OMYA Lucerne Valley

Geotechnical Engineering Report

May 7, 2024 | Terracon Project No. 60245013

Prepared for:

Powerflex
75 Broadway St.
New York, NY 10004

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May 7, 2024

Powerflex
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New York, NY 10004

Attn: Mr. Jack Kessler
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Re: Geotechnical Engineering Report
OMYA Lucerne Valley
Lucerne Valley, California
Terracon Project No. 60245013

Dear Mr. Kessler:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P60245013 dated March 13, 2024 and updated March 19, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and access roads for the proposed 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

REGISTERED PROFESSIONAL ENGINEER
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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of content

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed OMYA Lucerne Valley PV Solar facility to be located in Lucerne Valley, California. The purpose of these services was to provide information and geotechnical engineering recommendations relative to the proposed solar development.

The geotechnical engineering Scope of Services for this project included soil borings, field electrical resistivity testing, laboratory thermal resistivity testing, laboratory corrosion testing, and engineering analysis. Additional details can be found in the **Exploration and Testing Procedures** section of this report.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	The following information was provided to Terracon by Powerflex: ▪ *OMYA Lucerne Valley CA_Heliscope_simulation 1267632_summary* ▪ *Appendix B – Geotechnical Study Specifications*
Project Description	The project includes construction of photovoltaic (PV) solar facility. Ultimately, the facility will consist of solar panels installed on steel structures and various other equipment and appurtenances associated with the facility. The project will include PV modules aligned in arrays and affixed to single axis tracking systems. At this time, no substation or switchyard is proposed as part of the development.
Proposed Structures	Photovoltaic modules aligned in arrays and affixed to single-axis tracking system are proposed. Based on our experience on similar projects, we assume the module racks will be supported on small section driven steel piles (such as W6x9s). We anticipate that the proposed inverters will be supported by shallow spread footings, short drilled piers, or driven steel piles.

Item	Description
Maximum Loads (assumed)	Structural loads were not provided, but have been estimated based on our experience on projects using single axis tracking rack systems: ▪ Downward: 1 to 7 kips ▪ Lateral: 1 to 2 kips ▪ Uplift: ½ to 3 kips ▪ Moment: 0.1 to 30 kip-ft
Grading/Slopes	Finished grades are expected to follow existing grades with minimal grading to bring the site to final grade.
Infiltration	Based on our discussion with the client, the project requires a Stormwater management plan. As such, percolation test to determined infiltration rates are included in this report. The percolation tests were conducted on the lower elevation areas of the site in the direction of water drainage.
Access Roads	We anticipate access roads on site will consist of compacted native soil or aggregate base. We do not anticipate asphalt or other rigid surface covered road will be utilized.

Terracon should be notified if any of the above information is inconsistent with the planned construction, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located southeast of 7225 Crystal Creek Rd in Lucerne Valley, California. Approximate coordinates for the center of the site are 34.3767°N, 116.9403°W. See **Site Location**
Existing Improvements	Site is primarily undeveloped. North of the site is a mining facility that is in operation.
Current Ground Cover	The majority of the site is covered with moderately dense desert vegetation.

Item	Description
Existing Topography	The site project generally slopes toward the northeast section of the site and has an approximate elevation ranging from 4100 to 4040 feet within the proposed array area.

Geotechnical Characterization

Exploration Results

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project.

Subsurface soils encountered at the site generally consisted of loose to medium dense sand with various amounts of silt or stiff to very stiff silt with varying amounts of sand in the upper 7 feet overlying medium dense to very dense sand with varying amounts of silt and gravel to the maximum drilled depth of 21 feet below existing site grade (bgs).

Auger refusal was in encountered on very dense soils and possible cobbles at depths of 7.6 to 12 feet bgs in borings B-1, B-3, B-4.

Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** attachment of this report.

Groundwater

The borings were advanced using a hollow-stem-auger drilling technique that allows short term groundwater observations to be made while drilling. Groundwater was not observed in the borings while drilling, or for the short duration the boring remained open. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations.

According to data collected from the Water Data Library for the State of California from a nearby groundwater well, located approximately 1.5 miles north from the project site in the Local Well Name 04N01W26J001S, historic groundwater level from 1990 to 2012 were recorded at greater than 100 feet bgs. [1]

Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of exploration. Therefore, groundwater levels during construction or at other times may be higher or lower than expected.

Lab Results

Laboratory tests were conducted on selected soil samples and the test results are presented in the **Exploration Results** section and on the boring logs. Atterberg limit test results indicate that the on-site soils generally are non-plastic. Direct shear testing on sandy soils encountered at 5 feet indicate soils have an effective friction angle of approximately 37 degrees with apparent cohesion value of approximately 180 psf. Maximum density/optimum moisture content testing conducted in accordance with ASTM D1557(Modified Proctor) indicate that near surface soils tested have a maximum dry density range of 135.4 to 138.7 pounds per cubic feet (pcf) and optimum water content of range of 6.8 to 7.6 percent. CBR test at near surface clayey sand soils resulted in a CBR values of 22at 95% relative compaction.

Thermal Resistivity Testing

Terracon subcontracted Geotherm USA to perform laboratory thermal resistivity testing. Testing was conducted on two (2) bulk samples from the array areas. Samples were taken from a depth of 0 to 4 feet bgs. The bulk samples were then remolded to 85% and 95% compaction effort (as determined by ASTM D1557) of the material's maximum dry density for a total of four (4) thermal resistivity tests. Dry out curves targeted the higher of either the in-situ moisture content of the optimum moisture content as determined by ASTM D1557, totally dry condition, and two intermediate points. The thermal resistivity test results are presented in **Exploration Results** section of this report.

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[1] Water Data Library for the State of California. https://wdl.water.ca.gov/

Electrical Resistivity Testing

Terracon performed field measurements of soil electrical resistivity for the support of grounding design. Soil resistivity data was obtained from one perpendicular arrays at two (2) locations in the proposed PV array areas. The approximate locations of the test are shown in the **Exploration Plan**. The testing was performed in general accordance with Wenner Array (4-pin) method per ASTM G57. This method was performed in with IEEE Standard 81, IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System. The test locations included perpendicular arrays with "a" spacings 0.5, 1, 2, 5, 10, 15, and 25 feet. The "a" spacing is generally considered to be the depth of influence of the test. The electrical resistivity test results are included in the **Exploration Results**.

Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary

Boring	Sample Depth (feet)	Soluble Sulfate (%)	Sulfides (ppm)	Chloride (mg/kg)	Red-Ox Potential (mV)	Electrical Resistivity (Ω-cm)	Total Salts (ppm)	pH
B-4	0-5	0.001	Nil	35	+729	7,469	496	8.52

Results of soluble sulfate testing indicate samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 19.3.1.1 of the ACI Design Manual. Concrete should be designed in accordance with the exposure class S0 provisions of the ACI Design Manual, Section 318, Chapter 19.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7.

Description	Value
2022 California Building Code Site Classification (CBC)[1]	C[2]
Site Latitude (°N)	34.3777
Site Longitude (°W)	116.9397
S_s Spectral Acceleration for a 0.2-Second Period	1.449
S_1 Spectral Acceleration for a 1-Second Period	0.503
S_{DS} Numeric Seismic Design Value at 0.2 seconds SA	1.159
S_{D1} Numeric Seismic Design Value at 0.1 seconds SA	0.502
F_a Site Coefficient for a 0.2-Second Period	1.2
F_v Site Coefficient for a 1-Second Period	1.497

1. Seismic site classification in general accordance with the *2022 California Building Code*.
2. The 2022 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 21 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.

Typically, a site-specific ground motion study may generate less conservative coefficients and acceleration values which may reduce construction costs. We recommend consulting with a structural engineer to evaluate the need for such study and its potential impact on construction costs. Terracon should be contacted if a site-specific ground motion study is desired.

Faulting and Estimated Ground Motions

The 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. As calculated using the USGS Unified Hazard Tool, the North Frontal (West) Fault, which is considered to have the most significant effect at the site from a design standpoint, has a maximum credible earthquake magnitude of 7.18 and is located approximately 2.87 kilometers from the site.

Based on the USGS Design Maps Summary Report, using the American Society of Civil Engineers (ASCE 7-16) standard, the site-modified peak ground acceleration (PGA_M) at the project site is expected to be 0.742g. Based on the USGS Unified Hazard Tool, the project site has a mean magnitude of 6.51. Furthermore, the site is not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[2]

Liquefaction

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 the condition of loose sandy soils exists below groundwater. The California Geological Survey (CGS) has designated certain areas as potential liquefaction hazard zones.[3] 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.

Based on our review of the CGS map, the project site has not been mapped for a liquefaction hazard. However, according to the San Bernadino County Geologic Maps, the site's potential for liquefaction hazard is low. Furthermore, based on the anticipated depth to groundwater and encountered subsurface conditions, liquefaction hazard potential at the site is considered low.[4] Other geologic hazards related to liquefaction, such as lateral spreading, are therefore also considered low.

Stormwater Management

Two (2) in-situ percolation tests were performed to approximate depth of 5 feet bgs. A 2-inch-thick layer of gravel was placed in the bottom of each boring after the borings were drilled to investigate the soil profile. A 3-inch diameter perforated pipe was installed on top of the gravel layer in each boring. Gravel was used to backfill between the perforated pipes and the boring sidewall. The borings were then filled with water for a pre-soak period

[2] California Geological Survey (CGS), https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/

[3] California Geologic Survey, "Earthquake Zones of Required Investigation, https://maps.conservation.ca.gov/cgs/EQZApp/app/

[4] San Bernardino County Zoning and Overlay Maps, Geologic Hazard Maps, https://lus.sbcounty.gov/planning-home/zoning-and-overlay-maps/geologic-hazard-maps/

of 24 hours. Testing began after a pre-soak period. At the beginning of the test, the pipes were refilled with water and readings were taken at standardized time intervals. Percolation rates are provided in the following table:

TEST RESULTS			
Test Location (depth, feet bgs)	**Soil Classification**	**Measured Average Percolation Rate (in/hr.)**	**Correlated Average Infiltration Rate[1] (in/hr.)**
P-1 (0 to 5 ft)	Silty Sand (SM)	31	3.05
P-2 (0 to 5 ft)	Silty Sand (SM)	74	4.56
[1]If proposed infiltration system will mainly rely on vertical downward seepage, the correlated infiltration rates should be used. The infiltration rates were correlated using the Porchet method.			

With time, the bottoms of infiltration systems tend to plug with organics, sediments, and other debris. Long term maintenance will likely be required to remove these deleterious materials to help reduce decreases in actual percolation rates.

The percolation tests were performed with clear water, whereas the storm water will likely not be clear, but may contain organics, fines, and grease/oil. The presence of these deleterious materials will tend to decrease the rate that water percolates from the infiltration systems. Design of the stormwater infiltration systems should account for the presence of these materials and should incorporate structures/devices to remove these deleterious materials. A safety factor should be applied to these measured rates.

Based on the soils encountered in our borings, we expect the percolation rates of the soils could be different than measured in the field due to variations in fines and gravel content. The design elevation and size of the proposed infiltration system should account for this expected variability in infiltration rates.

Infiltration testing should be performed after construction of the infiltration system to verify the design infiltration rates. It should be noted that siltation and vegetation growth along with other factors may affect the infiltration rates of the infiltration areas. The actual infiltration rate may vary from the values reported here. Infiltration systems should be located a minimum of 10 feet from any existing or proposed foundation system.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the findings and recommendations presented in this report are incorporated into project design and construction.

We anticipate that the proposed inverter pads will be supported on a shallow foundation system bearing on engineered fill. Engineered fill should extend to a minimum depth of 1 foot below the bottom of foundations, or 3 feet below existing grades, whichever is greater. Grading for the proposed structures should incorporate the limits of the structure plus a lateral distance of 1 foot beyond the outside edge of perimeter footings. Alternatively, inverters can be supported on short drilled piers or driven steel pile foundations.

We anticipate that the PV panels will be supported on driven steel piles.

Overexcavation and replacement is not required for support of drilled shaft or driven pile foundations.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of test borings, laboratory testing, engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

The following presents recommendations for site preparation, excavation, subgrade preparation, and placement of engineered fills on the project. The recommendations presented for the design and construction of foundations are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation of bearing soils, and other geotechnical conditions exposed during construction of the project.

Site Preparation

Prior to placing fill, existing debris, vegetation and other deleterious materials should be removed from proposed foundation areas. Exposed surfaces within these areas should be free of mounds and depressions which could prevent uniform compaction. The site should be initially graded to create a relatively level surface to receive fill and provide for a relatively uniform thickness of fill beneath proposed structures.

We recommend stripping topsoil to depths that expose soils with less than 3 percent organics and no roots having a diameter greater than 1/8 inch. While the depth of the unsuitable soils should be expected to vary, the thickness of the topsoil layer may be estimated to range between 6 and 12 inches for construction budgeting purposes. The thickness of the top soil layer was not determined during our field exploration. Therefore, the actual depth of stripping should be verified by engineering observations made during the grading operations at the project. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

Stripped materials consisting of vegetation and organic materials should be wasted from the site or used to revegetate landscaped areas or exposed slopes after completion of grading operations. If it is necessary to dispose of organic materials on site, they should be placed in non-structural areas, and in fill sections not exceeding 5 feet in height.

Although no evidence of fills, utilities, or underground facilities such as septic tanks, cesspools, basements, and utilities was observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills, utilities, or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

We anticipate that the proposed inverter pads will be supported on a shallow foundation system bearing on engineered fill, or on drilled shaft foundations. Engineered fill should extend to a minimum depth of 1 foot below the bottom of foundations, or 3 feet below existing grades, whichever is greater. Grading for the proposed structures should incorporate the limits of the structure plus a lateral distance of 1 foot beyond the outside edge of perimeter footings.

Large gravels and cobble materials may be encountered at proposed excavation depths. If such conditions are encountered, any cobbles or boulders should be removed and be replaced with engineered fill.

Subgrade soils beneath proposed exterior slabs should be scarified to a minimum depth of 10 inches, moisture conditioned, and compacted. The moisture content and compaction of subgrade soils should be maintained until slab or pavement construction.

Structures supported on either drilled shafts or driven piles may be constructed without the above recommended remedial grading.

Exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 10 inches, moisture conditioned, and compacted per the compaction requirements in this report.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable. However, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavations

It is anticipated that excavations for the proposed construction in many locations can be accomplished with conventional earthmoving equipment. However, as excavations extend deeper into very dense soils additional excavation effort and larger equipment may be required. Auger refusal was encountered in multiple borings on cobbles and very dense soils. The owner should consider obtaining unit pricing for difficult excavations prior to the start of the project.

The subgrade soils exposed during construction are expected to be relatively stable. However, the stability of the subgrade may also be affected by precipitation, repetitive construction traffic or other factors.

The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Onsite soils consist of cohesionless gravelly and sandy soils. Such soils have the tendency to cave and slough during excavations. Therefore, formwork may be needed for foundation excavations.

Individual contractors are responsible for designing and constructing stable, temporary excavations. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

Fill Material and Placement

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than three inches in size. Pea gravel or other open-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

Clean on-site soils or approved imported materials may be used as fill material for the following:

- general site grading
- foundation backfill

- foundation areas
- exterior slab areas
- roadway areas

Imported soils for use as fill material within proposed structure areas should conform to low volume change materials as indicated in the following specifications:

Gradation	Percent Finer by Weight (ASTM C 136)
3″	100
No. 4 Sieve	50-100
No. 200 Sieve	10-30

- Liquid Limit .... 30 (max)
- Plasticity Index .... 15 (max)
- Maximum Expansion Index* .... 20 (max)

*ASTM D4829

The contractor shall notify the Geotechnical Engineer of import sources sufficiently ahead of their use so that the sources can be observed and approved as to the physical characteristic of the import material. For all import material, the contractor shall also submit current verified reports from a recognized analytical laboratory indicating that the import has a "not applicable" (Class S0) potential for sulfate attack based upon current ACI criteria and is "mildly corrosive" to ferrous metal and copper. The reports shall be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the job.

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed 10 inches loose thickness.

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

Material Type and Location	Per the Modified Proctor Test (ASTM D 1557)		
	Minimum Compaction Requirement	Range of Moisture Contents for Compaction Above Optimum	
		Minimum	Maximum
On-site soils or low volume change imported fill:			
Beneath foundations:	90%	-2%	+2%
Fill greater than 5 feet in depth:	95%	-2%	+2%
Miscellaneous backfill:	85%	-2%	+2%
Utility trenches*:	90%	-2%	+2%

Bottom of excavation receiving fill:	90%	-2%	+2%
Beneath pavements/roadways and exterior slabs:	95%	-2%	+2%
Aggregate base:	95%	-2%	+2%
*Upper 12 inches should be compacted to 95% within structural areas. Compaction requirements within utility trenches should be verified with electrical engineer based on thermal resistivity and may be modified accordingly.			

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Backfill against footings and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

We recommend a minimum horizontal setback distance of 10 feet from the perimeter of any structure and the high-water elevation of the nearest storm-water retention basin.

Exterior Slab Design and Construction

Exterior slabs-on-grade, exterior architectural features, and utilities founded on, or in backfill may experience some movement due to the volume change of the backfill. To reduce the potential for damage caused by movement, we recommend:

- minimizing moisture increases in the backfill;
- controlling moisture-density during placement of backfill;
- using designs which allow vertical movement between the exterior features and
- adjoining structural elements;
- placing effective control joints on relatively close centers

Utility Trenches

It is anticipated that the on-site soils will provide suitable support for underground utilities and piping that may be installed. Any soft and/or unsuitable material encountered at the bottom of excavations should be removed and be replaced with an adequate bedding material. A nonexpansive granular material with a sand equivalent greater than 30 should be used for bedding and shading of utilities, unless allowed or specified otherwise by the utility manufacturer.

On-site materials are considered suitable for backfill of utility and pipe trenches from one foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. If trenches are placed beneath footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Earthwork Construction Considerations

We recommend that a Terracon geotechnical engineer or qualified representative be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during stripping of topsoil, subgrade preparation, placement and compaction of controlled compacted fills, backfilling of excavations, and just prior to construction of any foundations, slabs, or roadways.

Care should be taken to avoid disturbance of prepared subgrade soils. The near surface soils can be easily disturbed, especially by construction traffic. Construction traffic should not operate directly on saturated or low strength soils. If the subgrade becomes saturated, desiccated, or disturbed, the affected materials should either be scarified and compacted, or be removed and replaced as previously discussed. Subgrades should be observed and tested by Terracon prior to construction.

Excavations for utility installations or shallow foundations are not expected to encounter shallow groundwater near-surface. The contractor is responsible for employing appropriate dewatering methods to control seepage and facilitate construction, if needed. In our experience, dewatering of excavations with perched water in granular soils above the water table can be accomplished with typical sump pits and pumps.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices as well as other applicable codes, and in accordance with any applicable local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, the contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor’s activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Construction Observation and Testing

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proof-rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade.

The exposed subgrade and each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the structural areas and 5,000 square feet in pavement/roadway areas. One density and water content test for every 50 linear feet of compacted utility trench backfill. This testing frequency criteria may be adjusted during construction as specified by the geotechnical engineer of record.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

The proposed inverters may be supported by shallow spread footing. If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters

DESCRIPTION	RECOMENDATION
Bearing Material[3]	Engineered fill should extend to a minimum depth of 1 foot below the bottom of foundations, or 3 feet below existing grades, whichever is greater.

DESCRIPTION	RECOMENDATION
Maximum Net Allowable Bearing pressure (1-inch Settlement) [1]	3,500 psf
Minimum Dimensions	12 inches
Ultimate Coefficient of Sliding Friction [4]	0.35
Ultimate Passive Resistance [5] **(equivalent fluid pressures)**	360 psf/ft
Minimum Embedment Depth Below Finished Grade	18 inches
Estimated Total Settlement from Structural Loads [2]	As-noted above
Estimated Differential Settlement [2,6]	About ½ of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied.
2. Unsuitable or loose/soft, dry, and low-density soils should be removed and replaced per the recommendations presented in the **Earthwork**.
3. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
5. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure. The designer should select an appropriate factor of safety during design.
6. Differential settlements are as measured over a span of 40 feet.

Settlement calculations were performed utilizing Westergaard and Hough's methods[5] to estimate the static settlement for various foundation widths with an allowable settlement of 1-inch.

Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter (or exterior) footings.

5 [5] FHWA Geotechnical Engineering Circular No. 6 – Shallow Foundations, FHWA – SA-02-054

The allowable foundation bearing pressure applies to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Deep Foundations

Driven Foundations – PV Arrays

Proposed solar PV panels and inverters can be supported on driven steel W-section foundations (assumed to be W6x9 or similar) in general accordance with the following sections.

Driven Pile Considerations

The proposed solar PV panels and inverters may be supported on a driven pile foundation system. The design capacity of a single-driven pile is a function of several factors including:

- Size and type of pile;
- Type and capacity of pile installation equipment;
- Pile integrity after installation; and
- Engineering properties of the subsurface soils.

Based on the results of the geotechnical borings, it is our opinion that there will be areas of the site where shallow refusal or difficult pile driving will be encountered for small section steel piles. These areas have near surface very dense soils and cobbles.

The tables below neglect a depth of 1 feet for axial and lateral resistance. This neglect is due to depth of topsoil, scour and/or disturbance from utilities near the piles. Depth of neglect should be verified by the design engineer.

The allowable axial parameters of the pile in compression and tension were determined by dividing the ultimate axial capacity by a minimum factor-of-safety (FOS) of 2.0 for skin friction and 3.0 for end bearing. The allowable unit skin friction was determined using the soil strengths based on our field and laboratory testing. The following geotechnical design parameters can be used to determine the capacity of driven W-section pile foundations. Pile capacity calculations and an example calculation are provided below the table.

Description	Top Depth Bottom Depth	Total Unit Weight (pcf)	Allowable Compression Unit Skin Friction (psf)[A]	Allowable Bearing Pressure (psf)[B,C]
Stratum 1	1 5	120	75	4,000
Stratum 2	5 16	125	300	8,000

[A] Allowable uplift capacity is on the order of 60% of the compression capacity values in the table. The values provided should be multiplied by the box perimeter of the pile times the depth. The box perimeter is considered two times the width of the flange plus two times the depth of the web.
[B] The values provided should be multiplied by the box area of the pile and be used for compression resistance only.
[C] Terracon recommends a minimum embedment depth of 5 feet.

Recommended Pile Capacity Calculations:

$$F_{total}\ (lbs) = F_{skin\ axial}\ (lbs) + F_{bearing}\ (lbs)$$

$$F_{skin\ axial}\ (lbs) = F_{s1} \times P \times (h_{1b} - h_{1t}) + F_{s2} \times P \times (h_{2b} - h_{2t}) + \ldots$$

$$F_{bearing}(lbs) = F_b \times A_P$$

Where:
$Fs1$ = Allowable Unit Skin Friction for layer 1 (psf)
P = Pile perimeter = 2 * Flange Width + 2 * Depth (ft)
h_{1b} = bottom depth of embedment of pile (ft) into or bottom of zone
h_{1t} = depth of top of zone (ft)
F_b = allowable bearing pressure at the embedded stratum (psf)
A_P = Box perimeter Area = Flange Width x Web Depth (ft^2)

Recommended soil parameters for lateral load analysis of driven pile foundations have been developed for use in LPILE computer programs. Engineering properties have been estimated as outlined below:

Description	Top Depth / Bottom Depth	Effective Unit Weight (pcf)	L-PILE/ GROUP Soil Type	Sand(deg)
Stratum 1	1	120	Reese Sand	34
	5			
Stratum 2	5	125		40
	16			

Note: LPILE default values can be used for the K modulus

Drilled Shaft Design Parameters

The proposed inverters and other equipment can be supported on drilled shafts. Total required embedment of the drilled shafts should be determined by the structural engineer based on structural loading and parameters provided in this report.

The allowable side friction and end bearing components of resistance were evaluated and are presented in the below table. The allowable total downward capacity is based on a minimum factor of safety of 2.5. The allowable uplift capacities should be based on 70% of the below skin friction values only. The depth below ground surface indicated in the attached graphs is referenced from the existing ground surface at the site at the time of the field exploration.

Recommended geotechnical parameters for lateral load analyses of drilled shaft foundations have been developed for use in the L-PILE computer program. Based on our review of the subsurface conditions within the outline of the substation the Standard Penetration Test (SPT) results, engineering properties have been estimated for the soils conditions as shown in the following table for the substation. Lateral and axial capacity of soils within the upper 2 feet should be neglected due to utilities and anticipated disturbance or scour around shafts. We recommend that Terracon review the final drilled shaft design to verify that sufficient embedment is achieved.

Axial and Lateral Load Design Parameters Estimated Engineering Properties of Soils						
Top Depth / Bottom Depth	**Effective Unit Weight (pcf)**	**L-PILE/ GROUP Soil Type**	**Internal Angle of Friction (Degrees)**	**Un-drained Shear Strength (ksf)**	**End Bearing (psf)**	**Skin Friction (psf)**
2	120	Sand (Reese)	34	--	4,000	125
7						
7	125	Sand (Reese)	40	--	8,000	350
18						

LPILE default values can be used for the K modulus. The depth below ground surface indicated in the table above is referenced from the existing ground surface at the site at the time of the field exploration. If fill is placed to raise the site grades, the depths shown in the table above must be increased by the thickness of fill placed. The required depths of shaft embedment should also be determined for design lateral loads and overturning moments to determine the most critical design condition.

Lateral load design parameters are valid within the elastic range of the soil. The coefficients of subgrade reaction are ultimate values; therefore, appropriate factors of safety should be applied in the shaft design or deflection limits should be applied to the design.

It should be noted that the load capacities provided herein are based on the stresses induced in the supporting soils. The structural capacity of the shafts should be checked to assure that they can safely accommodate the combined stresses induced by axial and lateral forces. Furthermore, the response of the drilled shaft foundations to lateral loads is dependent upon the soil/structure interaction as well as the shaft's actual diameter, length, stiffness and "fixity" (fixed or free-head condition).

Drilled Shaft Construction Considerations

Drilling to design depths should be possible with conventional single flight power augers. Due to the presence of sand on the site, caving of soils within the drilled shaft excavations should be anticipated. We do not anticipate drilled shafts to extend below the depth of groundwater. However, if foundation concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. Temporary steel casing will likely be required to properly drill and clean shafts prior to concrete placement. Auger refusal was encountered in multiple borings on-site. Therefore as drilled shafts extend below 7 feet, heavy duty rock bit or coring may be required to advance drilled shafts.

Drilled shaft foundation concrete should be placed immediately after completion of drilling and cleaning. If foundation concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

In the event drilled hole walls slough during drilling, temporary steel casing may be required to properly drilled shafts prior to concrete placement. We recommend the use of slurry drilling methods with polymers method to keep the solids in suspension during the drilling. Drilled shaft foundation concrete should be placed within 6 inches of the shaft base of the slurry-filled excavation immediately after completion of drilling and cleaning. The tremie should remain inserted several feet into the fresh concrete as it displaces the slurry upward and until placement is complete. The slurry should have a sand content no greater than 1% at the time concrete placement commences. The maximum unit weight of the slurry should be established in consultation with Terracon.

As an alternative to temporary casing, the shaft excavation may be backfilled with a slurry mix in order to help stabilize sloughing sidewalls of the excavation, allowed to dry, and re-drilled through the backfill. The slurry mix design should be submitted to the Geotechnical Engineer for review and approval.

If casing is used for drilled shaft construction, it should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent the creation of voids in shaft concrete. Shaft concrete should have a relatively high fluidity when placed in cased shaft holes or through a tremie. Shaft concrete with slump in the range of 6 to 8 inches is recommended.

If casing is used for drilled shaft construction, it should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or the creation of voids in shaft concrete. Shaft concrete should have a relatively high fluidity when placed in cased shaft holes or through a tremie. Shaft concrete with slump in the range of 6 to 8 inches is recommended.

Closely spaced shafts should be drilled and filled alternatively, allowing the concrete to set at least eight hours before drilling the adjacent shaft. All excavations should be filled with concrete as soon after drilling as possible. In no event should shaft holes be left open overnight.

Formation of mushrooms or enlargements at the tops of shafts should be avoided during shaft drilling. If mushrooms develop at the tops of the shafts during drilling, sono-tubes should be placed at the shaft tops to help isolate the shafts.

Free-fall concrete placement in drilled piers will only be acceptable if provisions are taken to avoid striking the concrete on the sides of the hole or reinforcing steel. The use of a bottom-dump hopper, or an "elephant's trunk" discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

We recommend that all drilled shaft installations be observed on a full-time basis by an experienced geotechnical engineer in order to evaluate that the soils encountered are consistent with the recommended design parameters. If the subsurface soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required. The Geotechnical Engineer should observe the installation of drilled piers to verify the soil conditions and the diameter and depth of piers. Drilled piers should be constructed true and plumb.

Drilled pier end bearing surfaces must be thoroughly cleaned prior to concrete placement. A representative of the Geotechnical Engineer should inspect the bearing surface and foundation pier configuration. If the subsurface soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

The contractor should check for gas and/or oxygen deficiency prior to any workers entering the excavation for observation and manual cleanup. All necessary monitoring and safety precautions as required by OSHA, State or local codes should be strictly enforced by the owner and the EPC.

Access Roadways

Compacted Native Soils Access Road Design Recommendations

Based upon the soil conditions encountered in the test borings, the use of on-site soils for construction of on-site roads is considered acceptable. Without the use of asphalt concrete or other hardened material to surface the roadways, there is an increased potential for erosion and deep rutting of the roadway to occur, however, post construction traffic is anticipated to only consist of pickup trucks for operations and maintenance personnel. Therefore, construction of the un-surfaced native roadways should consist of a minimum of 10-inches of compacted on-site soils.

It is our understanding that proposed compacted native roadway grades will match adjacent existing grades so that the existing natural drainage patterns are generally unchanged. The un-surfaced roads are expected to function with periodic maintenance.

Access Roadway Design Recommendations

It is our understanding that aggregate surfaced roads will be utilized during the construction of this project.

Aggregate surface roadway design was conducted in general accordance with the Army Corps of Engineers (ACOE) Technical Manual TM-5-822, Design of Aggregate Surface Roads and Airfields (1990). The design was based on Category III, traffic containing as much as 15% trucks, but with not more than 1% of the total traffic composed of trucks having three or more axles (Group 3 vehicles), and Road Class G (Under 70 vehicles per day). Based on the Category and Road Class, a Design Index of 1 was utilized. Terracon should be contacted if significant changes in traffic loads or in the characteristics described are anticipated.

Based on the pending CBR test results, we anticipate the roadway subgrade will have a CBR value of 22. Based on this assumption, the aggregate surface course should have a minimum thickness of 4 inches and should be constructed over a minimum of 12 inches of scarified, moisture conditioned, and compacted native soils to 95% of the maximum dry density using ASTM D1557. The recommended thicknesses should be measured after full compaction. The width of the roadway should extend a minimum distance of 1 foot on each side of the desired surface width.

Aggregate materials should conform to the specifications of Class II aggregate base in accordance with the requirements and specifications of the State of California Department of Transportation (Caltrans), or other approved local governing specifications.

Positive drainage should be provided during construction and maintained throughout the life of the roadways. Proposed roadway design should maintain the integrity of the road and eliminate ponding.

Roadway Design and Construction Considerations

Regardless of the design, un-surfaced roadways will display varying levels of wear and deterioration. We recommend an implementation of a site inspection program at a frequency of at least once per year to verify the adequacy of the roadways. Preventative measures should be applied as needed for erosion control and re-grading. An initial site inspection should be completed approximately three months following construction.

Preventative maintenance should be planned and provided for through an on-going management program to enhance future roadway performance. Preventative maintenance activities are intended to slow the rate of deterioration, and to preserve the roadway investment.

Surfacing materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of roadways to reduce lateral moisture transmission into the subgrade.

If rut depths become excessive as construction work progresses, re-grading and re-compaction should be performed as necessary. Care should be taken to reduce or eliminate trafficking of the unpaved access road when the subgrade is wet as this will result in accelerated rutting conditions. Scarification, moisture treatment as necessary, and re-compaction of the roadways will likely be necessary as the roadways deteriorate.

Materials and construction of roadways for the project should be in accordance with the requirements and specifications of the California Department of Transportation or the applicable local governing body.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Attachments

Exploration and Testing Procedures

Field Exploration

The following table provides a summary of our geotechnical explorations completed at the site.

Number of Locations	Type of Exploration	Depth (ft) or Description	Location
4	Hollow Stem Auger Boring	20 or refusal	PV Array Area
2		5	Infiltration Areas
2	Field Electrical Resistivity Testing	0.5, 1, 2, 5, 10, 15, and 25	PV Array Area
1	Corrosion testing samples	-	PV Array Area
2	Thermal Resistivity Tests	-	PV Array Area

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±20 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted, drill rig using continuous flight augers (hollow stem). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Test samples were collected during drilling in general accordance with the appropriate ASTM methods using Standard Penetration Testing (SPT) and sampling using either standard split-spoon or Modified California samplers. A sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration was recorded as the Standard Penetration Test (SPT) resistance value, also referred to as N-values. The N-values are indicated on the boring logs at the test depths.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless noted above.

Site Location

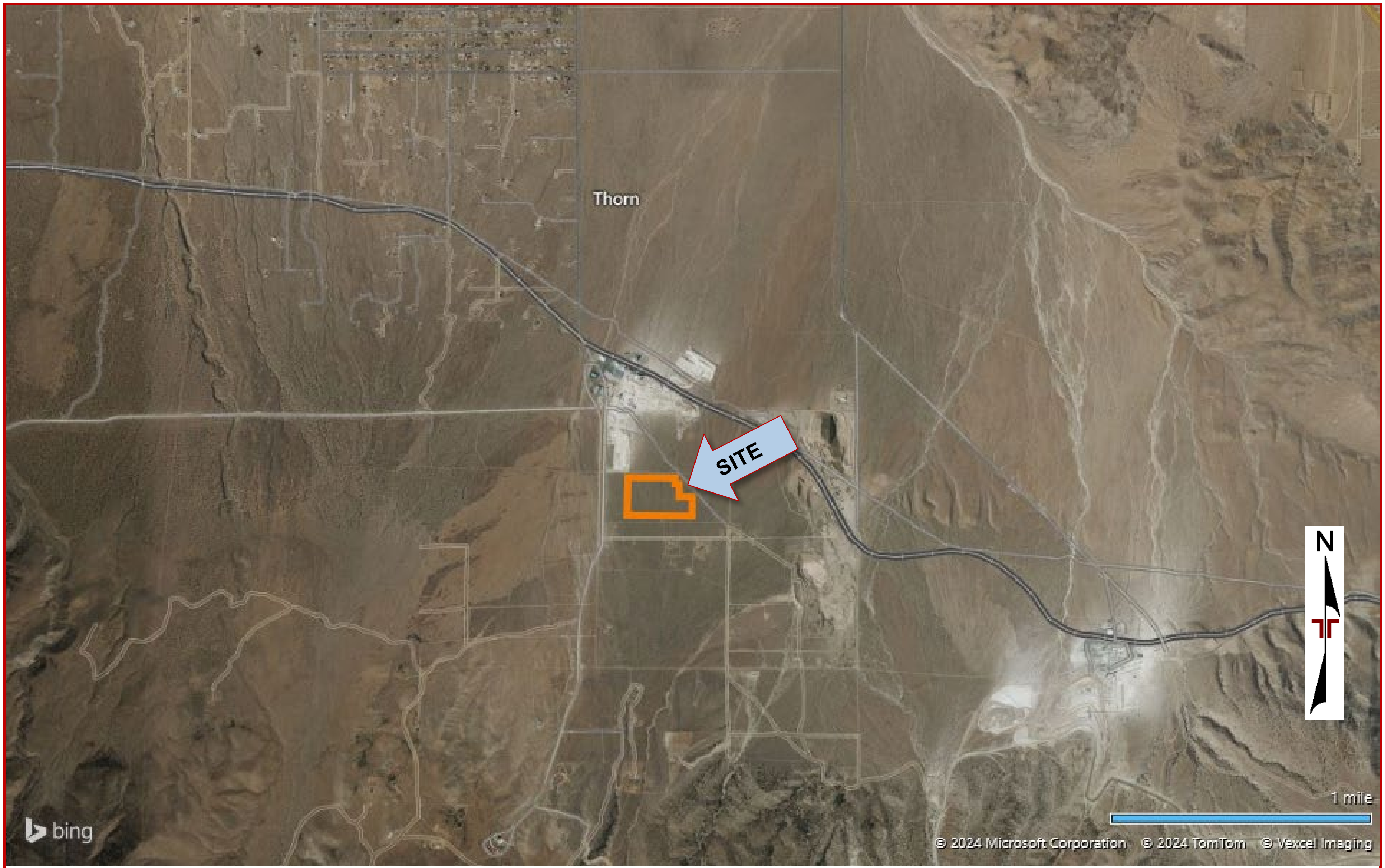


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

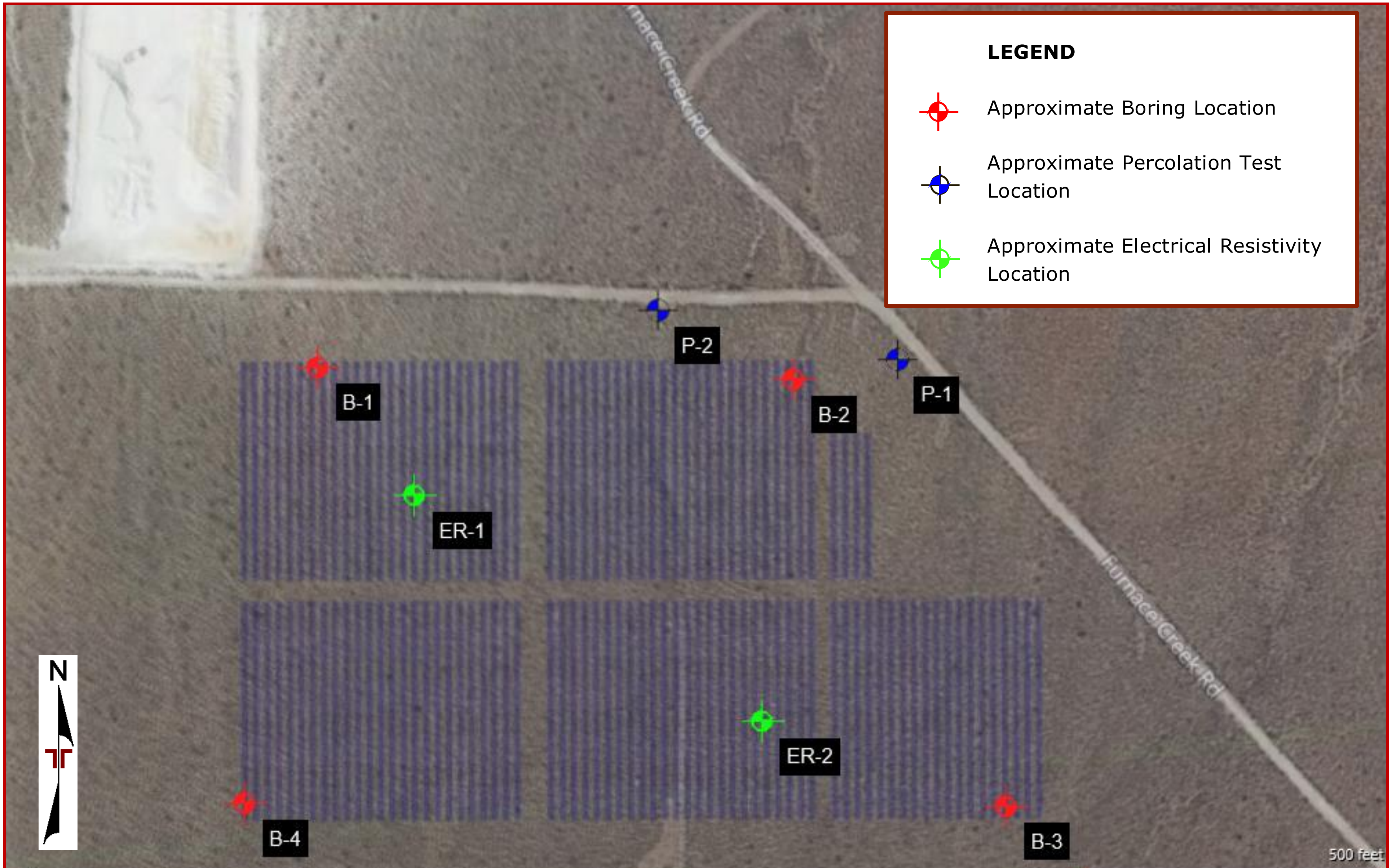


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Boring Logs (B-1 to B-4, P-1 and P-2)
Atterberg Limits
Compaction Graphs
Grain-Size Analysis
Direct Shear Graph
Corrosion Results
CBR Results
Electrical Resistivity Results
Thermal Resistivity Results

Terracon
23041 Avenida De La Carlota Ste 350
Laguna Hills, CA

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 34.3777° Longitude: -116.9423°

Graphic Log	Depth (Ft.) / Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
	SILTY SAND WITH GRAVEL (SM), brown								
	medium dense				11-15-24	6.0	112		
	very dense	5			20-33-33 N=66				
	7.6				50/1"				
	Auger Refusal at 7.6 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Notes
Auger refusal at very dense and gravelly sands

Advancement Method
Hollow Stem Suger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
CR

Boring Started
04-02-2024

Boring Completed
04-02-2024

Terracon
23041 Avenida De La Carlota Ste 350
Laguna Hills, CA

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 34.3777° Longitude: -116.9397°

Depth (Ft.)	Material Description	Sample Depth (Ft.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
	SANDY SILT WITH GRAVEL (ML), brown						
	very stiff	2.5	4-9-12 N=21	5.0			
	hard	5	28-50/6"	5.2	114		51
		7.5	50/6"				
		10	10-50/0"	4.1	104		52
		15	4-22-21 N=43				
21.0		20	24-50/6"	2.6	109		
	Boring Terminated at 21 Feet						

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Notes

Advancement Method
Hollow Stem Suger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
CR

Boring Started
04-02-2024

Boring Completed
04-02-2024

Terracon
23041 Avenida De La Carlota Ste 350
Laguna Hills, CA

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 34.3757° Longitude: -116.9385°

Depth (Ft.)	Material Description	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0.0	**SILTY SAND WITH GRAVEL (SM)**, brown							
	very dense			21-30-50	2.0 4.9	119		47
5	medium dense			17-17-20 N=37				16
	very dense			50/1"				
10				18-26-33 N=59				
12.0	***Auger Refusal at 12 Feet***							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Notes
Auger refusal at very dense and gravelly sands

Advancement Method
Hollow Stem Suger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
CR

Boring Started
04-02-2024

Boring Completed
04-02-2024

Terracon
23041 Avenida De La Carlota Ste 350
Laguna Hills, CA

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 34.3758° Longitude: -116.9427°

Depth (Ft.)	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
	SILTY SAND WITH GRAVEL (SM), brown								
	medium dense				10-7-4 N=11			NP	38
		5			12-25-22	5.5	110		46
	very dense				20-50/6"				
		10			50/2"				
12.0	***Auger Refusal at 12 Feet***								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Notes
Auger refusal at very dense and gravelly sands

Advancement Method
Hollow Stem Suger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Logged by
CR

Boring Started
04-02-2024

Boring Completed
04-02-2024

Terracon
23041 Avenida De La Carlota Ste 350
Laguna Hills, CA

Boring Log No. P-1

Location: See Exploration Plan

Latitude: 34.3777° Longitude: -116.9391°

Depth (Ft.)	Material Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
	SANDY SILT WITH GRAVEL (ML), brown			Grab					52
	hard				50/4"				
5.0	***Boring Terminated at 5 Feet***	5							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
Groundwater not encountered

Advancement Method
Hollow Stem Suger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Logged by
CR

Boring Started
04-02-2024

Boring Completed
04-02-2024

Terracon
23041 Avenida De La Carlota Ste 350
Laguna Hills, CA

Boring Log No. P-2

Location: See Exploration Plan

Latitude: 34.3780° Longitude: -116.9404°

Depth (Ft.)	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
	SILTY SAND WITH GRAVEL (SM), brown			Grab					
5.0	medium dense	5		Split spoon	8-22-20	5.8	177		49
	Boring Terminated at 5 Feet								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
Groundwater not encountered

Advancement Method
Hollow Stem Suger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Logged by
CR

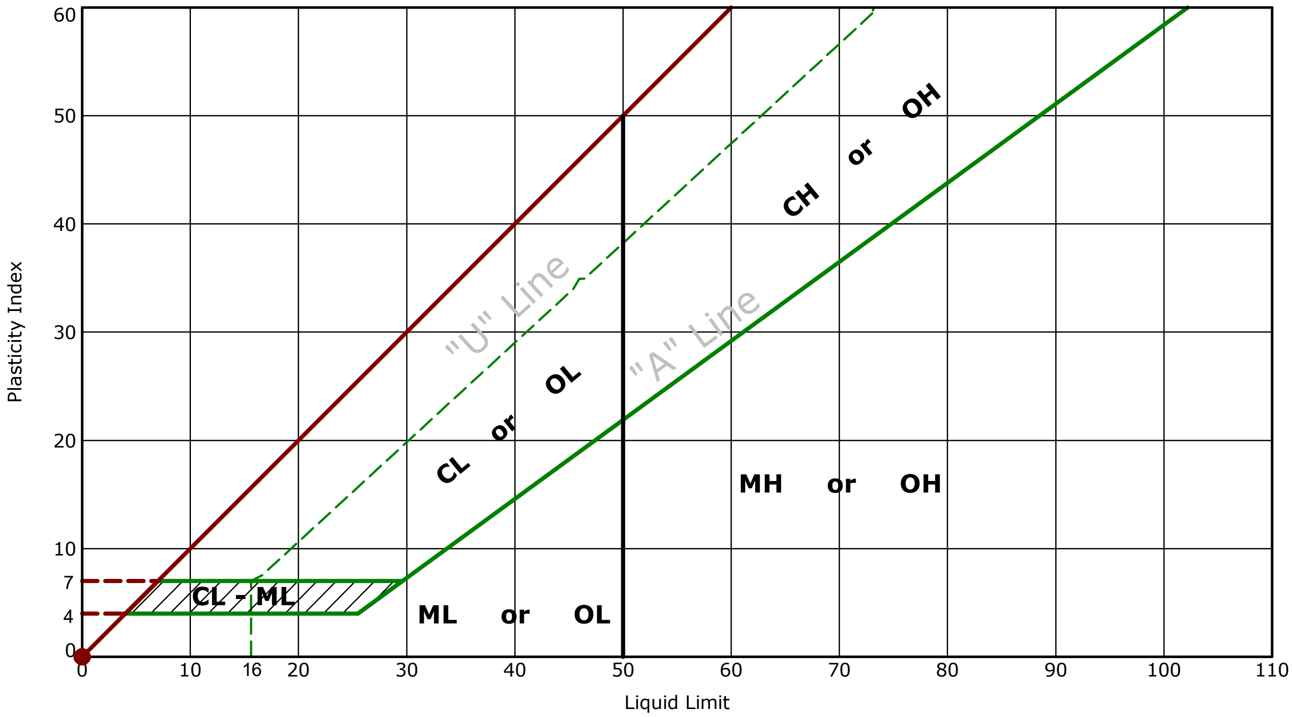
Boring Started
04-02-2024

Boring Completed
04-02-2024

Terracon
23041 Avenida De La Carlota
Ste 350
Laguna Hills, CA

Atterberg Limit Results

ASTM D4318

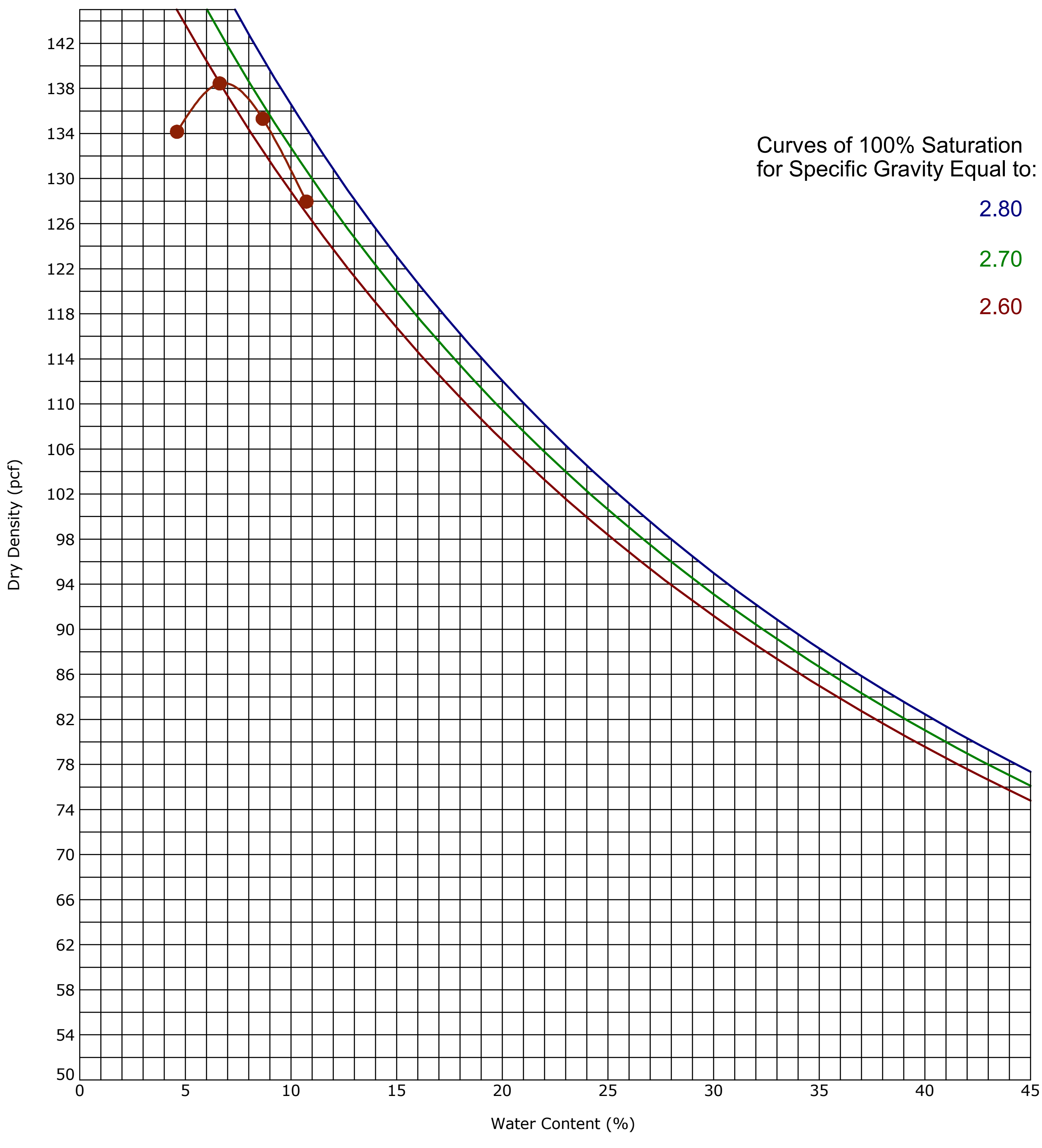


	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-4	2.5 - 4	NP	NP	NP		SM	Silty Sand with Gravel

23041 Avenida De La Carlota
Ste 350
Laguna Hills, CA

Moisture-Density Relationship

ASTM D1557-Method C



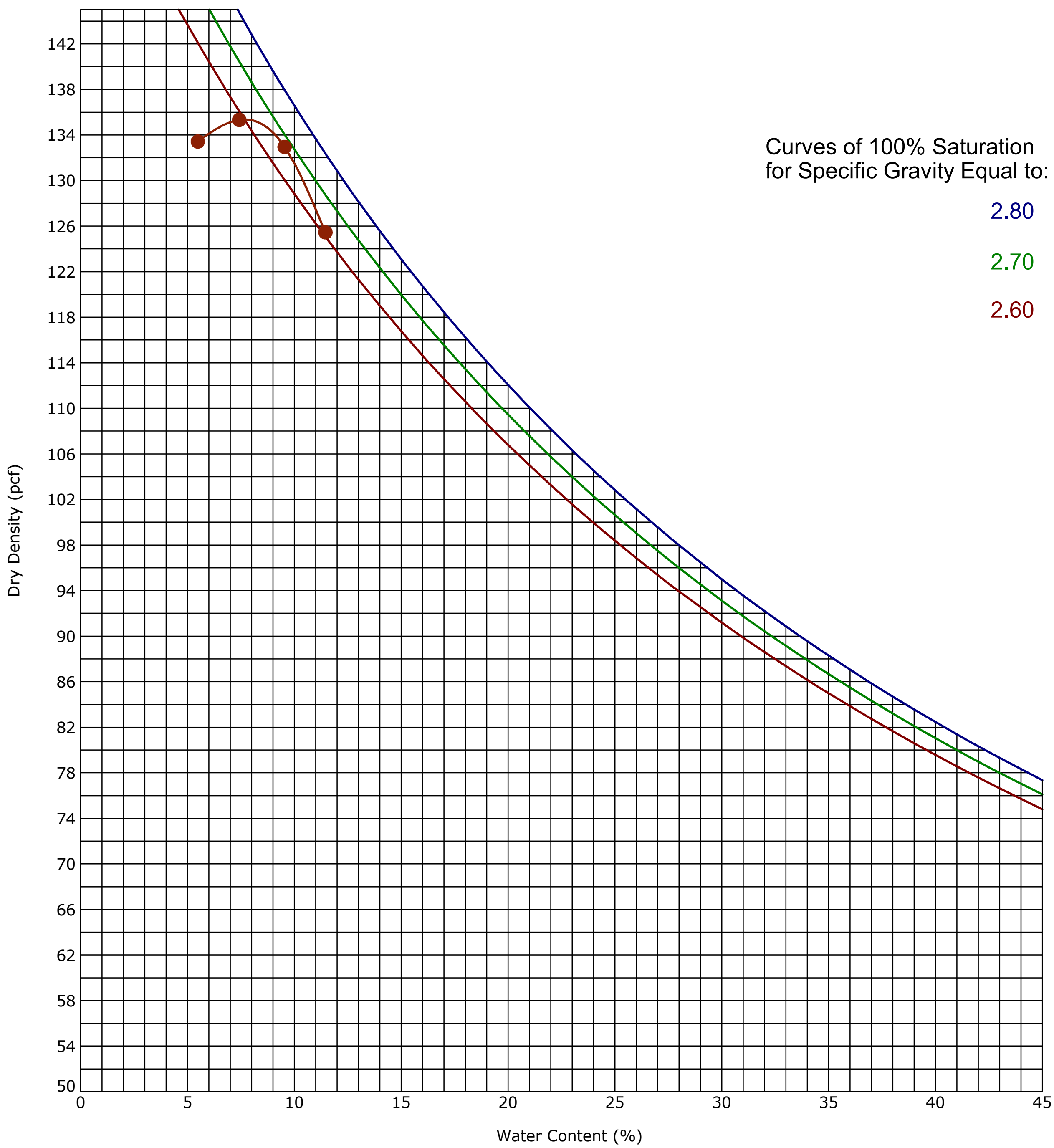
Boring ID	Depth (Ft)	Description of Materials
B-1	0 - 5	Silty Sand with Gravel

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
					ASTM D1557-Method C	138.5	6.8

23041 Avenida De La Carlota
Ste 350
Laguna Hills, CA

Moisture-Density Relationship

ASTM D1557-Method C



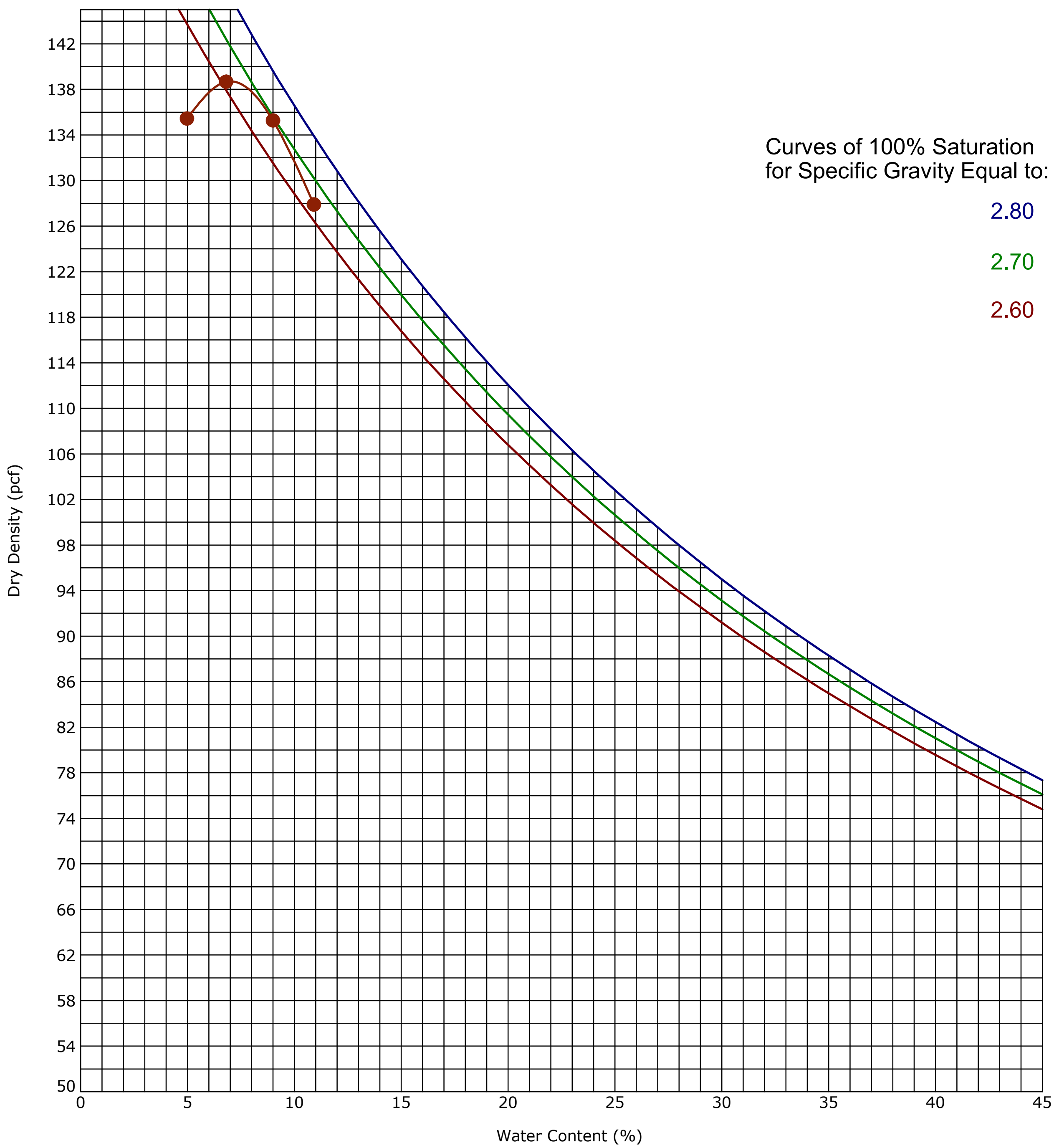
Boring ID	Depth (Ft)	Description of Materials
B-2	0 - 5	SIlty Sand with Gravel

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
					ASTM D1557-Method C	135.4	7.6

23041 Avenida De La Carlota
Ste 350
Laguna Hills, CA

Moisture-Density Relationship

ASTM D1557-Method C



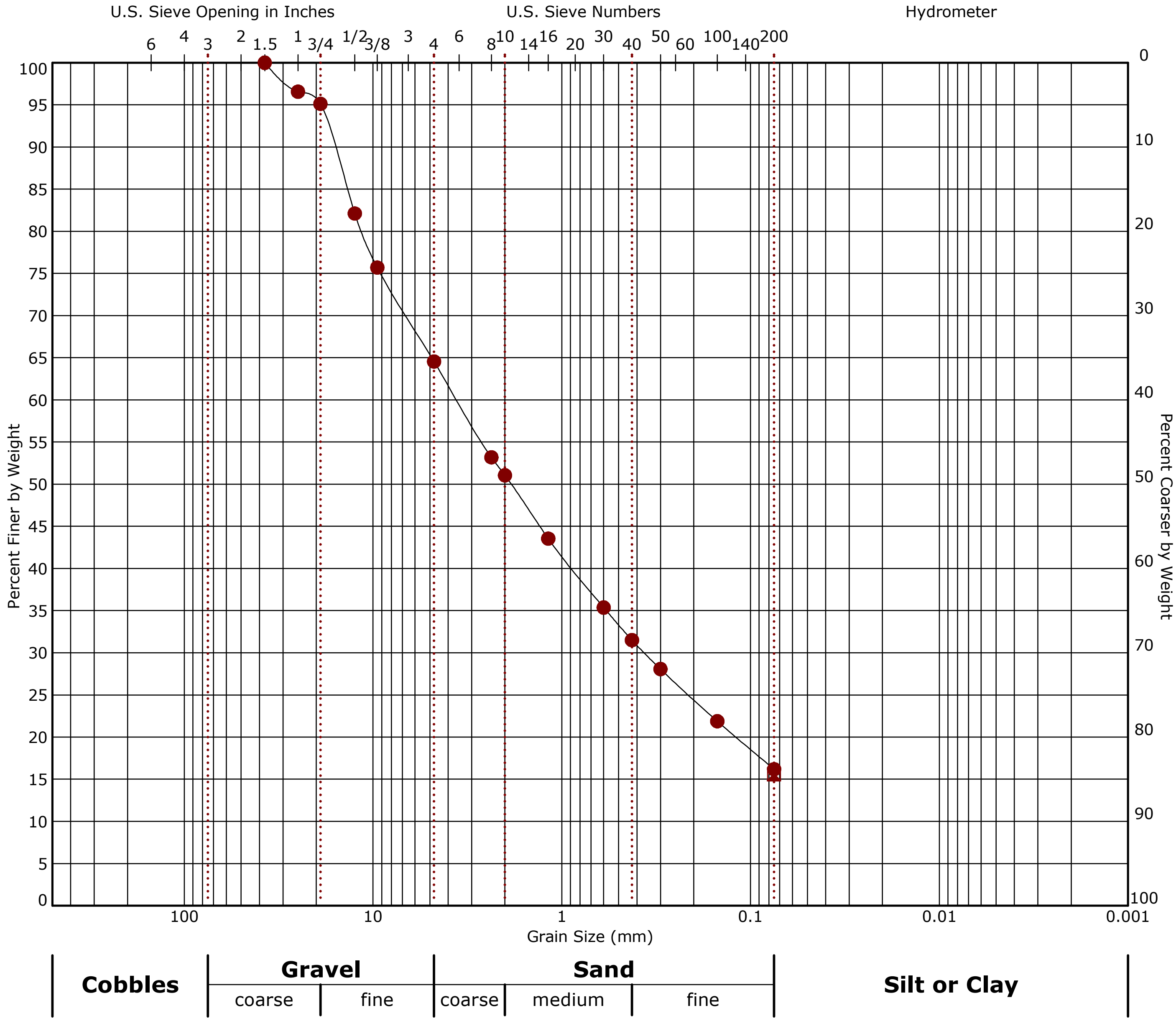
Boring ID	Depth (Ft)	Description of Materials
B-3	0 - 5	Silty Sand with Gravel

Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
					ASTM D1557-Method C	138.7	7.0

23041 Avenida De La Carlota
Ste 350
Laguna Hills, CA

Grain Size Distribution

ASTM D422 / ASTM C136



Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	B-3	2.5 - 4	Silty Sand with Gravel	SM					
☒	B-3	5 - 6.5	Silty Sand with Gravel	SM					

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-3	2.5 - 4	37.5	3.589	0.365		0.0	35.4	48.4	16.2		
☒	B-3	5 - 6.5	0.075							15.6		

OMYA Lucerne Valley
Lucerne Valley, California
Terracon Project No.: 60245013

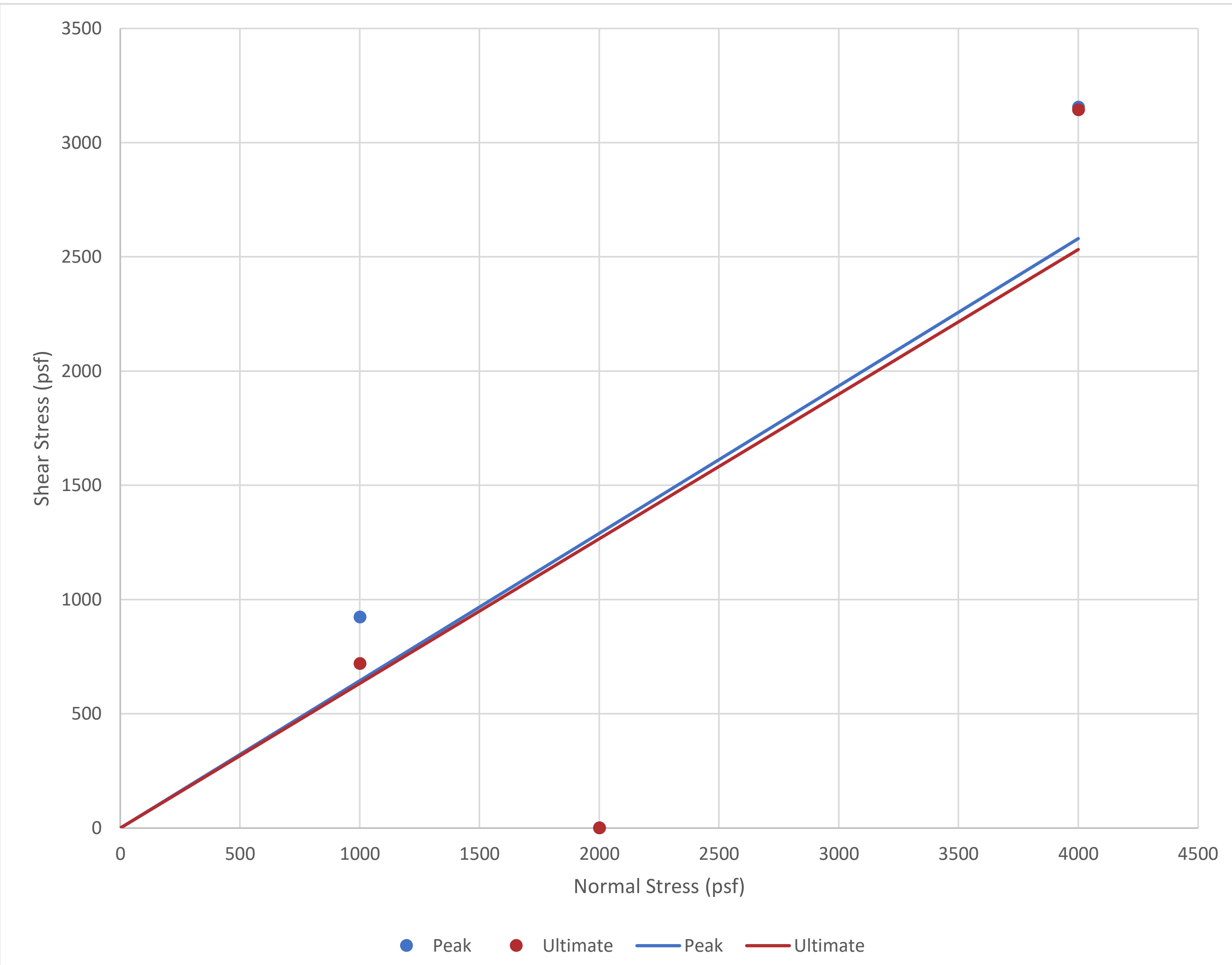
Terracon
145 W Walnut St.
Gardena, CA

Direct Shear Test

ASTM D3080

Boring ID	Depth (ft)	Description	USCS	γ_d (pcf)	W(%)
B-2	5'	Silty Sand with Gravel	SM	114	5.2

Normal Stress (psf)	Peak Shear Stress (psf)	Ultimate Shear Stress (psf)	Peak		Ultimate	
			φ°	C (psf)	φ°	C (psf)
1000	924	720	**37.0**	**180**	**39.0**	**0**
2000	NT	NT				
4000	3156	3144				



750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Terracon

Client
Powerflex Systems LLC

Project
OMYA - Lucerne Valley Solar Facility

Sample Submitted By: Terracon (60) **Date Received:** 4/16/2024 **Lab No.: 24-0142**

Results of Corrosion Analysis

Sample Number	--
Sample Location	B-4
Sample Depth (ft.)	0.0-5.0
pH Analysis, ASTM G51	8.52
Water Soluble Sulfate (SO4), ASTM C 15806 (Percent %)	0.01
Sulfides, AWWA 4500-S D, (mg/Kg)	Nil
Chlorides, ASTM D512, (mg/kg)	35
Red-Ox, ASTM G200, (mV)	+729
Total Salts, AWWA 2540, (mg/Kg)	496
Saturated Minimum Resistivity, ASTM G-187, (ohm-cm)	7469

Analyzed By N. Campo
Nathan Campo
Laboratory Coordinator

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CALIFORNIA BEARING RATIO (CBR)
OF LABORATORY-COMPACTED SOIL
ASTM D 1883

Project Name:	OMYA - Lucerne Valley Solar	Tested By :	ALB	Date	04/19/24
Project No. :	60245013	Input By:	NN	Date	04/22/24
Boring No.:	B-1	Checked By:	AP	Date	04/24/24
Sample No.:	-				
Depth (ft.) :	0-5				
Soil Description :	Clayey Sand				

SAMPLE DESCRIPTION BEFORE SOAKING

Mold Number	D
Blows Per Layer	10
Wt of Wet Soil & Mold (gm)	12355
Weight of Mold (gm)	7822
Weight of Wet Soil (gm)	4533
Mold Volume (cu.ft)	0.0750
Container No.	
Wet Wt. Soil + Container (gm)	675.63
Dry Wt. Soil + Container (gm)	662.07
Wt. Container (gm)	452.9
Moisture Content (%)	6.48
Wet Density (pcf)	133.2
Dry Density (pcf)	125.1

SAMPLE PREPARATION

Wt of Hammer (Lbs)	10
No. of Layers	5
No. of Blows/Layer	10
Drop Height (inches)	18
Surcharge Weight (Lbs)	10
Max. Dry Density (pcf)*	138.4
Molded Relative Comp (%)	90.4
Req'd % Moisture	6.7
No. of Trials	1
% Retained 3/4" Sieve	0.00%

**Note: Max. dry density provided by Terracon*

DEFORMATION DURING SOAKING PERIOD

Sample Length (inch) 4.584

DATE	TIME	Mold No.: D	
		Dial Rdgs	Swell (in)
04/19/24	15:15	0.0820	
04/20/24	07:20	0.0850	
04/22/24	08:40	0.0850	0.0030
Percent Swell/Collapse (+/-)			0.07

AFTER SOAKING

Mold Number	D
Wt. of Wet Soil + Mold (gm)	12510
Weight of Mold (gm)	7822
Weight of Wet Soil (gm)	4688
Final Sample Volume (cu.ft)	0.0750
Container No.	
Wet Wt. Soil + Container (gm)	773.71
Dry Wt. Soil + Container (gm)	719.49
Wt. Container (gm)	140.22
Mosture Content (%)	9.4
Wet Density (pcf)	137.7
After Test Dry Density (pcf)	125.9

TEST LOAD DATA

Piston Diameter (inches): 1.954

Penetration	Mold No.: D	
(inch)	LOAD (lb)	Stress (psi)
0.000	0	0.00
0.025	172	57.36
0.050	248	82.70
0.075	296	98.71
0.100	343	114.38
0.125	386	128.72
0.150	429	143.06
0.175	472	157.40
0.200	511	170.40
0.225	554	184.74
0.250	589	196.42
0.275	622	207.42
0.300	660	220.09
0.325	698	232.76
0.350	734	244.77
0.375	771	257.11
0.400	810	270.11
0.425	842	280.78
0.450	878	292.79
0.475	915	305.13
0.500	958	319.47

TEST RESULTS

CBR @ .1": 11

CBR @ .2": 11

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CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOIL
ASTM D 1883

Project Name:	OMYA - Lucerne Valley Solar	Tested By :	ALB	Date	04/19/24
Project No. :	60245013	Input By:	NN	Date	04/22/24
Boring No.:	B-1	Checked By:	AP	Date	04/24/24
Sample No.:	-				
Depth (ft.) :	0-5				
Soil Description :	Clayey Sand				

SAMPLE DESCRIPTION BEFORE SOAKING

Mold Number	E
Blows Per Layer	25
Wt of Wet Soil & Mold (gm)	12609.5
Weight of Mold (gm)	7812.5
Weight of Wet Soil (gm)	4797
Mold Volume (cu.ft)	0.0750
Container No.	
Wet Wt. Soil + Container (gm)	675.63
Dry Wt. Soil + Container (gm)	662.07
Wt. Container (gm)	452.9
Moisture Content (%)	6.48
Wet Density (pcf)	141.0
Dry Density (pcf)	132.4

SAMPLE PREPARATION

Wt of Hammer (Lbs)	10
No. of Layers	5
No. of Blows/Layer	25
Drop Height (inches)	18
Surcharge Weight (Lbs)	10
Max. Dry Density (pcf)*	138.4
Molded Relative Comp (%)	95.7
Req'd % Moisture	6.7
No. of Trials	1
% Retained 3/4" Sieve	0.00%

**Note: Max. dry density provided by Terracon*

DEFORMATION DURING SOAKING PERIOD

Sample Length (inch) 4.584

DATE	TIME	Mold No.:	E
		Dial Rdgs	Swell (in)
04/19/24	15:15	0.1000	
04/20/24	07:20	0.1000	
04/22/24	08:40	0.1000	0.0000
Percent Swell/Collapse (+/-)			0.00

AFTER SOAKING

Mold Number	E
Wt. of Wet Soil + Mold (gm)	12687
Weight of Mold (gm)	7813
Weight of Wet Soil (gm)	4874
Final Sample Volume (cu.ft)	0.0750
Container No.	
Wet Wt. Soil + Container (gm)	674.09
Dry Wt. Soil + Container (gm)	641.49
Wt. Container (gm)	147.91
Mosture Content (%)	6.6
Wet Density (pcf)	143.3
After Test Dry Density (pcf)	134.4

TEST LOAD DATA

Piston Diameter (inches): 1.954

Penetration	Mold No.: E	
(inch)	LOAD (lb)	Stress (psi)
0.000	0	0.00
0.025	174	58.02
0.050	351	117.05
0.075	507	169.07
0.100	669	223.09
0.125	839	279.78
0.150	1000	333.47
0.175	1172	390.83
0.200	1354	451.52
0.225	1543	514.55
0.250	1745	581.91
0.275	1955	651.94
0.300	2140	713.63
0.325	2305	768.66
0.350	2491	830.68
0.375	2671	890.71
0.400	2861	954.07
0.425	3032	1011.09
0.450	3217	1072.78
0.475	3401	1134.14
0.500	3573	1191.50

TEST RESULTS

CBR @ .1": **22**

CBR @ .2": **30**

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CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOIL
ASTM D 1883

Project Name:	OMYA - Lucerne Valley Solar	Tested By :	ALB	Date	04/19/24
Project No. :	60245013	Input By:	NN	Date	04/22/24
Boring No.:	B-1	Checked By:	AP	Date	04/24/24
Sample No.:	-				
Depth (ft.) :	0-5				
Soil Description :	Clayey Sand				

SAMPLE DESCRIPTION BEFORE SOAKING

Mold Number	F
Blows Per Layer	56
Wt of Wet Soil & Mold (gm)	12834.5
Weight of Mold (gm)	7792.5
Weight of Wet Soil (gm)	5042
Mold Volume (cu.ft)	0.0750
Container No.	
Wet Wt. Soil + Container (gm)	675.63
Dry Wt. Soil + Container (gm)	662.07
Wt. Container (gm)	452.9
Moisture Content (%)	6.48
Wet Density (pcf)	148.2
Dry Density (pcf)	139.2

SAMPLE PREPARATION

Wt of Hammer (Lbs)	10
No. of Layers	5
No. of Blows/Layer	56
Drop Height (inches)	18
Surcharge Weight (Lbs)	10
Max. Dry Density (pcf)*	138.4
Molded Relative Comp (%)	100.6
Req'd % Moisture	6.7
No. of Trials	1
% Retained 3/4" Sieve	0.00%

**Note: Max. dry density provided by Terracon*

DEFORMATION DURING SOAKING PERIOD

Sample Length (inch) 4.584

DATE	TIME	Mold No.: F	
		Dial Rdgs	Swell (in)
04/19/24	15:15	0.1200	
04/20/24	07:20	0.1190	
04/22/24	08:40	0.1190	-0.0010
Percent Swell/Collapse (+/-)			-0.02

AFTER SOAKING

Mold Number	F
Wt. of Wet Soil + Mold (gm)	12873
Weight of Mold (gm)	7793
Weight of Wet Soil (gm)	5081
Final Sample Volume (cu.ft)	0.0750
Container No.	
Wet Wt. Soil + Container (gm)	554.65
Dry Wt. Soil + Container (gm)	529.59
Wt. Container (gm)	141.02
Mosture Content (%)	6.4
Wet Density (pcf)	149.4
After Test Dry Density (pcf)	140.3

TEST LOAD DATA

Piston Diameter (inches): 1.954

Penetration	Mold No.: F	
(inch)	LOAD (lb)	Stress (psi)
0.000	0	0.00
0.025	47	15.67
0.050	147	49.02
0.075	299	99.71
0.100	549	183.08
0.125	869	289.79
0.150	1250	416.84
0.175	1703	567.90
0.200	2194	731.64
0.225	2719	906.71
0.250	3282	1094.46
0.275	3854	1285.21
0.300	4383	1461.61
0.325	4902	1634.69
0.350	5432	1811.43
0.375	5998	2000.17
0.400	6568	2190.25
0.425	7142	2381.67
0.450	7722	2575.08
0.475	8294	2765.83
0.500	8828	2943.90

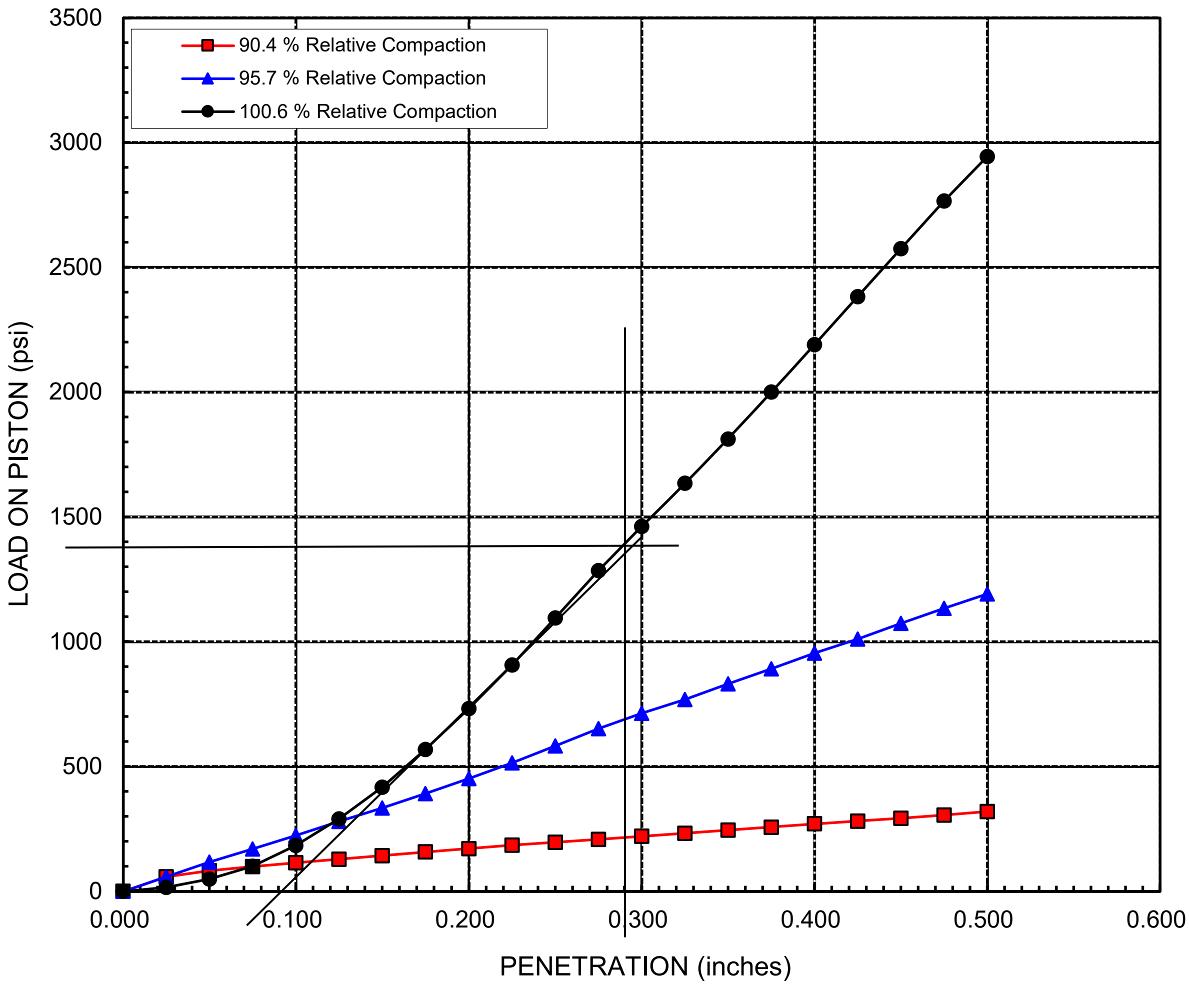
TEST RESULTS

CBR @ .1": 68

CBR @ .2": 93

CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOIL ASTM D 1883

Project Name:	OMYA - Lucerne Valley Solar	Tested By :	ALB	Date:	04/19/24
Project No. :	60245013	Data Input By:	NN	Date:	04/22/24
Boring No.:	B-1	Checked By:	AP	Date:	04/24/24
Sample No.:	-				
Depth (ft.) :	0-5				
Soil Description :	Clayey Sand				



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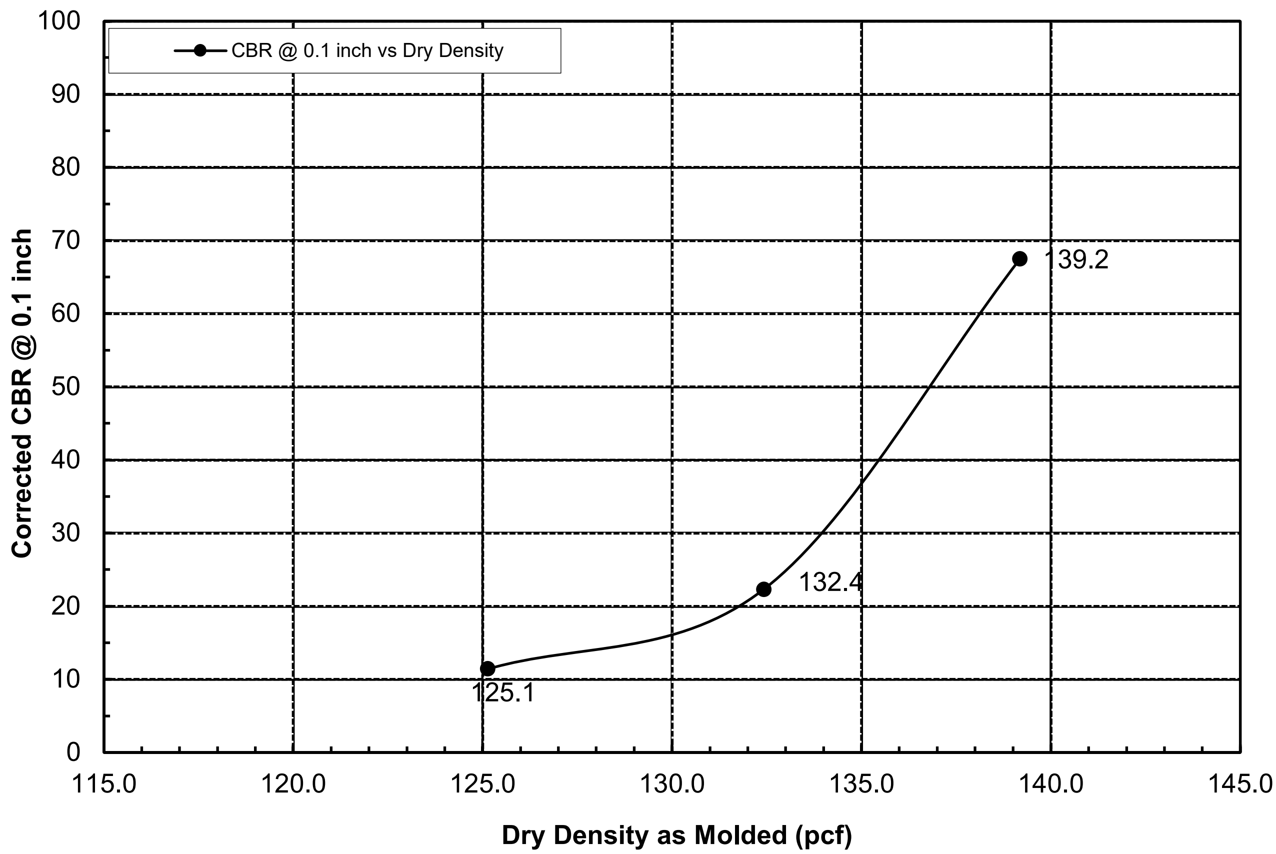
CALIFORNIA BEARING RATIO (CBR) OF LABORATORY-COMPACTED SOIL ASTM D 1883

Project Name:	OMYA - Lucerne Valley Solar	Tested By :	ALB	Date:	04/19/24
Project No. :	60245013	Data Input By:	NN	Date:	04/22/24
Boring No.:	B-1	Checked By:	AP	Date:	04/24/24
Sample No.:	-				
Depth (ft.) :	0-5				
Soil Description :	Clayey Sand				

TEST RESULTS

Dry Density (pcf)	Maximum Dry Density by ASTM D 1557 (pcf)	Relative Compaction (%)	Blow Per Layer	CBR @0.1"	CBR @0.2"
125.1	138.4	90.4	10	11	11
132.4	138.4	95.7	25	22	30
139.2	138.4	100.6	56	68	93



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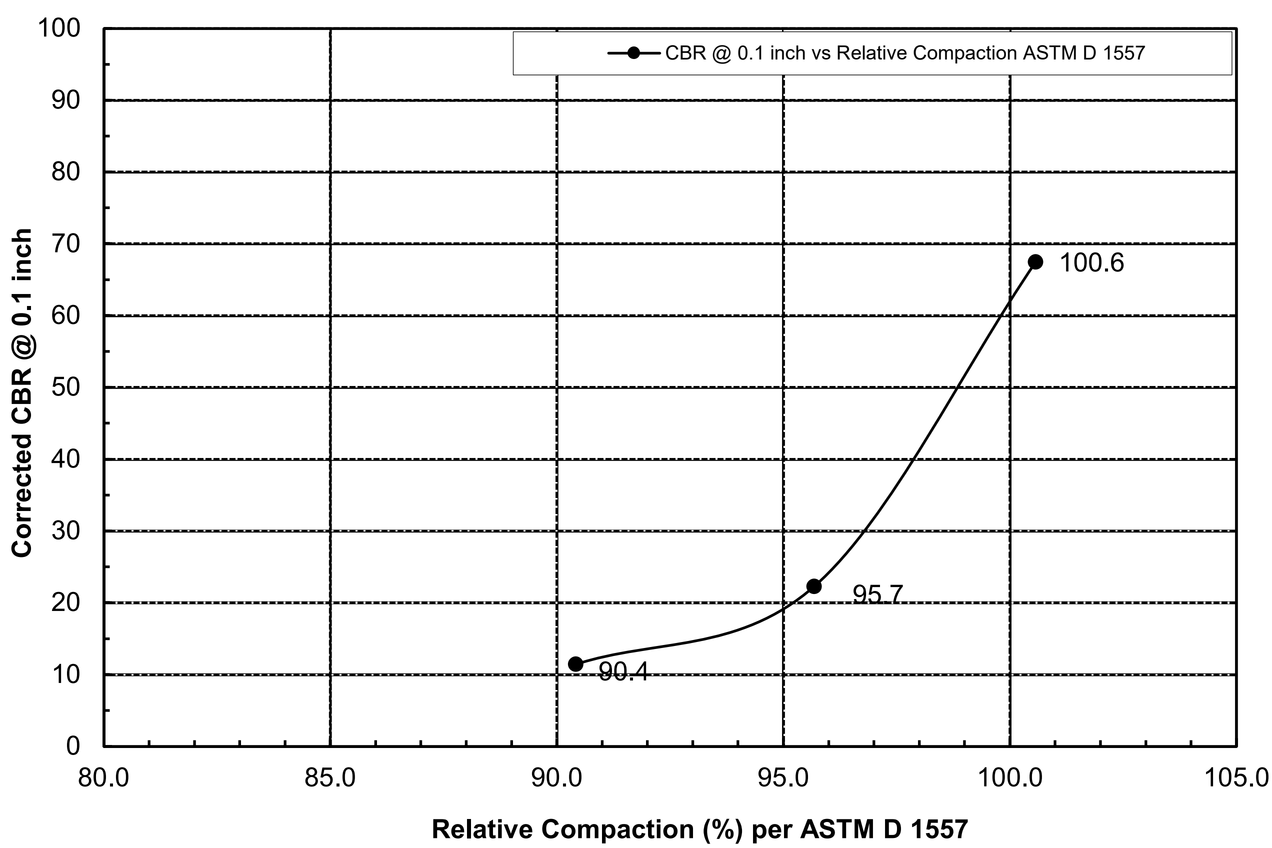
CALIFORNIA BEARING RATIO (CBR)
OF LABORATORY-COMPACTED SOIL
ASTM D 1883

Project Name:	OMYA - Lucerne Valley Solar	Tested By :	ALB	Date:	04/19/24
Project No. :	60245013	Data Input By:	NN	Date:	04/22/24
Boring No.:	B-1	Checked By:	AP	Date:	04/24/24
Sample No.:	-				
Depth (ft.) :	0-5				
Soil Description :	Clayey Sand				

TEST RESULTS

Dry Density (pcf)	Maximum Dry Density by ASTM D 1557 (pcf)	Relative Compaction (%)	Blow Per Layer	CBR @0.1"	CBR @0.2"
125.1	138.4	90.4	10	11	11
132.4	138.4	95.7	25	22	30
139.2	138.4	100.6	56	68	93



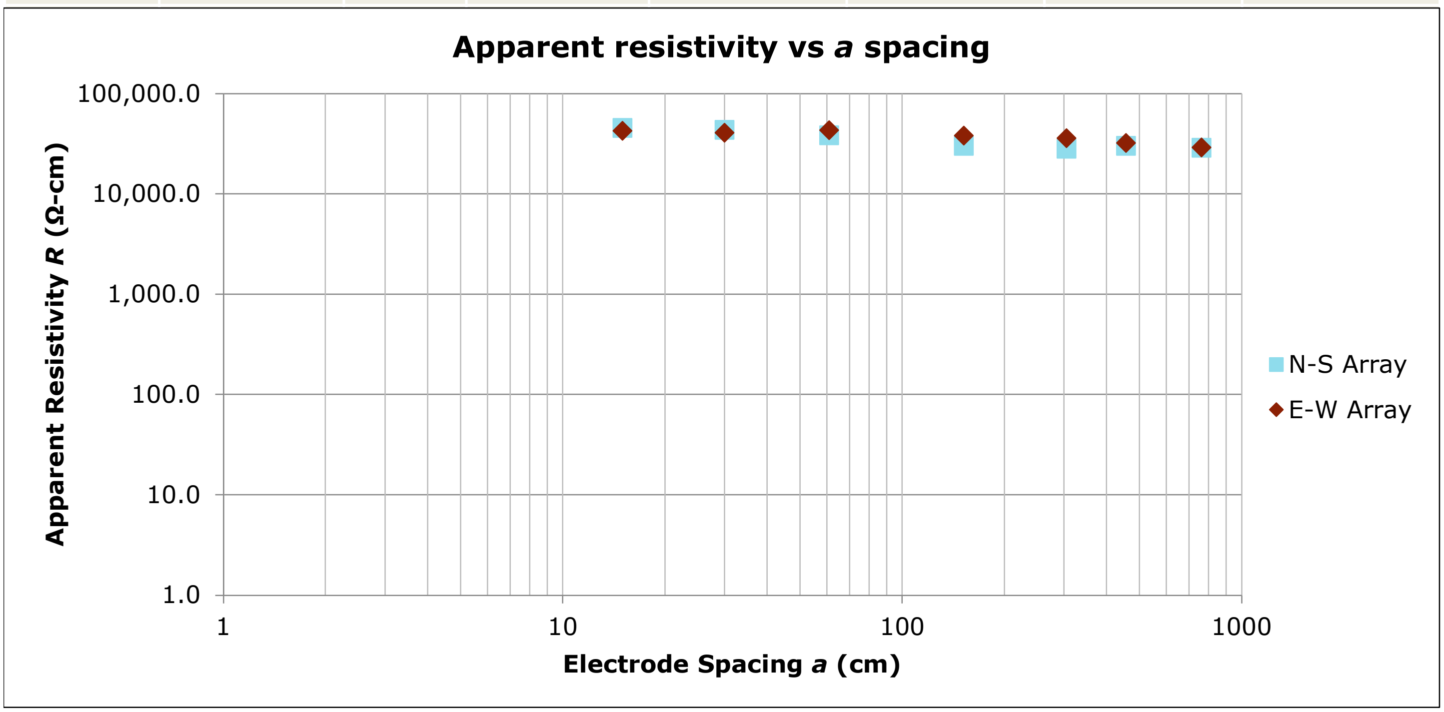
FIELD ELECTRICAL RESISTIVITY TEST DATA
OMYA | Lucerne Valley, California
Terracon Project No. 60245013

Array Loc.	ER-1 (34.3771, -116.9420)		
Instrument	Mini Sting	**Weather**	Sunny
Serial #	S2107129	**Ground Cond.**	Gravel &Desert sand
Cal. Check		**Tested By**	AL/DM
Test Date	April 29, 2024	**Method**	Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012)
Notes & Conflicts			

Apparent resistivity ρ is calculated as :

$$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$

Electrode Spacing *a*		**Electrode Depth *b***		**N-S Test**		**E-W Test**	
(feet)	(centimeters)	(inches)	(centimeters)	Measured Resistance *R* Ω	Apparent Resistivity ρ (Ω-cm)	Measured Resistance *R* Ω	Apparent Resistivity ρ (Ω-cm)
0.5	15	6	15	288	45720	270	42860
1	30	6	15	176	43680	165	40900
2	61	6	15	92	38600	103	43460
5	152	6	15	31	30210	39	38180
10	305	7	18	15	28380	19	36070
15	457	7	18	11	30320	11	32280
25	762	8	20	6.1	29020	6.1	29170



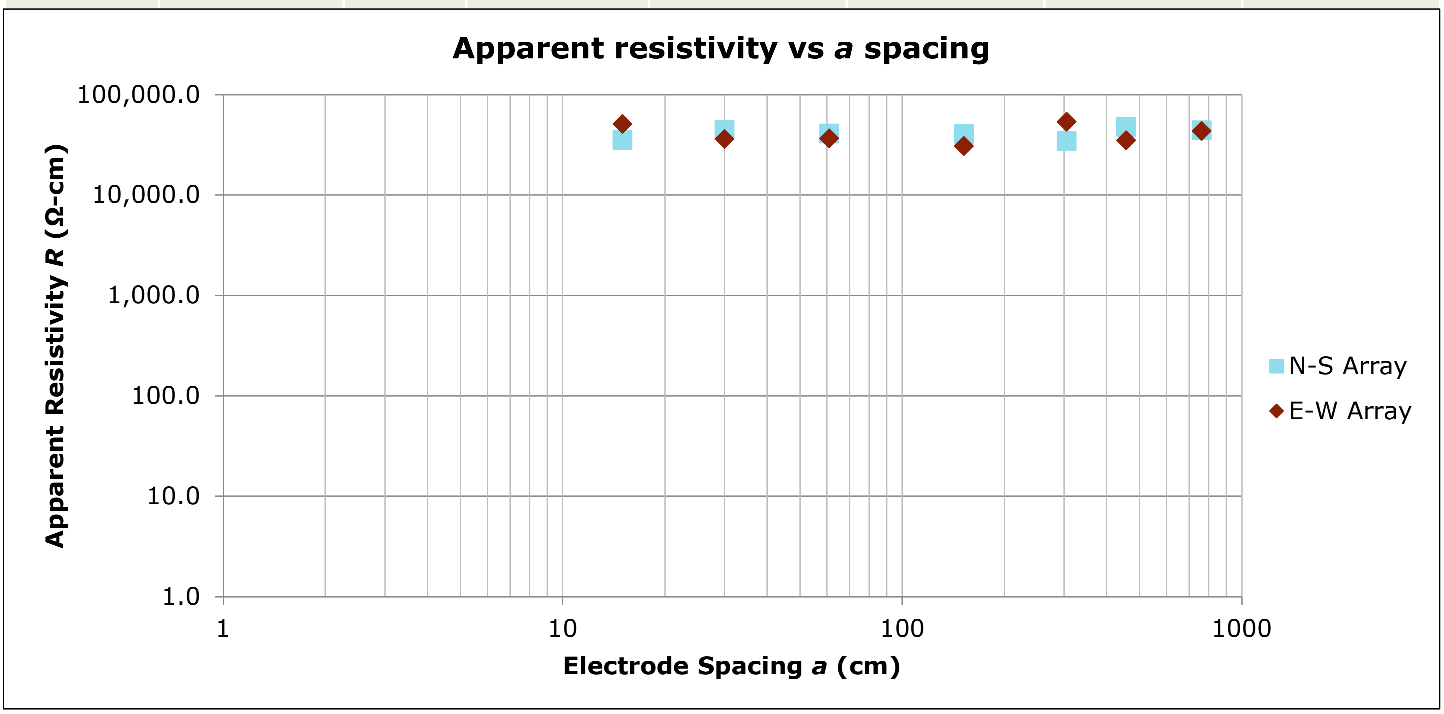
FIELD ELECTRICAL RESISTIVITY TEST DATA
OMYA | Lucerne Valley, California
Terracon Project No. 60245013

Array Loc.	ER-2 (34.3761 , -116.9399)		
Instrument	Mini Sting	**Weather**	Sunny
Serial #	S2107129	**Ground Cond.**	Gravel &Desert sand
Cal. Check		**Tested By**	AL/DM
Test Date	April 29, 2024	**Method**	Wenner 4-pin (ASTM G57-06 (2012); IEEE 81-2012)
Notes & Conflicts			

Apparent resistivity ρ is calculated as :

$$\rho = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$

Electrode Spacing *a*		**Electrode Depth *b***		**N-S Test**		**E-W Test**	
(feet)	(centimeters)	(inches)	(centimeters)	Measured Resistance *R*	Apparent Resistivity ρ	Measured Resistance *R*	Apparent Resistivity ρ
				Ω	(Ω-cm)	Ω	(Ω-cm)
0.5	15	6	15	224	35560	323	51220
1	30	6	15	181	44900	147	36390
2	61	6	15	98	41180	88	37040
5	152	6	15	42	40790	32	31060
10	305	6	15	18	34740	28	53940
15	457	6	15	17	47930	12	35470
25	762	7	18	9.2	44290	9.1	43810



Geotherm

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Cypress, TX 77433
info@geothermusa.com
http://www.geothermusa.com

May 2, 2024

Terracon
145 West Walnut Street
Carson, CA
Attn: Tami Price

Re: Thermal Analysis of Native Soil Samples (Project No.60245013)
OMYA-Lucerne Valley Solar Facility – San Bernardino County, CA

The following is the report of thermal dryout characterization tests conducted on two (2) bulk soil samples from the referenced project sent to our laboratory.

Thermal Resistivity Tests: The samples were tested at either the 'optimum' or 'as received' moisture content, whichever was greater, and at 85% and 95% of the modified proctor dry density ***provided by Terracon***. Per instructions, the soil descriptions were left blank in the report. The tests were conducted in accordance with the **IEEE standard 442-2017**. The results are tabulated below and the thermal dry out curves are presented in **Figures 1 & 2**.

Sample ID, Description, Thermal Resistivity, Moisture Content and Density

Sample ID	Depth (ft)	Effort (%)	Description	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
				Wet	Dry		
B-2	0	85	--	61	160	8	115
B-2	0	95	--	55	121	8	129
B-3	0	85	--	57	153	7	118
B-3	0	95	--	51	118	7	132

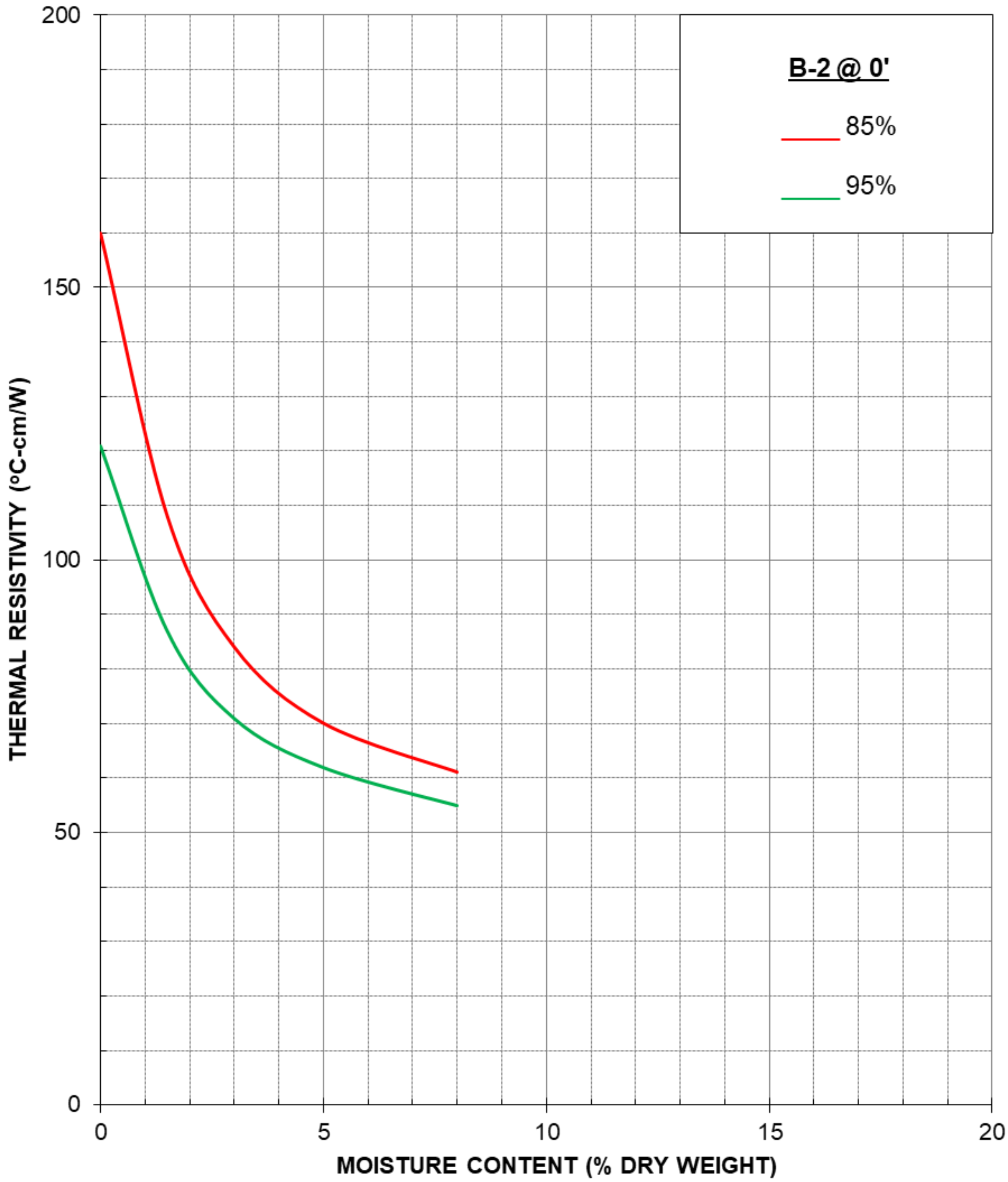
Comments: The thermal characteristic depicted in the dryout curves apply for the soils at their respective test dry density.

Please contact us if you have any questions or if we can be of further assistance.

Geotherm USA, LLC

Nimesh Patel

THERMAL DRYOUT CURVES



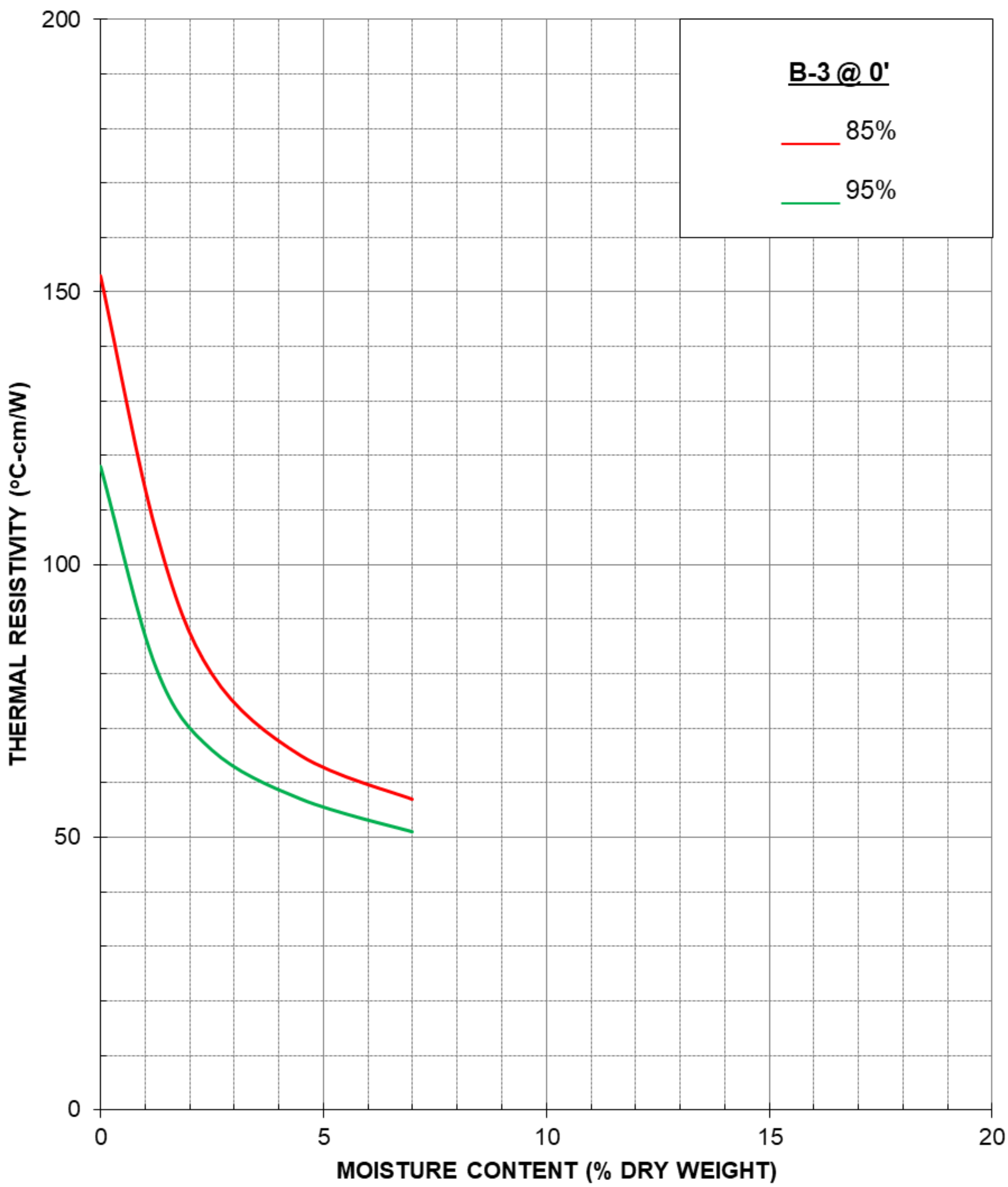
Terracon (Project No. 60245013)

OMYA-Lucerne Valley Solar Facility – San Bernardino County, CA

Thermal Analysis of Native Soil Samples

May 2024 **Figure 1**

THERMAL DRYOUT CURVES



Terracon (Project No. 60245013)

OMYA-Lucerne Valley Solar Facility – San Bernardino County, CA

Thermal Analysis of Native Soil Samples

May 2024 **Figure 2**

Supporting Information

Contents:

Terracon
145 W Walnut St
Carson, CA

General Notes

Sampling	Water Level	Field Tests
Auger Cuttings	Water Initially Encountered	N — Standard Penetration Test Resistance (Blows/Ft.)
Modified Dames & Moore Ring Sampler	Water Level After a Specified Period of Time	(HP) — Hand Penetrometer
Grab Sample	Water Level After a Specified Period of Time	(T) — Torvane
Standard Penetration Test	Cave In Encountered	(DCP) — Dynamic Cone Penetrometer
		UC — Unconfined Compressive Strength
		(PID) — Photo-Ionization Detector
		(OVA) — Organic Vapor Analyzer

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Ring Sampler (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**	**Ring Sampler (Blows/Ft.)**
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.