# Geotechnical Exploration Report

of

Proposed Lincoln Avenue Reconstruction
Ada, Hardin County, Ohio

Prepared for

Choice One Engineering
400 E. Hoewisher Road
Sidney, Ohio 45365

Raymond G. France
Branch Manager

Prepared by

Intertek/PSI
3751 Shawnee Road
Lima, OH 45806

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PSI Project No. 01251783

Ralph M. O'Quinn, P.E.
Chief Engineer / Principal Consultant

12/14/17

STATE OF OHIO
RALPH M. O'QUINN
E - 57532
REGISTERED PROFESSIONAL ENGINEER

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# 1 PROJECT INFORMATION

## 1.1 PROJECT AUTHORIZATION

The following Table summarizes (in chronological order) the Project Authorization History for the services performed and represented in this report by Professional Service Industries, Inc. (PSI):

| PROPOSED LINCOLN AVENUE, ADA RECONSTRUCTION PROJECT | | |
|---|---|---|
| **Document and Reference Number** | **Date** | **Requested/Provided By** |
| Request for Proposal | 11-13-2017 | Mr. Matt Hoying with Choice One Engineering |
| Intertek/PSI Proposal No: 0125-228168 | 11-15-2017 | Mr. Matt Hoying with Choice One Engineering/ Ms. Tiffani Wurst and Mr. Ralph O'Quinn of Intertek/PSI. |
| Choice One Purchase Agreement including Intertek/PSI Proposal No 0125-228168 | 11-17-2017 | Mr. Matt Hoying, P.E., Choice One Engineering |

## 1.2 PROJECT INFORMATION

Original project information was obtained during a phone call conversation and a follow-up email on November 13, 2017 from Mr. Matt Hoying of Choice One Engineering to Ms. Tiffani Wurst of Intertek/PSI. Based on the provided information, Intertek/PSI understands that the project will consist of the reconstruction of approximately 4,100 feet of existing pavement from approximately 465 feet west of Union Street to Klingler Road, including concrete and asphalt apron replacements. An Average Daily Traffic (ADT) value of 2180 was also provided.

No other design details, topographical, or grading information was provided at the time of this report. However, Intertek/PSI has estimated maximum cut/fills of approximately 2 feet to reach finish grades.

The geotechnical recommendations presented in this report are based on the available project information and the subsurface materials described in this report. If any of the information we have been given or assumed is incorrect, please contact us so that we may amend the recommendations presented accordingly. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

## 1.3 SCOPE OF SERVICES

The purpose of this study was to explore the subsurface conditions at the site to prepare recommendations and other design parameters for the proposed reconstruction. PSI's contracted scope of services included drilling a total of eleven (11) soil test borings to depths of approximately 7 feet below existing surface grades, a select laboratory testing program, and preparation of this geotechnical report. This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents recommendations regarding the following:

- A general assessment and description of area geology based on our local knowledge and study of available geological literature.

- General location, description of materials encountered in the borings which may interfere with construction progress or structure performance, including fills, cobbles/boulders, or organic soils.

- A graphic representation of the boring logs with classification of soils encountered, in accordance with the Ohio Department of Transportation (ODOT) System.

- Seismic Site Classification per latest IBC.

- Identification of water levels encountered at the time of drilling and when the borings are completed.

- Recommendations for fill including the selection of materials for use and procedures for placement.

- GB-1 analysis per ODOT requirements.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on, below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to further development of this site, an environmental assessment is advisable.

PSI's scope also did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence or the amplification of the same. Client should be aware that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. Client should be aware that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or reoccurrence of mold amplification.

# 2 SITE AND SUBSURFACE CONDITIONS

## 2.1 SITE LOCATION AND CONDITIONS

The proposed project is an approximate 4,100 lineal feet of roadway located on Lincoln Avenue from approximately 465 feet west of Union Street to Klingler Road in Ada, Hardin County, Ohio. The site latitude and longitude are approximately 40.7694°N and -83.8317°W, respectively.

Currently, the proposed site is predominately covered with asphalt and is being utilized for traffic. No topographical information was provided at the time of this report. The overall site drainage appears to be through surface runoff and infiltration. For the purposes of this report, we reviewed Google Earth™ images which indicate an overall site elevation difference of approximately 10 feet (955 to 965).

## 2.2 SITE GEOLOGY

Based on the on-line geologic map provided by the Ohio Geological Survey (available at http://www.dnr.state.oh.us/OhioGeologicalSurvey/SurficialGeology/tabid/23586/Default.aspx), the proposed site area is located in the Central Lowland Province, Till Plains Section, Central Ohio Clayey Till Plain Region, with Wave-planed ground moraine and Ground moraine topography underlain by Silurian age bedrock as part of the Wisconsinan Glaciation Period.

## 2.3 SUBSURFACE CONDITIONS

The scope of PSI's services included a subsurface exploration program consisting of drilling and Standard Penetration Testing (SPT) at eleven (11) locations to depths of about 7 feet beneath the existing surface grades. The test boring locations were selected and field located by Intertek/PSI.

The borings were advanced utilizing 3¼ inch inside diameter, hollow-stem auger drilling methods. Soil samples were routinely obtained during the drilling process. Select soil samples were later tested in the laboratory to obtain soil material properties for the pavement recommendations. Drilling, sampling, and laboratory testing was accomplished in general accordance with ASTM procedures.

The surface material thicknesses were determined in the field by measurements obtained during the drilling process. The surface of the proposed project area was covered with approximately 9 to 12 inches of asphalt. It must be recognized that the asphalt thickness is approximate and should be expected to vary across the site areas.

Beneath the surface materials, natural soils consisting of SILT AND CLAY A-6a, CLAY A-7-6, and SILTY CLAY A-6b with variable amounts of sand, silt and gravel, were encountered. The natural soils were encountered to the boring termination depths of about 7 feet beneath existing grades. The natural soils encountered had SPT values ($N_{60}$) ranging from 8 to 49 blows per foot (bpf) and moisture contents from 12 to 28 percent.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information at individual boring locations. These records include soil/rock

descriptions, stratifications, penetration resistances, and locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during the field operations is also shown on these boring logs. The samples that were not altered by laboratory testing will be retained for sixty (60) days from the date of this report and then will be discarded.

The following table summarizes the blow counts, moisture contents, and water levels encountered during the field and laboratory study.

**TABLE 1**

**SUMMARY OF SPT N VALUES, MOISTURE CONTENT & GROUND WATER LEVELS**

| Top of Soil Sampling Depth (ft) | SPT N Values (blows/ft) | | | | | | | | | | | | Top of Soil Sampling Depth (ft) | Moisture Content (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B-001-17 | B-002-17 | B-003-17 | B-004-17 | B-005-17 | B-006-17 | B-007-17 | B-008-17 | B-009-17 | B-010-17 | B-011-17 | Average | | B-001-17 | B-002-17 | B-003-17 | B-004-17 | B-005-17 | B-006-17 | B-007-17 | B-008-17 | B-009-17 | B-010-17 | B-011-17 | Average |
| **1.0** | 15 | 14 | 20 | 17 | 12 | 14 | 14 | 14 | 15 | 14 | 14 | ***15*** | **1.0** | 22 | 23 | 12 | 25 | 24 | 20 | 23 | 23 | 20 | 22 | 18 | ***21*** |
| **2.5** | 12 | 12 | 15 | 12 | 9 | 11 | 9 | 15 | 12 | 22 | 12 | ***13*** | **2.5** | 24 | 22 | 20 | 22 | 26 | 23 | 25 | 16 | 26 | 18 | 22 | ***22*** |
| **4.0** | 18 | 11 | 23 | 9 | 14 | 11 | 14 | 20 | 8 | 34 | 15 | ***16*** | **4.0** | 27 | 25 | 16 | 18 | 19 | 19 | 18 | 16 | 22 | 16 | 25 | ***20*** |
| **5.5** | 12 | 15 | 34 | 20 | 31 | 29 | 35 | 46 | 20 | 49 | 11 | ***27*** | **5.5** | 28 | 21 | 15 | 18 | 16 | 18 | 17 | 16 | 16 | 16 | 23 | ***19*** |
| **Groundwater Level Reading** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Water Level Encountered While Drilling** | | | | | | | | | | | | | | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | |
| **Water Level Reading Encountered Upon Completion** | | | | | | | | | | | | | | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | |

NE- Not Encountered

## 2.4 LABORATORY TESTING

Laboratory testing was conducted on selected split spoon samples obtained during the field drilling operations including Atterberg limit determination, grain size, and moisture contents. The results of this testing are represented in the following Tables 2 and 3.

**Table 2**
**Atterberg Limit Tests**

| Boring No. | Sample Depth (feet) | Liquid Limit | Plastic Limit | Plasticity Index | Moisture Content % |
|---|---|---|---|---|---|
| B-001-17 | 1.0 | 50 | 20 | 30 | 22 |
| B-001-17 | 2.5 | 40 | 20 | 20 | 24 |
| B-002-17 | 2.5 | 47 | 17 | 30 | 22 |
| B-002-17 | 4.0 | 44 | 21 | 23 | 25 |
| B-003-17 | 2.5 | 33 | 16 | 17 | 20 |
| B-003-17 | 5.5 | 30 | 17 | 13 | 15 |
| B-004-17 | 1.0 | 55 | 18 | 37 | 25 |
| B-004-17 | 2.5 | 44 | 20 | 24 | 22 |
| B-005-17 | 1.0 | 49 | 19 | 30 | 24 |
| B-005-17 | 4.0 | 30 | 17 | 13 | 19 |
| B-006-17 | 1.0 | 37 | 17 | 20 | 20 |
| B-006-17 | 4.0 | 28 | 17 | 11 | 19 |
| B-007-17 | 1.0 | 47 | 18 | 29 | 23 |
| B-007-17 | 5.5 | 30 | 17 | 13 | 17 |
| B-008-17 | 2.5 | 29 | 17 | 12 | 16 |
| B-008-17 | 4.0 | 29 | 17 | 12 | 16 |
| B-009-17 | 1.0 | 40 | 17 | 23 | 20 |
| B-009-17 | 2.5 | 50 | 18 | 32 | 26 |
| B-010-17 | 1.0 | 43 | 18 | 25 | 22 |
| B-010-17 | 5.5 | 29 | 17 | 12 | 16 |
| B-011-17 | 2.5 | 42 | 20 | 22 | 22 |
| B-011-17 | 4.0 | 42 | 19 | 23 | 25 |

**Table 3**
**Soil Grain Size Analysis**

| Boring No. | Sample Depth (feet) | Gravel % | Sand % | Silt and Clay % |
|---|---|---|---|---|
| B-001-17 | 1.0 | 11 | 16 | 73 |
| B-001-17 | 2.5 | 4 | 14 | 82 |
| B-002-17 | 2.5 | 5 | 10 | 85 |
| B-002-17 | 4.0 | 0 | 8 | 92 |
| B-003-17 | 2.5 | 4 | 32 | 64 |
| B-003-17 | 5.5 | 7 | 21 | 72 |
| B-004-17 | 1.0 | 0 | 6 | 94 |
| B-004-17 | 2.5 | 0 | 20 | 80 |
| B-005-17 | 1.0 | 0 | 8 | 92 |
| B-005-17 | 4.0 | 4 | 23 | 73 |
| B-006-17 | 1.0 | 0 | 16 | 84 |
| B-006-17 | 4.0 | 5 | 23 | 72 |
| B-007-17 | 1.0 | 0 | 4 | 96 |
| B-007-17 | 5.5 | 5 | 24 | 71 |
| B-008-17 | 2.5 | 2 | 23 | 75 |
| B-008-17 | 4.0 | 5 | 21 | 74 |
| B-009-17 | 1.0 | 1 | 15 | 84 |
| B-009-17 | 2.5 | 0 | 11 | 89 |
| B-010-17 | 1.0 | 2 | 18 | 80 |
| B-010-17 | 5.5 | 8 | 20 | 72 |
| B-011-17 | 2.5 | 1 | 14 | 85 |
| B-011-17 | 4.0 | 2 | 21 | 77 |

## 2.5 GROUNDWATER LEVEL MEASUREMENTS

No groundwater was encountered during or upon completion of drilling at the test boring locations. However, it must be recognized that free groundwater levels can significantly fluctuate (seasonally) and as a function of rainfall and may be present at other locations or to depths shallower than those encountered. During a time of year or weather different from the time of drilling, there may be a considerable change in the water table or the occurrence of water where not previously encountered. Furthermore, the free groundwater levels in the boreholes often are not representative of the actual groundwater level, because the boreholes remain open for a relatively short time. To obtain longer-term measurements, it is necessary to install water level observation wells or piezometers. The water level measurements presented in this report are the levels that were measured at the time of PSI's field activities. Therefore, we recommend that the contractor determine the actual groundwater levels at the time of construction to evaluate groundwater impact on the construction procedures.

# 3 GEOTECHNICAL EVALUATION

## 3.1 GEOTECHNICAL DISCUSSION

The project field exploration based on the ODOT GB1 Analysis has revealed concerns which may affect the performance of the pavement for this project. The following summarizes these concerns:

***In-Situ Moisture Content / $N_{60L}$***

The GB1 Analysis was conducted per the Ohio Department of Transportation (ODOT) guidelines for this project. The analysis has indicated two (2) items which might affect the subgrade preparation for the pavement. The first item was the average In-situ Moisture Content of 21% for the tested samples. The GB1 analysis established an Optimum Moisture Content of 16% based on the laboratory testing. Additionally, the analysis showed an average In-situ $N_{60L}$ value of 11.

Based upon the GB1 analysis, these two (2) issues resulted in 19 of the 44 samples classified as “unstable”. The unstable designation requires remedial measures be taken for the subgrade. The options provided are excavation and replacement, chemical stabilization with lime, or stabilization with geotextile and replacement. Please refer to the *Pavement Recommendations* section of this report for additional information on the analysis and remediation options.

# 4 GEOTECHNICAL RECOMMENDATIONS

The following geotechnical related recommendations have been developed based upon the subsurface conditions encountered, our experience with similar soils and site conditions, and PSI's understanding of the proposed development. Should changes in the project criteria occur, a review must be made by PSI to determine if modifications to our recommendations will be required.

## 4.1 SITE PREPARATION

PSI recommends that all asphalt, organic, frozen or otherwise objectionable soils in the construction areas be removed and either wasted or stockpiled for later use in non-structural areas. It should be noted that it is not unusual for asphalt or other objectionable material thicknesses to vary from the values observed in the soil test borings. A representative of the geotechnical engineer should determine and document the depth of removal at the time of construction.

In this region, these otherwise competent sands, silts and lean clays can undergo a significant loss of stability when construction activities are performed during wetter portions of the year. PSI anticipates that the soils in the project area can become easily disturbed if subjected to conventional rubber tire or narrow track-type equipment. Soils that become disturbed should be excavated and replaced; however, this remedial excavation may expose progressively wetter soils with depth, thus compounding the situation. Therefore, a normal approach to subgrade preparation may not be possible. Appropriate wide-track equipment selection should aid in minimizing potential disturbance.

After the selected subgrade remediation, the area should be proof-rolled in accordance with ODOT Item 204.06 Proof Rolling and Test Rolling and Item 206 if applicable, for all sections after excavation to the new subgrade level to determine the need for subgrade stabilization. Soils that are observed to rut or deflect excessively (typically greater than one (1) inch) under the moving load should be undercut and replaced with properly compacted low plasticity fill material. The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather. If the earthwork activities take place during wet seasons, lime stabilization of the subgrade could be required prior to engineered fill placement. Care should be taken during construction activities not to allow excessive drying or wetting of exposed soils. The subgrade soils should be scarified and compacted to the applicable ODOT specifications listed in Item 203 Earthwork section. Additionally, new fill for asphalt or concrete should not be placed on soft or frozen ground.

After subgrade preparation and observation has been completed, fill placement if necessary to establish grade may begin. Low plasticity structural fill materials should be free of organic or other deleterious materials and have a maximum particle size of less than three (3) inches. Low-plasticity soils are defined as having a liquid limit less than forty-five (45) and plasticity index between ten (10) and twenty (20). Samples of proposed fill materials should be provided to PSI well in advance of their use to determine if the proposed fill material is suitable for use at the project. Additionally, a representative of PSI should be on-site to observe, test, and document placement of the fill. If the fill is too dry, water should be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Close moisture content control will be required to achieve the recommended degree of compaction. If wet or cool season earthwork is necessary, PSI recommends the use of imported fill materials meeting the requirements of Ohio Department of Transportation (ODOT) No. 304 aggregate.

Fill should be placed and compacted in accordance with the ODOT Item 203 Earthwork section. Each lift of compacted-engineered fill should be tested and documented by a representative of the geotechnical engineer prior to placement of subsequent lifts. The edges of compacted fill should extend a minimum of five (5) feet beyond the pavement edges, or a distance equal to the depth of fill beneath the footings, or per the design drawing details, whichever is greater. The measurement should be taken from the outside edge of the pavement to the toe of the excavation prior to sloping.

In utility trenches, shallow foundation excavations, and other areas where large compaction equipment cannot be used, granular engineered fill should be placed as backfill. PSI recommends the use of material meeting Ohio Department of Transportation (ODOT) No. 304, for use as granular engineered fill. Engineered fill should be placed in accordance with the recommendations stated in this section of the report.

The fill placed should be tested and documented by a geotechnical technician and directed by a geotechnical engineer to evaluate the placement of fill material. It should be noted that the geotechnical engineer of record can only certify the testing that is performed, and the work observed by that engineer or staff in direct report to that engineer.

## 4.2 PAVEMENT RECOMMENDATIONS

***Planned Subgrades – GB1 Analysis***

The subgrade conditions were evaluated using the methodology described in Geotechnical Bulletin #1 (GB-1) published by The Ohio Department of Transportation. Eleven (11) borings were evaluated in the planned pavement area. No grading plan was provided at the time of this report. However, PSI has used elevation 100 for the finish pavement grade and 98.5 for the finish subgrade for this analysis. For the purposes of this report, we reviewed Google Earth™ images which indicate an overall site elevation difference of approximately 10 feet (955 to 965). We estimate that up to approximate fill operations of 2 feet will be required in the pavement areas.

The predominant soil types of the tested samples are SILT AND CLAY A-6a (39%), CLAY A-7-6 (34%), and SILTY CLAY A-6b (27%); in accordance with the ODOT Soil Classification System (OSCS) which is a modified AASHTO system. The GB-1 analysis indicates the subgrade has an average $N_{60}$ of 18 blows per foot and minimum $N_{60}$ of 8 blows per foot. The average moisture content is 21 percent and the average optimum moisture content is 16 percent indicating the average soil exceeds the optimum compaction moisture content by 5 percent. The predominant soil types generally have a medium to high shrink swell potential. The group index ranges from 8 to 19 and the average is 13. The design CBR based upon the GB-1 analysis is 5 percent.

Based on the soil types and the shrink-swell potential, the relative consistency ($N_{60}$), and natural water content compared to the optimum water content for compaction; three (3) options were indicated by the GB-1 analysis.

**Option 1 –** Excavate and replace an average of approximately 24 inches of “unstable” material. The recommended depth of removal, based upon the GB-1 anlysis, varies from 18 inches to 30 inches.

**Option 2** – Chemical Stabilization of the subgrade with Lime to a depth of 12 inches.

**Option 3** –Stabilization of the subgrade with geotextile and 12 inches of replacement.

While ODOT does not currently recognize the increased stabilized subgrade strength in the pavement design, literature[1] indicates that the resilient modulus of the subgrade may be increased by a factor of 2.0 where lime stabilization is used.

Therefore, PSI recommends the owner and engineer consider chemical stabilization of the subgrade with lime to a depth of 12 inches as an alternative to conventional subgrade preparation (ODOT Item 203). The following soil parameters may be used for pavement design:

| | |
|---|---|
| Non-stabilized Design CBR | 5 % |
| Non-stabilized Resilient Modulus, $M_r$ | 7200 psi |
| Resilient Modulus, $M_r$ of Lime Stabilized Subgrade | 14,400 psi |

Preparation of the subgrade may require significant drying to achieve the specified compaction. Depending on the time of year and weather conditions, drying of the soil could become difficult. Thus, the use of stabilization could, under certain conditions, expedite the project and provide an increased strength to the subgrade. The option to use chemical stabilization could be bid as an alternate to be used if authorized. Under this condition, it may not be practical or feasible to change the pavement section based on a stabilized subgrade.

***Pavement Subgrade Preparation for Pavement Structures***

Pavement design will include proper preparation of subgrade sectors, careful design of the pavement area drainage system, and utilization of an aggregate base course with asphalt concrete or concrete surface course. Final subgrade elevations shall be achieved employing procedures outlined in the previous section titled *Site Preparation*. Additionally, in the proposed pavement areas, the subgrade should be proof-rolled to detect zones of loose, soft and/or wet soils. Proof-rolling (ODOT Item 204.06) consists of repeated passes over the subgrade with a loaded dump truck. Areas, which rut, or pump excessively should be undercut and replaced with properly compacted fill.

[1] *"Structural Support of Lime or Cement Stabilized Subgrade Used with Flexible Pavements", Dr. Eddie Chou, Laurent Fournier, Zairen Luo, Jason Wielinski; The University of Toledo College of Engineering, Department of Civil Engineering, Toledo, OH.*

***Chemically Stabilized Subgrade (Design Alternate or As-Authorized in Bid Document)***

**In all areas to receive pavement the subgrade can be chemically stabilized with lime to a minimum depth of 12 inches.** The work shall be in accordance with ODOT Item 206 Chemically Stabilized Subgrade. The percentage of lime shall be determined in accordance with Mixture Design for Chemically Stabilized Soils ODOT Supplement 1120. For estimating purposes, a spreading rate of 5% by weight of dry soil may be used. The spreading rate may be based on a dry density of 110 pounds per cubic foot for soil.

***Drainage of Pavement Structures***

Design for drainage is of the utmost importance to minimize detrimental effects that may shorten the service life of the pavements. Inclusion of adequate surface and subsurface drainage systems within the pavement areas is considered imperative to maintain the compacted subgrades as close to optimum moisture conditions as possible. The pavement should be crowned or sloped to promote effective surface drainage and reduce the risk of water ponding. In addition, the subgrade should be similarly sloped to promote effective subgrade drainage.

The subgrade soils SILT AND CLAY A-6a, CLAY A-7-6, and SILTY CLAY A-6b, on this site are subject to shrinking and swelling whenever their moisture contents vary. Consideration should be given to the provision of an under-drain system to limit these moisture fluctuations. PSI also recommends “stub” or “finger” drains be provided at catch basins, and in other low areas of the proposed pavements to limit the accumulation of water on the frost susceptible subgrade soils. These drains are typically 4-inch perforated plastic tiles with a silt protective filter wrap, extending a minimum of 10 feet from the catch basins in four directions. Surface grades should be such that no pavement sectors can impound water. Surface water should be directed to a system of catch basins. At high points along the perimeter of the pavement, it is recommended that an open ditch drain or edge drain be installed to intercept seepage water and prevent it from flowing beneath the pavement and causing saturation of the aggregate base. This will prevent seepage from collecting in the somewhat impervious subgrade and the subsequent softening of the soils.

Subsurface drainage systems should be installed at least three (3) feet below the design subgrade elevations at regular intervals along the perimeter of the pavement areas. Subsurface drainage system consisting of perforated drain pipes bedded in and backfilled over with suitable filter materials (No. 57 coarse aggregate per AASHTO M-43) should be installed. The filter around the drainage members is to terminate in direct contact with the aggregate base course for the pavements. The under-drain pipe should be directed to appropriate inlets of the storm drain system. This will prevent the build-up of water beneath the pavement section at the low points that would eventually lead to pavement failure. Final grading plans should be reviewed to determine necessity and location of subsurface drains.

***Pavement Design Parameters***

No grading plan was provided at the time of this report. However, for this analysis, PSI has estimated finish subgrade elevation for the pavement areas to be at, or near, the existing subgrade elevation. Based on review of Google Earth™ images, we estimated an overall site elevation difference of approximately 10 feet (955 to 965). Accordingly, it is anticipated that there will be minimal cut/fill operations (less than 2 feet) required in the pavement areas.

It is anticipated that the pavement design will be for a 20-year life cycle. Additionally, the proposed pavement section provided by Choice One Engineering is indicated in the following table. The provided pavement section should provide the lifespan of 20 years with the traffic loading provided of an ADT value of 2180 and proper maintenance.

| Pavement Type | Surface Course, Type 1 (448) Thickness | Intermediate Course, Type 2 (448) Thickness | Asphalt Base Thickness | Aggregate Base Thickness |
|---|---|---|---|---|
| **Choice One Proposed Pavement Section** | 1-1/2” | 1-3/4” | 7” | 8” |

***Thickness Determination***

Pavement thickness and required structural numbers were determined in accordance with The AASHTO Interim Guide for Pavement Thickness Design. Many variables are considered in the data entry for both rigid and flexible pavement thickness and structural number determination. Generally, the thickness determination for rigid pavement and structural number determination for flexible pavement is in accordance with protocol established in the Pavement Design & Rehabilitation Manual, The Ohio Department of Transportation, 2003.

Some of the critical input values into the equations are stated below. Some values are based on the facility type or desired safety factor in the design. Regional conditions and local material properties determine other input values.

The Reliability is one input that relates to pavement life and factor of safety for both rigid and flexible pavements. A design life of 20 years does not provide a guarantee that the pavement will last 20 years. Rather pavement life is evaluated in terms of probability that the pavement will provide serviceability over the design period. A pavement designed with a reliability of 50% has an equal chance of reaching the design life as predicted by the equations. Another way to consider the reliability and design life is the aspect of long term maintenance of the pavement. For a pavement designed with a reliability of 90 percent one can expect to have major repairs totaling 10 percent of the pavement area over the design life.

For low volume or light axle loading, minimum pavement thicknesses may govern the design rather than the ESALs over the design life. The effect of weathering, freeze-thaw, and single wheel load applications will govern the thickness design for these pavement types.

***Materials***

The asphalt concrete pavement should be designed and constructed according to Ohio Highway Department Item 448, and the high quality aggregate base according to Item 304.

***Pavements General***

The subgrade should be prepared in accordance with ODOT Item 203 or Item 206 as applicable. Pavement joints, reinforcing, and details should be designed in accordance with the applicable American Concrete Institute (ACI) standards.

All pavements should be sloped to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade and cause premature pavement deterioration.

All materials to be employed and field operations required in connection with the contemplated pavement structures should follow recommendations and procedural details as per the latest Ohio Department of Transportation, Asphalt Institute, and/or American Concrete Institute. It is mandatory that all field operations be carried out employing careful construction techniques and under full field control by representatives of the project's geotechnical engineer.

## 4.3 UTILITIES TRENCHING

Excavation for utility trenches shall be performed in accordance with OSHA regulations as stated in 29 CFR Part 1926. It should be noted that utility trench excavations have the potential to degrade the properties of the adjacent fill materials. Utility trench walls that can move laterally can lead to reduced bearing capacity and increased settlement of adjacent structural elements and overlying slabs.

Backfill for utility trenches is as important as the original subgrade preparation or structural fill placed to support either a foundation or slab. Therefore, it is imperative that the backfill for utility trenches be placed to meet the project specifications for the structural fill of this project. PSI recommends that flowable fill or lean mix concrete be utilized for utility trench backfill. If on-site soils are placed as trench backfill, the backfill for the utility trenches should be placed in four (4) to six (6) inch loose lifts and compacted to a minimum of 98% of the maximum dry density achieved by the standard Proctor test. The backfill soil should be moisture conditioned to be within 2% of the optimum moisture content as determined by the standard Proctor test. Up to four (4) inches of bedding material placed directly under the pipes or conduits placed in the utility trench can be compacted to the 90% compaction criteria with respect to the standard Proctor. Compaction testing should be performed for every 200 cubic yards of backfill place or each lift within 200 linear feet of trench, whichever is less. Backfill of utility trenches should not be performed with water standing in the trench. If granular material is used for the backfill of the utility trench, the granular material should have a gradation that will filter protect the backfill material from the adjacent soils. If this gradation is not available, a geosynthetic non-woven filter fabric should be used to reduce the potential for the migration of fines into the backfill material. Granular backfill material shall be compacted to meet the above compaction criteria. The clean granular backfill material should be compacted to achieve a relative density greater than 75% or as specified by the geotechnical engineer for the specific material used.

## 4.4 SILTATION CONTROL

The Clean Water Act, implemented in 1990 includes a federal permit program called the National Pollutant Discharge Elimination System (NPDES). This program requires that projects sites more than one (1) acre or are part of a development which exceeds one (1) acre be covered under a permit. This typically includes the development of a storm water pollution prevention plan (SWPPP) as well as period inspections (typically once a week plus after significant rainfall). PSI is available to assist with these services.

# 5 CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance of the foundation system if not engaged to also provide construction observation and testing for this project.

## 5.1 MOISTURE SENSITIVE SOILS/WEATHER RELATED CONCERNS

The upper fine-grained soils encountered at this site will be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

## 5.2 DRAINAGE AND GROUNDWATER CONSIDERATIONS

No groundwater was encountered during drilling or upon completion of drilling at the test boring locations. However, PSI recommends that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

Proper perimeter drainage mechanisms should be provided along all exterior foundation members for the below grade structures. The elevation of the drainage lines should be adjusted to keep water at a minimum of three (3) feet below the design subgrade elevation of the lower level. A free flowing granular backfill is to be employed around all drainage lines. All below grade and slab-on-grade construction should include an adequately designed drainage blanket consisting of 12 inches and 4 inches, respectively, of selected granular material having less than five (5) percent by weight passing the U.S. Standard No. 200 sieve. Overall site area drainage is to be arranged in a manner such that the possibility of water impounding below slab-on-grade areas and over the structural fill, is prevented at all times during and after construction.

## 5.3 EXCAVATONS

In Federal Register, Volume 54, Number 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better enhance the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the new OSHA guidelines. It is PSI's understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case, should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations. A trench safety plan was beyond the scope of our services for this project.

# 6 GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding section constitutes PSI's professional estimate of those measures that are necessary for the proposed structure to perform per the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

# 7 REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by Choice One Engineering, for the proposed development. If there are any revisions to the plans for the proposed building structure or pavement areas, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be retained to determine if changes in the recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the geotechnical recommendations for the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

This report has been prepared for the exclusive use of Choice One Engineering, for the specific application to Lincoln Avenue Project located approximately 465 feet west of Union Street to Klingler Road in Ada, Hardin County, Ohio.

# APPENDIX

Professional Service Industries


- Indicates Approximate Test Boring Location

psi Information To Build On
Engineering • Consulting • Testing

**Boring Location Plan**
Lincoln Avenue
Ada, Hardin County, Ohio

Project No.: 01251783-1
Not to Scale

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-001-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: RIGHT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/21/17 END: 11/21/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.0 | | | | | | | | | | | | | | | | | |
| VERY STIFF, DARK GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, SLIGHTLY ORGANIC (2.9%), MOIST | 97.5 | 1 | 4 4 6 | 15 | 67 | SS-1 | 3.75 | 11 | 9 | 7 | 29 | 44 | 50 | 20 | 30 | 22 | A-7-6 | |
| VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST | 96.0 | 3 | 3 5 3 | 12 | 100 | SS-2 | 2.25 | 4 | 4 | 10 | 34 | 48 | 40 | 20 | 20 | 24 | A-6b | |
| VERY STIFF, DARK GRAY, **CLAY**, SOME SILT, TRACE SAND, MOIST | 94.5 | 4 5 | 3 5 7 | 18 | 100 | SS-3 | 2.50 | - | - | - | - | - | - | - | - | 27 | A-7-6 (V) | |
| VERY STIFF, GRAYISH BROWN, **SILTY CLAY**, TRACE SAND, MOIST | 93.0 | 6 | 4 4 4 | 12 | 100 | SS-4 | 2.25 | - | - | - | - | - | - | - | - | 28 | A-6b (V) | |
| | EOB | 7 | | | | | | | | | | | | | | | | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-002-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: RIGHT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/21/17 END: 11/21/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.0 | | | | | | | | | | | | | | | | | |
| VERY STIFF, GREENISH GRAY, **CLAY**, LITTLE GRAVEL, LITTLE SAND, MOIST | 97.5 | 1 | 4 4 5 | 14 | 100 | SS-1 | 3.75 | - | - | - | - | - | - | - | - | 23 | A-7-6 (V) | |
| VERY STIFF, GREENISH GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST | 96.0 | 2 3 | 4 4 4 | 12 | 67 | SS-2 | 3.25 | 5 | 4 | 6 | 35 | 50 | 47 | 17 | 30 | 22 | A-7-6 | |
| VERY STIFF, BROWN, **CLAY**, SOME SILT, TRACE SAND, MOIST | 94.5 | 4 5 | 4 3 4 | 11 | 100 | SS-3 | 2.50 | 0 | 1 | 7 | 28 | 64 | 44 | 21 | 23 | 25 | A-7-6 | |
| VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST | 93.0 | 6 7 EOB | 6 4 6 | 15 | 100 | SS-4 | 2.25 | - | - | - | - | - | - | - | - | 21 | A-6b (V) | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | |
|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: RIGHT |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded |

EXPLORATION ID B-003-17

PAGE 1 OF 1

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.2 | | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP | 97.5 | 1 | 5 6 7 | 20 | 100 | SS-1 | - | - | - | - | - | - | - | - | - | 12 | A-6a (V) | |
| VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST | 96.0 | 2 3 | 5 4 6 | 15 | 100 | SS-2 | 2.25 | 4 | 14 | 18 | 27 | 37 | 33 | 16 | 17 | 20 | A-6b | |
| HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP | 93.0 | 4 5 | 5 7 8 | 23 | 100 | SS-3 | 4.50 | - | - | - | - | - | - | - | - | 16 | A-6a | |
| | EOB | 6 7 | 7 10 12 | 34 | 100 | SS-4 | 4.50 | 7 | 8 | 13 | 30 | 42 | 30 | 17 | 13 | 15 | A-6a (V) | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:46 - 00 - ODOT V2

| | | | | |
|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-004-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: RIGHT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.1 | | | | | | | | | | | | | | | | | |
| VERY STIFF, GREENISH BROWN, **CLAY**, AND SILT, TRACE SAND, MOIST | 97.5 | 1 | 4 5 6 | 17 | 100 | SS-1 | 3.00 | 0 | 1 | 5 | 36 | 58 | 55 | 18 | 37 | 25 | A-7-6 | |
| VERY STIFF, BROWN, **CLAY**, SOME SILT, TRACE SAND, MOIST | 96.0 | 2 3 | 4 4 4 | 12 | 100 | SS-2 | 3.25 | 0 | 5 | 15 | 28 | 52 | 44 | 20 | 24 | 22 | A-7-6 | |
| VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST | 94.5 | 4 5 | 3 3 3 | 9 | 100 | SS-3 | 2.75 | - | - | - | - | - | - | - | - | 18 | A-6a (V) | |
| VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST | 93.0 | 6 7 EOB | 5 6 7 | 20 | 100 | SS-4 | 4.00 | - | - | - | - | - | - | - | - | 18 | A-6a (V) | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | | |
|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-005-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: RIGHT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.3 | | | | | | | | | | | | | | | | | |
| VERY STIFF, GREENISH GRAY AND BROWN, **CLAY**, AND SILT, TRACE SAND, MOIST | | 1 | 4 4 4 | 12 | 100 | SS-1 | 2.75 | 0 | 1 | 7 | 37 | 55 | 49 | 19 | 30 | 24 | A-7-6 | |
| | | 2 | | | | | | | | | | | | | | | | |
| | | 3 | 3 3 3 | 9 | 100 | SS-2 | 2.75 | - | - | - | - | - | - | - | - | 26 | A-7-6 (V) | |
| | 96.0 | 4 | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST | | | 3 4 5 | 14 | 100 | SS-3 | 2.25 | 4 | 9 | 14 | 29 | 44 | 30 | 17 | 13 | 19 | A-6a | |
| | 94.5 | 5 | | | | | | | | | | | | | | | | |
| HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP | | 6 | 8 10 10 | 31 | 100 | SS-4 | - | - | - | - | - | - | - | - | - | 16 | A-6a (V) | |
| | 93.0 | EOB 7 | | | | | | | | | | | | | | | | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | | |
|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-006-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: RIGHT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.1 | | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, MOIST | 97.5 | 1 | 5 4 5 | 14 | 100 | SS-1 | 3.00 | 0 | 2 | 14 | 41 | 43 | 37 | 17 | 20 | 20 | A-6b | |
| STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, MOIST | 96.0 | 3 | 3 4 3 | 11 | 100 | SS-2 | 1.75 | - | - | - | - | - | - | - | - | 23 | A-6b (V) | |
| VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST | 94.5 | 5 | 3 4 3 | 11 | 100 | SS-3 | 2.25 | 5 | 9 | 14 | 29 | 43 | 28 | 17 | 11 | 19 | A-6a | |
| HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, MOIST | 93.0 | 6 7 | 6 7 12 | 29 | 100 | SS-4 | 4.50 | - | - | - | - | - | - | - | - | 18 | A-7-6 (V) | |
| | | EOB 7 | | | | | | | | | | | | | | | | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | |
|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: LEFT |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded |

EXPLORATION ID B-007-17

PAGE 1 OF 1

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.2 | | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN AND GRAY, **CLAY**, AND SILT, TRACE SAND, MOIST | 97.5 | 1 | 3 4 5 | 14 | 67 | SS-1 | 3.00 | 0 | 1 | 3 | 43 | 53 | 47 | 18 | 29 | 23 | A-7-6 | |
| VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST | 96.0 | 3 | 3 3 3 | 9 | 100 | SS-2 | 2.50 | - | - | - | - | - | - | - | - | 25 | A-6b (V) | |
| VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, MOIST | 94.5 | 4 5 | 3 4 5 | 14 | 100 | SS-3 | 3.25 | - | - | - | - | - | - | - | - | 18 | A-6a (V) | |
| HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST | 93.0 | 6 7 EOB | 6 10 13 | 35 | 28 | SS-4 | 4.50 | 5 | 10 | 14 | 31 | 40 | 30 | 17 | 13 | 17 | A-6a | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-008-17 | |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: LEFT | | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 | |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.2 | | | | | | | | | | | | | | | | | |
| VERY STIFF, GREENISH BROWN, **SILTY CLAY**, SOME SAND, MOIST | 97.5 | 1 | 3 4 5 | 14 | 67 | SS-1 | 3.25 | - | - | - | - | - | - | - | - | 23 | A-6b (V) | |
| VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP | 96.0 | 2 3 | 5 5 5 | 15 | 100 | SS-2 | 4.50 | 2 | 8 | 15 | 34 | 41 | 29 | 17 | 12 | 16 | A-6a | |
| HARD, DARK BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP | 94.5 | 4 5 | 5 7 6 | 20 | 100 | SS-3 | 4.50 | 5 | 8 | 13 | 36 | 38 | 29 | 17 | 12 | 16 | A-6a | |
| HARD, DARK BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP | 93.0 | 6 7 EOB | 12 13 17 | 46 | 100 | SS-4 | 4.50 | - | - | - | - | - | - | - | - | 16 | A-6a (V) | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:34 - 00 - ODOT V2

| | | | | |
|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-009-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: LEFT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/22/17 END: 11/22/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.3 | | | | | | | | | | | | | | | | | |
| VERY STIFF, DARK BROWN AND BLACK, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE SAND, MODERATELY ORGANIC, MOIST | 97.5 | 1 | 5 5 5 | 15 | 100 | SS-1 | 4.00 | 1 | 3 | 12 | 40 | 44 | 40 | 17 | 23 | 20 | A-6b | |
| VERY STIFF, DARK BROWN AND GRAY, **CLAY**, AND SILT, LITTL SAND, MOIST | 96.0 | 3 | 4 4 4 | 12 | 100 | SS-2 | 2.50 | 0 | 2 | 9 | 41 | 48 | 50 | 18 | 32 | 26 | A-7-6 | |
| VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST | 94.5 | 5 | 3 3 2 | 8 | 89 | SS-3 | 4.75 | - | - | - | - | - | - | - | - | 22 | A-6b (V) | |
| HARD, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP | 93.0 | 6 EOB 7 | 6 6 7 | 20 | 100 | SS-4 | 4.50 | - | - | - | - | - | - | - | - | 16 | A-6b (V) | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:35 - 00 - ODOT V2

| | | | | |
|---|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: | EXPLORATION ID B-010-17 |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: LEFT | |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. | PAGE 1 OF 1 |
| START: 11/21/17 END: 11/21/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded | |

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.2 | | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST | 97.5 | 1 | 5<br>4<br>5 | 14 | 89 | SS-1 | 3.75 | 2 | 5 | 13 | 24 | 56 | 43 | 18 | 25 | 22 | A-7-6 | |
| HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRAVE GRAVEL, DAMP | 96.0 | 2<br>3 | 5<br>6<br>8 | 22 | 100 | SS-2 | 4.25 | - | - | - | - | - | - | - | - | 18 | A-6a (V) | |
| HARD, BROWN, **SILTY CLAY**, LITTLE SAND, DAMP | 94.5 | 4<br>5 | 7<br>10<br>12 | 34 | 100 | SS-3 | 4.50 | - | - | - | - | - | - | - | - | 16 | A-6b (V) | |
| HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP | 93.0 | 6<br>EOB 7 | 9<br>15<br>17 | 49 | 100 | SS-4 | 4.50 | 8 | 7 | 13 | 29 | 43 | 29 | 17 | 12 | 16 | A-6a | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:35 - 00 - ODOT V2

| | | | |
|---|---|---|---|
| PROJECT: ADA LINCOLN AVE. | DRILLING FIRM / OPERATOR: NORTHSTAR / CJ | DRILL RIG: DIEDRICH D50-ID:505 | STATION / OFFSET: |
| TYPE: ROADWAY | SAMPLING FIRM / LOGGER: NORTHSTAR / TOM/BRIAN | HAMMER: DIEDRICH AUTOMATIC | ALIGNMENT: LEFT |
| PID: BR ID: | DRILLING METHOD: 3.25" HSA | CALIBRATION DATE: N/A | ELEVATION: 100.0 (MSL) EOB: 7.0 ft. |
| START: 11/21/17 END: 11/21/17 | SAMPLING METHOD: SPT | ENERGY RATIO (%): 92.4 | LAT / LONG: Not Recorded |

EXPLORATION ID B-011-17

PAGE 1 OF 1

| MATERIAL DESCRIPTION AND NOTES | ELEV. 100.0 | DEPTHS | SPT/ RQD | $N_{60}$ | REC (%) | SAMPLE ID | HP (tsf) | GRADATION (%) GR | CS | FS | SI | CL | ATTERBERG LL | PL | PI | WC | ODOT CLASS (GI) | INST. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASPHALT** | 99.0 | | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN AND DARK BROWN, **CLAY**, SOME SILT, LITTLE SAND, SLIGHTLY ORGANIC (ESTIMATED), MOIST | 97.5 | 1 | 3 4 5 | 14 | 100 | SS-1 | 4.00 | - | - | - | - | - | - | - | - | 18 | A-7-6 (V) | |
| VERY STIFF, GREENISH DARK BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST | 96.0 | 2 | | | | | | | | | | | | | | | | |
| VERY STIFF, BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRAVE GRAVEL, MOIST | 94.5 | 3 | 3 4 4 | 12 | 100 | SS-2 | 3.75 | 1 | 3 | 11 | 34 | 51 | 42 | 20 | 22 | 22 | A-7-6 | |
| VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST | 93.0 | 4 | 3 5 5 | 15 | 100 | SS-3 | 2.75 | 2 | 4 | 17 | 19 | 58 | 42 | 19 | 23 | 25 | A-7-6 | |
| | | 5 | | | | | | | | | | | | | | | | |
| | | 6 | 5 4 3 | 11 | 100 | SS-4 | 2.50 | - | - | - | - | - | - | - | - | 23 | A-6b (V) | |
| | | EOB 7 | | | | | | | | | | | | | | | | |

NOTES: NO WATER ENCOUNTERED DURING OR UPON COMPLETION OF DRILLING. BOREHOLES BACKFILLED WITH BENTONITE/SOIL MIXTURE. BORHOLE PATCHED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

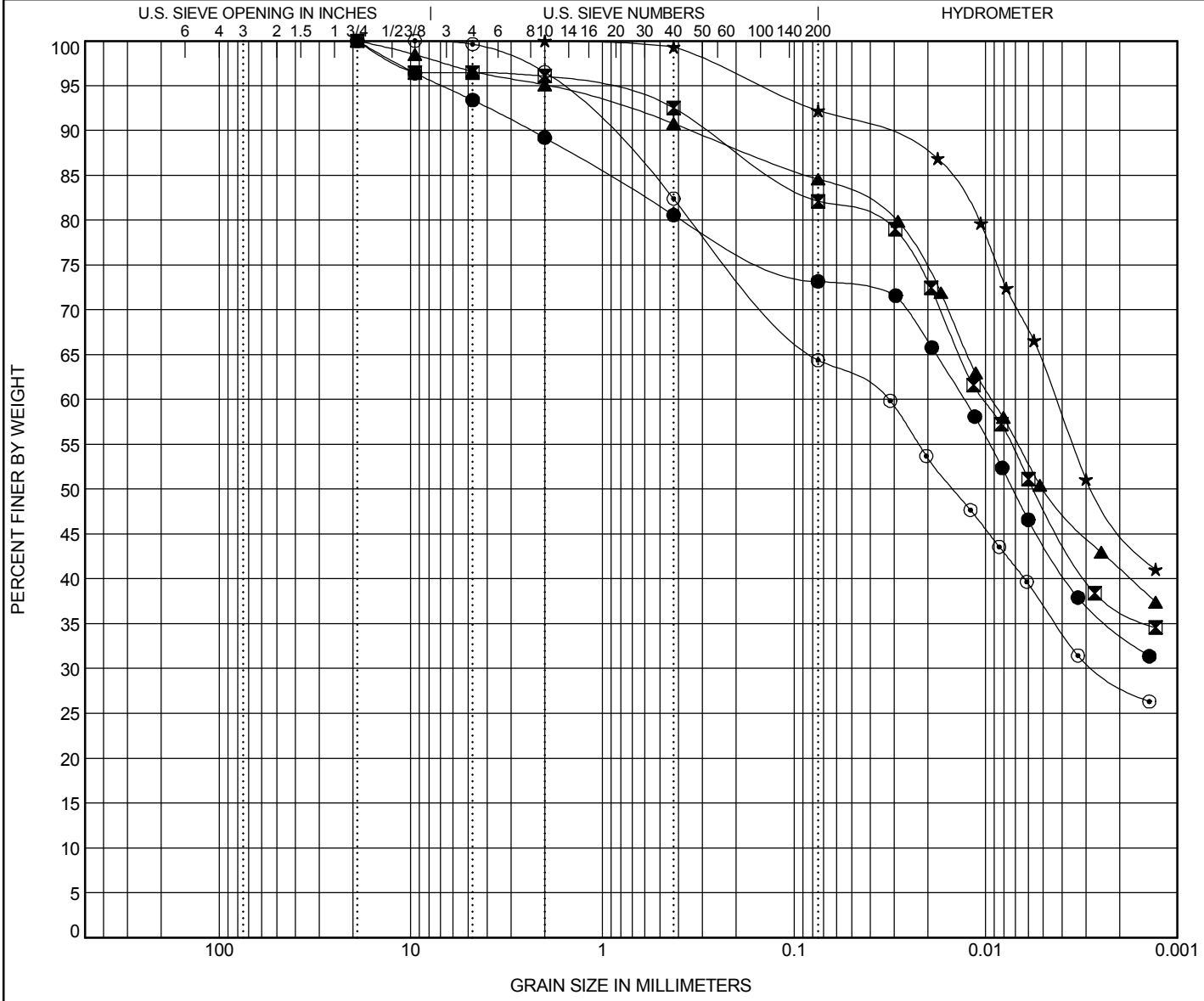
STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/8/17 12:35 - 00 - ODOT V2

# GRAIN SIZE DISTRIBUTION

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | B-001-17 | 1.0 | FAT CLAY with SAND(CH) | 50 | 20 | 30 | | |
| ⊠ | B-001-17 | 2.5 | LEAN CLAY with SAND(CL) | 40 | 20 | 20 | | |
| ▲ | B-002-17 | 2.5 | LEAN CLAY with SAND(CL) | 47 | 17 | 30 | | |
| ★ | B-002-17 | 4.0 | LEAN CLAY(CL) | 44 | 21 | 23 | | |
| ⊙ | B-003-17 | 2.5 | SANDY LEAN CLAY(CL) | 33 | 16 | 17 | | |

| Specimen Identification | | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-001-17 | 1.0 | 19 | 0.013 | | | 11 | 16 | 29 | 44 |
| ⊠ | B-001-17 | 2.5 | 19 | 0.01 | | | 4 | 14 | 34 | 48 |
| ▲ | B-002-17 | 2.5 | 19 | 0.009 | | | 5 | 10 | 35 | 50 |
| ★ | B-002-17 | 4.0 | 2 | 0.004 | | | 0 | 8 | 28 | 64 |
| ⊙ | B-003-17 | 2.5 | 9.5 | 0.032 | 0.003 | | 4 | 32 | 27 | 37 |

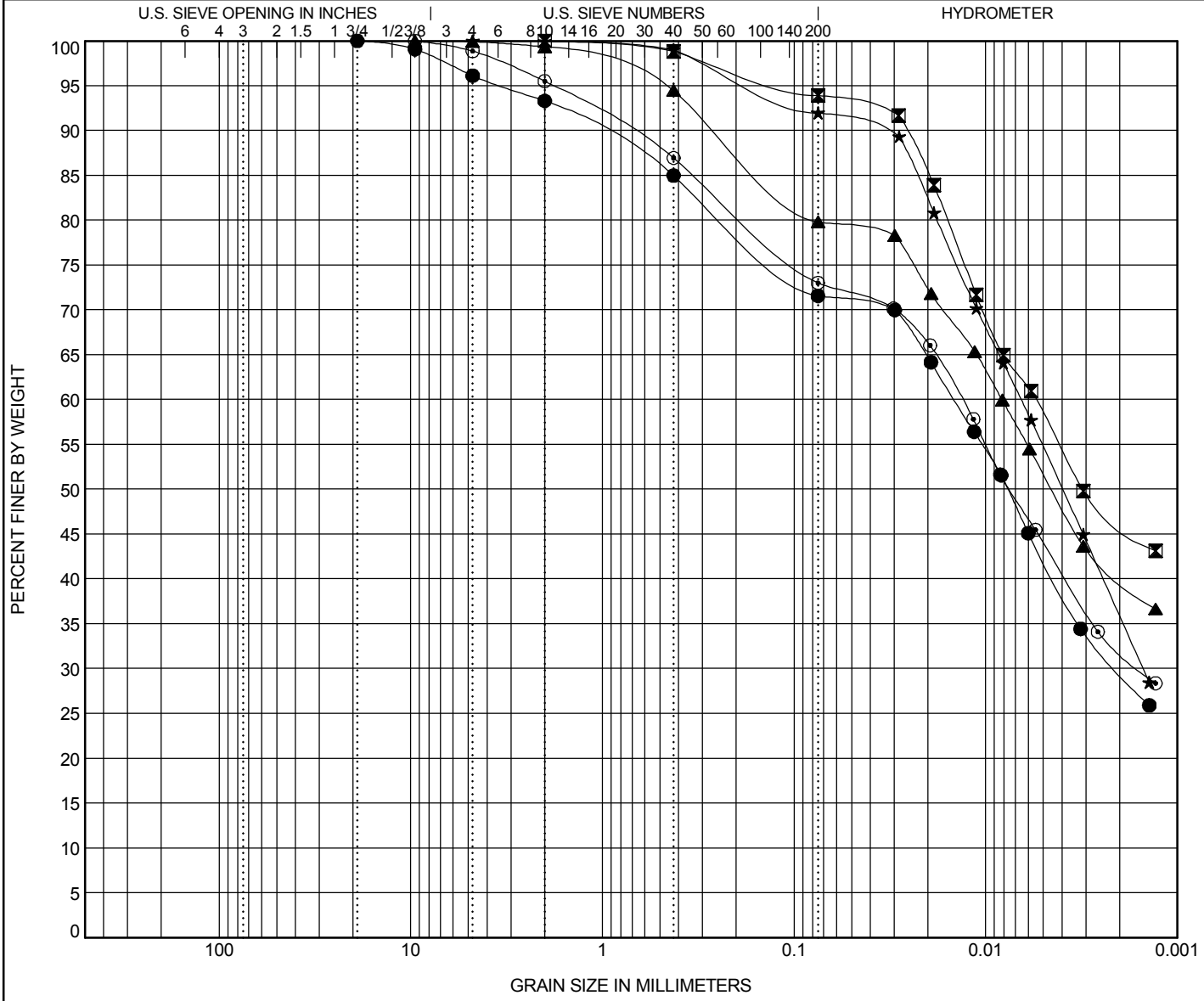
GRAIN SIZE - OH DOT.GDT - 12/6/17 09:12 - 00 - ODOT V2

# GRAIN SIZE DISTRIBUTION

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | B-003-17 | 5.5 | LEAN CLAY with SAND(CL) | 30 | 17 | 13 | | |
| ⊠ | B-004-17 | 1.0 | FAT CLAY(CH) | 55 | 18 | 37 | | |
| ▲ | B-004-17 | 2.5 | LEAN CLAY with SAND(CL) | 44 | 20 | 24 | | |
| ★ | B-005-17 | 1.0 | LEAN CLAY(CL) | 49 | 19 | 30 | | |
| ⊙ | B-005-17 | 4.0 | LEAN CLAY with SAND(CL) | 30 | 17 | 13 | | |

| Specimen Identification | | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-003-17 | 5.5 | 19 | 0.015 | 0.002 | | 7 | 21 | 30 | 42 |
| ⊠ | B-004-17 | 1.0 | 2 | 0.005 | | | 0 | 6 | 36 | 58 |
| ▲ | B-004-17 | 2.5 | 9.5 | 0.008 | | | 0 | 20 | 28 | 52 |
| ★ | B-005-17 | 1.0 | 4.75 | 0.007 | 0.002 | | 0 | 8 | 37 | 55 |
| ⊙ | B-005-17 | 4.0 | 9.5 | 0.013 | 0.002 | | 4 | 23 | 29 | 44 |

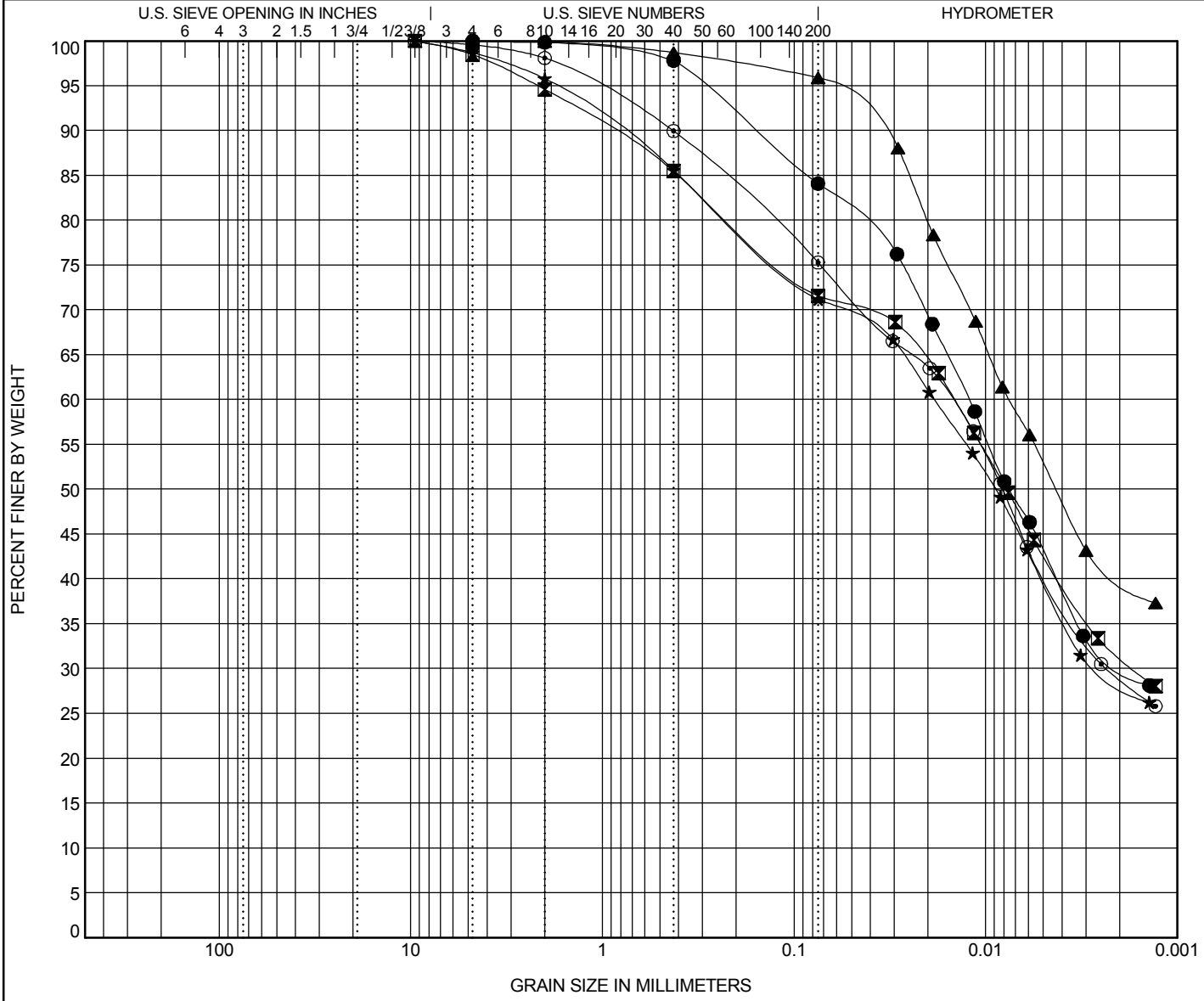
GRAIN SIZE - OH DOT.GDT - 12/6/17 09:13 - 00 - ODOT V2

# GRAIN SIZE DISTRIBUTION

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| ● | B-006-17 1.0 | LEAN CLAY with SAND(CL) | 37 | 17 | 20 | | |
| ⊠ | B-006-17 4.0 | LEAN CLAY with SAND(CL) | 28 | 17 | 11 | | |
| ▲ | B-007-17 1.0 | LEAN CLAY(CL) | 47 | 18 | 29 | | |
| ★ | B-007-17 5.5 | LEAN CLAY with SAND(CL) | 30 | 17 | 13 | | |
| ⊙ | B-008-17 2.5 | LEAN CLAY with SAND(CL) | 29 | 17 | 12 | | |

| Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|
| ● | B-006-17 1.0 | 4.75 | 0.012 | 0.002 | | 0 | 16 | 41 | 43 |
| ⊠ | B-006-17 4.0 | 9.5 | 0.015 | 0.002 | | 5 | 23 | 29 | 43 |
| ▲ | B-007-17 1.0 | 4.75 | 0.008 | | | 0 | 4 | 43 | 53 |
| ★ | B-007-17 5.5 | 9.5 | 0.018 | 0.003 | | 5 | 24 | 31 | 40 |
| ⊙ | B-008-17 2.5 | 9.5 | 0.015 | 0.002 | | 2 | 23 | 34 | 41 |

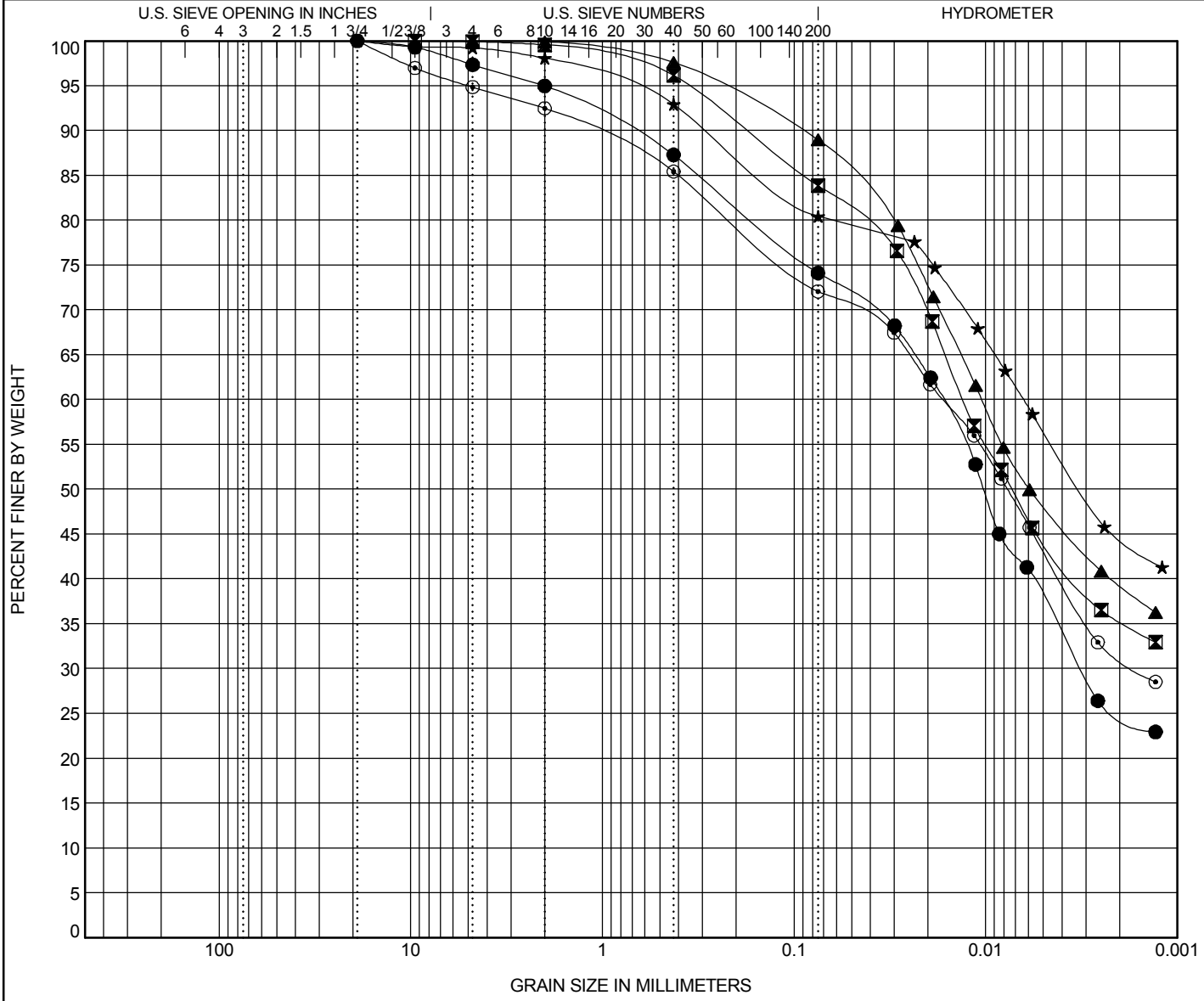
GRAIN SIZE - OH DOT.GDT - 12/6/17 09:13 - 00 - ODOT V2

# GRAIN SIZE DISTRIBUTION

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| Specimen Identification | | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | B-008-17 | 4.0 | LEAN CLAY with SAND(CL) | 29 | 17 | 12 | | |
| ⊠ | B-009-17 | 1.0 | LEAN CLAY with SAND(CL) | 40 | 17 | 23 | | |
| ▲ | B-009-17 | 2.5 | FAT CLAY(CH) | 50 | 18 | 32 | | |
| ★ | B-010-17 | 1.0 | LEAN CLAY with SAND(CL) | 43 | 18 | 25 | | |
| ⊙ | B-010-17 | 5.5 | LEAN CLAY with SAND(CL) | 29 | 17 | 12 | | |

| Specimen Identification | | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-008-17 | 4.0 | 19 | 0.017 | 0.003 | | 5 | 21 | 36 | 38 |
| ⊠ | B-009-17 | 1.0 | 9.5 | 0.013 | | | 1 | 15 | 40 | 44 |
| ▲ | B-009-17 | 2.5 | 4.75 | 0.01 | | | 0 | 11 | 41 | 48 |
| ★ | B-010-17 | 1.0 | 19 | 0.006 | | | 2 | 18 | 24 | 56 |
| ⊙ | B-010-17 | 5.5 | 19 | 0.017 | 0.002 | | 8 | 20 | 29 | 43 |

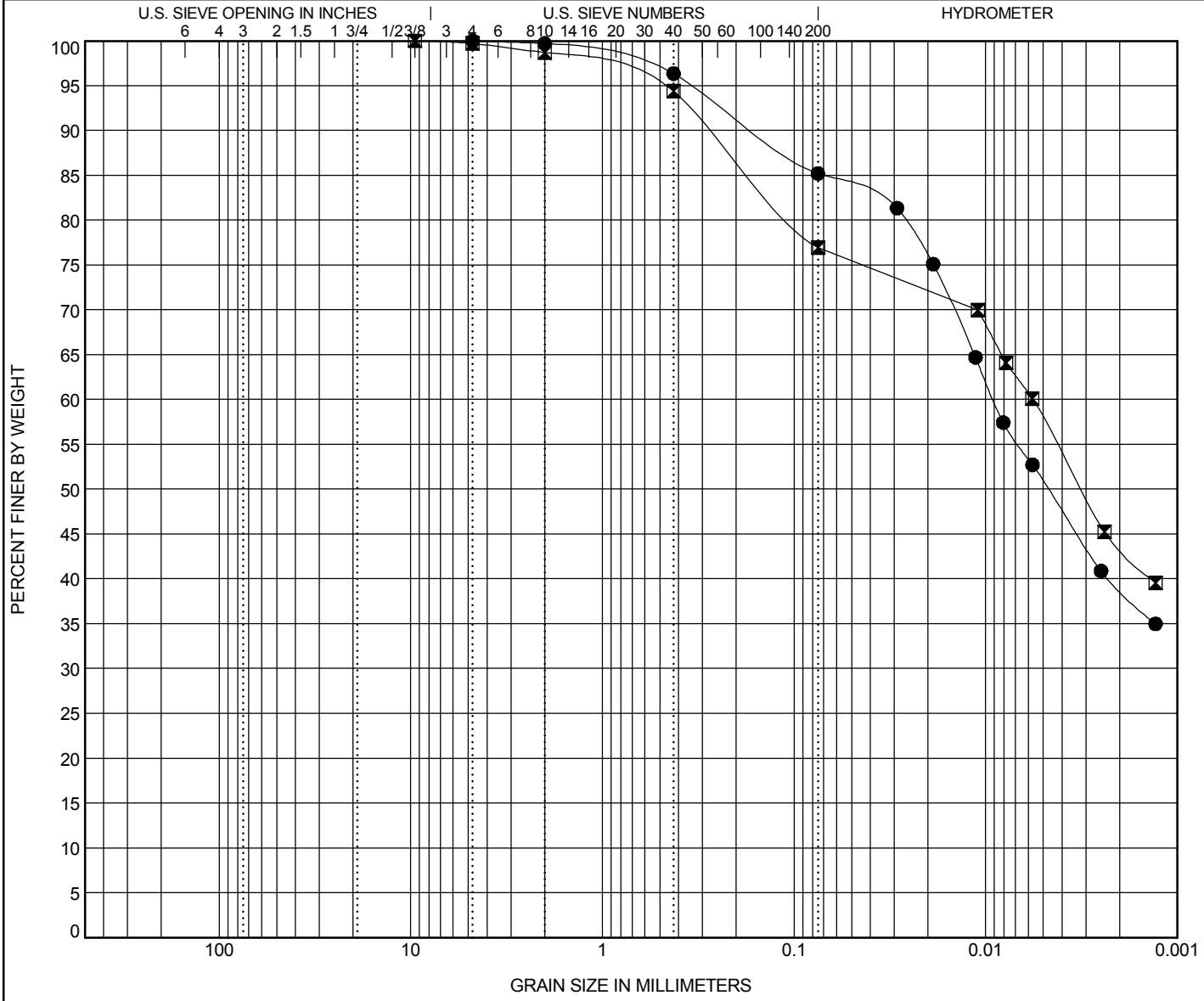
GRAIN SIZE - OH DOT.GDT - 12/6/17 09:14 - 00 - ODOT V2

# GRAIN SIZE DISTRIBUTION

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | B-011-17 | 2.5 | LEAN CLAY(CL) | 42 | 20 | 22 | | |
| ⊠ | B-011-17 | 4.0 | LEAN CLAY with SAND(CL) | 42 | 19 | 23 | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-011-17 | 2.5 | 4.75 | 0.009 | | | 1 | 14 | 34 | 51 |
| ⊠ | B-011-17 | 4.0 | 9.5 | 0.006 | | | 2 | 21 | 19 | 58 |

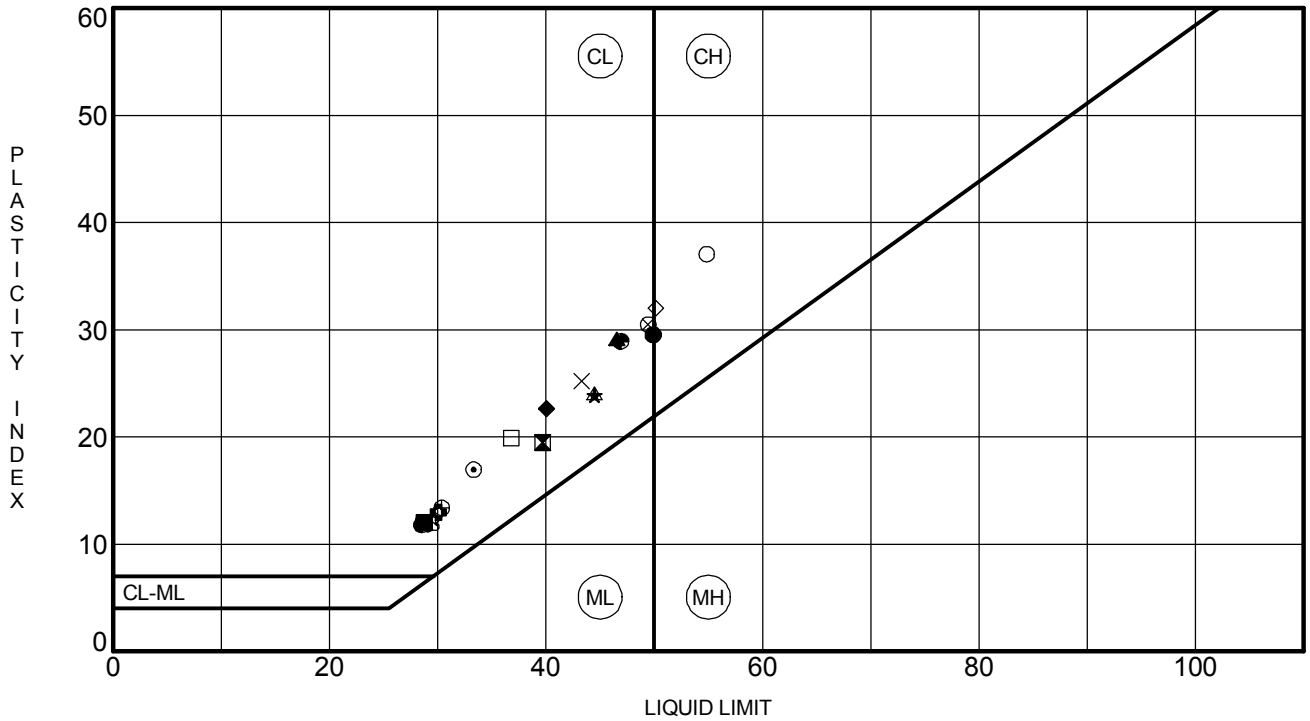
GRAIN SIZE - OH DOT.GDT - 12/6/17 09:14 - 00 - ODOT V2

# ATTERBERG LIMITS' RESULTS

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| Specimen Identification | | | LL | PL | PI | Fines | Classification |
|---|---|---|---|---|---|---|---|
| ● | B-001-17 | 1.0 | 50 | 20 | 30 | 73 | FAT CLAY with SAND(CH) |
| ⊠ | B-001-17 | 2.5 | 40 | 20 | 20 | 82 | LEAN CLAY with SAND(CL) |
| ▲ | B-002-17 | 2.5 | 47 | 17 | 30 | 85 | LEAN CLAY with SAND(CL) |
| ★ | B-002-17 | 4.0 | 44 | 21 | 23 | 92 | LEAN CLAY(CL) |
| ⊙ | B-003-17 | 2.5 | 33 | 16 | 17 | 64 | SANDY LEAN CLAY(CL) |
| ✿ | B-003-17 | 5.5 | 30 | 17 | 13 | 72 | LEAN CLAY with SAND(CL) |
| ○ | B-004-17 | 1.0 | 55 | 18 | 37 | 94 | FAT CLAY(CH) |
| △ | B-004-17 | 2.5 | 44 | 20 | 24 | 80 | LEAN CLAY with SAND(CL) |
| ⊗ | B-005-17 | 1.0 | 49 | 19 | 30 | 92 | LEAN CLAY(CL) |
| ⊕ | B-005-17 | 4.0 | 30 | 17 | 13 | 73 | LEAN CLAY with SAND(CL) |
| □ | B-006-17 | 1.0 | 37 | 17 | 20 | 84 | LEAN CLAY with SAND(CL) |
| ⊛ | B-006-17 | 4.0 | 28 | 17 | 11 | 72 | LEAN CLAY with SAND(CL) |
| ◕ | B-007-17 | 1.0 | 47 | 18 | 29 | 96 | LEAN CLAY(CL) |
| ☆ | B-007-17 | 5.5 | 30 | 17 | 13 | 71 | LEAN CLAY with SAND(CL) |
| ⊠ | B-008-17 | 2.5 | 29 | 17 | 12 | 75 | LEAN CLAY with SAND(CL) |
| ■ | B-008-17 | 4.0 | 29 | 17 | 12 | 74 | LEAN CLAY with SAND(CL) |
| ◆ | B-009-17 | 1.0 | 40 | 17 | 23 | 84 | LEAN CLAY with SAND(CL) |
| ◇ | B-009-17 | 2.5 | 50 | 18 | 32 | 89 | FAT CLAY(CH) |
| × | B-010-17 | 1.0 | 43 | 18 | 25 | 80 | LEAN CLAY with SAND(CL) |
| ⊠ | B-010-17 | 5.5 | 29 | 17 | 12 | 72 | LEAN CLAY with SAND(CL) |

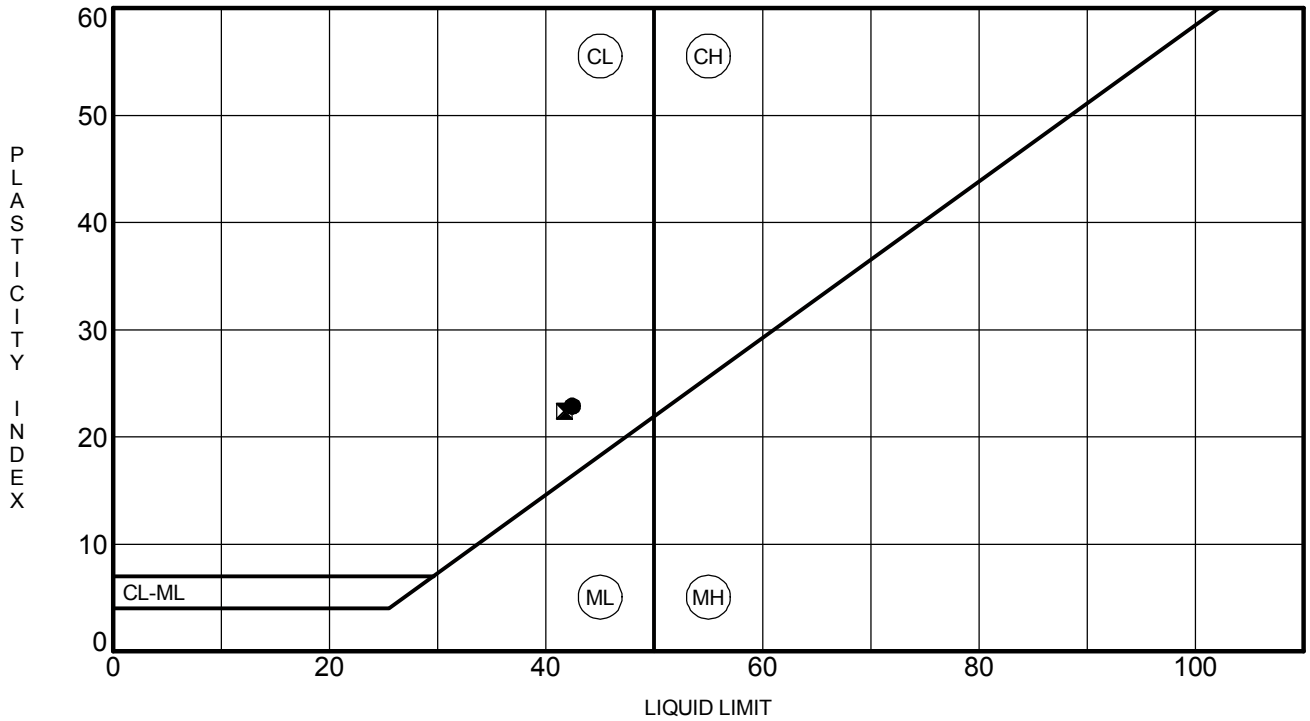
ATTERBERG LIMITS - OH DOT.GDT - 12/5/17 10:06 - 00 - ODOT V2

# ATTERBERG LIMITS' RESULTS

Professional Service Industries, Inc.

**PROJECT** ADA LINCOLN AVE. **PID**

**OGE NUMBER** PSI-0125-1783 **PROJECT TYPE** Roadway




| | Specimen Identification | | LL | PL | PI | Fines | Classification |
|---|---|---|---|---|---|---|---|
| ● | **B-011-17** | **2.5** | **42** | **20** | **22** | **85** | **LEAN CLAY(CL)** |
| ⊠ | **B-011-17** | **4.0** | **42** | **19** | **23** | **77** | **LEAN CLAY with SAND(CL)** |

OHIO DEPARTMENT OF TRANSPORTATION

# Subgrade Analysis

V. 14.00 7/21/2017

| | |
|---|---|
| PID: | |
| Alignment: | |
| County-Route-Section: | |
| No. of Borings: | 11 |
| No. of Rigs: | 1 |
| Geotechnical Consultant: | Intertek/PSI |
| Prepared By: | RF |
| Date prepared: | 12/7/2017 |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rig | A | | | | | | | | | | | | | | | | | | | | | | | |
| ER | 92 | | | | | | | | | | | | | | | | | | | | | | | |

| Chemical Stabilization Options | | |
|---|---|---|
| 320 | Rubblize & Roll | No |
| 206 | Cement Stabilization | No |
| | Lime Stabilization | Option |
| 206 | Depth | 12" |

| Excavate and Replace Stabilization Options | |
|---|---|
| Global Geotextile ($N_{60L}$, HP) | 12", 0" |
| Global Geogrid ($N_{60L}$, HP) | N/A, N/A |

| | |
|---|---|
| Design CBR | 5 |

| % Borings | | | |
|---|---|---|---|
| $N_{60L} \leq 5$ | 0% | HP ≤ 0.5 | 0% |
| $N_{60L} < 12$ | 16% | 0.5 ≤ HP < 1 | 0% |
| $12 \leq N_{60L} < 15$ | 7% | 1 ≤ HP < 2 | 2% |
| $N_{60L} \geq 20$ | 0% | HP ≥ 2 | 93% |
| M+ | 43% | | |
| Rock | 43% | | |
| Unsuitable | 43% | | |

| Excavate and Replace at Surface | |
|---|---|
| Average | 24" |
| Maximum | 30" |
| Minimum | 18" |

| % Surface | |
|---|---|
| Unstable & Unsuitable | 0% |
| Unstable | 173% |
| Unsuitable | 0% |

| | $N_{60}$ | $N_{60L}$ | HP | LL | PL | PI | Silt | Clay | P 200 | $M_C$ | $M_{OPT}$ | GI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 18 | 11 | 3.38 | 39 | 18 | 21 | 32 | 48 | 80 | 21 | 16 | 13 |
| Maximum | 49 | 15 | 4.75 | 55 | 21 | 37 | 43 | 64 | 96 | 28 | 18 | 19 |
| Minimum | 8 | 8 | 1.75 | 28 | 16 | 11 | 19 | 37 | 64 | 12 | 14 | 8 |

## Classification Counts by Sample

| ODOT Class | Rock | A-1-a | A-1-b | A-2-4 | A-2-5 | A-2-6 | A-2-7 | A-3 | A-3a | A-4a | A-4b | A-5 | A-6a | A-6b | A-7-5 | A-7-6 | A-8a | A-8b | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 12 | 0 | 15 | 0 | 0 | 44 |
| Percent | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 39% | 27% | 0% | 34% | 0% | 0% | 100% |
| % Rock\|Cohesive\|Granular | 0% | 0% | | | | | | | | | 100% | | | | | | | | 100% |
| Surface Class Count | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Surface Class Percent | | | | | | | | | | | | | | | | | | | 0% |

OHIO DEPARTMENT OF TRANSPORTATION

# Subgrade Analysis

V. 14.00 7/21/2017

| # | Boring ID | Station | Offset | Dir | Boring EL. | Proposed Subgrade EL | Cut Fill | Rig |
|---|---|---|---|---|---|---|---|---|
| 1 | B-101-17 | | | Right | 100.00 | 98.50 | 1.50 C | A |
| 2 | B-002-17 | | | Right | 100.00 | 98.50 | 1.50 C | A |
| 3 | B-003-17 | | | Right | 100.00 | 98.50 | 1.50 C | A |
| 4 | B-004-17 | | | Right | 100.00 | 98.50 | 1.50 C | A |
| 5 | B-005-17 | | | Right | 100.00 | 98.50 | 1.50 C | A |
| 6 | B-006-17 | | | Right | 100.00 | 98.50 | 1.50 C | A |
| 7 | B-007-17 | | | Left | 100.00 | 98.50 | 1.50 C | A |
| 8 | B-008-17 | | | Left | 100.00 | 98.50 | 1.50 C | A |
| 9 | B-009-17 | | | Left | 100.00 | 98.50 | 1.50 C | A |
| 10 | B-010-17 | | | Left | 100.00 | 98.50 | 1.50 C | A |
| 11 | B-011-17 | | | Left | 100.00 | 98.50 | 1.50 C | A |

| # | Boring ID | Station | Offset | Dir | Boring EL. | Proposed Subgrade EL | Cut Fill | Rig |
|---|---|---|---|---|---|---|---|---|

OHIO DEPARTMENT OF TRANSPORTATION

# Subgrade Analysis

V. 14.00 7/21/2017

| # | Boring | Sample | Sample Depth | | Subgrade Depth | | Standard Penetration | | HP (tsf) | Physical Characteristics | | | | | | Moisture | | Ohio DOT | | Sulfate Content (ppm) | Problem | | Excavate and Replace (Item 204) | | Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | From | To | From | To | $N_{60}$ | $N_{60L}$ | | LL | PL | PI | % Silt | % Clay | P200 | $M_C$ | $M_{OPT}$ | Class | GI | | Unsuitable | Unstable | Unsuitable | Unstable | |
| 1 | B 101-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 15 | | 3.75 | 50 | 20 | 30 | 29 | 44 | 73 | 22 | 18 | A-7-6 | 18 | | | Mc | | | Geotextile Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 12 | | 2.25 | 40 | 20 | 20 | 34 | 48 | 82 | 24 | 16 | A-6b | 12 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 18 | | 2.5 | | | | | | | 27 | 18 | A-7-6 | 16 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 12 | 12 | 2.25 | | | | | | | 28 | 16 | A-6b | 16 | | | | | | |
| 2 | B 002-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 14 | | 3.75 | | | | | | | 23 | 18 | A-7-6 | 16 | | | $N_{60}$ & Mc | | 12" | Geotextile Option: 30" GEOGRID Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 12 | | 3.25 | 47 | 17 | 30 | 35 | 50 | 85 | 22 | 18 | A-7-6 | 17 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 11 | | 2.5 | 44 | 21 | 23 | 28 | 64 | 92 | 25 | 18 | A-7-6 | 14 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 15 | 11 | 2.25 | | | | | | | 21 | 16 | A-6b | 16 | | | | | | |
| 3 | B 003-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 20 | | | | | | | | | 12 | 14 | A-6a | 10 | | | | | | |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 15 | | 2.25 | 33 | 16 | 17 | 27 | 37 | 64 | 20 | 16 | A-6b | 9 | | | Mc | | | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 23 | | 4.5 | | | | | | | 16 | 14 | A-6a | 10 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 34 | 15 | 4.5 | 30 | 17 | 13 | 30 | 42 | 72 | 15 | 14 | A-6a | 9 | | | | | | |
| 4 | B 004-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 17 | | 3 | 55 | 18 | 37 | 36 | 58 | 94 | 25 | 18 | A-7-6 | 19 | | | Mc | | | Geotextile Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 12 | | 3.25 | 44 | 20 | 24 | 28 | 52 | 80 | 22 | 18 | A-7-6 | 14 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 9 | | 2.75 | | | | | | | 18 | 14 | A-6a | 10 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 20 | 9 | 4 | | | | | | | 18 | 14 | A-6a | 10 | | | | | | |
| 5 | B 005-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 12 | | 2.75 | 49 | 19 | 30 | 37 | 55 | 92 | 24 | 18 | A-7-6 | 18 | | | $N_{60}$ & Mc | | 12" | Geotextile Option: 30" GEOGRID Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 9 | | 2.75 | | | | | | | 26 | 18 | A-7-6 | 16 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 14 | | 2.25 | 30 | 17 | 13 | 29 | 44 | 73 | 19 | 14 | A-6a | 9 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 31 | 9 | | | | | | | | 16 | 14 | A-6a | 10 | | | | | | |
| 6 | B 006-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 14 | | 3 | 37 | 17 | 20 | 41 | 43 | 84 | 20 | 16 | A-6b | 12 | | | $N_{60}$ & Mc | | 12" | Geotextile Option: 30" GEOGRID Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 11 | | 1.75 | | | | | | | 23 | 16 | A-6b | 16 | | | HP & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 11 | | 2.25 | 28 | 17 | 11 | 29 | 43 | 72 | 19 | 14 | A-6a | 8 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 29 | 11 | 4.5 | | | | | | | 18 | 14 | A-6a | 10 | | | | | | |
| 7 | B 007-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 14 | | 3 | 47 | 18 | 29 | 43 | 53 | 96 | 23 | 18 | A-7-6 | 17 | | | $N_{60}$ & Mc | | 12" | Geotextile Option: 30" GEOGRID Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 9 | | 2.5 | | | | | | | 25 | 16 | A-6b | 16 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 14 | | 3.25 | | | | | | | 18 | 14 | A-6a | 10 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 35 | 9 | 4.5 | 30 | 17 | 13 | 31 | 40 | 71 | 17 | 14 | A-6a | 8 | | | | | | |
| 8 | B 008-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 14 | | 3.25 | | | | | | | 23 | 14 | A-6a | 10 | | | $N_{60}$ & Mc | | 12" | |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 15 | | 4.5 | 29 | 17 | 12 | 34 | 41 | 75 | 16 | 14 | A-6a | 9 | | | | | | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 20 | | 4.5 | 29 | 17 | 12 | 36 | 38 | 74 | 16 | 14 | A-6a | 9 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 46 | 14 | 4.5 | | | | | | | 16 | 14 | A-6a | 10 | | | | | | |
| 9 | B 009-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 15 | | 4 | 40 | 17 | 23 | 40 | 44 | 84 | 20 | 16 | A-6b | 13 | | | Mc | | | Geotextile Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 12 | | 2.5 | 50 | 18 | 32 | 41 | 48 | 89 | 26 | 18 | A-7-6 | 18 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 8 | | 4.75 | | | | | | | 22 | 16 | A-6b | 16 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 20 | 8 | 4.5 | | | | | | | 17 | 16 | A-6b | 16 | | | | | | |

OHIO DEPARTMENT OF TRANSPORTATION

# Subgrade Analysis

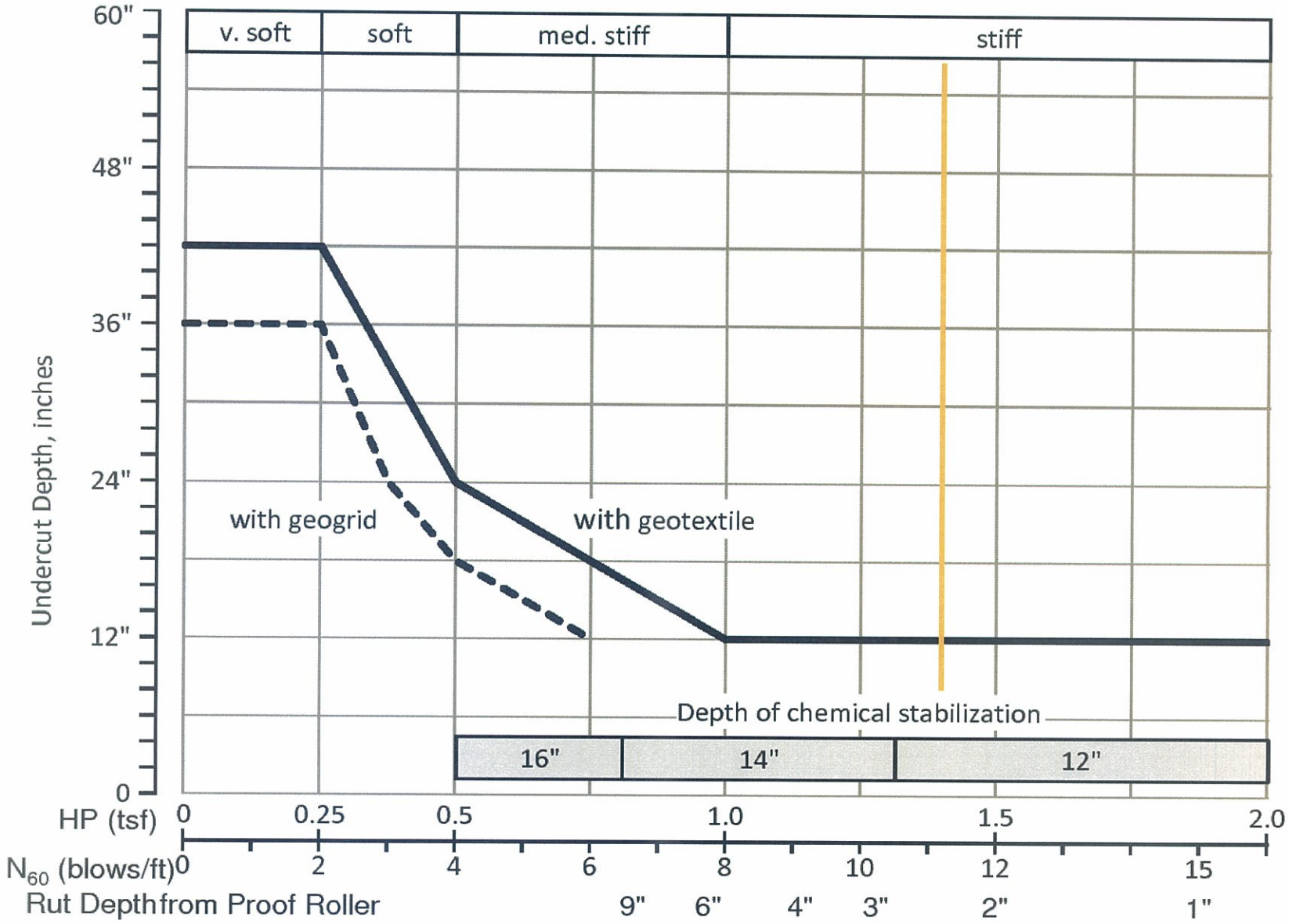
V. 14.00 7/21/2017

| # | Boring | Sample | Sample Depth | | Subgrade Depth | | Standard Penetration | | HP (tsf) | Physical Characteristics | | | | | | Moisture | | Ohio DOT | | Sulfate Content (ppm) | Problem | | Excavate and Replace (Item 204) | | Recommendation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | From | To | From | To | $N_{60}$ | $N_{60L}$ | | LL | PL | PI | % Silt | % Clay | P200 | $M_C$ | $M_{OPT}$ | Class | GI | | Unsuitable | Unstable | Unsuitable | Unstable | |
| 10 | B 010-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 14 | | 3.75 | 43 | 18 | 25 | 24 | 56 | 80 | 22 | 18 | A-7-6 | 15 | | | $N_{60}$ & Mc | | 12" | |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 22 | | 4.25 | | | | | | | 18 | 14 | A-6a | 10 | | | Mc | | | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 34 | | 4.5 | | | | | | | 16 | 16 | A-6b | 16 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 49 | 14 | 4.5 | 29 | 17 | 12 | 29 | 43 | 72 | 16 | 14 | A-6a | 8 | | | | | | |
| 11 | B 011-1 | 1 | 1.0 | 2.5 | -0.5 | 1.0 | 14 | | 4 | | | | | | | 18 | 18 | A-7-6 | 16 | | | | | | Geotextile Option: 18" |
| | | 2 | 2.5 | 4.0 | 1.0 | 2.5 | 12 | | 3.75 | 42 | 20 | 22 | 34 | 51 | 85 | 22 | 18 | A-7-6 | 13 | | | $N_{60}$ & Mc | | 18" | |
| | | 3 | 4.0 | 5.5 | 2.5 | 4.0 | 15 | | 2.75 | 42 | 19 | 23 | 19 | 58 | 77 | 25 | 18 | A-7-6 | 14 | | | | | | |
| | | 4 | 5.5 | 7.0 | 4.0 | 5.5 | 11 | 11 | 2.5 | | | | | | | 23 | 16 | A-6b | 16 | | | | | | |

GB1 Figure B – Subgrade Stabilization

**Subgrade Analysis**

V. 14.00 9/2/2016




OVERRIDE TABLE

| Calculated | New Values | Check to Override |
|---|---|---|
| 3.38 | | ☐ HP |
| 11.18 | | ☐ N60L |

Average HP

Average $N_{60L}$

# CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart.
The first classification that the test data fits is the correct classification.)

| SYMBOL | DESCRIPTION | Classifcation AASHTO | Classifcation OHIO | $LL_0/LL$ x 100* | % Pass #40 | % Pass #200 | Liquid Limit (LL) | Plastic Index (PI) | Group Index Max. | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel and/or Stone Fragments | A-1-a | | | 30 Max. | 15 Max. | | 6 Max. | 0 | Min. of 50% combined gravel, cobble and boulder sizes |
| | Gravel and/or Stone Fragments with Sand | A-1-b | | | 50 Max. | 25 Max. | | 6 Max. | 0 | |
| F S | Fine Sand | A-3 | | | 51 Min. | 10 Max. | NON-PLASTIC | | 0 | |
| | Coarse and Fine Sand | -- | A-3a | | | 35 Max. | | 6 Max. | 0 | Min. of 50% combined coarse and fine sand sizes |
| | Gravel and/or Stone Fragments with Sand and Silt | A-2-4 | | | | 35 Max. | 40 Max. | 10 Max. | 0 | |
| | | A-2-5 | | | | | 41 Min. | | | |
| | Gravel and/or Stone Fragments with Sand, Silt and Clay | A-2-6 | | | | 35 Max. | 40 Max. | 11 Min. | 4 | |
| | | A-2-7 | | | | | 41 Min. | | | |
| | Sandy Silt | A-4 | A-4a | 76 Min. | | 36 Min. | 40 Max. | 10 Max. | 8 | Less than 50% silt sizes |
| | Silt | A-4 | A-4b | 76 Min. | | 50 Min. | 40 Max. | 10 Max. | 8 | 50% or more silt sizes |
| | Elastic Silt and Clay | A-5 | | 76 Min. | | 36 Min. | 41 Min. | 10 Max. | 12 | |
| | Silt and Clay | A-6 | A-6a | 76 Min. | | 36 Min. | 40 Max. | 11 - 15 | 10 | |
| | Silty Clay | A-6 | A-6b | 76 Min. | | 36 Min. | 40 Max. | 16 Min. | 16 | |
| | Elastic Clay | A-7-5 | | 76 Min. | | 36 Min. | 41 Min. | $\leq$LL-30 | 20 | |
| | Clay | A-7-6 | | 76 Min. | | 36 Min. | 41 Min. | >LL-30 | 20 | |
| | Organic Silt | A-8 | A-8a | 75 Max. | | 36 Min. | | | | W/o organics would classify as A-4a or A-4b |
| | Organic Clay | A-8 | A-8b | 75 Max. | | 36 Min. | | | | W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6 |

MATERIAL CLASSIFIED BY VISUAL INSPECTION

- Sod and Topsoil
- Pavement or Base
- Uncontrolled Fill (Describe)
- Bouldery Zone
- Peat, S-Sedimentary W-Woody F-Fibrous L-Loamy & etc

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

## APPENDIX A.1 - ODOT Quick Reference for Visual Description of Soils

**1) STRENGTH OF SOIL:**

| Non-Cohesive (granular) Soils - Compactness | |
|---|---|
| **Description** | **Blows Per Ft.** |
| **Very Loose** | ≤ 4 |
| **Loose** | 5 – 10 |
| **Medium Dense** | 11 – 30 |
| **Dense** | 31 – 50 |
| **Very Dense** | > 50 |

**2) COLOR :**

If a color is a uniform color throughout, the term is single, modified by an adjective such as light or dark. If the predominate color is shaded by a secondary color, the secondary color procedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled"

**3) PRIMARY COMPONENT**

Use **DESCRIPTION** from ODOT Soil Classification Chart on Back

Cohesive (fine grained) Soils - Consistency

| Description | Qu (TSF) | Blows Per Ft. | Hand Manipulation |
|---|---|---|---|
| **Very Soft** | <0.25 | <2 | Easily penetrates 2" by fist |
| **Soft** | 0.25-0.5 | 2 - 4 | Easily penetrates 2" by thumb |
| **Medium Stiff** | 0.5-1.0 | 5 - 8 | Penetrates by thumb with moderate effort |
| **Stiff** | 1.0-2.0 | 9 - 15 | Readily indents by thumb, but not penetrate |
| **Very Stiff** | 2.0-4.0 | 16 - 30 | Readily indents by thumbnail |
| **Hard** | >4.0 | >30 | Indent with difficulty by thumbnail |

**4) COMPONENT MODIFIERS:**

| Description | Percentage By Weight |
|---|---|
| **Trace** | 0% - 10% |
| **Little** | 10% - 20% |
| **Some** | 20% - 35% |
| **"And"** | 35% -50% |

**5) Soil Organic Content**

| Description | % by Weight |
|---|---|
| **Slightly Organic** | 2% - 4% |
| **Moderately Organic** | 4% - 10% |
| **Highly Organic** | > 10% |

**6) Relative Visual Moisture**

| Description | Criteria | |
|---|---|---|
| | **Cohesive Soil** | **Non-cohesive Soils** |
| **Dry** | Powdery;<br>Cannot be rolled;<br>Water content well below the plastic limit | No moisture present |
| **Damp** | Leaves very little moisture when pressed between fingers;<br>Crumbles at or before rolled to $^1/_8$";<br>Water content below plastic limit | Internal moisture, but no to little surface moisture |
| **Moist** | Leaves small amounts of moisture when pressed between fingers;<br>Rolled to $^1/_8$" or smaller before crumbling;<br>Water content above plastic limit to -3% of the liquid limit | Free water on surface, moist (shiny) appearance |
| **Wet** | Very mushy;<br>Rolled multiple times to $^1/_8$" or smaller before crumbles;<br>Near or above the liquid limit | Voids filled with free water, can be poured from split spoon. |

# APPENDIX A.2 - ODOT Quick Reference Guide for Rock Description

**1) ROCK TYPE:** Common rock types are: Claystone; Coal; Dolomite; Limestone; Sandstone; Siltstone; & Shale.

**2) COLOR:** To be determined when rock is wet. When using the GSA Color charts use only Name, not code.

**3) WEATHERING**

| Description | Field Parameter |
|---|---|
| **Unweathered** | No evidence of any chemical or mechanical alternation of the rock mass. Mineral crystals have a bright appearance with no discoloration. Fractures show little or no staining on surfaces. |
| **Slightly weathered** | Slight discoloration of the rock surface with minor alterations along discontinuities. Less than 10% of the rock volume presents alteration. |
| **Moderately weathered** | Portions of the rock mass are discolored as evident by a dull appearance. Surfaces may have a pitted appearance with weathering "halos" evident. Isolated zones of varying rock strengths due to alteration may be present. 10 to 15% of the rock volume presents alterations. |
| **Highly weathered** | Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered rock may be present and some areas of severely weathered materials may be present. |
| **Severely weathered** | Majority of the rock mass reduced to a soil-like state with relic rock structure discernable. Zones of more resistant rock may be present, but the material can generally be molded and crumbled by hand pressures. |

**4) RELATIVE STRENGTH**

| Description | Field Parameter |
|---|---|
| **Very Weak** | Core can be carved with a knife and scratched by fingernail. Can be excavated readily with a point of a pick. Pieces 1 inch or more in thickness can be broken by finger pressure. |
| **Weak** | Core can be grooved or gouged readily by a knife or pick. Can be excavated in small fragments by moderate blows of a pick point. Small, thin pieces can be broken by finger pressure. |
| **Slightly Strong** | Core can be grooved or gouged 0.05 inch deep by firm pressure of a knife or pick point. Can be excavated in small chips to pieces about 1-inch maximum size by hard blows of the point of a geologist's pick. |
| **Moderately Strong** | Core can be scratched with a knife or pick. Grooves or gouges to ¼" deep can be excavated by hand blows of a geologist's pick. Requires moderate hammer blows to detach hand specimen. |
| **Strong** | Core can be scratched with a knife or pick only with difficulty. Requires hard hammer blows to detach hand specimen. Sharp and resistant edges are present on hand specimen. |
| **Very Strong** | Core cannot be scratched by a knife or sharp pick. Breaking of hand specimens requires hard repeated blows of the geologist hammer. |
| **Extremely strong** | Core cannot be scratched by a knife or sharp pick. Chipping of hand specimens requires hard repeated blows of the geologist hammer. |

**5) TEXTURE**

| Component | | Grain Diameter |
|---|---|---|
| **Boulder** | | >12" |
| **Cobble** | | 3"-12" |
| **Gravel** | | 0.08"-3" |
| **Sand** | **Coarse** | 0.02"-0.08" |
| | **Medium** | 0.01"-0.02" |
| | **Fine** | 0.005"-0.01" |
| | **Very fine** | 0.003"-0.005" |

**6) BEDDING**

| Description | Thickness |
|---|---|
| **Very Thick** | >36" |
| **Thick** | 18" – 36" |
| **Medium** | 10" – 18" |
| **Thin** | 2" – 10" |
| **Very Thin** | 0.4" – 2" |
| **Laminated** | 0.1" – 0.4" |
| **Thinly Laminated** | <0.1" |

## 7) DESCRIPTORS

| | | |
|---|---|---|
| Arenaceous – sandy | Argillaceous - clayey | Brecciated – contains angular to subangular gravel |
| Calcareous - contains calcium carbonate | Carbonaceous - contains carbon | Cherty- contains chert fragments |
| Conglomeritic - contains rounded to subrounded gravel | Crystalline – contains crystalline structure | Dolomitic- contains calcium/magnesium carbonate |
| Ferriferous – contains iron | Fissile – thin planner partings | Fossiliferous – contains fossils |
| Friable – easily broken down | Micaceous – contains mica | Pyritic – contains pyrite |
| Siliceous – contains silica | Stylolitic – contain stylotites (suture like structure) | Vuggy – contains openings |

## 8) DISCONTINUITIES

### a) Discontinuity Types

| Type | Parameters |
|---|---|
| ***Fault*** | Fracture which expresses displacement parallel to the surface that does not result in a polished surface. |
| ***Joint*** | Planar fracture that does not express displacement. Generally occurs at regularly spaced intervals. |
| ***Shear*** | Fracture which expresses displacement parallel to the surface that results in polished surfaces or slickensides. |
| ***Bedding*** | A surface produced along a bedding plane. |
| ***Contact*** | A surface produced along a contact plane. (generally not seen in Ohio) |
| | |

### b) Degree of Fracturing

| Description | Spacing |
|---|---|
| **Unfractured** | > 10 ft |
| **Intact** | 3 ft. – 10 ft. |
| **Slightly fractured** | 1 ft – 3 ft |
| **Moderately fractured** | 4 in. – 12 in. |
| **Fractured** | 2 in – 4 in. |
| **Highly fractured** | < 2 in. |

### c) Aperture Width

| Description | Spacing |
|---|---|
| **Open** | > 0.2 in. |
| **Narrow** | 0.05 in. - 0.2 in. |
| **Tight** | <0.05 in. |
| | |

### d) Surface Roughness

| Description | Criteria |
|---|---|
| **Very Rough** | Near vertical steps and ridges occur on the discontinuity surface. |
| **Slightly Rough** | Asperities on the discontinuity surface are distinguishable and can be felt. |
| **Slickensided** | Surface has a smooth, glassy finish with visual evidence of striation. |
| | |

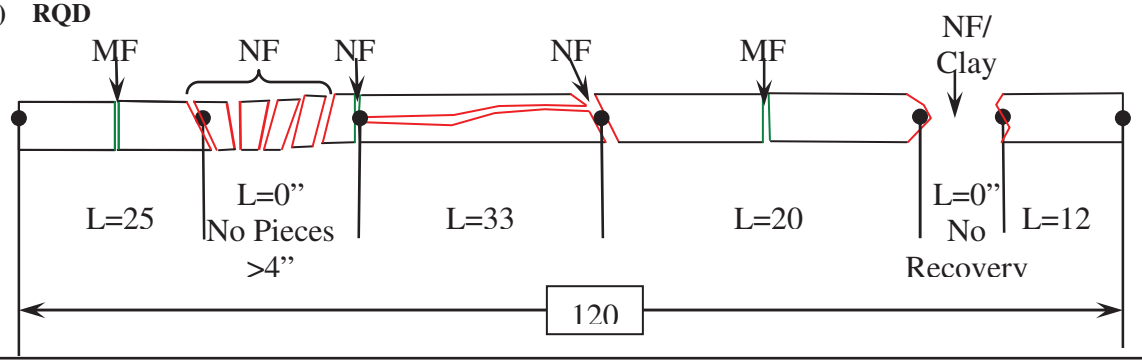
### 10) LOSS

$$Run\ Loss = \left(\frac{L_R - R_R}{L_R}\right) * 100 \qquad Unit\ Loss = \left(\frac{L_U - R_U}{L_U}\right) * 100$$

$L_R$=Run Length $R_R$=Run Recovery

$L_U$=Rock Unit Length $R_U$=Rock Unit Recovery

## 9) RQD




$$RQD = \left(\frac{\sum Length\ of\ Pieces > 4inches}{Total\ Length\ of\ Core}\right) * 100$$

$$RQD = \left(\frac{25+33+20+12}{120}\right) * 100 = 75\%$$

## APPENDIX A.3 - ODOT Rock Type

**GENERAL AND GLOSSARY:**

The following terms are use in describing the rock types found within Ohio. The following listing is presented in alphabetical order.

**Amorphous:** Does not contain crystalline structure with shapeless appearance.

**Anhydrous:** Does not contain water within the crystalline structure.

**Bioturbated:** Evidence of past organisms, such as filled burrows, within the rock mass.

**Conchodial Fracture:** A curved fracture plane with a rock mass.

**Concretion:** A solidified mass of concentrated material, usually of a single or multiple mineral composition.

**Dilute HCl:** A liquid composed of a 10% Hydrochloric Acid solution.

**Hydrous:** Contains water within the crystalline structure.

**Hardness:** When describing rock and minerals, the hardness of the material is commonly referred to. The hardness is the ability of the material to resist scratching. The easier the material is scratched, the lower the hardness, and the more resistant the material is to scratching, the higher the hardness. The following table list hardness of common items to aid in field determinations:

| Object | Hardness |
|---|---|
| Fingernail | 2.5 |
| Copper Penny (pre 1982) | 3.5 |
| Knife Blade/Nail | 5.5 |
| Window Glass | 5.5 |
| Hardened Steel (File) | 6.5 |

**Indurated:** Partially lithified (hardened) sediment.

**Lithified:** Process during which unconsolidated sediments are formed into sedimentary rock.

**Luster:** The ability of the material to reflect light resulting in a surface appearance.

**Vitreous:** Description referring to a glassy luster.

***ROCK TYPES:***

The following are descriptions of the basic rock types found within Ohio. It should be noted that when referencing a percentage of composition the percentage is based on volume not weight.

| ROCK TYPE | DESCRIPTION |
|---|---|
| **ANHYDRITE** | A rock or mineral consisting of anhydrous calcium sulfate ($CaSO_4$) which is common to massive evaporite beds and readily alters to gypsum. Anhydrite is white, has a vitreous or pearly luster, and a hardness of 3.5 |
| **BRECCIA** | A coarse-grained sedimentary rock comprised of more than 25% subangular to angular gravel, cobbles and/or boulders. These grains are supported by either inter-grain contact or a matrix of sands, silt and/or clay and cemented by calcite, dolomite, hematite, silica or hardened clay. Color depends on the cementing agent with white, gray, yellow, orange, brown, and red colors common. |
| **CHERT** | A hard dense sedimentary rock consisting of very fine quartz crystals and may contain amorphous silica or silica replaced fossils. Chert varieties in color, but commonly is white or ranges from brown to black, has a semi-vitreous to dull luster, and a hardness of 7. When broken it commonly produces conchoidal fractures. These fractures are smooth with sharp edges. Chert forms as oval or irregular nodular or concretionary segregations, or as layered deposits in limestone and dolomite. Also referred to as flint. |
| **CLAYSTONE** | A fine-grained rock formed of at least 75% clay sized particles. Claystone is comprised of lithified clay having the texture and composition of shale, but lacking the laminations and fissility of a shale. Generally has a blocky, thick to massive appearance. Claystone may range in color from red, gray, olive, yellow, or brown with multiple colors typical. Slickensides are commonly found within claystone. |
| **COAL** | A combustible substance containing more than 50%, by weight, and more than 70%, by volume, of carbonaceous material; formed from the compaction and lithification of plant remains. Colors of coals range from brown to black. It is generally light weight with a shiny appearance on fresh surfaces. |
| **CONGLOMERATE** | A coarse-grained sedimentary rock comprised of more than 25% rounded to subrounded gravel, cobbles, and/or boulders. These grains are supported by either inter-grain contact or a matrix of sands, silt and/or clay and cemented by calcite, hematite, silica or hardened clay. Color depends on the matrix and cementing agent with white, gray, yellow, orange, brown, and red colors common. |
| **DOLOMITE** | A sedimentary rock of which more than 50% consists of the mineral dolomite (calcium magnesium carbonate – $CaMg(CO_3)_2$) and less than 10% is comprised of the mineral calcite. It is commonly interbedded with limestone, and the magnesium can be replaced with ferrous iron. Dolomite typically has a hardness of 3.5 to 4, colors ranging from white to light gray and will weakly react with cold dilute HCl on fresh or powdered surfaces. |
| **FIRECLAY** | See Underclay for description. The preferred use is Underclay. |

| ROCK TYPE | DESCRIPTION |
|---|---|
| **FLINT** | A common name for chert, generally used by archaeologists. See Chert for a description. |
| **GYPSUM** | A rock or mineral consisting of hydrous calcium sulfate ($CaSO_4 \cdot 2H_2O$). It forms thick extensive beds in Silurian aged rock commonly associated with halite and anhydrite in evaporative deposits. Gypsum may be white, translucent or transparent with a vitreous to pearly luster and a hardness of 2.0. Does not react with dilute HCl. |
| **HALITE** | A rock or mineral occurring in massive, granular compact or cubic-crystalline forms associated with evaporite beds. It is comprised of sodium chloride (NaCl) and is commonly known as salt. Halite is colorless to white with a hardness of 2.0 to 2.5. Fresh samples will have a salty flavor. |
| **IRONSTONE** | A sedimentary rock that is heavy and compact, containing primary components of iron oxides, carbonates, clay, and/or sand. Fresh surfaces generally are gray which weathers (oxidizes) to yellowish brown (limonite) to deep red (hematite) depending on the type and amount of oxide/hydroxide formed. It is very distinct in that its density is greater than a typical sedimentary rock.<br><br>Purer forms of ironstone occur as concretionary forms within shale, sandstone and limestone or dolomite layers, or at bedding contacts. Generally these concretionary forms are composed of goethite (Fe(OH), hardness 5.0-5.5), limonite (FeX(OH), hardness 4.0-5.5), or siderite ($FeCO_3$ , hardness 3.5-4.5) and can be called "kidney ores" for their kidney shapes. Colors of these concretions vary between gray, yellowish brown, brown, brownish red or black depending upon the composition and degree of weathering. |
| **LIMESTONE** | A sedimentary rock consisting of the mineral calcite (calcium carbonate – $CaCO_3$). Impurities may include chert, clay and minor mineral crystals. It may be crystalline (hard, pure, fine to coarse texture) with very fine grains not visible to the naked eye and/or fossiliferous (contains remains of organisms). Limestone is typically white to dark gray in color with a hardness of 3.5 to 4.0 and reacts vigorously with cold dilute HCl.<br><br>Descriptions based on Folk or Dunham Carbonate Classification systems are not needed. |
| **MUDSTONE** | A fine grained sedimentary rock comprised of mud (silt and clay) sized particles. Mudstone can be used as a generic term incorporating the rock classes of siltstone, claystone, and shale with Ohio. Although this term was widely used on pasts projects, the three previous descriptions are preferred for current projects. For a detailed description see Claystone. |
| **SANDSTONE** | A sedimentary rock comprised of grains of angular or rounded sand in a matrix of silt and/or clay cemented together by silica, iron oxides, or calcium carbonate. Sandstones may be composed of up to 25% of particles of gravel, cobbles, and/or boulders sizes. Color depends on the cementing agent with white, gray, yellow, orange, brown, and red colors common. |

| ROCK TYPE | DESCRIPTION |
|---|---|
| **SHALE** | A fine-grained sedimentary rock formed by the lithification of clay, silt or mud (predominate particle size is less than 0.002 mm). Shale has a laminated structure, which gives it fissility along which the rock splits readily. Shale is commonly interbedded with sandstone or limestone. Carbonaceous shale often grades into coal. Typical colors may be red, brown, black, green or gray. |
| **SILTSTONE** | A fine-grained sedimentary rock formed from particles finer than sand, but coarser than clay. Siltstone is comprised of lithified silt and lacks lamination or fissility. Typical colors may be gray, olive, or brown. Generally, siltstone has a fine grit feeling when rubbed against teeth. |
| **UNDERCLAY** | A layer of clay lying immediately beneath a coal bed or carbonaceous shale. This layer may be bioturbated and indurated or lithified. It is chiefly comprised of siliceous or aluminous clay capable of withstanding high temperatures without deformation, and may have a high shrink/swell potential. |

**Rock Descriptors:**

The following listing of descriptors is for rock types found within Ohio. The following descriptors should be applied when the condition comprises 10% or more of the observed sample by volume. If the condition comprises less than 10% use "contains ---". For example if the core contains more than 10% mica then the rock is "micaceous", but if the rock is composed of 5% mica then the rock is "contains mica." The following listing is presented in alphabetical order.

| Percentage Composition | | Description |
|---|---|---|
| **>10%** | **≤ 10%** | |
| Arenaceous | NA | Contains sand sized particles. Should not be used to describe sandstone, conglomerate, or breccia. |
| Argillaceous | NA | Contains clay and/or silt sized particles that result in the appearance having a slightly clayey texture. Should not be used to describe shale, claystone, or mudstone. |
| Brecciated | NA | Contains less than 25% angular to subangular gravel, cobbles and boulders. Typically used to describe sandstone, limestone or dolomite. |
| Calcareous | NA | Contains calcium carbonate indicated by reaction with HCl. Should not be used for describing limestone or dolomite. |
| Carbonaceous | NA | Contains a significant amount of carbon, but is not combustible. Should not be used to describe coal. |
| Cherty | Contains chert fragments | Contains chert fragments. |
| Conglomeritic | NA | Contains less than 25% rounded to subrounded gravel, cobbles and boulders. Typically used to describe sandstone, limestone or dolomite |
| Crystalline | NA | Contains crystalline structure visible with the unaided eye or a 10 power hand lens. Generally referred to by the crystal size based upon texture chart, i.e. fine grained. |

| Percentage Composition | | Description |
|---|---|---|
| **>10%** | **≤ 10%** | |
| Dolomitic | NA | Contains calcium/magnesium carbonate. Reacts slightly with dilute HCl on a fresh surface, and slightly to moderately on a powdered surface. Should only be used with limestone |
| Ferriferous/Ferric | Slightly ferric | Contains iron based minerals that are either visible, or results in an increase density. |
| Fissile | NA | Partings along closely spaced planes parallel or nearly parallel to bedding. |
| Fossiliferous | Contains fossils | Contains remains of plant and animals including carbonized fossils, silica, pyrite or other mineral replaced organisms and sand, silt, and/or clay filled cast or burrows of organisms in most sedimentary rocks. |
| Friable | NA | Can be easily broken down with hand pressure. |
| Lithic | Contains lithic fragments | Contains less than 25% rounded to angular rock fragments. Typically used to describe claystone. |
| Marine | NA | Reference made to limestone and dolomites which were deposited in a salt water marine environment. |
| Micaceous | Contains Mica | Rock mass contains mica fragments. |
| Non-marine | NA | Reference made to limestone and dolomites which were deposited in a fresh water environment. Commonly also referred to as “impure”. |
| Petroliferous | NA | Contains free petroleum or petroleum staining, including natural asphalt. |
| Pyritic | Contains pyrite | Rock mass contains pyrite crystals or nodules |
| Siliceous | Contains silica | Rock mass contains very fine to fine silica material. |
| Stylolitic | NA | Contain stylotites (cranial suture like structure) within the rock mass. |
| Vuggy | NA | Contains solution cavities which may or may not contain mineral crystals. Typically used to describe carbonate rocks. |