Appendix F

Geotechnical Evaluation

Geotechnical Engineering Report

Athos Solar Facility

Desert Center, California

June 29, 2018

Terracon Project No. 60185052

Prepared for:

Intersect Power
San Francisco, California

Prepared by:

Terracon Consultants, Inc.
Tustin, California

terracon.com

Terracon

Environmental ■ Facilities ■ Geotechnical ■ Materials

June 29, 2018

Intersect Power
2 Embarcadero Center, 7th Floor
San Francisco, CA 94118

Attn: Mr. Seth Israel, Partner
M: 415-312-9911
E: seth@intersectpower.com

RE: Geotechnical Engineering Report
Athos Solar Facility
Desert Center, Riverside County, California
Terracon Project No. 60185052

Dear Mr. Israel,

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with our proposal, and discussions with the client. This report provides a description of subsurface exploration, in-situ soil resistivity testing, and laboratory testing. Based on field and laboratory test results, this report provides geotechnical engineering recommendations concerning earthwork and the design and construction of the proposed structures and site development elements for this project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.

Joshua R. Morgan P.E.
Project Engineer

F. Fred Buhamdan, P.E.
Principal

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GEOTECHNICAL ENGINEERING REPORT
ATHOS SOLAR FACILITY
DESERT CENTER, CALIFORNIA
Terracon Project No. 60185052
June 29, 2018

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed Athos Solar Facility Project. The proposed facility is comprised of multiple segregated abnormally shaped parcels located north and east of Desert Center, Riverside County, California. The Site Location Plan (Exhibit A-1) is included in Appendix A of this report. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- earthwork
- driven pile design and construction
- drilled shaft design and construction
- lateral earth pressures
- groundwater conditions
- pavement/roadway design and construction
- shallow foundation design and construction

Terracon's geotechnical engineering scope of work for this project included the advancement of thirty-seven (37) borings to approximate depths ranging between 21½ and 51½ feet below the ground surface (bgs) and forty (40) test pits to approximate depths of 10 feet bgs. In addition to the subsurface exploration, forty-five (45) field electrical resistivity surveys were performed. Furthermore, in-situ pile tests were performed on eighty (80) test piles installed at forty (40) locations.

Logs of the borings and test pits along with "Boring and Test Location Diagrams" (Exhibits A-2 through A-6) are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	Refer to the Site Plan and Boring and Test Location Diagrams (Exhibit A-1 and A-2 through A-6 in Appendix A).

ITEM	DESCRIPTION
Proposed Structures	It is our understanding that the Client intends to develop a photovoltaic (PV) electric power plant on the site. Ultimately, the power plant will consist of solar panels installed on steel structures and various other equipment and appurtenances associated with the power plant. The project also includes a total of five (5) substations and multiple transmission lines interconnecting the lot clusters and connecting to the Red Bluff substation located south of the I-10 freeway. The substation and transmission line development will include transformers, overhead transmission towers, bus supports, and self-contained support structures. Transmission line structures are not included in this phase of the project.
Maximum Loads (assumed)	Structural loads were not provided, but have been estimated based on our experience on projects: ■ PV Module Downward: 2 - 4 kips; ■ PV Module Uplift: 1 - 3 kips; and ■ PV Module Lateral: 2 - 4 kips. ■ Transformers: 400 - 800 psf contact pressure
Proposed grading	We anticipate that the final grades of the solar array field will generally follow the existing site grades with minimal grading.
Roads	We anticipate that unpaved and/or aggregate source roads are planned onsite.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The project is segmented into eight (8) disconnected clusters of lots. The developable area of the project site will encompass a gross area of approximately 3,216 acres. The project site is located between 2.4 and 9 miles northeast and east of Desert Center off Desert Center Rice Road in Riverside County, California.
Existing site features	The project site is mostly undeveloped; however, there are several unpaved roads across the area. Some parcels exhibit evidence of past and current agricultural operations. Two of the eastern parcels includes orchards, farm-type structures, and water basins. One of the southwestern parcels also has old farm buildings and evidence of former agricultural orchards and crops.
Current ground cover	The majority of the project site is undeveloped desert land with some evidence of current and former agricultural operations on several site parcels.
Existing topography	The site is relatively level with elevations ranging from 520 feet to 680 feet above mean sea level. The slopes at the site generally descend from southwest to northeast, with the exception of the northernmost parcel which slopes from the northeast to the southwest. The sites drain to a large wash which traverses this portion of the valley draining from northwest to southeast.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The site is situated within the Mojave Desert Geomorphic Province in Southern California. Geologic structures within this Province trend mostly northwest, in contrast to the prevailing east-west trend in the neighboring Transverse Ranges Geomorphic Province to the west. The Mojave Desert Province extends into lower California, and is bounded by the Garlock Fault to the north, the San Andreas Fault to the west and Nevada and Arizona borders to the east. [1, 2] Surficial geologic units in the site consist mainly of Alluvium deposits, portion of the northern and easternmost parcels of the project site are mapped for surficial deposits of Dune sands. Within the southwestern most portions of the site, Pleistocene non-marine deposits are mapped.[3]

3.2 Typical Subsurface Profile

Specific conditions encountered at each boring location are indicated on the individual boring logs and test pit logs. Stratification boundaries on the boring and test pit logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs included in Appendix A of this report. Based on the results of the borings and test pits, the subsurface materials encountered generally consisted of loose to very dense sand with variable amounts of silt, clay, gravel, and cobbles to the maximum depth of exploration of 51½ feet. Within borings B-35 and B-36, located within the outline of proposed substations 3 and 4, clayey soils were encountered at approximate depths ranging from 41 to 48 feet.

Laboratory tests were conducted on selected soil samples and the test results are presented in Appendix B. Atterberg limits test results indicated on-site sandy soils exhibit non-plastic characteristics. A consolidation test was performed on materials encountered at depths of 2.5 feet bgs within the outline of one of the proposed substations and indicates the soils have a moderate collapse potential under confining pressures of 2,000 psf. However, based on the in-situ dry density, it is likely that these samples were disturbed prior to testing. A direct shear test was performed on a sample obtained at a depth of 5 feet bgs and indicates on-site sandy soils have an effective friction angle of 32° with a corresponding cohesion of 72 psf. Moisture Density Relationship tests utilizing the modified proctor method (ASTM D1557) were performed on near surface samples at select locations across the site. Results from these tests indicated on-site soils have a maximum dry density ranging between 123.6 to 134.5 pcf with an optimum moisture content ranging between 6.3% and 7.9%. California Bearing Ratio tests are being

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1 Harden, D. R., "*California Geology, Second Edition*," Pearson Prentice Hall, 2004.

2 Norris, R. M. and Webb, R. W., *"Geology of California, Second Edition,"* John Wiley & Sons, Inc., 1990.

3 *State of California – Division of Mines and Geology, Geologic Map of California: Salton Sea Sheet, Charles W. Jennings, Compiled in 1967.*

performed on near surface samples at select locations across the site. Results from the CBR tests will be included in the final report. Laboratory test results are provided in Appendix B.

3.3 Field Soil Resistivity Test Results

Field measurements of soil resistivity were performed in general accordance with ASTM Test Method G57, and IEEE Standard 81, using the Wenner Four-Electrode Method. Two perpendicular arrays were performed for each test. Forty (40) tests were performed within the solar array sites, and five (5) tests were performed at the substation locations as shown on Exhibits A-3 through A-6. The soil resistivity measurements were performed using a 4-Point Ground Resistance Tester. The Wenner arrangement (equal electrode spacing) was used with the "a" spacings of 2, 4, 6, and 10 feet within the solar arrays and 2, 4, 6, 10, 20, 30, 50, 100, and 200 feet at the substation locations. The "a" spacing is generally considered to be the depth of influence of the test. The soil resistivity measurements is presented in Appendix E of this report.

3.4 Thermal Resistivity Test Results

Samples were collected for laboratory thermal resistivity testing at a total of twenty-five (25) locations. Twenty samples were obtained within the solar arrays and one sample was obtained from each of the five substations. The locations are shown on Exhibit A-3 through A-6. The samples were tested for laboratory thermal resistivity at 90% of the maximum dry density (as determined per ASTM D1557).

We recommend that the thermal resistivity results be discussed with an electrical design team to determine the influence on cable type and backfill materials. Terracon subcontracted Geotherm USA to perform these tests, and their report documenting the thermal resistivity test results is presented in Appendix B.

3.5 Groundwater

Groundwater was not observed while drilling the test borings or excavating the test pits. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations.

Based on a monitoring well located approximately 1-mile north of Desert Center Airport, identified by the California Department of Water Resources, recent groundwater levels are approximately 70 feet bgs[4].

[4] California Department of Water Resources, State Well No. 04S16E32M001S, measurements taken between 1961 and 1985 (www.water.ca.gov/waterdatalibrary)

3.6 Seismic Considerations

3.6.1 Seismic Site Class and Design Parameters

DESCRIPTION	Substation 1 (Boring B-33)	Substation 2 (Boring B-34)	Substation 3 / 4 (Borings B-35/B-36)	Substation 5 (Boring B-37)
2016 California Building Code Site Classification (CBC) [1]	D	D	C	D
Site Latitude (Degrees)	N 33.7803	N 33.7441	N 33.7152	N 33.7220
Site Longitude (Degrees)	W 115.3429	W 115.3445	W 115.3177	W 115.2477
S_s Spectral Acceleration for a Short Period [2]	0.739g	0.755g	0.743g	0.683g
S_1 Spectral Acceleration for a 1-Second Period [2]	0.308g	0.314g	0.312g	0.295g
F_a Site Coefficient for a Short Period [2]	1.209	1.198	1.103	1.253
F_v Site Coefficient for a 1-Second Period [2]	1.783	1.772	1.488	1.810

[1] The 2016 California Building Code (CBC) requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100 foot soil profile determination. Borings were extended to a maximum depth of 51½ feet, and this seismic site class definition considers that similar or denser soils continue below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

[2] To be verified by the structural engineer.

3.6.2 Faulting and Estimated Ground Motions

The project site is located in Southern California, which is a seismically active area. The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. The distance of the fault zones and the associated maximum credible earthquake that can be produced by nearby seismic events, was calculated using the USGS Unified Hazard Tool with the Dynamic: Conterminous U.S. 2014 Edition input, Return period of 2,475 years for each substation. The faulting and peak ground acceleration for each substation location is tabulated below:

Parameter	Substation 1 (Boring B-33)	Substation 2 (Boring B-34)	Substation 3 / 4 (Borings B-35/B-36)	Substation 5 (Boring B-37)
2016 California Building Code Site Classification (CBC)	D	D	C	D
Nearest Fault [a]	San Andreas (Coachella)			
Mean Magnitude [b]	6.64	6.7	6.69	6.72
Mean Distance (km)[b]	30.17	32.07	29.76	35.46
Peak Ground Acceleration (PGA_m)[c]	0.338g	0.341g	0.301g	0.318g

[a] This fault is considered to have the most significant effect at the site from a design standpoint based on deaggregations.
[b] Based on USGS deaggregations.
[c] Based on USGS U.S. Seismic Design Maps using the 2010 ASCE 7 (March 2013 errata).

The sites are not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[5]

3.6.3 Liquefaction Potential

Liquefaction is a mode of ground failure that results from the generation of high pore water pressures during earthquake ground shaking, causing loss of shear strength. Liquefaction is typically a hazard where loose sandy soils exist below groundwater. The California Geologic Survey (CGS) has designated certain areas within Southern California as potential liquefaction hazard zones. These are areas considered at a risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table. The project site is not located within a liquefaction hazard zone as mapped by the CGS. Based on the County of Riverside GIS website, the project site is located within a low to moderate liquefaction hazard potential zone. However, based on the subsurface conditions and depth to groundwater, we conclude that the potential for liquefaction at the site is considered low. Other geologic hazards related to liquefaction, such as lateral spreading, are therefore also considered low.

3.6.4 Dry Seismic Settlement

A seismic settlement analysis for the site was performed in general accordance with the DMG Special Publication 117. The liquefaction study utilized the software “LiquefyPro” by CivilTech Software. This analysis was based on the soil data from the substation soil borings (B-33

[5] *California Department of Conservation Division of Mines and Geology (CDMG), “Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern Region”, CDMG Compact Disc 2000-003, 2000.*

through B-37). A PGA of 0.301g to 0.341g and the mean magnitude of 6.64 to 6.72 for the project site was used. Calculations utilized the depth of groundwater at 70 feet bgs. Settlement analysis used the Tokimatsu M-Correction method. Fines were corrected for liquefaction using the Olson and Stark method.

Seismically induced settlement was calculated from a depth of 0 to 50 feet below the ground surface. Based on the calculation results, total and differential settlement for dry sands is estimated to be less than ¼ inch.

3.7 Corrosion Potential

Results of soluble sulfate testing indicate that ASTM Type I/II portland cement may be used for concrete on and below grade for construction of foundations and other elements onsite. Foundation concrete should be designed for negligible sulfate exposure Class S0 in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19.

Laboratory test results indicate that on-site soils have resistivity ranging between 873 and 4,559 ohm-centimeters, chloride contents ranging between 27 and 248 mg/kg, Redox Potential ranging between 638 and 732 mV, pH value ranging between 8.51 and 9.34, sulfate contents ranging between 0.01 to 0.02 and negligible concentrations of sulfides. These test results are provided to assist in determining the type and degree of corrosion protection that may be required. The following corrosion ranges are provided to show the general classification of corrosivity of on-site materials. We recommend a corrosion engineer be utilized to assess the corrosion rates or hazards present.

Resistivity (Ohm-cm)	Corrosivity Classification
0 – 500	Severely Corrosive
501 – 2,000	Corrosive
2,001 – 8,000	Moderately Corrosive
8,001 – 32,000	Mildly Corrosive
> 32,000	Progressively Less Corrosive

Chloride (ppm)	Corrosivity Classification
>1,500	Severely Corrosive
300 – 1,500	Corrosive
150 – 300	Moderately Corrosive
100 – 150	Mildly Corrosive
0 – 100	Non-Corrosive

Reference: ACI-318, Building Code Requirements for Reinforced Concrete (American Concrete Institute, 1999)

Sulfate (ppm)	Corrosivity Classification
>15,000	Severely Corrosive
2,000 – 15,000	Corrosive
1,000 – 2,000	Moderately Corrosive
200 – 1,000	Mildly Corrosive
0 – 200	Non-Corrosive

Reference: ACI-318, Building Code Requirements for Reinforced Concrete (American Concrete Institute, 1999)

pH	Corrosivity Classification
< 5.5	Corrosive
5.5 – 6.0	Moderately Corrosive
6.0 – 6.5	Mildly Corrosive
6.5 – 9.0	Non-Corrosive

Reference: M. Romanoff, Underground Corrosion, 1957

Refer to the results of corrosivity analysis attached to this report for the complete results of the various corrosivity testing conducted on the site soils in conjunction with this geotechnical exploration.

3.8 Geologic Hazards

- Slope stability – The site is within a gentle slope area, geologic hazards associated with slope instability may be considered low.

- Rock fall hazards - The site is within a gentle slope area, rock fall hazards may be considered low.
- Landslide hazards – The site is within a gentle slope area, landslide hazards may be considered low.
- Surface fault rupture - The site is not located within an Alquist-Priolo Special Study Zone or a fault zone based on the County of San Bernardino.
- Fissures - The site is not within an Alquist-Priolo Special Study Zone nor within a liquefaction zone. Therefore, the expectation of fissures occurring at the site is considered low.
- Liquefaction potential – The site is mapped within a low to moderate liquefaction zone by Riverside County. Based on the anticipated depth to groundwater and subsurface conditions encountered on-site, we conclude that the potential for liquefaction at the site is considered low.
- Collapsible and/or expansive soils – the laboratory test results indicate that the materials at a depth of approximately 2½ feet bgs exhibit a moderate collapse potential when saturated under a confining pressure of 2,000 psf. However, based on the in-situ dry density of the sample and the relatively granular nature of the soils, it is our opinion that this sample was slightly disturbed. Onsite soils are not considered expansive due to their non-plastic nature.
- Subsidence –Based on the County of Riverside GIS system, the site is located within an area susceptible to subsidence.
- Ground shaking potential - The site is not located with an Alquist-Priolo Fault Zone. However, with the active faults in the region, the site could be subjected to strong ground shaking that may result from earthquakes on local to distant sources during the life span of the project.
- Seismic Settlement – Based on subsurface conditions and our analysis, we anticipate seismic induced settlement at the site to be considered low.