SOIL EVALUATION
FOR
PROPOSED RENEWABLE ENERGY PARK
THOMAS TOWNSHIP, SAGINAW COUNTY, MICHIGAN

June 21, 2011

Prepared For:

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Project Number 11-130-098

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APPENDIX

I. INTRODUCTION

We have completed the requested soil evaluation for the proposed Renewable Energy Park to be located in Thomas Township of Saginaw County, Michigan. This report presents the results of our evaluation, our interpretation of the soil and groundwater conditions at the soil boring locations, and our geotechnical recommendations for design and construction of the proposed roadways, pump stations, relocated drain and installation of utility lines. Our evaluation was performed under the direction of a registered Professional Engineer in the State of Michigan.

A. Scope of Services

The scope of services for this soil evaluation included the following:

1. Drill seven (7) soil borings to depths of 30 feet below the existing ground surface along the route of the proposed sanitary sewer lines and in the area of the proposed pump station; four (4) soil borings to depths of 5 feet below the existing ground surface within the existing roadway surface of Graham Road; three (3) soil borings to depths of 5 feet and two (2) soil borings to depths of 20 feet below the existing ground surface in the area of the proposed 'Sunshine Court' roadway and three (3) soil borings to depths of 20 feet below the ground surface along the re-routed Faucher Drain and two (2) soil borings to depths of 30 feet below the existing ground surface of the proposed detention basin adjacent to the relocated drain.

2. Perform visual laboratory classification of each soil sample obtained from the soil borings, as well as routine strength and moisture content tests on portions of the cohesive soil samples retained.

3. Complete an engineering analysis and evaluation of the field and laboratory data and compile a written report to include the following:
    a. A description of our field and laboratory investigation procedures.
    b. A brief description of the soil and groundwater conditions observed in our soil borings.
    c. Suitability of the soils to support the proposed utilities.
    d. Recommendations with regard to foundation system for the pump station structures including net allowable soil pressure, anticipated depth to suitable bearing material and estimated settlement.
    e. Recommendations regarding management of groundwater and other construction considerations relating to installation of the recommended underground utilities, pump station and roadways based on the soil and groundwater conditions encountered in our soil borings.
    f. Recommendations regarding earthwork and excavations for pump station and associated pipe construction, including trench sidewall stability and shoring requirements, lateral loadings for braced

excavations, placement and compaction of engineered fill, and considerations for re-using material excavated from the site for engineered fill.

g. Recommendations regarding management of groundwater and/or surface runoff and other construction considerations relating to installation of the proposed pump stations and sanitary sewer lines based on the soil and groundwater conditions encountered in our soil borings.

B. Site and Project Description

It is our understanding the proposed project involves construction of the necessary roadways, installation of new pump stations and underground pump stations and re-routing of the existing Faucher Drain in preparation of the proposed Renewable Energy Park to be located in the existing agricultural field at the northwest corner of the intersection of Gratiot Road (State Highway M-46) and Graham Road in Thomas Township of Saginaw County, Michigan. It is our understanding the work will consist of installing new sanitary sewer lines along the north side of Gratiot Road, from West Stark Drive to Graham Road and the west side of Graham Road, from Gratiot Road to about ½ mile north of Gratiot Road including a pump station; reconstruction and widening of Graham Road from Gratiot Road, north about ½ mile; construction of a new roadway in the existing agricultural field, starting at Graham Road about a ¼ mile north of Gratiot Road, and commencing west ½ mile; and relocating the existing Faucher Drain south of Gratiot Road for about ¾ of a mile.

C. General

The recommendations submitted in this report have been based on the available soil boring information and the preliminary design details furnished for the proposed development. Any revisions in the noted location or design details for the proposed utilities and structures should be brought to our immediate attention so we may evaluate the extent to which our recommendations may be impacted by the changes. When final plans and specifications are available, we should be given the opportunity to review them to verify our understanding of the anticipated project and to verify our recommendations have been properly interpreted.

The conclusions, recommendations and considerations presented herein have been based on the information obtained from the twenty-one soil borings preformed at this site. This report does not reflect changes in subsurface conditions that may occur between these soil boring locations. If significant variations from our reported subsurface conditions are noted during construction, we should be notified immediately to determine if modifications to our recommendations are needed. We have strived to conduct this soil evaluation in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the locality of this project. No other warranties, implied or expressed, are made. The recommendations presented herein are intended solely for the use of Spicer Group and their design consultants in evaluating this site for the specific development being proposed.

II. DESRIPTION OF INVESTIGATION PROCEDURES

A. Field Operations

Seven soil borings, labeled as Borings B1, B3 through B5, B11 and B21 were drilled to depths of approximately 30 feet below the existing ground surface along the proposed route of the sanitary sewer and pump station. Three soil borings, labeled as Borings B6, B8, and B10, were drilled to a depth of 5 feet and two soil borings, labeled as Borings B7 and B9 were drilled to a depth of 20 feet below the existing ground surface along the proposed route of the new park roadway, to be named 'Sunshine Court'. Four soil borings, labeled as B12 through B15, were completed within the roadway of the existing ½ mile section of Graham Road north of Gratiot Road. Three soil borings, labeled Borings B16 through B18, were drilled to a depth of 20 feet below the existing ground surface in the area of the proposed relocation of Faucher Drain and two soil borings, labeled Borings B19 and B20, were drilled to a depth of 30 feet below the existing ground surface in the area of the proposed detention basin adjacent to the relocated drain. Refer to the attached soil boring location diagram for general location of these soil borings. Spicer Group determined the number, depth and locations of the soil borings. We did not determine ground surface elevations at the soil boring locations.

The soil borings were performed by a trailer-mounted rotary drill rig in general accordance with the American Society of Testing and Materials (ASTM) Standard D-1586 (Penetration Test and Split-Barrel Sampling of Soils) and ASTM D-1587 (using hollow-stem, continuous flight augers to advance the holes. The sampling intervals, standard penetration test results (N-values), groundwater observations and other pertinent field information are shown on the Soil Boring Logs included in the Appendix of this report. The symbols and notations used on the boring logs are defined on the General Notes, also appended to this report.

B. Laboratory Testing

The soil samples were sealed in labeled glass jars in the field and returned to the laboratory where they were visually classified by an experienced soils engineer in general accordance with the Unified Soil Classification System (USCS) (ASTM Standard D-2487). These descriptions appear on the appended Soil Boring Logs. A chart that describes the USCS group symbols, which appear in parenthesis after the soil descriptions, is also included in the Appendix of this report.

Additionally, selected representative portions of the cohesive soil samples were subjected to moisture content and calibrated hand penetrometer tests and torvane shear tests. The moisture content of a soil sample is the ratio of the weight of water in the sample to the oven-dried weight of the soil, as determined by ASTM Standard D-2216, expressed as a percentage. In the hand penetrometer test, the unconfined compressive strength of a soil sample is estimated by measuring the resistance of the soil to penetration of a calibrated spring-loaded cylinder. The capacity of the hand penetrometer is 4-1/2 tons per square foot (tsf). The Torvane shear test estimates the undrained shear strength of cohesive

soils. The Torvane can measure shear strengths ranging from 0.1 to 1 ton per square foot. Results of these laboratory tests are shown on the appended Soil Boring Logs.

III. DESCRIPTION OF SUBSURFACE CONDITIONS

The soil profile description and groundwater observations discussed herein are intended to provide a brief and general summary of the typical subsurface conditions encountered at this site. For a more detailed description of the soil and groundwater conditions encountered at the respective boring locations, please refer to the attached Soil Boring Logs and Soil Boring Location Diagram. The stratification lines of the boring logs are intended to indicate a general transition between soil types and the actual transition may vary between boring locations.

A. Soil Conditions

It appears a somewhat uniform soil profile was noted along the proposed sanitary sewer utility. These somewhat distinct soil profiles have been separated by major roadways the proposed sanitary sewer line is to be along, pump station locations and wastewater treatment facility.

Proposed Sanitary Sewer Line along Gratiot Road

In Soil Borings B3 through B5 and B21, the top foot or so consisted of variable surficial deposits. Beneath these surficial materials at Soil Borings B4 and B5, deposits of fine to clayey sand was encountered to depths of about 8 to 13 feet below the existing ground surface. Beneath these surficial materials and granular deposits at the above stated soil borings locations, hard to very soft, silty or sandy clay layers were encountered to the explored depth of soil borings. At Soil Boring B21, very stiff clayey silt was encountered at a depth of 17 feet, extending to a depth of 19¾ feet and a 2 foot layer of medium dense fine sand was encountered at a depth of 22 feet below the existing ground surface. These cohesive layers exhibited hand penetrometer unconfined compressive strengths ranging between less than ¼ tsf and in excess of 4½ tsf. Torvane shear strength values in the soft to very soft, cohesive soils ranged between 0.10 to 0.28 tsf. Corresponding natural moisture contents varied between 9 and 43 percent. These cohesive soils appear to be somewhat normally consolidated to slightly over consolidated.

Proposed Sanitary Sewer Line along Graham Road including Pump Station

In Soil Borings B1, B2 and B11, the typical soil profile generally consisted of surficial deposits of variable topsoil and fill materials. Clayey silt, silty and sandy clay was encountered beneath these surficial materials to the explored depth of the soil borings. These cohesive layers exhibited hand penetrometer unconfined compressive strengths ranging between less than ¼ tsf and in excess of 4½ tsf. Corresponding natural moisture contents varied between 7 and 43 percent. Torvane shear strength values in these soft to very soft, cohesive soils ranged from 0.14 to 0.25 tsf. These cohesive materials appear to be normally consolidated to slightly over-consolidated.

Proposed Sunshine Court Roadway

In Soil Borings B6 through B10, the typical soil profile generally consisted of surficial deposits of silty or sandy clay topsoil. Beneath the surficial materials described above, silty clay was encountered beneath the materials described above to the explored depth of the soil borings. Hand penetrometer unconfined compressive strengths in these clays were ranged from ¼ tsf to 4½ tsf. Corresponding natural moisture contents in these cohesive soils varied between 16 and 38 percent.

Proposed Reconstruction and Widening of Existing Graham Road

In Soil Borings B12 through B15, the typical soil profile generally consisted of 11 to 12 inches of bituminous pavement overlying 7 to 11 inches of crushed limestone base, with the exception of Soil Boring B12, where the existing asphalt pavement was overlying approximately 3 inches of fine sand sub-base. Silty and/or sandy clay layers were encountered beneath the pavement materials described above to the explored depth of the soil borings. The noted pavement section materials were medium dense in relative density with a standard penetration resistance (N) value of 10 to 16 blows per foot (bpf). Hand penetrometer unconfined compressive strengths in these clays ranged from 1 tsf up to 4 tsf. Corresponding natural moisture contents in these cohesive soils varied between 15 and 31 percent.

Proposed Re-location of Faucher Drain and Detention Basin

In Soil Borings B16 through B18, the typical soil profile generally consisted of surficial deposits of clayey topsoil and granular topsoil materials. At Soil Borings B17 and B18, granular material was encountered beneath these surficial deposits to depths of 1¼ to 1¾ feet below the existing ground surface. Beneath these surficial and granular materials, sandy and silty clays were encountered to the explored depth of the soil borings. At Soil Borings B17, B18 and B20, thin clayey silt layers were encountered at depths of 6¾, 3½ and 6¾, respectively. Hand penetrometer unconfined compressive strengths in these cohesive materials ranged from less than ¼ tsf to in excess of 4½ tsf. Corresponding natural moisture contents in these cohesive soils varied between 11 and 42 percent. Torvane shear strength values in these cohesive soils ranged from 0.20 to 0.33 tsf. These cohesive materials appear to be normally consolidated to slightly over-consolidated.

B. Groundwater Observations

At the soil borings along Gratiot Road, Borings B3 through B5 and B21, groundwater seepage was noted during the drilling or sampling operations at depths of 12'-0", 3'-0", 4'-0" and 22'-0", respectively. At soil borings performed along Graham Road, groundwater was only encountered in Soil Boring B2 at a depth of 12'-0" below the existing ground surface. No groundwater seepage was noted during drilling or sampling operations of Borings B1 and B11. Boring B17 performed along the proposed relocation of Faucher Drain, groundwater seepage was noted during the drilling or sampling operations at a depth of 12'-0". No groundwater seepage was noted during drilling or sampling operations in soil borings B16 and B18. At soil borings B19 and B20, ground

water seepage was noted at a depth of 22'-0". No groundwater seepage was encountered in the remaining soil borings during the drilling and sampling operations. Upon completion of the drilling operations and removal of the augers from the ground, there were visible signs of groundwater seepage in soil borings B1 through B5, B7, B9, B11, B16, B20 and B21 at various depths ranging from 4'-5" to 25'-0". All of the boreholes were backfilled with natural soils upon their completion; therefore no long-term groundwater observations are available.

Due to the inherent low permeability in cohesive soils, such as those typically encountered at this site, a long time may be required for the water level in an open bore hole to stabilize with the long-term hydrostatic groundwater level. For this reason the absence of groundwater seepage into a bore hole during or shortly after completion of the drilling does not necessarily mean the long-term hydrostatic groundwater level is below the explored depth of that particular boring. For this reason, the relatively short-term water level observations, as noted above, may not provide a reliable indication of long-term hydrostatic groundwater level at this site. Where granular soil layers are interbedded with cohesive soils, a complicated subsurface hydraulic condition, including the possibility of perched groundwater accumulations, artesian flow or multiple aquifers, may arise. To accurately determine the position of the long-term hydrostatic groundwater level in this area, and to differentiate perched groundwater conditions, it would be necessary to install piezometers along the proposed sanitary sewer alignment.

In our experience the depth at which the soil color changes from brown to gray often marks the approximate position of the hydrostatic groundwater level, particularly in cohesive soils. This color change, which results from the lack of soil oxidization below the hydrostatic groundwater level, was noted to occur at depths of approximately 8 to 19¼ feet below the existing ground surface in our soil borings. On this basis and from our experience in this area, we estimate the long term hydrostatic groundwater level is between depths of approximately 8 to 19¼ feet below the existing ground surface at the various soil boring locations along the proposed sanitary sewer routes, pump stations and relocation of the Faucher Drain. Groundwater seepage observed in Soil Borings B4 and B5 is judged to be the result of perched groundwater accumulations in the granular deposits.

Perched groundwater accumulations develop when surface runoff infiltrates the more pervious sandy or silty soil layers and partings above or within relatively impermeable clay mass. These groundwater accumulations may then become temporarily trapped or "perched" above the long-term groundwater level. For this reason, perched groundwater accumulations are generally more prevalent during the spring months after the snow melts or following periods of prolonged precipitation and they may essentially disappear during extended dry periods. Based on our soil boring information, conditions appear to be favorable for perched groundwater accumulations to develop at relatively shallow depths at this site given the presence of occasional granular soil intrusions and lenses within the massive clayey substrate.

Normal variations in the depth of the prevailing groundwater level should be expected due to its undulating surface. The long-term hydrostatic groundwater level at this site should be expected to fluctuate with variations in precipitation, evaporation and surface runoff. The groundwater levels indicated on the soil borings and discussed above represent the conditions at the time the measurements were taken.

IV. CONCLUSIONS AND RECOMMENDATIONS

The recommendations submitted herein have been based upon available soil boring and site plan information and the preliminary design details for the proposed development. If our understanding of the project, as previously described, is inaccurate or if any revisions in the plans are made, they should be brought to our attention so we may determine if changes to our recommendations are required. Likewise, if significant variations in the reported subsurface conditions are encountered during construction, we should be notified immediately.

A. Proposed Pump Station Structure

It is our understanding that the proposed depth of the pump station will be at a depth of about 30 feet below the existing ground surface in the area of Boring B2. The soils at this bearing elevation generally consisted of hard to very hard, sandy clay. We recommend pump station structure should bear directly on these hard sandy clays. A net allowable design bearing pressure on the order of 6,000 pounds per square foot shall be utilized to proportion the pump station foundation system at this stated bearing elevation.

Considering the depth of the required excavation for the proposed pump station, the contractor shall be required to engage a professional engineer licensed in the State of Michigan to prepare evaluate the proposed open cut excavation or if necessary, prepare design drawings and specifications for a braced type excavation shoring system capable of supporting a maximum lateral earth pressure as shown on appended sketch. Lateral earth pressure diagrams assume the levels of bracing are provided and installed such that it would be classified as a braced excavation. Any associated construction surcharge loading adjacent to the proposed trench should also be taken in account during shoring design.

With regard to settlement, we estimate total post-construction settlement for pump stations designed and constructed in accordance with the recommendations presented in this report will be on the order of ½ inch or less for the design given. This estimate is based on the anticipated loading conditions and our experience with similar soils.

B. Sewer Line Subsoil Suitability and Pipe Bedding Considerations

Based on the available soil boring information and discussion with the civil engineer, we anticipate excavations associated with the proposed sanitary line trench will have their bottom of excavations at depths of up to 22 feet below the existing ground surface at or near Stark Road and progressing up to a depth about 7 feet below the existing ground surface at approximately 1500 feet east of Graham Road. Based on the results of our soil

borings, these excavations will generally terminate in the natural, soft to very soft clays near Stark Road eventually terminated in the very stiff clays near Graham Road. Near Stark Road, the anticipated exposed clays at the planned bottom of the proposed pipe trench in the area of the soil borings will be very prone to disturbance due to construction activities. Where soft or unstable subgrade soils are encountered at the excavation bottoms, we recommend they be undercut and replaced with a layer of clean, well-graded, crushed aggregate or lean concrete mud mat to minimize further disturbance of the exposed soils.

The trench excavation will require excavation of medium dense granular materials, very soft silty clays and/or stiff to very stiff, silty/sandy clay materials. Therefore, the contractor shall be required to engage a professional engineer licensed in the State of Michigan to prepare design drawings and specifications of a trench shoring system capable of supporting a lateral earth pressure as shown on appended loading diagram (assumes levels of bracing provided such that the system would be classified as braced). Engineer needs to verify bottom of excavation has an adequate factor of safety for heave. Any associated construction surcharge loading adjacent to the proposed trench should also be taken in account during shoring design.

We recommend the sewer pipe be placed on a minimum 4-inch thick layer of compacted granular bedding material to help improve subgrade support and assist with grade control for the proposed utility. Where belled pipe joints are used, hand excavation may be necessary to ensure the minimum bedding thickness is maintained at the joint locations. Additionally, compacted granular fill material should be placed across the entire bottom of the excavation at least up to the spring-line of the pipe to provide added stability and lateral support for the new sanitary sewer pipe.

Where pipe bends in excess of 20 degrees are required, appropriate blocking should be provided to laterally support the pipe against movement. In general, the soils encountered in our soil borings may be presumed to have a minimum allowable passive resistance of 300 psf. If higher allowable passive earth pressures are warranted, we should be contacted to provide a more thorough analysis for design of blocking structures.

C. Pavement Subgrade Preparation for Proposed Sunshine Court

Based on the available soil boring information, stiff to hard existing silty clay deposits are present over the entire proposed roadway areas. We believe these natural deposits may be suitable for support of the proposed pavements following implementation of proper subgrade preparation activities as recommended herein.

We recommend the following pavement subgrade preparation activities be implemented at this site. All surficial sod and topsoil materials should be stripped from the roadway areas. Based on our soil boring information, we anticipate up to one foot of surficial topsoil materials will need to be removed in the area of Soil Borings B6 through B10. Following the removal of these surficial materials, the exposed subgrade materials will consist of natural silty clay deposits. It will be necessary for these exposed subgrade

materials to be thoroughly proof rolled under the observation of a qualified soils engineer. The proof rolling should be performed with a fully loaded dump truck or other heavily loaded pneumatic tired vehicle making continuous side-by-side passes across the entire floor slab area. The purpose of this procedure is to uniformly compact the surface and locate any soft areas that may require stabilization. Subgrade areas that deflect excessively or 'pump' during proof rolling should be excavated and backfilled with acceptable engineered fill.

After the exposed subgrade materials have been properly prepared, as described above, engineered fill can be placed to the planned final subgrade elevation. Refer to section below for material and placement requirements.

D. Engineered Fill Requirements

All engineered fill for the sewer line installation portion and proposed roadway construction of this project, including backfill of sanitary sewer line trenches within the roadway zone of influence or similar structures, should be an approved material free of frozen chunks, organics, debris or other deleterious material. The fill should be spread in level layers not exceeding 12 inches in loose thickness, with each layer being compacted to at least 95 percent of the maximum dry density value determined by ASTM Standard D-1557 (Modified Proctor). A sufficient number of field density tests should be performed during placement to verify proper compaction is achieved. Fill material should never be placed on frozen or muddy ground.

In general, the existing fill and natural, granular materials excavated for the proposed sanitary sewer line may be re-used for engineered fill with the understanding that any organic material, debris or otherwise deleterious materials must be completely removed from the proposed fill soil before it is placed and compacted. To facilitate compaction, we recommend any granular fill materials be placed within +/- 4 percent of the optimum moisture content determined by ASTM Standard D-1557 (Modified Proctor). If necessary to achieve this condition, appropriate moisture reconditioning should be performed at the time of placement. If it is necessary to add moisture, we recommend it be done be disking and harrowing the soil, as the water is added by spraying, to provide a relatively uniform moisture content throughout the soil mass. Alternately, if the soil is too wet at the time of placement, we recommend it be disked and aerated to allow it to dry to the desired moisture content prior to compaction, weather conditions permitting. In open areas, granular fill materials should be compacted using heavy vibratory smooth drummed rollers, however in confined or limited access areas, vibratory plate compactors are recommended.

In general, cohesive materials are more sensitive than granular fill materials to the moisture content at which they are placed with regard to achieving proper compaction. Therefore, we do not recommend any cohesive soils be used for engineered backfill for this project. Similarly, any organic or otherwise deleterious soils excavated from the sanitary sewer trenches should not be used where engineered backfill is specified. Such materials could be used where backfill of a general nature is allowed.

V. CONSTRUCTION CONSIDERATIONS

We do not anticipate any significant problems associated with excavating the pump station and pipe trench based on the results of our soil borings. We believe for a majority of the sewer line these materials will be able to be excavated with conventional equipment upon installation of properly designed trench bracing or earth retention systems. Based on the results of our borings, we believe portions of the proposed sewer line and pump station will be placed at or below the long-term groundwater table, but since the underlying soils generally consist of cohesive materials, the rate of groundwater seepage will be generally slow. Some groundwater seepage should be anticipated from surface runoff, perched water accumulations in upper granular materials above the cohesive layers and /or granular layers and lenses within the cohesive materials below the long term groundwater level and they should be manageable with standard sump pits and pumps.

Some sloughing or caving of the soils may occur during construction, particularly in conjunction with the loose granular soils in the upper portion of the excavations. All excavations must be properly braced or sloped to comply with Michigan Department of Occupational Safety and Health Administration requirements set forth in Part 9 (Excavation, Trenching and Shoring) of the Construction Standards to protect adjacent infrastructure and provide a safe work place for construction personnel. As a minimum, it should be anticipated that worker protection will be required during construction, consisting, shoring, sloping or shielding. The contractor shall engage a professional engineer to design the required trench bracing or earth retention system required for this project, with design drawings and associated calculations required to be submitted to the Engineer of Record for this project for review. The practice of stockpiling excavated soils adjacent to the footing excavation is not recommended as this surcharge loading may cause sudden collapse of the excavation sidewalls. If material and/or equipment are to be stored or operated near an excavation, additional bracing or shoring must be provided to resist these heavier surcharge loadings.

The utility excavation bottoms may also become disturbed due to water accumulations and/or construction operations. All loose or disturbed materials must be completely removed from the excavations bottoms prior to placing any concrete or utility bedding materials. Where soft or unstable subgrade soils are encountered, we recommend they be undercut and replaced with a layer of clean, well-graded, crushed aggregate or lean concrete to minimize further disturbance of the bearing soils. Lean concrete would also be suitable for this purpose. To further minimize the risk of disturbance, the concrete or sewer utility pipe should be placed as soon as possible after the excavations have been dug.

I. GENERAL COMMMENTS

Samples taken in the field will be retained in our laboratory for a period of sixty days from the date of this report and will then be disposed of, unless otherwise requested. Samples stored over an extended time period, even in sealed jars, are subject to moisture

loss and are then no longer representative of the in-situ condition in which they were sampled.

During the course of the soil evaluation, procedures were followed which represent accepted practices in the field of geotechnical engineering. Therefore, discrepancies may exist between the driller's field logs and the final Soil Boring Logs submitted operations and describe field occurrences, sampling locations and other relevant information. The engineer preparing the report reviews the field logs as well as the laboratory soil classifications and laboratory test data. The final Soil Boring Logs are then promulgated based on all the information available from the field and laboratory operations.

The services of a qualified independent testing agency should be engaged during construction to monitor the earthwork and foundation activities and to verify the use of proper materials, equipment and procedures. An appropriate number of field density tests should be preformed during the earthwork operations to verify proper compaction is achieved where engineered fill is used.

REPORT PREPARED BY: **REPORT REVIEWED BY:**

Pamela K. Howson **Michael D. Staley, P.E.**

APPENDIX

GENERAL NOTES
SOIL BORING LOCATION DIAGRAM (See Spicer Dwg.)
RECOMMENDATION FOR LATERAL PRESSURES
FOR BRACED EXCAVATIONS
SOIL BORING LOGS (B1 THROUGH B21)
UNIFIED SOIL CLASSIFICATION SYSTEM

SNYDER & STALEY ENGINEERING, P.L.C.

GENERAL NOTES

Drilling and Sampling Symbols

SS – Split-spoon Sample – 1 1/2" I.D., 2" O.D. except where noted.
ST – Shelby Tube Sample – 3" O.D. except where noted.
AS – Auger Sample
BS – Bag Sample
WS – Wash Sample
RC – Rock Core with Diamond Bit–NX Size except where noted.
NR – No Recovery
PS – Probe Sample
DR – Drove Rock
DS – Disturbed Sample

Water Level Measurement Symbols

WL – Water Level
WD – While Drilling
AB – After Boring
WC – Wet Cave-In
DC – Dry Cave-In
WS – While Sampling

NOTE:
Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. With impervious Soils, short term observations of water level may not be an accurate indication of the long term ground water level. These levels may also fluctuate throughout the year with variations in precipitation, evaporation, and runoff.

Soil Property Symbols

N – Standard Penetration Resistance (ASTM D–1586. Blows of a 140 lb hammer falling 30 inches req'd to drive a 2 inch O.D. split–spoon sampler (except where otherwise noted) 1 ft into the soil).
qp – Calibrated hand penetrometer unconfined compressive strength, tsf.
qu – Controlled strain unconfined compressive strength, tsf (ASTM D–2166)
cs – Calibrated Torvane shear strength, tsf.
w – Water content, % (ASTM D–2216)
γ – Natural unit weight, pcf.
LL – Liquid Limit, % (ASTM D–4318)
PL – Plastic Limit, % (ASTM D–4318)
PI – Plasticity Index, % (ASTM D–4318)

Sample Classification

All Samples are visually classified in general accordance with ASTM Standard D–2487 (Unified Soil Classification System), unless otherwise noted.

PARTICLE SIZE

Boulders: Greater than 12" (305mm)
Cobbles: 3" to 12" (76mm to 305mm)
Coarse Gravel: 3/4" to 3" (19mm to 76mm)
Fine Gravel: #4 to 3/4" (4.75mm to 19mm)
Coarse Sand: #10 to #4 (2.00mm to 4.75mm)
Medium Sand: #40 to #10 (0.425mm to 2.00mm)
Fine Sand: #200 to #40 (0.074mm to 0.425mm)
Silt: 0.005mm to 0.074mm
Clay: Less than 0.005mm

CONSTITUENT TERMS

Few/Trace:	Less than 10%
Occasional/Trace to Some:	10% to 20%
Frequent/Some:	20% to 35%
And:	35% for each type of soil identified.

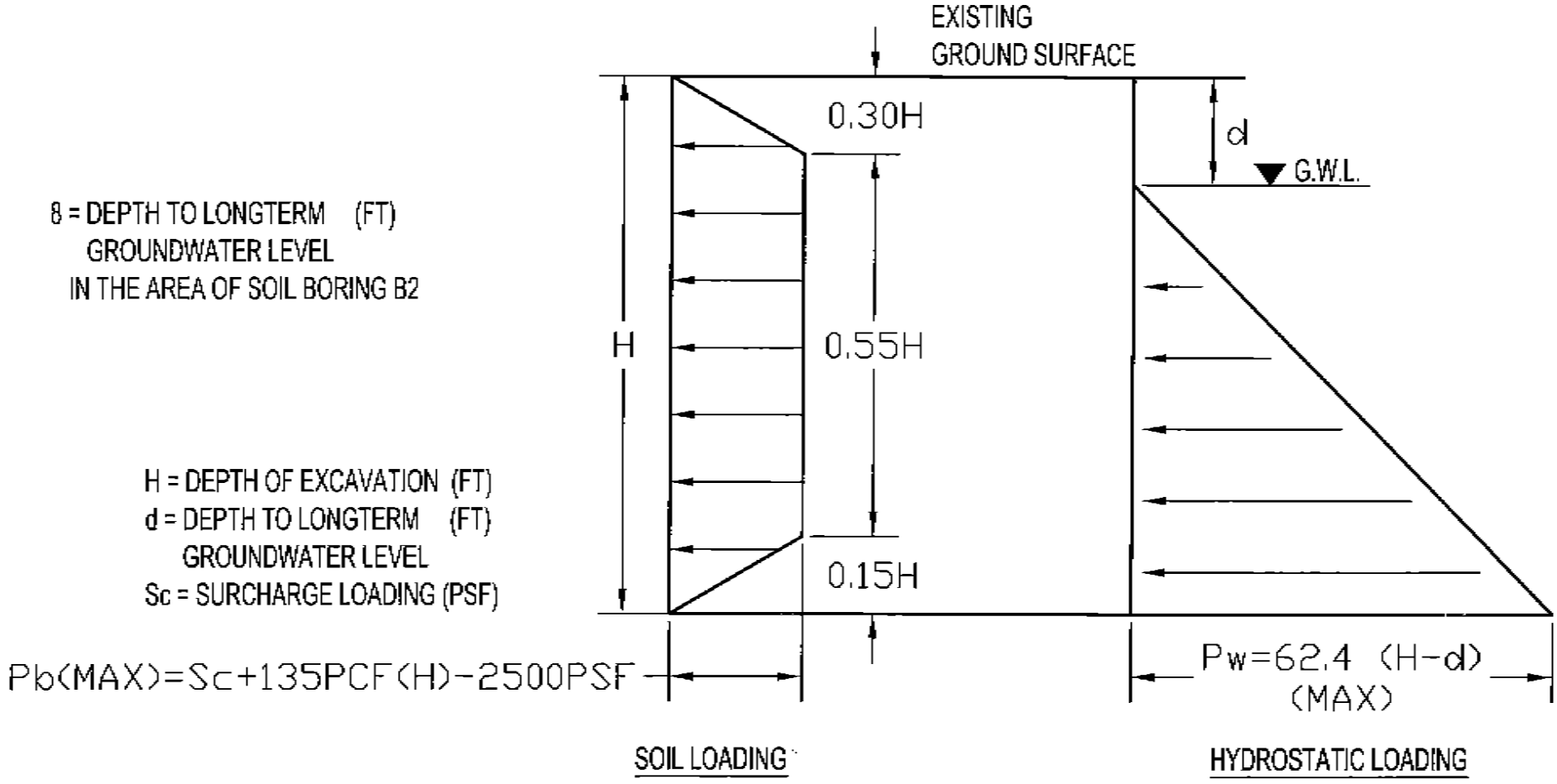
NOTE:
Soil constituents area based on visually estimated quantities.

RELATIVE DENSITY OF GRANULAR SOILS

	STANDARD PENETRATION (N) VALUE, BLOWS / FOOT
Very Loose	Less than 4
Loose	4 – 9
Medium Dense	10 – 29
Dense	30 – 49
Very Dense	50 – 80
Extremely Dense	Greater than 80

CONSISTENCY OF COHESIVE SOILS

	UNCONFINED COMPRESSIVE STRENGTH (qu or qp), tsf
Very Soft	Less than 0.25
Soft	0.25 – 0.49
Firm	0.50 – 0.99
Stiff	1.00 – 1.99
Very Stiff	2.00 – 3.99
Hard	Greater than 4.00



8 = DEPTH TO LONGTERM (FT)
GROUNDWATER LEVEL
IN THE AREA OF SOIL BORING B2

H = DEPTH OF EXCAVATION (FT)
d = DEPTH TO LONGTERM (FT)
GROUNDWATER LEVEL
Sc = SURCHARGE LOADING (PSF)

NOTE:
ANY SURCHARGE LOADING AT THE SURFACE NEEDS TO BE ADDED TO THESE LOADING DIAGRAMS. WE RECOMMEND A MINIMUM OF 300 PSF SURCHARGE LOADING BE APPLIED FOR DESIGN PURPOSES.

Recommendation for Lateral Pressures for Braced Excavations

SCALE: NTS

PROJECT NUMBER: 11-130-098	DATE: 06/17/11	PROJECT TITLE: Proposed Renewable Energy Park Thomas Township, Michigan	SNYDER & STALEY ENGINEERING, P.L.C.
SHEET NUMBER: SHT 1 SHT 1 OF 1	DRAWN BY: E.P.F.	SHEET TITLE: Recommendation for Lateral Pressures for Braced Excavations	CONSULTING ENGINEERS 3085 BAY ROAD, SUITE 6 SAGINAW, MI 48603 PH: (989) 797-1710 FX: (989) 797-1715
	CHK'D BY: MDS		

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B1

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (lsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 8 inches of sandy clay TOPSOIL; trace fine gravel and vegetation – dark brown (CL–TOPSOIL)			S1	SS	7	2			35	
Silty CLAY; trace sand and vegetation – brown – very stiff (CL)	5		S2	SS	12	1			22	
Silty CLAY; trace sand and vegetation, few gray silt partings – brown – stiff (CL)			S3	SS	17	3½			20	
Silty CLAY; trace fine sand – brown – very stiff (CL)	10		S4	SS	19	2¾			24	
Silty CLAY – brown – very stiff (CL)	15		S5	SS	4	<1/4		0.15	43	
Silty CLAY; trace fine sand – gray – very soft (CL)	20		S6	SS	2	<1/4		0.14	35	
Clayey SILT – gray – very soft (ML)	25		S7	SS	10	1/4		0.22	24	
Sandy CLAY; trace fine gravel and silt – gray – hard (CL)	30		S8	SS	53	4½+			7	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

25'–0" Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/18/11 Drawn By: P. HOWSON

Completed: 05/18/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B2

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 7 inches of fine sand TOPSOIL; trace clay and vegetation – dark brown – moist (SP–TOPSOIL)			S1	SS	9	1¾			18	
Fine SAND; trace vegetation – brown – moist – loose (SP)	5		S2	SS	8	2¼			33	
Sandy CLAY; trace silt and vegetation – mottled brown w/ gray – stiff (CL)			S3	SS	14	3¼			26	
Silty CLAY; trace fine sand and vegetation, few partings and lenses – mottled brown w/gray – very stiff (CL)	10		S4	SS	19	3½			23	
Silty CLAY; 2 inch layer of clayey silt at approx. 6 feet -- brown – very stiff (CL)										
Silty CLAY; trace fine sand – gray – very stiff to very soft (CL)	15		S5	SS	10	1/4		0.24	30	
	20		S6	SS	25	3/4			16	
Clayey SILT; trace fine gravel – gray – firm (ML)	25		S7	SS	29	4½			16	
Clayey SAND; trace silt and fine gravel – gray – moist – medium dense (SC)										
Sandy CLAY; trace fine to coarse gravel and silt – gray – hard to very hard (CL)	30		S8	SS	85	4½+			9	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

12'–0" While Sampling or Drilling

12–3" Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/18/11 Drawn By: P. HOWSON

Completed: 05/18/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B3

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 3 inches of sandy clay TOPSOIL overlying 7 inches of silty CLAY (CL-TOPSOIL)			S1	SS	6	2			24	
Silty CLAY; trace fine sand and vegetation – mottled brown with gray – very stiff (CL)	5		S2	SS	5	1			21	
Silty CLAY; trace fine sand and vegetation – brown – stiff (CL)			S3	SS	13	2¾			26	
	10		S4	SS	15	3½			28	
Silty CLAY; trace fine sand, occasional partings and lenses – brown – very stiff (CL)	15		S5	SS	5	3/4			30	
	20		S6	SS	4	1/4		0.23	27	
Silty CLAY; trace fine sand – gray – firm to very soft (CL)	25		S7	SS	8	1/4		0.20	26	
	30		S8	SS	8	<1/4		0.10	35	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

12'-0" While Sampling or Drilling

20-1" Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/20/11 Drawn By: P. HOWSON

Completed: 05/20/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B4

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 8 inches of crushed limestone FILL (GP-FILL)										
		■	S1	SS	7					
Fine SAND; trace silt and clay; few pockets clayey sand and sandy clay - brown - moist - loose (SP)	5	■	S2	SS	3					
		■	S3	SS	1					
Fine SAND; trace silt and clay - brown - wet - loose to very loose (SP)	10	■	S4	SS	1					
Silty CLAY; trace fine sand - gray - stiff (CL)	15	■	S5	SS	14	1			22	
	20	■	S6	SS	16	1½			21	
Silty CLAY; trace fine sand - gray - stiff to very soft (CL)										
	25	■	S7	SS	10	1¼			30	
	30	■	S8	SS	3	1/4		0.17	43	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

3'-0" While Sampling or Drilling

WC 4'-8" Immediately After Completion

___ @ ___ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/20/11 Drawn By: P. HOWSON

Completed: 05/20/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B5

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 3 inches of SOD overlying 7 inches of fine to medium sand FILL (SP–FILL)										
		■	S1	SS	2					
Fine SAND; trace silt, clay and vegetation – brown – moist – loose (SP)										
	5	■	S2	SS	18					
Clayey SAND; trace to some organics, trace silt – dark brown to black – moist – medium dense (SC)										
		■	S3	SS	15					
Clayey SAND; trace to some organics – black – moist – medium dense (SC)										
	10	■	S4	SS	10	¾–3			24	
Fine SAND; trace silt and clay – gray – very moist to wet – very loose (SC)										
Fine SAND; trace silt and clay – brown – wet – medium dense (SP)										
	15	■	S5	SS	11	1½			27	
	20	■	S6	SS	7	1			30	
Silty CLAY; trace fine sand – gray brown – stiff to very soft (CL)										
	25	■	S7	SS	2	<1/4		0.18	43	
	30	■	S8	SS	4	<1/4		0.15	40	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

4'–0" While Sampling or Drilling

4'–5" Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/20/11 Drawn By: P. HOWSON

Completed: 05/20/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B6

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Silty clay TOPSOIL; trace fine sand – dark gray (CL–TOPSOIL)										
Silty CLAY; trace sand – mottled, brown w/ gray – stiff (CL)			S1	SS	14	1¾			18	
Silty CLAY; trace fine sand – mottled brown w/ gray – very stiff (CL)			S2	SS	18	3¼			26	
Boring Terminated at 5 feet	5									

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/21/11 Drawn By: P. HOWSON

Completed: 05/21/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B7

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Silty CLAY; trace to some fine sand – dark gray to black (CL)										
Silty CLAY; trace fine sand – mottled, gray w/ brown – very stiff (CL)			S1	SS	11	2¼			24	
			S2	SS	7	3			31	
Silty CLAY; trace fine sand, occasional brown silt lenses – brown – very stiff to hard to soft (CL)	5		S3	SS	17	4½			25	
			S4	SS	14	½–2			25	
Clayey SILT; trace coarse gravel – brown – very stiff (CL)	10									
Silty CLAY; trace fine sand and coarse gravel – brown – very stiff to very soft (CL)			S5	SS	6	1/4		0.33	38	
Silty CLAY; trace fine sand – gray – very soft to stiff (CL)	15									
			S6	SS	6	1			26	
Boring Terminated at 20 feet	20									

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

5'–9" While Sampling or Drilling

13'–8" Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/21/11 Drawn By: P. HOWSON

Completed: 05/21/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B8

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Sandy clay TOPSOIL; trace silt – dark gray to black (CL–TOPSOIL)										
Silty CLAY; trace sand, few pockets of fine sand – mottled, brown w/ gray – very stiff (CL)			S1	SS	13	2			16	
Silty CLAY; trace fine gravel – mottled brown w/ gray – very stiff (CL)	5		S2	SS	18	2			24	
Boring Terminated at 5 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/21/11 Drawn By: P. HOWSON

Completed: 05/21/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B9

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration "N" Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Sandy CLAY – dark gray (CL)										
Silty CLAY; trace fine sand – brown – stiff to very stiff (CL)			S1	SS	6	1			18	
	5		S2	SS	11	2½			24	
Silty CLAY; trace fine sand, occasional brown silt lenses and partings – brown – very stiff to hard to very stiff (CL)			S3	SS	22	4¼			25	
	10		S4	SS	14	3			28	
Silty CLAY; trace fine sand, few fine sand partings – brown – very soft (CL)	15		S5	SS	4	<1/4		0.20	28	
Silty CLAY; trace fine sand – gray – firm (CL)	20		S6	SS	10	3/4			22	
Boring Terminated at 20 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

14'-6" While Sampling or Drilling

WC 18'-6" Immediately After Completion

___ @ ___ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/21/11 Drawn By: P. HOWSON

Completed: 05/21/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B10

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Sandy clay TOPSOIL; trace silt – dark brown (CL–TOPSOIL)										
Silty CLAY; trace fine sand – brown – very stiff (CL)			S1	SS	4	2¼			22	
Silty CLAY; trace fine sand, few fine sand lenses – brown – stiff (CL)	5		S2	SS	12	1½			23	
Boring Terminated at 5 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

___ @ ___ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/21/11 Drawn By: P. HOWSON

Completed: 05/21/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B11

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 8 inches of sandy clay TOPSOIL – dark brown (CL–TOPSOIL)										
Clayey SILT – brown – stiff (CL)		■	S1	SS	9	1½			20	
Silty CLAY – brown – stiff (CL)										
Silty CLAY; trace sand, few gray silt partings and lenses – brown – stiff (CL)	5	■	S2	SS	9	1¼			24	
Silty CLAY; trace fine sand – brown – stiff (CL)		■	S3	SS	27	4½			20	
	10	■	S4	SS	15	4½			27	
Silty CLAY; trace fine sand, few gray silt lenses – gray – very stiff (CL)										
	15	■	S5	SS	4	1/4		0.25	36	
Silty CLAY; trace fine sand and fine gravel – gray – very soft (CL)	20	■	S6	SS	5	<1/4		0.20	32	
	25	■	S7	SS	7	1/4			27	
Sandy CLAY; trace fine gravel and silt – dark gray – very hard (CL)	30	■	S8	SS	60	4½+			9	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

25'-0" Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/21/11 Drawn By: P. HOWSON

Completed: 05/21/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B12

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 12 inches of bituminous PAVEMENT overlying 3 inches of fine to medium sand SUBBASE										
Sandy CLAY; trace fine gravel – gray green – hard (CL)			S1	SS	16	4			15	
Silty CLAY; trace fine sand, few fine sand lenses and gray silt partings – brown – stiff (CL)	5		S2	SS	7	1			24	
Boring Terminated at 5 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/25/11 Drawn By: P. HOWSON

Completed: 05/25/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B13

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 13 inches of bituminous PAVEMENT overlying 7 inches of crushed limestone BASECOURSE										
Sandy CLAY; trace fine gravel, silt and clay – gray – very stiff (CL)			S1	SS	10	2			17	
Silty CLAY; trace fine sand, few gray silt partings and lenses – brown – stiff (CL)			S2	SS	7	1¾			22	
Boring Terminated at 5 feet	5									

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/25/11 Drawn By: P. HOWSON

Completed: 05/25/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B14

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 11 inches of bituminous PAVEMENT overlying 11 inches of crushed limestone BASECOURSE										
Silty CLAY; trace fine sand – dark gray to black – hard (CL)			S1	SS	14	4			24	
Silty CLAY; trace fine sand – mottled. brown w/gray – stiff (CL)	5		S2	SS	7	1			30	
Boring Terminated at 5 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/25/11 Drawn By: P. HOWSON

Completed: 05/25/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B15

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 11 inches of bituminous PAVEMENT overlying 8 inches of crushed limestone BASECOURSE										
Silty CLAY; trace fine sand – dark gray – very stiff (CL)			S1	SS	14	3			31	
Silty CLAY; trace fine sand – brown – stiff (CL)			S2	SS	7	1¼			27	
Boring Terminated at 5 feet	5									

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

___ @ ___ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 05/25/11 Drawn By: P. HOWSON

Completed: 05/25/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B16

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Clayey SAND – dark brown – moist – medium dense (SC)										
Silty CLAY; trace fine sand, few gray silt partings and lenses – brown – hard (CL)			S1	SS	10	4			14	
Silty CLAY; trace sand, few brown silt lenses – brown – very stiff (CL)	5		S2	SS	17	3½			27	
Silty CLAY; trace fine sand and fine gravel, few brown silt lenses – brown – hard (CL)			S3	SS	25	4½			23	
Silty CLAY; trace fine sand – gray w/rust – very stiff (CL)										
Silty CLAY; trace so some fine sand – gray w/rust – very stiff (CL)	10		S4	SS	19	3½			25	
Silty CLAY; trace fine gravel – gray – very stiff (CL)	15		S5	SS	13	2¾			23	
Sandy CLAY; trace sand and fine gravel – gray (CL)	20		S6	SS	54	DS			14	
Boring Terminated at 20 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 06/01/11 Drawn By: P. HOWSON

Completed: 06/01/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B17

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 3 inches of SOD overlying 6 inches of fine sand TOPSOIL										
Fine SAND; trace to some clay, trace vegetation – dark brown – loose – moist (SP)			S1	SS	4	1¼			29	
Silty CLAY; trace fine sand, few gray silt lenses and partings – brown – stiff to very stiff (CL)	5		S2	SS	15	3¾			24	
Clayey SILT – brown – very stiff (ML)			S3	SS	16	2			25	
Silty CLAY; trace fine sand – brown – very stiff to hard (CL)	10		S4	SS	24	4			29	
Silty CLAY; trace so some fine sand, trace fine gravel – brown – stiff (CL)	15		S5	SS	9	1¼			25	
Silty CLAY; trace to some fine sand, trace fine gravel – gray – very stiff (CL)	20		S6	SS	12	3			16	
Boring Terminated at 20 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

12'-0" While Sampling or Drilling

17'-8" Immediately After Completion

___ @ ___ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 06/01/11 Drawn By: P. HOWSON

Completed: 06/01/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B18

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	Depth (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 8 inches of clayey sand TOPSOIL – dark brown – moist (SC–TOPSOIL)										
Clayey SAND; trace fine gravel and vegetation – brown – loose – moist (SC)			S1	SS	7	4¼			25	
Silty CLAY; trace sand, few gray silt lenses – brown – hard (CL)										
Clayey SILT – brown – hard (ML)	5		S2	SS	22	4½+			20	
Silty CLAY; trace sand, few silt lenses and partings – brown – hard to very stiff (CL)			S3	SS	25	4			16	
	10		S4	SS	18	3			24	
Silty CLAY; trace fine sand and fine gravel – gray – very stiff (CL)	15		S5	SS	10	2¼			15	
Silty CLAY; trace to some fine sand, trace fine gravel – gray – very stiff (CL)	20		S6	SS	18	2			19	
Boring Terminated at 20 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

NONE While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 06/02/11 Drawn By: P. HOWSON

Completed: 06/02/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B19

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 8 inches of sandy clay TOPSOIL – dark brown (CL-TOPSOIL)										
Silty CLAY; trace fine sand – dark brown – very stiff (CL)			S1	SS	8	2½			26	
Silty CLAY; trace sand, few gray silt lenses – brown – very stiff (CL)	5		S2	SS	23	3¾			22	
Silty CLAY; trace fine sand, occasional gray silt lenses and partings – brown – very stiff to hard (CL)			S3	SS	25	4½			22	
Silty CLAY; trace fine sand – brown – hard (CL)	10		S4	SS	14	4½			20	
	15		S5	SS	9	DS			21	
Silty CLAY; trace to some fine sand, trace fine gravel – gray – very soft (CL)	20		S6	SS	10	1/4		0.23	24	
	25		S7	SS	42	4½+			11	
Sandy CLAY; trace fine gravel – dark gray – hard (CL)	30		S8	SS	77	4½+			11	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

22'-0" While Sampling or Drilling

NONE Immediately After Completion

. @ . After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 06/01/11 Drawn By: P. HOWSON

Completed: 06/01/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B20

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration N Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 9 inches of clayey sand TOPSOIL – dark brown (SC-TOPSOIL)										
Silty CLAY; trace fine sand – brown – very stiff (CL)			S1	SS	8	3			23	
Silty CLAY; few gray silt partings, frequent brown silt lenses – brown – very stiff (CL)	5		S2	SS	21	3¾			22	
Clayey SILT – brown – very stiff (CL)			S3	SS	20	3½			27	
Silty CLAY; trace fine sand and fine gravel – brown – very stiff (CL)	10		S4	SS	13	2½			19	
Silty CLAY; trace fine sand and fine gravel – gray – soft to stiff (CL)	15		S5	SS	5	1/2		0.28	42	
Sandy CLAY; trace fine gravel – dark gray – hard (CL)	20		S6	SS	8	1			15	
Fine to medium SAND; trace fine gravel, clay and silt – gray – wet – dense (SP)										
Sandy CLAY; trace fine gravel – dark gray – very hard (CL)	25		S7	SS	47	4½+			9	
Boring Terminated at 30 feet	30		S8	SS	74	4½+			11	

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

22'-0" While Sampling or Drilling

11'-0" Immediately After Completion

____ @ ____ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 06/01/11 Drawn By: P. HOWSON

Completed: 06/01/11 Approved: M. STALEY

SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

SOIL BORING LOG

Boring No: B21

Project: RENEWABLE ENERGY PARK Project No: 11-130-098

Location: THOMAS TOWNSHIP, SAGINAW CTY, MICHIGAN Client: SPICER GROUP

Description of Material	DEPTH (ft)	Sample Length	Sample I.D.	Sample Type	Standard Penetration 'N' Blows Per Ft.	Hand Penetrometer qp (tsf)	Unconfined compression qu (tsf)	Torvane Shear cs (tsf)	Moisture Content w (%)	Natural Unit Weight γ (pcf)
Driller reported 9 inches of fine sand TOPSOIL – dark brown (SP–TOPSOIL)										
Silty CLAY; trace fine sand – brown – very stiff (CL)		■	S1	SS	7	2½			20	
	5	■	S2	SS	15	3			26	
Silty CLAY; trace fine sand, frequent gray silt partings and lenses – brown – very stiff (CL)		■	S3	SS	19	3¼			24	
	10	■	S4	SS	13	2			25	
Silty CLAY; trace to some fine sand, trace fine gravel – brown – very stiff (CL)										
	15	■	S5	SS	3	1/2		0.28	32	
Silty CLAY; trace fine sand and fine gravel – gray – firm (CL)										
	20	■	S6	SS	14	2½			25	
Clayey SILT – gray – very stiff (ML)										
Silty CLAY – gray – very stiff (CL)										
Fine SAND; some silt – gray – wet – medium dense (SP)	25	■	S7	SS	28	4½+			10	
Sandy CLAY; trace silt, fine gravel – gray – very hard (CL)										
	30	■	S8	SS	61	4½+			9	
Boring Terminated at 30 feet										

NOTE: Changes in soil stratification indicated by lines are approximate. In situ, the transition between materials maybe gradual unless otherwise noted. The bored hole was backfilled with natural soil.

WATER LEVEL OBSERVATIONS

22'-0" While Sampling or Drilling

24'-8" Immediately After Completion

____ @ ____ After Completion

BORING

Rig: AFT Drilling Foreman: B. BELLOWS

Started: 06/03/11 Drawn By: P. HOWSON

Completed: 06/03/11 Approved: M. STALEY

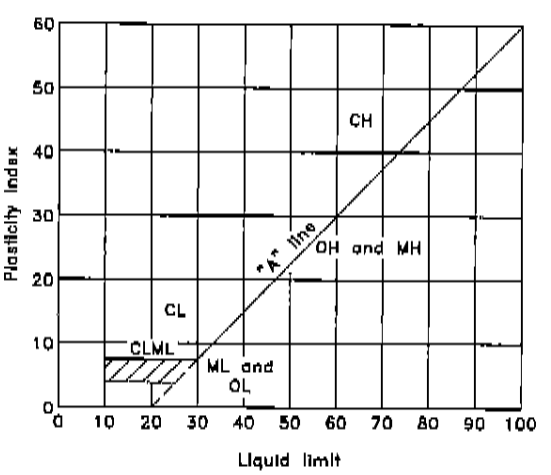
SHEET 1 of 1

SNYDER & STALEY ENGINEERING, P.L.C.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse grained soils are classified as follows:	$C_u=\frac{D_{60}}{D_{10}}$ greater than 4; $C_c=\frac{(D_{30})^2}{D_{10}\times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.		Not meeting all gradation requirements for GW.	
		Gravels with fines (Appreciable amount of fines)	GM[a] d / u	Silty gravels, gravel-sand-silt mixtures.	GW, GP, SW, SP GM, GC, SM, SC Borderline cases requiring dual symbols[b]	Atterberg limits below "A" line or P.I. less than 4.	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures.		Atterberg limits below "A" line with P.I. greater than 7.	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines.		$C_u=\frac{D_{60}}{D_{10}}$ greater than 6; $C_c=\frac{(D_{30})^2}{D_{10}\times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands little or no fines.		Not meeting all gradation requirements for SW.	
		Sands with fines (Appreciable amount of fines)	SM[a] d / u	Silty sands, sand-silt mixtures.	Less than 5 per cent More than 12 per cent 5 to 12 per cent	Atterberg limits above "A" line or P.I. less than 4.	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures.		Atterberg limits above "A" line with P.I. greater than 7.	
Fine grained soils (more than half material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.			
			OL	Organic silts and organic silty clays of low plasticity.			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.			
			CH	Inorganic clays of high plasticity, fat clays.			
			OH	Organic clays of medium to high plasticity, organic silts.			
	Highly organic soils		Pt	Peat and other highly organic soils.			

Plasticity Chart



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well graded gravel sand mixture with clay binder.