Preliminary Geotechnical Engineering Report

Cedar Falls Industrial Park West Expansion
Cedar Falls, Iowa
June 20, 2019
Terracon Project No. 13195013

Prepared for:
Snyder & Associates, Inc.
Cedar Rapids, Iowa

Prepared by:
Terracon Consultants, Inc.
Cedar Falls, Iowa

June 20, 2019

Terracon GeoReport

Snyder & Associates, Inc.
5005 Bowling Street SW. Suite A
Cedar Rapids, Iowa 52404

Attn: Mr. Patrick Schwickerath, P.E. – Civil Engineer
P: (319) 362 9394
E: pschwickerath@snyder-associates.com

Re: Preliminary Geotechnical Engineering Report
Cedar Falls Industrial Park West Expansion
South Union Road
Cedar Falls, Iowa
Terracon Project No. 13195013

Dear Mr. Schwickerath:

Terracon Consultants, Inc. (Terracon) has performed the Preliminary Geotechnical Engineering services for the above referenced project. Our services were performed in general accordance with Terracon Proposal No. P13195013R dated February 20, 2019. This report presents the findings of the subsurface exploration and provides preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations and pavements 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.

Kurt A. Drilling
Senior Staff Geologist

Jason P. Heinz, P.E.
Department Manager
Geotechnical Services
Iowa No. 18345

REPORT TOPICS

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

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

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

Preliminary Geotechnical Engineering Report

Cedar Falls Industrial Park West Expansion

South Union Road

Cedar Falls, Iowa

Terracon Project No. 13195013

June 20, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed industrial park planned east of South Union Road in Cedar Falls, Iowa. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Foundation design and construction
- Seismic site classification per IBC
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of sixteen (16) test borings to depths of approximately 25.5 to 30.5 feet below existing site grades. Maps showing the site and boring locations are shown in the **Site Location and Exploration Plans** section. The results of the laboratory testing are included on the boring logs in the **Exploration Results** section.

SITE CONDITIONS

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

Item	Description
Site Location	The project site is located south and east of the intersection of South Union Road and Viking Road in Cedar Falls, Iowa and is about 200 acres. See **Site Location**
Existing Improvements	Potential for field tile
Current Ground Cover	Crop residue
Existing Topography (from USGS 24K map)	Topographic contour elevations range from about 940 to 1000 feet.

PROJECT DESCRIPTION

Item	Description
Project Description	The approximate 200-acre site will be developed and require grading to provide relatively level building sites and to establish surface drainage. Site development will also include the installation of underground utilities and construction of pavements and detention basins. The project's grading plan was not available at the time of this report.
Grading/Slopes	Cuts and fills of about 10 feet or less have been assumed Side slopes of 3 Horizontal to 1 Vertical (3H:1V) or flatter
Pavements	Two-lane, city streets Design traffic and pavement design period not provided. We expect that 'standard' City of Cedar Falls pavement sections will be considered.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

Conditions encountered in each boring are indicated on the individual boring logs in the **Exploration Results** section. Stratification boundaries on the boring logs represent the approximate location of changes in soil types. The following depths are approximate and are in reference to the grades existing at the time the borings were performed. Based on the results of the borings, subsurface conditions can be generalized as follows.

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Relative Density
Surface	0.6 to 3	Topsoil	N/A
1a	2.5 to 6 (Borings 1 to 4, 6 to 9, 11, and 16)	Lean Clay, with varying amounts of sand	Soft
1b	4 to 9 (Borings 4 to 16)	Lean Clay, with varying amounts of sand	Medium Stiff
2	8 to 14 (Borings 9 and 12)	Lean to Fat Clay, with varying amounts of sand	Medium Stiff to Stiff

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Relative Density
3	9 to 28 [1] (Borings 1 to 11 and 13 to 16)	Sandy Lean Clay, trace gravel, with occasional sand seams and layers	Medium Stiff to Stiff
4	10 to 26 (Borings 1 to 3, 6, 10, 11, and 13 to 16)	Sand, with varying amounts of clay / Silt, with varying amounts of clay and sand	Medium Dense to Very Dense / Stiff to Very Stiff
5	24 to 25.5 [2] (Borings 8 and 15)	Lean to Fat Clay, with varying amounts of sand	Medium Stiff to Stiff
6	25.5 to 30.5 [3] (Borings 1 to 7 and 11 to 16)	Sandy Lean Clay, trace gravel, with occasional sand seams and layers	Very Stiff to Hard

1. Boring 9 terminated in Stratum 3 at a planned depth of 25.5 feet.
2. Boring 8 terminated in Stratum 5 at a planned depth of 25.5 feet.
3. Borings 1 to 7 and 11 to 16 terminated in Stratum 6 at planned depths of 25.5 to 30.5 feet.

Groundwater Conditions

The boreholes were observed during and after drilling and sampling for the presence and level of groundwater. Groundwater levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized in the following table. The following groundwater level observations are approximate and in reference to the grades existing at the time of the exploration.

Boring No.	Groundwater Depth While Drilling/Sampling (feet)	Groundwater Depth After Drilling/Sampling (feet)	Groundwater Depth on 5/14/2019 (feet)
1	4	16	2.5
2	5	23	9
3	4	1	N/A
4	4	24	3.5
5	6	25.5	3
6	6.5	24	3
7	5.5	9	2
8	14	20	2
9	14	N/A	None

Boring No.	Groundwater Depth While Drilling/Sampling (feet)	Groundwater Depth After Drilling/Sampling (feet)	Groundwater Depth on 5/14/2019 (feet)
10	7	6.5	2
11	5	10.5	3.5
12	10.5	16	1
13	6	11.5	3.5
14	9	20	3.5
15	14	9.5	3.5
16	13	12.5	3.5

Due to the relatively low 'permeability' of the soils encountered in the borings, a relatively long period is necessary for a groundwater level to develop and stabilize in a borehole. Groundwater level observations made within granular soils, however, are usually a reliable indication of the current groundwater conditions. Long-term observations in piezometers or groundwater observation wells sealed from the influence of surface water would be required to provide a better evaluation of groundwater levels at this site.

A review of the Black Hawk County, Iowa Soil Survey published by the United States Department of Agriculture / Soil Conservation Service indicates the following soils are present at the site, and also associates the following groundwater conditions and drainage characteristics with the soils.

USDA / SCS Pedology				
Mapped Soil Unit	**Seasonally High Groundwater Depth (feet)**	**Frequency of Flooding**	**Drainage Class**	**Approx. Percentage of Site Area**
Sparta loamy fine sand	>6	None	Excessively drained	4
Kenyon loam	4	None	Moderately well drained	57
Dinsdale silty clay loam	4	None	Moderately well drained	1
Maxfield silty clay loam	0	None	Poorly drained	17
Clyde-Floyd complex	0	None	Poorly drained	13
Aredale loam	>6	None	Well drained	3
Maxmore silty clay loam	0	None	Poorly drained	5

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. Perched (trapped) water can also develop with more 'permeable' soils within and/or above less 'permeable' soils. Therefore, groundwater levels during construction or at other times during the life of the development may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

Geotechnical considerations identified for this site include the presence of:

- Relatively thick, partly organic soils in some areas
- Lower strength and higher moisture content soils
- Medium to high plasticity soils
- Relatively shallow groundwater

Relatively thick layers of topsoil were encountered at Borings 4, 11, 12, 14, 15, and 16 to depths of about 15 to 36 inches. The presence of relatively thick layers of partly organic soils in some areas will affect earthwork for this project.

Lower strength and/or higher moisture content soils were encountered below the surficial topsoil in the majority of the borings to depths of about 2.5 to 6 feet below existing grades. Lower strength and/or higher moisture content soils can rut and pump under construction equipment loadings. Undercutting, placement of granular fill, or scarification, moisture conditioning, and compaction, should be expected to be required prior to fill placement. If lower strength soils are not undercut in areas that receive more than 5 feet of fill (if any), settlement resulting from the weight of new fill is expected, in addition to settlement resulting from structure loads, and a delay after the completion of fill placement on the order of several weeks should be planned prior to the construction of new improvements. The presence of lower strength soils will also affect earthwork in foundation, floor slab, pavement, and utility areas, and corrective earthwork should be expected to establish suitable support conditions for new improvements.

Medium to high plasticity soils (i.e., lean to fat clay) were encountered in Borings 8, 9, 12, and 16 to depths of about 8 to 25 feet below existing grades. Medium to high plasticity soils shrink and swell more than low plasticity soils (i.e., silty soils and lean clay soils) with changes in moisture conditions. Complete removal of these soils would not be practical due to the depths which these soils were encountered. Generally, undercutting and/or the provision of a minimum 2-foot thick layer of low plasticity fill below grade-supported elements is used to help reduce the amount of movement related to shrinking and expansion of medium to high plasticity soils. It is important to note that even if a layer of low plasticity fill is provided immediately below grade-supported elements, some movement and at least minor cracking in grade-supported elements (i.e., floor slabs, pavements, and sidewalks) should be anticipated. The severity of cracking and cosmetic damage, such as

uneven surfaces, will probably increase if modification of the site results in excessive wetting or drying of the expansive soil. 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 more expensive measures are used during construction. Terracon would be pleased to discuss other alternatives upon request.

Groundwater was generally observed in the borings at depths of about 1 to 3.5 feet below existing grades. Due to the presence of sand seams and layers, removal of groundwater should be expected to facilitate earthwork and construction of new improvements in some areas. Consideration should be given to 'pre-draining' the site prior to grading and providing permanent subsurface drainage systems for new improvements. Additional commentary is provided in subsequent sections of this report regarding subsurface drainage.

It is our opinion that following corrective earthwork, particularly in lower site areas, the site soils would be suitable for support of lightly-loaded buildings and pavements. If more heavily-loaded structures are planned on the site, the use of an intermediate foundation system or ground improvement system could be required to adequately support the structures. Preliminary recommendations for earthwork and building foundations are presented in the following sections.

EARTHWORK

Preliminary Earthwork Recommendations

Item	Descriptions and Values
Topsoil Stripping Depths [1]	■ 8 to 36 inches
Subgrade Improvement for Lightly-Loaded Floor Slabs and Pavements [2]	■ Undercut 12 to 18 inches of lower strength soil, and scarify, moisture condition, and compact the upper 9 inches of fine grained (i.e. clay or silt) soil, granular soil prior to earthen fill placement and construction of grade-supported elements. ■ Use 12 to 24 inches of crushed stone or other granular fill to 'stabilize' or 'bridge' lower strength soils
Potential Seasonally High Groundwater Levels [3]	■ 0 to 4 feet below existing grades

1. It is important to note that different thicknesses of topsoil could be encountered in the vicinities of low areas or along former and existing draws and swales. Plowing of the soils for agricultural purposes and erosion could have also created variable topsoil thicknesses in some areas. Actual stripping depths should be anticipated to vary.
2. Pre-draining the site and performing grading operation during warm seasons and dry periods would help reduce the amount of subgrade improvement required.
3. Groundwater seepage should be anticipated during construction due to the presence of granular seams and layers. Rapid groundwater inflows and rather significant amounts of groundwater could be encountered in the granular layers.

Preliminary Fill Material Types

Fill that will support foundations, floor slabs, and pavements should meet the following material property requirements.

Fill Type [1]	USCS Classification	Acceptable Areas for Placement
Imported, Low plasticity Fine-grained	CL, CL/SC (LL ≤ 45 and PI ≤ 23)	Below footings and the aggregate base for floor slabs and pavements
Imported Granular [2]	GW, GP, SW, SP	Below footings, floor slabs, and pavements
On-site Soils [3]	CL, CL/SC, SP, SC	The non-organic, on-site soil types appear suitable for use as fill below spread footings and the aggregate base for floor slabs and pavements.
	CL/CH, CH	≥ 2 feet below grade-supported elements

1. Fill should consist of approved materials that are free of organic matter debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. Each proposed fill material type should be sampled and evaluated by Terracon personnel prior to its delivery and/or use.
2. A 6-inch thick aggregate base is commonly sufficient immediately below lightly-loaded floor slabs and pavements.
3. Based on the results of the borings and laboratory testing, it appears that the non-organic, on-site soils could be reused. A significant amount of moisture conditioning should be expected achieve compaction requirements if on-site soils are used for fill below buildings and pavements.

Preliminary Fill Placement and Compaction Requirements

Fill in building and pavement areas should be placed and compacted in accordance with the following requirements.

Item	Description
Maximum Fill Lift Thickness	■ 9 inches in loose thickness when heavy, self-propelled compaction equipment is used ■ 4 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1, 2]	■ 98 percent · Below foundations designed using a net allowable bearing pressure of 2,000 psf or greater · ≤ 1.5 feet below pavements ■ 95 percent · Below foundations designed using a net allowable bearing pressure less than 2,000 psf · Below lightly-loaded floor slabs · > 1.5 feet below pavements
Moisture Content Range from Optimum [1, 3]	■ Low plasticity fine-grained: -2 to +3 percent ■ Medium to high plasticity fine-grained : 0 to +4 percent ■ Coarse-grained / Granular: -3 to +3 percent

1. As determined by the standard Proctor test (ASTM D 698).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70 percent relative density (ASTM D 4253 and D 4254).
3. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the granular fill bulking during placement and pumping when proofrolled.

Earthwork and Excavation Considerations

As mentioned previously, relatively shallow groundwater and granular soils were encountered at the site. Due to the presence of drainage ways/swales and granular soils at the site, and the presence of lower strength soils in some areas that could require removal prior to new fill placement, groundwater seepage should be expected during earthwork and excavations. The amount and rate of groundwater seepage encountered may vary substantially. Conventional sump pit and pump systems are anticipated to be sufficient to remove groundwater in areas of clay soils for this project, but more extensive groundwater control systems, such as a series of sump pits and pumps or wells, could be required to control groundwater levels in areas of granular soils.

Pre-draining of the site may be accomplished with a series of ditches, “French-drains”, drain lines and/or ditches in order to lower and control the groundwater level and minimize disturbance of bearing soils. In cut areas of the site and/or where granular soils are present, the use of well points could be considered. Consideration could also be given to placing an interceptor subdrain system upgradient of the site and/or structures, and divert groundwater and surface water around the construction area. To be the most beneficial, ‘pre-draining’ of the site should occur as far in advance of construction as possible. It should be noted that excavations made prior to controlling groundwater in granular soils can cause a ‘quick’ condition, and significantly reduce the support capability of soil and cause excessive settlement and construction delays.

Upon completion of filling and grading and prior to construction of grade-supported slabs and pavements, care should be taken to maintain the subgrade water content. The on-site soils will be highly susceptible to disturbances from construction activity and are moderately to highly susceptible to frost. Care should be taken during excavation and construction of footings to minimize disturbances of the bearing soil. Construction traffic over completed subgrades should be avoided. The site should also be graded to prevent ponding of water on prepared subgrades or in excavations. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to slab and pavement construction.

SHALLOW FOUNDATIONS

Preliminary Spread Footing Foundation Recommendations

Based on the limited project information and the results of the subsurface exploration, laboratory testing, and our preliminary evaluation, it is our opinion that lightly-loaded foundations could be supported on spread footing foundations at the site. The final recommended net allowable bearing pressures will partially depend on the selection of the building area, design grades, and the structure loads.

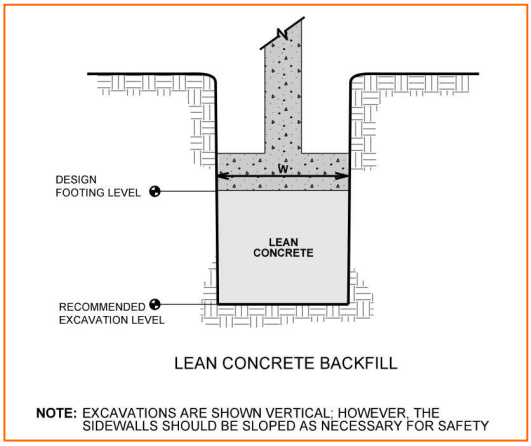
Item	Value	
Maximum Net Allowable Bearing Pressure [1]	■ Higher elevation areas: ■ Lower elevations areas:	2,000 to 3,000 psf 1,200 to 1,500 psf
Minimum Spread Footing Foundation Widths	■ Isolated/Columns: ■ Strip/Walls:	30 inches 16 inches
Minimum Embedment Depth Below Finished Grade [2, 3]	■ Footings in unheated areas: ■ Perimeter footings for heated areas: ■ Footings in heated areas:	60 inches 42 inches 18 inches

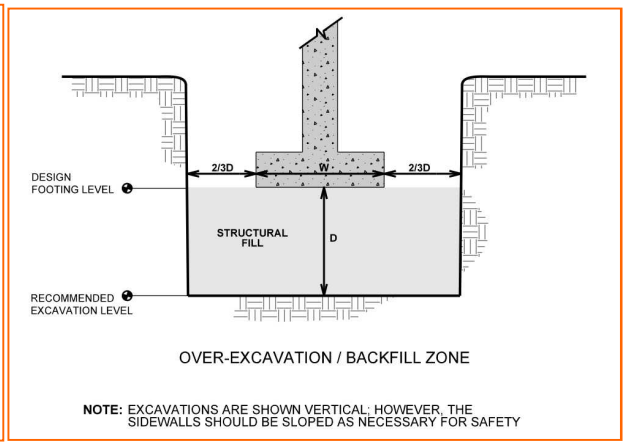
1. Assumes lower strength and unsuitable material, where present, will be removed and replaced with properly compacted fill. The net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended net allowable bearing pressure typically corresponds to a maximum total settlement of 1 inch. Foundation settlement will depend on variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of earthwork operations and foundation construction.
2. Interior footings should be provided with a minimum embedment depth of 48 inches if the footing will be subjected to freezing temperatures during construction.
3. Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter footings, and the finished floor level surrounding interior footings.

Foundation Construction Considerations

Due to the presence of granular seams and layers, groundwater seepage into foundation excavations could occur. Groundwater that collects in excavations should be removed as soon as possible. Excavations planned near and/or below groundwater levels will require the use of sump pit(s) and pump(s) to control groundwater levels, as a minimum. If construction occurs during the spring or following periods of heavy or prolonged precipitation, dewatering and/or groundwater removal could be required to facilitate construction.

If unsuitable bearing soil/material is encountered in a foundation excavation, the excavation should be extended deeper to suitable soil and the footing could bear directly on the soil at the lower level or on lean concrete backfill placed in the excavation. The footing could also bear on properly compacted fill extending down to suitable soil. Overexcavation for backfill placement below foundations should extend laterally beyond all edges of the foundations at least 8 inches per foot of overexcavation depth below the ‘design footing level’. The overexcavation should then be backfilled up to the ‘design footing level’ in accordance with final compaction recommendations. The overexcavation and backfill procedures are illustrated in the following figures.





SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our opinion that the Seismic Site Classification is D. Subsurface explorations at this site were extended to a maximum depth of 25.5 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.

GENERAL COMMENTS

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

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

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

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Jason P. Heinz, P.E. Date 6/20/19

My license renewal date is December 31, 2020.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Area
1 to 16	25.5 to 30.5 feet	Industrial Park

Boring Layout and Elevations: Terracon personnel selected the boring locations and Snyder & Associates staked the locations in the field and provided the surface elevations at the boring locations to Terracon.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight solid stem augers. Sampling was performed at intervals of about 2.5-feet in the upper 10 feet of each boring and at intervals of about 5 feet thereafter. Samples were obtained using split-barrel and thin-walled tube sampling methods. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was 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 was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. The boreholes were backfilled with auger cuttings upon completion.

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

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to aid in evaluation of the engineering properties of the various soil strata for this project. Laboratory testing for this project included moisture content, dry unit weight, and unconfined compressive strength. The laboratory testing program also included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in general accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

Cedar Falls Industrial Park West Expansion ■ Cedar Falls, Iowa
June 20, 2019 ■ Terracon Project No. 13195013

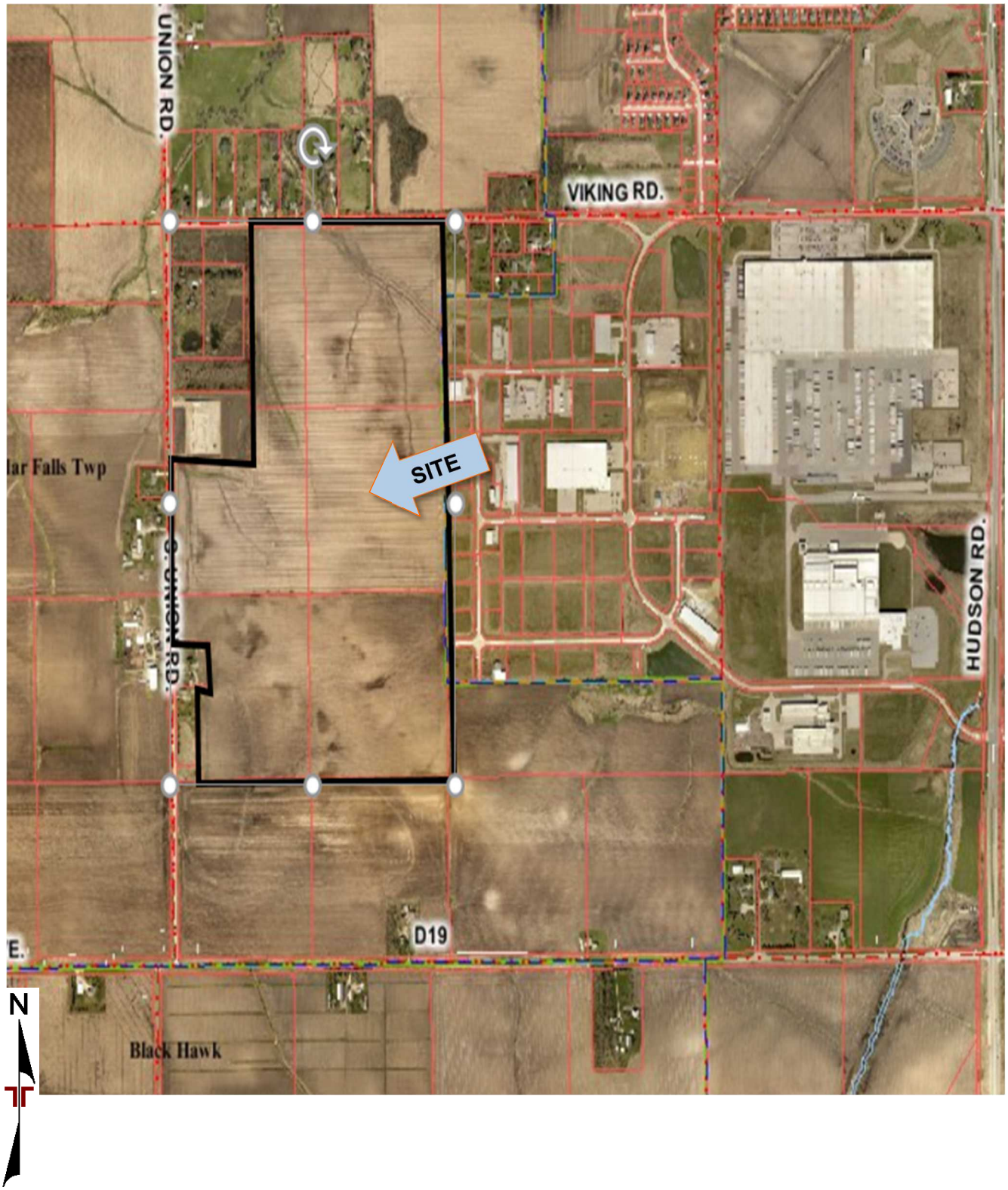


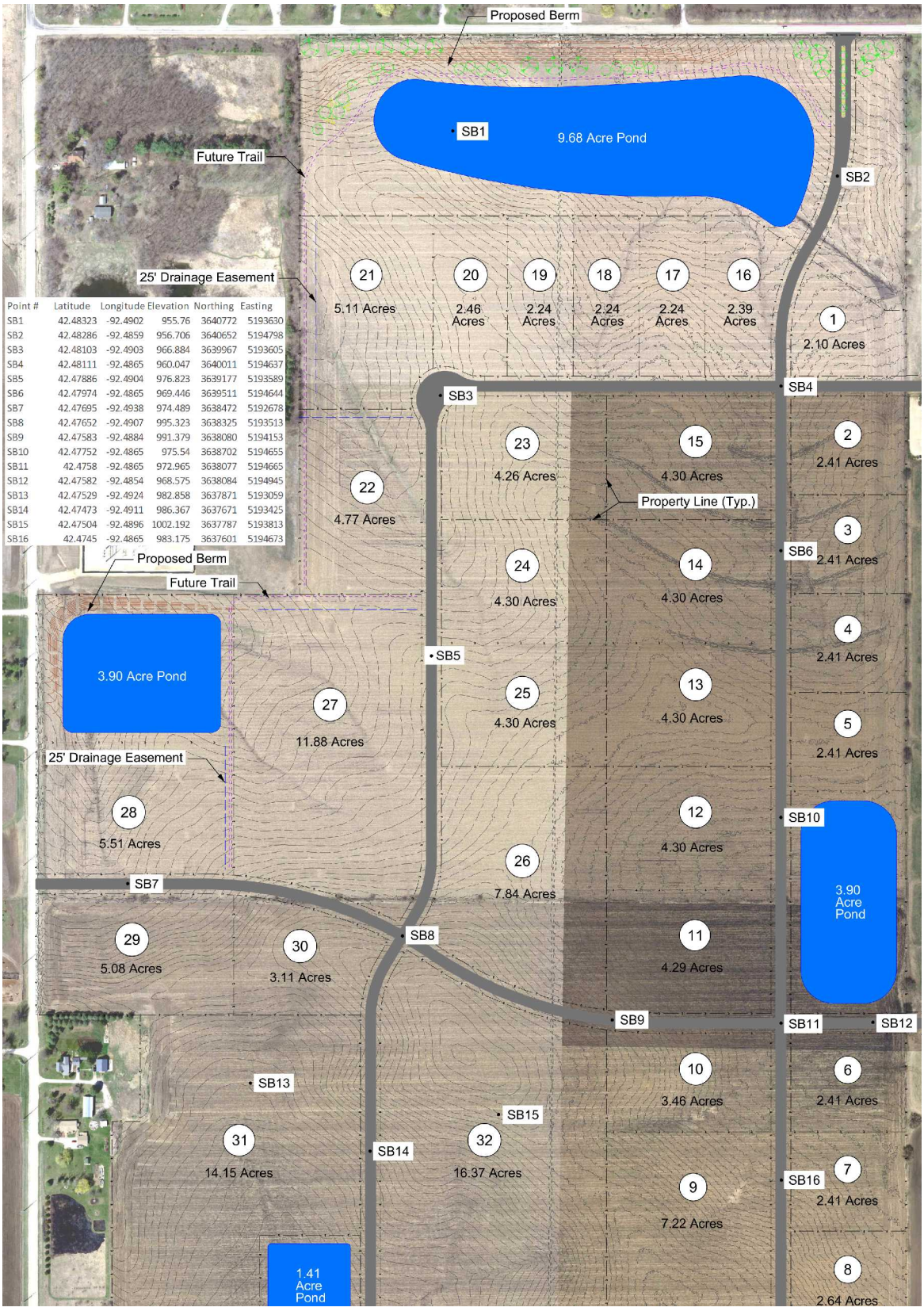
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY SNYDER & ASSOCIATES, INC.

EXPLORATION PLAN

Cedar Falls Industrial Park West Expansion ■ Cedar Falls, Iowa
June 20, 2019 ■ Terracon Project No. 13195013

Terracon GeoReport



Point #	Latitude	Longitude	Elevation	Northing	Easting
SB1	42.48323	-92.4902	955.76	3640772	5193630
SB2	42.48286	-92.4859	956.706	3640652	5194798
SB3	42.48103	-92.4903	966.884	3639967	5193605
SB4	42.48111	-92.4865	960.047	3640011	5194637
SB5	42.47886	-92.4904	976.823	3639177	5193589
SB6	42.47974	-92.4865	969.446	3639511	5194644
SB7	42.47695	-92.4938	974.489	3638472	5192678
SB8	42.47652	-92.4907	995.323	3638325	5193513
SB9	42.47583	-92.4884	991.379	3638080	5194153
SB10	42.47752	-92.4865	975.54	3638702	5194655
SB11	42.4758	-92.4865	972.965	3638077	5194665
SB12	42.47582	-92.4854	968.575	3638084	5194945
SB13	42.47529	-92.4924	982.858	3637871	5193059
SB14	42.47473	-92.4911	986.367	3637671	5193425
SB15	42.47504	-92.4896	1002.192	3637787	5193813
SB16	42.4745	-92.4865	983.175	3637601	5194673

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

MAP PROVIDED BY SNYDER & ASSOCIATES, INC.

EXPLORATION RESULTS

Contents:

Boring Logs (B-1 through B-16)

Note: All attachments are one page unless noted above.

BORING LOG NO. 1

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.48323° Longitude: -92.4902°

Surface Elev.: 956.0 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.2	955	**TOPSOIL**						
		SANDY LEAN CLAY (CL/SC), trace gravel, with occasional sand seams and layers, brown and gray, soft to medium stiff			14	1-1-1 N=2 1500 (HP)	21	
			5		18	2-2-2 N=4 2000 (HP)	18	
8.5	947.5				21		14	117
10.0	946	**SAND (SP-SC)**, with clay, trace gravel, fine to coarse grained, brown	10		17	8-12-13 N=25 9000+ (HP)	18 15	
		SANDY LEAN CLAY (CL/SC), trace gravel, with occasional sand seams and layers, brown to gray, very stiff to hard						
15.0	941				14	5-12-21 N=33 9000+ (HP)	12	
		SAND (SP-SC), with gravel, cobbles, boulders, and clay layers, fine to coarse grained, gray, dense boulder at about 15 feet	15					
		boulder at about 18 feet	20		16	27-27-50/5"	9	
22.0	934							
		SANDY LEAN CLAY (CL), trace gravel, with sand seams, gray, hard	25		18	11-24-26 N=50 9000+ (HP)	14	
30.5	925.5		30		18	8-15-18 N=33 9000+ (HP)	13	
		Boring Terminated at 30.5 Feet						

STRENGTH TEST: TEST TYPE | COMPRESSIVE STRENGTH (psf) | STRAIN (%) | LABORATORY HP (psf)

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *4' observed while sampling*
- *16' observed after drilling*
- *2.5' observed on 5/14/19*
- *Cave-in at 17' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 2

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.48286° Longitude: -92.4859°

Surface Elev.: 956.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.2	955.5	**TOPSOIL**											
		SANDY LEAN CLAY (CL/SC), trace gravel, with sand seams, brown and gray, medium stiff to stiff				16	1-1-2 N=3 2000 (HP)					21	
			5	▽		9			UC	3016	14.7	20	113
						18	3-5-7 N=12	5500 (HP)				17	
				▼									
			10			18	3-5-7 N=12	5500 (HP)				17	
12.0	944.5												
		SANDY LEAN CLAY (CL/SC), trace gravel, with sand seams, gray, very stiff				18	4-7-9 N=16 9000+ (HP)					12	
19.0	937.5		15	▩									
		SILTY SAND (SM), fine grained, gray, very dense	20			18	16-28-34 N=62					16	
23.0	933.5			▽									
		SANDY LEAN CLAY (CL/SC), trace gravel, with sand seams, gray, hard	25			18	5-11-15 N=26 9000+ (HP)					12	
30.5	926		30			18	7-14-19 N=33 9000+ (HP)					10	
		Boring Terminated at 30.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *5' observed while sampling*
- ▽ *23' observed after drilling*
- ▼ *9' observed on 5/14/19*
- ▩ *Cave-in at 17.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 3

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.48103° Longitude: -92.4903°

Surface Elev.: 967.0 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
0.6	966.5											
TOPSOIL												
SANDY LEAN CLAY (CL/SC), trace gravel, with occasional sand seams, brown, soft to medium stiff												
4.0	963											
CLAYEY SAND (SC), with clay layers, trace gravel, fine to coarse grained, brown, medium dense												
8.0	959											
CLAYEY SILT (ML), trace sand, brown, stiff to very stiff												
10.0	957											
SANDY LEAN CLAY (CL/SC), trace gravel, with occasional sand and silt layers, gray, hard												
					10	0-1-2 N=3 1000 (HP)	<500				22	
					8						13	
					16	3-4-7 N=11					15	
					16	3-6-7 N=13 9000+ (HP)	6500 (HP)				27 17	
					18	8-12-14 N=26 9000+ (HP)					11	
					18	6-10-14 N=24 9000+ (HP)					10	
					14	10-20-26 N=46 9000+ (HP)					12	
30.5	936.5				18	12-13-14 N=27 9000+ (HP)					13	
Boring Terminated at 30.5 Feet												

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *4' observed while sampling*
- *1' observed on 5/14/19*
- *Cave-in at 3.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 4

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.48111° Longitude: -92.4865°

Surface Elev.: 960.0 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
0.0	960	**TOPSOIL**											
2.0	958	**LEAN CLAY (CL)**, trace sand, with sand seams, brown/gray, medium stiff				12	2-3-3 N=6	2000 (HP)				23 26	
			5			10	1-1-2 N=3					23	
6.5	953.5	**SANDY LEAN CLAY (CL)**, trace gravel, with occasional sand seams, gray, stiff				17			UC	2485	15	18	115
9.0	951	**SANDY LEAN CLAY (CL)**, trace gravel, with occasional sand seams, gray, very stiff to hard	10			16	3-5-6 N=11 9000 (HP)					12	
			15			18	6-8-10 N=18 9000+ (HP)					10	
			20			18	5-8-11 N=19 9000+ (HP)					11	
25.5	934.5		25			18	6-12-15 N=27 9000+ (HP)					10	
		Boring Terminated at 25.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *4' observed while sampling*
- *24' observed after drilling*
- *3.5' observed on 5/14/19*
- *Cave-in at 17' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 5

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47886° Longitude: -92.4904°

Surface Elev.: 977.0 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.3	975.5	**TOPSOIL**											
		LEAN CLAY (CL), trace sand, dark brown and brown, medium stiff		▼		8	1-2-2 N=4 2000 (HP)					24	
4.0	973	**SANDY LEAN CLAY (CL)**, trace gravel, with sand seams, gray and brown, medium stiff	5	▽		17		1500 (HP)	UC	1646	15	16	114
						18	1-2-3 N=5	2000 (HP)				17	
9.0	968	**SANDY LEAN CLAY (CL)**, trace gravel, gray and brown, very stiff	10			19			UC	4339	15	14	122
12.0	965	**SANDY LEAN CLAY (CL)**, trace gravel, with sand seams and occasional silt layers, brown and gray, very stiff to hard				18	5-11-9 N=20 9000+ (HP)					18	
			15										
			20			18	5-8-9 N=17 9000+ (HP)					14	
21.0	956	**SANDY LEAN CLAY (CL)**, trace gravel, with sand seams, gray, hard											
			25	▽		18	10-16-18 N=34 9000+ (HP)					10	
30.5	946.5	***Boring Terminated at 30.5 Feet***	30	▩		18	7-15-22 N=37 9000+ (HP)					11	

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *6' observed while drilling*
- ▽ *25.5' observed after drilling*
- ▼ *3' observed on 5/14/19*
- ▩ *Cave-in at 17' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 6

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47974° Longitude: -92.4865°

Surface Elev.: 969.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.3	968	**TOPSOIL**											
		LEAN CLAY (CL), trace sand, brown and dark brown, soft to medium stiff		▼		8	1-2-1 N=3 1500 (HP)					24	
4.0	965.5	**SANDY LEAN CLAY (CL)**, trace gravel, with sand seams, gray and brown, stiff	5	▽		17		3500 (HP)	UC	3592	13.7	16	118
7.5	962	**SANDY LEAN CLAY (CL)**, trace gravel, with occasional sand seams, brown and gray, stiff to very stiff				18	6-5-4 N=9	2500 (HP) 6000 (HP)				13 19	
12.0	957.5	**SANDY LEAN CLAY (CL)**, trace gravel, gray, very stiff to hard	10			18	2-4-6 N=10	7500 (HP)				16	
			15	▩		18	4-8-10 N=18 9000+ (HP)					13	
			20			18	5-9-13 N=22 9000+ (HP)					10	
23.0	946.5	**CLAYEY SAND (SC)**, trace gravel, with clay layers, fine to coarse grained, gray brown, very dense	25	▽		16	13-24-36 N=60					15	
26.0	943.5	**SANDY LEAN CLAY (CL)**, trace gravel, gray, hard											
30.5	939	***Boring Terminated at 30.5 Feet***	30			18	9-14-21 N=35 9000+ (HP)					11	

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *6.5' observed while sampling*
- ▽ *24' observed after drilling*
- ▼ *3' observed on 5/14/19*
- ▩ *Cave-in at 14' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 7

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47695° Longitude: -92.4938°

Surface Elev.: 974.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.2	973.5											
TOPSOIL												
LEAN CLAY (CL), trace sand, brown and dark brown, soft to medium stiff			▼		10	1-1-2 N=3	1000 (HP) 1500 (HP)				25 21	
4.0	970.5											
SANDY LEAN CLAY (CL/SC), trace gravel, with sand seams, brown and gray, medium stiff to stiff		5	▽		17		2000 (HP)	UC	1780	15	18	117
					16	4-5-5 N=10	1500 (HP)				16	
		10	▽		17	3-3-5 N=8					19	
12.0	962.5											
SANDY LEAN CLAY (CL/SC), trace gravel, with sand seams, brown and gray, very stiff to hard												
		15			18	4-6-9 N=15 9000+ (HP)					19	
20.5	954	20			18	6-10-16 N=26 9000+ (HP)					17	
SANDY LEAN CLAY (CL), trace gravel, gray, very stiff to hard												
25.5	949	25			18	7-10-14 N=24 9000+ (HP)					13	
Boring Terminated at 25.5 Feet												

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *5.5' observed while sampling*
- ▽ *9' observed while sampling*
- ▼ *2' observed on 5/14/19*
- *Cave-in at 13.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 8

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47652° Longitude: -92.4907°

Surface Elev.: 995.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
0.7	995											
TOPSOIL												
LEAN CLAY (CL), trace sand, brown gray, soft			▼		8	0-1-1 N=2	1500 (HP)				21 24	
4.0	991.5											
FAT CLAY (CH), trace sand, gray, stiff		5			9		3000 (HP)	UC	2989	15	26	99
6.5	989											
SANDY LEAN TO FAT CLAY (CL/CH), trace gravel, gray and brown, stiff					18	1-3-4 N=7 4000 (HP)					24	
		10			11	3500 (HP)		UC	3958	15	22	104
			▽									
		15			21			UC	2305	15	20	108
		20	▽		17	4-3-6 N=9 3000 (HP)					16 15	
25.5	970	25			18	3-3-6 N=9 4000 (HP)					15	
Boring Terminated at 25.5 Feet												

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *14' observed while drilling*
- ▽ *20' observed after drilling*
- ▼ *2' observed on 5/14/19*
- ▩ *Cave-in at 13' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 9

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47583° Longitude: -92.4884°

Surface Elev.: 991.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
0.5	991	**TOPSOIL**										
		LEAN CLAY (CL), with sand seams, brown, soft to medium stiff										
				X	14	0-1-2 N=3	1000 (HP)				16 15	
4.0	987.5											
		FAT CLAY (CH), trace sand, dark brown to gray brown, medium stiff	5	X	13	2-2-3 N=5 2500 (HP)					28 20	
6.0	985.5											
		SANDY FAT CLAY (CH), trace gravel, brown gray, stiff		X	18	2-3-5 N=8 4000 (HP)					28	
8.0	983.5											
		SANDY LEAN CLAY (CL/SC), with sand layers, gray brown, stiff	10	■	15			UC	1680	3.5	19	113
14.0	977.5											
		SANDY LEAN CLAY (CL), trace gravel, light brown gray, stiff to very stiff	15	X	18	3-5-5 N=10 3500 (HP)					14	
			20	X	18	3-4-5 N=9 4500 (HP)					16	
25.5	966		25	X	18	3-5-8 N=13 4500 (HP)					14	
		Boring Terminated at 25.5 Feet										

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

▽ *14' observed while sampling*

None observed on 5/14/19

▨ *Wet cave-in at 3.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 10

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47752° Longitude: -92.4865°

Surface Elev.: 975.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.3	974	**TOPSOIL**											
		LEAN CLAY (CL), trace sand, brown and dark brown, medium stiff		▼		14	1-3-3 N=6 2000 (HP)					31	
4.0	971.5	**SANDY LEAN CLAY (CL/SC)**, trace gravel, with sand seams, brown, medium stiff to stiff	5			13			UC	1206	15	18	114
				▽		18	1-2-3 N=5	2000 (HP)				17	
9.0	966.5	**SANDY LEAN CLAY (CL)**, trace gravel, with sand seams, brown, very stiff	10			23	6000 (HP)					14	124
				▩									
			15			18	2-4-7 N=11 9000+ (HP)					15	
17.0	958.5	**SAND (SP-SC)**, with clay layers, fine to medium grained, brown, medium dense											
20.0	955.5	**SANDY LEAN CLAY (CL)**, trace gravel, brown and gray, very stiff to hard	20			18	6-9-9 N=18 9000+ (HP)					21 17	
			25			18	11-14-21 N=35 9000+ (HP)					12	
30.5	945		30			18	10-14-22 N=36 9000+ (HP)					12	
		Boring Terminated at 30.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *7' observed while sampling*
- ▽ *6.5' observed after drilling*
- ▼ *2' observed on 5/14/19*
- ▩ *Cave-in at 13' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 589 | Driller: MT

Project No.: 13195013

BORING LOG NO. 11

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.4758° Longitude: -92.4865°

Surface Elev.: 973.0 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
TOPSOIL												
3.0	970											
LEAN CLAY (CL), with sand, gray and brown, soft					7	1-1-2 N=3					25	
6.5	966.5				15	1-2-1 N=3 500 (HP)					20	
SANDY LEAN CLAY (CL/SC), trace gravel, with sand seams, gray and brown, stiff		5										
11.0	962				9			UC	3054	14.5	16	119
SAND (SP-SC), with clay, fine to medium grained, brown		10			11		5000 (HP)				17	116
14.5	958.5											
SANDY LEAN CLAY (CL), trace gravel, with sand layers, gray and brown, stiff to very stiff		15			12	0-3-6 N=9 5500 (HP)					24 16	
16.0	957											
SILT (ML), brown, very stiff		20			15	10-13-14 N=27 3500 (HP)					24	
22.0	951											
SANDY LEAN CLAY (CL), trace gravel, gray and brown, hard		25			18	8-13-19 N=32 9000+ (HP)					11	
25.5	947.5											
Boring Terminated at 25.5 Feet												

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *5' observed while sampling*
- *10.5' observed after drilling*
- *3.5' observed on 5/14/19*
- *Cave-in at 8' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 12

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47582° Longitude: -92.4854°

Surface Elev.: 968.5 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
			▼									
3.0	965.5				3	1-2-2 N=4					38	
		5			4	2-3-4 N=7	2000 (HP)				20	
6.5	962											
					10			UC	1730	15	22	104
			▨									
11.0	957.5	10	▽		18	3-4-4 N=8	4500 (HP)				20	
					18	5-8-10 N=18 9000+ (HP)					12	
16.0	952.5	15	▽									
					13	6-8-11 N=19 9000+ (HP)					10	
		20										
					18	8-12-16 N=28 9000+ (HP)					12	
		25										
30.5	938				18	10-20-26 N=46 9000+ (HP)					12	
		30										

TOPSOIL

LEAN CLAY (CL), trace sand, brown gray, medium stiff to stiff

SANDY LEAN TO FAT CLAY (CL/CH), trace gravel, gray and brown, medium stiff to stiff

SANDY LEAN CLAY (CL), trace gravel, gray and brown, very stiff

SANDY LEAN CLAY (CL), trace gravel, brown and gray, very stiff to hard

Boring Terminated at 30.5 Feet

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- ▽ *10.5' observed while sampling*
- ▽ *16' observed after drilling*
- ▼ *1' observed on 5/14/19*
- ▨ *Cave-in at 9' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 13

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47529° Longitude: -92.4924°

Surface Elev.: 983.0 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.0	982	**TOPSOIL**										
		LEAN CLAY (CL), trace sand and organics, dark brown, medium stiff										
4.0	979				10	1-2-2 N=4 1000 (HP)					31	
		LEAN CLAY (CL), with sand, gray and brown, soft to medium stiff	5		16	1000 (HP)		UC	983	15	21	108
					18	0-1-1 N=2 1000 (HP)					22	
9.0	974		10		9			UC	1740	15	18	112
		SANDY LEAN CLAY (CL), trace gravel, brown, medium stiff to stiff										
			15		18	2-5-8 N=13	6000 (HP)				15	
18.0	965											
		SILT (ML), with clay layers, gray brown, very stiff										
21.0	962		20		14	9-8-7 N=15 9000+ (HP)					20	
		SANDY LEAN CLAY (CL/SC), trace gravel, with sand layers, gray and brown, very stiff to hard										
			25		18	4-7-10 N=17 9000+ (HP)					19	
30.5	952.5		30		17	6-10-13 N=23 9000+ (HP)					13	
		Boring Terminated at 30.5 Feet										

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *6' observed while drilling*
- *11.5' observed after drilling*
- *3.5' observed on 5/14/19*
- *Cave-in at 17.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 14

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47473° Longitude: -92.4911°

Surface Elev.: 986.5 (Ft.)

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.5	985	**TOPSOIL**										
2.3	984.5	**LEAN CLAY (CL)**, trace sand, dark brown and brown, medium stiff										
		SANDY LEAN CLAY (CL), gray and brown, medium stiff to stiff			12	1-2-3 N=5	2500 (HP)				29 25	
			5		18	2-4-5 N=9 3500 (HP)					21	
6.5	980	**SANDY LEAN CLAY (CL)**, trace gravel, gray and brown, medium stiff			7	2000 (HP)		UC	1955	15	20	107
9.0	977.5	**SILT (ML)**, brown, soft to medium stiff	10		18	0-1-1 N=2 500 (HP)					30	
14.0	972.5	**SANDY LEAN CLAY (CL)**, trace gravel, light gray, stiff	15		18	2-3-4 N=7 3000 (HP)					17	
19.0	967.5	**SANDY LEAN CLAY (CL/SC)**, trace gravel, with sand seams, gray and brown, very stiff to hard	20		18	3-6-8 N=14 9000 (HP)					16	
25.5	961		25		13	6-8-11 N=19 9000+ (HP)					15	
		Boring Terminated at 25.5 Feet										

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *9' observed while sampling*
- *20' observed after drilling*
- *3.5' observed on 5/14/19*
- *Cave-in at 18.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 15

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.47504° Longitude: -92.4896°

Surface Elev.: 1002.0 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.7	1000.5											
TOPSOIL												
					11	1-2-3 N=5 1000 (HP)					27	
		5			6		3000 (HP)	UC	2935	15	17	115
					18	2-3-4 N=7 3000 (HP)					16	
		10			18		3000 (HP)	UC	2851	14.4	17	115
14.0	988											
CLAYEY SILT (ML), gray brown, medium stiff to stiff		15			15			UC	1731	15	31	95
17.0	985											
SANDY FAT CLAY (CH), gray and brown, stiff		20			18	2-4-6 N=10	6500 (HP) 7000 (HP)				25 23	
24.0	978											
SANDY LEAN CLAY (CL/SC), trace gravel, with sand layers, gray brown, very stiff		25			13	4-4-7 N=11 5000 (HP)					19	
28.0	974											
SANDY LEAN CLAY (CL), trace gravel, brown, very stiff		30			18	4-6-8 N=14 7000 (HP)					16	
30.5	971.5											
Boring Terminated at 30.5 Feet												

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *14' observed while drilling*
- *9.5' observed after drilling*
- *3.5' obsrved on 5/14/19*
- *Cave-in at 21.5' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

BORING LOG NO. 16

PROJECT: Cedar Falls Industrial Park West Expansion

CLIENT: Snyder & Associates, Inc.
Cedar Rapids, IA

SITE: Union Road
Cedar Falls, IA

LOCATION See Exploration Plan

Latitude: 42.4745° Longitude: -92.4865°

Surface Elev.: 983.0 (Ft.)

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (psf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (psf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
1.9	981											
TOPSOIL												
					7	2-3-3 N=6 3000 (HP)					22	
		5			18	2-1-2 N=3 <500	500 (HP)				22	
6.0	977											
SANDY LEAN CLAY (CL), trace gravel, brown to gray brown, medium stiff to stiff					15			UC	1894	13.1	21	111
		10			18		2000 (HP)	UC	1804	11.6	18	116
		15			21			UC	3668	15	15	115
17.0	966											
SILT (ML), brown, very stiff												
20.0	963											
		20			17	16-20-15 N=35	9000+ (HP)				21 15	
SANDY LEAN CLAY (CL/SC), trace gravel, with silt layers and sand seams, gray and brown, very stiff to hard												
		25			18	5-7-10 N=17	6000 (HP)				26	
		30			17	7-11-14 N=25	9000+ (HP)				13	
30.5	952.5											
Boring Terminated at 30.5 Feet												

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

Hammer Type: Automatic

Advancement Method:
Hollow stem auger

Abandonment Method:
Boring backfilled with soil cuttings and bentonite chips upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations were provided by others.

Notes:

WATER LEVEL OBSERVATIONS

- *13' observed while drilling*
- *12.5' observed after drilling*
- *3.5' observed on 5/14/19*
- *Cave-in at 20' on 5/14/19*

Terracon
3105 Capital Way, Ste 5
Cedar Falls, IA

Boring Started: 05-13-2019 | Boring Completed: 05-13-2019

Drill Rig: # 546 | Driller: WE

Project No.: 13195013

SUPPORTING INFORMATION

Contents:

General Notes
Unified Soil Classification System

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Cedar Falls Industrial Park West Expansion ■ Cedar Falls, IA

June 20, 2019 ■ Terracon Project No. 13195013

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Shelby Tube Split Spoon	**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.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	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

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 [$Cc<1$ or $Cc>3.0$] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or [$Cc<1$ or $Cc>3.0$] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots 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	< 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-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.