Preliminary Geotechnical Engineering Report

Front Range Midway Solar Project
Rancho Colorado Boulevard and El Hambra View
El Paso County, Colorado

August 25, 2014
Project No. 23145024

Prepared for:
TradeWind Energy, LLC
Lenexa, Kansas

Prepared by:
Terracon Consultants, Inc.
Colorado Springs, Colorado

August 25, 2014

TradeWind Energy, LLC
16105 West 113th Street, Suite 105
Lenexa, Kansas 66219

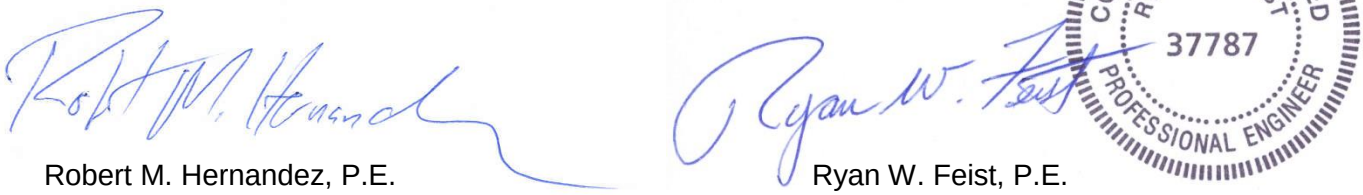
Attn: Mr. Justin Larson

Re: Preliminary Geotechnical Engineering Report
Front Range Midway Solar Project
Rancho Colorado Boulevard and El Hambra View
El Paso County, Colorado
Terracon Project Number: 23145024

Terracon Consultants, Inc. (Terracon) has performed preliminary geotechnical engineering services for the above referenced project. This study was performed in general accordance with our Proposal No. D2314145, dated June 13, 2014. This report presents the findings of the subsurface exploration and provides preliminary 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.



Robert M. Hernandez, P.E.
Project Engineer

Ryan W. Feist, P.E.
Geotechnical Services Manager

Copies to: Addressee (1, *pdf)

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EXECUTIVE SUMMARY

A preliminary geotechnical investigation has been performed for the proposed Front Range Midway Solar Project, located at Rancho Colorado Boulevard and El Hambra View in Colorado Springs, Colorado. Eight test borings were advanced to depths of approximately 15 feet below the existing ground surface within the general vicinity of the proposed solar project. The following geotechnical considerations were identified:

- The proposed solar arrays can be supported on driven H-piles, W-members, or pipe piles foundation systems.
- The 2009 International Building Code, Table 1613.5.2 IBC seismic site classification for this site is D.
- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
FRONT RANGE MIDWAY SOLAR PROJECT
RANCHO COLORADO BOULEVARD AND EL HAMBRA VIEW
COLORADO SPRINGS, COLORADO

Project No. 23145024
August 25, 2014

1.0 INTRODUCTION

A preliminary geotechnical investigation has been performed for the proposed Front Range Midway Solar Project, located at Rancho Colorado Boulevard and El Hambra View in Colorado Springs, Colorado. Eight test borings were advanced to depths of approximately 15 feet below the existing ground surface within the general vicinity of the proposed solar project. Boring logs along with a Boring Location Plan is included in Appendix A of this report.

The purpose of these services is to provide information and preliminary geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- foundation design and construction
- earthwork
- drainage

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	See Appendix A, Boring Location Plan.
Proposed Development	The project will include the construction of solar panels within an approximate 500 to 600 acre parcel of land.
Type of construction	Reportedly driven steel post piles.
Maximum loads	Solar array supports 2 to 4 kips (assumed)
Grading	A grading plan has not been provided. We anticipate little to no grading with the solar array and less than two feet of cut or fill to achieve planned site grades for roads.
Proposed free-standing retaining walls	Not reported as part of site development.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The project site is located at Rancho Colorado Boulevard and El Hambra View, El Paso County, Colorado.
Existing improvements and ground cover	The site was relatively undeveloped at the time of our field exploration. The site was bordered to the north by relatively undeveloped land similar in appearance to the subject site, to the east by Interstate 25, to the south by the unpaved Rancho Colorado Boulevard, and to the west by the Midway power station. Ground cover consisted of a heavy amount of native grasses, weeds, yucca, and cacti.
Existing topography	A majority of the site consisted of gently sloping terrain and rolling hills with localized areas of incised drainage channels.

3.0 SUBSURFACE CONDITIONS

3.1 General and Local Geology

The project site is located within the Colorado Piedmont section of the Great Plains physiographic province. The Colorado Piedmont, formed during the Late Tertiary and Early Quaternary time (approximately two million years ago), is a broad, erosional trench which separates the Southern Rocky Mountains from the High Plains. Structurally the site lies along the western flank of the Denver Basin. During the Late Mesozoic and Early Cenozoic periods (approximately 70 million years ago), intense tectonic activity occurred, causing the uplifting of the Front Range and associated downwarping of the Denver Basin to the east. Relatively flat uplands and broad valleys characterize the present-day topography of the Colorado Piedmont in this region.

Surficial geologic conditions at the site as mapped by the United States Geological Survey (USGS) (Scott, Taylor, Epis, and Wobus[1]) indicate the site is overlain by eolian sand, Slocum Alluvium, and Verdos Alluvium.

Eolian sand is described as fine to coarse, windblown sand. Slocum alluvium is described as weathered gravel about 100 feet above modern streams. Verdos alluvium is described weathered gravel on cut surface about 200 to 250 feet above modern streams.

[1]Scott, Glenn R., Taylor, Richard B., Epis, Rudy C., Wobus, Reinhard A., **Geologic Map of the Pueblo 1 degree by 2 degree Quadrangle, South-Central Colorado**, United States Geological Survey, Miscellaneous Investigations Series Map I-1022

3.2 Typical Profile

Subsurface conditions on the project site can be generalized as shown below:

Description	Approximate Depth to Bottom of Stratum	Material Encountered	Consistency/Density
Stratum 1	8 to 11 feet	Clay with varying amounts of sand	Medium stiff to stiff
Stratum 2	15 feet	Sand with varying amounts of silt and clay	Loose to medium dense

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.3 Laboratory Test Results

Laboratory test results indicate that the clay soil samples tested exhibit low compression at in-situ water contents. When elevated in water content, the clay soils tested exhibit non-expansion potential and low to high compression at increased loading.

Laboratory test results are presented on the Logs of Borings and in Appendix B, and were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations.

3.4 Groundwater

Groundwater was not encountered at the time of site exploration. These observations represent groundwater conditions at the time of the field exploration, and may not be indicative of other times, or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions.

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. Fluctuations in groundwater levels can best be determined by implementation of a groundwater monitoring plan. Such a plan would include installation of groundwater monitoring wells and periodic measurement of groundwater levels over a sufficient period of time.

3.5 Field Electrical Resistivity

Field measurement of soil electrical resistivity was performed in general accordance with the Wenner Four-Electrode Method at the locations of Borings B-1 and B-4. Two lines of testing were performed at each boring location, with one line in a north-to-south trend and the other in an east-to-west trend. The results of field electrical resistivity testing are presented in Appendix B of this report.

Test direction "A" at the location of Boring B-1 indicates two outliers at 100 feet and 200 feet. Contact resistance issues or other subsurface features not visible at the ground surface may be the cause for the outliers. Based on our experience with similar conditions, it is our opinion that the Test direction "B" should be used when interpreting test results at the location of Boring B-1.

3.6 Laboratory Thermal Resistivity

Bulk samples of subsurface materials obtained from Borings B-1 and B-5 were sent to GeothermUSA for thermal dryout characterization tests. Samples were re-compacted to approximately 85 percent of the maximum laboratory dry density as determined by ASTM D698 at optimum water content. Testing was conducted in general accordance with the IEEE standard. Results are presented in the table below and in Appendix B of this report. Thermal dryout curves are presented in Appendix B of this report.

Boring	Depth (ft)	Thermal Resistivity (^{o}C-cm/W)		Water Content (%)	Dry Density (pcf)
		Wet	Dry		
B-1	3-5	123	221	18	89
B-5	3-5	115	202	17	89

4.0 PRELIMINARY RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the results of our field investigation, laboratory testing program and geotechnical analyses, development of the site is considered feasible from a geotechnical viewpoint provided that the conclusions and considerations provided herein are incorporated into the design and construction of the project. Subsurface conditions, as identified by the field and laboratory testing programs, have been reviewed and evaluated with respect to the proposed plans known to us at this time.

4.2 Earthwork

4.2.1 Site Preparation

Although evidence of underground facilities was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected underground facilities are encountered, such features should be removed and the excavation benched to expose firm, approved materials prior to backfill placement and/or construction.

4.2.2 Material Types

Engineered fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
On-Site Soils	CL	Although not anticipated for re-use, if required, the on-site soils are considered suitable for reuse as compacted fill in non-structural areas. Fill for support of structural improvements should consist of imported soils as outlined herein.
Imported Soils	Varies	Imported soils meeting the gradation outlined herein can be considered acceptable for use as engineered fill beneath foundations and slabs.

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.

Imported soils for use when soils are placed in a confined condition should conform to the following:

Gradation	Percent finer by weight (ASTM C136)
3”	100
No. 4 Sieve	50-100
No. 200 Sieve	20-40

- Liquid Limit……...35 (max)
- Plastic Index……15 (max)
- Maximum Expansive Potential (%)……..1.5*

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at optimum water content. The sample is confined under a 100 psf surcharge and submerged.

Soils with a maximum 35 percent passing the No. 200 sieve can be used if placed in a manner that will allow positive drainage at the native clay/fill interface.

4.2.3 Compaction Requirements

ITEM	DESCRIPTION
Fill Lift Thickness	8-inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack, plate compactor) is used
Compaction Requirements [1]	95% of the materials maximum dry density (ASTM D698)
Water Content [2]	Within three percent of optimum water content

1. We recommend that engineered fill be tested for water content and compaction during placement. Should the results of the in-place density tests indicate the specified water or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified water and compaction requirements are achieved.
2. Specifically, water levels should be maintained low enough to allow for satisfactory compaction to be achieved without the compacted fill material pumping when proofrolled.

4.2.5 Grading and Drainage

All grades must be adjusted to provide positive drainage away from the structures during construction and maintained throughout the life of the proposed project. Infiltration of water into utility or foundation excavations must be prevented during construction. Water permitted to pond near or adjacent to the perimeter of the structures (either during or post-construction) can result in significantly higher soil movements than those discussed in this report. As a result, any estimations of potential movement described in this report cannot be relied upon if positive drainage is not obtained and maintained, and water is allowed to infiltrate the fill and/or subgrade. Backfill against utility line trenches should be well compacted and free of all construction debris to reduce the possibility of water infiltration. After construction and prior to project completion, we recommend that verification of final grading be performed to document that positive drainage, as described above, has been achieved.

4.2.6 Construction Considerations

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Should unstable subgrade conditions develop, stabilization measures will need to be employed. Options for subgrade stabilization can include removal of unsuitable material and replacement with approved fill material. An alternative can include the use of geogrid overlain by CDOT Class 5 or 6 aggregate base course. The depth of aggregate base course will depend on the severity of unstable soils.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs. Construction traffic over the completed subgrade

should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and re-compacted prior to floor slab construction.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

4.4 Driven Pile Foundations

4.4.1 Preliminary Design Recommendations

Driven piles (H-piles, W-members, or pipe piles) are considered suitable for support of the proposed solar arrays. A summary of the preliminary foundation design recommendations is shown on the following page. The maximum end bearing pressure given in the table is based on the cross-sectional area of the steel tip of the driven piles. Skin friction (S_d) should be applied to the rectangular surface area of the H-pile or circumference of pipe piles for that given length interval below a depth of 30 inches. The combination of skin friction and end bearing pressure can be used to determine the vertical compression capacity.

For lateral load and overturning design, we have included beam on elastic foundation spring constants, lateral equivalent earth pressures, and more commonly used LPILE parameters. For calculation of lateral deflection using the beam on elastic foundation method, a coefficient of subgrade reaction listed on the table may be used for the analysis. Lateral load design parameters are valid for maximum soil strain of 1 percent for the native soils acting over a distance of one pile width/diameter.

DESCRIPTION	MATERIAL TYPE AND DEPTH, FEET	
	Lean Clay* **2½ to 11 feet**	**Silty and Clayey Sand** **11 to 15 feet**
Allowable Vertical Parameters:		
Bearing (based on steel H-pile, W-member or pipe pile cross-sectional area), psf	2,000 psf	6,000 psf
Compression Skin Friction	150 psf	200 psf
Lateral Parameters		
Beam on Elastic Foundation: **Passive, EFP,psf/ft**	200	290
Soil Code	3 (Stiff clay without free water)	9 (Sand)
In-situ Unit Weight (pci)	0.052	0.064
Undrained Shear Strength, Cu (psi)	5	115
Angle of internal Friction, ϕ (degrees)	---	28
Horizontal Modulus of Subgrade Reaction:		
k (static) pci	100	90
k (cyclic) pci	---	90
Strain at 50% of Maximum Stress, ε_{50}	0.007	---

*Minimum bearing depth of at least 6 feet.

Groups of piles required to support concentrated loads will require appropriate reductions of the axial, uplift and lateral capacities based on the effective envelope of the pile group. This reduction can be avoided by spacing piles at a minimum distance of at least six diameters center to center. Piles spaced less than six diameters center to center should be evaluated on an individual basis to determine appropriate reductions in axial, uplift and lateral capacities.

4.4.2 Construction Considerations

The contractor should select a driving hammer and cushion combination which is capable of installing the selected piling without overstressing the pile material. The contractor should submit the pile driving plan and the pile hammer-cushion combination to the engineer for evaluation of the driving stresses in advance of pile installation.

Some ground heave may be experienced as a result of pile driving at each site. Therefore, it is recommended that the top elevations of the initial piles driven be surveyed. If any heave is noted after the driving of subsequent piles, the piles should be redriven to their original top elevation. This problem can be particularly acute in pile groups.

The pile hammer should be operated at the manufacturer's recommended stroke when measuring penetration resistance. A representative of the geotechnical engineer should observe

pile driving operations on a full-time basis. Each pile should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance, depth of embedment and general pile driving operations.

4.4 Seismic Considerations

Code Used	Site Classification
2009 International Building Code (IBC) [1]	D[2]
Mapped Spectral Acceleration for Short Periods, S_s [2]	0.193
Mapped Spectral Acceleration for a 1-second period, S_1 [2]	0.058

1. In general accordance with the *2009 International Building Code,* Table 1613.5.2. The 2009 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination as borings for this project extended to a maximum depth of approximately 15 feet. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a higher seismic site class.
2. In general accordance with the Pikes Peak Regional Building Code

4.8 Corrosion Considerations

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. These 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.

Boring	Soluble Sulfate (Percent)	Soluble Chloride (Percent)	Electrical Resistivity (ohm.cm)	pH	Redox Potential (mv)	Sulfide
B-5	0.005	0.0008	1,531	737	195	Negative

Results of soluble sulfate testing indicate that samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 4.3.1 of the ACI Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, 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. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project 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.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

NOTE: AERIAL SITE DRAWING OBTAINED FROM GOOGLE EARTH ON JULY 28, 2014,USED AS BASE DRAWING.

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

Project Mngr:	RWF
Drawn By:	RMH
Checked By:	RWF
Approved By:	RWF

Project No.	23145024
Scale:	NOT TO SCALE
File No.	Fig1-SVD
Date:	07-28-2014

Terracon
Consulting Engineers and Scientists
4172 Center Park Drive Colorado Springs, Colorado 80916
PH. (719) 597-2116 FAX. (719) 597-2117

SITE VICINITY PLAN

Tradewind Energy, LLC

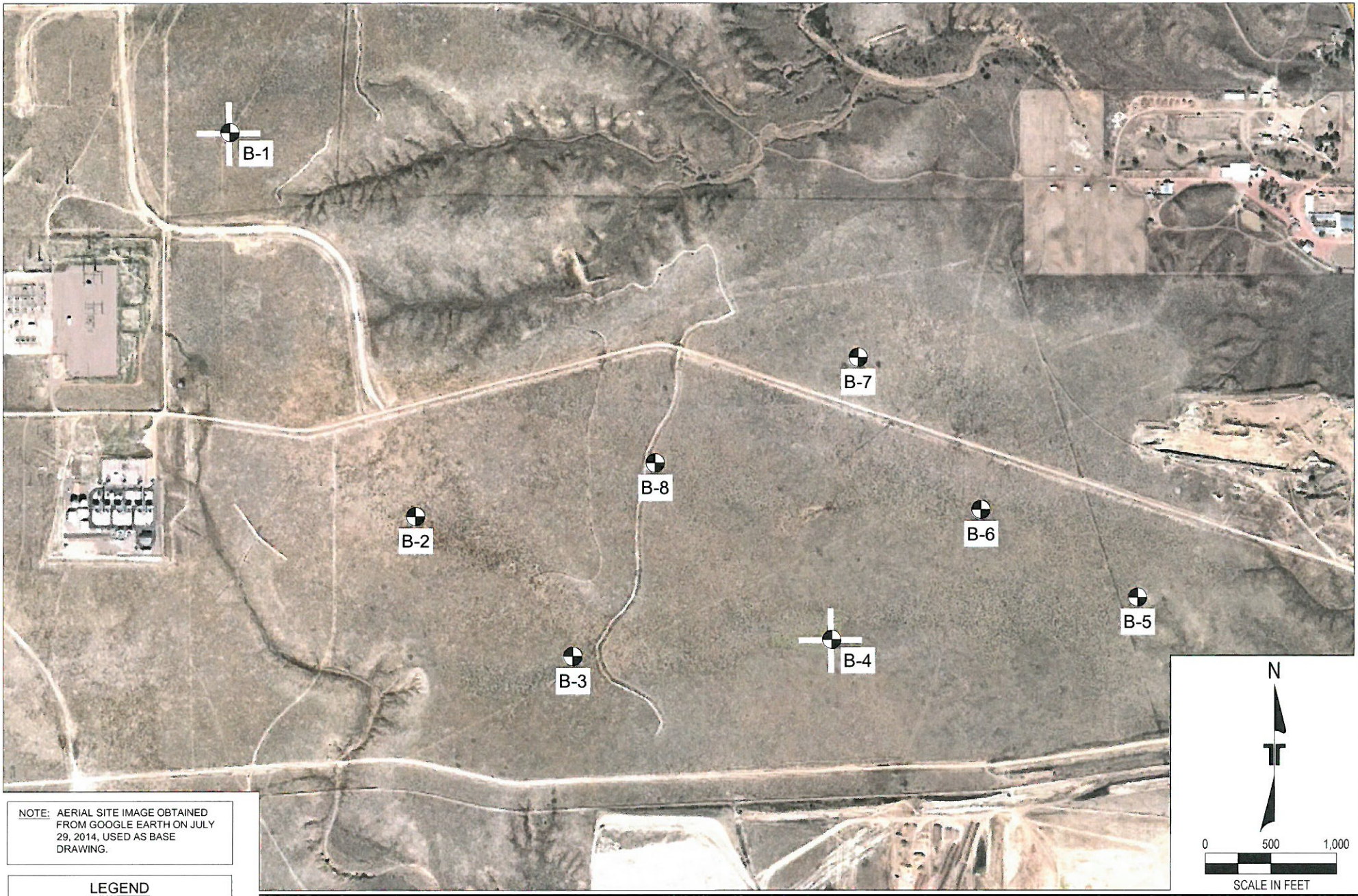
FRONT RANGE MIDWAY SOLAR PROJECT

RANCHO COLORADO BOULEVARD AND EL HAMBRA VIEW

EL PASO COUNTY COLORADO

Ex. No.

A-1



NOTE: AERIAL SITE IMAGE OBTAINED FROM GOOGLE EARTH ON JULY 29, 2014, USED AS BASE DRAWING.

LEGEND

B-1 — APPROXIMATE LOCATION OF TEST BORING

\+ — APPROXIMATE LOCATION OF RESISTIVITY TEST

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

Project Mngr:	RWF
Drawn By:	RMH
Checked By:	RWF
Approved By:	RWF

Project No.	23145024
Scale:	AS SHOWN
File No.	Fig1-BLP
Date:	07-07-2014

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4172 Center Park Drive Colorado Springs, Colorado 80916
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BORING LOCATION PLAN

Tradewind Energy, LLC

FRONT RANGE MIDWAY SOLAR PROJECT

RANCHO COLORADO BOULEVARD AND EL HAMBRA VIEW

EL PASO COUNTY COLORADO

Ex. No. A-2

Field Exploration Description

Eight test borings were advanced on July 23, 2014, to depths of approximately 15 feet below existing site grade at the approximate locations shown on the Boring Location Plan, Exhibit A-2. The borings were advanced with a truck-mounted drilling rig, utilizing 4-inch diameter solid-stem auger.

The borings were surveyed and located in the field by our client. The accuracy of boring locations should only be assumed to the level implied by the methods used.

Lithologic logs of the borings were recorded by the Terracon field representative during drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon and ring barrel samplers. Representative bulk samples of subsurface materials were also obtained.

Penetration resistance measurements were obtained by driving the standard split-spoon and ring barrel samplers into the subsurface materials with a 140-pound hammer falling 30 inches. The ring barrel sampler is a ring-lined, split barrel sampler with an inside diameter of 2.42 inches and an outside diameter of 3 inches. The penetration resistance value is a useful index to the consistency, relative density or hardness of the materials encountered.

An automatic SPT hammer was used to advance the samplers in the borings. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the barrel blow counts, SPT values, and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

Groundwater measurements were made in the borings at the time of site exploration. The borings were backfilled with bentonite chips, and then hydrated, prior to leaving the site.

BORING LOG NO. B-1

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5651° Longitude: -104.6843°

Surface Elev.: 5497.8 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
LEAN CLAY WITH SAND (CL), light brown, stiff to very stiff, trace rootlets at 2 feet.											
						6	7-9	17	88		
grab sample obtained from 3 to 5 feet below site grade.											
			5			8	7-8	9	83	40-18-22	83
trace coarse sand at 7 feet.	8.0	5490				10	17-23	10	95		
CLAYEY SAND (SC), gray, medium dense, medium to coarse grained.											
			10			9	12-17	12	97		
SILTY SAND (SM), brown, dense, medium to coarse grained.	11.0	5487									
						11	23-37	2	125		
Boring Terminated at 15 Feet	15.0	5483	15								

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-4

BORING LOG NO. B-2

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5572° Longitude: -104.6794°

Surface Elev.: 5478.3 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
				11	5-4	8	81		
				11	6-10	12	81	38-18-20	90
		5							
				11	7-14	15	68		
				11	3-4	10	80		
		10							
11.0	5467.5								
				11	15-34	4	109		
15.0	5463.5	15							

LEAN CLAY (CL), light brown, medium stiff to stiff, trace rootlets at 2 feet.

grab sample obtained from 3 to 5 feet below site grade.

color change to light gray at 7 feet.

color change to light brown at 9 feet.

SILTY SAND (SM), light brown, medium dense, medium to coarse grained.

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-5

BORING LOG NO. B-3

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5543° Longitude: -104.6752°

Surface Elev.: 5448.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
				8	7-7	8	79	38-19-19	93
				11	7-8	8	86		
		5							
				11	7-10	8	97		
				9	7-10	13	90		
		10							
				11	4-6	12	106		
		15							

LEAN CLAY (CL), light brown, stiff, trace rootlets at 2 feet.

grab sample obtained from 3 to 5 feet below site grade.

8.0 5440.5

CLAYEY SAND (SC), light brown, loose, fine to medium grained.

15.0 5433.5

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-6

BORING LOG NO. B-4

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5546° Longitude: -104.6684°

Surface Elev.: 5419.3 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
				6	9-14	9	82		
				9	8-10	9	88		
		5							
				7	10-13	9	109	42-17-25	94
				10	8-11	11	92		
		10							
				10	9-10	10	112		
		15							

LEAN CLAY (CL), light brown, stiff to very stiff, trace rootlets at 2 feet.

grab sample obtained from 3 to 5 feet below site grade.

trace fine to medium grained sand at 9 feet.

11.0 5408.5

CLAYEY SAND (SC), light brown, medium dense

15.0 5404.5

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-7

BORING LOG NO. B-5

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5555° Longitude: -104.6602°

Surface Elev.: 5379.4 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						11	5-6	7	80		
						10	5-7	8	87	36-19-17	90
			5								
						9	8-9	8	91		
						11	12-17	10	95		
			10								
	11.0	5368.5									
	15.0	5364.5	15			9	12-21	10	112		

LEAN CLAY (CL), light brown, stiff to very stiff.

grab sample obtained from 3 to 5 feet below site grade.

CLAYEY SAND (SC), light brown, medium dense, medium to coarse grained, trace iron staining.

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-8

BORING LOG NO. B-6

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5573° Longitude: -104.6643°

Surface Elev.: 5391.1 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		LEAN CLAY (CL), light brown, very stiff, trace rootlets at 2 feet.									
						11	10-11	10	87		
		grab sample obtained from 3 to 5 feet below site grade.									
			5			10	9-10	9	85		
		trace fine to medium grained sand at 7 feet.				11	12-17	9	107		
						10	9-10	9	86		
11.0	5380		10								
		CLAYEY SAND (SC), brown, medium dense, fine to medium grained.									
						11	6-16	10	106		
15.0	5376		15								
		Boring Terminated at 15 Feet									

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-9

BORING LOG NO. B-7

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5605° Longitude: -104.6676°

Surface Elev.: 5410.9 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
				11	3-5	8	79		
				8	6-10	7	91	32-19-13	89
		5							
				11	5-7	8	83		
				11	5-6	9	87		
		10							
				11	18-21	4	113		
		15							

LEAN CLAY (CL), light brown, medium to very stiff.

grab sample obtained from 3 to 5 feet below site grade.

11.0 5400

CLAYEY SAND (SC), brown, medium dense, fine to medium grained.

15.0 5396

Boring Terminated at 15 Feet

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

Project No.: 23145024 Exhibit: A-10

BORING LOG NO. B-8

PROJECT: Front Range Midway Solar Project

CLIENT: Tradewind Energy
Lenexa, Kansas

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

LOCATION See Exhibit A-2

Latitude: 38.5583° Longitude: -104.6731°

Surface Elev.: 5440.8 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
LEAN CLAY WITH SAND (CL), light brown, stiff, trace rootlets at 2 feet.										
					11	7-8	7	81		
					11	4-6	8	79		
		5								
					11	7-8	8	83	34-18-16	76
					11	12-19	10	94		
11.0	5430	10								
SILTY SAND (SM), light brown, medium dense.										
					11	20-25	5	116		
15.0	5426	15								
Boring Terminated at 15 Feet										

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

Hammer Type: Automatic

Advancement Method:
4-inch solid stem

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

Boring Started: 7/23/2014 Boring Completed: 7/23/2014

Drill Rig: CME-75 Driller: Denver

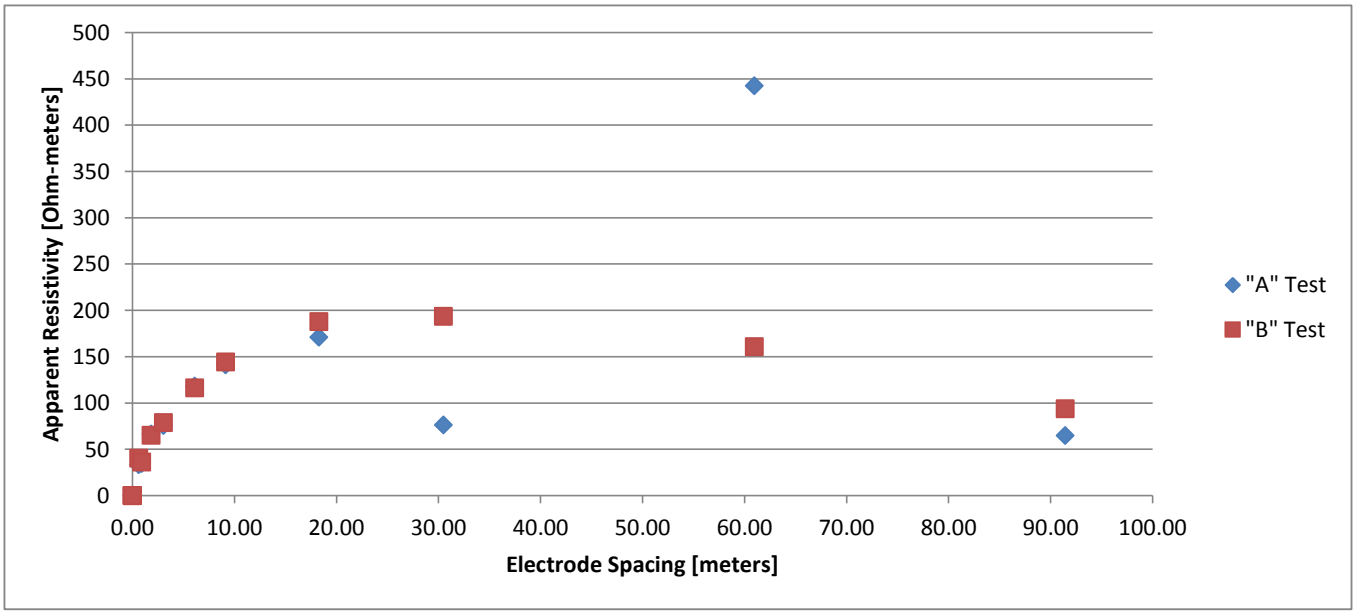
Project No.: 23145024 Exhibit: A-11

Electrical Earth Resistivity Test Data

Project	Midway Solar Project Boring #1	Weather	Sunny
Location	Pueblo, Colorado	Surface Soil	Sandy soil with pebbles
Project #	23145024	Instrument	MiniRES
Test Date	7/23/2014	Tested By	Chris Whittington and Joe Bowman

Centerpoint GPS Coordinates (per client supplied survey)	38.5651^0, -104.6843^0

Electrode Spacing		"A" Test Measured Resistance	East-West Apparent Resistivity	"B" Test Measured Resistance	North-South Apparent Resistivity
[feet]	[meters]	[Ohms]	[Ohms-meters]	[Ohms]	[Ohms-meters]
1	0.30	21.40	54	21.7	55
2	0.61	7.95	33	9.61	40
3	0.91	5.75	35	6.023	36
6	1.83	5.790	67	5.670	65
10	3.05	3.960	76	4.113	79
20	6.10	3.091	118	3.040	116
30	9.14	2.456	141	2.514	144
60	18.29	1.488	171	1.634	188
100	30.48	0.3985	76	1.011	194
200	60.96	1.155	442	0.420	161
300	91.44	0.113	65	0.163	94
	0.00		0		0
	0.00		0		0
	0.00		0		0
	0.00		0		0

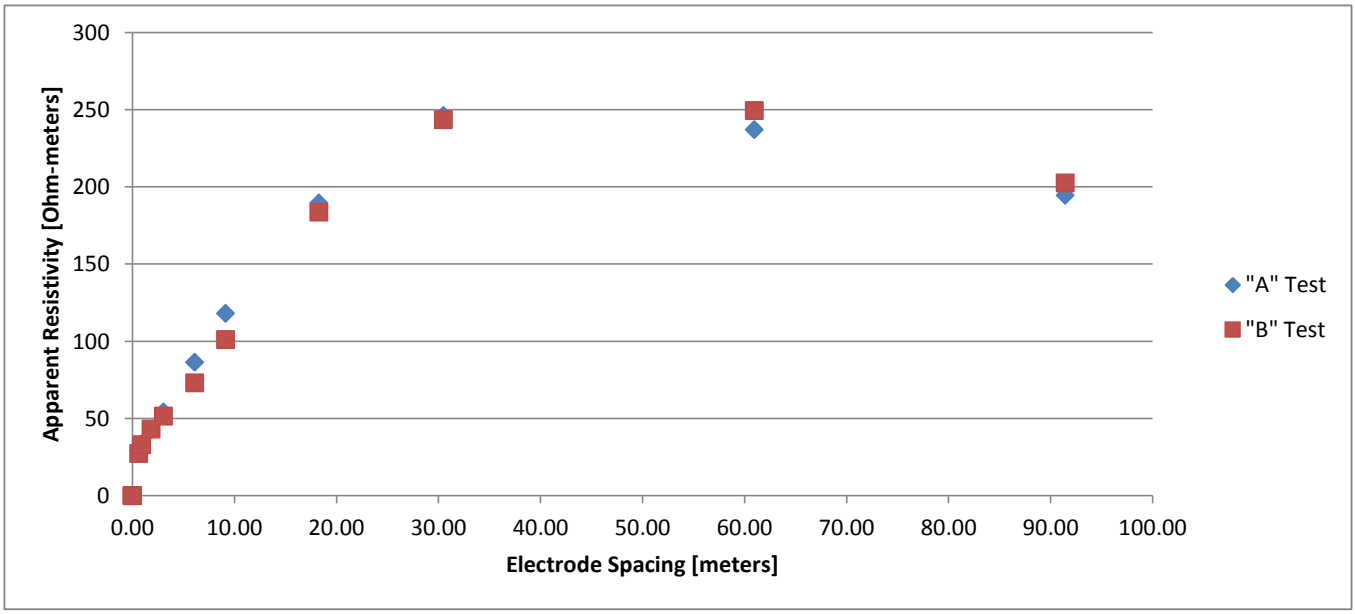


Electrical Earth Resistivity Test Data

Project	Midway Solar Project Boring #4	Weather	Sunny
Location	Pueblo, CO	Surface Soil	Sandy soil with pebbles
Project #	23145024	Instrument	MiniRES
Test Date	7/23/2014	Tested By	Chris Whittington and Joe Bowman

Centerpoint GPS Coordinates (per client supplied survey)	38.5546^0, -104.6684^0

Electrode Spacing		"A" Test Measured Resistance	East-West Apparent Resistivity	"B" Test Measured Resistance	North-South Apparent Resistivity
[feet]	[meters]	[Ohms]	[Ohms-meters]	[Ohms]	[Ohms-meters]
1	0.30	9.77	25	10.25	26
2	0.61	6.95	29	6.48	27
3	0.91	5.59	34	5.501	33
6	1.83	3.707	43	3.748	43
10	3.05	2.833	54	2.691	52
20	6.10	2.255	86	1.908	73
30	9.14	2.055	118	1.758	101
60	18.29	1.650	190	1.599	184
100	30.48	1.286	246	1.272	244
200	60.96	0.619	237	0.651	249
300	91.44	0.339	194	0.352	202
	0.00		0		0
	0.00		0		0
	0.00		0		0
	0.00		0		0



APPENDIX B

LABORATORY TESTING

Laboratory Testing

Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer. An applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials. The field descriptions were confirmed or modified as necessary, and were classified in general accordance with the Unified Soil Classification System described in Appendix C.

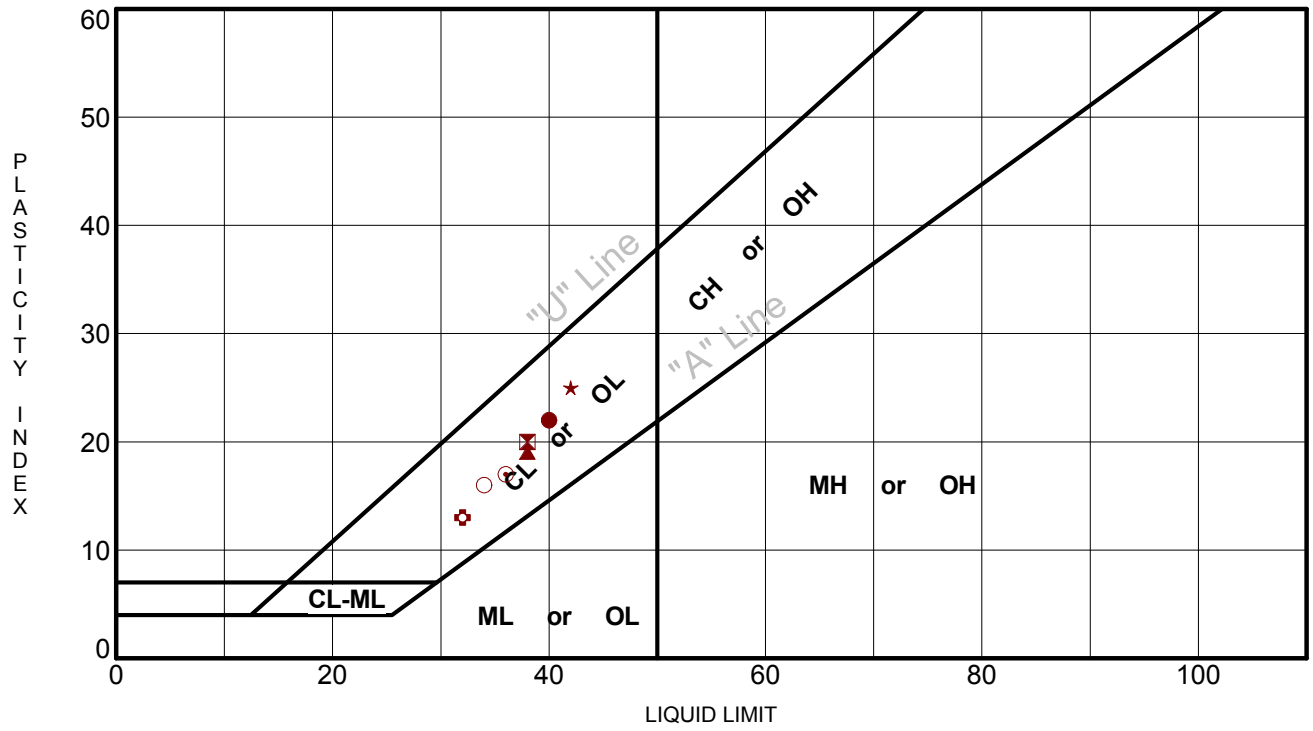
Laboratory test results are presented on the Logs of Borings and in Appendix B, and were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable Terracon test standards.

Selected soil samples were tested for the following engineering properties:

- Water content
- Dry density
- Consolidation/expansion
- Grain size
- Plasticity index
- Maximum laboratory dry density (ASTM D698)
- Electrical resistivity
- pH
- Water soluble sulfate content
- Water soluble chloride content

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
B-1	4.0	40	18	22	83	CL	LEAN CLAY with SAND
B-2	3.0	38	18	20	90	CL	LEAN CLAY
B-3	2.0	38	19	19	93	CL	LEAN CLAY
B-4	7.0	42	17	25	94	CL	LEAN CLAY
B-5	3.0	36	19	17	90	CL	LEAN CLAY
B-7	4.0	32	19	13	89	CL	LEAN CLAY
B-8	7.0	34	18	16	76	CL	LEAN CLAY with SAND

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

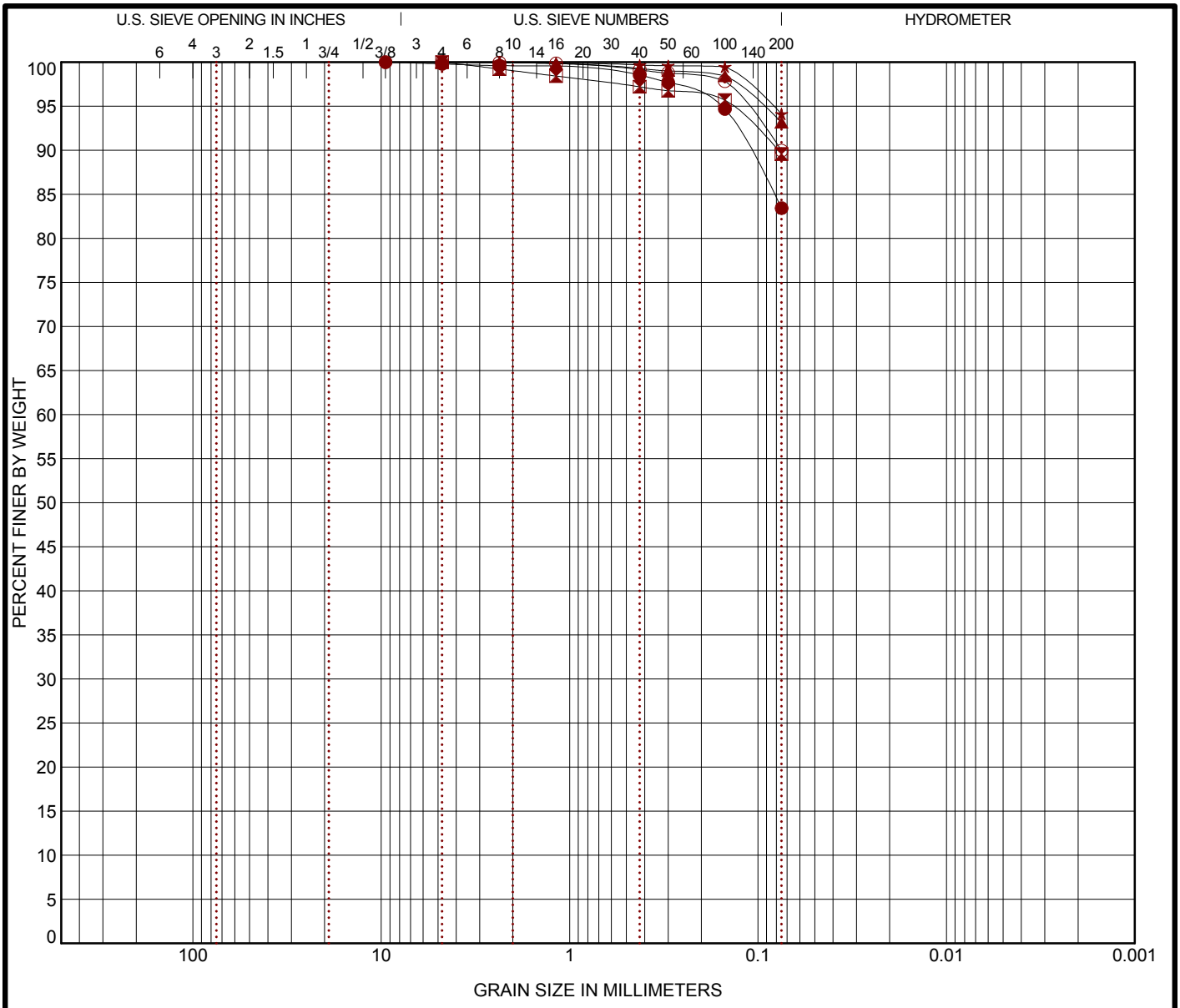
PROJECT NUMBER: 23145024

CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-1	4.0	LEAN CLAY with SAND(CL)	40	18	22		
⊠	B-2	3.0	LEAN CLAY(CL)	38	18	20		
▲	B-3	2.0	LEAN CLAY(CL)	38	19	19		
★	B-4	7.0	LEAN CLAY(CL)	42	17	25		
⊙	B-5	3.0	LEAN CLAY(CL)	36	19	17		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
●	B-1	4.0	9.5				0.2	16.4	83.4	
⊠	B-2	3.0	4.75				0.0	10.4	89.6	
▲	B-3	2.0	4.75				0.0	6.9	93.1	
★	B-4	7.0	2.36				0.0	5.9	94.1	
⊙	B-5	3.0	4.75				0.0	10.0	90.0	

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

PROJECT NUMBER: 23145024

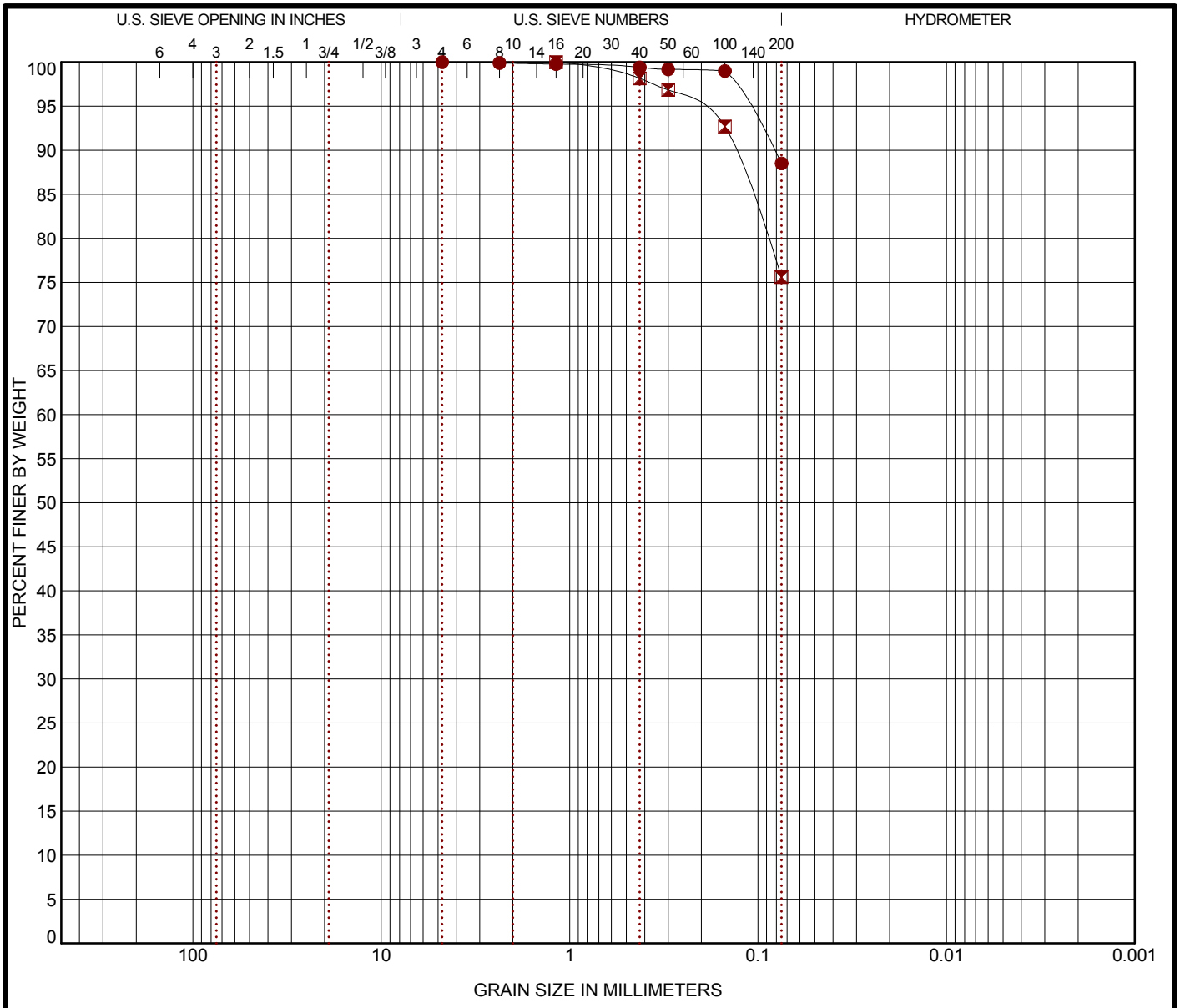
CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 23145024 - COPY.GPJ TERRACON2012.GDT 8/12/14

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-7	4.0	LEAN CLAY(CL)	32	19	13		
⊠	B-8	7.0	LEAN CLAY with SAND(CL)	34	18	16		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
●	B-7	4.0	4.75				0.0	11.5	88.5	
⊠	B-8	7.0	1.18				0.0	24.4	75.6	

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

PROJECT NUMBER: 23145024

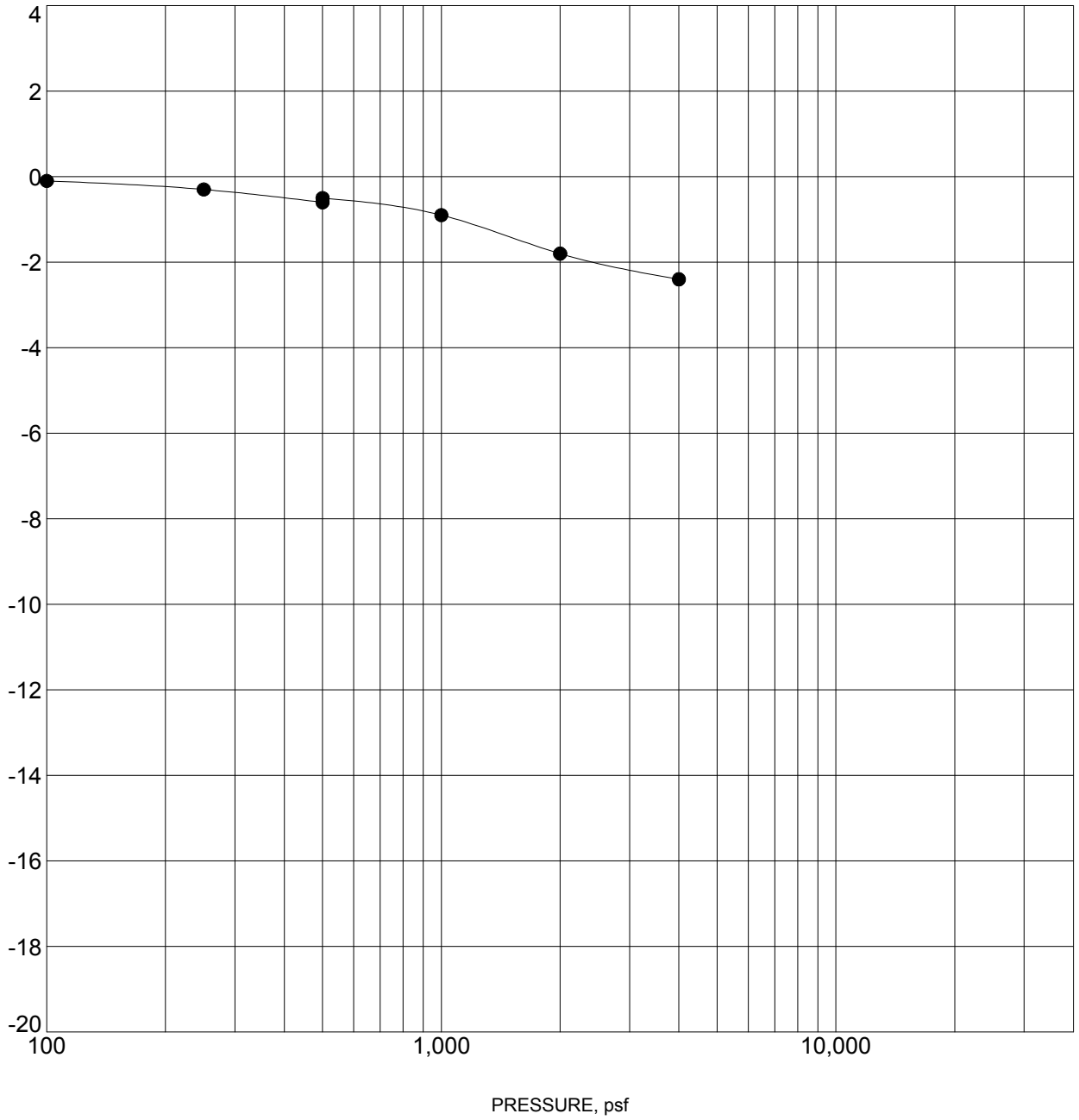
CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 23145024 - COPY.GPJ TERRACON2012.GDT 8/12/14

SWELL CONSOLIDATION TEST

ASTM D4546



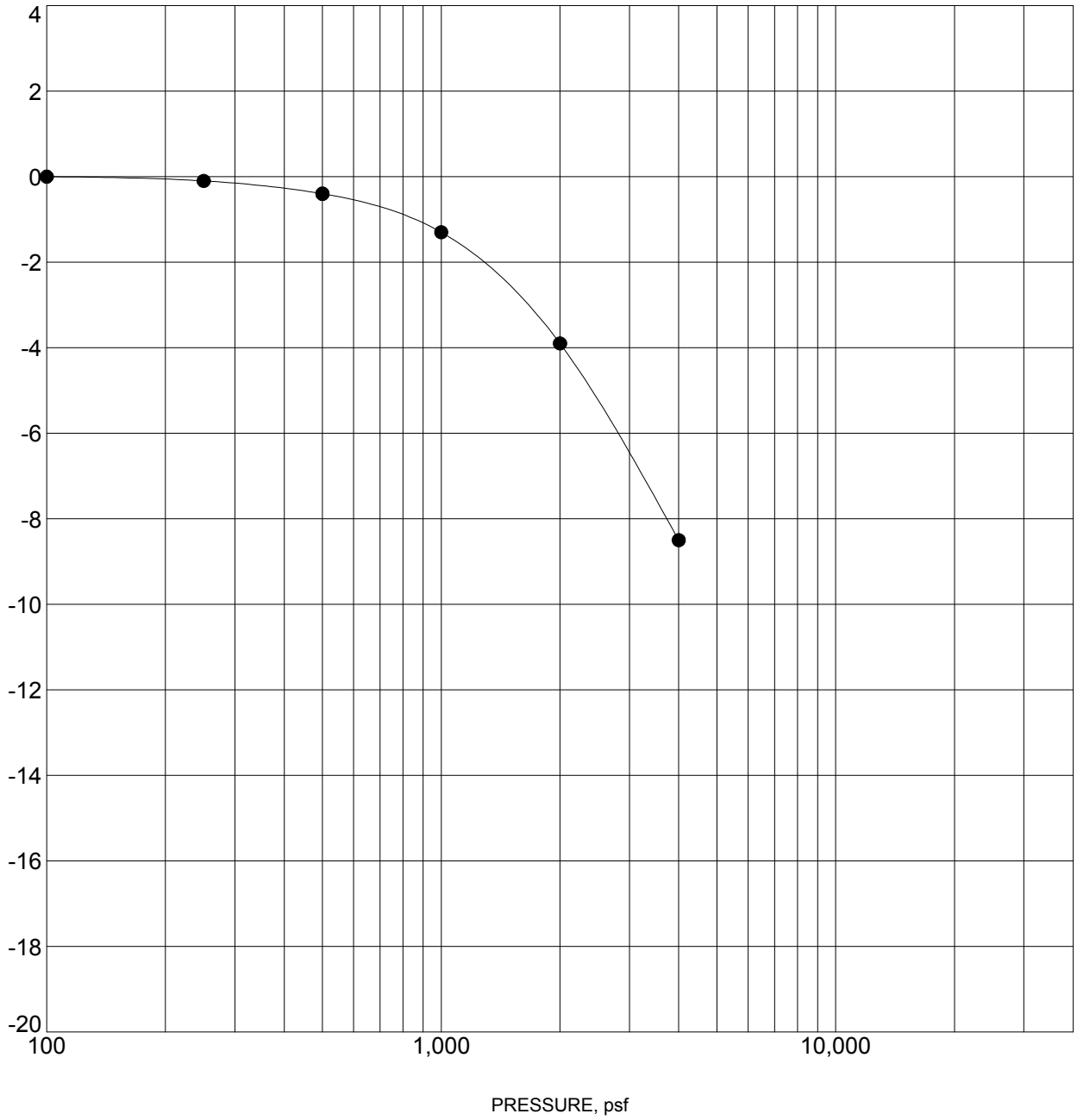
Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-1	2.0 ft	LEAN CLAY with SAND(CL)	88	17

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: Front Range Midway Solar Project	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: 23145024
SITE: Rancho Colorado Blvd. and El Hambra View El Paso County, Colorado		CLIENT: Tradewind Energy Lenexa, Kansas
		EXHIBIT: B-5

SWELL CONSOLIDATION TEST

ASTM D4546



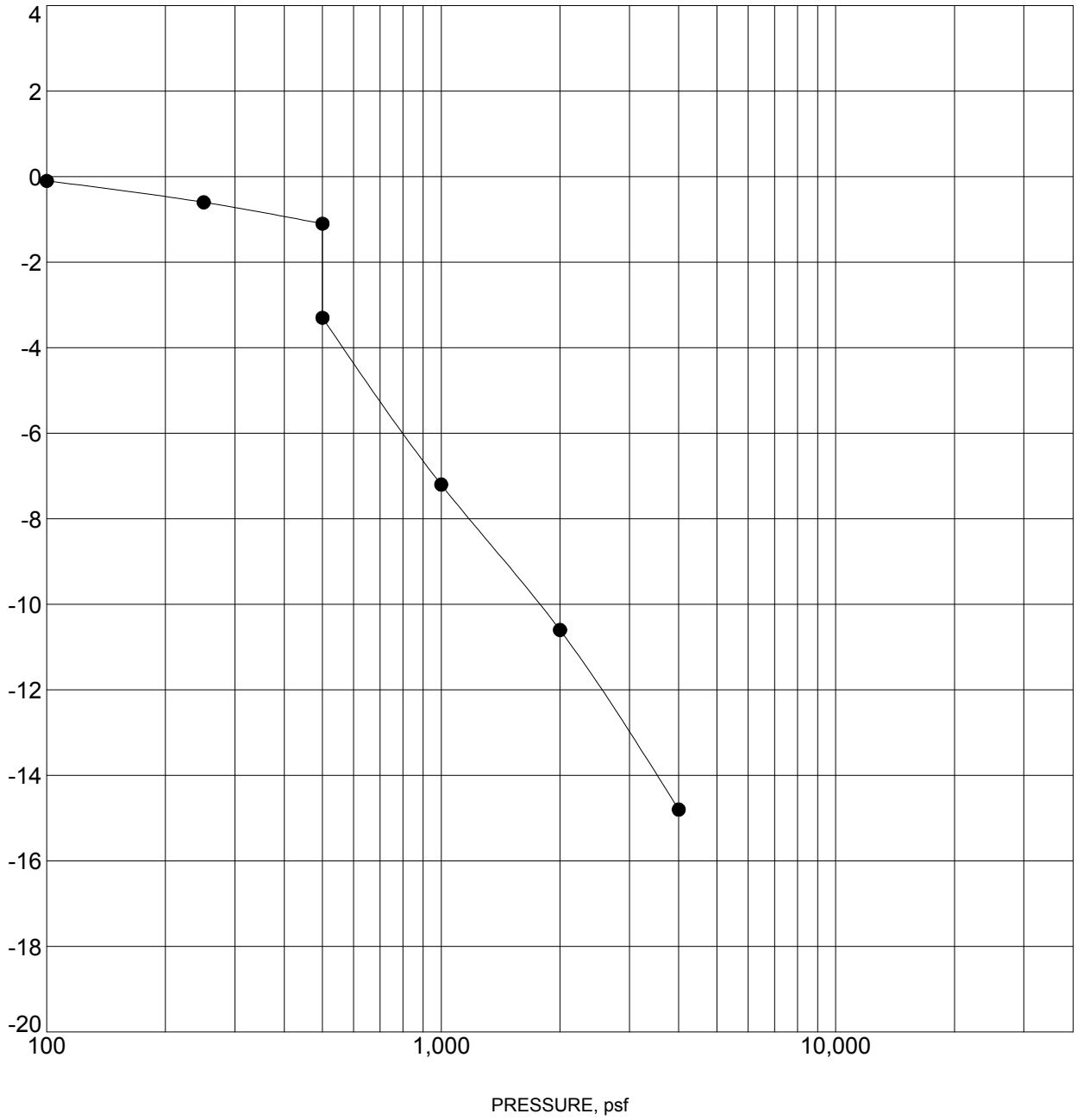
Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-2	4.0 ft	LEAN CLAY(CL)	81	12

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: Front Range Midway Solar Project	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: 23145024
SITE: Rancho Colorado Blvd. and El Hambra View El Paso County, Colorado		CLIENT: Tradewind Energy Lenexa, Kansas
		EXHIBIT: B-6

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-4	2.0 ft	LEAN CLAY(CL)	82	9

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

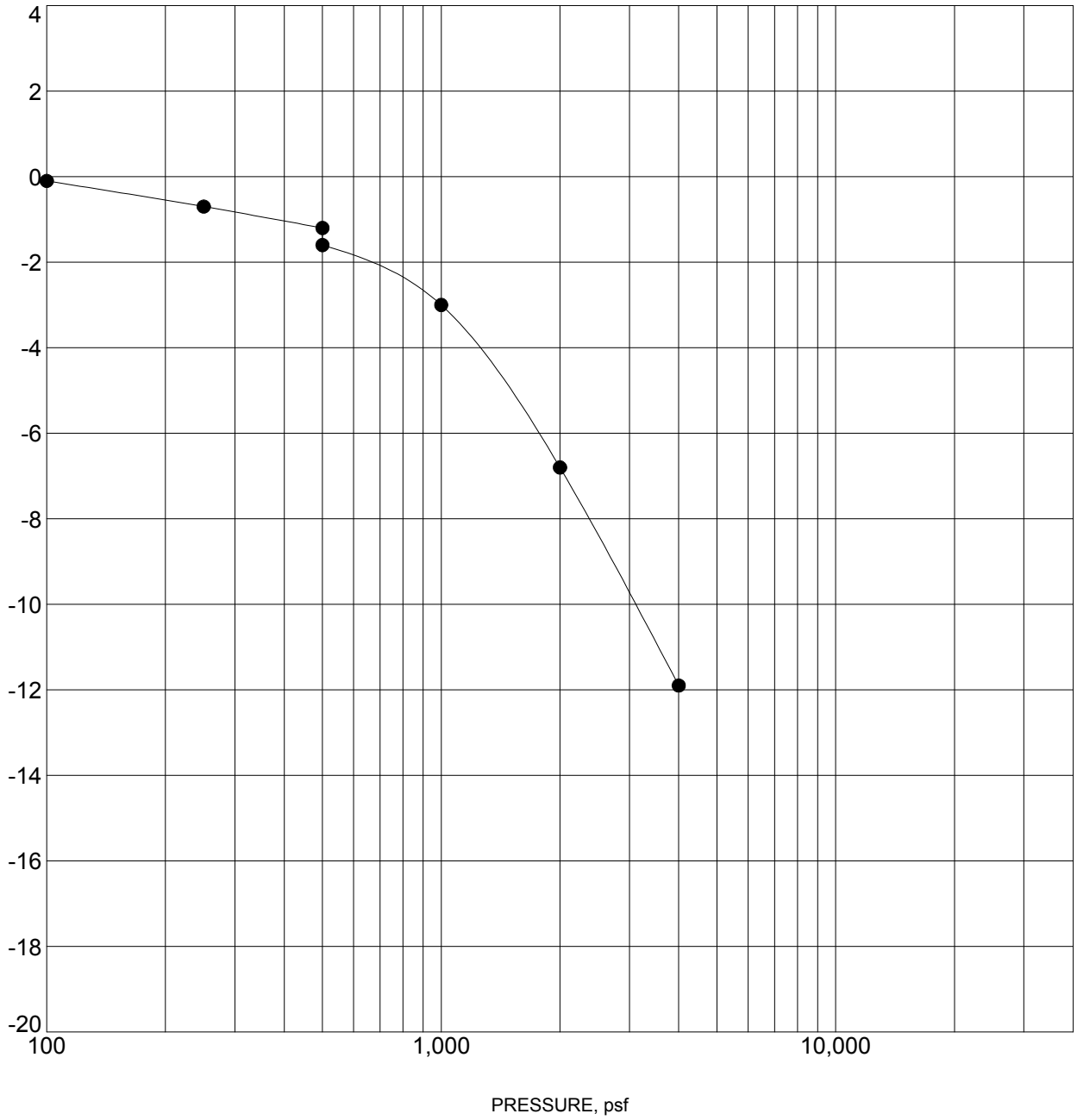
PROJECT NUMBER: 23145024

CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-7

SWELL CONSOLIDATION TEST

ASTM D4546



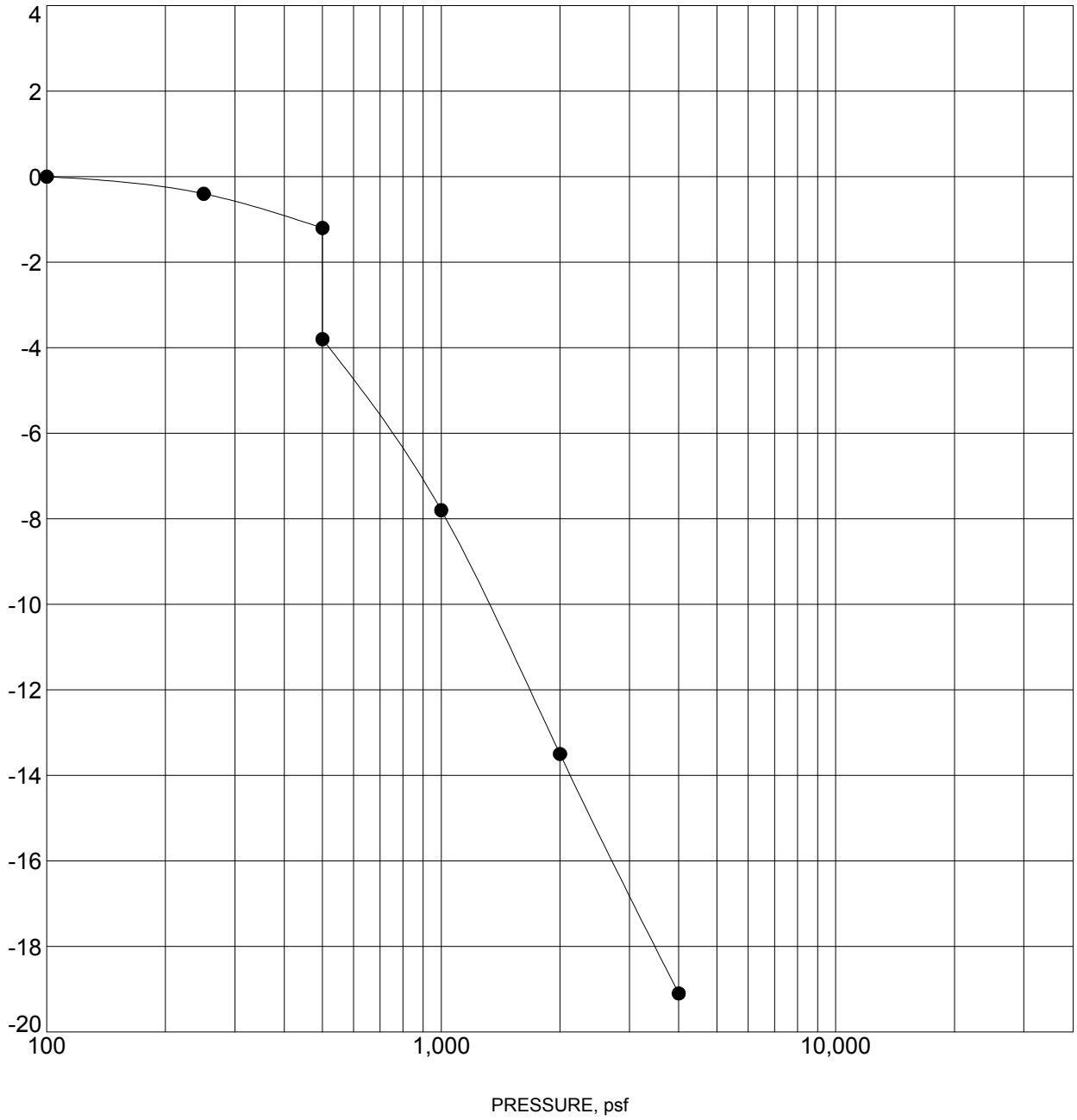
Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-6	4.0 ft	LEAN CLAY(CL)	85	9

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: Front Range Midway Solar Project	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: 23145024
SITE: Rancho Colorado Blvd. and El Hambra View El Paso County, Colorado		CLIENT: Tradewind Energy Lenexa, Kansas
		EXHIBIT: B-8

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-8	4.0 ft	LEAN CLAY with SAND(CL)	79	8

NOTES: Sample inundated with water at 500 pounds per square foot (psf.)

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

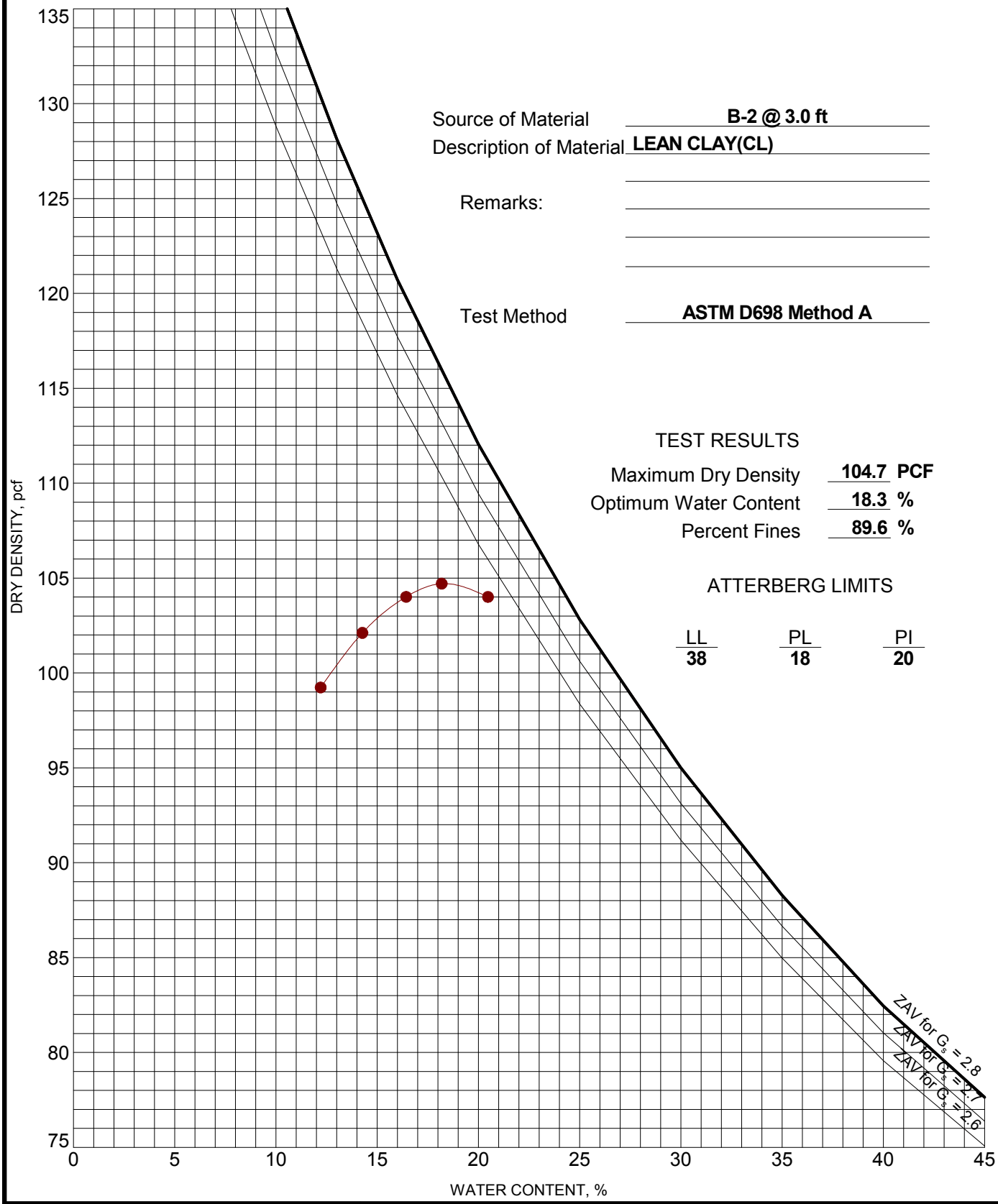
PROJECT NUMBER: 23145024

CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-9

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-2 @ 3.0 ft**

Description of Material: **LEAN CLAY(CL)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**104.7**	**PCF**
Optimum Water Content	**18.3**	**%**
Percent Fines	**89.6**	**%**

ATTERBERG LIMITS

LL	PL	PI
38	**18**	**20**

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

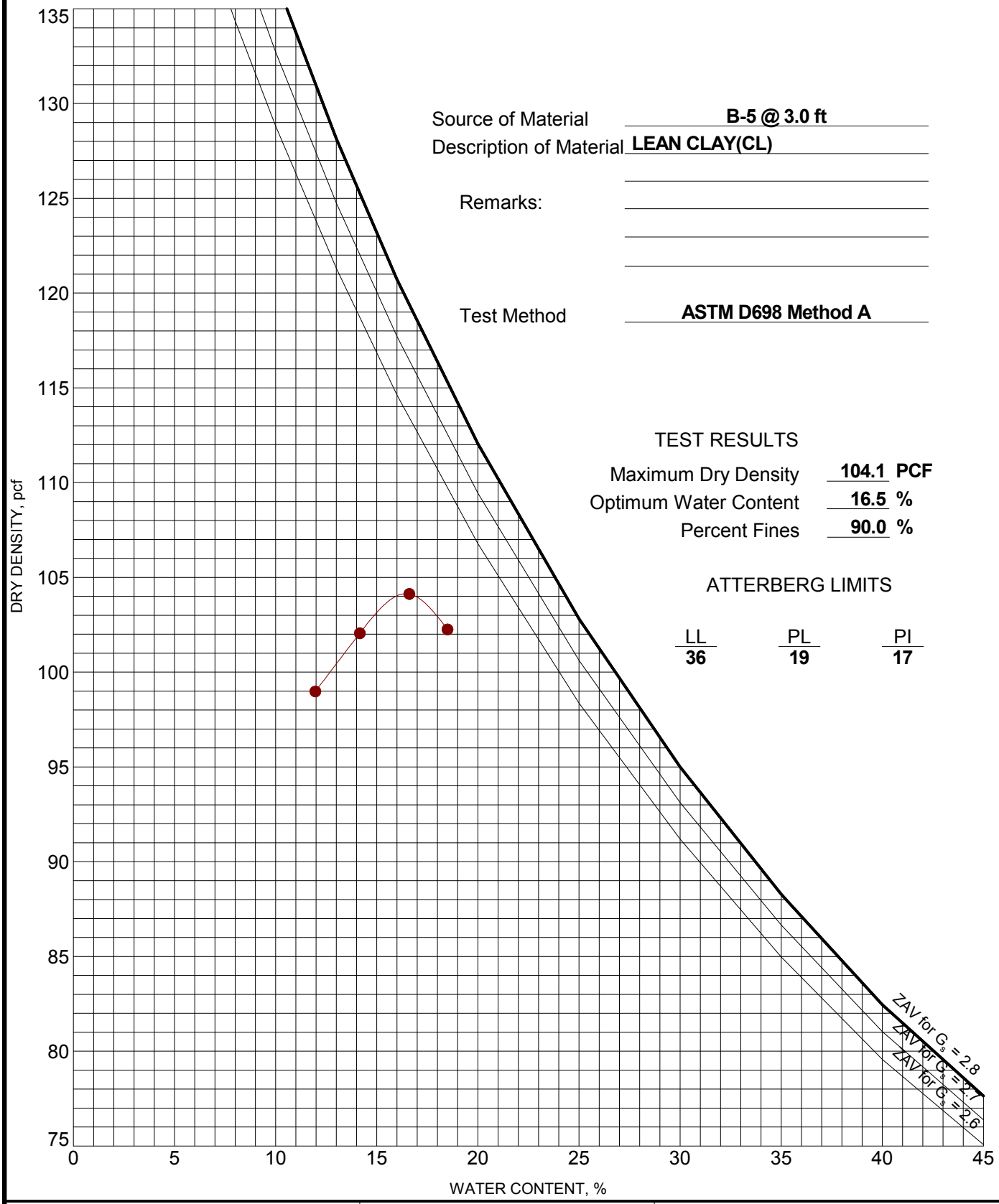
PROJECT NUMBER: 23145024

CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-10

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-5 @ 3.0 ft**

Description of Material: **LEAN CLAY(CL)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**104.1**	**PCF**
Optimum Water Content	**16.5**	**%**
Percent Fines	**90.0**	**%**

ATTERBERG LIMITS

LL	PL	PI
36	**19**	**17**

PROJECT: Front Range Midway Solar Project

SITE: Rancho Colorado Blvd. and El Hambra View
El Paso County, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

PROJECT NUMBER: 23145024

CLIENT: Tradewind Energy
Lenexa, Kansas

EXHIBIT: B-11

Colorado Analytical LABORATORIES, INC.

Analytical Results

TASK NO: 140728012

Report To: Ryan Feist
Company: Terracon, Inc. - Colo Springs
4172 Center Park Drive
Colo. Springs CO 80916

Bill To: Accounts Payable
Company: Terracon, Inc. - Lenexa
13910 W. 96th Terrace
Lenexa KS 66215

Task No.: 140728012
Client PO:
Client Project: Tradewind Energy 23145024

Date Received: 7/28/14
Date Reported: 8/4/14
Matrix: Soil - Geotech

Customer Sample ID 23145024 Tradewind B-5 3-5 Ft.
Lab Number: 140728012-01

Test	Result	Method
Chloride - Water Soluble	**0.0008 %**	AASHTO T291-91/ ASTM D4327
pH	**7.7 units**	AASHTO T289-91
Resistivity	**1531 ohm.cm**	AASHTO T288-91
Sulfate - Water Soluble	**0.005 %**	AASHTO T290-91/ ASTM D4327

Abbreviations/ References:

AASHTO - American Association of State Highway and Transportation Officials.
ASTM - American Society for Testing and Materials.
ASA - American Society of Agronomy.
DIPRA - Ductile Iron Pipe Research Association Handbook of Ductile Iron Pipe.

DATA APPROVED FOR RELEASE BY

240 South Main Street / Brighton, CO 80601-0507 / 303-659-2313
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507 / Fax: 303-659-2315

Colorado Analytical LABORATORIES, INC.

Analytical Results

TASK NO: 140730014

Report To: Ryan Feist
Company: Terracon, Inc. - Colo Springs
4172 Center Park Drive
Colo. Springs CO 80916

Bill To: Accounts Payable
Company: Terracon, Inc. - Lenexa
13910 W. 96th Terrace
Lenexa KS 66215

Task No.: 140730014
Client PO:
Client Project: Tradewind Energy 23145024

Date Received: 7/30/14
Date Reported: 8/6/14
Matrix: Soil - Geotech

Customer Sample ID 23145024 B-5 3-5 Ft.
Lab Number: 140730014-01

Test	Result	Method
Redox Potential	**195 mv**	ASTM D1498
Sulfide	**Negative**	AWWA C105

Abbreviations/ References:

AASHTO - American Association of State Highway and Transportation Officials.
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August 5, 2014

Terracon Consultants, Inc.
4172 Center Park Drive
Colorado Springs, CO 80916
Attn: Robert Hernandez, PE

Re: Thermal Analysis of Soil Samples - Tradewind Energy
Front Range Midway Solar Project, El Paso County, Colorado (P.O. No. 23145024)

The following is the report of thermal dryout characterization tests conducted on the 2 soil samples from the referenced project received at our laboratory.

Thermal Resistivity Tests: For thermal dryout tests, the samples were re-constituted at the optimum moisture content and at 85% of the Proctor density provided by ***Terracon.***. A series of thermal resistivity measurements were made in stages with moisture content ranging from the 'optimum' to the totally dry condition. The tests were conducted in accordance with the IEEE standard. The results are tabulated below and the thermal dryout curves are presented in **Figure 1.**

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

Sample ID	Description (Terracon)	Thermal Resistivity (°C-cm/W)		Moisture Content (%)	Dry Density (lb/ft^3)
		Wet	Dry		
B-2 @ 3'-5'	Lean Clay	123	221	18	89
B-5 @ 3'-5'	Lean Clay	115	202	17	89

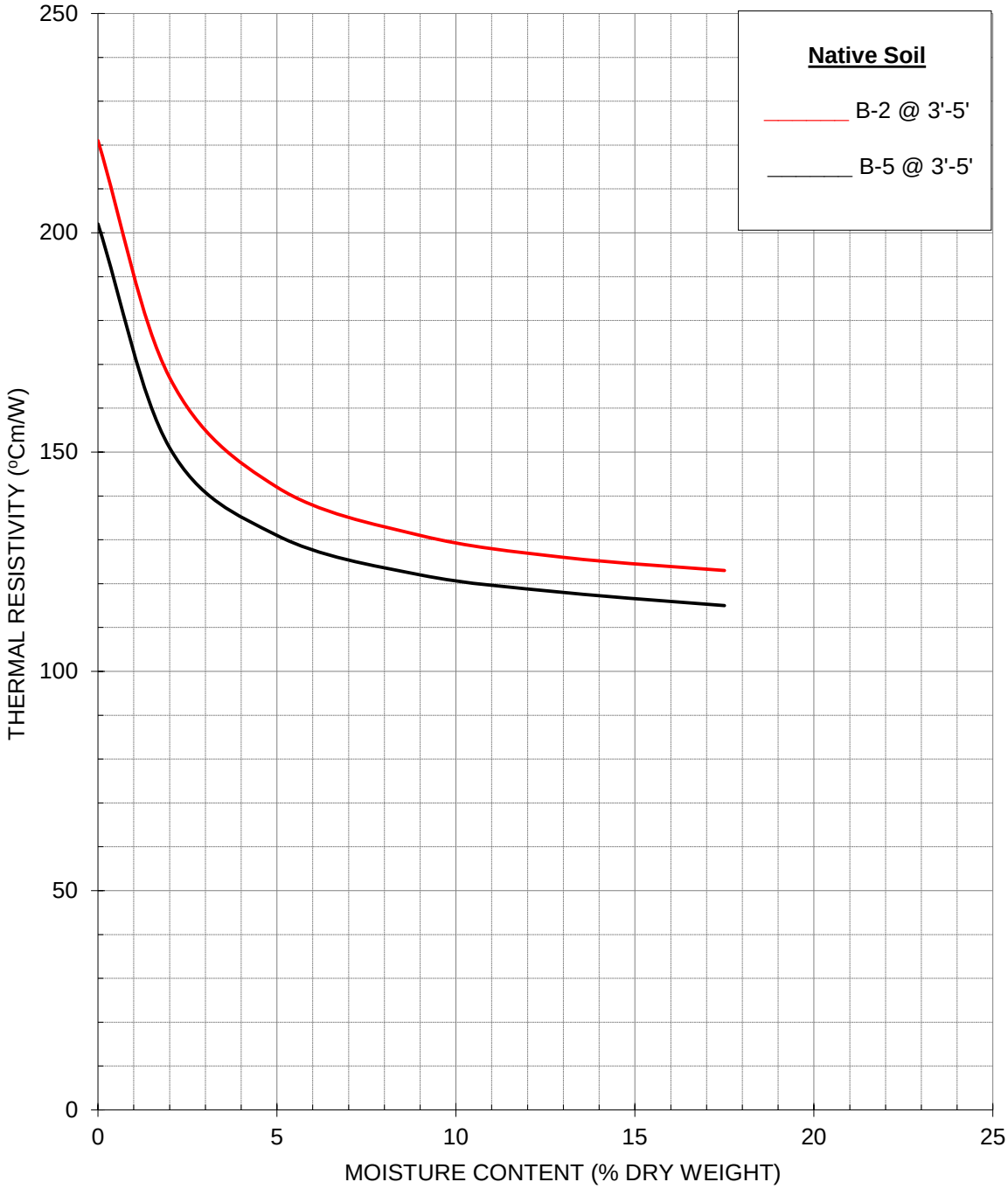
Comments: The thermal characteristics depicted in the dryout curves apply for the soils at their respective test dry density.

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

Geotherm USA

Deepak Parmar

THERMAL DRYOUT CURVES



Terracon - Tradewind Energy

Thermal Analysis of Native Soils Samples

Front Range Midway Solar Project, El Paso County, CO

August 2014 **Figure 1**

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING


Auger


Split Spoon


Shelby Tube


Macro Core


Ring Sampler


Rock Core


Grab Sample


No Recovery

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

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(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 Includes gravels, sands and silts.			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				BEDROCK		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3	< 30	< 20	Weathered
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4	30 - 49	20 - 29	Firm
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9	50 - 89	30 - 49	Medium Hard
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18	90 - 119	50 - 79	Hard
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42	> 119	>79	Very Hard
			Hard	> 8,000	> 30	> 42			

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	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 $1 > Cc > 3$ [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 $1 > Cc > 3$ [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	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			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	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			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-in. (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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.

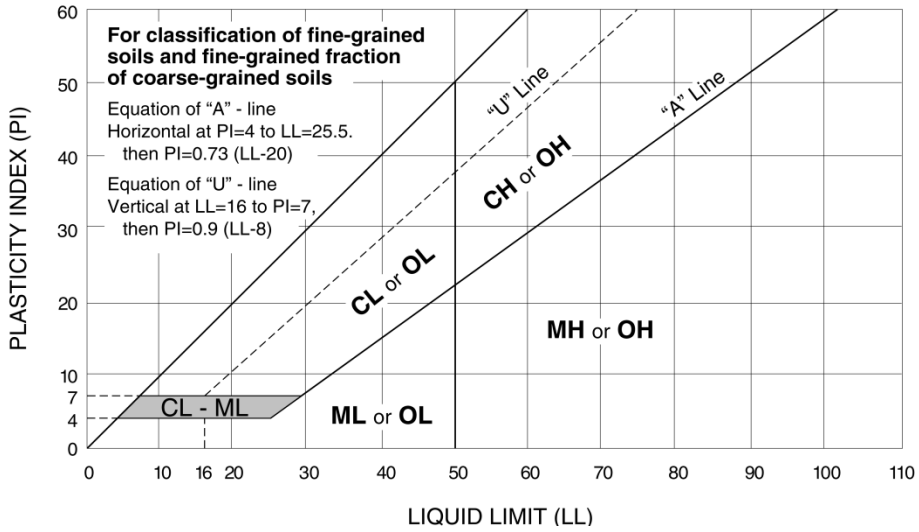
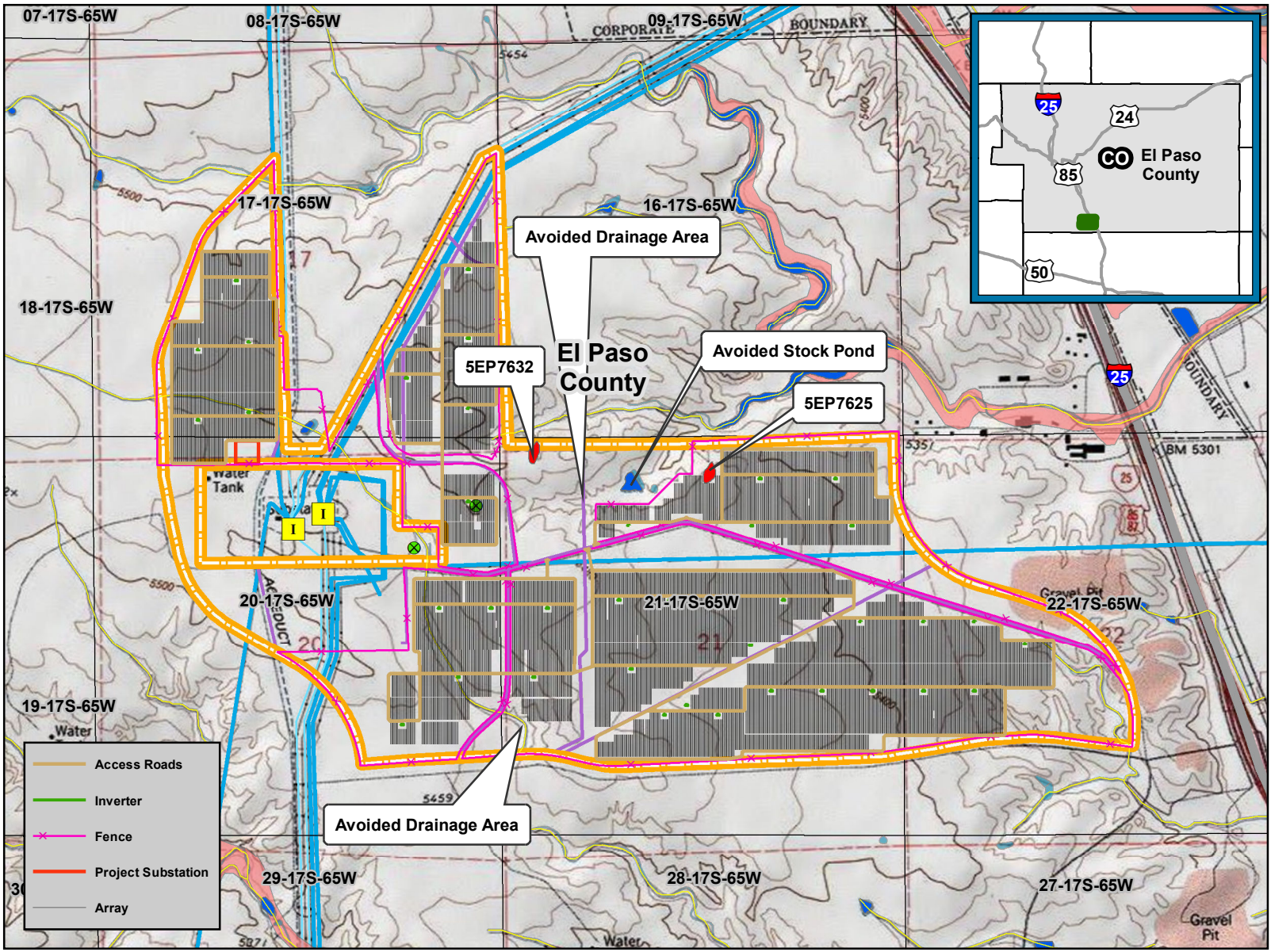


Exhibit C-2

Front Range - Midway Solar Project

Physical Constraints / Other Design Constraints Subject to Title Clearing / Preliminary Design



Project Boundary
Avoided Archeological Sites
I POI Location
NHD Lines
NHD Polygon
NWI Wetlands
FEMA
Other Design Constraints Subject to Title Clearing
Transmission Lines
Voltage kV
115
230
Communications Tower

tradewind energy

The following companies and organizations provided data that contributed to the production of this map.

U.S. Geological Survey (USGS)
Environmental Systems Research Institute (ESRI)
U. S. Department of Agriculture (USDA)
WhiteStar Corporation

N

0 0.125 0.25 0.5
Miles

Scale: 1:24,000

Date: 1/16/2018

Coordinate System:
NAD 1983 StatePlane Colorado Central FIPS 0502 Feet