CONSULTING GROUP

Report on Geotechnical Investigation

# Proposed Howell Armory Maintenance Garage 727 Isbell Street Howell, Michigan

Latitude 42.602947˚ N
Longitude -83.937375˚ W

Prepared for:

Beckett & Raeder, Inc.
535 West William Street, Suite 101
Ann Arbor, Michigan 48103

G2 Project No. 243351
June 17, 2024

June 17, 2024

Mr. Kristofer Enlow, P.E.
Partner
Beckett & Raeder, Inc.
535 West William Street, Suite 101
Ann Arbor, Michigan 48103

Re: Report on Geotechnical Investigation
Proposed Howell Armory Maintenance Garage
727 Isbell Street
Howell, Michigan 48843
G2 Project No. 243351

Dear Mr. Enlow:

We have completed the geotechnical investigation for the proposed construction of a maintenance garage building at the Howell Armory in Howell, Michigan. This report presents the results of our observations and analysis and our recommendations for subgrade preparation, foundation design, and construction considerations as they relate to the geotechnical conditions on site.

We appreciate the opportunity to be of service to Beckett & Raeder, Inc. 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**

Zachery R. Lilly, E.I.T.
Staff Engineer

Jason B. Stoops, P.E.
Associate / Project Manager

ZRL/JBS/jbs

Enclosures

**EXECUTIVE SUMMARY**

We understand the project consists of the construction of a single-story, slab-on-grade garage building. Plans related to the footprint and layout of the proposed garage building were not available at the time of this report; however we understand that the proposed garage will be constructed to the east side of the existing building on the property. Loading conditions of the proposed garage building were not available at the time of this report; however, we anticipate the proposed garage building will be lightly loaded.

The existing pavements at the boring locations generally consist of bituminous concrete and an underlying aggregate base. The bituminous concrete (asphalt) ranges in thickness from 3 to 4 inches. The underlying aggregate base consists of gravelly sand and measures between 4 to 5 inches in thickness; however, no aggregate base was present within soil boring B-02. Native cohesive soils consisting of generally medium to very stiff sandy clay and silty clay are generally present beneath the pavement section, generally extending to the explored depth of 20 feet below existing grades. However, native loose sand is present below the pavement section within soil boring B-02, extending to a depth of 3 feet below existing grade. Native loose to medium compact granular soils consisting of clayey sand and sand are present between the native clay layers at varying depths within soil boring B-03.

At the start of the earthwork operations, the existing pavement section must be completely removed from the influence of the proposed structure. We anticipate the exposed grade will consist of native sandy clay and sand. Prior to the placement of engineered fill, we recommend the exposed cohesive subgrade be thoroughly proof-rolled using a heavy rubber-tired vehicle, such as a fully loaded, tandem axle, dump truck and should be evaluated for instability and/or unstable conditions. Areas where granular soils are present should be thoroughly proof-compacted using a 10-ton vibratory roller with its vibration setting set to the maximum amplitude. We recommend the proof compaction operations consist of a minimum of 10 passes in two perpendicular directions. Any noted areas exhibiting unstable or otherwise unsuitable soil conditions should either be improved with additional compaction or removed and replaced with engineered fill.

Based upon the existing subgrade conditions and anticipated loading conditions, we recommend the proposed garage building be supported on conventional strip and/or spread footings designed to bear on the generally medium to very stiff native cohesive soils at the anticipated bearing elevation. We recommend a net allowable bearing capacity of 2,000 pounds per square foot (psf) be used for design of foundations. Exterior foundations should bear at a minimum depth of 3-1/2 feet below finished grade for protection against frost heave. Interior foundations can bear at shallower depths provided foundations are protected from frost. We recommend a qualified geotechnical engineer or technician be on site during construction to observe the excavations, measure the bearing depths, and confirm the bearing soils are consistent with the soils identified within this report.

Foundations can be earth formed within the native cohesive soils. However, the contractor should be prepared to over excavate and form foundations if the foundation trenches begin caving and/or sloughing within any areas consisting of native granular soils or with granular engineered fill. The side of the spread and/or strip foundations should be constructed straight and vertical to reduce the risk of frozen soil adhering to the concrete and raising the foundations.

We anticipate the proposed floor slab will be supported by the underlying medium to very stiff native cohesive soils or the loose to medium native granular soils and/or engineered fill. Provided the floor slab area has been prepared in accordance with the Site Preparation section of this report, a subgrade modulus (k) of up to 125 pounds per cubic inch (pci) may be used in the design of the floor slab supported by the native cohesive and granular soils or engineered fill placed atop the native soils.

Do not consider this summary 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**

We understand the project consists of the construction of a single-story, slab-on-grade garage building. Plans related to the footprint and layout of the proposed garage building were not available at the time of this report; however, we understand that the proposed garage will be constructed to the east side of the existing building on the property. Loading conditions of the proposed garage building were not available at the time of this report; however, we anticipate the proposed garage building will be lightly loaded.

The purpose of our exploration is to determine and evaluate the general subsurface conditions and groundwater conditions at the site and to develop recommendations for earthwork operations, foundations, and construction considerations as they relate to the proposed garage building.

**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 four (4) soil borings within the development area. Soil borings B-01 through B-04 were performed within the footprint of the proposed garage building and extended to a depth of 20 feet below existing grade.

2. We performed laboratory testing on representative samples obtained from the soil boring. Laboratory testing included visual engineering classification, natural moisture content, and unconfined compressive strength determinations.

3. We prepared this engineering report. The report includes recommendations regarding the soil bearing capacity, estimated settlement, and construction considerations related to construction of the proposed garage building and pavements.

**FIELD OPERATIONS**

Beckett & Raeder, Inc., in conjunction with G2 Consulting Group, LLC (G2), selected the depth and locations of the soil borings. The boring locations were determined in the field by a G2 representative using mobile assisted GPS technology and conventional taping methods from known surface features prior to our drilling operations. The approximate soil boring locations are shown on the Soil Boring Location Plan, Plate No. 1. Topographical information was not available at the time of this report. We recommend the boring locations be surveyed so the depths of the soil borings can be correlated to elevation.

The soil boring was drilled using a truck-mounted rotary drilling rig. Continuous flight 2-1/4 inch inside diameter hollow-stem augers were used to advance the borehole to the explored depth. Soil samples were obtained at intervals of 2-1/2 feet within the upper 10 feet and at intervals of 5 feet thereafter. The 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 soil boring log.

During field operations, the driller maintained a log of the subsurface conditions, including changes in stratigraphy and observed groundwater levels to be used in conjunction with our analysis of the subsurface conditions. The soil samples were placed in sealed containers and brought to our laboratory for testing and classification. The final boring log is based on the field boring log supplemented by laboratory soil classification. After completion of drilling operations, the borehole was backfilled with auger cuttings and capped with cold patch asphalt.

**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 accordance with the Unified Soil Classification System and G2 General Notes Terminology. Laboratory testing on representative samples included applications of:

- ASTM D2488 – Description and Identification of Soils – Visual Manual
- ASTM D2216 – Water Content of Soil and Rock by Mass
- ASTM D2166 – Unconfined Compressive Strength of Cohesive Soil

We also estimated the unconfined compressive strengths were estimated using a spring-loaded hand penetrometer. The hand penetrometer estimates the unconfined compressive strength to a maximum of 4-1/2 tons per square foot by measuring the resistance of the soil sample to the penetration of a spring-loaded cylinder.

The results of the field and laboratory testing are shown on the individual soil boring log at the depths the samples were obtained. The unconfined compressive strengths determined using ASTM D2166 is also presented graphically on the Unconfined Compressive Strength Test, Figure No. 5, in the Appendix. We will hold the soil samples for 60 days from the date of this report, after which they will be discarded. If you would like to retain the samples beyond this date, please let us know.

**SITE DESCRIPTION**

Howell Armory is located to the east of Isbell Street, approximately 1,000 feet north of Mason Road in Howell, Michigan. Two existing approaches lead eastward into the property from Isbell Street. The proposed garage building is located within the central area of the site, east of the existing building on the property. Existing pavements include bituminous concrete parking lots and drives, and Portland cement concrete sidewalks and approaches.

Based on topographical data obtained using Google Earth, site grades generally slope from west to east. The site is surrounded by Pepsi Bottling Company to the west, a rail line to the north, and residential properties to the south.

**SOIL AND GROUNDWATER CONDITIONS**

The existing pavements at the boring locations generally consist of bituminous concrete and an underlying aggregate base. The bituminous concrete (asphalt) ranges in thickness from 3 to 4 inches. The underlying aggregate base consists of gravelly sand and measures between 4 to 5 inches in thickness; however, no aggregate base was present within soil boring B-02. Native cohesive soils consisting of sandy clay and silty clay are generally present beneath the pavement section, generally extending to the explored depth of 20 feet below existing grades. However, native sand is present below the pavement section within soil boring B-02, extending to a depth of 3 feet below existing grade. Native granular soils consisting of clayey sand and sand are present between the native clay layers at varying depths within soil boring B-03.

The cohesive soils are generally medium to very stiff in consistency with natural moisture contents ranging between 11 and 25 percent, dry densities between 106 and 130 pounds per cubic foot, and unconfined compressive strengths ranging between 1,000 and 8,000 pounds per square foot (psf). The granular soils are generally loose to medium compact in relative density with Standard Penetration Test (SPT) N-values ranging from 5 to 15 blows per foot (bpf).

Groundwater measurements were performed during and upon completion of drilling operations. We observed the natural groundwater level at depths ranging from 3-1/2 to 18-1/2 feet during the drilling operations within soil borings B-01, B-02 and B-04. We observed the natural groundwater level at depths of 15-1/2 feet and 17 feet upon completion of the drilling operations within soil borings B-02 and B-04, respectively. No measurable groundwater was observed within soil boring B-03, or upon completion of drilling operations within soil boring B-01.

Fluctuations in perched and long-term groundwater levels should be anticipated due to seasonal variations and following periods of prolonged precipitation. It should also be noted that groundwater observations made during excavation 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.

The stratification depths shown on the soil boring log represent the soil conditions at the boring location. Variations may occur away from the boring location. Additionally, the stratigraphic lines represent the approximate boundaries between soil types. The transition may be more gradual than indicated. We have prepared the boring log based on the field log of the soil conditions encountered supplemented by laboratory classification.

The Soil Boring Location Plan, Plate No. 1, Soil Boring Logs, Figures Nos. 1-4, and Unconfined Compressive Strength Test Results, Figure No. 5, are presented in the Appendix. The soil profiles described above are generalized descriptions of the conditions encountered at the boring location. General Notes Terminology defining the nomenclature used on the soil boring log and elsewhere in this report are presented on Figure No. 6.

**SITE PREPARATION**

At the time of this investigation, no information regarding proposed finished grades were available. We anticipate proposed finished grades will be similar to existing site grades. Earthwork operations for the proposed development are therefore anticipated to consist of stripping the proposed garage building footprint of existing pavement section, proof-rolling or proof-compacting the exposed subgrade, improving the subgrade as necessary, placing engineered fill as necessary, excavating and backfilling for utilities and foundations, and preparing the site for support of the floor slab and pavement.

At the start of the earthwork operations, the existing pavement section must be completely removed from the influence of the proposed structure. We anticipate the exposed grade will consist of native sandy clay and sand. Prior to the placement of engineered fill, we recommend the exposed cohesive subgrade be thoroughly proof-rolled using a heavy rubber-tired vehicle, such as a fully loaded, tandem axle, dump truck and should be evaluated for instability and/or unstable conditions. Areas where granular soils are present should be thoroughly proof-compacted using a 10-ton vibratory roller with its vibration setting set to the maximum amplitude. We recommend the proof compaction operations consist of a minimum of 10 passes in two perpendicular directions. Any noted areas exhibiting unstable or otherwise unsuitable soil conditions should either be improved with additional compaction or removed and replaced with engineered fill.

Engineered fill should be free of organic matter, frozen soil, clods, or other harmful material. Frozen material should not be used as fill, nor should fill be placed on a frozen subgrade. Engineered fill should be placed in uniform horizontal layers, not more than 9 inches in loose thickness. Shallower lift thicknesses will be required within areas that are static rolled. 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 engineered fill material should be placed and compacted at moisture contents within 3 percent above and 1 percent below the optimum moisture content. Any granular engineered fill material should be placed and compacted at moisture contents within 2 percent above or below the optimum moisture content.

We recommend using a granular engineered fill within confined areas such as utility trenches, and adjacent to foundations. 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**

Based upon the existing subgrade conditions and anticipated loading conditions, we recommend the proposed garage building be supported on conventional strip and/or spread footings designed to bear on the generally medium to very stiff native cohesive soils at the anticipated bearing elevation. We recommend a net allowable bearing capacity of 2,000 pounds per square foot (psf) be used for design of foundations. Exterior foundations should bear at a minimum depth of 3-1/2 feet below finished grade for protection against frost heave. Interior foundations can bear at shallower depths provided foundations are protected from frost. We recommend a qualified geotechnical engineer or technician be on site during construction to observe the excavations, measure the bearing depths, and confirm the bearing soils are consistent with the soils identified within this report.

Continuous wall or strip footings should be at least 12 inches in width and isolated spread footings should be at least 30 inches in their least dimension. Adjacent spread footings at different levels should be designed and constructed so the least lateral distance between them is equivalent to or more than the difference in their bearing levels. To achieve a change in the level of a strip foundation, the foundation should be gradually stepped at a grade no steeper than two units horizontal to one unit vertical (2H:1V).

If the recommendations outlined in this report are adhered to, total and differential settlements for the completed structure should be within 1 inch and ½ inch, respectively. We expect settlements of these magnitudes are within tolerable limits for the type of structure proposed.

**FLOOR SLAB RECOMMENDATIONS**

We anticipate the proposed floor slab will be supported by the underlying medium to very stiff native cohesive soils or the loose to medium native granular soils and/or engineered fill. Provided the floor slab area has been prepared in accordance with the Site Preparation section of this report, a subgrade modulus (k) of up to 125 pounds per cubic inch (pci) may be used in the design of the floor slab supported by the native cohesive and granular soils or engineered fill placed atop the native soils.

We recommend at least 4 inches of clean coarse sand or pea gravel be placed between the subgrade and the bottom of the floor slab for use as a capillary break to reduce moisture transmission through the concrete floors and to reduce the potential for concrete curling. If moisture sensitive floor coverings are planned or if greater protection against vapor transmission is desired, a vapor barrier consisting of 10-mil plastic sheeting, or equivalent, may be placed on the sand layer beneath floor slabs. However, additional floor slab curing techniques will be required to prevent floor slab curling. The floor slab should be isolated from the foundation system to allow for independent movement.

**CONSTRUCTION CONSIDERATIONS**

In general, we do not anticipate accumulation of groundwater within foundation excavations at the depths anticipated for this project. However, if any groundwater or surface run off does occur, we expect groundwater should be controllable with normal pumping from properly constructed sumps.

Foundations can be earth formed within the native cohesive soils. However, the contractor should be prepared to over excavate and form foundations if the foundation trenches begin caving and/or sloughing within any areas consisting of native granular soils or with granular engineered fill. The side of the spread and/or strip foundations should be constructed straight and vertical to reduce the risk of frozen soil adhering to the concrete and raising the foundations.

All excavations must be safely shored or sloped in accordance with MI-OSHA requirements. If material is stored or equipment is operated near an excavation, lower angle slopes or stronger shoring must be used to resist the extra pressure due to the superimposed loads.

Where excavations extend deeper than 5 feet and sufficient space is available, we recommend maximum slopes of 2 horizontal units to 1 vertical units (2H:1V) within the native loose granular soils, 1-1/2H:1V with the medium compact granular soils, and 1H:1V within the medium to stiff cohesive soils, and 3/4H:1V within the very stiff native cohesive soils. Where seepage from excavation cuts is observed, the slopes will need to be flattened sufficiently to achieve stability, but in no case left steeper than 3H:1V at the seepage level. The soil exposed in slope faces should be inspected by a qualified technician so that modifications of the slopes may be made if variations in the soil and groundwater conditions are encountered.

Care should always be exercised when excavating near existing roadways or utilities to avoid undermining. In no case should excavations extend below the level of adjacent pavements and utilities unless underpinning is planned.

**GENERAL COMMENTS**

We have formulated the evaluations and recommendations presented in this report relative to site preparation and foundations on the basis of data provided to us relating to the project location and type of structure. 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 restroom. No chemical, environmental, or hydrogeological testing or analyses were included in the scope of this investigation.

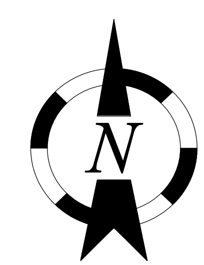
We base the analyses and recommendations submitted in this report upon the data from the soil boring performed at the approximate location shown on the Soil Boring Location Plan, Plate No. 1. This report does not reflect variations that may occur between the actual boring location and the actual structure location. 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


**Legend**

Soil borings performed by 2G Drilling on May 22, 2024




**Soil Boring Location Plan**

Proposed Howell Armory Maintenance Garage
727 Isbell Street
Howell, Michigan 48843

2G CONSULTING GROUP

Project No. 243351
Drawn by: ZRL
Date: 6/11/24
Scale: NTS
Plate No. 1

Project Name: Prop. Howell Armory Maintenance Garage

Project Location: 727 Isbell Street
Howell, Michigan

G2 Project No. 243351

Latitude: 42.602947° Longitude: -83.937375°

# Soil Boring No. B-01

G2 CONSULTING GROUP

| SUBSURFACE PROFILE | | | | | | SOIL SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DEPTH (ft) | PRO-FILE | GROUND SURFACE ELEVATION: N/A | | DEPTH (ft) | SAMPLE TYPE-NO. | BLOWS/ 6-INCHES | STD. PEN. RESISTANCE (N) | MOISTURE CONTENT (%) | DRY DENSITY (PCF) | UNCONF. COMP. STR. (PSF) |
| | | Bituminous Concrete (4 inches) | 0.3 | | | | | | | |
| | | Fill: Brown Gravelly Sand with trace silt (Aggregate Base) (4 inches) | 0.7 | | | | | | | |
| | | Very Stiff Brown Sandy Clay with trace gravel | 3.0 | | S-01 | 2 2 7 | 9 | 13.3 | | 4000* |
| 5 | | Medium Brown Sandy Clay with trace gravel | | 5 | S-02 | 1 2 3 | 5 | 17.5 | 122 | 1470 |
| | | | | | S-03 | 2 2 3 | 5 | 15.2 | | 1200** |
| 10 | | | 12.0 | 10 | S-04 | 1 2 3 | 5 | 22.6 | | 1000** |
| 15 | | Very Stiff Brown Sandy Clay with trace gravel; sand seam present at 14-1/2 feet | | 15 | S-05 | 3 4 6 | 10 | 19.6 | | 7000* |
| 20 | | | 20.0 | 20 | S-06 | WOH 2 3 | 5 | 20.3 | | 6000* |
| | | End of Boring @ 20 ft | | | | | | | | |

Total Depth: 20 ft
Drilling Date: May 22, 2024
Inspector: --
Contractor:
Driller: A. Guzdzial

Drilling Method:
2-1/4" inside diameter hollow-stem augers

Water Level Observation:
3-1/2 feet during; dry upon completion

Notes:
Borehole collapsed at 11 ft after auger removal
* Calibrated Hand Penetrometer
** Torvane

Excavation Backfilling Procedure:
Augger cuttings and cold patch asphalt

Figure No. 1

Project Name: Prop. Howell Armory Maintenance Garage

Project Location: 727 Isbell Street
Howell, Michigan

G2 Project No. 243351

Latitude: 42.602919° Longitude: -83.936900°

# Soil Boring No. B-02

G2 CONSULTING GROUP

| SUBSURFACE PROFILE | | | | SOIL SAMPLE DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (ft) | PRO-FILE | GROUND SURFACE ELEVATION: N/A | DEPTH (ft) | SAMPLE TYPE-NO. | BLOWS/ 6-INCHES | STD. PEN. RESISTANCE (N) | MOISTURE CONTENT (%) | DRY DENSITY (PCF) | UNCONF. COMP. STR. (PSF) |
| | | Bituminous Concrete (4 inches) 0.3 | | | | | | | |
| | | Loose Brown Sand with trace silt and gravel 3.0 | | S-01 | 4 3 3 | 6 | | | |
| 5 | | Stiff to Very Stiff Brown Sandy Clay with trace gravel | 5 | S-02 | 3 3 4 | 7 | 24.5 | 106 | 3930 |
| | | 8.0 | | S-03 | 3 4 5 | 9 | 12.2 | 127 | 7100 |
| 10 | | Very Stiff Mottled Brown and Gray Sandy Clay with trace gravel 12.0 | 10 | S-04 | 4 7 7 | 14 | 12.8 | | 4000* |
| 15 | | Very Stiff Brown Sandy Clay with trace gravel 17.0 | 15 | S-05 | 4 6 7 | 13 | 13.3 | | 5000* |
| 20 | | Hard Brown Silty Clay with trace sand 20.0 | 20 | S-06 | 1 2 3 | 5 | 24.6 | | 8000* |
| | | End of Boring @ 20 ft | | | | | | | |

Total Depth: 20 ft
Drilling Date: May 22, 2024
Inspector: --
Contractor:
Driller: A. Guzdzial

Drilling Method:
2-1/4" inside diameter hollow-stem augers

Water Level Observation:
13-1/2 feet during; 15-1/2 feet upon completion

Notes:
Borehole collapsed at 17 ft after auger removal
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Augger cuttings and cold patch asphalt

Project Name: Prop. Howell Armory Maintenance Garage

Project Location: 727 Isbell Street
Howell, Michigan

G2 Project No. 243351

Latitude: 42.6027773° Longitude: -83.937357°

# Soil Boring No. B-03

G2 CONSULTING GROUP

| SUBSURFACE PROFILE | | | | SOIL SAMPLE DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (ft) | PRO-FILE | GROUND SURFACE ELEVATION: N/A | DEPTH (ft) | SAMPLE TYPE-NO. | BLOWS/ 6-INCHES | STD. PEN. RESISTANCE (N) | MOISTURE CONTENT (%) | DRY DENSITY (PCF) | UNCONF. COMP. STR. (PSF) |
| | | Bituminous Concrete (3 Inches) 0.3 | | | | | | | |
| | | Fill: Brown Gravelly Sand with trace silt (Aggregate Base) (4 inches) 0.6 | | | | | | | |
| | | Very Stiff Brown Sandy Clay with trace gravel 4.0 | | S-01 | 4 2 3 | 5 | 16.3 | | 4000* |
| 5 | | Loose to Medium Compact Brown Clayey Sand with trace gravel 8.0 | 5 | S-02 | 2 2 3 | 5 | | | |
| | | | | S-03 | 4 5 6 | 11 | | | |
| 10 | | Stiff Brown Sandy Clay with trace gravel; occasional cobles 12.0 | 10 | S-04 | 3 3 3 | 6 | 12.9 | | 3000* |
| | | Loose Brown Sand with trace clay and silt 13.8 | | | | | | | |
| 15 | | Very Stiff Brown Sandy Clay with trace silt and gravel 17.0 | 15 | S-05 | 1 2 3 | 5 | 19.1 | | 5000* |
| 20 | | Medium Compact Gray Clayey Sand with trace silt and gravel 20.0 | 20 | S-06 | 3 6 9 | 15 | | | |
| | | End of Boring @ 20 ft | | | | | | | |

Total Depth: 20 ft
Drilling Date: May 22, 2024
Inspector: --
Contractor:
Driller: A. Guzdzial

Drilling Method:
2-1/4" inside diameter hollow-stem augers

Water Level Observation:
Dry during and upon completion

Notes:
Borehole collapsed at 17 ft after auger removal
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Augger cuttings and cold patch asphalt

Figure No. 3

Project Name: Prop. Howell Armory Maintenance Garage

Project Location: 727 Isbell Street
Howell, Michigan

G2 Project No. 243351

Latitude: 42.602758° Longitude: -83.936885°

# Soil Boring No. B-04

G2 CONSULTING GROUP

| SUBSURFACE PROFILE | | | | SOIL SAMPLE DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DEPTH (ft) | GROUND SURFACE ELEVATION: N/A | Layer bottom (ft) | DEPTH (ft) | SAMPLE TYPE-NO. | BLOWS/ 6-INCHES | STD. PEN. RESISTANCE (N) | MOISTURE CONTENT (%) | DRY DENSITY (PCF) | UNCONF. COMP. STR. (PSF) |
| | Bituminous Concrete (3 inches) | 0.3 | | | | | | | |
| | Fill: Brown Gravelly Sand with trace silt (Aggregate Base) (5 inches) | 0.7 | | | | | | | |
| | Hard Brown Sandy Clay with trace gravel | 3.0 | | S-01 | 9 13 9 | 22 | 12.6 | | 9000* |
| 5 | Very Stiff Mottled Brown and Gray Sandy Clay with trace silt and gravel | 6.0 | 5 | S-02 | WOH | --- | 15.3 | | 4000* |
| | Very Stiff Brown Sandy Clay with trace gravel | | | S-03 | 4 5 5 | 10 | 12.0 | 125 | 5500 |
| 10 | | | 10 | S-04 | 4 7 7 | 14 | 12.3 | | 7000* |
| 15 | | 17.0 | 15 | S-05 | 5 7 11 | 18 | 11.6 | | 4000* |
| 20 | Medium Gray Sandy Clay with trace silt and gravel | 20.0 | 20 | S-06 | WOH | --- | 13.9 | 130 | 1760 |
| | End of Boring @ 20 ft | | | | | | | | |

Total Depth: 20 ft
Drilling Date: May 22, 2024
Inspector: --
Contractor:
Driller: A. Guzdzial

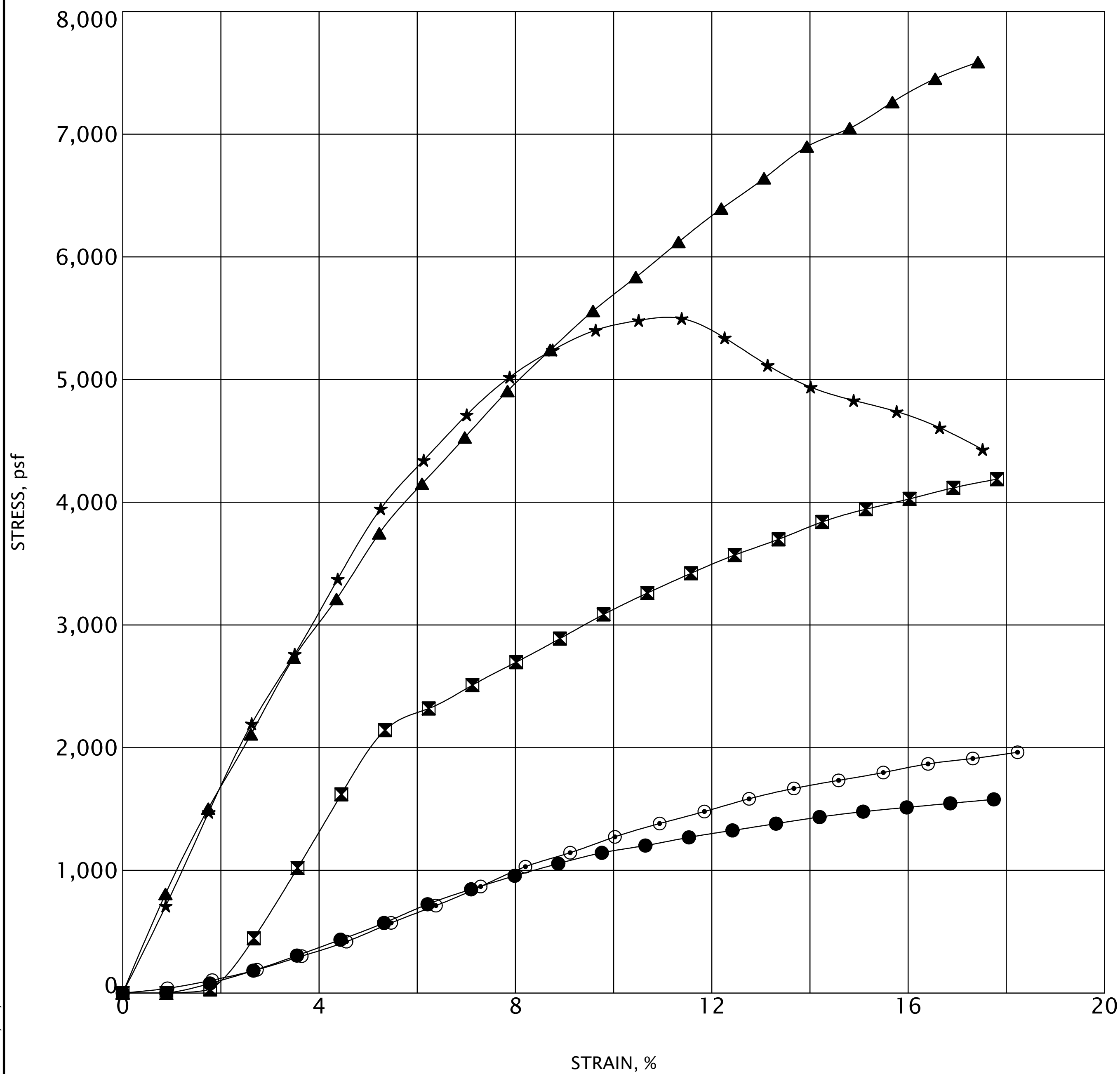
Drilling Method:
2-1/4" inside diameter hollow-stem augers

Water Level Observation:
18-1/2 feet during; 17 feet upon completion

Notes:
Borehole collapsed at 17 ft after auger removal
* Calibrated Hand Penetrometer

Excavation Backfilling Procedure:
Augger cuttings and cold patch asphalt

Figure No. 4




| | Specimen | | Classification | MC% | $\gamma_d$ | UC |
|---|---|---|---|---|---|---|
| ● | B-01 | S-02 | Brown Sandy Clay with trace gravel | 17 | 122 | 1470 |
| ⧗ | B-02 | S-02 | Brown Sandy Clay with trace gravel | 24 | 106 | 3930 |
| ▲ | B-02 | S-03 | Brown Sandy Clay with trace gravel | 12 | 127 | 7100 |
| ★ | B-04 | S-03 | Brown Sandy Clay with trace gravel | 12 | 125 | 5500 |
| ⊙ | B-04 | S-06 | Gray Sandy Clay with trace silt and gravel | 14 | 130 | 1760 |
| | | | | | | |

CONSULTING GROUP

# UNCONFINED COMPRESSIVE STRENGTH TEST

Project Name: Prop. Howell Armory Maintenance Garage

Project Location: 727 Isbell Street
Howell, Michigan

G2 Project No.: 243351

Figure No. 5

# 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:

| Second Major Constituent (percent by weight) | Minor Constituent (percent by weight) |
|---|---|
| Trace - 1 to 12% | Trace - 1 to 12% |
| Adjective - 12 to 35% | Little - 12 to 23% |
| And - over 35% | Some - 23 to 33% |

## 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) |
|---|---|---|
| Very Soft | Below 500 | 0 - 2 |
| Soft | 500 - 1,000 | 3 - 4 |
| Medium | 1,000 - 2,000 | 5 - 8 |
| Stiff | 2,000 - 4,000 | 9 - 15 |
| Very Stiff | 4,000 - 8,000 | 16 - 30 |
| Hard | 8,000 - 16,000 | 31 - 50 |
| Very Hard | Over 16,000 | Over 50 |

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) |
|---|---|---|
| Very Loose | 0 - 15 | 0 - 4 |
| Loose | 16 - 35 | 5 - 10 |
| Medium Compact | 36 - 65 | 11 - 30 |
| Compact | 66 - 85 | 31 - 50 |
| Very Compact | 86 - 100 | Over 50 |

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).