Geotechnical Investigation

Arrowhead Park

Neenah, Wisconsin

NEENA 148177 | August 13, 2019

SEH

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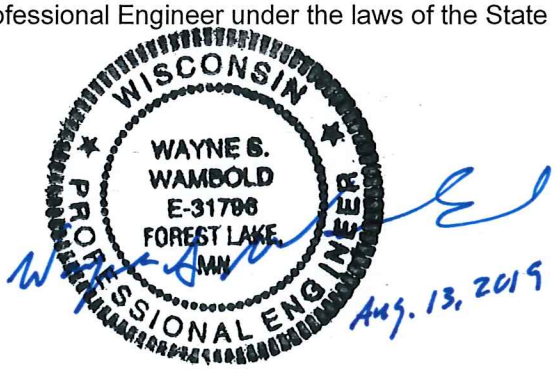
Geotechnical Investigation

Arrowhead Park
Neenah, Wisconsin

Prepared for:
City of Neenah, Wisconsin
Neenah, WI

Prepared by:
Short Elliott Hendrickson Inc.
3535 Vadnais Center Drive
Saint Paul, MN 55110-5196

I hereby certify that this report was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the State of Wisconsin.



Wayne Wambold, PE

Date: August 13, 2019 License No.: E-31796

SEH

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1	Michael Kading Director of Parks and Recreation City of Neenah – Park and Recreation Department 211 Walnut Street Neenah, WI 54956
1	Tess Brester Waste Management Engineer Wisconsin Department of Natural Resources 2984 Shawano Avenue Green Bay, WI 54313

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Prepared for City of Neenah, Wisconsin

1 Introduction

The City of Neenah (City) Parks and Recreation Department is proposing to redevelop a landfill previously utilized by the P. H. Glatfelter Company for disposal of wastewater treatment solids. The proposed project will create recreational park space on the site located north of Main Street on the southern shore of Little Lake Butte des Morts in the city of Neenah, Winnebago County, Wisconsin. The site has been referred to as the Arrowhead Park Landfill. The proposed park space includes site fill and grading, landscape elements, path construction, vehicular access and parking, activity building, and a boardwalk. The Neenah Park Sites #1 and #2 Site Investigation and Development Plan document dated March 2012 was used to understand the history and past construction activity in this site.

1.1 Landfill History

Winnebago Paper Company was founded in 1874 and was located at the intersection of Main Street and Wisconsin Avenue. In 1904, Bergstrom Paper Company (Bergstrom) purchased Winnebago Paper Company. The original southern limits of Little Lake Butte des Morts extended south of the landfill area to the approximate location of Main Street where it joins Union Street. The railroad tracks that formed the southern boundary of the landfill were constructed on a narrow dike.

In 1950, the City was granted a bulkhead line across the south end of Little Lake Butte des Morts. Bergstrom obtained the right from the City to use the area behind the bulkhead dike and they committed to the City that they would fill the area with solids extracted from Bergstrom's wastewater. Once Bergstrom had filled the area behind the bulkhead dike, the City planned to develop the property. The original plans for landfill construction included several small cells adjacent to the wastewater disposal plant and then extension of a dike along the bulkhead line. Soil filling in the area to be occupied by the wastewater treatment plant (WWTP) started in Late 1950 at the east end of the landfill. The treatment plant was constructed in 1952. Solids from the Bergstrom wastewater treatment system were dewatered by a vacuum filter system and then landfilled.

The bulkhead dike was extended about 2,500 feet from the area of the treatment plant, west to the location of the Neenah Slough. The bulkhead dike was constructed from 1957 to 1970. In 1974 the DNR granted Bergstrom a conditional landfill license and exemptions from the water body setback requirements. From the late 1960s and into the 1970s, the City planned to develop the landfill into a public park. The City and DNR also negotiated appropriate cover requirements during this time period. The landfill stopped receiving wastewater solids in 1976 and cover placement was completed before November 1979. The Bergstrom Neenah mill was purchased by Glatfelter in 1979.

1.2 Previous Construction Activities on the Landfill

There was construction on the landfill in addition to the dikes and original treatment plant. Other Bergstrom construction in the area included a clarifier and water treatment plant that were built in late 1967 to early 1968. A trailer truck parking area was constructed to the west of the clarifier in 1971. In 1976, the secondary WWTP was constructed and an aboveground fuel tank was erected. In 1990 and 1991, a combustor building and stabilization basin were constructed adjacent to the treatment plant. Other than the original treatment plant and parking lot, all construction was supported on pile foundations. The buildings and oil tank were demolished in 2007 after Glatfelter closed the Neenah mill.

The City constructed storm sewer extension and a sanitary sewer line below the landfill. The sanitary sewer and the storm sewer extension were installed in 1975. Both sewers were designed and installed with an understanding of the anticipated loads associates with the landfill overburden.

The Fox Valley Energy (FVE) Center (previously Minergy) was constructed in the central portion of the landfill in 1996. It was reported that the wastewater solids were removed from the footprint of the building prior to construction of the foundation. However, a current geotechnical investigation recovered samples containing paper mill waste at the FVE Center. The foundation details as well as their location and dimensions for the FVE Center remain unknown and unverified.

Park Site #1, located on the east side of the site, was used for sand storage during the 2008 sediment capping operations associated with the Fox River remediation. It was estimated that 10,000 to 15,000 tons of sand were stored at any one time approximately south of the bulkhead dike where the treatment plant and the FVE Center were located. The sand was estimated to be piled to a height of 15 to 20 feet at certain locations.

2 Geotechnical Investigation

Various geotechnical investigations were performed at different times throughout the project site. However, all recommendations provided herein are based on the results of the geotechnical investigation performed by ECS Midwest, LLC (ECS) of Neenah, Wisconsin during December 2018. The drilling program for the geotechnical investigation, field testing, and laboratory testing were developed by SEH geotechnical staff. Soil boring and testing locations were focused at the proposed vehicular access and parking, the activity building, and at the existing bulkhead dike near the proposed boardwalk. A geotechnical data report (GDR) prepared by ECS and dated February 18, 2019 summarizing the borings and laboratory testing is included as Appendix A. Shelby tube samples were also obtained for testing.

The geotechnical investigation consisted of 11 standard penetration test (SPT) soil borings using a hollow stem auger and sampling every 2.5 feet. The borings terminated at depths between 20 to 50 feet below the existing ground surface.

Laboratory testing consisted of moisture content, Atterberg limits, organic content, specific gravity, dry density, consolidation, triaxial compression unconsolidated undrained (UU), and triaxial compression consolidated undrained (CU). Field tests in addition to SPT included vane shear tests and pocket penetrometer.

3 Subsurface Conditions

Topsoil was encountered at borings B-1 and B-2 along the bulkhead dike. The topsoil varied in thickness from 9 to 10 inches. Underlying the topsoil is a fill layer predominantly classified as lean clay with gravel (CL). The fill is approximately 9 feet thick. Underlying the fill is a lacustrine deposit predominantly classified as fat clay (CH). Boring B-1 identifies a thin swamp deposit layer classified at organic silt (OL)/peat (PT) between the lacustrine deposit at an approximate depth of 13 feet below the surface. Boring B-2 identifies a 5 feet thick swamp deposit classified at peat (PT) underlying the lacustrine deposit. Underlying the lacustrine/swamp deposits is glacial till classified as lean clay (CL). The borings terminate in the glacial till at depths of 50 and 22 feet below the surface at borings B-1 and B-2, respectively.

Borings along the proposed vehicular access and parking do not show topsoil with the exception of boring B-3, which measured 4 inches of topsoil. Otherwise, a fill layer classified as lean clay (CL) is identified at the surface by the borings. It is presumed that this fill layer is part of the landfill cap. The cap thickness varies between 0.25 to 9 feet. Underlying the cap is a fill layer identified as paper mill waste. The paper mill waste varies in thickness between 8 to 11 feet. Boring B-6 to the southeast of the landfill did not encounter the paper mill waste. However, fill classified as lean clay (CL) is recorded up to a depth of 15 feet below the ground surface. Glacial till classified as lean clay (CL) underlies the paper mill waste. The borings terminate in the glacial till at depths between 20 and 22.5 feet below the surface.

Borings at the activity building site identify fill at the surface. Again the fill is presumed to be the landfill cap and fill placed for previous site development. The cap thickness varies from 5.5 to 10.5 feet. The top half of the fill is classified as silty gravel with cobbles (GM) while the bottom is classified as lean clay with gravel (CL), likely cap material. Underlying the cap is a fill layer identified as paper mill waste. The paper mill waste varies in thickness between 9 to 10.5 feet. Glacial till classified as lean clay (CL) underlies the paper mill waste. The borings terminate in the glacial till at depths between 22.5 and 25 feet below the surface.

Boring B-4 measure the cap to the paper mill waste at approximately 0.5 feet. It is recommended to re-establish the cap to a minimum of 3 feet throughout the project site.

4 Groundwater Conditions

Groundwater was observed at 7 of the 11 borings. The groundwater elevations vary greatly throughout the site. Excluding the two outlying measurements at borings B-1 and B-3 and at B-7 where the surface elevation is not recorded, the average groundwater elevation is 732.4 feet. See Table 1 for a summary of groundwater depths and elevations.

Table 1 – Groundwater Summary

Boring	Surface Elevation (ft)	Groundwater Depth (ft)	Groundwater Elevation (ft)
B-1	744.23	23	721.23
B-2	745.06	13	732.06
B-3	745	6	739
B-4	745.12	13	732.12
B-5	751.55	18	733.55
B-6	747.84	---	---
B-7	N/A	8	N/A
B-8	751.16	---	---
B-9	749.86	---	---
B-10	750.37	---	---
B-11	753.84	22	731.84

It is difficult to establish the natural water table aquifer from the boring measurements due to the nature of the soils. Groundwater depths recorded during drilling can be unreliable because of the short time period of the observation. In silty, clayey, or organic soils, longer duration observations within the borehole are typically necessary to obtain a more accurate measurement of the water table.

However, with the site adjacent to Little Lake Butte des Morts it can be assumed that groundwater will be equivalent to the lake water elevation. The water elevation of the lake is approximately 738 feet. Fluctuation of the groundwater elevation should be expected during periods of precipitation, snow melt, and variations in the Little Lake Butte des Morts water elevation.

5 Geotechnical Recommendations

5.1 Boardwalk Recommendations

The proposed boardwalk is a structure that extends into Little Lake Butte des Morts from the bulkhead dike. The boardwalk recommendations address the boardwalk foundation and interaction with the bulkhead dike. The borings at the bulkhead dike do not record any paper mill waste and therefore, settlement will be negligible. Cross sections were developed with existing stratigraphy to model the slope stability of the bulkhead dike at the contact location with the proposed boardwalk. Slope stability analysis results show a factor of safety of 1.3 at the proposed contact location with the boardwalk without foundation loading. This factor of safety is considered acceptable for the existing slope.

Due to the steep existing riprap slope, it is recommended not to bear the majority of the load from the boardwalk superstructure onto the bulkhead dike. An option recommended to connect the boardwalk to the bulkhead dike is to build an extension outward from the existing bulkhead dike to support the boardwalk superstructure load. It is recommended that the dike extension have a slope no steeper than 3 horizontal to 1 vertical and be protected with riprap similar in size to the bulkhead dike. A second recommended option is to drive piles, or use helical piles, to support the superstructure through the bulkhead dike to bear the majority of the load of the superstructure and connect the superstructure to the bulkhead dike via walkway access.

Pile foundations, consisting of either driven piling or helical piles, are recommended to support the boardwalk superstructure. The borings at the bulkhead dike do not terminate on either bedrock or dense granular soils. However, loads for boardwalks are typically low enough such that 10 to 20 ton piles could be designed to bear on the glacial till at a depth of approximately 45 feet.

Slope stability analysis was performed at the proposed boardwalk location at approximately Station 0+05 along the bulkhead dike alignment. Slope stability analysis results show a factor of safety of 1.3 as previously mentioned. The riprap protection slope in front of the bulkhead dike varies across the site and becomes steeper at places. If the proposed boardwalk location moves, it is recommended that slope stability analysis be performed at the new location to address the slope and riprap.

As part of the slope stability analysis, it was determined that site grading in the vicinity of the bulkhead dike does not negatively impact the slope stability of the dike.

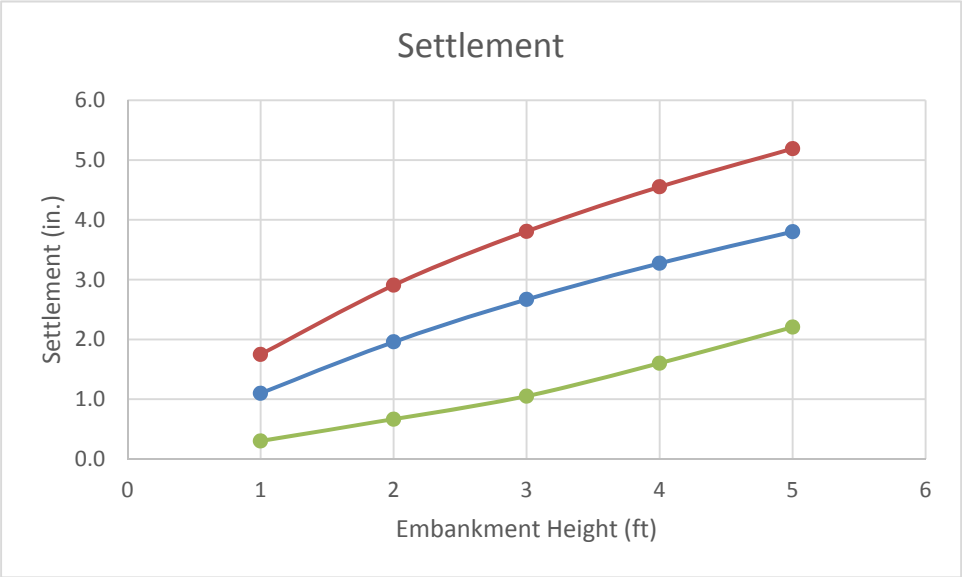
5.2 Vehicular Access and Parking Recommendations

Settlement analysis was performed for the vehicular access and parking at three of the boring locations. It was assumed that all settlement would occur in the paper mill waste layer. The profile for the vehicular access and parking were not available for the settlement analysis. Therefore, settlement analysis was performed assuming the vehicular access and parking embankment varied from 1 to 5 feet. Settlement estimates ranged from 0.3 to 5.2 inches depending on the embankment height. See Figure 1 for a summary of the estimated settlement along the vehicular access and parking.

Time rate of settlement calculations were performed for the vehicular access and parking to estimate the time it would take to reach an acceptable settlement tolerance. The time rate of settlement analysis was performed for an assumed range of post construction settlement,

ranging from 0.25 to 2 inches. The time rate of settlement varied from 1 to 5 months depending on the embankment height and settlement tolerance.

Figure 1 – Settlement Summary



It is recommended to construct the vehicular access and parking embankment to the elevation of the proposed pavement and leave the embankment in place for 5 months to reach an acceptable settlement tolerance. It is recommended to regrade the embankment and finish construction of the pavement after the appropriate amount of time has taken place and no further settlement is measured.

Subgrade soils will consist of onsite fill generally classified as lean clay (CL) and paper mill waste. It is recommended to use a Design Group Index (DGI) of 16 for pavement design.

Preloading the vehicular access and parking with a surcharge fill could be an option considered to accelerate the time required to reach an acceptable settlement tolerance. The surcharge should be designed during final design taking the construction schedule in consideration. A monitoring program is recommended to be designed as part of the surcharge in order to monitor the settlement during construction.

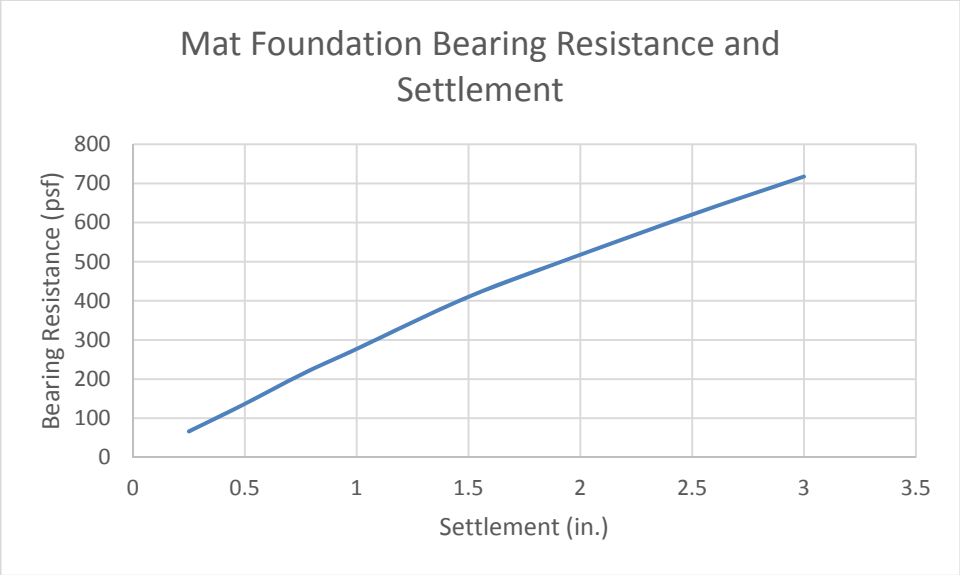
5.3 Activity Building Recommendations

The activity building in Arrowhead Park has not yet been designed. However, the building dimensions were assumed based on scaled concept drawings of the building. The building was assumed to be 50 feet by 125 feet. Bearing capacity and bearing resistance for acceptable settlement were estimated assuming the building foundations consisted of either a mat foundation or a strip footing. The bottom of the mat foundation was assumed to be 1 foot below existing grade. The bottom of the strip footing was assumed to be 3.5 feet below existing grade. Building loads for the activity building were estimated based on bearing resistance for acceptable settlement and bearing capacity.

5.3.1 Mat Foundation Bearing Resistance

In order to estimate the activity building's bearing resistance for settlement, a range of settlement values were assumed from 0.25 to 3 inches. The bearing resistance for the settlement range varies from 66 to 718 pounds per square foot. See Figure 2 for a chart showing the bearing resistance as a function of settlement.

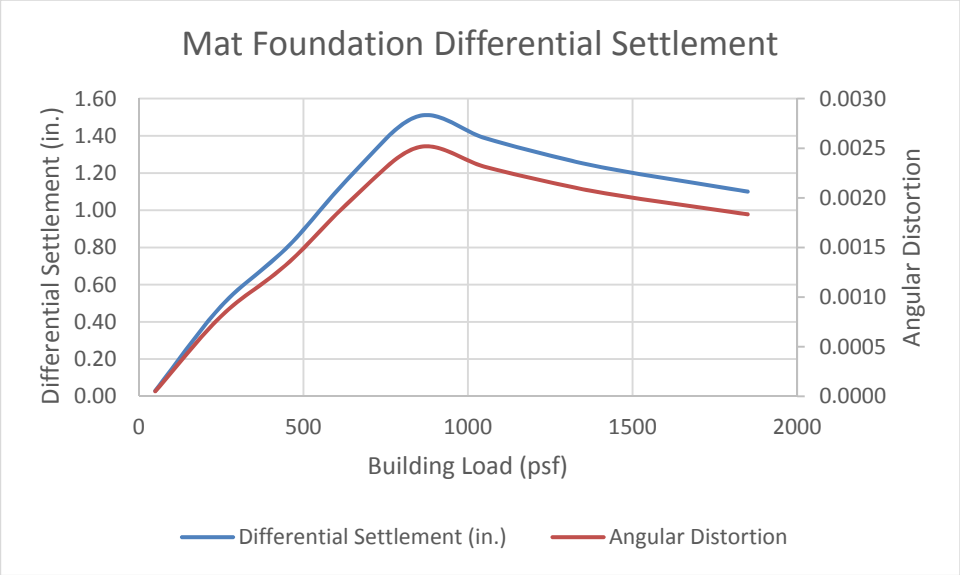
Figure 2 – Mat Foundation Bearing Resistance and Settlement



5.3.2 Mat Foundation Differential Settlement

The differential settlement was estimated between the corners of the building under building loads that vary from 50 to 1850 pounds per square foot. Differential settlement can be estimated by looking up the values based on the results from Figure 3.

Figure 3 – Mat Foundation Differential Settlement and Angular Distortion



With respect to differential settlement, change in angular distortion is the settlement difference between two points divided by the distance. It is recommended to keep angular distortion under a value of 0.002 to avoid either structural or architectural damage to the activity building.

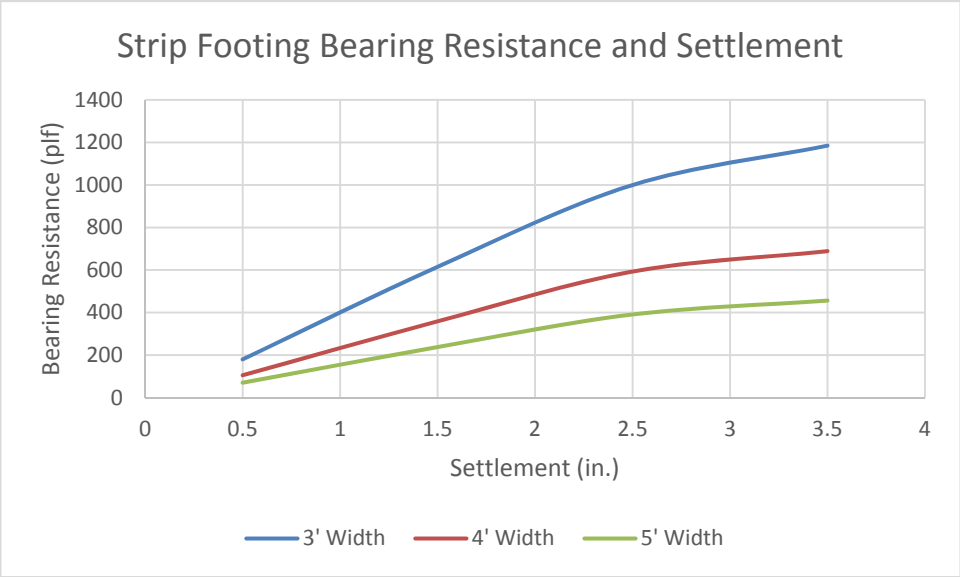
5.3.3 Mat Foundation Bearing Capacity

Bearing capacity was estimated for a mat foundation using the assumed activity building dimensions of 50 feet by 125 feet. The building load was assumed to be projected down unto the paper mill waste at a slope of 1H to 2V outward from the edge of the foundation. The allowable bearing capacity was estimated to be 520 pounds per square foot. Therefore, it is recommended to design the building with a maximum load of 520 pounds per square foot for a mat foundation buried 1 foot below grade. This will limit total settlement to approximately 2 inches with a differential settlement of 1 inch and meet the requirements for angular distortion of 0.002 or less.

5.3.4 Strip Footing Bearing Resistance

In order to estimate the activity building's bearing resistance for settlement, a range of settlement values were assumed from 0.5 to 3.5 inches. The bearing resistance for the settlement range varies for strip footings of different widths. See Figure 4 for the bearing resistance as a function of settlement and strip footing width.

Figure 4 – Strip Footing Bearing Resistance and Settlement



5.3.5 Mat Foundation Differential Settlement

The differential settlement was estimated between the corners of the building under building loads that vary from 100 to 1600 pounds per linear foot. Differential settlement can be estimated by looking up the values based on the results from Figure 5.

Figure 5 – Strip Footing Differential Settlement

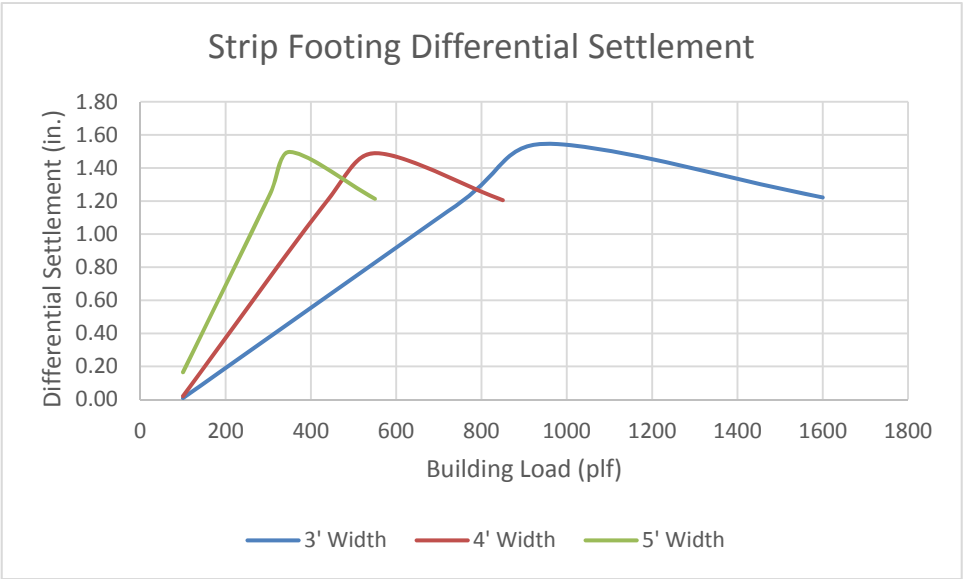
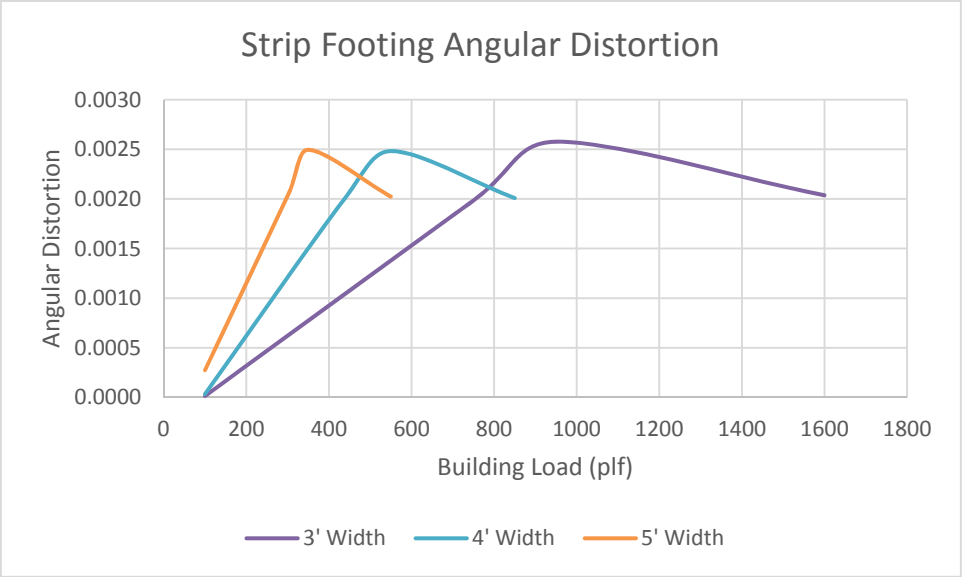


Figure 6 – Strip Footing Angular Distortion



It is recommended to keep angular distortion under a value of 0.002 to avoid either structural or architectural damage to the activity building. It is recommended to use Figure 6 to determine the acceptable building loads to prevent damage to the building.

5.3.6 Strip Footing Bearing Capacity

Bearing capacity was estimated for a strip footing of varying dimensions. The allowable bearing capacity of the strip footing was estimated as a function of the footing width. Settlement controls the allowable bearing capacity for the strip footing. See Table 2 for the relationship between footing width, allowable bearing capacity, and settlement.

Table 2 – Strip Footing Bearing Capacity

Footing Width (ft)	Allowable Bearing Capacity (plf)	Allowable Bearing Capacity (psf)	Total Settlement (in.)	Differential Settlement (in.)
3	750	250	2.6	1.2
4	435	109	2.6	1.2
5	300	60	2.8	1.2

Based on the allowable bearing capacity results, it is recommended to use a strip footing width of 3 feet. The allowable bearing capacity for a 3 foot strip footing is 250 pounds per square foot. This is significantly less than the allowable bearing capacity calculated for a mat foundation. It may be difficult to design a building to meet the allowable bearing capacity 250 pounds per square foot and therefore, a mat foundation is recommended as the foundation for the proposed activity building.

5.3.7 General Foundation Recommendations

It is understood that pile foundations for the FVE Center were abandoned during the demolition of the building. It is recommended to locate the FVE Center foundations and determine their condition. This could be accomplished by researching record drawings of the building and/or through geophysical methods. The FVE Center foundations could be used as a foundation for the proposed activity building if the existing foundations are properly located, the activity building fits inside the existing foundation footprint, and the existing foundations are in suitable condition to sustain the activity building load. A load transform platform (LTP) could be designed during final design to support the activity building. It is recommended to use geophysical methods to locate the FVE Center foundations prior to final design of the activity building in order to avoid constructing the activity building partially on the existing foundations and partially outside the foundation footprint as this will result in differential settlement detrimental to the building.

An option to using an LTP on the existing foundation footprint as a foundation to the proposed activity building, is to preload the paper mill waste with a surcharge fill. The surcharge fill should be designed during final design. It is estimated that the surcharge could consist of up to 10 to 12 feet of soil and have a width and length the size of the activity building.

6 Summary

It is recommended to minimize the boardwalk superstructure load on the existing bulkhead dike. Two options recommended are to construct an extension to the bulkhead dike to support the superstructure load or support the boardwalk superstructure on pile foundations through the bulkhead dike. Driven pile foundations are recommended to support the boardwalk superstructure. It is recommended that end bearing piles be driven to bedrock or dense granular soils.

It is recommended to construct the vehicular access and parking embankment to the elevation of the proposed pavement and leave the embankment in place for a period of time required to reach an acceptable settlement tolerance. It is recommended to regrade the embankment and finish construction of the pavement after the appropriate amount of time has taken place and no further settlement is measured. A surcharge fill can be considered to accelerate the time required to reach an acceptable settlement tolerance.

It is recommended to design and construct the activity building using the settlement and bearing capacity figures and tables provided in Section 5.3. If the building is located outside the FVE Center foundation footprint. It is recommended to use geophysical methods to locate the FVE Center foundations prior to final design of the activity building. A load transform platform (LTP) could be designed during final design to support the activity building. A surcharge can be designed during final design as an option to the LTP. Do not locate the activity building such that foundations will be partially located over the former FVE Center Foundations as this will result in detrimental differential settlement and structural damage.

dmk

Appendix A

ECS Geotechnical Data Report

February 18, 2019

Mr. Trevor Frank
S.E.H., Inc.
425 W. Water Street, Suite 300
Appleton, WI 54911
Email: tfrank@sehinc.com

ECS Project No: 59-1591

Reference: **Proposed Arrowhead Park Phase 1 Development**
Millview Drive
Neenah, Wisconsin

Dear Mr. Frank:

ECS Midwest, LLC (ECS) has completed the subsurface exploration and laboratory testing for the above-referenced project. Our services were performed in general accordance with our Proposal No. 59:884-GP, dated December 7, 2018. This factual letter presents our understanding of the geotechnical aspects of the project and the results of the field exploration and laboratory testing program.

Scope of Services

Our scope of services included performing eleven (11) standard penetration test borings at the project site. During the field exploration, ECS continuously monitored the airspace using a personal gas meter and followed the safety protocols outlined in our proposal. These safety protocols included decontamination of our equipment before mobilizing to and from the site, as well as storing wash water and solids, cuttings, drilling fluids, and used PPE in sealed 55-gallon drums in a designated area of the site. We also implemented an in-situ and laboratory-testing program to help characterize the physical and engineering properties of the subsurface soils.

Project Information

The project site is located at the Arrowhead Park property in the City of Neenah, Wisconsin. Mr. Wayne Wambold with S.E.H., Inc., provided ECS with project information, which included a conceptual site plan. Based on the information provided, we understand the proposed project will include the development of park facilities including the construction of an activity building, paved walkways and parking lots, and a boardwalk.

Field Exploration

On December 18, 19, 20, and 21, 2018, ECS advanced eleven (11) standard penetration test borings at the project site. We advanced Boring B1-18 to an approximate depth of 50 feet and Boring B2-18 to 22 feet below the existing grade within the clay bulkhead dike. Across the rest of the site, we advanced Boring B3-18, B4-18, B6-18, and B7-18 to 20 feet, Boring B5-18, B8-18, and B10-18 to 22½ feet, Boring B9-18 to 23 feet, and Boring B11-18 to 25 feet below the existing grade. We also advanced an offset Boring B7A-18 to a depth of 6 feet below the existing grade. We utilized truck-mounted and an all-

terrain vehicle (ATV)-mounted drill rig equipped with continuous flight hollow stem augers to drill the test borings.

S.E.H., Inc., marked the test boring locations in the field. The approximate as-drilled test boring locations are shown on the attached Boring Location Diagram. S.E.H., Inc., also determined the ground surface elevations at the boring locations.

The drillers conducted standard penetration tests (SPTs) in the test borings at regular intervals in general accordance with ASTM D1586. We used the collected small representative samples obtained during tests to classify the soils. The obtained standard penetration resistances provide a general indication of soil relative density and consistency. As requested, ECS personnel also conducted a total of four (4) vane shear tests during the field exploration. We conducted the vane shear tests in Boring B7-18, B7A-18, and B8-18.

ECS collected undisturbed Shelby tubes at select locations and depths in general accordance with ASTM D1587. The drillers sealed the tubes at the site and transported them to our laboratory for extrusion, observation, and logging.

Please note, borehole backfill settlement or expansion can and will occur over time. Long term monitoring the boreholes after the initial drilling activities is not within our Scope of Services. Settlement or expansion of the borehole backfill can create a hazard and should be carefully monitored by the client or property owner.

Laboratory Testing

The laboratory testing performed by ECS consisted of selected tests performed on samples obtained during the field exploration, and included testing requested by Mr. Wayne Wambold with S.E.H., Inc. We performed classification and index property tests on representative soil samples obtained from the test borings to aid classification of the soils using the Unified Soil Classification System, and to help estimate engineering properties. The following paragraphs briefly describe the results of the completed laboratory testing program.

A geotechnical engineer visually classified each collected soil sample from the test borings on the basis of texture and plasticity in general accordance with the Unified Soil Classification System (USCS) and ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). After classification, the geotechnical engineer grouped the various soil types into the major zones noted on the attached test boring logs. The group symbols for each soil type are indicated in parentheses at the beginning of the soil descriptions on the test boring logs. The stratification lines designating the interfaces between earth materials on the test boring logs are approximate; in-situ, the transitions may be gradual.

We performed calibrated hand penetrometer tests (Qp) on cohesive soil samples. In the hand penetrometer test, the unconfined compressive strength of a soil sample is estimated, to a maximum of 6 tons per square foot (tsf), by measuring the resistance of a soil sample to penetration by a small, calibrated, spring-loaded cylinder.

As requested by Mr. Wayne Wambold with S.E.H., Inc., ECS performed a one-dimensional consolidation test as well as tests to determine the moisture content, organic content, Atterberg limits (LL/PL), specific gravity, and dry density of select samples from the borings in accordance with relevant ASTM

procedures. In addition, ECS also contracted Soil Engineering Testing (S.E.T.), Inc. to perform triaxial testing and a one-dimensional consolidation test, as well as tests to determine the moisture content, organic content, Atterberg limits (LL/PL), specific gravity, and dry density of select samples from the borings. The results of these tests can be found in the attached to this report.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposal.

Closing

ECS has prepared this report of findings to guide geotechnical-related design and construction aspects of the project. In fulfilling our obligations and responsibilities, as listed in the proposal, we performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation, expressed or implied, and no warranty or guarantee is included or intended in this report.

It has been our pleasure to be of service to S.E.H, Inc. during the design phase of this project. We would appreciate the opportunity to provide our services during the construction phase to verify the assumptions of subsurface conditions made for this report. Please contact us should you have any questions concerning the information contained in this report, or if we can be of further assistance to you.

Respectfully,

ECS Midwest, LLC

Isaac MacMillan, E.I.T.
Staff Project Manager
imacmillan@ecslimited.com

Matthew A. Meyer, P.E.
Geotechnical Department Manager
mmeyer@ecslimited.com

Alex E. Barker, P.E.
Office Manager
abarker@ecslimited.com

Attachments:

- Reference Notes for Boring Logs
- Test Boring Logs B1-18 through B11-18
- Boring Location Diagram
- Subsurface Cross Sections
- Report of Vane Shear Tests
- Laboratory Test Reports
- Extruded TWT Sample Photographs
- Report of Environmental Monitoring

cc: Mr. Wayne Wambold, S.E.H., Inc.

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]	
	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	FILL[3] MAN-PLACED SOILS
GW	**WELL-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GP	**POORLY-GRADED GRAVEL** gravel-sand mixtures, little or no fines
GM	**SILTY GRAVEL** gravel-sand-silt mixtures
GC	**CLAYEY GRAVEL** gravel-sand-clay mixtures
SW	**WELL-GRADED SAND** gravelly sand, little or no fines
SP	**POORLY-GRADED SAND** gravelly sand, little or no fines
SM	**SILTY SAND** sand-silt mixtures
SC	**CLAYEY SAND** sand-clay mixtures
ML	**SILT** non-plastic to medium plasticity
MH	**ELASTIC SILT** high plasticity
CL	**LEAN CLAY** low to medium plasticity
CH	**FAT CLAY** high plasticity
OL	**ORGANIC SILT or CLAY** non-plastic to low plasticity
OH	**ORGANIC SILT or CLAY** high plasticity
PT	**PEAT** highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS			
SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION		
DESIGNATION		**PARTICLE SIZES**
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS		
UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	**SPT[5] (BPF)**	**CONSISTENCY[7] (COHESIVE)**
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS	
SPT[5]	**DENSITY**
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)[8]	FINE GRAINED (%)[8]
Trace	≤5	≤5
Dual Symbol *(ex: SW-SM)*	10	10
With	15 - 20	15 - 25
Adjective *(ex: "Silty")*	≥25	≥30

WATER LEVELS[6]		
	WL	Water Level (WS)(WD)
		(WS) While Sampling
		(WD) While Drilling
	SHW	Seasonal High WT
	ACR	After Casing Removal
	SWT	Stabilized Water Table
	DCI	Dry Cave-In
	WCI	Wet Cave-In

[1] Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.

[2] To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

*[3] Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-**FILL**)].*

[4] Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

[5] Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf).

[6] The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

[7] Minor deviation from ASTM D 2488-09 Note 16.

[8] Percentages are estimated to the nearest 5% per ASTM D 2488-09.

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B1-18	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC%

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

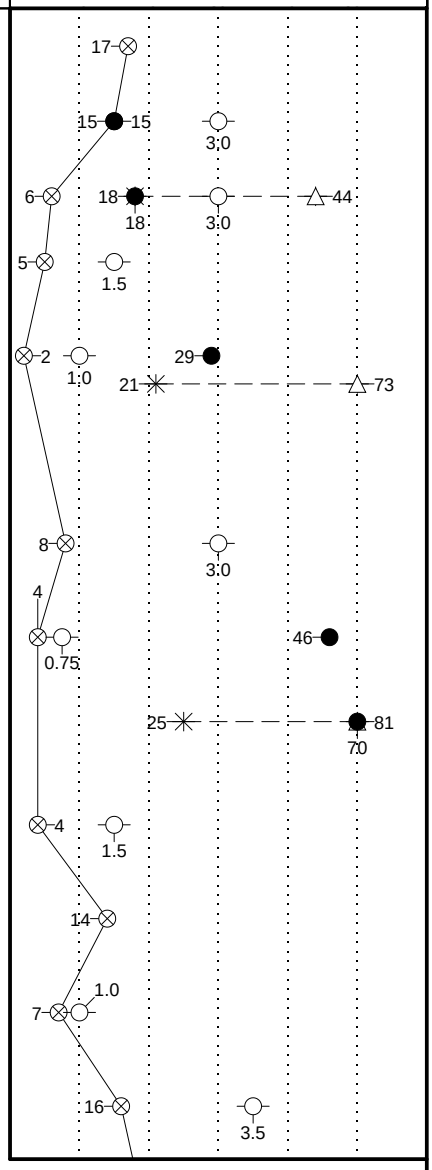
STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 744.23

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [9"]			4 8 9
	S-1	SS	24	18	(GM) Fill, SILTY GRAVEL, dark grayish brown, gray and brown, moist, medium dense			9 4 8
	S-2	SS	24	12	(CL) Fill, LEAN CLAY WITH GRAVEL, trace organic silt, brown and dark brown, moist, stiff to very stiff			7 7 4
5	S-3	SS	24	8	(CL) Fill, LEAN CLAY, trace gravel, lenses of organic silt, brown and dark brown, moist, very stiff to soft		740	3 3 3
	S-4	SS	18	9				2 2 3
	S-5	SS	18	6			735	1 1 1
10	S-6	ST	24	18	(CH) Lacustrine, FAT CLAY, reddish brown, moist, soft			
					(OH/PT) Swamp deposit, ORGANIC SILT/ PEAT, black, moist			
	S-7	SS	18	18	(CH) Lacustrine, FAT CLAY, lenses of silt, reddish brown and light gray, moist, soft to firm		730	3 3 5
15	S-8	SS	18	18	(CH) Lacustrine, FAT CLAY, reddish brown, moist, soft to firm			2 2 2
	S-9	ST	24	23				
20	S-10	SS	18	18	(CL) Lacustrine, LEAN CLAY, trace fine roots, grayish brown and brown, moist to wet, soft to firm		725	1 2 2
	S-11	SS	18	14	(SP) Glacial till, MEDIUM TO COARSE SAND, trace gravel, gray, wet, medium dense		720	2 6 8
25	S-12	SS	18	18	(CL) Glacial till, LEAN CLAY WITH GRAVEL, brown and reddish brown, wet, stiff to very stiff			2 2 5
	S-13	SS	18	18	(CL) Glacial till, LEAN CLAY, trace gravel, lenses of coarse sand, reddish brown, moist to wet, very stiff		715	5 7 9
30								



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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 23 WS ☐ WD ☒	BORING STARTED 12/18/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/18/18	HAMMER TYPE Auto
WL	RIG TRUCK FOREMAN BB/IM	DRILLING METHOD 3.25" HSA 0' to 25', DM 25' to 48.5'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B1-18	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 744.23

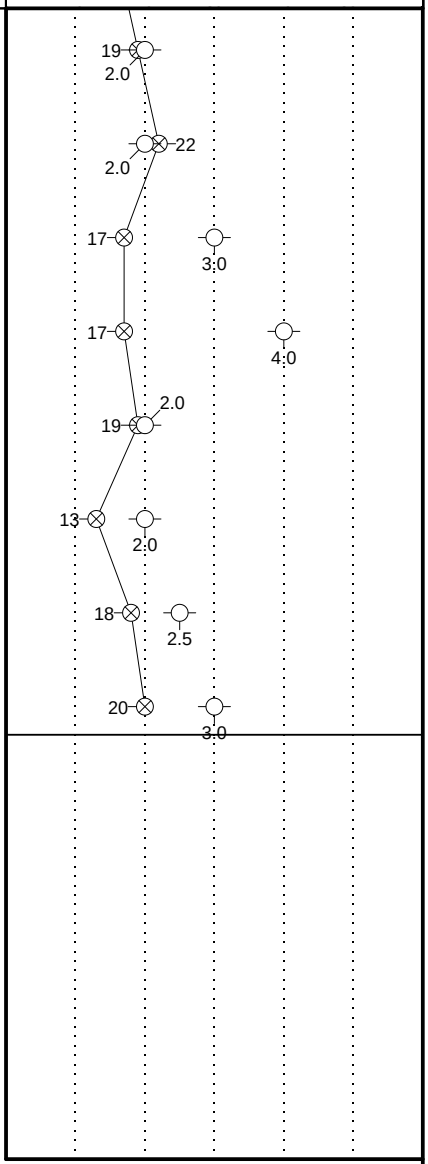
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
	S-14	SS	18	18			6 11 8
	S-15	SS	18	14		710	7 9 13
35							
	S-16	SS	18	16			6 6 11
	S-17	SS	18	10		705	4 6 11
40							
	S-18	SS	18	11			7 8 11
	S-19	SS	18	18		700	4 5 8
45							
	S-20	SS	18	18			7 8 10
	S-21	SS	18	18		695	6 8 12
50							
55						690	
60						685	

(CL) Glacial till, LEAN CLAY, trace gravel, lenses of coarse sand, reddish brown, moist to wet, very stiff

(CL) Glacial till, LEAN CLAY, trace gravel, reddish brown and brown, moist, very stiff to hard

(CL) Glacial till, LEAN CLAY WITH COBBLES, trace gravel, reddish brown, moist, stiff to very stiff

END OF BORING @ 50'



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 23 WS ☐ WD ☒	BORING STARTED 12/18/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/18/18	HAMMER TYPE Auto
WL	RIG TRUCK FOREMAN BB/IM	DRILLING METHOD 3.25" HSA 0' to 25', DM 25' to 48.5'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B2-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

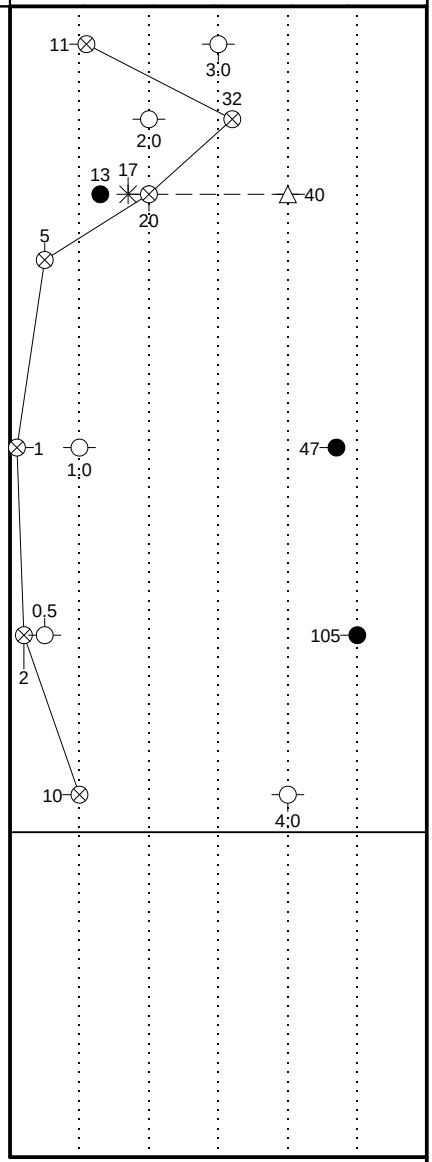
STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 745.06

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness [10"]		745	3 3 8
	S-1	SS	24	12	(CL) Fill, LEAN CLAY WITH GRAVEL AND COBBLES, brown, reddish brown and dark brown, moist, stiff to very stiff			13 22 21
	S-2	SS	24	15	(GC) Fill, CLAYEY GRAVEL WITH COBBLES, brown, moist, stiff to hard			11 10 6
5	S-3	SS	24	8	(CL) Fill, LEAN CLAY WITH SAND AND GRAVEL, brown, reddish brown and gray, moist, hard to firm		740	8 12 15
	S-4	SS	18	0				2 3 2
	S-5	ST	24	5	(CL) Lacustrine, LEAN CLAY, lenses of organic silt, reddish brown, gray and dark gray, moist, very soft to firm			
10	S-6	SS	18	10			735	1 0 1
	S-7	ST	24	20	(PT) Swamp deposit, PEAT, black, moist, very soft to soft			
15	S-8	SS	18	18			730	1 1 1
	S-9	ST	24	24	(CL) Glacial till, LEAN CLAY, trace gravel, dark brown, moist, stiff to very stiff			
20	S-10	SS	24	14			725	3 4 6 9
					END OF BORING @ 22'			
25							720	
30							715	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 13 WS ☐ WD ☒	BORING STARTED 12/19/18	CAVE IN DEPTH
WL(SHW) WL(ACR) 16	BORING COMPLETED 12/19/18	HAMMER TYPE Auto
WL	RIG TRUCK FOREMAN BB/IM	DRILLING METHOD 3.25" HSA 0' to 20'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B3-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 745.0

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0						745	2 1 3 5
	S-1	SS	24	20			
							2 2 2 2
	S-2	SS	24	11			
5	S-3	SS	24	13		740	1 1 1 2
	S-4	SS	18	18			1 1 1 1
	S-5	SS	18	10			1 1 1
10						735	
	S-6	SS	18	18			2 3 4
	S-7	SS	18	18			2 3 5
15						730	
	S-8	SS	18	18			2 2 3
	S-9	SS	18	18			2 2 2
20						725	
25						720	
30						715	

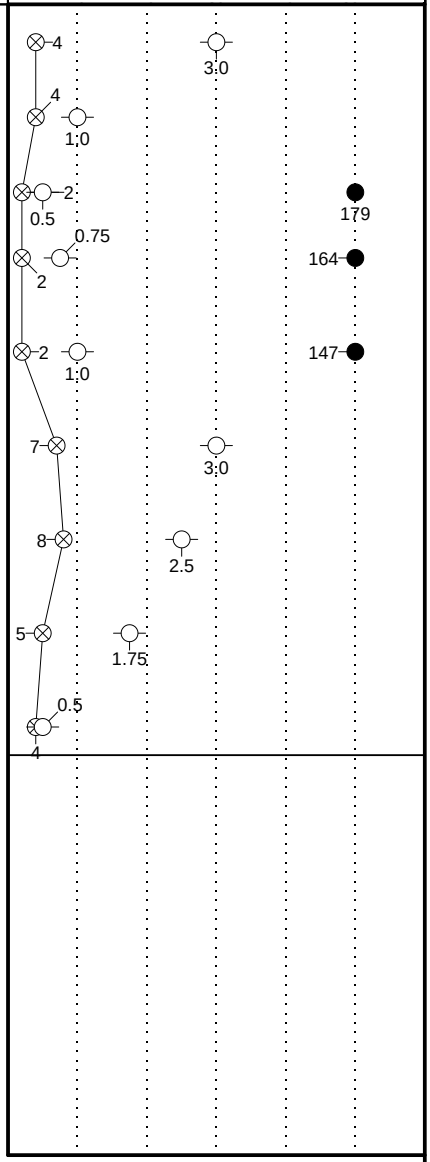
Topsoil Thickness [4"]

(CL) Fill, LEAN CLAY, trace sand and fine roots, reddish brown, moist, soft to very stiff

Fill, PAPERMILL WASTE, bluish gray, moist, very soft to firm

(CL) Lacustrine, LEAN CLAY, lenses of silt, reddish brown and light gray, moist, very stiff to soft

END OF BORING @ 20'



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 6 WS ☐ WD ☒	BORING STARTED 12/20/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/20/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN GB/IM	DRILLING METHOD 3.25" HSA 0' to 18.5

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B4-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 745.12

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	12	(CL) Fill, LEAN CLAY, trace fine roots, reddish brown, moist, very soft to form		745	2 1 1
					Fill, PAPERMILL WASTE, gray, moist, very soft to soft			3
	S-2	ST	24	6				1 1
	S-3	SS	12	0				1 0
5							740	
	S-4	ST	24	14				
	S-5	SS	18	4				1 1 1
10							735	
	S-6	SS	18	11	(CL) Possible fill, SANDY LEAN CLAY WITH GRAVEL, trace organic silt, reddish brown, dark brown and gray, moist, stiff			6 9 6
	S-7	SS	18	18	(CL) Glacial till, LEAN CLAY WITH SILT, brown, moist, soft to stiff			2 2 2
15							730	
	S-8	SS	18	15	(CL) Glacial till, LEAN CLAY, trace gravel, reddish brown, moist, stiff to hard			5 6 9
	S-9	SS	18	10				6 9 11
20					END OF BORING @ 20'		725	
25							720	
30							715	

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 13 WS ☐ WD ☒	BORING STARTED 12/20/18	CAVE IN DEPTH
WL(SHW) WL(ACR) 13	BORING COMPLETED 12/20/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN GB/IM	DRILLING METHOD 3.25" HSA 0' to 18.5

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B5-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

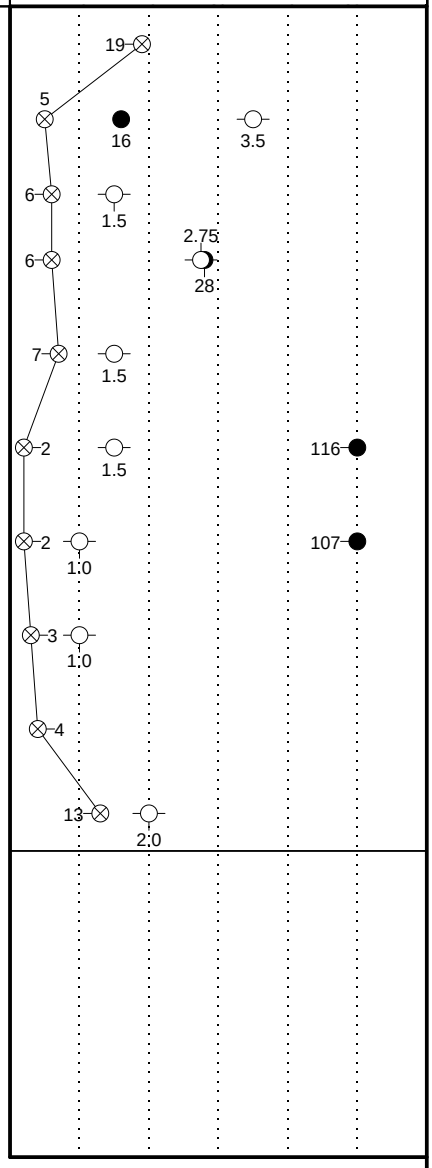
STANDARD PENETRATION BLOWS/FT

ENGLISH UNITS

BOTTOM OF CASING ▰ LOSS OF CIRCULATION ⋈

SURFACE ELEVATION 751.55

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	14	(GC) Fill, CLAYEY GRAVEL, brown, moist to wet, medium dense			9 14
	S-2	SS	24	10	(CL) Fill, LEAN CLAY, trace gravel, reddish brown, dark brown and brown, moist, firm		750	5 6 2 2 3 4
5	S-3	SS	24	9				2 1 5 4
	S-4	SS	18	12	(CL) Fill, LEAN CLAY, trace fine roots and organic silt, reddish brown and brown, moist, very stiff to firm		745	2 3 3
	S-5	SS	18	8	Fill, PAPERMILL WASTE, gray and light greenish gray, moist, very soft to firm			2 3 4
10	S-6	SS	18	18			740	1 1 1
	S-7	SS	18	18				1 1 1
15	S-8	SS	18	18			735	1 1 2
	S-9	SS	18	0	(CL) Lacustrine, SANDY LEAN CLAY WITH ORGANIC SILT, dark brown, moist, very soft to firm	▽		2 1 3
20	S-10	SS	24	24	(CL) Glacial till, SANDY LEAN CLAY, brown and reddish brown, moist to wet, soft to stiff		730	5 6 7 10
					END OF BORING @ 22.5'			
25							725	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

▽ WL 18 WS ☐ WD ☒	BORING STARTED 12/20/18	CAVE IN DEPTH
▽ WL(SHW) ▼ WL(ACR)	BORING COMPLETED 12/20/18	HAMMER TYPE Auto
▽ WL	RIG ATV FOREMAN GB/IM	DRILLING METHOD 3.25" HSA 0' to 20.5

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B6-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

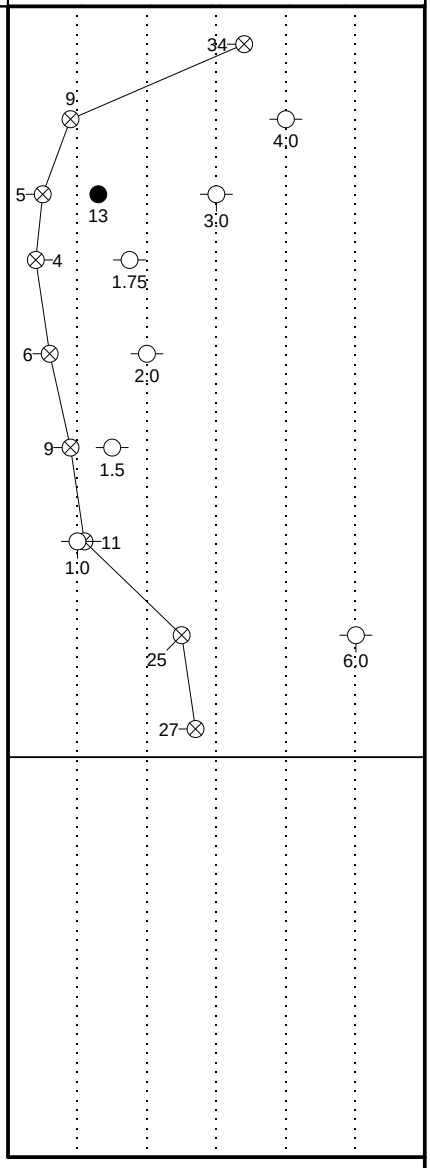
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 747.81

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	16	3" Breaker Run Thickness [6"] (GM) Fill, SILTY GRAVEL WITH COBBLES, dark brown, gray and grayish brown, moist, medium dense		745	15 21 13
	S-2	SS	24	2	(CL) Possible fill, SANDY LEAN CLAY WITH GRAVEL, reddish brown, moist, firm to hard			7 3 4
5	S-3	SS	24	13				5 5 3
	S-4	SS	18	6	(CL) Possible fill, LEAN CLAY WITH SILT, gray, moist, soft to very stiff		740	3 2 2 1 2 2
	S-5	SS	18	10	(CL) Possible fill, LEAN CLAY WITH GRAVEL, reddish brown, moist, firm to stiff			1 2 4
10	S-6	SS	18	12	(CL) Possible fill, SANDY LEAN CLAY WITH GRAVEL, brown, dark brown, reddish brown and gray, moist, stiff		735	2 4 5
	S-7	SS	18	14				6 5 6
15	S-8	SS	18	12	(CL) Glacial till, SANDY LEAN CLAY, trace gravel, reddish brown, moist, very stiff to hard		730	7 11 14
	S-9	SS	18	16				9 12 15
20					END OF BORING @ 20'		725	
25							720	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 12/20/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/20/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN GB/IM	DRILLING METHOD 3.25" HSA 0' to 18.5

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B7-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS; BOTTOM OF CASING; LOSS OF CIRCULATION; SURFACE ELEVATION)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	10	(CL) Fill, LEAN CLAY WITH FINE ROOTS, trace gravel, brown, moist to wet, soft firm			1 1 3
	S-2	SS	24	5				4 1 3
5	S-3	SS	24	0	Fill, PAPERMILL WASTE, gray and bluish gray, moist, very soft to stiff			5 5 1
	S-4	SS	18	14				2 1 1
								2 1
	S-5	SS	18	18				1 0 1
10								
	S-6	ST	24	23				
	S-7	SS	18	18	(CL) Lacustrine, LEAN CLAY, brown, moist, soft			1 2 1
15								
	S-8	SS	18	16	(CL) Glacial till, LEAN CLAY, trace sand and gravel, brown, moist, very stiff			3 4 6
20					END OF BORING @ 20'			
25								
30								

4, 0.5, 0.75, 8, 35, 3, 1, 1.5, 137, 1, 0.75, 88, 106, 3, 0.5, 10

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 8 WS ☐ WD ☒	BORING STARTED 12/21/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/21/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN BB/MH	DRILLING METHOD 3.25" HSA 0' to 20'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B7A-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

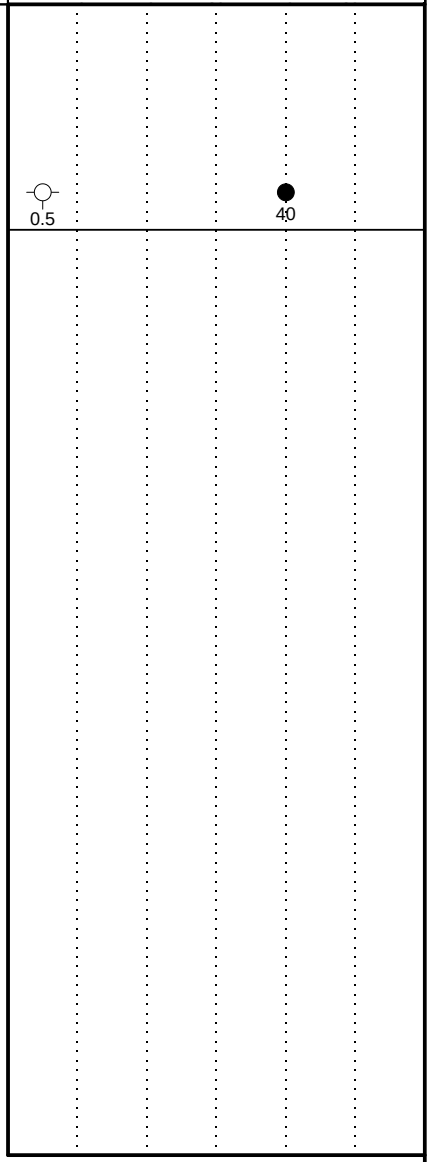
CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS; BOTTOM OF CASING; LOSS OF CIRCULATION; SURFACE ELEVATION)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Blind drill to 4'			
5	S-1	ST	24	12	Fill, PAPERMILL WASTE, gray and bluish gray, moist			
					END OF BORING @ 6'			
					Note: Boring offset 5' South of B7-18.			
10								
15								
20								
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 12/21/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/21/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN GB/MH	DRILLING METHOD 3.25" HSA 0' to 6'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B8-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

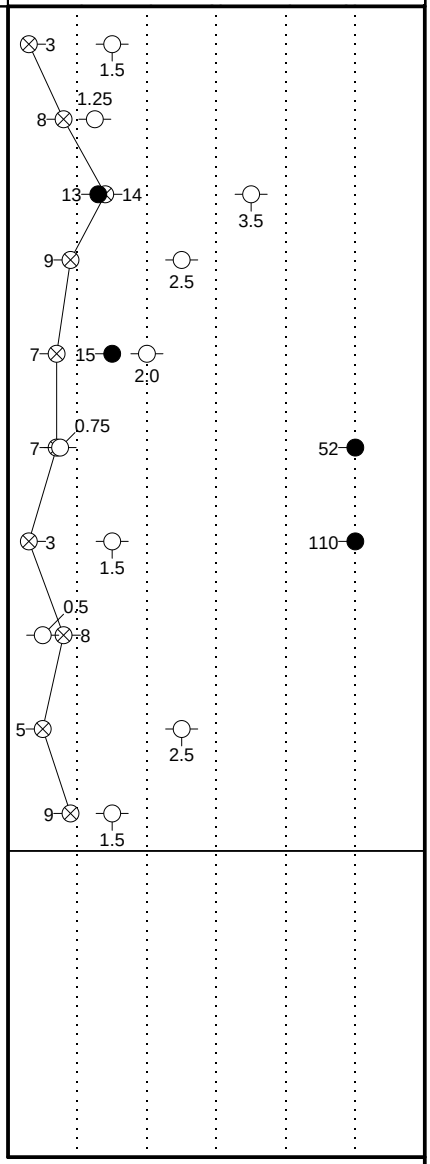
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 751.16

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	13	(CL) Fill, SANDY LEAN CLAY, trace gravel, reddish brown, gray and brown, moist, soft to stiff		750	1 2 1 2 2 3 5 6
	S-2	SS	24	8	(GM) Fill, SILTY GRAVEL, gray, moist, loose			3 4 10 12
5	S-3	SS	24	22	(CL) Fill, LEAN CLAY, trace gravel, reddish brown, moist, stiff to very stiff		745	3 4 5
	S-4	SS	18	13				
	S-5	SS	18	7	Fill, PAPERMILL WASTE, gray and bluish gray, moist, soft to stiff		740	3 3 4 7 3 4
10	S-6	SS	18	8				
	S-7	SS	18	18				3 1 2
15	S-8	SS	18	13			735	3 4 4
					(SP) Possible fill, MEDIUM SAND, dark gray, moist, loose			
	S-9	SS	18	18	(CL) Lacustrine, LEAN CLAY, lenses of silt, brown, moist, stiff to very stiff			2 2 3
20	S-10	SS	24	20			730	3 5 4
					END OF BORING @ 22.5'			
25							725	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 12/21/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/21/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN BB/MH	DRILLING METHOD 3.25" HSA 0' to 21'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B9-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

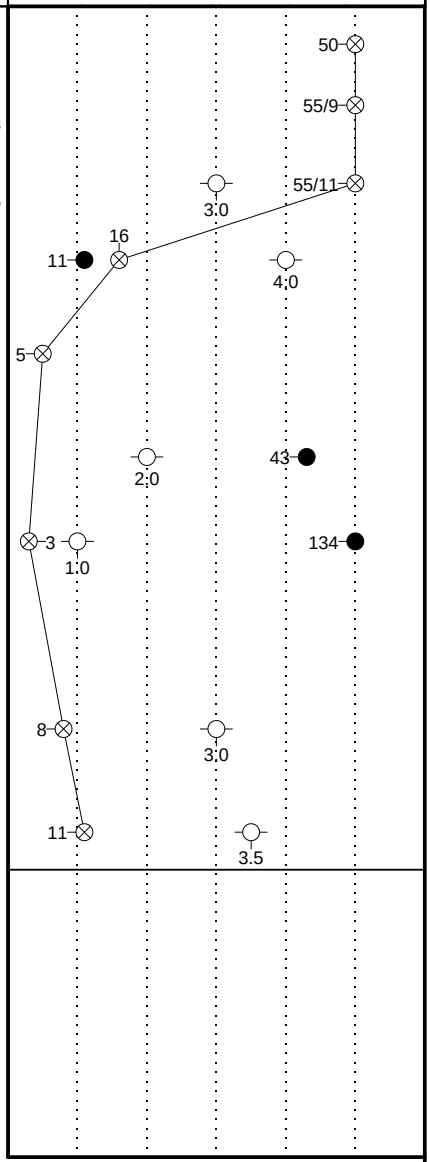
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 749.86

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	17	(GM) Fill, SILTY GRAVEL WITH COBBLES, brown, gray and dark brown, wet to moist, very dense			27 22 28
	S-2	SS	15	3				16 3 5
	S-3	SS	17	12	(CL) Fill, LEAN CLAY WITH GRAVEL, trace cobbles, brown, reddish brown and gray, moist, very hard to very stiff		745	50/3 3 5
5	S-4	SS	18	14				50/5 3 5
	S-5	SS	18	0	Fill, PAPERMILL WASTE, gray and bluish gray, moist, soft to firm		740	11 1 2
10	S-6	ST	24	18				3
	S-7	SS	18	16			735	2 1 2
15	S-8	ST	24	24	(CL) Glacial till, LEAN CLAY, brown and reddish brown, moist, firm to very stiff			
	S-9	SS	18	18			730	2 3 5
20	S-10	SS	24	24				3 5 6 10
25					END OF BORING @ 23'		725	
30							720	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 12/19/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/19/18	HAMMER TYPE Auto
WL	RIG TRUCK FOREMAN BB/IM	DRILLING METHOD 3.25" HSA 0' to 21'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B10-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

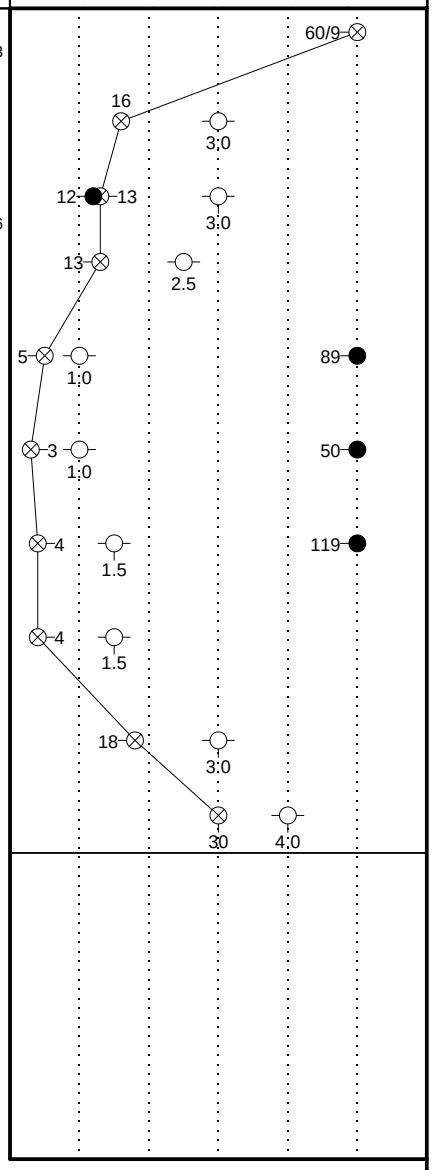
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 750.37

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	15	10	(GM) Fill, SILTY GRAVEL WITH COBBLES, gray and brown, moist, very dense		750	5 10 50/3
	S-2	SS	24	8	(CL) Fill, SANDY LEAN CLAY WITH GRAVEL, brown, dark brown, reddish brown and gray, moist, stiff to very stiff			10 8 8 7
5	S-3	SS	24	14			745	4 5 8 50/6
	S-4	SS	18	3	Fill, PAPERMILL WASTE, gray and bluish gray, moist, soft to stiff			5 8 5
	S-5	SS	18	16				2 3 2
10	S-6	SS	18	14			740	2 1 2
	S-7	SS	18	18				2 2 2
15	S-8	SS	18	18			735	4 2 2
	S-9	SS	24	20	(CL) Glacial till, LEAN CLAY, trace sand and gravel, brown and reddish brown, moist, very stiff to hard			6 6 12 14
20	S-10	SS	24	24			730	8 11 19 24
					END OF BORING @ 22.5'			
25							725	
30							720	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☒	BORING STARTED 12/20/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/20/18	HAMMER TYPE Auto
WL	RIG ATV FOREMAN GB/IM	DRILLING METHOD 3.25" HSA 0' to 20.5'

CLIENT	Job #:	BORING #	SHEET
Short Elliott Hendrickson, Inc.	59:1591	B11-18	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Arrowhead Park Phase 1	Alex E. Barker

SITE LOCATION: 355 Millview Drive, Neenah, Winnebago, WI

NORTHING | EASTING | STATION

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – — – REC% ———

PLASTIC LIMIT% | WATER CONTENT% | LIQUID LIMIT%

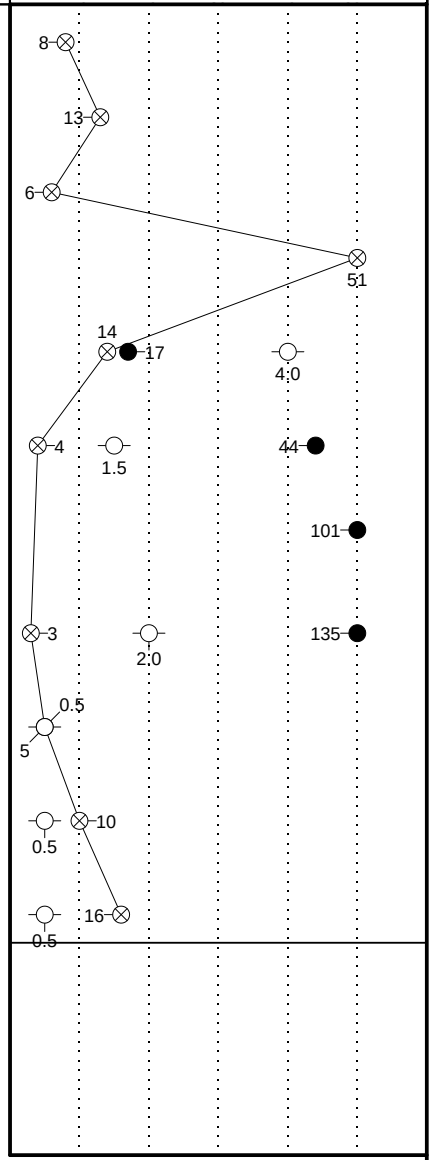
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING | LOSS OF CIRCULATION

SURFACE ELEVATION 753.84

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	SS	24	12	(GM) Fill, SILTY GRAVEL, lenses of clay, brown and gray, moist, loose to very dense		750	8 5 3 9 5 8 5 9 5 3 3 3 6 6 45
5	S-2	SS	24	13				
	S-3	SS	24	10				
	S-4	SS	18	6				
					(CL) Fill, LEAN CLAY WITH GRAVEL, brown and reddish brown, moist, stiff to very stiff		745	5 6 8
10	S-5	SS	18	9				
	S-6	SS	18	11	Fill, PAPERMILL WASTE, grey and bluish gray, moist, soft to stiff		740	2 2 2
	S-7	ST	24	23				
15	S-8	SS	18	18			735	1 2 1
	S-9	SS	18	4				1 2 3
20	S-10	SS	18	4	(CL) Possible fill, LEAN CLAY WITH SAND, brown, moist to wet, soft to stiff	▽	730	3 5 5
	S-11	SS	18	12				6 7 9
25					END OF BORING @ 25'		725	
30								



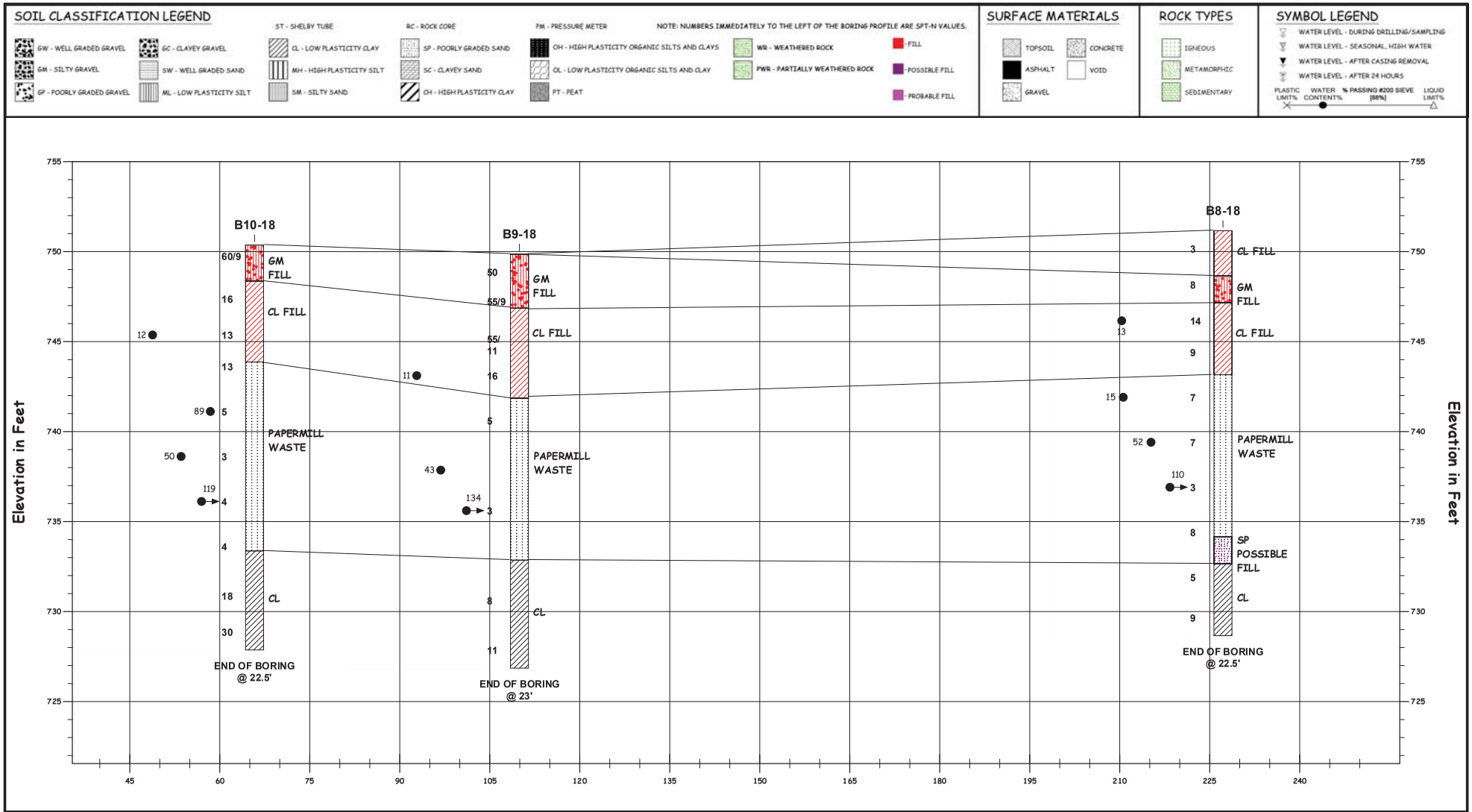
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 22 WS ☐ WD ☒	BORING STARTED 12/19/18	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 12/19/18	HAMMER TYPE Auto
WL	RIG TRUCK FOREMAN BB/IM	DRILLING METHOD 3.25" HSA 0' to 23.5'

Boring Location Diagram
ARROWHEAD PARK PHASE 1

355 MILLVIEW DRIVE, NEENAH, WI
SHORT ELLIOTT HENDRICKSON, INC.

ENGINEER	ILM
SCALE	1 " = 250 '
PROJECT NO.	59:1591
SHEET	1 OF 1
DATE	2/5/2019

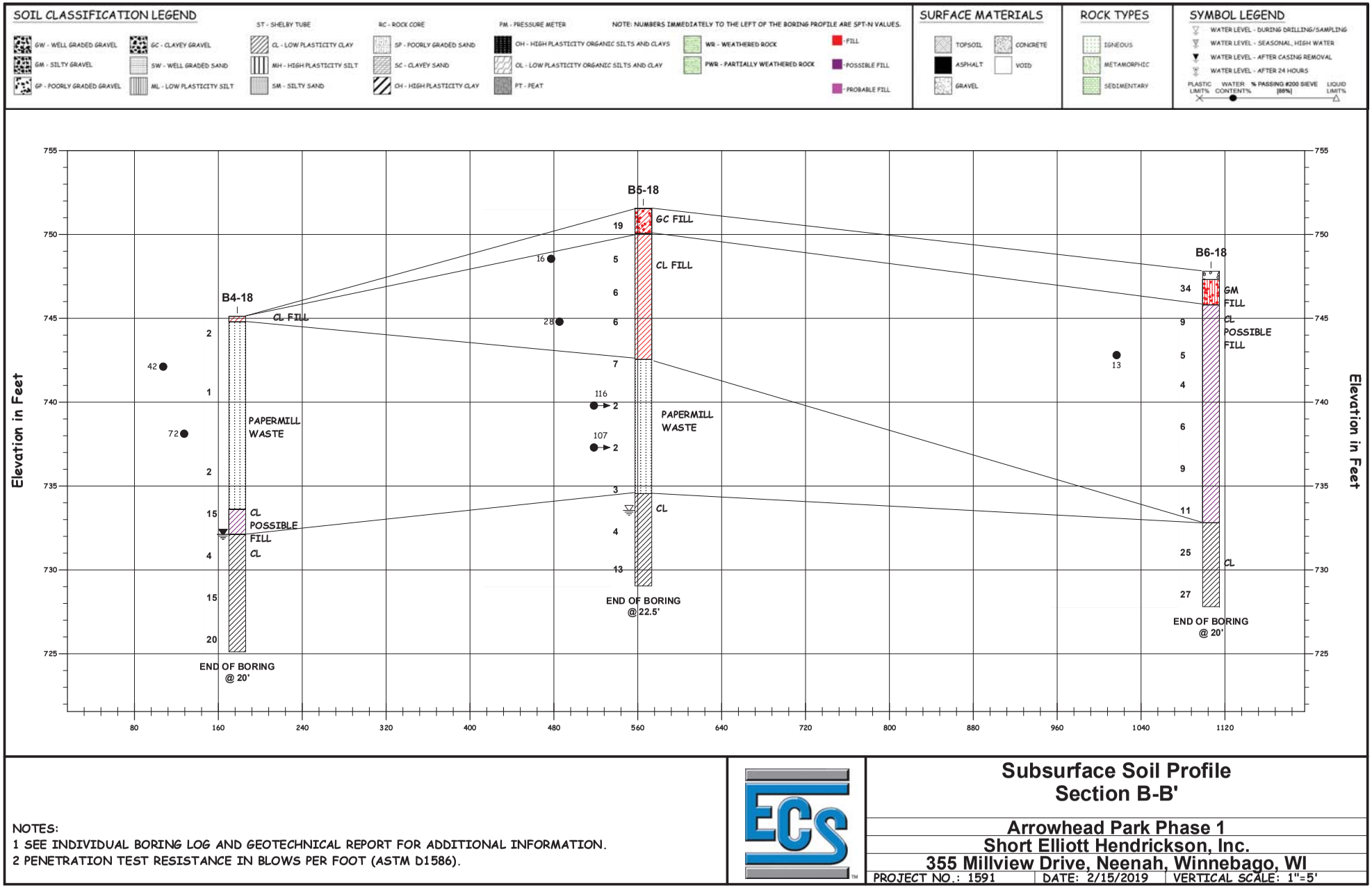


NOTES:
1 SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL REPORT FOR ADDITIONAL INFORMATION.
2 PENETRATION TEST RESISTANCE IN BLOWS PER FOOT (ASTM D1586).

Subsurface Soil Profile
Section A-A'

Arrowhead Park Phase 1
Short Elliott Hendrickson, Inc.
355 Millview Drive, Neenah, Winnebago, WI

PROJECT NO.: 1591 | DATE: 2/15/2019 | VERTICAL SCALE: 1"=5'



NOTES:
1 SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL REPORT FOR ADDITIONAL INFORMATION.
2 PENETRATION TEST RESISTANCE IN BLOWS PER FOOT (ASTM D1586).

Subsurface Soil Profile
Section B-B'

Arrowhead Park Phase 1
Short Elliott Hendrickson, Inc.
355 Millview Drive, Neenah, Winnebago, WI

PROJECT NO.: 1591	DATE: 2/15/2019	VERTICAL SCALE: 1"=5'

ECS

REPORT OF VANE SHEAR TESTS
1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

Project: Arrowhead Park Phase 1
Neenah, Wisconsin

Copies:

Client: Mr. Trevor Frank
S.E.H Inc.

Date: February 5, 2019

ECS Project No: 59-1591

GENERAL:
Scope of Work: Standard Test Method for Field Vane Shear Test in Cohesive Soil

Date of Test: December 21, 2018
Test Location: Soil Borings
Test Performed By: B. Broennimann of ECS

Field Engineer: I. MacMillan of ECS
Material Source: In-situ

RESULTS:
Test Method: ASTM D2573

Boring No:	B7-18	B7A-18	B8-18	B8-18
Test No:	V1	V2	V3	V4
Depth	8 feet	6 feet	11 feet	13 feet
Soil Classification	Mill Waste	Mill Waste	Mill Waste	Mill Waste
Vane Diameter (in)	2.5	2.5	2.5	2.5
Vane Constant, k	2.59	2.59	2.59	2.59
Measured Torque (lb-in)	720	1,320	*	600
Measured Remolded Torque (lb-in)	660	840	*	600
Shear Strength, $(s_u)_{fv}$ (psf)	1,865	3,419	*	1,554
Remolded Shear Strength, $(s_{ur})_{fv}$ (psf)	1,709	2,176	*	1,554
Sensitivity	1.1	1.6	*	1.0

*Test V3 encountered an obstruction in the borehole resulting in damage to the vane.

NOTE: The shear strength values reported above have not been modified by a correction factor.

Respectfully Submitted,
ECS Midwest, LLC.

REPORT OF LABORATORY ANALYSIS OF SOIL

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

Project: Arrowhead Park Phase 1
Neenah, Wisconsin

Copies:

Client: Mr. Trevor Frank
S.E.H, Inc.

Date: February 4, 2019

ECS File No: 59-1591

GENERAL:

Scope of Work: Perform laboratory testing on select soil samples.

Date of Test: January 22, 2019
Sampled By: B. Broennimann of ECS
Submitted By: M. Wisneski of ECS

Material Source: In-situ
Date Sampled: December 21, 2018

RESULTS:

Test Method:

ASTM D2487	Classification of Soils for Engineering Purposes
ASTM D2216	Moisture Content of Soil
ASTM D2974	Organic Content of Soil
ASTM D4318	Atterberg Limits
ASTM D854	Specific gravity of Soil Solids

Boring Number Sample Number Sample Depth	B1-18 3 4' – 6'	B2-18 3 4' – 6'	B3-18 4 6' – 7½'	B4-18 2 2' – 4'	B4-18 4 6' – 8'	B5-18 6 11' – 12½'	B7-18 4 6' – 7½'
USCS Classification	CL	CL	Mill Waste	Mill Waste	Mill Waste	Mill Waste	Mill Waste
% Moisture	18%	13%	164%	42%	72%	116%	137%
% Organic	-----	-----	58.4%	-----	36.7%	41.8%	-----
Atterberg Limits (LL/PL)	44 / 18	40 / 17	-----	-----	-----	-----	Not Plastic
Specific Gravity (G_s)	-----	-----	-----	2.138	-----	-----	-----

REMARKS:

A portion of the sample will be held for 30 days after the date of this report and will then be discarded unless notified otherwise.

Respectfully Submitted,

REPORT OF LABORATORY ANALYSIS OF SOIL

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

Project: Arrowhead Park Phase 1
Neenah, Wisconsin

Copies:

Client: Mr. Trevor Frank
S.E.H, Inc.

Date: February 4, 2019

ECS File No: 59-1591

GENERAL:

Scope of Work: Perform laboratory testing on select soil samples.

Date of Test: January 22, 2019
Sampled By: B. Broennimann of ECS
Submitted By: M. Wisneski of ECS

Material Source: In-situ
Date Sampled: December 21, 2018

RESULTS:

Test Method:

ASTM D2487	Classification of Soils for Engineering Purposes
ASTM D2216	Moisture Content of Soil
ASTM D2974	Organic Content of Soil
ASTM D4318	Atterberg Limits
ASTM D854	Specific gravity of Soil Solids
ASTM D7263	Dry Density of Soil

Boring Number Sample Number Sample Depth	B7A-18 1 4' – 6'	B8-18 7 13½' – 15'	B9-18 6 11' – 13'	B10-18 7 13½' – 15'
USCS Classification	Mill Waste	Mill Waste	Mill Waste	Mill Waste
% Moisture	40%	110%	43%	119%
% Organic	24.5%	-----	23.6%	-----
Atterberg Limits (LL/PL)	-----	Not Plastic	-----	-----
Specific Gravity (G_s)	-----	-----	2.195	2.096
Dry Density (pcf)	65.3	-----	65.8	-----

REMARKS:

A portion of the sample will be held for 30 days after the date of this report and will then be discarded unless notified otherwise.

Respectfully Submitted,

REPORT OF CONSOLIDATION TEST

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

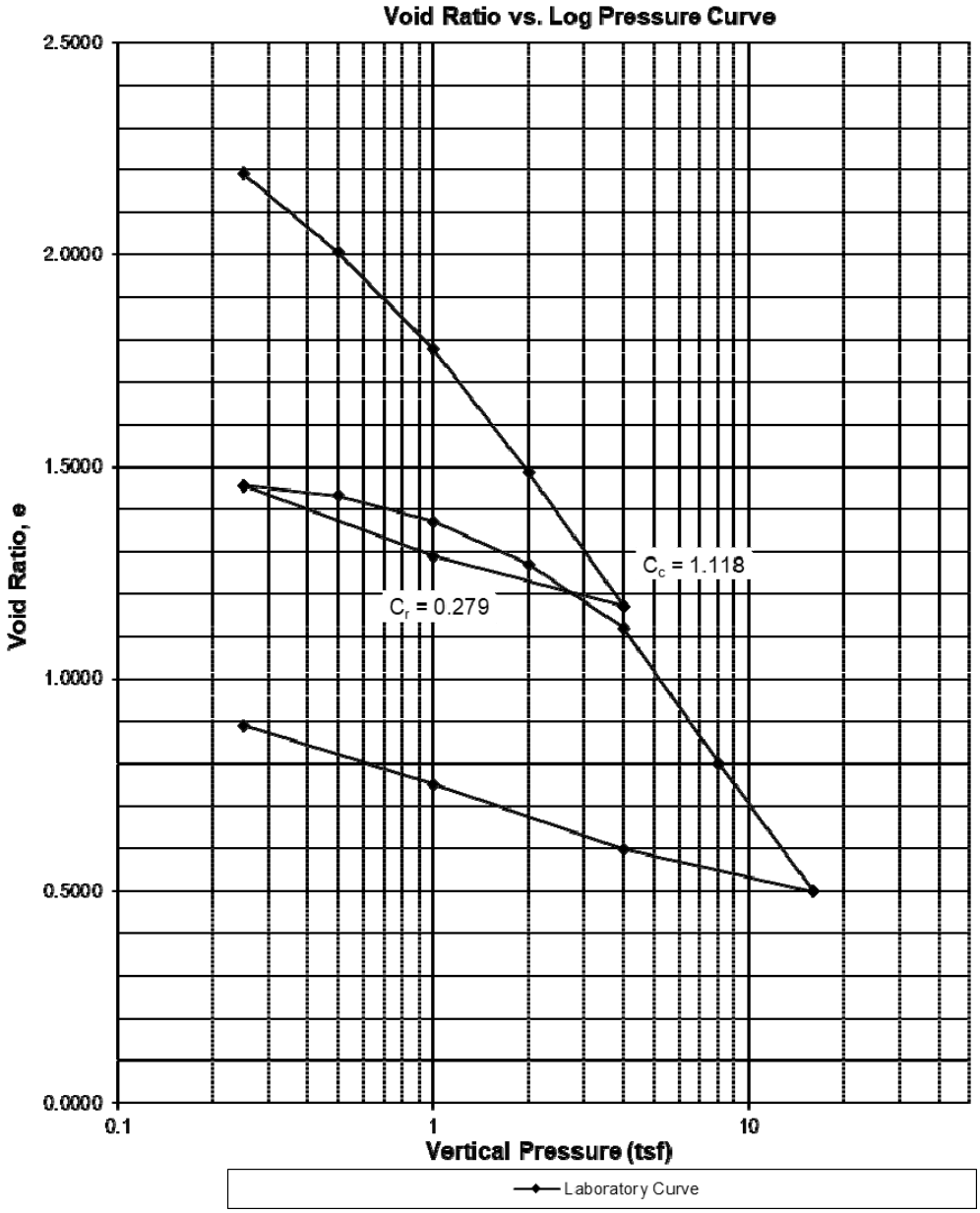
Project: **ARROWHEAD PARK PHASE 1**
NEENAH, WISCONSIN

ECS Project No: 59-1591

Client: Mr. Trevor Frank
S.E.H, Inc.

Date: February 4, 2019

Test Method	:	ASTM D2435					
Boring Number	:	B9-18	Specific Gravity	:	2.195	Initial Void Ratio, e_o	: 2.4271
Sample Number	:	6	Init. Dry Density	:	40 pcf	Est. Current Vert. Press., σ_o'	: 0.64 tsf
Sample Depth	:	11' – 13'	Init. Moisture	:	99.9%	Compression Index, C_c	: 1.118
USCS Description	:	Paper Mill Waste				Recompression Index, C_r	: 0.279
Ave. Coefficient of Consolidation, C_v:		1.94×10^{-3} cm^2/sec (0.18 ft^2/day)				Preconsolidation Press, P_c'	: 0.95 tsf



REPORT OF CONSOLIDATION TEST

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

Project: **ARROWHEAD PARK PHASE 1**
NEENAH, WISCONSIN

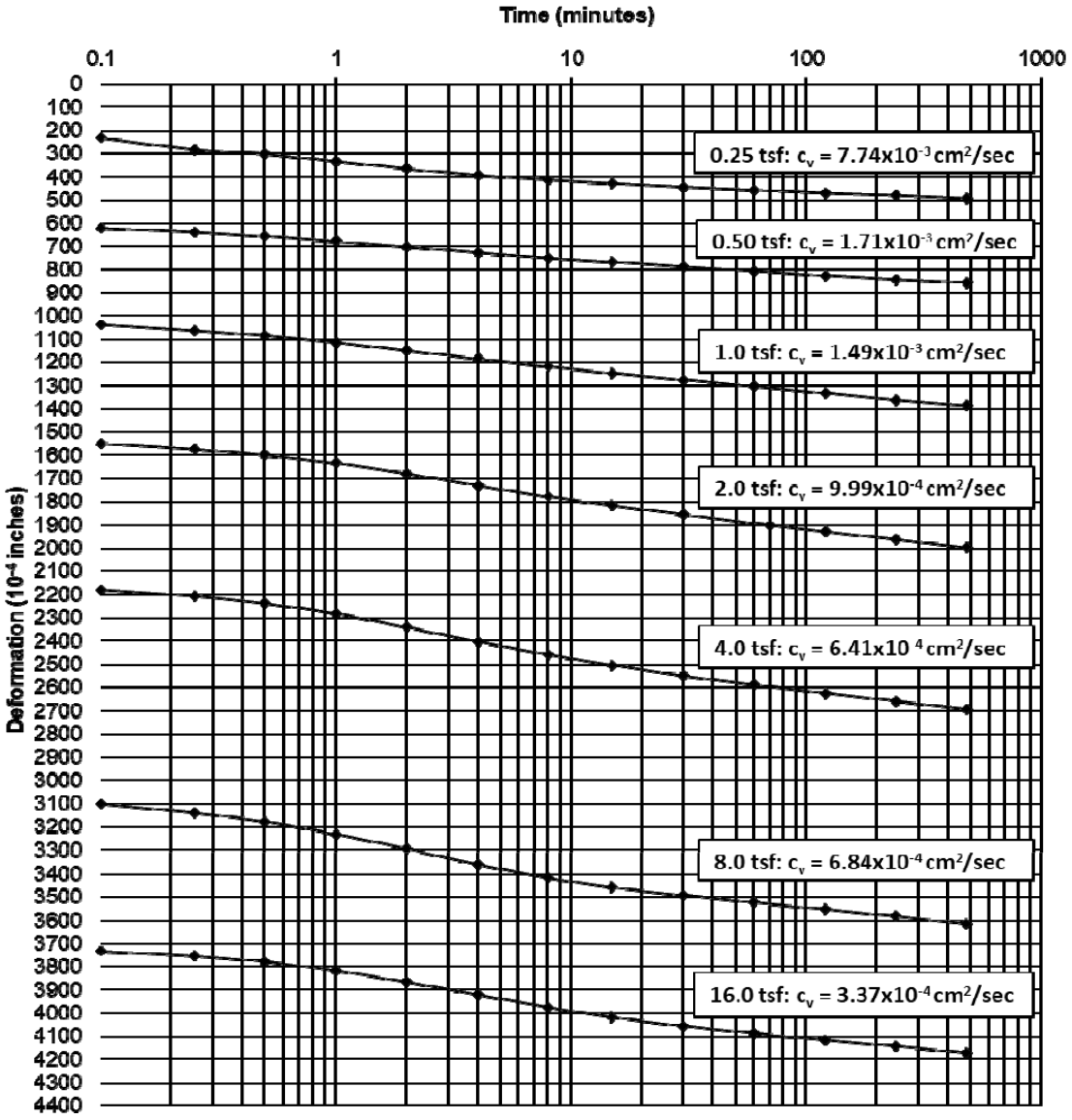
ECS Project No: 59-1591

Client: Mr. Trevor Frank
S.E.H, Inc.

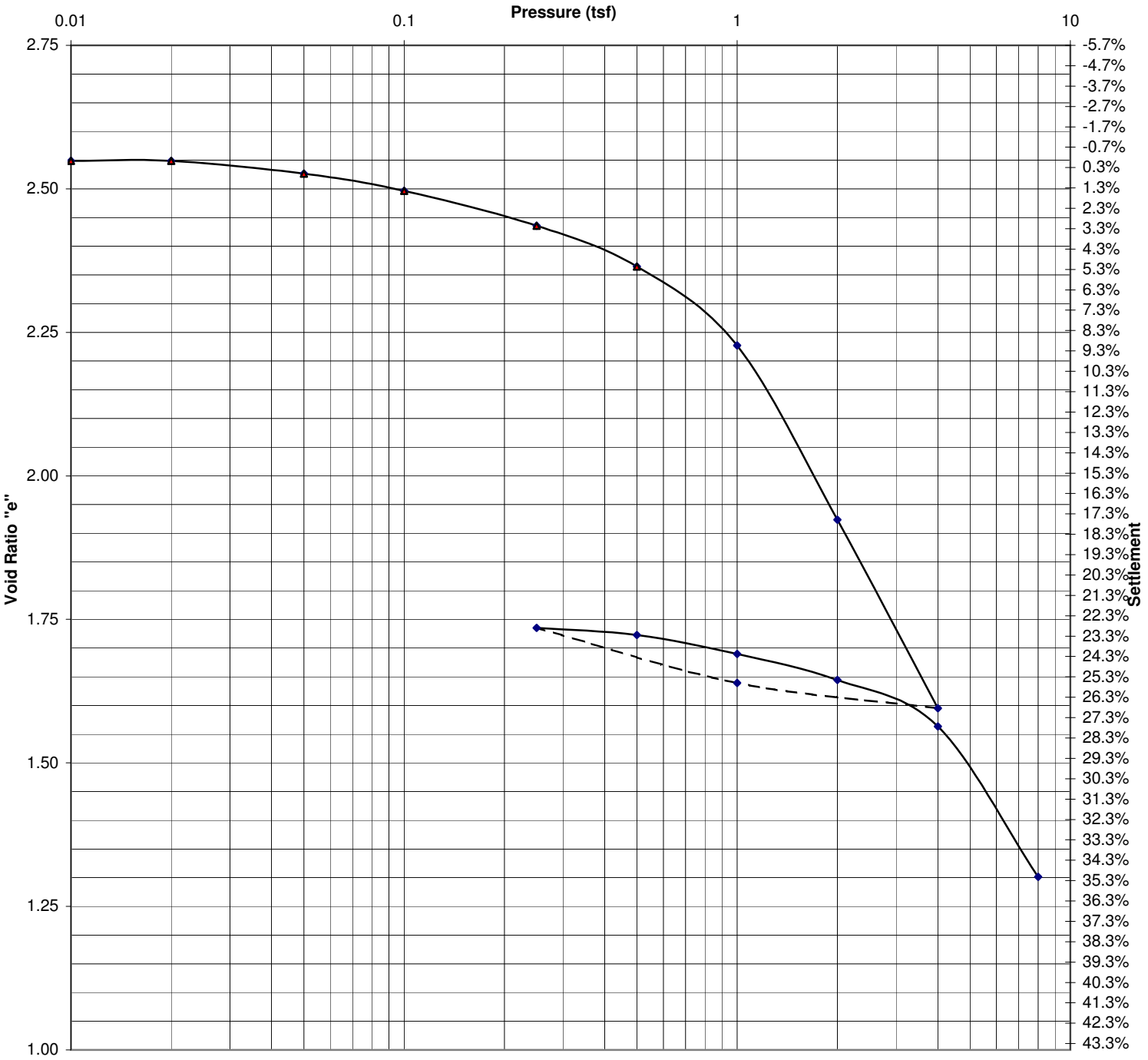
Date: February 4, 2019

Test Method	:	ASTM D2435					
Boring Number	:	B9-18	Specific Gravity	:	2.195	Initial Void Ratio, e_o	: 2.4271
Sample Number	:	6	Init. Dry Density	:	40 pcf	Est. Current Vert. Press., σ_o'	: 0.64 tsf
Sample Depth	:	11' – 13'	Init. Moisture	:	99.9%	Compression Index, C_c	: 1.118
USCS Description	:	Paper Mill Waste				Recompression Index, C_r	: 0.279
Ave. Coefficient of Consolidation, C_v:		$1.94x10^{-3}$ cm^2/sec (0.18 ft^2/day)				Preconsolidation Press, P_c'	: 0.95 tsf

Consolidation Log of Time Curves



Void Ratio and % Settlement vs. Log of Pressure



Project: Arrowhead Park Phase 1 / ECS Midwest, LLC			Date: 1/23/18
Sample #:	Boring #: B7-18	Depth ft: 11-13	Job #: 11799
Soil Type: Paper Sludge			
Initial W/C (%): 105.5	Dry Density (pcf): 42.0	LL: 149 PL: 62 PI: 87	Gs: 2.39
Organic Content (%): 14.8	Initial Height (in.): 0.894	Diameter (in.): 2.500	e_o= 2.549
Preconsolidation Pressure (Pc): 0.81 tsf	Compression Index (Cc): 1.05	Recompression Index (Cr): 0.14	

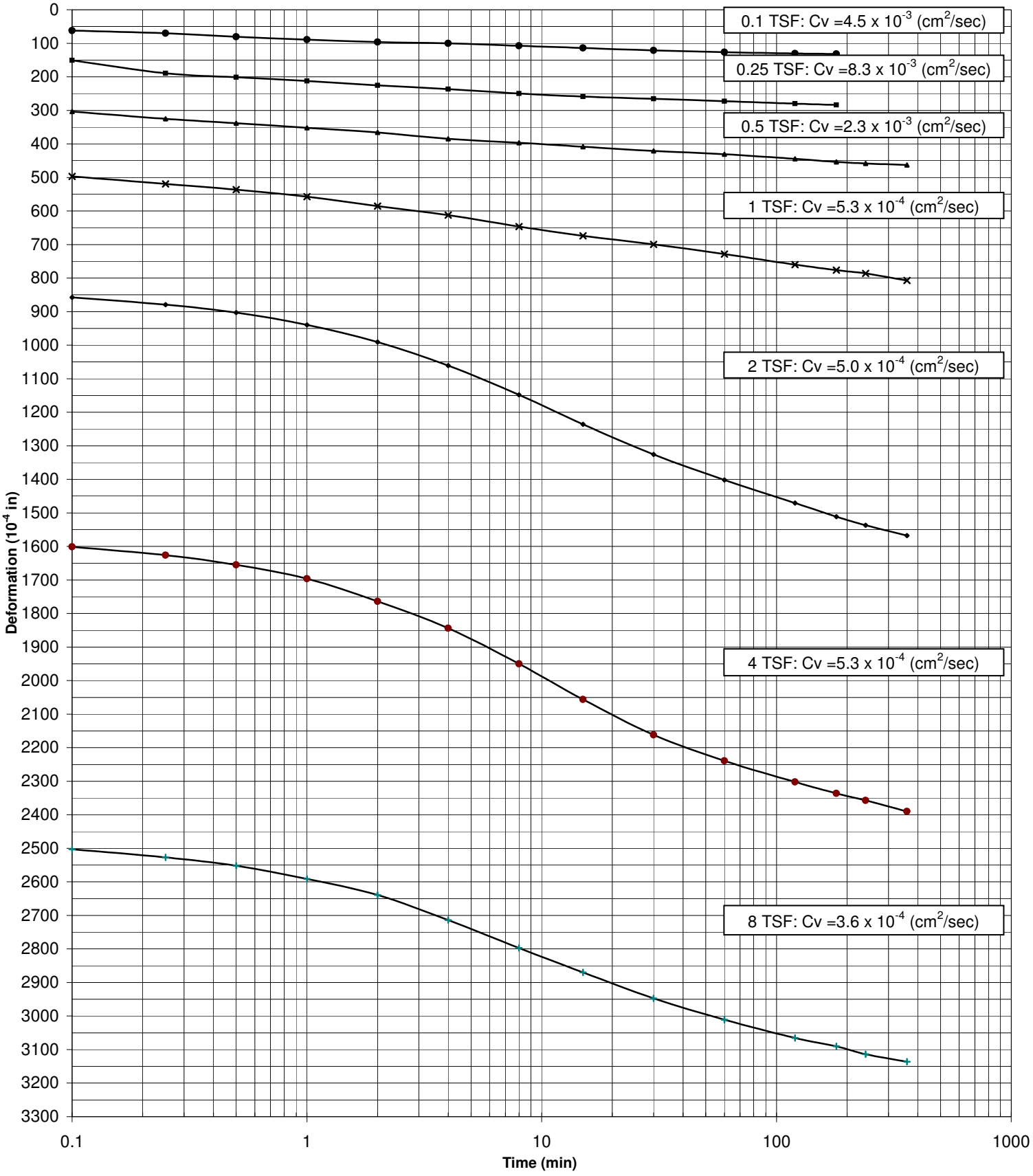
Remarks: Testing performed in general accordance with ASTM:D2435

9530 James Avenue South

SOIL ENGINEERING TESTING, INC.

Bloomington, Minnesota 55431

Consolidation Log of Time Curves



Project: Arrowhead Park Phase 1 / ECS Midwest, LLC			Date: 1/23/18
Sample #:	Boring #: B7-18	Depth ft: 11-13	Job #: 11799

9530 James Avenue South

SOIL ENGINEERING TESTING, INC.

Bloomington, Minnesota 55431

Laboratory Test Summary

Project: Arrowhead Park Phase 1 Job: 11799

Client: ECS Midwest, LLC Date: 1/22/2019

Sample Information & Classification

Boring #	B1-18	B1-18	B1-18	B7-18				
Sample #	(clay)	(organic)						
Depth (ft)	11-13	11-13	18-20	11-13				
Sample Type	TWT	TWT	TWT	TWT				
Material Classification	Fat Clay w/gravel (CH)	Organic Silt (OH/PT)	Fat Clay (CH)	Paper Sludge				

Atterberg Limits (ASTM:D4318)

Liquid Limit	73	253	81	149				
Plastic Limit	21	133	25	62				
Plasticity Index	52	120	56	87				

Sample Information & Classification

Boring #								
Sample #								
Depth (ft)								
Sample Type								
Material Classification								

Atterberg Limits (ASTM:D4318)

Liquid Limit								
Plastic Limit								
Plasticity Index								

Laboratory Testing Summary

Project: Arrowhead Park Phase 1 **Job:** 11799

Client: ECS Midwest, LLC **Date:** 1/24/19

Sample Information & Classification							
Boring #	B7-18	B11-18					
Sample #							
Depth	11-13	13-15					
Type or BPF	TWT	TWT					
Classification	Paper Sludge	Paper Sludge					
Water Content, Organic Content (ASTM:D2974)							
Water Content (%)	105.5	100.8					
Organic Content (%)	14.8	20.2					

Sample Information & Classification							
Boring #							
Sample #							
Depth (ft)							
Type or BPF							
Classification							
Water Content, Organic Content (ASTM:D2974)							
Water Content (%)							
Organic Content (%)							

Sample Information & Classification							
Boring #							
Sample #							
Depth (ft)							
Type or BPF							
Classification							
Water Content, Organic Content (ASTM:2974)							
Water Content (%)							
Organic Content (%)							

9530 James Ave South

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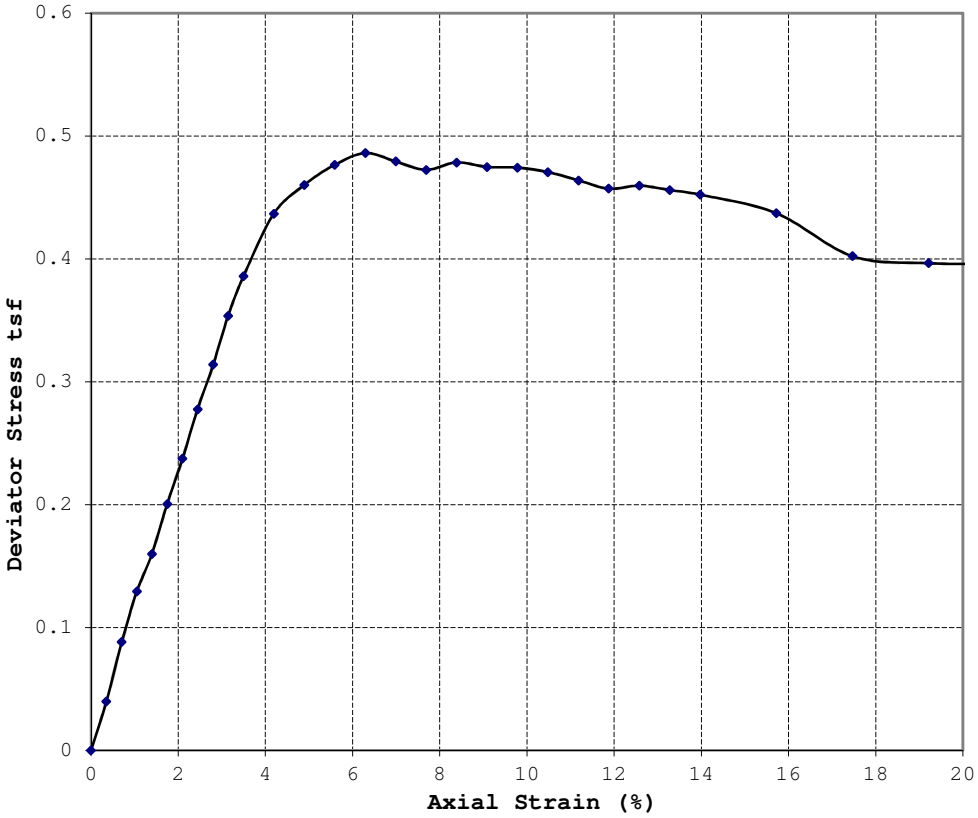
Bloomington, MN 55431

Triaxial U-U Stress/Strain Curves (ASTM:D2850)

Project: Arrowhead Park Phase 1 | Job: 11799
Client: ECS Midwest, LLC | Date: 1/17/19
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



Boring: B7-18 Depth: 11-13
Sample #:
Soil Type: Paper Sludge

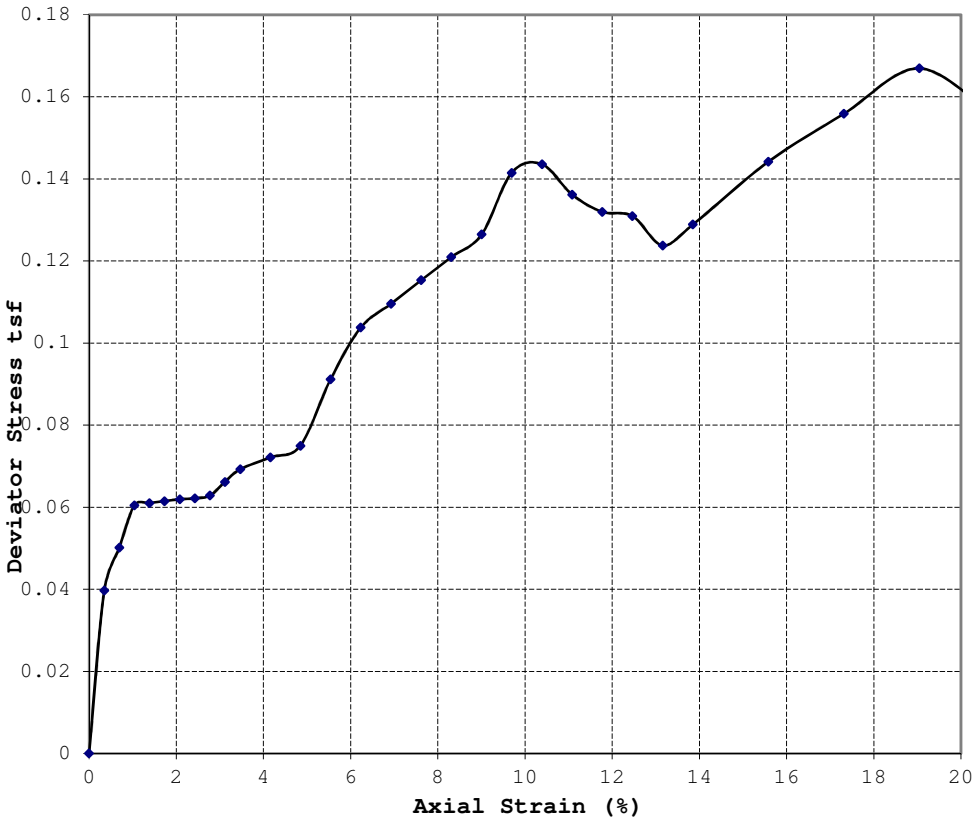
Strain Rate (in/min): 0.060
Sample Type: 3T
Dia. (in) 1.42 Ht. (in) 2.86
Height to Diameter Ratio: 2.01

Max Deviator Stress: 0.49 tsf
Strain at Failure (%): 6.3
Confining Pressure: 1.0 tsf

W.C. (%) 121.2
Yd (pcf): 37.2

LL: 149
PL: 62
PI: 87

Sketch of Specimen After Failure



Boring: B-11 Depth: 13-15
Sample #:
Soil Type: Paper Sludge

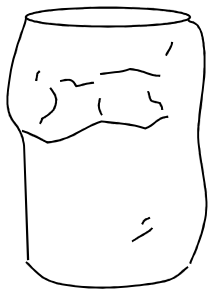
Strain Rate (in/min): 0.060
Sample Type: 3T

Dia. (in): 1.41 Ht. (in): 2.89
Height to Diameter Ratio: 2.04

Max Deviator Stress: 0.17 tsf
Strain at Failure (%): 19.0
Confining Pressure: 1.0 tsf

W.C. (%): 100.8
Yd (pcf): 42.3

Sketch of Specimen After Failure



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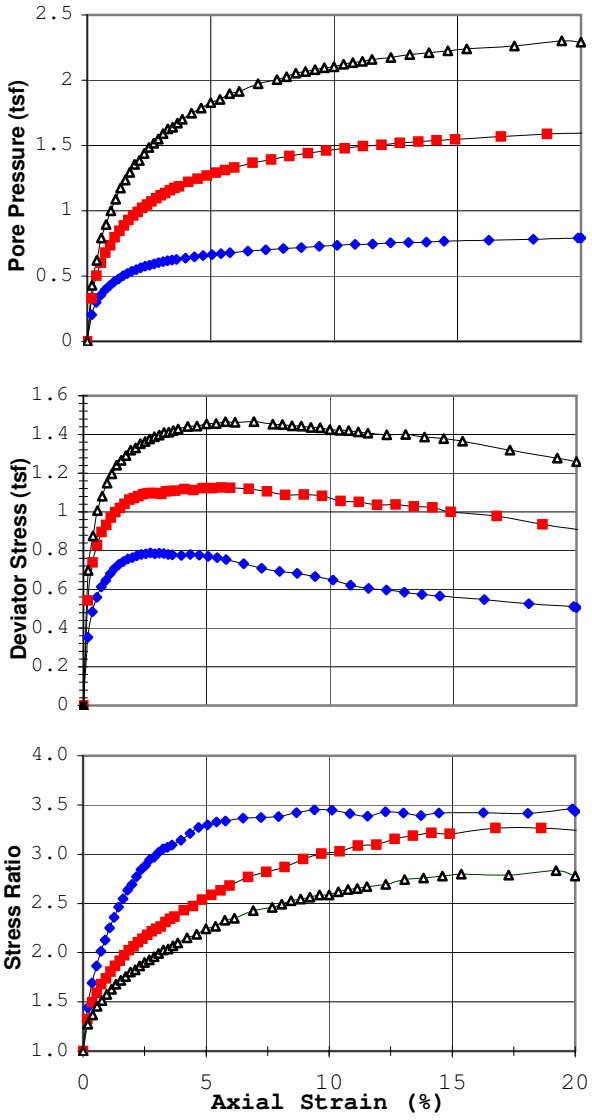
Bloomington, MN 55431

TRIAXIAL TEST ASTM: D 4767

Job No. **11799**
Date: **1/24/19**

Project: **Arrowhead Park Phase 1 / ECS Midwest, LLC**
Boring #: **B-1** Sample #: Type: **3T** Depth (ft): **18-20**
Soil Type: **Fat Clay (CH)**



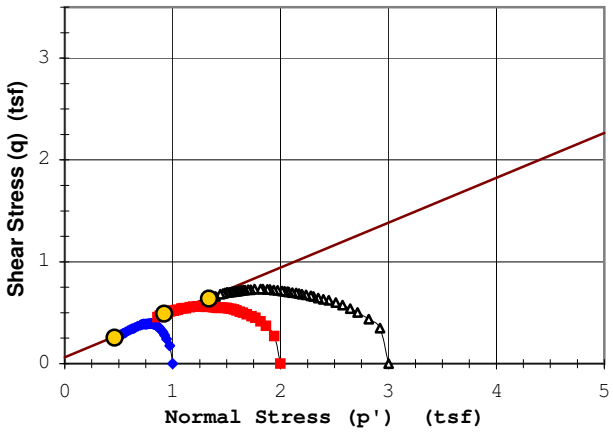
Failure Criterion: **Max. Stress Ratio**
Angle of internal friction, **ϕ' =** **26.1 °**
Apparent Cohesion, **c' =** **0.07 (tsf)**

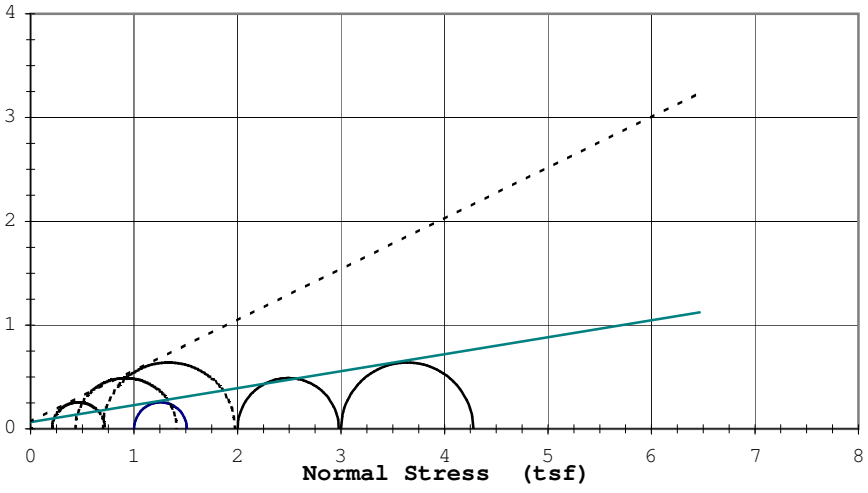
Test Date:	1/10/19		Liquid Limit:		81
Test Type:	CU w/pp		Plastic Limit:		25
Strain Rate (in/min):	0.000175		Plasticity Index:		56
Strain Rate (%/min):	0.006		Spec. Gravity (Assumed):		2.73

Before Consolidation	A	B	C	D	E
Diameter (in)	1.43	1.43	1.43		
Height (in)	2.86	2.86	2.86		
Water Content (%)	69.8	69.9	68.4		
Dry Density (pcf)	58.6	58.5	59.5		
Void Ratio	1.91	1.91	1.87		
After Consolidation					
Diameter (in)	1.34	1.35	1.35		
Height (in)	2.77	2.68	2.60		
Water Content (%)	53.6	52.4	48.4		
Dry Density (pcf)	69.2	70.1	73.4		
Void Ratio	1.46	1.43	1.32		
Back Pressure (tsf)	4.0	5.3	8.9		
Minor Principal Stress (tsf)	1.00	2.00	3.00		
Max. Deviator Stress (tsf)	0.79	1.13	1.47		
Ultimate Deviator Stress (tsf)	0.51	0.91	1.26		
Deviator Stress at Failure (tsf)	0.51	0.98	1.28		
Max. Pore Pressure Buildup (tsf)	0.79	1.59	2.30		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	19.9	16.8	19.2		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Radial drainage strips applied to trimmed specimen; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared.





Rupture Envelope at Failure
α = 23.8 ° a = 0.1 (tsf)

----------	Effective ϕ':	26.1 °	c'= 0.07 (tsf)
_____	Total ϕ:	9.3 °	c= 0.06 (tsf)

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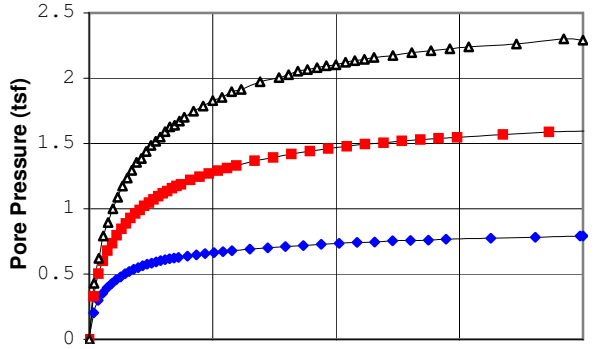
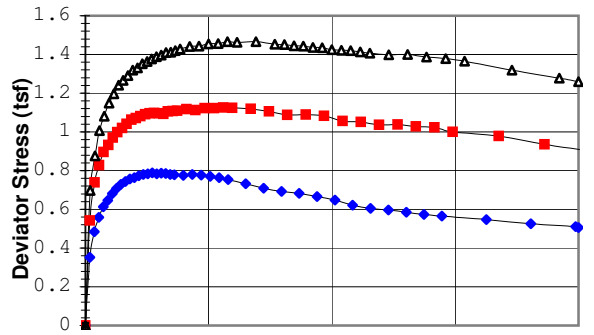
Bloomington, Minnesota 55431

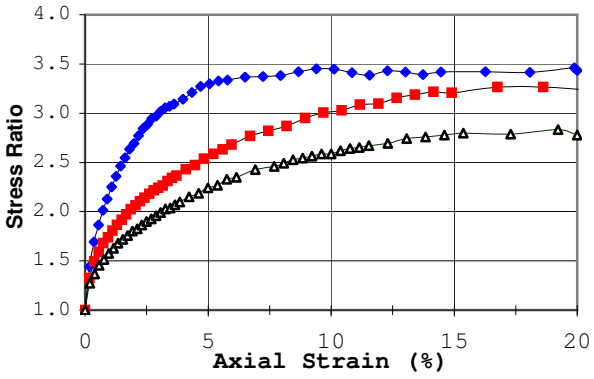
TRIAXIAL TEST ASTM: D 4767

Job No. **11799**
Date: **1/24/19**

Project: **Arrowhead Park Phase 1 / ECS Midwest, LLC**
Boring #: **B-1** Sample #: Type: **3T** Depth (ft): **18-20**
Soil Type: **Fat Clay (CH)**







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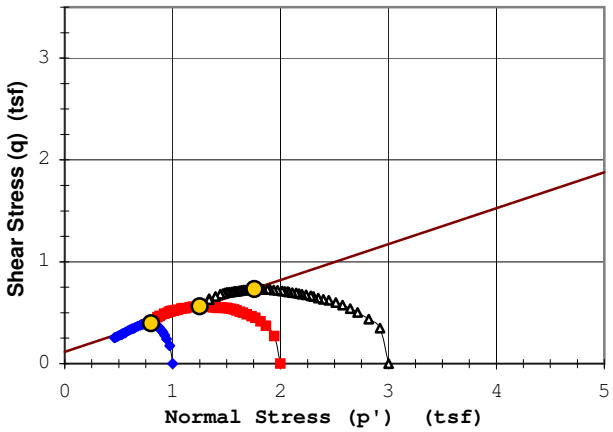
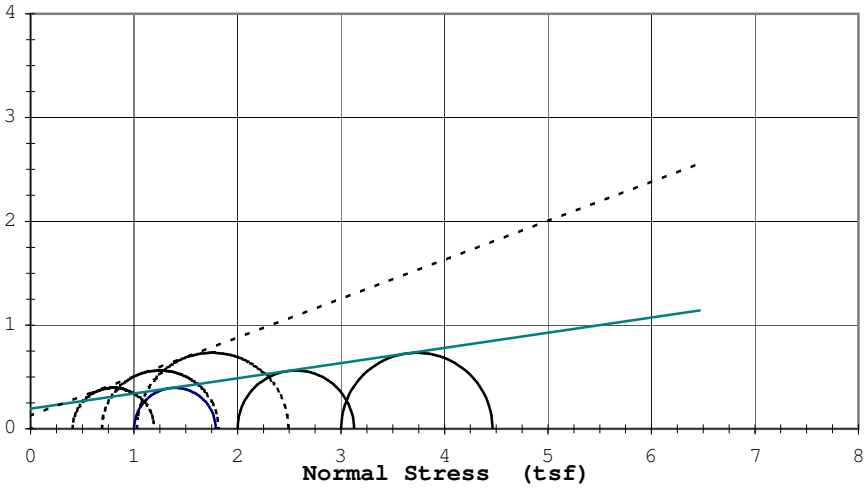
X

Failure Criterion:	Max. Deviator Stress				
Angle of internal friction, ϕ' =	20.6 °				
Apparent Cohesion, c' =	0.12 (tsf)				
Test Date: 1/10/19	Liquid Limit: 81				
Test Type: CU w/pp	Plastic Limit: 25				
Strain Rate (in/min): 0.000175	Plasticity Index: 56				
Strain Rate (%/min): 0.006	Spec. Gravity (Assumed): 2.73				
Before Consolidation	**A**	**B**	**C**	**D**	**E**
Diameter (in)	1.43	1.43	1.43		
Height (in)	2.86	2.86	2.86		
Water Content (%)	69.8	69.9	68.4		
Dry Density (pcf)	58.6	58.5	59.5		
Void Ratio	1.91	1.91	1.87		
After Consolidation					
Diameter (in)	1.34	1.35	1.35		
Height (in)	2.77	2.68	2.60		
Water Content (%)	53.6	52.4	48.4		
Dry Density (pcf)	69.2	70.1	73.4		
Void Ratio	1.46	1.43	1.32		
Back Pressure (tsf)	4.0	5.3	8.9		
Minor Principal Stress (tsf)	1.00	2.00	3.00		
Max. Deviator Stress (tsf)	0.79	1.13	1.47		
Ultimate Deviator Stress (tsf)	0.51	0.91	1.26		
Deviator Stress at Failure (tsf)	0.79	1.13	1.47		
Max. Pore Pressure Buildup (tsf)	0.79	1.59	2.30		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	2.7	5.6	6.9		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Radial drainage strips applied to trimmed specimen; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared.





Rupture Envelope at Failure
α = 19.4 ° a = 0.1 (tsf)

---------- Effective ϕ': 20.6 ° c'= 0.12 (tsf)
_____ Total ϕ: 8.3 ° c= 0.19 (tsf)

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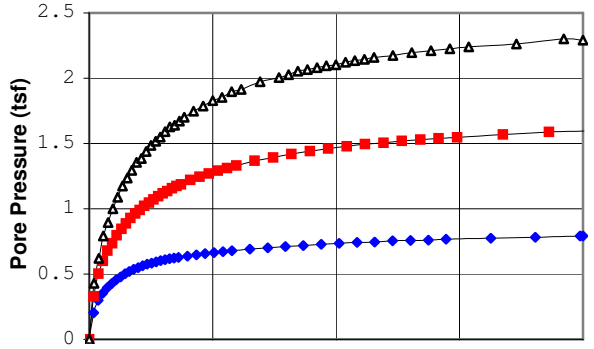
SOIL ENGINEERING TESTING, INC.

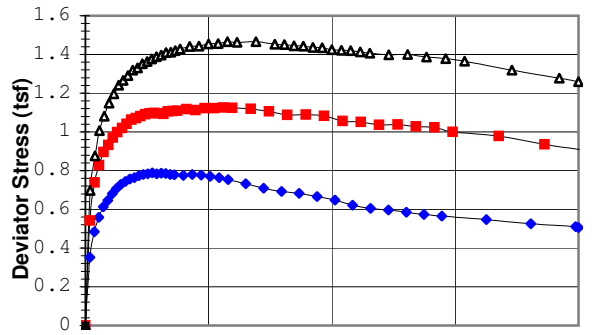
Bloomington, Minnesota 55431

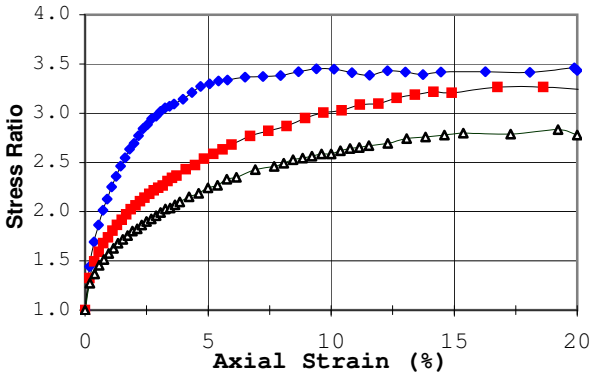
TRIAXIAL TEST ASTM: D 4767

Job No. **11799**
Date: **1/24/19**

Project: **Arrowhead Park Phase 1 / ECS Midwest, LLC**
Boring #: **B-1** Sample #: Type: **3T** Depth (ft): **18-20**
Soil Type: **Fat Clay (CH)**







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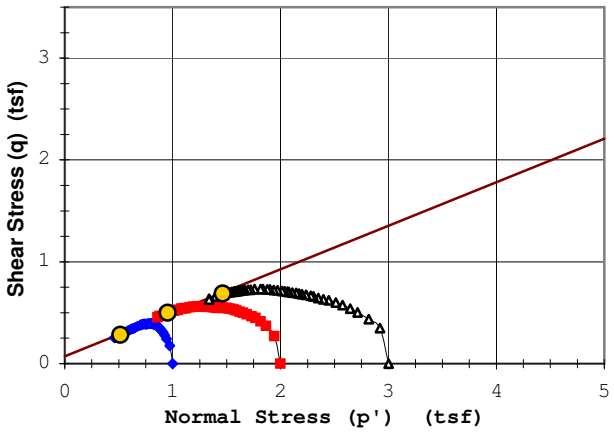
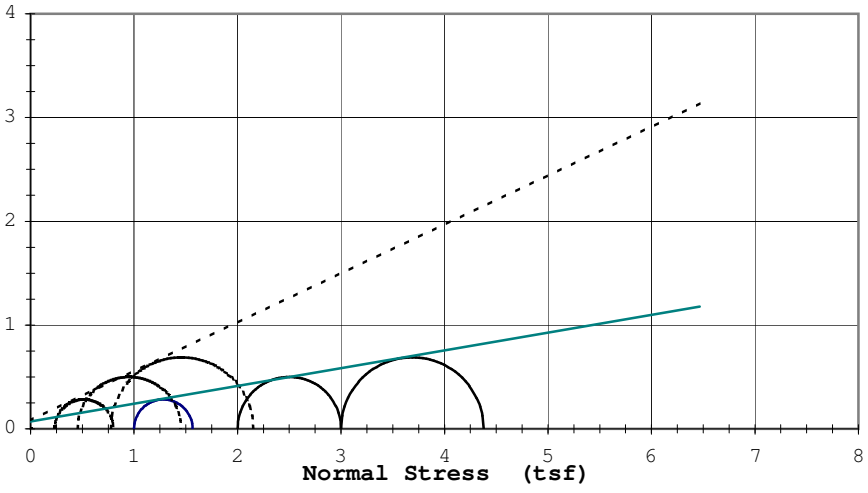
X

Failure Criterion:	Given Strain of: 15%				
Angle of internal friction, ϕ' =	25.3 °				
Apparent Cohesion, c' =	0.08 (tsf)				
Test Date: 1/10/19	Liquid Limit: 81				
Test Type: CU w/pp	Plastic Limit: 25				
Strain Rate (in/min): 0.000175	Plasticity Index: 56				
Strain Rate (%/min): 0.006	Spec. Gravity (Assumed): 2.73				
Before Consolidation	**A**	**B**	**C**	**D**	**E**
Diameter (in)	1.43	1.43	1.43		
Height (in)	2.86	2.86	2.86		
Water Content (%)	69.8	69.9	68.4		
Dry Density (pcf)	58.6	58.5	59.5		
Void Ratio	1.91	1.91	1.87		
After Consolidation					
Diameter (in)	1.34	1.35	1.35		
Height (in)	2.77	2.68	2.60		
Water Content (%)	53.6	52.4	48.4		
Dry Density (pcf)	69.2	70.1	73.4		
Void Ratio	1.46	1.43	1.32		
Back Pressure (tsf)	4.0	5.3	8.9		
Minor Principal Stress (tsf)	1.00	2.00	3.00		
Max. Deviator Stress (tsf)	0.79	1.13	1.47		
Ultimate Deviator Stress (tsf)	0.51	0.91	1.26		
Deviator Stress at Failure (tsf)	0.57	1.00	1.38		
Max. Pore Pressure Buildup (tsf)	0.79	1.59	2.30		
Pore Pressure Parameter "B"	0.95	0.95	0.95		
Pct. Axial Strain at Failure	15.0	15.0	15.0		

"These test results are for informational purposes only and must be reviewed by a qualified professional engineer to verify that the test parameters shown are appropriate for any particular design"

Remarks: Radial drainage strips applied to trimmed specimen; Saturated, backpressured until "B" response was 0.95 to 1.00; Consolidated; All Drainage valves closed and immediately sheared.





Rupture Envelope at Failure
α = 23.1 ° a = 0.1 (tsf)

---------- Effective ϕ': 25.3 ° c'= 0.08 (tsf)
_____ Total ϕ: 9.7 ° c= 0.07 (tsf)

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Bloomington, Minnesota 55431

Triaxial Data

Job: **11799**

Boring: B-1 Sample: Depth: 18-20 Date: 1/24/19

Sample 1			Sample 2			Sample 3			Sample 4			Sample 5		
Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)	Strain (%)	Deviator Stress (tsf)	Pore Pressure (tsf)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
0.18	0.35	0.20	0.19	0.54	0.33	0.19	0.70	0.43						
0.36	0.48	0.30	0.37	0.74	0.50	0.38	0.88	0.62						
0.54	0.56	0.35	0.56	0.83	0.60	0.58	1.01	0.79						
0.72	0.61	0.40	0.75	0.90	0.68	0.77	1.08	0.89						
0.90	0.65	0.43	0.93	0.93	0.74	0.96	1.15	1.00						
1.08	0.68	0.46	1.12	0.97	0.80	1.15	1.20	1.09						
1.26	0.71	0.48	1.30	1.00	0.85	1.35	1.24	1.18						
1.45	0.73	0.50	1.49	1.02	0.89	1.54	1.27	1.24						
1.63	0.74	0.52	1.68	1.04	0.93	1.73	1.29	1.30						
1.81	0.76	0.54	1.86	1.06	0.96	1.92	1.32	1.36						
1.99	0.76	0.55	2.05	1.07	0.99	2.11	1.33	1.39						
2.17	0.77	0.56	2.24	1.08	1.02	2.31	1.35	1.44						
2.35	0.78	0.58	2.42	1.09	1.05	2.50	1.36	1.48						
2.53	0.78	0.58	2.61	1.10	1.07	2.69	1.38	1.52						
2.71	0.79	0.59	2.79	1.10	1.10	2.88	1.39	1.55						
2.89	0.78	0.60	2.98	1.10	1.12	3.08	1.40	1.59						
3.07	0.79	0.61	3.17	1.09	1.14	3.27	1.41	1.63						
3.25	0.78	0.62	3.35	1.11	1.16	3.46	1.41	1.64						
3.43	0.78	0.62	3.54	1.11	1.17	3.65	1.42	1.67						
3.61	0.78	0.63	3.73	1.11	1.19	3.84	1.43	1.70						
3.98	0.78	0.64	4.10	1.12	1.22	4.23	1.44	1.75						
4.34	0.78	0.65	4.47	1.11	1.24	4.61	1.44	1.79						
4.70	0.78	0.66	4.84	1.12	1.27	5.00	1.46	1.83						
5.06	0.77	0.66	5.22	1.12	1.29	5.38	1.46	1.85						
5.42	0.76	0.67	5.59	1.13	1.31	5.77	1.47	1.90						
5.78	0.75	0.68	5.96	1.12	1.33	6.15	1.46	1.92						
6.51	0.73	0.69	6.71	1.12	1.37	6.92	1.47	1.97						
7.23	0.71	0.70	7.45	1.11	1.39	7.69	1.45	2.00						
7.95	0.69	0.71	8.20	1.09	1.42	8.07	1.45	2.03						
8.67	0.68	0.72	8.94	1.09	1.44	8.46	1.45	2.05						
9.40	0.67	0.73	9.69	1.08	1.46	8.84	1.44	2.07						
10.12	0.65	0.74	10.43	1.06	1.48	9.23	1.44	2.08						
10.84	0.62	0.74	11.18	1.05	1.50	9.61	1.43	2.10						
11.57	0.61	0.75	11.92	1.04	1.51	10.00	1.42	2.10						
12.29	0.60	0.75	12.67	1.04	1.52	10.38	1.42	2.12						
13.01	0.59	0.76	13.41	1.03	1.53	10.76	1.42	2.13						
13.73	0.57	0.76	14.16	1.02	1.54	11.15	1.41	2.14						
14.46	0.57	0.77	14.90	1.00	1.55	11.53	1.41	2.16						
16.26	0.55	0.77	16.76	0.98	1.57	12.30	1.40	2.17						
18.07	0.53	0.78	18.63	0.93	1.59	13.07	1.40	2.20						
19.88	0.51	0.79	20.03	0.91	1.59	13.84	1.39	2.21						
20.00	0.51	0.79				14.61	1.38	2.22						
						15.38	1.37	2.24						
						17.30	1.32	2.26						
						19.22	1.28	2.30						
						20.00	1.26	2.29						

Specific Gravity Testing Summary Sheet (ASTM:D854)

Project: **Arrowhead Park Phase 1** Job: **11799**

Client: **ECS Midwest, LLC** Date: **1/24/2019**

Boring / Location	Sample	Sample Type	Depth (ft)	Specific Gravity	Visual Classification
B7-18		**TWT**	**11-13**	**2.39**	**Paper Sludge**

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Bloomington, MN 55431

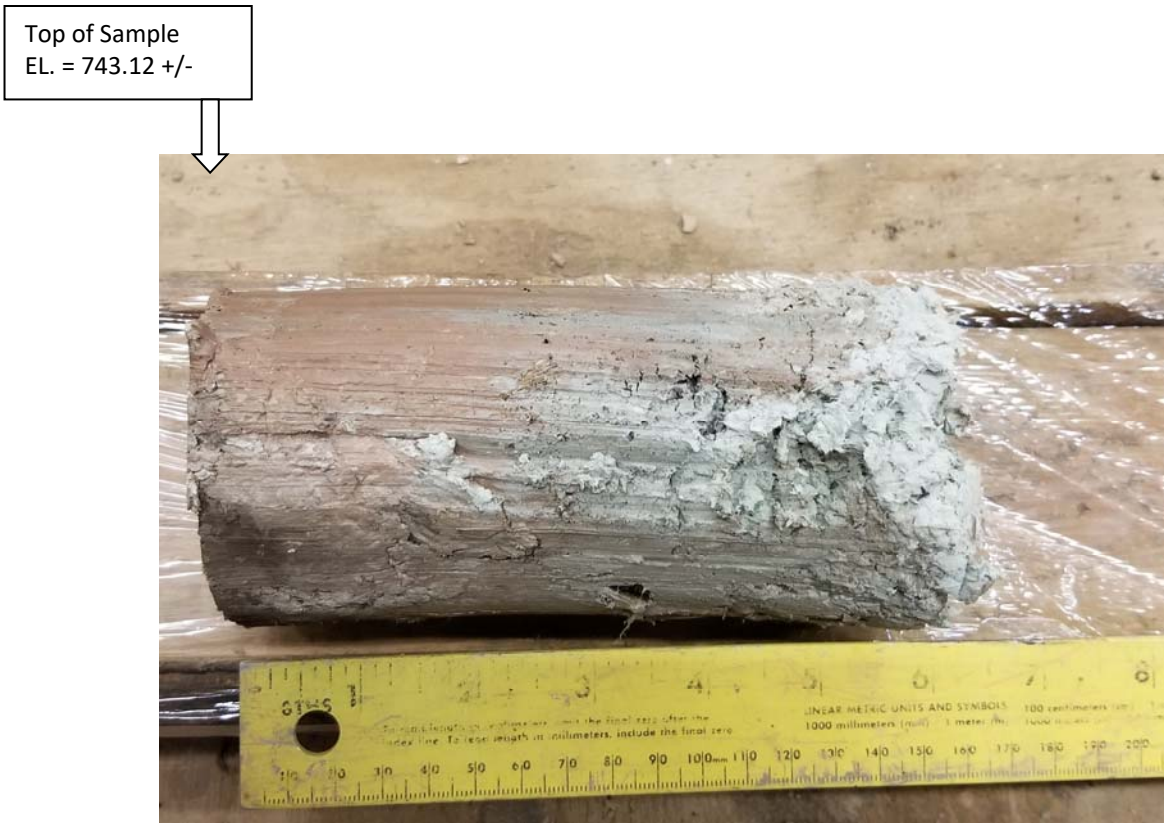

Figure 1 – Photograph of Boring B4-18 sample 2, from 2 to 4 feet below ground surface (EL. 743.12 to 741.12+/-).

Figure 2 – Photograph of Boring B4-18 sample 4, from 6 to 8 feet below ground surface (EL. 739.12 to 737.12 +/-).

Extruded TWT Sample Photographs

Project: Arrowhead Park Phase 1
Neenah, Winnebago County, Wisconsin

ECS Project No: 1591

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
Telephone: (920) 886-1406 Fax: (920) 886-1409

Figure 3 – Photograph of Boring B7A-18 sample 1, from 4 to 6 feet below ground surface

Figure 4 – Photograph of Boring B9-18 sample 6, from 11 to 13 feet below ground surface (EL. 738.86 to 736.86 +/-).

Extruded TWT Sample Photographs

Project: Arrowhead Park Phase 1
Neenah, Winnebago County, Wisconsin

ECS Project No: 1591

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
Telephone: (920) 886-1406 Fax: (920) 886-1409

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

REPORT OF ENVIRONMENTAL MONITORING

Project: Arrowhead Park Phase 1
Neenah, Wisconsin

Copies:

Client: Mr. Trevor Frank
S.E.H, Inc.

Date: February 4, 2019

ECS File No: 59-1591

GENERAL:

Scope of Work: Monitor drilling activities using a Flame Ionization Detector (FID) and collect vapor measurements using a Photoionization Detector (PID)

Date of Test: December 18-21, 2018
Sampled By: B. Broennimann of ECS
Submitted By: I. MacMillan of ECS

Material Source: In-situ

RESULTS:

Boring Number	Test Depth	FID result (ppm)	PID result (ppm)
B1-18	0 – 2	-----	0
	2 – 4	-----	0
	4 – 6	1,100	0
	6 – 7½	-----	0
	8½ – 10	500	0
	11 – 12½	1,450	0
	13½ – 15	1,630	0
	16 – 17½	200	0
	18½ – 20	801	0
	21 – 22½	-----	0
	23½ – 25	360	0
	26 – 27½	30	0
	28½ – 30	3.6	0
	31 – 32½	12.8	0
	33½ – 35	7.5	0
	36 – 37½	10.4	0
	38½ – 40	1.8	0
	41 – 42½	3.8	0
	43½ – 45	0	0
	46 – 47½	0	0
	48½ – 50	0	0

Respectfully Submitted,

REPORT OF ENVIRONMENTAL MONITORING

1060 Breezewood Lane, Suite 102
Neenah, WI 54956
ph 920-886-1406
fax 920-886-1409
www.ecslimited.com

Project: Arrowhead Park Phase 1
Neenah, Wisconsin

Copies:

Client: Mr. Trevor Frank
S.E.H, Inc.

Date: February 4, 2019

ECS File No: 59-1591

GENERAL:

Scope of Work: Monitor drilling activities using a Flame Ionization Detector (FID) and collect vapor measurements using a Photoionization Detector (PID)

Date of Test: December 18-21, 2018
Sampled By: B. Broennimann of ECS
Submitted By: I. MacMillan of ECS

Material Source: In-situ

RESULTS:

Boring Number	Test Depth	FID result (ppm)	PID result (ppm)
B2-18	0 – 2	-----	0
	2 – 4	700	0
	4 – 6	-----	0
	6 – 7½	-----	-----
	8½ – 10	300	-----
	11 – 12½	11,800	0
	13½ – 15	-----	0
	16 – 17½	100	0
	18½ – 20	-----	0
	21 – 22½	1,400	0
B3-18	0 – 2	-----	0
	2 – 4	120	0
	4 – 6	-----	2.5
	6 – 7½	280	0.5
	8½ – 10	1,200	5.8
	11 – 12½	-----	0
	13½ – 15	400	0
	16 – 17½	-----	0
	18½ – 20	2,800	0
B4-18	0 – 2	-----	0
	2 – 4	6.9	0
	4 – 6	-----	-----
	6 – 7½	-----	-----
	8½ – 10	65	0
	11 – 12½	-----	0
	13½ – 15	-----	-----
	16 – 17½	-----	0
	18½ – 20	2,500	0
	23½ – 25	-----	0

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Material Source: In-situ

RESULTS:

Boring Number	Test Depth	FID result (ppm)	PID result (ppm)
B5-18	0 – 2	-----	0
	2 – 4	-----	0
	4 – 6	40	0
	6 – 7½	-----	0
	8½ – 10	15	0
	11 – 12½	-----	2.5
	13½ – 15	25	4
	16 – 17½	-----	0
	18½ – 20	-----	-----
	21 – 22½	1,300	0
B6-18	0 – 2	-----	0
	2 – 4	-----	-----
	4 – 6	40	0
	6 – 7½	-----	0
	8½ – 10	28	0
	11 – 12½	-----	0
	13½ – 15	1,800	0
	16 – 17½	-----	0
	18½ – 20	50	0
B7-18	0 – 2	350	0
	2 – 4	16,000	0
	4 – 6	-----	----
	6 – 7½	23	0.8
	8½ – 10	1,700	-----
	11 – 12½	18,000	0
	13½ – 15	4,000	0
	16 – 17½	570	-----

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Material Source: In-situ

RESULTS:

Boring Number	Test Depth	FID result (ppm)	PID result (ppm)
B8-18	0 – 2	4,800	-----
	2 – 4	360	-----
	4 – 6	30	-----
	6 – 7½	-----	0
	8½ – 10	75	0
	11 – 12½	500	0
	13½ – 15	1,100	0.1
	16 – 17½	Gauge max – hit gas pocket	0
	18½ – 20	4,000	0
	21 – 22½	10,000	0
	23½ – 25	-----	0
B9-18	0 – 2	-----	0
	2 – 4	10,000	-----
	4 – 6	55	0
	6 – 7½	-----	0
	8½ – 10	120	-----
	11 – 12½	-----	0
	13½ – 15	2,500	0
	16 – 17½	24,900	0
	18½ – 20	5,500	0
	21 – 22½	5,800	0
B10-18	0 – 2	-----	0
	2 – 4	-----	0
	4 – 6	1,300	0
	6 – 7½	-----	-----
	8½ – 10	120	0
	11 – 12½	-----	0
	13½ – 15	150	0
	16 – 17½	-----	0
	18½ – 20	3,800	0

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Material Source: In-situ

RESULTS:

Boring Number	Test Depth	FID result (ppm)	PID result (ppm)
B11-18	0 – 2	-----	0
	2 – 4	-----	0
	4 – 6	280	0
	6 – 7½	-----	0
	8½ – 10	250	0
	11 – 12½	40	0
	13½ – 15	290	0
	16 – 17½	280	0
	18½ – 20	1,100	0
	21 – 22½	Gauge max	-----
	23½ – 25	16,000	-----

Respectfully Submitted,

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