SOIL EXPLORATION;
SOUTH MAIN STREET WATER LINE PROJECT
VILLAGE OF WEST UNITY
WEST UNITY, WILLIAMS COUNTY, OHIO
JONES & HENRY Job 982-8048.001

Submitted To:

VILLAGE OF WEST UNITY
Attention: Mr. Joshua Fritsch
224 W. Jackson Street
West Unity, Ohio 43570

BMI Report No. 216032-0924-021

September 20, 2024

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Report To: Village of West Unity
Attention: Mr. Joshua Fritsch
224 W. Jackson Street
West Unity Ohio 43570

Date: September 20, 2024
Laboratory Job No.: 216032
BMI Report No.: 216032-0924-021
Report Consists of 27 Pages

Report On: SOIL EXPLORATION
South Main Street Water Line Project, Village of West Unity
West Unity, Williams County, Ohio
Jones & Henry Job 982-8048.001

Dear Mr. Fritsch:

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 water line design and construction. All work was performed in accordance with BMI technical proposal No. T-28762-Revised dated July 31, 2024 and its attached *Proposal Acceptance Sheet* between The Village of West Unity and BMI. Authorization to proceed with the necessary work was given by Mr. Joshua Fritsch on July 31, 2024. 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, four soil test borings were drilled at the approximate locations shown on the attached *Boring Location Plan*. The borings were drilled to a depth of 10 feet. Boring locations were established in the field by Jones & Henry. Boring elevations were provided by Jones & Henry.

All soil sampling and standard penetration testing was conducted in general accordance with American Society for Testing and Materials (ASTM) Standard D1586. The borings were advanced by a truck-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.

2.3 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 No.	Sample No.	Sample Depth (ft)	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	Strain at Failure (%)
1	SS-2	3.5-5.0	20.2	109.2	5,697	9.8
2	SS-4	8.5-10.0	15.8	125.6	8,438	6.7
3	SS-1	1.0-2.5	17.9	114.8	1,317	5.6
4	SS-3	6.0-7.5	16.9	118.3	6,918	6.6

pcf = pounds per cubic foot

psf = pounds per square foot

Natural moisture content determinations were made on 13 split spoon samples recovered from the soil test borings. The results of the moisture content determination tests are shown on the attached *Moisture Content Summary Sheet*.

Chloride ion concentration, Sulfate ion concentration and pH testing have been performed on representative combined soil samples taken from the borings in accordance with ASTM D512, ASTM D516 and ASTM D4972 specifications. Laboratory test results are summarized below:

Chloride Ion Concentration, and
And Sulfate Ion Concentration

Test Parameter	Combined Sample Borings: 1 and 3 SS-2 and SS-3, Boring 2 SS-2, Boring 4 SS-3
Water Soluble Sulfate Ion, ppm	190
Water Soluble Chloride Ion, ppm	266
pH (in Distilled Water)	7.8
pH (in Calcium Chloride Solution)	7.2

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

Electrical Resistivity

Test Method	Combined Sample Borings: 1 and 3 SS-2 and SS-3, Boring 2 SS-2, Boring 4 SS-3
Moisture Content, As Received, %:	17.7
Resistivity (As Received), Ohm-cm:	51,750
Resistivity (100% Saturation), Ohm-cm:	1,823

cm= centimeters ppm= parts per million

The soil resistivity indicated progressively less 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

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 project site is located along South Main Street and South High Street 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.

The asphalt and crushed stone thicknesses can be found summarized in the table below.

Boring No.	Asphalt Concrete Thickness (in)	Crushed Stone Base Thickness (in)	Soil Type
1	5.0	6.0	Sand and Silt, Trace of Clay
2	8.0	9.0	(Fill) Clay and Silt, Some Sand, Trace of gravel
3	5.0	9.0	(Fill) Clay and Silt, Some Sand, Trace of gravel
4	4.0	7.0	(Fill) Clay and Silt, Some Sand, Trace of gravel

Underlying the fill in boring 4 was a layer of sand with varying amounts of silt and gravel. Below the sand and silt in borings 1 and 4, and the fill in borings 2 and 3 was glacial till consisting of clay and silt with some sand and a trace of gravel. The silty clay soil extended to depths between 6 and 8.5 feet where very loose to loose sandy soil was encountered in borings 1, 2 and 4. The sandy soil extended to the bottom of borings 1 and 4 and to a depth of 8.5 feet in boring 2 where silt and clay was encountered. The silty soil extended to the bottom of borings 2 and 3.

The consistency of the sandy soil was very loose to loose. The estimated undrained shear strength of the glacial till was on the order of 4,000 to greater than 4,500 psf. The estimated undrained shear strength of the silty soil was on the order of 1,000 to 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	None	---	None	---
2	6.5	782.2	None	---
3	None	---	None	---
4	9.0	780.4	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 South Main Street and South High Street in the Village of 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 soils with varying amounts of sand and clay interbeded in the silty clay soil is layers of sandy soil.

The excavations in the granular soils above the groundwater level will not stand open. Excavations made below the groundwater level in the granular materials will cave and fill in rapidly. Dewatering can best be achieved by using dewatering wells or well points in the sandy soil.

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 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 Groundwater Control

During the field exploration, groundwater was encountered below a depth of 6.5 feet. The difficulty with groundwater will depend on the groundwater level at the time of construction. If the sands are saturated at the time of construction, subgrades will be tender and easily disturbed. If saturated subgrades are encountered, the excavations can be over-excavated several inches and backfilled with ODOT No. 67 or No. 6 crushed stone. The stone will provide a more stable working surface and facilitate drainage to sumps. Groundwater that accumulates in excavations can be controlled by pumping from prepared sumps.

The amount and type of dewatering required during construction will depend on the weather and groundwater levels at the time of construction and the effectiveness of the contractor's techniques in preventing surface runoff from entering open excavations. Typically, groundwater levels are highest during winter and spring months and lower in summer and early fall.

5.3 Soil Seismic Site Classification

We have evaluated the available soil profile data developed during this study to determine the Site Class in accordance with the 2021 IBC. The test borings for this project did not extend to 100 feet deep; therefore, we have estimated the depth to rock based on records we keep on file. We have also estimated the soil strength and soil types below the bottoms of the on-site borings. Based on this analysis, we have determined the Site Class is D. We may be able to upgrade the class to C with seismic wave testing. We can perform this service.

5.4 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 Occupational Safety and Health Administration (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, such as OSHA Health and Safety Standards for Excavations, Chapter 29 of the Code of Federal Regulations (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 lacustrine origin. Some fill, estimated at depths of 3.5 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. The naturally occurring sandy soils would likely be classified as Type C.

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.

5.5 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; 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. Therefore, changes in rock level, soil conditions, and groundwater 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 surface water 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, non-uniform 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. Intersecting trenches can also 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:

- Four 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 and Henry;
- limited interaction with Mr. Kyle Brueggemeier of Jones and Henry; 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 site assessment for the presence or absence of hazardous substances in the soil, surface water, groundwater, or air, on, within, or beyond the site studied. Our scope of services also did not include an evaluation for the presence or absence of mold, 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.

This report has been prepared for the exclusive use of The Village of West Unity for specific application to the proposed water line project 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.

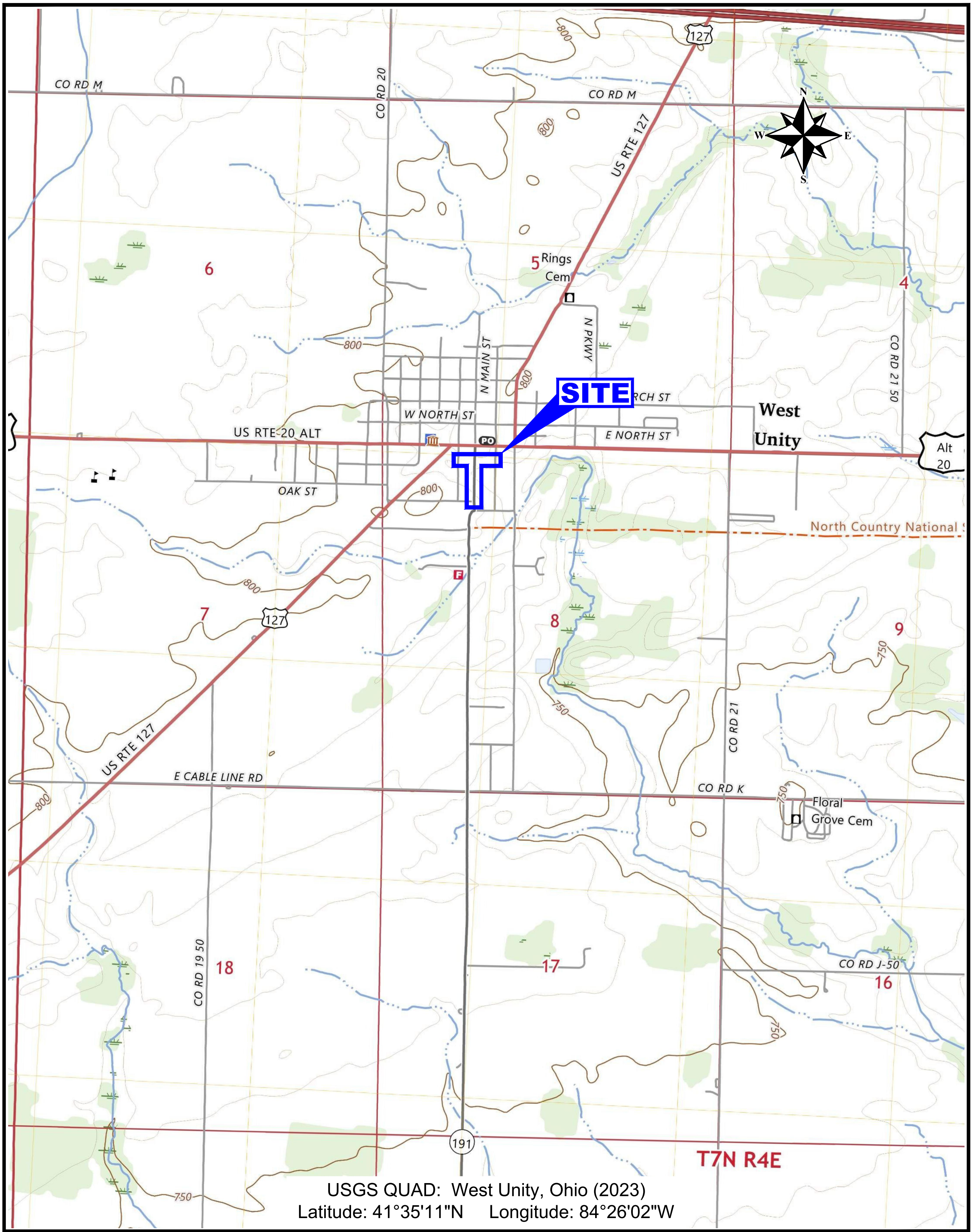
Nicole Redinger

Nicole S. Redinger, E.I.
Geotechnical Engineer

Ahmad Rashid

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

NSR/AKR:kko
Attachments: *Vicinity Map*
Boring Location Plan
Boring Log Terminology
Boring Logs
Moisture Content Summary Sheets
1-Client (via email: administrator@westunity.org)
1-Jones & Henry Engineers, Ltd., Attn: Mr. Kyle M. Brueggemeier (via email: KBrueggemeier@jheng.com)



USGS QUAD: West Unity, Ohio (2023)

Latitude: 41°35'11"N Longitude: 84°26'02"W

VICINITY MAP

Soil Exploration
South Main Street Water Line Project
West Unity, Williams County, Ohio

For: Village of West Unity c/o Jones & Henry Engineering, Ltd.

08-2024 EM

PROJECT NO.	216032
SCALE	1" = 2000'
FIGURE NO.	1

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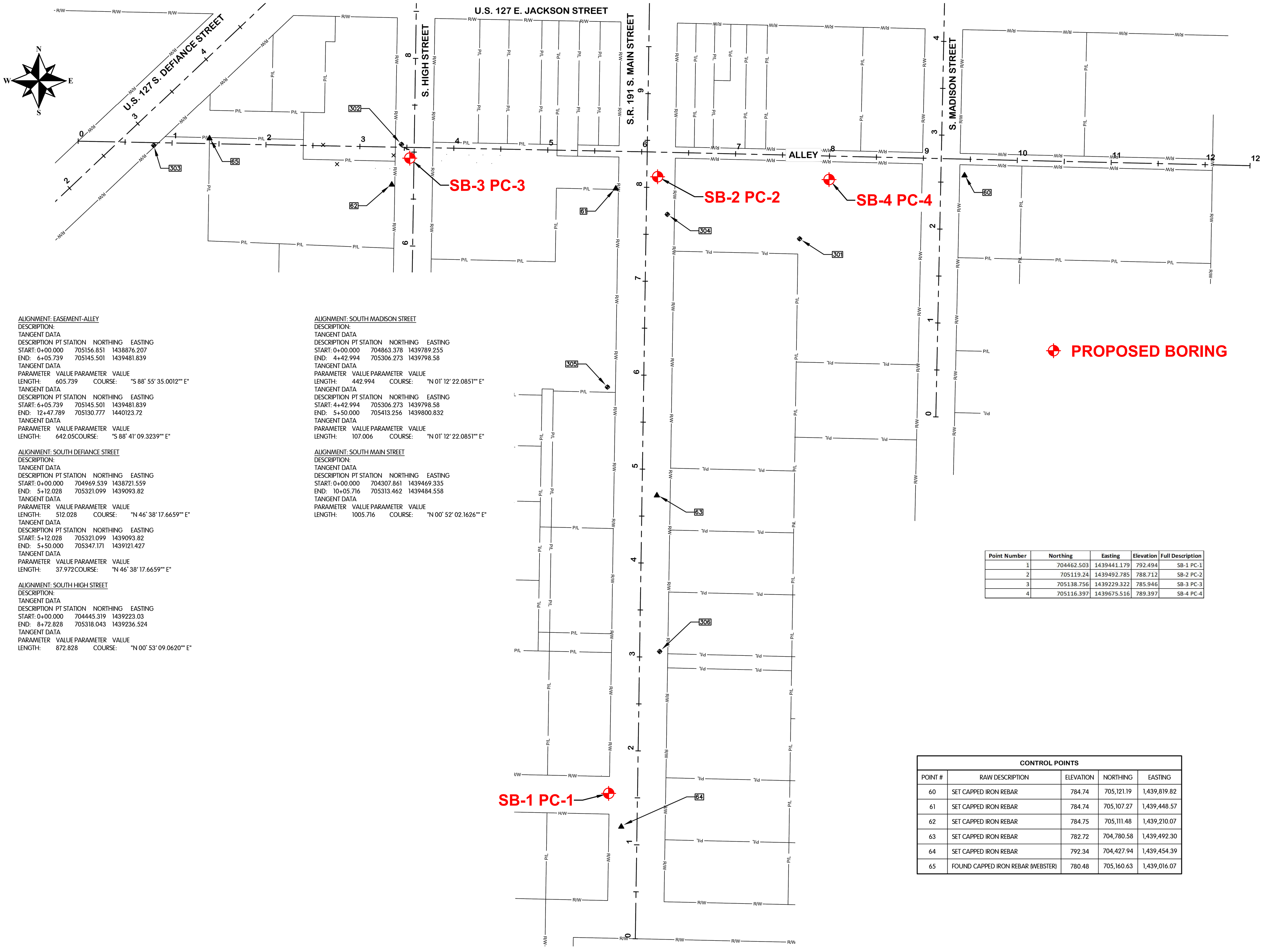

ALIGNMENT: EASEMENT-ALLEY
DESCRIPTION:
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 0+00.000 705156.851 1438876.207
END: 6+05.739 705145.501 1439481.839
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 605.739 COURSE: "S 88° 55' 35.0012"" E"
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 6+05.739 705145.501 1439481.839
END: 12+47.789 705130.777 1440123.72
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 642.05COURSE: "S 88° 41' 09.3239"" E"

ALIGNMENT: SOUTH DEFIANCE STREET
DESCRIPTION:
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 0+00.000 704969.539 1438721.559
END: 5+12.028 705321.099 1439093.82
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 512.028 COURSE: "N 46° 38' 17.6659"" E"
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 5+12.028 705321.099 1439093.82
END: 5+50.000 705347.171 1439121.427
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 37.972COURSE: "N 46° 38' 17.6659"" E"

ALIGNMENT: SOUTH HIGH STREET
DESCRIPTION:
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 0+00.000 704445.319 1439223.03
END: 8+72.828 705318.043 1439236.524
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 872.828 COURSE: "N 00° 53' 09.0620"" E"

ALIGNMENT: SOUTH MADISON STREET
DESCRIPTION:
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 0+00.000 704863.378 1439789.255
END: 4+42.994 705306.273 1439798.58
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 442.994 COURSE: "N 01° 12' 22.0851"" E"
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 4+42.994 705306.273 1439798.58
END: 5+50.000 705413.256 1439800.832
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 107.006 COURSE: "N 01° 12' 22.0851"" E"

ALIGNMENT: SOUTH MAIN STREET
DESCRIPTION:
TANGENT DATA
DESCRIPTION PT STATION NORTHING EASTING
START: 0+00.000 704307.861 1439469.335
END: 10+05.716 705313.462 1439484.558
TANGENT DATA
PARAMETER VALUE PARAMETER VALUE
LENGTH: 1005.716 COURSE: "N 00° 52' 02.1626"" E"

Point Number	Northing	Easting	Elevation	Full Description
1	704462.503	1439441.179	792.494	SB-1 PC-1
2	705119.24	1439492.785	788.712	SB-2 PC-2
3	705138.756	1439229.322	785.946	SB-3 PC-3
4	705116.397	1439675.516	789.397	SB-4 PC-4

CONTROL POINTS

POINT #	RAW DESCRIPTION	ELEVATION	NORTHING	EASTING
60	SET CAPPED IRON REBAR	784.74	705,121.19	1,439,819.82
61	SET CAPPED IRON REBAR	784.74	705,107.27	1,439,448.57
62	SET CAPPED IRON REBAR	784.75	705,111.48	1,439,210.07
63	SET CAPPED IRON REBAR	782.72	704,780.58	1,439,492.30
64	SET CAPPED IRON REBAR	792.34	704,427.94	1,439,454.39
65	FOUND CAPPED IRON REBAR (WEBSTER)	780.48	705,160.63	1,439,016.07

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PROJECT NO.
216032

SCALE
1" = 100'

FIGURE NO.
2

08-2024 EM

BORING LOCATION PLAN

Soil Exploration
South Main Street Water Line Project
West Unity, Williams County, Ohio
For: Village of West Unity c/o Jones & Henry Engineering, Ltd.

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 of 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

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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:

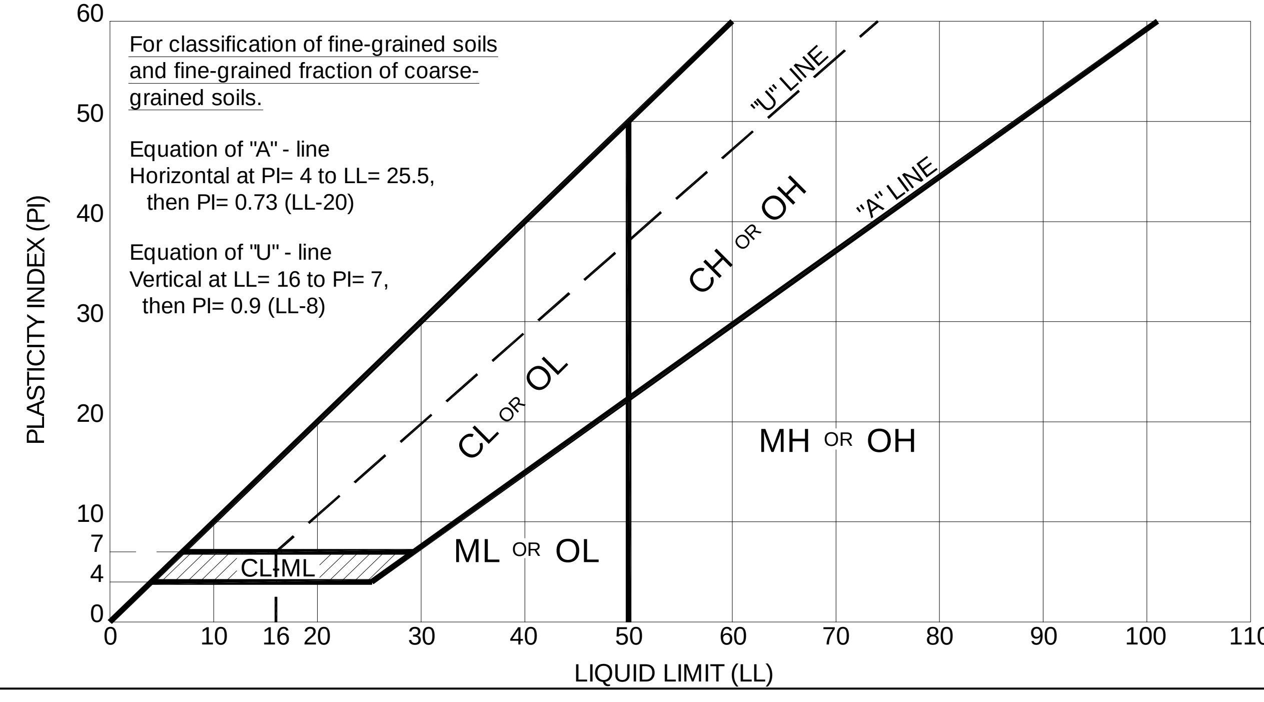
Standard penetration resistance. This value is based on the total number of blows required for the last 12 inches of penetration. (Example: 3/8/9 : N = 8 + 9 = 17)

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
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)	▨	GW	WELL-GRADED GRAVEL WELL-GRADED GRAVEL WITH SAND
			▨	GP	POORLY GRADED GRAVEL POORLY GRADED GRAVEL WITH SAND
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES APPRECIABLE AMT. OF FINES)	▨	GM	SILTY GRAVEL SILTY GRAVEL WITH SAND
			▨	GC	CLAYEY GRAVEL CLAYEY GRAVEL WITH SAND
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)	▨	SW	WELL-GRADED SAND WELL-GRADED SAND WITH GRAVEL
			▨	SP	POORLY GRADED SAND POORLY GRADED SAND WITH GRAVEL
	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMT. OF FINES)	▨	SM	SILTY SAND SILTY SAND WITH GRAVEL
			▨	SC	CLAYEY SAND CLAYEY SAND WITH GRAVEL
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILT AND CLAYS	LIQUID LIMIT LESS THAN 50	▨	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
	SILT AND CLAYS	LIQUID LIMIT GREATER THAN 50	▨	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

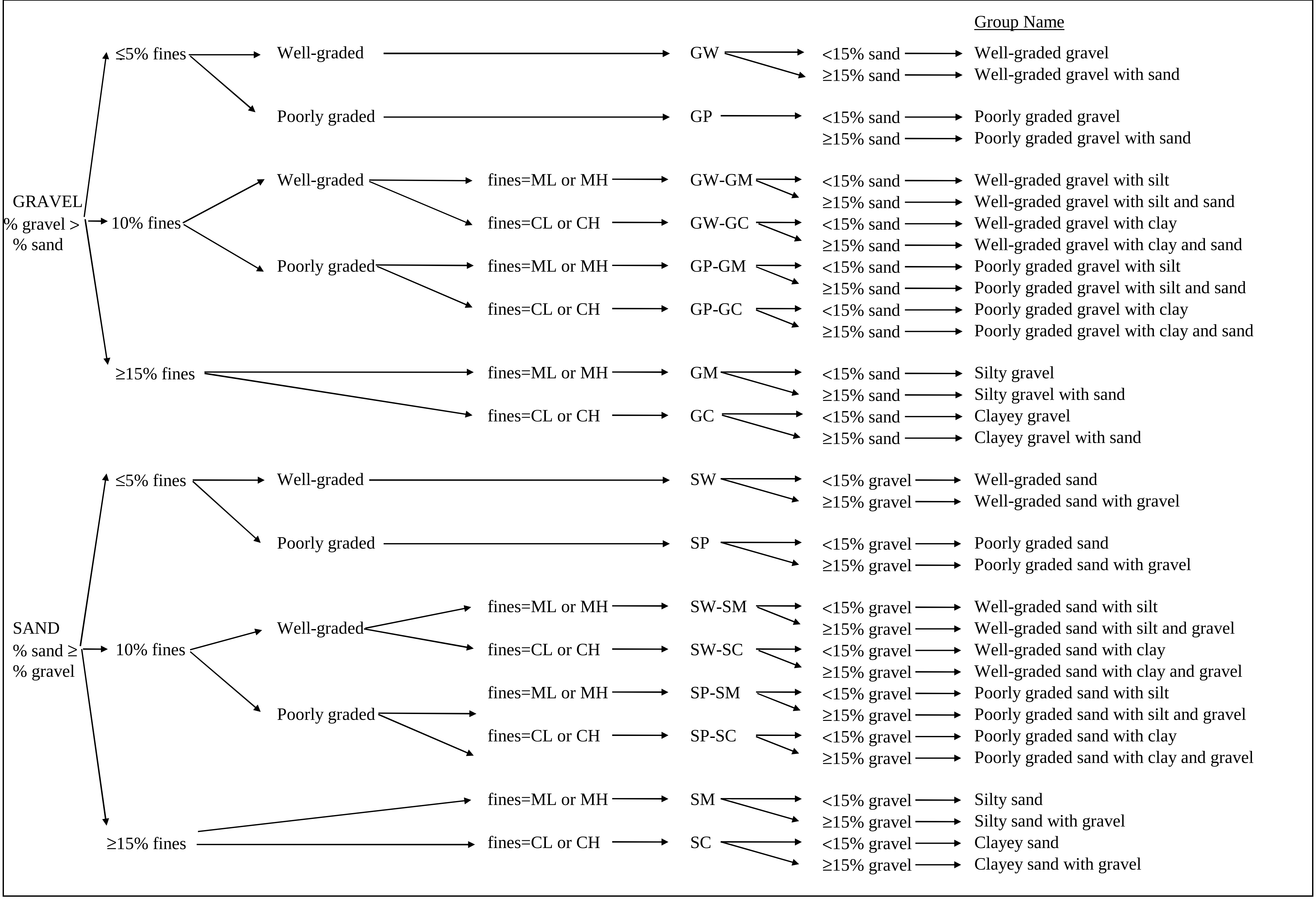


For classification of fine-grained soils and fine-grained fraction of coarse-grained soils.

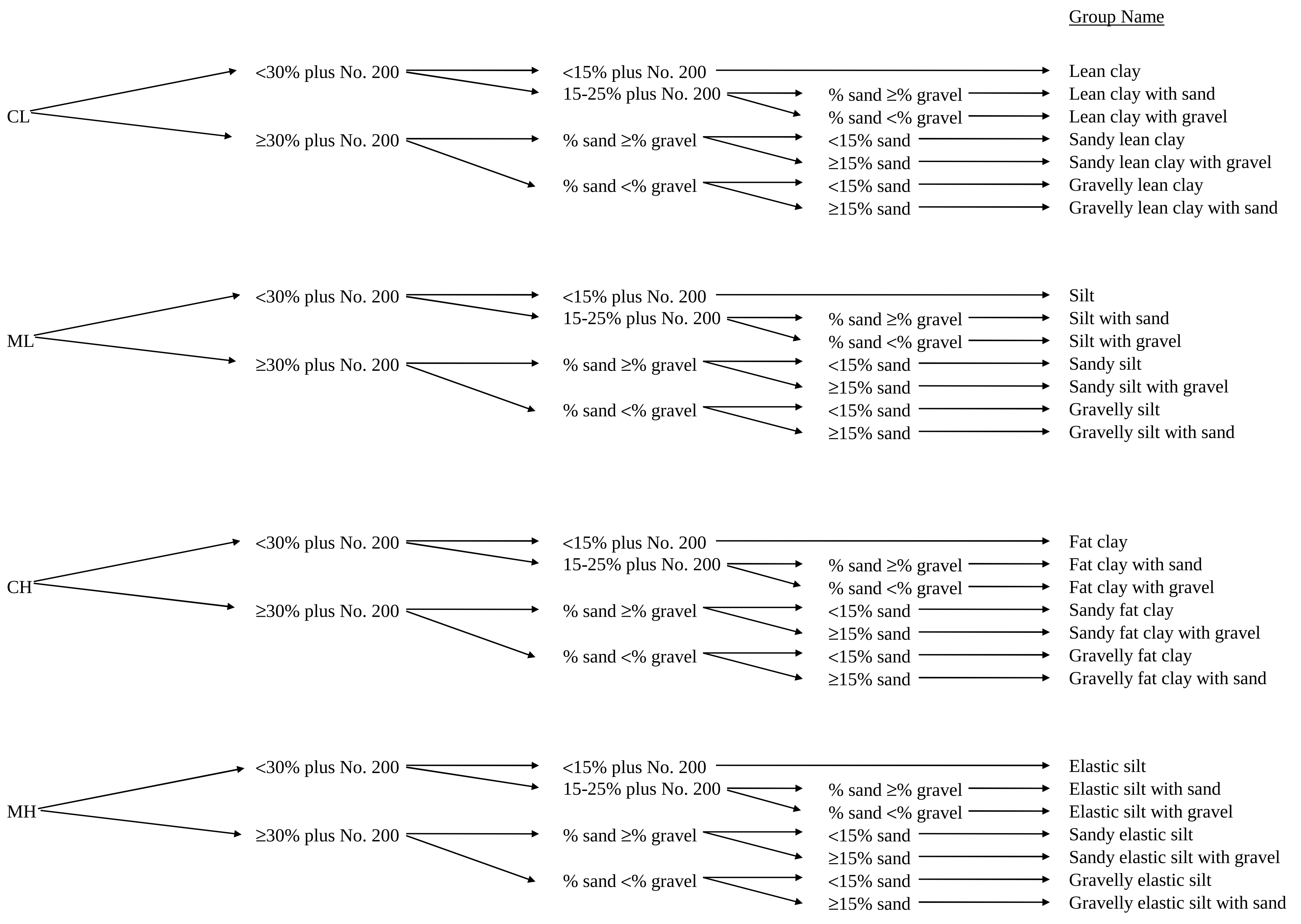
Equation of "A" - line
Horizontal at PI= 4 to LL= 25.5,
then PI= 0.73 (LL-20)

Equation of "U" - line
Vertical at LL= 16 to PI= 7,
then PI= 0.9 (LL-8)

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 flows required for the last two 6-inche 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)

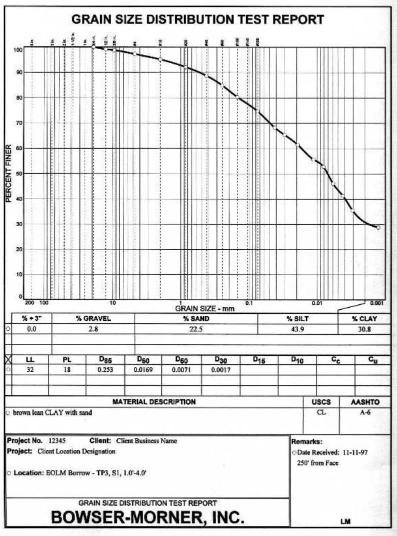
The purpose of this test is to determine the compressibility of the soil. This test is performed on a sample of soil which is 2.5 inches in diameter and 1.0 inch in height, and has been trimmed from relatively “undisturbed” samples. The test is performed with a lever system or an air activated piston 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.



GRAIN SIZE DISTRIBUTION TEST REPORT

	% + 3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	2.8	22.5	43.9	30.8

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	32	18	0.253	0.0169	0.0071	0.0017				

MATERIAL DESCRIPTION	USCS	AASHTO
○ brown lean CLAY with sand	CL	A-6

Project No. 12345 **Client:** Client Business Name
Project: Client Location Designation

○ **Location:** EOLM Borrow - TP3, S1, 1.0'-4.0'

Remarks:
○Date Received: 11-11-97
250' from Face

GRAIN SIZE DISTRIBUTION TEST REPORT
BOWSER-MORNER, INC.

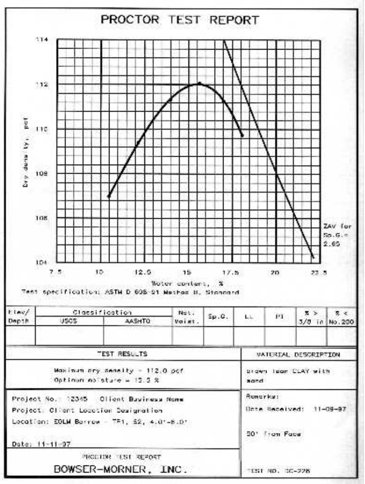
LM

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.



PROCTOR TEST REPORT

Test specification: ASTM D 698-91 Method B, Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in	% < No.200
	USCS	AASHTO						

TEST RESULTS

Maximum dry density = 112.0 pcf
Optimum moisture = 15.5 %

MATERIAL DESCRIPTION

Brown lean CLAY with sand

Project No.: 12345 Client Business Name
Project: Client Location Designation
Location: EOLM Borrow - TP1, S2, 4.0'-8.0'

Date: 11-11-97

Remarks:
Date Received: 11-08-97

50' from Face

PROCTOR TEST REPORT
BOWSER-MORNER, INC.

TEST NO. SC-228

CLIENT
VILLAGE OF WEST UNITY

PROJECT
SOUTH MAIN STREET WATER LINE PROJECT, VILLAGE OF WEST UNITY, WEST UNITY, WILLIAMS COUNTY, OHIO

JOB NO. **216032**

BORING STARTED **8/8/24**
BORING COMPLETED **8/8/24**
DRILLER **XTERRA**
METHOD **2 1/4" HSA**
TYPED BY **kko**

B-1
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. LONG.
SURFACE ELEVATION **792.49'**
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.

COMMENTS

REMARKS

DEPTH	SAMPLE NO.	SAMPLER TYPE	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.
0.0			Asphalt (5")		
			Crushed stone (6")		
1.0	SS-1	▩	Loose brown sand, some silt, trace of clay, moist	1 2 3	5
3.5	SS-2	▩	Stiff brown clay and silt, some sand, moist	2 4 5	9
6.0	SS-3	▩		3 4 4	8
7.0			Loose brown sand, some silt, moist		
8.5	SS-4	▩	(Becomes very loose at 8.5')	1 2 2	4
10.0			Bottom of boring at 10.0 feet		

N VALUE, blows/ft.: 10 20 30 40 50 60 70 80 90

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	▽	8/8/2024
AT COMPLETION	NONE	▼	8/8/2024
OTHER		▼	

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ◧ NQ— ROCK CORE
- ☒ ST — SHELBY TUBE
- ◨ AS — AUGER CUTTINGS
- ⬚ SC— SONIC

BOWSER MORNER.

CLIENT
VILLAGE OF WEST UNITY

PROJECT
SOUTH MAIN STREET WATER LINE PROJECT, VILLAGE OF WEST UNITY, WEST UNITY, WILLIAMS COUNTY, OHIO

JOB NO. **216032**
BORING STARTED **8/8/24**
BORING COMPLETED **8/8/24**
DRILLER **XTERRA**
METHOD **2 1/4" HSA**
TYPED BY **kko**

B-2
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. LONG.
SURFACE ELEVATION **788.71'**
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.

COMMENTS

SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.	REMARKS
	Asphalt (8")			
	Crushed stone (9")			
SS-1	(Fill) Stiff brown clay and silt, some sand, trace of gravel, moist	2 2 2	4	
SS-2	Stiff brown and gray silt and sand, trace of clay, moist	5 7 6	13	
SS-3	Very loose brown sand, some silt, wet	2 1 4	5	⊽
SS-4	Hard gray silt and clay, trace of sand, moist	6 8 11	19	

Bottom of boring at 10.0 feet

DEPTH 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0

N VALUE, blows/ft. 10 20 30 40 50 60 70 80 90

WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	6.5	⊽	8/8/2024
AT COMPLETION	NONE	▼	8/8/2024
OTHER		▼	

- ▩ SS — SPLIT SPOON
- ▥ SL — SPLIT SPOON W/SOIL LINER
- ■ NQ — ROCK CORE
- ☒ ST — SHELBY TUBE
- ▮ AS — AUGER CUTTINGS
- ░ SC — SONIC

BOWSER MORNER.

CLIENT
VILLAGE OF WEST UNITY

PROJECT
SOUTH MAIN STREET WATER LINE PROJECT, VILLAGE OF WEST UNITY, WEST UNITY, WILLIAMS COUNTY, OHIO

JOB NO. **216032**

BORING STARTED **8/8/24**
BORING COMPLETED **8/8/24**
DRILLER **XTERRA**
METHOD **2 1/4" HSA**
TYPED BY **kko**

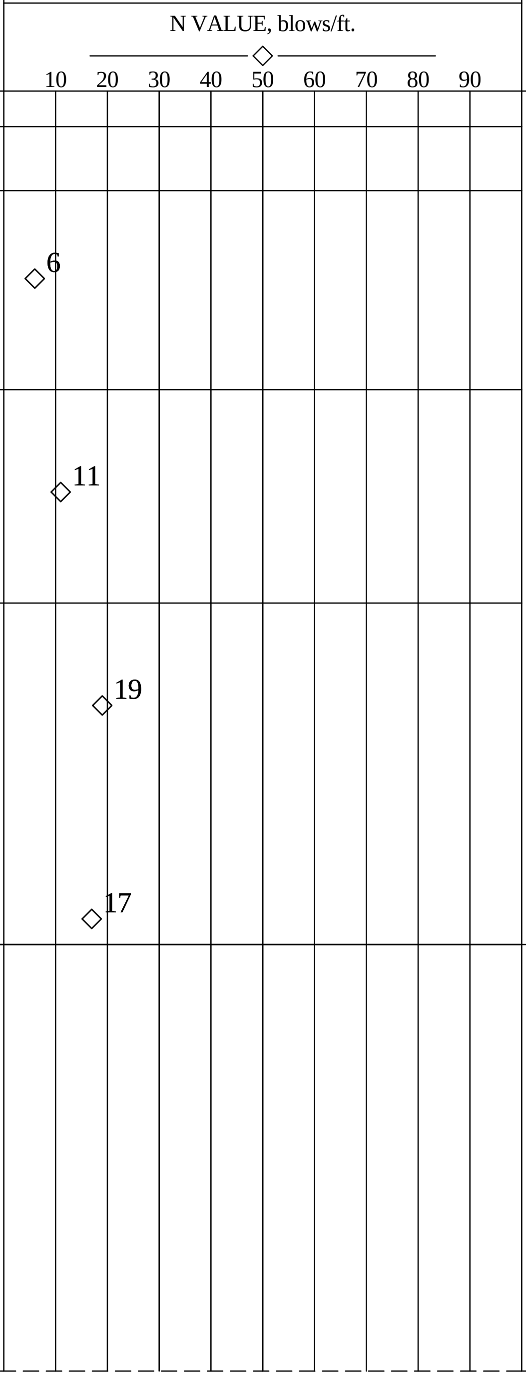
B-3
Boring No.
Sheet 1 of 1

PROJECT LOCATION
LAT. LONG.
SURFACE ELEVATION **785.95'**
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.

COMMENTS

REMARKS

DEPTH	SAMPLE NO.	SAMPLER TYPE	RECOVERY	GRAPHIC LOG	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	N VALUE, blows/ft.
0.0				■	Asphalt (5")		
				☒	Crushed stone (9")		
1.0	SS-1	SS	■	☒	(FILL) Stiff brown clay and silt, some sand, trace of gravel, moist	3 3 3	6
3.5	SS-2	SS	■		Hard brown and gray clay and silt, some sand, trace of gravel, moist	2 5 6	11
6.0	SS-3	SS	■		Very stiff gray silt, some clay, trace of sand, wet	6 9 10	19
8.5	SS-4	SS	■		(Becomes stiff at 8.5')	7 8 9	17
10.0					Bottom of boring at 10.0 feet		



WATER LEVEL MEASUREMENTS

	DEPTH		DATE
INITIAL	NONE	∇	8/8/2024
AT COMPLETION	NONE	▼	8/8/2024
OTHER		▼	

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
⬚ SC— SONIC

BOWSER MORNER.

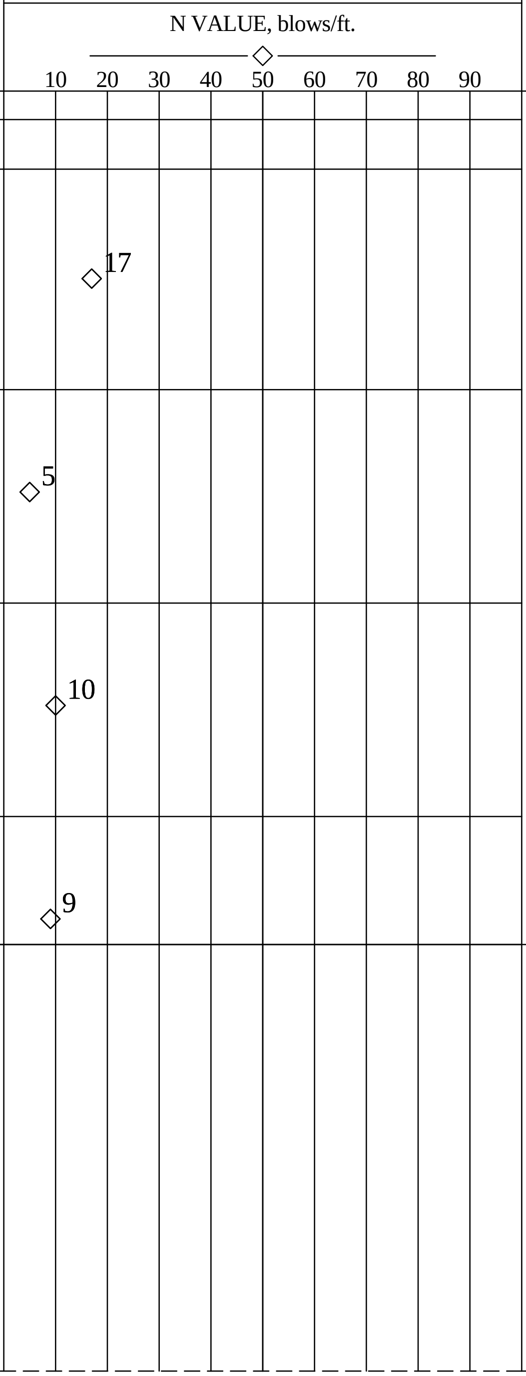
GINT Report Used: NEWLOGIN Report No.: 216032.GPJ GINT Template Used: NATALIE_EDITS.GDT Date Printed: 9/20/24

CLIENT **VILLAGE OF WEST UNITY**	JOB NO. **216032**		
	BORING STARTED **8/8/24**	BORING COMPLETED **8/8/24**	**B-4** Boring No.
PROJECT **SOUTH MAIN STREET WATER LINE PROJECT, VILLAGE OF WEST UNITY, WEST UNITY, WILLIAMS COUNTY, OHIO**	DRILLER **XTERRA**	METHOD **2 1/4" HSA**	
	TYPED BY **kko**		**Sheet 1 of 1**

PROJECT LOCATION
LAT. LONG.
SURFACE ELEVATION **789.40'**
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.

COMMENTS

DEPTH	SAMPLE NO.	VISUAL CLASSIFICATION OF THE MATERIAL	BLOW COUNTS	REMARKS
0.0–0.3		Asphalt (4")		
0.3–0.9		Crushed stone (7")		
0.9–3.5	SS-1	(FILL) Hard brown clay and silt, some sand, trace of gravel, moist	6 9 8	
3.5–6.0	SS-2	Very loose brown sand, some silt, trace of gravel, moist	5 3 2	
6.0–8.5	SS-3	Hard brown and gray clay and silt, some sand, trace of gravel, moist	5 4 6	
8.5–10.0	SS-4	Loose brown sand, some silt, wet	2 4 5	⊽
10.0		Bottom of boring at 10.0 feet		



WATER LEVEL MEASUREMENTS	DEPTH		DATE
INITIAL	8.5	⊽	8/8/2024
AT COMPLETION	NONE	▼	8/8/2024
OTHER		▼	

▩ SS — SPLIT SPOON
▥ SL — SPLIT SPOON W/SOIL LINER
◧ NQ— ROCK CORE
☒ ST — SHELBY TUBE
◨ AS — AUGER CUTTINGS
⬚ SC— SONIC

GINT Report Used: NEWLOGIN Report No.: 216032.GPJ GINT Template Used: NATALIE_EDITS.GDT Date Printed: 9/20/24

MOISTURE CONTENT SUMMARY SHEET

Job No. 216032

Boring No.	Sample No.	Depth (Feet)	Moisture (%)
1	SS-1	1.0-2.5	15.8
	SS-2	3.5-5.0	20.2
	SS-3	6.0-7.5	8.5
	SS-4	8.5-10.0	6.7
2	SS-1	1.0-2.5	20.2
	SS-2	3.5-5.0	18.8
	SS-3	6.0-7.5	*
	SS-4	8.5-10.0	12.6
3	SS-1	1.0-2.5	17.9
	SS-2	3.5-5.0	22.6
	SS-3	6.0-7.5	19.6
	SS-4	8.5-10.0	*
4	SS-1	1.0-2.5	15.1
	SS-2	3.5-5.0	8.0
	SS-3	6.0-7.5	16.9
	SS-4	8.5-10.0	*

*Saturated

BOWSER MORNER®