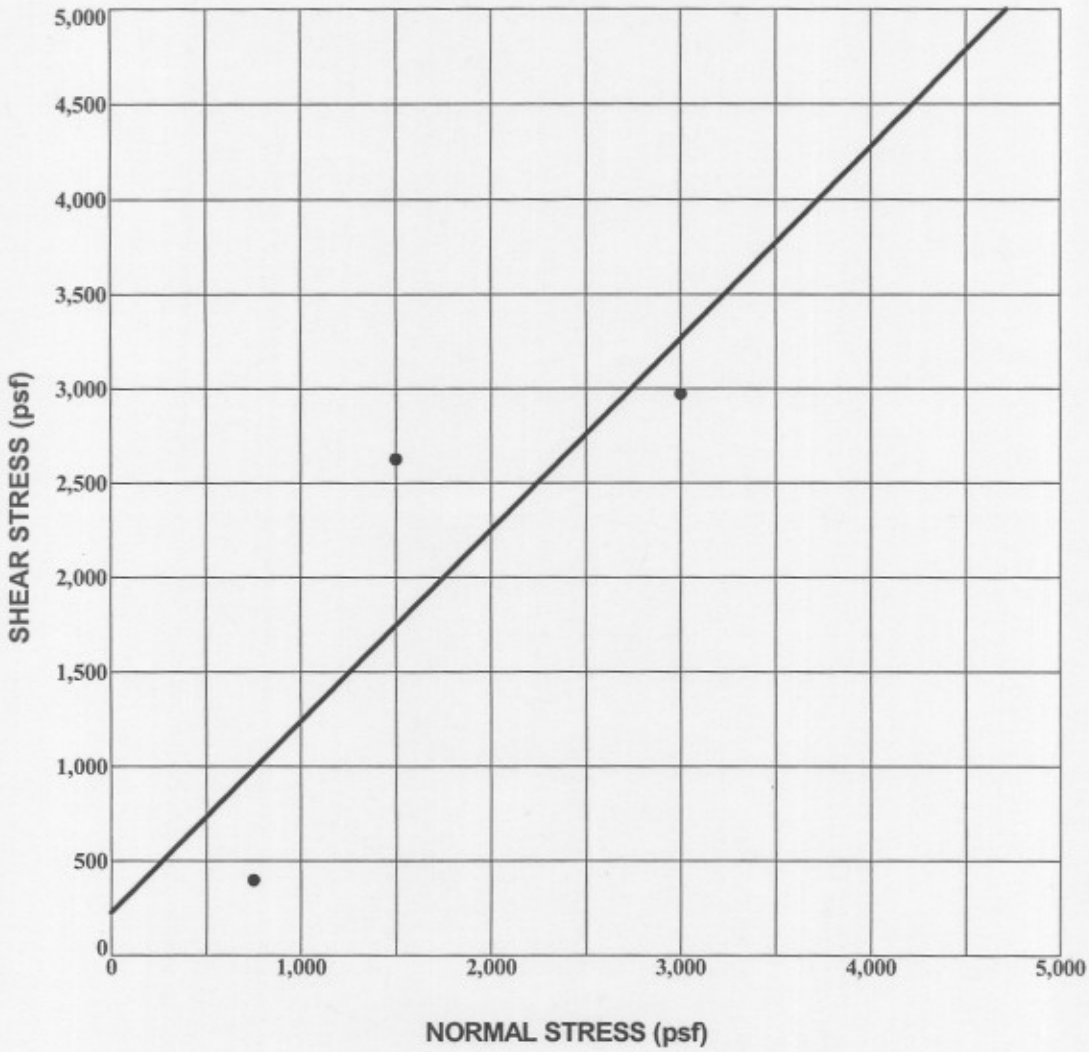
DIRECT SHEAR TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE
B-4

DIRECT SHEAR



Source:	**B-17** (Relatively Undisturbed)	**Friction Angle =**	**45 deg**
Depth:	**10.0 ft**	**Cohesion =**	**220 psf**
Test Type:	**Consolidated - Drained**		
Soil Description:	**SAND (SP)**		

Dry Density (pcf)	**113.7**	**113.5**	**113.5**
Initial Water Content (%)	**3.8**	**3.8**	**3.8**
Final Water Content (%)	**17.0**	**17.2**	**16.9**
Normal Stress (psf)	**750**	**1500**	**3000**
Shear Stress(psf)	**396**	**2626**	**2970**

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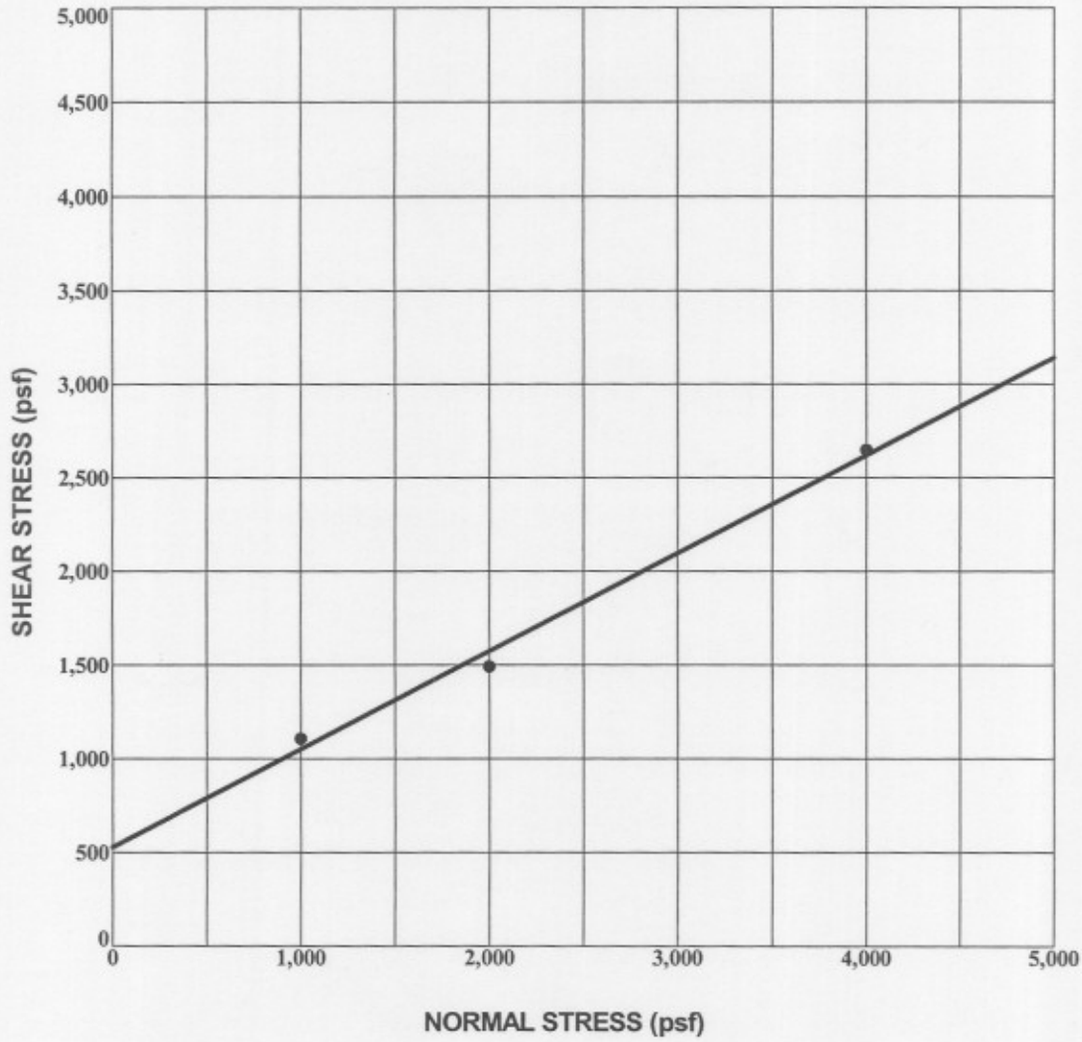
DIRECT SHEAR TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-5

DIRECT SHEAR



Source:	**B-20** (Relatively Undisturbed)	**Friction Angle =**	**28 deg**
Depth:	**2.0 ft**	**Cohesion =**	**530 psf**
Test Type:	**Consolidated - Drained**		
Soil Description:	**SILTY SAND (SM)**		

Dry Density (pcf)	**105.8**	**105.8**	**105.8**
Initial Water Content (%)	**2.7**	**2.7**	**2.7**
Final Water Content (%)	**22.8**	**22.8**	**22.8**
Normal Stress (psf)	**1000**	**2000**	**4000**
Shear Stress(psf)	**1106**	**1491**	**2646**

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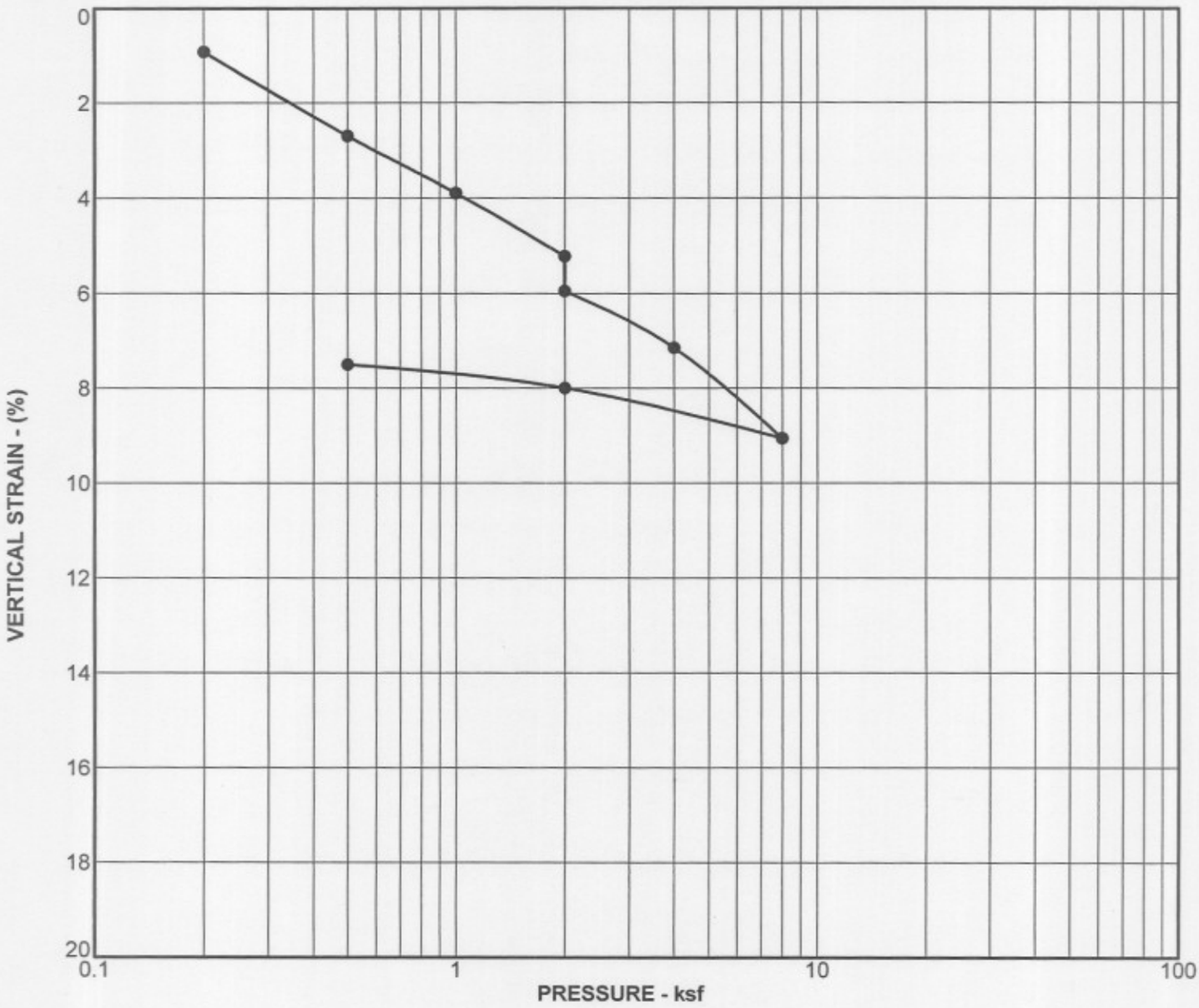
DIRECT SHEAR TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-6



Sample (Relatively Undisturbed)	B - 8
Depth	2.0 ft
Description	CLAYEY SAND
Classification	SC

	Initial	Final
Dry density, pcf	93.9	100.5
Water content, %	2.7	24.2
Sample height, in.	1	0.9325

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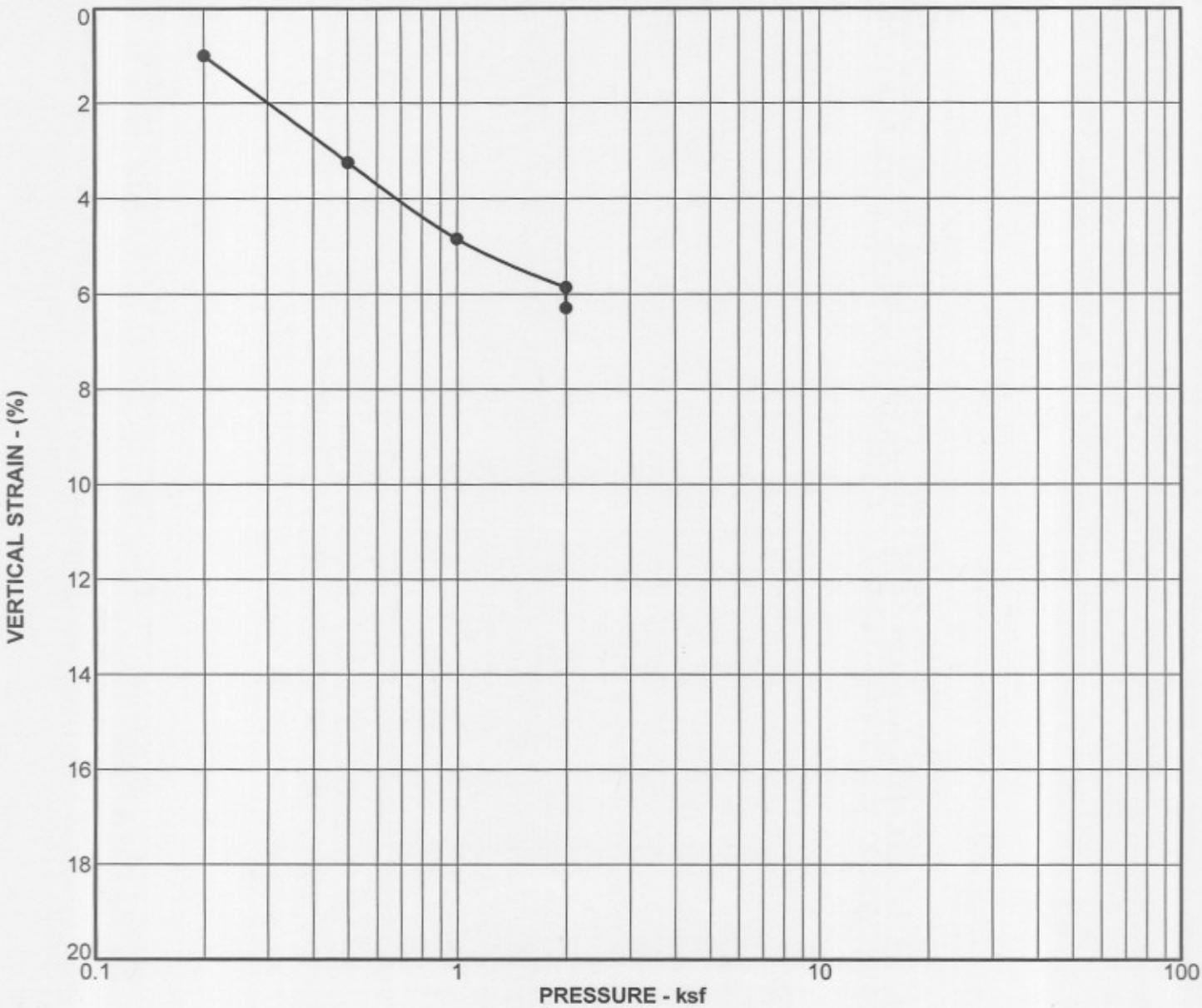
CONSOLIDATION TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-7



Sample (Relatively Undisturbed)	B - 9
Depth	5.0 ft
Description	SAND
Classification	SP

	Initial	Final
Dry density, pcf	94.5	100.6
Water content, %	2.5	23.7
Sample height, in.	1	0.9385

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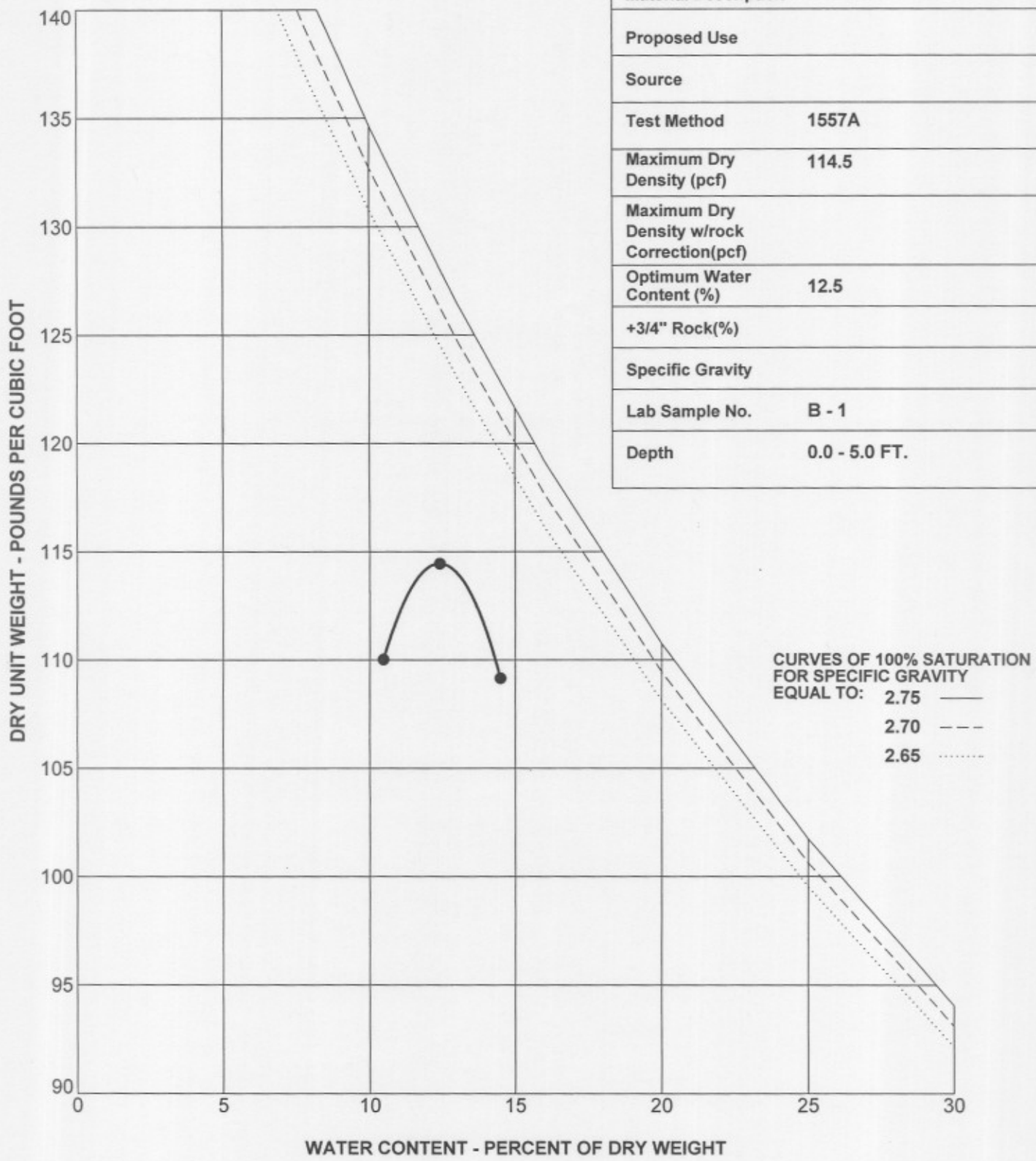
COLLAPSE TEST
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-8

SUMMARY OF TEST RESULTS	
Material Description	SANDY SILT
Proposed Use	
Source	
Test Method	1557A
Maximum Dry Density (pcf)	114.5
Maximum Dry Density w/rock Correction(pcf)	
Optimum Water Content (%)	12.5
+3/4" Rock(%)	
Specific Gravity	
Lab Sample No.	B - 1
Depth	0.0 - 5.0 FT.



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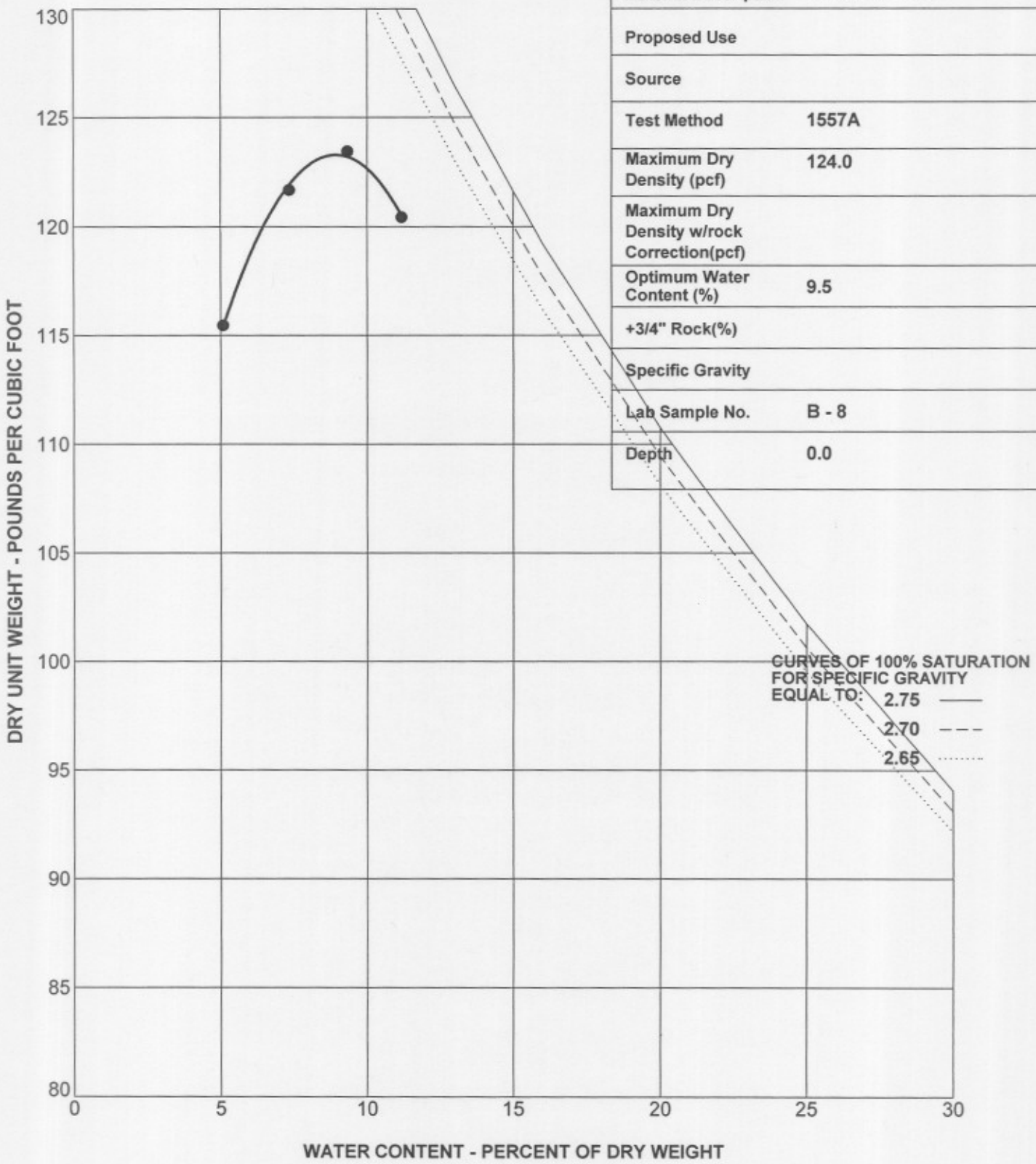
PROJECT NO. 86405.GEO2

MOISTURE DENSITY RELATIONSHIP
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-9



SUMMARY OF TEST RESULTS	
Material Description	CLAYEY SAND
Proposed Use	
Source	
Test Method	1557A
Maximum Dry Density (pcf)	124.0
Maximum Dry Density w/rock Correction(pcf)	
Optimum Water Content (%)	9.5
+3/4" Rock(%)	
Specific Gravity	
Lab Sample No.	B - 8
Depth	0.0

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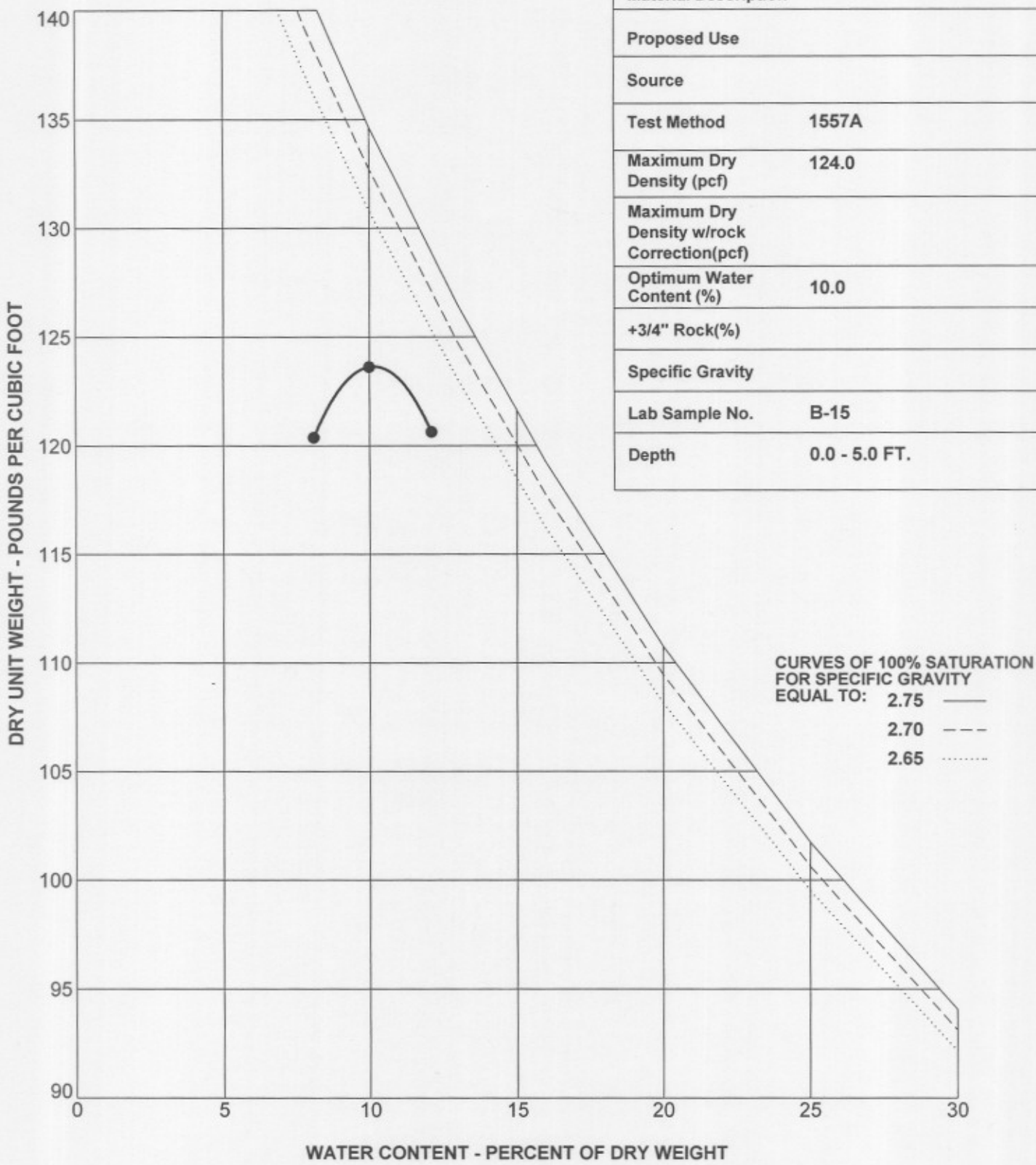
MOISTURE DENSITY RELATIONSHIP
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-10

SUMMARY OF TEST RESULTS	
Material Description	SILTY SAND
Proposed Use	
Source	
Test Method	1557A
Maximum Dry Density (pcf)	124.0
Maximum Dry Density w/rock Correction(pcf)	
Optimum Water Content (%)	10.0
+3/4" Rock(%)	
Specific Gravity	
Lab Sample No.	B-15
Depth	0.0 - 5.0 FT.



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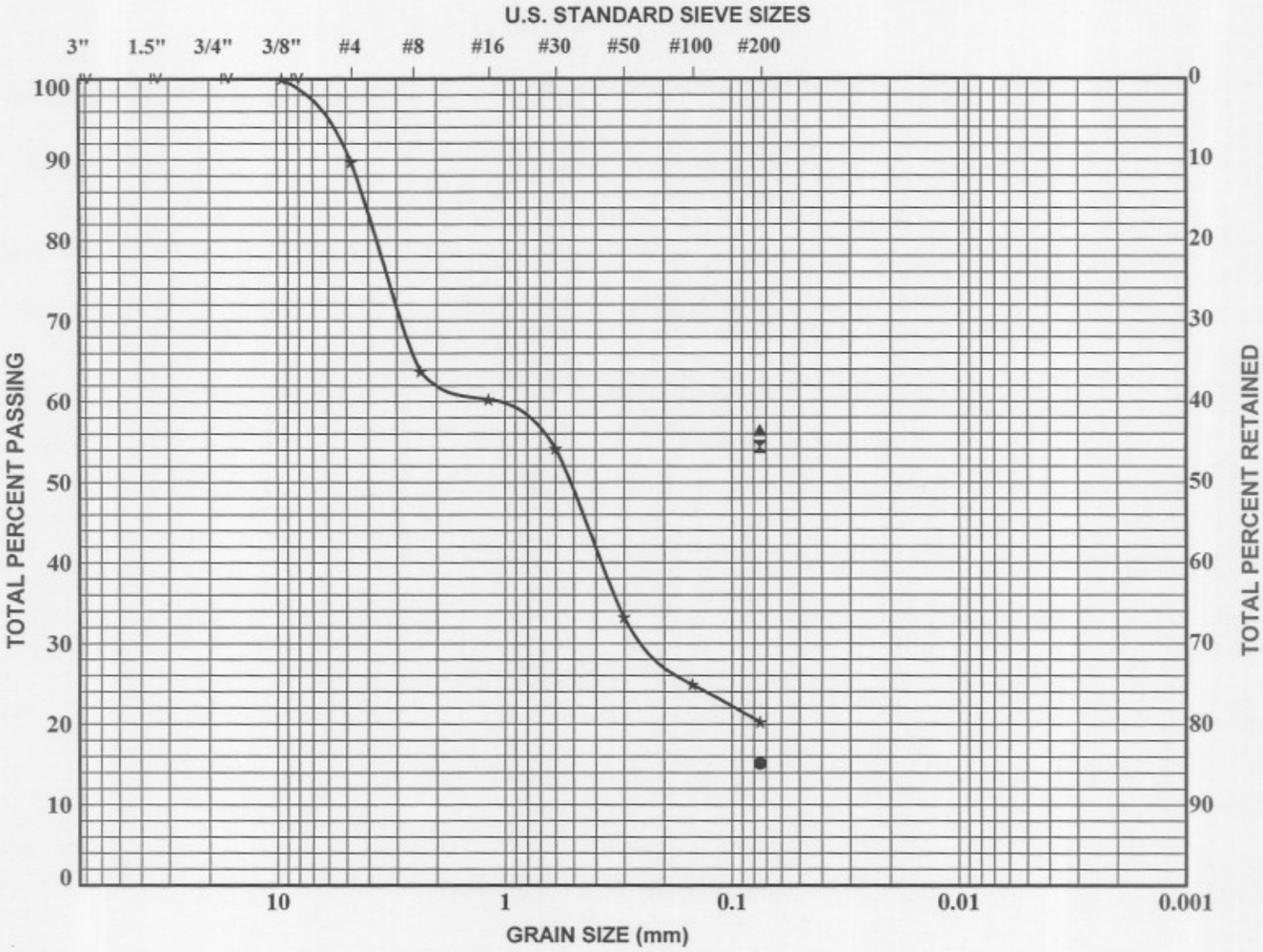
PROJECT NO. 86405.GEO2

MOISTURE DENSITY RELATIONSHIP
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-11

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Sample	Depth (ft)	Description	Classification
●	B - 1	15.0	Silty Sand	SM
⊠	B - 2	5.0	Sandy Silt	ML
▲	B - 3	30.0	Sandy Silt	ML
★	B - 5	10.0	Silty Sand	SM

KLEINFELDER

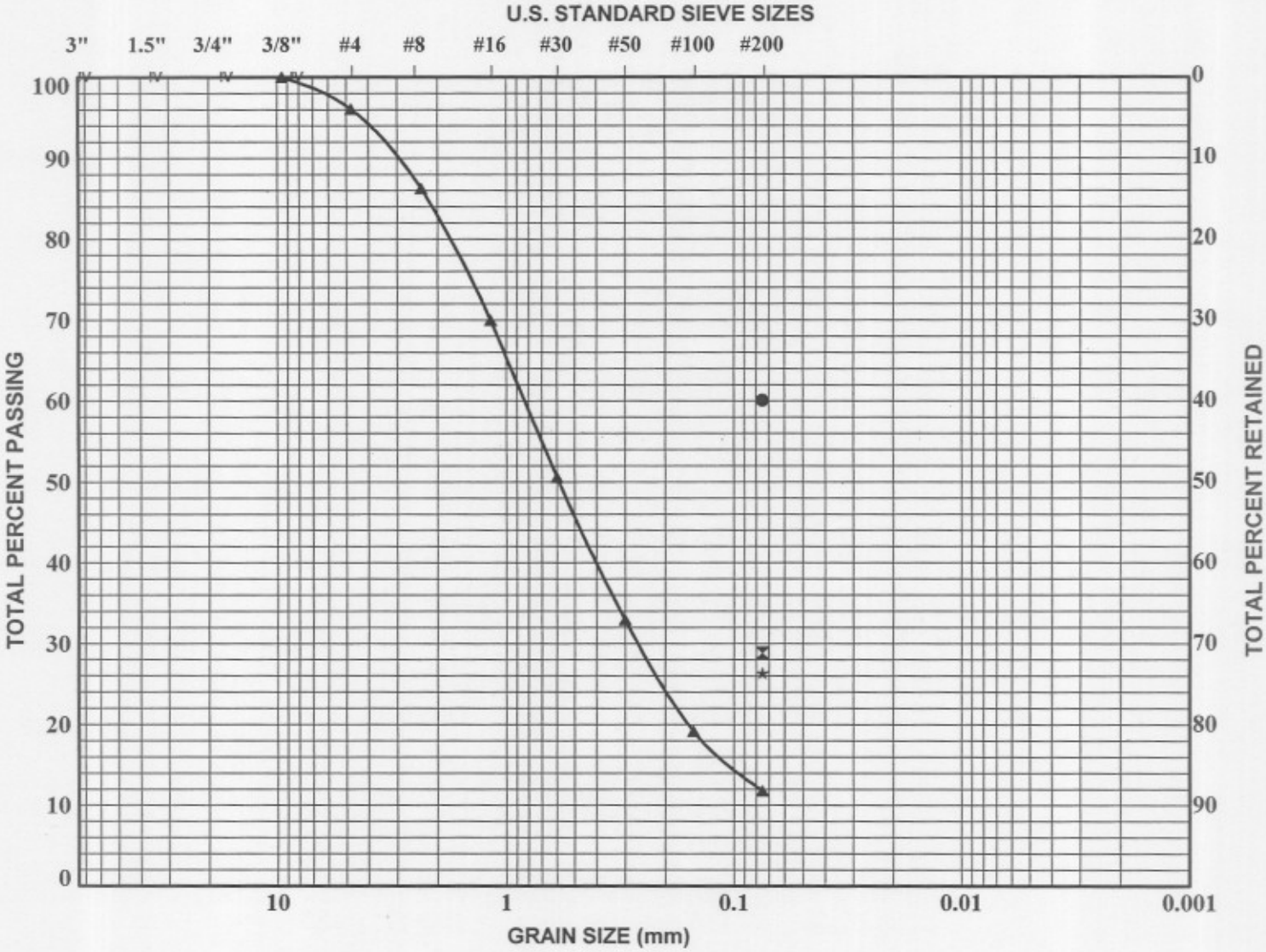
PROJECT NO. 86405.GEO2

GRAIN SIZE DISTRIBUTION
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-12

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Sample	Depth (ft)	Description	Classification
●	B - 6	5.0	Sandy Silt	ML
⊠	B - 7	2.0	Silty Sand	SM
▲	B - 8	5.0	Silty Sand	SM
★	B - 8	30.0	Silty Sand	SM

KLEINFELDER

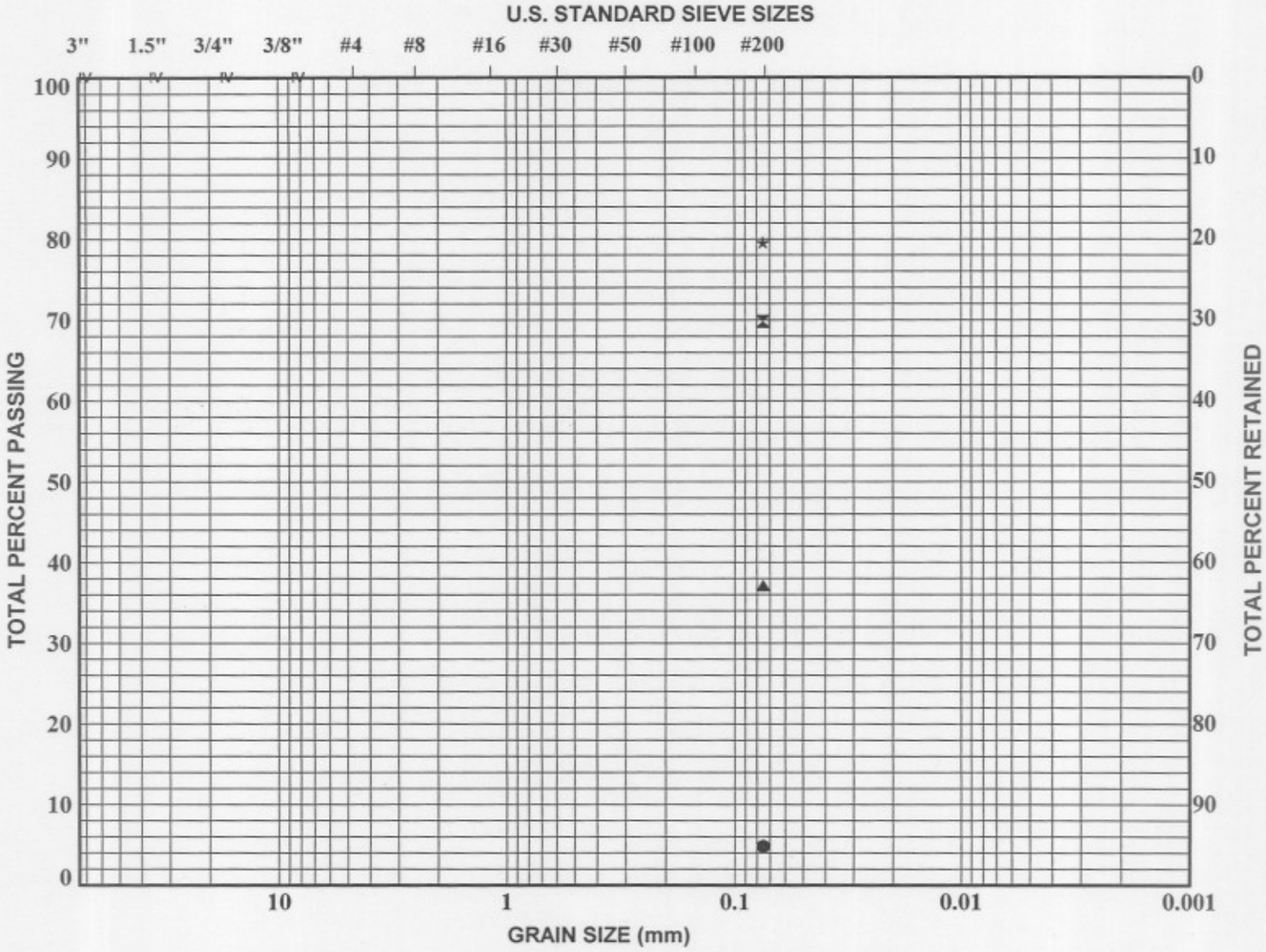
PROJECT NO. 86405.GEO2

GRAIN SIZE DISTRIBUTION
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-13

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Sample	Depth (ft)	Description	Classification
●	B - 8	40.0	Poorly Graded Sand	SP
⊠	B - 9	31.0	Sandy Silt	ML
▲	B - 9	50.0	Silty Sand	SM
★	B - 9	60.0	Sandy Silt	ML

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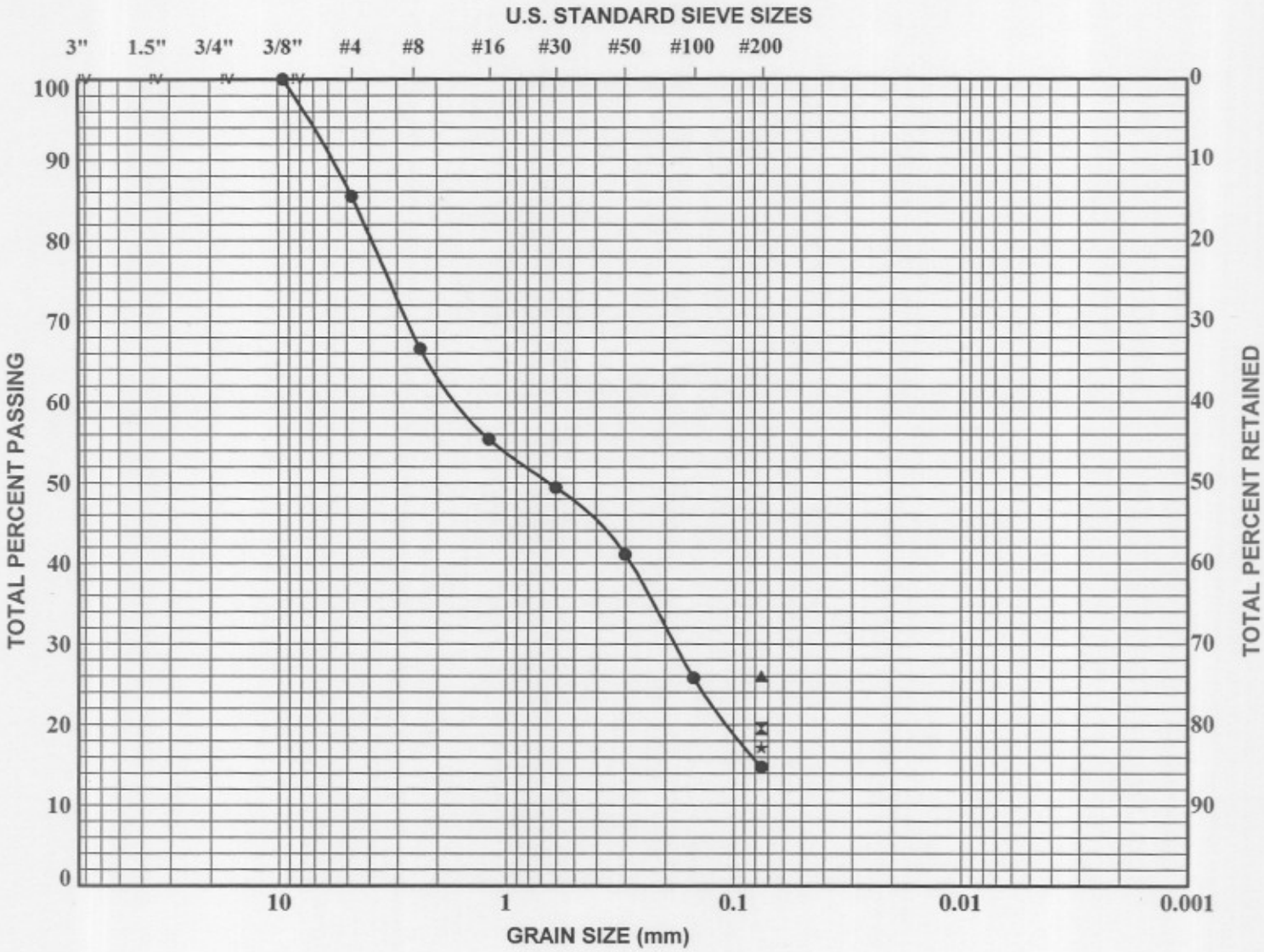
GRAIN SIZE DISTRIBUTION
FPL ENERGY PROPOSED 250MW SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-14

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Sample	Depth (ft)	Description	Classification
●	B-12	5.0	Silty Sand	SM
⊠	B-13	15.0	Silty Sand	SM
▲	B-16	10.0	Silty Sand	SM
★	B-17	5.0	Silty Sand	SM

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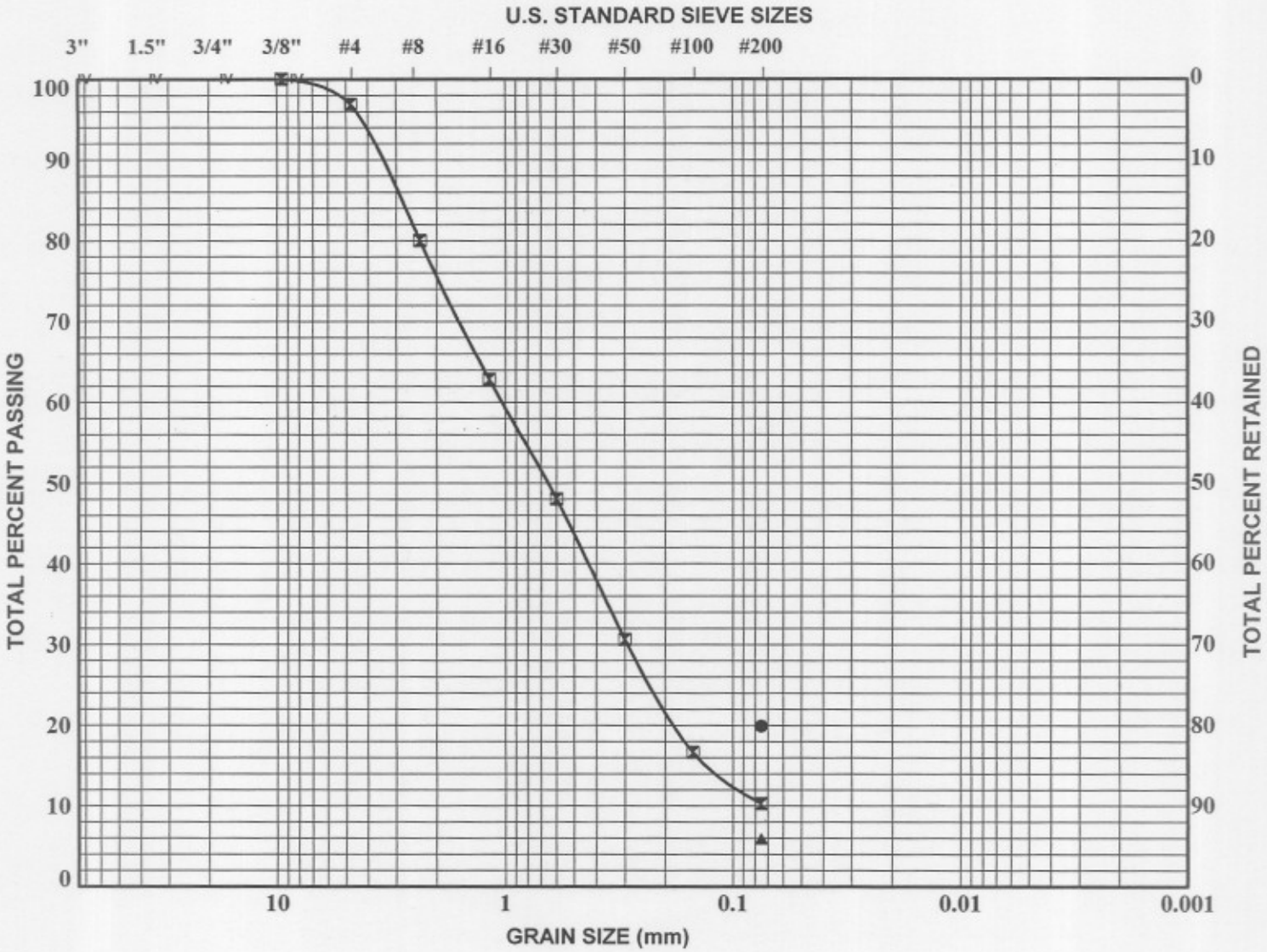
GRAIN SIZE DISTRIBUTION
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE
B-15

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Sample	Depth (ft)	Description	Classification
●	B-18	15.0	Silty Sand	SM
⊠	B-19	10.0	Poorly Graded Sand with Silt	SP-SM
▲	B-20	10.0	Poorly Graded Sand with Silt	SP-SM

KLEINFELDER

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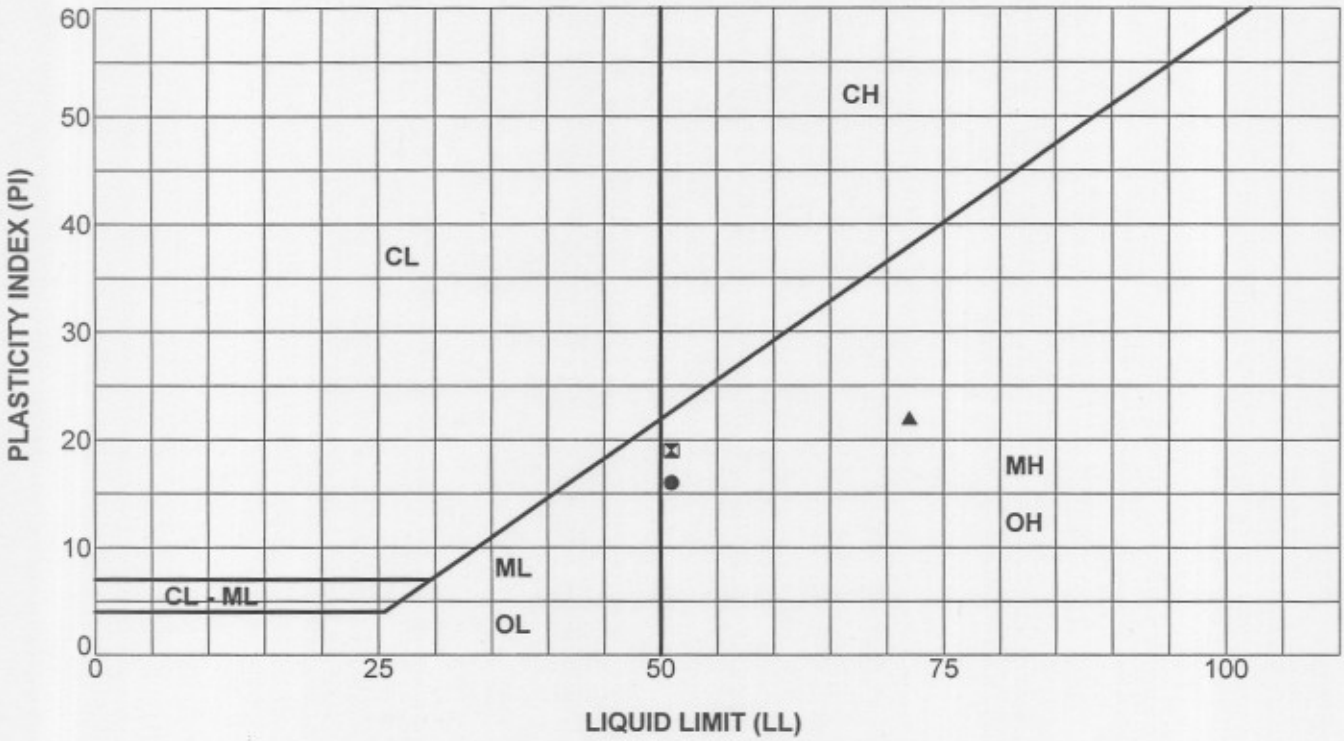
GRAIN SIZE DISTRIBUTION
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE
B-16



	Sample	Depth (ft)	LL (%)	PL (%)	PI (%)	LI (-)	Description
●	B - 1	0.0 - 5.0 FT.	51.0	35.0	16.0		SANDY SILT (MH)
⊠	B - 3	0.0 - 5.0 FT.	51.0	32.0	19.0		SANDY SILT (MH)
▲	B - 6	2.0	72.0	50.0	22.0		SANDY SILT (MH)

LL - Liquid Limit

PL - Plasticity Limit

PI - Plasticity Index

LI - Liquidity Index

Unified Soil Classification
Fine Grained Soil Groups

	LL < 50
ML	Inorganic clayey silts to very fine sands of slight plasticity
CL	Inorganic clays of low to medium plasticity
OL	Organic silts and organic silty clays of low plasticity

	LL > 50
MH	Inorganic silts and clayey silts of high plasticity
CH	Inorganic clays of high plasticity
OH	Organic clays of medium to high plasticity, organic silts

KLEINFELDER

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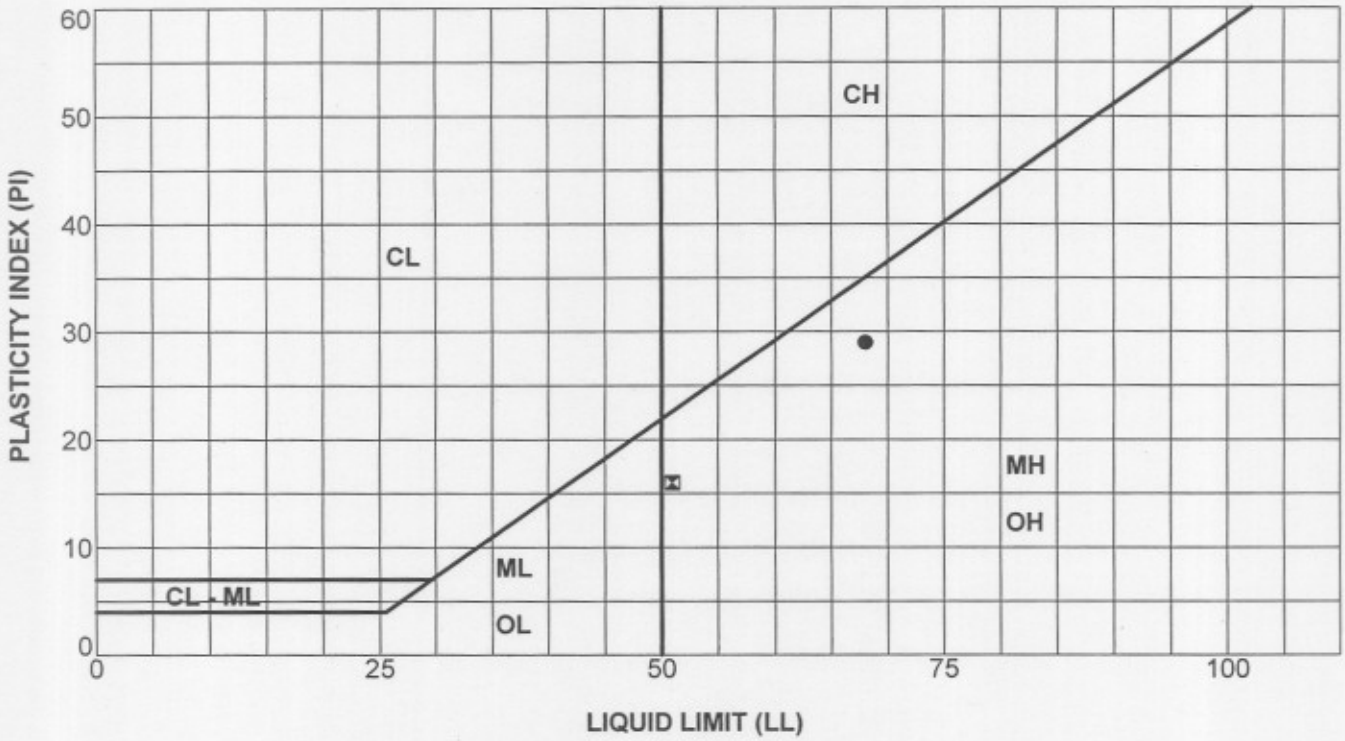
PLASTICITY INDEX
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-17



	Sample	Depth (ft)	LL (%)	PL (%)	PI (%)	LI (-)	Description
●	B - 8	45.0	68.0	39.0	29.0		SANDY SILT (MH)
⊠	B-18	2.0	51.0	35.0	16.0		SANDY SILT (MH)

LL - Liquid Limit

PL - Plasticity Limit

PI - Plasticity Index

LI - Liquidity Index

Unified Soil Classification
Fine Grained Soil Groups

	LL < 50
ML	Inorganic clayey silts to very fine sands of slight plasticity
CL	Inorganic clays of low to medium plasticity
OL	Organic silts and organic silty clays of low plasticity

	LL > 50
MH	Inorganic silts and clayey silts of high plasticity
CH	Inorganic clays of high plasticity
OH	Organic clays of medium to high plasticity, organic silts

KLEINFELDER

PROJECT NO. 86405.GEO2

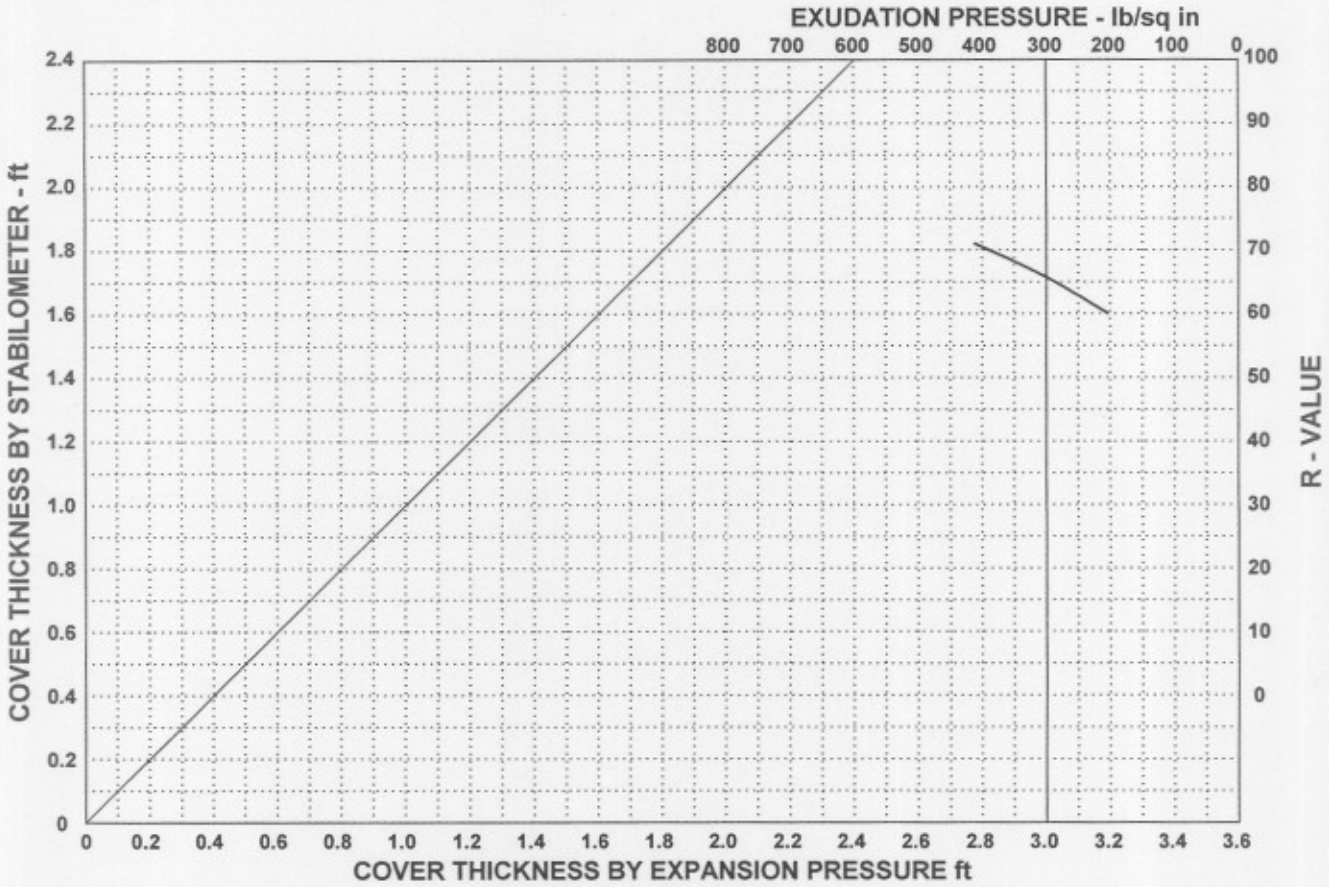
PLASTICITY INDEX
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE

B-18

RESISTANCE VALUE

SAMPLE LOCATION: B-11
SAMPLE DEPTH: 0.0 - 5.0 FT.
SAMPLE DESCRIPTION: SILTY SAND



SPECIMEN	A	B	C
EXUDATION PRESSURE, lb/sq in	203	305	411
EXPANSION DIAL (0.0001")	0	0	0
EXPANSION PRESSURE, lb/sq ft	0	0	0
RESISTANCE VALUE, R	60	66	71
MOISTURE AT TEST, %	12.2	11.3	10.5
DRY DENSITY AT TEST, lb/cu ft	114.1	114.5	124.8
R-VALUE AT 300 lb/sq in EXUDATION PRESSURE		66	
R-VALUE BY EXPANSION PRESSURE(Tl=)			

KLEINFELDER

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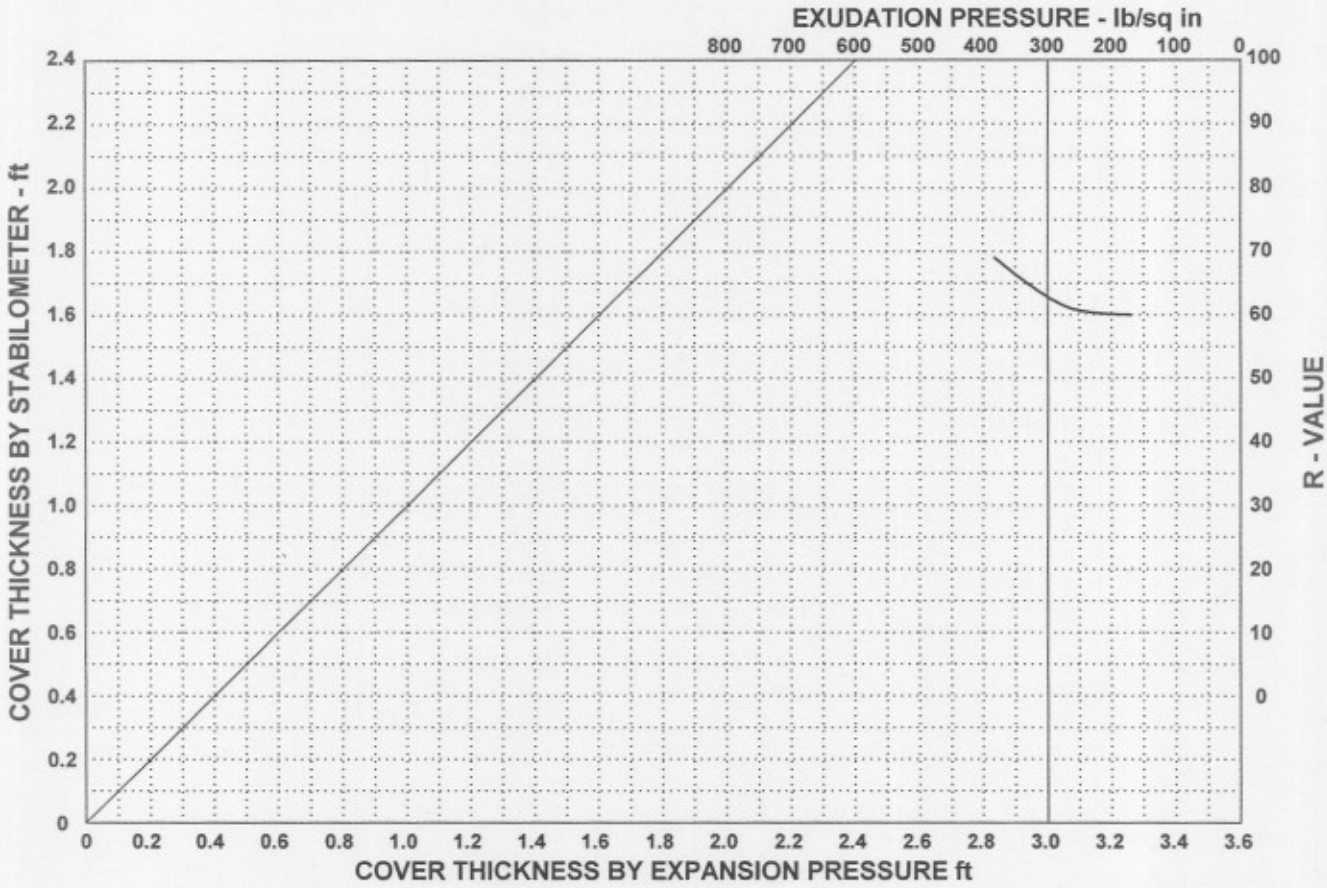
RESISTANCE VALUE
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE
B-19

RESISTANCE VALUE

SAMPLE LOCATION: B-20
SAMPLE DEPTH: 0.0 - 5.0 FT.
SAMPLE DESCRIPTION: SILTY SAND



SPECIMEN	A	B	C
EXUDATION PRESSURE, lb/sq in	170	262	381
EXPANSION DIAL (0.0001")	0	0	0
EXPANSION PRESSURE, lb/sq ft	0	0	0
RESISTANCE VALUE, R	60	61	69
MOISTURE AT TEST, %	10.4	9.5	8.7
DRY DENSITY AT TEST, lb/cu ft	113.9	115.9	124.8
R-VALUE AT 300 lb/sq in EXUDATION PRESSURE		63	
R-VALUE BY EXPANSION PRESSURE(TI=)			

KLEINFELDER

PROJECT NO. 86405.GEO2

RESISTANCE VALUE
FPL ENERGY 250MW PROPOSED SOLAR PLANT
CALIFORNIA HIGHWAY 14
CALIFORNIA CITY, CALIFORNIA

PLATE
B-20