

**SOIL EXPLORATION;
PROPOSED WATER LINE,
JACKSON, JEFFERSON, AND CHURCH STREETS
WEST UNITY, WILLIAMS COUNTY, OHIO**

VILLAGE OF WEST UNITY
C/O JONES & HENRY ENGINEERS, LTD.
ATTENTION: Mr. Michael L. Karafa
3103 Executive Parkway, Suite 300
Toledo, Ohio 43606

BMI Report No. 200805-0621-8856

June 18, 2021

**BOWSER
MORNER®**

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Report To: Jones & Henry Engineers, Ltd.

Date: June 18, 2021

Attention: Mr. Michael L. Karafa
3103 Executive Parkway, Suite 300
Toledo, Ohio 43606

Laboratory Job No.: 200805

BMI Report No.: 200805-0621-8856

Report Consists of 26 Pages

Report On: SOIL EXPLORATION,
Proposed Water Line, Jackson, Jefferson, and Church Streets
West Unity, Williams County, Ohio

Dear Ladies and Gentlemen:

Bowser-Morner, Inc. (BMI) has completed the authorized subsurface exploration and geotechnical engineering evaluation at the above referenced project. The following report briefly reviews our exploration procedures, describes existing site and subsurface conditions, and presents our evaluations, conclusions, and recommendations.

1.0 AUTHORIZATION

The purpose of this subsurface exploration and geotechnical engineering evaluation was to determine the subsurface conditions at the project site and to analyze these conditions as they relate to sanitary sewer and pump station design and construction. All work was performed in accordance with BMI technical proposal No. T-27186 dated April 28, 2021 and its attached *Proposal Acceptance Sheet* between Jones & Henry Engineers, Ltd. and BMI dated May 4, 2021. The scope of the exploration included subsurface drilling and sampling, limited laboratory testing, engineering evaluation of the field and laboratory data, and the preparation of this report.

2.0 WORK PERFORMED

2.1 Field Exploration

During this exploration, five soil test borings were drilled at the approximate locations shown on the attached *Boring Location Plan*. The borings were drilled to a depth of 15 feet each. Boring locations were established in the field and surveyed by Jones & Henry.

All soil sampling and standard penetration testing was conducted in general accordance with ASTM D 1586. The borings were advanced by an all terrain vehicle (ATV) mounted drilling rig by mechanically twisting hollow-stem augers into the soil. At regular intervals, soil samples were

obtained with a standard 2-inch outside diameter (O. D.) split spoon sampler driven 18 inches into the soil with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and designated the "standard penetration resistance." The standard penetration resistance, or "N" value, when properly evaluated, is an index of the soil's strength, density, and ability to support foundations. The disturbed samples recovered by the split spoon sampler were visually classified in the field, logged, sealed in glass jars, and returned to the laboratory for testing and evaluation by a geotechnical engineer.

Boring Logs indicating soil descriptions, penetration resistances, and observed groundwater levels are attached.

2.2 Laboratory Testing

In the laboratory, each of the samples recovered from the borings was examined and visually classified by a geotechnical engineer. In addition, samples of cohesive soils from the split spoon samplers were tested to determine the soil's approximate strength using a hand-held, calibrated spring penetrometer. These values were used by the geotechnical engineer to assist in the evaluation of the relative strengths of the subsurface soils and to aid in classification of the samples.

Four unconfined compressive strength tests were performed on the disturbed samples recovered by the liner samplers. These tests were performed on a constant rate of strain apparatus with a deformation rate adjusted to cause failure of the sample in less than 10 minutes. Note that care should be utilized in applying these test values due to the method of sampling. The results of these tests have been summarized and tabulated below.

| Boring | Sample No. | Sample Depth (ft) | Moisture Content (%) | Dry Unit Weight (pcf) | Unconfined Compressive Strength (psf) | Strain at Failure (%) |
|--------|------------|-------------------|----------------------|-----------------------|---------------------------------------|-----------------------|
| 2 | SS-3 | 6.0-7.5 | 18.6 | 116.4 | 18,301 | 15.0 |
| 2 | SS-4 | 8.5-10.0 | 15.6 | 117.6 | 9,199 | 12.5 |
| 4 | SS-5 | 13.5-15.0 | 17.0 | 117.7 | 4,558 | 14.1 |
| 5 | SS-2 | 3.5-5.0 | 16.1 | 113.8 | 9,949 | 9.2 |

pcf = pounds per cubic foot

psf = pounds per square foot

Chloride ion concentration and Sulfate ion concentration testing have been performed on representative combined soil samples taken from boring location 3 between the depth of 3.5 and 15 feet. Laboratory test results are summarized below:

**Chloride Ion Concentration, and
And Sulfate Ion Concentration**

| Test Parameter | Boring 3 (3.5'-15.0') |
|---------------------------------|-----------------------|
| Water Soluble Sulfate Ion, ppm | 127.0 |
| Water Soluble Chloride Ion, ppm | 230.0 |
| pH | 8.7 |

A soil resistivity test was performed on a combined samples recovered from boring location 3 in accordance with ASTM D2216 and ASTM G187 specifications. The results of the soil resistivity tests are tabulated below:

Electrical Resistivity

| Test Method | Boring 3 (3.5'-15.0') |
|--|-----------------------|
| Moisture Content, As Received, %: | 34.1 |
| Resistivity (As Received), Ohm-cm: | 3,150 |
| Resistivity (100% Saturation), Ohm-cm: | 1,193 |

cm= centimeters ppm= parts per million

The soil resistivity indicated mildly corrosive soils at the as-received moisture content. The table below shows the relative corrosivity as a function of soil resistivity. It should be noted that the relationships given in the table below are approximate and intended as a general reference. Actual field performance can vary based on location specific conditions.

Soil Corrosivity as a Function of Soil Resistivity

| Resistivity | Corrosivity |
|-------------------------|------------------------------|
| 0 to 1,000 ohm-cm | Very corrosive |
| 1,000 to 2,000 ohm-cm | Corrosive |
| 2,000 to 10,000 ohm-cm | Mildly Corrosive |
| 10,000 ohm-cm and above | Progressively Less Corrosive |

Natural moisture content determinations were made on 21 split spoon samples recovered from the soil borings. The results of the moisture content determination tests are shown on the attached Moisture Content Summary Sheet.

Soil samples are normally retained in our laboratory for a period of 60 days before they are discarded. To view the samples or arrange for longer storage of samples, please contact us.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Description

The proposed site is located along Jackson, Jefferson, and Church Streets in West Unity, Williams County, Ohio.

3.2 Soil Profile

Data from the soil test borings are shown on the attached *Boring Logs*. The subsurface conditions discussed in the following paragraphs and those shown on the *Boring Logs* represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Geologically, the project site is situated in a glacial ground moraine consisting of till containing an unsorted, unstratified mixture of clay, silt, sand, and coarser fragments deposited discontinuously by advancing ice. Overlying the glacial till deposit is a layer of beach sand that was formed at the margins of an ancient glacial lake.

All the borings were drilled through the existing roadway pavement. The table below summarizes the surface conditions at each boring location.

Summary of Pavement/Surface Composition

| Boring No. | Asphalt Concrete Thickness (in.) | Portland Concrete Thickness (in) | Crushed Stone Thickness (in.) |
|------------|----------------------------------|----------------------------------|-------------------------------|
| 1 | 3.0 | 7.0 | --- |
| 2 | 2.5 | 7.5 | --- |
| 3 | 6.0 | 4.0 (Brick Pavers) | --- |
| 4 | 5.0 | --- | --- |
| 5 | --- | --- | 3.0 |

At boring location 1, fill materials were encountered to a depth of 13.5 feet. The fill materials consisted of 6 inches of sand with some silt overlying silty clay soil with varying amounts of sand and gravel. These soils had a petroleum odor to a depth of about 10 feet. Underlying fill and the surface materials was glacial till that was described as brown and gray clay and silt varying amounts of sand and gravel. With depth the till became gray and transitioned into a silt with varying amounts of clay and sand then extended to the bottom of the borings.

The glacial till soil has an average undrained shear strength between 2,500 to greater than 5,000 psf. The underlying silt has an average undrained shear strength between 750 and 2,500 psf.

3.3 Groundwater Observations

During the field exploration, the drilling rods and sampling equipment were continuously checked by the drillers for indications of groundwater or seepage. The *Boring Logs* list our driller's observations of groundwater or seepage. Three readings are recorded on the logs. The initial groundwater level indicates the depth(s) at which groundwater or seepage was initially noted by the drillers as the boring was being advanced and the intensity of the seepage. The completion groundwater level represents the depth groundwater was observed in the borehole immediately

after the completion of the hole. The last reading on the *Boring Logs* represents the depth groundwater was observed in the borehole after an increment of time has passed. In this case, both the depth and time are listed.

| Boring No. | Depth Groundwater First Encountered (ft) | | Depth to Groundwater at Completion of Drilling (ft) | |
|------------|--|-------|---|-------|
| | Depth | Elev. | Depth | Elev. |
| 1 | 8.5 | --- | 9.0 | --- |
| 2 | None | --- | None | --- |
| 3 | 7.0 | --- | None | --- |
| 4 | None | --- | None | --- |
| 5 | 14.0 | --- | None | --- |

Groundwater levels fluctuate with seasonal and climatic variations and may be different at other times. More specific information regarding groundwater levels, standard penetration resistances, and soil descriptions is detailed on the attached *Boring Logs*.

4.0 PROPOSED CONSTRUCTION

It is our understanding that the proposed construction is to consist of a new water line along Jackson, Jefferson, and Church Streets in West Unity, Williams County, Ohio.

5.0 EVALUATIONS AND CONCLUSIONS

The following evaluations and conclusions are based on our interpretation of the field and laboratory data obtained during the exploration and our experience with similar subsurface conditions. Soil penetration data and laboratory data have been used to estimate allowable bearing pressures using commonly accepted geotechnical engineering practices. Subsurface conditions in uninvestigated locations between borings may vary considerably from those encountered in the borings. If structure location, loadings, or levels are changed, we request we be advised so we may re-evaluate our recommendations.

5.1 Water Line Construction

As previously described, the soil profile at this site consists of silty clay soil with varying amounts of sand and gravel. We anticipate that excavations for the water line will stand open and that water intrusion into the excavations will be relatively minor.

In order to provide protection for workers, a trenchbox or similar device will be needed. As an alternate, the excavations could be laid back at a slope of about 1:1. The dewatering requirements during construction will depend upon the weather and groundwater conditions at the time of construction. In general, the soil materials encountered at the invert elevation are medium stiff to hard clays that will provide adequate support for the water pipe. In general

granular material Type 1 and 2 is recommended for bedding and should be six inches thick. Type 3 can be used if necessary to control water inflow into the excavation.

5.2 Slopes and Temporary Excavation

The owner and the contractor should make themselves aware of and become familiar with applicable local, state, and federal safety regulations, including current OSHA excavation and trench safety standards. Construction site safety generally is the sole responsibility of the contractor. The contractor shall also be solely responsible for the means, methods, techniques, sequences, and operations of construction operations. BMI is providing the following information solely as a service to the client. Under no circumstances should BMI's provision of the following information be construed to mean BMI is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not implied and should not be inferred.

The contractor should be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if not followed, the owner, the contractor, or earthwork or utility subcontractors could be liable for substantial penalties.

For this site, the overburden soil encountered in our exploration is mostly silty clay of glacial till origin. Some fill, estimated at depths of 13.5 feet or more, will be encountered. We anticipate OSHA will classify the fill materials as Type C. The underlying naturally occurring undisturbed clay soils would be likely classified as Type B.

Note: Soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in widely spaced borings. The contractor should verify similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, BMI recommends we be contacted immediately to evaluate the conditions encountered.

If any excavation, including a utility trench, is extended to a depth of more than 20 feet, OSHA requires the side slopes of such excavation be designed by a professional engineer.

5.3 General Considerations

In evaluating the geotechnical engineering recommendations and soil data of this report, the following guidelines and information should be considered. Soil does not possess unique or linear stress/strain relationships and, therefore, strength parameters indicated in this report are simply estimates and idealizations based upon engineering judgment and limited laboratory tests. Most soils are sensitive to disturbance from sampling, and thus the behavior measured by laboratory tests may be unlike that of the in situ soil. As a consequence of the above items, the interpretation of the data in this report and the selection of soil parameters to be utilized for design of construction items in the field requires experience and a high degree of intuition – specifically engineering judgement. Therefore, these parameters should be used carefully and only by experienced personnel in order to determine the sizes and strength of excavation bracing and trench protection devices. Soil behavior depends on loading, time, the environment, and

construction technique; therefore, a given excavation will perform differently at various times of the year as weather conditions change. As excavations are opened, more information becomes available and modifications to the preliminary plans may be required.

The subsurface conditions indicated by the borings are representative of the conditions at the specific boring locations on the dates shown and may not be representative of conditions at locations between the borings. Changes in rock level, soil conditions, and groundwater, therefore, are likely to occur and may not be uniform between the borings. Furthermore, the physical properties of soil and rock can be highly variable and can change drastically within a few feet of lateral or vertical travel.

Several other considerations are very important. Groundwater and surfacewater are major contributors to excavation instability and can cause the failure of a trench excavation. This can occur either by undermining and raveling of a wet zone beneath otherwise stable soils, or by the filling of cracks and fissures in the soil profile causing horizontal pressures that allow the soil to slab off. Some soil types are more prone to failure than others. One that is particularly hazardous is hard, over-consolidated clays. These soils appear to be very stable upon excavation, but can allow large chunks of material to fall into an excavation without warning.

Man-made fills are the most hazardous of all soils. Man-made fills are often a random, nonuniform mixture of soils and construction debris that were placed in an uncontrolled manner. Sometimes it is not easy to identify old fill deposits, which makes them even more hazardous. Not only is old fill a particular hazard, but intersecting trenches can cause original soil materials in the surrounding area to fail unexpectedly. Thus, when excavating in or near old fill areas, extreme caution is advised.

Finally, it should be kept in mind that this report provides only general recommendations and guidelines to be utilized in the actual design work. None of the recommendations should be utilized out of context or without specific engineering review.

6.0 QUALIFICATIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project, and our experience with similar sites and subsurface conditions. Data used during this exploration included, but was not necessarily limited to:

- five exploratory borings performed during this study;
- observations of the project site by our staff;
- results of limited laboratory soil testing;
- preliminary site plans and drawings furnished by Jones & Henry Engineers, Ltd.;
- limited interaction with Mr. Michael Karafa of Jones & Henry Engineers, Ltd.; and
- published soil or geologic data of this area.

In the event changes in the project characteristics are planned, or if additional information or differences from the conditions anticipated in this report become apparent, BMI should be notified so the conclusions

and recommendations contained in this report can be reviewed and, if necessary, modified or verified in writing.

The subsurface conditions discussed in this report and those shown on the *Boring Logs* represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Regardless of the thoroughness of a subsurface exploration, there is the possibility conditions between borings will differ from those at the boring locations, conditions are not as anticipated by designers, or the construction process has altered the soil conditions. As variations in the soil profile are encountered, additional subsurface sampling and testing may be necessary to provide data required to re-evaluate the recommendations of this report. Consequently, after submission of this report, it is recommended BMI be authorized to perform additional services to work with the designer(s) to minimize errors and/or omissions regarding the interpretation and implementation of this report.

Prior to construction, we recommend that BMI:

- work with the designers to implement the recommended geotechnical design parameters into plans and specifications;
- consult with the design team regarding interpretation of this report;
- establish criteria for the construction observation and testing for the soil conditions encountered at this site; and
- review final plans and specifications pertaining to geotechnical aspects of design.

During construction, we recommend that BMI:

- observe the construction, particularly site preparation, fill placement, and foundation excavation or installation;
- perform in-place density testing of all compacted fill;
- perform materials testing of soil and other materials as required; and
- consult with the design team to make design changes in the event differing subsurface conditions are encountered.

If BMI is not retained for these services, we shall assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made.

The scope of our services did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on, within, or beyond the site studied. Our work also did not include anything related to mold. Our scope of services also did not include an evaluation for the presence or absence of wetlands or protected species. Any statements in the report

or on the *Boring Logs* regarding odors, staining of soils, or other unusual items or conditions observed are strictly for the information of our client.

To evaluate the site for possible environmental liabilities, we recommend an environmental assessment, consisting of a detailed site reconnaissance, a record review, and report of findings. Additional subsurface drilling and sampling, including groundwater sampling, may be required. The presence or absence of wetlands or protected species should be determined by a wetlands study. BMI can provide these services and would be pleased to provide a cost proposal to perform these studies, if requested.

This report has been prepared for the exclusive use of Jones & Henry Engineers, Ltd. for specific application to the proposed Water Line along Jackson, Jefferson, and Church Streets in West Unity, Williams County, Ohio. Specific design and construction recommendations have been provided in the various sections of the report. The report should, therefore, be used in its entirety. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw their own conclusions regarding specific construction techniques and methods chosen. BMI is not responsible for the independent conclusions, opinions, or recommendations made by others based on the field exploration and laboratory test data presented in this report.

Respectfully submitted,

BOWSER-MORNER, INC.



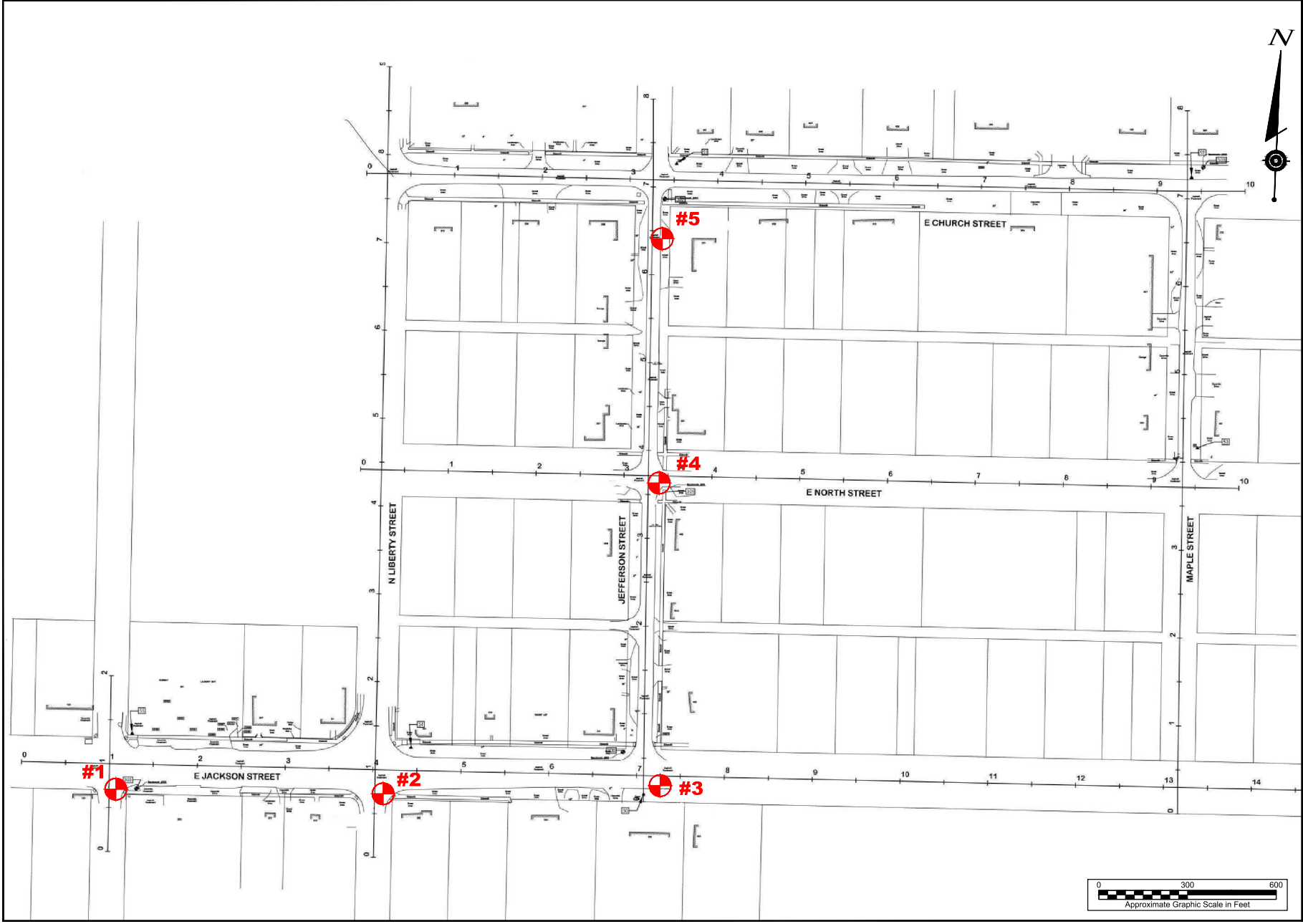
Ahmad K. Rashid, P.E.
Chief Geotechnical Engineer
Manager, Toledo Engineering &
Environmental Services

AKR:all

Attachments: *Boring Location Plan*
Boring Log Terminology
Boring Logs

1-Client (via email mkarafa@jheng.com)

This document has been provided in an electronic format to expedite delivery of results and/or recommendations to Bowser-Morner's Client. Because electronic files can be altered, if there is any question about the validity of the document you are reviewing, please contact our office to view the reference copy of the document stored at 1419 Miami Street, Toledo, Ohio 43605



BORING LOCATION PLAN

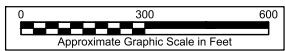
Proposed Water Line,
 Jackson, Jefferson, and Church Streets
 West Unity, Williams County, Ohio

PROJECT NO.

200805

SCALE

5-2021/SR Graphic



BORING LOG TERMINOLOGY

Stratum Depth:

Distance in feet and/or inches below ground surface.

Description of Materials:

When the color of the soil is uniform throughout, the color recorded will be such as brown, gray, or black and may be modified by adjectives such as light and dark. If the soil's predominant color is shaded by a secondary color, the secondary color precedes the primary color, such as gray and brown, yellow and brown. If two major and distinct colors are swirled throughout the soil, the colors will be modified by the term mottled, such as mottled brown and gray.

There are two types of visual classification methods currently used by Bowser-Morner, Inc. The first is ASTM D2488. This method results in classifications such as "lean clay". The second method is the ASEE system or Burmister system. This system results in classifications such as "silt and clay, with traces of sand" and is described below.

| Particle Size | | Visual |
|---------------|--------|--|
| Boulders | | Larger than 8" |
| Cobbles | | 8" to 3" |
| Gravel: | Coarse | 3" to 3/4" |
| | Fine | 3/4" to 2 mm |
| Sand: | Coarse | 2 mm to 0.6 mm (pencil size) |
| | Medium | 0.6 mm to 0.2 mm (table sugar & salt size) |
| | Fine | 0.2 mm to 0.06 mm (powdered sugar size) |
| Silt | | 0.06 mm to 0.002 mm |
| Clay | | 0.002 mm and smaller (particles of silt and clay size are not visible to the naked eye) |

| Soil Components | |
|------------------|----------------------|
| Major Components | Minor Component Term |
| Gravel | Trace.....1 - 10% |
| Sand | Some.....11 - 35% |
| Silt | And.....36 - 50% |
| Clay | |

| Moisture Content | |
|------------------|--|
| Term | Relative Moisture |
| Dry | Powdery |
| Damp | Moisture content below plastic limit |
| Moist | Moisture content above plastic limit, but below liquid limit |
| Wet | Moisture content above liquid limit |

| Condition of Soil Relative to Compactness (Granular Material) | |
|--|---------------------|
| Condition | N |
| Very Loose | 5 blows/ft or less |
| Loose | 6 to 10 blows/ft |
| Medium Dense | 11 to 30 blows/ft |
| Dense | 31 to 50 blows/ft |
| Very Dense | 51 blows/ft or more |

| Condition of Soil Relative to Consistency (Cohesive Material) | |
|--|--------------------------------------|
| Condition | Approximate Undrained Shear Strength |
| Very Soft | Less than 250 psf |
| Soft | 250 to 500 psf |
| Medium Stiff | 500 to 1,000 psf |
| Stiff | 1,000 to 2,000 psf |
| Very Stiff | 2,000 to 4,000 psf |
| Hard | Greater than 4,000 psf |



Sample Number:

Sample numbers are designated consecutively, increasing with depth for each boring.

Sample Type:

- "A" Split spoon, 2-inch O.D., 1-3/8-inch I.D., 18 inches in length.
- "B" One of the following:
 - Power Auger Sample
 - Piston Sample
 - Liner Sample
 - Denison Sample
 - Sonic Sample
- "C" Shelby Tube 3-inch O.D., except where noted.

Sample Depth:

The depth below top of ground at which the sample was taken.

Blows per 6 inches on Sampler:

The number of blows required to drive a 2-inch O.D., 1-3/8-inch I.D., split spoon sampler, using a 140-pound hammer with a 30-inch free fall, is recorded for 6 inch drive increments. (Example: 3/8/9)

"N" Blows/Feet:

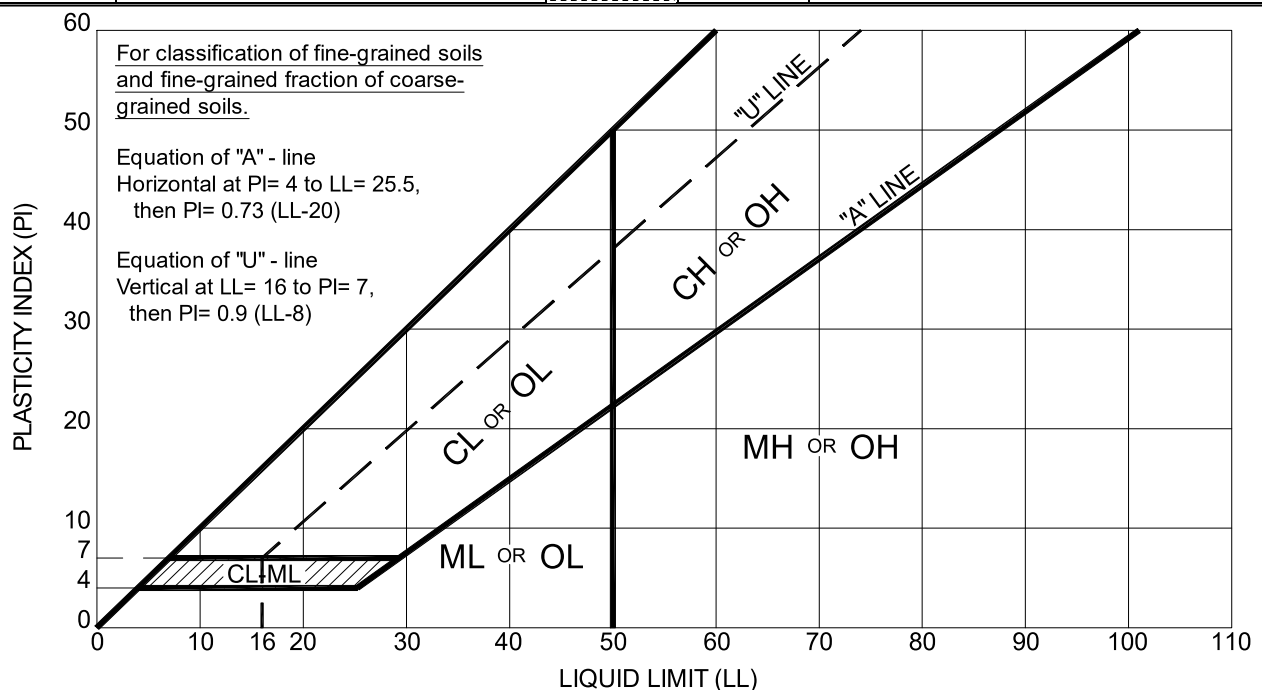
Standard penetration resistance. This value is based on the total number of blows required for the last 12 inches of penetration. (Example: 3/8/9 : N = 8 + 9 = 17)

Water Observations:

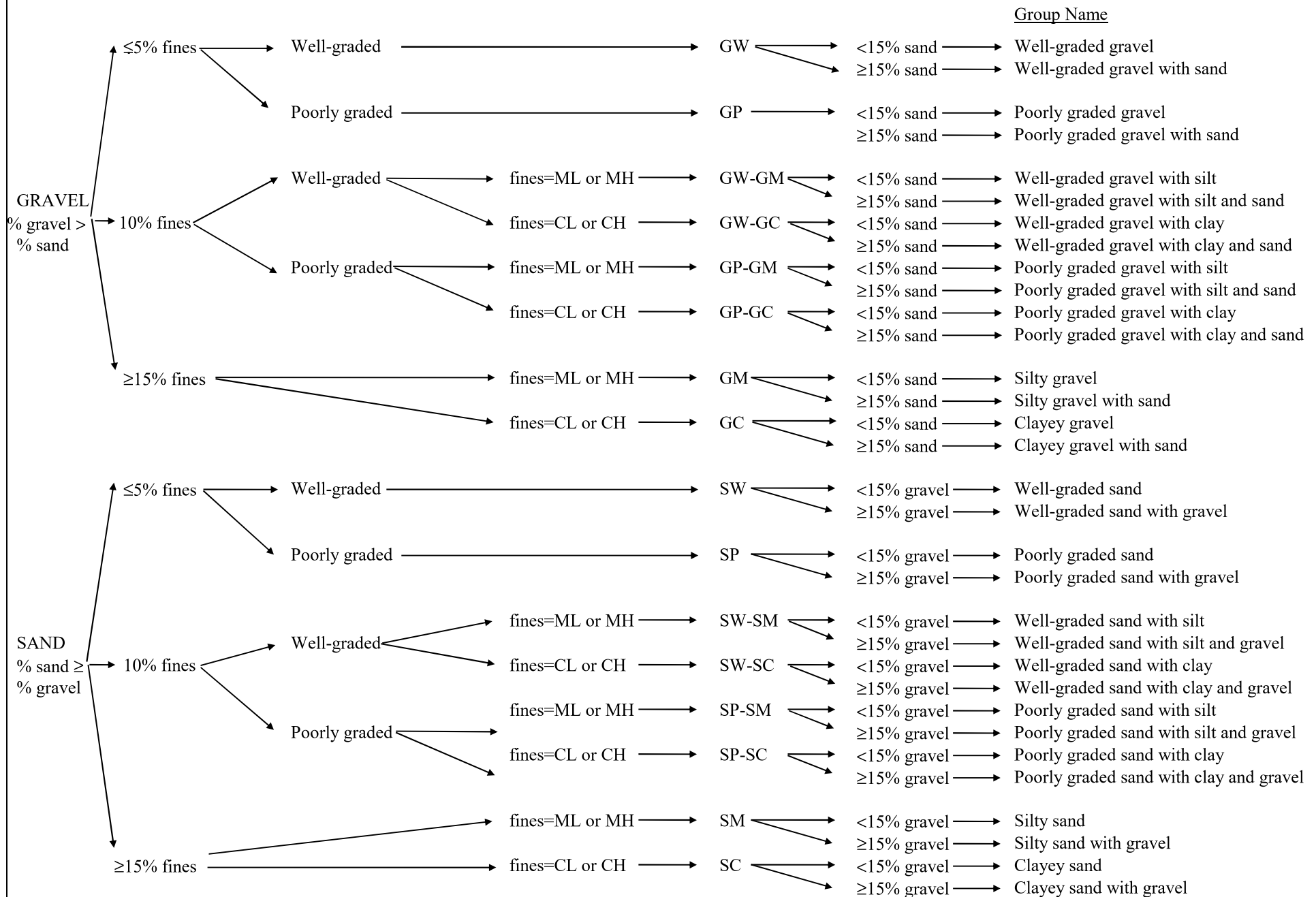
The depth of water recorded in the test boring is measured from the top of ground to the top of the water level. Initial depth indicates the water level during boring, completion depth indicates the water level immediately after boring, and depth after "X" number of hours indicates the water level after letting the water rise or fall over a time period. Water observations in pervious (sand and gravel) soils are considered reliable ground water levels for that date, Water observations in impervious (silt and clay) soils cannot be considered accurate unless records are made over a time period of several days to a month. Factors such as weather, soil porosity, etc. will cause the ground water level to fluctuate for both pervious and impervious soils.

UNIFIED CLASSIFICATION SYSTEM

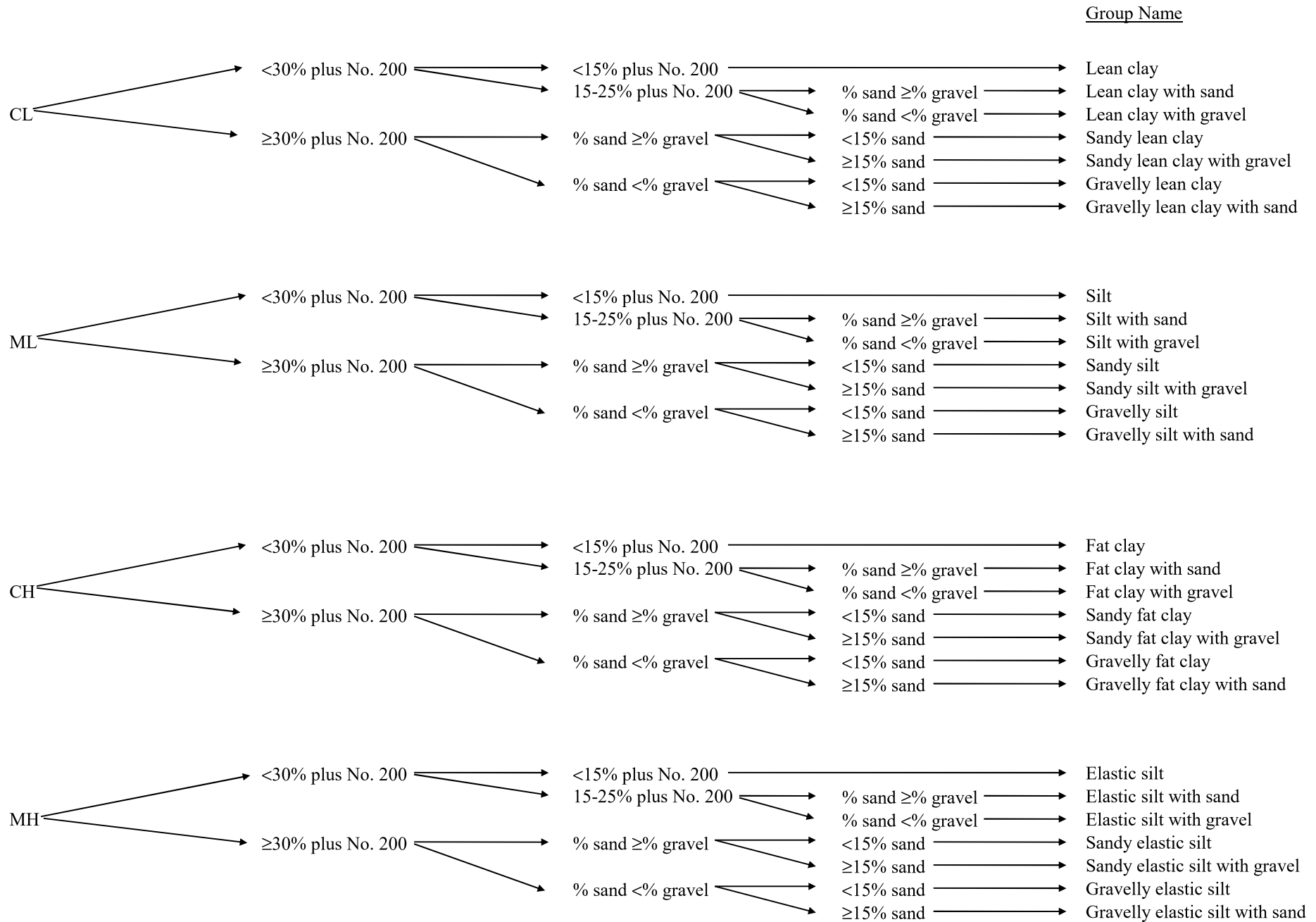
| MAJOR DIVISIONS | | GRAPH SYMBOL | LETTER SYMBOL | TYPICAL DESCRIPTIONS | |
|---|--|---|---|--|--|
| <p>COARSE GRAINED SOILS</p> <p>MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE</p> | <p>GRAVEL AND GRAVELLY SOILS</p> <p>MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE</p> | CLEAN GRAVELS (LITTLE OR NO FINES) | GW | WELL-GRADED GRAVEL WELL-GRADED GRAVEL WITH SAND | |
| | | GRAVELS WITH FINES (APPRECIABLE AMT. OF FINES) | GP | POORLY GRADED GRAVEL POORLY GRADED GRAVEL WITH SAND | |
| | | <p>SAND AND SANDY SOILS</p> <p>MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE</p> | CLEAN SAND (LITTLE OR NO FINES) | SW | WELL-GRADED SAND WELL-GRADED SAND WITH GRAVEL |
| | | | SANDS WITH FINES (APPRECIABLE AMT. OF FINES) | SP | POORLY GRADED SAND POORLY GRADED SAND WITH GRAVEL |
| | <p>FINE GRAINED SOILS</p> <p>MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE</p> | <p>SILT AND CLAYS</p> <p>LIQUID LIMIT <u>LESS</u> THAN 50</p> | ML | SILT, SILT WITH SAND, SANDY SILT GRAVELLY SILT, GRAVELLY SILT WITH SAND | |
| | | | CL | LEAN CLAY WITH SAND, SANDY LEAN CLAY GRAVELLY LEAN CLAY WITH SAND | |
| | | | OL | ORGANIC CLAY, SANDY ORGANIC CLAY ORGANIC SILT, SANDY ORGANIC SILT WITH GRAVEL | |
| | | <p>SILT AND CLAYS</p> <p>LIQUID LIMIT <u>GREATER</u> THAN 50</p> | MH | ELASTIC SILT WITH SAND, SANDY ELASTIC SILT GRAVELLY ELASTIC SILT WITH SAND | |
| | | | CH | FAT CLAY WITH SAND, SANDY FAT CLAY GRAVELLY FAT CLAY WITH SAND | |
| | | | OH | ORGANIC CLAY WITH SAND, SANDY ORGANIC CLAY, ORGANIC SILT, SANDY ORGANIC SILT | |
| HIGHLY ORGANIC SOILS | | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS | | |



Flow Chart for Visually Identifying Soils Based on ASTM D-2488



Flow Chart for Visually Identifying Soils Based on ASTM D-2488



STANDARD PENETRATION RESISTANCE (ASTM D1586)

The purpose of this test is to determine the relative consistency of the soils in a boring, or from boring over the site. This method consists of making a hole in the ground and driving a 2-inch O.D. split spoon sampler into the soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven 18 inches and the number of blows recorded for each 6 inches of penetration. Values of standard penetration (N) are determined in blows per foot, summarizing the blows required for the last two 6-inch increments of penetration.

Example : 2-6-8; N = 14

THIN-WALLED SAMPLER (ASTM D1587)

The purpose of the thin-walled sampler is to recover a relatively undisturbed soil sample for laboratory tests. The sampler is a thin-walled seamless tube with a 3-inch outside diameter, which is hydraulically pressed into the ground, at a constant rate. The ends are then sealed to prevent soil moisture loss, and the tube is returned to the laboratory for tests.



UNCONFINED COMPRESSION OR TRIAXIAL TESTS (ASTM D 2166)



The unconfined compression test and the triaxial tests are performed to determine the shearing strength of the soil, to use in establishing its safe bearing capacity. In order to perform the unconfined compression test, it is necessary that the soil exhibit sufficient cohesion to stand in an unsupported cylinder. These tests are normally performed on samples which are 6.0 inches in height and 2.85 inches in diameter. In the triaxial test, various lateral stresses can be applied to more closely simulate the actual field conditions. There are several different types of triaxial tests. These are, however, normally performed on constant strain apparatus with a deformation rate of 0.05 inches per minute.

CONSOLIDATION TEST (ASTM D 2435)



The purpose of this test is to determine the compressibility of the soil. This test is performed on a sample of soil which is 2.5 inches in diameter and 1.0 inch in height, and has been trimmed from relatively “undisturbed” samples. The test is performed with a lever system or an air activated piston for applying load. The loads are applied in increments and allowed to remain on the sample for a period of 24 hours. The consolidation of the sample under each individual load is measured and a curve of void ratio vs. Pressure is obtained. From the information obtained in this manner and the column loads of the structure, it is possible to calculate the settlement of each individual building column. This information, together with the shearing strength of the soil, is used to determine the safe bearing capacity for a particular structure.

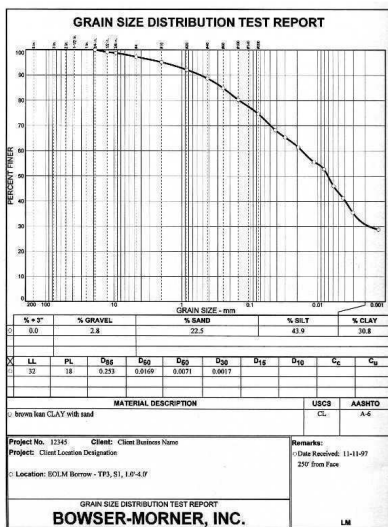
REVISED TO ASTM D4318
ATTERBERG LIMITS (ASTM D423 AND D424)

These tests determine the liquid and plastic limits of soils having a predominant percentage of fine particle (silt and clay) sizes. The liquid limit of a soil is the moisture content expressed as a percent at which the soil changes from a liquid to a plastic state, and the plastic limit is the moisture content at which the soil changes from a plastic to a semi-solid state. Their difference is defined as the plasticity index ($P.I. = L.L. - P.L.$), which is the change in moisture content required to change the soil from a “semi-solid” to a liquid. These tests furnish information about the soil properties which is important in determining their relative swelling potential and their classifications.



MECHANICAL ANALYSIS (ASTM D422)

This test determines the percent of each particle size of a soil. A sieve analysis is conducted on particle sizes greater than a No. 200 sieve (0.074 mm), and a hydrometer test on particles smaller than the No.200 sieve. The gradation curve is drawn through the points of cumulative percent of particle size, and plotted on semi-logarithmic paper for the combined sieve and hydrometer analysis. This test, together with the Atterberg Limits tests, is used to classify a soil.



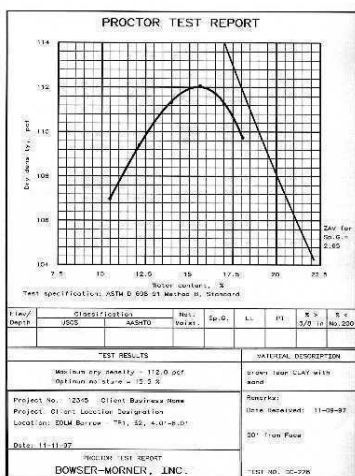
NATURAL MOISTURE CONTENT (ASTM D2216)

The purpose of this test is to indicate the range of moisture contents present in the soil. A wet sample is weighed, placed in the constant temperature oven at 105° for 24 hours, and re-weighed. The moisture content is the change in weight divided by the dry weight.



PROCTOR TESTS

The purpose of these tests is to determine the maximum density and optimum moisture content of a soil. The Modified Proctor test is performed in accordance with ASTM D1557. The test is performed by dropping a 10-pound hammer 25 times from an 18-inch height on each of 5 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 56,250 foot pounds per cubic foot. The moisture content is then raised, and this procedure is repeated. A moisture density curve is then plotted, with the density on the ordinate axis and the moisture on the abscissa axis. The moisture content at which the maximum density requirement can be achieved with a minimum compactive effort is designated as the optimum moisture content (O.M.C.). The Standard Proctor test is performed in accordance with ASTM D698. This test is similar to the Modified Proctor test and is performed by dropping a 5.5 pound hammer 25 times from a height of 12 inches on 3 equal layers of soil in a 1/30 cubic foot mold, which represents a compaction effort of 12,375 foot pounds per cubic foot. This test gives proportionately lower results than the Modified Proctor test.



CLIENT
VILLAGE OF WEST UNITY

JOB NO.
200805

PROJECT
**PROPOSED WATER LINE, JACKSON, JEFFERSON,
AND CHURCH STREETS, WEST UNITY, OHIO**

BORING STARTED **5/21/21** BORING COMPLETED **5/21/21**
DRILLER **JW, JA** METHOD **3 1/4" HSA**
TYPED BY **all**

1
Boring No.
Sheet 1 of 1

| DEPTH | SAMPLE NO. | SAMPLER TYPE | RECOVERY | GRAPHIC LOG | PROJECT LOCATION | | COMMENTS | REMARKS |
|-------|------------|--------------|----------|-------------|--|-------|-------------|---------|
| | | | | | LAT. | LONG. | | |
| | | | | | SURFACE ELEVATION | | BLOW COUNTS | |
| | | | | | BORING LOCATION | | | |
| | | | | | As shown on Boring Location Plan. | | | |
| | | | | | It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute. | | | |
| | | | | | VISUAL CLASSIFICATION OF THE MATERIAL | | | |
| | | | | | Asphalt (3") | | | |
| | | | | | Concrete (7") | | | |
| | | | | | (Fill) Medium dense brown sand, some silt, trace of gravel, moist | | | |
| | | | | | (Fill) Medium stiff brown clay and silt, some sand, moist | | | |
| | | | | | (Fill) Medium stiff brown and gray clay and silt, trace of sand, trace of gravel, moist | | | |
| | | | | | Medium stiff gray silt, some clay, trace of sand, wet | | | |
| | | | | | Bottom of boring at 15.0 feet | | | |

GINT Report Used: NEWLOGIN Report No.: 200805-XXXX-XXXX.GPJ GINT Template Used: NATALIE_EDITS.GDT Date Printed: 6/18/21

WATER LEVEL MEASUREMENTS

| | DEPTH | DATE |
|---------------|-------|-----------|
| INITIAL | 8.5' | 5/21/2021 |
| AT COMPLETION | 9.0' | 5/21/2021 |
| OTHER | | |

- SS — SPLIT SPOON
- SL — SPLIT SPOON W/SOIL LINER
- NQ — ROCK CORE
- ST — SHELBY TUBE
- AS — AUGER CUTTINGS
- SC — SONIC



CLIENT
VILLAGE OF WEST UNITY

JOB NO.
200805

PROJECT
**PROPOSED WATER LINE, JACKSON, JEFFERSON,
AND CHURCH STREETS, WEST UNITY, OHIO**

BORING STARTED **5/21/21** BORING COMPLETED **5/21/21**
DRILLER **JW, JA** METHOD **3 1/4" HSA**
TYPED BY **all**

2
Boring No.
Sheet 1 of 1

| DEPTH | SAMPLE NO. | SAMPLER TYPE RECOVERY | GRAPHIC LOG | PROJECT LOCATION | | COMMENTS | REMARKS |
|-------|------------|--------------------------|-------------|--|-------|--------------------|---------|
| | | | | LAT. | LONG. | | |
| | | | | SURFACE ELEVATION | | BLOW COUNTS | |
| | | | | BORING LOCATION | | | |
| | | | | As shown on Boring Location Plan. | | N VALUE, blows/ft. | |
| | | | | It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute. | | | |
| | | | | VISUAL CLASSIFICATION OF THE MATERIAL | | 10 | |
| | | | | Asphalt (2.5") | | 20 | |
| | | | | Concrete (7.5") | | 30 | |
| | | | | Very stiff brown clay and silt, some sand, trace of gravel, moist | | 40 | |
| 1.0 | SS-1 | | | | | 50 | |
| 2.0 | | | | | | 60 | |
| 3.0 | | | | | | 70 | |
| 4.0 | SS-2 | | | | | 80 | |
| 5.0 | | | | | | 90 | |
| 6.0 | | | | | | | |
| 7.0 | SS-3 | | | | | | |
| 8.0 | | | | | | | |
| 9.0 | | | | | | | |
| 10.0 | SS-4 | | | | | | |
| 11.0 | | | | | | | |
| 12.0 | | | | | | | |
| 13.0 | | | | | | | |
| 14.0 | SS-5 | | | Hard gray silt, some clay, trace of sand, moist | | | |
| 15.0 | | | | Bottom of boring at 15.0 feet | | | |
| 16.0 | | | | | | | |
| 17.0 | | | | | | | |
| 18.0 | | | | | | | |
| 19.0 | | | | | | | |
| 20.0 | | | | | | | |
| 21.0 | | | | | | | |
| 22.0 | | | | | | | |

GINT Report Used: NEWLOGIN Report No.: 200805-XXXX-XXXX.GPJ GINT Template Used: NATALIE_EDITS.GDT Date Printed: 6/18/21

WATER LEVEL MEASUREMENTS

| | | |
|---------------|-------|-----------|
| INITIAL | DEPTH | DATE |
| | NONE | 5/21/2021 |
| AT COMPLETION | NONE | 5/21/2021 |
| OTHER | | |

- SS — SPLIT SPOON
- SL — SPLIT SPOON W/SOIL LINER
- NQ — ROCK CORE
- ST — SHELBY TUBE
- AS — AUGER CUTTINGS
- SC — SONIC



CLIENT
VILLAGE OF WEST UNITY

JOB NO.
200805

PROJECT
**PROPOSED WATER LINE, JACKSON, JEFFERSON,
AND CHURCH STREETS, WEST UNITY, OHIO**

BORING STARTED **5/21/21** BORING COMPLETED **5/21/21**
DRILLER **JW, JA** METHOD **3 1/4" HSA**
TYPED BY **all**

3
Boring No.
Sheet 1 of 1

| DEPTH | SAMPLE NO. | SAMPLER TYPE RECOVERY | GRAPHIC LOG | PROJECT LOCATION | | COMMENTS | REMARKS | | | | | | | |
|-------|------------|--------------------------|-------------|--|-------|--------------------|---------|----|----|----|----|----|----|----|
| | | | | LAT. | LONG. | | | | | | | | | |
| | | | | SURFACE ELEVATION | | BLOW COUNTS | | | | | | | | |
| | | | | BORING LOCATION | | | | | | | | | | |
| | | | | As shown on Boring Location Plan. | | N VALUE, blows/ft. | | | | | | | | |
| | | | | It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute. | | | | | | | | | | |
| | | | | VISUAL CLASSIFICATION OF THE MATERIAL | | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
| | | | | Asphalt (6") | | | | | | | | | | |
| | | | | Red Brick (4") | | | | | | | | | | |
| 1.0 | | | | Very stiff brown clay and silt, some sand, trace of gravel, moist | | 12 | | | | | | | | |
| 2.0 | SS-1 | | | | | 5 | | | | | | | | |
| 3.0 | | | | | | 4 | | | | | | | | |
| 4.0 | | | | | | | | | | | | | | |
| 5.0 | SS-2 | | | | | 6 | | | | | | | | |
| 6.0 | | | | | | 8 | | | | | | | | |
| 7.0 | | | | | | 9 | | | | | | | | |
| 8.0 | | | | | | | | | | | | | | |
| 9.0 | | | | Stiff brown silt, some clay, with a trace of sand, wet | | 4 | | | | | | | | |
| 10.0 | SS-3 | | | | | 5 | | | | | | | | |
| 11.0 | | | | | | 6 | | | | | | | | |
| 12.0 | | | | | | | | | | | | | | |
| 13.0 | | | | | | | | | | | | | | |
| 14.0 | | | | | | | | | | | | | | |
| 15.0 | SS-4 | | | | | 4 | | | | | | | | |
| 16.0 | | | | | | 5 | | | | | | | | |
| 17.0 | | | | | | 5 | | | | | | | | |
| 18.0 | | | | | | | | | | | | | | |
| 19.0 | | | | | | | | | | | | | | |
| 20.0 | | | | | | | | | | | | | | |
| 21.0 | | | | | | | | | | | | | | |
| 22.0 | | | | | | | | | | | | | | |
| | | | | Stiff gray clay and silt, trace of sand, moist | | 3 | | | | | | | | |
| | SS-5 | | | | | 3 | | | | | | | | |
| | | | | | | 5 | | | | | | | | |
| | | | | Bottom of boring at 15.0 feet | | | | | | | | | | |

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WATER LEVEL MEASUREMENTS

| | | |
|---------------|-------|-----------|
| INITIAL | DEPTH | DATE |
| | 7.0' | 5/21/2021 |
| AT COMPLETION | NONE | 5/21/2021 |
| OTHER | | |

- SS — SPLIT SPOON
- SL — SPLIT SPOON W/SOIL LINER
- NQ — ROCK CORE
- ST — SHELBY TUBE
- AS — AUGER CUTTINGS
- SC — SONIC



CLIENT
VILLAGE OF WEST UNITY

JOB NO.
200805

PROJECT
**PROPOSED WATER LINE, JACKSON, JEFFERSON,
AND CHURCH STREETS, WEST UNITY, OHIO**

BORING STARTED **5/21/21** BORING COMPLETED **5/21/21**
DRILLER **JW, JA** METHOD **3 1/4" HSA**
TYPED BY **all**







4
Boring No.
Sheet 1 of 1

| DEPTH | SAMPLE NO. | SAMPLER TYPE RECOVERY | GRAPHIC LOG | PROJECT LOCATION | | COMMENTS | REMARKS |
|-------|------------|--------------------------|-------------|--|-------|--------------------|---------|
| | | | | LAT. | LONG. | | |
| | | | | SURFACE ELEVATION | | BLOW COUNTS | |
| | | | | BORING LOCATION | | | |
| | | | | As shown on Boring Location Plan. | | N VALUE, blows/ft. | |
| | | | | It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute. | | | |
| | | | | VISUAL CLASSIFICATION OF THE MATERIAL | | 10 | 20 |
| | | | | Asphalt (5") | | 30 | 40 |
| | | | | Stiff and brown silt and sand, some clay, moist | | 50 | 60 |
| 1.0 | | | | | | 70 | 80 |
| 2.0 | SS-1 | | | | | 80 | 90 |
| 3.0 | | | | | | | |
| 4.0 | SS-2 | | | Stiff brown clay and silt, some sand, trace of gravel, moist | | | |
| 5.0 | | | | | | | |
| 6.0 | | | | | | | |
| 7.0 | SS-3 | | | | | | |
| 8.0 | | | | | | | |
| 9.0 | SS-4 | | | (becomes very stiff at 8.5') | | | |
| 10.0 | | | | | | | |
| 11.0 | | | | | | | |
| 12.0 | | | | | | | |
| 13.0 | | | | | | | |
| 14.0 | SS-5 | | | (becomes gray at 13.5') | | | |
| 15.0 | | | | Bottom of boring at 15.0 feet | | | |
| 16.0 | | | | | | | |
| 17.0 | | | | | | | |
| 18.0 | | | | | | | |
| 19.0 | | | | | | | |
| 20.0 | | | | | | | |
| 21.0 | | | | | | | |
| 22.0 | | | | | | | |

GINT Report Used: NEWLOGIN Report No.: 200805-XXXX-XXXX.GPJ GINT Template Used: NATALIE_EDITS.GDT Date Printed: 6/18/21

WATER LEVEL MEASUREMENTS

| | | |
|---------------|-------|-----------|
| | DEPTH | DATE |
| INITIAL | NONE | 5/21/2021 |
| AT COMPLETION | NONE | 5/21/2021 |
| OTHER | | |

-  SS — SPLIT SPOON
-  SL — SPLIT SPOON W/SOIL LINER
-  NQ — ROCK CORE
-  ST — SHELBY TUBE
-  AS — AUGER CUTTINGS
-  SC — SONIC



CLIENT
VILLAGE OF WEST UNITY

JOB NO.
200805

PROJECT
**PROPOSED WATER LINE, JACKSON, JEFFERSON,
AND CHURCH STREETS, WEST UNITY, OHIO**

BORING STARTED **5/21/21** BORING COMPLETED **5/21/21**
DRILLER **JW, JA** METHOD **3 1/4" HSA**
TYPED BY **all**







5
Boring No.
Sheet 1 of 1

| DEPTH | SAMPLE NO. | SAMPLER TYPE RECOVERY | GRAPHIC LOG | PROJECT LOCATION | | COMMENTS | REMARKS |
|-------|------------|--------------------------|-------------|--|-------|--------------------|---------|
| | | | | LAT. | LONG. | | |
| | | | | SURFACE ELEVATION | | BLOW COUNTS | |
| | | | | BORING LOCATION | | | |
| | | | | As shown on Boring Location Plan. | | N VALUE, blows/ft. | |
| | | | | It has been necessary to interpolate between samples. Therefore, the contacts between the various soil strata should not be taken as absolute. | | | |
| | | | | VISUAL CLASSIFICATION OF THE MATERIAL | | 10 | 20 |
| | | | | Crushed stone (3") | | 30 | 40 |
| | | | | Stiff dark brown clay and silt, some sand, trace of gravel, moist | | 50 | 60 |
| 1.0 | | | | | | 70 | 80 |
| 2.0 | SS-1 | | | | | 90 | |
| 3.0 | | | | | | | |
| 4.0 | | | | (becomes very stiff at 3.5') | | | |
| 5.0 | SS-2 | | | | | | |
| 6.0 | | | | | | | |
| 7.0 | | | | (becomes hard at 6') | | | |
| 8.0 | | | | | | | |
| 9.0 | | | | (becomes gray at 8.5') | | | |
| 10.0 | SS-4 | | | | | | |
| 11.0 | | | | | | | |
| 12.0 | | | | | | | |
| 13.0 | | | | | | | |
| 14.0 | SS-5 | | | Stiff gray silt and sand, some clay, wet | | | |
| 15.0 | | | | Bottom of boring at 15.0 feet | | | |
| 16.0 | | | | | | | |
| 17.0 | | | | | | | |
| 18.0 | | | | | | | |
| 19.0 | | | | | | | |
| 20.0 | | | | | | | |
| 21.0 | | | | | | | |
| 22.0 | | | | | | | |

GINT Report Used: NEWLOGIN Report No.: 200805-XXXX-XXXX.GPJ GINT Template Used: NATALIE_EDITS.GDT Date Printed: 6/18/21

WATER LEVEL MEASUREMENTS

| | | |
|---------------|-------|-----------|
| | DEPTH | DATE |
| INITIAL | 14' | 5/21/2021 |
| AT COMPLETION | NONE | 5/21/2021 |
| OTHER | | |

-  SS — SPLIT SPOON
-  SL — SPLIT SPOON W/SOIL LINER
-  NQ — ROCK CORE
-  ST — SHELBY TUBE
-  AS — AUGER CUTTINGS
-  SC — SONIC



MOISTURE CONTENT SUMMARY SHEET

Job No. 200805

| Boring No. | Sample No. | Depth (Feet) | Moisture (%) |
|------------|------------|--------------|--------------|
| 1 | SS-1 | 1.0-2.5 | 17.5 |
| | SS-2 | 3.5-5.0 | 17.3 |
| | SS-3 | 6.0-7.5 | 23.8 |
| | SS-4 | 8.5-10.0 | 47.2 |
| | SS-5 | 13.5-15.0 | * |
| 2 | SS-1 | 1.0-2.5 | 15.6 |
| | SS-2 | 3.5-5.0 | 15.2 |
| | SS-3 | 6.0-7.5 | 18.6 |
| | SS-4 | 8.5-10.0 | 15.6 |
| | SS-5 | 13.5-15.0 | * |
| 3 | SS-1 | 1.0-2.5 | 15.5 |
| | SS-2 | 3.5-5.0 | 16.7 |
| | SS-3 | 6.0-7.5 | 21.1 |
| | SS-4 | 8.5-10.0 | 26.2 |
| | SS-5 | 13.5-15.0 | * |
| 4 | SS-1 | 1.0-2.5 | 17.0 |
| | SS-2 | 3.5-5.0 | 13.1 |
| | SS-3 | 6.0-7.5 | 19.5 |
| | SS-4 | 8.5-10.0 | 18.8 |
| | SS-5 | 13.5-15.0 | 17.0 |

* Not Tested



MOISTURE CONTENT SUMMARY SHEET

Job No. 200805

| Boring No. | Sample No. | Depth (Feet) | Moisture (%) |
|------------|------------|--------------|--------------|
| 5 | SS-1 | 1.0-2.5 | 22.0 |
| | SS-2 | 3.5-5.0 | 16.1 |
| | SS-3 | 6.0-7.5 | 13.2 |
| | SS-4 | 8.5-10.0 | 13.4 |
| | SS-5 | 13.5-15.0 | * |

* Not Tested