Geotechnical Engineering Report

Grover Tower

Weld County, Colorado

April 16, 2018

Terracon Project No. 20175082

Prepared for:

Communication Infrastructure Corporation

Austin, Texas

Prepared by:

Terracon Consultants, Inc.

Fort Collins, Colorado

April 16, 2018

Communication Infrastructure Corporation
3903 South Congress Avenue
Austin, TX 78704

Attn: Mr. Brett Bonomo
P: (303) 829 8838
E: bbonomo@cicusa.com

Re: Geotechnical Engineering Report
Grover Tower
Southwest of County Road 128 and County Road 105
Weld County, Colorado
Terracon Project No. 20175082

Dear Mr. Bonomo:

We have completed the geotechnical engineering services for the project referenced above. This study was performed in general accordance with our proposal number P20175082 dated September 25, 2017. 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. Materials testing and construction observation services are provided by Terracon as well. We would be please to discuss these services with you. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

COLORADO REGISTERED PROFESSIONAL ENGINEER
ERIC D. BERNHARDT
4/16/18
38829

Rick S. Greeley, E.I.
Field Engineer

Eric D. Bernhardt, P.E.
Geotechnical Department 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 logo in the top right corner will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Overview	A geotechnical exploration has been performed for the proposed Grover Tower to be constructed southwest of the intersection of County Road 128 and County Road 105 in Weld County, Colorado. One (1) boring was performed to a depth of approximately 60 feet below existing site grades.
Subsurface Conditions	Subsurface conditions encountered in our exploratory boring generally consisted of about 6 feet of silt with sand over silty sand to the maximum depth of exploration. The boring log is presented in the **Exploration Results** section of this report.
Groundwater Conditions	Groundwater was not encountered in our test boring. Groundwater levels can fluctuate in response to site development and to varying seasonal and weather conditions, and fluctuations in nearby water features.
Earthwork	On-site soils typically appear suitable for use as general engineered fill and backfill on the site provided they are placed and compacted as described in this report. Import materials (if needed) should be evaluated and approved by Terracon prior to delivery to the site. Earthwork recommendations are presented in the **Earthwork** section of this report.
Grading and Drainage	The amount of movement of foundations will be related to the wetting of underlying supporting soils. Therefore, it is imperative the recommendations discussed in the **Grading and Drainage** section of this report be followed to reduce potential movement.
Foundations	We recommend constructing the proposed tower on a drilled pier foundation system bottomed in medium dense to very dense silty sand. As an alternative, we believe the proposed tower can be constructed on a reinforced concrete mat foundation system, provided the foundations extend through the upper silt down about 6 feet to the medium dense to very dense silty sand.
Seismic Considerations	As presented in the **Seismic Considerations** section of this report, the 2015 International Building Code, which refers to Section 20 of ASCE 7-10, indicates the seismic site classification for this site is D.
Construction Observation and Testing	Close monitoring of the construction operations and implementing drainage recommendations discussed herein will be critical in achieving the intended foundation, slab and pavement performance. We therefore recommend that Terracon be retained to monitor this portion of the work.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics (bold orange font) above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes. It should be recognized that specific 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.

Geotechnical Engineering Report

Grover Tower

Southwest of County Road 128 and County Road 105

Weld County, Colorado

Terracon Project No. 20175082

April 16, 2018

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Grover Tower to be located southwest of the intersection of County Road 128 and County Road 105 in Weld County, Colorado. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- Site preparation and earthwork
- Demolition considerations
- Foundation design and construction
- Excavation considerations
- Seismic site classification per IBC

The geotechnical engineering scope of services for this project included the advancement of 1 test boring to a depth of approximately 60 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 log and as separate graphs in the **Exploration Results** section of this report.

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 southwest of the intersection of Weld County Road (WCR) 128 and WCR 105 in Weld County, Colorado. The approximate latitude/longitude for the center of the site are 40.91293° N /104.08997° W (See **Site Location**).

Item	Description
Existing Improvements	The project involves construction of a new radio tower next to an existing tower and the subsequent decommission of the existing tower.
Current Ground Cover	Earthen, moderately vegetated.
Existing Topography	The site is relatively flat.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. 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	Email correspondence from Brett Bonomo with Eric Bernhardt dated September 18, 2017.
Project Description	Project includes construction of a new 265-foot tall, self-supporting tower adjacent to an existing tower and the subsequent decommission of the existing tower.
Maximum Loads (assumed)	■ Vertical: 150 kips maximum ■ Horizontal: 20 to 40 kips maximum ■ Uplift: 20 kips maximum
Grading/Slopes	We anticipate minor cuts and fills on the order of 3 feet or less.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

Specific conditions encountered at the boring location are indicated on the individual boring log. Stratification boundaries on the boring log represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for the boring can be found in **Exploration Results**. A discussion of field sampling and laboratory testing procedures and test results are presented in **Exploration and Testing Procedures**. Based on the results of the boring, subsurface conditions on the project site can be generalized as follows:

Material Description	Approximate Depth to Bottom of Stratum	Consistency/Density
Vegetative layer	About 8 inches	--

Material Description	Approximate Depth to Bottom of Stratum	Consistency/Density
Silt with sand	About 6 feet below existing site grades	Medium stiff
Silty sand	To the maximum depth of exploration of about 60 feet.	Medium dense to very dense

Groundwater Conditions

The borehole was observed while drilling and after completion for the presence and level of groundwater. Water was not encountered during exploration.

This observation represents 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, and other factors.

Laboratory Testing

A representative soil sample was selected for one-dimensional swell-consolidation testing and exhibited 1.9 percent compression when wetted. Samples of site soils selected for plasticity testing exhibited low plasticity with liquid limits ranging from non-plastic to 33 and plasticity indices ranging from non-plastic to 5. Laboratory test results are presented in the **Exploration Results** section of this report.

GEOTECHNICAL OVERVIEW

Based on subsurface conditions encountered in the boring, the site appears suitable for the proposed construction from a geotechnical point of view provided certain precautions and design and construction recommendations described in this report are followed.

Foundation and Floor System Recommendations

Terracon recommends constructing the proposed Grover Tower on a drilled pier foundation system or a reinforced concrete mat foundation system bottomed in the medium dense to very dense silty sand soils discovered on-site. If a shallow reinforced concrete mat foundation system is selected to support the proposed tower, we recommend extending the foundations through the upper silt soils about 6 feet to bottom on the silty sands.

Design recommendations for foundations for the proposed tower and related structural elements are presented in the following sections.

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

EARTHWORK

The following presents recommendations for site preparation, demolition, excavation, subgrade preparation, fill materials, compaction requirements, utility trench backfill, and grading and drainage. Earthwork on the project should be observed and evaluated by Terracon. Evaluation of earthwork should include observation and/or testing of subgrade preparation, placement of engineered fills, subgrade stabilization and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Prior to placing any fill, strip and remove existing vegetation, topsoil, and any other deleterious materials from the proposed construction areas.

Stripped organic materials should be wasted from the site or used to re-vegetate landscaped areas or exposed slopes after completion of grading operations. Prior to the placement of fills, the site should be graded to create a relatively level surface to receive fill, and to provide for a relatively uniform thickness of fill beneath proposed structures.

Demolition

The extent and type of foundation system supporting the existing tower is not known. If the foundation systems of the existing tower or guy wire supports extend into the proposed construction area, demolition of the existing tower should include complete removal of all foundation systems, below-grade structural elements, and exterior flat work within the proposed construction area. This should include removal of any utilities to be abandoned along with any loose utility trench backfill or loose backfill found adjacent to existing foundations. All materials derived from the demolition of existing structures should be removed from the site. If the existing tower is supported by drilled piers, the existing piers should be truncated a minimum depth of 3 feet below areas of planned new construction.

Excavation

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

Excavation penetrating the cemented soils may require the use of specialized heavy-duty equipment to advance the excavation and facilitate rock break-up and removal. Consideration

should be given to obtaining a unit price for difficult excavation in the contract documents for the project.

The soils to be excavated can vary significantly across the site as their classifications are based solely on the materials encountered in a single test boring. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.

Although evidence of fills or underground utilities was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills or underground utilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Any over-excavation that extends below the bottom of foundation elevation should extend laterally beyond all edges of the foundations at least 8 inches per foot of over-excavation depth below the foundation base elevation. The over-excavation should be backfilled to the foundation base elevation in accordance with the recommendations presented in this report.

The subgrade soil conditions should be evaluated during the excavation process and the stability of the soils determined at that time by the contractors' Competent Person. Slope inclinations flatter than the OSHA maximum values may have to be used. The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

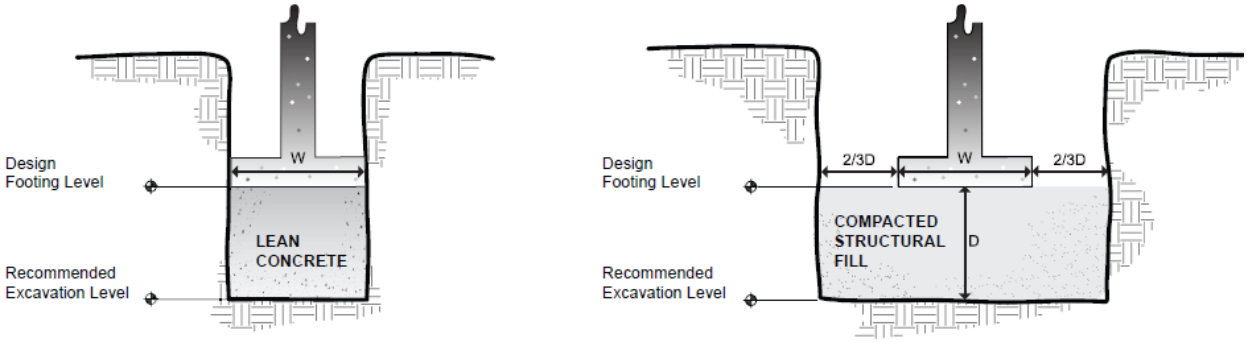
As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to the slope height. The exposed slope face should be protected against the elements

Subgrade Preparation

After existing vegetation, topsoil, and any other deleterious materials have been removed from the construction areas, the foundation excavation should extend down about 6 feet to the medium dense to very dense silty sand materials. The top 10 inches of the exposed ground surface should be scarified, moisture conditioned, and recompacted to at least 95 percent of the maximum dry unit weight as determined by ASTM D698 before any new fill or foundation is placed.

If pockets of soft, loose, or otherwise unsuitable materials are encountered at the bottom of the foundation excavations and it is inconvenient to lower the foundations, the proposed foundation

elevations may be reestablished by over-excavating the unsuitable soils and backfilling with compacted engineered fill or lean concrete.



Lean Concrete Backfill **Overexcavation / Backfill**

NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

After the bottom of the excavation has been compacted, engineered fill can be placed to bring the subgrade to the desired grade. Engineered fill should be placed in accordance with the recommendations presented in subsequent sections of this report.

The stability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unstable conditions develop, workability may be improved by scarifying and drying. Alternatively, over-excavation of wet zones and replacement with granular materials may be used, or crushed gravel and/or rock can be tracked or "crowded" into the unstable surface soil until a stable working surface is attained. Lightweight excavation equipment may also be used to reduce subgrade pumping.

Fill Materials

The on-site soils or approved granular and low plasticity cohesive imported materials may be used as fill material. The earthwork contractor should expect significant mechanical processing and moisture conditioning of the site soils and will be needed to achieve proper compaction

Imported soils (if required) should meet the following material property requirements:

Gradation	Percent finer by weight (ASTM C136)
4"	100
3"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	50 (max.)

Soil Properties	Values
Liquid Limit	35 (max.)
Plastic Limit	6 (max.)

Other import fill materials types may be suitable for use on the site depending upon proposed application and location on the site, and could be tested and approved for use on a case-by-case basis.

Compaction Requirements

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.

Item	Description
Fill lift thickness	9 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 or plate compactor) is used
Minimum compaction requirements	95 percent of the maximum dry unit weight as determined by ASTM D698 100 percent of the maximum dry unit weight as determined by ASTM D698 below foundations for over-excavation backfill if a reinforced mat foundation is selected
Moisture content cohesionless soil (sand)	-3 to +3 % of the optimum moisture content

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

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction.

All underground piping within or near the proposed tower or existing control building should be designed with flexible couplings, so minor deviations in alignment do not result in breakage or distress. Utility knockouts should be oversized to accommodate differential movements. It is imperative that utility trenches be properly backfilled with relatively clean materials. If utility

trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill in to reduce the infiltration and conveyance of surface water through the trench backfill.

Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the tower and control building should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the structures. We recommend constructing an effective clay "trench plug" that extends at least 5 feet out from the face of the control building exterior. The plug material should consist of clay compacted at a water content at or above the soil's optimum water content. The clay fill should be placed to completely surround the utility line and be compacted in accordance with recommendations in this report.

It is strongly recommended that a representative of Terracon provide full-time observation and compaction testing of trench backfill within building.

Grading and Drainage

Grades must be adjusted to provide effective drainage away from the proposed tower during construction and maintained throughout the life of the proposed project. Infiltration of water into foundation excavations must be prevented during construction. Water permitted to pond near or adjacent to the perimeter of the tower (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.

Exposed ground should be sloped at a minimum of 10 percent grade for at least 5 feet beyond the perimeter of the proposed tower, where possible. Backfill against foundations should be properly compacted and free of all construction debris to reduce the possibility of moisture infiltration. After construction of the proposed tower and prior to project completion, we recommend verification of final grading be performed to document positive drainage, as described above, has been achieved.

Flatwork will be subject to post-construction movement. Maximum grades practical should be used for flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post-construction movement of flatwork, particularly if such movement would be critical. Where flatwork abuts the structures, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water.

Exterior Slab Design and Construction

Exterior slabs on-grade and utilities founded on, or in backfill or the site soils will likely experience some movement due to the volume change of the material. Potential movement could be reduced by:

- Minimizing moisture increases in the backfill;
- Controlling moisture-density during placement of the backfill;
- Using designs which allow vertical movement between the exterior features and adjoining structural elements; and
- Placing control joints on relatively close centers.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of Terracon. Monitoring should include documentation of adequate removal of vegetation and topsoil, proof-rolling and mitigation of areas delineated by the proof-roll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by Terracon prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the structure areas. One density and water content test for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade and exposed conditions at the base of the excavation should be evaluated under the direction of Terracon. In the event that unanticipated conditions are encountered, Terracon should prescribe mitigation options.

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

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following deign parameters are applicable for the Grover Tower to be supported on shallow foundations bottomed in the medium dense to very dense silty sand.

Reinforced Mats - Design Recommendations

Description	Values
Bearing material	Properly prepared on-site silty sand soil, or new, properly placed engineered fill.
Maximum net allowable bearing pressure[1]	3,500 psf
Minimum foundation dimensions	Columns: 30 inches Continues: 18 inches
Lateral earth pressure coefficients[2]	Active, K_a = 0.22 Passive, K_p = 4.6 At-rest, K_o = 0.36
Sliding coefficients[2]	μ = 0.67
Moist soil unit weight	γ = 120 pcf
Minimum embedment depth below finished grade [3]	30 inches
Estimated total movement	About 1 inch
Estimated differential movement	About ½ to ¾ of total movement

1. The recommended maximum net allowable bearing pressure assumes any unsuitable fill or soft/loose soils, if encountered, will be over-excavated and replaced with properly compacted engineered fill. The design bearing pressure applies to a dead load plus design live load condition. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions.
2. The lateral earth pressure coefficients and sliding coefficients are ultimate values and do not include a factor of safety. The foundation designer should include the appropriate factors of safety.
3. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils.

Foundations should be proportioned to reduce differential foundation movement. As discussed, total movement resulting from the assumed structural loads is estimated to be on the order of about 1 inch. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction and throughout the life of the structure. Failure to maintain the proper drainage as recommended in the **Grading and Drainage** section of this report will nullify the movement estimates provided above.

Reinforced Mats - Construction Considerations

To reduce the potential of “pumping” and softening of the foundation soils at the foundation bearing level and the requirement for corrective work, we suggest the foundation excavation for the tower be completed remotely with a track-hoe operating outside of the excavation limits.

Spread footing construction should only be considered if the estimated foundation movement can be tolerated. Subgrade soils beneath footings should be moisture conditioned and compacted as described in the **Earthwork** section of this report. The moisture content and compaction of subgrade soils should be maintained until foundation construction.

Footings should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement.

Unstable surfaces will need to be stabilized prior to backfilling excavations and/or constructing the tower foundation. The use of angular rock, recycled concrete and/or gravel pushed or "crowded" into the yielding subgrade is considered suitable means of stabilizing the subgrade. The use of geogrid materials in conjunction with gravel could also be considered and could be more cost effective.

Unstable subgrade conditions should be observed by Terracon to assess the subgrade and provide suitable alternatives for stabilization. Stabilized areas should be proof-rolled prior to continuing construction to assess the stability of the subgrade.

Foundation excavations should be observed by Terracon. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

DEEP FOUNDATIONS

Drilled Piers Bottomed in Bedrock - Design Recommendations

Description	Value
Minimum pier length	16 feet
Minimum pier diameter	18 inches
Maximum allowable end-bearing pressure	5,000 psf
Allowable skin friction	500 psf

Piers should be considered to work in group action if the horizontal spacing is less than three pier diameters. A minimum practical horizontal clear spacing between piers of at least three diameters should be maintained, and adjacent piers should bear at the same elevation. The capacity of individual piers must be reduced when considering the effects of group action. Capacity reduction is a function of pier spacing and the number of piers within a group. If group action analyses are necessary, capacity reduction factors can be provided for the analyses.

To satisfy forces in the horizontal direction using LPILE, piers may be designed for the following lateral load criteria:

Parameters	Sand and Gravel
LPILE soil type	Sand (Reese)
Effective unit weight (pcf)	120
Friction angle, Φ (degrees)	40
Coefficient of subgrade reaction, k (pci)	225

Drilled Piers Bottomed in Bedrock - Construction Considerations

Drilling to design depth should be possible with conventional single-flight power augers on the majority of the site; however, specialized drilling equipment may be required for cemented soil layers.

Caving soil conditions indicate temporary steel casing may be required to properly drill and clean piers prior to concrete placement. Groundwater (if encountered) should be removed from each pier hole prior to concrete placement. Pier concrete should be placed immediately after completion of drilling and cleaning. If pier concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. Free-fall concrete placement in piers will only be acceptable if provisions are taken to avoid striking the concrete on the sides of the hole or reinforcing steel. The use of a bottom-dump hopper, or an elephant's trunk discharging near the bottom of the hole where concrete segregation will be minimized, is recommended. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

Casing should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or caving soils or the creation of voids in pier concrete. Pier concrete should have a relatively high fluidity when placed in cased pier holes or through a tremie. Pier concrete with slump in the range of 5 to 7 inches is recommended. A representative of Terracon should observe the bearing surface and shaft configuration.

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 7-10.

Description	Value
2015 International Building Code Site Classification	D [2]
Site Latitude	40.91293
Site Longitude	-104.08997
S_{DS} Spectral Acceleration for a Short Period [3]	0.121g
S_{D1} Spectral Acceleration for a 1-Second Period [3]	0.074g

1. Seismic site classification in general accordance with the *2015 International Building Code*, which refers to ASCE 7-10.
2. The 2015 International Building Code (IBC) uses a site profile extending to a depth of 100 feet for seismic site classification. The boring at this site were extended to a maximum depth of 60 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.
3. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).

CORROSIVITY

Results of water-soluble sulfate testing indicate that ASTM Type I or II portland cement should be specified for all project concrete on and below grade. Foundation concrete should be designed for low sulfate exposure in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

GENERAL COMMENTS

Our services are conducted with the understanding of the project as described in the proposal, and will incorporate collaboration with the design team as we complete our services to verify assumptions. Revision of our understanding to reflect actual conditions important to our services will be based on these verifications and will be reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the geotechnical conditions in the area, the data obtained from our site exploration and from our understanding of the project. Variations will occur between exploration point locations, 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. Terracon should be retained as the Geotechnical

Engineer, where noted in the final report, to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

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

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes only. 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.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

The field exploration program consisted of the following:

Number of Borings	Boring Depth (feet) [1]	Location
1	60 or auger refusal	Planned tower area

Boring Layout and Elevations: We used handheld GPS equipment to locate the boring with an estimated horizontal accuracy of +/-20 feet. Elevations were established using an on-site temporary benchmark.

Subsurface Exploration Procedures: We advanced the boring with a truck-mounted rotary drill rig using continuous-flight augers (solid-stem and/or hollow-stem as necessary depending on soil conditions). Three samples were obtained in the upper 10 feet of the boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is 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 log at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring lined sampler is used for sampling. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, the boring was backfilled with auger cuttings after completion.

Our exploration team prepared a field boring log as part of standard drilling operations including sampling depths, penetration distances, and other relevant sampling information. A field log includes visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring log, prepared from the field log, represents the geotechnical engineer's interpretation, and include modifications based on observations and laboratory tests.

Property Disturbance: We backfilled the boring with auger cuttings after completion. Our services do not include repair of the site beyond backfilling our borehole. Because backfill material often settles below the surface after a period, we recommend the borehole is checked periodically and backfilled, if necessary. We can provide this service, or grout the borehole for additional fees, at your request.

Laboratory Testing

The project engineer reviews field data and assigns various laboratory tests to better understand the engineering properties of various soil and rock strata. Exact types and number of tests cannot be defined until completion of field work. Testing is performed under the direction of a geotechnical engineer and included the following:

- Visual classification
- Moisture content
- Dry density
- Atterberg limits
- Grain-size analysis
- Consolidation/swell
- Water-soluble sulfates

Laboratory testing is conducted in general accordance with applicable or other locally recognized standards.

Our laboratory testing program often includes examination of soil samples by an engineer. Based on the material's texture and plasticity, we describe and classify soil samples in accordance with the Unified Soil Classification System (USCS).

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION

Proposed Radio Tower ■ Grover, Colorado
April 16, 2018 ■ Terracon Project No. 20175082

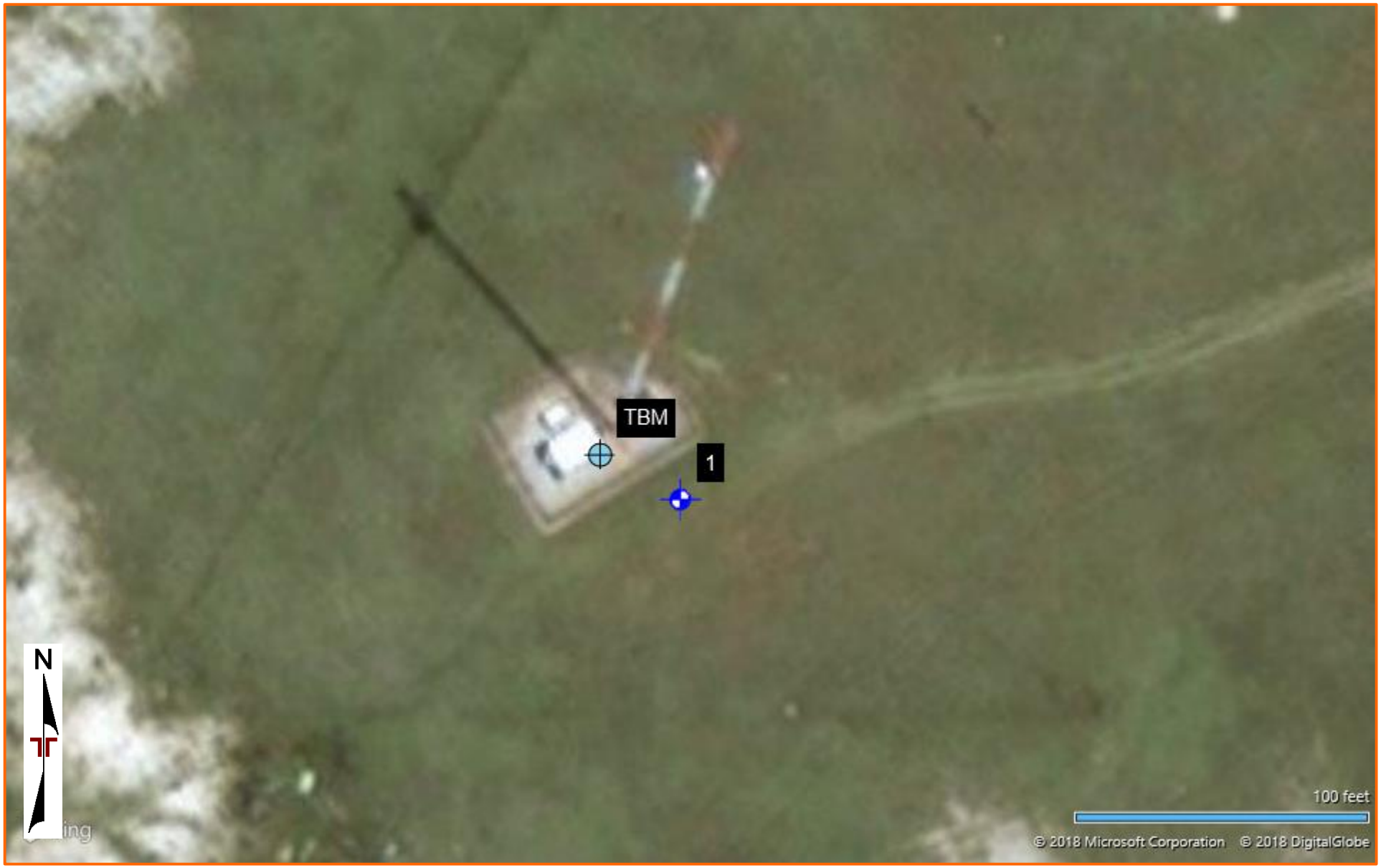
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: GROVER NE, CO (1997).

EXPLORATION PLAN

Proposed Radio Tower ■ Grover, Colorado

April 16, 2018 ■ Terracon Project No. 20175082



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AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. 1

PROJECT: Grover Tower

CLIENT: Communication Infrastructure Corporation
Austin, TX

SITE: Southwest of CR 128 and CR 105
Weld County, CO

LOCATION See Exploration Plan

Latitude: 40.9133° Longitude: -104.0899°

Surface Elev.: 299.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	SWELL-CONSOL /LOAD (%/psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.7	299									
VEGETATIVE LAYER, about 8 inches										
SILT WITH SAND, light brown, brown, medium stiff					2-2-2 N=4		12		33-28-5	72
					3-5	-1.9/1000	10	82		
6.0	293.5	5								
SILTY SAND, fine grained, light brown, tan, medium dense to very dense Cemented layer at a depth of about 6 to 8 feet		10			15-27-27 N=54		6			
		15			12-28		6	114		
		20			10-16-20 N=36		6		NP	24
Gravel content in sample at a depth of about 24 feet		25			12-16-16 N=32		7			
		30			28-34-20 N=54		6			
		35			50/2"		9			
		40			29-23-21 N=44		13		24-23-1	41
		45			21-26-28 N=54		6			
Cemented layer at a depth of about 49 to 50 feet		50			50/0.5"		1			
		55			23-26-32 N=58		6		NP	38
59.4	240									
Boring Terminated at 59.4 Feet					50/5"					

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

Hammer Type: Automatic

Advancement Method:
4" Continuous Flight Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Supporting Information for explanation of symbols and abbreviations.

Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
1901 Sharp Point Dr Ste C
Fort Collins, CO

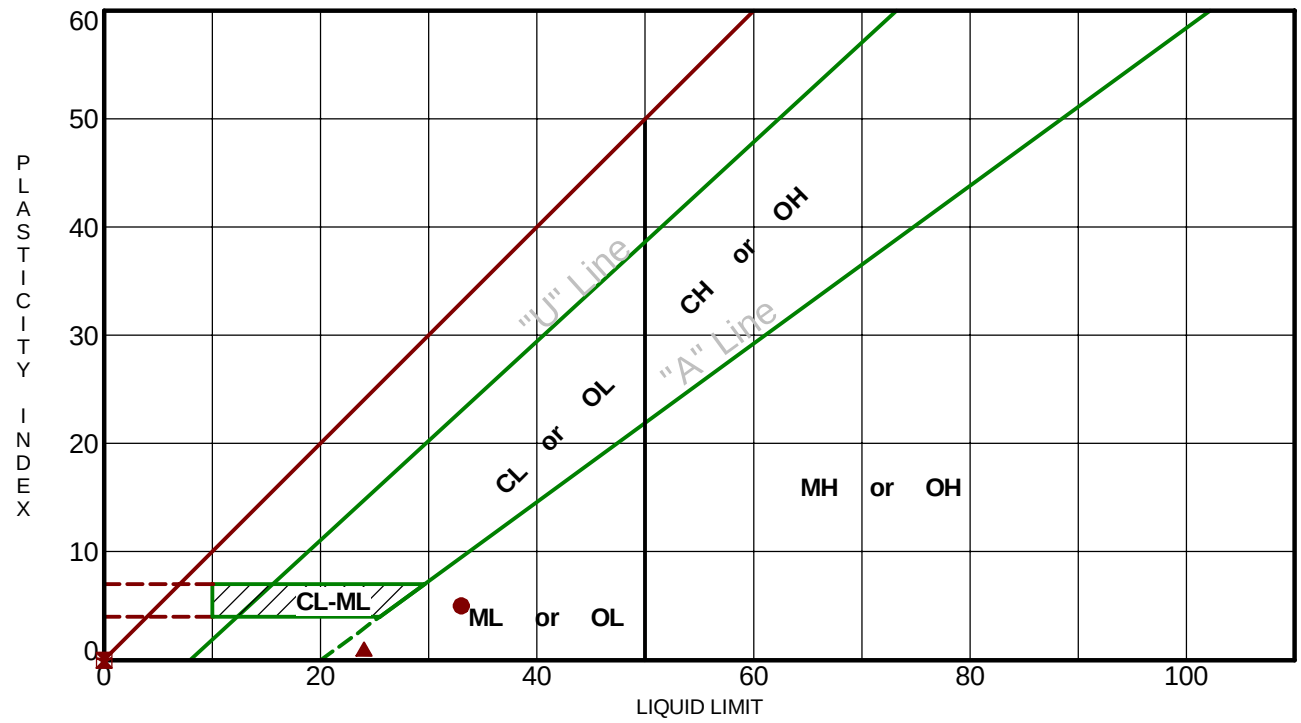
Boring Started: 03-30-2018 | Boring Completed: 03-30-2018

Drill Rig: CME 75 | Driller: Drilling Engineers, Inc.

Project No.: 20175082

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth	LL	PL	PI	Fines	USCS	Description
●	1	2 - 3.5	33	28	5	72	ML	SILT with SAND
⊠	1	19 - 20.5	NP	NP	NP	24	SM	SILTY SAND
▲	1	39 - 40.5	24	23	1	41	SM	SILTY SAND
★	1	54 - 55.5	NP	NP	NP	38	SM	SILTY SAND

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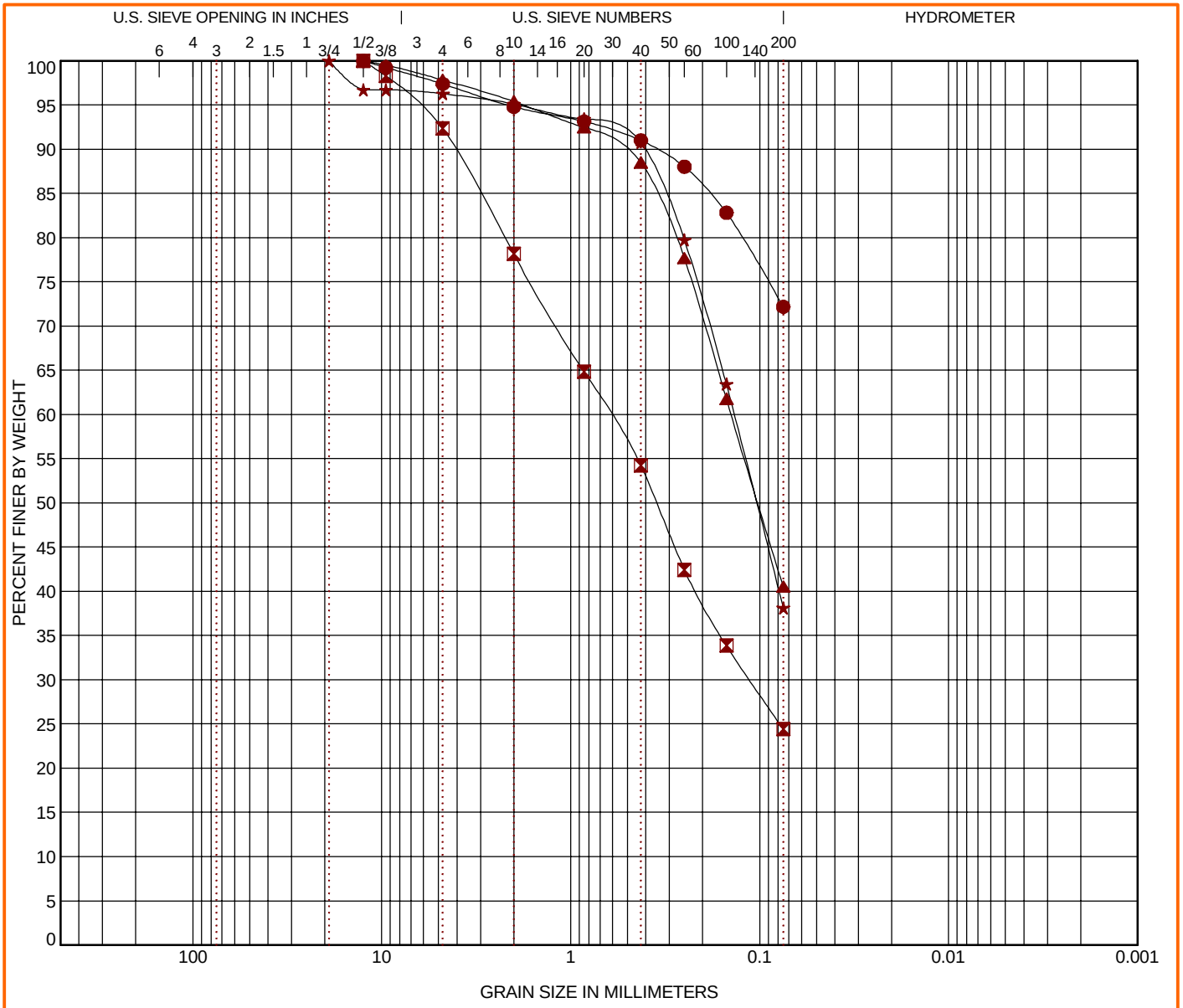
GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	1	2 - 3.5	SILT with SAND (ML)	12	33	28	5		
⊠	1	19 - 20.5	SILTY SAND (SM)	6	NP	NP	NP		
▲	1	39 - 40.5	SILTY SAND (SM)	13	24	23	1		
★	1	54 - 55.5	SILTY SAND (SM)	6	NP	NP	NP		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	1	2 - 3.5	12.5				2.6	25.2		72.2	
⊠	1	19 - 20.5	12.5	0.62	0.113		7.6	67.9		24.4	
▲	1	39 - 40.5	12.5	0.141			2.2	57.3		40.5	
★	1	54 - 55.5	19	0.137			3.7	58.2		38.1	

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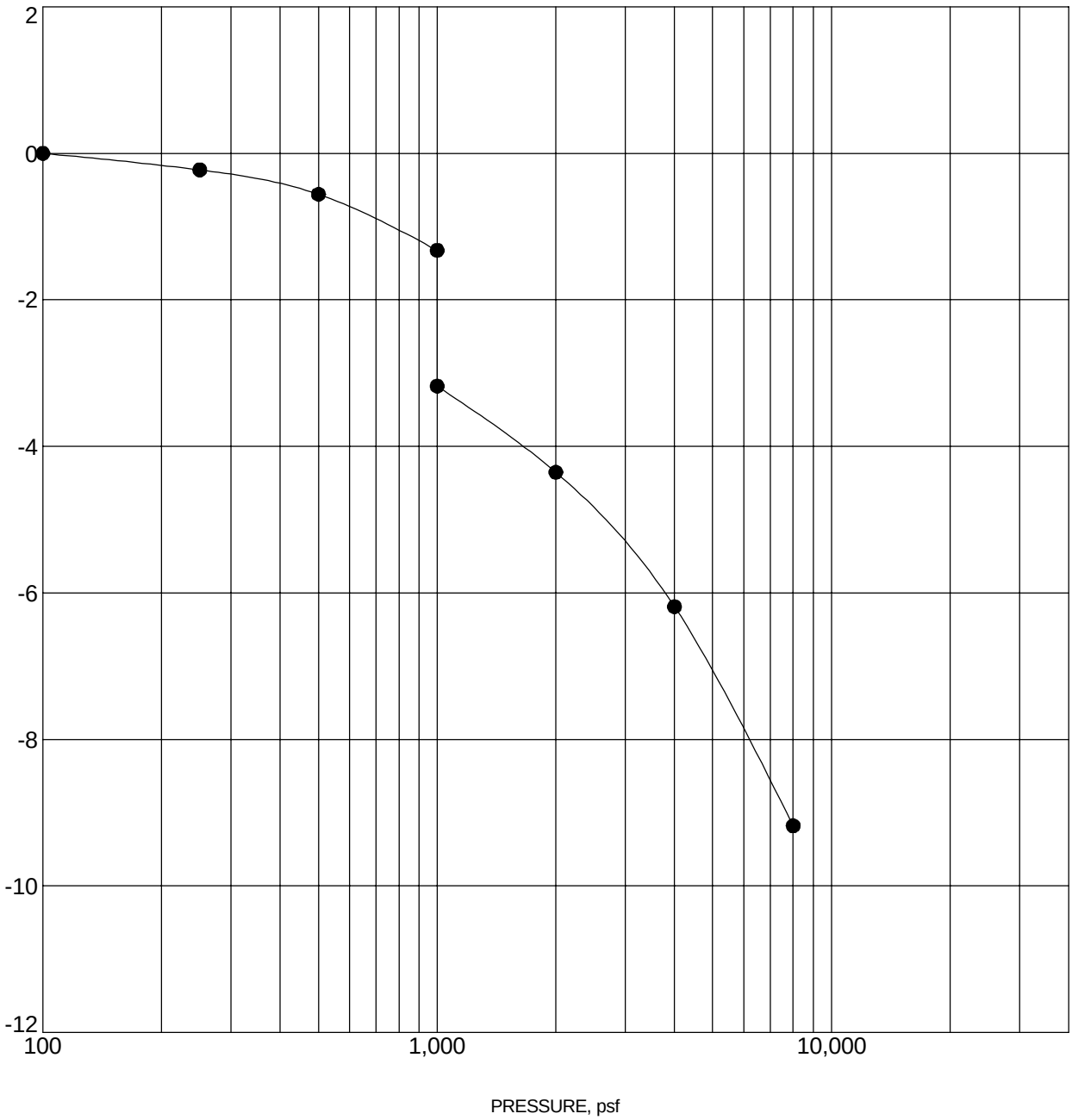
Austin, TX

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 20175082 PROPOSED RADIO TO.GPJ TERRACON_DATATEMPLATE.GDT 4/10/18

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	1	4 - 5 ft	SILT WITH SAND	96	10

NOTES: Sample exhibited 1.9 percent compression upon wetting at 1000 psf.

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CHEMICAL LABORATORY TEST REPORT

Project Number: 20175082
Service Date: 04/09/18
Report Date: 04/13/18
Task:

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

Client

Communication Infrastructure Corporation

Project

Grover Tower

Sample Submitted By: Terracon (20) **Date Received:** 4/5/2018 **Lab No.: 18-0385**

Results of Corrosion Analysis

Sample Number	
Sample Location	1
Sample Depth (ft.)	4
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	47

Analyzed By: Trisha Campo

Trisha Campo
Chemist

SUPPORTING INFORMATION

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Grover Tower ■ Weld County, CO

4/16/2018 ■ Terracon Project No. 20175082

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Modified Dames & Moore Ring Sampler Standard Penetration Test	**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.	**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, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	> 99	Very Stiff	4,000 to 8,000	15 - 30
			Hard	> 8,000	> 30

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

Grover Tower ■ Weld County, Colorado

April 13, 2018 ■ Terracon Project No. 20175082

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 ≥ 4 and 1 ≤ Cc ≤ 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 ≥ 6 and 1 ≤ Cc ≤ 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"		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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.