Report on Preliminary Geotechnical Investigation

Chesterfield Township Property
21 Mile Road and Sugarbush Road
Chesterfield Township, Michigan

Latitude 42.644164° N
Longitude 82.826732° W

Prepared for:
Chesterfield Township Public Library
50560 Patricia Avenue
Chesterfield, MI 48051

G2 Project No. 180709
October 25, 2018
October 25, 2018

Elizabeth Madson
Library Director
Chesterfield Township Public Library
50560 Patricia Avenue
Chesterfield, MI 48051

Re: Report on Preliminary Geotechnical Investigation
Chesterfield Township Property
21 Mile Road and Sugarbush Road
Chesterfield Township, Michigan
G2 Project No. 180709

Dear Ms. Madson:

We have completed the preliminary geotechnical investigation for the development of the vacant parcel for a potential library in Chesterfield Township, Michigan. This report presents the results of our observations and analyses, our preliminary recommendations for subgrade preparation and foundation design, and construction considerations as they relate to the geotechnical conditions at the site.

We appreciate the opportunity to be of service to Chesterfield Township Public Library and look forward to discussing the recommendations presented. In the meantime, if you have any questions regarding the report or any other matter pertaining to the project, please call us.

Sincerely,

G2 Consulting Group, LLC

Amy L. Schneider, P.E.
Project Manager

Noel J. Hargrave-Thomas, P.E.
Principal

ALS/NJHT/ljv

Enclosures
EXECUTIVE SUMMARY

We understand the subject parcel is being evaluated for the new Chesterfield Township library potential development. The investigation is to understand limitations for building on the site for potential purchase of the property. We understand the library would likely be a single story, slab-on-grade structure of steel frame construction with some masonry cladding. Column loads are expected to be on the order of 100 kips or less. At the time of this investigation, the proposed development layout as well as existing and proposed grades had not been determined. When proposed building types and locations have been determined, additional soil borings must be performed in conjunction with a final investigation. G2 Consulting Group, LLC (G2) will review preliminary findings presented herein and provide final design recommendations.

Six soil borings, B-1 through B-6, were drilled throughout the overall property to evaluate potential site development. Approximately 7 to 12 inches of topsoil are typically present at the soil boring locations, with the exception of boring B-5 which had 18 inches of topsoil present. Very loose to loose and to a lesser extent medium compact silty sand underlies the topsoil at borings B-1 through B-4 and extends to approximate depths ranging from 2 to 11 feet below existing grade. Stiff to very stiff silty clay is generally present below the silty sand at borings B-1 through B-4 and topsoil at the remaining borings and extends to approximate depths ranging from 8 to 18 feet below existing grade. Very soft to soft silty clay underlies the stiff to very stiff material and extends to the explored depth of 20 feet.

Groundwater measurements were obtained during and upon completion of drilling operations at the soil boring locations. Groundwater was encountered borings B-1 through B-3 during drilling operations at approximate depths ranging from 3 to 8-1/2 feet below existing grade. Upon completion of drilling at borings B-1 and B-2, a wet cave of the boreholes was measured at the approximate encountered groundwater elevation. No measurable groundwater was encountered during or upon completion of drilling operations at borings B-4 through B-6 nor upon completion at boring B-3.

The most significant issue pertaining to site development is the presence of the very soft to soft silty clay with high natural moisture contents. This material is very sensitive to consolidation associated with additional loads, such as foundations or engineered fill to raise site grades. Additionally, to support the structure on shallow foundations, a suitable “crust” thickness of stiff to very stiff material must be present between the foundation bearing surface and the interface of the very soft to soft material to support the foundation loads. Therefore, we anticipate existing grades cannot be varied greater than +/- 12 inches. In consideration of these assumptions, the east half of the property in the vicinity of borings B-4 through B-6 appears to be relatively flat and likely the best location for the building; however, this area also has the thinnest “crust” section. We anticipate preliminary bearing capacities for design of shallow foundations will range between 1,500 and 2,500 pounds per square foot (psf). Additional soil borings and consolidation testing are required to further evaluate the site based on layout and grades. This will require balancing the loading conditions, thickness of the stiff to very stiff material below foundation bearing depth, and proposed grades.

Alternatively, if grades are be raised or loading conditions are high, the building will need to be supported on deep foundations extending through the very soft to soft clay to more competent bearing soils, depth to be determined through deeper soil borings. Additionally, settlement plates and surcharging the site for an extended period of time will likely be required prior to site development. To minimize deep foundation requirement potential, loading conditions should be kept to a minimum.

We anticipate the stiff to very stiff silty clay, very loose to medium compact sand and silty sand, or engineered fill to raise site grade, if required, will be suitable for support of building floor slabs, following satisfactory completion of subgrade preparation as presented in the SITE PREPARATION section of this report.

This summary is not to be considered separate from the entire text of this report, with all the conclusions and qualifications mentioned herein. Details of our analysis and recommendations are discussed in the following sections and in the Appendix of this report.
PROJECT DESCRIPTION AND SITE CONDITIONS

We understand the vacant property is being evaluated for the new Chesterfield Township library potential development. The investigation is to understand limitations for building on the site for potential purchase of the property. We understand the library would likely be a single story, slab-on-grade structure of steel frame construction with some masonry cladding. Column loads are expected to be on the order of 100 kips or less. Existing and finished grades were not available at the time of this investigation.

Based on aerial photographs and our site visit, the property is covered with high brush and trees. The south side of the property is designated as wetlands. At the time of this investigation, the proposed development layout had not been determined nor was a topographic survey of the property available. Based on visual observations and preliminary data obtained from Google Earth, elevations generally slope downward from the intersection of Sugarbush Road and 12 Mile Road to the east, varying up to 10 feet across the entire parcel. The majority of the elevation change occurs within the west half of the property, while the east half of the parcel appears to be relatively flat.

When proposed building types and locations have been determined, additional soil borings must be performed in conjunction with a final investigation. G2 will review preliminary findings presented herein and provide final design recommendations.

SCOPE OF SERVICES

The field operations, laboratory testing, and engineering report preparation were performed under direction and supervision of a licensed professional engineer. Our services were performed according to generally accepted standards and procedures in the practice of geotechnical engineering in this area. Our scope of services for this project is as follows:

1. We drilled six soil borings throughout the property extending to a depth of 20 feet each below existing grade.

2. We performed laboratory testing on representative samples obtained from the soil borings. Laboratory testing included visual engineering classification, natural moisture content, organic content (loss-on-ignition), dry density, and unconfined compressive strength determinations.

3. We prepared this engineering report. Our report includes recommendations regarding foundation types suitable for the encountered subsurface conditions, preliminary allowable capacities for shallow foundations, site development issues, and construction considerations related to foundation construction and associated development.

FIELD OPERATIONS

G2 was provided the number and depth of the soil borings by Chesterfield Township Public Library in an effort to provide an overall evaluation of the property for development. The boring locations were located in the field by G2 prior to drilling operations by use of GPS assisted mobile technology. A representative of Chesterfield Township cleared paths through the existing brush to allow access of the drill rig to the staked locations prior to our field operations. The approximate soil boring locations are shown on the Soil Boring Location Plan, Plate No. 1.

No ground surface elevations were available at the time of this investigation. We recommend the soil boring locations be surveyed prior to any earthwork operations and finished grade design layout so the soil stratigraphy and groundwater depths can be reference to elevations. Following obtaining boring elevations in-situ and proposed grading plans, G2 should be retained to perform additional field and laboratory work for preparation of an addendum to the report in reference to the proposed development.
The soil borings were drilled using an all-terrain vehicle (ATV) rotary drilling rig. Continuous flight, 2-1/4 inch inside diameter hollow-stem augers were used to advance the boreholes to the explored depths. Within each soil boring, soil samples were obtained at intervals of 2-1/2 feet within the upper 10 feet and at intervals of 5 feet thereafter. These samples were obtained by the Standard Penetration Test method ASTM D 1586, which involves driving a 2-inch diameter split-spoon sampler into the soil with a 140-pound weight falling 30 inches. The sampler is generally driven three successive 6-inch increments with the number of blows for each increment recorded. The number of blows required to advance the sampler the last 12 inches is termed the Standard Penetration Resistance (N). The blow counts for each 6-inch increment and the resulting N-value are presented on the individual soil boring logs.

The soil samples were placed in sealed containers in the field and brought to the laboratory for testing and classification. During drilling operations, the drilling crew maintained logs of the encountered subsurface conditions, including changes in stratigraphy and observed groundwater levels of the soil borings to be used in conjunction with our analysis of the subsurface conditions. The final boring logs are based on the field logs and laboratory soil classification of these results. After completion of the drilling operations, the boreholes were backfilled with the auger cuttings.

LABORATORY TESTING

Representative soil samples were subjected to laboratory testing to determine soil parameters pertinent to foundation design and site preparation. An experienced geotechnical engineer classified the samples in general conformance with the Unified Soil Classification System.

Laboratory testing included natural moisture content, organic matter content, dry density, and unconfined compressive strength determinations. The organic matter content of representative samples was determined in accordance with ASTM Test Method D 2974, “Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils”. The unconfined compressive strengths were determined by ASTM Test Method D 2166 and using a spring loaded hand penetrometer. Per ASTM Test Method D 2166, the unconfined compressive strength of cohesive soils is determined by axially loading a small cylindrical soil sample under a slow rate of strain. The unconfined compressive strength is defined as the maximum stress applied to the soil sample before shear failure. If shear failure does not occur prior to a total strain of fifteen percent, the unconfined compressive strength is defined as the stress at a strain of fifteen percent. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot (tsf) by measuring the resistance of the soil sample to the penetration of a calibrated spring loaded cylinder.

The results of the moisture content, organic matter content, dry density, and unconfined compressive strength determinations are presented on the boring logs at the depths samples were obtained. Unconfined compressive strengths are also presented graphically on the Unconfined Compressive Strength Test, Figure No. 7 in the appendix of this report. We will hold the soil samples for a period of 60 days following the issuance of this report. If you would like the soils samples returned to you or retained beyond this period, please let us know.

SOIL CONDITIONS

Six soil borings, B-1 through B-6, were drilled throughout the overall property to evaluate potential site development. Approximately 7 to 12 inches of topsoil are typically present at the soil boring locations, with the exception of boring B-5 which had 18 inches of topsoil present. Silty sand underlies the topsoil at borings B-1 through B-4 and extends to approximate depths ranging from 2 to 11 feet below existing grade. Silty clay is generally present below the silty sand at borings B-1 through B-4 and topsoil at the remaining borings and extends to the explored depth of 20 feet below existing grades.
The silty sand is typically very loose to loose in compactness with Standard Penetration Test N-values ranging from 4 to 9 blows per foot. Layers of medium compact silty sand are present at borings B-1 and B-3 with N-values of 11 and 13 blows per foot. The silty clay is typically stiff to very stiff in consistency extending to approximate depths ranging from 8 to 18 feet with natural moisture contents ranging from 19 to 42 percent, dry densities ranging from 99 to 107 pounds per cubic foot (pcf), and unconfined compressive strengths ranging from 2,500 to 8,000 psf. A layer of hard silty clay is present at boring B-6 from an approximate depth of 3 to 6 feet with a natural moisture content of 19 percent and an unconfined compressive strength of 9,000 psf. The underlying silty clay extending to the explored depth is very soft to soft in consistency with natural moisture contents ranging from 42 to 66 percent, dry densities ranging from 77 to 81 pcf, and unconfined compressive strengths of 650 and 790 psf or less.

The stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transitions may be more gradual than what are shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

The Stratification depths shown on the soil boring logs represent the soil conditions at the boring locations. Variations may occur between borings. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transitions may be more gradual than what are shown. We have prepared the boring logs on the basis of laboratory classification and testing as well as field logs of the soils encountered.

GROUNDWATER CONDITIONS AND CONSTRUCTION CONSIDERATIONS

Groundwater measurements were obtained during and upon completion of drilling operations at the soil boring locations. Groundwater was encountered in borings B-1 through B-3 during drilling operations at approximate depths ranging from 3 to 8-1/2 feet below existing grade. Upon completion of drilling at borings B-1 and B-2, a wet cave of the boreholes was measured at the approximate encountered groundwater elevation. No measurable groundwater was encountered during or upon completion of drilling operations at borings B-4 through B-6 nor upon completion at boring B-3.

An estimate of the long-term groundwater can be made based on soil color. Often color changes in the soil layers from browns (aerobic condition) to grays (anaerobic condition) is a reliable indicator of long-term groundwater levels in predominantly clay soils at or near the long term groundwater table. This color change depth is generally noted to occur at approximate depths ranging from 3 to 11 feet below existing grades at borings B-1 through B-3, estimated to be near the same elevation based on visual observations of grades at the boring locations.

Fluctuations in groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation. It should be noted that groundwater observations made during drilling operations in predominantly cohesive soils are not necessarily indicative of the static groundwater level. This is due to the low permeability of such soils and the tendency of drilling operations to seal off the natural paths of groundwater flow.

Based on the encountered groundwater elevation at borings B-1 through B-3, groundwater will be encountered in excavations, such as foundations or utilities, extending to depths ranging from 3 to 8-1/2 feet below existing grade. Groundwater can typically be lowered between 1 and 2 feet with property constructed sumps and pumps in granular soil. If excavations extend to greater depths, we anticipate dewatering will likely be required to construct foundations or utilities in dry conditions. Within the vicinity of borings B-4 through B-6, we do not anticipate groundwater will be encountered within excavations.
SITE PREPARATION

Based on the existing conditions, we anticipate a moderate amount of earthwork will be required to develop the site depending on finished grades and the type and location of structure proposed. Earthwork operations are expected to consist of removing any existing topsoil and vegetation within the location of the proposed building and pavements, grading the site as necessary depending on the final site layout, subgrade preparation for floor slabs and pavements, and excavating and backfilling of foundations and utilities. Based on the existing soil conditions, we recommend grade changes no more than 12 inches from the existing grade. Raising site grades will induce site aerial site settlement. If proposed plans raise site grades more than 12 inches, G2 must be notified to evaluate settlement due to earthwork operations. We recommend all earthwork operations be performed in accordance with comprehensive specifications and be properly monitored in the field by qualified geotechnical engineers and technicians.

At the start of earthwork operations, any vegetation, trees, and topsoil should be completely removed from within the limits of any areas of development, including buildings and pavements. Following satisfactory removal of any vegetation and topsoil and prior to placement of engineered fill, the exposed granular subgrade should be thoroughly proofrolled with a fully loaded dump truck where cohesive soils are present and proof compacted with a heavy vibratory roller where granular soils are present. The subgrade should be monitored by a qualified geotechnical engineer or technician. Any unstable or unsuitable areas noted should be improved by additional compaction or removed and replaced with specified engineered fill. Any soils that are disturbed during grading operations or during removal of existing surface vegetation should be removed and replaced with engineered fill.

Any engineered fill placed within the site should consist of an approved, environmentally clean material. Engineered fill should be free of organic matter, frozen soil, clods, or other harmful substances. The fill should be placed in uniform horizontal layers, not more than 9 inches in loose thickness. The engineered fill should be compacted to achieve a density of at least 95 percent of the maximum dry density, as determined by the Modified Proctor compaction test (ASTM D 1557). Any cohesive fill used within the site may be compacted within 3 percent above and one percent below optimum moisture content. Any granular fill used within the site should be compacted within 3 percent of optimum moisture content. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade.

The existing silty sand can be reused as engineered fill; however, due to high natural moisture contents, we do not recommend the existing silty clay be reused as engineered fill. The material would likely require a significant amount of moisture conditioning to attain optimum moisture content. The silty clay can be used on landscape areas if desired.

We recommend using granular engineered fill within confined areas such as utility trenches and adjacent to foundation walls and catch basins. Granular engineered fill is generally more easily compacted than cohesive soils within these confined areas. Additionally, the proper placement and compaction of backfill within these areas is imperative to provide adequate support for overlying floor slabs and pavements.

FOUNDATION RECOMMENDATIONS AND CONSTRUCTION CONSIDERATIONS

The most significant issue pertaining to site development on the property is the presence of the very soft to soft silty clay with high natural moisture contents. This material is very sensitive to consolidation associated with additional loads, such as foundations or engineered fill to raise site grades. Additionally, to support the structure on shallow foundations, a suitable “crust” thickness of stiff to very stiff material must be present between the foundation bearing surface and the interface of the very soft to soft material to support the foundation loads. Therefore, existing grades cannot be varied greater than +/- 12 inches. In consideration of these assumptions, the east half of the property in the vicinity of borings B-4 through B-6 appears to be relatively flat and likely the best location for the building. We
anticipate preliminary bearing capacities for design of shallow foundations will range between 1,500 and 2,500 psf. Bearing capacities values are dependent on the loading conditions, size of the foundation, and thickness of stiff to very stiff silty clay below the footing. Additional soil borings and consolidation testing are required to further evaluate the site based on final layout and grades. This will require balancing the loading conditions, thickness of the stiff to very stiff material below foundation bearing depth, and proposed grades.

Alternatively, if grades are be raised or loading conditions are heavy, the building will need to be supported on deep foundations extending through the very soft to soft clay to more competent bearing soils, depth to be determined through deeper soil borings. We anticipate the deep foundation system may consist of drilled piers, driven piles, or augercast piles in conjunction with grade beams. To minimize deep foundation requirement potential, loading conditions should be kept to a minimum.

Where stiff to very stiff silty clay is present, the contractor will be able to excavate shallow foundations and utilities in open, neat excavations. However, where granular soil is present above the groundwater table, we anticipate caving and sloughing of the granular soil will occur. Therefore, the contractor should be prepared to over excavate and form foundations where granular soil is present, as necessary. The sides of the spread and/or strip footing foundations should be constructed straight and vertical to reduce the risk of frozen soil adhering to the concrete and raising the foundations.

In general, we do not anticipate groundwater will be encountered in foundation excavations across the site. We expect accumulations of surface run-off water or groundwater at the base of the foundation excavations should be controllable with pumping from properly constructed sumps.

FLOOR SLAB RECOMMENDATIONS AND CONSTRUCTION CONSIDERATIONS

We anticipate the stiff to very stiff silty clay, very loose to medium compact silty sand, or engineered fill to raise site grades (if required), will be suitable for support of building floor slabs, following satisfactory completion of subgrade preparation as presented in the SITE PREPARATION section of this report. Based on the subsurface soils encountered at the soil boring locations, we do not anticipate construction issues will arise for floor slab design.

GENERAL COMMENTS

We have formulated the evaluations and recommendations presented in this report relative to site preparation and development on the basis of data provided to us relating to the project location, type of structure, and surface grade for the proposed site. Any significant change in this data should be brought to our attention for review and evaluation with respect to prevailing subsurface conditions. Furthermore, if changes occur in the design, location, or concept of the project, conclusions and recommendations contained in this report are not valid unless G2 Consulting Group, LLC reviews the changes. G2 Consulting Group, LLC will then confirm the recommendations presented herein or make changes in writing.

The scope of the present investigation was limited to evaluation of subsurface conditions for the support of proposed structure and other related aspects of the development. No chemical, environmental, or hydrogeological testing or analyses were included in the scope of this investigation.

We base the analyses and recommendations submitted in this report upon the data from the soil borings performed at the approximate locations shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring locations and the actual structure locations. The nature and extent of any such variations may not become clear until the time of construction. If significant variations then become evident, it may be necessary for us to re-evaluate our report recommendations.
We recommend G2 Consulting Group, LLC observe all geotechnical related work, including foundation construction, subgrade preparation, and engineered fill placement. G2 Consulting Group, LLC will perform the appropriate testing to confirm the geotechnical conditions given in the report are found during construction.
APPENDIX

Soil Boring Location Plan

Soil Boring Logs

Unconfined Compressive Strength Test

General Notes Terminology

Plate No. 1

Figure Nos. 1 through 6

Figure No. 7

Figure No. 8
Soil Borings Performed by Strata Drilling, Inc. on October 12, 2018

Legend

- Soil Borings Performed by Strata Drilling, Inc. on October 12, 2018

**Wetland Delineation:**
21 Mile & Sugarbush Property
Chesterfield Township, Macomb County, MI

Soil Borings Performed by Strata Drilling, Inc. on October 12, 2018

**Legend**

- Soil Borings Performed by Strata Drilling, Inc. on October 12, 2018
## Soil Sample Data

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<th>BLOWS/6-INCHES</th>
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### Subsurface Profile

- **Topsoil:** Dark Brown Silty Sand (8 inches)
- **Very Loose Brown Silty Sand**
- **Loose to Medium Compact Brown Silty Sand**
- **Stiff to Very Stiff Gray Silty Clay with trace sand and gravel**
- **Very Soft Gray Silty Clay with trace sand**
- **End of Boring @ 20 ft**

### Notes
- *Calibrated Hand Penetrometer
- Water Level Observation: 7 feet during drilling operations; wet cave at 7-1/2 feet upon completion
- Excavation Backfilling Procedure: Auger cuttings

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**Project Details:**
- **Project Name:** Chesterfield Township Property
- **Project Location:** 21 Mile Road and Sugarbush Road, Chesterfield Township, Michigan
- **G2 Project No.:** 180709
- **Latitude:** N/A  
- **Longitude:** N/A

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**Figure No. 1**
Subsurface Profile:

- Topsoil: Dark Brown Silty Sand (7 inches) at 0.6 ft
- Loose Brown Silty Sand with trace gravel at 5 ft
- Stiff to Very Stiff Gray Silty Clay with trace sand and gravel at 11.0 ft
- Very Soft Gray Silty Clay with trace sand at 18.0 ft
- End of Boring @ 20 ft

Soil Sample Data:

- Sample Type No.
- Blows/6-inches
- Std. Pen. Resistance (N)
- Moisture Content (%)
- Dry Density (PCF)
- Unconf. Comp. Str. (PSF)

- S-1: 3, 7
- S-2: 3, 7
- S-3: 3, 9
- S-4: 2, 7
- S-5: 2, 7, 23.5, 4000*
- S-6: 4, 13, 24.2, 4000*
- S-7: 0, 0, 43.1

Water Level Observation:
8-1/2 feet during drilling operations; wet cave at 9 feet upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings

Total Depth: 20 ft
Drilling Date: October 12, 2018
Inspector: B. Sienkiewicz
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz
Drilling Method: 2-1/4 inch inside diameter hollow stem auger

Figure No. 2
Soil Boring No. B-3

SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: N/A

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SOIL SAMPLE DATA

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Total Depth: 20 ft
Drilling Date: October 12, 2018
Inspector: B. Sienkiewicz
Contractor: Strata Drilling, Inc.
Driller: B. Sienkiewicz

Drilling Method: 2-1/4 inch inside diameter hollow stem auger

Water Level Observation:
3 feet during drilling operations; dry upon completion

Notes:
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Auger cuttings

Figure No. 3
**Soil Boring No. B-4**

**Soil / Pavement Boring 180709.GPJ  20150116 G2 CONSULTING DATA TEMPLATE.GDT  10/31/18**

**SUBSURFACE PROFILE**

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</tbody>
</table>

**SOIL SAMPLE DATA**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>TYPE NO.</th>
<th>BLOWS/6-INCHES</th>
<th>STD. PEN. RESISTANCE (N)</th>
<th>MOISTURE CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
<th>UNCONF. COMP. STR. (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>21.1</td>
<td>4000*</td>
<td></td>
</tr>
<tr>
<td>S-2a</td>
<td>4</td>
<td>6</td>
<td>14</td>
<td>22.7</td>
<td>8000*</td>
<td></td>
</tr>
<tr>
<td>S-2b</td>
<td>4</td>
<td>8</td>
<td>14</td>
<td>22.7</td>
<td>8000*</td>
<td></td>
</tr>
<tr>
<td>S-3a</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>33.0</td>
<td>5000*</td>
<td></td>
</tr>
<tr>
<td>S-3b</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>33.0</td>
<td>5000*</td>
<td></td>
</tr>
<tr>
<td>S-4a</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>47.3</td>
<td>650</td>
<td></td>
</tr>
<tr>
<td>S-4b</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>47.3</td>
<td>700**</td>
<td></td>
</tr>
<tr>
<td>S-5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>54.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>66.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Depth:** 20 ft  
**Drilling Date:** October 12, 2018  
**Inspector:**  
**Contractor:** Strata Drilling, Inc.  
**Driller:** B. Sienkiewicz  
**Drilling Method:** 2-1/4 inch inside diameter hollow stem auger  
**Water Level Observation:** Dry during and upon completion  
**Notes:**  
* Calibrated Hand Penetrometer  
** Torvane  
**Excavation Backfilling Procedure:** Auger cuttings  

**Figure No. 4**
### Soil Boring No. B-5

**Project Name:** Chesterfield Township Property  
**Project Location:** 21 Mile Road and Sugarbush Road, Chesterfield Township, Michigan  
**G2 Project No.:** 180709  
**Latitude:** N/A  
**Longitude:** N/A

#### Subsurface Profile

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Profile</th>
<th>Ground Surface Elevation: N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>Topsoil: Dark Brown Silty Clay (18 inches)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Very Stiff Brown and Gray Silty Clay with trace sand and gravel, roots @2-1/2 feet (Organic Content @ 2-1/2' = 3.3%)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Medium to Stiff Gray Silty Clay with trace sand</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Very Soft Gray Silty Clay with trace sand</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>End of Boring @ 20 ft</td>
<td></td>
</tr>
</tbody>
</table>

#### Soil Sample Data

<table>
<thead>
<tr>
<th>Sample Type-No.</th>
<th>Blows/6-Inches</th>
<th>Std. Pen. Resistance (N)</th>
<th>Moisture Content (%)</th>
<th>Dry Density (PCF)</th>
<th>Unconf. Comp. Str. (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>3 4 5</td>
<td>9</td>
<td>23.0</td>
<td>4000*</td>
<td></td>
</tr>
<tr>
<td>S-2a</td>
<td></td>
<td>21.1</td>
<td></td>
<td>7000*</td>
<td></td>
</tr>
<tr>
<td>S-2b</td>
<td>3 6</td>
<td>12</td>
<td>26.0</td>
<td>5000*</td>
<td></td>
</tr>
<tr>
<td>S-3a</td>
<td></td>
<td>26.9</td>
<td></td>
<td>7000*</td>
<td></td>
</tr>
<tr>
<td>S-3b</td>
<td>3 5</td>
<td>10</td>
<td>29.7</td>
<td>7000*</td>
<td></td>
</tr>
<tr>
<td>S-4a</td>
<td></td>
<td>28.1</td>
<td></td>
<td>2500*</td>
<td></td>
</tr>
<tr>
<td>S-4b</td>
<td>1</td>
<td>2</td>
<td>45.7</td>
<td>77</td>
<td>1010</td>
</tr>
<tr>
<td>S-5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>38.7</td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>44.0</td>
<td></td>
</tr>
<tr>
<td>S-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>48.7</td>
<td></td>
</tr>
</tbody>
</table>

#### Additional Information

- **Total Depth:** 20 ft  
- **Drilling Date:** October 12, 2018  
- **Inspector:** B. Sienkiewicz  
- **Contractor:** Strata Drilling, Inc.  
- **Driller:** B. Sienkiewicz  
- **Drilling Method:** 2-1/4 inch inside diameter hollow stem auger

**Water Level Observation:** Dry during and upon completion

**Notes:**  
* Calibrated Hand Penetrometer

**Excavation Backfilling Procedure:** Auger cuttings

Figure No. 5
# Soil Boring No. B-6

- **Project Name:** Chesterfield Township Property
- **Project Location:** 21 Mile Road and Sugarbush Road, Chesterfield Township, Michigan
- **G2 Project No.:** 180709
- **Latitude:** N/A  
- **Longitude:** N/A

## Subsurface Profile

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Profile</th>
<th>Ground Surface Elevation: N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>Topsoil: Dark Brown Silty Clay (8 inches)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Very Stiff to Hard Brown and Gray Silty Clay with trace sand and gravel (Organic Content @ 2-1/2' = 3.3%)</td>
<td></td>
</tr>
<tr>
<td>8.0</td>
<td>Medium to Stiff Brownish Gray Silty Clay with trace sand</td>
<td></td>
</tr>
<tr>
<td>11.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Very Soft Gray Silty Clay with trace sand</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>End of Boring @ 20 ft</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Soil Sample Data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S-1</td>
<td>4 5 7</td>
<td>12 20.3</td>
<td>107</td>
<td>4990</td>
<td></td>
</tr>
<tr>
<td>S-2a</td>
<td>4 6 7</td>
<td>19.3</td>
<td>9000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-2b</td>
<td>4 6 7 13 19.6</td>
<td>9000*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-3a</td>
<td>3 4 6 7 31.3</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-3b</td>
<td>3 4 6 10 30.1</td>
<td>5000*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-4a</td>
<td>2 2 4 39.2 85</td>
<td>3240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-4b</td>
<td>2 2 4 41.6</td>
<td>2000*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-5</td>
<td>0 0</td>
<td>48.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-6</td>
<td>0 0</td>
<td>43.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-7</td>
<td>0 0</td>
<td>47.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Notes
- **Water Level Observation:** Dry during and upon completion
- **Drilling Method:** 2-1/4 inch inside diameter hollow stem auger
- **Excavation Backfilling Procedure:** Auger cuttings
- **Drilling Date:** October 12, 2018
- **Inspector:** B. Sienkiewicz
- **Contractor:** Strata Drilling, Inc.
<table>
<thead>
<tr>
<th>Specimen</th>
<th>Classification</th>
<th>MC%</th>
<th>γₜ</th>
<th>UC</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-3 S-3</td>
<td>Gray Silty Clay</td>
<td>30</td>
<td>99</td>
<td>6220</td>
</tr>
<tr>
<td>B-3 S-4</td>
<td>Gray Silty Clay</td>
<td>42</td>
<td>81</td>
<td>790</td>
</tr>
<tr>
<td>B-4 S-4a</td>
<td>Gray Silty Clay</td>
<td>44</td>
<td>78</td>
<td>650</td>
</tr>
<tr>
<td>B-5 S-4b</td>
<td>Gray Silty Clay</td>
<td>46</td>
<td>77</td>
<td>1010</td>
</tr>
<tr>
<td>B-6 S-1</td>
<td>Brown and Gray Silty Clay</td>
<td>20</td>
<td>107</td>
<td>4990</td>
</tr>
<tr>
<td>B-6 S-4a</td>
<td>Brownish Gray Silty Clay</td>
<td>39</td>
<td>85</td>
<td>3240</td>
</tr>
</tbody>
</table>

**UNCONFINED COMPRESSIVE STRENGTH TEST**

- **Project Name:** Chesterfield Township Property
- **Project Location:** 21 Mile Road and Sugarbush Road, Chesterfield Township, Michigan
- **G2 Project No.:** 180709
- **Figure No.:** 7
GENERAL NOTES TERMINOLOGY

Unless otherwise noted, all terms herein refer to the Standard Definitions presented in ASTM 653.

PARTICLE SIZE

- **Boulders** - greater than 12 inches
- **Cobbles** - 3 inches to 12 inches
- **Gravel**
  - Coarse - 3/4 inches to 3 inches
  - Fine - No. 4 to 3/4 inches
- **Sand**
  - Coarse - No. 10 to No. 4
  - Medium - No. 40 to No. 10
  - Fine - No. 200 to No. 40
- **Silt** - 0.005mm to 0.074mm
- **Clay** - Less than 0.005mm

CLASSIFICATION

The major soil constituent is the principal noun, i.e. clay, silt, sand, gravel. The second major soil constituent and other minor constituents are reported as follows:

<table>
<thead>
<tr>
<th>Second Major Constituent</th>
<th>Minor Constituent</th>
</tr>
</thead>
<tbody>
<tr>
<td>(percent by weight)</td>
<td>(percent by weight)</td>
</tr>
<tr>
<td>Trace - 1 to 12%</td>
<td>Trace - 1 to 12%</td>
</tr>
<tr>
<td>Adjective - 12 to 35%</td>
<td>Little - 12 to 23%</td>
</tr>
<tr>
<td>And - over 35%</td>
<td>Some - 23 to 33%</td>
</tr>
</tbody>
</table>

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier, i.e. sandy clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils, i.e. silty clay, trace sand, little gravel.

**Consistency**  
**Unconfined Compressive Strength (psf)**  
**Approximate Range of (N)**

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Strength (psf)</th>
<th>Approximate Range of (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>Below 500</td>
<td>0 - 2</td>
</tr>
<tr>
<td>Soft</td>
<td>500 - 1,000</td>
<td>3 - 4</td>
</tr>
<tr>
<td>Medium</td>
<td>1,000 - 2,000</td>
<td>5 - 8</td>
</tr>
<tr>
<td>Stiff</td>
<td>2,000 - 4,000</td>
<td>9 - 15</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>4,000 - 8,000</td>
<td>16 - 30</td>
</tr>
<tr>
<td>Hard</td>
<td>8,000 - 16,000</td>
<td>31 - 50</td>
</tr>
<tr>
<td>Very Hard</td>
<td>Over 16,000</td>
<td>Over 50</td>
</tr>
</tbody>
</table>

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

**COHESIONLESS SOILS**  
**Density Classification**  
**Relative Density %**  
**Approximate Range of (N)**

<table>
<thead>
<tr>
<th>Density Classification</th>
<th>Relative Density %</th>
<th>Approximate Range of (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0 - 15</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Loose</td>
<td>16 - 35</td>
<td>5 - 10</td>
</tr>
<tr>
<td>Medium Compact</td>
<td>36 - 65</td>
<td>11 - 30</td>
</tr>
<tr>
<td>Compact</td>
<td>66 - 85</td>
<td>31 - 50</td>
</tr>
<tr>
<td>Very Compact</td>
<td>86 - 100</td>
<td>Over 50</td>
</tr>
</tbody>
</table>

Relative Density of cohesionless soils is based upon the evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

**SAMPLE DESIGNATIONS**

- **AS** - Auger Sample - Cuttings directly from auger flight
- **BS** - Bottle or Bag Samples
- **S** - Split Spoon Sample - ASTM D 1586
- **LS** - Liner Sample with liner insert 3 inches in length
- **ST** - Shelby Tube sample - 3 inch diameter unless otherwise noted
- **PS** - Piston Sample - 3 inch diameter unless otherwise noted
- **RC** - Rock Core - NX core unless otherwise noted

**STANDARD PENETRATION TEST (ASTM D 1586)** - A 2.0 inch outside-diameter, 1-3/8 inch inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The total number of blows required for the final 12 inches of penetration is the Standard Penetration Resistance (N).