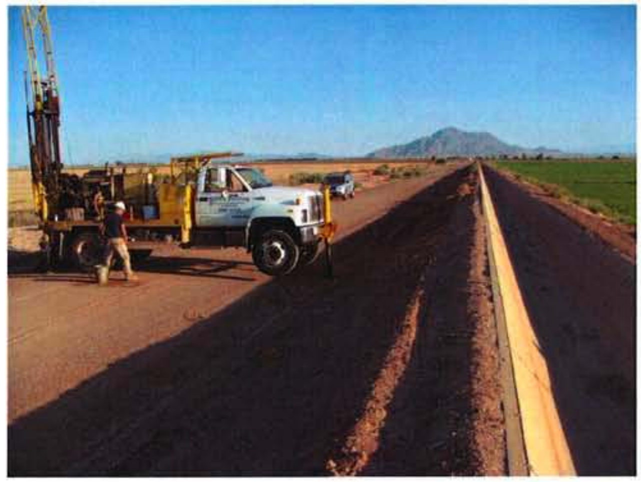
APPENDIX D

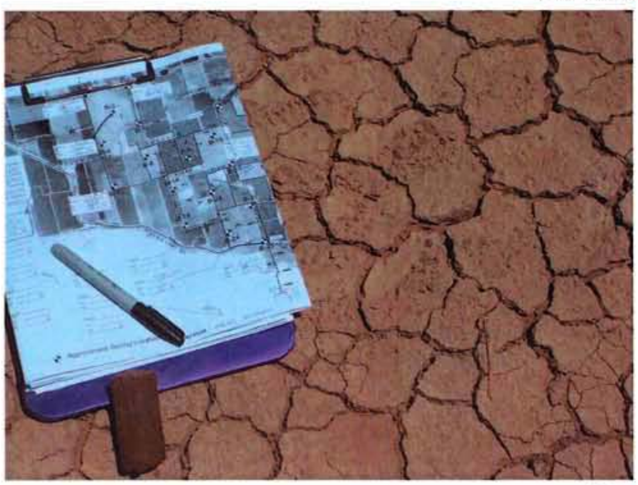
PRELIMINARY GEOTECHNICAL INVESTIGATION



PRELIMINARY GEOTECHNICAL INVESTIGATION:
PROPOSED MOUNT SIGNAL SOLAR FARM AND ASSOCIATED STRUCTURES
WEST OF DREW ROAD AND SOUTH OF INTERSTATE 8
IMPERIAL COUNTY, CALIFORNIA

Presented to:

US SOLAR HOLDINGS, INC.
6111 Severin Drive
La Mesa, CA 91942




Prepared by:

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June, 2011
Project No. TS646.1

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applications

June 16, 2011
Project No. TS646.1

Site: PROPOSED MT. SIGNAL SOLAR FARM
SEELEY, CALIFORNIA

Executive Summary (page 1 of 3)

Based on our preliminary geotechnical study of the site, our review of available reports and literature and our experience, it is our opinion that the proposed solar farm and associated construction is feasible from a geotechnical standpoint. There appear to be no significant geotechnical constraints on-site that cannot be mitigated by proper planning, design, and utilization of sound construction practices.

Our scope of work included the excavation and sampling of twenty-five (25) exploratory borings to a maximum depth of 50 feet below existing grade.

The following key elements are conclusions confirmed from this investigation:

- The study area is part of the low-lying Salton Trough and is uniformly underlain by 1 to 2 feet of crop/road surficial fill which is underlain by firm to stiff lacustrine clays with traces of silts and sands (CL). The clays have a low permeability: 10^{-7} cm/sec.
- The site study area is located approximately 35 feet below mean sea level.
- The depth to groundwater across the site predominantly ranges from 10 to 15 feet.
- Laboratory results indicate that the subgrade earth materials possess an Expansion Index ranging from very low to medium.
- Based on both soils lab and field resistivity surveys by HDR/Schiff, the soils are considered to be severely corrosive toward ferrous metals. We recommend the pier, pipe and cable designs include the corrosion mitigation measures included in Appendix C, herein.

SEISMICITY

The Imperial Fault, which is located about 20 km east of the study area is the governing fault with an average slip rate of 20 mm/yr and a maximum magnitude of 7.0 (ref: 2003 CDMG).

Seismic Values (B-15, site centroid):	
Site Longitude (Decimal Degrees)	-115.716
Site Latitude (Decimal Degrees)	32.7491
Site Class Definition (Table 1613.5.2)	D
Mapped Spectral Response Acceleration at 0.2s Period, S_s	1.445
Mapped Spectral Response Acceleration at 1s Period, S_1	0.566
Short Period Site Coefficient at 0.2 Period, F_a	1.0
Long Period Site Coefficient at 1s Period, F_v	1.5
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS}	1.445
Adjusted Spectral Response Acceleration at 1s Period, S_{M1}	0.849
Design Spectral Response Acceleration at 0.2s Period, S_{DS}	0.964
Design Spectral Response Acceleration at 1s Period, S_{D1}	0.566

SUMMARY OF RECOMMENDATIONS

Underpinning of the solar module arrays is recommended using galvanized steel piles (W6X9 wide flange beams) or helical anchors. The following Geotechnical Parameters may be used in the design of the underpinning:

June 16, 2011
Project No. TS646.1

Site: PROPOSED MT. SIGNAL SOLAR FARM
SEELEY, CALIFORNIA

Executive Summary*, continued *(page 2 of 3)

Design Item	Recommendations
End Bearing Pressure	2,000 psf for lacustrine deposits
Passive Lateral Resistence	300 psf per foot
Coefficient of Friction	0.35
Allowable Skin Friction	500 psf between piles and lacustrine deposits
Uplift Forces	80 percent of the allowable capacity

Coefficients
Active Ka=0.30
Passive Kp=3.60
At Rest Ko=0.50

The anchors/piers shall be driven a minimum depth of 6 feet below grade.

For design purposes the upper 1 foot of soils shall not be considered for skin friction values.

Pile/anchor fixity may be taken at the crop/road fill - competent lacustrine deposit transition at 1 feet b.g..

A representative sample of the piles/anchors should be lateral load- and pull-tested prior to construction. These tests shall be performed by a qualified testing firm using calibrated equipment and an industry-recognized testing procedure. The in situ load test results will provide empirical data for point-specific actual embedment depths.

The wind pressure threshold value shall be determined by the project design engineer. For comparative analysis, velocity values of 115 mph and 85 mph are provided herein.

Pile Capacities

When considering an H-Pile with 4-inch flanges and a 6-inch web:
Ult. Capacity: = 4.2 kips
Allow Capacity: 4.0 / SF = 2.1 kips [Factor of Safety = 2.0]

Layer	Depth (ft)	Soil Type	Effective Unit Weight (pcf)	Cohesion (psf)	Adhesion (psf)	Phi (degrees)
1	0 - 1	Crops Topsoil (ML/CL)	110	460	460	28
2	1 - 12	Stiff Clay w/o free water (CL)	110	500	500	28
3	12 - 50	Silty Sand and Sand in perched groundwater (SM/SP)	120	NA	NA	32

Anchor spacing and dimensions should be determined by the structural engineer.

June 16, 2011
Project No. TS646.1

Site: PROPOSED MT. SIGNAL SOLAR FARM
SEELEY, CALIFORNIA

Executive Summary, continued (page 3 of 3)

The following Geotechnical Parameters may be used in the design of the conventional foundation construction for the inverter pads and/or associated structures:

Mat Slab Foundation

For the inverter pads and associated structures, if applicable, a mat slab foundation system is recommended due to the presence of heavy loads and expansive soils. The actual design of the foundation and slabs should be completed by the structural engineer.

Min. Design Item	Recommendations
Mat Foundations:	
Allowable Bearing Pressure:	2,000 psf
Passive Lateral Resistence:	300 psf per foot
Mat Slab Thickness:	min. 18 inches with thickened edges (+ 6 inches)
Steel Reinforcement:	No. 6 bars @ 12" o.c. each way, top and bottom
Coefficient of Friction:	0.35
Soil Sulfate Content	Negligible to Severe
	Note: As an alternative to the above-referenced mat slab, manufactured pre-cast pads may be considered by the project structural engineer.
Ground Level Invertor Pad Removals:	min. 3 ft. overexcavation, with 2 ft. envelope. Remove and re-compact to min. 90 % relative compaction (based on ASTM: D 1557). We recommend that fill soils be placed at moisture contents at least 4 percent over optimum for cohesive soils and at least 2 percent over optimum for granular soils.

Sulfate Content and Cement Type

The results of our laboratory testing indicates that the soluble sulfate content of the on-site soils likely to come in contact with concrete/steel is negligible to severe, based on the UBC classification. As a conservative approach, type V cement and a concrete strength f'c of 4,500 psi is therefore recommended for use in concrete in contact with the on-site soils.

Site Preparation

Site preparation includes removal of deleterious materials, existing structures, or other improvements from areas to be subjected to fill or structural loads. Deleterious materials, including vegetation, trash, construction debris, and contaminated soils, should be removed from the site. Existing subsurface utilities that are to be abandoned should be removed and the excavations back filled and compacted. For the solar arrays we recommend plowing or discing the upper 10 inches and re-compacting via tractor/loaders, or vibratory rollers, making a minimum single pass. Placement of engineered fill is not required for anchored arrays.

June 16, 2011
Project No. TS646.1

PRELIMINARY GEOTECHNICAL INVESTIGATION
(PROPOSED MT. SIGNAL SOLAR FARM)
AT APPROX. 2000-ACRE SITE LOCATED
WEST OF DREW ROAD AND SOUTH OF INTERSTATE 8
SEELEY, CALIFORNIA

TABLE OF CONTENTS

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June 16, 2011
Project No. TS646.1

US SOLAR HOLDINGS, INC.
6111 Severin Drive
La Mesa, CA 91942

Attention: Tommy Nelson, Project Engineer

Subject: **PRELIMINARY GEOTECHNICAL INVESTIGATION**
PROPOSED ***MT. SIGNAL SOLAR FARM***
AT APPROX. 2000-ACRE SITE LOCATED
WEST OF DREW ROAD AND SOUTH OF INTERSTATE 8
SEELEY, CALIFORNIA

Dear Mr. Nelson,

In accordance with your request we have completed our Preliminary Geotechnical Investigation for the above referenced photovoltaic solar project. This investigation was performed to determine the site soil conditions and to provide geotechnical parameters for the proposed construction.

It is our understanding that underpinning/anchoring of solar arrays are contemplated. Our investigation consisted of site-specific document review, subsurface exploration, laboratory testing, field resistivity surveys, corrosivity analysis, photographic documentation, geotechnical analysis of field and laboratory data, and the preparation of this report including pier/anchor specifications and minimum embedment depths.

Additionally, specifications for the associated improvements including the proposed inverter pads, are included in this report.

This opportunity to be of service is appreciated. If you have any questions, please call.

Very truly yours,

EGA Consultants, LLC

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June 16, 2011
Project No. TS646.1

PRELIMINARY GEOTECHNICAL INVESTIGATION
(PROPOSED MT. SIGNAL SOLAR FARM)
AT APPROX. 2000-ACRE SITE LOCATED
WEST OF DREW ROAD AND SOUTH OF INTERSTATE 8
SEELEY, CALIFORNIA

INTRODUCTION

In response to your request we have completed a preliminary geotechnical investigation for the proposed Mt. Signal Solar Farm project in the City of Seeley, County of Imperial, California (see Site Location Map, Figure 1). The purpose of our investigation was to evaluate the existing geotechnical conditions at the subject site and provide recommendations and geotechnical parameters for the proposed solar farm re-development.

The approximate 2000 acre, low-lying study area is situated within the southwestern portion of Imperial County and is delineated in Figures 1 and 2 herein.

This report presents the results of our findings, as well as our conclusions and recommendations.

SCOPE OF STUDY

The scope of our investigation included the following tasks:

- Review of readily available published and unpublished literature and documents;
- Geologic reconnaissance and mapping;
- Excavation and sampling of twenty-five (25) exploratory borings, to a maximum depth of 50 feet below existing grade (b.g.);
- Geotechnical laboratory testing of representative soil samples obtained from the exploratory borings;
- Field Resistivity Surveys and corrosivity testing by HDR/Schiff and Associates of Claremont, California;
- Soil Thermal testing of undisturbed soils by Geothermal USA of Dublin, California.

- Seismicity, Engineering and geologic analysis including seismicity coefficients in accordance with the 2010 CBC;
- Liquefaction analysis, engineering and geologic analysis including soil parameters for recommended pile underpinning for the solar arrays;
- Preparation of this report presenting our findings, conclusions, and recommendations.

GENERAL SITE CONDITIONS

With the exception of the Westside Elementary School at 2294 Vaughn Road, the site is currently under agricultural use. A few residential ranch homes, fallow lots, flood irrigation canals/drains, and alfalfa crops are currently used on the subject site.

The study area is bound to the north by Interstate 8, to the east by Drew Road, to the west generally by Hyde Road and to the south by Mandrapa Road. The Westside Main canal and vacant desert lands are located south and adjacent to Mandrapa Road (see Figures 1 and 2, herein).

A majority of the lots are currently used for alfalfa crops which are flood-irrigated using a system of canals, drain tiles, and lined "V" ditches. The alfalfa plants yield a low density root mass, and hence are typically farmed in low permeable clayey soils.

PHOTOGRAPHS

Photographs were taken of the observed site conditions and drilling operations at the time of our investigation. The original photographs are available in our files for review.

SUBSURFACE EXPLORATION

Our subsurface exploration consisted of the excavation of twenty-five (25) exploratory borings (B-1 through B-25) to a maximum depth of 50 feet below grade (b.g.). Representative bulk and relatively undisturbed soil samples were obtained for laboratory testing. Geologic logs of the soil borings are included in Appendix A.

The borings were continuously logged by a representative of our firm who obtained soil samples for geotechnical laboratory analysis. The approximate locations of the borings are shown on Figure 2, Site Plan.

Geotechnical soil samples were obtained using a modified California sampler filled with 2 ⅜ inch diameter, 1-inch tall brass rings. Additionally, Standard Penetrometer Tests (SPT) and pocket penetrometer tests were generally performed at 5 ft. intervals in the majority of the borings. The SPT samplers were driven 18 inches into the soil by a 140-pound hammer falling 30 inches. The number of blows required to penetrate the last 12 inches is shown in the attached boring logs. Bulk samples were obtained by collecting representative bore hole cuttings. Locations of geotechnical samples and other data are presented on the boring logs in Appendix A.

The soils were visually classified according to the Unified Soil Classification System. Classifications are shown on the boring logs included in Appendix A.

LABORATORY TESTING

Laboratory testing was performed on representative soil samples obtained during our subsurface exploration. The following tests were performed:

* Soil Classification
  (ASTM: D 2487)

* Dry Density and Moisture Content
  (ASTM: D 2216)

* Maximum Dry Density and Optimum Moisture Content
  (ASTM: D 1557)

* Direct Shear
  (ASTM: D 3080)

* Sulfate Content
  (CA 417)

* Expansion Index
  (UBC 18-2, ASTM: D 4829)

* Grain Size Analysis
  (ASTM: D 422)

* Atterberg Limits
  (ASTM D 4318)

* Resistivity (ohm-cm) Full Suite - pH, sulfate, chloride, calcium, nitrates, etc.
  (ASTM G 57)

* Consolidation
  (ASTM D 2435)

* Thermal Resistivity
  (ASTM D 5334)

Geotechnical test results are shown in Appendix B of this report.

SOIL AND GEOLOGIC CONDITIONS

The site soil and geologic conditions are as follows:

Geologic Setting

According to a United States Geological Survey (USGS) Map of the Mt. Signal Quadrangle the site is approximately 35 feet below Mean Sea Level (-35 ft. MSL). The site is located within the Salton Trough, a topographic and structural depression bound to the north by the Coachella Valley and to the south by the Gulf of California. The Salton Trough is a region of transition from the extensional tectonics of the East Pacific Rise to the transform tectonic environment of the San Andreas system. The Salton Trough is an actively growing rift valley associated with late Cenozoic extension which formed the Gulf of California. As rifting continued the Colorado River delta filled the trough and conditions gradually changed from marine, to deltaic to subaerial river and lake deposits.

The site is located in an area that has been covered by lakes during the Quaternary time. The Imperial valley is directly underlain by lacustrine (lake) deposits, which consist of interbedded lenticular and tabular silt, sand, and clay.

A Geologic Map is presented in Figure 5, herein.

The Late Pleistocene to Holocene lake deposits are generally between 15 to 50 feet thick and derived from periodic flooding of the Colorado river which formed an ancient fresh water lake (Lake Cahuilla). Records indicated approximately 300 years ago the shorelines of Lake Cahuilla raised as high as 40 feet above MSL (see Figure 5). Older deposits in the region consist of Miocene to Pleistocene non-marine and marine sediments deposited during intrusions of the Gulf of California and are located to the west of the site. Basement rock consisting of Mesozoic granite and Paleozoic metamorphic rocks are estimated to exist at depths between 15,000-20,000 feet near the center of the basin (Theilig et al., 1978, and Elders, 1979).

Deposits to the west of the project site consist of the Pliocene Palm Spring and Imperial Formations. The Palm Spring Formation consists of non-marine sandstones and claystones. The Imperial Formation consists of fossiliferous marine sediments.

Faulting and Surface Rupture

A review of available geologic records indicates that no active faults cross the subject property (reference No. 5). A fault zone map is included herein (see Figure 4).

Surface rupture is the result of movement on an active fault reaching the surface. The site is not located within an Alquist-Priolo Earthquake Fault Zone, and no evidence of active faulting was found during our investigation. Consequently, surface rupture is not considered to be a substantial geologic hazard at the site.

Seismicity

The effects of seismic shaking can be mitigated by adhering to the 2010 Uniform Building Code or the standards of care established by the Structural Engineers Association of California.

Based on our review of the "Seismic Zone Map," published by the California Department of Mines and Geology in conjunction with Special Publication 117, there are no earthquake landslide zones on or adjacent to the site. Figure 4 shows the location of the site in relation to regional faults and seismicity.

The proposed development shall be designed in accordance with seismic considerations contained in the 2010 CBC and the County of Imperial requirements.

Based on Chapter 16 of the 2010 CBC and on Maps of Known Active Near-Source Zones in California and Adjacent Portions of Nevada (ASCE 7 Standard), the following parameters may be considered:

2010 CBC Seismic Design Parameters

Mt. Signal Solar, Seeley, CA (Centroid Boring B-15)

Site Longitude (Decimal Degrees)	-115.716
Site Latitude (Decimal Degrees)	32.7491
Site Class Definition	D
Mapped Spectral Response Acceleration at 0.2s Period, S_S	1.445
Mapped Spectral Response Acceleration at 1s Period, S_1	0.566
Short Period Site Coefficient at 0.2 Period, Fa	1.00
Long Period Site Coefficient at 1s Period, Fv	1.50
Adjusted Spectral Response Acceleration at 0.2s Period, S_{MS}	1.445

Adjusted Spectral Response Acceleration at 1s Period, S_{M1}	0.849
Design Spectral Response Acceleration at 0.2s Period, S_{DS}	0.964
Design Spectral Response Acceleration at 1s Period S_{D1}	0.566

Liquefaction

Liquefaction of soils can be caused by strong vibratory motion in response to earthquakes. Both research and historical data indicate that loose, granular soils are susceptible to liquefaction, while cohesive clays are not adversely affected by vibratory motion. Liquefaction is generally known to occur only in saturated or near saturated granular soils at depths shallower than approximately 50 feet. The soils which predominantly underlie the site are lean, stiff, clays. Liquefaction is not considered to be a hazard in clays.

Our analysis indicated that sandy zones underlying the lacustrine clays, down to 50 feet in depth may liquefy given the Design Basis Earthquake. Assuming a groundwater level of 5 feet, the total post-liquefaction settlement is estimated to vary from roughly 0 to ½ inch at the site. According to state guidelines, a differential settlement equal to about one-half of the anticipated total liquefaction settlement may be conservatively assumed for structural design (SCES, 1999). Consequently, we may estimate that ¼ inch post-liquefaction differential settlement may occur across the length of the proposed arrays.

Tsunamis, Seiches

The site is located within the Salton Trough approximately 35 feet below sea level. This suggests that the potential may exist for inundation in the event of a tsunami generated from the Gulf of California (from Mexico to the south). However, the configuration of the Gulf of California, and the higher ground surface elevation near Calexico, has historically provided an obstruction from such events. There are no records which indicate that tsunamis have impacted the Imperial Valley in the last several hundred years.

The great distance between the subject site and the Gulf of California most likely precludes damage due to seismically induced waves (tsunamis). However, it is possible that a seiche could occur within one of the shallow reservoirs adjacent to the proposed arrays. This could result in limited earthquake induced flooding at the site.

Other Geologic Hazards

Other geologic hazards such as landsliding do not appear to be evident at the subject or adjacent sites. There is not sufficient topography for soil landslides, soil creep, or lateral spreading.

FINDINGS

Seepage and Groundwater

Irrigation water is supplied to the site from the West Side Main Canal (WSM) which forms the southern property boundary. At the time of our study, a majority of the lots were used for alfalfa crops which are flood-irrigated using a system of canals, drain tiles, and lined "V" ditches. The alfalfa plants yield a low density root mass, and hence are typically farmed in low permeable clayey soils.

Groundwater was encountered in our test excavations generally between 10 to 15 feet below grade (b.g). A depth-to-groundwater contour map is presented as Figure 3, herein. The contours are based on measurements of static groundwater level during the drilling operations in April, 2011. Perched levels are expected to fluctuate with changes in seasons (rainfall), canal flow, and irrigation. The mapped groundwater levels should not be interpreted to represent a permanent condition.

Subsurface Soils

As encountered in our test borings, the site is underlain by fill/crop, lacustrine clays, and alluvial soils as follows:

Fill/Crop Soils

Fill and/or crop soils were encountered in the upper 1 to 2 feet in each test boring (B-1 through B-25). The fill soils consist generally of gray and olive brown, moist to very moist, soft to firm, sandy silty clay and clayey silts (Unified Soil Classification System Symbol CL/ML) with mica grains and rootlets. The fill/crop soils are similar in consistency to the surficial lake deposits from which they were derived.

Lacustrine Deposits (Ql)

The fill/crop soils are underlain by lacustrine deposits associated with the ancient lakes in the area. The lacustrine deposits generally consisted of lean clay (CL) with a few thin beds of sandy silt (ML). The lacustrine deposits were generally moist to saturated, and firm to very stiff in consistency. The average dry density of the saturated lacustrine clays was 93.4 pcf (18 tests), with an average moisture content of 23.1 percent (89 tests).

Alluvium (Qal)

The lacustrine deposits are underlain by medium dense to dense, saturated, fine-grained silty sands and sands.

The average moisture content of the alluvial soils was 26.9 percent (38 tests).

RECOMMENDATIONS and Geotechnical Parameters

Based on our discussions with the project engineers, H-piles are planned to support the solar arrays. The advantage of this underpinning method, as opposed to cast-in-place caissons, is less soil disturbance, less concrete, limited access, shorter construction time and target load capacity of a representative sample of the piles are verified in the field. Additionally, adjustable brackets and lifting bolts allow for future elevation corrections.

Underpinning of the solar module arrays is recommended using galvanized steel H-piles (W6X9 wide flange beams) or helical anchors. The following Geotechnical Parameters may be used in the design of the underpinning:

Design Item	Recommendations
End Bearing Pressure	2,000 psf for lacustrine deposits
Passive Lateral Resistence	300 psf per foot
Coefficient of Friction	0.35
Allowable Skin Friction	500 psf between piles and lacustrine deposits
Uplift Forces	80 percent of the allowable capacity

Coefficients	
Active	Ka = 0.30
Passive	Kp = 3.60
At Rest	Ko = 0.50

Prior to driving or pushing piles, a check should be made for underground utilities.

Pile Capacities

For piles in cohesive clayey soils, the pile capacity is based on adhesion, and is a function of soil cohesion, circumference of pile, and pile length.

When considering an H-Pile with 4-inch flanges and a 6-inch web, a circumference of 20 inches (1.67 ft.) may be considered and used for the "$2 * \pi * L * R$" value in the equations. For a 6 ft. pile length, (Z = 6), and 500 psf cohesion (CA/C = 1), pile capacities of 2.1 kips may be assumed (reference: NAVFAC Design Manual 7.02, 1986).

Ult. Capacity: 1.67 x 5 (ft.) x 500 = 4.2 kips

Allow Capacity: 4.0 / SF = 2.1 kips [Using a Factor of Safety = 2.0]

Layer	Depth (ft)	Soil Type	Effective Unit Weight (pcf)	Cohesion (psf)	Adhesion (psf)	Phi (degrees)
1	0 - 1	Topsoil Crops (ML/CL)	110	460	460	28
2	1 - 12	Stiff Clay w/o free water (CL)	110	500	500	28
3	12 - 50	Silty Sand and Sand in perched groundwater (SM/SP)	120	NA	NA	32

The anchors/piles shall be driven a minimum depth of 6 feet below grade.

For design purposes the upper 1 foot of soils shall not be considered for skin friction values.

Pile/anchor fixity may be taken at the crop/road fill - competent lacustrine deposit transition at 1 feet b.g..

With respect to uplift capacities, ultimate loads in compression and tension would be the same, as end bearing is not included in design. However, it would be prudent to provide some reduction in capacity for uplift.

It is our understanding that lateral load- and pull-tests are planned throughout the study area prior to construction. These tests shall be performed by a qualified testing firm using calibrated equipment and an industry-recognized testing procedure. The in situ test results will provide empirical data for point-specific actual embedment depths.

Pile spacing and dimensions should be determined by the structural engineer.

<u>Seismic Loading</u>

Note that the allowable gross axial pile capacities incorporate a safety factor of approximately 2.0. A one-third increase in the pile capacity may be used when considering short-term wind and seismic loads. The compressive strength of the pile section should be verified by the project structural engineer.

Pile foundations do not reduce dynamic settlement. We estimate that a total dynamic settlement of up to ½ inch may occur at the site. Current design philosophies suggest that such settlement will not decrease the axial pile capacity. Instead, the pile may experience increased internal stress and undergo a small fraction of the total dynamic settlement. The axial capacities presented above were not reduced to reflect dragload.

Design for High Winds

The wind pressure threshold value shall be determined by the project design engineer. However, high wind values of 115 mph and 85 mph are considered for design of the solar arrays as follows:

Example A: 115 mph Velocity:

Lateral Movement can be Tolerated at Ground Level = 0.5 inches
115 mph 3 Sec Gust = 25 psf Wind Pressure
Modules @ 45 Degrees to Wind, Pressure = 25 x 12 x 6 x 0.7 = 1260 psf
Modules @ 30 Degrees to Wind, Pressure = 25 x 12 x 6 x 0.5 = 900 psf
Seismic Lateral Loading Factor Approx = 0.20 Gives 160 lbs lateral demand per panel/module

We recommend the solar modules be constructed with an automatic safety feature. Hence, modules retract and return to stow position when wind pressures (velocity) reach a pre-established percentage of maximum.

Example B: 85 mph Velocity:

In comparison to 115 mph:
At 85 mph design wind speed, the reduction ratio = 18.5/34 =.544

Therefore, multiply each value by .544

1260 psf is reduced to 686 psf

900 psf is reduced to 490 psf

Therefore, at a design wind speed of 85 mph, and 3 sec gust, there is no requirement to retract the array.

The following Geotechnical Parameters may be used in the design of the conventional foundation construction for the inverter pads and/or associated structures:

Mat Slab Foundation

For the inverter pads and associated structures, if applicable, a mat slab foundation system is recommended due to the presence of heavy loads and expansive soils. Mat slabs founded in fill materials may be designed for an allowable bearing value of 2000 psf (for dead-plus-live load). These values may be increased by one-third for loads of short duration, including wind or seismic forces. The actual design of the foundation and slabs should be completed by the structural engineer.

Min. Design Item	**Recommendations**
Mat Foundations:	
Allowable Bearing Pressure:	2,000 psf
Passive Lateral Resistence:	300 psf per foot
Mat Slab Thickness:	min. 18 inches with thickened edges (+ 6 inches)
Steel Reinforcement:	No. 6 bars @ 12" o.c. each way, top and bottom
Coefficient of Friction:	0.35

Reinforcement requirements may be increased if recommended by the project structural engineer. In no case should they be decreased from the previous recommendations.

Note: As an alternative to the above-referenced mat slab, manufactured pre-cast pads may be considered by the project structural engineer.

Sulfate Content and Cement Type

The results of our laboratory testing indicates that the soluble sulfate content of the on-site soils likely to come in contact with concrete is negligible to severe, based on the UBC classification. As a conservative approach, type V cement and a concrete strength f'c of 4,500 psi is therefore recommended for use in concrete in contact with the on-site soils. The maximum water to cement ratio, by weight shall be 0.45 (reference: 2010 UBC, Volume 2).

ACI 318 BUILDING CODE (Table 4.3.1)
Requirements for Concrete Exposed to Sulfate-containing Solutions

Sulfate Exposure	Water soluble sulfate (SO_4) in soil percent by weight	Sulfate (SO_4) in water, ppm	Cement Type	Maximum water-cementitious material ratio, by weight, normal weight concrete	Minimum fc', normal-weight and light weight concrete, psi
Negligible	$0.00 \le SO_4 < 0.10$	$0 \le SO_4 < 150$	------	-----	-----
Moderate	$0.10 < SO_4 < 0.20$	$150 < SO_4 < 1500$	II,IP(MS), IS(MS),P(MS) I(PM)(MS), I(SM)(MS)	0.50	4000
Severe	$0.20 \le SO_4 < 2.00$	$1500 < SO_4 <$ 10,000	V	0.45	4500
Very Severe	$SO_4 > 2.00$	$SO_4 > 10{,}000$	V plus pozzalan	0.45	4500

Field Resistivity Survey

Field resistivity surveys were conducted by HDR/Schiff of Claremont, California. The resistivity tests were performed in the field using the Wenner Four Pin Method. This procedure gives the average resistivity from the surface to a depth equal to the pin spacing. Pin spacings of 2.5, 5, 20, and 50 feet were used so that variations with depth were evaluated.

Based on the report by HDR/Schiff, the soils are considered to be severely corrosive toward ferrous metals. Accordingly, protection of buried cast iron or ductile utility pipes/cables shall be provided based on the corrosion mitigation measures included in the HDR/ Schiff report (see Appendix C, herein).

The results and recommendations are presented in Appendix C.

Soil Corrosivity Testing

In-situ soil corrosivity testing was conducted by HDR/Schiff of Claremont, California. The laboratory results correlate with the field resistivity survey, and hence, the soils are considered to be severely corrosive toward ferrous metals.

The results and recommendations are presented in Appendix C.

Thermal Resistivity Testing

In-situ earth and thermal resistivity testing was conducted by Geothermal USA of Dublin, California. The thermal test of the site undisturbed soil was performed in accordance with IEEE standards 81, 442 and ASTM D 5334. The results (including the thermal dry-out curve) are presented in Appendix C.

Settlement

Utilizing the design recommendations presented herein, we anticipate that the majority of any settlement will occur during construction activities. We estimate that the total settlement for the proposed piles, arrays and mat foundations will be on the order of 1 inch. Differential settlement is not expected to exceed ½ inch across the length of the structures. In addition to the static settlement estimates, mat foundations may experience dynamic differential settlements on the order of 1/4 inch

The estimated seismic induced settlement will be mitigated/reduced by the proposed pile system which is expected to undergo settlement not greater than ½ inch total and 1/8 inch differential between adjacent piles.

These settlement values are expected to be within tolerable limits for properly designed and constructed piles/foundations.

Lateral Load Resistance

Piles/mat foundations founded in competent lacustrine soils or fill materials may be designed for a passive lateral bearing pressure of 300 pounds per square foot per foot of depth. A coefficient of friction against sliding between concrete and soil of 0.35 may be assumed.

Site Preparation

Site preparation includes removal of deleterious materials, existing structures, or other improvements from areas to be subjected to fill or structural loads. Deleterious materials, including vegetation, trash, construction debris, and contaminated soils, should be removed from the site. Existing subsurface utilities that are to be abandoned should be removed and the excavations back filled and compacted.

* For the solar arrays we recommend plowing or discing the upper 10 inches and re-compacting via tractor/loaders, or vibratory rollers, making a minimum single pass. The arrays shall be anchored by piles and hence, the placement of engineered fill is not required.

* For the ground level Invertor pads we recommend a min. 3 ft. overexcavation, with a 2 ft. envelope. We recommend re-compaction to a min. 90 % relative compaction (based on ASTM: D 1557). We recommend that fill soils be placed at moisture contents at least 4 percent over optimum for cohesive soils and at least 2 percent over optimum for granular soils. Removals should expose competent lacustrine sediments as determined by personnel during grading.

Structural Fills (outside of arrays)

If applicable, after removal of any loose, compressible soils, all areas to receive fill and/or other surface improvements should be scarified to a minimum depth of 12 inches and compacted to at least 90 percent relative compaction (based on ASTM: D 1557).

Lift thicknesses will be dependent on the size and type of equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches. Placement and compaction of fill should be in accordance with local grading ordinances under the observation and testing of the geotechnical consultant.

We recommend that fill soils be placed at moisture contents at least 4 percent over optimum for cohesive soils and at least 2 percent overt optimum for granular soils (based on ASTM: D 1557).

We recommend that oversize materials (materials over 8 inches) should they be encountered, be stockpiled and removed from the site.

Construction operations described herein should be performed by a qualified, licensed subcontractor in compliance with governing regulations and appropriate construction materials. To verify compliance with guidelines provided in this report, a consultant should review the proposed plans and recommendations prior to the onset of construction. The consultant should also observe and evaluate ongoing construction operations.

LIMITATIONS

The geotechnical services described herein have been conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical engineering profession practicing contemporaneously under similar conditions in the subject locality. Under no circumstance is any warranty, expressed or implied, made in connection with the providing of services described herein. Data, interpretations, and recommendations presented herein are based solely on information available to this office at the time work was performed. *EGA Consultants, LLC* will not be responsible for other parties' interpretations or use of the information developed in this report.

We do not direct the contractor's operations, and we cannot be responsible for the safety of others. The contractor should notify the owner if he considers any of the recommended actions presented herein to be unsafe.

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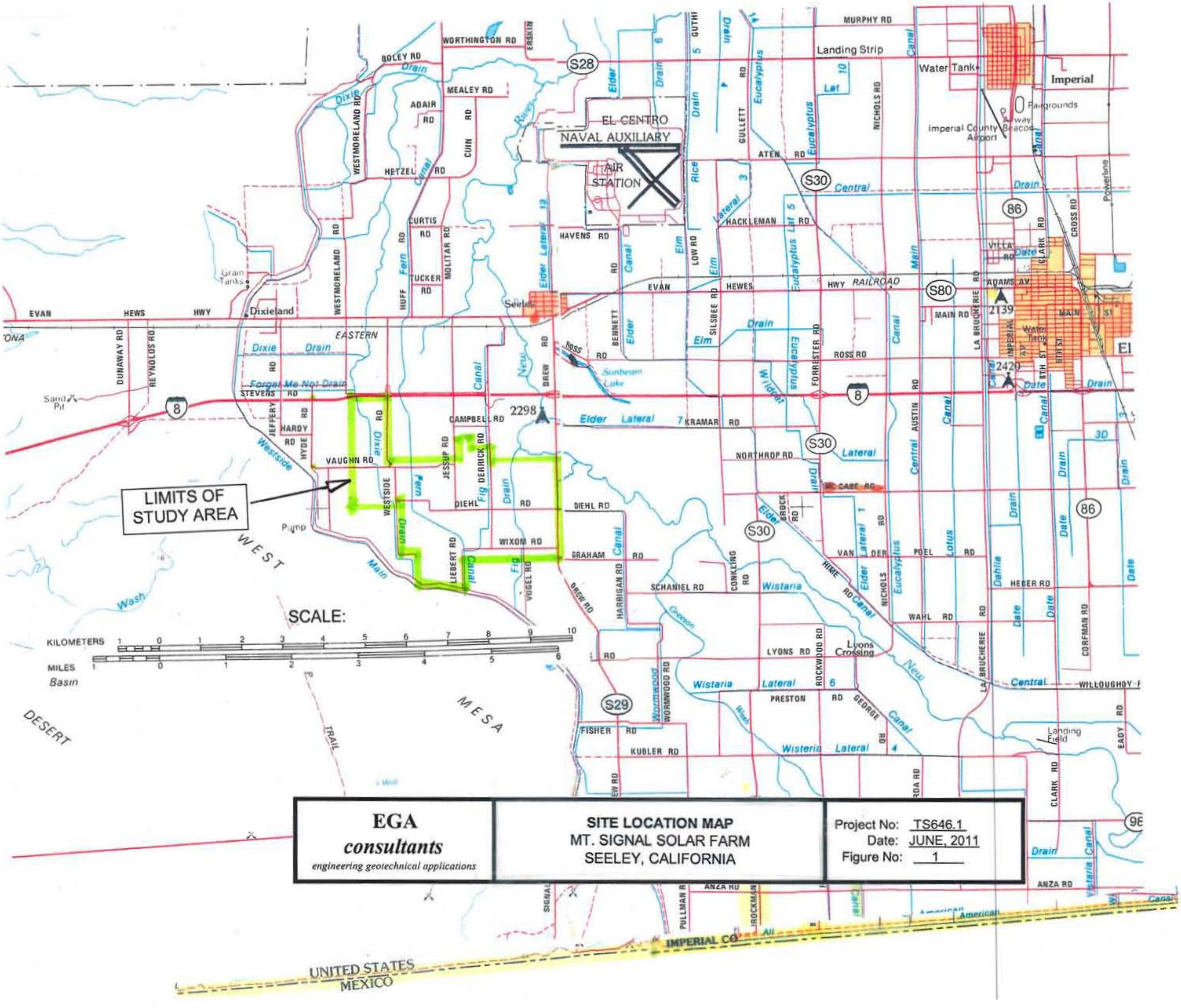
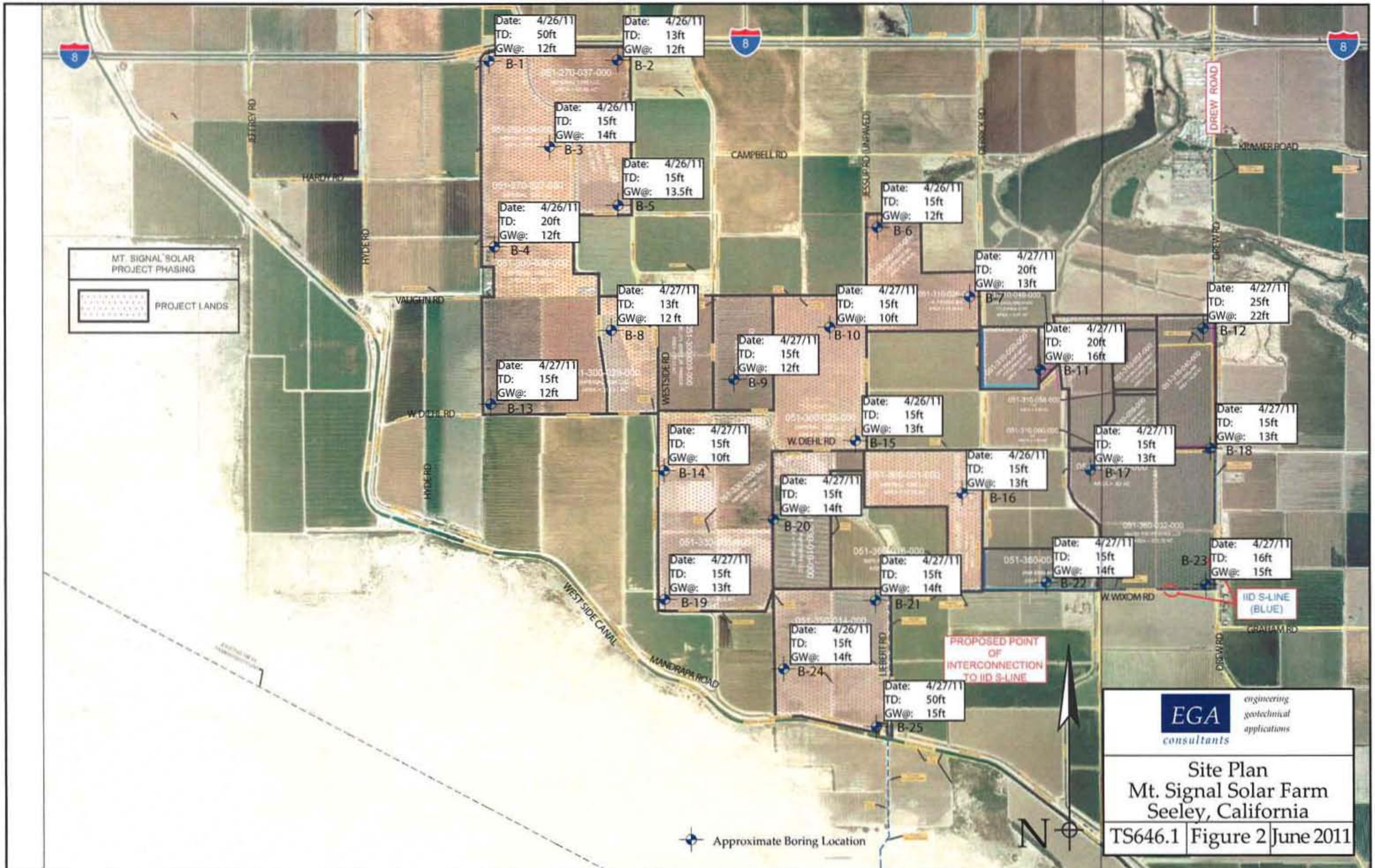
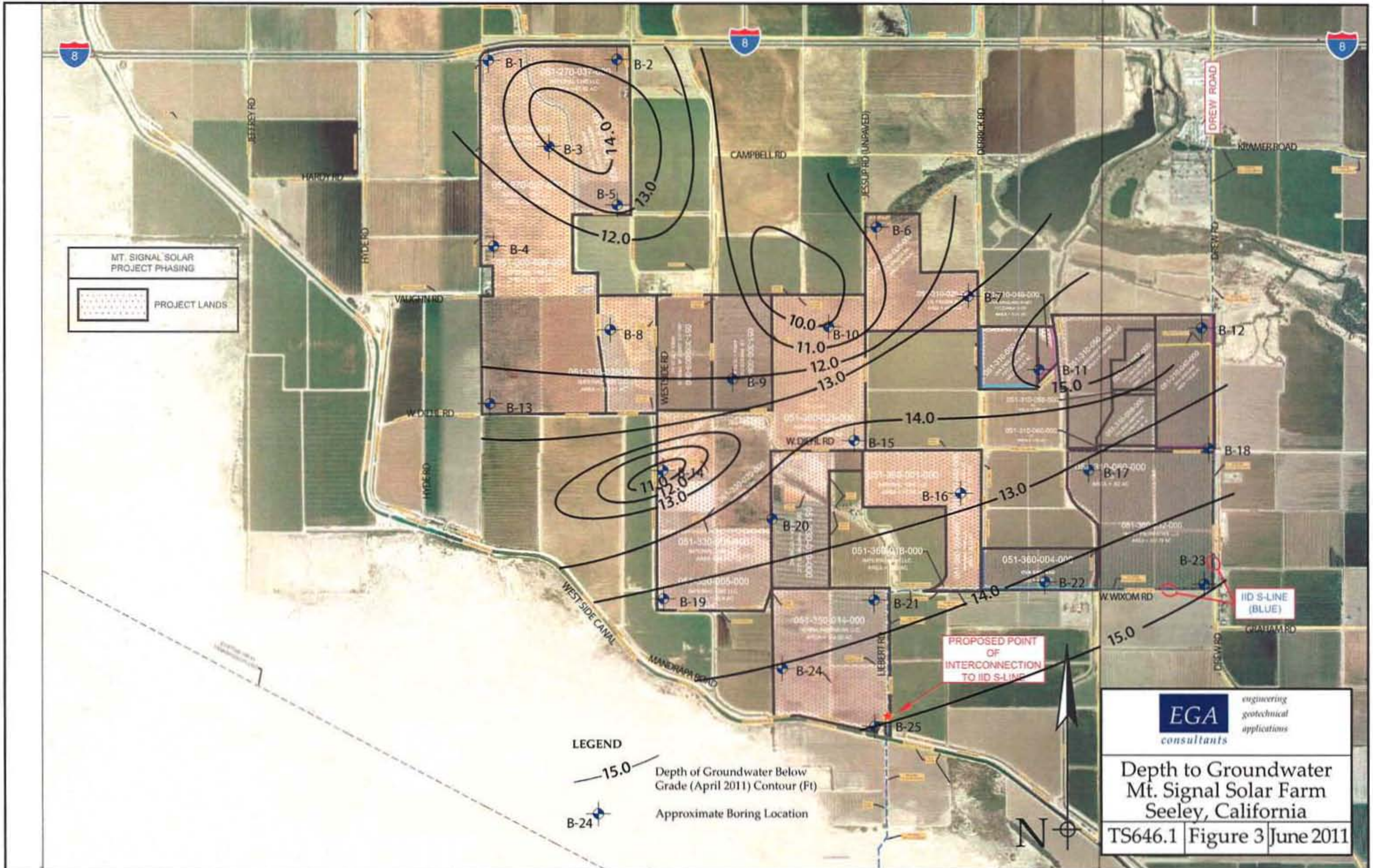


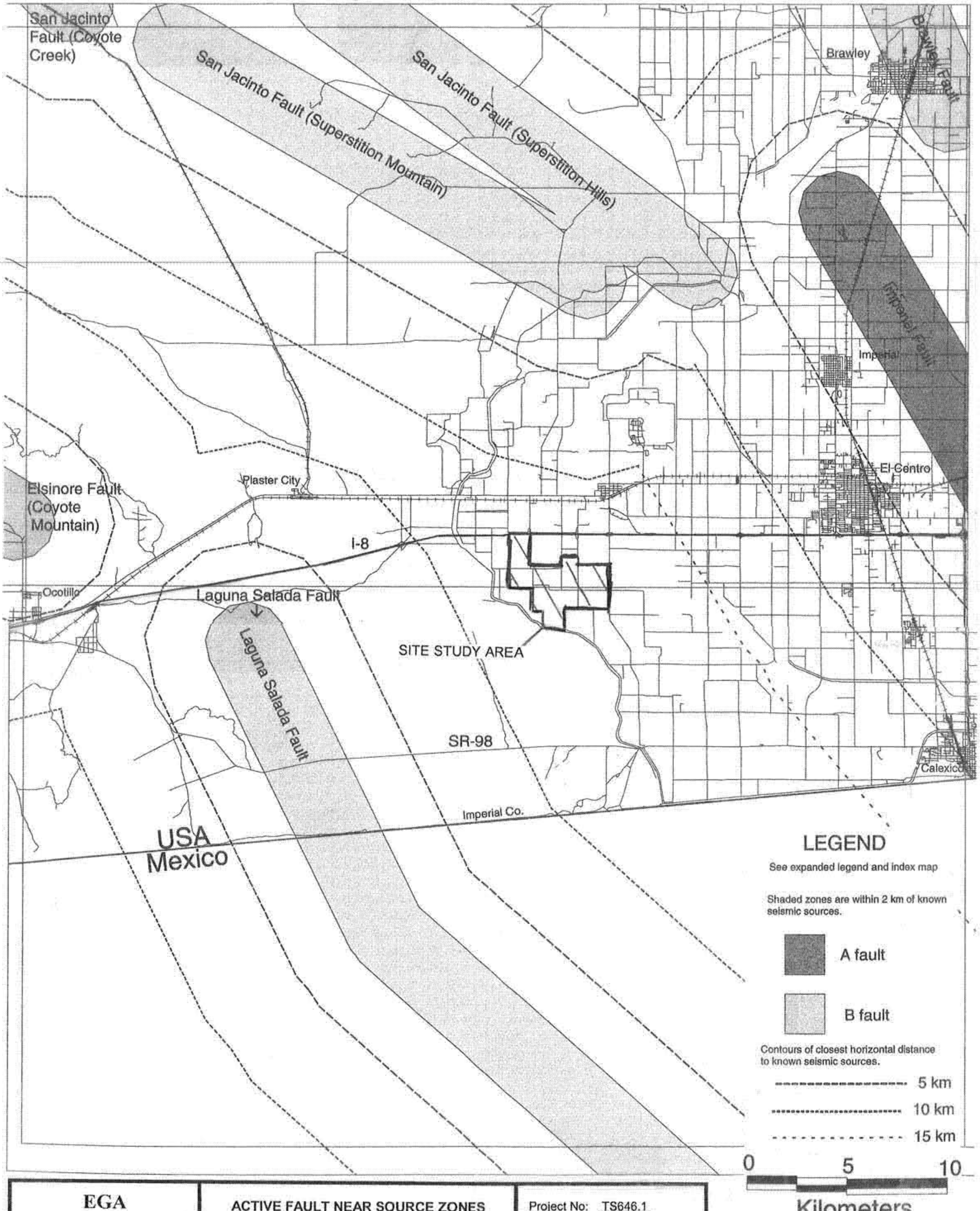
EGA *consultants* *engineering geotechnical applications*	**SITE LOCATION MAP** MT. SIGNAL SOLAR FARM SEELEY, CALIFORNIA	Project No: TS646.1 Date: JUNE, 2011 Figure No: 1


MT. SIGNAL SOLAR PROJECT PHASING
PROJECT LANDS
8
8
8
DREW ROAD
KRAMER ROAD
CAMPBELL RD
HARDY RD
JEFFREY RD
HYDE RD
VAUGHN RD
W. DIEHL RD
WESTSIDE RD
JESSUP RD (UNPAVED)
DERRICK RD
DREW RD
W. WIXOM RD
GRAHAM RD
LIEBERT RD
WEST SIDE CANAL
MANDRAPA ROAD
051-270-037-000
Date: 4/26/11 TD: 50ft GW@: 12ft B-1
Date: 4/26/11 TD: 13ft GW@: 12ft B-2
Date: 4/26/11 TD: 15ft GW@: 14ft B-3
Date: 4/26/11 TD: 20ft GW@: 12ft B-4
Date: 4/26/11 TD: 15ft GW@: 13.5ft B-5
Date: 4/26/11 TD: 15ft GW@: 12ft B-6
Date: 4/27/11 TD: 20ft GW@: 13ft B-7
Date: 4/27/11 TD: 13ft GW@: 12 ft B-8
Date: 4/27/11 TD: 15ft GW@: 12ft B-9
Date: 4/27/11 TD: 15ft GW@: 10ft B-10
Date: 4/27/11 TD: 20ft GW@: 16ft B-11
Date: 4/27/11 TD: 25ft GW@: 22ft B-12
Date: 4/27/11 TD: 15ft GW@: 12ft B-13
Date: 4/27/11 TD: 15ft GW@: 10ft B-14
Date: 4/26/11 TD: 15ft GW@: 13ft B-15
Date: 4/26/11 TD: 15ft GW@: 13ft B-16
Date: 4/27/11 TD: 15ft GW@: 13ft B-17
Date: 4/27/11 TD: 15ft GW@: 13ft B-18
Date: 4/27/11 TD: 15ft GW@: 13ft B-19
Date: 4/27/11 TD: 15ft GW@: 14ft B-20
Date: 4/27/11 TD: 15ft GW@: 14ft B-21
Date: 4/27/11 TD: 15ft GW@: 14ft B-22
Date: 4/27/11 TD: 16ft GW@: 15ft B-23
Date: 4/26/11 TD: 15ft GW@: 14ft B-24
Date: 4/27/11 TD: 50ft GW@: 15ft B-25
IID S-LINE (BLUE)
PROPOSED POINT OF INTERCONNECTION TO IID S-LINE
Approximate Boring Location
N
EGA consultants
engineering geotechnical applications
Site Plan
Mt. Signal Solar Farm
Seeley, California
TS646.1
Figure 2
June 2011



Depth to Groundwater
Mt. Signal Solar Farm
Seeley, California

TS646.1	Figure 3	June 2011



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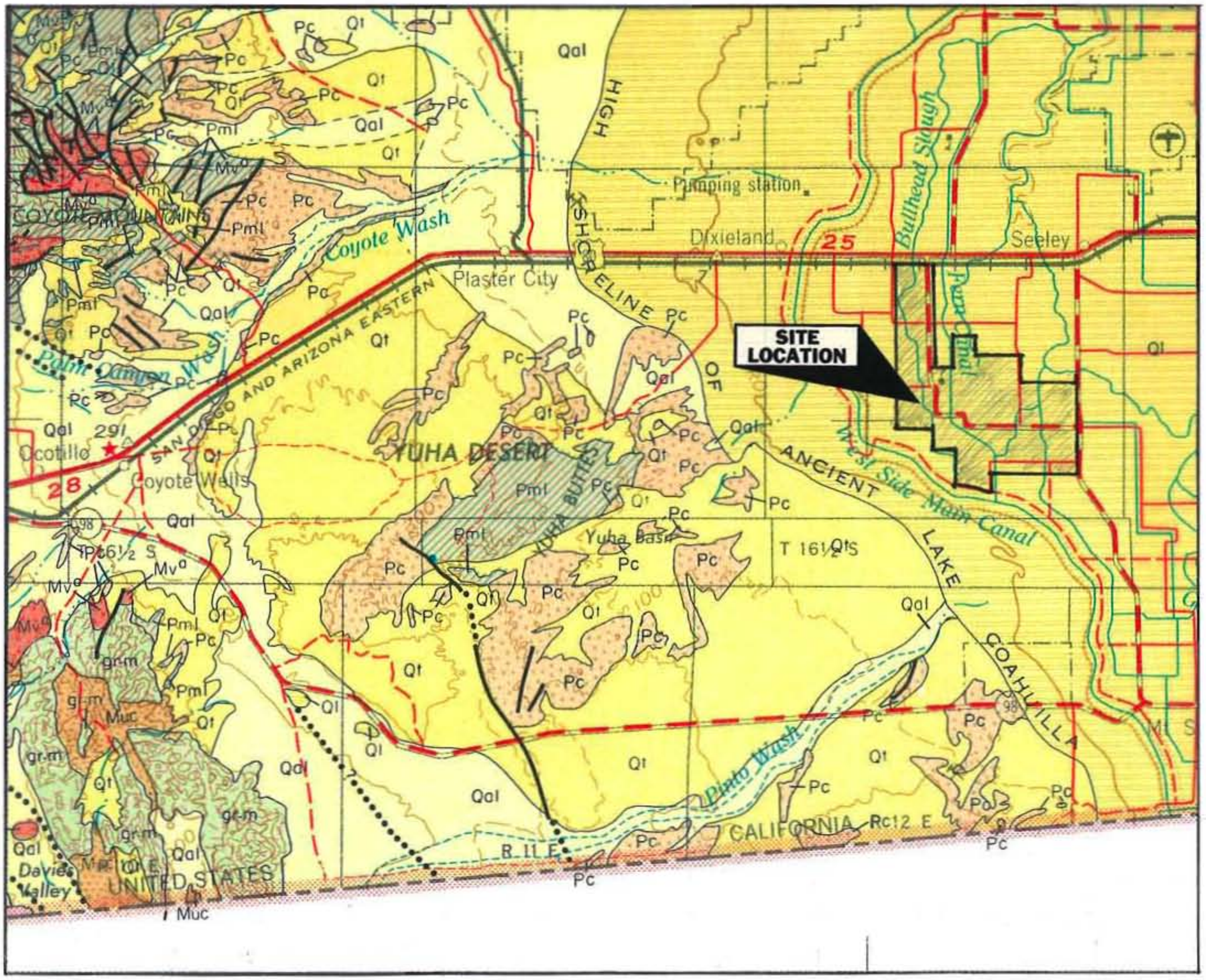
ACTIVE FAULT NEAR SOURCE ZONES
MT. SIGNAL SOLAR FARM
SEELEY, CALIFORNIA

Project No: TS646.1
Date: JUNE , 2011
Figure No: 4



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EXPLANATION

QUATERNARY

Symbol	Description
Qal	Alluvium
Ql	Quaternary lake deposits
Qst	Salt deposits

N

EGA *consultants* *engineering geotechnical applications*	**GEOLOGIC MAP** MT. SIGNAL SOLAR FARM SEELEY, CALIFORNIA	Project No: TS646.1 Date: JUNE , 2011 Figure No: 5

APPENDIX A:

GEOLOGIC LOGS

BORING LOG LEGEND

SPT - Standard Penetration Split Barrel (1.5"IDx18"Length, with liners), ASTM D1586

SB - Split Barrel Sampler (2.5"ID x 18" length, with liners), ASTM D 1586

TW - Thin Wall Tube (Shelby) Sampler, ASTM D1587

SC - Sand Cone Compaction Test, ASTM D 1556

Nspt- Result of Standard Penetration Test. N represents the number of blows with a 140 lb. hammer falling 30" to drive a **SPT** sampler 12" into insitu material.

Neq - Approximately equivalent to Nspt but is based upon the number of blows with a 140 lb. hammer falling 30" to drive a **SB** sampler 12" into insitu material and calculating an equivalent standard penetration blow count, after R. H. Karol, *Soils and Soils Engineering*, Pretenice - Hall, Inc. 4/64 Page 23 .

▽ - Indicates elevation of free water surface encountered

USCS- Unified Soil Classification System - Method of defining soil types

USCS - MAJOR DIVISION			Group Symbol	DESCRIPTION	
	Gravely Soils With Over 50% of The Coarse Fraction Larger Than No. 4 Sieve Size	Clean Gravley Soils With Little or No Fines	GW	Well Graded Gravels	
			GP	Poorly Graded Gravels	
		Sandy Gravely With Fines	GM	Silty Gravels Well or Poorly Graded Gravel-Sand-Silt Mixtures	
			GC	Clayey Gravels Well or Poorly Graded Gravel-Sand-Clay Mixtures	
	Sandy Soils With Over 50% of the Coarse Fraction Smaller Than No. 4 Sieve Size	Clean Sandy Soils With Little or No Fines	SW	Well Graded Sands	
			SP	Poorly Graded Sands	
		Sandy Soils With Fines	SM	Sand-Silt, Silty Sands Well or Poorly Graded Sand-Silt Mixtures	
			SC	Clayey Sands Well or Poorly Graded Sand-Clay Mixtures	
	Silty and Clayey Soils Liquid Limit Less Than 50%		ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity	
			CL	Inorganic Clays of Low to Medium Plasticity, Gravely Clays, Sandy Clays, Silty Clays or Lean Clays	
			OL	Organic Clays or Organic Silty Clays of Low Plasticity	
	Silty and Clayey Soils Liquid Limit Greater Than 50%		MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, or Elastic Silts	
			CH	Inorganic Clays of High Plasticity, or Fat Clays	
			OH	Organic Clays of Medium to High Plasticity, or Organic silts	
Highly Organic Soils			PT	Peat or Other Highly Organic Soil	

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-1**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	% Passing #200 Sieve
1	ML/CL	Fill/Crop Soil: dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.	22							
		Native Lacustrine Deposits: At 1 ft. becomes light olive brown, moist to very moist, firm to very		12.0	88.8		1.5			79
	CL	stiff lean to fat clay and clayey silt with trace fine	20							
5		sands and fine mica grains.		20.1			4.0			
		at 7.5 ft. becomes reddish and olive brown, very moist, stiff silty clay.	23	26.0			2.5			73.8
10		at 10 ft Becomes wet olive brown fine silty sand with clay. Groundwater at 12 ft.	15	25.5			2.5			
	SM/SC	Native Alluvium Deposits: at 12 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.								
15			17	23.5			0.75			
20	SC	same as above.	26	17.2			1.5			
25			26	26.9			2.0			
	SM	at 25.5 ft. becomes grayish brown, wet, dense, fine-grained silty sand.								30.1
30	SP	at 30 ft. becomes olive brown, dense, saturated, fine-grained sand, porous.	60	21.1			2.75			
35	SP	same as above.	38.0	21.7			2.5			
40		*CONTINUES -*	40.0	21.2			2.75			

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-1**
Boring Location: See Figure 2
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen., tsf	Direct Shear: ϕ°	Direct Shear: C psf	Other Tests
40	SP	Standard Split Spoon	Bulk	Olive gray, dense, saturated, fine silty sand, micaceous.	40	21.2			2.75			
45		Standard Split Spoon	Bulk	same as above.	43	22.2			2.0			
		Standard Split Spoon	Bulk	same as above.	40	18.8			2.5			
50				Total Depth: 50 ft. Groundwater at 12 ft. No Caving Backfilled and Compacted 4/26/2011								
55												
60												
65												
70												
75												
80												

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-2**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	% Passing #200 Sieve
0–1	ML/ CL		Bulk	Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas,								
2	CL	2.5" Ring	Bulk	Native Lacustrine Deposits: At 1 ft. Becomes light Olive brown, moist to very moist, firm to very		20.5	102.9	43	2.25	28	258	
4–5			Bulk	stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.		19.8						
6–7			Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.		22.2						
10	SM SC			at 10 ft Becomes wet olive brown fine silty sand with clay. Groundwater at 12 ft.								
12		Static Water Table	Bulk	Saturated, dense, fine sand with silt and clay.		35.0						

Total Depth: 13 ft.
Groundwater at 12 ft.
No Caving
Backfilled and Compacted 4/26/2011

Depth scale: 1, 5, 10, 15, 20, 25, 30, 35, 40

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-3**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Soil Description	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	% Passing #200 Sieve
1	ML/ CL	Fill/Crop Soil: dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.	22							
5	CL	Native Lacustrine Deposits: at 1 ft. becomes light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.	17	23.5	93.8		2.0			
		at 7.5 ft. becomes reddish and olive brown, very moist, stiff silty clay.	17	28.5			1.75			
10	SM	at 10 ft Becomes wet olive brown fine silty sand with clay. Groundwater at 14 ft.	13	31.8			2.0			
	SP/ SC	Native Alluvium Deposits: at 12 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.	26	24.8			2.25			
15										

Total Depth: 15 ft.
Groundwater at 14 ft.
No Caving
Backfilled and Compacted 4/26/2011

Note: Undisturbed Sample in brass sleeve obtained at 1.5 ft. for Thermal Testing.

Depth scale: 20, 25, 30, 35, 40

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-4**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	% Passing #200 Sieve
0–1	ML/CL		Bulk	Fill/Crop Soil: dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
1	CL	Split Spoon		Native Lacustrine Deposits: at 1 ft. becomes light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.	11	18.9			0.75			
5		Split Spoon	Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay. at 11 ft Becomes wet olive brown fine silty sand with lean clays.	12	20.5			1.75			
10	SM	Ring		Groundwater at 12 ft.	20	21.5	99.0		1.75			
12	SP/SC			Native Alluvium Deposits: at 12 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.								
15		Split Spoon	Bulk		14	27.1			2.25			
19		Split Spoon	Bulk		20	24.5			2.5			
20				Total Depth: 20 ft. Groundwater at 12 ft. No Caving Backfilled and Compacted 4/26/2011								

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-5**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	% Passing #200 Sieve
1	ML/ CL		Bulk	Fill/Crop Soil: Light Brown, dry to moist, loose to soft, silty clay with trace fine-grained sand, fine micas,	9	23.0	98.8		1.0			
	CL	Ring		Native Lacustrine Deposits: Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.								
5		Ring			17	24.7	96.2		2.25			
		Split Spoon	Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty lean clay. at 10.5 ft Becomes olive brown fine silty sand	14	25.0			2.5			
10	SM	Split Spoon	Bulk	with lean clays, very moist.	17	27.4			3.0			
	SP/ SC	Static Water Table		Native Alluvium Deposits: at 11 ft. becomes med. gray, med. dense to dense, saturated fine silty sand with trace clay.	17	24.5			2.5			
15		Split Spoon	Bulk									

Total Depth: 15 ft.
Groundwater at 13.5 ft.
No Caving
Backfilled and Compacted 4/26/2011

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-6**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	Soil Description	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/CL			Fill/Crop Soil: Light Brown, dry to moist, loose to soft, silty clay with trace fine-grained sand, fine micas,								
	CL			Native Lacustrine Deposits: Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine								
5		2.5" Ring Sample	Bulk Sample	sands and fine mica grains.	15	20.2	94.5		2.0			
				at 7 ft. becomes reddish and olive brown, very moist, stiff silty lean clay.								
10	CL/SM	Standard Split Spoon Sample	Bulk Sample	at 10 ft Becomes olive brown, wet, fine silty sand with lean clays.	14	30.4			2.5			
	SP/SC	Static Water Table		Native Alluvium Deposits: at 11 ft. becomes med. gray, med. dense to dense, wet to saturated fine silty sand with trace clay.	15	31.4			2.75			
15		Standard Split Spoon Sample	Bulk Sample									
20				Total Depth: 15 ft. Groundwater at 12 ft. No Caving Backfilled and Compacted 4/26/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm, Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-7**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
0–1	CL			Fill/Crop Soil: Light brown, dry to moist, soft, clay and silty clay with trace fine-grained sand, fine mica.								
1–5	CL			Native Lacustrine Deposits: at 1 ft. becomes light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.								
6		Standard Split Spoon	Bulk	at 6 ft. becomes reddish and olive brown, very moist, stiff silty clay.	17	26.9			2.25			
11		Standard Split Spoon	Bulk	at 11 ft Becomes wet olive brown fine silty sand with lean clays.	19	26.4			2.75			
13	SM	Static Water Table		Groundwater at 13 ft.								
13–15	SC/ SP/	Standard Split Spoon	Bulk	Native Alluvium Deposits: at 13 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.	28	24.1			3.0			
19		Standard Split Spoon	Bulk	No sample recovery.	44							
20				Total Depth: 20 ft. Groundwater at 13 ft. No Caving Backfilled and Compacted 4/27/2011								

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-8**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
	CL		Bulk	Native Lacustrine Deposits: Light Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands. Cohesive. Low porosity.		29.0						
5						27.4						
			Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.		29.7						
10	SM SC			at 11 ft Becomes wet olive brown fine silty sand with clay.								
		Static Water Table	Bulk	Groundwater at 12 ft. Saturated, dense, fine sand with silt and clay.								
15				Total Depth: 13 ft. Groundwater at 12 ft. No Caving Backfilled and Compacted 4/27/2011								
20												
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number:	TS646.1	Boring No:	**B-9**
Project:	Mt. Signal Solar Farm Seeley, CA	Boring Location:	See Figure 2
		Drive Wt:	40 lbs. 30" drop
Date Started:	4/27/2011	Rig:	Mob. w/4" augers
Date Completed:	4/27/2011	Grnd Elev.	-35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/ CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
5	CL		Bulk	Native Lacustrine Deposits: at 1 ft. becomes Light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands. Cohesive. Low porosity.		22.6						
			Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.		31.9						
10	SM SC		Bulk	at 11 ft Becomes wet olive brown fine silty sand with clay. Groundwater at 12 ft.		28.7						
		Static Water Table	Bulk	12 ft. Saturated, dense, fine sand with silt and clay (Alluvium). at 14.5 ft becomes more sandy (Alluvium)		35.0						
15												
20				Total Depth: 15 ft. Groundwater at 12 ft. No Caving Backfilled and Compacted 4/27/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm, Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-10**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/ CL			Fill/Crop Soil: dry, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
				Native Lacustrine Deposits:								
	CL	Standard Split Spoon	Bulk	Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine	18							
5		Standard Split Spoon	Bulk	sands and fine mica grains. Cohesive.	21	12.7			2.0			
		2.5" Ring		at 7.5 ft. becomes reddish and olive brown, very moist, stiff silty clay. No sample recovered.	22							
10	SM	Static Water Table; Standard Split Spoon	Bulk	at 9.5 ft Becomes wet olive brown fine silty sand with lean clays, med. Dense to dense, micaceous. No sample recovered.	27							
				Native Alluvium Deposits:								
	SP/ SC			at 12 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.	39	18.8			3.0			
15		Standard Split Spoon	Bulk									

Total Depth: 15 ft.
Groundwater at 10 ft.
No Caving
Backfilled and Compacted 4/27/2011

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-11**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Sample Type legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
0–1	ML/SC		Bulk	Fill/Crop Soil: Light brown, dry to moist, soft, clay and silt with ine-grained sand, fine micas.								
1–5	CL		Bulk	Native Lacustrine Deposits: At 1 ft becomes light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.								
5		Standard Split Spoon	Bulk		24	24.7			2.75			
6				at 6 ft. becomes reddish and olive brown, very moist, stiff silty clay.								
10		2.5" Ring		at 11.5 ft Becomes wet olive brown fine silty sand with lean clays.	25	28.5	92.2		3.75			
	SM											
13–15	SC/SP/SM	Standard Split Spoon	Bulk	Native Alluvium Deposits: at 13 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.	21	27.4			4.0			
16		Static Water Table		Groundwater at 16 ft., more granular.								
19		Standard Split Spoon	Bulk	No sample recovery.	29				3.0			
20												

Total Depth: 20 ft.
Groundwater at 16 ft.
No Caving
Backfilled and Compacted 4/27/2011

Depth scale: 1, 5, 10, 15, 20, 25, 30, 35, 40

LOG OF EXPLORATORY BORING

Job Number:	TS646.1	Boring No:	**B-12**
Project:	Mt. Signal Solar Farm Seeley, CA	Boring Location:	See Figure 2
		Drive Wt:	140 lbs. 30" drop
Date Started:	4/27/2011	Rig:	Mob. CME55 w/8" augers
Date Completed:	4/27/2011	Grnd Elev.	-30 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ °	Direct Shear: C psf	% Passing #200 Sieve
0–1	CL		Bulk	Fill/Crop Soil: Light brown, dry to moist, soft, clay and silty clay with trace fine-grained sand, fine micas.								
1–5	CL		Bulk	Native Lacustrine Deposits: Light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains. Cohesive.								
5		2.5" Ring	Bulk		26	22.2	88.3		1.0	22	288	
6.5				at 6.5 ft. becomes reddish and olive brown, very moist, stiff silty clay.								
11.5	CL	Split Spoon	Bulk	at 11.5 ft Becomes firm, very moist olive brown lean clays with trace fine sands.	17	16.4			2.5			
15		Split Spoon	Bulk		25	27.7			2.5			
16	SC/ SP/			Native Alluvium Deposits: at 16 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.								
20		Split Spoon	Bulk		17	29.5			2.25			
22	SM	Static Water Table		Groundwater at 22 ft., more granular. No sample recovery.								
25				Total Depth: 22 ft. Groundwater at 25 ft. No Caving Backfilled and Compacted 4/27/2011								

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-13**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ °	Direct Shear C psf	% Passing #200 Sieve
1	ML/ CL			Fill/Crop Soil: Light Brown, dry to moist, loose to soft, silty clay with trace fine-grained sand, fine micas,								
	CL	2.5" Ring		Native Lacustrine Deposits: Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine	21		89.9		2.25			
5		Split Spoon	Bulk	sands and fine mica grains. Low permeability.	21	24.5			2.5			
		Split Spoon	Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty lean clay.	21	23.3			3.0			
10	CL/ SM	Split Spoon	Bulk	at 10 ft Becomes olive brown, wet, fine silty sand with lean clays.	17	29.0			2.5			
		Static Water Table										
15	SC	Split Spoon	Bulk	Native Alluvium Deposits: at 14 ft. med. gray, med med. dense to dense, silty sand with trace clay.	22	28.2			2.0			

Total Depth: 15 ft.
Groundwater at 12 ft.
No Caving
Backfilled and Compacted 4/27/2011

Depth scale: 20, 25, 30, 35, 40

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm, Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-14**
Boring Location: See Figure 2
Drive Wt: 140 lbs. 30" drop
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend (Sample Type): Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
0–1	ML/CL			Fill/Crop Soil: Light Brown, dry to moist, loose to soft, silty clay with trace fine-grained sand, fine micas.								
1	CL			Native Lacustrine Deposits: at 1 ft. becomes Light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains. Low permeability.								
6		2.5" Ring Sample			20	21.1	97.8		2.5			
7				at 7 ft. becomes reddish and olive brown, very moist, stiff silty lean clay.								
10	CL/SM	Standard Split Spoon Sample; Static Water Table	Bulk Sample	at 10 ft Becomes olive brown, fine silty sand with lean clays, saturated (groundwater).	20	26.6			3.0			
11	SC			Native Alluvium Deposits: at 11 ft. med. gray, med. med. dense to dense, silty sand with trace clay.								
15		Standard Split Spoon Sample	Bulk Sample		22	26.3			2.25			

Total Depth: 15 ft.
Groundwater at 10 ft.
No Caving
Backfilled and Compacted 4/27/2011

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm, Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-15**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	OTHER TESTS
1	ML/CL		Bulk	Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.		18.8						OPT 8.50%
	CL		Bulk	Native Lacustrine Deposits: Light Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands. Cohesive. Low porosity.		23.8						MAX 125.0
5			Bulk			23.0						
			Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.		25.9						
10	SM		Bulk	at 11 ft Becomes wet olive brown fine silty sand with clay.		24.4						
	CL	Static Water Table	Bulk	Groundwater at 12 ft. 12 ft. Saturated, stiff, fine sand with silt and clay. (Alluvium). at 14.5 ft becomes more sandy (Alluvium)		25.9						
15			Bulk			29.2						

Total Depth: 15 ft.
Groundwater at 12 ft.
No Caving
Backfilled and Compacted 4/26/2011

EGA Consultants

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-16**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: ϕ °	Direct Shear: C psf	OTHER TESTS
1	ML/ CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
	CL			Native Lacustrine Deposits: Light Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands. Cohesive. Low porosity.		29.9						
5			Bulk	at 6 ft. becomes reddish and olive brown, very moist, stiff silty clay.		29.7						
			Bulk			27.9						
10	SM SC		Bulk	at 10 ft Becomes wet olive brown fine silty sand with clay. Groundwater at 13 ft.								
		Static Water Table	Bulk	12 ft. Saturated, stiff, fine sand with silt and clay (Alluvium). at 14.5 ft becomes more sandy (Alluvium)		32.3						
15												
20				Total Depth: 15 ft. Groundwater at 13 ft. No Caving Backfilled and Compacted 4/26/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number:	TS646.1	Boring No:	**B-17**
Project:	Mt. Signal Solar Farm Seeley, CA	Boring Location:	See Figure 2
		Drive Wt:	40 lbs. 30" drop
Date Started:	4/27/2011	Rig:	Mob. w/4" augers
Date Completed:	4/27/2011	Grnd Elev.	-35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	OTHER TESTS
1	ML/CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
				Native Lacustrine Deposits:								
	CL		Bulk	Light Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands. Cohesive. Low porosity.		25.8						
5			Bulk			23.8						
				at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.								
			Bulk			25.9						
10	SM SC			at 11 ft Becomes wet olive brown fine silty sand with clay.								
				Groundwater at 13 ft.								
		Static Water Table	Bulk	12 ft. Saturated, dense, fine sand with silt and clay (Alluvium).		28.7						
				at 14.5 ft becomes more sandy (Alluvium)								
15												
20				Total Depth: 15 ft. Groundwater at 13 ft. No Caving Backfilled and Compacted 4/27/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number:	TS646.1	Boring No:	**B-18**
Project:	Mt. Signal Solar Farm Seeley, CA	Boring Location:	See Figure 2
		Drive Wt:	140 lbs. 30" drop
Date Started:	4/27/2011	Rig:	Mob. CME55 w/8" augers
Date Completed:	4/27/2011	Grnd Elev.	-35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	% Passing #200 Sieve
1	ML/CL			Fill/Crop Soil: Light Brown, dry to moist, loose to soft, silty clay with trace fine-grained sand, fine micas,								
	CL	Standard Split Spoon	Bulk	Native Lacustrine Deposits: Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine	15	19.3			2.0			
5		2.5" Ring	Bulk	sands and fine mica grains.	23	26.1	85.2		3.0			
				at 7 ft. becomes reddish and olive brown, very moist, stiff silty lean clay.								
10	CL/SM	Standard Split Spoon	Bulk	at 10 ft Becomes olive brown, wet, fine silty sand with lean clays.	4.0	26.4			4.0			
	SP/SC	Static Water Table		Native Alluvium Deposits: at 11 ft. becomes med. gray, med. dense to dense, wet to saturated fine silty sand with trace clay.								
15		Standard Split Spoon	Bulk		17	34.2			3.0			
20				Total Depth: 15 ft. Groundwater at 13 ft. No Caving Backfilled and Compacted 4/27/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-19**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear φ°	Direct Shear C psf	OTHER TESTS
	ML/			Fill/Crop Soil: Dry, loose to soft, clayey silt	13				1.5			
1	CL	Split Spoon	Bulk	and silty clay with trace fine-grained sand, fine micas.		15.7						
				Native Lacustrine Deposits:								
		Ring		Light Olive brown, moist to very moist, firm to very	18	24.4	91.5		2.25			
	CL			stiff lean to fat clay and clayey silt with trace fine								
5		Split Spoon	Bulk	sands. Cohesive. Low porosity.	22	25.5			3.0			
				at 7 ft. becomes reddish and olive brown, very	28	29.5			3.25			
		Split Spoon	Bulk	moist, stiff silty clay.								
					32	32.1			3.0			
10	SM	Split Spoon	Bulk	at 11 ft Becomes wet olive brown fine silty sand with clay.								
	SC			Groundwater at 13 ft.								
				12 ft. Saturated, dense, fine sand with silt and clay (Alluvium).								
	SM	Static Water Table		at 14.5 ft becomes more sandy (Alluvium)								
15												
20				Total Depth: 15 ft. Groundwater at 13 ft. No Caving Backfilled and Compacted 4/27/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-20**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Sample Type legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	OTHER TESTS
1	ML/ CL		Bulk	Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.				0				
		Ring		Native Lacustrine Deposits:		12.4	112.7		3.0			
	CL			Light Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine								
5			Bulk	sands. Cohesive. Low porosity.		12.5						
			Bulk	at 7.5 ft. becomes reddish and olive brown, very moist, stiff silty clay.		20.8						
						20.9						
10	SM		Bulk	at 11 ft Becomes wet olive brown fine silty sand with clay.								
	SC			Groundwater at 14 ft.		25.8						
			Bulk	12 ft. Saturated, dense, fine sand with silt and clay (Alluvium).								
	SP	Static Water Table		at 14.5 ft becomes more sandy (Alluvium)								
15												
20				Total Depth: 15 ft. Groundwater at 14 ft. No Caving Backfilled and Compacted 4/27/2011								
25												
30												
35												
40												

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-21**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Sample Type legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	Soil Description	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	OTHER TESTS
0–1	ML/ CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
1–5	CL	2.5" Ring		Native Lacustrine Deposits: At 1.0 ft. becomes light Olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands. Cohesive. Low porosity.		12.1	103.9		3.0			
5			Bulk			11.5						
7				at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.		15.9						
9			Bulk			24.7						
10–11	SM SC		Bulk	at 11 ft Becomes wet olive brown gray, fine silty sand with clay, firm to dense.		31.6						
13			Bulk	13 ft. Saturated, dense, fine sand with silt and clay. (Alluvium).								
14.5	SP	Static Water Table		at 14.5 ft becomes more sandy (Alluvium).								

Total Depth: 15 ft.
Groundwater at 14 ft.
No Caving
Backfilled and Compacted 4/27/2011

LOG OF EXPLORATORY BORING

Job Number:	TS646.1	Boring No:	**B-22**
Project:	Mt. Signal Solar Farm	Boring Location:	See Figure 2
	Seeley, CA	Drive Wt:	40 lbs. 30" drop
Date Started:	4/27/2011	Rig:	Mob. w/4" augers
Date Completed:	4/27/2011	Grnd Elev.	-35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/ CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
		2.5" Ring		Native Lacustrine Deposits: At 1 ft. Becomes light olive brown, moist to very moist, firm to very		14.0	75.4		2.25			
5	CL		Bulk	stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains. Cohesive, low permeable clay.		18.5						
			Bulk	at 8 ft. becomes reddish and olive brown, very moist, stiff silty clay.		23.8						
10	SM SC		Bulk	at 10 ft Becomes wet olive brown fine silty sand with clay.		17.5						
			Bulk	Wet, firm to dense, fine sand with silt and clay.		19.3						
			Bulk			20.2						
15		Static Water Table	Bulk	Groundwater at 14 ft.		20.5						

Total Depth: 15 ft.
Groundwater at 14 ft.
No Caving
Backfilled and Compacted 4/27/2011

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-23**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Sample Type legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/ CL		Bulk	Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.		8.1						
		Ring		Native Lacustrine Deposits: At 1 ft. Becomes light olive brown, moist to very moist, firm to very		17.0	71.2		2.0			
	CL			stiff lean to fat clay and clayey silt with trace fine								
5			Bulk	sands and fine mica grains. Cohesive, low permeable clay.		21.8						
			Bulk	at 7 ft. becomes reddish and olive brown, very moist, stiff silty clay.		27.6						
						25.6						
10	SM SC		Bulk	at 10 ft Becomes wet, gray brown fine silty sand with clay.		28.5						
			Bulk			27.7						
		Static Water Table	Bulk	Wet, gray, firm to dense, fine sand with silt and clay.								
15			Bulk	Groundwater at 15 ft.		28.4						

Total Depth: 16 ft.
Groundwater at 15 ft.
No Caving
Backfilled and Compacted 4/26/2011

Depth scale: 20, 25, 30, 35, 40

EGA Consultants

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/26/2011
Date Completed: 4/26/2011

Boring No: **B-24**
Boring Location: See Figure 2
Drive Wt: 40 lbs. 30" drop
Rig: Mob. w/4" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	ML/ CL			Fill/Crop Soil: Dry to moist, loose to soft, clayey silt and silty clay with trace fine-grained sand, fine micas.								
	CL		Bulk	Native Lacustrine Deposits: At 1 ft. Becomes light olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains. Cohesive,		10.0						
5		Ring		low permeable clay.		21.7	99.5		3.0			
			Bulk	at 7.5 ft. becomes reddish and olive brown, very moist, stiff silty clay.		28.9						
10	SM SC		Bulk	at 10 ft Becomes wet, gray brown fine silty sand with clay.		17.2						
			Bulk			21.5						
			Bulk	Wet, gray, firm to dense, fine sand with silt and clay.								
		Static Water Table		Groundwater at 14 ft.		21.5						
15			Bulk	Becomes more granular (Alluvium)		28.2						

Total Depth: 15 ft.
Groundwater at 14 ft.
No Caving
Backfilled and Compacted 4/26/2011

Depth scale: 20, 25, 30, 35, 40

LOG OF EXPLORATORY BORING

Job Number:	TS646.1	Boring No:	**B-25**
Project:	Mt. Signal Solar Farm	Boring Location:	See Figure 2
	Seeley, CA	Drive Wt:	140 lbs. 30" drop
Date Started:	4/27/2011	Rig:	Mob. CME55 w/8" augers
Date Completed:	4/27/2011	Grnd Elev.	-35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen, tsf	Direct Shear: φ°	Direct Shear: C psf	% Passing #200 Sieve
1	SM SC			Fill/Crop Soil: Gray, dry to moist, loose to med. Dense fine silty sand and clay with trace fine micas.								9.5
	CL			Native Lacustrine Deposits: At 1 ft. Becomes gray and olive brown, moist to very moist, firm to very stiff lean to fat clay and clayey silt with trace fine sands and fine mica grains.	22				2.0			
5	SC			at 6 ft. becomes reddish brown, very moist, firm sandy clay.	23	15.1			2.25			
					22	22.7			2.5			
10				at 10 ft Becomes gray and brown fine silty sand and clay.	22	22.2			4.25			
	SM/ SC			Groundwater at 15 ft.								
15	SM/ SC			Native Alluvium Deposits: at 15 ft. becomes gray, med. dense to dense, saturated fine silty sand with trace clay, porous.	31	25.5			3.75			
20				same as above.	32	25.3			3.0			
25	SM			at 25 ft. becomes grayish brown, wet, dense, fine-grained silty sand.	36	30.4			2.0			
30	SP/ SC			at 30 ft. becomes gray, dense to firm, saturated, fine-grained silty sand and clay.	23	25.0			2.5			
35				Less clayey, more dense (sand interbedding).	47	24.5			2.75			
40					30	26.9			2.5			

CONTINUES -

LOG OF EXPLORATORY BORING

Job Number: TS646.1
Project: Mt. Signal Solar Farm
Seeley, CA
Date Started: 4/27/2011
Date Completed: 4/27/2011

Boring No: **B-25**
Boring Location: See Figure 2
Rig: Mob. CME55 w/8" augers
Grnd Elev. -35 ft. below MSL

Legend: Thin Wall Tube; 2.5" Ring Sample; Bulk Sample; Standard Split Spoon Sample; Static Water Table

Depth in Feet	Soil Type	Sample Type: Undisturbed	Sample Type: Bulk	SOIL DESCRIPTION	Blows/foot	Moisture Content, %	Dry Density, pcf	Expansion Index	Pocket Pen., tsf	Direct Shear: φ°	Direct Shear: C psf	Other Tests
40	SM	Standard Split Spoon	Bulk	Grayish brown, dense, saturated, fine silty sand, with trace clays, micaceous.	30	26.9			2.5			
45		Standard Split Spoon	Bulk	No sample recovery.	35				2.5			
50		Standard Split Spoon	Bulk	same as above.	36	26.1			3.0			

Total Depth: 50 ft.
Groundwater at 15 ft.
No Caving
Backfilled and Compacted 4/27/2011

(Depth scale continues to 55, 60, 65, 70, 75, 80 with no entries.)

APPENDIX B:

GEOTECHNICAL LABORATORY TEST RESULTS

By SoilWorks

SoilWorks
Earth Sciences Group
3130 Airway Avenue
Costa Mesa, CA 92626
T: 888-544-4164
www.soilworksinc.com

EGA Consultants
375-C Monte Vista Avenue
Costa Mesa, California 92627

June 7, 2011
Project No.114-057-10

Attention: Mr. David Worthington, C.E.G.

Subject: Laboratory Test Results
Mt. Signal Solar
Seeley, California

Dear Mr. Worthington:

SoilWorks, Inc. performed the requested laboratory tests on soil specimens delivered to our office for the subject project. The results of these tests are included as an attachment to this report.

We appreciate the opportunity of providing our services to you on this project. Should you have any questions, please contact the undersigned.

Sincerely,

SOILWORKS, INC.

REGISTERED PROFESSIONAL ENGINEER
DANIEL J. MORIKAWA
No. GE2726
Exp. 9-30-12
GEOTECHNICAL
STATE OF CALIFORNIA

By: ______________________
Daniel J. Morikawa, PE, GE
RGE 2726, Reg. Expires 9/30/12

Attachment: Laboratory Test Results
Distribution: Addressee (2 copies)

File: 114-057-10 Mt. Signal Solar, Seeley, CA.doc

LABORATORY TEST RESULTS

Summarized below are the results of requested laboratory testing on samples submitted to our office.

Dry Density and Moisture Content

Tabulated on Plate A, attached, are the requested results of field dry density and moisture contents of undisturbed soils samples retained in 2 3/8–inch inside diameter by one-inch height rings. Moisture only results were obtained from small bulk samples.

Soil Classification

Requested soil samples were classified using ASTM D2487 as a guideline and are based on visual and textural methods only. These classifications are shown below:

Sample Identification	Soil Description	Group Symbol
B-1 @ 5.0'	Silty Clay – Olive brown	CL
B-1 @ 7.5'	Silty Clay – Olive brown	CL
B-1 @ 10.0'	Silty Fine Sand –Olive brown	SM
B-1 @ 15.0'	Silty Fine Sand – Olive brown, with clay	SM
B-1 @ 20.0'	Clayey fine Sand – Olive brown	SC
B-1 @ 25.0'	Silty Fine Sand – Olive brown	SM
B-1 @ 30.0'	Fine Sand – Olive brown	SP
B-1 @ 35.0'	Fine Sand – Olive brown	SP
B-1 @ 40.0'	Fine Sand – Olive gray brown	SP
B-1 @ 45.0'	Fine Sand –Olive gray	SP
B-1 @ 50.0'	Fine Sand –Olive gray	SP

Direct Shear

Direct shear tests were performed on relatively undisturbed ring samples, identified as B-2 @ 2.5' and B-12 @ 5.0', with a direct shear machine of the strain-controlled type. The controlled rate of strain is 0.005 inch per minute. The samples were soaked in a confined state prior to shearing. Then the samples were sheared under varied loads ranging from 1.0 ksf to 4.0 ksf. The test results are plotted on Plate B-1 and B-2.

Sulfate Content

Selected bulk samples were tested for soluble sulfate content in accordance with Hach procedure. The test results are shown below:

Sample Identification	Water Soluble Sulfate In Soil (Percentage by weight (%))	Sulfate Exposure (UBC Table 19-A-4)
B-5 @ 0-4'	0.056	Negligible
B-22 @ 0-3'	0.051	Negligible

Expansion Index:

Bulk soil samples were tested for expansion potential following the ASTM D-4829 Test Procedure. Test results are presented below:

Sample Identification	Expansion Index	Expansion Potential (UBC 18-1-B)
B-2 @ 0-3'	43	Low
B-20 @ 0-3'	0	Very Low

Maximum Dry Density and Optimum Moisture Content

A maximum dry density and optimum moisture content test was performed on the requested bulk soil sample in accordance with ASTM: D 1557. The results are shown below:

Sample Identification	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
B-15 @ 0-3'	125.0	8.5

Consolidation

A consolidation test was performed on a relatively undisturbed sample of the soils identified as B-11 @ 10' to determine the compressibility characteristics. The sample was soaked during the test to simulate possible adverse field conditions. The test results are presented on Plate B-3.

Atterberg Limits Test

The results of Atterberg Limits test on the designated sample are shown below. These tests were performed in accordance with ASTM: D 4318.

Sample Identification	Liquid Limit %	Plastic Limit %	Plasticity Index %	Classification
B-2 @ 2.5'	41.8	13.2	28.6	CL

200 Wash Sieve

The following samples were tested in accordance with ASTM D: 1140 to determine the amount material finer than the No. 200 sieve by washing as an aid in classification of soil types. The test result is shown below.

Sample Location	Percent Passing
B-1 @ 0-4'	79.0
B-1 @ 6-11'	73.8
B-1 @ 25-35'	30.1
B-25 @ 0-5'	9.5

Particle Size Analysis

Soil samples were tested in accordance with ASTM: D 442 test procedure to determine soil particle size as an aid in classification of soil types. The test results are shown graphically on Plates B-4 through B-6.

PLATE A
LABORATORY MOISTURE / DENSITY TEST RESULTS

Boring	Depth	Dry Density, pcf	Moisture, %
B-1	2.5	88.8	12.0
B-1	5.0	*	20.1
B-1	7.5	*	26.0
B-1	10.0	*	25.5
B-1	15.0	*	23.5
B-1	20.0	*	17.2
B-1	25.0	*	26.9
B-1	30.0	*	21.1
B-1	35.0	*	21.7
B-1	40.0	*	21.2
B-1	45.0	*	22.2
B-1	50.0	*	18.8
B-2	2.5	102.9	20.5
B-2	3.5	*	19.8
B-2	6.0	*	22.2
B-2	10.0	*	35.0
B-3	4.0	93.8	23.5
B-3	7.5	*	28.5
B-3	10.0	*	31.8
B-3	15.0	*	24.8
B-4	2.5	*	18.9
B-4	5.0	*	20.5
B-4	10.0	99.0	21.5
B-4	15.0	*	27.1
B-4	20.0	*	24.5
B-5	2.5	98.8	23.0
B-5	5.0	96.2	24.7
B-5	7.5	*	25.0
B-5	7.5		
B-5	10.0	*	27.4

PLATE A
LABORATORY MOISTURE / DENSITY TEST RESULTS

Boring	Depth	Dry Density, pcf	Moisture, %
B-5	15.0	*	24.5
B-6	5.0	94.5	20.2
B-6	10.0	*	30.4
B-6	15.0	*	31.4
B-7	5.0	*	26.9
B-7	10.0	*	26.4
B-7	15.0	*	24.1
B-8	3.0	*	29.0
B-8	6.0	*	27.4
B-8	8.0	*	29.7
B-9	5.0	*	22.6
B-9	7.0	*	31.9
B-9	9.0	*	28.7
B-9	11.0	*	35.0
B-10	5.0	*	12.7
B-10	15.0	*	18.8
B-11	5.0	*	24.7
B-11	10.0	92.2	28.5
B-11	15.0	*	27.4
B-12	5.0	88.3	22.2
B-12	10.0	*	16.4
B-12	15.0	*	27.7
B-12	20.0	*	29.5
B-13	2.5	89.9	5.5
B-13	5.0	*	24.5
B-13	7.5	*	23.3
B-13	10.0	*	29.0
B-13	15.0	*	28.2

PLATE A
LABORATORY MOISTURE / DENSITY TEST RESULTS

Boring	Depth	Dry Density, pcf	Moisture, %
B-14	5.0	97.8	21.1
B-14	10.0	*	26.6
B-14	15.0	*	26.3
B-15	1.0	*	18.8
B-15	2.5	*	23.8
B-15	4.0	*	23.0
B-15	6.0	*	25.9
B-15	9.0	*	24.4
B-15	12.0	*	25.9
B-15	15.0	*	29.2
B-16	3.0	*	29.9
B-16	6.0	*	29.7
B-16	9.0	*	27.9
B-16	12.0	*	32.3
B-17	3.0	*	25.8
B-17	6.0	*	23.8
B-17	9.0	*	25.9
B-17	12.0	*	28.7
B-18	2.5	*	19.3
B-18	5.0	85.2	26.1
B-18	10.0	*	26.4
B-18	15.0	*	34.2
B-19	1.0	*	15.7
B-19	2.5	91.5	24.4
B-19	5.0	*	25.5
B-19	7.0	*	29.5
B-19	9.0	*	32.1
B-20	2.5	112.7	12.4
B-20	5.0	*	12.5
B-20	7.0	*	20.8
B-20	9.0	*	20.9

PLATE A
LABORATORY MOISTURE / DENSITY TEST RESULTS

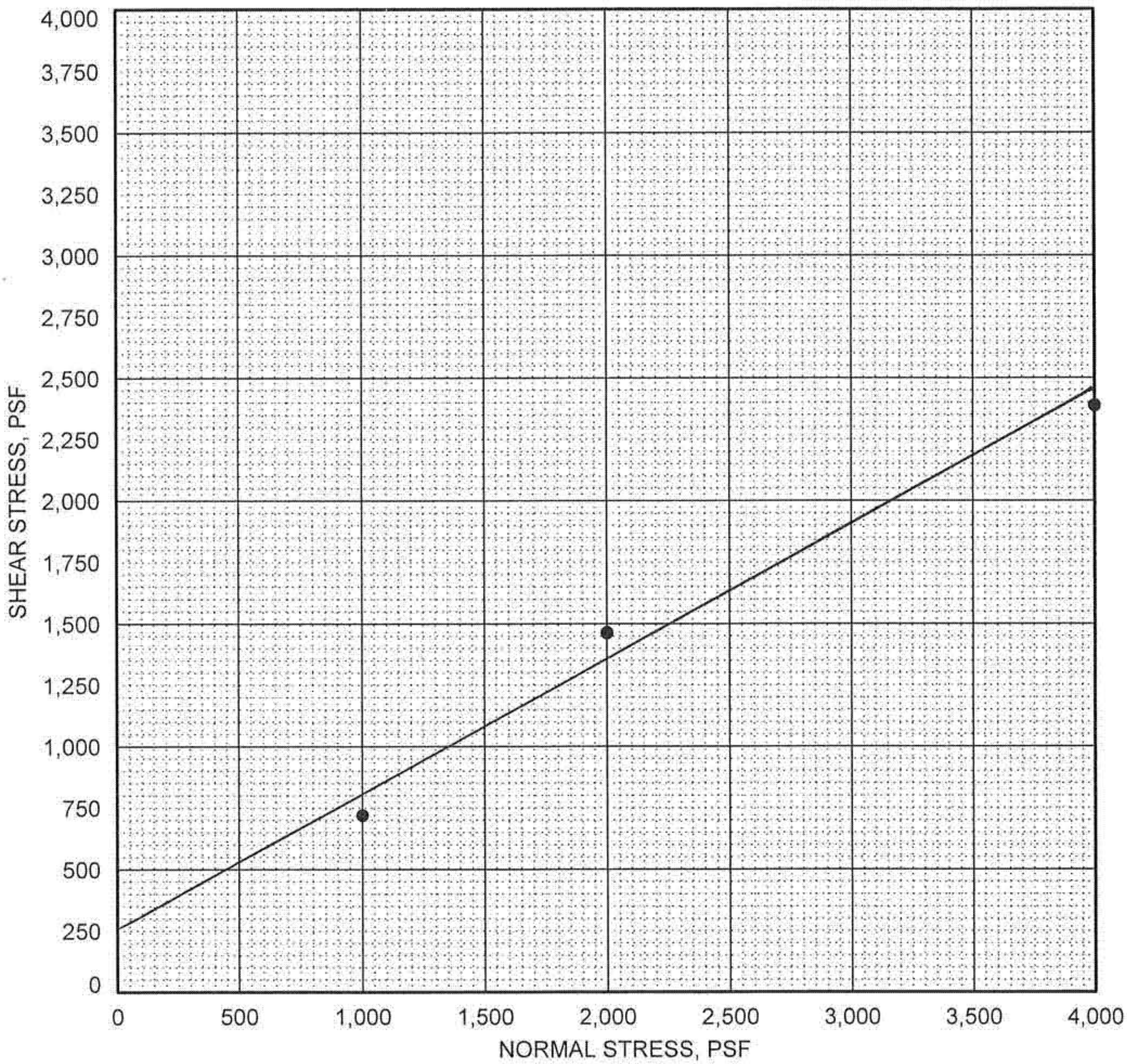
Boring	Depth	Dry Density, pcf	Moisture, %
B-20	11.0	*	25.8
B-21	2.5	103.9	12.1
B-21	5.0	*	11.5
B-21	7.0	*	15.9
B-21	9.0	*	24.7
B-21	11.0	*	31.6
B-21	13.0	*	29.4
B-22	2.5	75.4	14.0
B-22	5.0	*	18.5
B-22	7.0	*	23.8
B-22	9.0	*	17.5
B-22	11.0	*	19.3
B-22	13.0	*	20.2
B-22	15.0	*	20.5
B-23	1.0	*	8.1
B-23	2.5	71.2	17.0
B-23	5.0	*	21.8
B-23	7.0	*	27.6
B-23	9.0	*	25.6
B-23	11.0	*	28.5
B-23	13.0	*	27.7
B-23	15.0	*	28.4
B-24	2.5	*	10.0
B-24	5.0	99.5	21.7
B-24	7.0	*	28.9
B-24	9.0	*	17.2
B-24	11.0	*	21.5
B-24	13.0	*	21.5
B-24	15.0	*	28.2
B-25	5.0	*	15.1
B-25	7.5	*	22.7
B-25	10.0	*	22.2

PLATE A
LABORATORY MOISTURE / DENSITY TEST RESULTS

Boring	Depth	Dry Density, pcf	Moisture, %
B-25	15.0	*	25.5
B-25	20.0	*	25.3
B-25	25.0	*	30.4
B-25	30.0	*	25.0
B-25	35.0	*	24.5
B-25	40.0	*	26.9
B-25	50.0	*	26.1

Note (*): Small bulk soil samples for moisture determination only

DIRECT SHEAR TEST
Undisturbed



Mt. Signal Solar, Seeley, CA	COHESION	258	psf.
	FRICTION ANGLE	28.0	degrees

symbol	boring	depth (ft.)	symbol	boring	depth (ft.)
●	B-2	2.5			

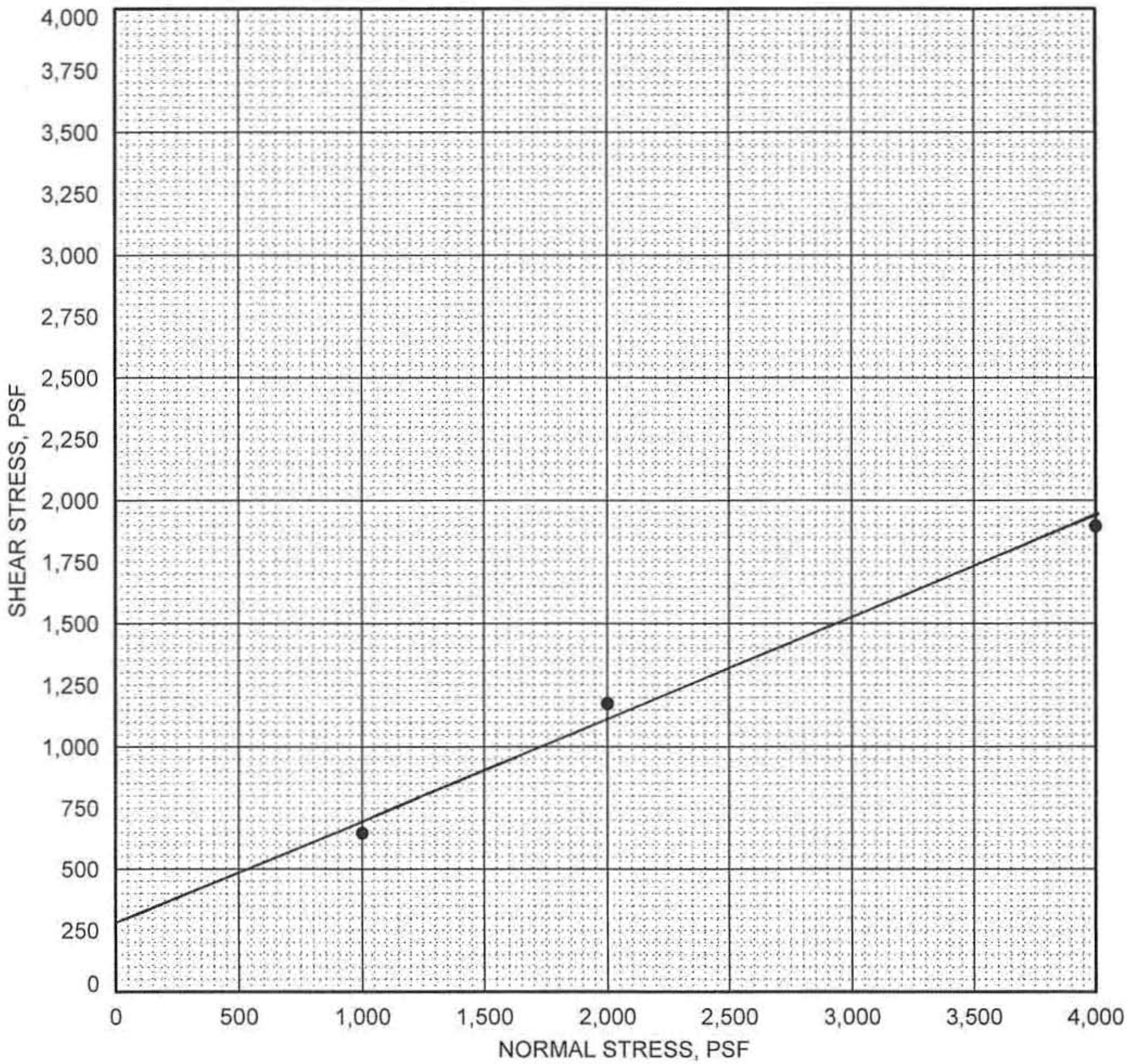
DIRECT SHEAR TEST

SoilWorks, Inc.
3130 Airway Avenue
Costa Mesa, CA 92626
714-668-5600

P.N. 114-057-10 **DATE 6/7/11**

PLATE B-1

DIRECT SHEAR TEST
Undisturbed



Mt. Signal Solar, Seeley, CA	COHESION	288	psf.
	FRICTION ANGLE	22.0	degrees

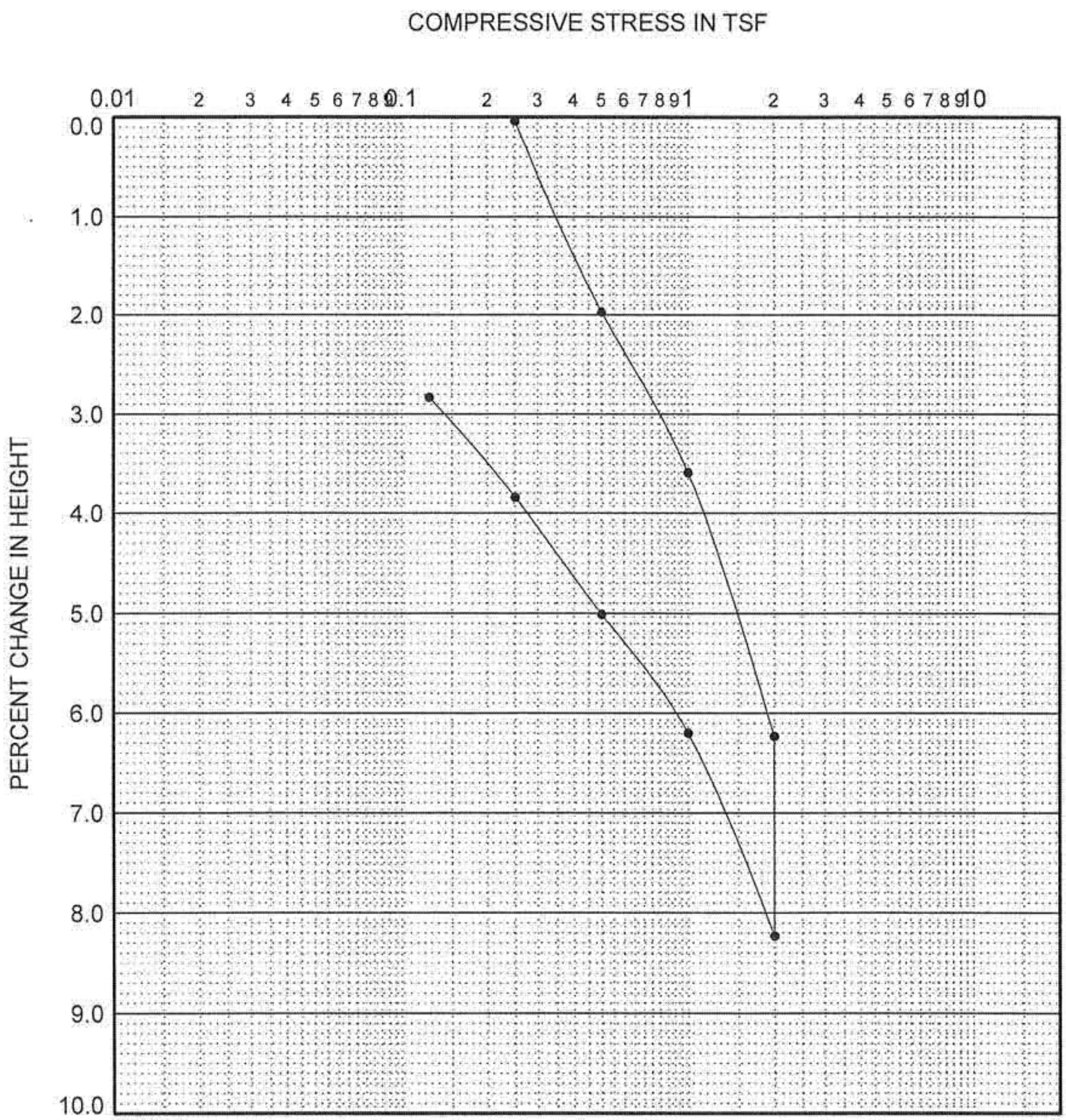
symbol	boring	depth (ft.)	symbol	boring	depth (ft.)
●	B-12	5.0			

DIRECT SHEAR TEST

SoilWorks, Inc.
3130 Airway Avenue
Costa Mesa, CA 92626 714-668-5600

P.N. 114-057-10 **DATE 6/7/11**

PLATE B-2

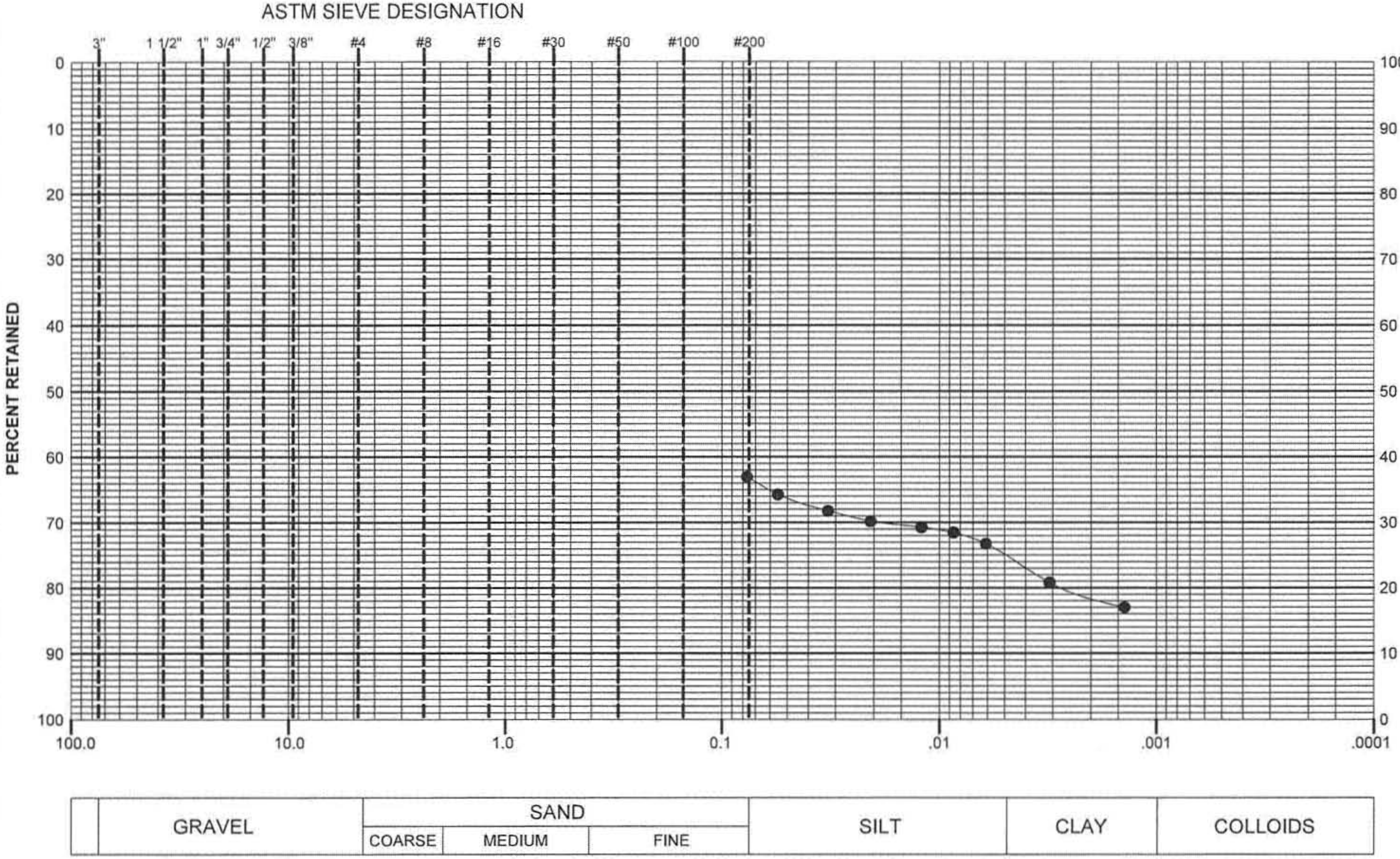


Boring	Depth(ft.)	Dry Density	in situ Moist.	-200 sieve	Group Symbol	Soil Description
B-11	10.0					Mt. Signal Solar, Seeley, CA

WATER ADDED AT 2 TSF.

CONSOLIDATION CURVE	**SoilWorks, Inc.** 3130 Airway Avenue Costa Mesa, CA 92626 714-668-5600 **PN 114-057-10** **DATE 6/7/11**

PLATE B-3



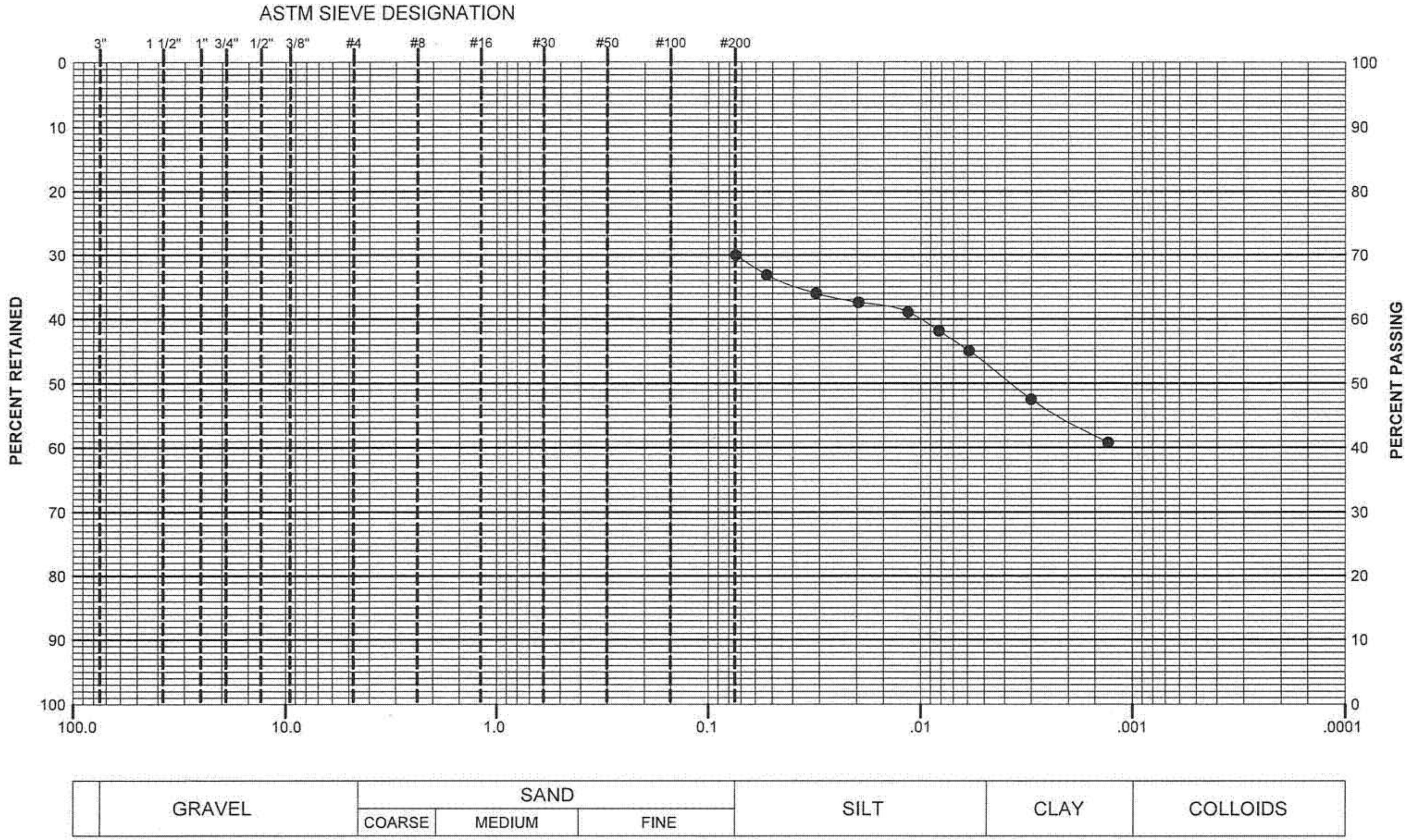
Symbol	Boring or Trench	Depth (ft.)	L.L.	P.L.	P.I.	% Passing #200 sieve	Group Symbol	Typical Names
●	B-1	0 - 4						

GRAIN SIZE DISTRIBUTION

SoilWorks, Inc.
3130 Airway Avenue
Costa Mesa, CA 92626 714-668-5600

P.N. 114-057-10 DATE 6/7/11

PLATE B-4

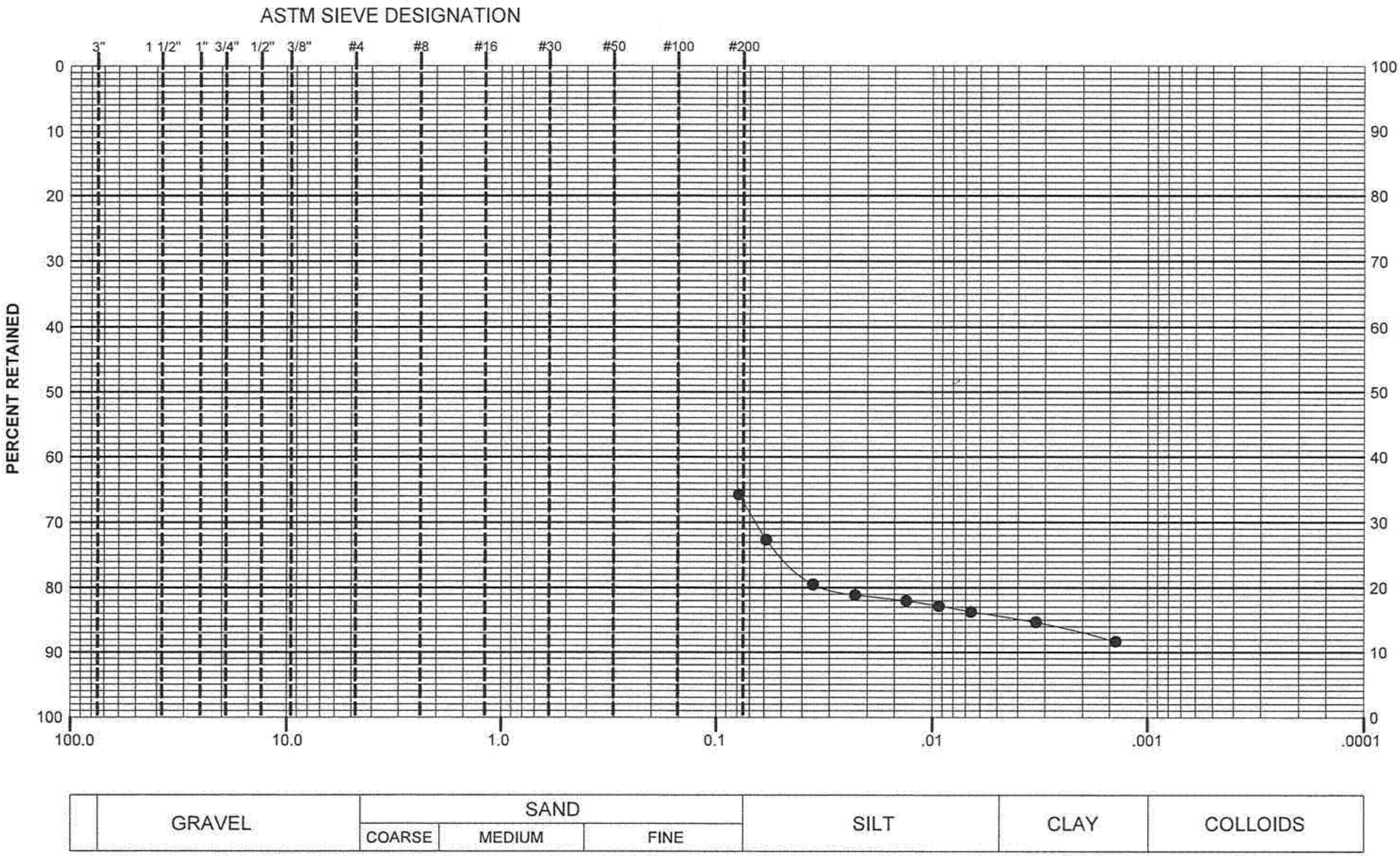


Symbol	Boring or Trench	Depth (ft.)	L.L.	P.L.	P.I.	% Passing #200 sieve	Group Symbol	Typical Names
●	B-1	6-10						

GRAIN SIZE DISTRIBUTION

SoilWorks, Inc.
3130 Airway Avenue
Costa Mesa, CA 92626
714-668-5600

P.N. 114-057-10 **DATE 6/7/11**



Symbol	Boring or Trench	Depth (ft.)	L.L.	P.L.	P.I.	% Passing #200 sieve	Group Symbol	Typical Names
●	B-1	25-35						

GRAIN SIZE DISTRIBUTION

SoilWorks, Inc.
3130 Airway Avenue
Costa Mesa, CA 92626 714-668-5600

P.N. 114-057-10 **DATE 6/7/11**

APPENDIX C:

TEST RESULTS

Corrosivity by HDR/Schiff
Thermal Resistivity by Geothermal USA

June 14, 2011 via email: Worthy10@aol.com

EGA CONSULTANTS, LLC.
375-C Monte Vista Avenue
Costa Mesa, CA 92627

Attention: Mr. David A. Worthington, C.E.G.

Re: Soil Corrosivity Study
Mt. Signal Solar
Seeley, California
HDR|Schiff #11-0424SCS

INTRODUCTION

Field and laboratory tests have been completed for the subject project. The proposed construction consists of a solar power plant located in Seeley, California. Perched groundwater was generally encountered by the consultant during the drilling of 25 borings in April of 2011between 10-15 below grade.

Laboratory tests have been completed on two soil samples provided by EGA Consultants. The purpose of these tests was to determine the electrical resistivity of the soil for grounding design and to determine if the soil might have deleterious effects on underground utility piping and concrete structures.

For grounding design, soil electrical resistivity values are provided as 'data only' in order to aid other engineers in their design.

The scope of this study is limited to a determination of soil corrosivity and general corrosion control recommendations for materials likely to be used for construction. Our recommendations do not constitute, and are not meant as a substitute for, design documents for the purpose of construction. If the architects and/or engineers desire more specific information, designs, specifications, or review of design, HDR|Schiff will be happy to work with them as a separate phase of this project.

TEST PROCEDURES

The electrical resistivity of the soil was measured in place at five locations using the Wenner Four Pin Method per ASTM G57. This procedure gives the average resistivity to a depth equal to the spacing between the pins. Approximate pin spacings of 2.5, 5, 20, and 50 feet were used so that variations with depth could be evaluated. Strata resistivities were calculated from resistance data using the Barnes Procedure. Test results are shown in Table 1. The boring location map provided by EGA Consultants is included. HDR|Schiff performed Wenner pin tests adjacent to boring locations B-3 and B-24 (see figure attached). HDR|Schiff performed the two Wenner Four pin tests.

The electrical resistivity of each sample was measured in a soil box per ASTM G187 in its as-received condition and again after saturation with distilled water. Resistivities are at about their lowest value when the soil is saturated. The pH of the saturated samples was measured per ASTM G51. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327, D6919, and D513. Test results are shown in Table 2.

SOIL CORROSIVITY

A major factor in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. Corrosion currents, following Ohm's Law, are inversely proportional to soil resistivity. Lower electrical resistivities result from higher moisture and soluble salt contents and indicate corrosive soil.

A correlation between electrical resistivity and corrosivity toward ferrous metals is:[1]

Soil Resistivity in ohm-centimeters	Corrosivity Category
Greater than 10,000	Mildly Corrosive
2,000 to 10,000	Moderately Corrosive
1,000 to 2,000	Corrosive
0 to 1,000	Severely Corrosive

Other soil characteristics that may influence corrosivity towards metals are pH, soluble salt content, soil types, aeration, anaerobic conditions, and site drainage.

The average resistivities and stratum resistivities measured in the field were in the mildly to severely corrosive categories.

Electrical resistivities measured in the laboratory were in the mildly corrosive category with as-received moisture. When saturated, the resistivities were in the moderately to severely corrosive categories. The resistivities dropped considerably with added moisture because the samples were dry as-received.

Soil pH values varied from 7.6 to 8.1. This range is mildly to moderately alkaline.[2] These values do not particularly increase soil corrosivity.

---

[1] *Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, pp. 166–167.*

[2] *Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, p. 8.*

The soluble salt content of the samples ranged from low to very high. The soluble salt content was very high in the sample from boring B-3 @ 0-4' and less in the other. Chloride and sulfate salts were the predominant constituents. Chloride is particularly corrosive to ferrous metals, and in the higher concentrations measured in the soil samples, chloride can overcome the corrosion inhibiting effect of concrete on reinforcing steel. High concentrations of sulfate, as was measured in the soil samples, can react with components in concrete to cause degradation and reduced strength in a mechanism known as sulfate attack.

The ammonium and nitrate concentration was high enough to be aggressive to copper.

Tests were not made for sulfide and negative oxidation-reduction (redox) potential because these samples did not exhibit characteristics typically associated with anaerobic conditions.

This soil is classified as severely corrosive to ferrous metals, aggressive to copper, severe for sulfate attack on concrete, and aggressive with respect to exposure of reinforcing steel to the migration of chloride.

CORROSION CONTROL RECOMMENDATIONS

The life of buried materials depends on thickness, strength, loads, construction details, soil moisture, etc., in addition to soil corrosivity, and is, therefore, difficult to predict. Of more practical value are corrosion control methods that will increase the life of materials that would be subject to significant corrosion.

The following recommendations are based on the soil conditions discussed in the Soil Corrosivity section above. Unless otherwise indicated, these recommendations apply to the entire site or alignment.

Steel Pipe

Implement *all* the following measures:

1. Underground steel pipe with rubber gasketed, mechanical, grooved end, or other nonconductive type joints should be bonded for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection.
2. Install corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection:
    a. At each end of the pipeline.
    b. At each end of all casings.
    c. Other locations as necessary so the interval between test stations does not exceed 1,200 feet.
3. To prevent dissimilar metal corrosion cells and to facilitate the application of cathodic protection, electrically isolate each buried steel pipeline per NACE Standard SP0286 from:
    a. Dissimilar metals.

   b. Dissimilarly coated piping (cement-mortar vs. dielectric).
   c. Above ground steel pipe.
   d. All existing piping.
4. Apply a suitable dielectric coating intended for underground use such as:
   a. Polyurethane per AWWA C222 *or*
   b. Extruded polyethylene per AWWA C215 *or*
   c. A tape coating system per AWWA C214 *or*
   d. Hot applied coal tar enamel per AWWA C203 *or*
   e. Fusion bonded epoxy per AWWA C213.
5. Apply cathodic protection to steel piping as per NACE Standard SP0169.

NOTE: Some steel piping systems, such as for oil, gas, and high-pressure piping systems, have special corrosion and cathodic protection requirements that must be evaluated for each specific application.

Iron Pipe

Implement *all* the following measures:

1. Electrically insulate underground iron pipe from dissimilar metals and from above ground iron pipe with insulating joints per NACE Standard SP0286.
2. Bond all nonconductive type joints for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection.
3. Install corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection:
   a. At each end of the pipeline.
   b. At each end of any casings.
   c. Other locations as necessary so the interval between test stations does not exceed 1,200 feet.
4. Apply a suitable coating intended for underground use such as:
   a. Polyethylene encasement per AWWA C105; *or*
   b. Epoxy coating; *or*
   c. Polyurethane; *or*
   d. Wax tape.

   NOTE: The thin factory-applied asphaltic coating applied to ductile iron pipe for transportation and aesthetic purposes does not constitute a corrosion control coating.
5. Apply cathodic protection to cast and ductile iron piping as per NACE Standard SP0169.

Copper Tubing

Protect buried copper tubing by *one* of the following measures:

1. Prevention of soil contact. Soil contact may be prevented by placing the tubing above ground or encasing the tubing using PVC pipe with solvent-welded joints.
2. Installation of a factory-coated copper pipe with a minimum 25-mil thickness such as Kamco's Aqua Shield™, Mueller's Streamline Protec™, or equal. The coating must be continuous with no cuts or defects.

3. Installation of 12-mil polyethylene pipe wrapping tape with butyl rubber mastic over a suitable primer. Protect wrapped copper tubing by applying cathodic protection per NACE Standard SP0169.

Plastic and Vitrified Clay Pipe

1. No special precautions are required for plastic and vitrified clay piping placed underground from a corrosion viewpoint.
2. Protect all metallic fittings and valves with wax tape per AWWA C217 or epoxy.

All Pipe

1. On all pipes, appurtenances, and fittings not protected by cathodic protection, coat bare metal such as valves, bolts, flange joints, joint harnesses, and flexible couplings with wax tape per AWWA C217 after assembly.
2. Where metallic pipelines penetrate concrete structures such as building floors, vault walls, and thrust blocks use plastic sleeves, rubber seals, or other dielectric material to prevent pipe contact with the concrete and reinforcing steel.

Concrete

1. Protect concrete structures and pipe from sulfate attack in soil with a severe sulfate concentration, 0.2 to 2.0 percent. Use Type V cement, a maximum water/cement ratio of 0.45, and minimum strength of 4500 psi per applicable code.[3,4,5,6]
2. Chloride levels were measured at levels[7] where additional protective measures are required for concrete. Protect steel and iron embedded in concrete structures and pipe from chloride

---

[3] 1997 Uniform Building Code (UBC) Table 19-A-4

[4] 2006 International Building Code (IBC) which refers to American Concrete Institute (ACI-318) Table 4.3.1

[5] 2006 International Residential Code (IRC) which refers to American Concrete Institute (ACI-318) Table 4.3.1

[6] 2007 California Building Code (CBC) which refers to American Concrete Institute (ACI-318) Table 4.3.1

attack. This applies to such items as reinforcing steel and anchor bolts but not post-tensioning strands and anchors. The protection could be one or a combination of the following:

a. Protective Concrete - A concrete mix designed to protect embedded steel and iron that should be based on the following parameters: 1) a chloride content of 3,600 ppm in the soil; 2) the desired service life; and 3) concrete cover. A protective concrete mix may include a corrosion inhibitor admixture and/or silica fume admixture.

b. Waterproof Concrete - Waterproofing for concrete could be a gravel capillary break under the concrete, a waterproof membrane, and/or a liquid applied waterproof barrier coating such as Grace PrePrufe® product. Visqueen, similar rolled barriers, or bentonite-based membranes are not viable waterproofing systems, from a corrosion standpoint.

c. Coat Embedded Metal - A coating for embedded steel and iron could be an epoxy coating applied to the metal. Purple fusion bonded epoxy (FBE) (ASTM A934) intended for prefabricated reinforcing steel reinforcing steel is suitable. The green flexible FBE (ASTM A775) is not recommended.

d. Cathodic Protection - Cathodic protection is most practical for pipelines and must be designed for each application. The amount of cathodic protection current needed can be minimized by coating the steel or iron.

3. Due to the high perched ground water encountered at this site, cyclical or continual wetting may be an issue. Any contact between concrete structures and ground water should be prevented. Contact can be prevented with an impermeable waterproofing system.

Resistivity for Electrical Grounding System

1. Refer to Table 1 for average soil resistivity values to depth for design of electrical ground grids and ground rods for the proposed site.

Steel Piles

1. Steel piles are most susceptible to corrosion in disturbed soil where oxygen is available. Further, a dissimilar environment corrosion cell would exist between the steel embedded in concrete, such as pile caps and the steel in the soil. In the cell, the steel in the soil is the anode (corroding metal), and the steel in concrete is the cathode (protected metal). This cell can be minimized by coating the part of the steel piles that will be embedded in concrete to prevent contact with concrete and reinforcing steel.

---

[7] *Design Manual 303: Concrete Cylinder Pipe. Ameron. p.65*

Alternative 1: Coated Piles

Coat the piles with coal tar epoxy or polyurethane recommended by the manufacturer for the steel piles; apply to 25 mil thickness per manufacturer's recommendations.

Alternative 2: Coat Upper Portion of Pile

Coat the piles from the top to 10 feet below the water table. For the remainder use a corrosion allowance of 0.05 inches.

Alternative 3: Bare Piles

Corrosion rates in disturbed soil, such as fill and loose native soil, and/or within 3 feet of the water table are estimated to be 0.006 inches per year for single side corrosion or 0.167 inches per year for double sided based upon soil similarities to published data.[8] Therefore, for a twenty-five year design life provide a corrosion allowance of 0.42 inches above what is required for structural capacity for H-piles and 0.21 inches for pipe piles with sealed bottoms. In undisturbed soil use a corrosion allowance of 0.05 inches.

All Steel Piles

1. After driving, cutoff, and welding any steel to be welded to the piles, coat exposed steel in the piles and bare steel welded to the piles to prevent pile/concrete contact and to prevent electrical contact between the piles and bare steel such as reinforcing steel and anchor bolts. Abrasive blast and use at least 8 mils dry film thickness of polyurethane or coal tar epoxy intended for underground use or coat with mastic such as Polyken 900 12-mil tape wrap with a 1027 primer or equivalent. Irregular shaped surfaces that can't be coated with the tape wrap can be coated with wax tape per AWWA C217. The coating should be allowed to cure at least hard enough to prevent damage by the placement of reinforcing steel and concrete before those materials are placed.

2. Steel pipe pile interiors may be protected by filling them with concrete or hermetically sealing the ends.

[8] *Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, pp. 19–20, 110.*

CLOSURE

Our services have been performed with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended.

Please call if you have any questions.

Respectfully Submitted,
SCHIFF ASSOCIATES

Leobardo Solis

Steven R. Fox, P.E.

REGISTERED PROFESSIONAL ENGINEER
STEVEN R. FOX
CR 1137
EXP 3/31/13
CORROSION
STATE OF CALIFORNIA

Enc: Table 1-Soil Electrical Resistivity Field Tests
Table 2-Laboratory Tests on Soil Samples
Boring Map

Table 1 - Soil Resistivity Field Tests

EGA Consultants, LLC
Mt. Signal Solar
HDR|Schiff #11-0424SCS
17-May-11

LOCATION	DEPTH (feet)	MEASURED RESISTANCE (ohms)	AVERAGE RESISTIVITY TO DEPTH (ohm-cm)	STRATUM RESISTIVITY (ohm-cm)
B-3 North/South Direction	2.5	0.50	239	239
	5.0	0.28	268	305
	10.0	0.24	460	1,609
	20	0.10	383	328
	50	0.08	766	2,298
B-3 East/West Direction	2.5	0.41	196	196
	5.0	0.25	239	307
	10	0.22	421	1,755
	20	0.11	421	421
	50	0.05	479	527
B-24 North/South Direction	2.5	3.4	1,628	1,628
	5.0	2.0	1,915	2,325
	10	1.6	3,064	7,660
	20	1.1	4,213	6,741
	50	0.49	4,692	5,076

CORROSIVITY LEGEND (FERROUS METALS)			
Mildly	Moderately	Corrosive	Severely

Table 1 - Soil Resistivity Field Tests

EGA Consultants, LLC
Mt. Signal Solar
HDR|Schiff #11-0424SCS
17-May-11

LOCATION	DEPTH (feet)	MEASURED RESISTANCE (ohms)	AVERAGE RESISTIVITY TO DEPTH (ohm-cm)	STRATUM RESISTIVITY (ohm-cm)
				1,963
B-24	2.5	4.1	1,963	
East/West Direction				3,402
	5.0	2.6	2,490	
				3,395
	10	1.5	2,873	
				3,756
	20	0.9	3,256	
				7,695
	50	0.52	4,979	

CORROSIVITY LEGEND (FERROUS METALS)			
Mildly	Moderately	Corrosive	Severely

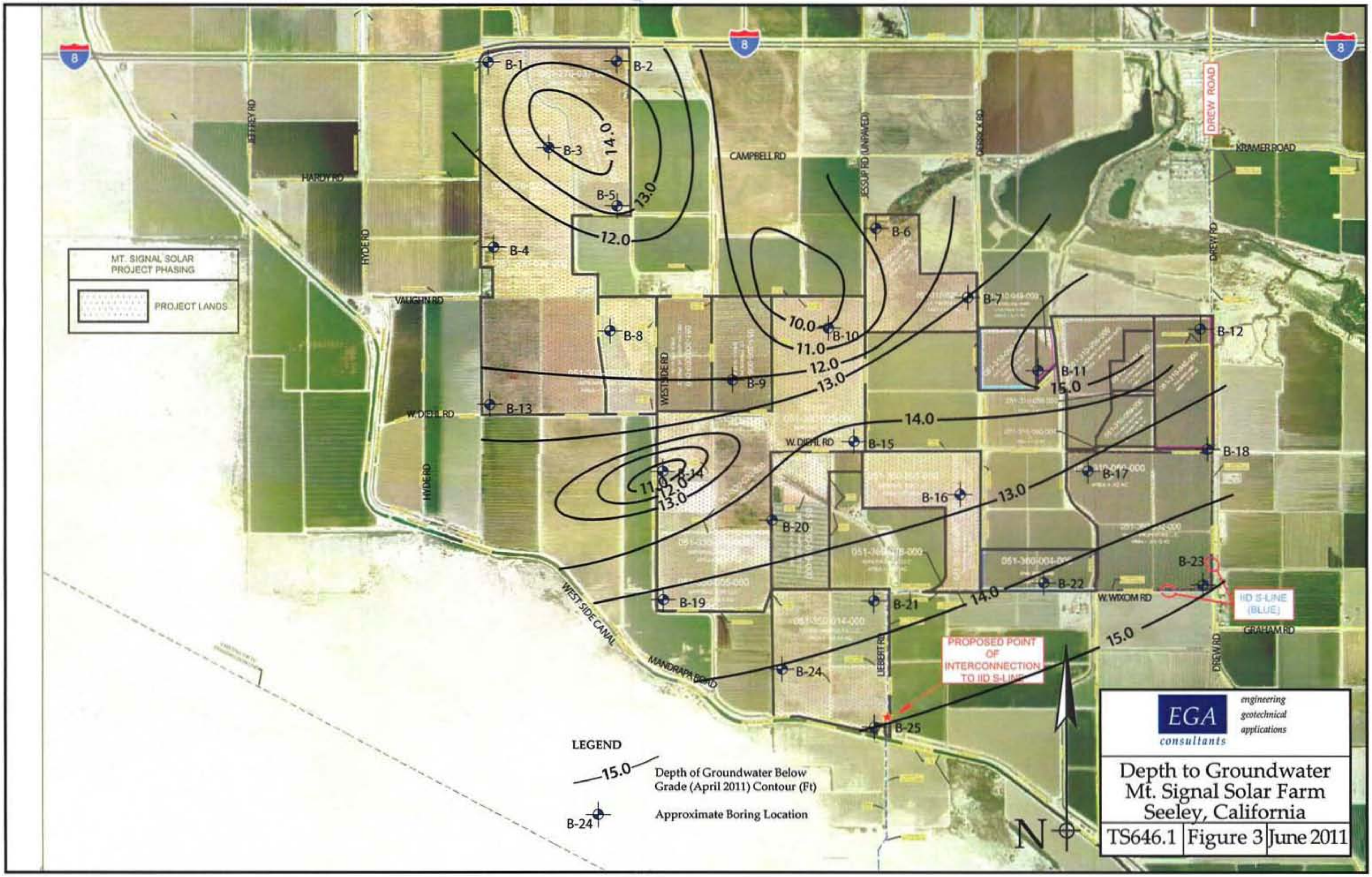
Table 2 - Laboratory Tests on Soil Sample(s)

EGA Consultants, LLC
Mt. Signal Solar
Your #TS646.1, HDR|Schiff #11-0424SCS
11-May-11

Sample ID			B-3 @ 0'-4' ML/CL	B-24 @ 0'-3' ML/CL
Resistivity		**Units**		
as-received		ohm-cm	27,600	72,000
minimum		ohm-cm	141	2,990
pH			7.6	8.1
Electrical Conductivity		mS/cm	5.34	0.11
Chemical Analyses				
Cations				
calcium	Ca^{2+}	mg/kg	2,295	57
magnesium	Mg^{2+}	mg/kg	305	11
sodium	Na^{1+}	mg/kg	4,005	63
potassium	K^{1+}	mg/kg	154	13
Anions				
carbonate	CO_3^{2-}	mg/kg	ND	24
bicarbonate	HCO_3^{1-}	mg/kg	98	55
fluoride	F^{1-}	mg/kg	1.1	0.5
chloride	Cl^{1-}	mg/kg	3,541	21
sulfate	SO_4^{2-}	mg/kg	8,573	87
phosphate	PO_4^{3-}	mg/kg	ND	2.3
Other Tests				
ammonium	NH_4^{1+}	mg/kg	32	1.1
nitrate	NO_3^{1-}	mg/kg	115	19
sulfide	S^{2-}	qual	na	na
Redox		mV	na	na

Minimum resistivity per CTM 643, Chlorides per CTM 422, Sulfates per CTM 417

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed



Depth to Groundwater
Mt. Signal Solar Farm
Seeley, California

TS646.1	Figure 3	June 2011

GeothermUSA
http://www.geotherm.net
6354 Clark Ave.
Dublin, CA 94568
Tel: 925-999-9232
Fax: 925-999-8837
info@geothermusa.com

May 10, 2011

EGA Consultants
375-C Monte Vista Ave
Costa Mesa, CA 92627
Attn: David A. Worthington, PEG

Re: Thermal Analysis of Native Soil Sample
El Centro Solar Project – El Centro, CA

The following is the report of thermal dryout characterization tests conducted on one (1) undisturbed tube sample of native soil.

Thermal Resistivity Tests: A laboratory type thermal probe with a thermistor type temperature sensor was installed in the sample. A series of thermal resistivity measurements were made to establish the thermal dryout characteristics. The tests were conducted in accordance with IEEE Standard using our Thermal Property Analyzer Model TPA-2000. The thermal dryout curve is presented in **Figure 1**.

Test Results:

Sample ID	Visual Description	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
		Wet	Dry		
B-3 @ 1.5'	Red Brown Silty Clay/Clayey SILT with trace micaceous fine sand	63	170	13	94

Comments: The thermal characteristic depicted in Figure 1 applies for the material at the test dry density reported above.

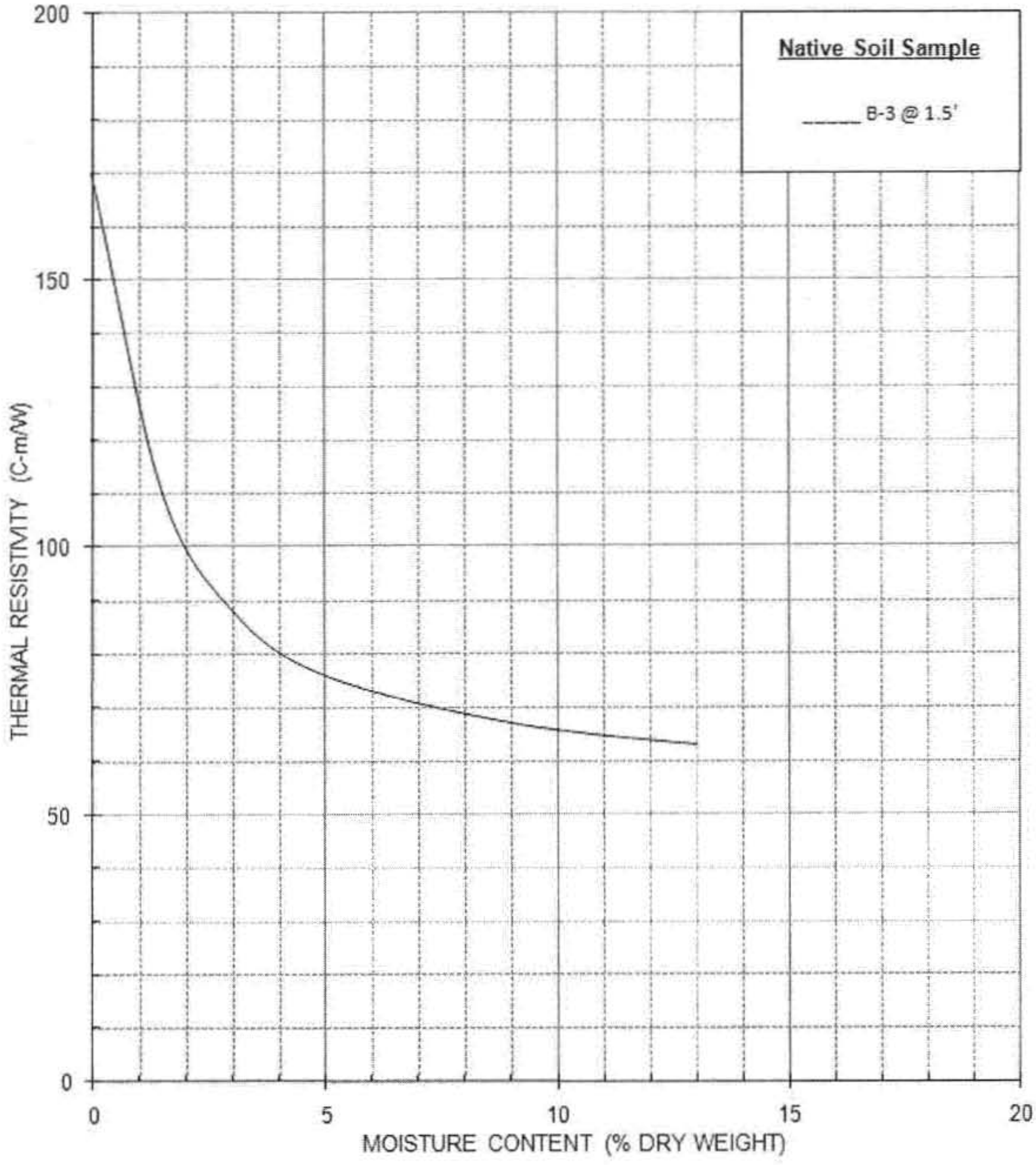
Geotherm USA

Nimesh Patel

Please Note: All samples will be disposed of after 5 days from date of report.

GeothermUSA

THERMAL DRYOUT CHARACTERISTIC



EGA Consultants

Thermal Analysis of Native Soil

El Centro Solar Project - El Centro, CA

May 2011 **Figure 1**

(1) RE: NATIVE SOIL SAMPLE (UNDISTURBED - BRASS TUBE) FOR THERMAL ANALYSIS (THERMAL RESISTIVITY, W/ THERMAL DRY-OUT CURVES, ASTM D5334).

GEOTHERM USA

Chain Of Custody Form

shipped 4/29/11 VIA FED EX ($60.00)

Please include this form in a Ziploc bag for each sample submitted:

Shipper -Company Name: EGA CONSULTANTS

Shipper -Contact Name: DAVID WORTHINGTON

Project Name: EL CENTRO SOLAR

Project Location: EL CENTRO, CA

Sample Location/ID: B-3 @ 1.5'

Sample Collection Date: 4/26/11 Sample Depth: 1.5'

Soil Description: RED. BRN. SILTY CLAY / CLAYEY SILT (ML/CL) W/ TRACE MICACEOUS FINE SAND.

Does the sample require recompaction: __Yes? ✓No?

- If the sample requires recompaction:

1. What is the % compaction required?

   a. _____ (85%, 90%, 95% or specific density)

2. What is the starting moisture content?

   a. ____ As Received/In-situ?

   b. ____ Optimum?

EGA consultants

engineering geotechnical applications

David A. Worthington
Principal Engineering Geologist
CEG 2124

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