Geotechnical Engineering Report

Town & Country Land Co. Greenhouse
5012 Copeland Circle
Colorado City, Colorado
April 4, 2015
Project No. B8155003

Prepared for:
Town and Country Land Co.
Denver, Colorado

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

April 4, 2015

Town and Country Land Co.
3600 South Yosemite Street, Suite 1000
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Attn: Mr. Trent Cunningham

Re: Geotechnical Engineering Report
Town & Country Land Co. Greenhouse
5012 Copeland Circle
Colorado City, Colorado
Terracon Project Number: B8155003

Terracon Consultants, Inc. (Terracon) has performed geotechnical engineering services for the above referenced project. This study was performed in general accordance with our Proposal No. D2315021, dated February 2, 2015. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs 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

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EXECUTIVE SUMMARY

A geotechnical investigation has been performed for the proposed Town & Country Land Co. Greenhouse, located at 5012 Copeland Circle in Colorado City, Colorado. Six test borings were advanced to depths of approximately 9 to 20 feet below the ground surface within the general vicinity of the proposed building areas. Two bulk samples were also obtained from an existing on-site stockpile of soils. The following geotechnical considerations were identified:

- Expansive soils and bedrock are present on this site. These materials are prone to volume change, particularly with increased water. This report provides recommendations to help mitigate the effects of soil and bedrock expansion.

- On-site soils are not considered suitable for reuse as engineered fill beneath foundations and slabs. On-site soils may be reused in non-structural areas.

- Imported soils meeting the gradation presented herein are also considered suitable for use as compacted fill.

- The 2009 International Building Code, Table 1613.5.2 IBC seismic site classification for this site is C.

- 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.

GEOTECHNICAL ENGINEERING REPORT
TOWN & COUNTRY LAND CO. GREENHOUSE
5012 COPELAND CIRCLE
COLORADO CITY, COLORADO

Project No. B8155003
April 4, 2015

1.0 INTRODUCTION

A geotechnical investigation has been performed for the proposed Town & Country Land Co. Greenhouse, located at 5012 Copeland Circle in Colorado Springs, Colorado. Six test borings were advanced to depths of approximately 9 to 20 feet below the ground surface within the general vicinity of the proposed building areas. Two bulk samples were also obtained from an existing stockpile of soils at the site. Boring logs along with a Boring Location Plan are included in Appendix A of this report.

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

- subsurface soil and bedrock conditions
- groundwater conditions
- foundation design and construction
- floor slab design and construction
- earthwork
- drainage

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	See Appendix A, Exploration Plan
Proposed development	The proposed project consists of the construction of a single-story greenhouse that will have a footprint of about 60,000SF. A proposed single-story warehouse with a footprint of about 18,000SF will also be constructed directly east of the greenhouse.
Building construction	Warehouse: We anticipate clear span, pre-manufactured and metal-frame construction will be utilized. The floor is anticipated to be slab-on-grade. Greenhouse: Reportedly metal frame with glass roof and walls. The earthen floor will be lined with an HDPE material to collect irrigation water. The liner is anticipated to be replaced annually.

ITEM	DESCRIPTION
Anticipated foundations	Warehouse: Reinforced concrete shallow spread footings. Greenhouse: Shallow, reinforced concrete drilled piers approximately 3 to 4 feet deep.
Finished floor elevation	We anticipate finished floor within four feet of existing grades
Maximum loads	The following are assumed maximum loads based on experience with similar projects: ■ Columns: 40 to 80 kips (assumed) ■ Walls: 1 to 3 klf (assumed) ■ Greenhouse column posts: 5 to 15 kips (assumed) ■ Slabs: 150 psf max (assumed)
Grading	We anticipate up to five feet of grading will be necessary to achieve finished construction grades.
Cut and fill slopes	Assumed to be no steeper than 4H:1V (Horizontal to Vertical)
Proposed free standing retaining walls	Retaining walls are not reported as part of the construction.
Below grade structures	Not reported as part of site development.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The project site is located at 5012 Copeland Circle, Colorado City, Colorado.
Existing improvements / ground cover	The site is currently undeveloped with the exception of stockpiled soil along the western portion of the site, measuring approximately 325 to 350 feet long by 225 to 250 feet wide by 13 to 15 feet in height. Additionally, end dumped fill piles approximately 150 to 175 feet in length by 100 to 125 feet in width by 8 to 10 feet in height was observed within the central portion of the site. Ground cover consisted of a moderate amount of native grasses and weeds.
Existing topography	The site was relatively flat to gently sloping downward to the east.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

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

Description	Approximate Depth to Bottom of Stratum	Material Encountered	Consistency/Density
Stratum 1	5½ to 14 feet	Clay with varying amounts of sand	Very stiff to hard
Stratum 2	6 to 14 feet (Borings B-2 & B-4)	Weathered claystone and sandstone bedrock	Medium hard
Stratum 3	9 to 20 feet	Claystone and sandstone bedrock	Hard to very hard

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 and bedrock types; 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.

Laboratory test results indicate that the clay and claystone samples tested exhibit low compression at in-situ water contents. When elevated in water content, the clay and claystone samples tested exhibit moderate expansion potential and low to moderate compression at increased loading. It is our opinion that the on-site clays and claystone should be considered to have moderate to high expansive potential.

Two soil samples were obtained at the north and south ends of the stockpile at the approximate locations shown on the Exploration Plan, Exhibit A-2. Test results indicate the soils within the stockpile have moderate plasticity and a high amount of fines material.

The following table lists the results of laboratory compaction testing performed on bulk samples of materials collected from the on-sit soil stockpile. Testing was performed in general accordance with ASTM D698.

Laboratory Compaction Characteristics Test Results

Maximum Laboratory Dry Density (pcf)	Optimum Water Content (%)
106.8	17.2

Bulk samples collected from the soil stockpile were remolded to about 95 percent of the referenced maximum dry density at optimum water content. The samples were then inundated with water while at a surcharge pressure of 200 and 500 psf. The results are shown below:

Remolded Swell Test Results

Surcharge Pressure	Remolded Swell/Consolidation at Optimum (+/-) (%)	
200 psf	+3.0	+4.2
500 psf	+1.0	+1.9

3.2 Groundwater

Groundwater was not encountered at the time of field 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.

Our borings were backfilled upon completion due to site safety concerns. 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.

4.0 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 project.

As mentioned, an existing stockpile of soil measuring approximately 300 feet long by 100 feet wide by 15 feet in height was noted within the western portion of the site. Reportedly, the stockpile of fill was derived from grading activities on the property directly to the south of the subject property. At our client's request, Terracon obtained surficial samples of the stockpile at two locations. The surficial soils of the stockpile appear similar to those encountered within our borings and visually classify as lean clay based on the Unified Soil Classification System (USCS.) Based on the stockpile soils appearing similar to the on-site clay soils, and the results

of lab testing of the on-site soils, the on-site stockpile is not considered suitable for reuse as compacted fill within the greenhouse or warehouse building areas. The end-dumped fill material present on site may be used, provided the material is processed to a soil-like consistency and meets the recommendations in Section 4.2.2 of this report.

Expansive soils and bedrock are present on this site. This report provides recommendations to help mitigate the effects of soil and bedrock shrinkage and expansion. However, even if these procedures are followed, some movement and at least minor cracking in the structure should be anticipated. The severity of cracking and other cosmetic damage such as uneven slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and cosmetic distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction.

All grades must provide effective drainage away from the structures during and after construction. Water permitted to pond next to the structures can result in greater foundation movements than those discussed in this report. Estimated movements described in this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained.

Exposed ground should be sloped at a minimum 10 percent away from the structures for at least 10 feet beyond the perimeter of the structures. After construction, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

Due to the presence of expansive soils and bedrock, we recommend the proposed warehouse structure be supported on imported, newly placed, compacted fill. Movement tolerances for the proposed greenhouse were not provided to Terracon at the time of report preparation. We have provided several alternatives for the proposed greenhouses, depending on movement tolerances.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined herein. The recommendations contained in this report are based upon the results of data presented herein, engineering analyses, and our current understanding of the proposed project.

4.2 Earthwork

4.2.1 Site Preparation

All vegetation, existing fill material, and any otherwise unsuitable material should be removed from planned fill areas and proposed building improvements. The subgrade should be proof-rolled where possible or probed with a metal T-probe to aid in locating loose or soft areas.

Proof-rolling can be performed with a loaded tandem axle dump truck. Soft, dry and low-density soil should be removed or compacted in place prior to placing fill.

Although evidence of underground facilities such as septic tanks, cesspools, and basements, 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, CH	The on-site soils are not considered suitable for reuse as engineered fill within 3 feet of the bottom of foundations and within 4 feet of the bottom of slabs. The on-site soils may be reused at depths greater than 3 feet from the bottom of foundations and at depths greater than 4 feet from the bottom of slabs. On-site soils and soils within the on-site stockpile may also be re-used in non-structural areas.
On-Site Bedrock	Claystone	The on-site claystone bedrock is not considered suitable for reuse as engineered fill beneath foundations and slabs. On-site claystone bedrock may be re-used in non-structural areas provided it is processed to a soil-like consistency and materials greater than 3 inches are removed.
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 should conform to the following:

Gradation	Percent finer by weight (ASTM C136)
3”	100
No. 4 Sieve	50-100
No. 200 Sieve	25-60

- Liquid Limit……30 (max)
- Plastic Index……..10 (max)

- Maximum Expansive Potential (%)……..1.0*

*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 200 psf surcharge and submerged.

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) for foundations and slabs.
Water Content [2]	Two percent below to three percent above optimum (cohesionless and cohesive sand soils) Optimum to three percent above optimum (clay soils)

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.

4.2.4 Grading and Drainage

All grades must be adjusted to provide positive drainage away from the structure during construction and maintained throughout the life of the proposed project. Infiltration of water into utility or foundation excavations must be prevented during construction. Landscaped irrigation adjacent to foundation systems should be minimized or eliminated. 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.

Exposed ground should be sloped at a minimum of 10 percent grade for at least 10 feet beyond the perimeter of the building, where possible. Where ADA or other requirements or existing site features limit the gradient, slopes on the order of ½ to 1 percent minimum are considered acceptable. Backfill against footings, exterior walls and in utility line trenches should be well compacted and free of all construction debris to reduce the possibility of water infiltration. After building 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.

Consideration should be given to snow removal practices that will minimize the stockpiling of snow adjacent to structural improvements. Roof drains should be extended away from the structure a minimum of 5 feet through the use of splash blocks or downspout extensions. A preferred alternative is to have the roof drains discharge to storm sewers by solid pipe or other appropriate outfall.

4.2.5 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. 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 and pavements. 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 recompacted prior to floor slab and pavement 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.

4.3 Foundation Systems

4.3.1 Warehouse Spread Footing Design Recommendations

Spread footing foundations supported on newly placed, compacted fill, are considered suitable for support of the proposed office building. Additional design recommendations are presented in the table below:

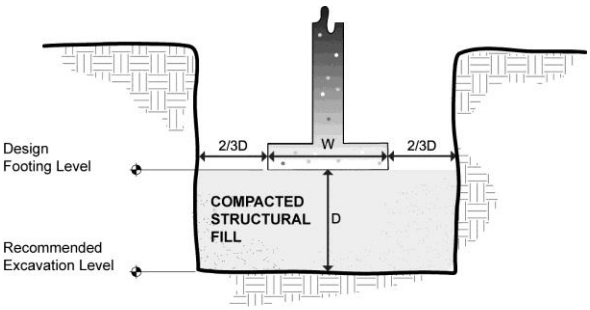
DESCRIPTION	Column	Wall
Net allowable bearing pressure [1]	3,000 psf	3,000 psf
Minimum dimensions	24 inches	16 inches
Minimum amount of compacted fill beneath footings	6 feet	6 feet
Minimum embedment below finished grade for frost protection [2]	30 inches	30 inches
Approximate total movement [3]	1 inch	1 inch
Estimated differential movement [3]	½ to ¾ of total between columns	½ to ¾ of total over 40 feet
Coefficient of friction at base of foundation	0.35	0.35

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes fill or unsuitable soils, if encountered, will be undercut and replaced with engineered fill.
2. For exterior foundations beneath continuously heated structures, depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure. The minimum depth for interior footings in continuously heated structures is 12 inches below finished grade.
3. The foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, the quality of the earthwork operations, and maintaining uniform soil water content throughout the life of the structure. The estimated movements are based on maintaining uniform soil water content during the life of the structure. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage and irrigation practices should be incorporated into the design and operation of the facility. Failure to maintain soil water content and positive drainage will nullify the movement estimates provided above.

The on-site soils are not considered suitable for reuse as engineered fill within 3 feet of the bottom of foundations. The on-site soils may be reused at depths greater than 3 feet from the bottom of foundations. The upper 3 feet of fill materials beneath foundations should consist of imported soils that meet the recommendations contained in this report.

4.3.2 Construction Considerations

The base of all foundation excavations should be free of water and loose soil and rock prior to placing concrete. If unsuitable soils are encountered at the base of the over-excavation, supplemental recommendations will be required, such as additional removal and replacement. Over-excavation for compacted backfill placement below footings should extend laterally beyond all edges of the footings at



Overexcavation / Backfill

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

least 8 inches per foot of overexcavation depth below footing base elevation.

Fill should be placed in lifts of 8 inches or less in loose thickness and compacted to at least 95 percent of the material's maximum dry density (ASTM D698). Compactive effort should be in accordance with recommendations provided in the **EARTHWORK** section of this report. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed or saturated, or frozen, the affected soil should be removed prior to placing concrete. It is recommended that a construction testing laboratory be retained to observe and test the soil foundation bearing materials.

4.3.3 Spread Footing Uplift Considerations

The soil mass providing uplift resistance for the foundations should be calculated as the zone contained within planes that extend up and out from the edges of the top of the foundations to the ground surface at an angle of approximately 30 degrees from vertical. The base of the inverted cone may be assumed to extend from the top of the foundation if the footing sides are vertical. The ultimate uplift capacity should then be taken as the sum of the weight of soil in this zone plus the weight of the concrete footings. Effective unit weights of 110 pcf for compacted on-site soils and 145 pcf for reinforced concrete can be used for these calculations. Soils should be compacted as outlined in the “Earthwork” and “Compaction Requirements” sections of this report. The ultimate combined uplift capacity should then be divided by a factor of safety of at least 3.0 to obtain the allowable uplift capacity.

4.3.5 Greenhouse Shallow Drilled Pier Foundation Design Recommendations

Reportedly, the proposed greenhouse is planned to be supported on a shallow drilled pier foundation system. Depending on the movement tolerances of the greenhouse structure, we have provided several alternatives for support. For this project, we recommend the following:

DESCRIPTION	STRAIGHT SHAFT PIERS		
Minimum pier diameter	10 inches		
Pier concrete slump (uncased piers)	5 to 7 inches		
Pier concrete slump (cased piers)	7 to 9 inches		
Minimum pier length	3 feet	3 feet	3 feet
Approximate total movement [1]	1 inch, when bearing on 6 feet of compacted fill. The fill should extend laterally 6 feet beyond the edge of piers.	2 to 4 inches, when piers are placed in 4 feet of compacted fill. The fill should extend 1 foot below bearing level and 3 feet laterally beyond the edge of piers.	Greater than 4 inches, If placed in undisturbed soils or bedrock

DESCRIPTION	STRAIGHT SHAFT PIERS
1.	The foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the quality of the earthwork operations, and maintaining uniform soil water content throughout the life of the structure. The estimated movements are based on maintaining uniform soil water content during the life of the structure. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage and irrigation practices should be incorporated into the design and operation of the facility. Failure to maintain soil water content and positive drainage will nullify the movement estimates provided above.

A summary of the drilled pier foundation design recommendations is shown in the table on the following page. The maximum end bearing pressures given in the table are based on the cross-sectional area of the tip of the drilled shaft. Skin friction (S_d) should be applied to the surface area of the drilled shaft for that given length interval below a depth of 36 inches. The combination of skin friction and end bearing pressure can be used to determine the vertical compression capacity. The skin friction value should be used to determine the uplift capacity of the soil. 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 strain of 1 percent for soils and ½ percent for bedrock acting over a distance of one shaft diameter. The passive pressure, coefficient of horizontal subgrade reaction, and LPILE parameters are ultimate values; therefore, appropriate factors of safety should be applied in the pier design. Shafts should be reinforced full-depth for the applied axial, lateral and uplift stresses imposed.

DESCRIPTION	MATERIAL TYPE AND DEPTH, FEET	
	Clay **3 to 14 feet**	**Bedrock** **14 to 20 feet**
Allowable Vertical Parameters:		
Bearing, psf	3,000[1]	20,000[2]
Skin Friction, psf	250	1,000
Lateral Parameters		
Beam on Elastic Foundation: **Passive, EFP,psf/ft**	200	450
Soil Code	3 (Stiff clay without free water)	9 (Weak rock)
In-situ Unit Weight (pci)	0.058	0.075
Undrained Shear Strength, Cu (psi)	10	100
Horizontal Modulus of Subgrade Reaction:		
k (static) pci	500	2,000
k (cyclic) pci	200	800
Strain at 50% of Maximum Stress, ε_{50}	0.007	---

[1]Minimum bearing depth of 6 feet below site grade.
[2]Minimum 5-foot embedment into bedrock.

We recommend neglecting skin friction and lateral resistance for the upper 36 inches of drilled piers because of the effects of frost penetration.

For reinforcing design, the tensile force on each pier can be determined on the basis of the following equation:

$$U_p = 30 \times D$$

Where: U_p = the uplift force in kips, and
D = the pier diameter in feet

Uplift forces on piers should be applied to the upper 12 feet of the subsurface profile resisted by a combination of dead-load and pier penetration below a depth of 12 feet.

4.3.4 Drilled Pier Construction Considerations

Drilling to design depths should be possible with single-flight power augers equipped with rock teeth. Difficult drilling should be anticipated due to the presence of very hard bedrock. Specialized drilling equipment may be required to penetrate the very hard bedrock. Pier concrete should be placed soon after completion of drilling and cleaning. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

A tremie or casing should be used for concrete placement. If casing is used for pier construction, it should be withdrawn in a slow, continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or the creation of voids in pier concrete. Pier concrete should have a relatively high fluidity when placed in cased pier holes or through a tremie.

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. Shaft bearing surfaces must be free of loose materials prior to concrete placement.

4.4 Seismic Considerations

Code Used	Site Classification
2009 International Building Code (IBC) [1]	C[2]
Mapped Spectral Acceleration for Short Periods, S_s [2]	0.212
Mapped Spectral Acceleration for a 1-second period, S_1 [2]	0.071

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 20 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. USGS Seismic Hazard Curves, Response Parameters and Design Parameters

4.5 Floor Slab

4.5.1 Design Recommendations

ITEM	DESCRIPTION
Floor slab support[1]	We recommend concrete floor slabs be supported on a minimum of 6 feet of newly placed, compacted fill. The on-site soils are not considered suitable for reuse as engineered fill within 4 feet of the bottom of slabs. The on-site soils may be reused at depths greater than 4 feet from the bottom of foundations. The upper 4 feet of fill materials beneath slabs should consist of imported soils that meet the recommendations contained in this report.

1. We recommend subgrades be maintained at the proper moisture condition until floor slabs and pavements are constructed. If the subgrade should become desiccated prior to construction of floor slabs and pavements, the affected material should be removed or the materials scarified, moistened, and recompacted. Upon completion of grading operations in the building areas, care should be taken to maintain the recommended subgrade moisture content and density prior to construction of the building floor slabs.

Where appropriate, saw-cut control joints should be placed in the slab to help control the location and extent of cracking. The use of a vapor retarder should be used directly beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

4.5.2 Construction Considerations

We recommend subgrades be maintained at the proper moisture condition until floor slabs and are constructed. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier, areas where backfilled trenches are located, as well as the backfill zone adjacent to the existing structure. Areas where unsuitable conditions are located should be repaired by removing and replacing the affected material with properly compacted fill. All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the base rock and concrete.

4.6 Exterior Slabs

Exterior slabs-on-grade, exterior architectural features, and utilities founded in backfill may experience some movement due to the volume change of the material. We recommend exterior slabs be supported on a minimum of 12 inches of scarified, water conditioned, and re-compacted fill. Additional recommendations to reduce potential movement are as follows:

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

4.7 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
B-2	0.076	0.0131	531	7.4

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.

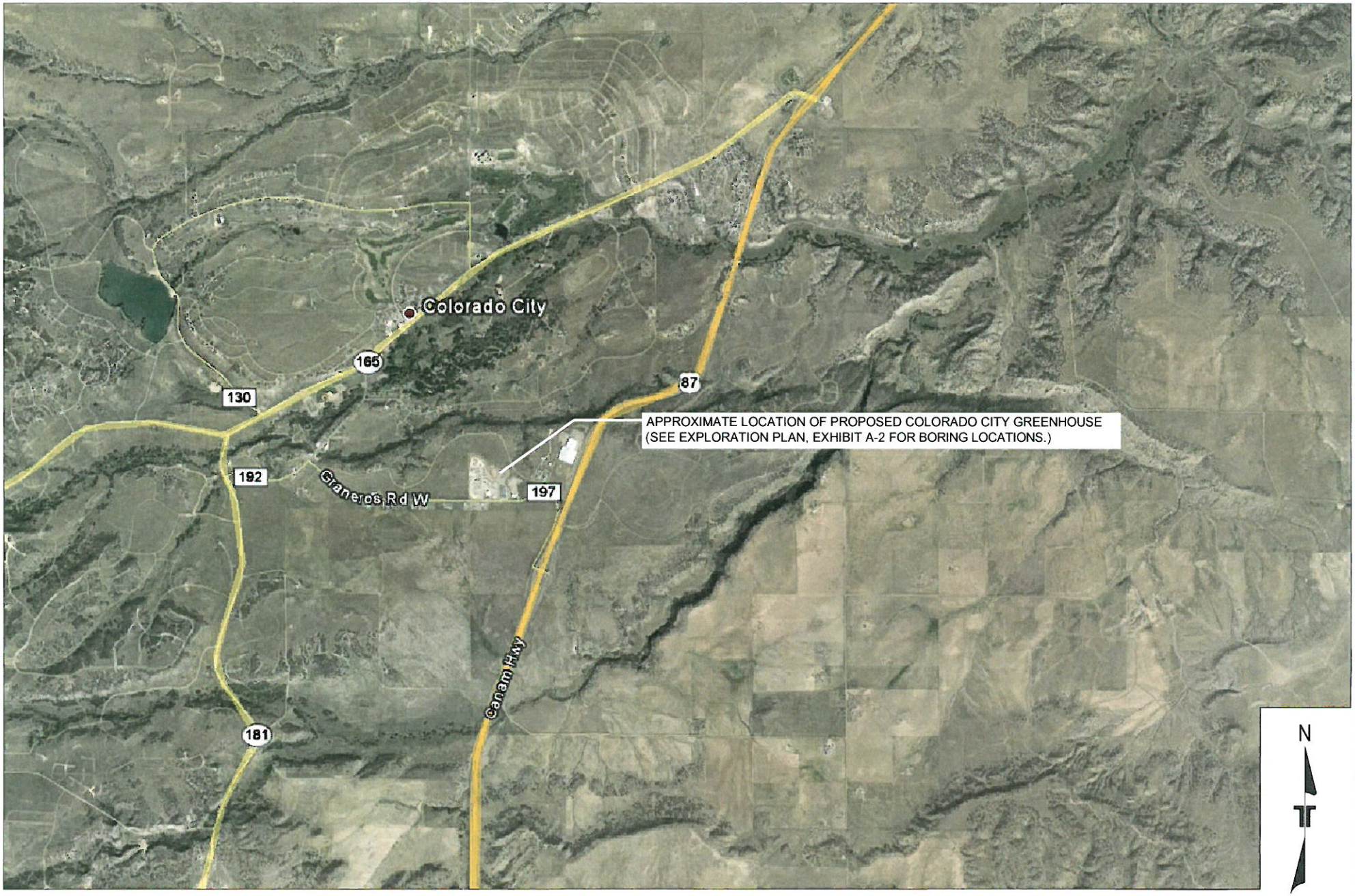
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the 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 JANUARY 20, 2015, 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.	B8155003
Scale:	NOT TO SCALE
File No.	Fig1-SVD
Date:	02-18-2015

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

SITE VICINITY PLAN

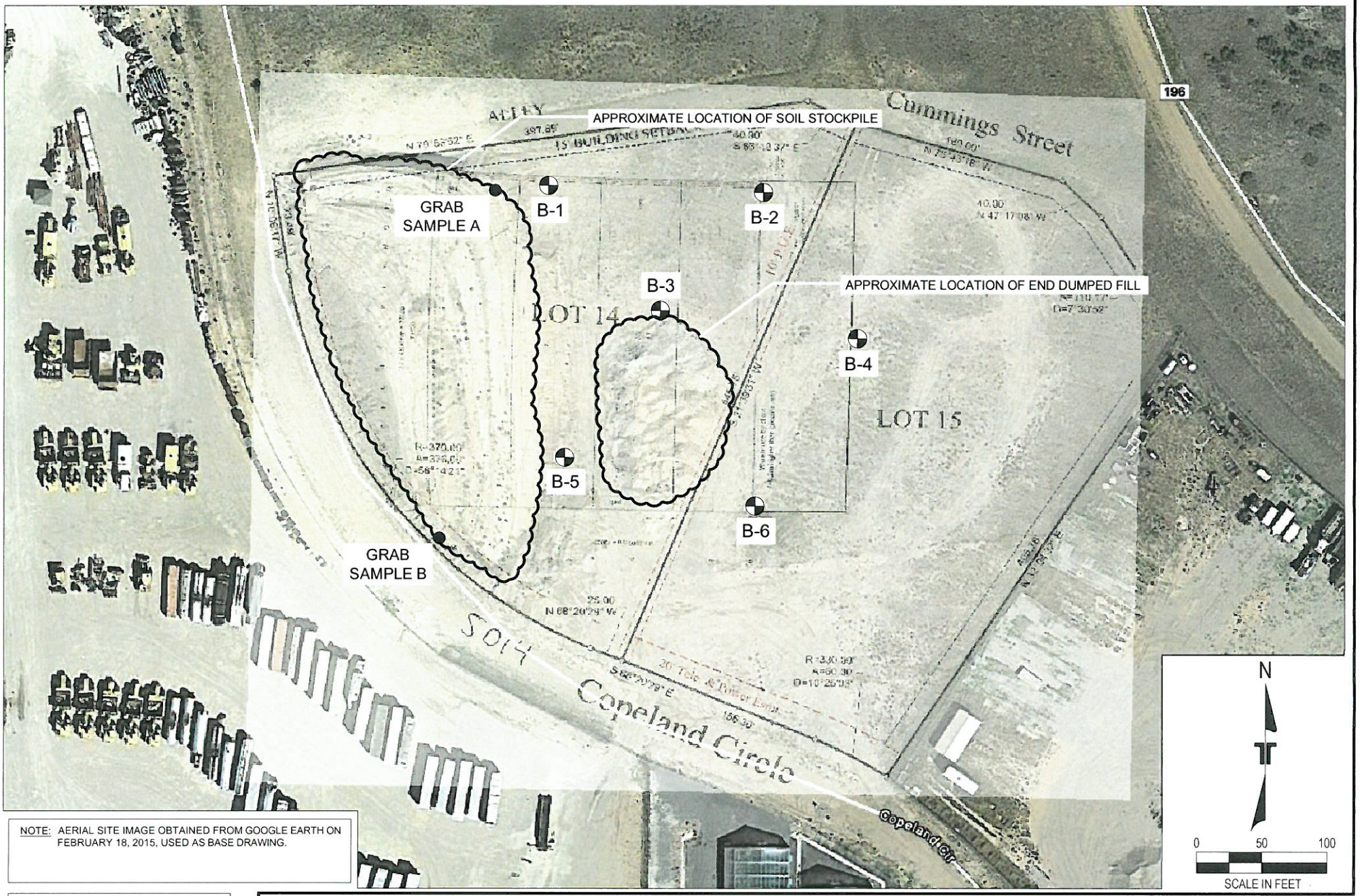
Town & Country Land Co.

COLORADO CITY GREENHOUSE

5012 COPELAND CIRCLE

COLORADO CITY COLORADO

Ex. No. A-1



NOTE: AERIAL SITE IMAGE OBTAINED FROM GOOGLE EARTH ON FEBRUARY 18, 2015, USED AS BASE DRAWING.

LEGEND

B-1 APPROXIMATE LOCATION OF TEST BORING

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.	B8155003
Scale:	AS SHOWN
File No.	Fig1-BLP
Date:	02-18-2015

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

EXPLORATION PLAN WITH PROPOSED IMPROVEMENTS

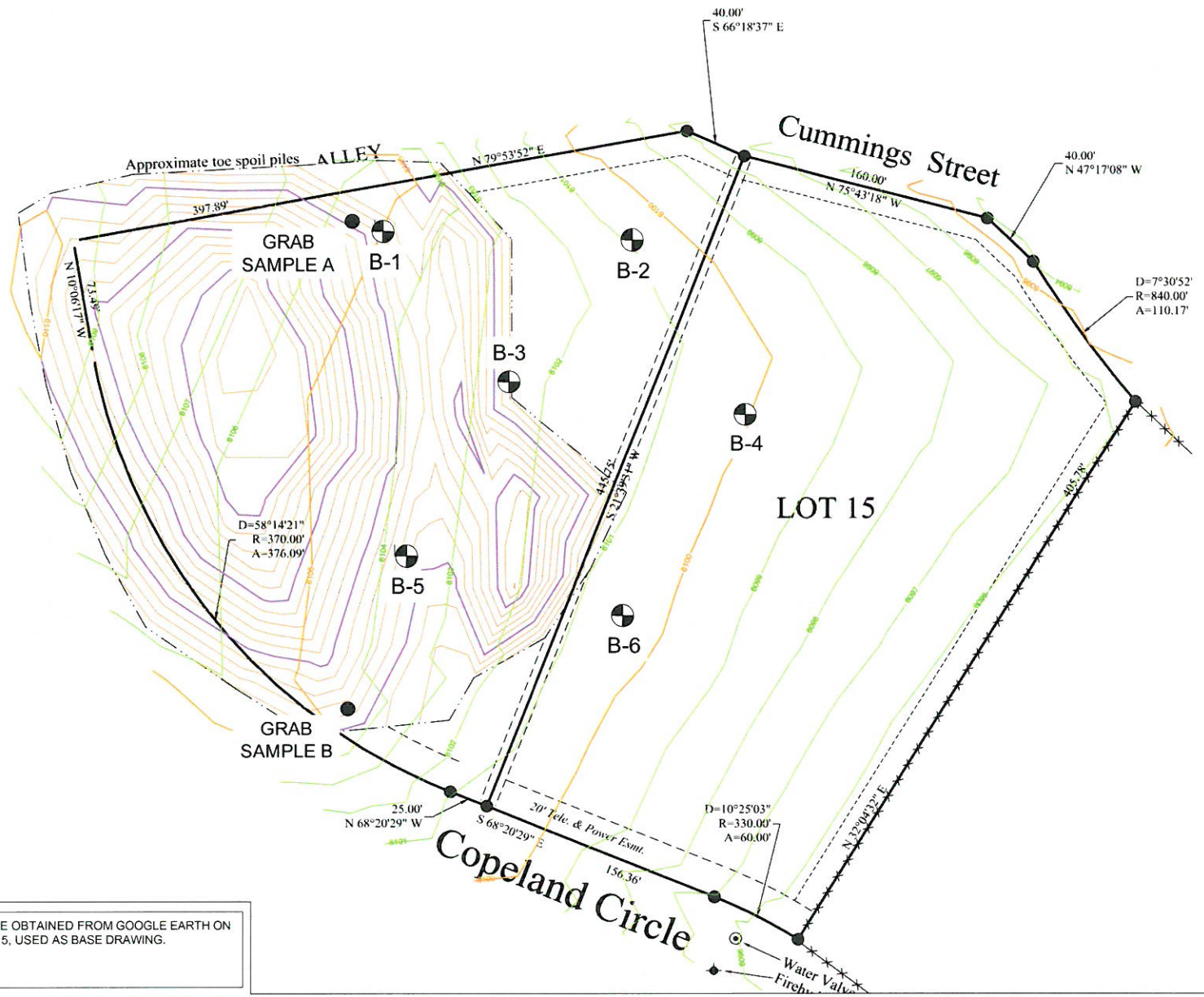
Town & Country Land Co

COLORADO CITY GREENHOUSE

5021 COPELAND CIRCLE

COLORADO CITY COLORADO

Ex. No. A-2



NOTE: AERIAL SITE IMAGE OBTAINED FROM GOOGLE EARTH ON FEBRUARY 18, 2015, USED AS BASE DRAWING.

LEGEND

B-1 APPROXIMATE LOCATION OF TEST BORING

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.	B8155003
Scale:	AS SHOWN
File No.	Fig1-BLP
Date:	02-18-2015

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

EXPLORATION PLAN WITH ON-SITE SOIL STOCKPILES

Town & Country Land Co

COLORADO CITY GREENHOUSE

5021 COPELAND CIRCLE

COLORADO CITY COLORADO

Ex. No. A-3

Field Exploration Description

Six test borings were advanced in the vicinity of the proposed building areas on February 10, 2015 to depths of approximately 9 to 20 feet below existing site grade at the approximate locations shown on the Exploration Plan, Exhibit A-2. The borings were advanced with a truck-mounted drilling rig, utilizing 4-inch diameter solid-stem auger.

The borings were located in the field by a handheld GPS device with typical horizontal accuracy within 20 feet. The accuracy of the 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 split-spoon and ring barrel samplers into the subsurface materials with a 140-pound hammer falling 30 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. Borings were backfilled with auger cuttings prior to leaving the site. Some settlement of the backfill should be anticipated.

BORING LOG NO. B-1

PROJECT: Colorado City Greenhouse

CLIENT: Town and Country Land Co.
Denver, Colorado

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

LOCATION See Exhibit A-2

Latitude: 37.9332° Longitude: -104.8266°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	LEAN CLAY (CL), brown, very stiff to hard							
				10-17	13	99		
	color change to light brown, with calcium deposits below 3 feet.							
5				12-17	10	96	43-21-22	91
				10-11	9	94		
	color change to dark brown below 8 feet.							
				20-32	14	114		
10								
14.0	**CLAYSTONE**, light brown, hard			23-50/5"	5	117		
15								
20.0				50/0"	1			
20	***Boring Terminated at 20 Feet***							

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

Hammer Type: Automatic

Advancement Method:
4-inch solid-stem auger

Abandonment Method:
Borings backfilled with soil cuttings 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: 2/10/2015 Boring Completed: 2/10/2015

Drill Rig: CME-75 Driller: Precision

Project No.: B8155003 Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Colorado City Greenhouse

CLIENT: Town and Country Land Co.
Denver, Colorado

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

LOCATION See Exhibit A-2

Latitude: 37.9332° Longitude: -104.8261°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDY LEAN CLAY (CL), brown, very stiff, with calcium deposits								
	3.0				12-15	10	87		
	LEAN CLAY (CL), brown, very stiff								
	5.0				20-18	9	93		
	SANDY LEAN CLAY (CL), brown to dark brown, very stiff, with calcium deposits	5							
	8.0				18-20	13	105	45-20-25	83
	WEATHERED CLAYEY SANDSTONE, light brown to brown, medium hard								
	very hard drilling at 14 feet.	10			13-32	15	104		
	14.0								
	SANDSTONE, light brown, hard				50/0"	14	106		
	15.5	15							
	Auger refusal at 15.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
4-inch solid-stem auger

Abandonment Method:
Borings backfilled with soil cuttings 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: 2/10/2015 Boring Completed: 2/10/2015

Drill Rig: CME-75 Driller: Precision

Project No.: B8155003 Exhibit: A-6

BORING LOG NO. B-3

PROJECT: Colorado City Greenhouse

CLIENT: Town and Country Land Co.
Denver, Colorado

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

LOCATION See Exhibit A-2

Latitude: 37.9329° Longitude: -104.8264°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	LEAN CLAY (CL), light brown, very stiff, with calcium deposits								
					10-8	9	83		
					12-19	9	101		
		5							
	7.0								
	CLAYSTONE, light brown, hard, with iron staining, weathered claystone observed in 7-foot sample.				20-50/4"	13	102		
					50/4"	14	89		
	sample disturbed at 9 feet, very hard drilling at 10 feet.	10							
	11.0								
	Auger refusal at 11 Feet				50/0"				

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

Hammer Type: Automatic

Advancement Method:
4-inch solid-stem auger

Abandonment Method:
Borings backfilled with soil cuttings 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: 2/10/2015 Boring Completed: 2/10/2015

Drill Rig: CME-75 Driller: Precision

Project No.: B8155003 Exhibit: A-7

BORING LOG NO. B-4

PROJECT: Colorado City Greenhouse

CLIENT: Town and Country Land Co.
Denver, Colorado

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

LOCATION See Exhibit A-2

Latitude: 37.9329° Longitude: -104.8259°

DEPTH	GRAPHIC LOG		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		LEAN CLAY (CL), light brown, very stiff, with calcium deposits								
						23-22	12	105		
						18-19	9	98		
6.0			5							
		WEATHERED SANDY CLAYSTONE, brown to dark brown, medium hard				22-38	13	113	44-18-26	83
9.0										
		CLAYSTONE, dark brown to gray, hard				50/2"	6	88		
		sample disturbed at 9 and 14 feet	10							
						50/2"	5			
19.0			15							
		Boring Terminated at 19 Feet				50/1"	3			

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

Hammer Type: Automatic

Advancement Method:
4-inch solid-stem auger

Abandonment Method:
Borings backfilled with soil cuttings 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: 2/10/2015 Boring Completed: 2/10/2015

Drill Rig: CME-75 Driller: Precision

Project No.: B8155003 Exhibit: A-8

BORING LOG NO. B-5

PROJECT: Colorado City Greenhouse

CLIENT: Town and Country Land Co.
Denver, Colorado

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

LOCATION See Exhibit A-2

Latitude: 37.9327° Longitude: -104.8266°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	LEAN CLAY (CL), brown, very stiff, with calcium deposits								
					12-11	16	88		
					13-13	10	99		
		5							
					18-16	14	107		
	9.0								
	CLAYSTONE, dark brown and gray, hard to very hard				33-50/5"	29			
	sample disturbed at 9 feet.	10							
					50/5"	7	107		
	19.0	15							
	Boring Terminated at 19 Feet				50/1"	3			

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

Hammer Type: Automatic

Advancement Method:
4-inch solid-stem auger

Abandonment Method:
Borings backfilled with soil cuttings 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: 2/10/2015 Boring Completed: 2/10/2015

Drill Rig: CME-75 Driller: Precision

Project No.: B8155003 Exhibit: A-9

BORING LOG NO. B-6

PROJECT: Colorado City Greenhouse

CLIENT: Town and Country Land Co.
Denver, Colorado

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

GRAPHIC LOG	LOCATION See Exhibit A-2 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	LEAN CLAY (CL), brown, hard								
	3.0				20-50	10	90		
	FAT CLAY WITH SAND (CH), brown, hard, with calcium deposits.								
	5.5	5			30-32	16	101	53-24-29	83
	CLAYSTONE, light brown to brown, hard to very hard								
					50/6"	14	108		
	very hard drilling at 9 feet, offset hole 10' east, redrilled to 9 feet. Auger refusal.				50/0"	18			
	9.0								
	Auger refusal at 9 Feet								

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

Hammer Type: Automatic

Advancement Method:
4-inch solid-stem auger

Abandonment Method:
Borings backfilled with soil cuttings 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: 2/10/2015 | Boring Completed: 2/10/2015

Drill Rig: CME-75 | Driller: Precision

Project No.: B8155003 | Exhibit: A-10

PHOTO LOG

		
Photo #1 Center of Main Stockpile Looking North		**Photo #2** Center of Main Stockpile Looking South
		
Photo #3 South Side of Stockpile Looking North		**Photo #4** Main Stockpile on Left Side of Photo, End Dumped Stockpiles on Right Side of Photo

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.

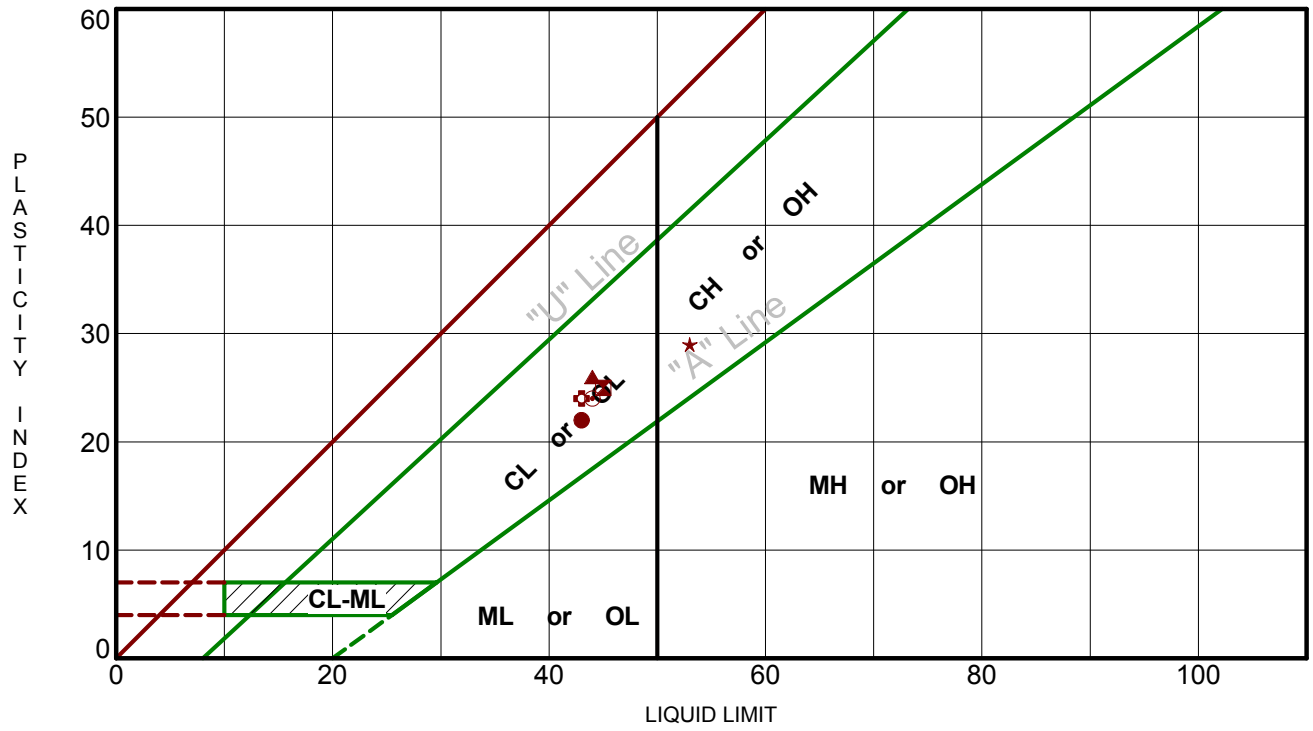
Laboratory test results are presented on the Logs of Borings and in Appendix B, and were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable Terracon test standards.

Selected soil samples were tested for the following engineering properties:

- Water content
- Dry density
- Consolidation/expansion
- Grain size
- Atterberg Limits
- Electrical resistivity
- pH
- Water soluble sulfate content
- Water soluble chloride content
- Moisture-density relationship

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
B-1	4 - 5	43	21	22	91	CL	LEAN CLAY
B-2	7 - 8	45	20	25	83	CL	LEAN CLAY with SAND
B-4	7 - 8	44	18	26	83	CL	WEATHERED CLAYSTONE
B-6	4 - 5	53	24	29	83	CH	FAT CLAY with SAND
Bag A	0 - 1	44	20	24	83	CL	LEAN CLAY with SAND
Bag B	0 - 1	43	19	24	78	CL	LEAN CLAY with SAND

PROJECT: Colorado City Greenhouse

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

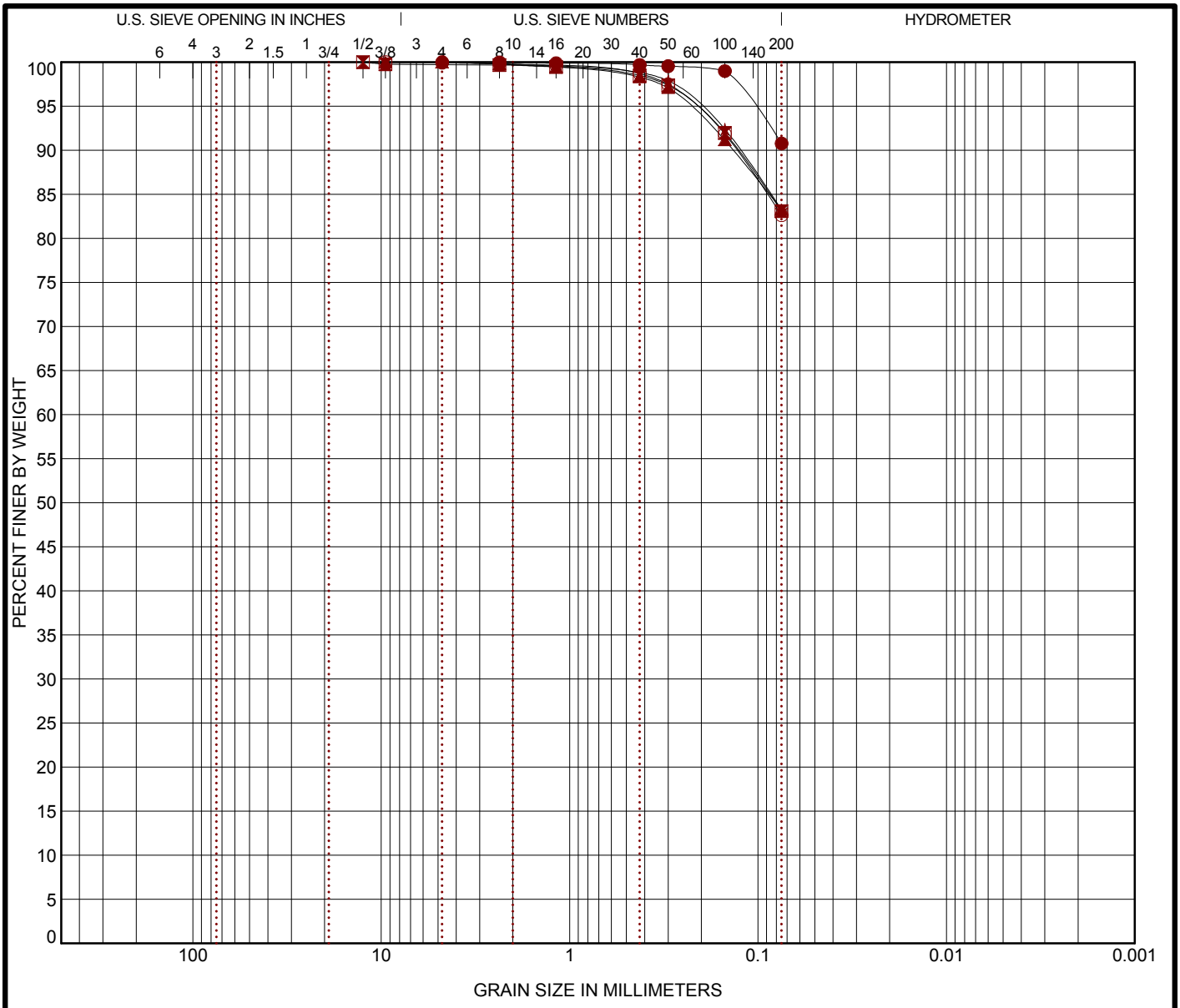
PROJECT NUMBER: B8155003

CLIENT: Town and Country Land Co.
Denver, Colorado

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 - 5	LEAN CLAY(CL)	43	21	22		
⊠	B-2	7 - 8	LEAN CLAY with SAND(CL)	45	20	25		
▲	B-4	7 - 8	WEATHERED CLAYSTONE	44	18	26		
★	B-6	4 - 5	FAT CLAY with SAND(CH)	53	24	29		
⊙	Bag A	0 - 1	LEAN CLAY with SAND(CL)	44	20	24		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
●	B-1	4 - 5	4.75				0.0	9.2	90.8	
⊠	B-2	7 - 8	12.5				0.3	16.6	83.1	
▲	B-4	7 - 8	9.5				0.0	16.7	83.3	
★	B-6	4 - 5	4.75				0.0	16.8	83.2	
⊙	Bag A	0 - 1	9.5				0.1	17.3	82.6	

PROJECT: Colorado City Greenhouse

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

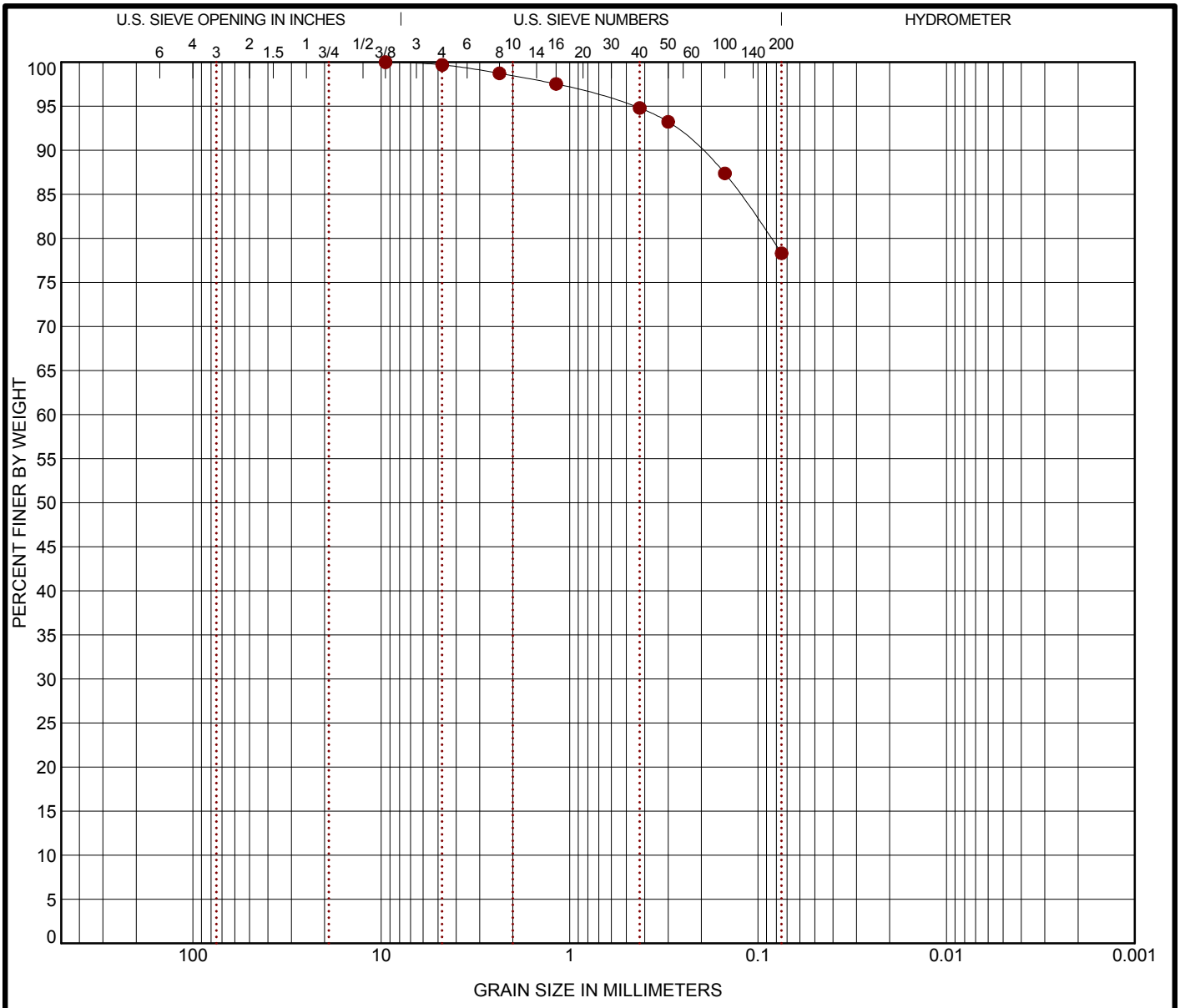
PROJECT NUMBER: B8155003

CLIENT: Town and Country Land Co.
Denver, Colorado

EXHIBIT: B-3

GRAIN SIZE DISTRIBUTION

ASTM D422



Boring ID	Depth	USCS Classification	LL	PL	PI	Cc	Cu
Bag B	0 - 1	LEAN CLAY with SAND(CL)	43	19	24		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
Bag B	0 - 1	9.5				0.3	21.4	78.3	

PROJECT: Colorado City Greenhouse

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

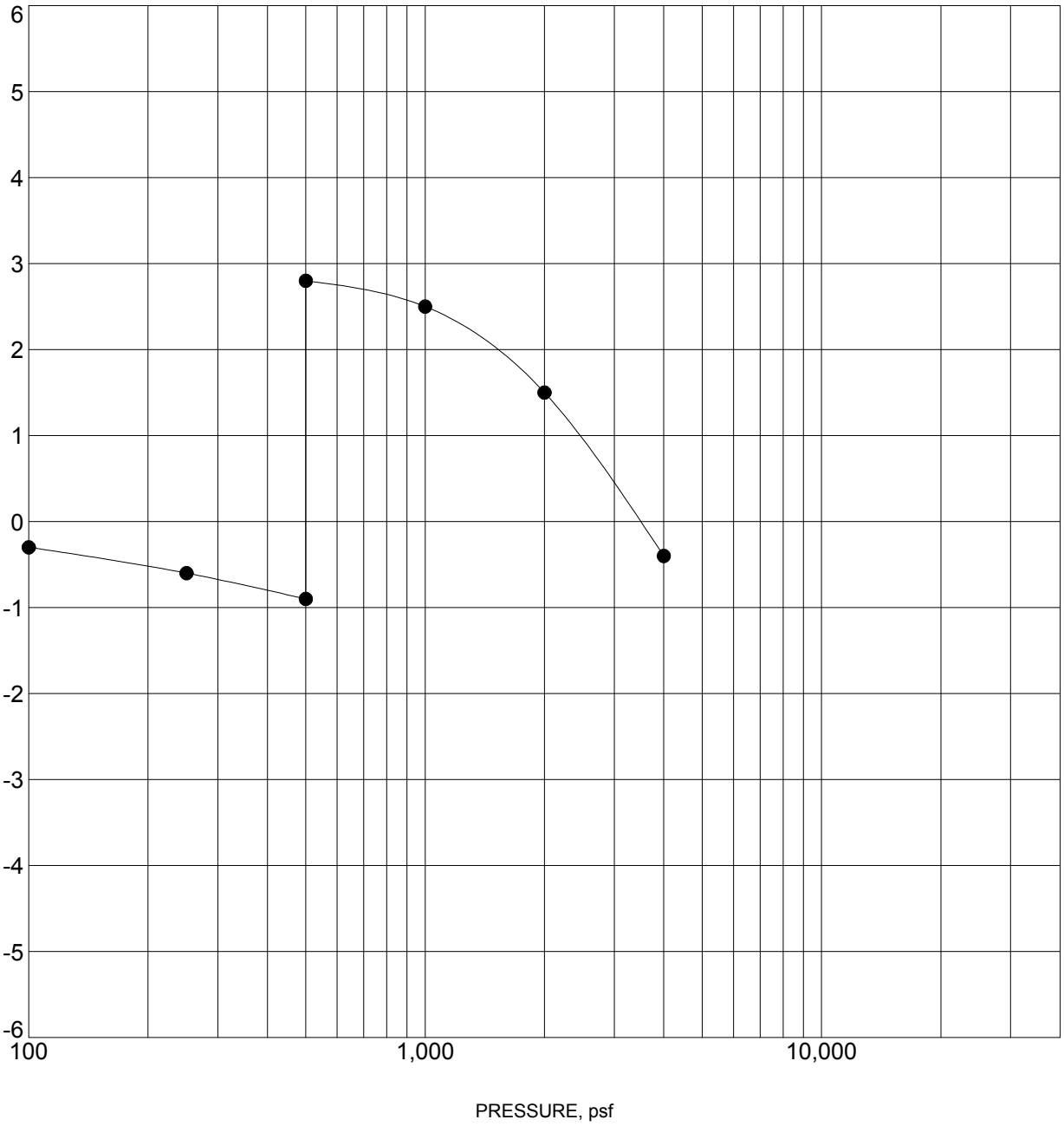
PROJECT NUMBER: B8155003

CLIENT: Town and Country Land Co.
Denver, Colorado

EXHIBIT: B-4

SWELL CONSOLIDATION TEST

ASTM D4546



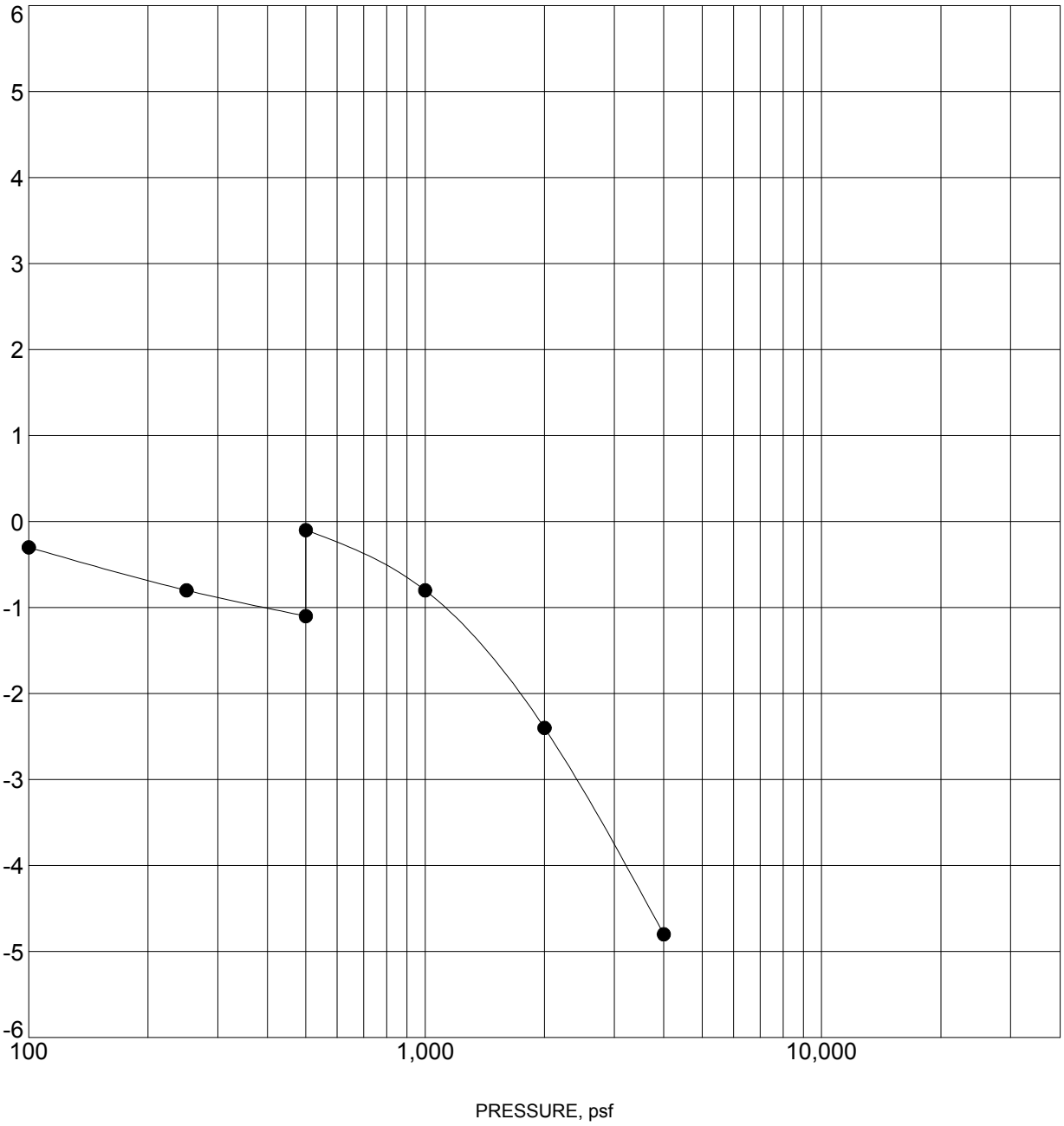
Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-1	2 - 3 ft	LEAN CLAY(CL)	99	13

NOTES: Sample inundated with water at 500 pounds per square foot

PROJECT: Colorado City Greenhouse	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: B8155003
SITE: Graneros Road and Copeland Circle Colorado City, Colorado		CLIENT: Town and Country Land Co. Denver, Colorado
		EXHIBIT: B-5

SWELL CONSOLIDATION TEST

ASTM D4546



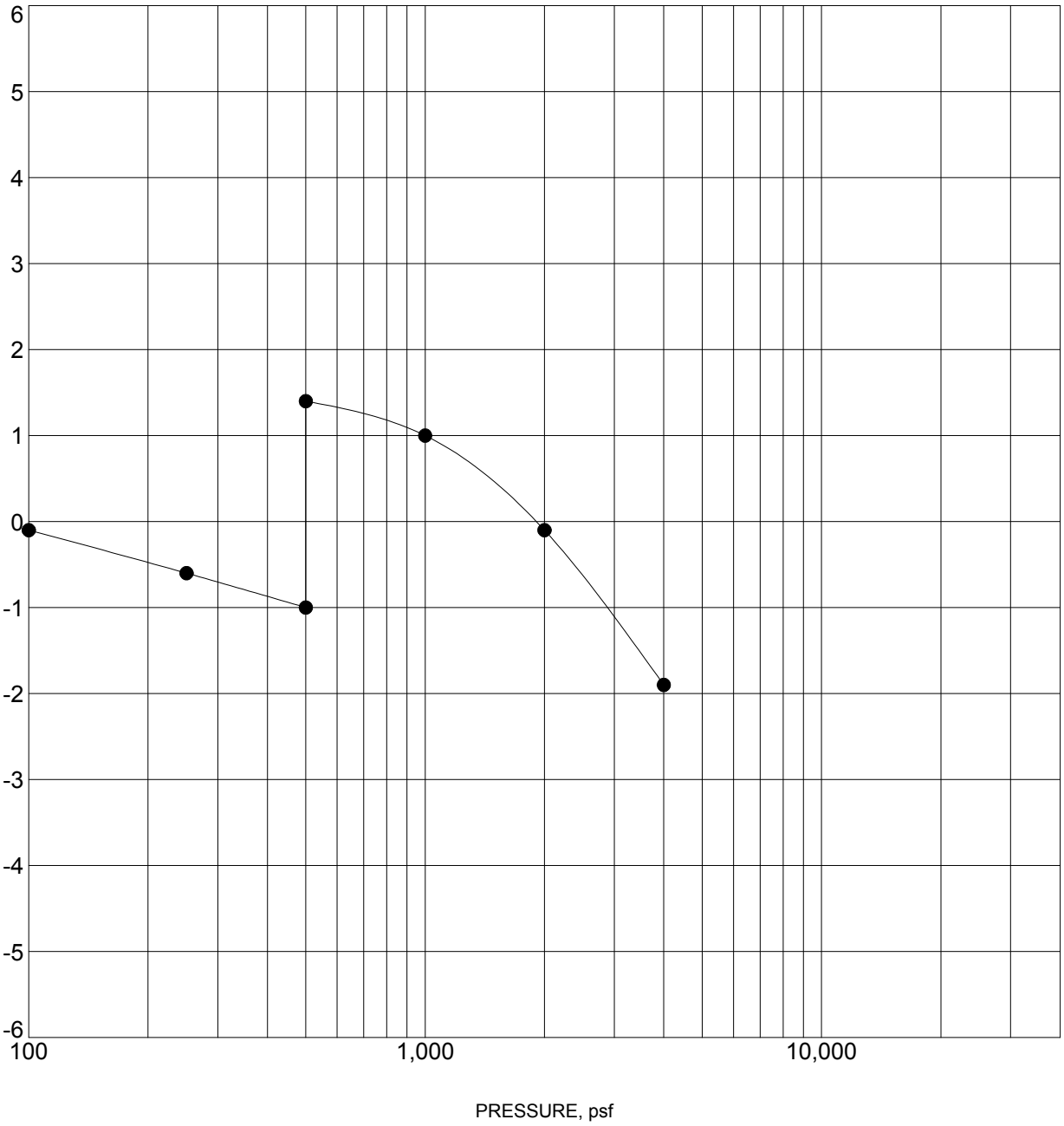
Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-2	4 - 5 ft	LEAN CLAY(CL)	93	9

NOTES: Sample inundated with water at 500 pounds per square foot

PROJECT: Colorado City Greenhouse	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: B8155003
SITE: Graneros Road and Copeland Circle Colorado City, Colorado		CLIENT: Town and Country Land Co. Denver, Colorado
		EXHIBIT: B-6

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-3	7 - 8 ft	CLAYSTONE	102	13

NOTES: Sample inundated with water at 500 pounds per square foot

PROJECT: Colorado City Greenhouse

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

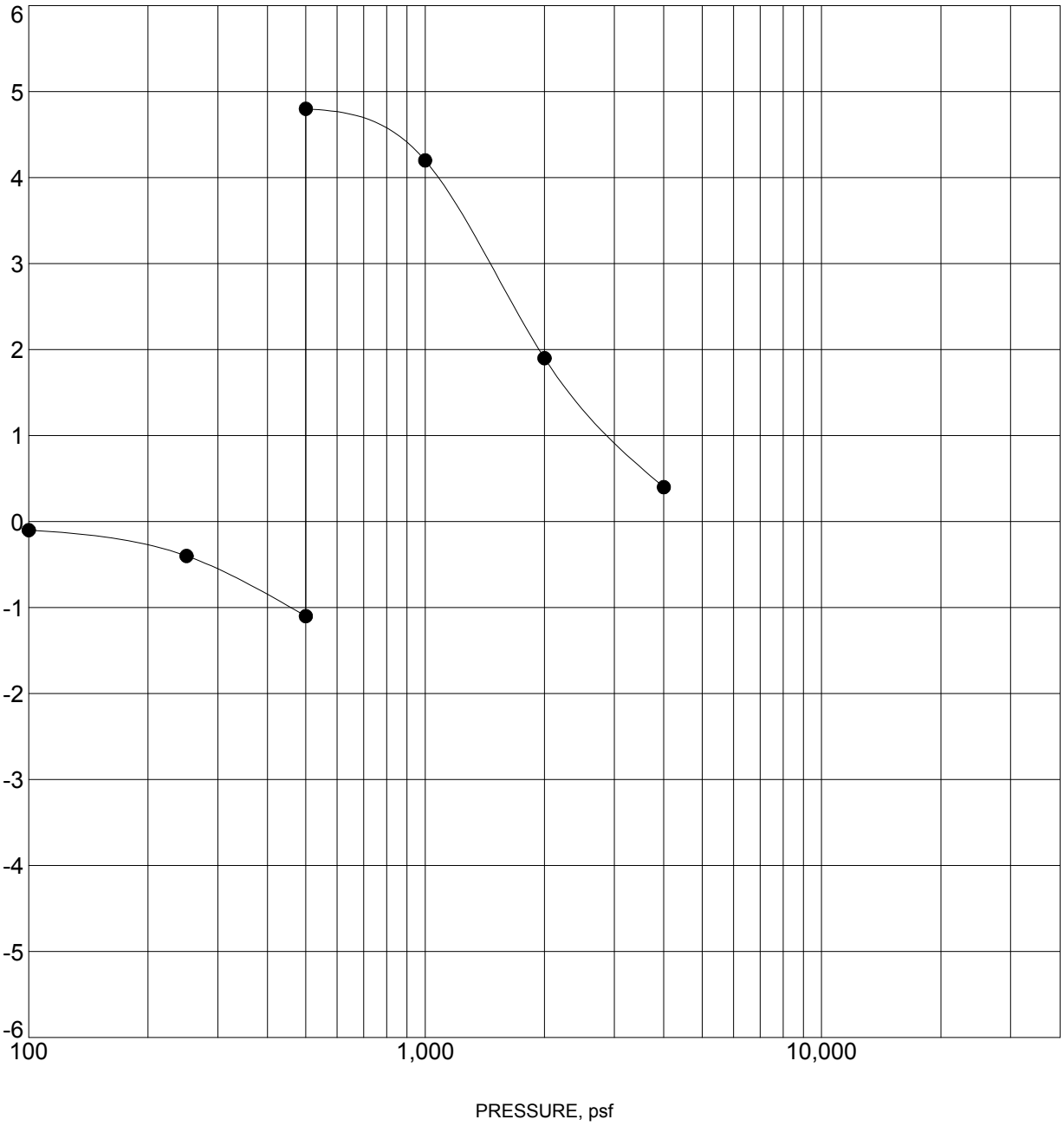
PROJECT NUMBER: B8155003

CLIENT: Town and Country Land Co.
Denver, Colorado

EXHIBIT: B-7

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-4	7 - 8 ft	WEATHERED CLAYSTONE	113	13

NOTES: Sample inundated with water at 500 pounds per square foot

PROJECT: Colorado City Greenhouse

SITE: Graneros Road and Copeland Circle
Colorado City, Colorado

Terracon
4172 Center Park Drive
Colorado Springs, Colorado

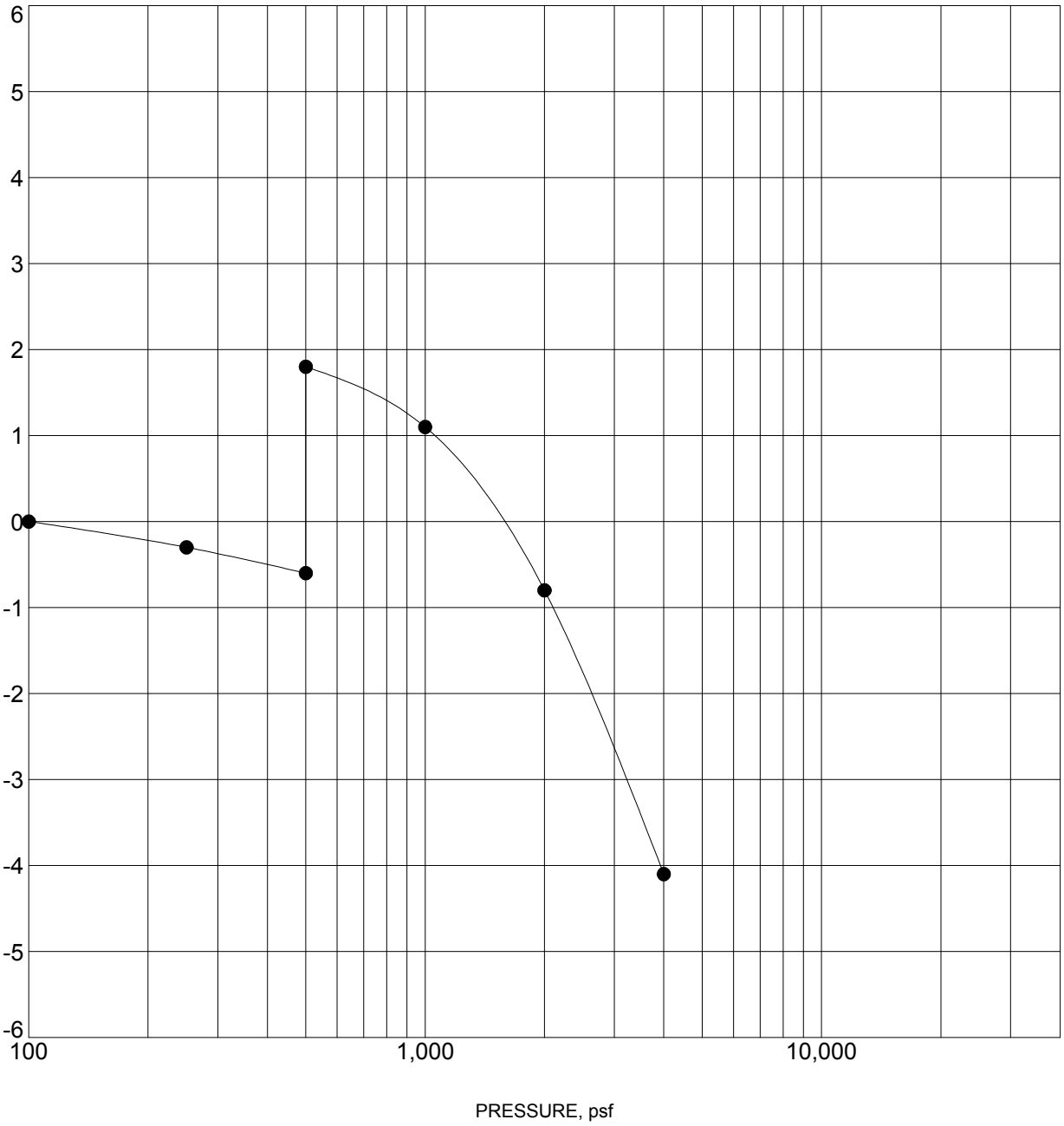
PROJECT NUMBER: B8155003

CLIENT: Town and Country Land Co.
Denver, Colorado

EXHIBIT: B-8

SWELL CONSOLIDATION TEST

ASTM D4546



Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-5	4 - 5 ft	LEAN CLAY(CL)	99	10

NOTES: Sample inundated with water at 500 pounds per square foot

PROJECT: Colorado City Greenhouse	Terracon 4172 Center Park Drive Colorado Springs, Colorado	PROJECT NUMBER: B8155003
SITE: Graneros Road and Copeland Circle Colorado City, Colorado		CLIENT: Town and Country Land Co. Denver, Colorado
		EXHIBIT: B-9

Colorado Analytical LABORATORIES, INC.

Analytical Results

TASK NO: 150219004

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.: 150219004
Client PO:
Client Project: B8155003

Date Received: 2/19/15
Date Reported: 2/26/15
Matrix: Soil - Geotech

Customer Sample ID B8155003 Boring B-2 1-10 Ft.
Lab Number: 150219004-01

Test	Result	Method
Chloride - Water Soluble	**0.0131 %**	AASHTO T291-91/ ASTM D4327
pH	**7.4 units**	AASHTO T289-91
Resistivity	**531 ohm.cm**	AASHTO T288-91
Sulfate - Water Soluble	**0.076 %**	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

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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.

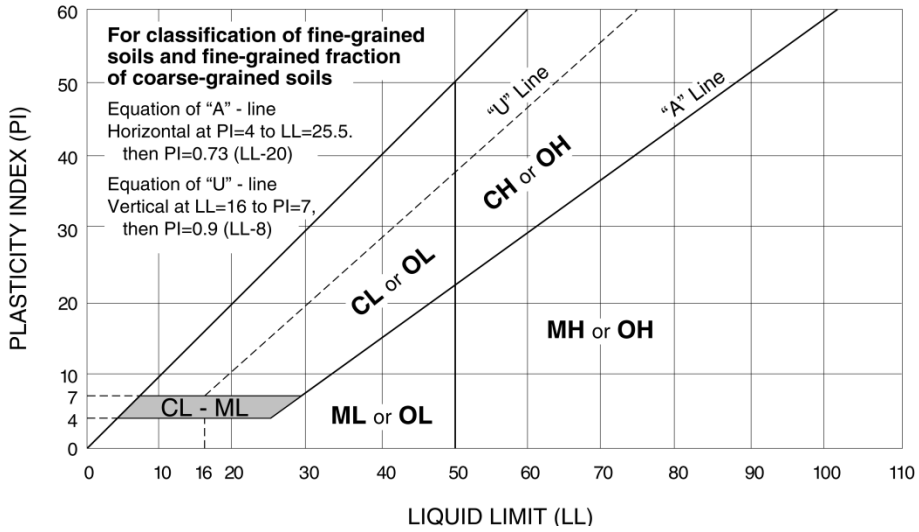

Exhibit C-2

GENERAL NOTES

Description of Rock Properties

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [a]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD)		Joint Openness Descriptors	
RQD, as a percentage	Diagnostic description	Openness	Descriptor
Exceeding 90	Excellent	No Visible Separation	Tight
90 – 75	Good	Less than 1/32 in.	Slightly Open
75 – 50	Fair	1/32 to 1/8 in.	Moderately Open
50 – 25	Poor	1/8 to 3/8 in.	Open
Less than 25	Very poor	3/8 in. to 0.1 ft.	Moderately Wide
		Greater than 0.1 ft.	Wide

a. RQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976.
U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.