CASE STUDY

42 STELCOR DDMS FOR WIND TURBINES IN CALIFORNIA

DESIGN LOADS:
123 Tons Compression Load
123 Tons Tension Load

TEST LOADS:
163 Tons Compression Load
163 Tons Tension Load

PILE DETAIL:
STELCOR 1600
18” Drive Plate
16” Corrugated Grout Column
13” Solid Grout Column
11” Reverse Grout Auger
7.00” O.D. X 0.408” W.T. – 80 ksi
Central Shaft

PILE LENGTH: 50’

NUMBER OF PILES: 42

GEOLOGY:
Subsurface explorations at this site mainly encountered loose to medium dense sands with layers that contained silt and clay. The borings were terminated at 51 feet, and the final 10 feet consisted of sandy silt and stiff lean clays with varying amounts of sand and gravel.

OVERVIEW:

Dole’s salad processing plant in Soledad, CA, recently began a $10 million project to install two wind turbines. The turbines will provide power to the facility to aid Dole in achieving its goal of net zero carbon emissions from Dole-managed operations by 2030. The two 500’ tall wind turbines are capable of producing 2.7-megawatts each for a combined total of 5.4 megawatts of renewable energy.

CHALLENGES:

The most significant obstacle encountered was the soil conditions at the project locations. Due to the nature of the structure of a wind turbine, the foundation must be able to resist high tension and compression loads. Achieving the loads was challenging as the soil mainly consisted of silty sands with sandy clays in a few areas. Geotechnical borings taken at the install locations found the subsurface conditions to consist primarily of loose, granular soils. Within the 50-foot boring, a suitable bearing layer was not encountered.

Grouted helicals were considered for this project in the design phase, but they would have failed in tension. The lack of a suitable bearing layer also introduced many uncertainties when designing the foundations with helical piles. Mobilizing a dedicated piling rig for only two foundations would have been cost prohibitive. Therefore, traditional micropiles, auger cast piles, and other piling methods that rely on a dedicated rig were too costly.

THE DESIGNED STELCOR PILE WAS TESTED TO 163 TONS IN COMPRESSION AND ONLY MOVED 3/8 OF AN INCH.

SOLUTION:

The engineer specified STELCOR DDMS to support the wind turbines as alternate pile types were either cost prohibitive or incapable of resisting the loads in the conditions present. Drilled-in Displacement Micropiles have been proven to achieve lower cost per kip than alternate piling methods and perform well in sandy soils, making STELCOR a perfect fit. The IDEAL design team configured a STELCOR DDM with a 16” grout column and a 7” steel core to meet the loading requirements. The designed STELCOR pile was tested to 163 tons in compression and only moved 3/8 of an inch. The same pile was also used for the tension piles and is capable of resisting the designed tension load of 123 tons.

Avalon Structural, a certified STELCOR installer, installed 42 total STELCOR DDMS. Each foundation consisted of 21 piles, with an inner ring of 7 compression piles and an outer ring of 14 tension piles. STELCOR was installed using only an excavator with a hydraulic drive motor attachment and a colloidal grout mixer. Mobilization and moving between install locations while on-site is very efficient as there is minimal setup. Even when set up, the installation equipment is highly mobile. Due to the efficiencies of STELCOR, installation rates were increased, saving time, money, and a lot of headaches.

IDEAL Manufacturing, Inc.   WEB | www.idl-grp.com   TEL | 800.789.4810   EMAIL | info@idl-grp.com

Geotechnical Engineering Report

Dole Wind Turbines
Soledad, California
April 22, 2019
Terracon Project No. NA195043

Prepared for:
Foundation Windpower, LLC
San Francisco, CA

Prepared by:
Terracon Consultants, Inc.
Lodi, California

April 22, 2019

Foundation Windpower, LLC
505 Sansome Street, Suite 900
San Francisco, CA 94111

Attn: Steven Grant
P: (916) 224-1100
E: steven.grant@foundationwindpower.com

Re: Geotechnical Engineering Report
Dole Wind Turbines
32655 Camphora Gloria Road
Soledad, California
Terracon Project No. NA195043

Dear Steve:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PNA195043 dated March 26, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations 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 Consultants, Inc.

Patrick C. Dell, Senior Associate
Geotechnical Engineer 2186
Geotechnical Department Manager

Garret S.H. Hubbart, Principal
Geotechnical Engineer 2588
Office Manager

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange 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 ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report

Dole Wind Turbines
32655 Camphora Gloria Road
Soledad, California
Terracon Project No. NA195043
April 22, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed wind turbines to be located at 32655 Camphora Gloria Road in Soledad, California. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Seismic site classification per 2016 CBC
- Foundation design and construction
- Excavation considerations
- Lateral earth pressures

The geotechnical engineering Scope of Services for this project included the advancement of two test borings to depths of approximately 51½ feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

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 at 32655 Camphora Gloria Road in Soledad, California. Approximate coordinates 36.4566°N 121.3513°W See **Site Location**
Existing Improvements	Agricultural row crops.
Current Ground Cover	Bare ground or row crops.
Existing Topography	Relatively gentle, slopes up towards the east.

Item	Description
Geology	Pleistocene-age Alluvial sediments of lower, younger terraces (Qoa).

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	Information regarding the project was provided in several emails from Steven Grant of Foundation Windpower, LLC. These emails contained a scope of work as well as aerial photos indicating the proposed wind turbine generators (WTG) locations.
Project Description	The project will consist of the construction of two wind turbines.
Proposed Structures	Two WTGs.
Structure Construction	Patrick & Henderson™ (P&H) pier foundation
Maximum Loads	Loads were not provided at the time this proposal was prepared.
Grading/Slopes	Minimal cut and fill area anticipated, less than 2 feet with the exception of the excavations for the pier foundations.
Estimated Start of Construction	Unknown

GEOTECHNICAL CHARACTERIZATION

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. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Silty and Clayey Sand**	Loose Silty and Clayey Sand
2	**Poorly Graded and Silty Sand**	Loose to Medium Dense Poorly Graded Sand and Silty Sand

3	**Sand**	Medium Dense Poorly Graded Sand with Silt, Silty and Clayey Sand
4	**Sandy Silt**	Stiff to Very Stiff Sandy Silt
5	**Lean Clay**	Very Stiff to Hard Lean Clay with varying amounts of Sand and Gravel
6	**Clayey Sand**	Medium Dense Clayey Sand

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration the borings remained open. Some perched groundwater was observed in boring B1 at a depth of about 10 feet below the ground surface. However, this does not necessarily mean the borings terminated above groundwater. Due to the low permeability of some of the soils encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The soils encountered in our borings consisted of interbedded layers of loose to medium dense sand with varying amounts of silt, and clay, stiff to very stiff sandy silt, and very stiff to hard lean clay with varying amounts of sand and gravel. Based on the soils encountered in our borings, the WTGs may be constructed as planned with P&H Foundations™.

The **P&H Foundations** section addresses support of the turbines bearing in native soils.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement.

No significant grade changes and earthwork are anticipated for the WTGs. The following presents recommendations for site preparation, subgrade preparation and placement of engineered fills on the project, if needed.

A third-party inspector should be present during site preparation operations to observe stripping and grubbing depths, to observe the removal of unsuitable soils, to observe subgrade preparation, and to verify the foundation bearing materials and access road subgrades have been prepared in accordance with our recommendations and the project plans and specifications.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed turbine areas.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck. The proofrolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed or modified by stabilizing with lime/cement or aggregate base with geogrids. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Fill Material Types

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

Imported earth materials for use as engineered fill should be pre-approved by our representative prior to construction. Imported non-expansive soils may be used as fill material for the following:

- general site grading
- foundation backfill

Soils for use as compacted engineered fill material within the proposed turbine areas should conform to non-expansive materials as indicated in the following recommendations:

Percent Finer by Weight

Gradation	**(ASTM C 136)**
3”	100
No. 4 Sieve	50 - 100
No. 200 Sieve	15 - 50

- Liquid Limit 30 (max)
- Plasticity Index 10 (max)
- Maximum Expansive Index* 20 (max)

*ASTM D 4829

The on-site near surface silty and clayey sands should meet the specifications above. 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 ten inches in loose thickness.

Fill Compaction Requirements

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 sandy soils and Low volume change (non-expansive) imported fill:			
Non-structural areas:	90	0%	+3%
Utility Trenches*:	90	0%	+4%
Miscellaneous backfill:	90	+0%	+3%

*The upper 12 inches beneath pavement should be compacted to 95% of the maximum dry density as determined in the ASTM D1557 test method.

We recommend that compacted native soil or any engineered fill be tested for moisture content and relative compaction during placement. Should the results of the in-place density tests indicate the specified moisture content or compaction requirements have not been met, the area represented by the test should be reworked and retested as required until the specified moisture content and relative compaction requirements are achieved.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the project. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Surface features which could retain water in areas adjacent to the tower facility should be sealed or eliminated. Backfill against foundations and in utility line trenches should be properly compacted and free of all construction debris to reduce the possibility of moisture infiltration.

Earthwork Construction Considerations

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

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 1,000 square feet of compacted fill in the turbine areas. One density and water content test should be performed for every 12-inch thick lift for 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If 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.

P&H FOUNDATIONS

Based on the results of our field investigation, the site is suitable for the proprietary P&H tensionless pier foundation at the turbine locations. All details of the foundation system, including diameter and depth of the piers, as well as spacing and connection of steel tie rods, are to be designed by P&H. The bearing capacity and skin friction are to be determined by the design engineer.

We have summarized the soil parameters, in the tables below, that may affect the design of P&H foundations at this site.

Lateral Compression Load Analysis Estimated Engineering Properties of Soils				
Depth (feet bgs)	**Effective Unit Weight (pcf)**	**L-Pile Soil Type**	**Friction Angle°/Cohesion (psf)**	**Coefficient of Static Horizontal Subgrade Reaction K_s (pci)[1, 2]**
2 to 5	120	Sand	34°	75
5 to 13	110	Sand	36°	90
13 to 18	115	Sand	38°	60
18 to 34	125	Sand	40°	90
34 to 48	120	Clay w/o water	2000 psf	750[3]/300[4]
48 to 51½	130	Sand	40°	90

1) These values are based upon parameters for LPILE v.6.0 analyses.
2) The soil modulus increases linearly with depth by an amount equal to the coefficient of horizontal subgrade reaction and is independent of shaft diameter.
3) Static loading.
4) Cyclic loading.

Lateral load design parameters are valid within the elastic range of the soil. The coefficient 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.

We recommend that all drilled shaft installations be observed on a full-time basis by an experienced geotechnical engineer in order to confirm that soils encountered are consistent with the recommended design parameters.

Foundation soil stiffness was evaluated based on our geotechnical exploration and laboratory testing. Geotechnical parameters to evaluate overall foundation system stiffness are as follows:

Soil Dynamic Properties				
Depth (feet bgs)	**Blow Counts N_{60}**	**Poisson's Ratio, u**	**Estimated Small Strain Shear Modulus, G_o (ksf)**	**Estimated Small Strain Elastic Modulus, E_o (ksf)**
2 to 5	15	0.405	1740	4895
5 to 13	20	0.405	1860	5225
13 to 18	11	0.405	1415	3980
18 to 34	27	0.405	2475	6965
34 to 48	20	0.405	2470	6940
48 to 51½	40	0.405	3175	8920

The geotechnical parameters outlined above should be considered approximate and preliminary and are based upon values obtained from the limited test data and the correlations outlined. It should be noted that the preliminary parameters obtained from these analyses are subject to the inherent variability of the subsurface profile and idealized methods used in the analysis. Variations of the soils and their engineering properties are likely to be found by additional field exploration and laboratory testing, or during construction, that could result in deviations from the parameters discussed in this report. If any of the information regarding foundation loading and geometry outlined in this report is incorrect or changes occur during design, Terracon should be contacted so that modifications to our analysis can be made, as appropriate.

P&H Foundation Construction Considerations

Design and construction of P&H foundation should account for the following considerations.

The P&H Pier design utilizes large diameter, cast-in-place piers. Typically, the foundation is excavated using a long-reach excavator, up to 40 feet in depth maximum. The upper soils may slough and cave during excavation of the P&H foundation, especially if perched groundwater is encountered. The Contractor should be prepared to protect the sides and bottom of the excavations and remove loose and disturbed soils from the sides and base of the excavation.

Once excavated a corrugated steel pipe (CMP) in installed and the annular space between the excavation and the CMP backfilled with a sand-cement slurry. Once this has occurred, the excavation is considered to be shored. The slurry should be placed to as near the ground surface as possible to maintain the contact between the CMP and the native soils. Additional volume of grout in areas of sloughing soils may be necessary.

Steel anchor bolts, with PVC sleeves, are installed utilizing a template ring at the top and an embedment ring at the bottom. Once leveled and in place, an inner CMP is placed, a concrete plug poured to stabilize the CMP and the majority of the spoils from the excavation are placed within the inner CMP to act as ballast. This fill does not require compaction. Electrical conduits are installed, the cap is formed, and some reinforcing steel is placed for the foundation cap to minimize shrinkage cracking. Structural concrete is then placed using tremie methods between the CMPs and cap forms. Once the concrete has set the template ring is removed, creating a grout trough, and once adequate strength is achieved in the concrete, the tower may be set.

SEISMIC CONSIDERATIONS

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 and the 2016 California Building Code (CBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 51½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

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 loose sandy soils or non-plastic fine-grained soils exist below groundwater. The California Geologic Survey (CGS) has designated certain areas within 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 mapped by the CGS.

Due to the depth of groundwater at this site, in our opinion, the potential for liquefaction to occur is low.

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)**	**Soil Description**	**Soluble Sulfate (ppm)**	**Soluble Chloride (ppm)**	**Electrical Resistivity (Ω-cm)**	**pH**
B-1	2½ -4	Clayey Sand	226	48	3492	8.46

The sulfate test results indicate that the soil from boring B-1 classifies as Class S1 according to Table 19.3.1.1 of ACI 318-14. For further information, see ACI 318-14, Section 19.3.

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. Natural 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 or collaboration through this system 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.

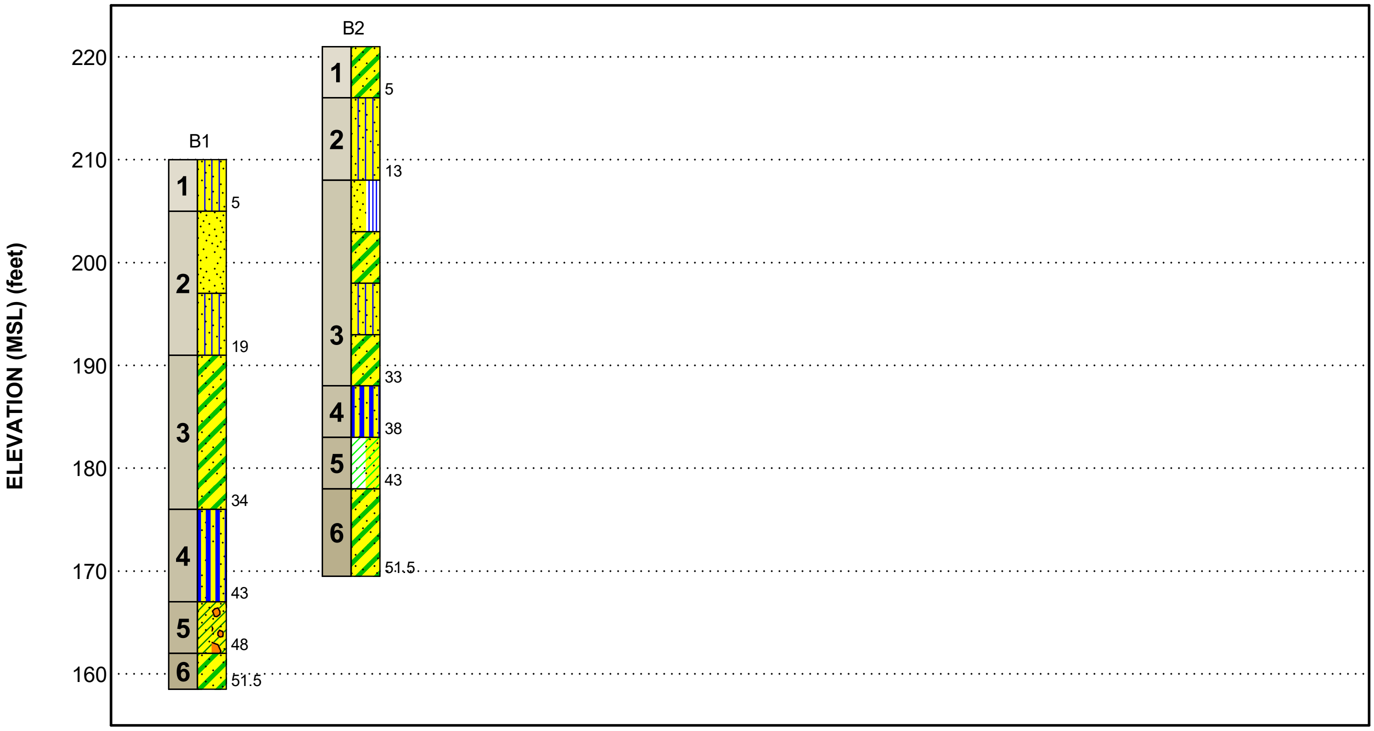
Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

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 impact 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. 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.

FIGURES

Contents:

GEOMODEL
Dole Wind Turbines ■ Soledad, CA
4/18/2019 ■ Terracon Project No. NA195043



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

LEGEND

- Silty Sand
- Poorly-graded Sand
- Clayey Sand
- Sandy Silt
- Sandy Lean Clay with Gravel
- Poorly-graded Sand with Silt
- Lean Clay with Sand

Model Layer	Layer Name	General Description
1	Silty and Clayey Sand	Loose Silty and Clayey Sand
2	Poorly Graded Sand and Silty Sand	Loose to Medium Dense Poorly Graded Sand and Silty Sand
3	Sand	Medium Dense Poorly Graded Sand with Silt, Silty and Clayey Sand
4	Sandy Silt	Stiff to Very Stiff Sandy Silt
5	Lean Clay	Very Stiff to Hard Lean Clay with varying amounts of Sand and Gravel
6	Clayey Sand	Medium Dense Clayey Sand

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

- First Water Observation
- Second Water Observation
- Third Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
2	51½	WTG

Boring Layout and Elevations: Foundation Windpower provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from Google Earth Pro™. If more precise elevations and boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous hollow stem flight augers. We obtained samples at depths of 2½ feet, 5 feet, 7½ feet, and 10 feet and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel 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 is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 2.5-inch O.D. split-barrel Modified California sampling spoon with 2.0-inch I.D. tube lined sampler was used for sampling. Tube-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are not equivalent to the SPT blow counts. We observed and recorded groundwater levels during drilling and sampling. As required by the Monterey County Health Department, all borings were backfilled with grout after their completion.

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 encountered 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.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM D1140 Standard Test Method for Determining the Amount of Material Finer than No. 200 Sieve by Soil Washing
- Corrosivity Tests

The laboratory testing program included examination of soil samples by a geotechnical engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Dole Wind Turbines ■ Soledad, California
April 22, 2019 ■ Terracon Project No. NA195043

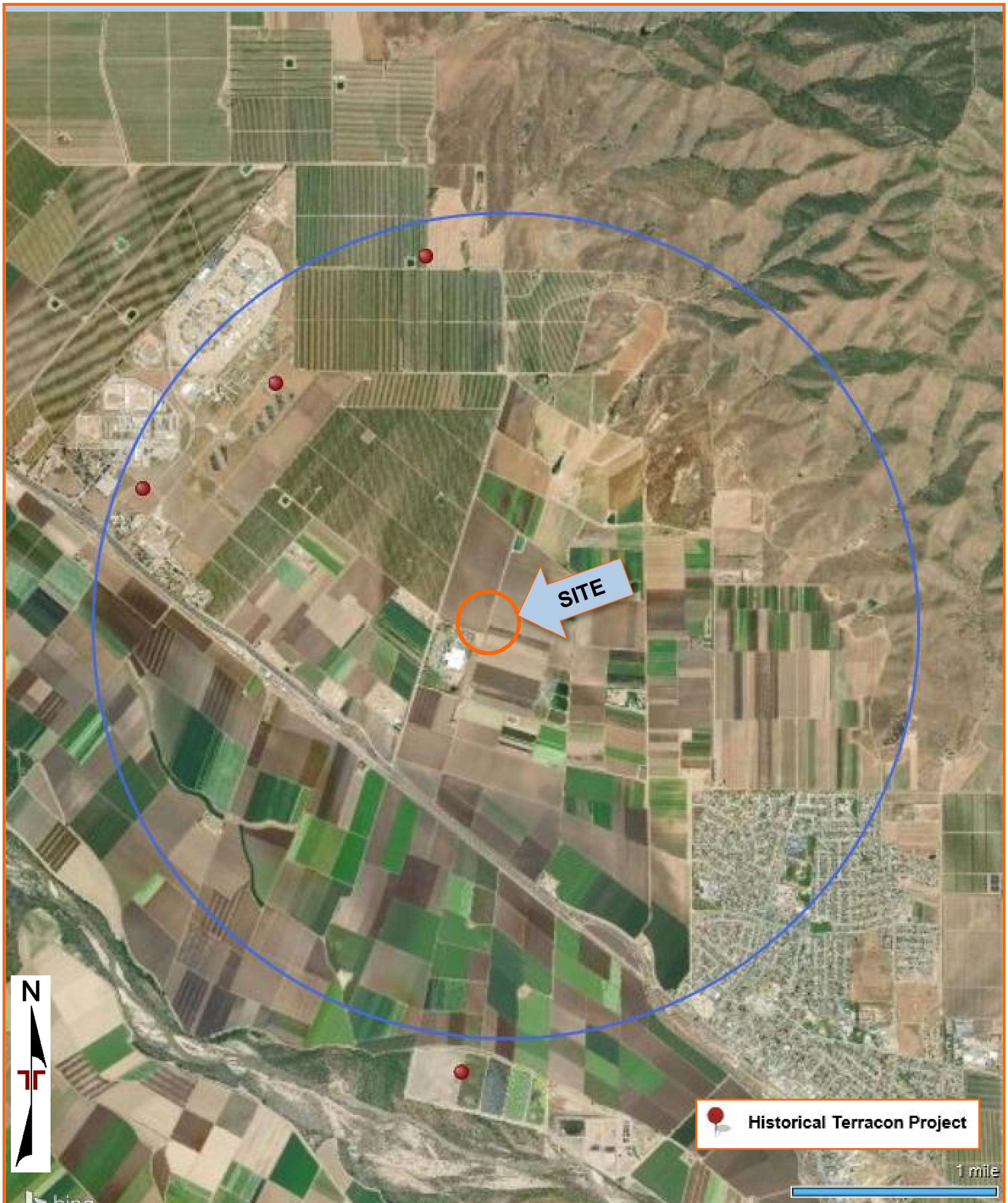


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Dole Wind Turbines ■ Soledad, California

April 22, 2019 ■ Terracon Project No. NA195043

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

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOG NO. B1

PROJECT: Dole Wind Turbines

CLIENT: Foundation Windpower, LLC. San Francisco, CA

SITE: Camphora Gloria Road Soledad, CA

LOCATION See Exploration Plan

Latitude: 36.456° Longitude: -121.3515°

MODEL LAYER	DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	Unconfined Compressive Strength, (psf)	Strain, %	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	PERCENT FINES
1		**SILTY SAND (SM)**, fine to coarse grained, brown, loose				4-5-6				9	111	
	5.0		5			5-6-7				4	105	
2		**POORLY GRADED SAND (SP)**, fine to coarse grained, brown, loose to medium dense				5-6-12				4	107	4
			10			7-8-8				3	107	
	13.0	**SILTY SAND (SM)**, fine to coarse grained, brown, loose	15			7-6-2 N=8				18		
	19.0											
3		**CLAYEY SAND (SC)**, fine to medium grained, brown, medium dense	20			4-7-9				17	116	27
			25			10-11-13 N=24				13		
			30			16-17-20				12	129	
	34.0											
4		**SANDY SILT (ML)**, fine grained, brown, very stiff, Non-plastic	35			6-8-10 N=18			4.25 (HP)	19		54
			40			8-8-11	2.6	15	4.25 (HP)	16	115	
	43.0											
5		**SANDY LEAN CLAY WITH GRAVEL (CL)**, fine to coarse grained, brown, hard	45			13-29-23 N=52			3.75 (HP)	9		
	48.0											
6		**CLAYEY SAND (SC)**, fine to medium grained, brown, medium dense	50			11-11-12				21	116	
	51.5	***Boring Terminated at 51.5 Feet***										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6 inch Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

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.

Elevations were estimated using Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 04-08-2019	Boring Completed: 04-08-2019
Drill Rig: D-50 track	Driller: R. Anderson
Project No.: NA195043	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL NA195043 DOLE WIND TURBINE.GPJ MODELLAYER.GPJ 4/18/19

BORING LOG NO. B2

PROJECT: Dole Wind Turbines

**CLIENT: Foundation Windpower, LLC.
San Francisco, CA**

**SITE: Camphora Gloria Road
Soledad, CA**

LOCATION See Exploration Plan

Latitude: 36.4592° Longitude: -121.3504°

MODEL LAYER	DEPTH	Description
1	5.0	**CLAYEY SAND (SC)**, fine to coarse grained, brown, medium dense
2	13.0	**SILTY SAND (SM)**, fine to coarse grained, brown, loose
3	18.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to coarse grained, brown, medium dense
3	23.0	**CLAYEY SAND (SC)**, fine to coarse grained, brown, loose
3	28.0	**SILTY SAND (SM)**, fine to medium grained, brown, medium dense
3	33.0	**CLAYEY SAND (SC)**, fine to coarse grained, brown, medium dense
4	38.0	**SANDY SILT (ML)**, fine grained, brown, stiff
5	43.0	**LEAN CLAY WITH SAND (CL)**, fine grained, brown, very stiff
6	51.5	**CLAYEY SAND (SC)**, fine to medium grained, brown, medium dense
		Boring Terminated at 51.5 Feet

FIELD TEST RESULTS	Unconfined Compressive Strength, (psf)	Strain, %	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	PERCENT FINES
11-13-15				5	121	
4-7-7				5	104	
4-4-5				7	113	
4-5-7				9	110	
7-10-11				5	109	5
4-5-5 N=10				7	128	
6-11-11				12	125	
9-11-8 N=19				23	117	34
5-7-10	1.7	13.4	2.75 (HP)	19	116	
8-9-9 N=18			4.0 (HP)	27	104	74
5-11-15				19	108	
13-14-15 N=29				14	123	

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6 inch Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

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.

Elevations were estimated using Google Earth.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

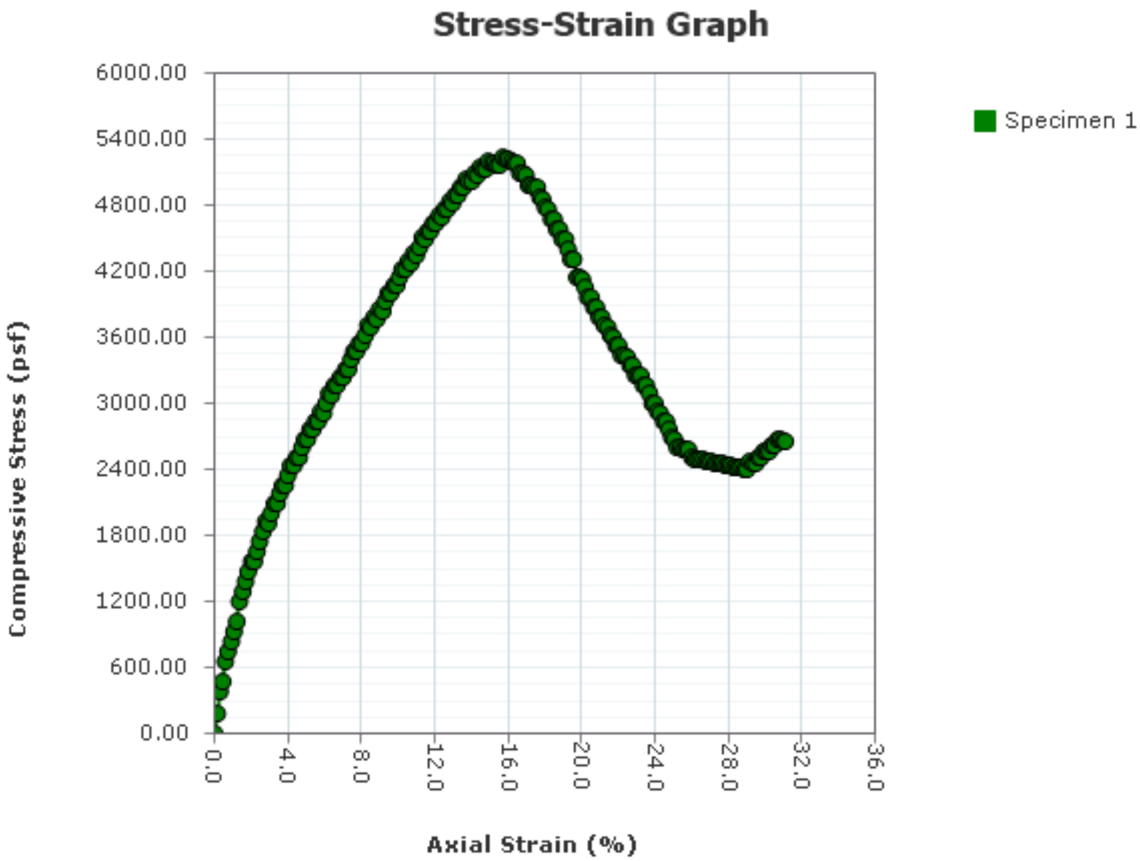
Boring Started: 04-08-2019 | Boring Completed: 04-08-2019

Drill Rig: D-50 track | Driller: R. Anderson

Project No.: NA195043

Unconfined Compression Test

ASTM D2166



Project:	Dole Wind Turbines
Project Number:	NA195043
Received Date:	4/15/2019
Sampling Date:	4/15/2019
Sample Number:	B1-40.0-41.5
Sample Depth:	40-41.5 ft
Boring Number:	B1
Location:	
Client Name:	
Remarks:	

Unconfined Compression Test

ASTM D2166

	Specimen Number							
Before Test	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Moisture Content (%):	22.5							
Wet Density (pcf)	132.3							
Dry Density (pcf)	107.9							
Saturation (%):	107.0							
Void Ratio:	0.573							
Height (in)	2.7300							
Diameter (in)	1.3967							
Strain Limit @ 15% (in)	0.4							
Height To Diameter Ratio:	1.95							
Test Data	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Failure Angle (°):	0							
Strain Rate (in/min)	0							
Strain Rate (%/min):	0.00							
Unconfined Compressive Strength (psf)	5187.42							
Undrained Shear Strength (psf)	2593.71							
Strain at Failure (%):	15.09							

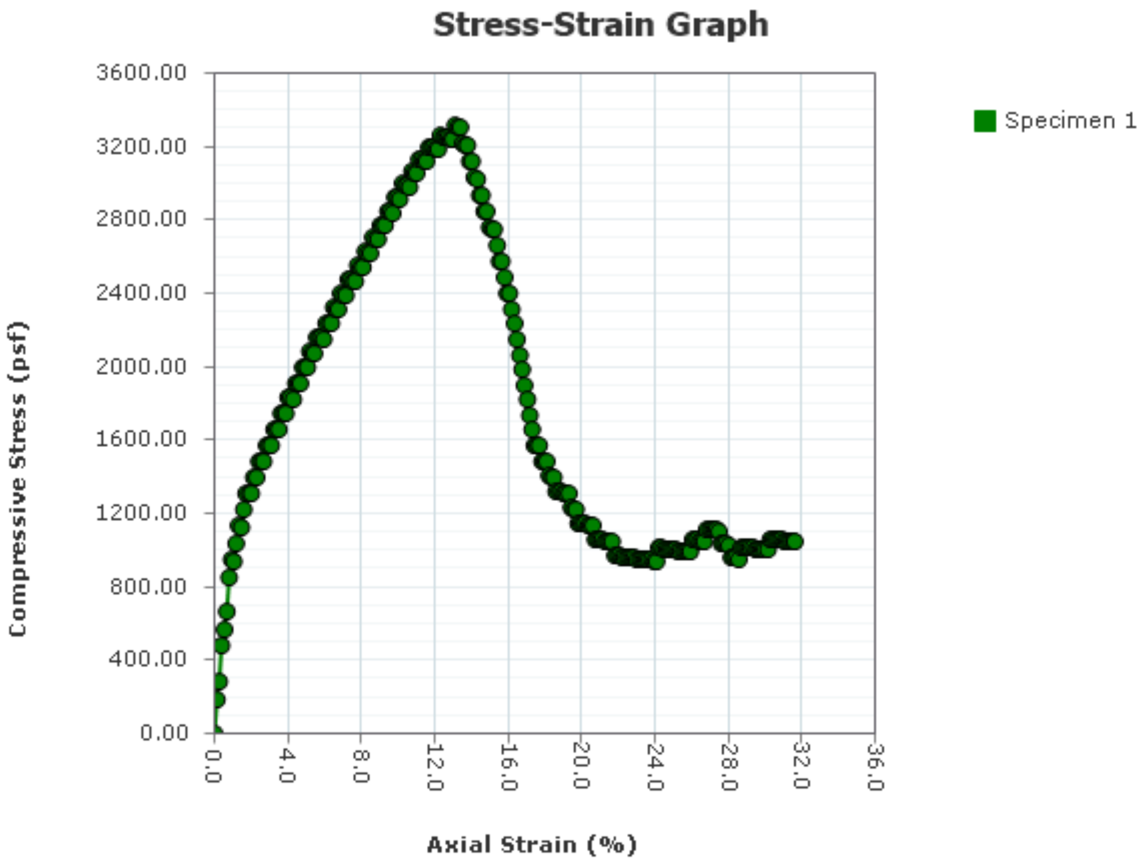
Specific Gravity:	2.72	Plastic Limit:	0	Liquid Limit:	0
Type:	tube	Soil Classification:	Brown Clay		

Project:	Dole Wind Turbines
Project Number:	NA195043
Sampling Date:	4/15/2019
Sample Number:	B1-40.0-41.5
Sample Depth:	40-41.5 ft
Boring Number:	B1
Location:	
Client Name:	
Remarks:	

Specimen 1 Failure Sketch	Specimen 2 Failure Sketch	Specimen 3 Failure Sketch	Specimen 4 Failure Sketch	Specimen 5 Failure Sketch	Specimen 6 Failure Sketch	Specimen 7 Failure Sketch	Specimen 8 Failure Sketch
							

Unconfined Compression Test

ASTM D2166



Project:	Dole Wind Turbines
Project Number:	NA195043
Received Date:	4/15/2019
Sampling Date:	4/15/2019
Sample Number:	B2-35.0-36.5
Sample Depth:	35-36.5 ft
Boring Number:	B2
Location:	
Client Name:	
Remarks:	

Unconfined Compression Test

ASTM D2166

	Specimen Number							
Before Test	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Moisture Content (%):	18.3							
Wet Density (pcf)	131.8							
Dry Density (pcf)	111.4							
Saturation (%):	94.9							
Void Ratio:	0.525							
Height (in)	3.1433							
Diameter (in)	1.3867							
Strain Limit @ 15% (in)	0.5							
Height To Diameter Ratio:	2.27							
Test Data	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Failure Angle (°):	0							
Strain Rate (in/min)	0							
Strain Rate (%/min):	0.00							
Unconfined Compressive Strength (psf)	3303.23							
Undrained Shear Strength (psf)	1651.62							
Strain at Failure (%):	13.39							

Specific Gravity:	2.72	Plastic Limit:	0	Liquid Limit:	0
Type:	Tube	Soil Classification:	Clay		

Project:	Dole Wind Turbines
Project Number:	NA195043
Sampling Date:	4/15/2019
Sample Number:	B2-35.0-36.5
Sample Depth:	35-36.5 ft
Boring Number:	B2
Location:	
Client Name:	
Remarks:	

Specimen 1 Failure Sketch	Specimen 2 Failure Sketch	Specimen 3 Failure Sketch	Specimen 4 Failure Sketch	Specimen 5 Failure Sketch	Specimen 6 Failure Sketch	Specimen 7 Failure Sketch	Specimen 8 Failure Sketch
							

CHEMICAL LABORATORY TEST REPORT

Project Number: NA195043
Service Date: 04/15/19
Report Date: 04/18/19
Task:

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

Client

Foundation Windpower, LLC.
San Francisco, CA

Project

Dole Wind Turbines

Sample Submitted By: Terracon (NA) **Date Received:** 4/15/2019 **Lab No.: 19-0395**

Results of Corrosion Analysis

Sample Number	1
Sample Location	B1
Sample Depth (ft.)	2.5-4.0
pH Analysis, AWWA 4500 H	8.46
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	226
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	48
Red-Ox, AWWA 2580, (mV)	+679
Total Salts, AWWA 2520 B, (mg/kg)	334
Resistivity, ASTM G 57, (ohm-cm)	3492

Analyzed By: Trisha Campo

Trisha Campo
Chemist

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Dole Wind Turbines ■ Soledad, CA

April 18, 2019 ■ Terracon Project No. NA195043

Terracon GeoReport

SAMPLING

Modified California Ring Sampler

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

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.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
UC	**Unconfined Compressive Strength**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. 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			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (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

RELATIVE PROPORTIONS OF SAND AND GRAVEL		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		PLASTICITY DESCRIPTION	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

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 ³ 4 and 1 £ Cc £ 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 ³ 6 and 1 £ Cc £ 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 on or above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - 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:	Liquid limit - oven dried / Liquid limit - 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 ³ 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 ³ 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 ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 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.