STRUCTURE FOUNDATION EXPLORATION

WOO-75-29.93, PID 119007

Proposed Bridge Replacement

Interstate Route 75 and Lime City Road
Rossford, Wood County, Ohio

Submitted to *ODOT District 2*
Date *August 2023*

Prepared by

TTL associates inc
Environmental, Geotechnical Engineering & Testing

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August 22, 2023 **TTL Project No. 230574**

Ms. Jorey Summersett, P.E.
ODOT District 2
317 East Poe Road
Bowling Green, Ohio 43402

FINAL REPORT
Structure Foundation Exploration
WOO-75-29.93, PID 119007
Proposed Bridge Replacement
Interstate Route 75 and Lime City Road
Rossford, Wood County, Ohio

Dear Ms. Summersett:

Following is the report of the Structure Foundation Exploration performed by TTL Associates, Inc. (TTL) at the site of the referenced project. This exploration was performed in general accordance with TTL Proposal No. 230574, dated March 23, 2023, and was authorized on March 31, 2023 in accordance with Agreement No. 37607, referencing encumbrance number 740898.

A draft report was issued on July 27, 2023. This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, and our recommendations for design and construction of bridge foundations, new embankment fill, and pavements. Additionally, this report incorporates comments from ODOT provided on July 28, 2023 with regards to pile drivability, tips, boulders, time rate of consolidation, and undercut materials. Upon addressing these comments, we are now submitting the report as "FINAL" in accordance with ODOT protocol.

Should you have any questions regarding this report or require additional information, please contact our office.

Sincerely,

TTL Associates, Inc.

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FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
WOO-75-29.93, PID 119007
PROPOSED BRIDGE REPLACEMENT
INTERSTATE ROUTE 75 AND LIME CITY ROAD
ROSSFORD, WOOD COUNTY, OHIO

FOR

ODOT DISTRICT 2
317 EAST POE ROAD
BOWLING GREEN, OHIO 43402

SUBMITTED

AUGUST 22, 2023
TTL PROJECT NO. 230574

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EXECUTIVE SUMMARY

This Structure Foundation Exploration report has been prepared for the replacement of the existing bridge for the referenced project. This project is location along Lime City Road over Interstate Route 75 (I-75) in Rossford, Wood County, Ohio. This exploration included seven test borings. A summary of the conclusions and recommendations of this study are as follows:

1. Borings B-001, B-002, and B-006 encountered surface materials consisting of asphalt ranging in thickness from 7⅝ to 8½ inches, which were underlain by pavement base materials ranging in thickness from 6⅛ to 11½ inches. Borings B-004 and B-007 encountered surface materials consisting of topsoil ranging in thickness 7 to 8 inches. Distinct surface cover was not encountered in Borings B-003 and B-005.

2. At the surface of Borings B-003 and B-005, as well as underlying the surface materials in each of the borings except Boring B-007, cohesive existing **embankment fill materials** were encountered to Elevs. 628 to 624. The cohesive existing embankment fill consisted of sandy silt, silt and clay, silty clay, as well as clay.

3. The subsoils encountered underlying the surface and fill materials can be generally described as four strata of predominantly cohesive soils exhibiting varying strength and moisture characteristics, overlying a stratum of granular soils, overlying bedrock. **Stratum I** consisted of predominantly stiff to very stiff cohesive lacustrine deposits encountered underlying the surface materials in Boring B-007, as well as the existing fill materials in the remaining borings, to approximate Elevs. 622 to 619. These cohesive soils consisted of sandy silt (ODOT A-4a), silt and clay (ODOT A-6a), silty clay (ODOT A-6b), as well as clay (ODOT A-7-6). **Stratum II** consisted of predominantly stiff to very stiff cohesive glacial till deposits encountered underlying Stratum I to approximate Elevs. 603 to 589. Borings B-002, B-006, and B-007 were terminated within Stratum II. The Stratum II cohesive soils consisted of silty clay (ODOT A-6b), as well as silt and clay (ODOT A-6a). **Stratum III** consisted of predominantly stiff cohesive soils encountered underlying Stratum II to approximate Elevs. 582 to 580. The Stratum III cohesive soils consisted of silty clay (ODOT A-6b), as well as silt and clay (ODOT A-6a). **Stratum IV** consisted of very stiff to hard cohesive glacial till, commonly referred to as "hardpan" in this region, encountered underlying Stratum III to approximate Elevs. 573 to 565. The Stratum IV hardpan materials consisted of sandy silt (ODOT A-4a), silt and clay (ODOT A-6a), as well as silty clay (ODOT A-6b). A zone of granular soils was encountered within each of the borings underlying the hardpan, just above the bedrock. The granular soils consisted of gravel and/or stone fragments with sand and silt (ODOT A-2-4), as well as course and fine sand (ODOT A-3a).

4. Weathered dolomite bedrock was encountered underlying the granular soil zone Borings B-0003 and B-005, at approximate Elevs. 566 to 562. The weathered rock zones were on the order of ½ to 1 foot in thickness. A distinct weathered rock zone was not encountered in Boring B-004. Auger refusal on "intact" dolomite bedrock was encountered in each of the pier borings at approximate Elevs. 567 to 562. Rock core data are summarized in the following table.

Summary of Rock Core Data						
Boring Number	**Rock Core**	**Depth Below Ground Surface (feet)**	**Approximate Elevation (feet)**	**Rock Core Recovery (%)**	**RQD (%)**	**Unconfined Compressive Strength (psi)**
B-003	NQ2-1	65½ to 70½	562 to 557	93	83	18,880
B-004	NQ2-1	64½ to 69½	567 to 562	93	70	14,940
	NQ2-2	69½ to 74½	562 to 557	95	95	-
B-005	NQ2-1	64 to 69	565 to 560	80	48	14,530

5. Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that "normal" groundwater levels at this structure location will generally occur at approximate Elevs. 615 to 610.

6. Fill will be placed to achieve design grades throughout the project area. Approximately 2 feet of fill is generally anticipated to raise site grades relative to the existing roadway centerline. Fill will also be required to widen embankments. Where sidehill fills are planned on the face of an existing slope which is steeper than 4H:1V, ODOT Office of Geotechnical Engineering (OGE) recommends special benching to assure that the new fill section and existing embankment are "knitted" together. This is expected to be the case for much of the project area along existing slopes. For the general fill anticipated to achieve design grades on the order of 2 feet, settlement was calculated to be on the order of 1½ to 2 inches at the bridge abutments.

7. To accommodate the bridge widening, additional pier support is required. For our evaluations, an ultimate capacity of 180 kips was considered, based on a factor of safety of 2 applied to the required 45 tons allowable (working) capacity. DRIVEN analyses indicate that the 12x53 H-Piles are expected to achieve the required capacity in the Stratum II predominantly stiff to very stiff cohesive glacial till deposits, the Stratum III predominantly stiff cohesive soils, or at the transition to the Stratum IV "hardpan." We also evaluated smaller 10x42 H-Piles in the event they are more economical, which are expected to achieve the required capacity in the Stratum III predominantly stiff cohesive soils, or at the transition to the Stratum IV "hardpan."

8. Based on the ODOT "Subgrade Analysis" worksheet (V14.6, 02/11/22), none of the borings contained subgrade soils which indicated subgrade modification is likely to be required. Based on the subgrade analysis and our understanding of the project, it is our recommendation to plan for undercuts for approximately 10 percent of the roadway subgrades to a depth of 12 inches and replacement with geotextile and granular engineered fill for soils which were determined to be significantly wet of optimum.

9. Based on the ODOT "Subgrade Analysis" worksheet, a design CBR value of 6 percent was determined for the project.

This executive summary highlights our evaluations and recommendations and should only be utilized in conjunction with the accompanying report, including the detailed findings, analysis and recommendations, and qualifications presented herein.

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1.0 INTRODUCTION

This Structure Foundation Exploration report has been prepared for the replacement of the existing bridge along Lime City Road and raising clearances over Interstate Route 75 (I-75) in Rossford, Wood County, Ohio. The general project area is shown on the Site Location Map (Plate 1.0).

This exploration was performed in general accordance with TTL Proposal No. 230574, dated March 23, 2023, and was authorized on March 31, 2023 in accordance with Agreement No. 37607, referencing encumbrance number 740898.

1.1 Purpose and Scope of Exploration

The purpose of this exploration was to evaluate the subsurface conditions relative to the design and construction of foundations for a new bridge structure, new embankment fill, as well as design and construction of pavements at the referenced location. To accomplish this, TTL performed seven test borings, field and laboratory soil testing, a geotechnical engineering evaluation of the test results, and a review of available geologic and soils data for the project area.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures utilized to evaluate the subsurface conditions at the site, and presents our findings from the field and laboratory testing. This report also presents our evaluations and conclusions in accordance with ODOT Geotechnical Design Manual (GDM) Section 600 (formerly GB-1) (January 20, 2023), as well as provides our design and construction recommendations for foundations for the proposed bridge replacement structure.

This report includes:

- A description of the subsurface soil and groundwater conditions encountered in the borings.
- Design recommendations for bridge foundations, new embankment fill, and pavements.
- Recommendations concerning soil- and groundwater-related construction procedures such as site preparation, earthwork, foundation, embankment, and pavement construction, as well as related field testing.

Appendix B includes pertinent ODOT Geotechnical Engineering Design Checklists that apply to the scope of this report.

This exploration did not include an environmental assessment of the surface or subsurface materials at the site.

1.2 Proposed Construction

It is our understanding that the existing four-span bridge will be replaced with a new superstructure. The superstructure will be raised two feet to provide a vertical clearance of 16½ feet, and widening the bridge to include a multi-use path. The existing piers and abutments will remain for the new bridge structure. To accommodate the bridge widening, additional pier support is required. The bottom of pile cap elevation for Pier 1, Pier 2, and Pier 3 (from south to north) are indicated to be Elevs. 618.50, 624.00, and 619.50, respectively. Based on the original bridge drawings, design loads were indicated to be 45 tons.

For the roadway, we have assumed that the proposed roadway section will be approximately 15 inches thick.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 General Geology and Hydrogeology

Published geologic maps from the Ohio Department of Natural Resources (ODNR) indicate that the project site is located within the Maumee Lake Plains Physiographic Region of Ohio. This region includes upper profile soils consisting of silty and clayey lacustrine deposits which are underlain by predominantly silty and clayey glacial till, before encountering bedrock.

The lacustrine soils consist of predominantly silty clays and lean clays, and often exhibit alternating thin layers of interbedded silts and clays known as varves. Varved soils are characteristic of lacustrine deposits, and the thin layering is typically attributed to seasonal or other cyclic variations of sedimentation in the lake waters. In addition, thin sand seams and partings may be encountered.

The glacial till, also referred to as moraine, was deposited by the advance and retreat of glacial ice. Due to the weight of the ice mass, the till deposits are moderately to highly over-consolidated, that is, the existing soil deposits have experienced a previous vertical stress significantly higher than the present effective vertical stress due to the remaining overlying soil strata in the profile. The till may contain cobbles and/or boulders left in the till soil matrix. Additionally, seams of granular soils may also be encountered within glacial tills. These granular seams may or may not be water bearing.

Bedrock at the site is Silurian age, broadly mapped as the Monroe limestone formation. Specific to the project site, the uppermost carbonate rock formation is mapped as Greenfield Dolomites. Based on available bedrock topography maps, the top of bedrock can be expected to be on the order of 60 to 90 feet below existing grades.

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey indicates that soils in the project area are predominantly mapped as Latty silty clay. The Latty silty clay soils consist of lacustrine deposits over till formed on till-floored lake plains as well as wave-worked till plains. The Latty silty clay soils are considered very poorly drained and exhibit very low permeability.

2.2 Observations of the Project

TTL performed site reconnaissance on May 31 and July 10, 2023. We traversed the site on foot while performing a visual inspection of the ground to evaluate the accessibility to the boring locations along Lime City Road and Interstate Route 75 (I-75) in Rossford, Wood County, Ohio.

The northbound lane of the existing bridge was closed to traffic, and a portion of the bridge deck had been demolished. Pavements south of the bridge structure appeared to be in good condition with a recent overlay. Pavements north of the bridge structure were in poor to fair condition, considering the alligator and longitudinal cracking observed throughout the pavement surface.

The existing slopes were largely covered with vegetation, and appeared in generally good condition. Some surface sloughing was observed surrounding a storm drain along the southeast slope.

Ponded water was observed under the bridge between the Rear (South) Abutment and Pier 1.

Surrounding site grades were generally level. Surrounding land usage included agricultural, rural residential, and commercial.

3.0 EXPLORATION

3.1 Historic Borings

Historic borings were performed for the structure in 1963, prior to the construction of the existing embankments and bridge structure. Ground surface elevations within the historic borings were Elevs. 625.7 and 625.4. The encountered soils consisted of predominantly stiff to very stiff native cohesive soils to Elevs. 575.7 and 575.4, which were underlain by very stiff to hard native cohesive soils (commonly referred to as “hardpan”). Bedrock was encountered at Elevs. 560.7 and 563.4. Historic Logs of Test Borings are attached to this report for reference only, and were not used for our evaluations.

Pile lengths and soils at the pile tip ascertained from the historic borings as well as the historic plans for the existing bridge are summarized in the following table.

3.1 Historic Pile Information

Location	Historic Bottom of Pile Cap Elevation (feet)	Estimated Average Pay Length of Piles (feet)	Pile Stickup (feet)	Pile Tip Elevation (feet)	Nearby Historic Boring	Soils at Pile Tip
Pier 1	617.5	55	1	563.5	B-001-0-63	Within “dolomite boulders,” 3 feet above bedrock
Pier 2	623.0	55	1	569.0	None	Approximately 6 feet into hardpan
Pier 3	618.5	55	1	564.5	B-008-0-63	Within hardpan, 1 foot above bedrock

3.2 Project Exploration Program

This exploration included seven test borings, designated as Borings B-001-0-23 through B-007-0-23, performed by TTL on June 9 through 14, 2023. These borings are fully designated as Borings B-001-0-23 through B-007-0-23 in accordance with ODOT protocol, but the “-0-23” portion of the nomenclature is generally omitted for ease of identification in the discussions within this report. The borings were located in the field by TTL based on the provided plan for the existing structure and coordination with ODOT District 2 (ODOT District 2). Borings B-001, B-002, and B-006 were performed within the existing roadway along Lime City Road. Borings B-003, B-004, and B-005 were performed at the rear abutment, pier, and forward abutment of the existing bridge, respectively. The approximate locations of the borings are shown on the Test Boring Location Plan (Plate 2.0).

Horizontal coordinates and ground surface elevations at the boring locations were surveyed by TTL. This boring data, as well as boring termination depths and elevations, are summarized in the following table.

Table 3.2 Boring Locations and Depths

Boring Number	Location	Type	Latitude (degrees)	Longitude (degrees)	Ground Surface Elevation (feet)	Boring Termination Depth (feet)	Boring Termination Elevation (feet)
B-001	Lime City Road	Roadway - A	41.57996916	-83.56743314	636.1	7.5	628.6
B-002	Lime City Road	Roadway - A Embankment - B1	41.58072254	-83.56747036	646.1	40	606.1
B-003	Lime City Road	Bridge - E1	41.581606	-83.56737456	627.4	70.5	556.9
B-004	I-75	Bridge - E1	41.582072	-83.567374	631.4	74.5	556.9
B-005	Lime City Road	Bridge - E1	41.58236052	-83.56754709	629.3	69	560.3
B-006	Lime City Road	Roadway - A Embankment - B1	41.58329049	-83.56746701	643.9	40	603.9
B-007	Lime City Road (Toe)	Embankment - B1	41.58305305	-83.56776578	626.1	10	616.1

In accordance with the ODOT Specifications for Geotechnical Explorations (SGE), Borings B-001, B-002, and B-006 were planned as ODOT Type A subgrade borings. Borings B-002, B-006, and B-007 were planned as ODOT Type B1 roadway borings. Borings B-003, B-004, and B-005 were planned as ODOT Type E1 structure borings. Termination depths for the borings are shown above in Table 3.2.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering and inspection services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.3 Boring Methods

The test borings performed during this exploration were drilled with a CME 75 truck-mounted drilling rig, a Diedrich D70 track-mounted drilling rig, as well as a track-mounted Geoprobe® 7822DT with drilling capabilities, utilizing 3-inch outside diameter solid stem augers or 3¼-inch inside diameter hollow-stem augers. During auger advancement, samples were obtained continuously over 18-inch split-spoon sample drives in Type A roadway borings. Samples were obtained at 2½-foot intervals in the Type B1 embankment borings. Samples were obtained at 2½-foot intervals to a depth of 30 feet and at 5-foot intervals thereafter in Type B and E3 borings.

Split-spoon (SS) soil samples were obtained by the Standard Penetration Test Method (ASTM D 1586). The Standard Penetration Test (SPT) consists of driving a 2-inch outside diameter split-spoon sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments, with the number of blows per increment being recorded, and these data are presented under the "SPT" column on the Logs of Test Borings attached to this report. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance, or N_m-value, and is typically reported in blows per foot (bpf). The N_m-values were corrected to an equivalent rod energy ratio of 60 percent, N_{60}. The calibrated hammer/rod energy ratios are summarized in the following table.

Table 3.3. Drilling Rig Calibration Data

Drilling Rig	Calibration Date	Hammer/Rod Energy Ratio
CME 75	February 20, 2023	72.9 percent
Diedrich D70	April 13, 2022	90.0 percent
GeoProbe®	March 16, 2022	91.0 percent*

* This energy ratio is limited to an upper bound of 90 percent for the purposes of analyses and reporting in accordance with the ODOT Specification for Geotechnical Explorations (SGE).

The N_{60}-values are presented on the attached Logs of Test Borings attached to this report. In conjunction with published data and typical correlations, the N_{60}-values can be evaluated as a measure of soil compactness/consistency as well as shear strength and bearing capacity.

Ten Shelby tube samples, designated ST on the Logs of Test Borings, were obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into relatively undisturbed soil in accordance with ASTM D 1587. The Shelby tubes were then extracted from the subsoils, and the ends were capped and sealed. The samples were transported to our laboratory where they were extruded, classified, and tested.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings along with information related to sample data, SPT results and corresponding N_{60}-values, water conditions observed in the borings, and laboratory test data. Field and laboratory data were incorporated into gINT™ software for presentation purposes. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

3.4 Laboratory Testing Program

All soil samples were visually or manually classified in accordance with the ODOT Soil Classification System. All samples of the subsoils were also tested in our laboratory for moisture content (ASTM D 2216). Atterberg limits tests (ASTM D 4318) and particle size analyses (ASTM D 422) were performed on selected samples to determine soil classification and index properties. Dry density determinations and unconfined compressive strength tests (ASTM D 2166) by the constant rate of strain method were performed on eight Shelby tube samples. Unconfined compressive strength estimates were obtained for the remaining intact cohesive samples using a calibrated hand penetrometer. These test results are presented on the Logs of Test Borings attached to this report. Unconfined Compressive Strength sheets are attached for the tested Shelby tube specimens.

Additionally, a one-point unconsolidated-undrained (UU) triaxial compressive strength test (ASTM D 2850) was performed on the recovered Shelby tube sample from Boring B-5 (ST-16). The UU test was performed on a specimen tested at confining pressures approximately equal to the existing overburden pressure at the sample depth. The results of this test are attached to this report.

One-dimensional consolidation tests (ASTM D 2435) were performed on samples from Borings B-0002 (ST-9), B-005 (ST-16), and B-007 (ST-3). The results of these tests are attached to this report.

Recovered rock core specimens were visually classified in general accordance with Ohio Department of Transportation (ODOT) “Specifications for Geotechnical Explorations” (SGE) criteria. Selected intact rock specimens were tested for unconfined compressive strength in accordance with ASTM D 7012, Method C. Results of these tests are presented on the Logs of Test Borings and the attached Unconfined Compressive Strength Test results.

The rock core specimens were prepared using a table saw to obtain flat perpendicular ends with respect to the longitudinal specimen, then the ends were capped using capping compound to ensure they were relatively flat. The planeness of the bearing surfaces of the specimens were checked by means of a straightedge and feeler gauge, and the capped surfaces were determined to be plane within 0.002 inches (0.05 mm). The surfaces of the specimens in contact with the lower bearing block of the testing machine were similarly evaluated for perpendicularity to the axis by less than 1 degree (approximately equivalent to a deviance of 0.07 inches along the 4-inch specimen). ASTM D 7012 requires that we indicate the sample was not prepared using specialized equipment per ASTM D 4543, and that the reported results may differ from those obtained using a test specimen prepared per ASTM D 4543. However, the difference should be insignificant for strong rock, such as encountered for this project, but the difference can be more pronounced for weak rock.

4.0 FINDINGS

4.1 General Site Conditions

The project site is located along Lime City Road, between Mandell Road and Buck Road, in Rossford, Wood County, Ohio. Lime City Road traverses over I-75, with elevations at the top of the embankments on the order of Elev. 648 at the overpass. Grades along I-75 were generally level with the exception of existing ditches, and ground surface elevations at the pier boring locations ranging from Elevs. 631 to 627.

4.2 General Surface, Soil, and Bedrock Conditions

Borings B-001, B-002, and B-006 were performed along Lime City Road, and encountered surface materials consisting of asphalt ranging in thickness from 7⅝ to 8½ inches, which were underlain by pavement base materials ranging in thickness from 6⅛ to 11½ inches. Photographic logs of the pavement cores are attached to this report.

Borings B-003, B-004, and B-005 were performed along the grassy shoulders and median of I-75. Boring B-007 was performed at the toe of the embankment slope southeast of the bridge structure. Borings B-004 and B-007 encountered surface materials consisting of topsoil ranging in thickness 7 to 8 inches. Distinct surface cover was not encountered in Borings B-003 and B-005.

At the surface of Borings B-003 and B-005, as well as underlying the surface materials in each of the borings except Boring B-007, cohesive existing **embankment fill materials** were encountered to Elevs. 628 to 624. Boring B-001 was terminated within the embankment fill at approximate Elev. 629. The cohesive existing embankment fill consisted of sandy silt, silt and clay, silty clay, as well as clay. Non-soil materials within the fill consisted of asphalt fragments and organics, in trace quantities. SPT N_{60}-values ranged from 9 to 30 blows per foot (bpf), indicative of stiff to very stiff consistency. Moisture contents generally varied from 13 to 21 percent, although a moisture content of 27 percent was determined for the sample from Boring B-004 (SS-1).

Underlying the embankment fill in Boring B-002, a 4-inch-thick section of buried asphalt was encountered.

The subsoils encountered underlying the surface and fill materials can be generally described as four strata of predominantly cohesive soils exhibiting varying strength and moisture characteristics, overlying a stratum of granular soils, overlying bedrock. These strata have been interpreted based on broad geological depositional patterns, as well as soil texture, moisture contents, dry unit weights, unconfined compressive strengths, undrained shear strengths, and SPT N_{60}-values recorded in the borings. It should be noted that the demarcations between cohesive soil strata can be transitional with respect to strength and moisture conditions, particularly where there are influences of fluctuating groundwater conditions, and depositional changes between the lacustrine soils, reworked till, and underlying parent till zones.

Descriptions of soil characteristics and properties for each of the generalized strata are provided below. Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

Stratum I consisted of predominantly stiff to very stiff cohesive lacustrine deposits encountered underlying the surface materials in Boring B-007, as well as the existing fill materials in the remaining borings, to approximate Elevs. 622 to 619. These cohesive soils consisted of sandy silt (ODOT A-4a), silt and clay (ODOT A-6a), silty clay (ODOT A-6b), as well as clay (ODOT A-7-6). SPT N_{60}-values generally ranged from 11 to 19 blows per foot (bpf). Unconfined compressive strengths generally ranged from 2,395 to 6,500 pounds per square foot (psf), with occasional higher values likely indicative of desiccation. Moisture contents ranged from 14 to 30 percent.

Stratum II consisted of predominantly stiff to very stiff cohesive glacial till deposits encountered underlying Stratum I to approximate Elevs. 603 to 589. Borings B-002, B-006, and B-007 were terminated within Stratum II. The Stratum II cohesive soils consisted of silty clay (ODOT A-6b), as well as silt and clay (ODOT A-6a). SPT N_{60}-values generally ranged from 12 to 30 bpf. Unconfined compressive strengths ranged from approximately 2,800 to 8,000 psf. Moisture contents ranged from 14 to 18 percent.

In Boring B-003, a 1½-inch seam of wet granular soils consisting of fine sand (ODOT A-3) was encountered within Stratum II at approximate Elev. 610.5.

Stratum III consisted of predominantly stiff cohesive soils encountered underlying Stratum II to approximate Elevs. 582 to 580. The Stratum III cohesive soils consisted of silty clay (ODOT A-6b), as well as silt and clay (ODOT A-6a). SPT N_{60}-values ranged from 8 to 12 bpf. Unconfined compressive strengths ranged from 2,000 psf or greater. An unconsolidated-undrained (UU) triaxial compressive shear strength (s_u) of 1,050 psf was determined for one sample from Boring B-005 (ST-16). Moisture contents ranged from 16 to 25 percent.

Stratum IV consisted of very stiff to hard cohesive glacial till, commonly referred to as "hardpan" in this region, encountered underlying Stratum III to approximate Elevs. 573 to 565. The Stratum IV hardpan materials consisted of sandy silt (ODOT A-4a), silt and clay (ODOT A-6a), as well as silty clay (ODOT A-6b). SPT N_{60}-values ranged from 30 to 47 bpf in the upper portion of the hardpan. Increased resistance occurred with increased depth, resulting in split-spoon refusal (50 or more blows per foot over six inches or less penetration) for the deepest sample from this stratum in Boring B-003 (SS-18). Unconfined compressive strengths ranged from 9,000 psf to greater than 9,000 psf (the highest obtainable reading using a calibrated hand penetrometer). Moisture contents ranged from 8 to 17 percent.

A zone of granular soils was encountered within each of the borings underlying the hardpan, just above the bedrock. The granular soils consisted of gravel and/or stone fragments with sand and silt (ODOT A-2-4), as well as course and fine sand (ODOT A-3a). Within the granular soils, the SPT resulted in refusal. Moisture contents varied from 10 to 13 percent.

One-dimensional consolidation tests were performed on four samples within the soil strata and results are summarized in the following table.

Table 4.2.A. One-Dimensional Consolidation Test Results

Boring / Sample Number	Sample Depth (feet)	Approx. Sample Elevation (feet)	Interpreted Stratum	Compression Index (C_c) / Recompression Index (C_r)	Estimated Previous Consolidation Pressure, p_c (psf)	Liquid Limit/ Plasticity Index (% / %)	Moisture Content (%)	Void Ratio, e_o
B-002 (ST-9)	16 to 17.7	630 to 628	Embankment Fill	0.213 / 0.039	8,400	44 / 22	22	0.654
B-005 (ST-16)	41 to 43	588 to 586	Stratum III	0.115 / 0.026	6,000	30 / 13	19	0.453
B-007 (ST-3)	6 to 8	620 to 618	Stratum II	0.134 / 0.021	5,200	30 / 12	15	0.462

Weathered dolomite bedrock was encountered underlying the granular soil zone Borings B-0003 and B-005, at approximate Elevs. 566 to 562. The weathered rock zones were on the order of ½ to 1 foot in thickness. A distinct weathered rock zone was not encountered in Boring B-004.

Auger refusal on "intact" dolomite bedrock was encountered in each of the pier borings at approximate Elevs. 567 to 562. Upon encountering auger refusal, the borings were extended into the bedrock by coring methods. The encountered rock consisted of generally slightly weathered dolomite, which was jointed – generally fractured to intact (with occasional highly fractured zones). Rock core photographic logs are attached to this report. Rock core data are summarized in the following table.

Table 4.2.B. Summary of Rock Core Data						
Boring Number	**Rock Core**	**Depth Below Ground Surface (feet)**	**Approximate Elevation (feet)**	**Rock Core Recovery (%)**	**RQD (%)**	**Unconfined Compressive Strength (psi)**
B-003	NQ2-1	65½ to 70½	562 to 557	93	83	18,880
B-004	NQ2-1	64½ to 69½	567 to 562	93	70	14,940
	NQ2-2	69½ to 74½	562 to 557	95	95	-
B-005	NQ2-1	64 to 69	565 to 560	80	48	14,530

RQD values ranged from 48 to 95 percent for rock core specimens, indicating the rock mass quality of the dolomite bedrock in the upper bedrock profile can be generally described as varying from fair to good. Unconfined compressive strengths ranged from 14,530 to 18,880 pounds per square inch indicates strong to very strong bedrock.

4.3 Groundwater Conditions

Groundwater was initially encountered during drilling in Borings B-003, B-004, and B-005 at approximate Elevs. 573 to 566. Groundwater was observed upon completion of the drilling operations in the same borings at approximate Elevs. 608 to 597. It should be noted that the borings were drilled and sealed within the same day. Therefore, stabilized water levels may not have occurred over this limited time period. Instrumentation was not installed to observe long-term groundwater levels.

Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that "normal" groundwater levels at this structure location will generally occur at approximate Elevs. 615 to 610. It should be noted that groundwater elevations can also fluctuate with seasonal and climatic influences, as well as streamflow conditions in the creek. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this exploration.

4.4 Remedial Measures

Where sidehill fills are planned on the face of an existing slope which is steeper than 4H:1V, ODOT Office of Geotechnical Engineering (OGE) recommends special benching to assure that the new fill section and existing embankment are "knitted" together. This is expected to be the case for much of the project area along existing slopes. Additional discussion regarding special benching is provided in Section 5.1.1.

Based on consolidation test results and correlations with soil index properties, as well as the indicated fill heights and range of compressible cohesive soil layer thicknesses, the time required to achieve 90 percent consolidation was generally calculated to be on the order of 1 to 30 weeks. Design alternatives such as a surcharge loading and or wick drains may accelerate settlement rates. Calculations indicate that a wick drain spacing of 15 feet would result in a consolidation time of about 4 months of 90% consolidation, while a spacing of 10 feet would result in a consolidation time of about 2 months. If surcharge loading or wick drain installation is cost prohibitive, construction should consider additional overlays at the approach slabs/abutments to level out any dips once 2 inches of settlement has occurred, or one year after the completion of installation of the new embankment fill, whichever occurs first.

Based on the ODOT "Subgrade Analysis" worksheet (V14.6, 02/11/22), none of the borings contained subgrade soils which indicated subgrade modification is likely to be required. Based on the subgrade analysis and our understanding of the project, it is our recommendation to plan for undercuts for approximately 10 percent of the roadway subgrades to a depth of 12 inches and replacement with geotextile and granular engineered fill for soils which were determined to be significantly wet of optimum.

5.0 ANALYSES AND RECOMMENDATIONS

The following analyses and recommendations are based on our understanding of the proposed construction and upon the data obtained during our field exploration. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by TTL.

5.1 New Embankment Fill

Fill will be placed to achieve design grades throughout the project area. Approximately 2 feet of fill is generally anticipated to raise site grades relative to the existing roadway centerline. Fill will also be required to widen embankments. We have assumed that the new fill will consist of cohesive soils from a nearby borrow source.

5.1.1 Special Benching and Sidehill Embankment Fills

The purpose of the following evaluations is to identify areas for consideration in accordance with ODOT Geotechnical Design Manual (GDM) Section 800 (July 2023), "Special Benching and Sidehill Embankment Fills."

Special benching is to be used whenever there will be a stability problem with new fill and/or there are weak soils in an existing slope. Special benching is utilized to improve stability in a sidehill fill placed on an existing slope, or to remediate an unstable existing slope. Based on the test borings, weak soils are not anticipated to be present in the existing slope(s). Based on our site reconnaissance, the existing slopes in the project area appear to be performing satisfactorily, and are not in need of remediation due to instability.

Where sidehill fills are planned on the face of an existing slope which is steeper than 4H:1V, ODOT Office of Geotechnical Engineering (OGE) recommends special benching to assure that the new fill section and existing embankment are "knitted" together. This is expected to be the case for much of the project area along existing slopes.

The soils in the project area where benching will be performed consist of predominantly cohesive existing embankment materials. For these soils, GDM Section 800 indicates that a 1H:1V backslope should be planned. Based on the conditions encountered in the borings, a 1H:1V backslope should be generally achievable for short-term excavations. Based on the borings, thin zones of granular existing embankment materials may also be encountered where benching is performed. For granular soils, GDM Section 800 indicates that a backslope at

1¾H:1V may be more appropriate, assuming an effective friction angle of approximately 30 degrees.

If fill will be placed along slopes that are flatter than 4 horizontal to 1 vertical (4H:1V) but steeper than 8H:1V, ODOT Construction and Materials Specifications (CMS) Item 203.05, which describes "standard specification" benching, should be followed.

5.1.2 Settlement

For each of the encountered soil strata, soil compressibility parameters were evaluated for use in embankment settlement calculations. The compressibility parameters were evaluated using one-dimensional consolidation test results, as well as correlations with moisture contents and Atterberg limits test results.

Settlement was evaluated based on maximum embankment fill heights and widths planned for the bridge abutment locations. Total embankment settlement calculations include consolidation of the foundation soils, existing embankment soils, as well as settlement of the new embankment fill under its own weight. For the general fill anticipated to achieve design grades on the order of 2 feet, settlement was calculated to be on the order of 1½ to 2 inches at the bridge abutments.

Based on consolidation test results and correlations with soil index properties, as well as the indicated fill heights and range of compressible cohesive soil layer thicknesses, the time required to achieve 90 percent consolidation was generally calculated to be on the order of 1 to 30 weeks. Based on our experience in Northwest Ohio, the time required for 90 percent consolidation is anticipated to be toward the lower end of this range, likely on the order of 1 to 6 weeks. It should be noted for the embankment heights and settlement magnitudes indicated above, after 90 percent consolidation, the remaining foundation/embankment settlement would be less than ½ inch for the higher embankment fills at the abutment locations.

Settlement plates and routine monitoring should be incorporated to verify the actual rates of settlement versus expected values.

Design alternatives such as a surcharge loading and or wick drains may accelerate settlement rates. Calculations indicate that a wick drain spacing of 15 feet would result in a consolidation time of about 4 months of 90% consolidation, while a spacing of 10 feet would result in a consolidation time of about 2 months. These calculations are presented in Appendix A.

If surcharge loading or wick drain installation is cost prohibitive, construction should consider additional overlays at the approach slabs/abutments to level out any dips once 2 inches of settlement has occurred, or one year after the completion of installation of the new embankment fill, whichever occurs first. While these dips are especially undesirable in high-speed highway applications, for a local road such as Lime City Road with a speed limit of 45 miles per hour, they may be somewhat more tolerable until they are leveled out with pavement overlays.

5.2 Bridge Foundations

It is our understanding that the existing four-span bridge will be replaced with a new superstructure. The existing piers and abutments will remain for the new bridge structure. To accommodate the bridge widening, additional pier support is required. The bottom of pile cap elevation for Pier 1, Pier 2, and Pier 3 (from south to north) are indicated to be Elevs. 618.50, 624.00, and 619.50, respectively. Based on the original bridge drawings, design loads were indicated to be 45 tons.

Pile resistance analyses were performed for each pier location using FHWA pile analysis software DRIVEN. In the DRIVEN analyses, adhesion for cohesive soils was modeled using the Tomlinson method (1979). Based on TTL experience in the Toledo area, the lower profile "hardpan" layer is better modeled by treating these soils as an FHWA "cohesionless" soil by assigning an effective internal angle of friction (ϕ') to this layer, and therefore, the "hardpan" layer was modeled using a ϕ' value of 36.6 degrees, based on SPT N_{60}-values ranging from 30 to 47 bpf. Resistance for granular soils was determined by the Peck, Hanson, and Thornburn method (1974).

For our evaluations, an ultimate capacity of 180 kips was considered, based on a factor of safety of 2 applied to the required 45 tons allowable (working) capacity. DRIVEN analyses indicate that the 12x53 H-Piles are expected to achieve the required capacity in the Stratum II predominantly stiff to very stiff cohesive glacial till deposits, the Stratum III predominantly stiff cohesive soils, or at the transition to the Stratum IV "hardpan." We also evaluated smaller 10x42 H-Piles in the event they are more economical, which are expected to achieve the required capacity in the Stratum III predominantly stiff cohesive soils, or at the transition to the Stratum IV "hardpan." Results of the DRIVEN analyses are attached to this report in Appendix A, and are summarized in the following table. The summary table includes the estimated pile length and order length. The estimated pile length includes the calculated length from anticipated pile cut-off elevation to pile tip elevation, rounded to the nearest 5 feet. The order length is the estimated length plus 5 feet.

Table 5.1. Estimated Pile Lengths and Order Lengths								
Location	**Boring Number**	**Pile Size**	**Ultimate Capacity (kips)**	**Footing Elevation (feet)**	**Pile Cut-Off Elevation (feet)**	**Recommended (Minimum) Pile Tip Elevation (feet)**	**Estimated Pile Length (feet)**	**Pile Order Length (feet)**
Pier 1	B-003	HP10x42	180	618.5	619.5	581.3	40	45
		HP12x53	180			591.2	30	35
Pier 2	B-004	HP10x42	180	624.0	625.0	582.4	45	50
		HP12x53	180			586.9	40	45
Pier 3	B-005	HP10x42	180	619.5	620.5	582.3	40	45
		HP12x53	180			582.3	40	45

ODOT specifications indicate that the maximum center-to-center spacing of driven piles should be 8 feet in capped pile abutments. We recommend that the minimum center-to-center spacing for piles be 3 pile diameters to avoid superposition of stresses and possible reduction in group resistance due to close spacing.

Driven piles should be installed under adequate specifications and monitored by a qualified geotechnical engineer. A static pile load test (ASTM D 1143) is required only if the total pile order length for an individual structure exceeds 10,000 feet for piling of the same size and capacity. As such, a static pile load test is not expected to be required for this project. However, as mentioned previously, pile design is based on piles installed in accordance with ODOT CMS Item 523 "Dynamic Load Test." ODOT typically requires dynamic load testing to establish the driving criteria (i.e., blow count) for all piling not driven to refusal on bedrock. For an individual structure, the Designer shall specify one dynamic load testing item for each pile size. If multiple pile capacities are required for a given pile size, the Designer shall specify one testing item for each pile size. If multiple pile capacities are required for a given pile size, the Designer shall specify one testing item for each capacity. Although not anticipated, if static load tests are required, additional provisions include two dynamic load testing items **and** two restrike items for each static load test item. One dynamic load testing item consists of testing a minimum of two piles and performing a Case Pile Wave Analysis Program (CAPWAP) analysis on one of the two piles. One restrike item consists of performing dynamic testing on two piles and performing CAPWAP analysis on one of the two piles. Driven piles should be installed under adequate specifications and monitored by a qualified geotechnical engineer.

If suitable pile resistance is not observed in the field with driving of the entire pile order length, a pile setup period may be required. The ODOT BDM indicates a minimum 7-day waiting period. It is our experience that pile setup can occur within a few days, but more typically occurs within one to three weeks.

Steel pile points shall be used in order to protect the tips of the steel "H" piling in accordance with ODOT BDM 305.3.5.6 when piles are driven to refusal onto strong bedrock, piling is driven through overburden containing boulders, or piling is driven through very dense granular soils of 10 feet or greater in thickness. Such conditions were not encountered during drilling and are not expected for this project, and steel pile points are not recommended.

Although not encountered within the borings performed for this exploration, the presence of cobbles or boulders within glacial till is not unusual for this region, and these conditions could hamper pile-driving operations and possibly damage some piles. If piles are observed to meet refusal at a depth/elevation less than that indicated above, boulder obstruction may be indicated. For an isolated occurrence, one or more replacement piles could be driven with relatively little additional cost on pile cap re-design. If persistent boulder conditions are indicated, a static pile load test should be performed in accordance with ASTM D 1143 to evaluate the bearing resistance of the pile(s).

5.3 <u>Drivability Analysis</u>

WEAP evaluations were performed using GRLWEAP™ software considering the ultimate capacity planned for this project.

The planned pile hammer for the project was not indicated at this time. A Delmag D 19-42 hammer was utilized for this evaluation. Pile hammer and associated hammer cushion standard data from GRLWEAP™ software were utilized for our evaluations.

Soil input data was initially generated using FHWA DRIVEN for each evaluated boring, with parameters modified based on the recommended procedure outlined in ODOT GDM 1304.2.1.

Our evaluations considered the largest pile evaluated for this project, using properties following the recommended procedure outlined in ODOT GDM 1304.2.2.

Results of the WEAP evaluations at the UBV / maximum Rndr planned for this project are summarized in the following table, and are attached to this report.

Table 5.3. Summary of WEAP Results at Planned UBV / Maximum Rndr

Location	Associated Boring Number	Delmag D 19-42	
		Maximum Compression Stress (ksi)	Blow Count (blows/ft)
Pier 1	B-003	22.763	8.8
Pier 2	B-004	22.656	8.7
Pier 3	B-005	22.898	9.1

If a pile hammer other than what was utilized for this evaluation is planned for this project, the evaluation should be performed using that hammer. Additionally, if the values presented in the above table are not suitable for design, alternative pile hammers could be evaluated.

5.4 GDM Section 600 "Plan Subgrades" Evaluation

5.4.1 Subgrade Analysis Worksheet

An evaluation of the subgrade soils was completed in general accordance with ODOT Geotechnical Design Manual (GDM) Section 600 (July 2023). As part of this evaluation, the ODOT "Subgrade Analysis" worksheet (V14.6, 02/11/22) was completed and is attached to this report.

Our evaluations assumed pavement cross-sections of 15 inches (approximately 1.3 feet) for the proposed pavements.

Based on GDM Section 600, soils classified as ODOT A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, or rock have been designated as being problematic with respect to pavement subgrade support. None of these soil types were encountered at planned subgrade elevations in the borings performed for this exploration.

Based on GDM Section 600 criteria, subgrade soils with moisture contents greater than 3 percent above optimum likely indicate the presence of unstable subgrade that may require some form of subgrade modification. For this site, approximately 15 percent of tested cohesive subgrade soil samples was greater than 3 percent above the optimum as determined using GDM Section 600 criteria.

For the evaluated sample with a moisture content greater than 3 percent above optimum, approximately 50 percent of the evaluated samples with moisture contents greater than 3 percent above optimum had moisture contents greater than or equal to 5 percent above optimum. Thus, where moisture contents were wet of optimum, they were appreciably wet of optimum. These data indicate that scarification and aeration methods may not be feasible to achieve satisfactory proof rolling and stabilization of the predominantly cohesive subgrades.

The type and thickness of subgrade modification is determined by GDM Section 600 criteria based on the average, low SPT N_{60}-value (N_{60L}) of the subgrade soils in a particular portion of the project area, hand penetrometer values, soil type, and moisture content. Based on these criteria, none of the borings contained subgrade soils which indicated subgrade modification is likely to be required.

5.4.2 Construction Considerations

Undercut and Replacement Option

If undercut and replacement is required, all fill should consist of ODOT Item 304 Aggregate Base or Item 703.16C, Granular Material Type C. As prescribed by GDM Section 600 criteria, excavate unstable subgrades to 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians, including under new curbs and gutters. Always drain the excavation to an underdrain, catch basin, or pipe. It is recommended that geotextile fabric (referenced in ODOT Item 204, and specified as ODOT Item 712.09, Type D) be utilized on the subgrade at the bottom of the undercut zone. Although not anticipated to be required based on the conditions encountered in the borings and the proposed sections and grades, if particularly unstable subgrades are encountered during construction, or undercuts exceed approximately 18 inches, a geogrid could be used to reduce the total undercut and replacement of the unsuitable soils by 6 inches. Do not use geotextile or geogrid in the areas of underdrains.

Additionally, if the current cement shortage precludes the use of cement for chemical stabilization, subgrade modification should consider over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill.

Chemical Stabilization Option

GDM Section 600 indicates that, if it is determined that 30 percent or more of the subgrade area must be stabilized, consideration should be given to stabilizing the entire project (global stabilization). Since our analyses indicated subgrade conditions in none of borings requiring chemical stabilization or undercut based on moisture conditions or N_{60L}, chemical stabilization is anticipated to be the least cost-effective method of treatment.

General

It should be noted that subgrade analyses are used as a pre-construction tool to plan subgrade modification alternatives. **Actual subgrade modification will depend on field observations of proof-rolling conditions at the time of construction.** Changes in soil moisture content could create more or less favorable subgrade conditions that may result in adjustments to subgrade modification or soil stabilization requirements at the time of construction.

5.4.3 Sulfate Content Considerations

As required by GDM Section 600, sulfate content tests (ODOT Supplement 1122) were performed on a sample typically within the upper 3 feet of each roadway boring. The sulfate content test results are summarized in the following table.

Table 5.4.3. Sulfate Content

Boring Number	Sulfate Content (mg/kg)
B-001	250
B-002	250
B-006	240

GDM Section 600 indicates that chemical stabilization cannot be utilized when sulfate contents for the majority of the samples exceed 3,000 parts per million (ppm), or individual soil samples exhibit sulfate contents of greater than 5,000 ppm. Based on the tested samples, sulfate content will not preclude the use of chemical stabilization for this project.

5.4.4 Planned Subgrade Modification Recommendation

Based on the subgrade analysis and our understanding of the project, it is our recommendation to plan for undercuts for approximately 10 percent of the roadway subgrades to a depth of 12 inches and replacement with geotextile and granular engineered fill for soils which were determined to be significantly wet of optimum.

5.5 Flexible (Asphalt) Pavement Design

Based on the ODOT "Subgrade Analysis" worksheet, a design CBR value of 6 percent was determined for the project. It should be noted that the CBR determination by the "Subgrade Analysis" spreadsheet is based on an **average** Group Index of all the evaluated samples, which was 9. Group indices for the tested samples ranged from 6 to 11, which would correlate with a CBR value of 5 to 7 percent. Based on the average design value calculations from the subgrade analysis spreadsheet, it does not appear to be unconservative to use the spreadsheet design CBR value of 6 percent for new pavement sections throughout the project area.

It should also be noted that the design CBR value is based on subgrades compacted to at least 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof-rolling.

All pavement design and paving operations should conform to ODOT specifications. The pavement and subgrade preparation procedures to be outlined in the final report should result in a reasonably workable and satisfactory pavement. It should be recognized, however, that all pavements need repairs or overlays over time as a result of progressive yielding under repeated loading for a prolonged period.

It is recommended that proof rolling, placement of aggregate base, and placement of asphalt be performed within as short a time period as possible. Exposure of the aggregate base to rain, snow, or freezing conditions may lead to deterioration of the subgrade and/or base materials due to excessive moisture conditions and to difficulties in achieving the required compaction.

5.6 Construction Dewatering and Groundwater Control

Groundwater conditions encountered in the borings were summarized in Section 4.3. Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that "normal" groundwater levels at this structure location will generally occur at approximate Elevs. 615 to 610. It should be noted that groundwater elevations can also fluctuate with seasonal and climatic influences, as well as streamflow conditions in the creek.

Groundwater seepage, perched water, and surface water runoff into relatively shallow excavations should be controllable by pumping from prepared sumps. In the event excessive seepage is encountered during construction, TTL should be notified to evaluate whether other dewatering methods are required.

5.7 Construction

5.7.1 Site Preparation and Earthwork

Site and subgrade preparation activities should conform to ODOT CMS Item 204 specifications (Subgrade Compaction and Proof Rolling). Prior to proceeding with construction operations, all structures, pavements, topsoil, root systems, vegetation, and other deleterious non-soil materials should be removed from the proposed construction areas.

Pavement subgrades should be proof rolled in accordance with ODOT CMS 204.06. The "planned" subgrade modification is recommended to include undercuts for approximately 10 percent of the roadway subgrades to a depth of 12 inches and replacement with geotextile and granular engineered fill for soils which were determined to be significantly wet of optimum.

5.7.2 Fill

Material for engineered fill or backfill required to achieve design grades should meet ODOT Item 203 "Embankment Fill" placement and compaction requirements.

The upper profile on-site soils consist of granular and cohesive soils. As such, the contractor should be prepared to use a sheepsfoot roller to provide effective compaction of the cohesive soils and a smooth-drum roller for effective compaction of the granular soils. In narrow utility or footing excavations, the on-site cohesive soils may be difficult to compact; therefore, a clean granular material may be required in these areas.

5.7.3 Excavations and Slopes

The sides of temporary excavations for utility installations and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed.

Based on the encountered soils, excavations may encounter the following OSHA type soils:

- Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and
- Type C soils (existing fill materials and granular soils).

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required by the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

For permanent excavations and slopes, we recommend that grades generally be no steeper than 3H:1V. It should be noted that ODOT routinely uses 2H:1V slopes for roadway embankments and spill-through sections. While these steeper slopes may be used, it is our experience that the embankment faces on these slopes are more prone to erosion and sloughing.

6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of bridge foundations, embankment fill, and roadway pavement design and construction conditions has been based on our understanding of the site and project information and the data obtained during our field investigation. The general subsurface conditions used were based on interpretation of the subsurface data at specific boring locations. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. This potential is increased at previously developed sites. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, a qualified geotechnical engineer should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. TTL is not responsible for the conclusions, opinions, or recommendations of others based on this data.

PLATES

LEGEND

APPROXIMATE SITE LOCATION

N

APPROXIMATE SCALE – FEET

0 1,700 3,400

PLATE 1.0
SITE LOCATION MAP
WOO–75–23.93, PID 119007
PROPOSED BRIDGE REPLACEMENT
ROSSFORD, WOOD COUNTY, OHIO

PREPARED FOR
ODOT DISTRICT 2
BOWLING GREEN, OHIO

DRAWN	TRR/7–11–23	CHECKED	KCH/7–14–2023
REVISED		APPROVED	
JOB NO.	230574		
DRAWING NUMBER	**230574–01G**		

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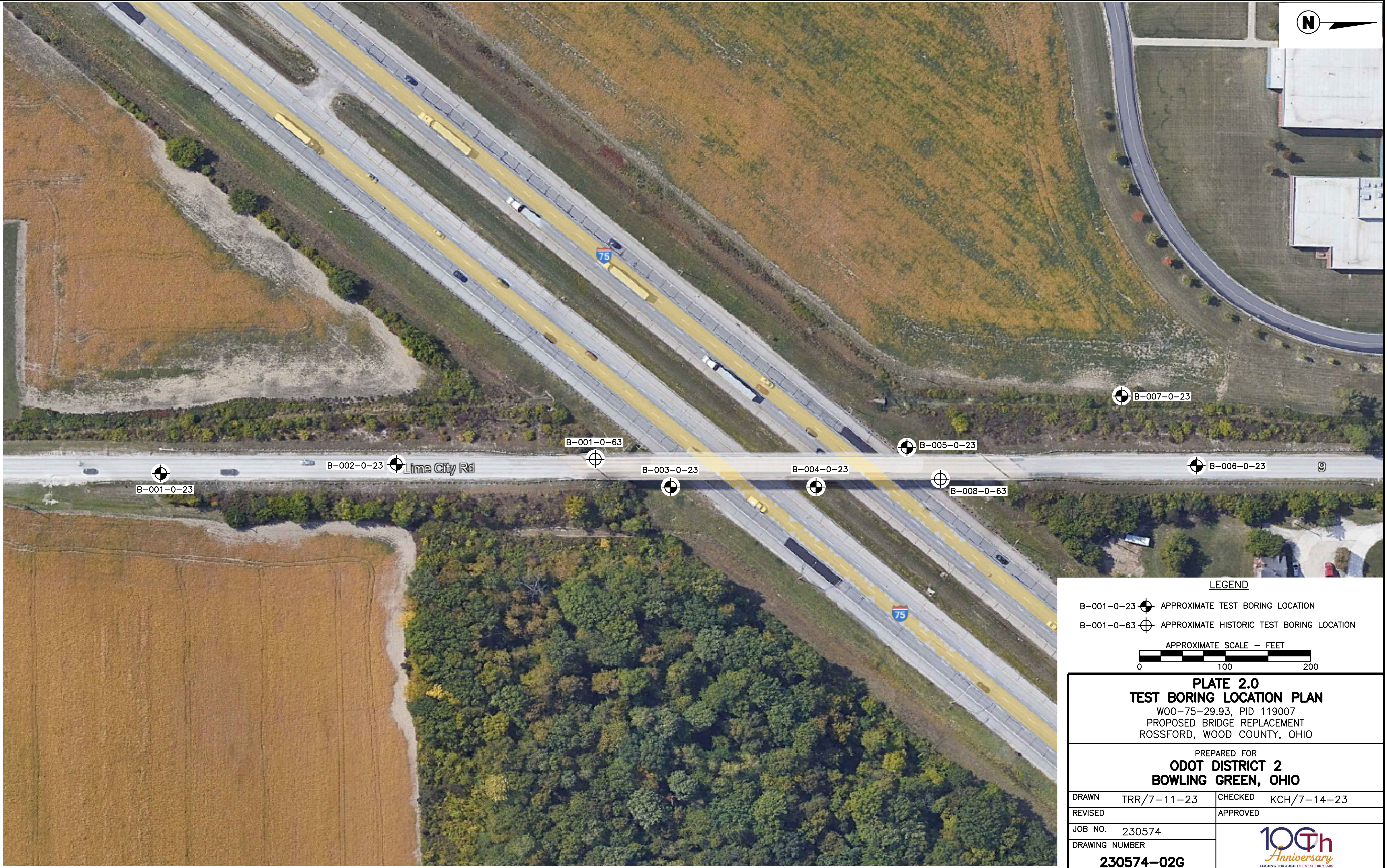


LEGEND

B-001-0-23 ⊕ APPROXIMATE TEST BORING LOCATION

B-001-0-63 ⊕ APPROXIMATE HISTORIC TEST BORING LOCATION

APPROXIMATE SCALE – FEET

0 100 200

PLATE 2.0

TEST BORING LOCATION PLAN

WOO-75-29.93, PID 119007

PROPOSED BRIDGE REPLACEMENT

ROSSFORD, WOOD COUNTY, OHIO

PREPARED FOR

ODOT DISTRICT 2

BOWLING GREEN, OHIO

DRAWN	TRR/7-11-23	CHECKED	KCH/7-14-23
REVISED		APPROVED	
JOB NO.	230574		
DRAWING NUMBER	**230574-02G**		

100th Anniversary
LEADING THROUGH THE NEXT 100 YEARS

FIGURES

LOG OF BORING

Date Started 7-17-63 | Sampler Type SS | Dia. 1 3/8" | Water Elev.

Date Completed 7-18-63 | Casing: Length | Dia.

Boring No. B-1 | Station & Offset 97+61, 11' Lt., (REAR ABUTMENT) | Surface Elev. 625.7'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
625.7	0														
	2														
	4														
620.7	6	4/5			Brown and Gray Silty Clay	1	0	2	1	40	57	40	20	26	
618.2	8	5/5			Brown and Gray Sandy Clay	2	7	4	12	28	49	43	22	26	
615.7	10	10/19			Brownish-Gray Sandy Clay	3	13	7	12	28	40	29	12	15	
	12														
613.2	14	10/20			Brown Sandy Clay	4	7	7	14	28	44	29	11	16	
610.7	16	7/10			Gray Sandy Silt	5	0	13	13	28	46	26	8	18	
608.2	18	9/11			Gray Sandy Clay	6	9	8	12	30	41	26	11	16	
605.7	20														
	22	10/12			Gray Sandy Silt	7	8	8	13	27	44	25	9	16	
603.2	24	7/9			Gray Clayey Silt	8	0	7	8	35	50	26	10	18	
600.7	26	8/11			Gray Sandy Clay	9	9	6	11	26	48	28	12	18	
	28														
595.7	30														
	32	9/12			Gray Silt and Clay	10	0	4	12	28	56	31	13	20	
	34														
590.7	36	7/9			Gray Silt and Clay	11	0	6	10	35	49	28	11	19	
	38														
585.7	40														
	42	8/10			Gray Silt and Clay	12	0	5	12	27	56	27	12	20	
	44														
580.7	46	7/9			Gray Sandy Clay	13	0	12	9	28	51	31	14	23	
	48														
575.7	50														
	52	23/34			Gray Gravelly Sandy Silt	14		V	I	S	U	A	L	8	
	54														
570.7	56	24/38			Gray Gravelly Sandy Silt	15		V	I	S	U	A	L	12	
	58														
565.7	60														
	62				Dolomite boulders.										
	64														
560.7	66				TOP OF ROCK										
	68		5.0	0.0	Limestone, dolomitic, gray, hard, broken, jointed. Core loss 10%.										
	70														
553.7	72		1.1	0.9	BOTTOM OF BORING										

LOG OF BORING

Date Started 7-10-63 | Sampler Type SS | Dia. 1 3/8" | Water Elev. ______

Date Completed 7-11-63 | Casing: Length ______ | Dia. ______

Boring No. B-8 | Station & Offset 101+47, 15' Rt. (FORWARD PIER) | Surface Elev. 625.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
625.4	0														
	2														
	4														
620.4	6	4/6			Brown and Gray Silt and Clay	1	0	3	7	29	61	35	13	21	
617.9	8	4/10			Mottled Brown and Gray Silty Clay	2	0	2	3	29	66	39	17	22	
615.4	10	5/9			Mottled Brown and Gray Silt and Clay	3	0	6	9	33	52	30	13	22	
612.9	12, 14	4/11			Mottled Brown and Gray Sandy Clay	4	12	5	11	22	50	33	13	18	
610.4	16	7/12			Brown and Gray Gravelly Sandy Silt	5	18	7	13	23	39	28	8	16	
607.9	18	7/10			Gray Gravelly Sandy Silt	6	16	6	12	22	44	22	7	16	
605.4	20	7/10			Gray Sandy Silt	7	14	7	13	27	39	23	10	18	
602.9	22, 24	7/9			Gray Gravelly Sandy Silt	8	15	6	11	21	47	23	6	16	
600.4	26	9/10			Gray Gravelly Sandy Clay	9	16	6	13	22	43	25	11	17	
	28														
595.4	30, 32	5/7			Gray Sandy Clay	10	10	6	12	23	49	26	11	22	
	34														
590.4	36	7/9			Gray Gravelly Silt	11	15	3	9	29	44	24	9	18	
	38														
585.4	40, 42	7/8			Gray Sandy Silt	12	0	8	16	17	59	25	8	19	
	44														
580.4	46	6/8			Brown Sandy Gravelly Silt	13	22	5	13	17	43	25	9	17	
	48														
575.4	50, 52	10/19			Gray Silt and Clay	14	9	4	6	27	54	29	14	16	
	54														
570.4	56	12/23			Gray Gravelly Clay	15	11	3	6	21	59	34	15	17	
	58														
565.4	60	12/26			Gray Silty Sandy Gravel	16	41	9	16	18	16	NP	NP	14	
563.4	62				TOP OF ROCK										
	64		3.5	0.5	Limestone, light-gray, firm, argillaceous, carbonaceous laminae, cleaves at laminae, becomes arenaceous at base. Top 3.0' badly jointed and broken. Core loss 18%.										
	66														
	68		4.7	0.3											
555.4	70				BOTTOM OF BORING										

PROJECT: WOO-75-29.93	DRILLING FIRM / OPERATOR: CT CONSULTANTS / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET:	EXPLORATION ID B-001-0-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK	HAMMER: CME AUTOMATIC	ALIGNMENT: LIME CITY ROAD	
PID: 119007 SFN: 8704716	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/23	ELEVATION: 636.1 (NAVD88) EOB: 7.5 ft.	PAGE 1 OF 1
START: 6/9/23 END: 6/9/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.9	LAT / LONG: 41.579969, -83.567433	

MATERIAL DESCRIPTION AND NOTES	ELEV. 636.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 7.875 INCHES	635.4																		
AGGREGATE BASE - 6.125 INCHES	634.9	1																	
STIFF, GRAY/BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST FILL		2	3 5 5	12	100	SS-1	3.25	7	5	16	25	47	33	16	17	19	A-6b (10)	250	
@3': BROWN, LITTLE GRAVEL, MOIST TO DAMP		3–4	3 5 6	13	100	SS-2	4.50	10	6	15	23	46	30	14	16	14	A-6b (9)	-	
@4.5': VERY STIFF, MOIST		5	8 11 13	29	100	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@6': GRAY/BROWN, LITTLE SAND	628.6	6–7 EOB	12 12 13	30	100	SS-4	4.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:05 - S:\PROJECTS\230574.GPJ

PROJECT: WOO-75-29.93	DRILLING FIRM / OPERATOR: CT CONSULTANTS / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET:
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK	HAMMER: CME AUTOMATIC	ALIGNMENT: LIME CITY ROAD
PID: 119007 SFN: 8704716	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 646.1 (NAVD88) EOB: 40.0 ft.
START: 6/9/23 END: 6/9/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 72.9	LAT / LONG: 41.580723, -83.567470

EXPLORATION ID B-002-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 646.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT - 8.5 INCHES	645.4																		
AGGREGATE BASE - 11.5 INCHES	644.4	1																	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP FILL		2	5 5 5	12	100	SS-1	-	9	5	12	25	49	31	15	16	13	A-6b (10)	250	
@3': MOIST		3 – 4	4 5 6	13	83	SS-2	4.50	6	5	10	24	55	33	16	17	18	A-6b (11)	-	
@4.5': VERY STIFF, MOIST TO DAMP		5	7 9 11	24	89	SS-3	3.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
@6': STIFF, GRAY/BROWN, TRACE ROCK FRAGMENTS, DAMP		6 – 7	4 5 7	15	94	SS-4	-	-	-	-	-	-	-	-	-	10	A-6b (V)	-	
@7.5': BROWN		8	4 6 7	16	100	SS-5	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
		9 – 10	13 11 11	27	100	SS-6	4.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
@10': VERY STIFF, GRAY/BROWN, MOIST																			
@11': DAMP		11 – 12	4 7 10	21	100	SS-7	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		13																	
@13.5': BROWN, MOIST		14 – 15	4 6 10	19	100	SS-8	4.00	2	3	13	25	57	34	17	17	20	A-6b (11)	-	
	630.1	16																	
VERY STIFF, BROWN/GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE ASPHALT FRAGMENTS, DAMP FILL @16.0' TO 17.7': Qu=9,942 PSF, γ_{WET}=138.4 PCF, γ_{DRY}=125.0 PCF	628.4	17			67	ST-9A	3.00	1	4	14	25	56	44	22	22	11	A-7-6 (14)	-	
	628.1	18				ST-9B	-	-	-	-	-	-	-	-	-	-	UCF (V)	-	
BURIED ASPHALT - 4 INCHES																			
VERY STIFF, GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST		19 – 20	5 7 9	19	100	SS-10	3.75	-	-	-	-	-	-	-	-	25	A-7-6 (V)	-	
@21': STIFF TO VERY STIFF, BROWN/GRAY		21 – 22	3 4 5	11	100	SS-11	3.25	2	1	4	25	68	42	21	21	27	A-7-6 (13)	-	
	622.1	23																	
STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP		24 – 25	3 5 7	15	100	SS-12A SS-12B	- 4.50	- -	- -	- -	- -	- -	- -	- -	- -	- 16	A-7-6 (V) A-6a (V)	- -	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:05 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/9/23	END: 6/9/23	PG 2 OF 2	B-002-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 620.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP *(continued)* @27': VERY STIFF		27	7 11 11	27	100	SS-13	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
	617.6	28																	
VERY STIFF TO HARD, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP		29	5 10 11	26	100	SS-14	4.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		30																	
@31': VERY STIFF, GRAY, MOIST		31–32	4 6 8	17	100	SS-15	2.50	7	5	16	25	47	32	15	17	16	A-6b (10)	-	
		33																	
@33.5': MOIST TO DAMP		34	4 6 7	16	100	SS-16	2.75	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		35																	
		36–37	7 10 13	28	100	SS-17	3.00	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		38																	
@38.5': LITTLE GRAVEL, DAMP	606.1	39 – EOB 40	4 6 9	18	100	SS-18	3.75	12	5	12	19	52	31	14	17	14	A-6b (10)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; PUMPED 11 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:05 - S:\PROJECTS\230574.GPJ

PROJECT: WOO-75-29.93	DRILLING FIRM / OPERATOR: CT CONSULTANTS / T	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET:	EXPLORATION ID B-003-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: LIME CITY ROAD	
PID: 119007 SFN: 8704716	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/13/22	ELEVATION: 627.4 (NAVD88) EOB: 70.5 ft.	PAGE 1 OF 3
START: 6/13/23 END: 6/13/23	SAMPLING METHOD: SPT / ST / NQ	ENERGY RATIO (%): 90	LAT / LONG: 41.581606, -83.567375	

MATERIAL DESCRIPTION AND NOTES	ELEV. 627.4
MEDIUM STIFF, BROWN/GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP FILL	624.4
STIFF TO VERY STIFF, FAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, TRACE IRON OXIDE STAIN SEAM, MOIST	621.4
STIFF, BROWN/GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, MOIST	619.4
VERY STIFF TO HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, DAMP @11': VERY STIFF, BROWN/GRAY @13.8': GRAY	610.5
BROWN/GRAY, **FINE SAND**, TRACE SILT, WET	610.4
STIFF, BROWN/GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @17.0' TO 18.0': Qu=2,799 PSF, γ_{WET}=135.9 PCF, γ_{DRY}=117.5 PCF @18.5': STIFF TO VERY STIFF, DAMP TO MOIST @21': VERY STIFF	

DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
1–2.5	4 3 3	9	83	SS-1	>4.5	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
3.5–5	2 3 4	11	89	SS-2	2.75	11	6	15	26	42	33	16	17	18	A-6b (9)	-	
6–7.5	2 4 5	14	100	SS-3	>4.5	4	4	6	20	66	31	18	13	21	A-6a (9)	-	
8.5–10	5 8 12	30	100	SS-4	>4.5	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
11–12.5	6 9 11	30	100	SS-5	4.00	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
13.5–15	3 5 6	17	100	SS-6	2.75	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
16–18			100	ST-7A	0.75	-	-	-	-	-	-	-	-	-	A-6a (V)	-	
				ST-7B	-	-	-	-	-	-	-	-	-	-	A-3 (V)	-	
				ST-7C	1.75	9	5	13	26	47	27	16	11	16	A-6a (8)	-	
18.5–20	3 4 5	14	100	SS-8	3.00	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
21–22.5	4 5 7	18	100	SS-9	3.75	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
23.5–25	3 5 7	18	100	SS-10	2.75	-	-	-	-	-	-	-	-	15	A-6a (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/13/23	END: 6/13/23	PG 2 OF 3	B-003-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 601.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF, BROWN/GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @17.0' TO 18.0': Qu=2,799 PSF, γ_{WET}=135.9 PCF, γ_{DRY}=117.5 PCF *(continued)* @26.0' TO 28.0': Qu=5,030 PSF, γ_{WET}=135.6 PCF, γ_{DRY}=117.6 PCF @26': MOIST		27			100	ST-11	-	4	6	9	22	59	29	14	15	15	A-6a (10)	-	
		29	3 5 6	17	100	SS-12	3.25	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
		34	3 5 6	17	100	SS-13	3.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
	588.9																		
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, MOIST		39	3 3 5	12	100	SS-14	2.00	10	4	11	20	55	32	15	17	17	A-6b (11)	-	
	583.9																		
MEDIUM STIFF TO STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		44	2 3 4	11	100	SS-15	1.00	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
	580.4																		
HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		49	8 12 18	45	100	SS-16	>4.5	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	575.4																		
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TRACE DOLOMITE FRAGMENTS, DAMP		53																	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/13/23	END: 6/13/23	PG 3 OF 3	B-003-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 573.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TRACE DOLOMITE FRAGMENTS, DAMP *(continued)*		55	9 13 18	47	89	SS-17	>4.5	14	11	18	20	37	23	12	11	9	A-6a (5)	-	
		59	27 50/3"	-	89	SS-18	>4.5	-	-	-	-	-	-	-	-	8	A-6a (V)	-	
	565.4	W 565.4																	
VERY DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, LITTLE DOLOMITE FRAGMENTS, TRACE CLAY, DAMP		64	50/4"	-	75	SS-19	-	31	8	27	31	3	NP	NP	NP	13	A-2-4 (0)	-	
	562.4	TR																	
GRAY, **WEATHERED DOLOMITE**	561.9																		
DOLOMITE, GRAY, SLIGHTLY WEATHERED, VERY STRONG, JOINTED - HIGHLY FRACTURED TO FRACTURED, TIGHT; RQD 51%, REC 79%. @65.5' TO 66.0': Qu=18,880 PSI, γ_{DRY}=157.7 PCF	560.3																		
DOLOMITE, GRAY, SLIGHTLY WEATHERED, VERY STRONG, JOINTED - SLIGHTLY FRACTURED, TIGHT; RQD 100%, REC 100%.		68	83		93	NQ2-1											CORE		
	556.9	EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 20 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PROJECT: WOO-75-29.93	DRILLING FIRM / OPERATOR: CT CONSULTANTS / T	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET:
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: LIME CITY ROAD
PID: 119007 SFN: 8704716	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/13/22	ELEVATION: 631.4 (NAVD88) EOB: 74.5 ft.
START: 6/14/23 END: 6/14/23	SAMPLING METHOD: SPT / ST / NQ	ENERGY RATIO (%): 90	LAT / LONG: 41.582072, -83.567374

EXPLORATION ID B-004-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 631.4	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
TOPSOIL - 8 INCHES	630.7																	
STIFF, BROWN/DARK GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE ORGANICS, MOIST FILL	628.4	3 5 5	15	89	SS-1	3.75	0	2	5	20	73	44	20	24	27	A-7-6 (14)	-	
VERY STIFF TO HARD, BROWN/DARK GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST		5 6 7	20	100	SS-2	>4.5	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
@6': VERY STIFF, BROWN/GRAY	622.9	4 6 8	21	100	SS-3	3.75	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
MEDIUM STIFF TO STIFF, GRAY/BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, TRACE IRON OXIDE STAIN SEAM, MOIST	620.4	2 2 2	6	100	SS-4	2.00	1	2	9	20	68	43	21	22	30	A-7-6 (13)	-	
VERY STIFF, GRAY/BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP @11.0' TO 13.0': TRACE ORGANICS, γ_{WET}=120.3 PCF, γ_{DRY}=104.5 PCF				15	ST-5	2.50	7	7	11	21	54	30	18	12	15	A-6a (9)	-	
@13.5': VERY STIFF TO HARD, BROWN/GRAY, TRACE IRON OXIDE STAIN SEAM, DAMP TO MOIST	615.4	5 7 11	27	100	SS-6	>4.5	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
STIFF, GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST	612.9	3 3 5	12	100	SS-7	2.50	6	7	14	21	52	31	15	16	16	A-6b (10)	-	
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP		3 5 7	18	100	SS-8	2.25	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
@21.0' TO 23.0': Qu=3,965 PSF, γ_{WET}=135.6 PCF, γ_{DRY}=117.5 PCF @21': STIFF TO VERY STIFF, BROWN/GRAY, LITTLE GRAVEL, DAMP @21.5': GRAY	607.9			100	ST-9	2.00	10	5	12	20	53	28	17	11	15	A-6a (8)	-	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	605.4	2 3 5	12	100	SS-10	3.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/14/23	END: 6/14/23	PG 2 OF 3	B-004-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 605.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		27	4 6 7	20	100	SS-11	3.00	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
	602.9	28																	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		29	2 4 4	12	100	SS-12	2.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		30–33																	
		34	3 3 5	12	100	SS-13	3.00	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
		35–38																	
@38.5': SOME SAND, MOIST		39	3 3 5	12	100	SS-14	2.50	5	5	16	26	48	32	15	17	17	A-6b (11)	-	
		40–43																	
@43.5': TRACE SAND		44	4 4 4	12	100	SS-15	2.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		45–48																	
	582.4																		
VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		49	4 8 12	30	100	SS-16	>4.5	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
		50–53																	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/14/23	END: 6/14/23	PG 3 OF 3	B-004-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 577.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
@53.5': HARD VERY STIFF TO HARD, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST *(continued)*	573.1	W 573.1 (55–58)	6 11 15	39	100	SS-17	>4.5	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
VERY DENSE, GRAY, **COARSE AND FINE SAND**, SOME SILT, TRACE DOLOMITE FRAGMENTS, TRACE CLAY, WET	572.4	59	17 17 50/5"	-	82	SS-18A	-	-	-	-	-	-	-	-	-	-	A-3a (V)	-	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE DOLOMITE FRAGMENTS, DAMP	571.8					SS-18B	>4.5	-	-	-	-	-	-	-	-	11	A-6a (V)	-	
VERY DENSE, GRAY, **COARSE AND FINE SAND**, SOME DOLOMITE FRAGMENTS, SOME SILT, TRACE CLAY, DAMP		60–63				SS-18C	-	-	-	-	-	-	-	-	-	-	A-3a (V)	-	
	566.9	TR (64)	31 50/4"	-	100	SS-19	-	22	10	45	21	2	NP	NP	NP	11	A-3a (0)	-	
DOLOMITE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 67%, REC 93%. @64.5' TO 64.9': Qu=14,940 PSI, γ_{DRY}=166.7 PCF @68.7': HIGHLY FRACTURED FRAGMENTS	562.4	65–69	70		93	NQ2-1											CORE		
@68.9': HIGHLY FRACTURED FRAGMENTS **DOLOMITE**, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - SLIGHTLY FRACTURED TO INTACT, TIGHT; RQD 95%, REC 95%.	556.9	EOB (70–74)	95		95	NQ2-2											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 21 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PROJECT: WOO-75-29.93	DRILLING FIRM / OPERATOR: CT CONSULTANTS / T	DRILL RIG: DIEDRICH D70 TRACK	STATION / OFFSET:	EXPLORATION ID B-005-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: LIME CITY ROAD	
PID: 119007 SFN: 8704716	DRILLING METHOD: 3.25" HSA / NQ	CALIBRATION DATE: 4/13/22	ELEVATION: 629.3 (NAVD88) EOB: 69.0 ft.	PAGE 1 OF 3
START: 6/12/23 END: 6/12/23	SAMPLING METHOD: SPT / ST / NQ	ENERGY RATIO (%): 90	LAT / LONG: 41.582361, -83.567547	

MATERIAL DESCRIPTION AND NOTES	ELEV. 629.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, TRACE ORGANICS, DAMP FILL		1, 2	3 4 6	15	67	SS-1	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
	626.3	3																	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		4, 5	2 4 4	12	89	SS-2	3.50	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
	623.3	6																	
STIFF TO VERY STIFF, GRAY/BROWN, **CLAY**, SOME SILT, LITTLE SAND, MOIST		7	4 4 5	14	100	SS-3	3.00	0	3	13	26	58	44	21	23	26	A-7-6 (14)	-	
		8, 9	6 5 13	27	100	SS-4A	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	-	
	619.6																		
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		10				SS-4B	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
		11, 12	6 10 12	33	89	SS-5	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
	616.3	13																	
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		14, 15	4 4 5	14	100	SS-6	2.00	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
@16.8': VERY STIFF, "AND" SAND, BROWN/GRAY, MOIST		16, 17	4 5 8	20	100	SS-7	4.00	7	11	27	27	28	32	16	16	17	A-6b (6)	-	
@18': STIFF TO VERY STIFF, MOIST TO DAMP		18, 19, 20	2 3 5	12	100	SS-8	2.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		21, 22, 23	4 4 5	14	100	SS-9	3.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		24, 25	3 4 5	14	100	SS-10	2.25	-	-	-	-	-	-	-	-	16	A-6b (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/12/23	END: 6/12/23	PG 2 OF 3	B-005-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 603.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
STIFF TO VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP *(continued)*	600.8	27	3 5 6	17	100	SS-11	2.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST TO DAMP		29	2 3 4	11	100	SS-12	2.00	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
@31.0' TO 33.0': Qu=2,352 PSF, γ_{WET}=132.2 PCF, γ_{DRY}=113.6 PCF @31': STIFF, DAMP		32			100	ST-13	1.50	7	8	18	25	42	27	16	11	16	A-6a (7)	-	
@33.5': STIFF TO VERY STIFF, MOIST	590.8	34	2 3 5	12	100	SS-14	2.25	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	588.3	39	2 2 3	8	100	SS-15	1.00	-	-	-	-	-	-	-	-	25	A-6a (V)	-	
STIFF TO VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP @41.0' TO 43.0': UU TRIAXIAL C = 1,050 PSF (STIFF), γ_{WET}=137.6 PCF, γ_{DRY}=117.2 PCF		42			100	ST-16	-	6	4	10	23	57	30	17	13	17	A-6a (9)	-	
@43.5': STIFF TO VERY STIFF, MOIST	582.3	44	3 4 4	12	100	SS-17	2.00	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	577.3	49	6 10 14	36	100	SS-18	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, MOIST		53																	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/12/23	END: 6/12/23	PG 3 OF 3	B-005-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 575.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, MOIST *(continued)*	572.3	55, 56, 57	8 12 18	45	89	SS-19	-	-	-	-	-	-	-	-	-	17	A-4a (V)	-	
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP	566.3	58, 59, 60, 61, 62; W 566.3 TR	7 9 17	39	100	SS-20	-	19	15	33	30	3	NP	NP	NP	10	A-2-4 (0)	-	
GRAY, **WEATHERED DOLOMITE** (FREE WATER NOTED) @64.3' TO 64.6': HIGHLY FRACTURED FRAGMENTS	565.3	63, 64	50/2"	-	100	SS-21	-	-	-	-	-	-	-	-	-	12	Rock (V)	-	
DOLOMITE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT; RQD 48%, REC 80%. @64.6' TO 65.3': Qu=14,530 PSI, γ_{DRY}=162.5 PCF @65.3' TO 65.6': HIGHLY FRACTURED FRAGMENTS @66.1' TO 66.4': HIGHLY FRACTURED FRAGMENTS @66.9' TO 67.0': HIGHLY FRACTURED FRAGMENT @67.3' TO 68.6': HIGHLY FRACTURED FRAGMENTS @68.8' TO 69.0': HIGHLY FRACTURED FRAGMENT	560.3	65, 66, 67, 68, 69 EOB	48		80	NQ2-1											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 19 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PROJECT: WOO-75-29.93	DRILLING FIRM / OPERATOR: CT CONSULTANTS / CW	DRILL RIG: CME 75 TRUCK 844	STATION / OFFSET:
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK	HAMMER: CME AUTOMATIC	ALIGNMENT: LIME CITY ROAD
PID: 119007 SFN: 8704716	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/23	ELEVATION: 643.9 (NAVD88) EOB: 40.0 ft.
START: 6/9/23 END: 6/9/23	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 72.9	LAT / LONG: 41.583290, -83.567467

EXPLORATION ID B-006-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 643.9	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm
ASPHALT - 8.5 INCHES	643.2																
AGGREGATE BASE - 6.5 INCHES	642.6																
STIFF, BROWN, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, MOIST FILL	640.9	4 5 5	12	100	SS-1	4.50	6	7	20	24	43	20	12	8	13	A-4a (6)	240
STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST FILL	639.4	5 6 6	15	100	SS-2	3.75	5	8	18	26	43	33	16	17	17	A-6b (10)	-
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, MOIST FILL		11 11 14	30	100	SS-3	4.50	6	6	17	43	28	19	12	7	14	A-4a (7)	-
	636.9	5 5 6	13	100	SS-4A	-	-	-	-	-	-	-	-	-	-	A-4a (V)	-
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST FILL					SS-4B	4.50	-	-	-	-	-	-	-	-	21	A-6b (V)	-
@7.5': MOIST TO DAMP		4 5 7	15	100	SS-5	4.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-
@9': VERY STIFF, GRAY/BROWN		8 11 13	29	100	SS-6	4.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-
@11.0' TO 13.0': Qu=4,369 PSF, γ_{WET}=140.4 PCF, γ_{DRY}=122.2 PCF" @11': BROWN/GRAY, DAMP				88	ST-7	4.50	5	7	16	26	46	36	17	19	15	A-6b (11)	-
	627.7	4 7 9	19	100	SS-8	4.50	-	-	-	-	-	-	-	-	13	A-4a (V)	-
VERY STIFF, GRAY, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, MOIST	625.9	4 6 8	17	100	SS-9	3.50	1	5	19	27	48	44	20	24	28	A-7-6 (14)	-
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		5 5 7	15	100	SS-10	4.00	-	-	-	-	-	-	-	-	23	A-6b (V)	-
@21.0' TO 23.0': Qu=2,395 PSF, γ_{WET}=130.8 PCF, γ_{DRY}=110.2 PCF @21': VERY STIFF	620.4			83	ST-11	3.75	6	6	17	26	45	36	17	19	19	A-6b (11)	-
VERY STIFF TO HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP	617.9	6 9 13	27	100	SS-12	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PID: 119007	SFN: 8704716	PROJECT: WOO-75-29.93	STATION / OFFSET:	START: 6/9/23	END: 6/9/23	PG 2 OF 2	B-006-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 617.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
HARD, BROWN/GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, MOIST TO DAMP		27	8 13 15	34	100	SS-13	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
		28																	
		29	7 11 13	29	100	SS-14	3.50	8	9	21	25	37	30	14	16	15	A-6b (8)	-	
	612.9	30																	
STIFF TO VERY STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP		31–32	4 5 6	13	100	SS-15	2.75	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		33																	
		34	4 6 8	17	100	SS-16	3.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
	607.9	35																	
VERY STIFF TO HARD, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST TO DAMP		36–37	7 10 12	27	100	SS-17	4.25	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		38																	
@38.5': VERY STIFF	603.9	39 – EOB 40	5 7 8	18	100	SS-18	3.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 8.5 CF CEMENT-BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

PROJECT: WOO-75-29.93 TYPE: ROADWAY PID: 119007 SFN: 8704716 START: 6/9/23 END: 6/9/23	DRILLING FIRM / OPERATOR: CT CONSULTANTS / CW SAMPLING FIRM / LOGGER: CT CONSULTANTS / KK DRILLING METHOD: HSA SAMPLING METHOD: SPT / ST	DRILL RIG: GEOPROBE 7822DT HAMMER: AUTOMATIC HAMMER CALIBRATION DATE: 3/16/22 ENERGY RATIO (%): 90*	STATION / OFFSET: ALIGNMENT: LIME CITY ROAD ELEVATION: 626.1 (NAVD88) EOB: 10.0 ft. LAT / LONG: 41.583053, -83.567766

EXPLORATION ID B-007-0-23

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 626.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL - 7 INCHES	625.5																		
STIFF, BROWN, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, TRACE ORGANICS, MOIST		1–2	5 5 6	17	100	SS-1	4.50	2	2	14	44	38	22	16	6	18	A-4a (8)	-	
@3.5': SOME CLAY, LITTLE GRAVEL	620.1	3.5–5	2 5 6	17	100	SS-2	4.50	10	8	17	43	22	20	12	8	14	A-4a (6)	-	
MEDIUM STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TRACE IRON OXIDE STAIN SEAM, TRACE ORGANICS, DAMP @6.0' TO 8.0': Qu=1,966 PSF, γ_{WET}=130.6 PCF, γ_{DRY}=113.9 PCF	617.6	6–8			63	ST-3	>4.5	19	6	16	25	34	30	18	12	15	A-6a (6)	-	
VERY STIFF TO HARD, BROWN, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP TO MOIST	616.1	8.5–10 (EOB 10)	6 10 10	30	100	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-4a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/25/23 16:06 - S:\PROJECTS\230574.GPJ

LEGEND KEY

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

A-2-4: Ohio DOT: A-2-4, gravel and/or stone fragments with sand and silt

A-3: Ohio DOT: A-3, fine sand

A-3A: Ohio DOT: A-3a, coarse and fine sand

A-4A: Ohio DOT: A-4a, sandy silt

A-6A: Ohio DOT: A-6a, silt and clay

A-6B: Ohio DOT: A-6b, silty clay

A-7-6: Ohio DOT: A-7-6, clay

DOLOMITE: Ohio DOT: Dolomite

PAVEMENT OR BASE: Ohio DOT: Pavement or Aggregate base

TOPSOIL: Ohio DOT: Sod and Topsoil

SAMPLER SYMBOLS

Thin Walled Undisturbed Sample

WELL CONSTRUCTION SYMBOLS

Bentonite: Bottom of hole

Soil Cuttings Backfill mixed with Bentonite Pellets or Chips

Asphalt or Concrete Pavement Patch

Notes:

1. Exploratory borings were performed on June 9 through 14, 2023, utilizing 3-inch outside diameter solid stem augers or 3¼-inch inside diameter hollow-stem augers and NQ2 rock core barrels.

2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.

3. The test borings were located in the field by TTL based on the provided plan for the existing structure and coordination with ODOT District 2 (ODOT District 2). Latitude and longitude coordinates, and ground surface elevations were surveyed by TTL utilizing a handheld GPS device.

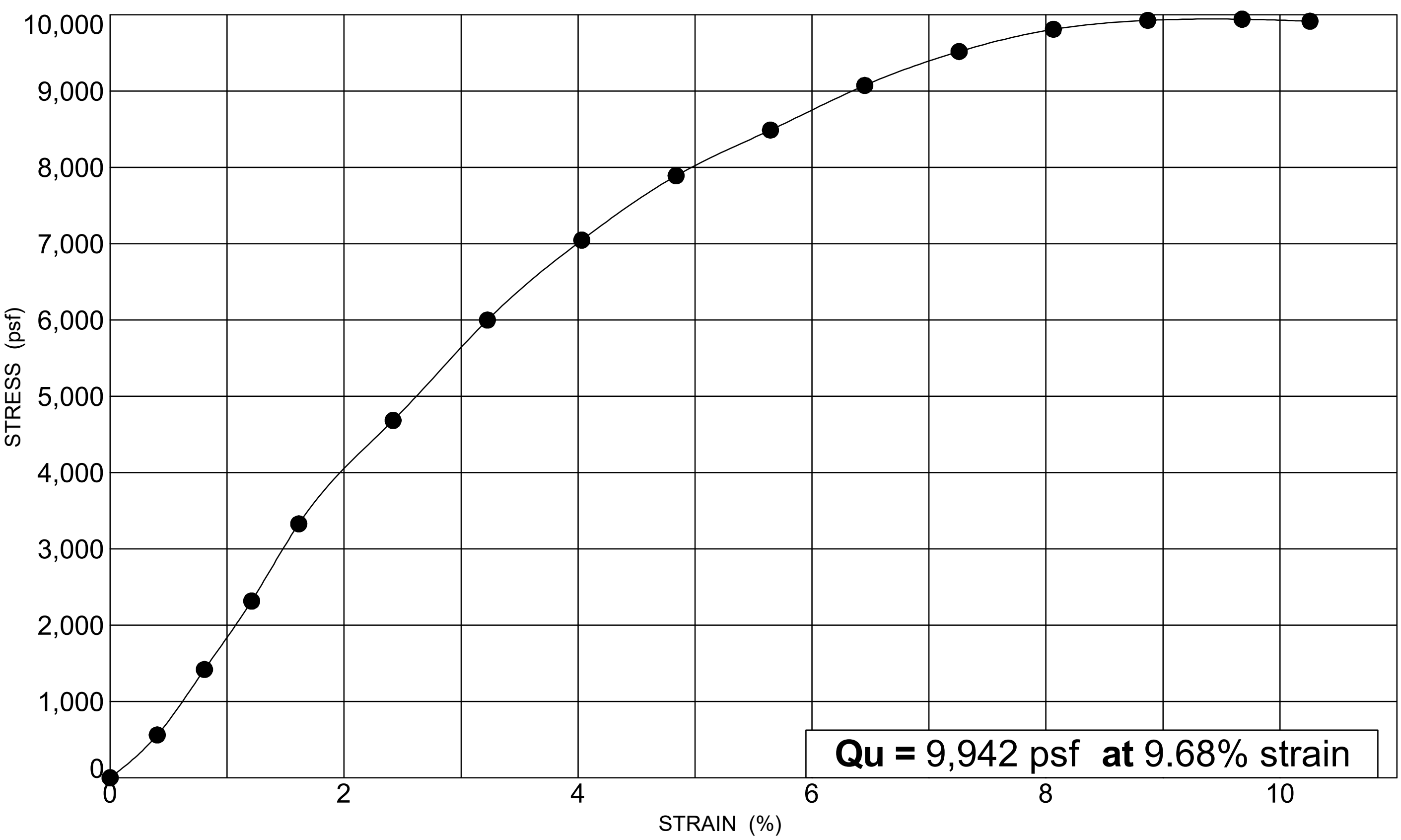
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT WOO-75-29.93
PID 119007
OGE NUMBER N/A
PROJECT TYPE STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-002-0-23
SAMPLE ID: ST-9A
STATION: NOT RECORDED
DEPTH: 16.0 - 17.7 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW

SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 157.500 mm

DIAMETER: 73.200 mm

WET UNIT WT: 138.42 pcf

DRY UNIT WT: 125.04 pcf

TESTED BY: KKC 6/23/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
1	4	14	25	56

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
44	22	22	11

ODOT CLASS: A-7-6
HP (tsf): 3.0

DESCRIPTION:

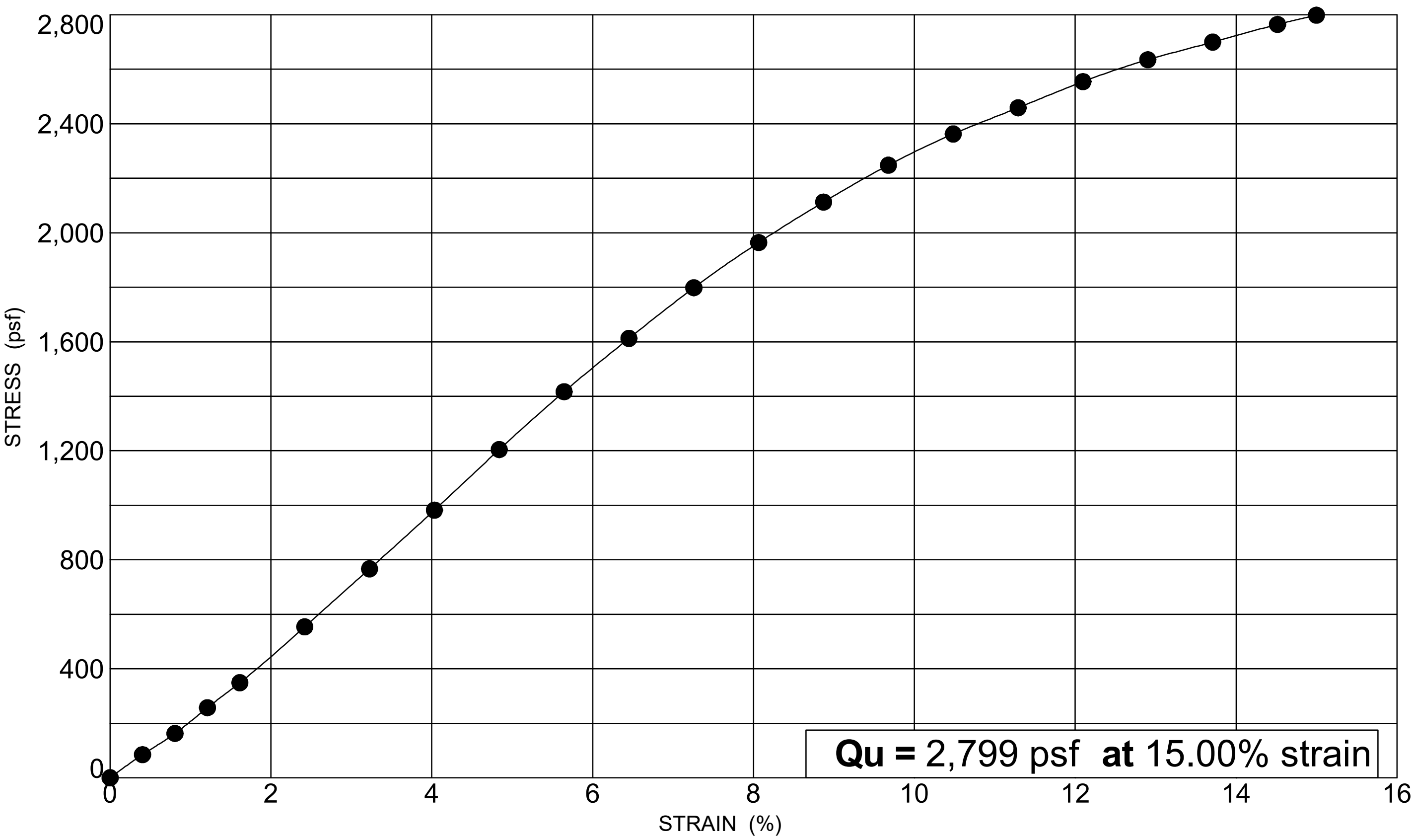
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT WOO-75-29.93 **PID** 119007
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-003-0-23 SAMPLE ID: ST-7C
STATION: NOT RECORDED DEPTH: 17.0 - 18.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 157.500 mm
DIAMETER: 72.600 mm
WET UNIT WT: 135.94 pcf
DRY UNIT WT: 117.49 pcf

TESTED BY: KKC 6/29/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
9	5	13	26	47

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
27	16	11	16

ODOT CLASS: A-6a HP (tsf): 1.75
DESCRIPTION:

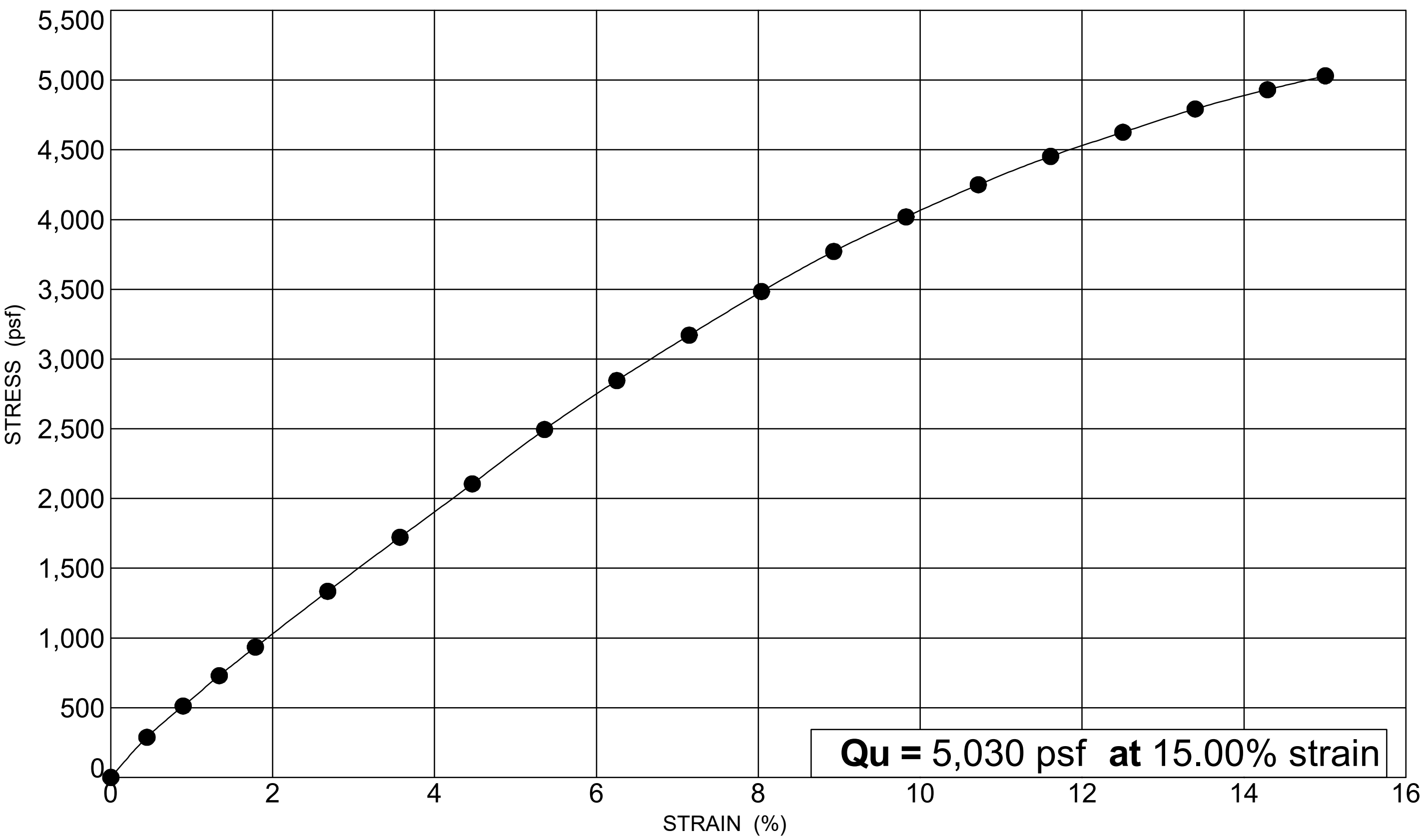
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT WOO-75-29.93 **PID** 119007
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-003-0-23 SAMPLE ID: ST-11
STATION: NOT RECORDED DEPTH: 26.0 - 28.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 142.200 mm
DIAMETER: 73.200 mm
WET UNIT WT: 135.65 pcf
DRY UNIT WT: 117.65 pcf

TESTED BY: KKC 7/7/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
4	6	9	22	59

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
29	14	15	15

ODOT CLASS: A-6a HP (tsf):
DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 7/24/23 12:29 - S:\PROJECTS\230574.GPJ

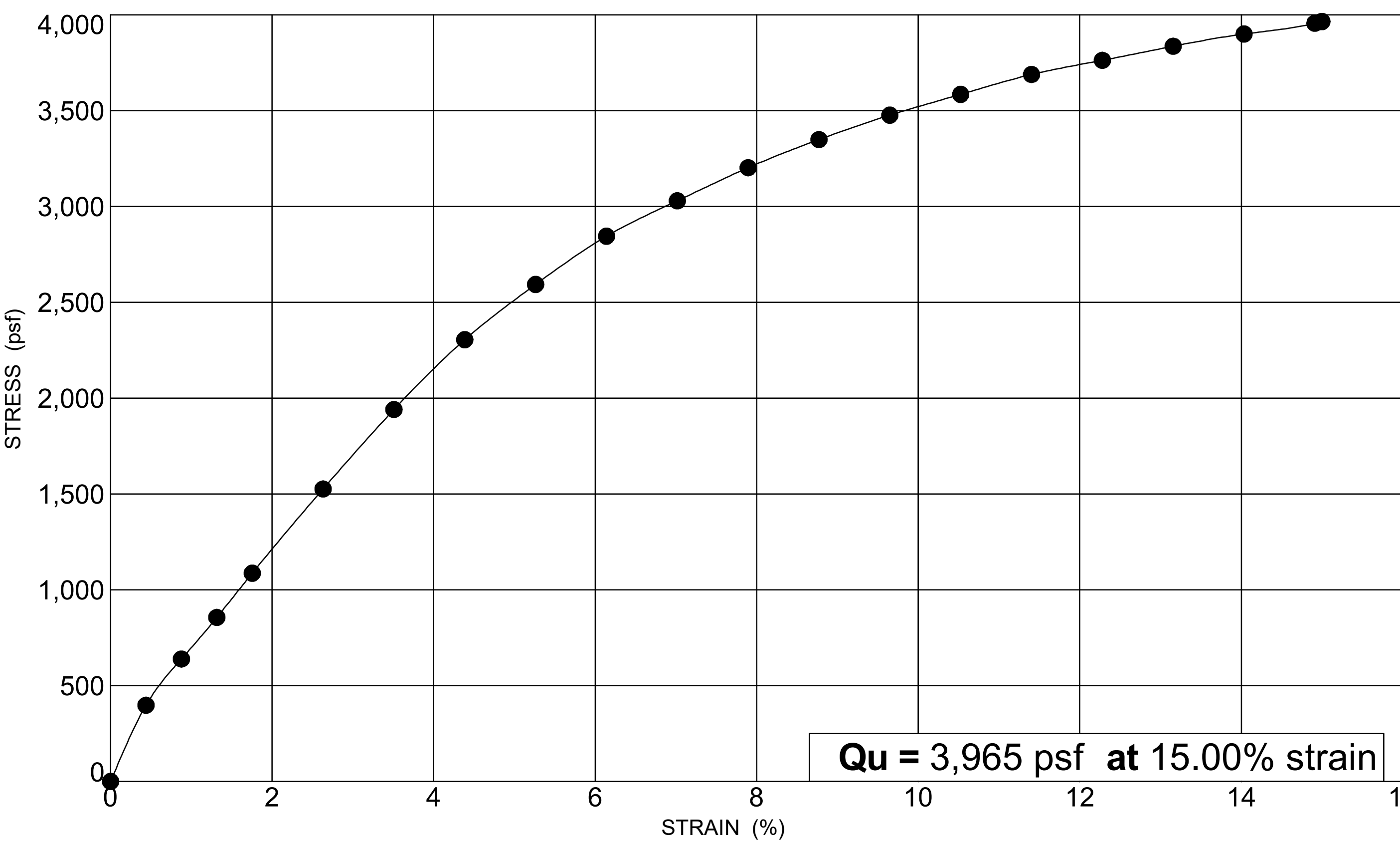
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT WOO-75-29.93 **PID** 119007
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-004-0-23 SAMPLE ID: ST-9
STATION: NOT RECORDED DEPTH: 21.0 - 23.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 144.800 mm
DIAMETER: 73.200 mm
WET UNIT WT: 135.64 pcf
DRY UNIT WT: 117.54 pcf

TESTED BY: KKC 6/29/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
10	5	12	20	53

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
28	17	11	15

ODOT CLASS: A-6a HP (tsf): 2.0
DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 7/24/23 12:31 - S:\PROJECTS\230574.GPJ

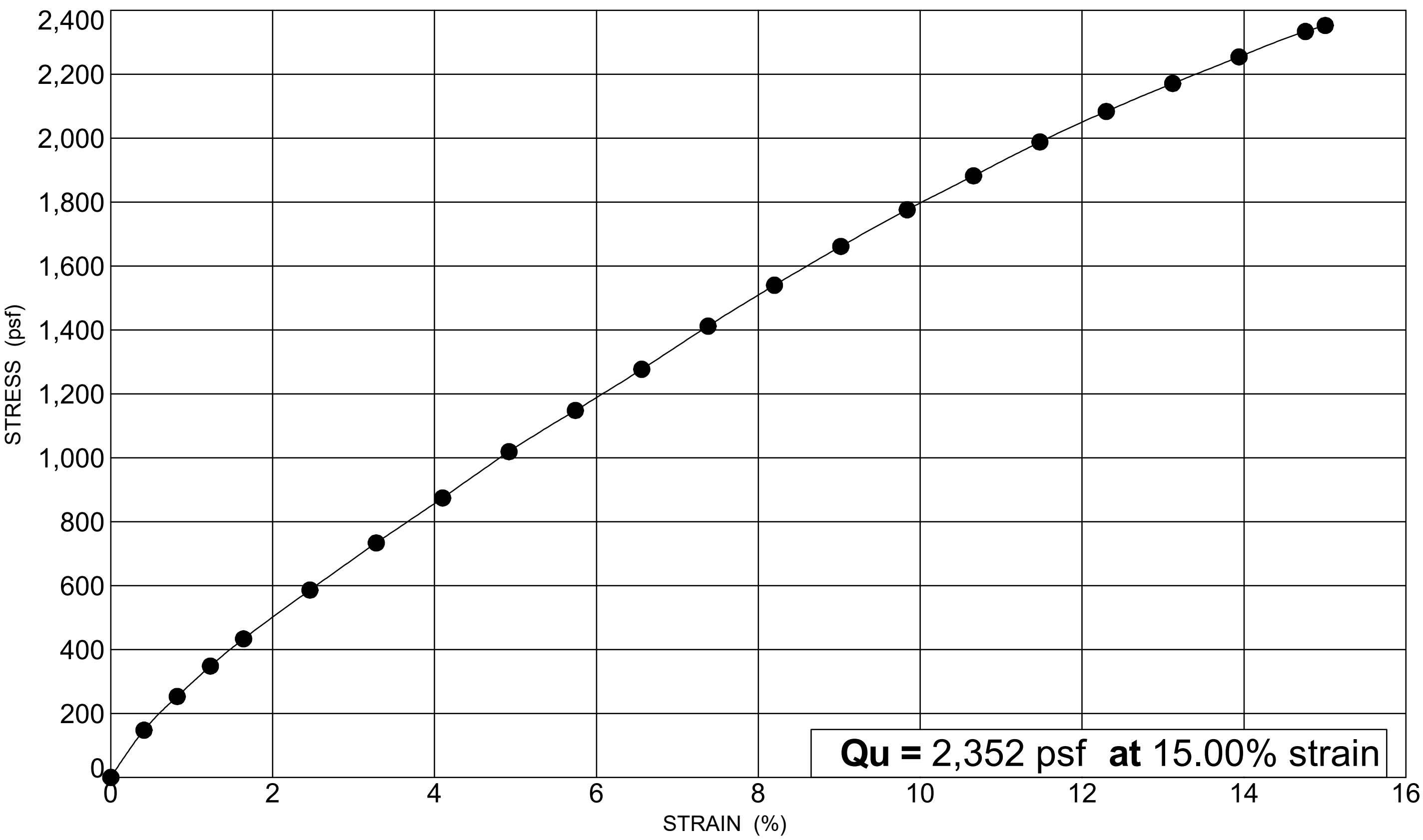
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-75-29.93 **PID** 119007
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-005-0-23 SAMPLE ID: ST-13
STATION: NOT RECORDED DEPTH: 31.0 - 33.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 154.900 mm

DIAMETER: 71.400 mm

WET UNIT WT: 132.20 pcf

DRY UNIT WT: 113.58 pcf

TESTED BY: RS 6/24/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
7	8	18	25	42

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
27	16	11	16

ODOT CLASS: A-6a HP (tsf): 1.50

DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 7/24/23 12:33 - S:\PROJECTS\230574.GPJ

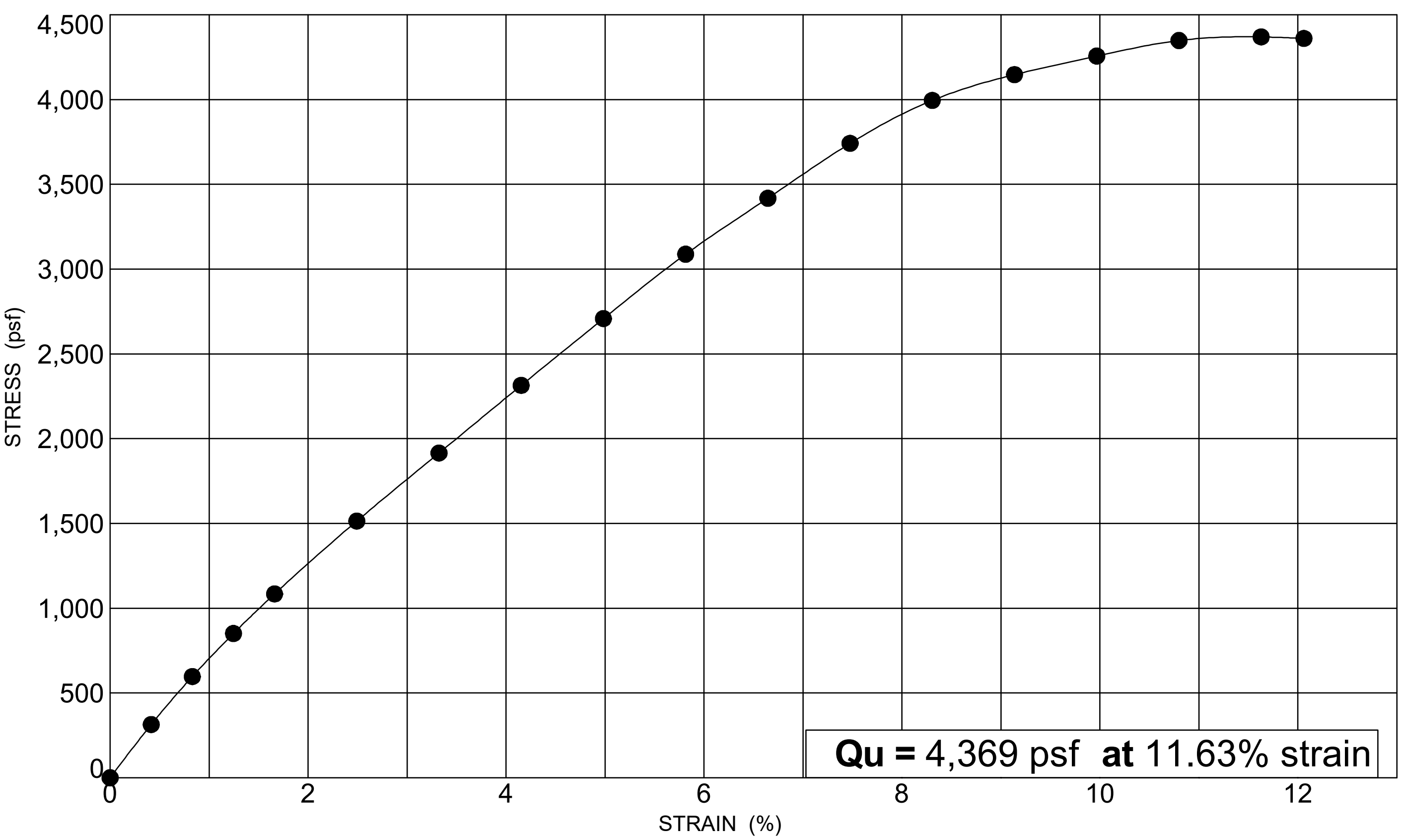
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-75-29.93 **PID** 119007
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-006-0-23 SAMPLE ID: ST-7
STATION: NOT RECORDED DEPTH: 11.0 - 13.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 152.900 mm
DIAMETER: 70.100 mm
WET UNIT WT: 140.40 pcf
DRY UNIT WT: 122.20 pcf

TESTED BY: RS 6/24/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
5	7	16	26	46

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
36	17	19	15

ODOT CLASS: A-6b HP (tsf): 4.5
DESCRIPTION:

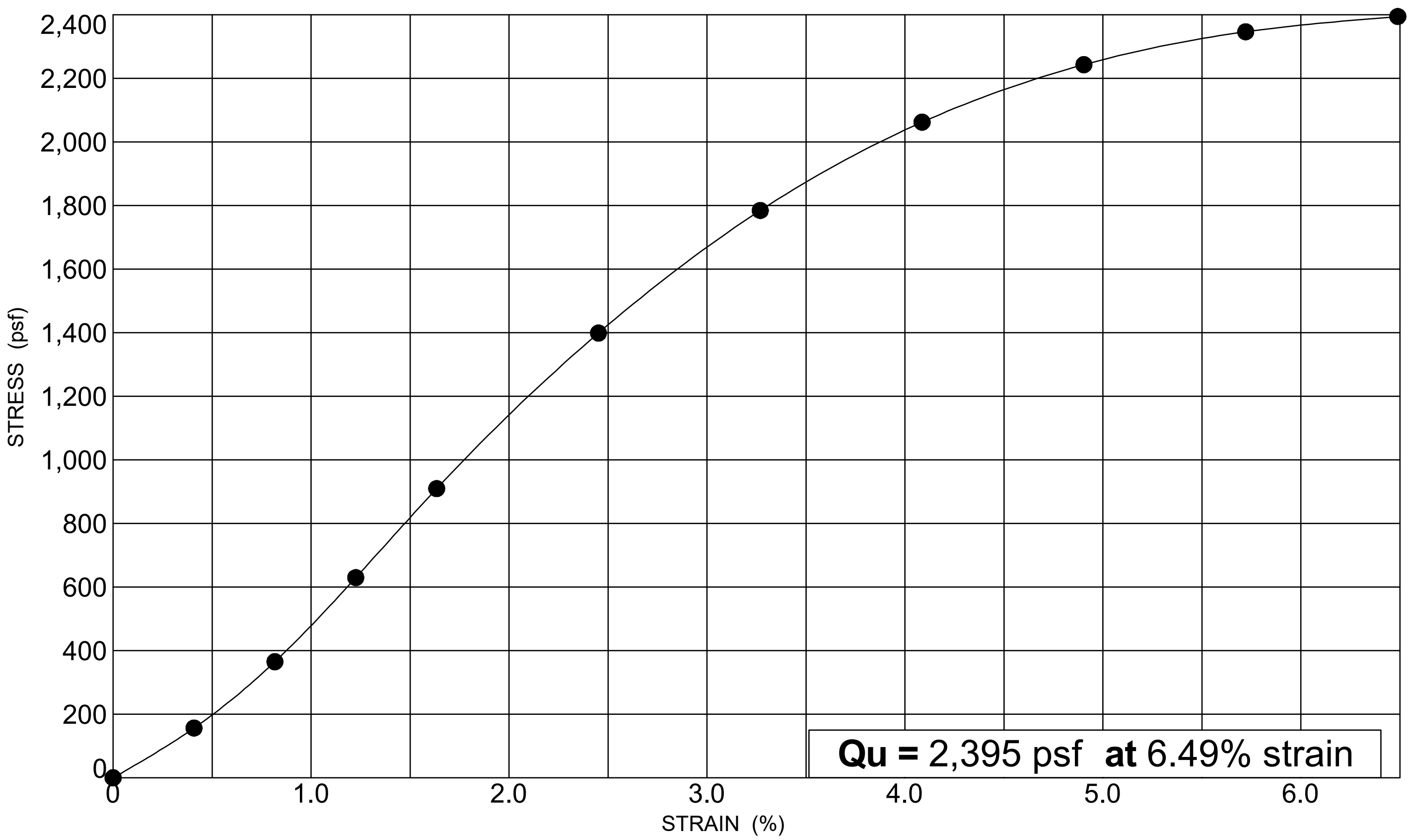
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-75-29.93
PID 119007
OGE NUMBER N/A
PROJECT TYPE STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-006-0-23
SAMPLE ID: ST-11
STATION: NOT RECORDED
DEPTH: 21.0 - 23.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 155.400 mm
DIAMETER: 72.600 mm
WET UNIT WT: 130.76 pcf
DRY UNIT WT: 110.16 pcf

TESTED BY: RS 6/24/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
6	6	17	26	45

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
36	17	19	19

ODOT CLASS: A-6b
HP (tsf): 3.75
DESCRIPTION:

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 7/24/23 12:37 - S:\PROJECTS\230574.GPJ

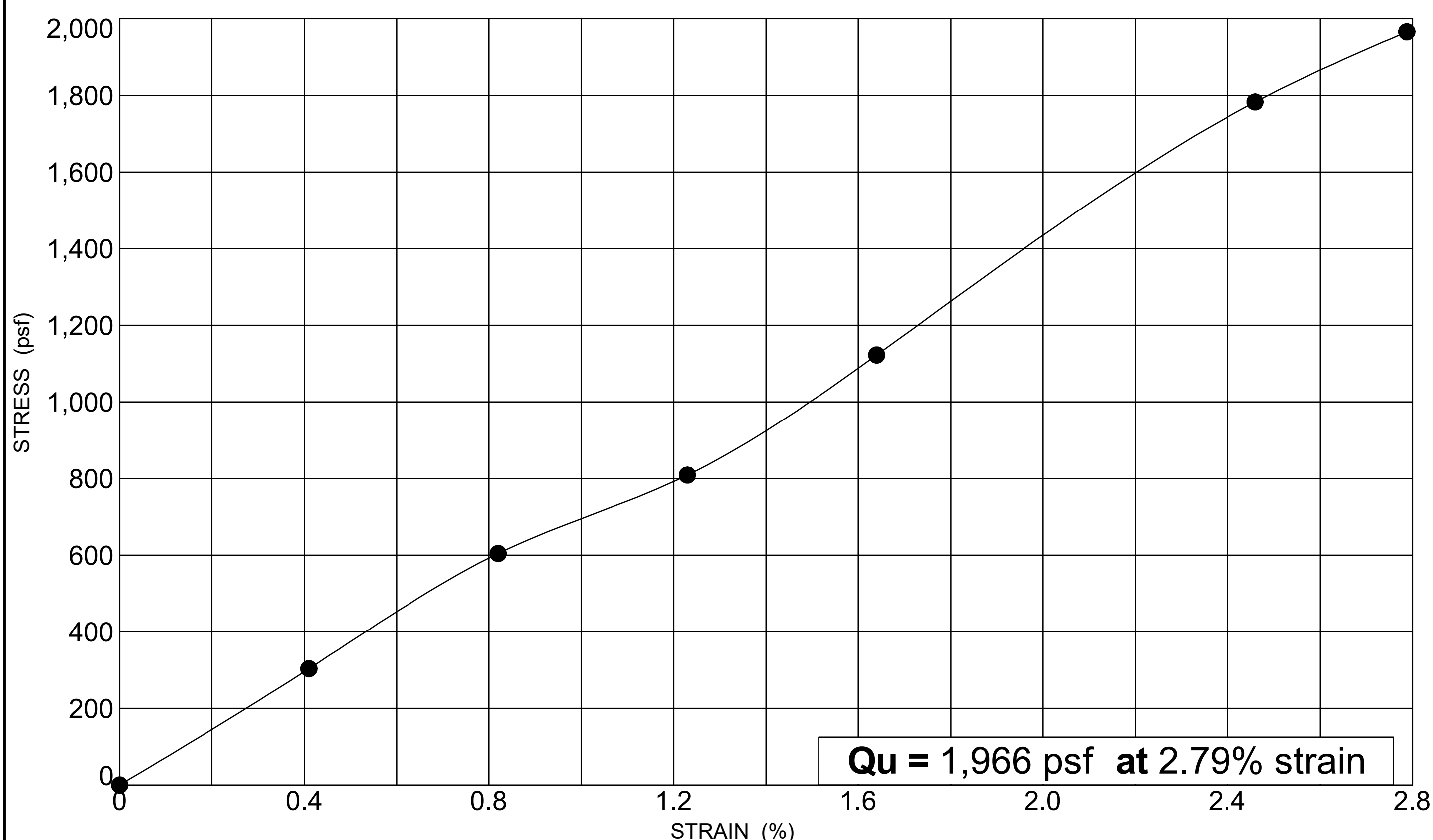
UNCONFINED COMPRESSION TEST
AASHTO T - 208

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-75-29.93 **PID** 119007
OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION

SAMPLE IDENTIFICATION

BORING ID: B-007-0-23 SAMPLE ID: ST-3
STATION: NOT RECORDED DEPTH: 6.0 - 8.0 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 154.900 mm
DIAMETER: 73.200 mm
WET UNIT WT: 130.60 pcf
DRY UNIT WT: 113.86 pcf

TESTED BY: KKC 6/23/2023

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
19	6	16	25	34

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
30	18	12	15

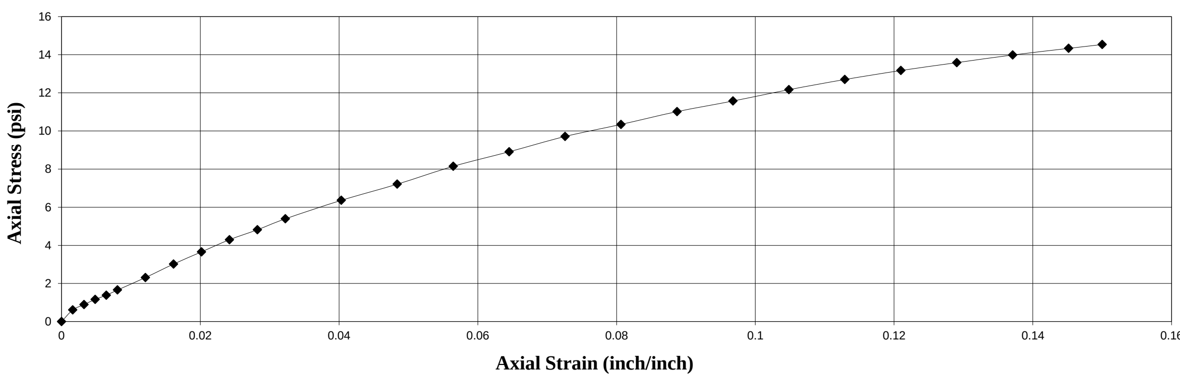
ODOT CLASS: A-6a HP (tsf): >4.5
DESCRIPTION:

Unconsolidated - Undrained Triaxial Shear Strength Test

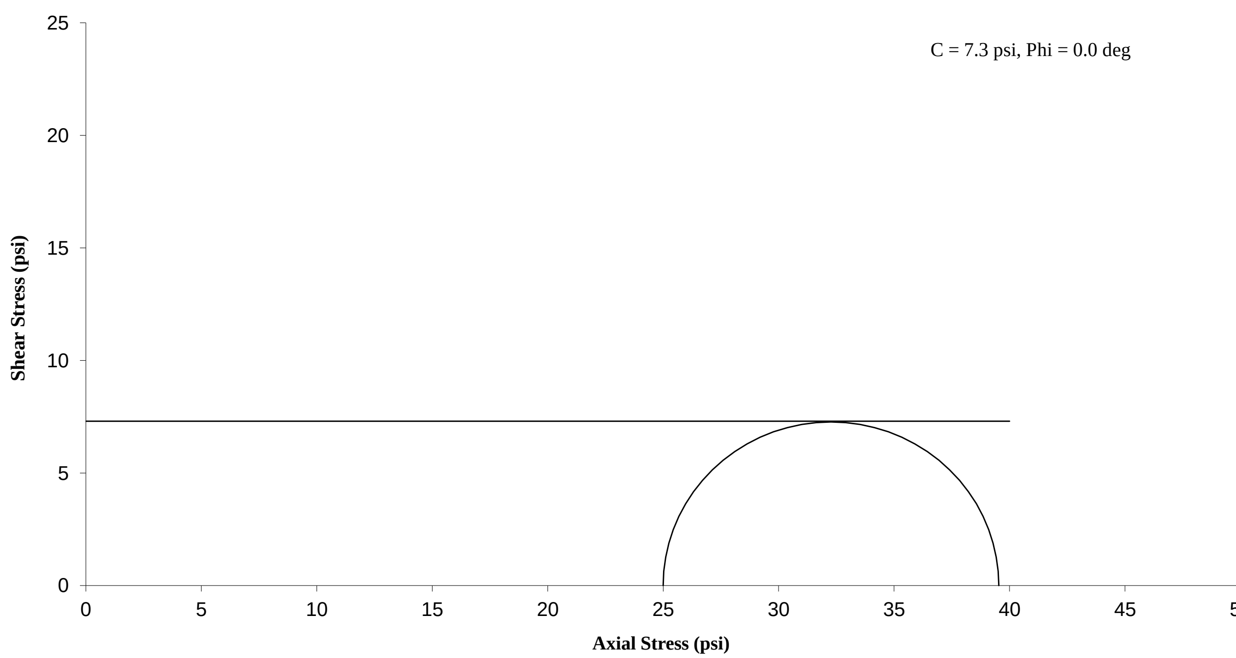
ASTM D 2850

General Sample Data		Triaxial Specimen Data			
TTL Project No.:	230574	Symbol	◆	■	●
Project:	WOO-75-29.93, PID 119007	Init. Specimen Height (in.)	6.20	-	-
Sample ID:	B-005-0-23 ST-16	Init. Specimen Diameter (in.)	2.80	-	-
Sample Interval:	41.0 - 43.0'	Init. Moisture Content* (%)	17.4	-	-
Soil Description:	Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (9)	Init. Dry Unit Weight (pcf)	117.2	-	-
Liquid Limit:	30	Init. Void Ratio	0.46	-	-
Plastic Limit:	17	Init. Degree of Saturation (%)	103	-	-
Plasticity Index:	13	Minor Principal Stress (psi)	25.0	-	-
Specific Gravity:	2.75 (Assumed)	Deviator Stress at Failure (psi)	14.5	-	-
Rate of Strain:	0.03 Inches per Minute	Major Principal Stress (psi)	39.5	-	-
Failure Criteria:	Peak Deviator Stress or Deviator Stress at 15% Axial Strain	Axial Strain at Failure (%)	15.0	-	-

Stress/Strain



Mohr Circle Plot



UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH
OF COHESIVE SOILS IN TRIAXIAL COMPRESSION (ASTM D 2850)

Project: WOO-75-29.93, PID 119007
Date: 6/30/2023
Client: ODOT District 2
File: 230574B-005-0-23ST-16
Sample ID: B-005-0-23 ST-16
Depth: 41.0 - 43.0'
TTL Project No.: 230574
Specimen ID: "D" (42.5 - 43.0 Feet)

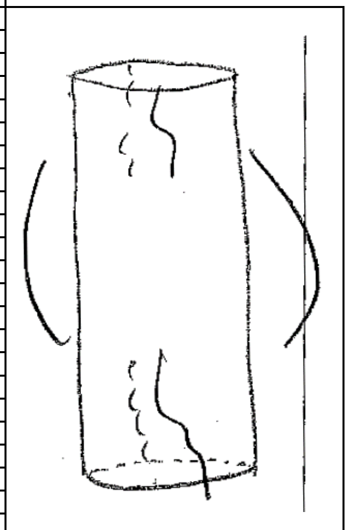
SAMPLE PROPERTIES

Visual Description: Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (9)

Diameter: 2.8 in.
Initial Dry Unit Weight of Sample: 117.2 pcf
Area: 6.158 in^2
Initial Moisture Content: 17.4 %
Length: 6.20 in.
Specific Gravity (assumed): 2.75
Initial Void Ratio: 0.46
Initial Degree of Saturation: 103 %
Chamber Pressure: 25 psi
Proving Ring Number: 1155-12-13322

STRESS-STRAIN DATA

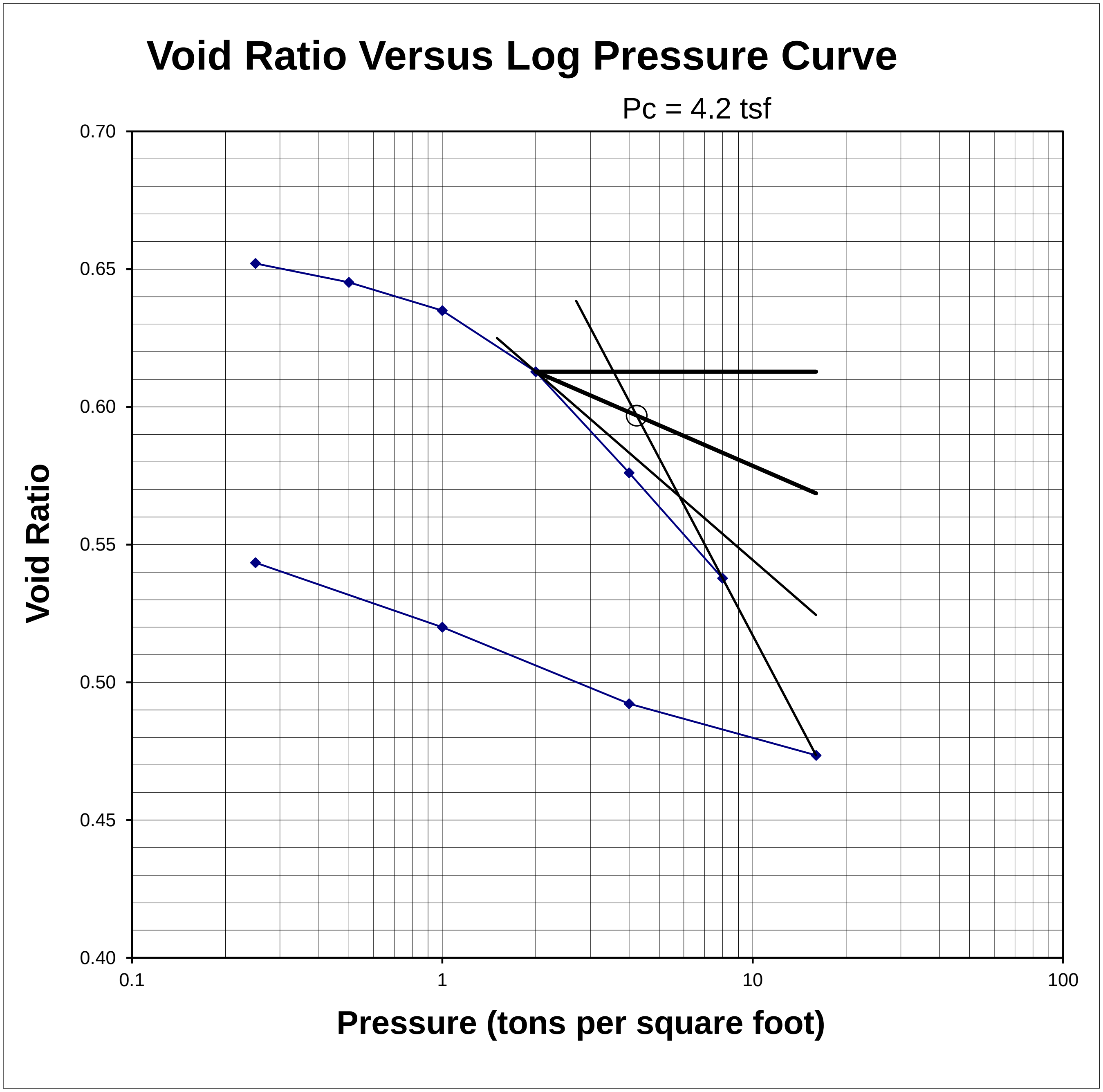
Speciman Deformation (in)	Vertical Strain	Proving Ring Reading	Piston Load (lbs)	Corrected Area (in^2)	Deviator Stress (psi)
0.000	0.000	0.0	0.0	6.158	0.0
0.010	0.002	5.5	3.8	6.167	0.6
0.020	0.003	8.0	5.5	6.177	0.9
0.030	0.005	10.5	7.2	6.187	1.2
0.040	0.006	12.5	8.6	6.198	1.4
0.050	0.008	15.0	10.3	6.208	1.7
0.075	0.012	21.0	14.4	6.233	2.3
0.100	0.016	27.5	18.9	6.258	3.0
0.125	0.020	33.5	23.0	6.284	3.7
0.150	0.024	39.5	27.1	6.310	4.3
0.175	0.028	44.5	30.5	6.336	4.8
0.200	0.032	50.0	34.3	6.363	5.4
0.250	0.040	59.5	40.8	6.416	6.4
0.300	0.048	68.0	46.6	6.471	7.2
0.350	0.056	77.5	53.2	6.526	8.1
0.400	0.065	85.5	58.7	6.582	8.9
0.450	0.073	94.0	64.5	6.639	9.7
0.500	0.081	101.0	69.3	6.698	10.3
0.550	0.089	108.5	74.4	6.757	11.0
0.600	0.097	115.0	78.9	6.817	11.6
0.650	0.105	122.0	83.7	6.879	12.2
0.700	0.113	128.5	88.2	6.941	12.7
0.750	0.121	134.5	92.3	7.005	13.2
0.800	0.129	140.0	96.0	7.070	13.6
0.850	0.137	145.5	99.8	7.136	14.0
0.900	0.145	150.5	103.2	7.203	14.3
0.930	0.150	153.5	105.3	7.244	14.5


Sketch of Tested Specimen

RESULTS

Maximum Deviator Stress 14.5 psi

Project No.: 230574
Date: 6/23/2023
Client: ODOT District 2
Project: WOO-75-29.93, PID 119007
Wood County, OH
Boring No.: B-002-0-23
Sample No.: ST-9
Depth: 16.0 - 18.0'



Project No.: 230574
Date: 6/23/2023
Client: ODOT District 2
Project: WOO-75-29.93, PID 119007
Wood County, OH
Boring No.: B-002-0-23
Sample No.: ST-9
Depth: 16.0 - 18.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.125	1.00000	1.00000	0.00000	1.0000	0.654				
0.25	0.99900	1.00000	0.00100	0.9995	0.652	0.3	0.125	0.003280	1.968
0.5	0.99485	0.99900	0.00515	0.9969	0.645	4.5	0.375	0.000181	0.109
1	0.98865	0.99485	0.01135	0.9918	0.635	5.5	0.75	0.000147	0.088
2	0.97525	0.98865	0.02475	0.9820	0.613	8.5	1.5	0.000093	0.056
4	0.95305	0.97525	0.04695	0.9642	0.576	22.5	3	0.000034	0.020
8	0.92990	0.95305	0.07010	0.9415	0.538	19.6	6	0.000037	0.022
16	0.89105	0.92990	0.10895	0.9105	0.474	28.6	12	0.000024	0.014
4	0.90235	0.89105	0.09765	0.8967	0.492		10		
1	0.91915	0.90235	0.08085	0.9108	0.520		2.5		
0.25	0.93335	0.91915	0.06665	0.9263	0.543		0.625		

Estimated Cc: 0.213
Estimated Cr: 0.039

Soil Description: Gray CLAY, Some Silt, Little Sand, Trace Gravel A-7-6 (14)
Specific Gravity: 2.702
Liquid Limit: 44
Plastic Limit: 22
Plasticity Index: 22

Initial Water Content:	22.0 %	Final Water Content:	21.2 %
Inital Dry Density:	102.0 pcf	Final Dry Density:	109.3 pcf
Initial Void Ratio:	0.654	Final Void Ratio:	0.543
Initial Degree of Saturation:	91.1 %	Final Degree of Saturation	105.4 %

Estimated Preconsolidation Pressure: 4.2 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

TTL associates inc
Environmental, Geotechnical Engineering & Testing

Consolidation Laboratory Calculations

Consolidometer:	**1**		
Method:	ASTM D 2435 Method B		
Project No. :	230574		
Client:	ODOT District 2		
Project:	WOO-75-29.93, PID 119007		
Location:	Wood County, OH		
Boring No. :	B-002-0-23	Visual Description:	Gray CLAY, Some Silt, Little Sand, Trace Gravel A-7-6 (14)
Sample No.:	ST-9	Liquid Limit:	44 %
Depth:	16.0 - 18.0'	Plastic Limit:	22 %
Date of Test:	6/23/2023	Plasticity Index:	22 %

Initial Sample Data			***Final Sample Data***		
Initial Height	1.000 in.		Final Height	0.933 in.	
Ring Dia.	2.493 in.		Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2		Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3	Final Volume	4.5560 in^3	0.00264 ft^3
Specific Gravity	2.702				
			Final wet mass soil, pan & ring	352.9 g	
			Wt of Pan	49.8 g	
Initial wet mass soil & ring	304.2 g		Final wet mass soil & ring	303.1	
Mass of ring	144.7 g		Mass of ring	144.7 g	
			Final dry mass of soil, pan & ring	325.2 g	
Initial wet mass soil	159.5 g	0.35164 lb	Final wet mass soil	158.4 g	0.34921 lb
			Weight of water	27.7 g	0.06107 lb

Initial Water Content

Mass can & wet soil	429.8 g
Mass can & dry soil	366.3 g
Mass of can	50.9 g
Mass of water	63.5 g
Mass of soil	315.4 g
Initial water content	20.13 % (trimmings)

Initial water content	22.04 % (based on final dry weight)		Final water content	21.19 % (based on final dry weight)	
			Final weight of solids (Md)	130.7 g	0.28815 lb
Initial dry density	102.0 pcf		Final dry density	109.3 pcf	
			Final volume of solids (Vs)	2.9517 in^3	0.00171 ft^3
			Final height of solids (Hs)	0.6047 in.	
Initial void ratio (eo)	0.654		Final void ratio (ef)	0.543	
Initial volume of voids (Vvo)	1.9296 in^3	0.00112 ft^3	Final volume of voids (Vvf)	1.6042 in^3	0.00093 ft^3
Initial volume of water (Vwo)	1.7574 in^3	0.00102 ft^3	Final volume of water (Vwf)	1.6903 in^3	0.00098 ft^3
Initial degree of saturation (So)	91.08 %		Final degree of saturation (Sf)	105.37 %	

Project No. : 230574 Sample No.: ST-9
Boring No. : B-002-0-23 Depth: 16.0 - 18.0'

0.25 tsf Load

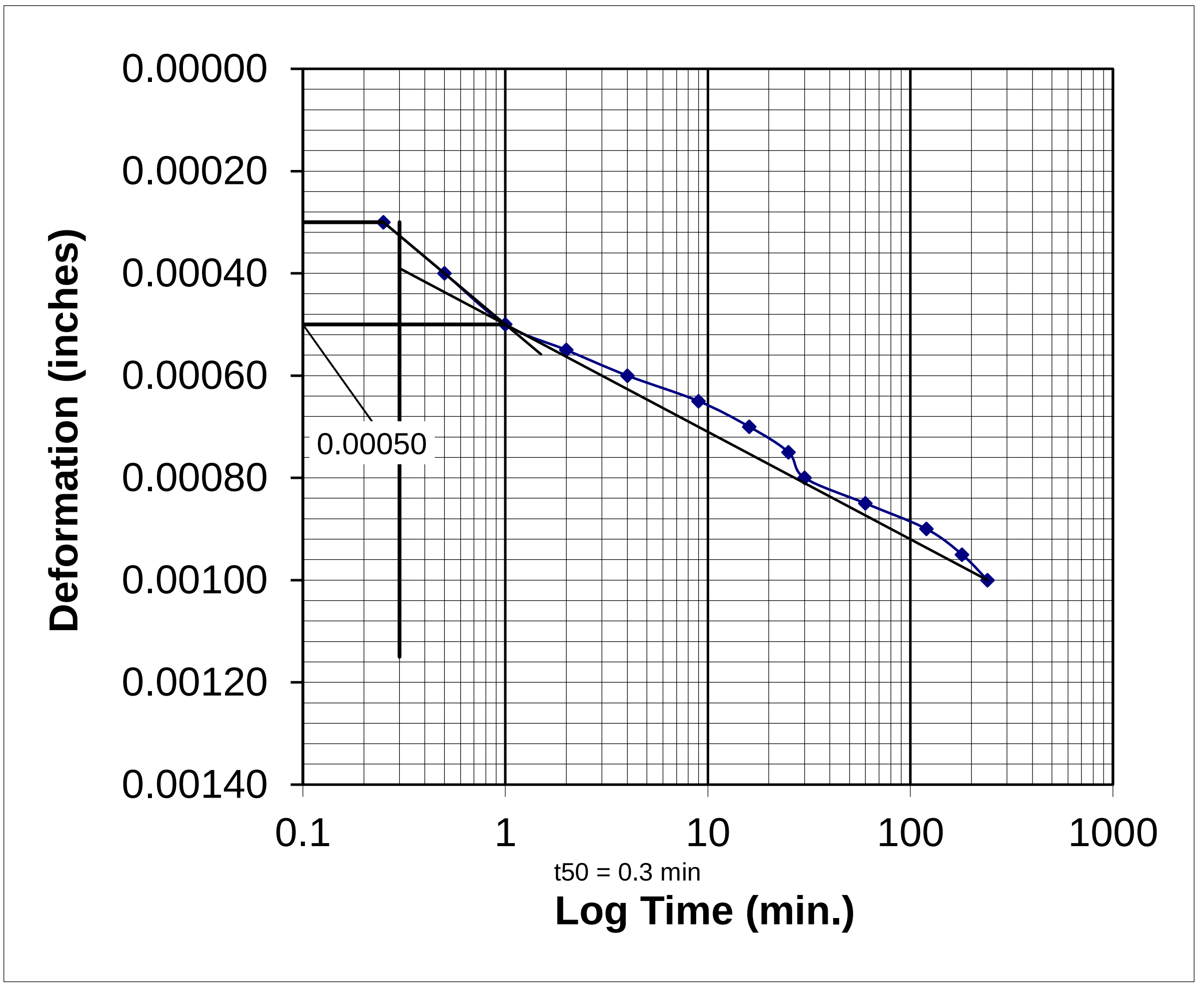
initial height= 1 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00010
2) 0.5 to 2.0: 0.00025
3) 1.0 to 4.0: 0.00040
Do Avg 1&2: 0.00018
Do Avg 1-3: 0.00025

Use Do= 0.00010
D100= 0.00050
D50= D100+0.5(Do-D100)
D50= 0.00030

t50 = 0.3 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39955				
0.25	0.39925	0.00030	0.00000	0.00030	0.99970
0.5	0.39915	0.00040	0.00000	0.00040	0.99960
1	0.39905	0.00050	0.00000	0.00050	0.99950
2	0.39900	0.00055	0.00000	0.00055	0.99945
4	0.39895	0.00060	0.00000	0.00060	0.99940
9	0.39890	0.00065	0.00000	0.00065	0.99935
16	0.39885	0.00070	0.00000	0.00070	0.99930
25	0.39880	0.00075	0.00000	0.00075	0.99925
30	0.39875	0.00080	0.00000	0.00080	0.99920
60	0.39870	0.00085	0.00000	0.00085	0.99915
120	0.39865	0.00090	0.00000	0.00090	0.99910
180	0.39860	0.00095	0.00000	0.00095	0.99905
240	0.39855	0.00100	0.00000	0.00100	0.99900



Project No. : 230574 Sample No.: ST-9
Boring No. : B-002-0-23 Depth: 16.0 - 18.0'

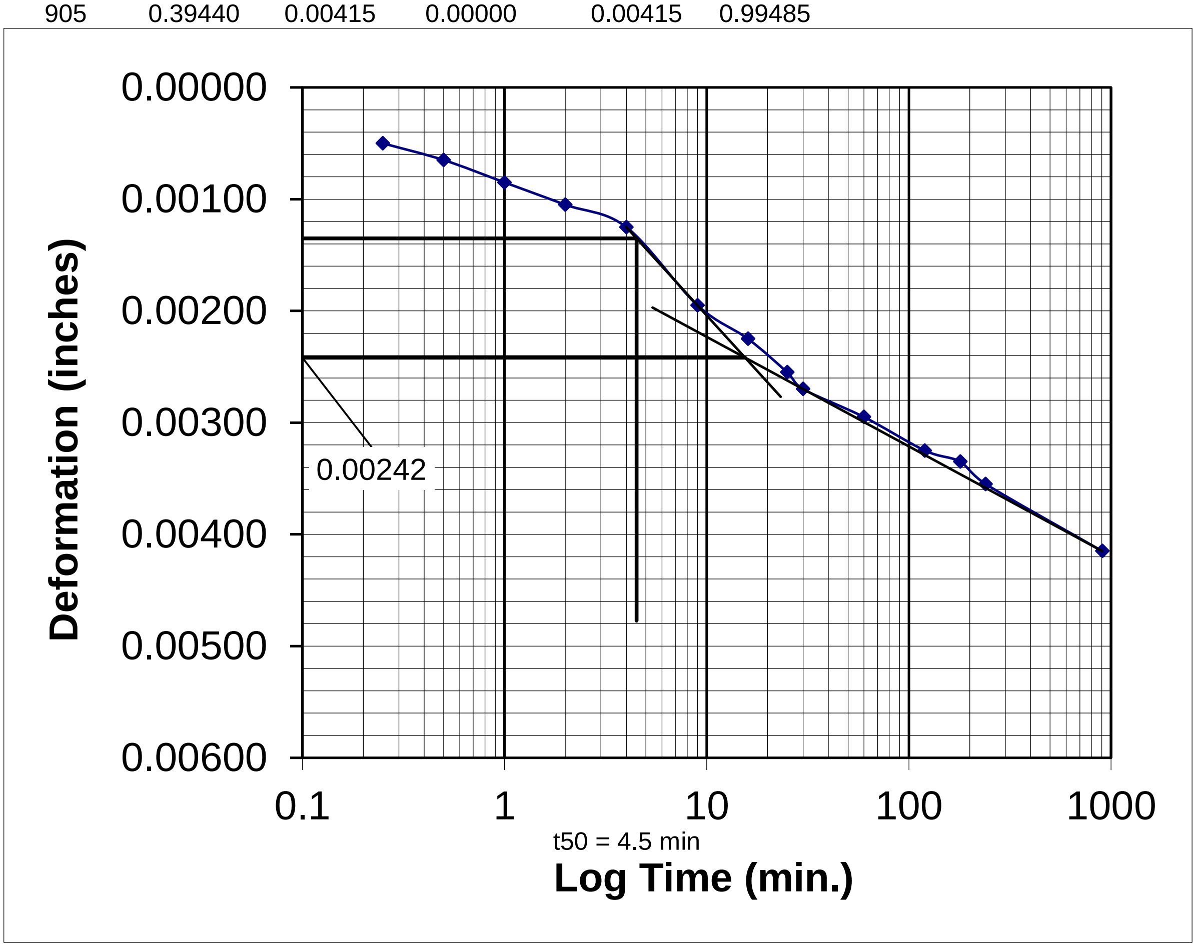
0.5 tsf Load

initial height= 0.999 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00015
2) 0.5 to 2.0: 0.00025
3) 1.0 to 4.0: 0.00045
Do Avg 1&2: 0.00020
Do Avg 1-3: 0.00028
Use Do= 0.00028
D100= 0.00242
D50= D100+0.5(Do-D100)
D50= 0.00135

t50 = 4.5 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39855				
0.25	0.39805	0.00050	0.00000	0.00050	0.99850
0.5	0.39790	0.00065	0.00000	0.00065	0.99835
1	0.39770	0.00085	0.00000	0.00085	0.99815
2	0.39750	0.00105	0.00000	0.00105	0.99795
4	0.39730	0.00125	0.00000	0.00125	0.99775
9	0.39660	0.00195	0.00000	0.00195	0.99705
16	0.39630	0.00225	0.00000	0.00225	0.99675
25	0.39600	0.00255	0.00000	0.00255	0.99645
30	0.39585	0.00270	0.00000	0.00270	0.99630
60	0.39560	0.00295	0.00000	0.00295	0.99605
120	0.39530	0.00325	0.00000	0.00325	0.99575
180	0.39520	0.00335	0.00000	0.00335	0.99565
240	0.39500	0.00355	0.00000	0.00355	0.99545
905	0.39440	0.00415	0.00000	0.00415	0.99485



Project No. : 230574
Boring No. : B-002-0-23

Sample No.: ST-9
Depth: 16.0 - 18.0'

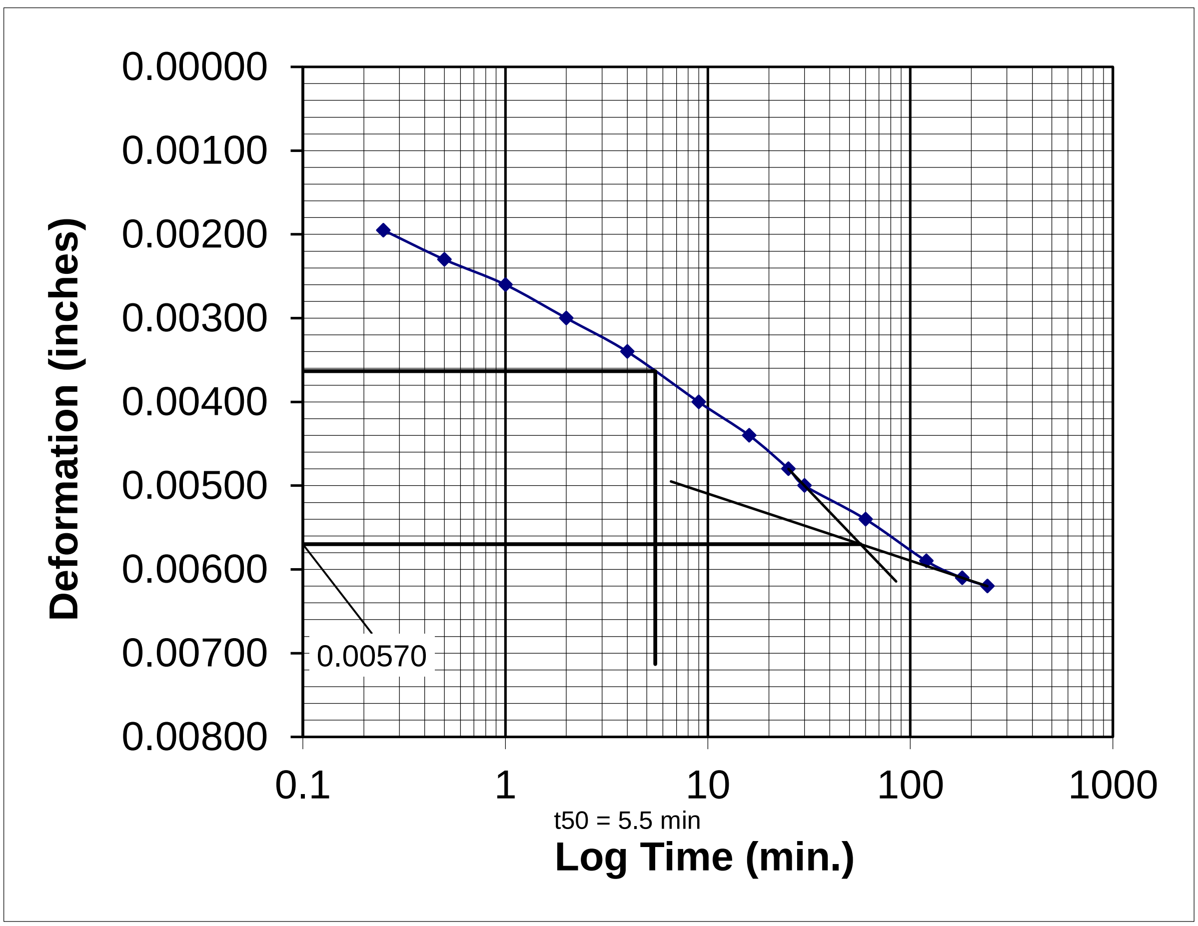
1.0 tsf Load

initial height= 0.99485 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00130
2) 0.5 to 2.0: 0.00160
3) 1.0 to 4.0: 0.00180
Do Avg 1&2: 0.00145
Do Avg 1-3: 0.00157
Use Do= 0.00157
D100= 0.00570
D50= D100+0.5(Do-D100)
D50= 0.00363

t50 = 5.5 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.39440				
0.25	0.39245	0.00195	0.00000	0.00195	0.99290
0.5	0.39210	0.00230	0.00000	0.00230	0.99255
1	0.39180	0.00260	0.00000	0.00260	0.99225
2	0.39140	0.00300	0.00000	0.00300	0.99185
4	0.39100	0.00340	0.00000	0.00340	0.99145
9	0.39040	0.00400	0.00000	0.00400	0.99085
16	0.39000	0.00440	0.00000	0.00440	0.99045
25	0.38960	0.00480	0.00000	0.00480	0.99005
30	0.38940	0.00500	0.00000	0.00500	0.98985
60	0.38900	0.00540	0.00000	0.00540	0.98945
120	0.38850	0.00590	0.00000	0.00590	0.98895
180	0.38830	0.00610	0.00000	0.00610	0.98875
240	0.38820	0.00620	0.00000	0.00620	0.98865



Project No. : 230574
Boring No. : B-002-0-23

Sample No.: ST-9
Depth: 16.0 - 18.0'

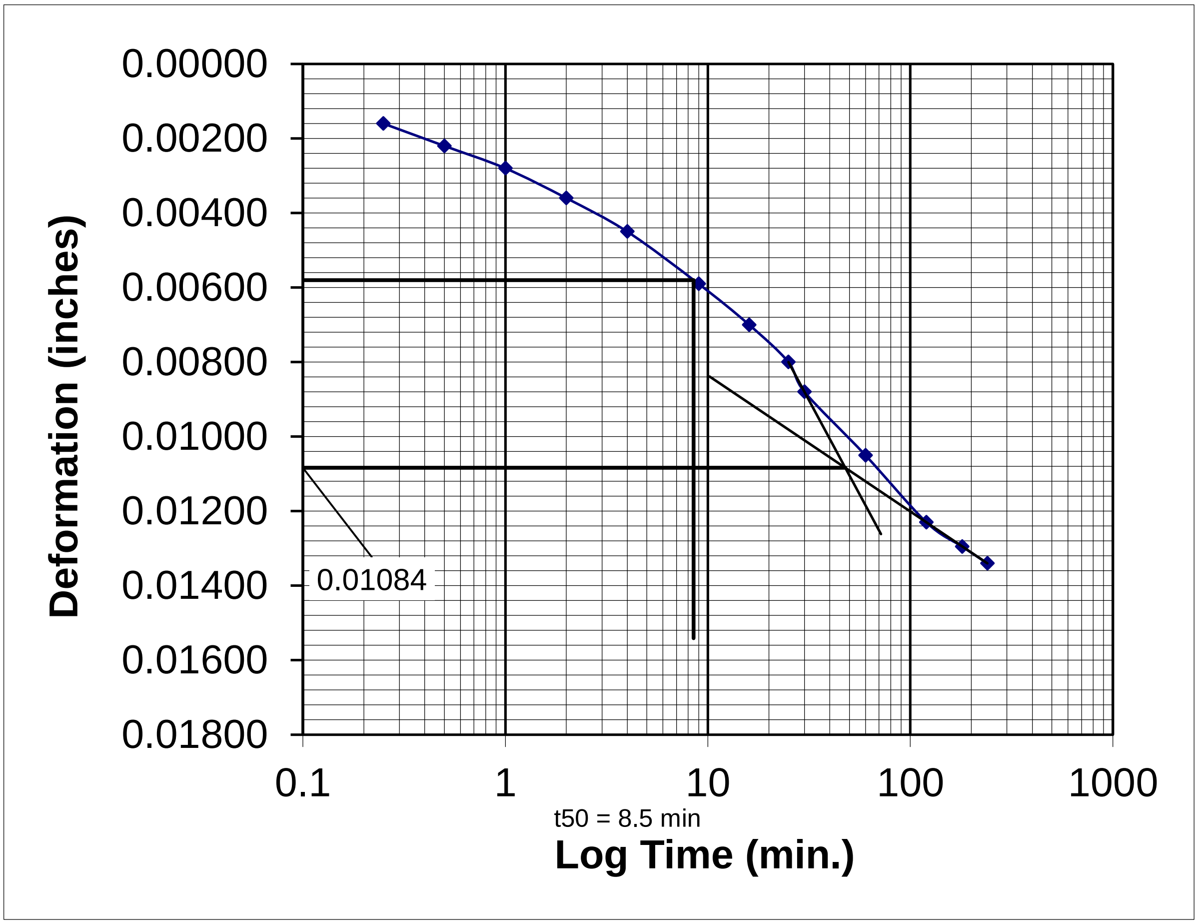
2.0 tsf Load

initial height= 0.98865 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00040
2) 0.5 to 2.0: 0.00080
3) 1.0 to 4.0: 0.00110
Do Avg 1&2: 0.00060
Do Avg 1-3: 0.00077
Use Do= 0.00077
D100= 0.01084
D50= D100+0.5(Do-D100)
D50= 0.00580

t50 = 8.5 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.38820				
0.25	0.38370	0.00450	0.00290	0.00160	0.98705
0.5	0.38310	0.00510	0.00290	0.00220	0.98645
1	0.38250	0.00570	0.00290	0.00280	0.98585
2	0.38170	0.00650	0.00290	0.00360	0.98505
4	0.38080	0.00740	0.00290	0.00450	0.98415
9	0.37940	0.00880	0.00290	0.00590	0.98275
16	0.37830	0.00990	0.00290	0.00700	0.98165
25	0.37730	0.01090	0.00290	0.00800	0.98065
30	0.37650	0.01170	0.00290	0.00880	0.97985
60	0.37480	0.01340	0.00290	0.01050	0.97815
120	0.37300	0.01520	0.00290	0.01230	0.97635
180	0.37235	0.01585	0.00290	0.01295	0.97570
240	0.37190	0.01630	0.00290	0.01340	0.97525



Project No. : 230574 Sample No.: ST-9
Boring No. : B-002-0-23 Depth: 16.0 - 18.0'

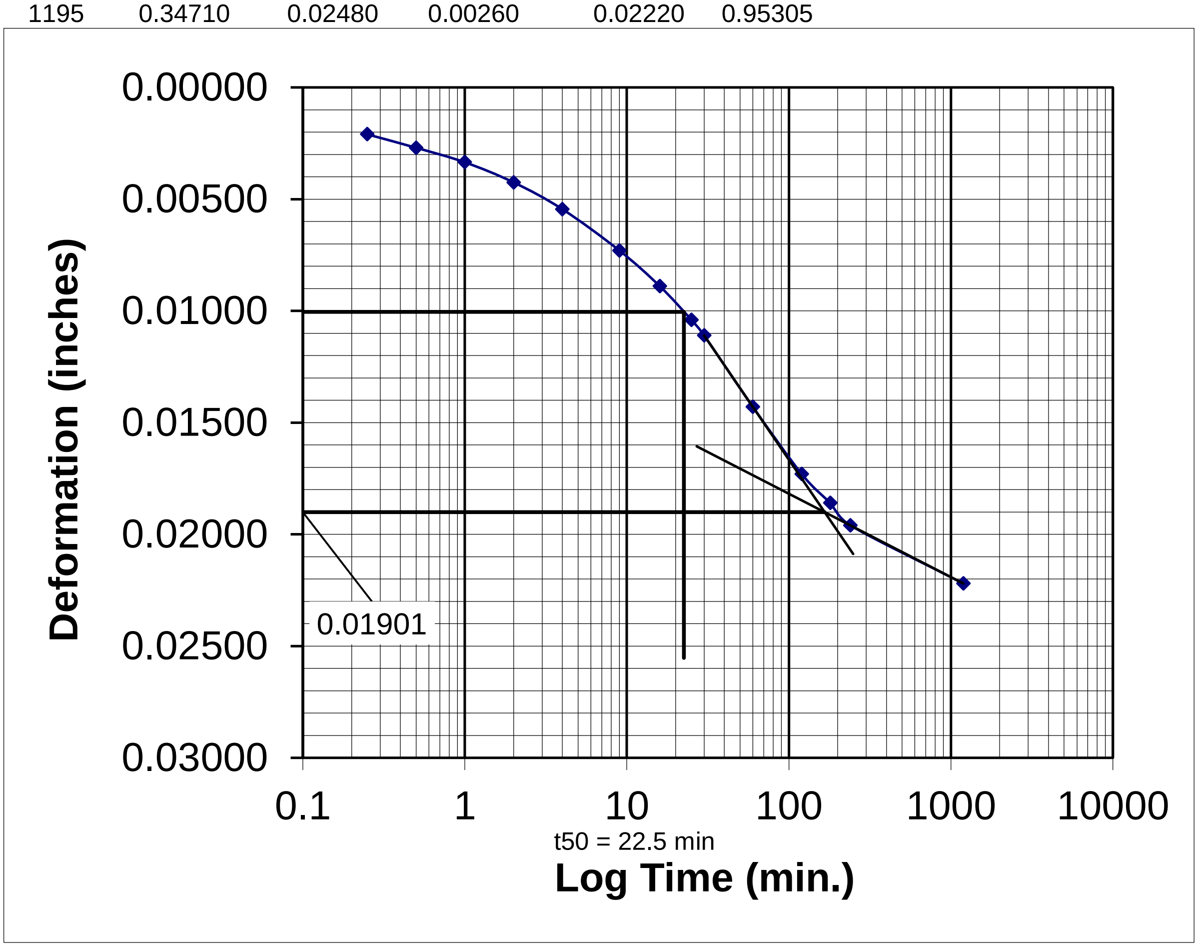
4.0 tsf Load

initial height= 0.97525 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00085
2) 0.5 to 2.0: 0.00115
3) 1.0 to 4.0: 0.00125
Do Avg 1&2: 0.00100
Do Avg 1-3: 0.00108
Use Do= 0.00108
D100= 0.01901
D50= D100+0.5(Do-D100)
D50= 0.01004

t50 = 22.5 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.37190				
0.25	0.36720	0.00470	0.00260	0.00210	0.97315
0.5	0.36660	0.00530	0.00260	0.00270	0.97255
1	0.36595	0.00595	0.00260	0.00335	0.97190
2	0.36505	0.00685	0.00260	0.00425	0.97100
4	0.36385	0.00805	0.00260	0.00545	0.96980
9	0.36200	0.00990	0.00260	0.00730	0.96795
16	0.36040	0.01150	0.00260	0.00890	0.96635
25	0.35890	0.01300	0.00260	0.01040	0.96485
30	0.35820	0.01370	0.00260	0.01110	0.96415
60	0.35500	0.01690	0.00260	0.01430	0.96095
120	0.35200	0.01990	0.00260	0.01730	0.95795
180	0.35070	0.02120	0.00260	0.01860	0.95665
240	0.34970	0.02220	0.00260	0.01960	0.95565
1195	0.34710	0.02480	0.00260	0.02220	0.95305



Project No. : 230574   Sample No.: ST-9
Boring No. : B-002-0-23   Depth: 16.0 - 18.0'

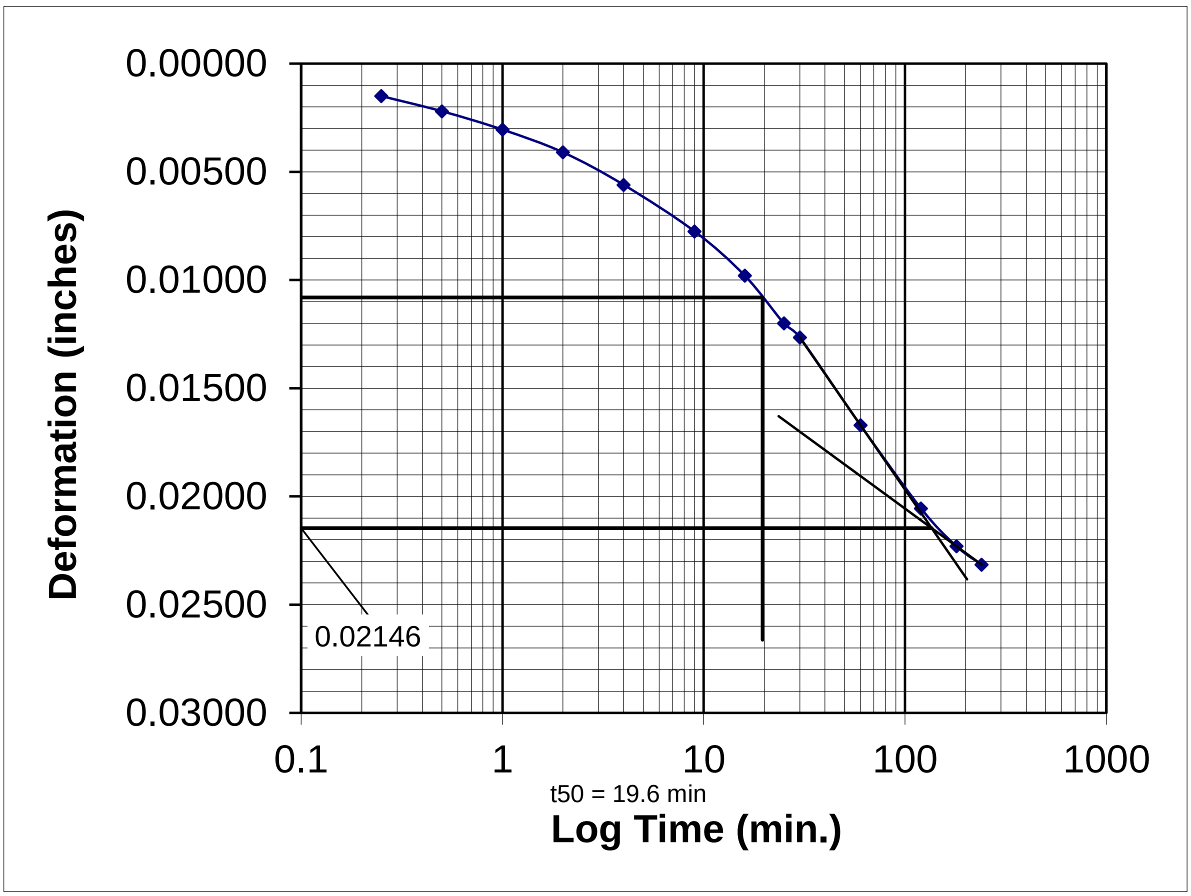
8.0 tsf Load

initial height= 0.95305 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00005
2) 0.5 to 2.0: 0.00030
3) 1.0 to 4.0: 0.00050
Do Avg 1&2: 0.00013
Do Avg 1-3: 0.00025
Use Do= 0.00015
D100= 0.02146
D50= D100+0.5(Do-D100)
D50= 0.01081

t50 = 19.6 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.34710				
0.25	0.34340	0.00370	0.00220	0.00150	0.95155
0.5	0.34270	0.00440	0.00220	0.00220	0.95085
1	0.34185	0.00525	0.00220	0.00305	0.95000
2	0.34080	0.00630	0.00220	0.00410	0.94895
4	0.33930	0.00780	0.00220	0.00560	0.94745
9	0.33715	0.00995	0.00220	0.00775	0.94530
16	0.33510	0.01200	0.00220	0.00980	0.94325
25	0.33290	0.01420	0.00220	0.01200	0.94105
30	0.33225	0.01485	0.00220	0.01265	0.94040
60	0.32820	0.01890	0.00220	0.01670	0.93635
120	0.32435	0.02275	0.00220	0.02055	0.93250
180	0.32260	0.02450	0.00220	0.02230	0.93075
240	0.32175	0.02535	0.00220	0.02315	0.92990



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Project No. : 230574
Boring No. : B-002-0-23

Sample No.: ST-9
Depth: 16.0 - 18.0'

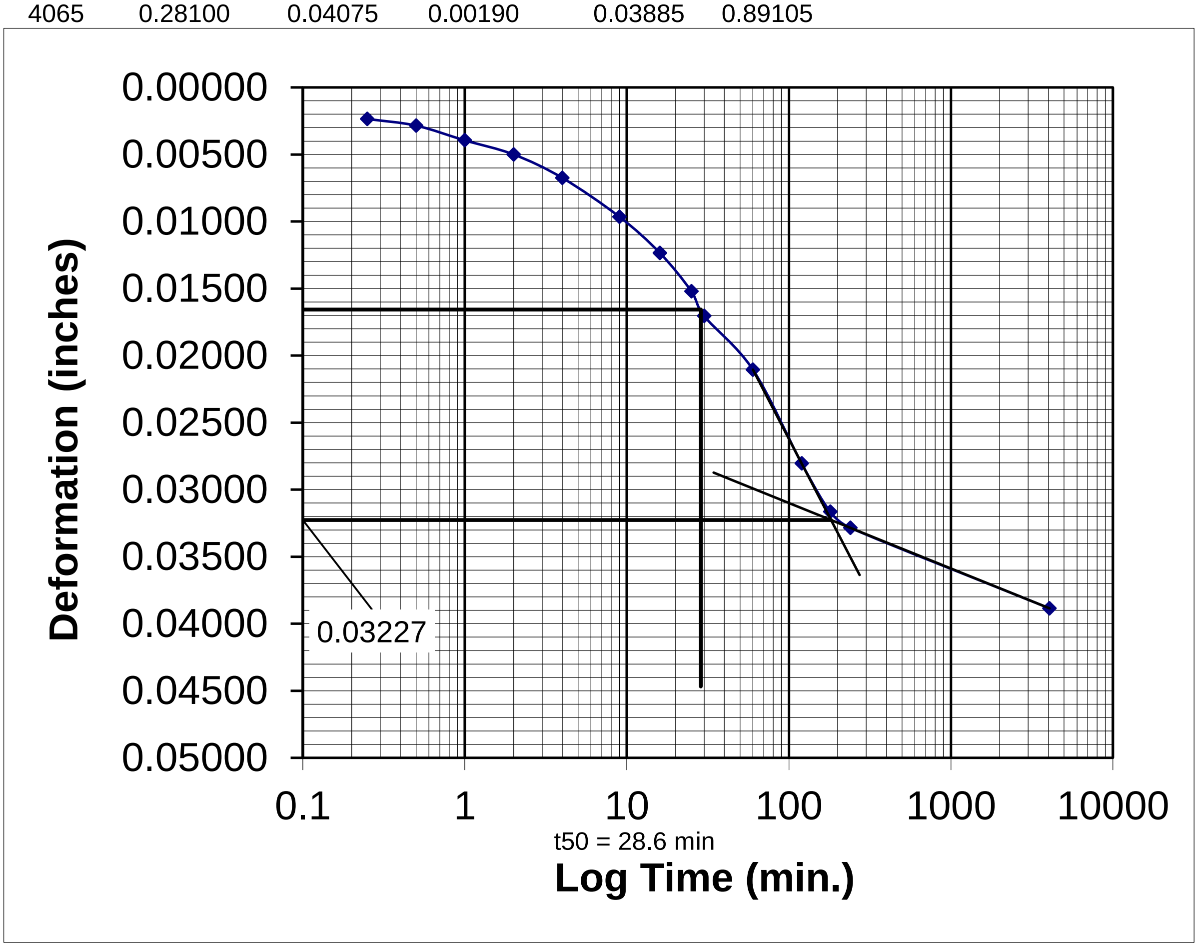
16 tsf Load

initial height= 0.9299 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00075
2) 0.5 to 2.0: 0.00070
3) 1.0 to 4.0: 0.00115
Do Avg 1&2: 0.00072
Do Avg 1-3: 0.00087
Use Do= 0.00087
D100= 0.03227
D50= D100+0.5(Do-D100)
D50= 0.01657

t50 = 28.6 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.32175				
0.25	0.31750	0.00425	0.00190	0.00235	0.92755
0.5	0.31700	0.00475	0.00190	0.00285	0.92705
1	0.31590	0.00585	0.00190	0.00395	0.92595
2	0.31485	0.00690	0.00190	0.00500	0.92490
4	0.31310	0.00865	0.00190	0.00675	0.92315
9	0.31020	0.01155	0.00190	0.00965	0.92025
16	0.30750	0.01425	0.00190	0.01235	0.91755
25	0.30465	0.01710	0.00190	0.01520	0.91470
30	0.30280	0.01895	0.00190	0.01705	0.91285
60	0.29880	0.02295	0.00190	0.02105	0.90885
120	0.29180	0.02995	0.00190	0.02805	0.90185
180	0.28820	0.03355	0.00190	0.03165	0.89825
240	0.28700	0.03475	0.00190	0.03285	0.89705
4065	0.28100	0.04075	0.00190	0.03885	0.89105

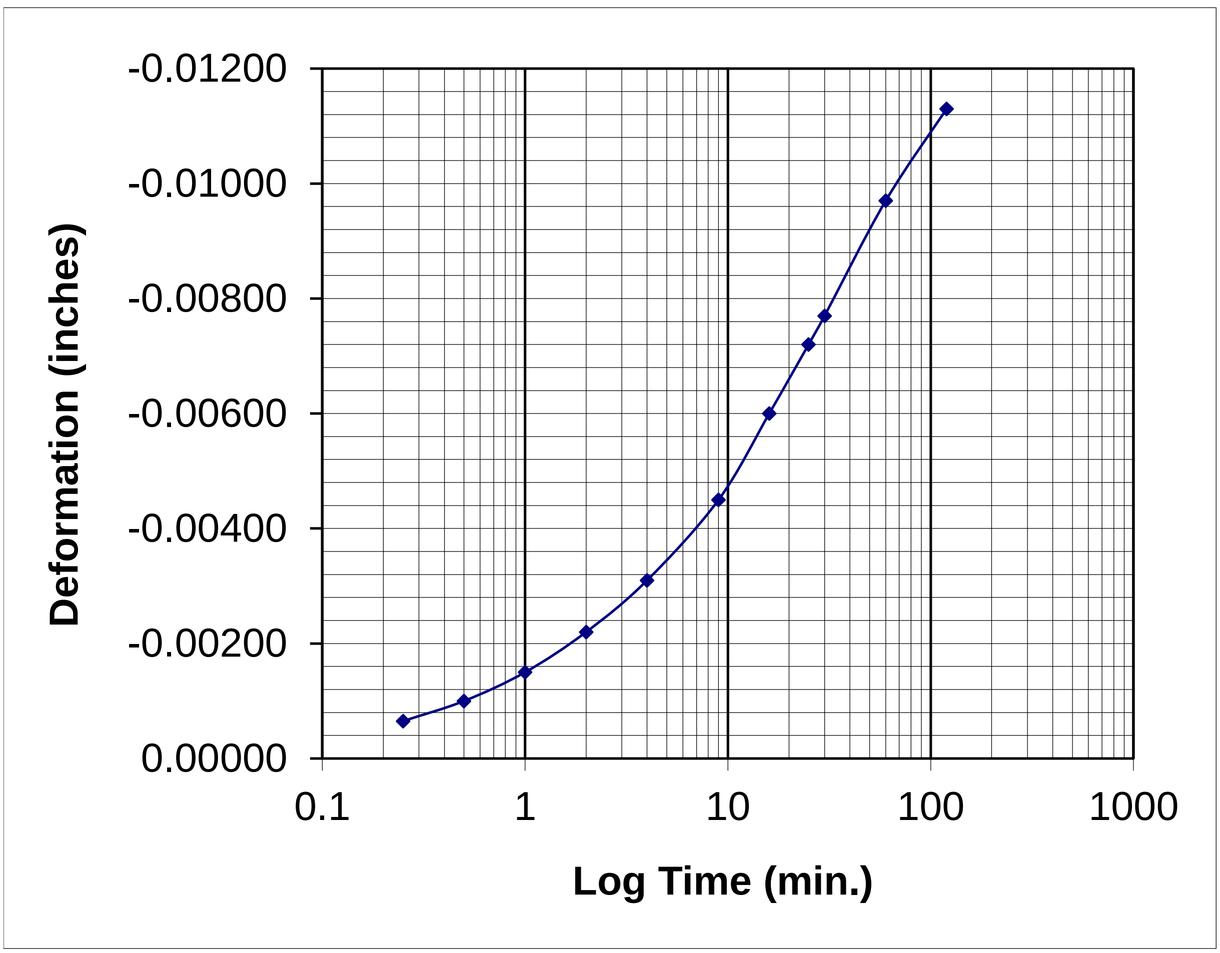


Project No. : 230574 Sample No.: ST-9
Boring No. : B-002-0-23 Depth: 16.0 - 18.0'

4.0 tsf Unload

initial height= 0.89105 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.28100				
0.25	0.28295	-0.00195	-0.00130	-0.00065	0.89170
0.5	0.28330	-0.00230	-0.00130	-0.00100	0.89205
1	0.28380	-0.00280	-0.00130	-0.00150	0.89255
2	0.28450	-0.00350	-0.00130	-0.00220	0.89325
4	0.28540	-0.00440	-0.00130	-0.00310	0.89415
9	0.28680	-0.00580	-0.00130	-0.00450	0.89555
16	0.28830	-0.00730	-0.00130	-0.00600	0.89705
25	0.28950	-0.00850	-0.00130	-0.00720	0.89825
30	0.29000	-0.00900	-0.00130	-0.00770	0.89875
60	0.29200	-0.01100	-0.00130	-0.00970	0.90075
120	0.29360	-0.01260	-0.00130	-0.01130	0.90235



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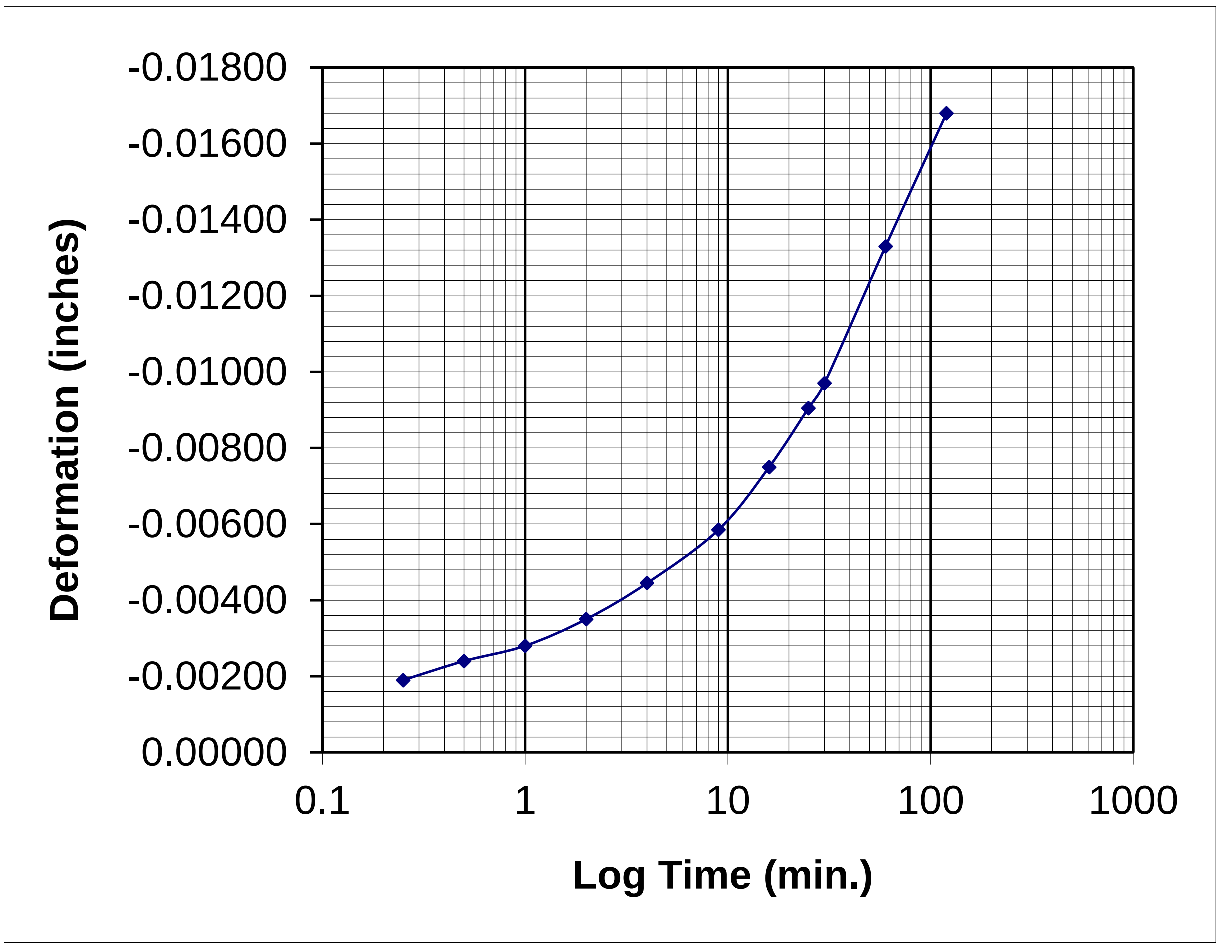
Project No. : 230574 Sample No.: ST-9
Boring No. : B-002-0-23 Depth: 16.0 - 18.0'

1.0 tsf Unload

initial height= 0.90235 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29360				
0.25	0.29550	-0.00190	0.00000	-0.00190	0.90425
0.5	0.29600	-0.00240	0.00000	-0.00240	0.90475
1	0.29640	-0.00280	0.00000	-0.00280	0.90515
2	0.29710	-0.00350	0.00000	-0.00350	0.90585
4	0.29805	-0.00445	0.00000	-0.00445	0.90680
9	0.29945	-0.00585	0.00000	-0.00585	0.90820
16	0.30110	-0.00750	0.00000	-0.00750	0.90985
25	0.30265	-0.00905	0.00000	-0.00905	0.91140
30	0.30330	-0.00970	0.00000	-0.00970	0.91205
60	0.30690	-0.01330	0.00000	-0.01330	0.91565
120	0.31040	-0.01680	0.00000	-0.01680	0.91915



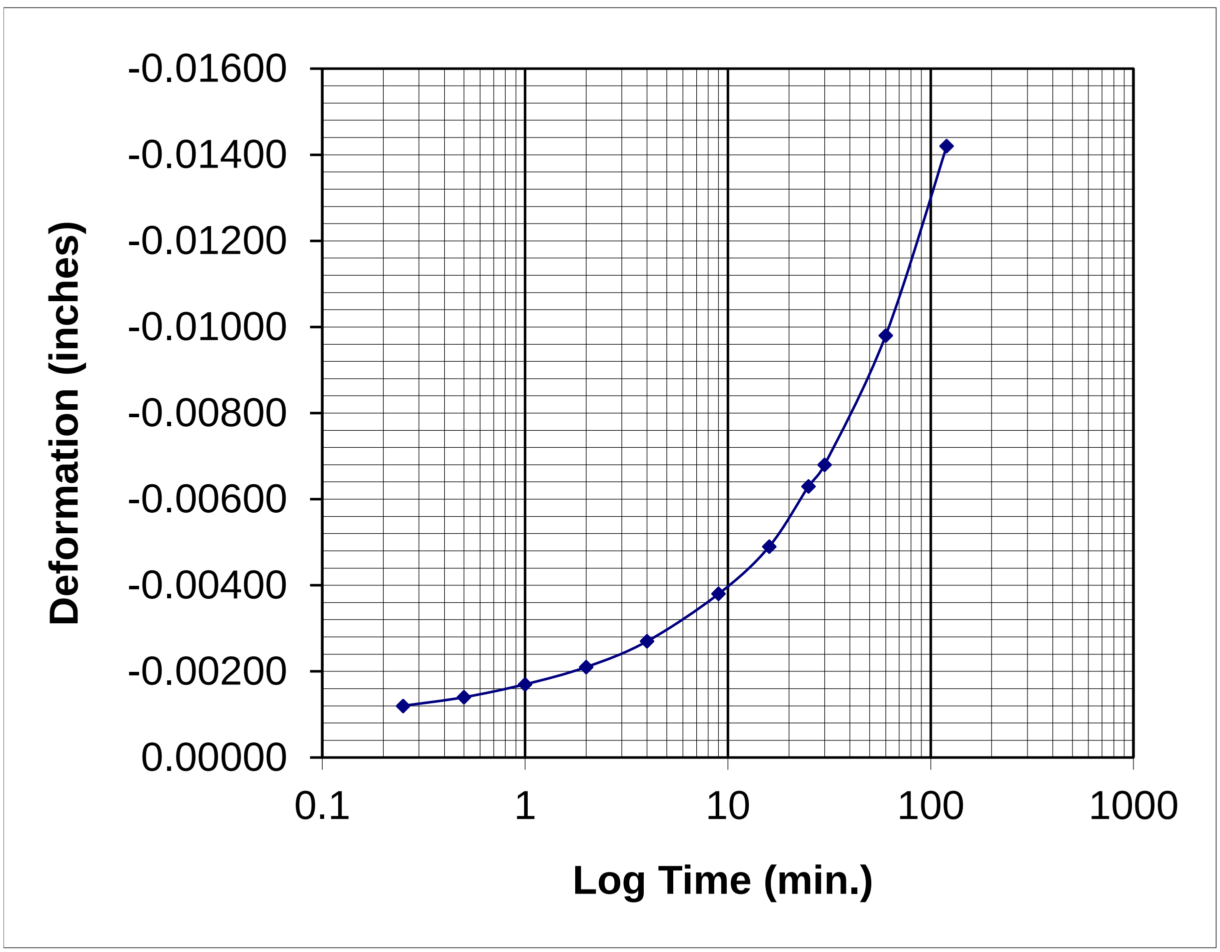
Project No. : 230574
Boring No. : B-002-0-23

Sample No.: ST-9
Depth: 16.0 - 18.0'

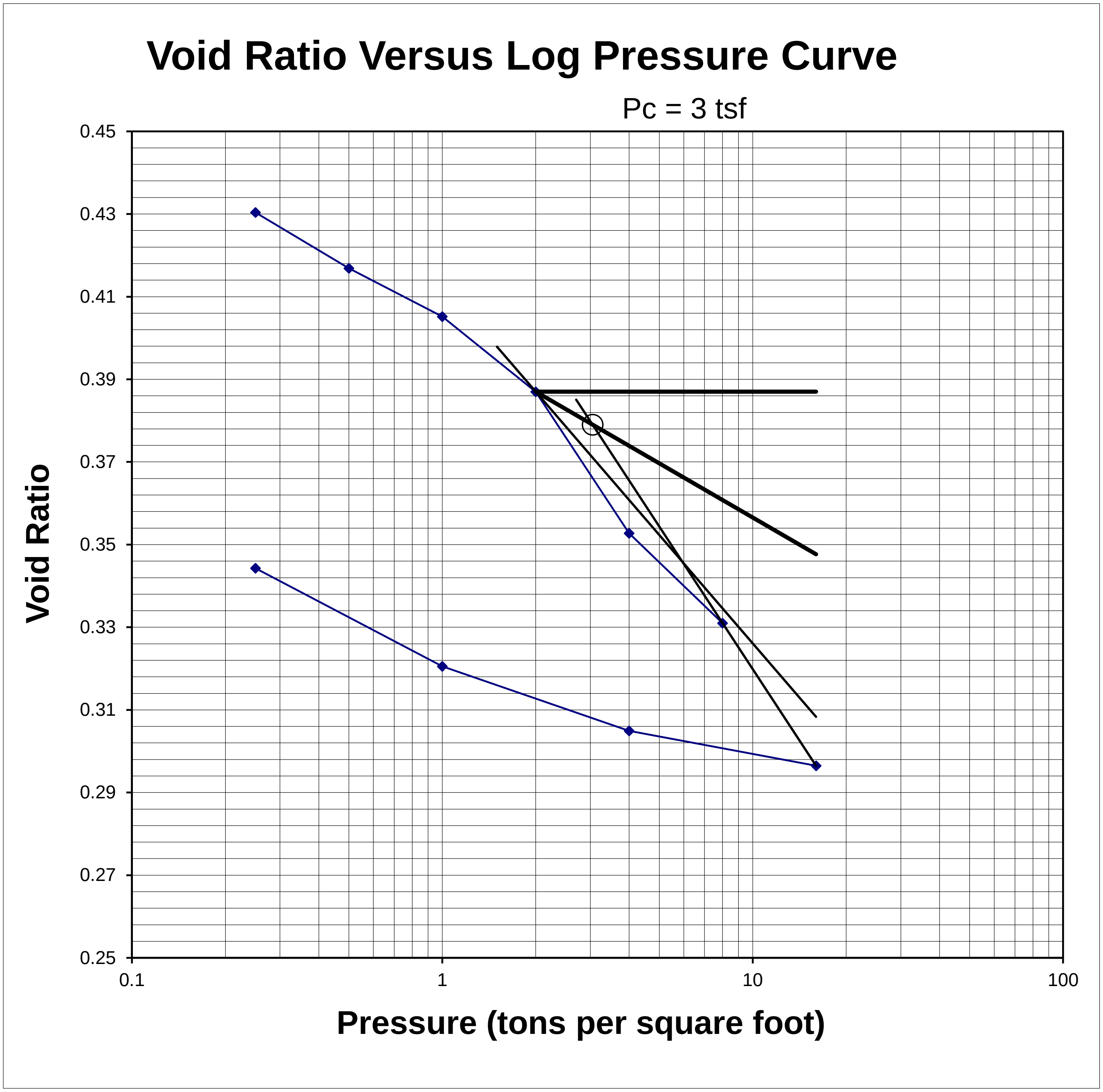
0.25 tsf Unload

initial height= 0.91915 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31040				
0.25	0.31160	-0.00120	0.00000	-0.00120	0.92035
0.5	0.31180	-0.00140	0.00000	-0.00140	0.92055
1	0.31210	-0.00170	0.00000	-0.00170	0.92085
2	0.31250	-0.00210	0.00000	-0.00210	0.92125
4	0.31310	-0.00270	0.00000	-0.00270	0.92185
9	0.31420	-0.00380	0.00000	-0.00380	0.92295
16	0.31530	-0.00490	0.00000	-0.00490	0.92405
25	0.31670	-0.00630	0.00000	-0.00630	0.92545
30	0.31720	-0.00680	0.00000	-0.00680	0.92595
60	0.32020	-0.00980	0.00000	-0.00980	0.92895
120	0.32460	-0.01420	0.00000	-0.01420	0.93335



Project No.: 230574
Date: 6/29/2023
Client: ODOT District 2
Project: WOO-75-29.93, PID 119007
Wood County, OH
Boring No.: B-005-0-23
Sample No.: ST-16
Depth: 41.0 - 43.0'



Project No.: 230574
Date: 6/29/2023
Client: ODOT District 2
Project: WOO-75-29.93, PID 119007
Wood County, OH
Boring No.: B-005-0-23
Sample No.: ST-16
Depth: 41.0 - 43.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.125	1.00000	1.00000	0.00000	1.0000	0.453				
0.25	0.98445	1.00000	0.01555	0.9922	0.430	8.5	0.125	0.000095	0.057
0.5	0.97515	0.98445	0.02485	0.9798	0.417	8.2	0.375	0.000096	0.058
1	0.96710	0.97515	0.03290	0.9711	0.405	4.3	0.75	0.000181	0.109
2	0.95460	0.96710	0.04540	0.9609	0.387	4.3	1.5	0.000177	0.106
4	0.93100	0.95460	0.06900	0.9428	0.353	3.2	3	0.000228	0.137
8	0.91605	0.93100	0.08395	0.9235	0.331	3.0	6	0.000232	0.139
16	0.89230	0.91605	0.10770	0.9042	0.296	2.2	12	0.000309	0.185
4	0.89810	0.89230	0.10190	0.8952	0.305		10		
1	0.90885	0.89810	0.09115	0.9035	0.321		2.5		
0.25	0.92520	0.90885	0.07480	0.9170	0.344		0.625		

Estimated Cc: 0.115
Estimated Cr: 0.026

Soil Description: Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (9)
Specific Gravity: 2.681
Liquid Limit: 30
Plastic Limit: 17
Plasticity Index: 13

Initial Water Content:	18.8 %	Final Water Content:	16.3 %
Inital Dry Density:	115.2 pcf	Final Dry Density:	124.5 pcf
Initial Void Ratio:	0.453	Final Void Ratio:	0.344
Initial Degree of Saturation:	111.1 %	Final Degree of Saturation	127.1 %

Estimated Preconsolidation Pressure: 3 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

Consolidation Laboratory Calculations

Consolidometer: **1**

Method:	ASTM D 2435 Method B
Project No. :	230574
Client:	ODOT District 2
Project:	WOO-75-29.93, PID 119007
Location:	Wood County, OH
Boring No. :	B-005-0-23
Sample No.:	ST-16
Depth:	41.0 - 43.0'
Date of Test:	6/29/2023

Visual Description:	Gray SILT and CLAY, Little Sand, Trace Gravel A-6a (9)	
Liquid Limit:	30	%
Plastic Limit:	17	%
Plasticity Index:	13	%

Initial Sample Data

Initial Height	1.000	in.		
Ring Dia.	2.493	in.		
Area of Ring	4.8813	in^2		
Initial Volume	4.8813	in^3	0.00282	ft^3
Specific Gravity	2.681			
Initial wet mass soil & ring	320.0	g		
Mass of ring	144.7	g		
Initial wet mass soil	175.3	g	0.38647	lb

Final Sample Data

Final Height	0.925	in.		
Ring Dia.	2.493	in.		
Area of Ring	4.8813	in^2		
Final Volume	4.5162	in^3	0.00261	ft^3
Final wet mass soil, pan & ring	367	g		
Wt of Pan	50.6	g		
Final wet mass soil & ring	316.4			
Mass of ring	144.7	g		
Final dry mass of soil, pan & ring	342.9	g		
Final wet mass soil	171.7	g	0.37854	lb
Weight of water	24.1	g	0.05313	lb

Initial Water Content

Mass can & wet soil	535.9	g
Mass can & dry soil	460	g
Mass of can	49.8	g
Mass of water	75.9	g
Mass of soil	410.2	g
Initial water content	18.50	% (trimmings)

Initial water content	18.77	% (based on final dry weight)		
Initial dry density	115.2	pcf		
Initial void ratio (eo)	0.453			
Initial volume of voids (Vvo)	1.5218	in^3	0.00088	ft^3
Initial volume of water (Vwo)	1.6903	in^3	0.00098	ft^3
Initial degree of saturation (So)	111.08	%		

Final water content	16.33	% (based on final dry weight)		
Final weight of solids (Md)	147.6	g	0.32540	lb
Final dry density	124.5	pcf		
Final volume of solids (Vs)	3.3595	in^3	0.00194	ft^3
Final height of solids (Hs)	0.6882	in.		
Final void ratio (ef)	0.344			
Final volume of voids (Vvf)	1.1567	in^3	0.00067	ft^3
Final volume of water (Vwf)	1.4706	in^3	0.00085	ft^3
Final degree of saturation (Sf)	127.15	%		

Project No. : 230574 Sample No.: ST-16
Boring No. : B-005-0-23 Depth: 41.0 - 43.0'

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00180
2) 0.5 to 2.0: 0.00270
3) 1.0 to 4.0: 0.00490
Do Avg 1&2: 0.00225
Do Avg 1-3: 0.00313

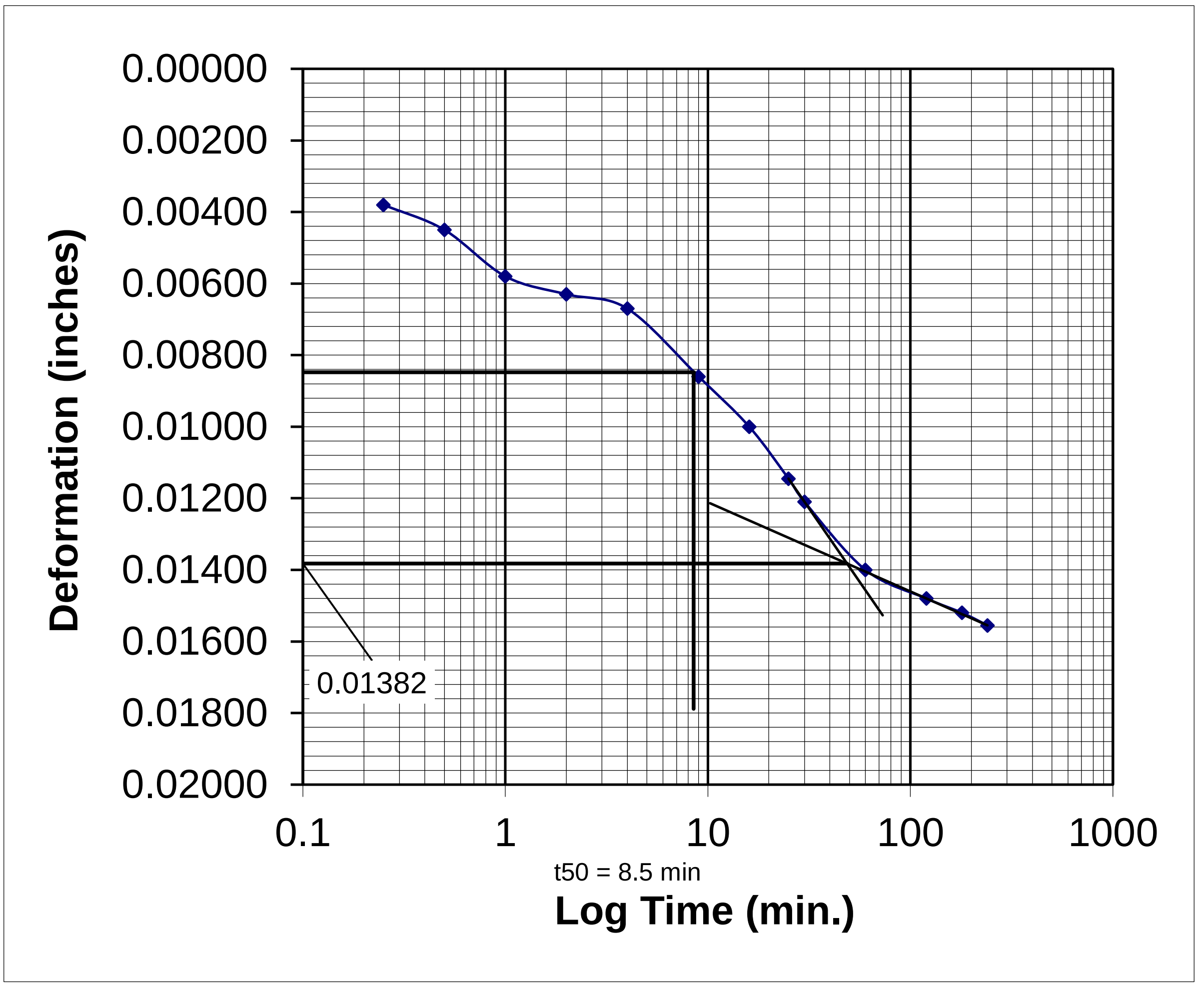
0.25 tsf Load

initial height= 1 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39370				
0.25	0.38990	0.00380	0.00000	0.00380	0.99620
0.5	0.38920	0.00450	0.00000	0.00450	0.99550
1	0.38790	0.00580	0.00000	0.00580	0.99420
2	0.38740	0.00630	0.00000	0.00630	0.99370
4	0.38700	0.00670	0.00000	0.00670	0.99330
9	0.38510	0.00860	0.00000	0.00860	0.99140
16	0.38370	0.01000	0.00000	0.01000	0.99000
25	0.38225	0.01145	0.00000	0.01145	0.98855
30	0.38160	0.01210	0.00000	0.01210	0.98790
60	0.37970	0.01400	0.00000	0.01400	0.98600
120	0.37890	0.01480	0.00000	0.01480	0.98520
180	0.37850	0.01520	0.00000	0.01520	0.98480
240	0.37815	0.01555	0.00000	0.01555	0.98445

Use Do= 0.00313
D100= 0.01382
D50= D100+0.5(Do-D100)
D50= 0.00848

t50 = 8.5 min.



Project No. : 230574 Sample No.: ST-16
Boring No. : B-005-0-23 Depth: 41.0 - 43.0'

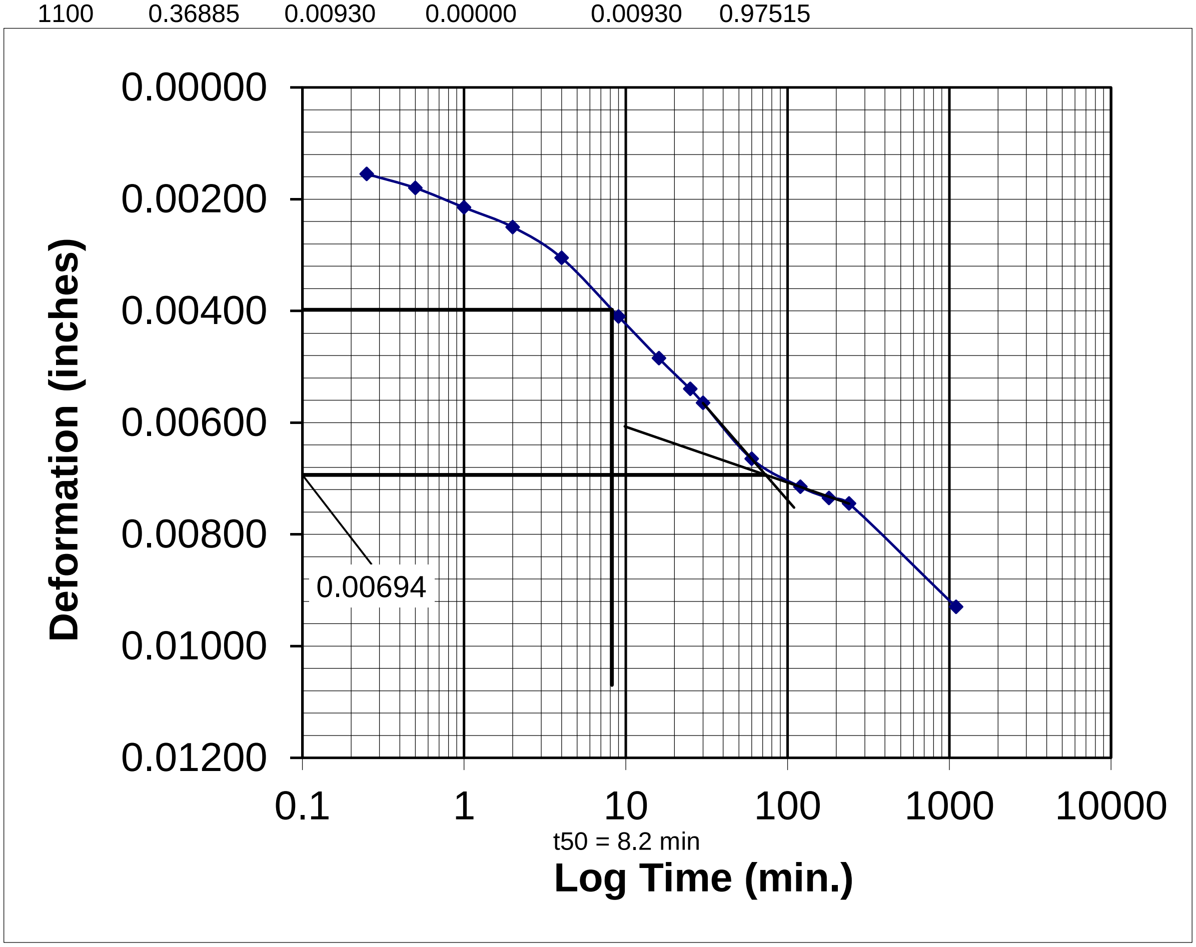
0.5 tsf Load

initial height= 0.98445 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00095
2) 0.5 to 2.0: 0.00110
3) 1.0 to 4.0: 0.00125
Do Avg 1&2: 0.00102
Do Avg 1-3: 0.00110
Use Do= 0.00102
D100= 0.00694
D50= D100+0.5(Do-D100)
D50= 0.00398

t50 = 8.2 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.37815				
0.25	0.37660	0.00155	0.00000	0.00155	0.98290
0.5	0.37635	0.00180	0.00000	0.00180	0.98265
1	0.37600	0.00215	0.00000	0.00215	0.98230
2	0.37565	0.00250	0.00000	0.00250	0.98195
4	0.37510	0.00305	0.00000	0.00305	0.98140
9	0.37405	0.00410	0.00000	0.00410	0.98035
16	0.37330	0.00485	0.00000	0.00485	0.97960
25	0.37275	0.00540	0.00000	0.00540	0.97905
30	0.37250	0.00565	0.00000	0.00565	0.97880
60	0.37150	0.00665	0.00000	0.00665	0.97780
120	0.37100	0.00715	0.00000	0.00715	0.97730
180	0.37080	0.00735	0.00000	0.00735	0.97710
240	0.37070	0.00745	0.00000	0.00745	0.97700
1100	0.36885	0.00930	0.00000	0.00930	0.97515



Project No. : 230574 | Sample No.: ST-16
Boring No. : B-005-0-23 | Depth: 41.0 - 43.0'

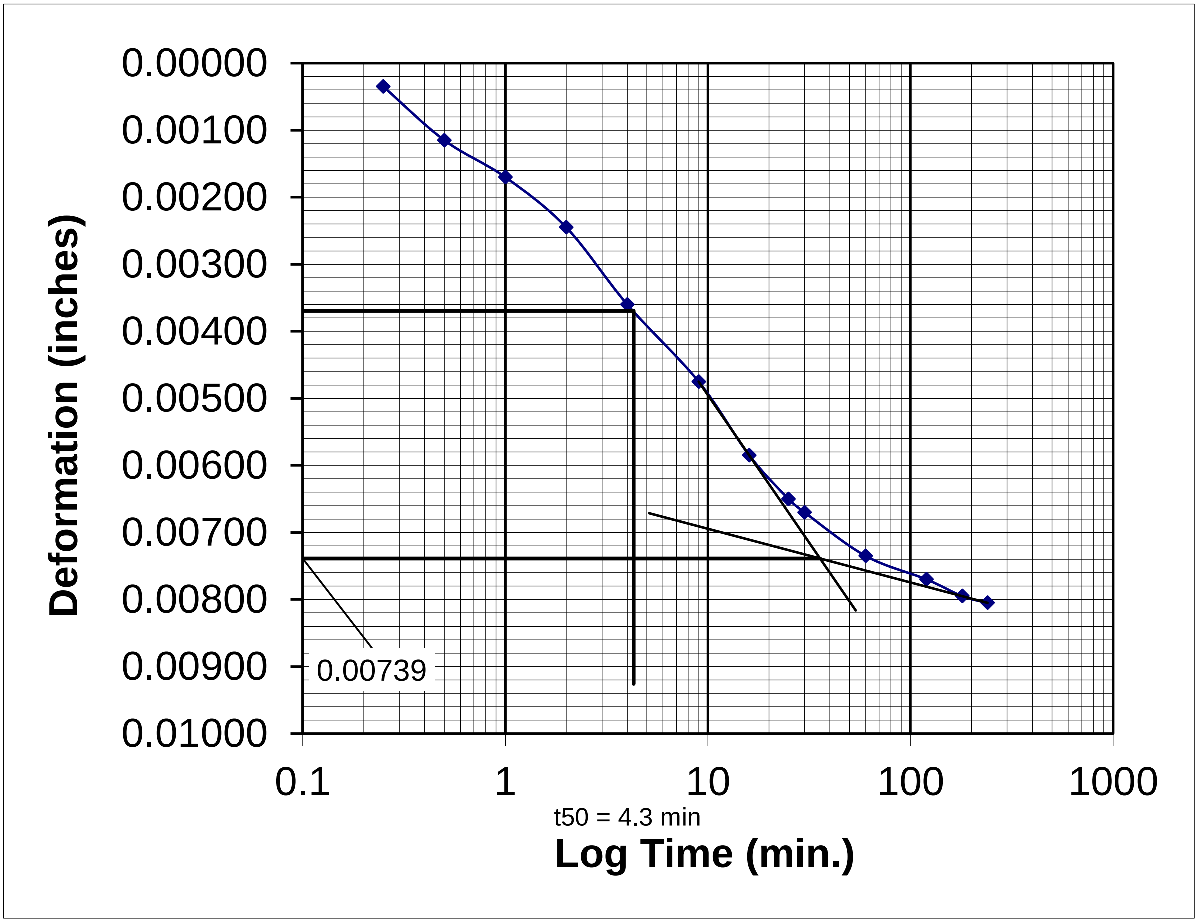
1.0 tsf Load

initial height= 0.97515 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00100
2) 0.5 to 2.0: -0.00015
3) 1.0 to 4.0: -0.00020
Do Avg 1&2: -0.00058
Do Avg 1-3: -0.00045
Use Do= 0.00000
D100= 0.00739
D50= D100+0.5(Do-D100)
D50= 0.00369

t50 = 4.3 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.36885				
0.25	0.36600	0.00285	0.00250	0.00035	0.97480
0.5	0.36520	0.00365	0.00250	0.00115	0.97400
1	0.36465	0.00420	0.00250	0.00170	0.97345
2	0.36390	0.00495	0.00250	0.00245	0.97270
4	0.36275	0.00610	0.00250	0.00360	0.97155
9	0.36160	0.00725	0.00250	0.00475	0.97040
16	0.36050	0.00835	0.00250	0.00585	0.96930
25	0.35985	0.00900	0.00250	0.00650	0.96865
30	0.35965	0.00920	0.00250	0.00670	0.96845
60	0.35900	0.00985	0.00250	0.00735	0.96780
120	0.35865	0.01020	0.00250	0.00770	0.96745
180	0.35840	0.01045	0.00250	0.00795	0.96720
240	0.35830	0.01055	0.00250	0.00805	0.96710



Project No. : 230574   Sample No.: ST-16
Boring No. : B-005-0-23   Depth: 41.0 - 43.0'

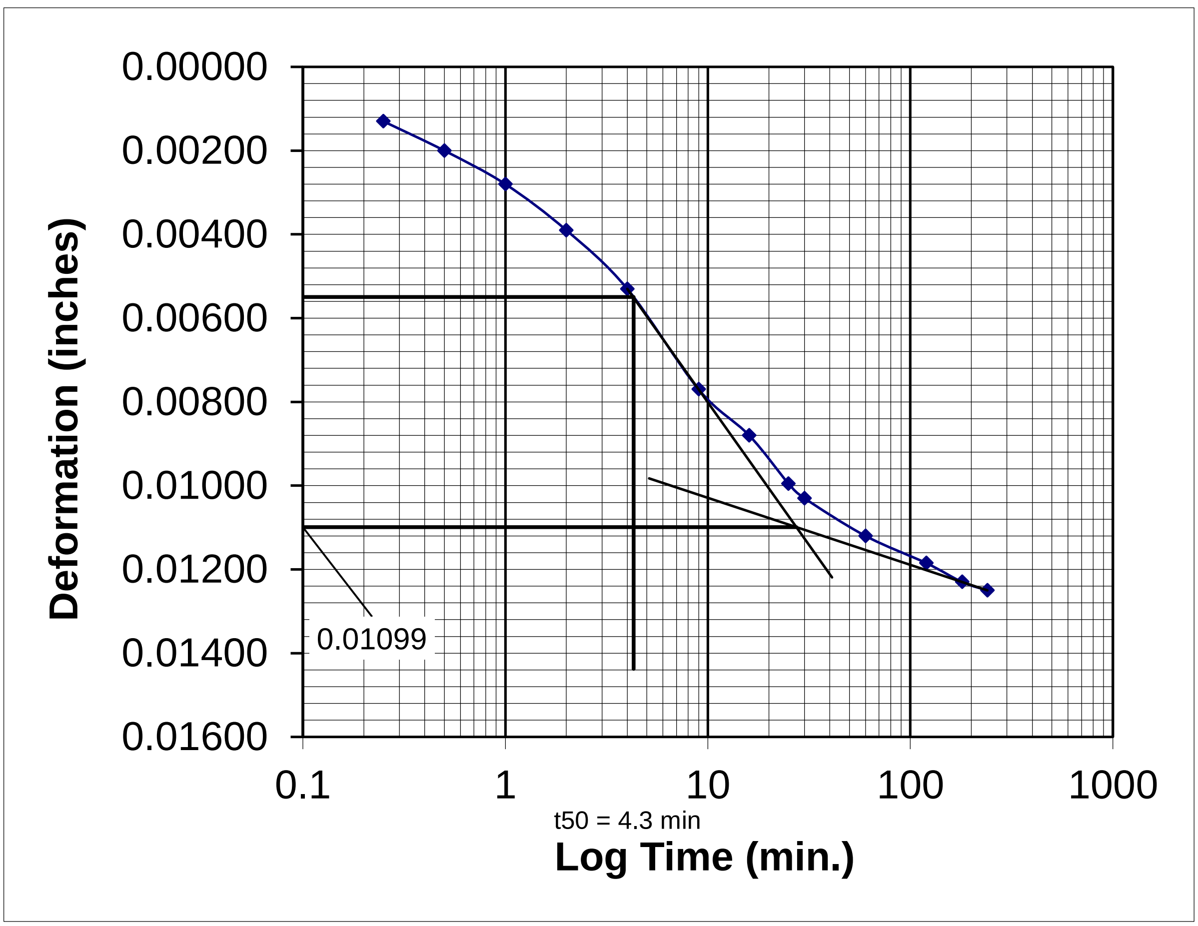
2.0 tsf Load

initial height= 0.9671 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00020
2) 0.5 to 2.0: 0.00010
3) 1.0 to 4.0: 0.00030
Do Avg 1&2: -0.00005
Do Avg 1-3: 0.00007
Use Do= 0.00000
D100= 0.01099
D50= D100+0.5(Do-D100)
D50= 0.00550

t50 = 4.3 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.35830				
0.25	0.35410	0.00420	0.00290	0.00130	0.96580
0.5	0.35340	0.00490	0.00290	0.00200	0.96510
1	0.35260	0.00570	0.00290	0.00280	0.96430
2	0.35150	0.00680	0.00290	0.00390	0.96320
4	0.35010	0.00820	0.00290	0.00530	0.96180
9	0.34770	0.01060	0.00290	0.00770	0.95940
16	0.34660	0.01170	0.00290	0.00880	0.95830
25	0.34545	0.01285	0.00290	0.00995	0.95715
30	0.34510	0.01320	0.00290	0.01030	0.95680
60	0.34420	0.01410	0.00290	0.01120	0.95590
120	0.34355	0.01475	0.00290	0.01185	0.95525
180	0.34310	0.01520	0.00290	0.01230	0.95480
240	0.34290	0.01540	0.00290	0.01250	0.95460



Project No. : 230574 | Sample No.: ST-16
Boring No. : B-005-0-23 | Depth: 41.0 - 43.0'

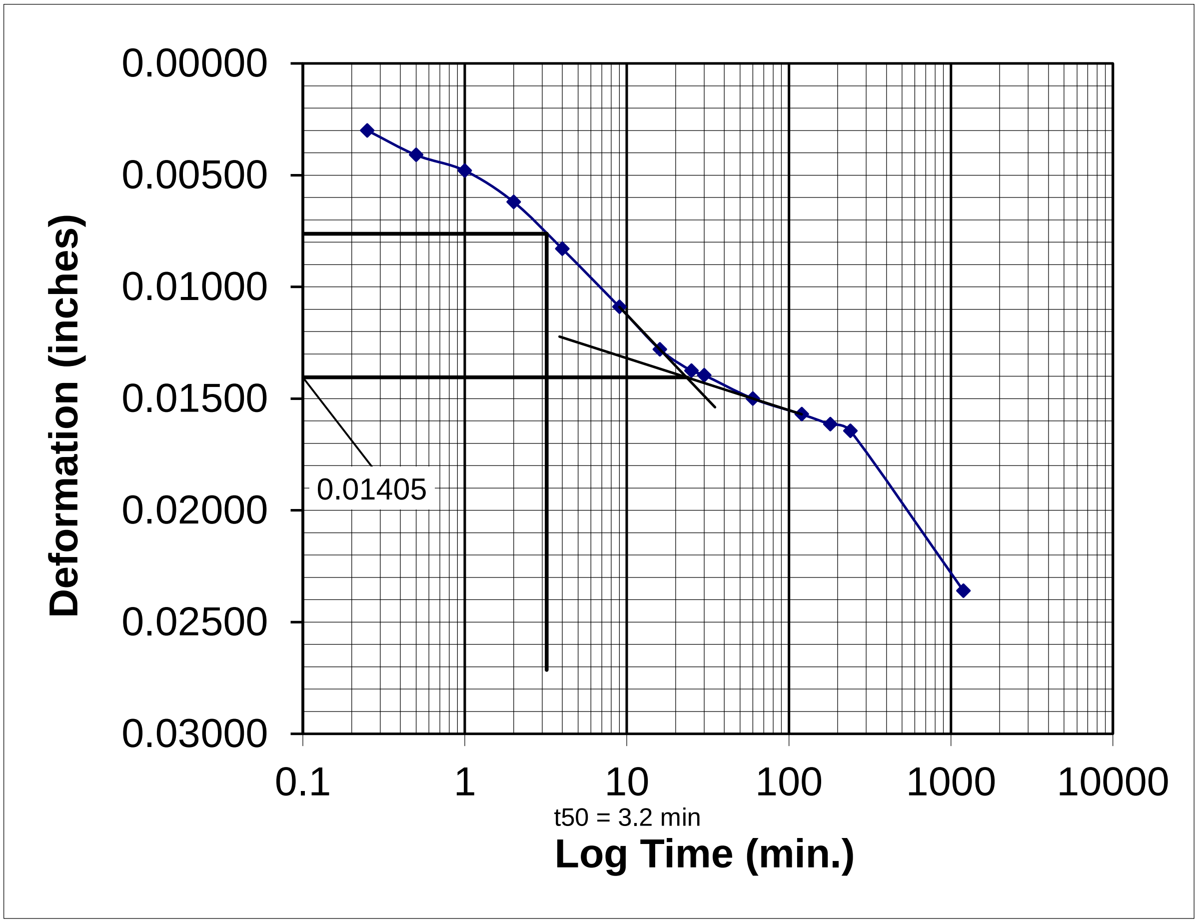
4.0 tsf Load

initial height= 0.9546 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00120
2) 0.5 to 2.0: 0.00200
3) 1.0 to 4.0: 0.00130
Do Avg 1&2: 0.00160
Do Avg 1-3: 0.00150
Use Do= 0.00120
D100= 0.01405
D50= **D100+0.5(Do-D100)**
D50= 0.00762

t50 = 3.2 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.34290				
0.25	0.33730	0.00560	0.00260	0.00300	0.95160
0.5	0.33620	0.00670	0.00260	0.00410	0.95050
1	0.33550	0.00740	0.00260	0.00480	0.94980
2	0.33410	0.00880	0.00260	0.00620	0.94840
4	0.33200	0.01090	0.00260	0.00830	0.94630
9	0.32940	0.01350	0.00260	0.01090	0.94370
16	0.32750	0.01540	0.00260	0.01280	0.94180
25	0.32655	0.01635	0.00260	0.01375	0.94085
30	0.32635	0.01655	0.00260	0.01395	0.94065
60	0.32530	0.01760	0.00260	0.01500	0.93960
120	0.32460	0.01830	0.00260	0.01570	0.93890
180	0.32415	0.01875	0.00260	0.01615	0.93845
240	0.32385	0.01905	0.00260	0.01645	0.93815
1195	0.31670	0.02620	0.00260	0.02360	0.93100



Project No. : 230574 Sample No.: ST-16
Boring No. : B-005-0-23 Depth: 41.0 - 43.0'

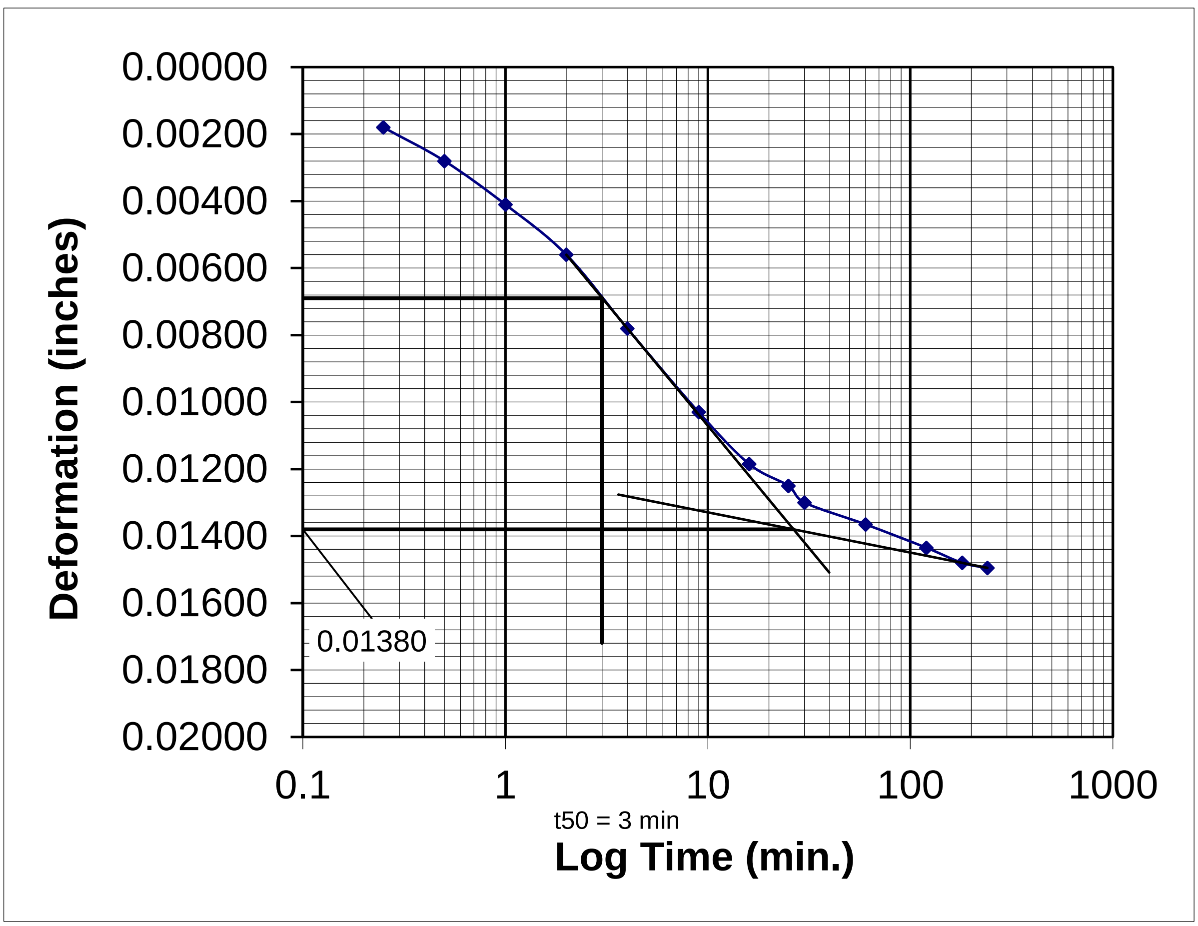
8.0 tsf Load

initial height= 0.93100 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00050
2) 0.5 to 2.0: 0.00000
3) 1.0 to 4.0: 0.00040
Do Avg 1&2: -0.00025
Do Avg 1-3: -0.00003
Use Do= 0.00000
D100= 0.01380
D50= D100+0.5(Do-D100)
D50= 0.00690

t50 = 3.0 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.31670				
0.25	0.31270	0.00400	0.00220	0.00180	0.92920
0.5	0.31170	0.00500	0.00220	0.00280	0.92820
1	0.31040	0.00630	0.00220	0.00410	0.92690
2	0.30890	0.00780	0.00220	0.00560	0.92540
4	0.30670	0.01000	0.00220	0.00780	0.92320
9	0.30420	0.01250	0.00220	0.01030	0.92070
16	0.30265	0.01405	0.00220	0.01185	0.91915
25	0.30200	0.01470	0.00220	0.01250	0.91850
30	0.30150	0.01520	0.00220	0.01300	0.91800
60	0.30085	0.01585	0.00220	0.01365	0.91735
120	0.30015	0.01655	0.00220	0.01435	0.91665
180	0.29970	0.01700	0.00220	0.01480	0.91620
240	0.29955	0.01715	0.00220	0.01495	0.91605



Project No. : 230574
Boring No. : B-005-0-23

Sample No.: ST-16
Depth: 41.0 - 43.0'

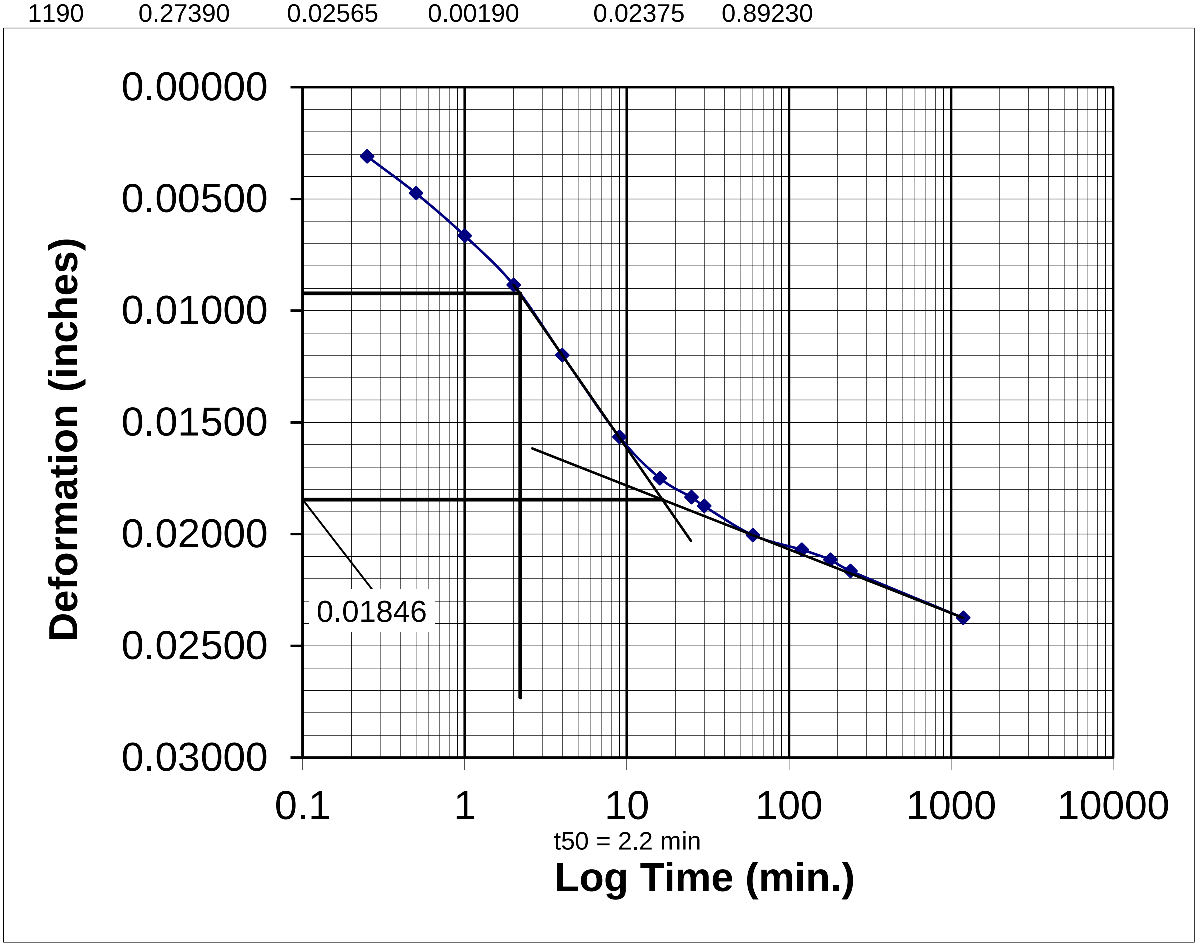
16 tsf Load

initial height= 0.91605 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00045
2) 0.5 to 2.0: 0.00065
3) 1.0 to 4.0: 0.00130
Do Avg 1&2: 0.00010
Do Avg 1-3: 0.00050
Use Do= 0.00000
D100= 0.01846
D50= **D100+0.5(Do-D100)**
D50= 0.00923

t50 = 2.2 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29955				
0.25	0.29455	0.00500	0.00190	0.00310	0.91295
0.5	0.29290	0.00665	0.00190	0.00475	0.91130
1	0.29100	0.00855	0.00190	0.00665	0.90940
2	0.28880	0.01075	0.00190	0.00885	0.90720
4	0.28565	0.01390	0.00190	0.01200	0.90405
9	0.28200	0.01755	0.00190	0.01565	0.90040
16	0.28015	0.01940	0.00190	0.01750	0.89855
25	0.27930	0.02025	0.00190	0.01835	0.89770
30	0.27890	0.02065	0.00190	0.01875	0.89730
60	0.27760	0.02195	0.00190	0.02005	0.89600
120	0.27695	0.02260	0.00190	0.02070	0.89535
180	0.27650	0.02305	0.00190	0.02115	0.89490
240	0.27600	0.02355	0.00190	0.02165	0.89440
1190	0.27390	0.02565	0.00190	0.02375	0.89230

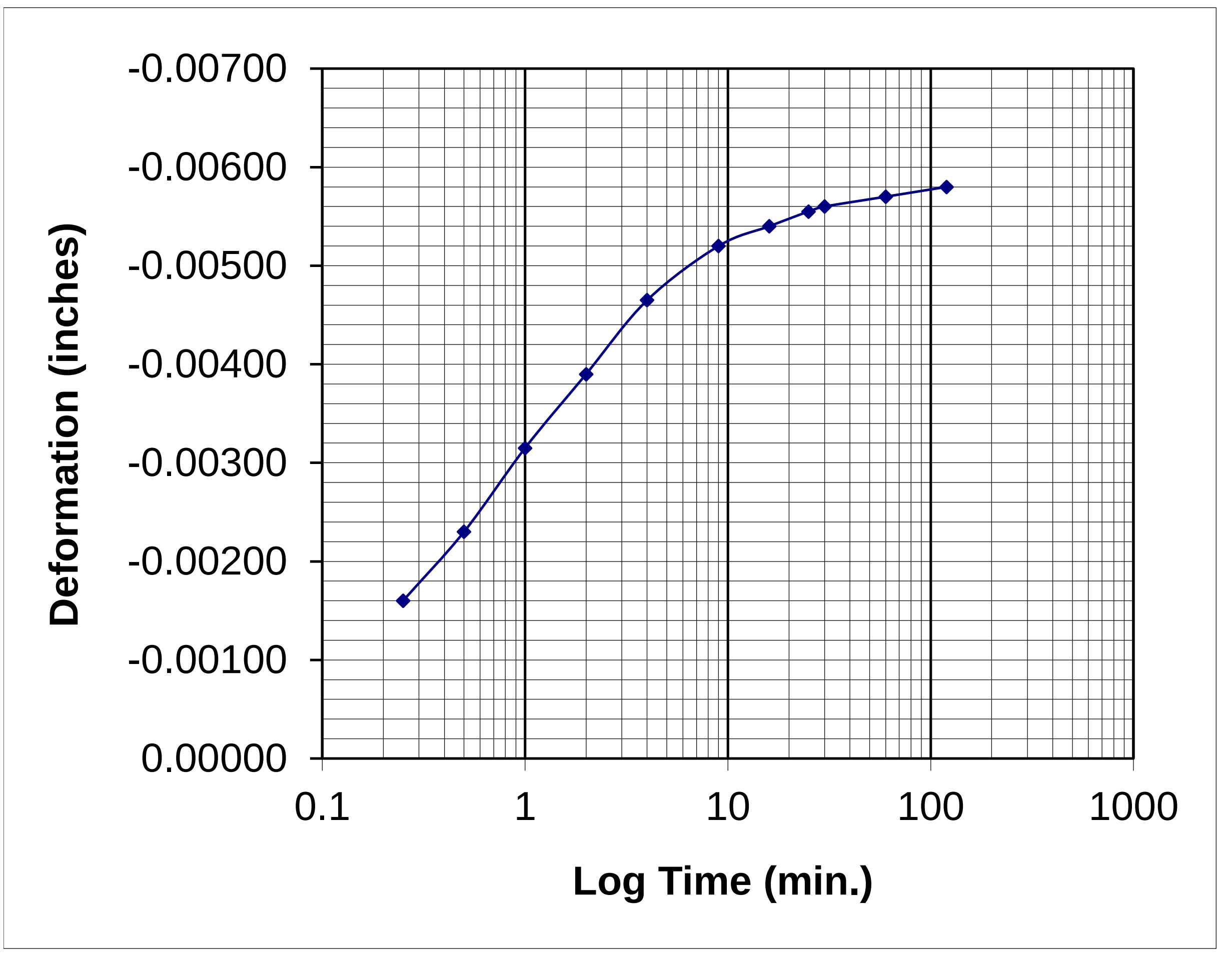


Project No. : 230574 Sample No.: ST-16
Boring No. : B-005-0-23 Depth: 41.0 - 43.0'

4.0 tsf Unload

initial height= 0.8923 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.27390				
0.25	0.27680	-0.00290	-0.00130	-0.00160	0.89390
0.5	0.27750	-0.00360	-0.00130	-0.00230	0.89460
1	0.27835	-0.00445	-0.00130	-0.00315	0.89545
2	0.27910	-0.00520	-0.00130	-0.00390	0.89620
4	0.27985	-0.00595	-0.00130	-0.00465	0.89695
9	0.28040	-0.00650	-0.00130	-0.00520	0.89750
16	0.28060	-0.00670	-0.00130	-0.00540	0.89770
25	0.28075	-0.00685	-0.00130	-0.00555	0.89785
30	0.28080	-0.00690	-0.00130	-0.00560	0.89790
60	0.28090	-0.00700	-0.00130	-0.00570	0.89800
120	0.28100	-0.00710	-0.00130	-0.00580	0.89810



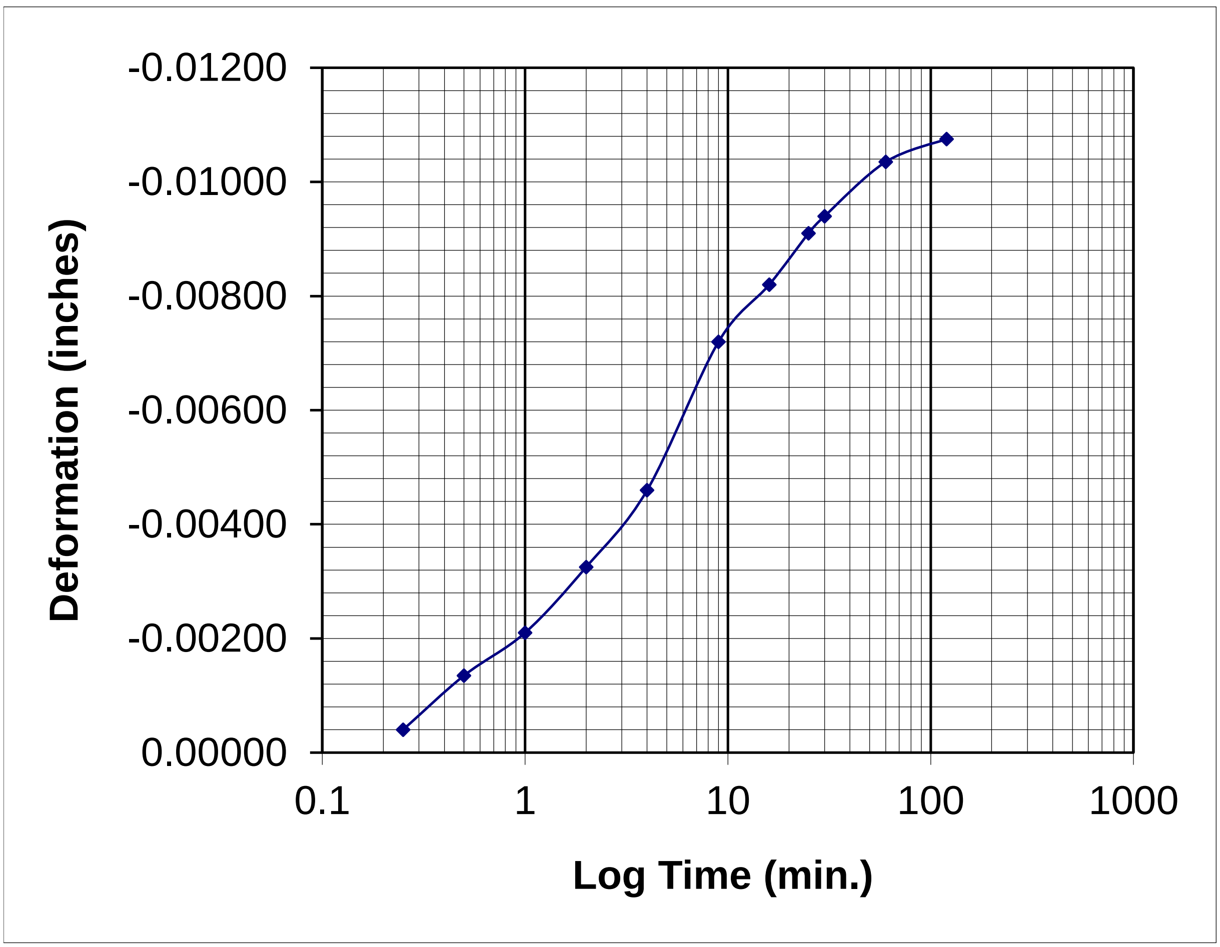
Project No. : 230574
Boring No. : B-005-0-23

Sample No.: ST-16
Depth: 41.0 - 43.0'

1.0 tsf Unload

initial height= 0.8981 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.28100				
0.25	0.28330	-0.00230	-0.00190	-0.00040	0.89850
0.5	0.28425	-0.00325	-0.00190	-0.00135	0.89945
1	0.28500	-0.00400	-0.00190	-0.00210	0.90020
2	0.28615	-0.00515	-0.00190	-0.00325	0.90135
4	0.28750	-0.00650	-0.00190	-0.00460	0.90270
9	0.29010	-0.00910	-0.00190	-0.00720	0.90530
16	0.29110	-0.01010	-0.00190	-0.00820	0.90630
25	0.29200	-0.01100	-0.00190	-0.00910	0.90720
30	0.29230	-0.01130	-0.00190	-0.00940	0.90750
60	0.29325	-0.01225	-0.00190	-0.01035	0.90845
120	0.29365	-0.01265	-0.00190	-0.01075	0.90885

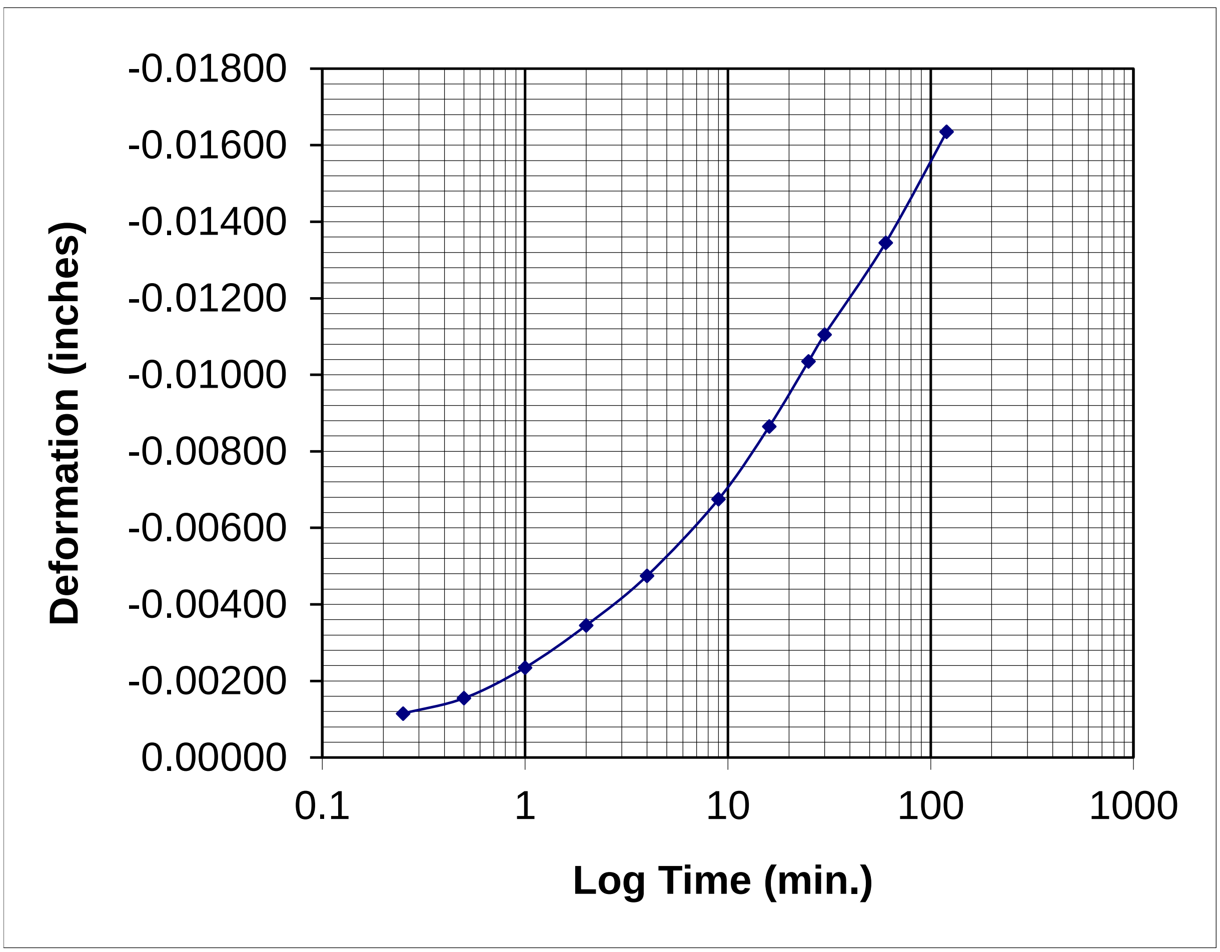


Project No. : 230574 Sample No.: ST-16
Boring No. : B-005-0-23 Depth: 41.0 - 43.0'

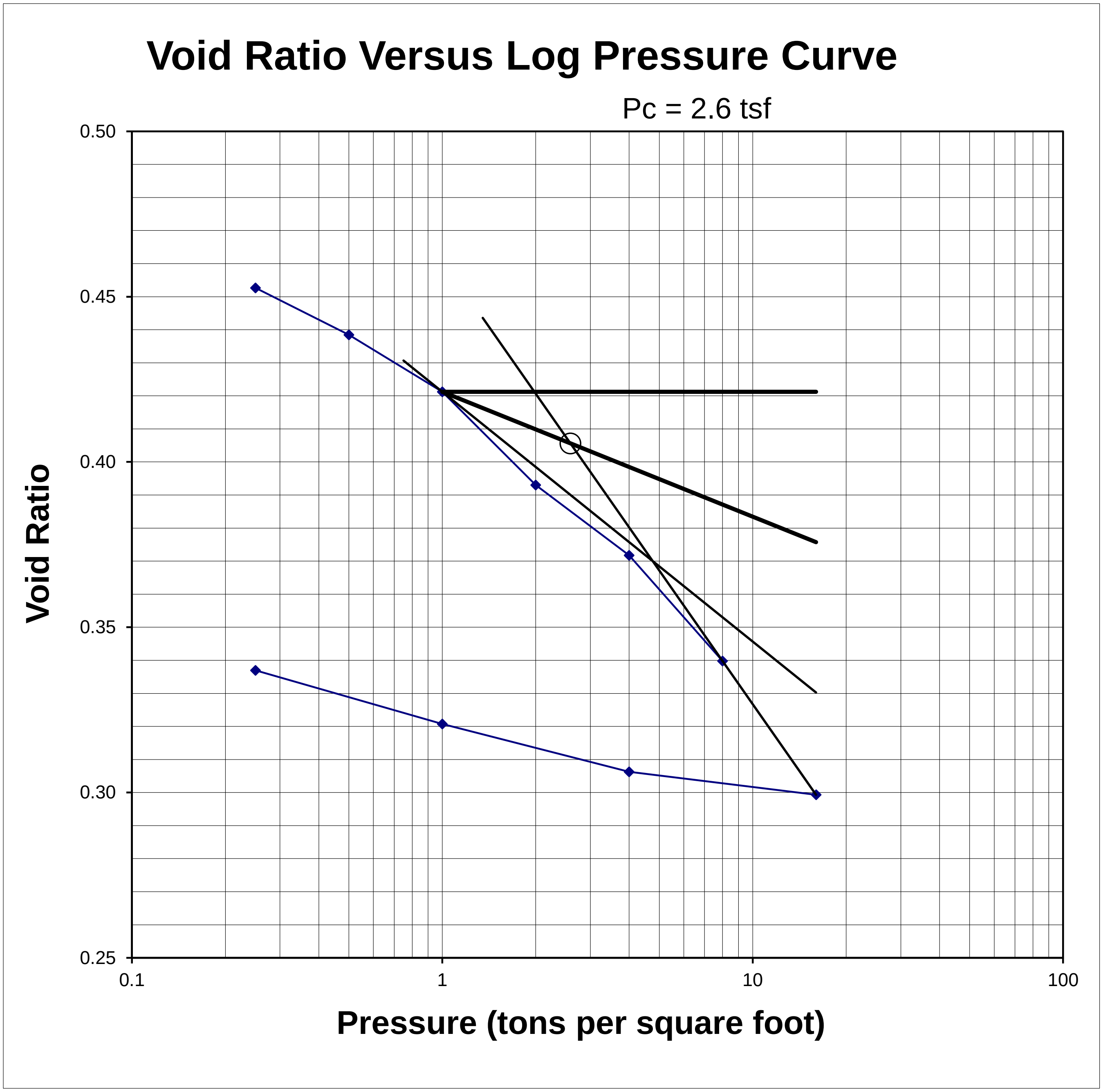
0.25 tsf Unload

initial height= 0.90885 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29365				
0.25	0.29480	-0.00115	0.00000	-0.00115	0.91000
0.5	0.29520	-0.00155	0.00000	-0.00155	0.91040
1	0.29600	-0.00235	0.00000	-0.00235	0.91120
2	0.29710	-0.00345	0.00000	-0.00345	0.91230
4	0.29840	-0.00475	0.00000	-0.00475	0.91360
9	0.30040	-0.00675	0.00000	-0.00675	0.91560
16	0.30230	-0.00865	0.00000	-0.00865	0.91750
25	0.30400	-0.01035	0.00000	-0.01035	0.91920
30	0.30470	-0.01105	0.00000	-0.01105	0.91990
60	0.30710	-0.01345	0.00000	-0.01345	0.92230
120	0.31000	-0.01635	0.00000	-0.01635	0.92520



Project No.: 230574
Date: 6/23/2023
Client: ODOT District 2
Project: WOO-75-29.93, PID 119007
Wood County, OH
Boring No.: B-007-0-23
Sample No.: ST-3
Depth: 6.0 - 8.0'



Project No.: 230574
Date: 6/23/2023
Client: ODOT District 2
Project: WOO-75-29.93, PID 119007
Wood County, OH
Boring No.: B-007-0-23
Sample No.: ST-3
Depth: 6.0 - 8.0'

Initial H= 1 inches

Pressure tsf	Final Height (in)	Initial Height (in)	DH	Average H (in)	e	t50 (min)	Ave P (tsf)	Cv (in2/s)	Cv (ft2/d)
0.25	0.99330	1.00000	0.00670	0.9967	0.453	45.4	0.125	0.000018	0.011
0.5	0.98360	0.99330	0.01640	0.9885	0.438	0.4	0.375	0.002129	1.278
1	0.97180	0.98360	0.02820	0.9777	0.421	0.7	0.75	0.001179	0.707
2	0.95250	0.97180	0.04750	0.9622	0.393	0.5	1.5	0.001487	0.892
4	0.93800	0.95250	0.06200	0.9453	0.372	0.7	3	0.000996	0.598
8	0.91610	0.93800	0.08390	0.9271	0.340	1.0	6	0.000703	0.422
16	0.88845	0.91610	0.11155	0.9023	0.299	1.4	12	0.000465	0.279
4	0.89320	0.88845	0.10680	0.8908	0.306		10		
1	0.90310	0.89320	0.09690	0.8982	0.321		2.5		
0.25	0.91420	0.90310	0.08580	0.9087	0.337		0.625		

Estimated Cc: 0.134
Estimated Cr: 0.021

Soil Description: Brown SILT and CLAY, Some Sand, little Gravel A-6a (6)
Specific Gravity: 2.704
Liquid Limit: 30
Plastic Limit: 18
Plasticity Index: 12

Initial Water Content:	14.5 %	Final Water Content:	16.4 %
Inital Dry Density:	115.4 pcf	Final Dry Density:	126.3 pcf
Initial Void Ratio:	0.462	Final Void Ratio:	0.337
Initial Degree of Saturation:	85.0 %	Final Degree of Saturation	131.3 %

Estimated Preconsolidation Pressure: 2.6 tsf

The sample for the test was trimmed from a Shelby tube sample using a cutting shoe. Test Method B was used with the specimen inundated during testing. Coefficients of consolidation were computed by log of time method.

Consolidation Laboratory Calculations

Consolidometer:	**2**
Method:	ASTM D 2435 Method B
Project No. :	230574
Client:	ODOT District 2
Project:	WOO-75-29.93, PID 119007
Location:	Wood County, OH
Boring No. :	B-007-0-23
Sample No.:	ST-3
Depth:	6.0 - 8.0'
Date of Test:	6/23/2023

Visual Description:	Brown SILT and CLAY, Some Sand, little Gravel A-6a (6)
Liquid Limit:	30 %
Plastic Limit:	18 %
Plasticity Index:	12 %

Initial Sample Data

Initial Height	1.000 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Initial Volume	4.8813 in^3	0.00282 ft^3
Specific Gravity	2.704	
Initial wet mass soil & ring	315.7 g	
Mass of ring	146.3 g	
Initial wet mass soil	169.4 g	0.37347 lb

Final Sample Data

Final Height	0.914 in.	
Ring Dia.	2.493 in.	
Area of Ring	4.8813 in^2	
Final Volume	4.4625 in^3	0.00258 ft^3
Final wet mass soil, pan & ring	369.5 g	
Wt of Pan	51.1 g	
Final wet mass soil & ring	318.4	
Mass of ring	146.3 g	
Final dry mass of soil, pan & ring	345.3 g	
Final wet mass soil	172.1 g	0.37942 lb
Weight of water	24.2 g	0.05335 lb

Initial Water Content

Mass can & wet soil	496.1 g
Mass can & dry soil	443.5 g
Mass of can	50.5 g
Mass of water	52.6 g
Mass of soil	393 g
Initial water content	13.38 % (trimmings)

Initial water content	14.54 % (based on final dry weight)		Final water content	16.36 % (based on final dry weight)	
			Final weight of solids (Md)	147.9 g	0.32607 lb
Initial dry density	115.4 pcf		Final dry density	126.3 pcf	
			Final volume of solids (Vs)	3.3377 in^3	0.00193 ft^3
			Final height of solids (Hs)	0.6838 in.	
Initial void ratio (eo)	0.462		Final void ratio (ef)	0.337	
Initial volume of voids (Vvo)	1.5436 in^3	0.00089 ft^3	Final volume of voids (Vvf)	1.1248 in^3	0.00065 ft^3
Initial volume of water (Vwo)	1.3120 in^3	0.00076 ft^3	Final volume of water (Vwf)	1.4767 in^3	0.00085 ft^3
Initial degree of saturation (So)	85.00 %		Final degree of saturation (Sf)	131.29 %	

Project No. : 230574 Sample No.: ST-3
Boring No. : B-007-0-23 Depth: 6.0 - 8.0'

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00095
2) 0.5 to 2.0: 0.00125
3) 1.0 to 4.0: 0.00145
Do Avg 1&2: 0.00110
Do Avg 1-3: 0.00122

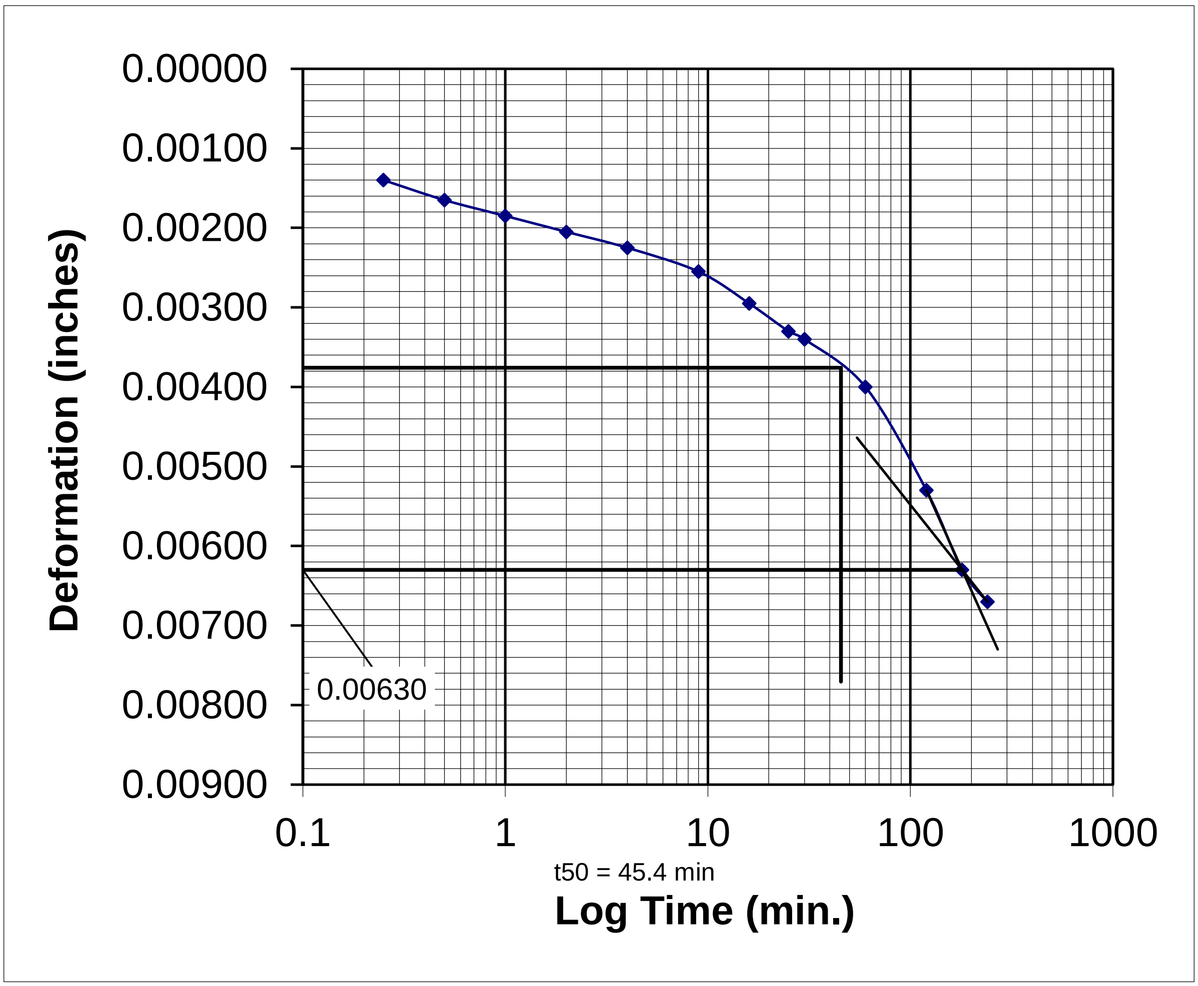
0.25 tsf Load

initial height= 1 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39920				
0.25	0.39680	0.00240	0.00100	0.00140	0.99860
0.5	0.39655	0.00265	0.00100	0.00165	0.99835
1	0.39635	0.00285	0.00100	0.00185	0.99815
2	0.39615	0.00305	0.00100	0.00205	0.99795
4	0.39595	0.00325	0.00100	0.00225	0.99775
9	0.39565	0.00355	0.00100	0.00255	0.99745
16	0.39525	0.00395	0.00100	0.00295	0.99705
25	0.39490	0.00430	0.00100	0.00330	0.99670
30	0.39480	0.00440	0.00100	0.00340	0.99660
60	0.39420	0.00500	0.00100	0.00400	0.99600
120	0.39290	0.00630	0.00100	0.00530	0.99470
180	0.39190	0.00730	0.00100	0.00630	0.99370
240	0.39150	0.00770	0.00100	0.00670	0.99330

Use Do= 0.00122
D100= 0.00630
D50= D100+0.5(Do-D100)
D50= 0.00376

t50 = 45.4 min.



Project No. : 230574 | Sample No.: ST-3
Boring No. : B-007-0-23 | Depth: 6.0 - 8.0'

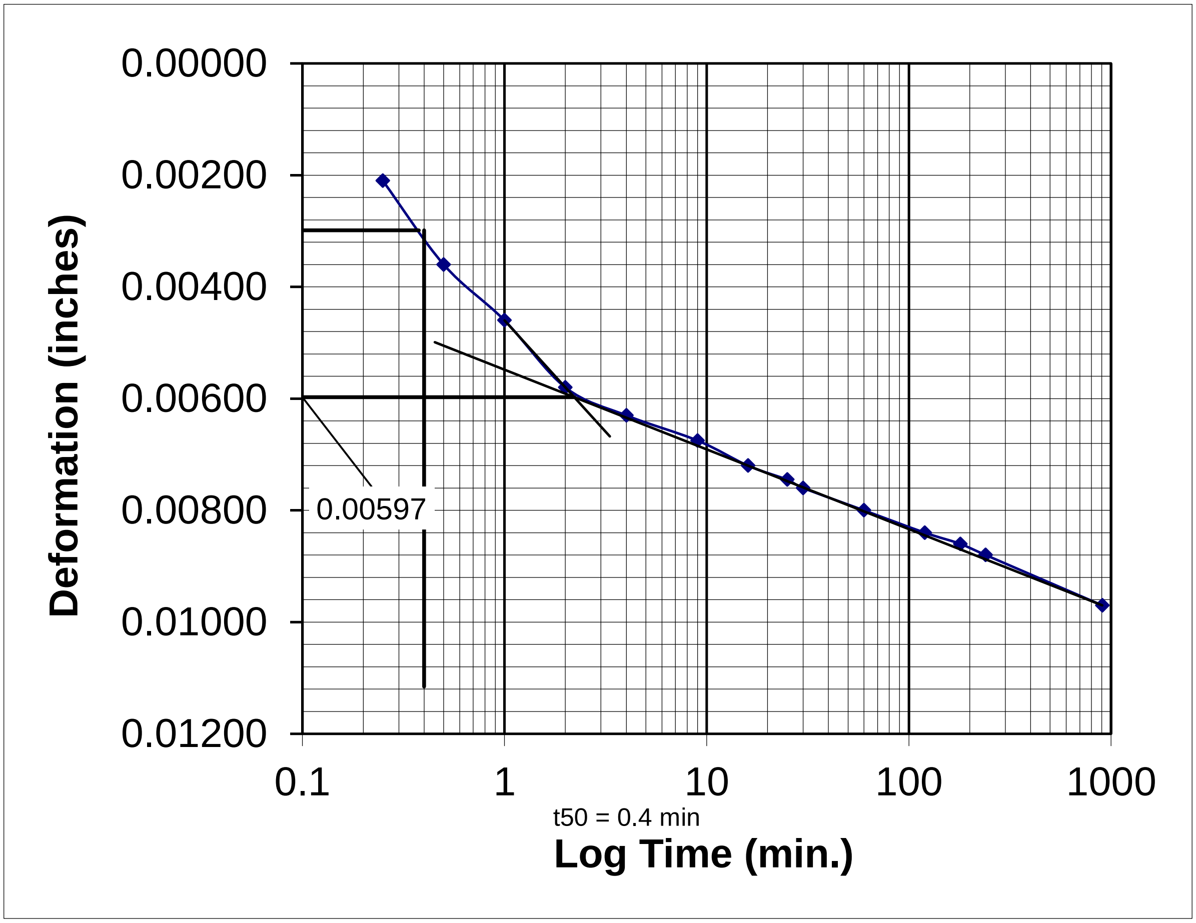
0.5 tsf Load

initial height= 0.9933 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: -0.00040
2) 0.5 to 2.0: 0.00140
3) 1.0 to 4.0: 0.00290
Do Avg 1&2: 0.00050
Do Avg 1-3: 0.00130
Use Do= 0.00000
D100= 0.00597
D50= D100+0.5(Do-D100)
D50= 0.00299

t50 = 0.4 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.39150				
0.25	0.38800	0.00350	0.00140	0.00210	0.99120
0.5	0.38650	0.00500	0.00140	0.00360	0.98970
1	0.38550	0.00600	0.00140	0.00460	0.98870
2	0.38430	0.00720	0.00140	0.00580	0.98750
4	0.38380	0.00770	0.00140	0.00630	0.98700
9	0.38335	0.00815	0.00140	0.00675	0.98655
16	0.38290	0.00860	0.00140	0.00720	0.98610
25	0.38265	0.00885	0.00140	0.00745	0.98585
30	0.38250	0.00900	0.00140	0.00760	0.98570
60	0.38210	0.00940	0.00140	0.00800	0.98530
120	0.38170	0.00980	0.00140	0.00840	0.98490
180	0.38150	0.01000	0.00140	0.00860	0.98470
240	0.38130	0.01020	0.00140	0.00880	0.98450
905	0.38040	0.01110	0.00140	0.00970	0.98360



TTL associates inc
Environmental, Geotechnical Engineering & Testing

Project No. : 230574
Boring No. : B-007-0-23

Sample No.: ST-3
Depth: 6.0 - 8.0'

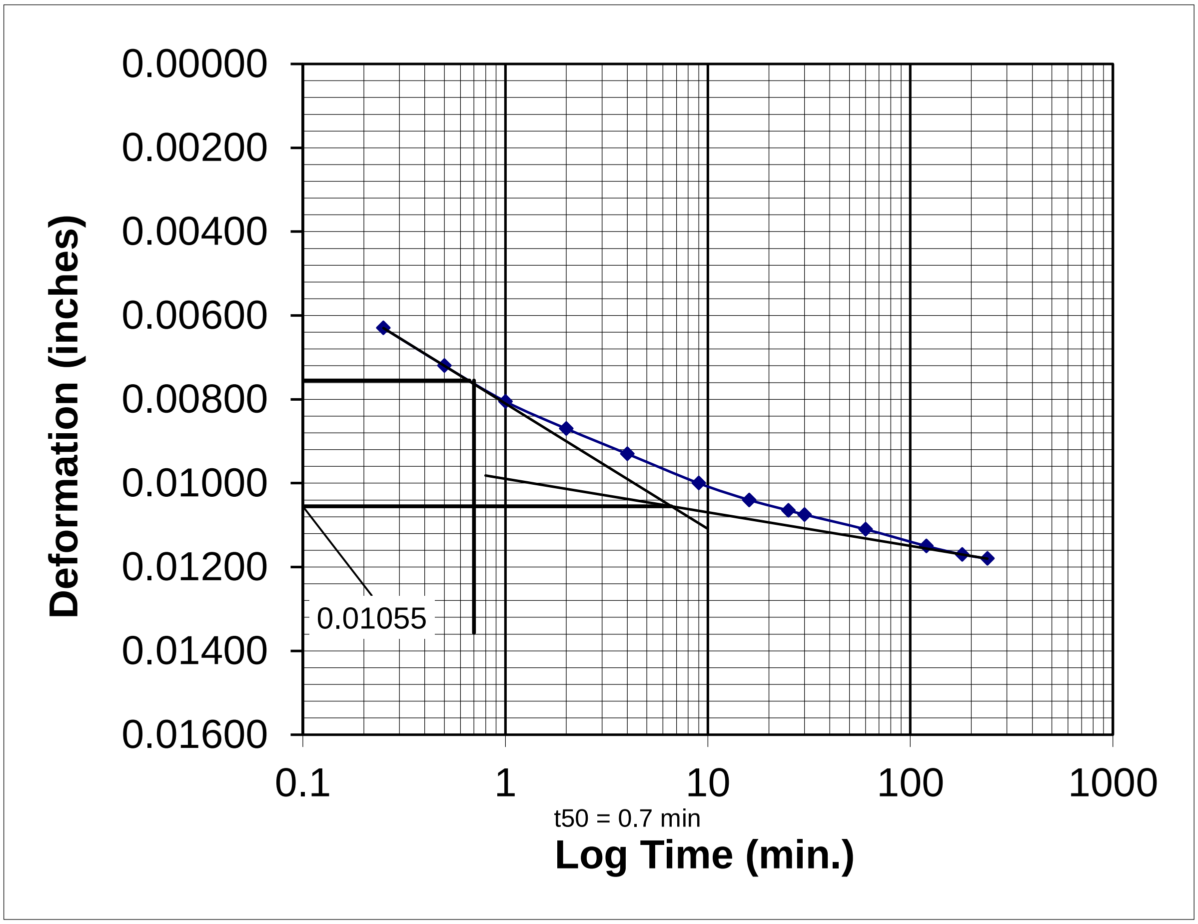
1.0 tsf Load

initial height= 0.9836 inches

Do= D1-(D2-D1)

1) 0.25 to 1.0:	0.00455
2) 0.5 to 2.0:	0.00570
3) 1.0 to 4.0:	0.00680
Do Avg 1&2:	0.00513
Do Avg 1-3:	0.00568
Use Do=	0.00455
D100=	0.01055
D50=	**D100+0.5(Do-D100)**
D50=	0.00755
t50 =	0.7 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.38040				
0.25	0.37240	0.00800	0.00170	0.00630	0.97730
0.5	0.37150	0.00890	0.00170	0.00720	0.97640
1	0.37065	0.00975	0.00170	0.00805	0.97555
2	0.37000	0.01040	0.00170	0.00870	0.97490
4	0.36940	0.01100	0.00170	0.00930	0.97430
9	0.36870	0.01170	0.00170	0.01000	0.97360
16	0.36830	0.01210	0.00170	0.01040	0.97320
25	0.36805	0.01235	0.00170	0.01065	0.97295
30	0.36795	0.01245	0.00170	0.01075	0.97285
60	0.36760	0.01280	0.00170	0.01110	0.97250
120	0.36720	0.01320	0.00170	0.01150	0.97210
180	0.36700	0.01340	0.00170	0.01170	0.97190
240	0.36690	0.01350	0.00170	0.01180	0.97180



Project No. : 230574　　Sample No.: ST-3
Boring No. : B-007-0-23　　Depth: 6.0 - 8.0'

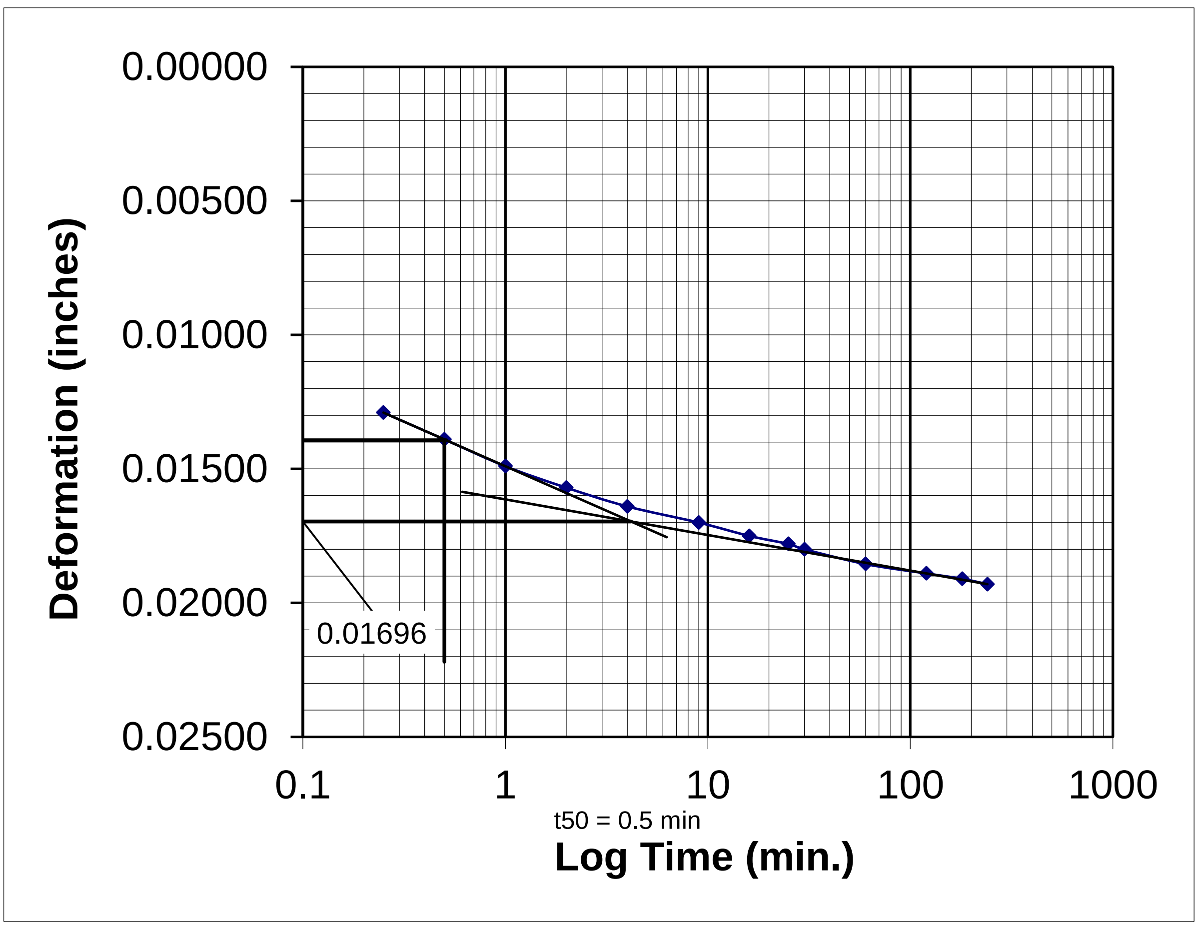
2.0 tsf Load

initial height= 0.9718 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.01090
2) 0.5 to 2.0: 0.01210
3) 1.0 to 4.0: 0.01340
Do Avg 1&2: 0.01150
Do Avg 1-3: 0.01213
Use Do= 0.01090
D100= 0.01696
D50= D100+0.5(Do-D100)
D50= 0.01393

t50 = 0.5 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.36690				
0.25	0.35130	0.01560	0.00270	0.01290	0.95890
0.5	0.35030	0.01660	0.00270	0.01390	0.95790
1	0.34930	0.01760	0.00270	0.01490	0.95690
2	0.34850	0.01840	0.00270	0.01570	0.95610
4	0.34780	0.01910	0.00270	0.01640	0.95540
9	0.34720	0.01970	0.00270	0.01700	0.95480
16	0.34670	0.02020	0.00270	0.01750	0.95430
25	0.34640	0.02050	0.00270	0.01780	0.95400
30	0.34620	0.02070	0.00270	0.01800	0.95380
60	0.34565	0.02125	0.00270	0.01855	0.95325
120	0.34530	0.02160	0.00270	0.01890	0.95290
180	0.34510	0.02180	0.00270	0.01910	0.95270
240	0.34490	0.02200	0.00270	0.01930	0.95250



Project No. : 230574 Sample No.: ST-3
Boring No. : B-007-0-23 Depth: 6.0 - 8.0'

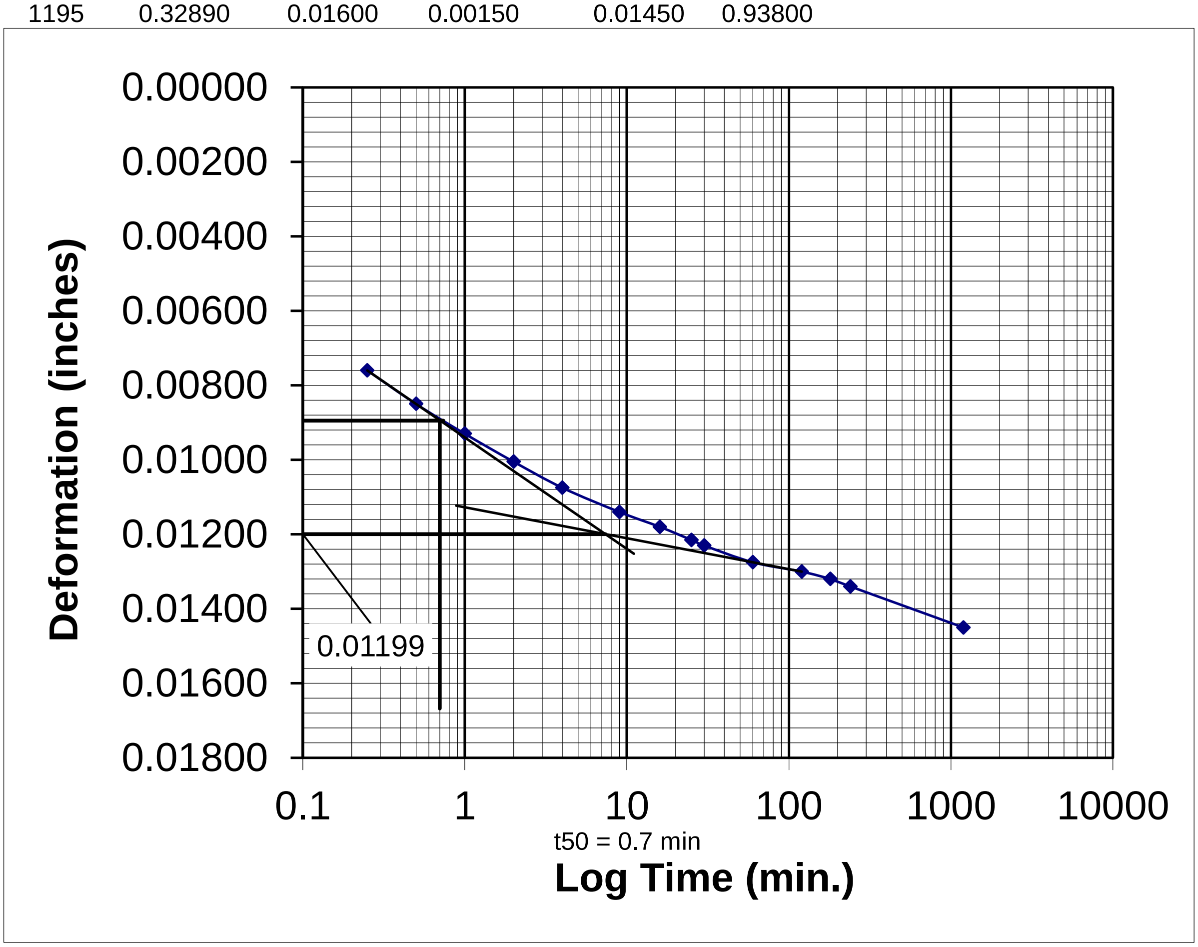
4.0 tsf Load

initial height= 0.9525 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00590
2) 0.5 to 2.0: 0.00695
3) 1.0 to 4.0: 0.00785
Do Avg 1&2: 0.00643
Do Avg 1-3: 0.00690
Use Do= 0.00590
D100= 0.01199
D50= D100+0.5(Do-D100)
D50= 0.00895

t50 = 0.7 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.34490				
0.25	0.33580	0.00910	0.00150	0.00760	0.94490
0.5	0.33490	0.01000	0.00150	0.00850	0.94400
1	0.33410	0.01080	0.00150	0.00930	0.94320
2	0.33335	0.01155	0.00150	0.01005	0.94245
4	0.33265	0.01225	0.00150	0.01075	0.94175
9	0.33200	0.01290	0.00150	0.01140	0.94110
16	0.33160	0.01330	0.00150	0.01180	0.94070
25	0.33125	0.01365	0.00150	0.01215	0.94035
30	0.33110	0.01380	0.00150	0.01230	0.94020
60	0.33065	0.01425	0.00150	0.01275	0.93975
120	0.33040	0.01450	0.00150	0.01300	0.93950
180	0.33020	0.01470	0.00150	0.01320	0.93930
240	0.33000	0.01490	0.00150	0.01340	0.93910
1195	0.32890	0.01600	0.00150	0.01450	0.93800



Project No. : 230574
Boring No. : B-007-0-23

Sample No.: ST-3
Depth: 6.0 - 8.0'

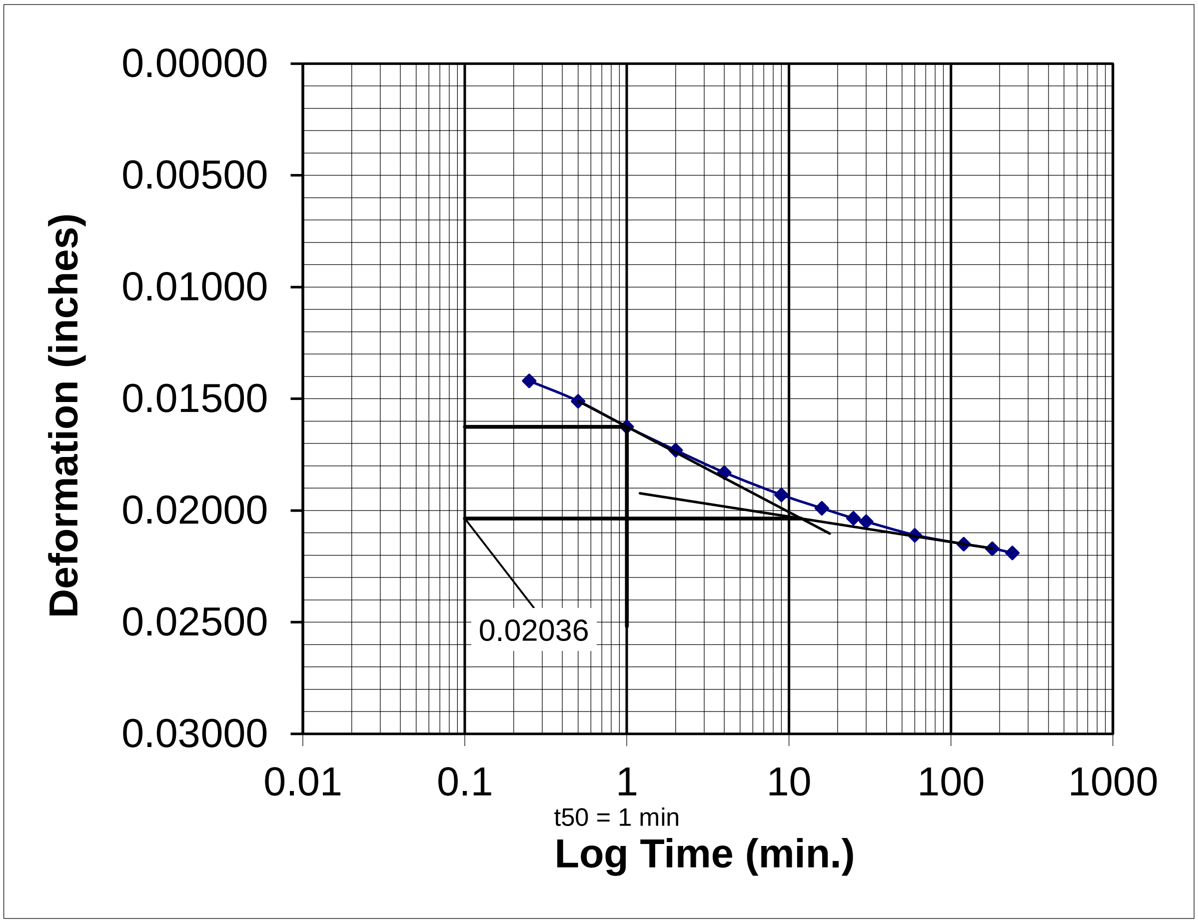
8.0 tsf Load

initial height= 0.93800 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.01215
2) 0.5 to 2.0: 0.01290
3) 1.0 to 4.0: 0.01420
Do Avg 1&2: 0.01253
Do Avg 1-3: 0.01308
Use Do= 0.01215
D100= 0.02036
D50= D100+0.5(Do-D100)
D50= 0.01626

t50 = 1.0 min.

Interval Minutes	**Dial Reading**	**ΔH**	**Deformation Constant**	**TRUE ΔH**	**Height of Sample**
0	0.32890				
0.25	0.31290	0.01600	0.00180	0.01420	0.92380
0.5	0.31200	0.01690	0.00180	0.01510	0.92290
1	0.31085	0.01805	0.00180	0.01625	0.92175
2	0.30980	0.01910	0.00180	0.01730	0.92070
4	0.30880	0.02010	0.00180	0.01830	0.91970
9	0.30780	0.02110	0.00180	0.01930	0.91870
16	0.30720	0.02170	0.00180	0.01990	0.91810
25	0.30675	0.02215	0.00180	0.02035	0.91765
30	0.30660	0.02230	0.00180	0.02050	0.91750
60	0.30600	0.02290	0.00180	0.02110	0.91690
120	0.30560	0.02330	0.00180	0.02150	0.91650
180	0.30540	0.02350	0.00180	0.02170	0.91630
240	0.30520	0.02370	0.00180	0.02190	0.91610



Project No. : 230574
Boring No. : B-007-0-23

Sample No.: ST-3
Depth: 6.0 - 8.0'

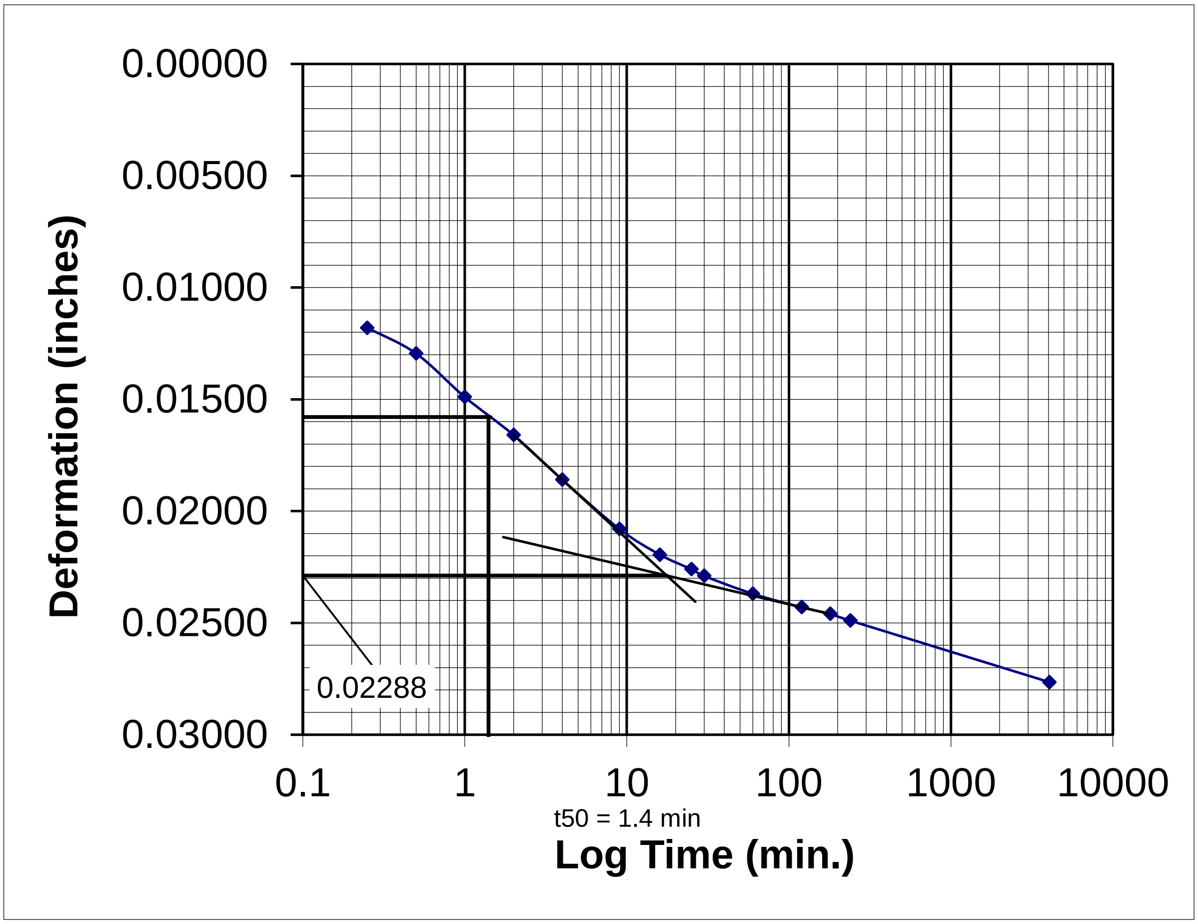
16 tsf Load

initial height= 0.9161 inches

Do= D1-(D2-D1)
1) 0.25 to 1.0: 0.00870
2) 0.5 to 2.0: 0.00930
3) 1.0 to 4.0: 0.01120
Do Avg 1&2: 0.00900
Do Avg 1-3: 0.00973
Use Do= 0.00870
D100= 0.02288
D50= D100+0.5(Do-D100)
D50= 0.01579

t50 = 1.4 min.

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.30520				
0.25	0.29160	0.01360	0.00180	0.01180	0.90430
0.5	0.29045	0.01475	0.00180	0.01295	0.90315
1	0.28850	0.01670	0.00180	0.01490	0.90120
2	0.28680	0.01840	0.00180	0.01660	0.89950
4	0.28480	0.02040	0.00180	0.01860	0.89750
9	0.28260	0.02260	0.00180	0.02080	0.89530
16	0.28145	0.02375	0.00180	0.02195	0.89415
25	0.28080	0.02440	0.00180	0.02260	0.89350
30	0.28050	0.02470	0.00180	0.02290	0.89320
60	0.27970	0.02550	0.00180	0.02370	0.89240
120	0.27910	0.02610	0.00180	0.02430	0.89180
180	0.27880	0.02640	0.00180	0.02460	0.89150
240	0.27850	0.02670	0.00180	0.02490	0.89120
4065	0.27575	0.02945	0.00180	0.02765	0.88845



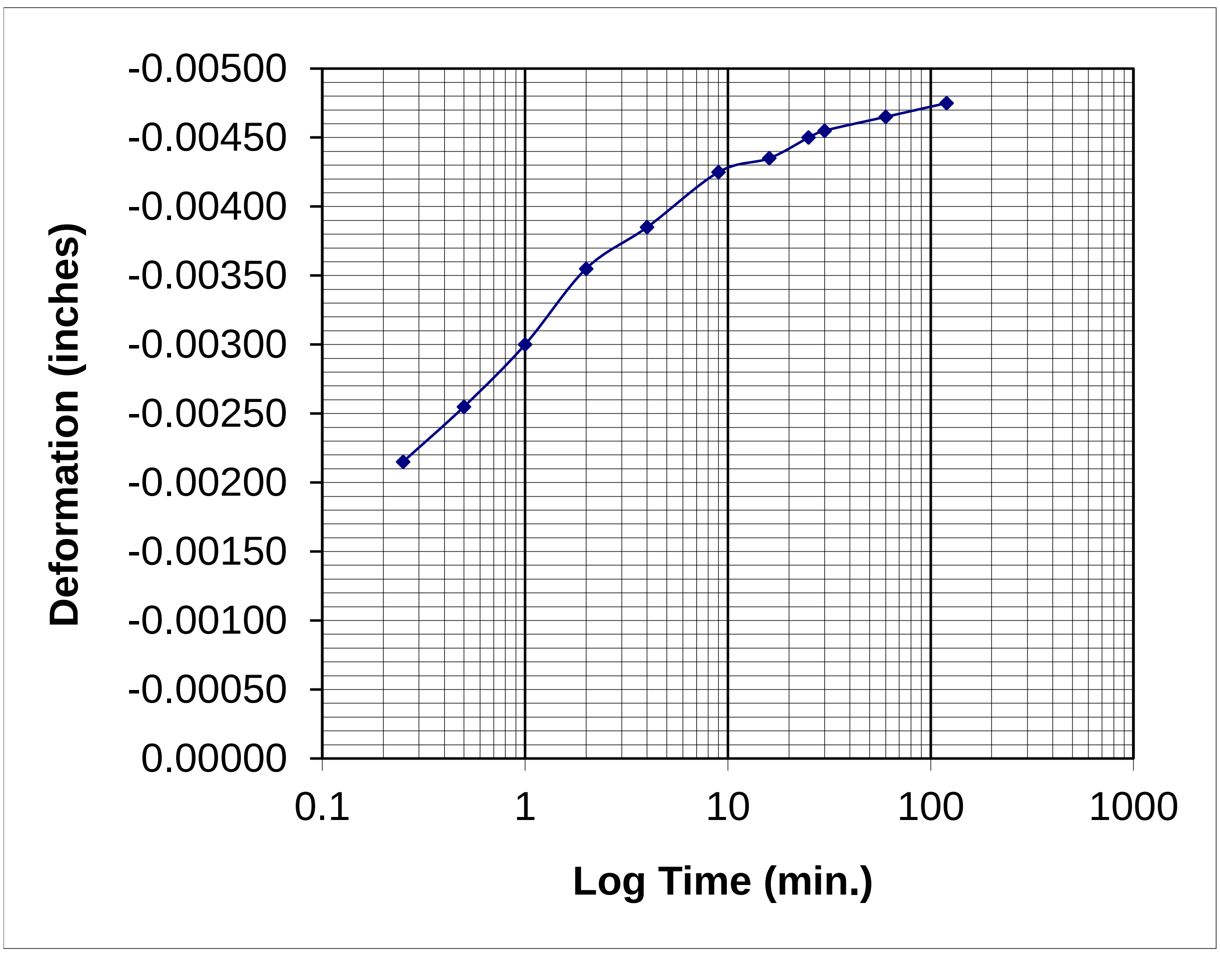
Project No. : 230574
Boring No. : B-007-0-23

Sample No.: ST-3
Depth: 6.0 - 8.0'

4.0 tsf Unload

initial height= 0.88845 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.27575				
0.25	0.27900	-0.00325	-0.00110	-0.00215	0.89060
0.5	0.27940	-0.00365	-0.00110	-0.00255	0.89100
1	0.27985	-0.00410	-0.00110	-0.00300	0.89145
2	0.28040	-0.00465	-0.00110	-0.00355	0.89200
4	0.28070	-0.00495	-0.00110	-0.00385	0.89230
9	0.28110	-0.00535	-0.00110	-0.00425	0.89270
16	0.28120	-0.00545	-0.00110	-0.00435	0.89280
25	0.28135	-0.00560	-0.00110	-0.00450	0.89295
30	0.28140	-0.00565	-0.00110	-0.00455	0.89300
60	0.28150	-0.00575	-0.00110	-0.00465	0.89310
120	0.28160	-0.00585	-0.00110	-0.00475	0.89320

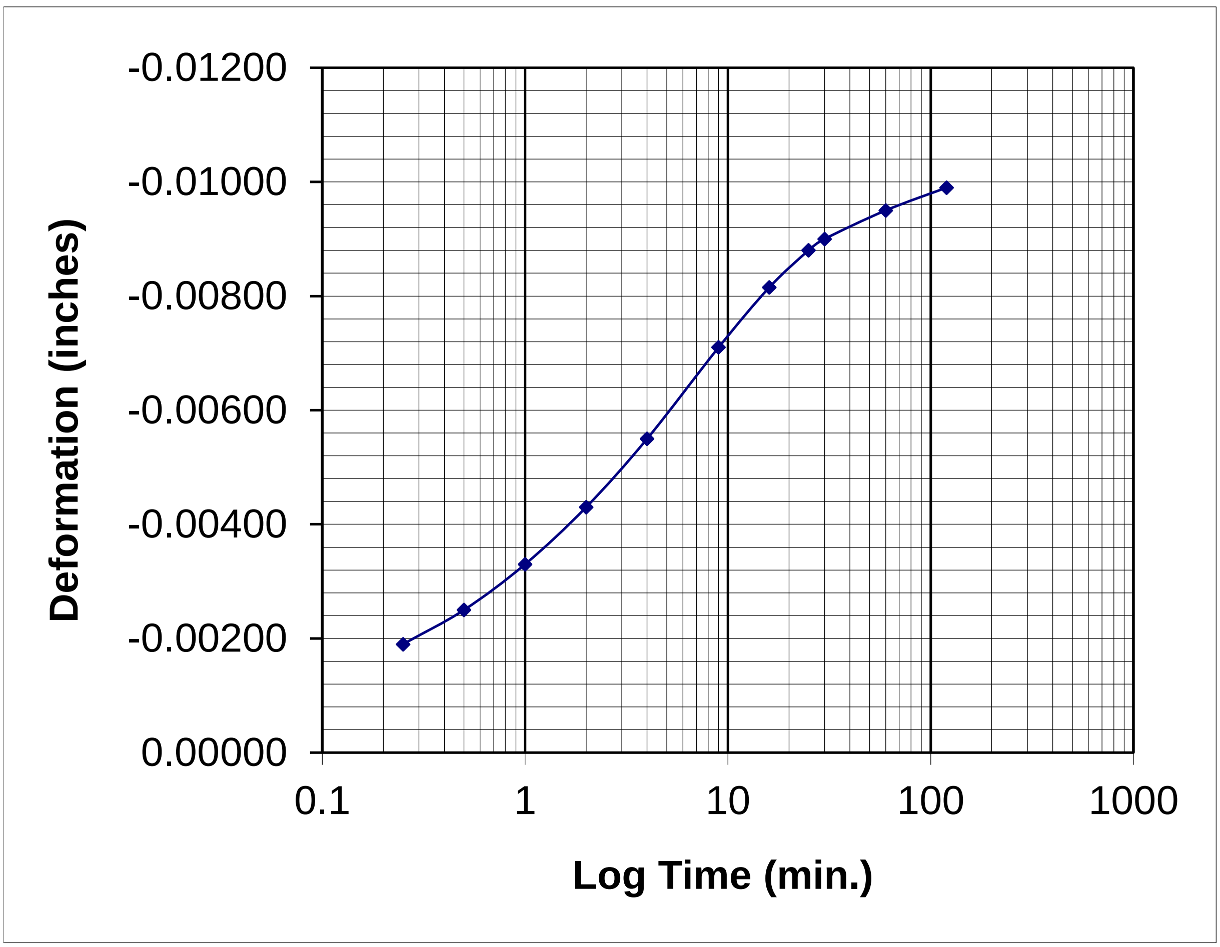


Project No. : 230574 Sample No.: ST-3
Boring No. : B-007-0-23 Depth: 6.0 - 8.0'

1.0 tsf Unload

initial height= 0.8932 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.28160				
0.25	0.28510	-0.00350	-0.00160	-0.00190	0.89510
0.5	0.28570	-0.00410	-0.00160	-0.00250	0.89570
1	0.28650	-0.00490	-0.00160	-0.00330	0.89650
2	0.28750	-0.00590	-0.00160	-0.00430	0.89750
4	0.28870	-0.00710	-0.00160	-0.00550	0.89870
9	0.29030	-0.00870	-0.00160	-0.00710	0.90030
16	0.29135	-0.00975	-0.00160	-0.00815	0.90135
25	0.29200	-0.01040	-0.00160	-0.00880	0.90200
30	0.29220	-0.01060	-0.00160	-0.00900	0.90220
60	0.29270	-0.01110	-0.00160	-0.00950	0.90270
120	0.29310	-0.01150	-0.00160	-0.00990	0.90310

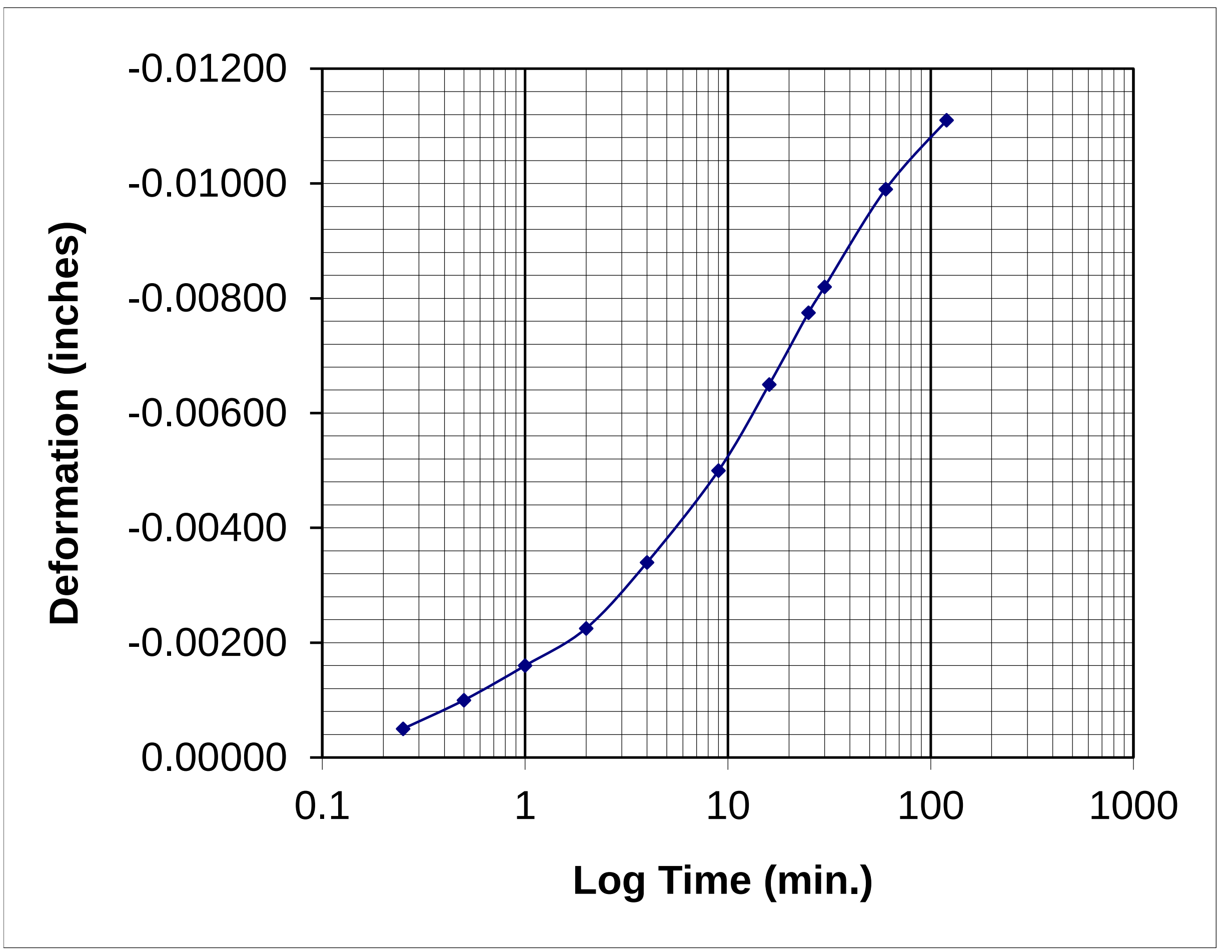


Project No. : 230574 Sample No.: ST-3
Boring No. : B-007-0-23 Depth: 6.0 - 8.0'

0.25 tsf Unload

initial height= 0.9031 inches

Interval Minutes	Dial Reading	ΔH	Deformation Constant	TRUE ΔH	Height of Sample
0	0.29310				
0.25	0.29500	-0.00190	-0.00140	-0.00050	0.90360
0.5	0.29550	-0.00240	-0.00140	-0.00100	0.90410
1	0.29610	-0.00300	-0.00140	-0.00160	0.90470
2	0.29675	-0.00365	-0.00140	-0.00225	0.90535
4	0.29790	-0.00480	-0.00140	-0.00340	0.90650
9	0.29950	-0.00640	-0.00140	-0.00500	0.90810
16	0.30100	-0.00790	-0.00140	-0.00650	0.90960
25	0.30225	-0.00915	-0.00140	-0.00775	0.91085
30	0.30270	-0.00960	-0.00140	-0.00820	0.91130
60	0.30440	-0.01130	-0.00140	-0.00990	0.91300
120	0.30560	-0.01250	-0.00140	-0.01110	0.91420



Core Log For B-001-0-23

Project: WOO-75-29.93, PID 119007

Rossford, Wood County, Ohio

CT Project No. 230574

Core Date: June 9, 2023

ASPHALT THICKNESS (in)	=	7.875
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

Core Log For B-002-0-23

Project: WOO-75-29.93, PID 119007

Rossford, Wood County, Ohio

CT Project No. 230574

Core Date: June 9, 2023

ASPHALT THICKNESS (in)	=	9.04
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

Core Log For B-006-0-23

Project: WOO-75-29.93, PID 119007

Rossford, Wood County, Ohio

CT Project No. 230574

Core Date: June 9, 2023

ASPHALT THICKNESS (in)	=	8.50
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

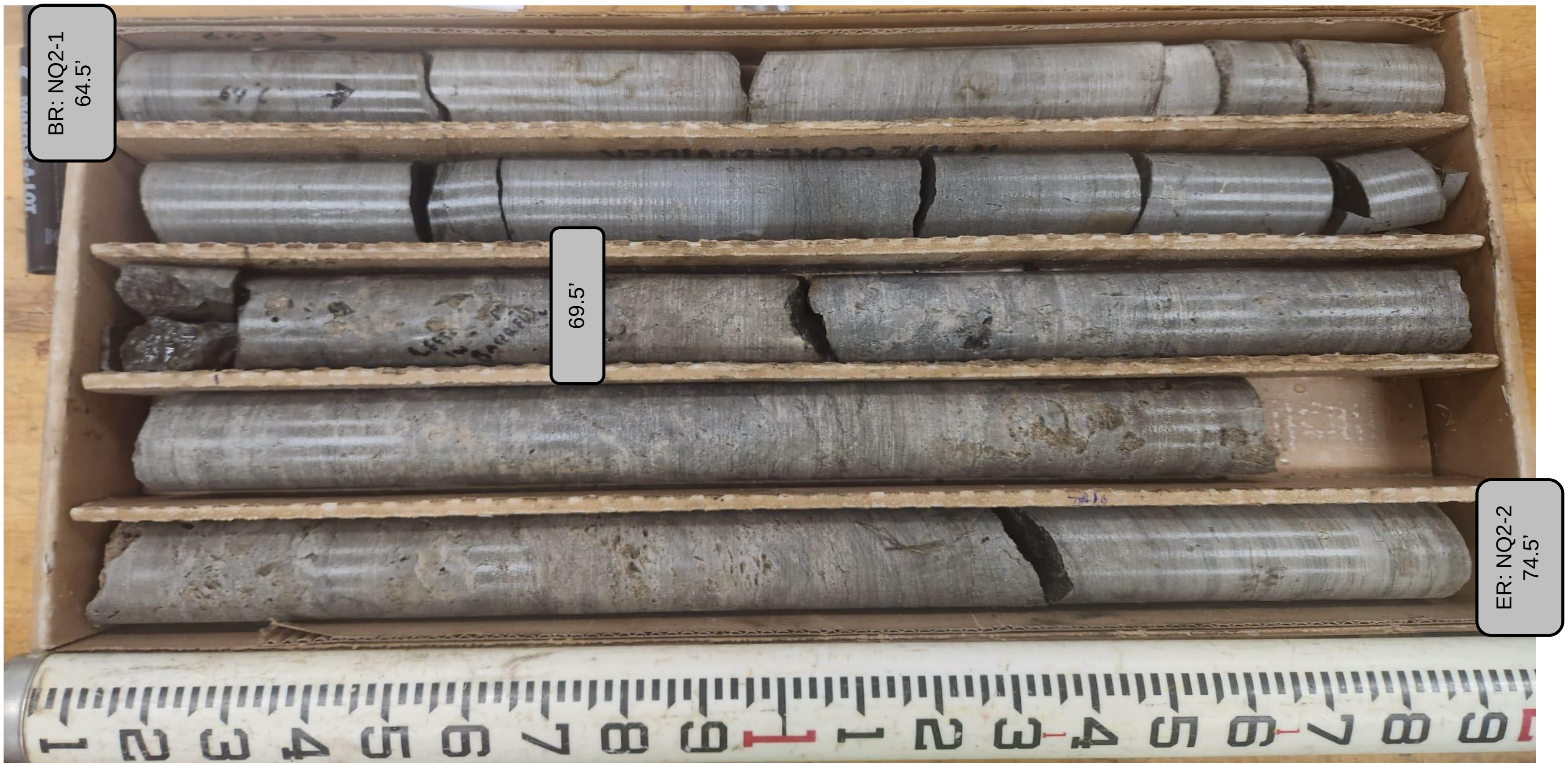
B-003-0-23

Core Date: June 14, 2023					Ground Surface Elevation: 627.4'			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	65.5'	70.5'	561.9'	556.9'	56/60	93%	50/60	83%
WOO-75-29.93, PID 119007								

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-004-0-23



Core Date: June 14, 2023					Ground Surface Elevation: 631.4’			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	64.5’	69.5’	566.9’	561.9’	56/60	93%	42/60	70%
NQ2-2	69.5’	74.5’	561.9’	556.9’	57/60	95%	57/60	95%
WOO-75-29.93, PID 119007								

Prepared by

CT Project No.: 230574

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-005-0-23

Core Date: June 12, 2023					Ground Surface Elevation: 629.3’			
Run #:	Depth		Elevation		Recovery		RQD	
NQ2-1	64.0’	69.0’	565.3’	560.3’	48/60	80%	29/60	48%
WOO-75-29.93, PID 119007								

Prepared by

CT Project No.: 230574

Compressive Strength of Rock
ASTM D 7012, Method C

PROJECT	WOO-75-29.93, PID 119007	TTL PROJECT NUMBER	230574
LOCATION	Interstate Route 75 and Lime City Road, Rossford, Wood County, Ohio		
CLIENT	ODOT District 2		
BORING NUMBER	B-003-0-23	SAMPLE NUMBER	NQ2-1
SAMPLE DEPTH (FEET)	65.5–70.5 (NQ2-1)	SPECIMEN DEPTH (FEET)	65.5–66.0

ROCK DESCRIPTION	DOLOMITE, GRAY, SLIGHTLY WEATHERED, VERY STRONG, JOINTED - HIGHLY FRACTURED TO FRACTURED, TIGHT

LENGTH (INCHES)	4.05
DIAMETER (INCHES)	1.98
LENGTH / DIAMETER	2.05
CORRECTION FACTOR	1.0
AREA (SQ. IN.)	3.08

MASS (GRAMS)	516.52
UNIT WEIGHT (LBS/CU. FT.)	157.7
MAXIMUM LOAD (LBS)	58,130
COMPRESSIVE STRENGTH (PSI)	18,880

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock
ASTM D 7012, Method C

PROJECT	WOO-75-29.93, PID 119007	TTL PROJECT NUMBER	230574
LOCATION	Interstate Route 75 and Lime City Road, Rossford, Wood County, Ohio		
CLIENT	ODOT District 2		
BORING NUMBER	B-004-0-23	SAMPLE NUMBER	NQ2-1
SAMPLE DEPTH (FEET)	64.5–69.5 (NQ2-1)	SPECIMEN DEPTH (FEET)	64.5–64.9

ROCK DESCRIPTION	GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT

LENGTH (INCHES)	4.08
DIAMETER (INCHES)	1.98
LENGTH / DIAMETER	2.06
CORRECTION FACTOR	1.0
AREA (SQ. IN.)	3.08

MASS (GRAMS)	549.74
UNIT WEIGHT (LBS/CU. FT.)	166.7
MAXIMUM LOAD (LBS)	46,010
COMPRESSIVE STRENGTH (PSI)	14,940

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock
ASTM D 7012, Method C

Project	WOO-75-29.93, PID 119007	TTL Project Number	230574
Location	Interstate Route 75 and Lime City Road, Rossford, Wood County, Ohio		
Client	ODOT District 2		
Boring Number	B-005-0-23	Sample Number	NQ2-1
Sample Depth (feet)	64.0–69.0 (NQ2-1)	Specimen Depth (feet)	64.6–65.3

Rock Description	DOLOMITE, GRAY, SLIGHTLY WEATHERED, STRONG, JOINTED - FRACTURED TO MODERATELY FRACTURED, TIGHT

Length (inches)	4.09
Diameter (inches)	1.98
Length / Diameter	2.07
Correction Factor	1.0
Area (sq. in.)	3.08

Mass (grams)	537.3
Unit Weight (lbs/cu. ft.)	162.5
Maximum Load (lbs)	44,750
Compressive Strength (psi)	14,530

Test Specimen Photo

Test Specimen Photo

Appendix A:
Engineering Calculations

Project Name: WOO-75-29.93, PID 119007
Project Number: 230574
Calculated by: KCH 7/12/2023

Boring Number B-002 - Rear Abutment - Existing Condition (H = 24 feet)
Analysis Type Embankment

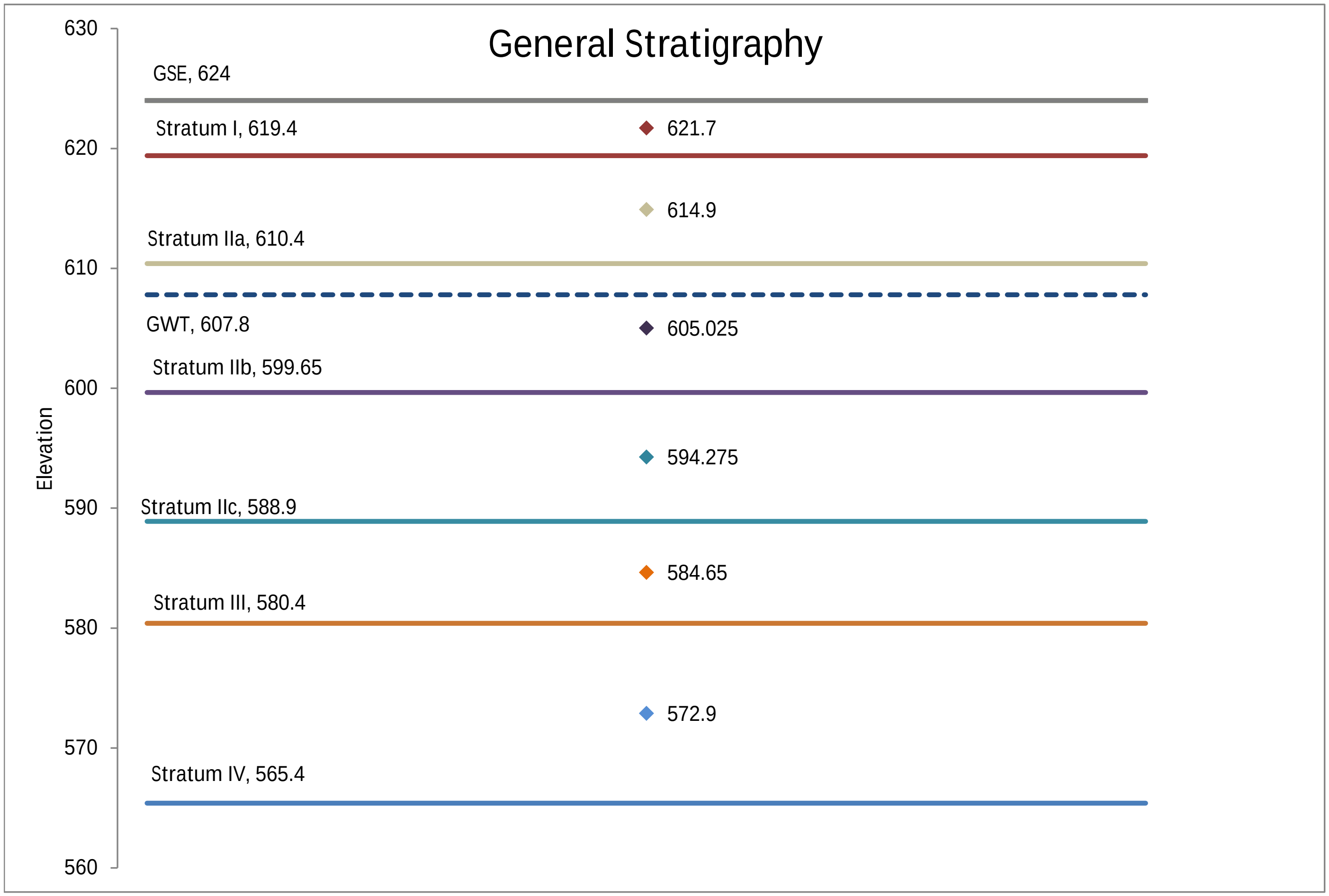
Settlement Analysis Results:

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	$I_{z,A}$	ΔP_A at P_A of 3360 psf	$I_{z,B}$	ΔP_B at P_B of 3360 psf	Total ΔP (psf)	ΔH (inches)
Stratum I	4.6	*	0.62	299	2.3	0.500	1,680	0.500	1,680	3,360	2.80
Stratum IIa	9	*	0.46	1,183	9.1	0.495	1,663	0.495	1,663	3,326	0.39
Stratum IIb	10.75	*	0.46	2,294	18.975	0.480	1,613	0.48	1,613	3,226	0.97
Stratum IIc	10.75	*	0.46	3,020	29.725	0.450	1,512	0.45	1,512	3,024	1.21
Stratum III	8.5	*	0.45	3,692	39.35	0.425	1,428	0.425	1,428	2,856	0.69
Stratum IV	15	0.014	0.48	4,523	51.1	0.390	1,310	0.39	1,310	2,621	0.34

Sum ΔH (in.) below embankment	6.39
+15%	7.35
-15%	5.44

Settlement Under Self Weight (CL)	4.35

Previous Settlement	10 to 11.75 inches



Project Name:	WOO-75-29.93, PID 119007	Boring Number	B-002 - Rear Abutment - Existing Condition (H = 24 feet)
Project Number:	230574	Analysis Type	Embankment
Calculated by:	KCH 7/12/2023		

Boring Properties & Settlement Analysis Inputs:

G	2.7				
GSE	624				
GWT	607.8				
Bearing Elev	624				
$B_{2,A}$	60.72 ft		$B_{1,A}$	19 ft	
$B_{2,B}$	60 ft		$B_{1,B}$	19 ft	
P_A	3,360 psf		H_A	24 ft	
P_B	3,360 psf		H_B	24 ft	

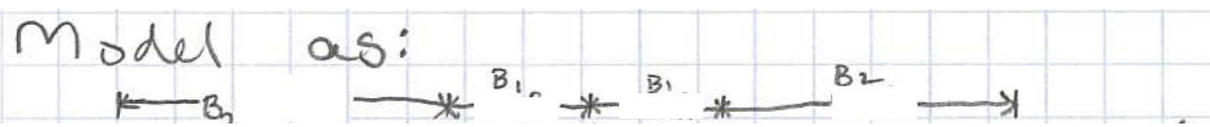
Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.226	0.023	1,913	130	Estimated
II	0.46	0.134	0.021	5,200	130	Tested
III	0.45	0.115	0.026	6,000	135	Tested
IV	0.48	0.135	0.014	33,180	132	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Layer Inputs based on Encountered Strata:

Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer C_r	e_o	$B_{1,A}/z$	$B_{2,A}/z$	$I_{z,A}$	$B_{1,B}/z$	$B_{2,B}/z$	$I_{z,B}$
Stratum I	619.4	621.7	4.6	2.3	2.3	130	-13.9	299	3,659	1,913	Cc and Cr	*	0.62	8.3	26.4	0.500	8.3	26.1	0.500
Stratum IIa	610.4	614.9	9	9.1	9.1	130	-7.1	1,183	4,509	1,913	Cc and Cr	*	0.46	2.1	6.7	0.495	2.1	6.6	0.495
Stratum IIb	599.65	605.025	10.8	18.975	18.975	130	2.775	2,294	5,519	5,200	Cc and Cr	*	0.46	1.0	3.2	0.480	1.0	3.2	0.480
Stratum IIc	588.9	594.275	10.8	29.725	29.725	130	13.525	3,020	6,044	5,200	Cc and Cr	*	0.46	0.6	2.0	0.450	0.6	2.0	0.450
Stratum III	580.4	584.65	8.5	39.35	39.35	135	23.15	3,692	6,548	6,000	Cc and Cr	*	0.45	0.5	1.5	0.425	0.5	1.5	0.425
Stratum IV	565.4	572.9	15	51.1	51.1	132	34.9	4,523	7,144	33,180	Cr	0.014	0.48	0.4	1.2	0.390	0.4	1.2	0.390



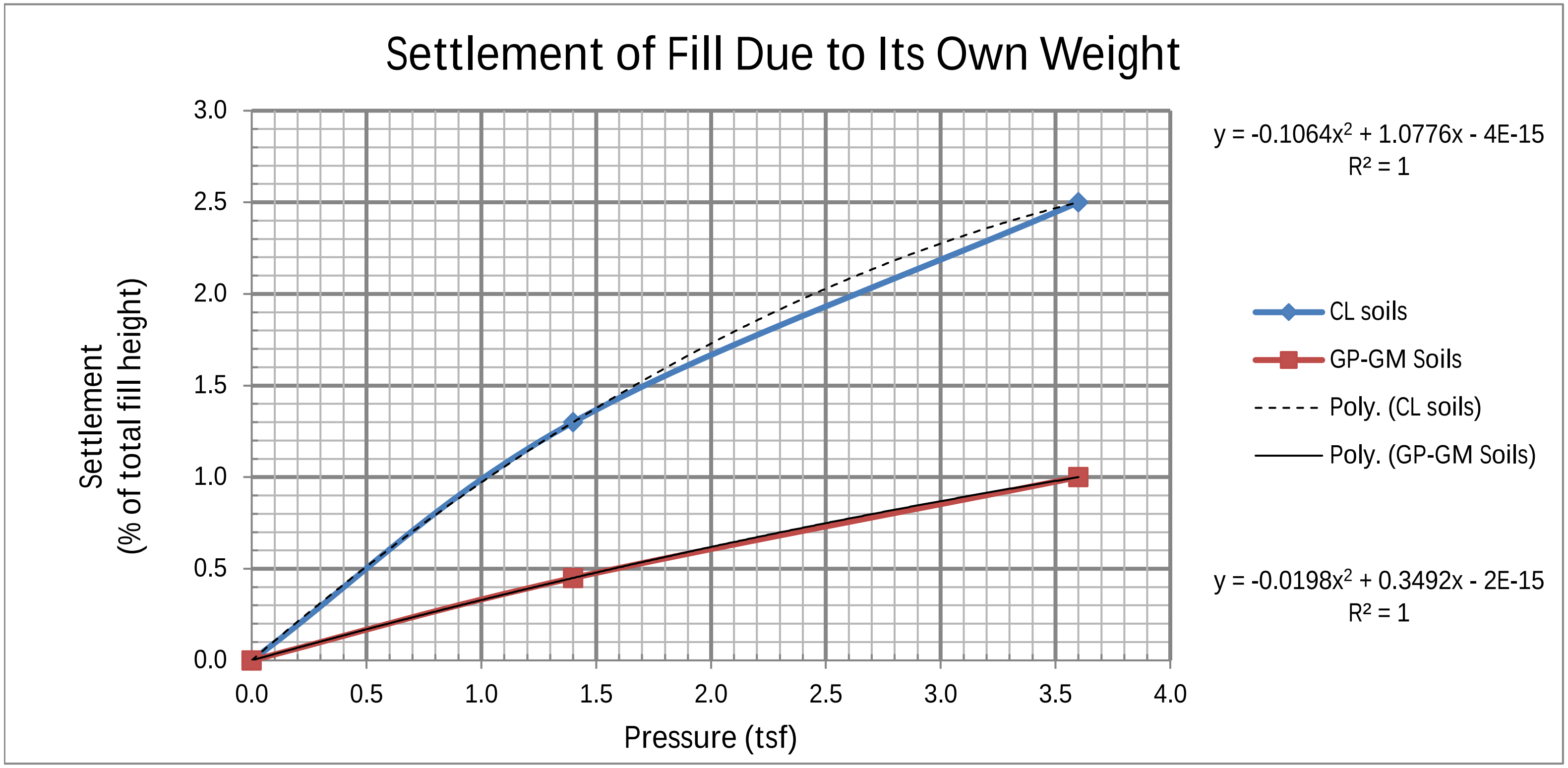
clays of low to medium plasticity (CL)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	1.3
3.6	2.5

Poorly Graded Gravel with sand and silt (GP-GM)

pressure	typical value of compression - (percent of total fill height)
0	0
1.4	0.45
3.6	1

Max. Embankment Pressure =	3,360	psf
=	1.68	tsf
Settlement CL	1.5	%
Max. Embankment Height =	24	ft
Settlement =	4.35	inches
Settlement GP-GM	0.5	%
Max. Embankment Height =	24	ft
Settlement =	1.53	inches

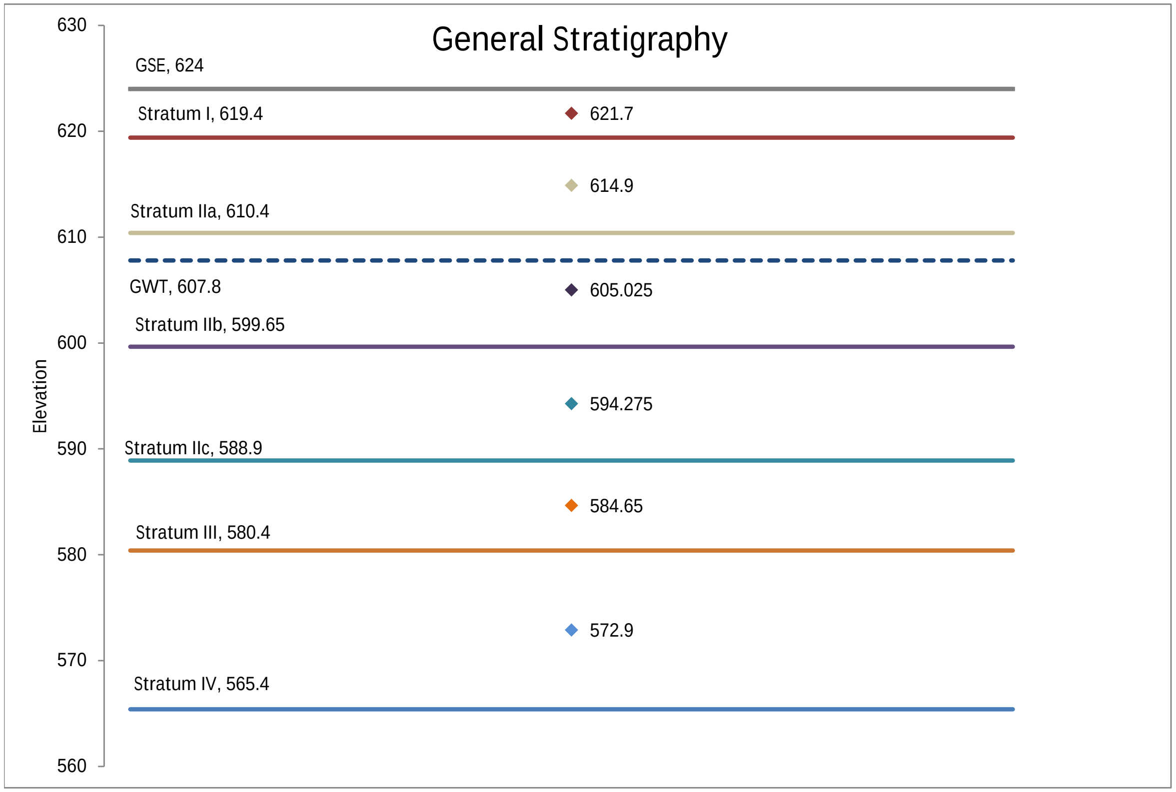


Project Name: WOO-75-29.93, PID 119007
Project Number: 230574
Calculated by: KCH 7/12/2023

Boring Number B-002 - Rear Abutment - Additional Embankment Condition (H = 26 feet)
Analysis Type Embankment

Settlement Analysis Results:

Layer	H (feet)	C_c or C_r	e_o	σ_v' (psf)	z (feet)	$I_{z,A}$	ΔP_A at P_A of 3640 psf	$I_{z,B}$	ΔP_B at P_B of 3640 psf	Total ΔP (psf)	ΔH at 26 feet (inches)	ΔH at 24 feet (inches)	New ΔH (inches)
Stratum I	4.6	*	0.62	299	2.3	0.500	1,820	0.500	1,820	3,640	3.05	2.80	0.25
Stratum IIa	9	*	0.46	1,183	9.1	0.495	1,802	0.495	1,802	3,604	0.64	0.39	0.26
Stratum IIb	10.75	*	0.46	2,294	18.975	0.480	1,747	0.48	1,747	3,494	1.21	0.97	0.24
Stratum IIc	10.75	*	0.46	3,020	29.725	0.450	1,638	0.45	1,638	3,276	1.42	1.21	0.21
Stratum III	8.5	*	0.45	3,692	39.35	0.425	1,547	0.425	1,547	3,094	0.82	0.69	0.13
Stratum IV	15	0.014	0.48	4,523	51.1	0.390	1,420	0.39	1,420	2,839	0.36	0.34	0.02



	ΔH at 26 feet	ΔH at 24 feet
Sum ΔH (in.) below embankment	7.50	6.39
+15%	8.62	7.35
-15%	6.37	5.44

Settlement Under Self Weight (CL)	5.02	4.35

Total Settlement (26 ft)	11.5 to 13.75 inches
Previous Settlement	10 to 11.75 inches

Total New Settlement	**1.5 to 2 inches**

Project Name:	WOO-75-29.93, PID 119007	Boring Number	B-002 - Rear Abutment - Additional Embankment Condition (H = 26 feet)
Project Number:	230574	Analysis Type	Embankment
Calculated by:	KCH 7/12/2023		

Boring Properties & Settlement Analysis Inputs:

G	2.7				
GSE	624				
GWT	607.8				
Bearing Elev	624				
$B_{2,A}$	65.78 ft		$B_{1,A}$	19	ft
$B_{2,B}$	65 ft		$B_{1,B}$	19	ft
P_A	3,640 psf		H_A	26	ft
P_B	3,640 psf		H_B	26	ft

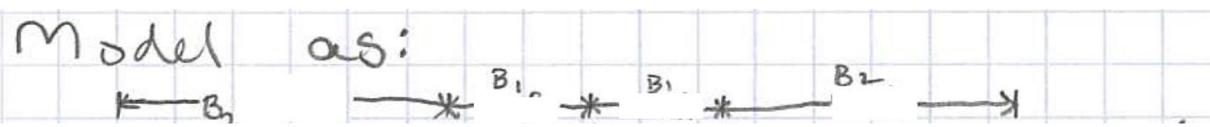
Project-Specific Consolidation Soil Properties:

Stratum	e_o	C_c	C_r	P_c (psf)	γ_T (pcf)	Basis
I	0.62	0.226	0.023	1,913	130	Estimated
II	0.46	0.134	0.021	5,200	130	Tested
III	0.45	0.115	0.026	6,000	135	Tested
IV	0.48	0.135	0.014	33,180	132	Estimated

note: Hardpan considered highly overconsolidated. Use Cr.

Layer Inputs based on Encountered Strata:

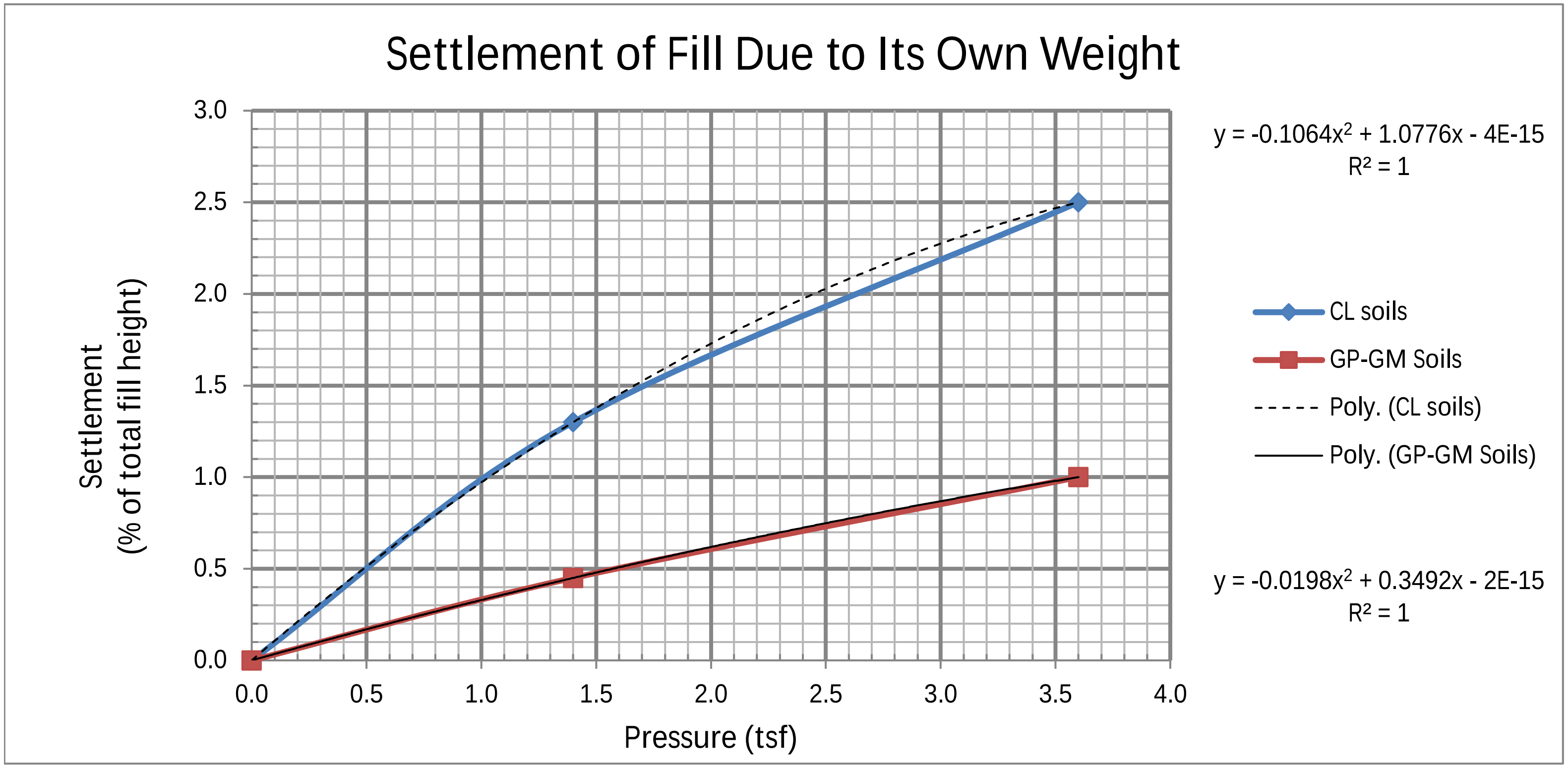
Encountered Layer	Bot. Elev.	Centroid (C) Elev.	H (ft)	z below footing	z below GSE	γ_T (pcf)	H_{GWT-C}	σ_v' (psf)	$\Delta P+\sigma_v'$ (psf)	Layer Pc (psf)	Use	Layer C_r	e_o	$B_{1,A}/z$	$B_{2,A}/z$	$I_{z,A}$	$B_{1,B}/z$	$B_{2,B}/z$	$I_{z,B}$
Stratum I	619.4	621.7	4.6	2.3	2.3	130	-13.9	299	3,939	1,913	Cc and Cr	*	0.62	8.3	28.6	0.500	8.3	28.3	0.500
Stratum IIa	610.4	614.9	9	9.1	9.1	130	-7.1	1,183	4,787	1,913	Cc and Cr	*	0.46	2.1	7.2	0.495	2.1	7.1	0.495
Stratum IIb	599.65	605.025	10.8	18.975	18.975	130	2.775	2,294	5,788	5,200	Cc and Cr	*	0.46	1.0	3.5	0.480	1.0	3.4	0.480
Stratum IIc	588.9	594.275	10.8	29.725	29.725	130	13.525	3,020	6,296	5,200	Cc and Cr	*	0.46	0.6	2.2	0.450	0.6	2.2	0.450
Stratum III	580.4	584.65	8.5	39.35	39.35	135	23.15	3,692	6,786	6,000	Cc and Cr	*	0.45	0.5	1.7	0.425	0.5	1.7	0.425
Stratum IV	565.4	572.9	15	51.1	51.1	132	34.9	4,523	7,362	33,180	Cr	0.014	0.48	0.4	1.3	0.390	0.4	1.3	0.390

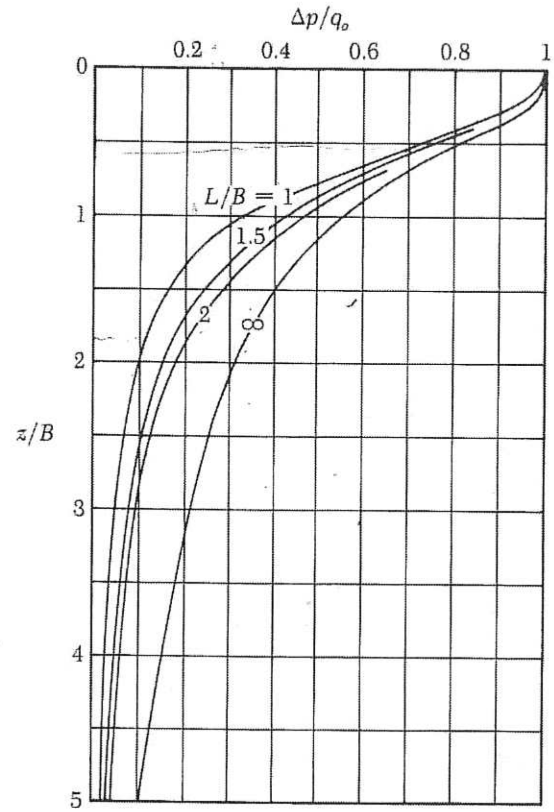


clays of low to medium plasticity (CL)	
pressure	typical value of compression - (percent of total fill height)
0	0
1.4	1.3
3.6	2.5

Poorly Graded Gravel with sand and silt (GP-GM)	
pressure	typical value of compression - (percent of total fill height)
0	0
1.4	0.45
3.6	1

Max. Embankment Pressure =	3,640	psf
=	1.82	tsf
Settlement CL	1.6	%
Max. Embankment Height =	26	ft
Settlement =	5.02	inches
Settlement GP-GM	0.6	%
Max. Embankment Height =	26	ft
Settlement =	1.78	inches





▼ **FIGURE 3.41** Increase of stress under the center of a flexible loaded rectangular area

method (Figure 3.42, page 200). According to this method, the increase of stress at depth z is

$$\Delta p = \frac{q_o \times B \times L}{(B + z)(L + z)} \tag{3.108}$$

Note that Eq. (3.108) is based on the assumption that the stress from the foundation spreads out along lines with a *2 vertical to 1 horizontal slope.*

Stress Increase Under an Embankment

Figure 3.43 shows the cross section of an embankment of height H. For this two-dimensional loading condition the vertical stress increase may be expressed as

$$\Delta p = \frac{q_o}{\pi}\left[\left(\frac{B_1 + B_2}{B_2}\right)(\alpha_1 + \alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right] \tag{3.109}$$

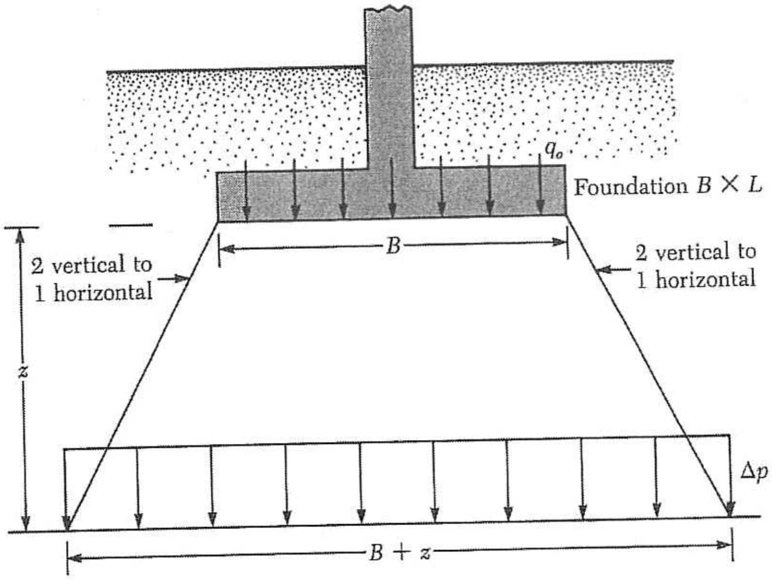


FIGURE 3.42 2:1 method of finding stress increase under a foundation

where $q = \gamma H$
γ = unit weight of the embankment soil
H = height of the embankment

$$\alpha_1 \text{ (radians)} = \tan^{-1}\left(\frac{B_1 + B_2}{z}\right) - \tan^{-1}\left(\frac{B_1}{z}\right) \tag{3.110}$$

$$\alpha_2 = \tan^{-1}\left(\frac{B_1}{z}\right) \tag{3.111}$$

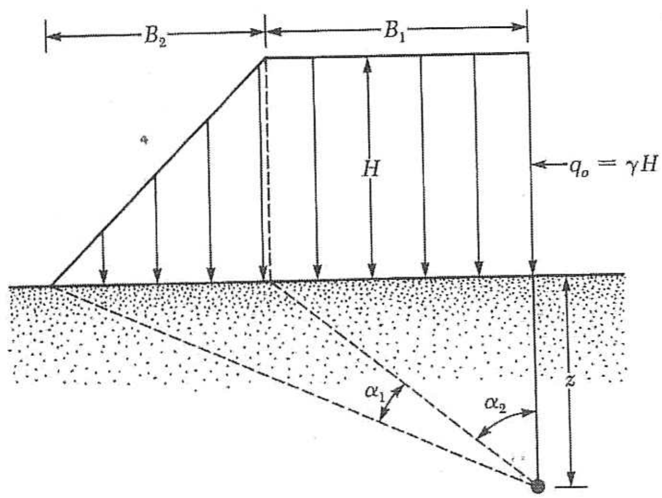


FIGURE 3.43 Embankment loading

3.110)

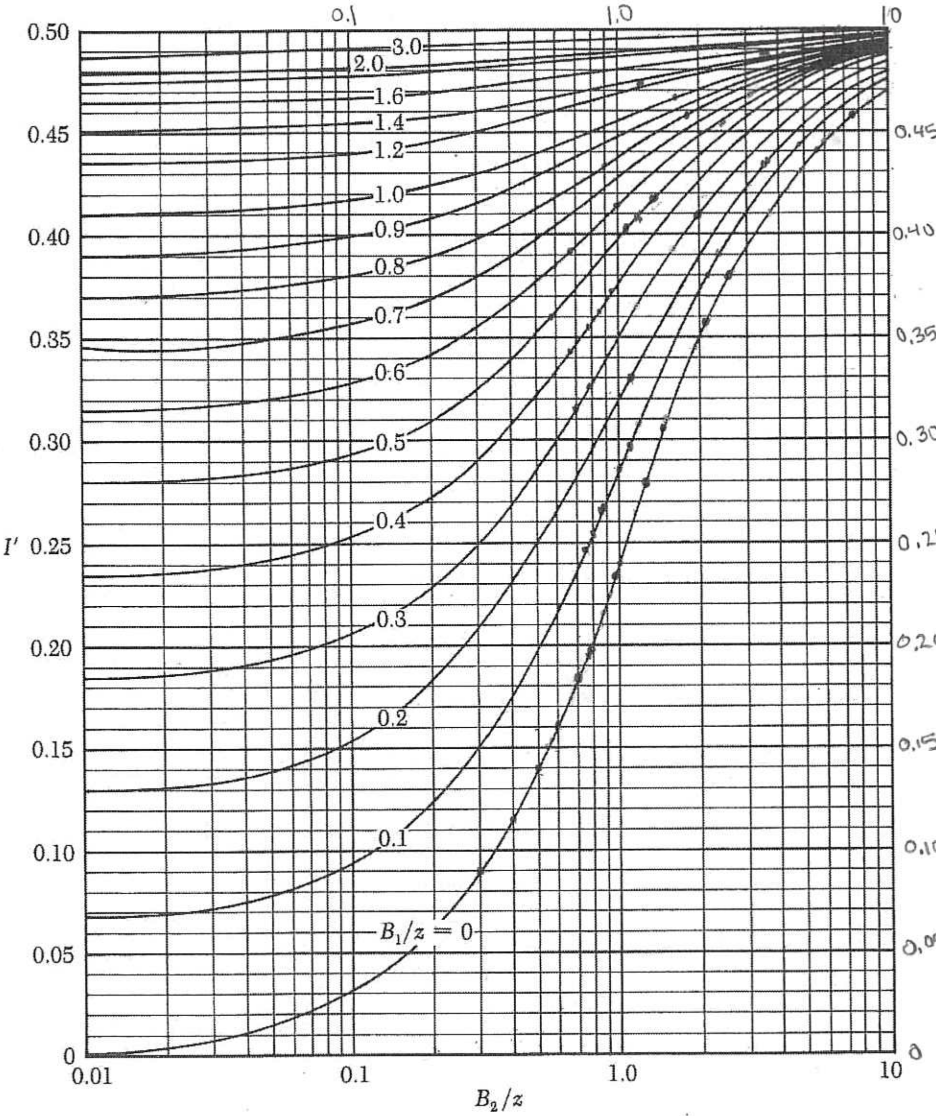
3.111)

For a detailed derivation of the equation, see Das (1983). A simplified form of Eq. (1.109) is

$$\Delta p = q_o I' \tag{3.112}$$

where I' = a function of B_1/z and B_2/z.

The variation of I' with B_1/z and B_2/z is shown in Figure 3.44. Application of this diagram is shown in Example 3.12 on page 204.



▼ **FIGURE 3.44** Influence value of I' for embankment loading (after Osterberg, 1957)

Principles of Foundation Engineering, Third Ed., Braja M. Das.

Project Name: WOO-75-29.93, PID 119007
Project Number: 230574
Calculated by: KCH 7/12/2023

Embankment Parameters

Height		Pressure @ 140 pcf	
24	feet	3360 psf	1.68 tsf
26	feet	3640 psf	1.82 tsf
			0.14 tsf, new pressure

Coefficient of Consolidation from NAVFAC Figure 4 (7.1-144)

Stratum	LL	Virgin Compression		Recompression		Average
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	C_v (ft^2/day)
I (low end LL)	20	>0.05	>0.5	>0.3	>2	0.4
I (high end LL)	44	0.00	0.2	0.0	1	
I (average LL)	35	0.00	0.4	0.0	2	
II (low end LL)	27	>0.05	>0.5	>0.3	>2	0.5
II (high end LL)	32	0.005	0.4	>0.3	>2	
II (average LL)	30	0.01	0.5	>0.3	>2	
III (low end LL)	27	>0.05	>0.5	>0.3	>2	0.5
III (high end LL)	32	0.00	0.4	>0.3	>2	
III (average LL)	30	0.01	0.5	>0.3	>2	
IV (low end LL)	23	>0.05	>0.5	>0.3	>2	>2
IV (high end LL)	23	>0.05	>0.5	>0.3	>2	
IV (average LL)	23	>0.05	>0.5	>0.3	>2	

Coefficient of Consolidation from Tested Values

Stratum	Pressure (tsf)	Virgin Compression		Recompression		Cv for 0.14 tsf
		C_v (cm^2/sec)	C_v (ft^2/day)	C_v (cm^2/sec)	C_v (ft^2/day)	
B-002 (ST-9)	0.25	-		-	1.968	1.10
Embankment Fill	0	-		-	0	
B-007 (ST-3)	0.25	-		-	0.057	0.03
Stratum II	0	-		-	0	
B-005 (ST-16)	0.25	-		-	0.011	0.006
Stratum III	0	-		-	0	

Project Nar WOO-75-29.93, PID 119007
Project Nu 230574
Calculated KCH 7/12/2023

Encountered Conditions

	Low H_{dr} (feet)	High H_{dr} (feet)
Embankment Fill layer thicknesses: >6.3, 14.3, 1.7, 1.7, 1.5, 2.5, 9.2	1.5	14.3
Stratum I layer thicknesses: 6, 3, 2, 5.5, 2.5, 3, 3.7, 1.8, 5.5	1.8	6
Stratum II layer thicknesses: 4.5, >11.5, 9, 21.5, 5, 2.5, 5, 2.5, 2.5, 3.3, 15.5, 2.5, 5, 5, >4	2.5	21.5
Stratum III layer thicknesses: 5, 4.5, 20.5, 10, 2.5, 6	2.5	20.5
Stratum IV layer thicknesses: 5, 10, 9.3, 5, 5	5	10

Assume double drainage between embankment fill and strata
Assume single drainage between Stratum IV & rock

Time for 90% Consolidation

$$t = \frac{T\,(H_{dr})^2}{C_v}$$

where T = 0.848 for 90% consolidation

Results Based on Low End H_{dr}

Stratum	From NAVFAC Cv Values		
	t (days)	t (weeks)	t (months)
EF	-	-	-
I	1.9	0.3	0.06
II	1.5	0.21	0.049
III	2.8	0.41	0.095
IV	10.6	1.51	0.353

Stratum	From Lab Cv Value			
	t (days)	t (weeks)	t (months)	
EF	0.4	0.1	0.0	
I	-	-	-	
II	41.5	5.9	1.4	
III	215.1	30.7	7.2	typically 2 to 3 months Toledo Area for full embankment
IV	-	-	-	

Project Nar WOO-75-29.93, PID 119007
Project Nui 230574
Calculated KCH 7/12/2023

Results Based on High End H_{dr}

Stratum	From NAVFAC Cv Values			
	t (days)	t (weeks)	t (months)	
EF	-	-	-	
I	20.8	3.0	0.69	
II	210.0	30.00	7.000	typically 2 to 3 months Toledo Area for full embankment
III	190.9	27.27	6.364	typically 2 to 3 months Toledo Area for full embankment
IV	42.4	6.06	1.413	

Stratum	From Lab Cv Value			
	t (days)	t (weeks)	t (months)	
EF	39.3	5.6	1.3	
I	-	-	-	
II	3070.1	438.6	102.3	2 years, too high
III	14463.1	2066.2	482.1	4 years, too high
IV	-	-	-	

Final Conclusions

Expect 1 to 30 weeks for 90% consolidation, likely toward the lower end of this range at about 1 to 6 weeks

Project Name: WOO-75-29.93, PID 119007

Project Number: 230574

Calculated by: KCH 8/21/2023

Consider Wick Drains

Assume trianular spacings such that H_{dr} = 1.05*s

Limiting layer is Stratum III, for which Cv = 0.5 ft^2/day

		From NAVFAC Cv Values		
s (feet)	**H_{dr} (feet)**	**t (days)**	**t (weeks)**	**t (months)**
15	15.75	112.7	16.1	3.8
14	14.7	98.2	14.0	3.3
13	13.65	84.6	12.1	2.8
12	12.6	72.1	10.3	2.4
11	11.55	60.6	8.7	2.0
10	10.5	50.1	7.2	1.7

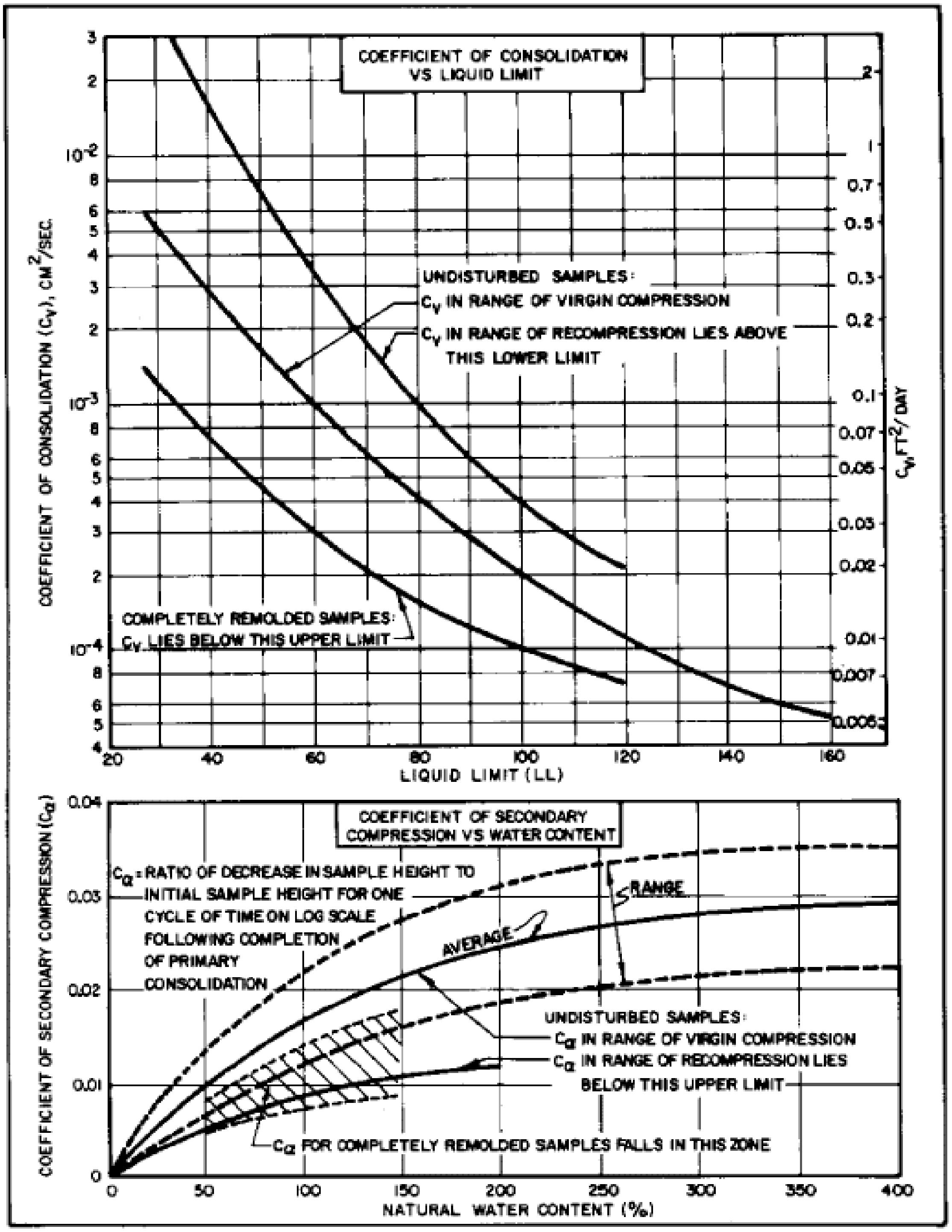


FIGURE 4
Approximate Correlations for Consolidation Characteristics
of Silts and Clays

From NAVFAC 7.1-144

Cohesive Fill

CF	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	18	15	30	9	7	22
N_{60}*250	4,580	3,750	7,500	2,250	1,659	22
UCS	6,169	6,169	9,942	2,395	3,774	2
HP	8,341	9,000	9,000	6,000	1,004	22
DD	124	124	125	122	1	2
Tot D	139	139	140	139	1	2
w	16	16	27	10	4	24
LL	32	33	44	19	8	11
PI	16	17	24	7	5	11

Cohesive Fill Use for design:

γ_{tot} = 140 pcf (rounded tested value - two shelby tubes)
c = 2000 psf (GDM Table 500-2)
c' = 200 psf (GDM Table 500-2)
phi' = 26 deg (GDM Table 500-2)

A-4a, A-6a, A-6b, and A-7-6
Various soil types so conservative values utilized.

Stratum I

1	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	15	15	21	6	4	13
N_{60}*250	3,731	3,750	5,250	1,500	1,012	13
UCS	-	-	-	-	-	0
HP	7,321	7,500	9,000	4,000	1,434	14
DD	110	110	110	110	-	1
Tot D	131	131	131	131	-	1
w	23	23	30	14	4	14
LL	35	36	44	20	9	9
PI	17	19	24	6	6	9

Native Cohesive Soils Use for design:

γ_{tot} = 130 pcf (rounded average of tested values)
c = 1750 psf (N60x125)

Estimated Pc = 1,913 psf (based on tested Stratum II Pc, less the overburden for 24 feet)
Cc = 0.226
Cr = 0.023
e_o = 0.62

Stratum II

2	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	21	18	34	12	7	36
N_{60}*250	5,160	4,500	8,500	3,000	1,654	36
UCS	3,440	3,382	5,030	1,966	1,161	4
HP	6,598	6,500	9,000	1,500	1,929	41
DD	114	118	118	105	5	5
Tot D	132	136	136	120	6	5
w	15	15	18	14	1	41
LL	30	30	32	27	2	10
PI	14	16	17	11	2	10

Native Cohesive Soils Use for design:

γ_{tot} = 130 pcf (rounded average of tested values)
c = 2500 psf (Average of N60x125, Qu/2, HP/2)

Estimated Pc = 5,200 psf (tested value)
Cc = 0.134
Cr = 0.021
e_o = 0.46

Stratum III

3	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	11	12	12	8	1	10
N_{60}*250	2,850	3,000	3,000	2,000	300	10
UCS	3,361	3,361	4,369	2,352	1,009	2
HP	3,955	4,000	6,000	2,000	1,157	11
DD	115	115	117	114	2	2
Tot D	135	135	138	132	3	2
w	18	17	25	16	2	12
LL	30	31	32	27	2	4
PI	15	15	17	11	3	4

UU: c = 1,050 psf

Native Cohesive Soils Use for design:

γ_{tot} = 135 pcf (rounded average of tested values)
c = 1050 psf (tested value, slightly lower than avg for N60x125, Qu/2, and HP/2)

Estimated Pc = 6,000 psf (tested value)
Cc = 0.115
Cr = 0.026
e_o = 0.45

Stratum IV

4	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	40	42	47	30	6	6
N_{60}*250	10,083	10,500	11,750	7,500	1,498	6
UCS	-	-	-	-	-	0
HP	9,000	9,000	9,000	9,000	-	7
DD	-	-	-	-	-	0
Tot D	-	-	-	-	-	0
w	14	15	17	8	3	8
LL	23	23	23	23	-	1
PI	11	11	11	11	-	1

c ≈ 10667 psf (by GDM 404.1; too high; use phi for hardpan for pile length estimates)

Native Cohesive Soils Use for design:

γ_{tot} = 132 pcf (GDM 405, Table 400-4)
c = 5000 psf (N60x125)
or phi = 36.6 deg (AASHTO LRFD Table 10.4.6.2.4-1, GDM Table 400-3)
Linear Inerpolate between avg phi values for N60 of 30 and 50, minus 2.5 degrees (A-4a)

Estimated Pc = 33,180 psf (based on c, PI)
Cc = 0.135
Cr = 0.014
e_o = 0.48

Granular Zone Above Rock

ZONE	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	39	39	39	39	-	1
N_{60}*250	9,750	9,750	9,750	9,750	-	1
UCS	-	-	-	-	-	0
HP	-	-	-	-	-	0
DD	-	-	-	-	-	0
Tot D	-	-	-	-	-	0
w	11	11	13	10	1	3
LL	-	-	-	-	-	0
PI	-	-	-	-	-	0

Native Granular Soils Use for design:

γ_{tot} = 130 pcf (GDM 405, Table 400-4)
phi = 39.4 deg (AASHTO LRFD Table 10.4.6.2.4-1, GDM Table 400-3)
Linear Inerpolate between avg phi values for N60 of 30 and 50, plus 0.5 degrees
A-3a and A-2-4 since predominantly A-2-4

Rock

ROCK	Average	Median	High	Low	Std Dev	Quantity
SPT N_{60}	-	-	-	-	-	0
N_{60}*250	-	-	-	-	-	0
UCS	-	-	-	-	-	0
HP	-	-	-	-	-	0
DD	158	158	158	158	-	1
Tot D	158	158	158	158	-	1
w	6	6	12	0	6	2
LL	-	-	-	-	-	0
PI	-	-	-	-	-	0

Filename: T:\GEOTECH\DRIVEN\230574\B-003.DVN

Pier 1
B-003
HP10x42

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230574\B-003.DVN
Project Name: WOO-75-29.93 PID 119007 Project Date: 07/18/2023
Project Client: ODOT District 2
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 8.90 ft ← Pier 1 Pile Cap Elev. 618.50 (8.9 feet)
Perimeter Analysis: Box
Tip Analysis: Box Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.80 ft
	- Driving/Restrike	13.80 ft
	- Ultimate:	13.80 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	140.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	5.00 ft	0.00%	130.00 pcf	1750.00 psf	T-79 Steel
3	Cohesive	30.50 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	8.50 ft	0.00%	135.00 pcf	1050.00 psf	T-79 Steel
5	Cohesionless	15.00 ft	0.00%	132.00 pcf	36.6/36.6	Nordlund
6	Cohesionless	3.00 ft	0.00%	130.00 pcf	39.4/39.4	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	1010.51 psf	0.00 Kips
17.01 ft	Cohesive	N/A	N/A	1179.55 psf	31.53 Kips
26.01 ft	Cohesive	N/A	N/A	1367.14 psf	77.10 Kips
35.01 ft	Cohesive	N/A	N/A	1525.00 psf	131.23 Kips
38.49 ft	Cohesive	N/A	N/A	1525.00 psf	148.72 Kips
38.51 ft	Cohesive	N/A	N/A	984.50 psf	148.81 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	176.32 Kips
47.01 ft	Cohesionless	4111.17 psf	26.83	N/A	176.42 Kips
56.01 ft	Cohesionless	4424.37 psf	26.83	N/A	243.22 Kips
61.99 ft	Cohesionless	4632.47 psf	26.83	N/A	292.83 Kips
62.01 ft	Cohesionless	5155.16 psf	28.88	N/A	293.03 Kips
64.99 ft	Cohesionless	5255.88 psf	28.88	N/A	326.68 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
38.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
47.01 ft	Cohesionless	4111.52 psf	85.76	124.11 Kips	124.11 Kips
56.01 ft	Cohesionless	4737.92 psf	85.76	124.11 Kips	124.11 Kips
61.99 ft	Cohesionless	5154.12 psf	85.76	124.11 Kips	124.11 Kips
62.01 ft	Cohesionless	5155.50 psf	145.12	251.30 Kips	251.30 Kips
64.99 ft	Cohesionless	5356.94 psf	145.12	251.30 Kips	251.30 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.89 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.90 ft	0.00 Kips	15.27 Kips	15.27 Kips
17.01 ft	31.53 Kips	15.27 Kips	46.80 Kips
26.01 ft	77.10 Kips	15.27 Kips	92.37 Kips
35.01 ft	131.23 Kips	15.27 Kips	146.50 Kips
38.49 ft	148.72 Kips	15.27 Kips	163.99 Kips
38.51 ft	148.81 Kips	6.41 Kips	155.22 Kips
46.99 ft	176.32 Kips	6.41 Kips	182.74 Kips
47.01 ft	176.42 Kips	124.11 Kips	300.53 Kips
56.01 ft	243.22 Kips	124.11 Kips	367.33 Kips
61.99 ft	292.83 Kips	124.11 Kips	416.94 Kips
62.01 ft	293.03 Kips	251.30 Kips	544.32 Kips
64.99 ft	326.68 Kips	251.30 Kips	577.97 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	1010.51 psf	0.00 Kips
17.01 ft	Cohesive	N/A	N/A	1179.55 psf	31.53 Kips
26.01 ft	Cohesive	N/A	N/A	1367.14 psf	77.10 Kips
35.01 ft	Cohesive	N/A	N/A	1525.00 psf	131.23 Kips
38.49 ft	Cohesive	N/A	N/A	1525.00 psf	148.72 Kips
38.51 ft	Cohesive	N/A	N/A	984.50 psf	148.81 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	176.32 Kips
47.01 ft	Cohesionless	4111.17 psf	26.83	N/A	176.42 Kips
56.01 ft	Cohesionless	4424.37 psf	26.83	N/A	243.22 Kips
61.99 ft	Cohesionless	4632.47 psf	26.83	N/A	292.83 Kips
62.01 ft	Cohesionless	5155.16 psf	28.88	N/A	293.03 Kips
64.99 ft	Cohesionless	5255.88 psf	28.88	N/A	326.68 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
38.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
47.01 ft	Cohesionless	4111.52 psf	85.76	124.11 Kips	124.11 Kips
56.01 ft	Cohesionless	4737.92 psf	85.76	124.11 Kips	124.11 Kips
61.99 ft	Cohesionless	5154.12 psf	85.76	124.11 Kips	124.11 Kips
62.01 ft	Cohesionless	5155.50 psf	145.12	251.30 Kips	251.30 Kips
64.99 ft	Cohesionless	5356.94 psf	145.12	251.30 Kips	251.30 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.89 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.90 ft	0.00 Kips	15.27 Kips	15.27 Kips
17.01 ft	31.53 Kips	15.27 Kips	46.80 Kips
26.01 ft	77.10 Kips	15.27 Kips	92.37 Kips
35.01 ft	131.23 Kips	15.27 Kips	146.50 Kips
38.49 ft	148.72 Kips	15.27 Kips	163.99 Kips
38.51 ft	148.81 Kips	6.41 Kips	155.22 Kips
46.99 ft	176.32 Kips	6.41 Kips	182.74 Kips
47.01 ft	176.42 Kips	124.11 Kips	300.53 Kips
56.01 ft	243.22 Kips	124.11 Kips	367.33 Kips
61.99 ft	292.83 Kips	124.11 Kips	416.94 Kips
62.01 ft	293.03 Kips	251.30 Kips	544.32 Kips
64.99 ft	326.68 Kips	251.30 Kips	577.97 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	1010.51 psf	0.00 Kips
17.01 ft	Cohesive	N/A	N/A	1179.55 psf	31.53 Kips
26.01 ft	Cohesive	N/A	N/A	1367.14 psf	77.10 Kips
35.01 ft	Cohesive	N/A	N/A	1525.00 psf	131.23 Kips
38.49 ft	Cohesive	N/A	N/A	1525.00 psf	148.72 Kips
38.51 ft	Cohesive	N/A	N/A	984.50 psf	148.81 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	176.32 Kips
47.01 ft	Cohesionless	4111.17 psf	26.83	N/A	176.42 Kips
56.01 ft	Cohesionless	4424.37 psf	26.83	N/A	243.22 Kips
61.99 ft	Cohesionless	4632.47 psf	26.83	N/A	292.83 Kips
62.01 ft	Cohesionless	5155.16 psf	28.88	N/A	293.03 Kips
64.99 ft	Cohesionless	5255.88 psf	28.88	N/A	326.68 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
38.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
47.01 ft	Cohesionless	4111.52 psf	85.76	124.11 Kips	124.11 Kips
56.01 ft	Cohesionless	4737.92 psf	85.76	124.11 Kips	124.11 Kips
61.99 ft	Cohesionless	5154.12 psf	85.76	124.11 Kips	124.11 Kips
62.01 ft	Cohesionless	5155.50 psf	145.12	251.30 Kips	251.30 Kips
64.99 ft	Cohesionless	5356.94 psf	145.12	251.30 Kips	251.30 Kips

GSE = 627.4

ULTIMATE - SUMMARY OF CAPACITIES

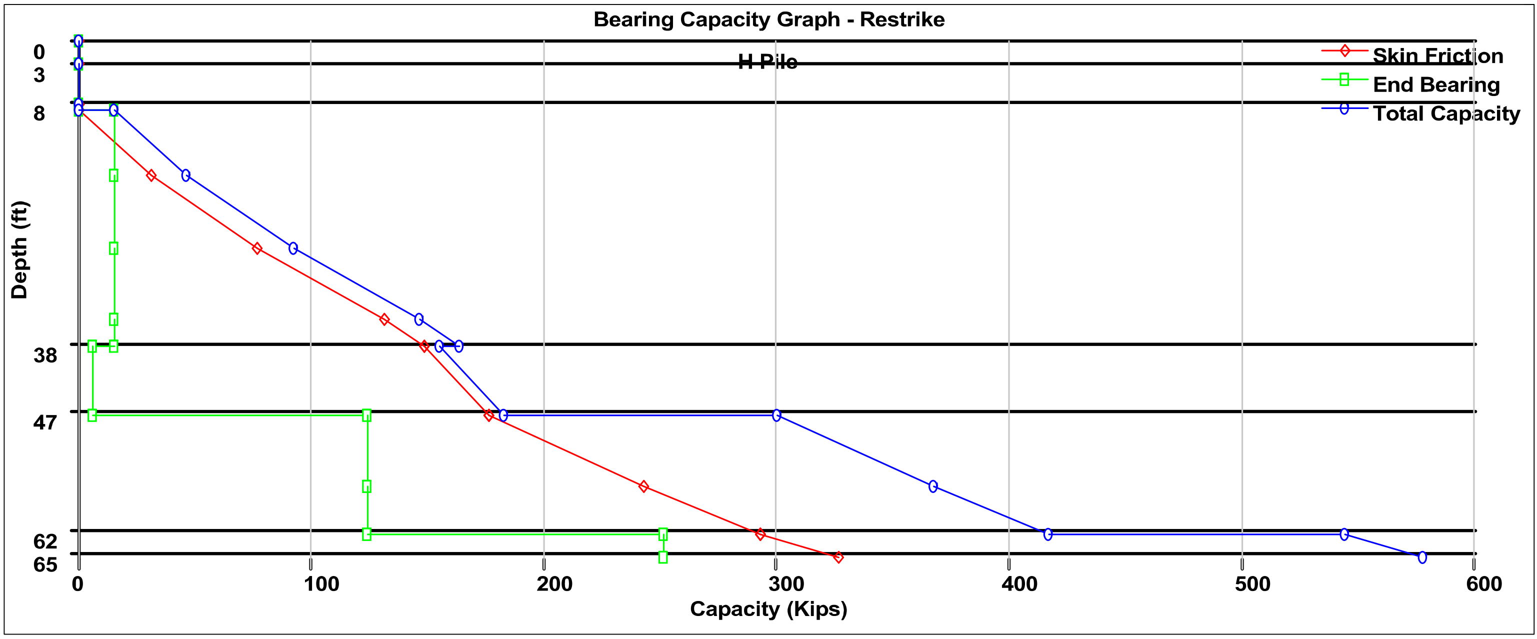
Pier 1
B-003
HP10x42

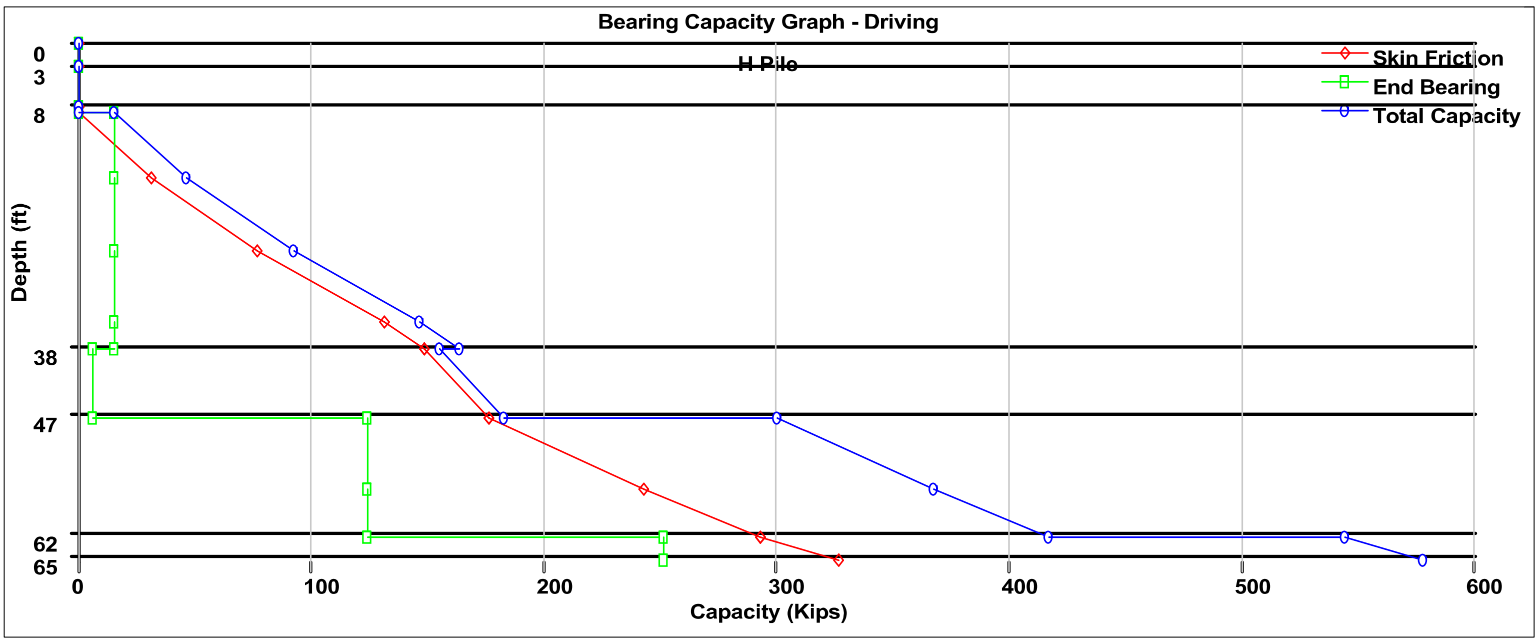
Depth		Skin Friction	End Bearing	Total Capacity
0.01 ft	Embankment Fill	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	Stratum I Lac	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	Stratum II Till	0.00 Kips	0.00 Kips	0.00 Kips
8.89 ft		0.00 Kips	0.00 Kips	0.00 Kips
8.90 ft		0.00 Kips	15.27 Kips	15.27 Kips
17.01 ft		31.53 Kips	15.27 Kips	46.80 Kips
26.01 ft		77.10 Kips	15.27 Kips	92.37 Kips
35.01 ft		131.23 Kips	15.27 Kips	146.50 Kips
38.49 ft		148.72 Kips	15.27 Kips	163.99 Kips
38.51 ft	Stratum III Till	148.81 Kips	6.41 Kips	155.22 Kips
46.99 ft		176.32 Kips	6.41 Kips	182.74 Kips
47.01 ft	Stratum IV Hardpan	176.42 Kips	124.11 Kips	300.53 Kips
56.01 ft		243.22 Kips	124.11 Kips	367.33 Kips
61.99 ft		292.83 Kips	124.11 Kips	416.94 Kips
62.01 ft	Dense Granular	293.03 Kips	251.30 Kips	544.32 Kips
64.99 ft		326.68 Kips	251.30 Kips	577.97 Kips

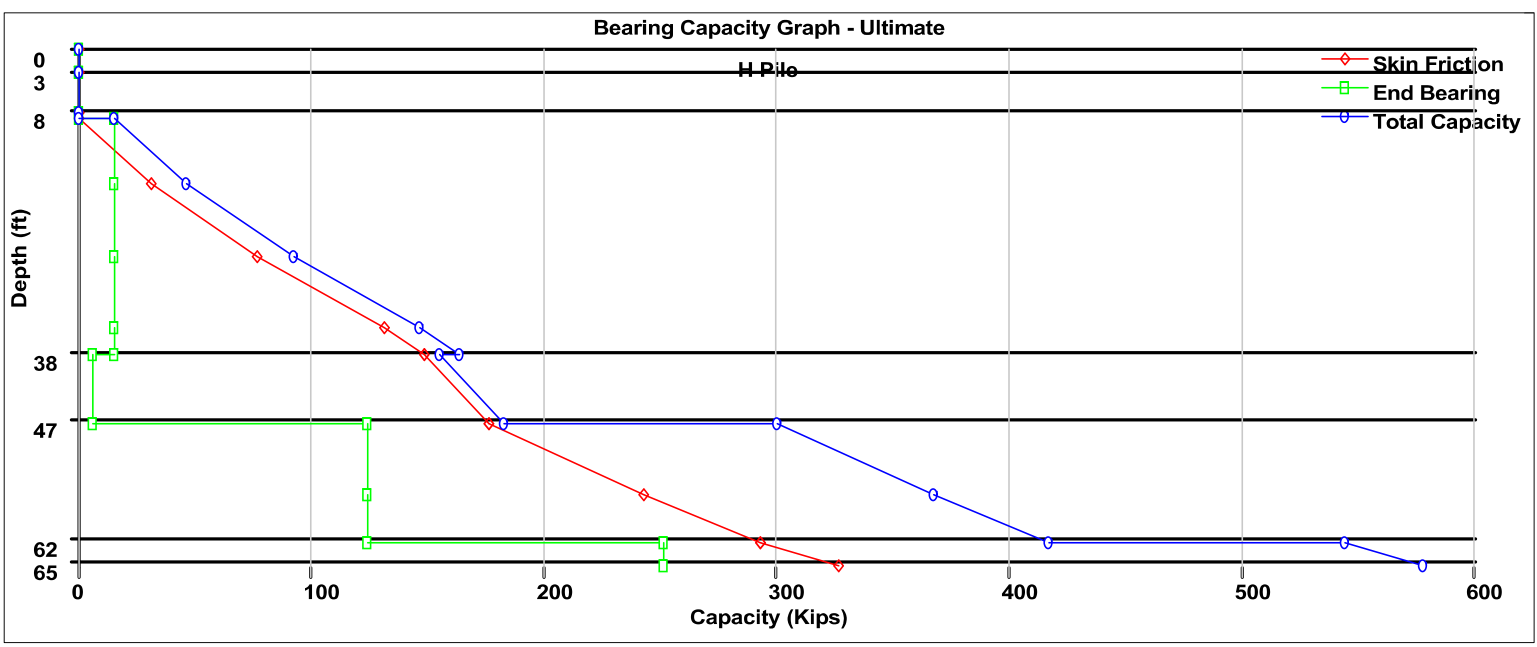
180 K at 46.1 feet

Settlement due to new embankment <0.4" for any one layer so no downdrag
Design Load: 45 tons = 90 kips
For FOS = 2, Ult = 180 kips

See spreadsheet attachment for calculation of pile Tip Elevation, Est. Length, and Order Length.


Bearing Capacity Graph - Restrike
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
8
38
47
62
65
0
100
200
300
400
500
600
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
8
38
47
62
65
0
100
200
300
400
500
600
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
8
38
47
62
65
0
100
200
300
400
500
600
Capacity (Kips)

Pier 1
B-003
HP12x53

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230574\B-003.DVN
Project Name: WOO-75-29.93 PID 119007 Project Date: 07/18/2023
Project Client: ODOT District 2
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 8.90 ft ← Pier 1 Pile Cap Elev. 618.50 (8.9 feet)
Perimeter Analysis: Box
Tip Analysis: Box Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.80 ft
	- Driving/Restrike	13.80 ft
	- Ultimate:	13.80 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	140.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	5.00 ft	0.00%	130.00 pcf	1750.00 psf	T-79 Steel
3	Cohesive	30.50 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	8.50 ft	0.00%	135.00 pcf	1050.00 psf	T-79 Steel
5	Cohesionless	15.00 ft	0.00%	132.00 pcf	36.6/36.6	Nordlund
6	Cohesionless	3.00 ft	0.00%	130.00 pcf	39.4/39.4	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	1000.00 psf	0.00 Kips
17.01 ft	Cohesive	N/A	N/A	1121.56 psf	36.12 Kips
26.01 ft	Cohesive	N/A	N/A	1278.47 psf	86.86 Kips
35.01 ft	Cohesive	N/A	N/A	1435.39 psf	148.82 Kips
38.49 ft	Cohesive	N/A	N/A	1496.06 psf	175.78 Kips
38.51 ft	Cohesive	N/A	N/A	975.87 psf	175.90 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	209.05 Kips
47.01 ft	Cohesionless	4111.17 psf	27.56	N/A	209.18 Kips
56.01 ft	Cohesionless	4424.37 psf	27.56	N/A	295.00 Kips
61.99 ft	Cohesionless	4632.47 psf	27.56	N/A	358.74 Kips
62.01 ft	Cohesionless	5155.16 psf	29.67	N/A	358.99 Kips
64.99 ft	Cohesionless	5255.88 psf	29.67	N/A	402.51 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
38.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
47.01 ft	Cohesionless	4111.52 psf	85.76	180.19 Kips	180.19 Kips
56.01 ft	Cohesionless	4737.92 psf	85.76	180.19 Kips	180.19 Kips
61.99 ft	Cohesionless	5154.12 psf	85.76	180.19 Kips	180.19 Kips
62.01 ft	Cohesionless	5155.50 psf	145.12	364.85 Kips	364.85 Kips
64.99 ft	Cohesionless	5356.94 psf	145.12	364.85 Kips	364.85 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.89 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.90 ft	0.00 Kips	22.17 Kips	22.17 Kips
17.01 ft	36.12 Kips	22.17 Kips	58.29 Kips
26.01 ft	86.86 Kips	22.17 Kips	109.03 Kips
35.01 ft	148.82 Kips	22.17 Kips	170.99 Kips
38.49 ft	175.78 Kips	22.17 Kips	197.95 Kips
38.51 ft	175.90 Kips	9.31 Kips	185.21 Kips
46.99 ft	209.05 Kips	9.31 Kips	218.36 Kips
47.01 ft	209.18 Kips	180.19 Kips	389.37 Kips
56.01 ft	295.00 Kips	180.19 Kips	475.19 Kips
61.99 ft	358.74 Kips	180.19 Kips	538.93 Kips
62.01 ft	358.99 Kips	364.85 Kips	723.84 Kips
64.99 ft	402.51 Kips	364.85 Kips	767.35 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	1000.00 psf	0.00 Kips
17.01 ft	Cohesive	N/A	N/A	1121.56 psf	36.12 Kips
26.01 ft	Cohesive	N/A	N/A	1278.47 psf	86.86 Kips
35.01 ft	Cohesive	N/A	N/A	1435.39 psf	148.82 Kips
38.49 ft	Cohesive	N/A	N/A	1496.06 psf	175.78 Kips
38.51 ft	Cohesive	N/A	N/A	975.87 psf	175.90 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	209.05 Kips
47.01 ft	Cohesionless	4111.17 psf	27.56	N/A	209.18 Kips
56.01 ft	Cohesionless	4424.37 psf	27.56	N/A	295.00 Kips
61.99 ft	Cohesionless	4632.47 psf	27.56	N/A	358.74 Kips
62.01 ft	Cohesionless	5155.16 psf	29.67	N/A	358.99 Kips
64.99 ft	Cohesionless	5255.88 psf	29.67	N/A	402.51 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
38.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
47.01 ft	Cohesionless	4111.52 psf	85.76	180.19 Kips	180.19 Kips
56.01 ft	Cohesionless	4737.92 psf	85.76	180.19 Kips	180.19 Kips
61.99 ft	Cohesionless	5154.12 psf	85.76	180.19 Kips	180.19 Kips
62.01 ft	Cohesionless	5155.50 psf	145.12	364.85 Kips	364.85 Kips
64.99 ft	Cohesionless	5356.94 psf	145.12	364.85 Kips	364.85 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.89 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.90 ft	0.00 Kips	22.17 Kips	22.17 Kips
17.01 ft	36.12 Kips	22.17 Kips	58.29 Kips
26.01 ft	86.86 Kips	22.17 Kips	109.03 Kips
35.01 ft	148.82 Kips	22.17 Kips	170.99 Kips
38.49 ft	175.78 Kips	22.17 Kips	197.95 Kips
38.51 ft	175.90 Kips	9.31 Kips	185.21 Kips
46.99 ft	209.05 Kips	9.31 Kips	218.36 Kips
47.01 ft	209.18 Kips	180.19 Kips	389.37 Kips
56.01 ft	295.00 Kips	180.19 Kips	475.19 Kips
61.99 ft	358.74 Kips	180.19 Kips	538.93 Kips
62.01 ft	358.99 Kips	364.85 Kips	723.84 Kips
64.99 ft	402.51 Kips	364.85 Kips	767.35 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	1000.00 psf	0.00 Kips
17.01 ft	Cohesive	N/A	N/A	1121.56 psf	36.12 Kips
26.01 ft	Cohesive	N/A	N/A	1278.47 psf	86.86 Kips
35.01 ft	Cohesive	N/A	N/A	1435.39 psf	148.82 Kips
38.49 ft	Cohesive	N/A	N/A	1496.06 psf	175.78 Kips
38.51 ft	Cohesive	N/A	N/A	975.87 psf	175.90 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	209.05 Kips
47.01 ft	Cohesionless	4111.17 psf	27.56	N/A	209.18 Kips
56.01 ft	Cohesionless	4424.37 psf	27.56	N/A	295.00 Kips
61.99 ft	Cohesionless	4632.47 psf	27.56	N/A	358.74 Kips
62.01 ft	Cohesionless	5155.16 psf	29.67	N/A	358.99 Kips
64.99 ft	Cohesionless	5255.88 psf	29.67	N/A	402.51 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.89 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
8.90 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
17.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
26.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
35.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
38.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
38.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
47.01 ft	Cohesionless	4111.52 psf	85.76	180.19 Kips	180.19 Kips
56.01 ft	Cohesionless	4737.92 psf	85.76	180.19 Kips	180.19 Kips
61.99 ft	Cohesionless	5154.12 psf	85.76	180.19 Kips	180.19 Kips
62.01 ft	Cohesionless	5155.50 psf	145.12	364.85 Kips	364.85 Kips
64.99 ft	Cohesionless	5356.94 psf	145.12	364.85 Kips	364.85 Kips

ULTIMATE - SUMMARY OF CAPACITIES

GSE = 627.4

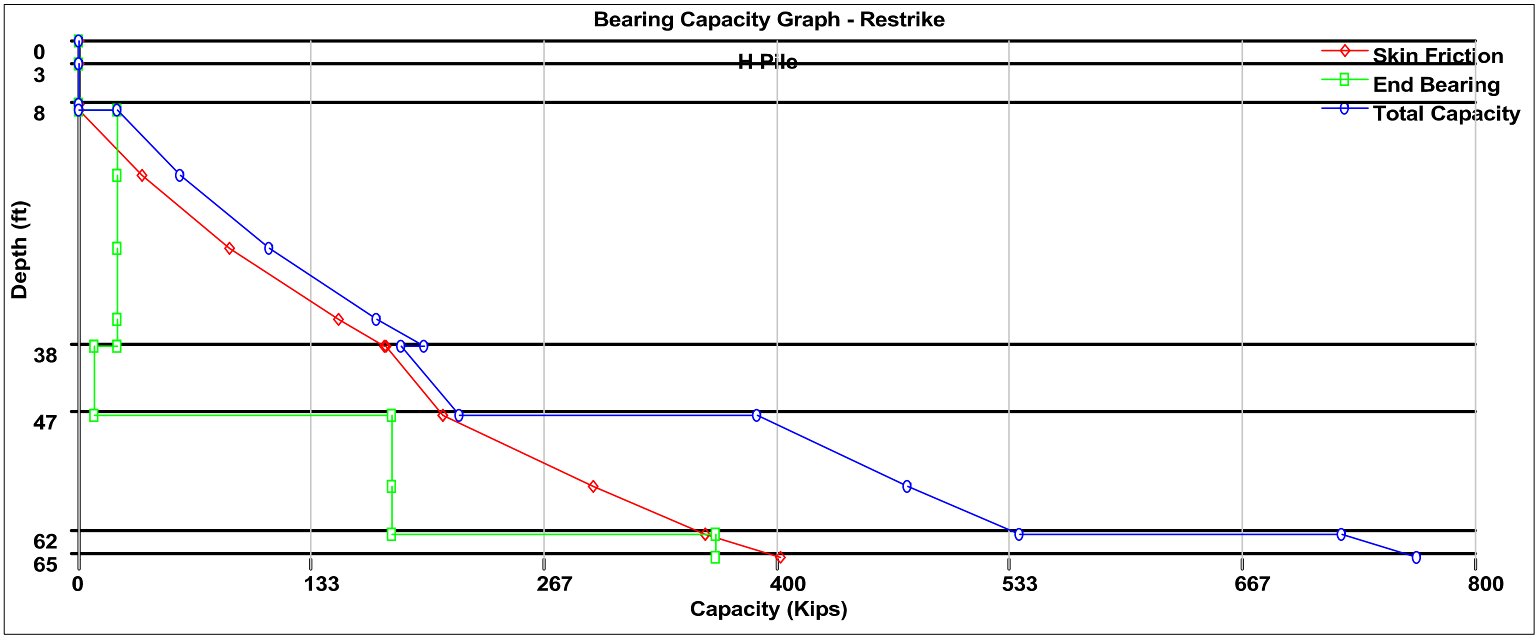
Pier 1
B-003
HP12x53

Depth		Skin Friction	End Bearing	Total Capacity
0.01 ft	Embankment Fill	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	Stratum I Lac	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
8.01 ft		0.00 Kips	0.00 Kips	0.00 Kips
8.89 ft		0.00 Kips	0.00 Kips	0.00 Kips
8.90 ft	Stratum II Till	0.00 Kips	22.17 Kips	22.17 Kips
17.01 ft		36.12 Kips	22.17 Kips	58.29 Kips
26.01 ft		86.86 Kips	22.17 Kips	109.03 Kips
35.01 ft		148.82 Kips	22.17 Kips	170.99 Kips
38.49 ft		175.78 Kips	22.17 Kips	197.95 Kips
38.51 ft	Stratum III Till	175.90 Kips	9.31 Kips	185.21 Kips
46.99 ft		209.05 Kips	9.31 Kips	218.36 Kips
47.01 ft	Stratum IV Hardpan	209.18 Kips	180.19 Kips	389.37 Kips
56.01 ft		295.00 Kips	180.19 Kips	475.19 Kips
61.99 ft		358.74 Kips	180.19 Kips	538.93 Kips
62.01 ft	Dense Granular	358.99 Kips	364.85 Kips	723.84 Kips
64.99 ft		402.51 Kips	364.85 Kips	767.35 Kips

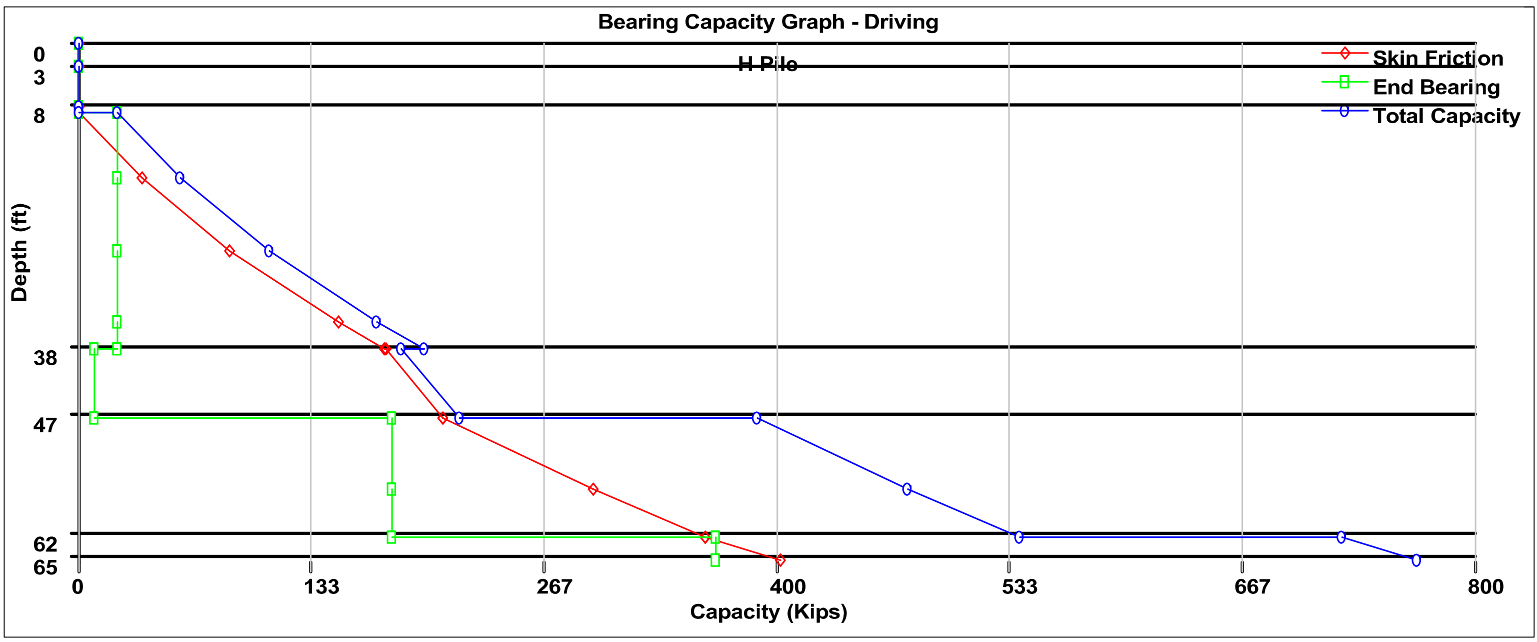
180 K at 36.2 feet

Settlement due to new embankment <0.4" for any one layer so no downdrag
Design Load: 45 tons = 90 kips
For FOS = 2, Ult = 180 kips

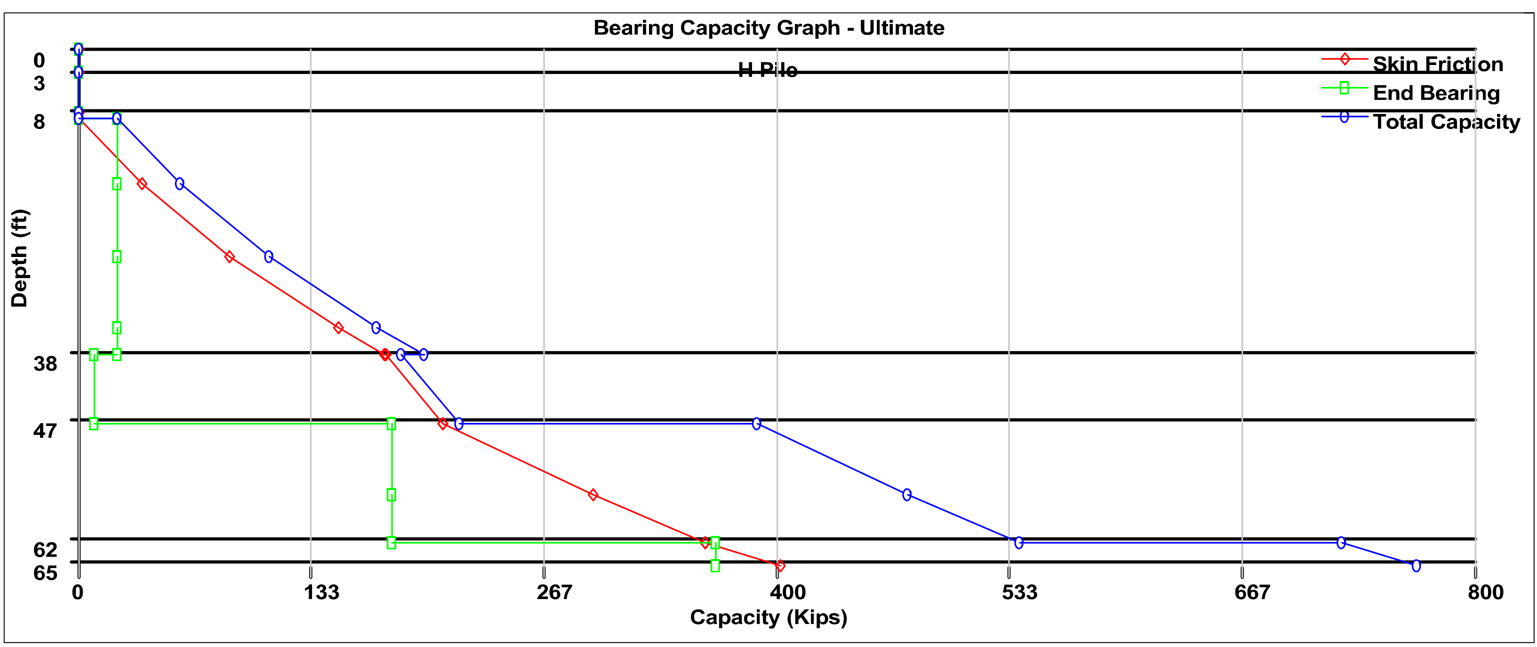
See spreadsheet attachment for calculation of pile Tip Elevation, Est. Length, and Order Length.



Bearing Capacity Graph - Restrike
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
8
38
47
62
65
0
133
267
400
533
667
800
Capacity (Kips)

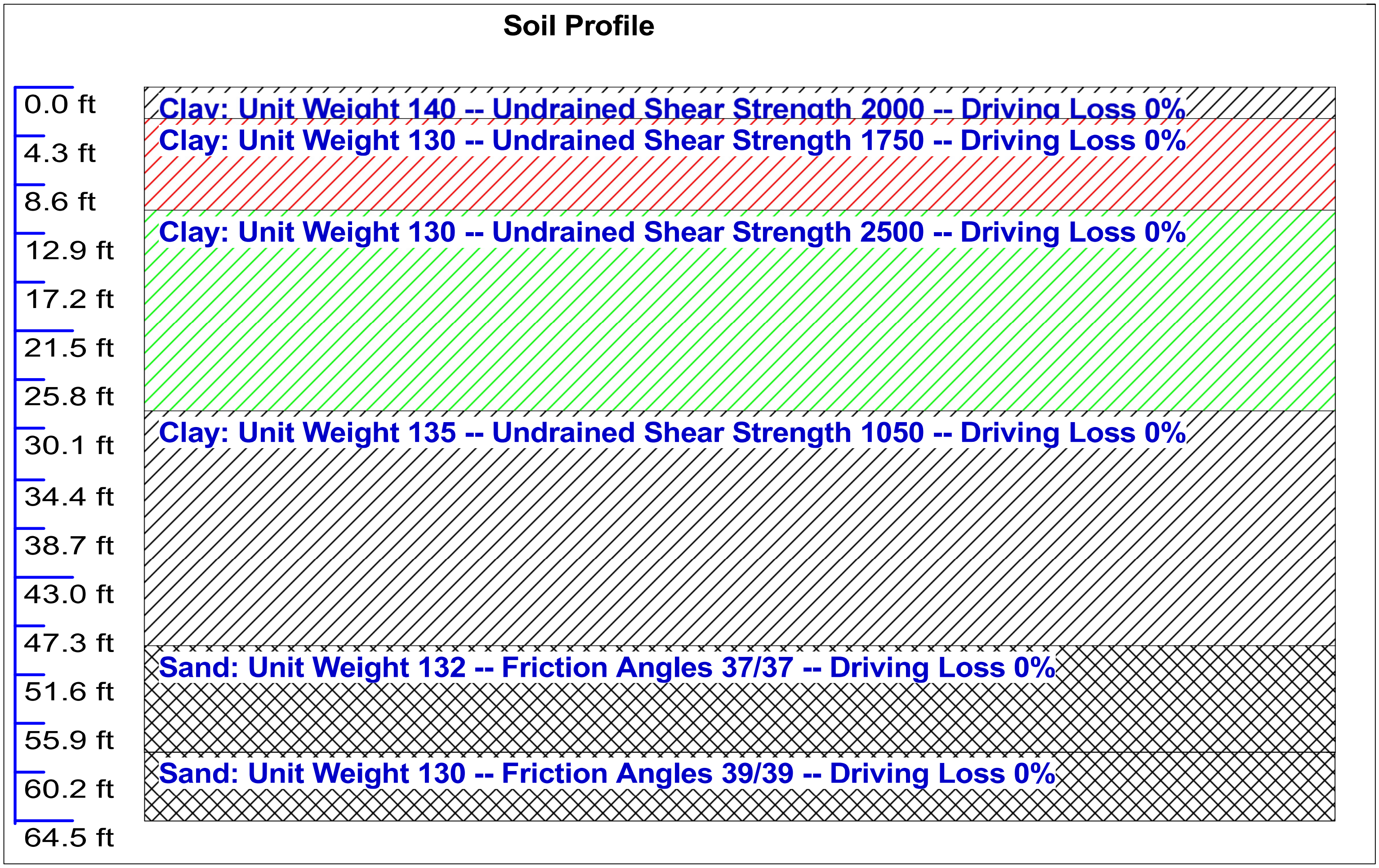


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
8
38
47
62
65
0
133
267
400
533
667
800
Capacity (Kips)



Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
8
38
47
62
65
0
133
267
400
533
667
800
Capacity (Kips)

Filename: T:\GEOTECH\DRIVEN\230574\B-004.DVN



Pier 2
B-004
HP10x42

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230574\B-004.DVN
Project Name: WOO-75-29.93 PID 119007 Project Date: 07/18/2023
Project Client: ODOT District 2
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 7.40 ft ← Pier 2 Pile Cap Elev. 624.0 (7.4 feet)
Perimeter Analysis: Box
Tip Analysis: Box Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	16.00 ft
	- Driving/Restrike	16.00 ft
	- Ultimate:	16.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	140.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	8.00 ft	0.00%	130.00 pcf	1750.00 psf	T-79 Steel
3	Cohesive	17.50 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	20.50 ft	0.00%	135.00 pcf	1050.00 psf	T-79 Steel
5	Cohesionless	9.30 ft	0.00%	132.00 pcf	36.6/36.6	Nordlund
6	Cohesionless	6.20 ft	0.00%	130.00 pcf	39.4/39.4	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	1169.87 psf	13.84 Kips
11.01 ft	Cohesive	N/A	N/A	1054.49 psf	13.92 Kips
20.01 ft	Cohesive	N/A	N/A	1242.08 psf	50.77 Kips
28.49 ft	Cohesive	N/A	N/A	1418.84 psf	95.67 Kips
28.51 ft	Cohesive	N/A	N/A	952.57 psf	95.76 Kips
37.51 ft	Cohesive	N/A	N/A	984.50 psf	124.96 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	154.17 Kips
48.99 ft	Cohesive	N/A	N/A	984.50 psf	162.21 Kips
49.01 ft	Cohesionless	4443.65 psf	26.83	N/A	162.32 Kips
58.01 ft	Cohesionless	4756.85 psf	26.83	N/A	234.14 Kips
58.29 ft	Cohesionless	4766.59 psf	26.83	N/A	236.52 Kips
58.31 ft	Cohesionless	5090.92 psf	28.88	N/A	236.72 Kips
64.49 ft	Cohesionless	5299.80 psf	28.88	N/A	307.08 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	N/A	10.69 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	10.69 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
48.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
49.01 ft	Cohesionless	4444.00 psf	85.76	124.11 Kips	124.11 Kips
58.01 ft	Cohesionless	5070.40 psf	85.76	124.11 Kips	124.11 Kips
58.29 ft	Cohesionless	5089.88 psf	85.76	124.11 Kips	124.11 Kips
58.31 ft	Cohesionless	5091.26 psf	145.12	251.30 Kips	251.30 Kips
64.49 ft	Cohesionless	5509.02 psf	145.12	251.30 Kips	251.30 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.40 ft	0.00 Kips	10.69 Kips	10.69 Kips
10.99 ft	13.84 Kips	10.69 Kips	24.53 Kips
11.01 ft	13.92 Kips	15.27 Kips	29.19 Kips
20.01 ft	50.77 Kips	15.27 Kips	66.04 Kips
28.49 ft	95.67 Kips	15.27 Kips	110.94 Kips
28.51 ft	95.76 Kips	6.41 Kips	102.17 Kips
37.51 ft	124.96 Kips	6.41 Kips	131.38 Kips
46.51 ft	154.17 Kips	6.41 Kips	160.58 Kips
48.99 ft	162.21 Kips	6.41 Kips	168.63 Kips
49.01 ft	162.32 Kips	124.11 Kips	286.43 Kips
58.01 ft	234.14 Kips	124.11 Kips	358.25 Kips
58.29 ft	236.52 Kips	124.11 Kips	360.63 Kips
58.31 ft	236.72 Kips	251.30 Kips	488.01 Kips
64.49 ft	307.08 Kips	251.30 Kips	558.38 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	1169.87 psf	13.84 Kips
11.01 ft	Cohesive	N/A	N/A	1054.49 psf	13.92 Kips
20.01 ft	Cohesive	N/A	N/A	1242.08 psf	50.77 Kips
28.49 ft	Cohesive	N/A	N/A	1418.84 psf	95.67 Kips
28.51 ft	Cohesive	N/A	N/A	952.57 psf	95.76 Kips
37.51 ft	Cohesive	N/A	N/A	984.50 psf	124.96 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	154.17 Kips
48.99 ft	Cohesive	N/A	N/A	984.50 psf	162.21 Kips
49.01 ft	Cohesionless	4443.65 psf	26.83	N/A	162.32 Kips
58.01 ft	Cohesionless	4756.85 psf	26.83	N/A	234.14 Kips
58.29 ft	Cohesionless	4766.59 psf	26.83	N/A	236.52 Kips
58.31 ft	Cohesionless	5090.92 psf	28.88	N/A	236.72 Kips
64.49 ft	Cohesionless	5299.80 psf	28.88	N/A	307.08 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	N/A	10.69 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	10.69 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
48.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
49.01 ft	Cohesionless	4444.00 psf	85.76	124.11 Kips	124.11 Kips
58.01 ft	Cohesionless	5070.40 psf	85.76	124.11 Kips	124.11 Kips
58.29 ft	Cohesionless	5089.88 psf	85.76	124.11 Kips	124.11 Kips
58.31 ft	Cohesionless	5091.26 psf	145.12	251.30 Kips	251.30 Kips
64.49 ft	Cohesionless	5509.02 psf	145.12	251.30 Kips	251.30 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.40 ft	0.00 Kips	10.69 Kips	10.69 Kips
10.99 ft	13.84 Kips	10.69 Kips	24.53 Kips
11.01 ft	13.92 Kips	15.27 Kips	29.19 Kips
20.01 ft	50.77 Kips	15.27 Kips	66.04 Kips
28.49 ft	95.67 Kips	15.27 Kips	110.94 Kips
28.51 ft	95.76 Kips	6.41 Kips	102.17 Kips
37.51 ft	124.96 Kips	6.41 Kips	131.38 Kips
46.51 ft	154.17 Kips	6.41 Kips	160.58 Kips
48.99 ft	162.21 Kips	6.41 Kips	168.63 Kips
49.01 ft	162.32 Kips	124.11 Kips	286.43 Kips
58.01 ft	234.14 Kips	124.11 Kips	358.25 Kips
58.29 ft	236.52 Kips	124.11 Kips	360.63 Kips
58.31 ft	236.72 Kips	251.30 Kips	488.01 Kips
64.49 ft	307.08 Kips	251.30 Kips	558.38 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	1169.87 psf	13.84 Kips
11.01 ft	Cohesive	N/A	N/A	1054.49 psf	13.92 Kips
20.01 ft	Cohesive	N/A	N/A	1242.08 psf	50.77 Kips
28.49 ft	Cohesive	N/A	N/A	1418.84 psf	95.67 Kips
28.51 ft	Cohesive	N/A	N/A	952.57 psf	95.76 Kips
37.51 ft	Cohesive	N/A	N/A	984.50 psf	124.96 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	154.17 Kips
48.99 ft	Cohesive	N/A	N/A	984.50 psf	162.21 Kips
49.01 ft	Cohesionless	4443.65 psf	26.83	N/A	162.32 Kips
58.01 ft	Cohesionless	4756.85 psf	26.83	N/A	234.14 Kips
58.29 ft	Cohesionless	4766.59 psf	26.83	N/A	236.52 Kips
58.31 ft	Cohesionless	5090.92 psf	28.88	N/A	236.72 Kips
64.49 ft	Cohesionless	5299.80 psf	28.88	N/A	307.08 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	N/A	10.69 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	10.69 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
48.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
49.01 ft	Cohesionless	4444.00 psf	85.76	124.11 Kips	124.11 Kips
58.01 ft	Cohesionless	5070.40 psf	85.76	124.11 Kips	124.11 Kips
58.29 ft	Cohesionless	5089.88 psf	85.76	124.11 Kips	124.11 Kips
58.31 ft	Cohesionless	5091.26 psf	145.12	251.30 Kips	251.30 Kips
64.49 ft	Cohesionless	5509.02 psf	145.12	251.30 Kips	251.30 Kips

GSE = 631.4

ULTIMATE - SUMMARY OF CAPACITIES

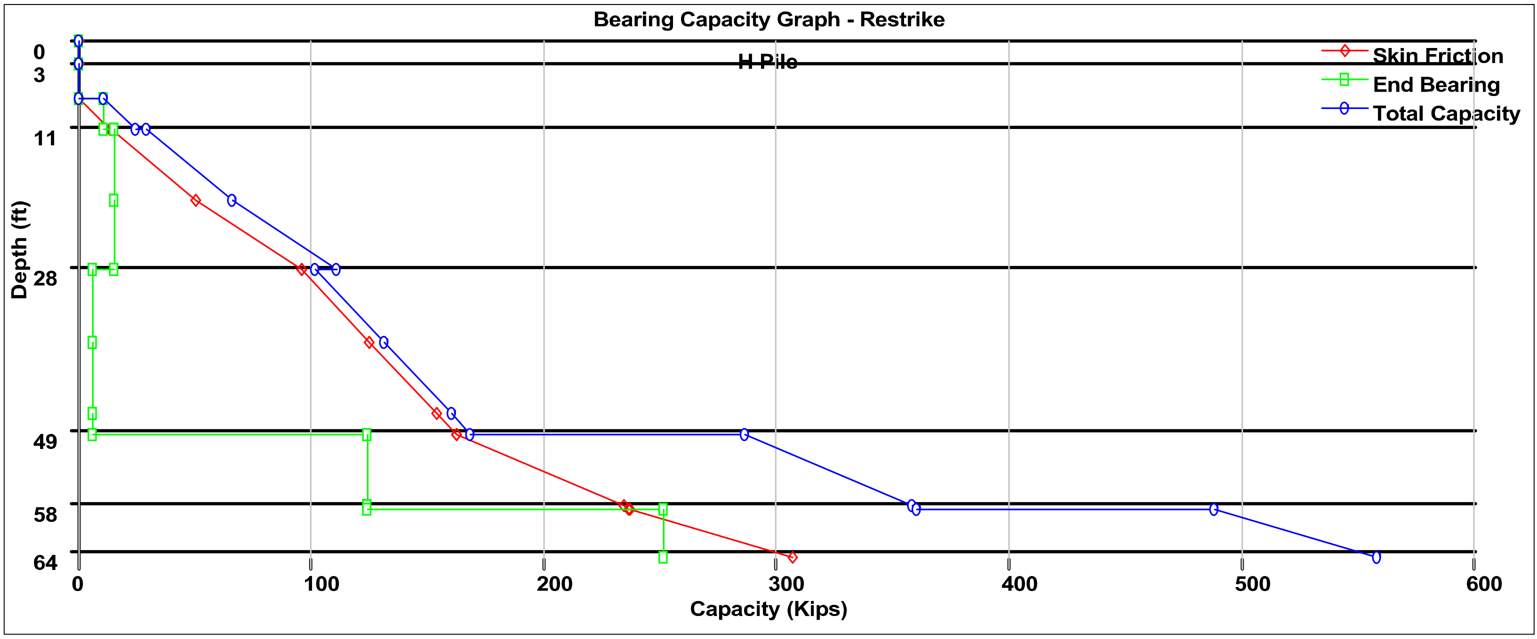
Pier 2
B-004
HP10x42

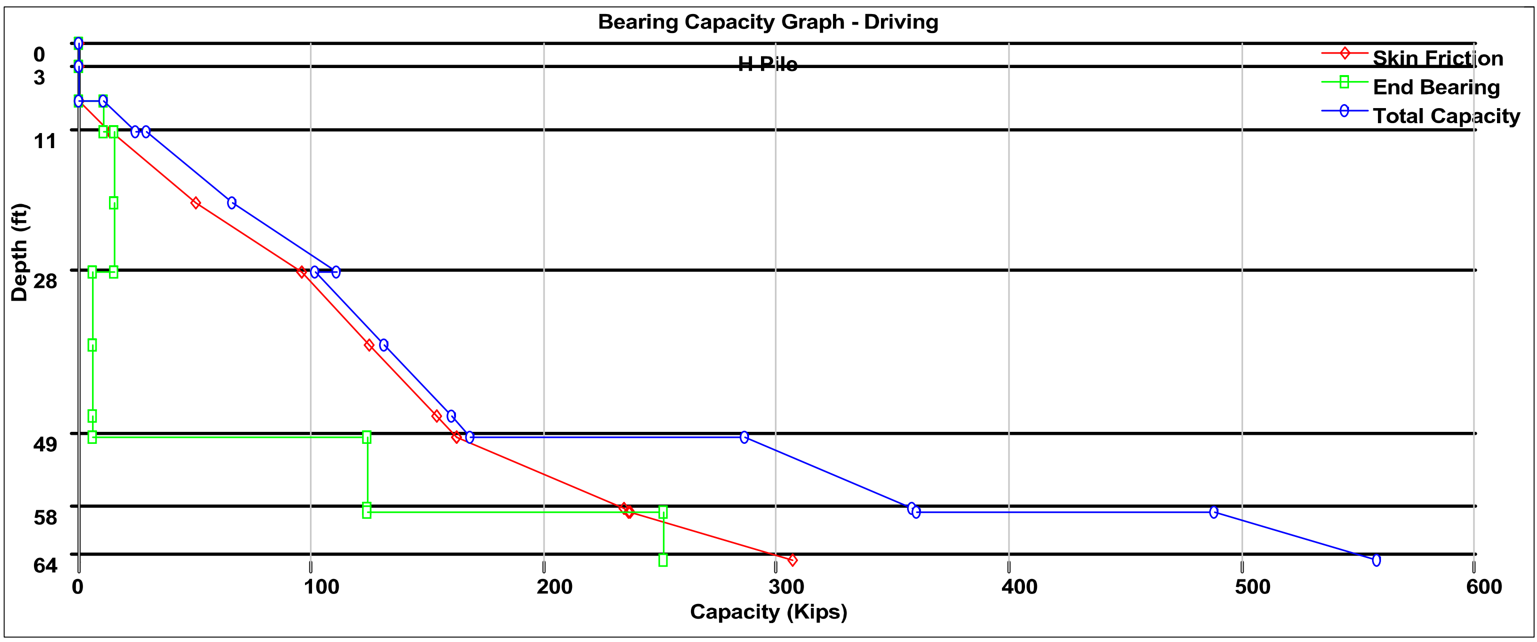
Depth	Stratum	Skin Friction	End Bearing	Total Capacity
0.01 ft	Embankment Fill	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	Stratum I Lac	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft		0.00 Kips	0.00 Kips	0.00 Kips
7.40 ft		0.00 Kips	10.69 Kips	10.69 Kips
10.99 ft		13.84 Kips	10.69 Kips	24.53 Kips
11.01 ft	Stratum II Till	13.92 Kips	15.27 Kips	29.19 Kips
20.01 ft		50.77 Kips	15.27 Kips	66.04 Kips
28.49 ft		95.67 Kips	15.27 Kips	110.94 Kips
28.51 ft	Stratum III Till	95.76 Kips	6.41 Kips	102.17 Kips
37.51 ft		124.96 Kips	6.41 Kips	131.38 Kips
46.51 ft		154.17 Kips	6.41 Kips	160.58 Kips
48.99 ft		162.21 Kips	6.41 Kips	168.63 Kips
49.01 ft	Stratum IV Hardpan	162.32 Kips	124.11 Kips	286.43 Kips
58.01 ft		234.14 Kips	124.11 Kips	358.25 Kips
58.29 ft		236.52 Kips	124.11 Kips	360.63 Kips
58.31 ft	Dense Granular	236.72 Kips	251.30 Kips	488.01 Kips
64.49 ft		307.08 Kips	251.30 Kips	558.38 Kips

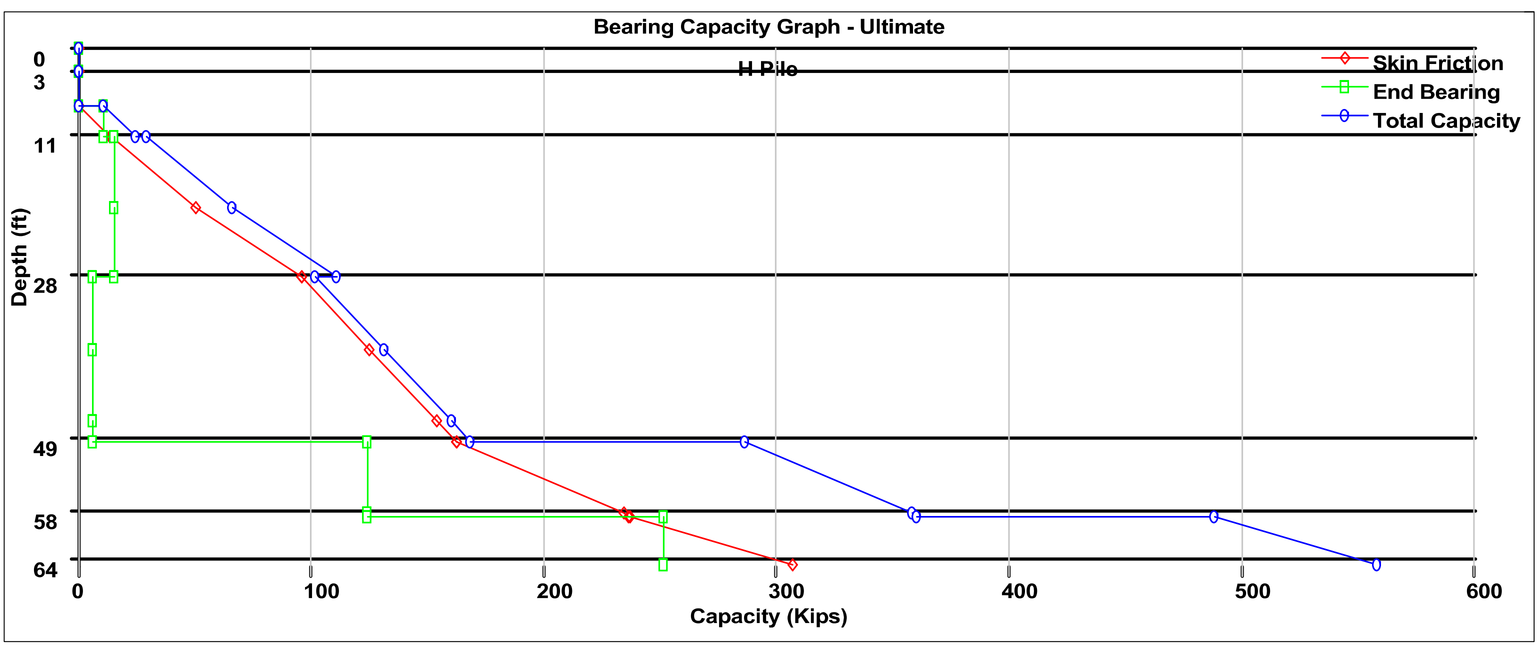
180 K at 49.0 feet

Settlement due to new embankment <0.4" for any one layer so no downdrag
Design Load: 45 tons = 90 kips
For FOS = 2, Ult = 180 kips

See spreadsheet attachment for calculation of pile Tip Elevation, Est. Length, and Order Length.


Bearing Capacity Graph - Restrike
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
11
28
49
58
64
0
100
200
300
400
500
600
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
11
28
49
58
64
0
100
200
300
400
500
600
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
11
28
49
58
64
0
100
200
300
400
500
600
Capacity (Kips)

Pier 2
B-004
HP12x53

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230574\B-004.DVN
Project Name: WOO-75-29.93 PID 119007 Project Date: 07/18/2023
Project Client: ODOT District 2
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 7.40 ft ← Pier 2 Pile Cap Elev. 624.0 (7.4 feet)
Perimeter Analysis: Box
Tip Analysis: Box Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	16.00 ft
	- Driving/Restrike	16.00 ft
	- Ultimate:	16.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	140.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	8.00 ft	0.00%	130.00 pcf	1750.00 psf	T-79 Steel
3	Cohesive	17.50 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	20.50 ft	0.00%	135.00 pcf	1050.00 psf	T-79 Steel
5	Cohesionless	9.30 ft	0.00%	132.00 pcf	36.6/36.6	Nordlund
6	Cohesionless	6.20 ft	0.00%	130.00 pcf	39.4/39.4	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	1149.17 psf	16.38 Kips
11.01 ft	Cohesive	N/A	N/A	1016.96 psf	16.47 Kips
20.01 ft	Cohesive	N/A	N/A	1173.87 psf	58.43 Kips
28.49 ft	Cohesive	N/A	N/A	1321.71 psf	108.22 Kips
28.51 ft	Cohesive	N/A	N/A	923.23 psf	108.32 Kips
37.51 ft	Cohesive	N/A	N/A	970.60 psf	143.01 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	178.69 Kips
48.99 ft	Cohesive	N/A	N/A	984.50 psf	188.39 Kips
49.01 ft	Cohesionless	4443.65 psf	27.56	N/A	188.52 Kips
58.01 ft	Cohesionless	4756.85 psf	27.56	N/A	280.79 Kips
58.29 ft	Cohesionless	4766.59 psf	27.56	N/A	283.85 Kips
58.31 ft	Cohesionless	5090.92 psf	29.67	N/A	284.11 Kips
64.49 ft	Cohesionless	5299.80 psf	29.67	N/A	375.10 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	N/A	15.52 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	15.52 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
48.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
49.01 ft	Cohesionless	4444.00 psf	85.76	180.19 Kips	180.19 Kips
58.01 ft	Cohesionless	5070.40 psf	85.76	180.19 Kips	180.19 Kips
58.29 ft	Cohesionless	5089.88 psf	85.76	180.19 Kips	180.19 Kips
58.31 ft	Cohesionless	5091.26 psf	145.12	364.85 Kips	364.85 Kips
64.49 ft	Cohesionless	5509.02 psf	145.12	364.85 Kips	364.85 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.40 ft	0.00 Kips	15.52 Kips	15.52 Kips
10.99 ft	16.38 Kips	15.52 Kips	31.90 Kips
11.01 ft	16.47 Kips	22.17 Kips	38.64 Kips
20.01 ft	58.43 Kips	22.17 Kips	80.60 Kips
28.49 ft	108.22 Kips	22.17 Kips	130.39 Kips
28.51 ft	108.32 Kips	9.31 Kips	117.63 Kips
37.51 ft	143.01 Kips	9.31 Kips	152.32 Kips
46.51 ft	178.69 Kips	9.31 Kips	188.00 Kips
48.99 ft	188.39 Kips	9.31 Kips	197.70 Kips
49.01 ft	188.52 Kips	180.19 Kips	368.71 Kips
58.01 ft	280.79 Kips	180.19 Kips	460.98 Kips
58.29 ft	283.85 Kips	180.19 Kips	464.05 Kips
58.31 ft	284.11 Kips	364.85 Kips	648.95 Kips
64.49 ft	375.10 Kips	364.85 Kips	739.95 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	1149.17 psf	16.38 Kips
11.01 ft	Cohesive	N/A	N/A	1016.96 psf	16.47 Kips
20.01 ft	Cohesive	N/A	N/A	1173.87 psf	58.43 Kips
28.49 ft	Cohesive	N/A	N/A	1321.71 psf	108.22 Kips
28.51 ft	Cohesive	N/A	N/A	923.23 psf	108.32 Kips
37.51 ft	Cohesive	N/A	N/A	970.60 psf	143.01 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	178.69 Kips
48.99 ft	Cohesive	N/A	N/A	984.50 psf	188.39 Kips
49.01 ft	Cohesionless	4443.65 psf	27.56	N/A	188.52 Kips
58.01 ft	Cohesionless	4756.85 psf	27.56	N/A	280.79 Kips
58.29 ft	Cohesionless	4766.59 psf	27.56	N/A	283.85 Kips
58.31 ft	Cohesionless	5090.92 psf	29.67	N/A	284.11 Kips
64.49 ft	Cohesionless	5299.80 psf	29.67	N/A	375.10 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	N/A	15.52 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	15.52 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
48.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
49.01 ft	Cohesionless	4444.00 psf	85.76	180.19 Kips	180.19 Kips
58.01 ft	Cohesionless	5070.40 psf	85.76	180.19 Kips	180.19 Kips
58.29 ft	Cohesionless	5089.88 psf	85.76	180.19 Kips	180.19 Kips
58.31 ft	Cohesionless	5091.26 psf	145.12	364.85 Kips	364.85 Kips
64.49 ft	Cohesionless	5509.02 psf	145.12	364.85 Kips	364.85 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.40 ft	0.00 Kips	15.52 Kips	15.52 Kips
10.99 ft	16.38 Kips	15.52 Kips	31.90 Kips
11.01 ft	16.47 Kips	22.17 Kips	38.64 Kips
20.01 ft	58.43 Kips	22.17 Kips	80.60 Kips
28.49 ft	108.22 Kips	22.17 Kips	130.39 Kips
28.51 ft	108.32 Kips	9.31 Kips	117.63 Kips
37.51 ft	143.01 Kips	9.31 Kips	152.32 Kips
46.51 ft	178.69 Kips	9.31 Kips	188.00 Kips
48.99 ft	188.39 Kips	9.31 Kips	197.70 Kips
49.01 ft	188.52 Kips	180.19 Kips	368.71 Kips
58.01 ft	280.79 Kips	180.19 Kips	460.98 Kips
58.29 ft	283.85 Kips	180.19 Kips	464.05 Kips
58.31 ft	284.11 Kips	364.85 Kips	648.95 Kips
64.49 ft	375.10 Kips	364.85 Kips	739.95 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	1140.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	1149.17 psf	16.38 Kips
11.01 ft	Cohesive	N/A	N/A	1016.96 psf	16.47 Kips
20.01 ft	Cohesive	N/A	N/A	1173.87 psf	58.43 Kips
28.49 ft	Cohesive	N/A	N/A	1321.71 psf	108.22 Kips
28.51 ft	Cohesive	N/A	N/A	923.23 psf	108.32 Kips
37.51 ft	Cohesive	N/A	N/A	970.60 psf	143.01 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	178.69 Kips
48.99 ft	Cohesive	N/A	N/A	984.50 psf	188.39 Kips
49.01 ft	Cohesionless	4443.65 psf	27.56	N/A	188.52 Kips
58.01 ft	Cohesionless	4756.85 psf	27.56	N/A	280.79 Kips
58.29 ft	Cohesionless	4766.59 psf	27.56	N/A	283.85 Kips
58.31 ft	Cohesionless	5090.92 psf	29.67	N/A	284.11 Kips
64.49 ft	Cohesionless	5299.80 psf	29.67	N/A	375.10 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.39 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
7.40 ft	Cohesive	N/A	N/A	N/A	15.52 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	15.52 Kips
11.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
20.01 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
48.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
49.01 ft	Cohesionless	4444.00 psf	85.76	180.19 Kips	180.19 Kips
58.01 ft	Cohesionless	5070.40 psf	85.76	180.19 Kips	180.19 Kips
58.29 ft	Cohesionless	5089.88 psf	85.76	180.19 Kips	180.19 Kips
58.31 ft	Cohesionless	5091.26 psf	145.12	364.85 Kips	364.85 Kips
64.49 ft	Cohesionless	5509.02 psf	145.12	364.85 Kips	364.85 Kips

GSE = 631.4

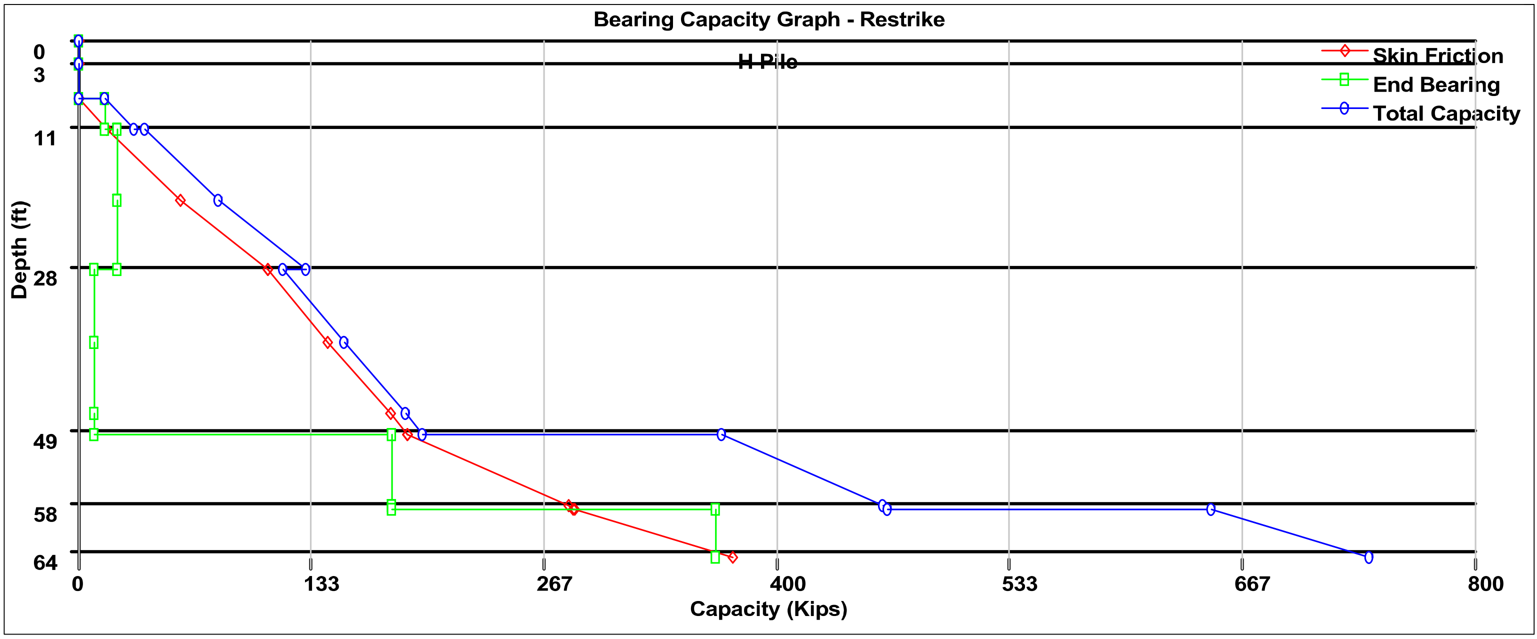
Pier 2
B-004
HP12x53

ULTIMATE - SUMMARY OF CAPACITIES

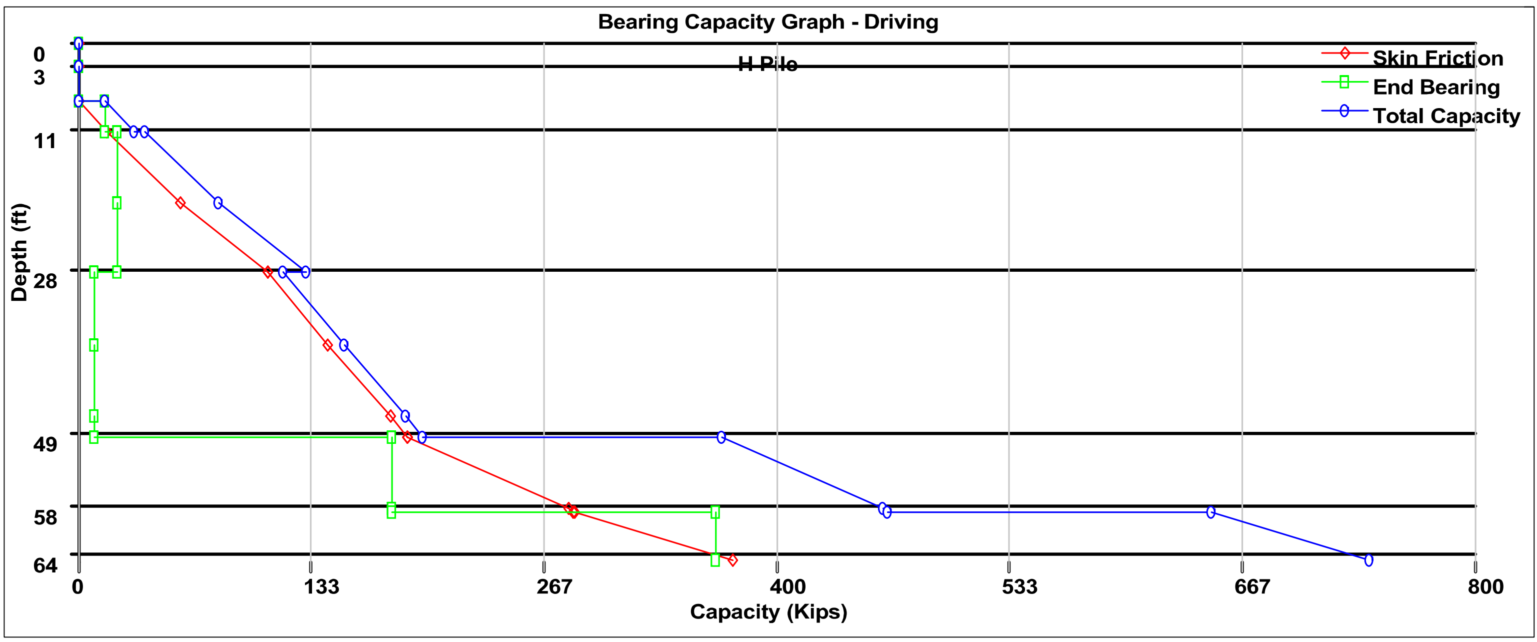
Depth	Stratum	Skin Friction	End Bearing	Total Capacity
0.01 ft	Embankment Fill	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	Stratum I Lac	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft		0.00 Kips	0.00 Kips	0.00 Kips
7.40 ft		0.00 Kips	15.52 Kips	15.52 Kips
10.99 ft		16.38 Kips	15.52 Kips	31.90 Kips
11.01 ft	Stratum II Till	16.47 Kips	22.17 Kips	38.64 Kips
20.01 ft		58.43 Kips	22.17 Kips	80.60 Kips
28.49 ft		108.22 Kips	22.17 Kips	130.39 Kips
28.51 ft	Stratum III Till	108.32 Kips	9.31 Kips	117.63 Kips
37.51 ft		143.01 Kips	9.31 Kips	152.32 Kips
46.51 ft		178.69 Kips	9.31 Kips	188.00 Kips ← 180 K at 44.5 feet
48.99 ft		188.39 Kips	9.31 Kips	197.70 Kips
49.01 ft	Stratum IV Hardpan	188.52 Kips	180.19 Kips	368.71 Kips
58.01 ft		280.79 Kips	180.19 Kips	460.98 Kips
58.29 ft		283.85 Kips	180.19 Kips	464.05 Kips
58.31 ft	Dense Granular	284.11 Kips	364.85 Kips	648.95 Kips
64.49 ft		375.10 Kips	364.85 Kips	739.95 Kips

Settlement due to new embankment <0.4" for any one layer so no downdrag
Design Load: 45 tons = 90 kips
For FOS = 2, Ult = 180 kips

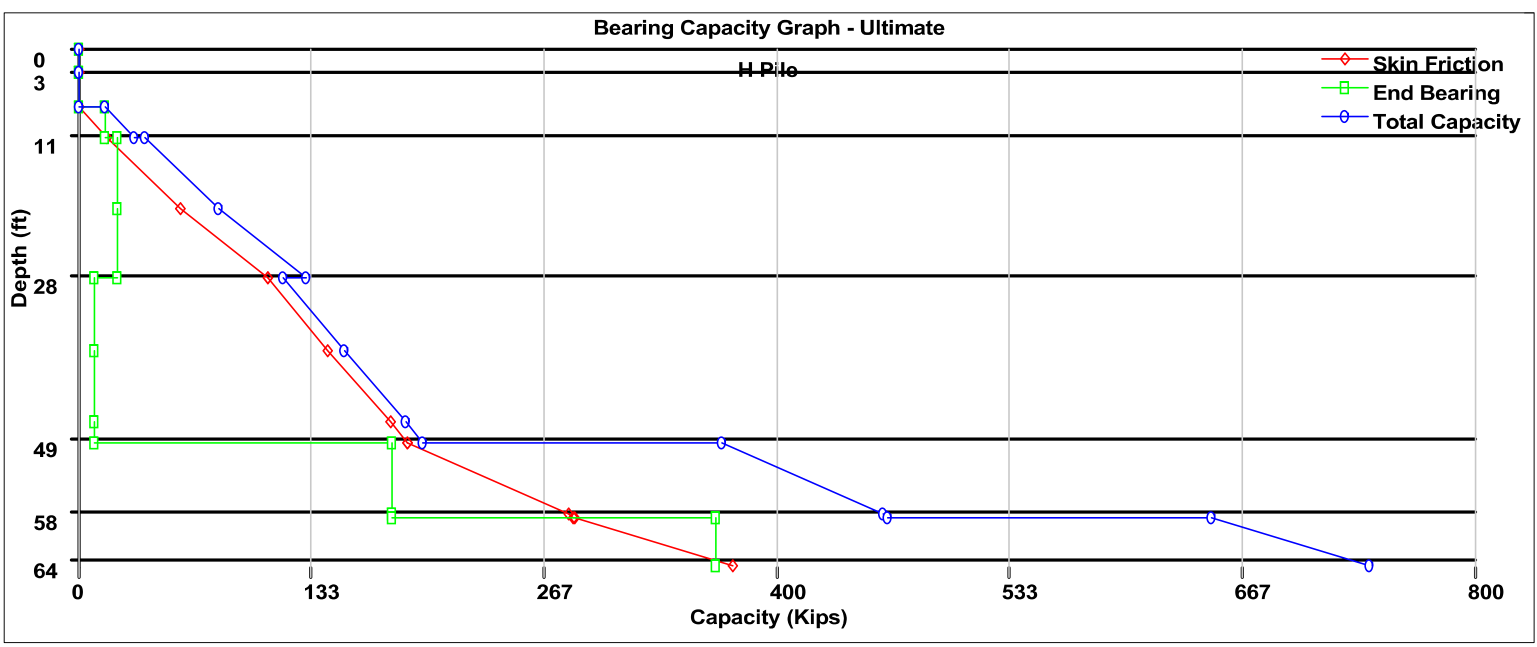
See spreadsheet attachment for calculation of pile Tip Elevation, Est. Length, and Order Length.



Bearing Capacity Graph - Restrike
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
11
28
49
58
64
0
133
267
400
533
667
800
Capacity (Kips)

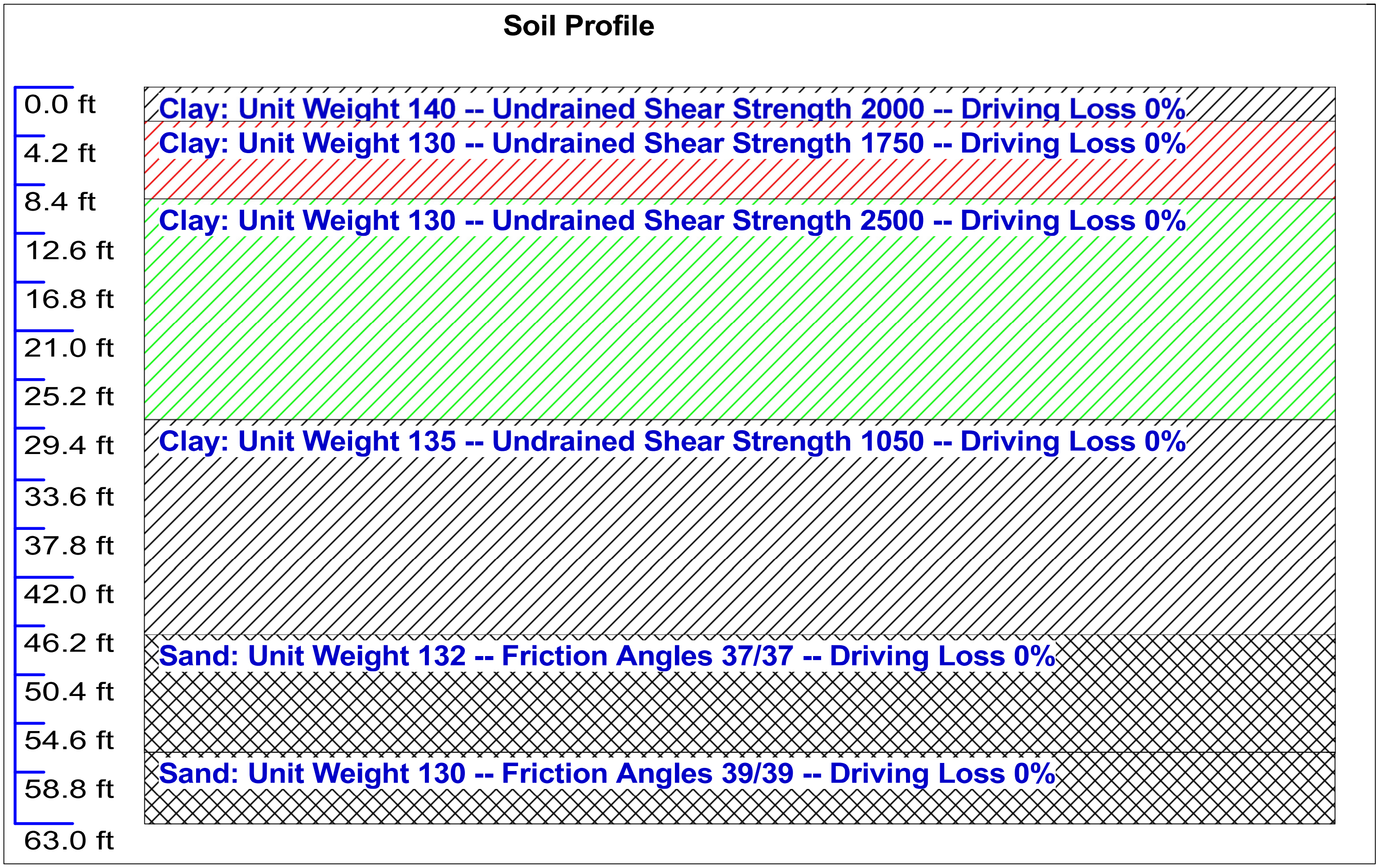


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
11
28
49
58
64
0
133
267
400
533
667
800
Capacity (Kips)



Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
11
28
49
58
64
0
133
267
400
533
667
800
Capacity (Kips)

Filename: T:\GEOTECH\DRIVEN\230574\B-005.DVN



DRIVEN 1.2

Pier 3
B-005
HP10x42

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230574\B-005.DVN
Project Name: WOO-75-29.93 PID 119007 Project Date: 07/18/2023
Project Client: ODOT District 2
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: H Pile - HP10X42
Top of Pile: 9.80 ft
Perimeter Analysis: Box
Tip Analysis: Box Area

Pier 3 Pile Cap Elev. 619.5 (9.8 feet)

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.00 ft
	- Driving/Restrike	13.00 ft
	- Ultimate:	13.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	140.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	6.70 ft	0.00%	130.00 pcf	1750.00 psf	T-79 Steel
3	Cohesive	18.80 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	18.50 ft	0.00%	135.00 pcf	1050.00 psf	T-79 Steel
5	Cohesionless	10.00 ft	0.00%	132.00 pcf	36.6/36.6	Nordlund
6	Cohesionless	6.00 ft	0.00%	130.00 pcf	39.4/39.4	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	1029.27 psf	0.00 Kips
18.71 ft	Cohesive	N/A	N/A	1214.99 psf	35.68 Kips
27.71 ft	Cohesive	N/A	N/A	1402.58 psf	82.79 Kips
28.49 ft	Cohesive	N/A	N/A	1418.84 psf	87.40 Kips
28.51 ft	Cohesive	N/A	N/A	952.57 psf	87.49 Kips
37.51 ft	Cohesive	N/A	N/A	984.50 psf	116.69 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	145.90 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	147.45 Kips
47.01 ft	Cohesionless	4111.25 psf	26.83	N/A	147.56 Kips
56.01 ft	Cohesionless	4424.45 psf	26.83	N/A	214.35 Kips
56.99 ft	Cohesionless	4458.55 psf	26.83	N/A	222.20 Kips
57.01 ft	Cohesionless	4807.24 psf	28.88	N/A	222.38 Kips
62.99 ft	Cohesionless	5009.36 psf	28.88	N/A	286.74 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
18.71 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
27.71 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
47.01 ft	Cohesionless	4111.60 psf	85.76	124.11 Kips	124.11 Kips
56.01 ft	Cohesionless	4738.00 psf	85.76	124.11 Kips	124.11 Kips
56.99 ft	Cohesionless	4806.20 psf	85.76	124.11 Kips	124.11 Kips
57.01 ft	Cohesionless	4807.58 psf	145.12	251.30 Kips	251.30 Kips
62.99 ft	Cohesionless	5211.82 psf	145.12	251.30 Kips	251.30 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.69 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.71 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.79 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.80 ft	0.00 Kips	15.27 Kips	15.27 Kips
18.71 ft	35.68 Kips	15.27 Kips	50.95 Kips
27.71 ft	82.79 Kips	15.27 Kips	98.06 Kips
28.49 ft	87.40 Kips	15.27 Kips	102.67 Kips
28.51 ft	87.49 Kips	6.41 Kips	93.90 Kips
37.51 ft	116.69 Kips	6.41 Kips	123.11 Kips
46.51 ft	145.90 Kips	6.41 Kips	152.31 Kips
46.99 ft	147.45 Kips	6.41 Kips	153.87 Kips
47.01 ft	147.56 Kips	124.11 Kips	271.67 Kips
56.01 ft	214.35 Kips	124.11 Kips	338.46 Kips
56.99 ft	222.20 Kips	124.11 Kips	346.31 Kips
57.01 ft	222.38 Kips	251.30 Kips	473.68 Kips
62.99 ft	286.74 Kips	251.30 Kips	538.03 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	1029.27 psf	0.00 Kips
18.71 ft	Cohesive	N/A	N/A	1214.99 psf	35.68 Kips
27.71 ft	Cohesive	N/A	N/A	1402.58 psf	82.79 Kips
28.49 ft	Cohesive	N/A	N/A	1418.84 psf	87.40 Kips
28.51 ft	Cohesive	N/A	N/A	952.57 psf	87.49 Kips
37.51 ft	Cohesive	N/A	N/A	984.50 psf	116.69 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	145.90 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	147.45 Kips
47.01 ft	Cohesionless	4111.25 psf	26.83	N/A	147.56 Kips
56.01 ft	Cohesionless	4424.45 psf	26.83	N/A	214.35 Kips
56.99 ft	Cohesionless	4458.55 psf	26.83	N/A	222.20 Kips
57.01 ft	Cohesionless	4807.24 psf	28.88	N/A	222.38 Kips
62.99 ft	Cohesionless	5009.36 psf	28.88	N/A	286.74 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
18.71 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
27.71 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
47.01 ft	Cohesionless	4111.60 psf	85.76	124.11 Kips	124.11 Kips
56.01 ft	Cohesionless	4738.00 psf	85.76	124.11 Kips	124.11 Kips
56.99 ft	Cohesionless	4806.20 psf	85.76	124.11 Kips	124.11 Kips
57.01 ft	Cohesionless	4807.58 psf	145.12	251.30 Kips	251.30 Kips
62.99 ft	Cohesionless	5211.82 psf	145.12	251.30 Kips	251.30 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.69 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.71 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.79 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.80 ft	0.00 Kips	15.27 Kips	15.27 Kips
18.71 ft	35.68 Kips	15.27 Kips	50.95 Kips
27.71 ft	82.79 Kips	15.27 Kips	98.06 Kips
28.49 ft	87.40 Kips	15.27 Kips	102.67 Kips
28.51 ft	87.49 Kips	6.41 Kips	93.90 Kips
37.51 ft	116.69 Kips	6.41 Kips	123.11 Kips
46.51 ft	145.90 Kips	6.41 Kips	152.31 Kips
46.99 ft	147.45 Kips	6.41 Kips	153.87 Kips
47.01 ft	147.56 Kips	124.11 Kips	271.67 Kips
56.01 ft	214.35 Kips	124.11 Kips	338.46 Kips
56.99 ft	222.20 Kips	124.11 Kips	346.31 Kips
57.01 ft	222.38 Kips	251.30 Kips	473.68 Kips
62.99 ft	286.74 Kips	251.30 Kips	538.03 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	1029.27 psf	0.00 Kips
18.71 ft	Cohesive	N/A	N/A	1214.99 psf	35.68 Kips
27.71 ft	Cohesive	N/A	N/A	1402.58 psf	82.79 Kips
28.49 ft	Cohesive	N/A	N/A	1418.84 psf	87.40 Kips
28.51 ft	Cohesive	N/A	N/A	952.57 psf	87.49 Kips
37.51 ft	Cohesive	N/A	N/A	984.50 psf	116.69 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	145.90 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	147.45 Kips
47.01 ft	Cohesionless	4111.25 psf	26.83	N/A	147.56 Kips
56.01 ft	Cohesionless	4424.45 psf	26.83	N/A	214.35 Kips
56.99 ft	Cohesionless	4458.55 psf	26.83	N/A	222.20 Kips
57.01 ft	Cohesionless	4807.24 psf	28.88	N/A	222.38 Kips
62.99 ft	Cohesionless	5009.36 psf	28.88	N/A	286.74 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
18.71 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
27.71 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	15.27 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	6.41 Kips
47.01 ft	Cohesionless	4111.60 psf	85.76	124.11 Kips	124.11 Kips
56.01 ft	Cohesionless	4738.00 psf	85.76	124.11 Kips	124.11 Kips
56.99 ft	Cohesionless	4806.20 psf	85.76	124.11 Kips	124.11 Kips
57.01 ft	Cohesionless	4807.58 psf	145.12	251.30 Kips	251.30 Kips
62.99 ft	Cohesionless	5211.82 psf	145.12	251.30 Kips	251.30 Kips

GSE = 629.3

ULTIMATE - SUMMARY OF CAPACITIES

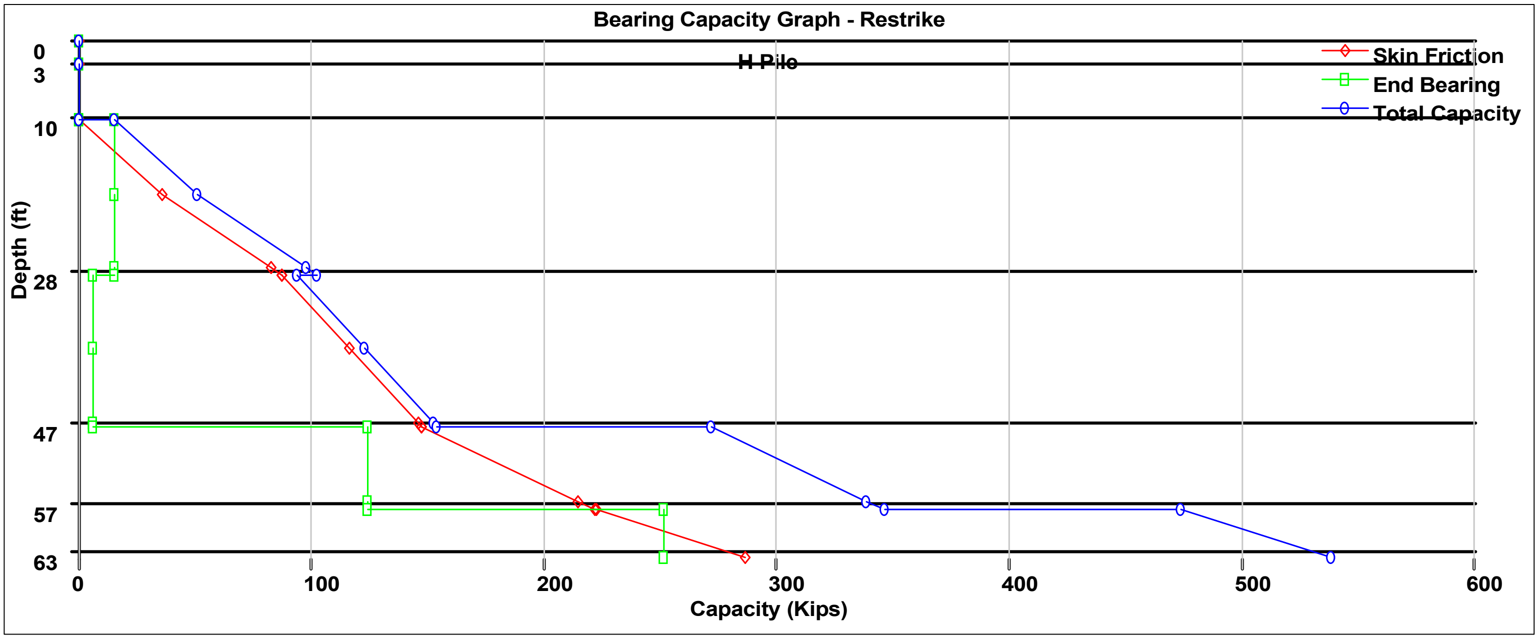
Pier 3
B-005
HP10x42

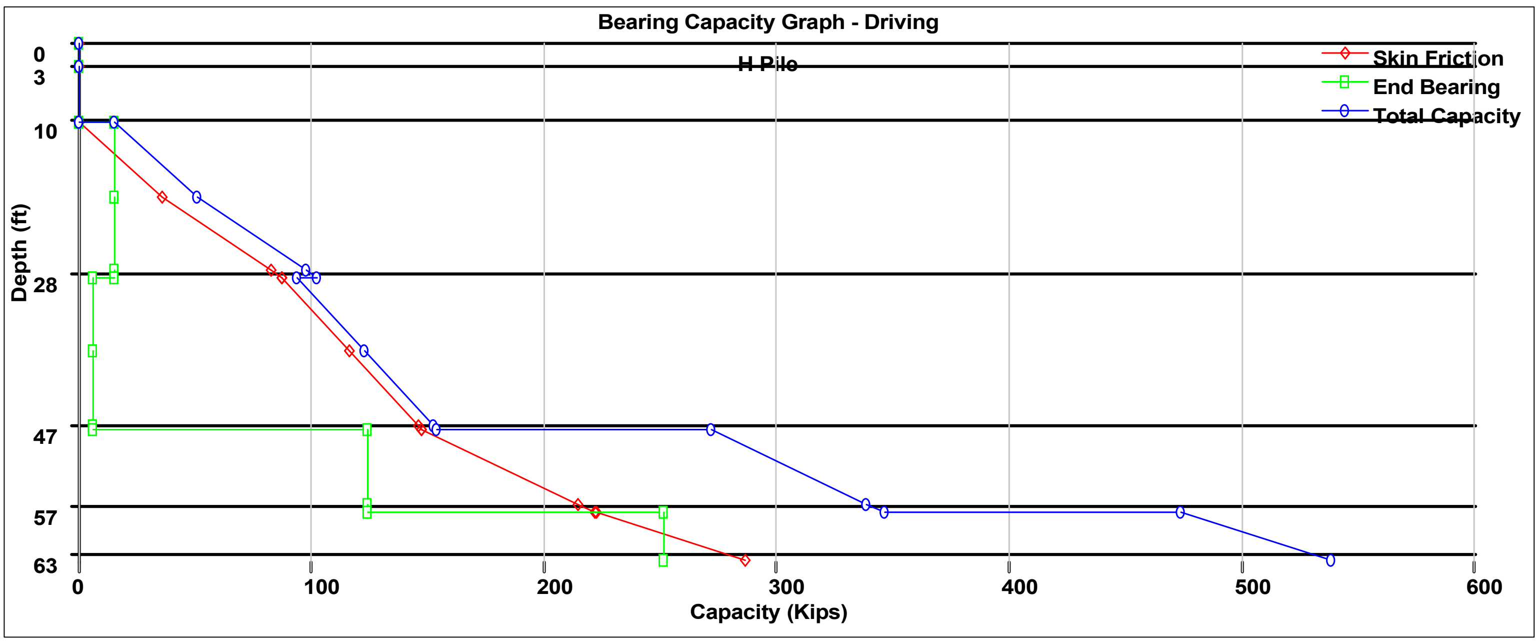
Depth		Skin Friction	End Bearing	Total Capacity
0.01 ft	Embankment Fill	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	Stratum I Lac	0.00 Kips	0.00 Kips	0.00 Kips
9.69 ft		0.00 Kips	0.00 Kips	0.00 Kips
9.71 ft		0.00 Kips	0.00 Kips	0.00 Kips
9.79 ft		0.00 Kips	0.00 Kips	0.00 Kips
9.80 ft	Stratum II Till	0.00 Kips	15.27 Kips	15.27 Kips
18.71 ft		35.68 Kips	15.27 Kips	50.95 Kips
27.71 ft		82.79 Kips	15.27 Kips	98.06 Kips
28.49 ft		87.40 Kips	15.27 Kips	102.67 Kips
28.51 ft	Stratum III Till	87.49 Kips	6.41 Kips	93.90 Kips
37.51 ft		116.69 Kips	6.41 Kips	123.11 Kips
46.51 ft		145.90 Kips	6.41 Kips	152.31 Kips
46.99 ft		147.45 Kips	6.41 Kips	153.87 Kips
47.01 ft	Stratum IV Hardpan	147.56 Kips	124.11 Kips	271.67 Kips
56.01 ft		214.35 Kips	124.11 Kips	338.46 Kips
56.99 ft		222.20 Kips	124.11 Kips	346.31 Kips
57.01 ft	Dense Granular	222.38 Kips	251.30 Kips	473.68 Kips
62.99 ft		286.74 Kips	251.30 Kips	538.03 Kips

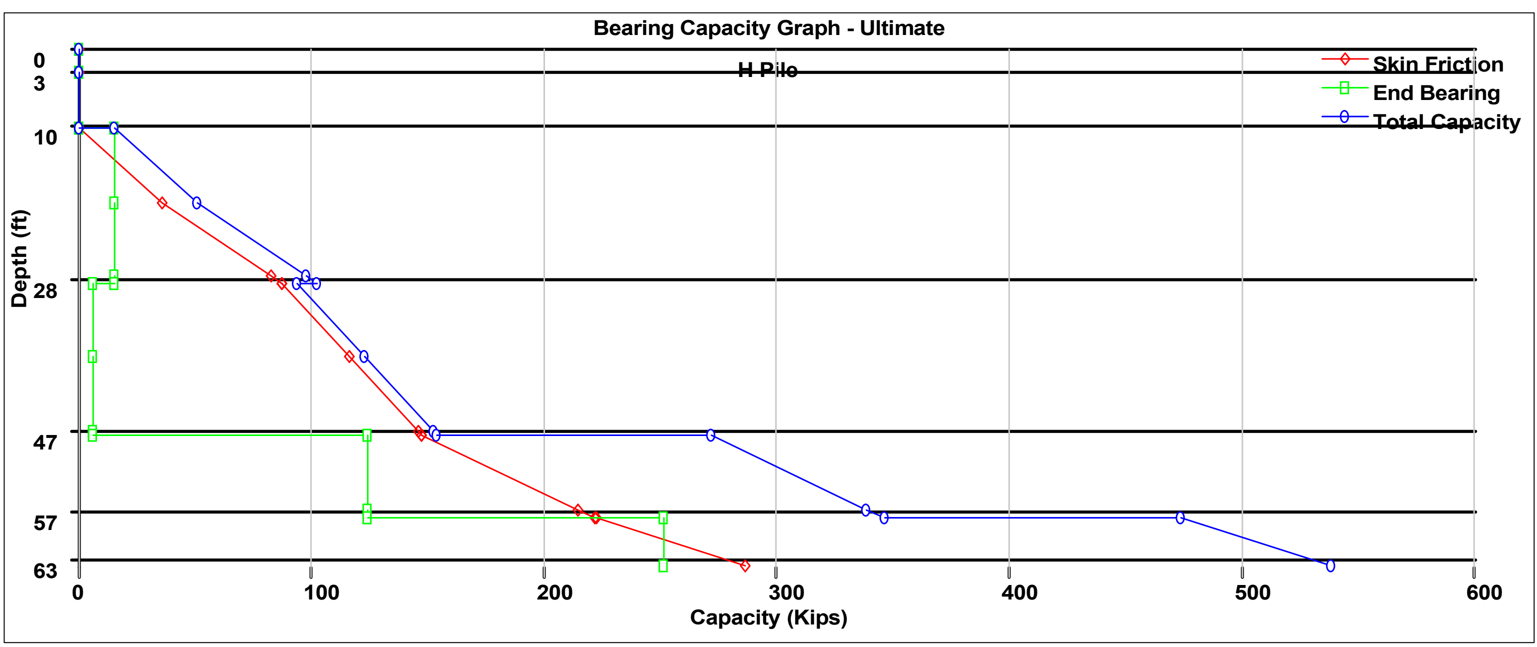
180 K at 47.0 feet

Settlement due to new embankment <0.4" for any one layer so no downdrag
Design Load: 45 tons = 90 kips
For FOS = 2, Ult = 180 kips

See spreadsheet attachment for calculation of pile Tip Elevation, Est. Length, and Order Length.


Bearing Capacity Graph - Restrike
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
10
28
47
57
63
0
100
200
300
400
500
600
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
10
28
47
57
63
0
100
200
300
400
500
600
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
10
28
47
57
63
0
100
200
300
400
500
600
Capacity (Kips)

Pier 3
B-005
HP12x53

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: T:\GEOTECH\DRIVEN\230574\B-005.DVN
Project Name: WOO-75-29.93 PID 119007   Project Date: 07/18/2023
Project Client: ODOT District 2
Computed By: KCH
Project Manager: KCH

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 9.80 ft ← Pier 3 Pile Cap Elev. 619.5 (9.8 feet)
Perimeter Analysis: Box
Tip Analysis: Box Area

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	13.00 ft
	- Driving/Restrike	13.00 ft
	- Ultimate:	13.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	140.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	6.70 ft	0.00%	130.00 pcf	1750.00 psf	T-79 Steel
3	Cohesive	18.80 ft	0.00%	130.00 pcf	2500.00 psf	T-79 Steel
4	Cohesive	18.50 ft	0.00%	135.00 pcf	1050.00 psf	T-79 Steel
5	Cohesionless	10.00 ft	0.00%	132.00 pcf	36.6/36.6	Nordlund
6	Cohesionless	6.00 ft	0.00%	130.00 pcf	39.4/39.4	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	1000.00 psf	0.00 Kips
18.71 ft	Cohesive	N/A	N/A	1151.20 psf	40.73 Kips
27.71 ft	Cohesive	N/A	N/A	1308.11 psf	93.03 Kips
28.49 ft	Cohesive	N/A	N/A	1321.71 psf	98.09 Kips
28.51 ft	Cohesive	N/A	N/A	923.23 psf	98.19 Kips
37.51 ft	Cohesive	N/A	N/A	970.60 psf	132.88 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	168.56 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	170.44 Kips
47.01 ft	Cohesionless	4111.25 psf	27.56	N/A	170.57 Kips
56.01 ft	Cohesionless	4424.45 psf	27.56	N/A	256.39 Kips
56.99 ft	Cohesionless	4458.55 psf	27.56	N/A	266.46 Kips
57.01 ft	Cohesionless	4807.24 psf	29.67	N/A	266.70 Kips
62.99 ft	Cohesionless	5009.36 psf	29.67	N/A	349.93 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
18.71 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
27.71 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
47.01 ft	Cohesionless	4111.60 psf	85.76	180.19 Kips	180.19 Kips
56.01 ft	Cohesionless	4738.00 psf	85.76	180.19 Kips	180.19 Kips
56.99 ft	Cohesionless	4806.20 psf	85.76	180.19 Kips	180.19 Kips
57.01 ft	Cohesionless	4807.58 psf	145.12	364.85 Kips	364.85 Kips
62.99 ft	Cohesionless	5211.82 psf	145.12	364.85 Kips	364.85 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.69 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.71 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.79 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.80 ft	0.00 Kips	22.17 Kips	22.17 Kips
18.71 ft	40.73 Kips	22.17 Kips	62.90 Kips
27.71 ft	93.03 Kips	22.17 Kips	115.20 Kips
28.49 ft	98.09 Kips	22.17 Kips	120.26 Kips
28.51 ft	98.19 Kips	9.31 Kips	107.50 Kips
37.51 ft	132.88 Kips	9.31 Kips	142.19 Kips
46.51 ft	168.56 Kips	9.31 Kips	177.87 Kips
46.99 ft	170.44 Kips	9.31 Kips	179.75 Kips
47.01 ft	170.57 Kips	180.19 Kips	350.76 Kips
56.01 ft	256.39 Kips	180.19 Kips	436.58 Kips
56.99 ft	266.46 Kips	180.19 Kips	446.66 Kips
57.01 ft	266.70 Kips	364.85 Kips	631.55 Kips
62.99 ft	349.93 Kips	364.85 Kips	714.78 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	1000.00 psf	0.00 Kips
18.71 ft	Cohesive	N/A	N/A	1151.20 psf	40.73 Kips
27.71 ft	Cohesive	N/A	N/A	1308.11 psf	93.03 Kips
28.49 ft	Cohesive	N/A	N/A	1321.71 psf	98.09 Kips
28.51 ft	Cohesive	N/A	N/A	923.23 psf	98.19 Kips
37.51 ft	Cohesive	N/A	N/A	970.60 psf	132.88 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	168.56 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	170.44 Kips
47.01 ft	Cohesionless	4111.25 psf	27.56	N/A	170.57 Kips
56.01 ft	Cohesionless	4424.45 psf	27.56	N/A	256.39 Kips
56.99 ft	Cohesionless	4458.55 psf	27.56	N/A	266.46 Kips
57.01 ft	Cohesionless	4807.24 psf	29.67	N/A	266.70 Kips
62.99 ft	Cohesionless	5009.36 psf	29.67	N/A	349.93 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
18.71 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
27.71 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
47.01 ft	Cohesionless	4111.60 psf	85.76	180.19 Kips	180.19 Kips
56.01 ft	Cohesionless	4738.00 psf	85.76	180.19 Kips	180.19 Kips
56.99 ft	Cohesionless	4806.20 psf	85.76	180.19 Kips	180.19 Kips
57.01 ft	Cohesionless	4807.58 psf	145.12	364.85 Kips	364.85 Kips
62.99 ft	Cohesionless	5211.82 psf	145.12	364.85 Kips	364.85 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.69 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.71 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.79 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.80 ft	0.00 Kips	22.17 Kips	22.17 Kips
18.71 ft	40.73 Kips	22.17 Kips	62.90 Kips
27.71 ft	93.03 Kips	22.17 Kips	115.20 Kips
28.49 ft	98.09 Kips	22.17 Kips	120.26 Kips
28.51 ft	98.19 Kips	9.31 Kips	107.50 Kips
37.51 ft	132.88 Kips	9.31 Kips	142.19 Kips
46.51 ft	168.56 Kips	9.31 Kips	177.87 Kips
46.99 ft	170.44 Kips	9.31 Kips	179.75 Kips
47.01 ft	170.57 Kips	180.19 Kips	350.76 Kips
56.01 ft	256.39 Kips	180.19 Kips	436.58 Kips
56.99 ft	266.46 Kips	180.19 Kips	446.66 Kips
57.01 ft	266.70 Kips	364.85 Kips	631.55 Kips
62.99 ft	349.93 Kips	364.85 Kips	714.78 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	1000.00 psf	0.00 Kips
18.71 ft	Cohesive	N/A	N/A	1151.20 psf	40.73 Kips
27.71 ft	Cohesive	N/A	N/A	1308.11 psf	93.03 Kips
28.49 ft	Cohesive	N/A	N/A	1321.71 psf	98.09 Kips
28.51 ft	Cohesive	N/A	N/A	923.23 psf	98.19 Kips
37.51 ft	Cohesive	N/A	N/A	970.60 psf	132.88 Kips
46.51 ft	Cohesive	N/A	N/A	984.50 psf	168.56 Kips
46.99 ft	Cohesive	N/A	N/A	984.50 psf	170.44 Kips
47.01 ft	Cohesionless	4111.25 psf	27.56	N/A	170.57 Kips
56.01 ft	Cohesionless	4424.45 psf	27.56	N/A	256.39 Kips
56.99 ft	Cohesionless	4458.55 psf	27.56	N/A	266.46 Kips
57.01 ft	Cohesionless	4807.24 psf	29.67	N/A	266.70 Kips
62.99 ft	Cohesionless	5009.36 psf	29.67	N/A	349.93 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.69 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.71 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.79 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.80 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
18.71 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
27.71 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.49 ft	Cohesive	N/A	N/A	N/A	22.17 Kips
28.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
37.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.51 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
46.99 ft	Cohesive	N/A	N/A	N/A	9.31 Kips
47.01 ft	Cohesionless	4111.60 psf	85.76	180.19 Kips	180.19 Kips
56.01 ft	Cohesionless	4738.00 psf	85.76	180.19 Kips	180.19 Kips
56.99 ft	Cohesionless	4806.20 psf	85.76	180.19 Kips	180.19 Kips
57.01 ft	Cohesionless	4807.58 psf	145.12	364.85 Kips	364.85 Kips
62.99 ft	Cohesionless	5211.82 psf	145.12	364.85 Kips	364.85 Kips

GSE = 629.3

ULTIMATE - SUMMARY OF CAPACITIES

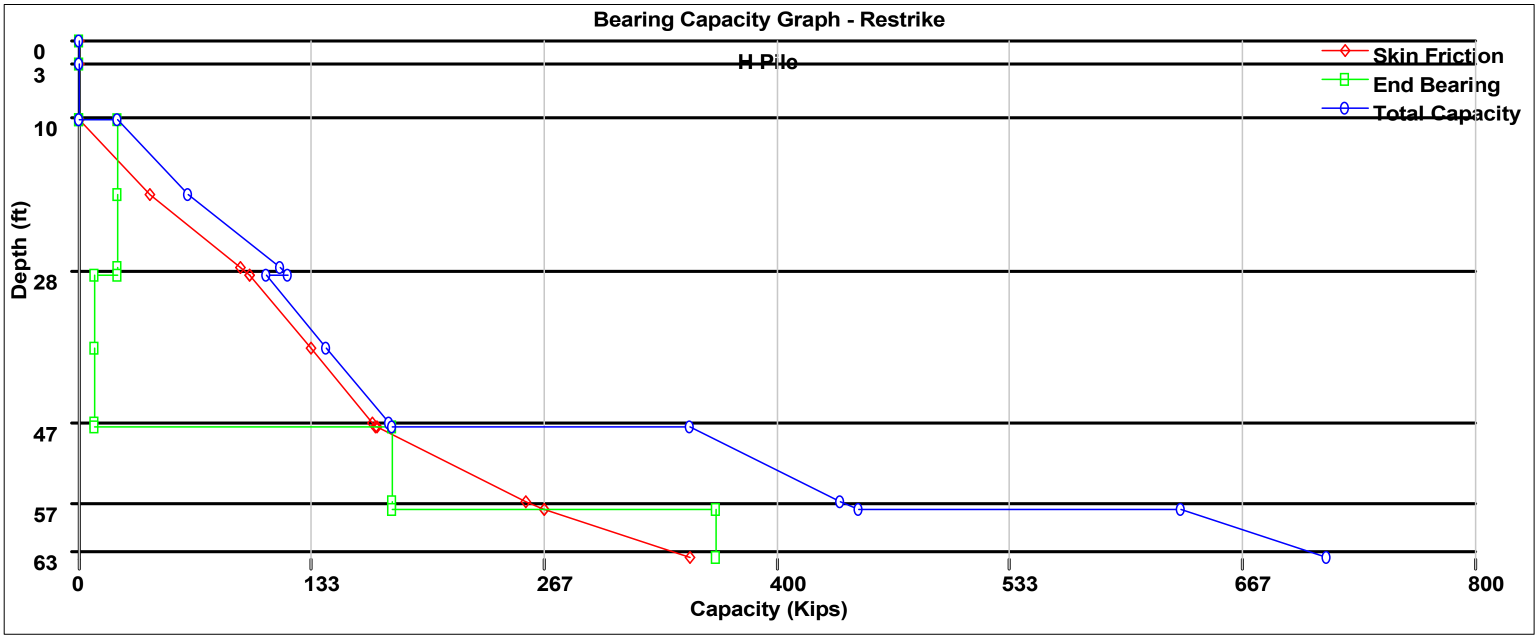
Pier 3
B-005
HP12x53

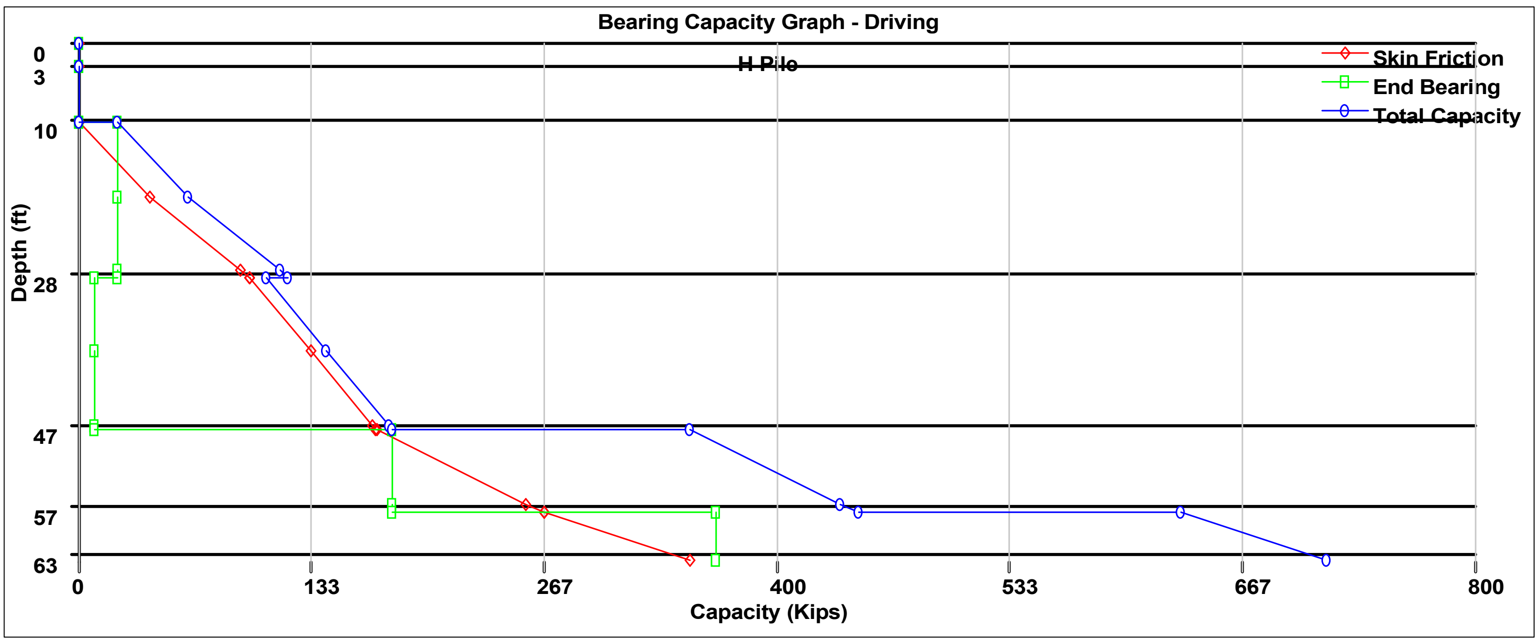
Depth		Skin Friction	End Bearing	Total Capacity
0.01 ft	Embankment Fill	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft		0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	Stratum I Lac	0.00 Kips	0.00 Kips	0.00 Kips
9.69 ft		0.00 Kips	0.00 Kips	0.00 Kips
9.71 ft		0.00 Kips	0.00 Kips	0.00 Kips
9.79 ft		0.00 Kips	0.00 Kips	0.00 Kips
9.80 ft	Stratum II Till	0.00 Kips	22.17 Kips	22.17 Kips
18.71 ft		40.73 Kips	22.17 Kips	62.90 Kips
27.71 ft		93.03 Kips	22.17 Kips	115.20 Kips
28.49 ft		98.09 Kips	22.17 Kips	120.26 Kips
28.51 ft	Stratum III Till	98.19 Kips	9.31 Kips	107.50 Kips
37.51 ft		132.88 Kips	9.31 Kips	142.19 Kips
46.51 ft		168.56 Kips	9.31 Kips	177.87 Kips
46.99 ft		170.44 Kips	9.31 Kips	179.75 Kips
47.01 ft	Stratum IV Hardpan	170.57 Kips	180.19 Kips	350.76 Kips
56.01 ft		256.39 Kips	180.19 Kips	436.58 Kips
56.99 ft		266.46 Kips	180.19 Kips	446.66 Kips
57.01 ft	Dense Granular	266.70 Kips	364.85 Kips	631.55 Kips
62.99 ft		349.93 Kips	364.85 Kips	714.78 Kips

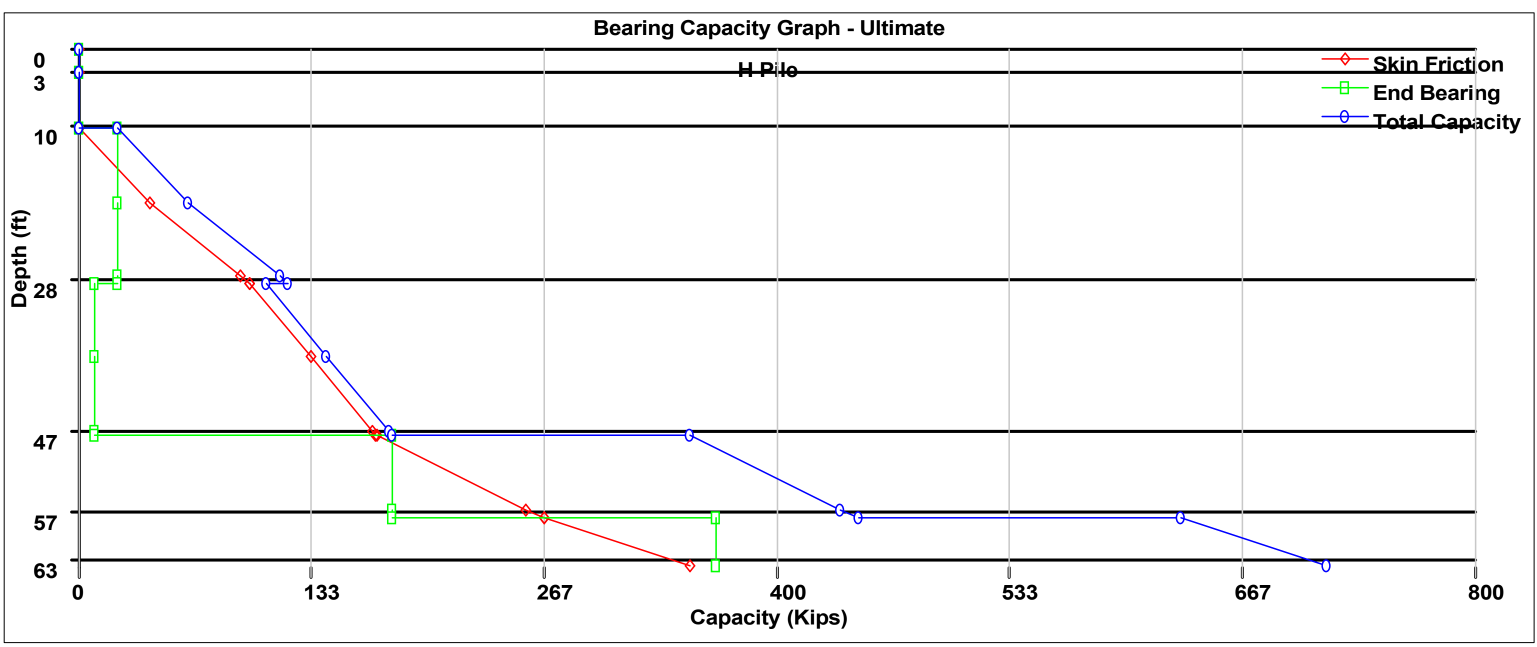
180 K at 47.0 feet

Settlement due to new embankment <0.4" for any one layer so no downdrag
Design Load: 45 tons = 90 kips
For FOS = 2, Ult = 180 kips

See spreadsheet attachment for calculation of pile Tip Elevation, Est. Length, and Order Length.


Bearing Capacity Graph - Restrike
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
10
28
47
57
63
0
133
267
400
533
667
800
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
10
28
47
57
63
0
133
267
400
533
667
800
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
3
10
28
47
57
63
0
133
267
400
533
667
800
Capacity (Kips)

Project Name: WOO-75-29.93, PID 119007
Project Number: 230574
Calculated by: KCH 7/12/2023
Subject: DRIVEN Results

Cut off = 1 feet

Filename	Trial Summary	GSE	Target Strength (kips)	Depth 1	Strength 1	Depth 2	Strength 2	Interpolated Depth	Tip Elev.	Footing Elev.	Footing Depth	Cut-off Elev.	Length	Est. Length	Order Length
B-003	HP10x42, box perimeter + box tip area	627.4	180	38.51	155.2200	46.99	182.7400	46.146	581.3	618.5	8.9	619.5	38.2	40	45
B-003	HP12x53, box perimeter + box tip area	627.4	180	35.01	170.9900	38.49	197.9500	36.173	591.2	618.5	8.9	619.5	28.3	30	35
	PIER 2														
B-004	HP10x42, box perimeter + box tip area	631.4	180	48.99	168.6300	49.01	286.4300	48.992	582.4	624	7.4	625	42.6	45	50
B-004	HP12x53, box perimeter + box tip area	631.4	180	37.51	152.3200	46.51	188.0000	44.492	586.9	624	7.4	625	38.1	40	45
	PIER 3														
B-005	HP10x42, box perimeter + box tip area	629.3	180	46.99	153.8700	47.01	271.6700	46.994	582.3	619.5	9.8	620.5	38.2	40	45
B-005	HP12x53, box perimeter + box tip area	629.3	180	46.99	179.7500	47.01	350.7600	46.990	582.3	619.5	9.8	620.5	38.2	40	45

Project Name:	WOO-75-29.93, PID 119007
Project Number:	230574
Calculated by:	KCH 8/9/2023
Subject:	Driveability Analysis

Pile type: HP12X53

Prebore through Embankment? No
Sleeved through Embankment No

Required Inputs:

Section Area =	15.5	square inches
Box Area =	141.6	square inches
D =	11.8	inches
BF =	12.0	inches
Pile Perimeter =	3.967	ft
Pile Size =	11.8	inches
Elastic Modulus =	30,000	ksi, per GDM 1304.2.2
Spec Weight =	492	pcf, per GDM 1304.2.2

Boring Number	Location	Pile Length* (feet)	GSE (feet)	Footing Elev. (feet)	Tip Elev. (feet)	Penetration** (feet)	GWT (feet)	Overburden Pressure (psf)
B-003	Pier 1	35	627.4	618.5	591.2	27.38	13.8	1187
B-004	Pier 2	45	631.4	624	586.9	37.18	16	992
B-005	Pier 3	45	629.3	619.5	582.3	37.28	13	1304

*GRLWEAP input is named "Pile Length." ODOT GDM 1304.2.2 specifies to use Order Length.

**Model driving 1" into end-bearing material

Stratum	Top Depth (feet)	Bottom Depth (feet)	c (psf)	SPT N60	Overburden Pressure (ksf)	CN	SPT N1,60	D/Qt (GDM Table 1300-2)	Qt	ODOT Soil Class	Skin Damping, Js (GDM Table 1300-3)	Set-up Time, SU T (GDM Table 1300-4) (hours)	Setup Factor, f_{su} (BDM Table 305-2)	DRIVEN % Driving Strength Loss (BDM Table 305-2)	Shaft Gain/Loss Factor
Cohesive Fill	0	3	2000	18	-	-	-	102.0	0.116	A-6b	0.2	168	1.75	43	0.57
I	3	8	1750	15	-	-	-	97.7	0.121	A-6a, A-6b	0.15	168	1.75	43	0.57
II	8	38.5	2500	21	-	-	-	105.7	0.112	A-6a	0.15	168	1.5	33	0.67
III	38.5	47	1050	11	-	-	-	90.9	0.130	A-6b	0.2	168	1.75	43	0.57

Shaft Gain/Loss	Toe Gain/Loss
0.57	1.0
0	0
0	0
0	0
0	0

Stratum	Top Depth (feet)	Bottom Depth (feet)	c (psf)	SPT N60	Overburden Pressure (ksf)	CN	SPT N1,60	D/Qt (GDM Table 1300-2)	Qt	ODOT Soil Class	Skin Damping, Js (GDM Table 1300-3)	Set-up Time, SU T (GDM Table 1300-4) (hours)	Setup Factor, f_{su} (BDM Table 305-2)	DRIVEN % Driving Strength Loss (BDM Table 305-2)	Shaft Gain/Loss Factor
Cohesive Fill	0	3	2000	18	-	-	-	102.0	0.116	A-7-6	0.2	168	2	50	0.50
I	3	11	1750	15	-	-	-	97.7	0.121	A-7-6	0.2	168	2	50	0.50
II	11	28.5	2500	21	-	-	-	105.7	0.112	A-6a, A-6b	0.15	168	1.75	43	0.57
III	28.5	49	1050	11	-	-	-	90.9	0.130	A-6b	0.15	168	1.75	43	0.57

Shaft Gain/Loss	Toe Gain/Loss
0.50	1.0
0	0
0	0
0	0
0	0

Stratum	Top Depth (feet)	Bottom Depth (feet)	c (psf)	SPT N60	Overburden Pressure (ksf)	CN	SPT N1,60	D/Qt (GDM Table 1300-2)	Qt	ODOT Soil Class	Skin Damping, Js (GDM Table 1300-3)	Set-up Time, SU T (GDM Table 1300-4) (hours)	Setup Factor, f_{su} (BDM Table 305-2)	DRIVEN % Driving Strength Loss (BDM Table 305-2)	Shaft Gain/Loss Factor
Cohesive Fill	0	3	2000	18	-	-	-	102.0	0.116	A-6a	0.15	168	1.75	43	0.57
I	3	9.7	1750	15	-	-	-	97.7	0.121	A-6b, A-7-6	0.15	168	2	50	0.50
II	9.7	28.5	2500	21	-	-	-	105.7	0.112	A-6a, A-6b	0.15	168	1.75	43	0.57
III	28.5	47	1050	11	-	-	-	90.9	0.130	A-6a	0.15	168	1.5	33	0.67

Shaft Gain/Loss	Toe Gain/Loss
0.50	1.0
0	0
0	0
0	0
0	0

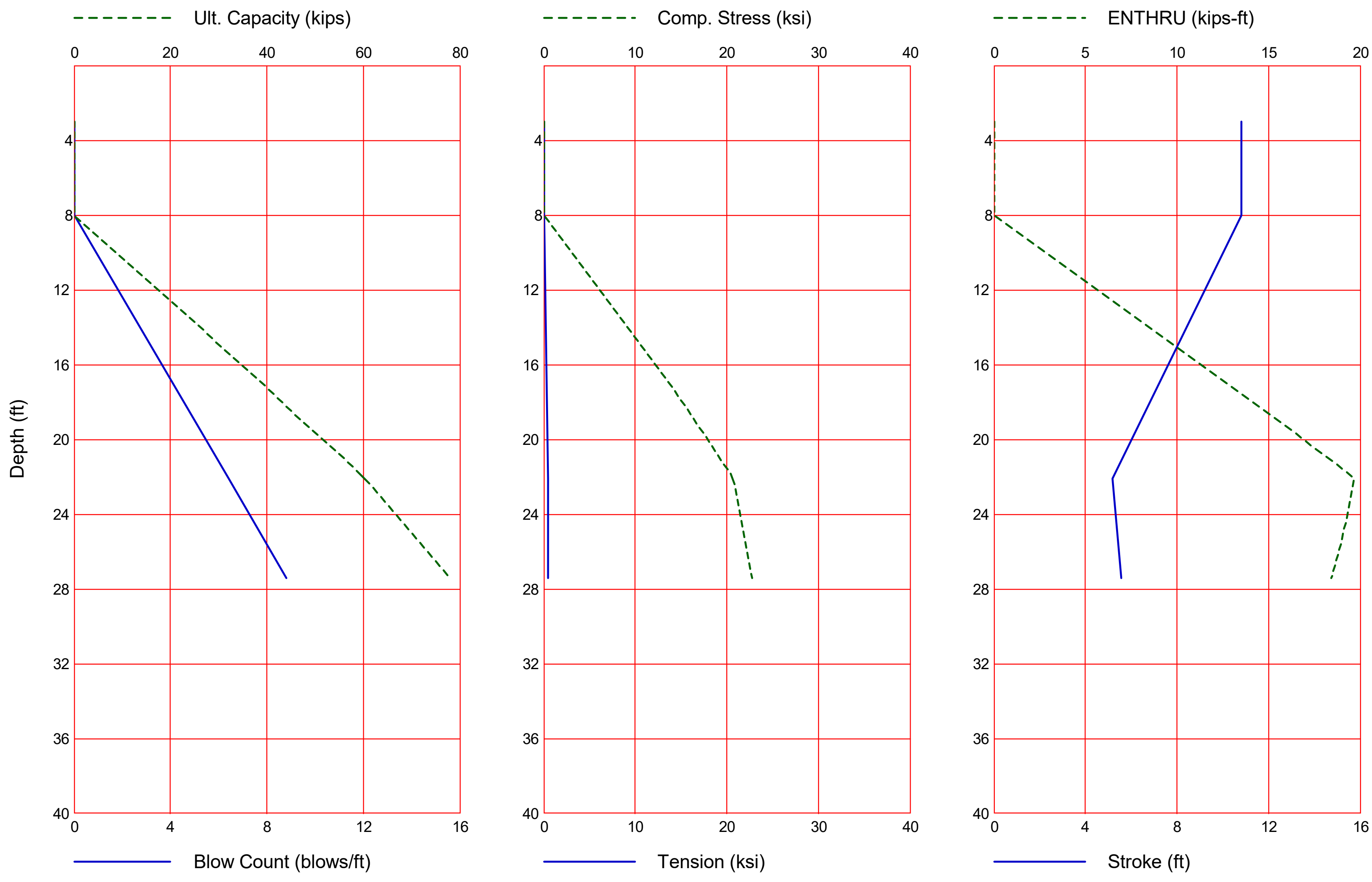
TTL Associates Inc

Aug 18 2023

WOO-75-29.93 PID 119007

Gain/Loss 1 at Shaft and Toe 0.570 / 1.000

GRLWEAP(TM) Version 2005



GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.
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ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: T:\GEOTECH\GRLWEAP\230574\B-3.GWI
Hammer File: C:\Program Files (x86)\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (8/28/2009)

```
                     Input File Contents
    WOO-75-29.93 PID 119007
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
   Pile g  Hammer g  Toe Area Pile Size           Pile Type
   32.170    32.170   141.600    12.000              H Pile
     W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
    1.900   227.000     530.0     2.000     0.800     0.010       0.0
     A Cu      E Cu      T Cu       CoR      ROut      StCu
    0.000       0.0     0.000     0.000     0.000       0.0
     LPle      APle      EPle      WPle      Peri      Strg       CoR      ROut
   35.000    15.500 30000.000   492.000     3.967     0.000     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42        1        5
   Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
     4.00    129.10     12.60     11.86     10.81      0.80
   IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
     0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
    16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
    P atm        P1        P2        P3        P4        P5
    14.70   1520.00   1368.00   1231.00   1108.00      0.00
   Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
  10.8100    0.8000 1520.0000    0.0000    0.0000    0.0000    0.0100    0.0000
       Qs        Qt        Js        Jt        Qx        Jx      Rati      Dept
    0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
    0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
    0.000     0.000     0.000     0.000
  Res. Distribution
   Dpth    Rskn    Rtoe      Qs      Qt      Js      Jt    SU F    LimD    SU T
   0.01    0.00    0.00    0.10    0.12    0.20    0.15    1.75    6.00  168.00
   2.99    0.00    0.00    0.10    0.12    0.20    0.15    1.75    6.00  168.00
   3.01    0.00    0.00    0.10    0.12    0.15    0.15    1.75    6.00  168.00
   7.99    0.00    0.00    0.10    0.12    0.15    0.15    1.75    6.00  168.00
   8.01    0.00    0.00    0.10    0.11    0.15    0.15    1.50    6.00  168.00
   8.89    0.00    0.00    0.10    0.11    0.15    0.15    1.50    6.00  168.00
   8.90    1.00   22.17    0.10    0.11    0.15    0.15    1.50    6.00  168.00
  17.01    1.12   22.17    0.10    0.11    0.15    0.15    1.50    6.00  168.00
  26.01    1.28   22.17    0.10    0.11    0.15    0.15    1.50    6.00  168.00
  35.00    1.43   22.17    0.10    0.11    0.15    0.15    1.50    6.00  168.00
  Gain/Loss factors: shaft and toe
  0.57000   0.00000   0.00000   0.00000   0.00000
  1.00000   0.00000   0.00000   0.00000   0.00000
     Dpth         L      Wait      Strk      Pmx%      Eff.      Stff       CoR
     2.98      0.00      0.00     0.000     0.000     0.000     0.000     0.000
     3.02      0.00      0.00     0.000     0.000     0.000     0.000     0.000
     5.50      0.00      0.00     0.000     0.000     0.000     0.000     0.000
```

7.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
8.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
22.09	0.00	0.00	0.000	0.000	0.000	0.000	0.000
27.38	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

Diameter	COGHammer	WHammer	ABatter	Depth Sup	Flag
0.000	0.000	0.000	0.000	0.000	0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

WOO-75-29.93 PID 119007

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		12178.6			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0

Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

Depth	(ft)	3.0		
Shaft Gain/Loss Factor		0.570	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	141.600	Pile Type	H Pile
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
35.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 4.165

Pile and Soil Model — Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.169	12179.	0.010	0.000	0.85	0.0	0.000	0.100	3.18	4.0	15.5
2	0.169	12179.	0.000	0.000	1.00	0.0	0.000	0.100	6.36	4.0	15.5
11	0.169	12179.	0.000	0.000	1.00	0.0	0.200	0.100	35.00	4.0	15.5
Toe						0.0	0.150	0.116			

1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
1.854 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
		Pile Damping Fact.(k/ft/s)	0.553
Driveability Analysis			
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Normal			

Gravity Mass, Pile, Hammer: 32.170 32.170 32.170
Output Segment Generation: Automatic

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
2.98	10.81	1.00	0.800

```
INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     4.5     0.0
 Hammer+Pile Weight > Rult: Pile Runs
```


Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min


```
 Depth                  (ft)       3.0
 Shaft Gain/Loss Factor        0.570  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area             (in2)   141.600  Pile Type                    H Pile
 Pile Size           (inch)    12.000
```

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
35.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms)   4.165

Pile and Soil Model   Total Capacity Rut (kips)   0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.169	12179.	0.010	0.000	0.85	0.0	0.000	0.100	3.18	4.0	15.5
2	0.169	12179.	0.000	0.000	1.00	0.0	0.000	0.100	6.36	4.0	15.5
11	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	35.00	4.0	15.5
Toe						0.0	0.150	0.121			

```
     1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
     1.854 kips total reduced pile weight   (g= 32.17 ft/s2)
```

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
3.02	10.81	1.00	0.800

```
INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     4.5     0.0
 Hammer+Pile Weight > Rult: Pile Runs
```

```
    Rut    Bl Ct    Stroke (ft) Ten Str    i    t Comp Str    i    t ENTHRU    Bl Rt
   kips    b/ft    down      up     ksi               ksi          kip-ft    b/min
```

```
WOO-75-29.93 PID 119007                                             08/18/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005

 Depth                  (ft)       5.5
 Shaft Gain/Loss Factor          0.570  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area             (in2)   141.600  Pile Type                    H Pile
 Pile Size           (inch)    12.000

  L b Top     Area     E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
       ft      in2       ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
      0.0    15.50   30000.    492.0      4.0    0.000    16807.     27.7
     35.0    15.50   30000.    492.0      4.0    0.000    16807.     27.7

 Wave Travel Time 2L/c (ms)     4.165

        Pile and Soil Model            Total Capacity Rut  (kips)       0.0
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.169  12179. 0.010 0.000 0.85     0.0   0.000 0.100    3.18   4.0  15.5
  2  0.169  12179. 0.000 0.000 1.00     0.0   0.000 0.100    6.36   4.0  15.5
 10  0.169  12179. 0.000 0.000 1.00     0.0   0.200 0.100   31.82   4.0  15.5
 11  0.169  12179. 0.000 0.000 1.00     0.0   0.150 0.100   35.00   4.0  15.5
Toe                                     0.0   0.150 0.121

     1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
     1.854 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
     5.50     10.81      1.00     0.800


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     4.5     0.0
 Hammer+Pile Weight > Rult: Pile Runs
```


```
WOO-75-29.93 PID 119007                                             08/18/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005

    Rut    Bl Ct    Stroke (ft) Ten Str    i    t Comp Str    i    t ENTHRU    Bl Rt
   kips    b/ft    down      up     ksi               ksi          kip-ft    b/min

WOO-75-29.93 PID 119007                                             08/18/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005
```

Depth (ft) 8.0
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
35.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 4.165

Pile and Soil Model Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.169	12179.	0.010	0.000	0.85	0.0	0.000	0.100	3.18	4.0	15.5
2	0.169	12179.	0.000	0.000	1.00	0.0	0.000	0.100	6.36	4.0	15.5
9	0.169	12179.	0.000	0.000	1.00	0.0	0.200	0.100	28.64	4.0	15.5
10	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	31.82	4.0	15.5
11	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	35.00	4.0	15.5
Toe						0.0	0.150	0.121			

1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
1.854 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
7.98	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 4.5 0.0
Hammer+Pile Weight > Rult: Pile Runs

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

Depth (ft) 8.0
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile

Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
35.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 4.165

Pile and Soil Model — Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.169	12179.	0.010	0.000	0.85	0.0	0.000	0.100	3.18	4.0	15.5
2	0.169	12179.	0.000	0.000	1.00	0.0	0.000	0.100	6.36	4.0	15.5
9	0.169	12179.	0.000	0.000	1.00	0.0	0.200	0.100	28.64	4.0	15.5
10	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	31.82	4.0	15.5
11	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	35.00	4.0	15.5
Toe						0.0	0.150	0.112			

1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
1.854 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
8.02	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 4.5 0.0
Hammer+Pile Weight > Rult: Pile Runs

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

Depth (ft) 22.1
Shaft Gain/Loss Factor 0.570 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

35.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 4.165

Pile and Soil Model   Total Capacity Rut (kips) 60.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.169	12179.	0.010	0.000	0.85	0.0	0.000	0.100	3.18	4.0	15.5
2	0.169	12179.	0.000	0.000	1.00	0.0	0.000	0.100	6.36	4.0	15.5
5	0.169	12179.	0.000	0.000	1.00	0.0	0.177	0.100	15.91	4.0	15.5
6	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	19.09	4.0	15.5
7	0.169	12179.	0.000	0.000	1.00	1.2	0.150	0.100	22.27	4.0	15.5
8	0.169	12179.	0.000	0.000	1.00	8.7	0.150	0.100	25.45	4.0	15.5
9	0.169	12179.	0.000	0.000	1.00	9.1	0.150	0.100	28.64	4.0	15.5
10	0.169	12179.	0.000	0.000	1.00	9.5	0.150	0.100	31.82	4.0	15.5
11	0.169	12179.	0.000	0.000	1.00	9.9	0.150	0.100	35.00	4.0	15.5
Toe						22.2	0.150	0.112			

1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
1.854 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
22.09	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
60.5	6.4	5.17	5.14	-0.44	8	49	20.78	8	3	19.7	51.9

Depth (ft) 27.4
Shaft Gain/Loss Factor 0.570   Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600   Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
35.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 4.165

Pile and Soil Model — Total Capacity Rut (kips) 78.1

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.169	12179.	0.010	0.000	0.85	0.0	0.000	0.100	3.18	4.0	15.5
2	0.169	12179.	0.000	0.000	1.00	0.0	0.000	0.100	6.36	4.0	15.5
3	0.169	12179.	0.000	0.000	1.00	0.0	0.200	0.100	9.55	4.0	15.5
4	0.169	12179.	0.000	0.000	1.00	0.0	0.150	0.100	12.73	4.0	15.5
6	0.169	12179.	0.000	0.000	1.00	6.9	0.150	0.100	19.09	4.0	15.5
7	0.169	12179.	0.000	0.000	1.00	8.9	0.150	0.100	22.27	4.0	15.5
8	0.169	12179.	0.000	0.000	1.00	9.3	0.150	0.100	25.45	4.0	15.5
9	0.169	12179.	0.000	0.000	1.00	9.8	0.150	0.100	28.64	4.0	15.5
10	0.169	12179.	0.000	0.000	1.00	10.2	0.150	0.100	31.82	4.0	15.5
11	0.169	12179.	0.000	0.000	1.00	10.7	0.150	0.100	35.00	4.0	15.5
Toe						22.2	0.150	0.112			

1.854 kips total unreduced pile weight (g= 32.17 ft/s2)
1.854 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
27.38	10.81	1.00	0.800

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TTL Associates Inc GRLWEAP(TM) Version 2005

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
78.1	8.8	5.55	5.61	-0.52	6	42	22.76	6	3	18.4	49.9

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SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.570 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
5.5	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
8.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
8.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
22.1	60.5	38.4	22.2	6.4	20.777	-0.435	5.17	19.7
27.4	78.1	55.9	22.2	8.8	22.763	-0.524	5.55	18.4

Total Driving Time 2 minutes; Total No. of Blows 85

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Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
2.98	35.00	0.00	10.81	1.00	0.80	1.00	1.00
3.02	35.00	0.00	10.81	1.00	0.80	1.00	1.00
5.50	35.00	0.00	10.81	1.00	0.80	1.00	1.00
7.98	35.00	0.00	10.81	1.00	0.80	1.00	1.00
8.02	35.00	0.00	10.81	1.00	0.80	1.00	1.00
22.09	35.00	0.00	10.81	1.00	0.80	1.00	1.00
27.38	35.00	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.00	0.100	0.116	0.200	0.150	1.000	6.000	168.000
2.99	0.00	0.00	0.100	0.116	0.200	0.150	1.000	6.000	168.000
3.01	0.00	0.00	0.100	0.121	0.150	0.150	1.000	6.000	168.000
7.99	0.00	0.00	0.100	0.121	0.150	0.150	1.000	6.000	168.000
8.01	0.00	0.00	0.100	0.112	0.150	0.150	0.778	6.000	168.000
8.89	0.00	0.00	0.100	0.112	0.150	0.150	0.778	6.000	168.000
8.90	1.00	22.17	0.100	0.112	0.150	0.150	0.778	6.000	168.000
17.01	1.12	22.17	0.100	0.112	0.150	0.150	0.778	6.000	168.000
26.01	1.28	22.17	0.100	0.112	0.150	0.150	0.778	6.000	168.000
35.00	1.43	22.17	0.100	0.112	0.150	0.150	0.778	6.000	168.000

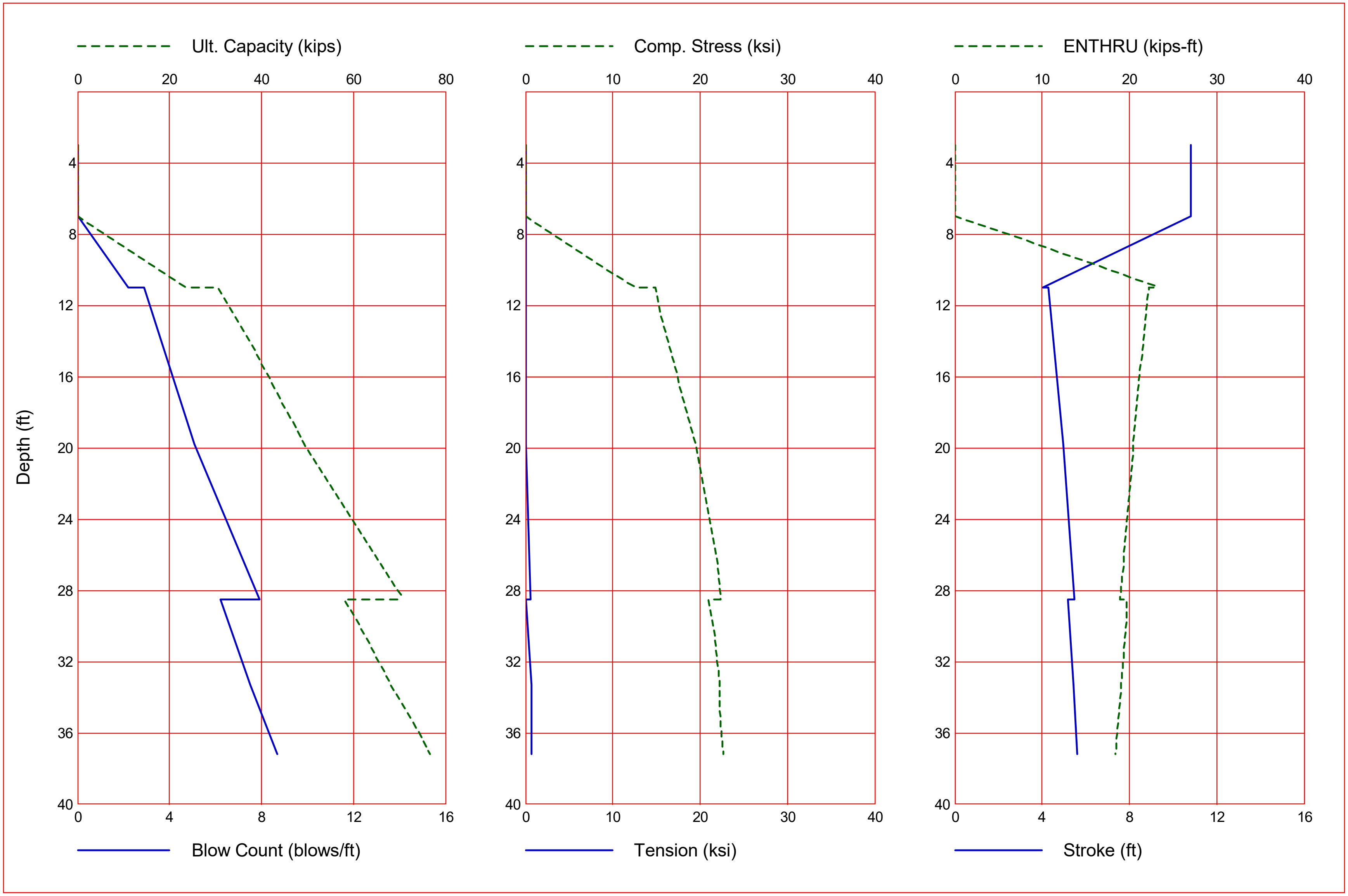
Gain/Loss 1 at Shaft and Toe 0.570 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
5.5	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
8.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
8.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
22.1	60.5	38.4	22.2	6.4	20.777	-0.435	5.17	19.7
27.4	78.1	55.9	22.2	8.8	22.763	-0.524	5.55	18.4

Total Continuous Driving Time 2.00 minutes; Total Number of Blows 85

TTL Associates Inc Aug 18 2023

WOO-75-29.93 PID 119007 Gain/Loss 1 at Shaft and Toe 0.500 / 1.000 GRLWEAP(TM) Version 2005



GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.
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ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

↑

Input File: T:\GEOTECH\GRLWEAP\230574\B-4.GWI
Hammer File: C:\Program Files (x86)\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (8/28/2009)

```
                       Input File Contents
    WOO-75-29.93 PID 119007
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
   Pile g  Hammer g  Toe Area Pile Size           Pile Type
   32.170    32.170   141.600    12.000              H Pile
     W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
    1.900   227.000     530.0     2.000     0.800     0.010       0.0
     A Cu      E Cu      T Cu       CoR      ROut      StCu
    0.000       0.0     0.000     0.000     0.000       0.0
     LPle      APle      EPle      WPle      Peri      Strg       CoR      ROut
   45.000    15.500 30000.000   492.000     3.967     0.000     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42         1        5
   Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
     4.00    129.10     12.60     11.86     10.81      0.80
   IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
     0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
    16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
    P atm        P1        P2        P3        P4        P5
    14.70   1520.00   1368.00   1231.00   1108.00      0.00
   Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
  10.8100    0.8000 1520.0000    0.0000    0.0000    0.0000    0.0100    0.0000
       Qs        Qt        Js        Jt        Qx        Jx      Rati      Dept
    0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
    0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
    0.000     0.000     0.000     0.000
  Res. Distribution
   Dpth    Rskn    Rtoe      Qs      Qt      Js      Jt    SU F    LimD    SU T
   0.01    0.00    0.00    0.10    0.12    0.20    0.15    2.00    6.00  168.00
   2.99    0.00    0.00    0.10    0.12    0.20    0.15    2.00    6.00  168.00
   3.01    0.00    0.00    0.10    0.12    0.20    0.15    2.00    6.00  168.00
   7.39    0.00    0.00    0.10    0.12    0.20    0.15    2.00    6.00  168.00
   7.40    1.14   15.52    0.10    0.12    0.20    0.15    2.00    6.00  168.00
  10.99    1.15   15.52    0.10    0.12    0.20    0.15    2.00    6.00  168.00
  11.01    1.02   22.17    0.10    0.11    0.15    0.15    2.00    6.00  168.00
  20.01    1.17   22.17    0.10    0.11    0.15    0.15    2.00    6.00  168.00
  28.49    1.32   22.17    0.10    0.11    0.15    0.15    2.00    6.00  168.00
  28.51    0.92    9.31    0.10    0.13    0.15    0.15    1.75    6.00  168.00
  37.51    0.97    9.31    0.10    0.13    0.15    0.15    1.75    6.00  168.00
  45.00    0.98    9.31    0.10    0.13    0.15    0.15    1.75    6.00  168.00
  Gain/Loss factors: shaft and toe
  0.50000   0.00000   0.00000   0.00000   0.00000
  1.00000   0.00000   0.00000   0.00000   0.00000
     Dpth         L      Wait      Strk      Pmx%      Eff.      Stff       CoR
     2.98      0.00      0.00     0.000     0.000     0.000     0.000     0.000
```

3.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
7.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000
10.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
11.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
19.75	0.00	0.00	0.000	0.000	0.000	0.000	0.000
28.48	0.00	0.00	0.000	0.000	0.000	0.000	0.000
28.52	0.00	0.00	0.000	0.000	0.000	0.000	0.000
33.29	0.00	0.00	0.000	0.000	0.000	0.000	0.000
37.18	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

Diameter	COGHammer	WHammer	ABatter	Depth Sup	Flag
0.000	0.000	0.000	0.000	0.000	0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

WOO-75-29.93 PID 119007

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		12055.6			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

Depth	(ft)	3.0			
Shaft Gain/Loss Factor		0.500	Toe Gain/Loss Factor		1.000

PILE PROFILE:

Toe Area	(in2)	141.600	Pile Type	H Pile
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.116			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
		Pile Damping Fact.(k/ft/s)	0.553
Driveability Analysis			
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Normal			
Gravity Mass, Pile, Hammer:	32.170	32.170	32.170
Output Segment Generation: Automatic			

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
2.98	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R)   5.0   0.0
Hammer+Pile Weight > Rult: Pile Runs

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

Depth (ft) 3.0
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model   Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.121			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
3.02	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R)   5.0   0.0

Hammer+Pile Weight > Rult: Pile Runs

↑

WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

↑

WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 7.0
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	38.57	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.121			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
7.00	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 5.0 0.0
Hammer+Pile Weight > Rult: Pile Runs

↑

WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt

kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

↑

Depth	(ft)	11.0		
Shaft Gain/Loss Factor		0.500	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	141.600	Pile Type	H Pile
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 23.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	35.36	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	0.8	0.200	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	7.3	0.200	0.100	45.00	4.0	15.5
Toe						15.5	0.150	0.121			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
10.98	10.81	1.00	0.800

↑

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
23.7	2.2	4.04	4.01	0.00	1	0	12.64	1	2	23.5	59.0

↑

Depth	(ft)	11.0		
Shaft Gain/Loss Factor		0.500	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	141.600	Pile Type	H Pile
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model						Total Capacity Rut	(kips)	30.4			
No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	35.36	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	0.9	0.200	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	7.3	0.200	0.100	45.00	4.0	15.5
Toe						22.2	0.150	0.112			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
11.02	10.81	1.00	0.800

↑

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Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
30.4	2.9	4.29	4.31	0.00	1	0	14.92	1	2	22.2	57.1

↑

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Depth	(ft)	19.8		
Shaft Gain/Loss Factor		0.500	Toe Gain/Loss Factor	1.000

PILE PROFILE:

Toe Area	(in2)	141.600	Pile Type	H Pile
Pile Size	(inch)	12.000		

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 49.3

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
8	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	25.71	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	6.2	0.200	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	6.8	0.165	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	6.9	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	7.3	0.150	0.100	45.00	4.0	15.5
Toe						22.2	0.150	0.112			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
19.75	10.81	1.00	0.800

↑
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Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
49.3	5.1	4.95	4.92	0.00	1	0	19.43	11	4	20.4	53.1

↑
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Depth (ft) 28.5
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 70.9

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	19.29	4.0	15.5
8	0.170	12056.	0.000	0.000	1.00	4.1	0.200	0.100	25.71	4.0	15.5
9	0.170	12056.	0.000	0.000	1.00	7.0	0.179	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	6.8	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	7.2	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	7.5	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	7.9	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	8.2	0.150	0.100	45.00	4.0	15.5
Toe						22.2	0.150	0.112			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
28.48	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
70.9	7.9	5.50	5.49	-0.63	8	47	22.32	8	3	18.9	50.3

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Depth (ft) 28.5
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 58.1

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	19.29	4.0	15.5

8	0.170	12056.	0.000	0.000	1.00	4.2	0.200	0.100	25.71	4.0	15.5
9	0.170	12056.	0.000	0.000	1.00	7.0	0.179	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	6.8	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	7.2	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	7.5	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	7.9	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	8.2	0.150	0.100	45.00	4.0	15.5
Toe						9.3	0.150	0.130			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
28.52	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
58.1	6.2	5.20	5.18	0.00	1	0	21.00	8	3	19.7	51.8

Depth (ft) 33.3
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 68.2

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
4	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	12.86	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	0.4	0.200	0.100	19.29	4.0	15.5
7	0.170	12056.	0.000	0.000	1.00	7.3	0.200	0.100	22.50	4.0	15.5
8	0.170	12056.	0.000	0.000	1.00	6.7	0.154	0.100	25.71	4.0	15.5

9	0.170	12056.	0.000	0.000	1.00	7.0	0.150	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	7.4	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	7.7	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	8.1	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	7.6	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	6.8	0.150	0.100	45.00	4.0	15.5
Toe						9.3	0.150	0.130			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
33.29	10.81	1.00	0.800

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Rut	Bl Ct	Stroke (ft) down	Stroke (ft) up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft			ksi			ksi			kip-ft	b/min
68.2	7.5	5.45	5.44	-0.65	7	48	22.25	7	3	19.0	50.5

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Depth (ft) 37.2
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 76.7

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
3	0.170	12056.	0.000	0.000	1.00	0.0	0.200	0.100	9.64	4.0	15.5
5	0.170	12056.	0.000	0.000	1.00	1.9	0.200	0.100	16.07	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	7.2	0.193	0.100	19.29	4.0	15.5
7	0.170	12056.	0.000	0.000	1.00	6.7	0.150	0.100	22.50	4.0	15.5
8	0.170	12056.	0.000	0.000	1.00	7.1	0.150	0.100	25.71	4.0	15.5

9	0.170	12056.	0.000	0.000	1.00	7.4	0.150	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	7.8	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	8.1	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	7.3	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	6.9	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	7.0	0.150	0.100	45.00	4.0	15.5
Toe						9.3	0.150	0.130			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
37.18	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
76.7	8.7	5.60	5.64	-0.74	11	10	22.66	6	3	18.4	49.7

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.500 1.000

Depth ft	Rut kips	Frictn kips	End Bg kips	Bl Ct bl/ft	Com Str ksi	Ten Str ksi	Stroke ft	ENTHRU kip-ft
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
7.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
11.0	23.7	8.1	15.5	2.2	12.639	0.000	4.04	23.5
11.0	30.4	8.2	22.2	2.9	14.920	0.000	4.29	22.2
19.8	49.3	27.2	22.2	5.1	19.428	0.000	4.95	20.4
28.5	70.9	48.7	22.2	7.9	22.322	-0.628	5.50	18.9
28.5	58.1	48.8	9.3	6.2	20.996	0.000	5.20	19.7
33.3	68.2	58.9	9.3	7.5	22.253	-0.655	5.45	19.0
37.2	76.7	67.4	9.3	8.7	22.656	-0.744	5.60	18.4

Total Driving Time 3 minutes; Total No. of Blows 161

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
2.98	45.00	0.00	10.81	1.00	0.80	1.00	1.00
3.02	45.00	0.00	10.81	1.00	0.80	1.00	1.00
7.00	45.00	0.00	10.81	1.00	0.80	1.00	1.00
10.98	45.00	0.00	10.81	1.00	0.80	1.00	1.00
11.02	45.00	0.00	10.81	1.00	0.80	1.00	1.00
19.75	45.00	0.00	10.81	1.00	0.80	1.00	1.00
28.48	45.00	0.00	10.81	1.00	0.80	1.00	1.00
28.52	45.00	0.00	10.81	1.00	0.80	1.00	1.00
33.29	45.00	0.00	10.81	1.00	0.80	1.00	1.00
37.18	45.00	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.00	0.100	0.116	0.200	0.150	1.000	6.000	168.000
2.99	0.00	0.00	0.100	0.116	0.200	0.150	1.000	6.000	168.000
3.01	0.00	0.00	0.100	0.121	0.200	0.150	1.000	6.000	168.000
7.39	0.00	0.00	0.100	0.121	0.200	0.150	1.000	6.000	168.000
7.40	1.14	15.52	0.100	0.121	0.200	0.150	1.000	6.000	168.000
10.99	1.15	15.52	0.100	0.121	0.200	0.150	1.000	6.000	168.000
11.01	1.02	22.17	0.100	0.112	0.150	0.150	1.000	6.000	168.000
20.01	1.17	22.17	0.100	0.112	0.150	0.150	1.000	6.000	168.000
28.49	1.32	22.17	0.100	0.112	0.150	0.150	1.000	6.000	168.000
28.51	0.92	9.31	0.100	0.130	0.150	0.150	0.857	6.000	168.000
37.51	0.97	9.31	0.100	0.130	0.150	0.150	0.857	6.000	168.000
45.00	0.98	9.31	0.100	0.130	0.150	0.150	0.857	6.000	168.000

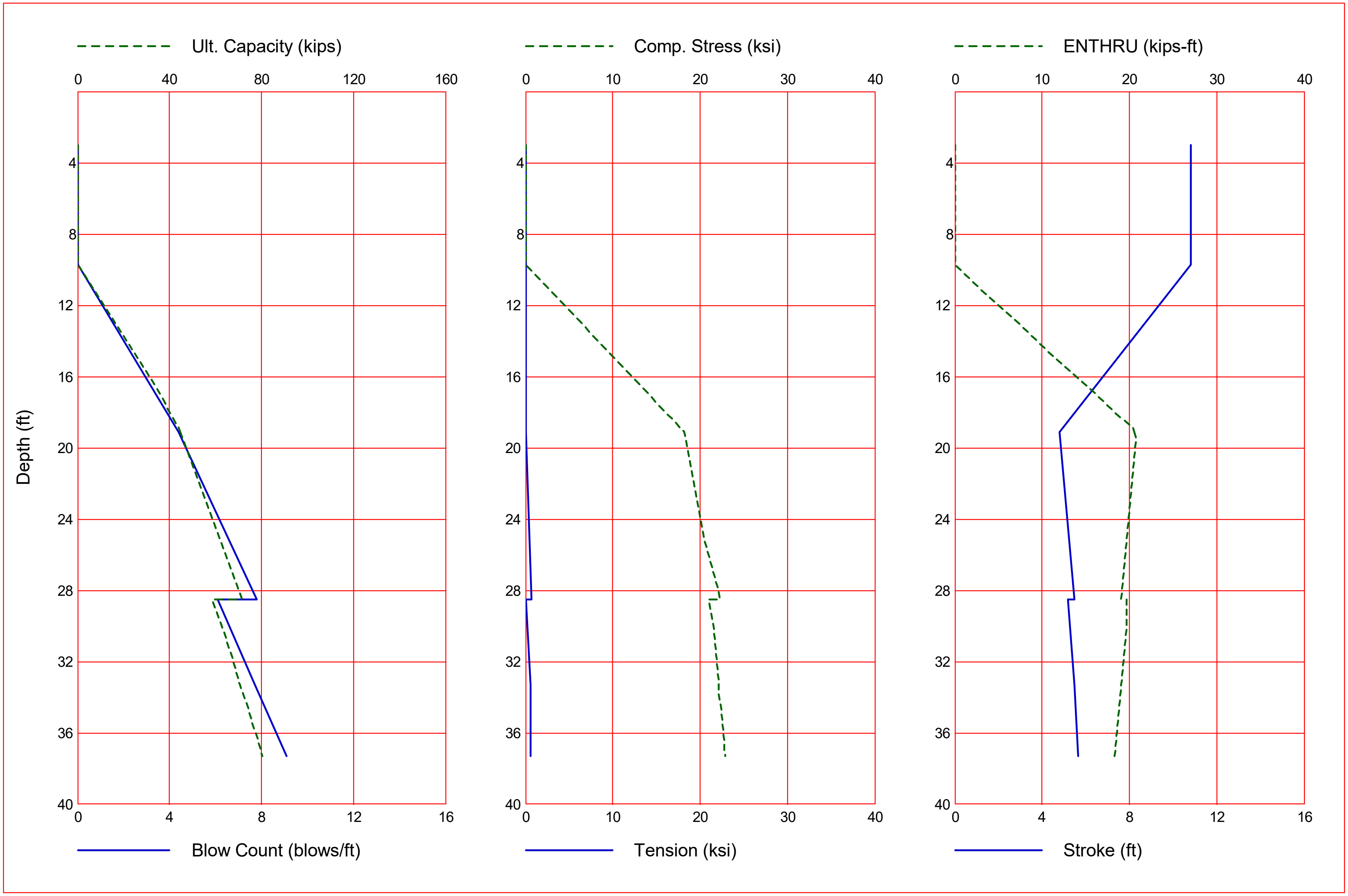
Gain/Loss 1 at Shaft and Toe 0.500 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
7.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
11.0	23.7	8.1	15.5	2.2	12.639	0.000	4.04	23.5
11.0	30.4	8.2	22.2	2.9	14.920	0.000	4.29	22.2
19.8	49.3	27.2	22.2	5.1	19.428	0.000	4.95	20.4
28.5	70.9	48.7	22.2	7.9	22.322	-0.628	5.50	18.9
28.5	58.1	48.8	9.3	6.2	20.996	0.000	5.20	19.7
33.3	68.2	58.9	9.3	7.5	22.253	-0.655	5.45	19.0
37.2	76.7	67.4	9.3	8.7	22.656	-0.744	5.60	18.4

Total Continuous Driving Time 3.00 minutes; Total Number of Blows 161

TTL Associates Inc — Aug 18 2023

WOO-75-29.93 PID 119007 — Gain/Loss 1 at Shaft and Toe 0.500 / 1.000 — GRLWEAP(TM) Version 2005



GRLWEAP - Version 2005
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.
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ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local non-axial stresses and prestress effects must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: T:\GEOTECH\GRLWEAP\230574\B-5.GWI
Hammer File: C:\Program Files (x86)\PDI\GRLWEAP 2005\HAMMER2003.GW
Hammer File Version: 2003 (8/28/2009)

```
                        Input File Contents
     WOO-75-29.93 PID 119007
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
-100   0  41   0   0   0  0   0   0   1   0   0  0   0   0   0   0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.170    32.170   141.600    12.000              H Pile
      W Cp      A Cp      E Cp      T Cp       CoR      ROut      StCp
     1.900   227.000     530.0     2.000     0.800     0.010       0.0
      A Cu      E Cu      T Cu       CoR      ROut      StCu
     0.000       0.0     0.000     0.000     0.000       0.0
      LPle      APle      EPle      WPle      Peri      Strg       CoR      ROut
    45.000    15.500 30000.000   492.000     3.967     0.000     0.850     0.010
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-42         1        5
    Ram Wt     Ram L   Ram Dia   MaxStrk   RtdStrk    Efficy
      4.00    129.10     12.60     11.86     10.81      0.80
    IB. Wt     IB. L    IB.Dia    IB CoR     IB RO
      0.75     25.30     12.60     0.900     0.010
  CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
     16.65    124.70    157.70     0.002     0.002     1.250      0.00      0.00
     P atm        P1        P2        P3        P4        P5
     14.70   1520.00   1368.00   1231.00   1108.00      0.00
    Stroke    Effic.  Pressure  R-Weight   T-Delay Exp-Coeff   Eps-Str  Total-AW
   10.8100    0.8000 1520.0000    0.0000    0.0000    0.0000    0.0100    0.0000
        Qs        Qt        Js        Jt        Qx        Jx      Rati      Dept
     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
  Research Soil Model: Atoe, Plug,  Gap, Q-fac
     0.000     0.000     0.000     0.000
  Research Soil Model: RD-skn: m, d, toe: m, d
     0.000     0.000     0.000     0.000
  Res. Distribution
    Dpth    Rskn    Rtoe      Qs      Qt      Js      Jt    SU F    LimD    SU T
    0.01    0.00    0.00    0.10    0.12    0.15    0.15    1.75    6.00  168.00
    2.99    0.00    0.00    0.10    0.12    0.15    0.15    1.75    6.00  168.00
    3.01    0.00    0.00    0.10    0.12    0.15    0.15    2.00    6.00  168.00
    9.69    0.00    0.00    0.10    0.12    0.15    0.15    2.00    6.00  168.00
    9.71    0.00    0.00    0.10    0.11    0.15    0.15    1.75    6.00  168.00
    9.79    0.00    0.00    0.10    0.11    0.15    0.15    1.75    6.00  168.00
    9.80    1.00   22.17    0.10    0.11    0.15    0.15    1.75    6.00  168.00
   18.71    1.15   22.17    0.10    0.11    0.15    0.15    1.75    6.00  168.00
   27.71    1.31   22.17    0.10    0.11    0.15    0.15    1.75    6.00  168.00
   28.49    1.32   22.17    0.10    0.11    0.15    0.15    1.75    6.00  168.00
   28.51    0.92    9.31    0.10    0.13    0.15    0.15    1.50    6.00  168.00
   37.51    0.97    9.31    0.10    0.13    0.15    0.15    1.50    6.00  168.00
   45.00    0.98    9.31    0.10    0.13    0.15    0.15    1.50    6.00  168.00
  Gain/Loss factors: shaft and toe
   0.50000   0.00000   0.00000   0.00000   0.00000
   1.00000   1.00000   1.00000   1.00000   1.00000
      Dpth         L      Wait      Strk      Pmx%      Eff.      Stff       CoR
```

2.98	0.00	0.00	0.000	0.000	0.000	0.000	0.000
3.02	0.00	0.00	0.000	0.000	0.000	0.000	0.000
6.35	0.00	0.00	0.000	0.000	0.000	0.000	0.000
9.68	0.00	0.00	0.000	0.000	0.000	0.000	0.000
9.72	0.00	0.00	0.000	0.000	0.000	0.000	0.000
19.10	0.00	0.00	0.000	0.000	0.000	0.000	0.000
28.48	0.00	0.00	0.000	0.000	0.000	0.000	0.000
28.52	0.00	0.00	0.000	0.000	0.000	0.000	0.000
33.34	0.00	0.00	0.000	0.000	0.000	0.000	0.000
37.28	0.00	0.00	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000

Diameter	COGHammer	WHammer	ABatter	Depth Sup	Flag
0.000	0.000	0.000	0.000	0.000	0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2005
English Units

WOO-75-29.93 PID 119007

Hammer Model: D 19-42 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.7	1.000	0.0100	
3	0.800	140046.7	1.000	0.0100	
4	0.800	140046.7	1.000	0.0100	
5	0.800	140046.7	1.000	0.0100	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		12055.6			

HAMMER OPTIONS:

Hammer File ID No.	41	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.86			
Rated Stroke	(ft)	10.81	Efficiency		0.800
Maximum Pressure	(psi)	1520.00	Actual Pressure	(psi)	1520.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		1.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

Depth (ft) 3.0
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.116			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:
Uniform pile Pile Segments: Automatic
No. of Slacks/Splices 0 Pile Damping (%) 1
Pile Damping Fact.(k/ft/s) 0.553
Driveability Analysis
Soil Damping Option Smith
Max No Analysis Iterations 0 Time Increment/Critical 160
Output Time Interval 1 Analysis Time-Input (ms) 0
Output Level: Normal
Gravity Mass, Pile, Hammer: 32.170 32.170 32.170

Output Segment Generation: Automatic

Depth ft	Stroke ft	Pressure Ratio	Efficy
2.98	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 5.0 0.0
Hammer+Pile Weight > Rult: Pile Runs

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min

Depth (ft) 3.0
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 0.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.121			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
3.02	10.81	1.00	0.800

```
INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     5.0     0.0
 Hammer+Pile Weight > Rult: Pile Runs
↑
WOO-75-29.93 PID 119007                                           08/18/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005

    Rut   Bl Ct   Stroke (ft) Ten Str   i   t Comp Str   i   t ENTHRU   Bl Rt
   kips    b/ft   down     up     ksi             ksi         kip-ft   b/min
↑
WOO-75-29.93 PID 119007                                           08/18/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005

 Depth                (ft)       6.3
 Shaft Gain/Loss Factor        0.500  Toe Gain/Loss Factor          1.000

 PILE PROFILE:
 Toe Area            (in2)   141.600  Pile Type                    H Pile
 Pile Size          (inch)    12.000

  L b Top     Area    E-Mod  Spec Wt    Perim Strength  Wave Sp      EA/c
       ft      in2      ksi   lb/ft3       ft      ksi     ft/s    k/ft/s
      0.0    15.50   30000.    492.0      4.0    0.000   16807.      27.7
     45.0    15.50   30000.    492.0      4.0    0.000   16807.      27.7

 Wave Travel Time 2L/c (ms)     5.355

       Pile and Soil Model            Total Capacity Rut  (kips)       0.0
No. Weight  Stiffn C-Slk T-Slk  CoR  Soil-S  Soil-D Quake   LbTop Perim  Area
      kips    k/in    ft    ft         kips    s/ft  inch      ft    ft   in2
  1  0.170  12056. 0.010 0.000 0.85     0.0   0.000 0.100    3.21   4.0  15.5
  2  0.170  12056. 0.000 0.000 1.00     0.0   0.000 0.100    6.43   4.0  15.5
 13  0.170  12056. 0.000 0.000 1.00     0.0   0.150 0.100   41.79   4.0  15.5
 14  0.170  12056. 0.000 0.000 1.00     0.0   0.150 0.100   45.00   4.0  15.5
Toe                                     0.0   0.150 0.121

     2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
     2.383 kips total reduced pile weight   (g= 32.17 ft/s2)


    Depth    Stroke  Pressure    Efficy
       ft        ft     Ratio
     6.35     10.81      1.00     0.800


INITIAL STATIC ANALYSIS: Total Wt, Sum(R)     5.0     0.0
 Hammer+Pile Weight > Rult: Pile Runs
↑
WOO-75-29.93 PID 119007                                           08/18/2023
TTL Associates Inc                                   GRLWEAP(TM) Version 2005
```

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

↑

Depth (ft) 9.7
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	35.36	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.121			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
9.68	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 5.0 0.0
Hammer+Pile Weight > Rult: Pile Runs

↑

WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

↑

WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 9.7
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model   Total Capacity Rut (kips) 0.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	35.36	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	45.00	4.0	15.5
Toe						0.0	0.150	0.112			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
9.72	10.81	1.00	0.800

INITIAL STATIC ANALYSIS: Total Wt, Sum(R) 5.0 0.0
Hammer+Pile Weight > Rult: Pile Runs

Rut	Bl Ct	Stroke (ft) down	up	Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min

Depth (ft) 19.1
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 44.9

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
9	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	28.93	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	6.7	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	7.8	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	8.2	0.150	0.100	45.00	4.0	15.5
Toe						22.2	0.150	0.112			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
19.10	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
44.9	4.4	4.78	4.75	0.00	1	0	18.19	8	3	20.9	54.2

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Depth (ft) 28.5
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 71.3

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	19.29	4.0	15.5
9	0.170	12056.	0.000	0.000	1.00	6.1	0.150	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	7.8	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	8.2	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	8.6	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	9.0	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	9.4	0.150	0.100	45.00	4.0	15.5
Toe						22.2	0.150	0.112			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
28.48	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
71.3	7.8	5.48	5.46	-0.70	9	47	22.35	9	3	19.0	50.4

Depth (ft) 28.5
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 58.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2

1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	19.29	4.0	15.5
9	0.170	12056.	0.000	0.000	1.00	6.2	0.150	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	7.8	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	8.2	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	8.6	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	9.0	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	9.4	0.150	0.100	45.00	4.0	15.5
Toe						9.3	0.150	0.130			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth ft	Stroke ft	Pressure Ratio	Efficy
28.52	10.81	1.00	0.800

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
58.5	6.1	5.18	5.15	0.00	1	0	20.96	9	3	19.7	51.9

Depth (ft) 33.3
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	Strength ksi	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model Total Capacity Rut (kips) 70.5

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
4	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	12.86	4.0	15.5
7	0.170	12056.	0.000	0.000	1.00	2.4	0.150	0.100	22.50	4.0	15.5

8	0.170	12056.	0.000	0.000	1.00	7.6	0.150	0.100	25.71	4.0	15.5
9	0.170	12056.	0.000	0.000	1.00	8.0	0.150	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	8.4	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	8.8	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	9.2	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	8.7	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	8.0	0.150	0.100	45.00	4.0	15.5
Toe						9.3	0.150	0.130			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
33.34	10.81	1.00	0.800

↑
WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
70.5	7.7	5.47	5.45	-0.62	7	48	22.11	8	3	19.0	50.4

↑
WOO-75-29.93 PID 119007 08/18/2023
TTL Associates Inc GRLWEAP(TM) Version 2005

Depth (ft) 37.3
Shaft Gain/Loss Factor 0.500 Toe Gain/Loss Factor 1.000

PILE PROFILE:
Toe Area (in2) 141.600 Pile Type H Pile
Pile Size (inch) 12.000

L b Top	Area	E-Mod	Spec Wt	Perim	Strength	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft	ksi	ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7
45.0	15.50	30000.	492.0	4.0	0.000	16807.	27.7

Wave Travel Time 2L/c (ms) 5.355

Pile and Soil Model — Total Capacity Rut (kips) 80.5

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.170	12056.	0.010	0.000	0.85	0.0	0.000	0.100	3.21	4.0	15.5
2	0.170	12056.	0.000	0.000	1.00	0.0	0.000	0.100	6.43	4.0	15.5
3	0.170	12056.	0.000	0.000	1.00	0.0	0.150	0.100	9.64	4.0	15.5
6	0.170	12056.	0.000	0.000	1.00	4.1	0.150	0.100	19.29	4.0	15.5
7	0.170	12056.	0.000	0.000	1.00	7.7	0.150	0.100	22.50	4.0	15.5
8	0.170	12056.	0.000	0.000	1.00	8.1	0.150	0.100	25.71	4.0	15.5

9	0.170	12056.	0.000	0.000	1.00	8.5	0.150	0.100	28.93	4.0	15.5
10	0.170	12056.	0.000	0.000	1.00	8.9	0.150	0.100	32.14	4.0	15.5
11	0.170	12056.	0.000	0.000	1.00	9.3	0.150	0.100	35.36	4.0	15.5
12	0.170	12056.	0.000	0.000	1.00	8.4	0.150	0.100	38.57	4.0	15.5
13	0.170	12056.	0.000	0.000	1.00	8.0	0.150	0.100	41.79	4.0	15.5
14	0.170	12056.	0.000	0.000	1.00	8.2	0.150	0.100	45.00	4.0	15.5
Toe						9.3	0.150	0.130			

2.383 kips total unreduced pile weight (g= 32.17 ft/s2)
2.383 kips total reduced pile weight (g= 32.17 ft/s2)

Depth	Stroke	Pressure	Efficy
ft	ft	Ratio	
37.28	10.81	1.00	0.800

Rut	Bl Ct	Stroke (ft)		Ten Str	i	t	Comp Str	i	t	ENTHRU	Bl Rt
kips	b/ft	down	up	ksi			ksi			kip-ft	b/min
80.5	9.1	5.65	5.69	-0.54	7	43	22.90	6	3	18.3	49.5

SUMMARY OVER DEPTHS

G/L at Shaft and Toe: 0.500 1.000

Depth	Rut	Frictn	End Bg	Bl Ct	Com Str	Ten Str	Stroke	ENTHRU
ft	kips	kips	kips	bl/ft	ksi	ksi	ft	kip-ft
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
6.3	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
9.7	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
9.7	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
19.1	44.9	22.8	22.2	4.4	18.192	0.000	4.78	20.9
28.5	71.3	49.1	22.2	7.8	22.346	-0.697	5.48	19.0
28.5	58.5	49.2	9.3	6.1	20.957	0.000	5.18	19.7
33.3	70.5	61.2	9.3	7.7	22.108	-0.622	5.47	19.0
37.3	80.5	71.1	9.3	9.1	22.898	-0.540	5.65	18.3

Total Driving Time 3 minutes; Total No. of Blows 144

Table of Depths Analyzed with Driving System Modifiers

Depth ft	Temp. Length ft	Wait Time hr	Equivalent Stroke ft	Pressure Ratio	Efficy.	Stiffn. Factor	Cushion CoR
2.98	45.00	0.00	10.81	1.00	0.80	1.00	1.00
3.02	45.00	0.00	10.81	1.00	0.80	1.00	1.00
6.35	45.00	0.00	10.81	1.00	0.80	1.00	1.00
9.68	45.00	0.00	10.81	1.00	0.80	1.00	1.00
9.72	45.00	0.00	10.81	1.00	0.80	1.00	1.00
19.10	45.00	0.00	10.81	1.00	0.80	1.00	1.00
28.48	45.00	0.00	10.81	1.00	0.80	1.00	1.00
28.52	45.00	0.00	10.81	1.00	0.80	1.00	1.00
33.34	45.00	0.00	10.81	1.00	0.80	1.00	1.00
37.28	45.00	0.00	10.81	1.00	0.80	1.00	1.00

Soil Layer Resistance Values

Depth ft	Shaft Res. k/ft2	End Bearing kips	Shaft Quake inch	Toe Quake inch	Shaft Damping s/ft	Toe Damping s/ft	Soil Setup Normlzd	Limit Distance ft	Setup Time hrs
0.01	0.00	0.00	0.100	0.116	0.150	0.150	0.857	6.000	168.000
2.99	0.00	0.00	0.100	0.116	0.150	0.150	0.857	6.000	168.000
3.01	0.00	0.00	0.100	0.121	0.150	0.150	1.000	6.000	168.000
9.69	0.00	0.00	0.100	0.121	0.150	0.150	1.000	6.000	168.000
9.71	0.00	0.00	0.100	0.112	0.150	0.150	0.857	6.000	168.000
9.79	0.00	0.00	0.100	0.112	0.150	0.150	0.857	6.000	168.000
9.80	1.00	22.17	0.100	0.112	0.150	0.150	0.857	6.000	168.000
18.71	1.15	22.17	0.100	0.112	0.150	0.150	0.857	6.000	168.000
27.71	1.31	22.17	0.100	0.112	0.150	0.150	0.857	6.000	168.000
28.49	1.32	22.17	0.100	0.112	0.150	0.150	0.857	6.000	168.000
28.51	0.92	9.31	0.100	0.130	0.150	0.150	0.667	6.000	168.000
37.51	0.97	9.31	0.100	0.130	0.150	0.150	0.667	6.000	168.000
45.00	0.98	9.31	0.100	0.130	0.150	0.150	0.667	6.000	168.000

Gain/Loss 1 at Shaft and Toe 0.500 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
6.3	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
9.7	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
9.7	0.0	0.0	0.0	0.0	0.000	0.000	10.81	0.0
19.1	44.9	22.8	22.2	4.4	18.192	0.000	4.78	20.9
28.5	71.3	49.1	22.2	7.8	22.346	-0.697	5.48	19.0
28.5	58.5	49.2	9.3	6.1	20.957	0.000	5.18	19.7
33.3	70.5	61.2	9.3	7.7	22.108	-0.622	5.47	19.0
37.3	80.5	71.1	9.3	9.1	22.898	-0.540	5.65	18.3

Total Continuous Driving Time 3.00 minutes; Total Number of Blows 144

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

WOO-75-29.93
119007
Proposed Bridge Replacement
Interstate Route 75 and Lime City Road, Rossford, Wood County, Ohio

TTL Associates, Inc.

Prepared By: Katherine C. Hennicken, P.E.
Date prepared: Wednesday, July 12, 2023

Katherine C. Hennicken, P.E.
TTL Associates, Inc.
1915 North 12th Street,
Toledo, Ohio 43604
419-214-5026
khennicken@ttlassoc.com

NO. OF BORINGS: 3

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	Lime City Road				CME 75 Truck 844	73	636.1	636.8	0.7 F
2	B-002-0-23	Lime City Road				CME 75 Truck 844	73	646.1	646.8	0.7 F
3	B-006-0-23	Lime City Road				CME 75 Truck 844	73	643.9	644.6	0.7 F

Ohio Department of Transportation

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.2	3.0	1.9	3.7	12		3.25	33	16	17	25	47	72	19	16	A-6b	10	250					No Undercut
	001-0	SS-2	3.0	4.5	3.7	5.2	13		4.5	30	14	16	23	46	69	14	16	A-6b	9						
	23	SS-3	4.5	6.0	5.2	6.7	29		4.5							15	16	A-6b							
		SS-4	6.0	7.5	6.7	8.2	30	12	4							17	16	A-6b							
2	B	SS-1	1.7	3.0	2.4	3.7	12			31	15	16	25	49	74	13	16	A-6b	10	250					No Undercut
	002-0	SS-2	3.0	4.5	3.7	5.2	13		4.5	33	16	17	24	55	79	18	16	A-6b	11						
	23	SS-3	4.5	6.0	5.2	6.7	24		3							16	16	A-6b							
		SS-4	6.0	7.5	6.7	8.2	15	12								10	16	A-6b							
3	B	SS-1	1.3	3.0	2.0	3.7	12		4.5	20	12	8	24	43	67	13	10	A-4a	6	240					No Undercut
	006-0	SS-2	3.0	4.5	3.7	5.2	15		3.75	33	16	17	26	43	69	17	16	A-6b	10						
	23	SS-3	4.5	7.0	5.2	7.7	30		4.5	19	12	7	43	28	71	14	10	A-4a							
		SS-4	7.0	7.5	7.7	8.2	13	12	4.5							21	16	A-6b							

PID: 119007

County-Route-Section: WOO-75-29.93
No. of Borings: 3

Geotechnical Consultant: TTL Associates, Inc.
Prepared By: Katherine C. Hennicken, P.E.
Date prepared: 7/12/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12''

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	 12'' 0''
Global Geogrid Average(N60L): Average(HP):	 0'' 0''

Design CBR	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	0%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	56%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	33%	HP > 2	89%
M+	0%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	
Maximum	0''
Minimum	0''

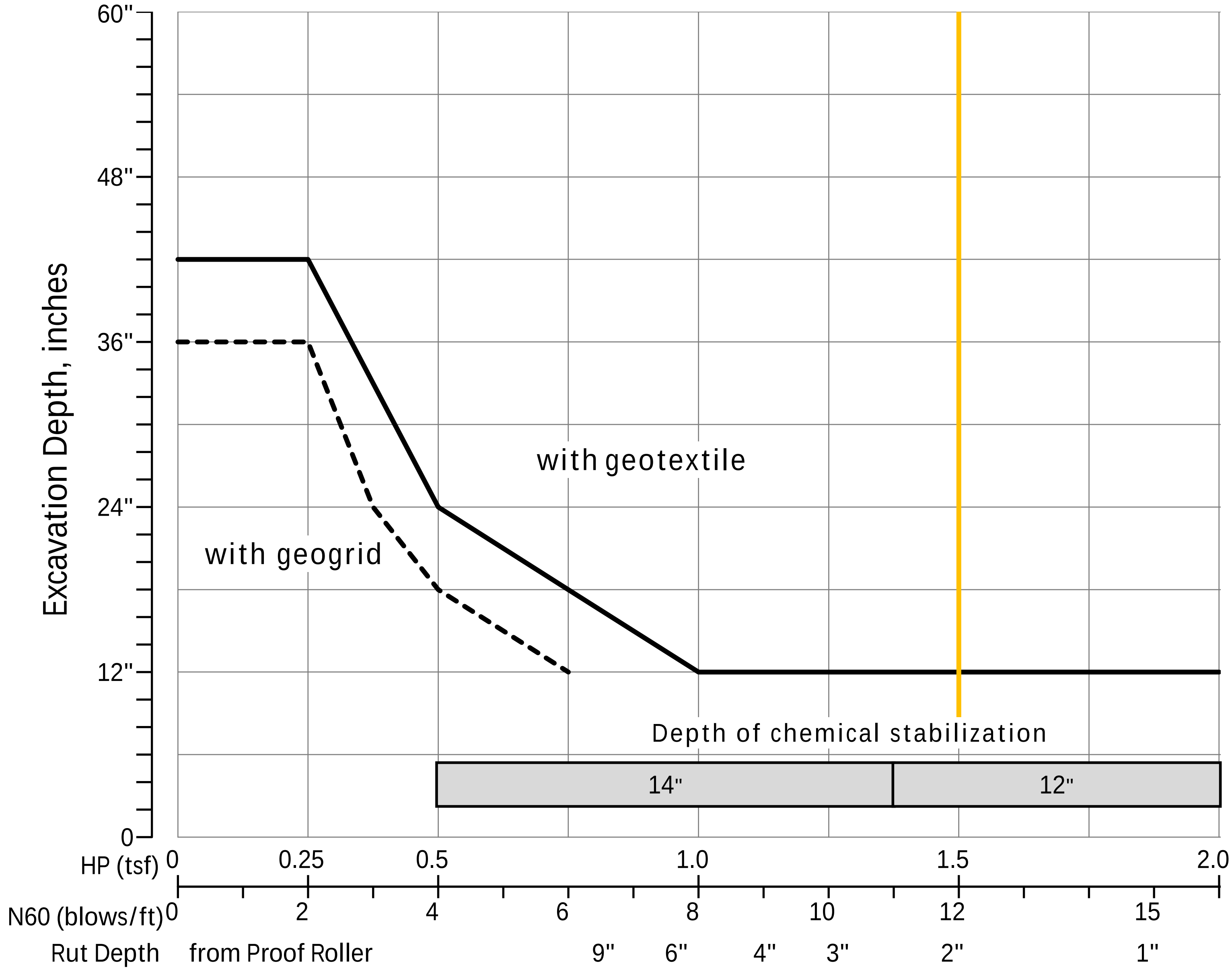
% Proposed Subgrade Surface	
Unstable & Unsuitable	0%
Unstable	0%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	18	12	4.10	28	14	14	27	44	72	16	15	9
Maximum	30	12	4.50	33	16	17	43	55	79	21	16	11
Minimum	12	12	3.00	19	12	7	23	28	67	10	10	6

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	2	0	0	0	10	0	0	0	0	12
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	0%	0%	0%	83%	0%	0%	0%	0%	100%
% Rock|Granular|Cohesive	0%	17%									83%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	3
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	33%	0%	0%	0%	67%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

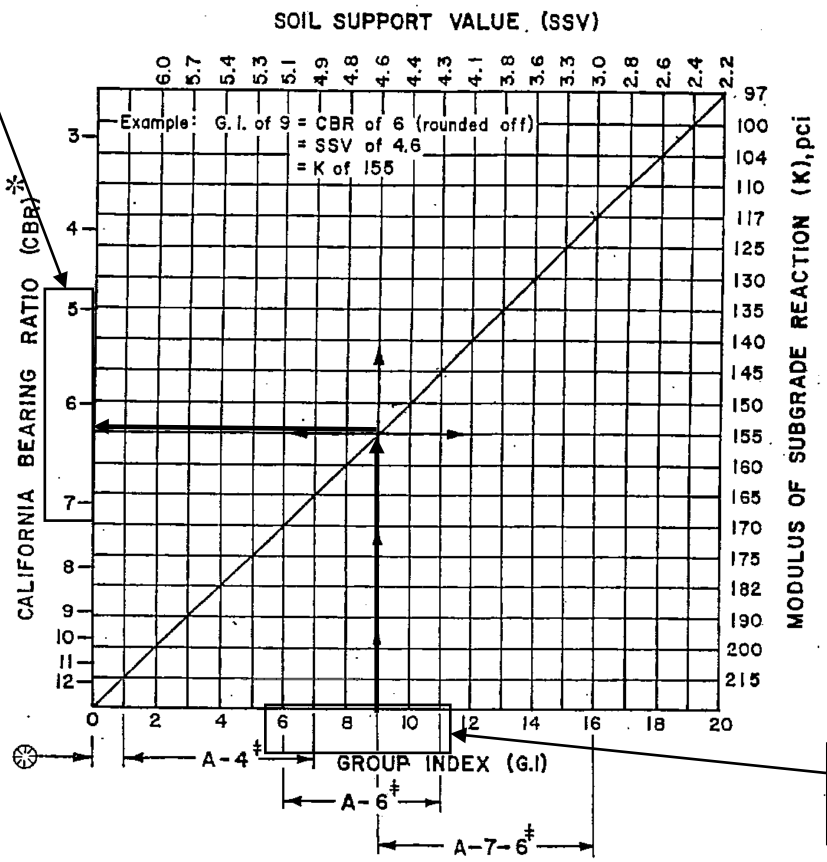
Calculated Average	New Values	Check to Override
4.10		☐ HP
12.00		☐ N60L

Average HP
Average N_{60L}

WOO-75-29.93, PID 119007

Range of GI from 6 to 11 for pavement subgrade samples corresponds to CBR values ranging from 5 to 7 percent. Average GI of 9 corresponds with CBR of 6 percent.

Fig.1301-3
Feb.1978



Range of GI for pavement subgrade samples: 6 to 11 for A-4a and A-6b soils. Average GI was 9.

⊛ AASHTO Classes A-1, A-2 & A-3 lie below 0. SSV=6-10; K=200+.

‡ Usual range of AASHTO Classes.

✲ 5-1/2 Lb. hammer, 12" drop, 4 layers, 45 blows per layer, compacted at optimum moisture as determined by AASHTO T-99.

CORRELATION CHART FOR
SUBGRADE STRENGTHS

Based on the subgrade analysis, a design CBR value of 6 percent was determined for the project. It should be noted that the CBR determination by the subgrade analysis spreadsheet is based on the **average** Group Index of all the evaluated samples, which was 9. Group indices for the tested samples ranged from 6 to 11, which would correlate with a CBR value of 5 to 7 percent. Based on the average design value calculations from the subgrade analysis spreadsheet, it does not appear to be unconservative to use the spreadsheet design CBR value of 6 percent for new pavement sections throughout the project area.

Appendix B:
Geotechnical Engineering Design Checklists

I. Geotechnical Design Checklists

Project: WOO-75-29.93	**PDP Path:**
PID: 119007	**Review Stage:**

Checklist	**Included in This Submission**
II. Reconnaissance and Planning	✓
III. A. Centerline Cuts	
III. B. Embankments	✓
III. C. Subgrade	✓
IV. A. Foundations of Structures	✓
IV. B. Retaining Wall	
V. A. Landslide Remediation	
V. B. Rockfall Remediation	
V. C. Wetland or Peat Remediation	
V. D. Underground Mine Remediation	
V. E. Surface Mine Remediation	
V. F. Karst Remediation	
VI. A. Geotechnical Profile	
VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S: WOO-75-29.93	PID: 119007	Reviewer: KCH	Date: 8/22/2023

Reconnaissance		(Y/N/X)	Notes:
1	Based on Section 302.1 in the SGE, have the necessary plans been developed in the following areas prior to the commencement of the subsurface exploration reconnaissance:	X	Plans to be prepared by others.
	Roadway plans		
	Structures plans		
	Geohazards plans		
2	Have the resources listed in Section 302.2.1 of the SGE been reviewed as part of the office reconnaissance?	Y	
3	Have all the features listed in Section 302.3 of the SGE been observed and evaluated during the field reconnaissance?	Y	
4	If notable features were discovered in the field reconnaissance, were the GPS coordinates of these features recorded?	X	
Planning - General		(Y/N/X)	Notes:
5	In planning the geotechnical exploration program for the project, have the specific geologic conditions, the proposed work, and historic subsurface exploration work been considered?	Y	
6	Has the ODOT Transportation Information Mapping System (TIMS) been accessed to find all available historic boring information and inventoried geohazards?	Y	
7	Have the borings been located to develop the maximum subsurface information while using a minimum number of borings, utilizing historic geotechnical explorations to the fullest extent possible?	Y	
8	Have the topography, geologic origin of materials, surface manifestation of soil conditions, and any other special design considerations been utilized in determining the spacing and depth of borings?	Y	
9	Have the borings been located so as to provide adequate overhead clearance for the equipment, clearance of underground utilities, minimize damage to private property, and minimize disruption of traffic, without compromising the quality of the exploration?	Y	

II. Reconnaissance and Planning Checklist

Planning - General		(Y/N/X)	Notes:
10	Have the scaled boring plans, showing all project and historic borings, and a schedule of borings in tabular format, been submitted to the District Geotechnical Engineer?	Y	
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	Y	
b.	location by station and offset	N	
c.	estimated amount of rock and soil, including the total for each for the entire program.	Y	
Planning – Exploration Number		(Y/N/X)	Notes:
11	Have the coordinates, stations and offsets of all explorations (borings, soundings, test pits, etc.) been identified?	Y	
12	Has each exploration been assigned a unique identification number, in the following format X-ZZZ-W-YY, as per Section 303.2 of the SGE?	Y	
13	When referring to historic explorations that did not use the identification scheme in 12 above, have the historic explorations been assigned identification numbers according to Section 303.2 of the SGE?	Y	

II. Reconnaissance and Planning Checklist

Planning – Boring Types		(Y/N/X)	Notes:
14	Based on Sections 303.3 to 303.7.6 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?	Y	
	Check all boring types utilized for this project:		
	Existing Subgrades (Type A)	✓	
	Roadway Borings (Type B)		
	Embankment Foundations (Type B1)	✓	
	Cut Sections (Type B2)		
	Sidehill Cut Sections (Type B3)		
	Sidehill Cut-Fill Sections (Type B4)		
	Sidehill Fill Sections on Unstable Slopes (Type B5)		
	Geohazard Borings (Type C)		
	Lakes, Ponds, and Low-Lying Areas (Type C1)		
	Peat Deposits, Compressible Soils, and Low Strength Soils (Type C2)		
	Uncontrolled Fills, Waste Pits, and Reclaimed Surface Mines (Type C3)		
	Underground Mines (C4)		
	Landslides (Type C5)		
	Rock Slope (Type C6)		
	Karst (Type C7)		
	Proposed Underground Utilities (Type D)		
	Structure Borings (Type E)		
	Bridges (Type E1)	✓	
	Culverts (Type E2 a,b,c)		
	Retaining Walls (Type E3 a and b)		
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

III.B. Embankments Checklist

C-R-S: WOO-75-29.93	**PID:** 119007	**Reviewer:** KCH	**Date:** 8/22/2023

Use this checklist in conjunction with the Embankment Design Guidance in GDM Section 500
If you do not have an embankment on the project, you do not have to fill out this checklist.

Settlement		(Y/N/X)	Notes:
1	If soil conditions and project requirements warrant, have settlement issues been addressed? If not applicable (X), go to Question 14	Y	
2	Have consolidation properties of the foundation soils been determined?	Y	
	Check methods used:		
	laboratory consolidation tests	✓	
	empirical correlations with moisture content and Atterberg values	✓	
	other (describe other methods)		
3	Have calculations been performed to estimate the total expected embankment settlement and the time of consolidation? Indicate method used.	Y	Hand calculations
4	If differing foundation soil and/or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate consolidation at locations representative of the most critical conditions?	Y	
5	Have the total settlement and the time of consolidation analyses indicated acceptable values at all locations for the scope of the embankment work?	Y	
6	If total settlement or time of consolidation is unacceptable, have the stations and lateral extent of the problem areas been defined?	X	
7	Has a method been chosen as a solution to the settlement issues?	X	
	Check the method(s) used:		
	waiting periods with monitoring		
	drainage blanket and wick drains		
	surcharge (preloading)		
	removal and replacement of weak soil		
	lowering proposed grade / change alignment		
	lightweight fill		
	other (describe other methods)		

III.B. Embankments Checklist

Settlement		(Y/N/X)	Notes:
8	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?	X	
9	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?	X	
10	Have all necessary notes, specifications, and details for the chosen solution been determined?	X	
11	Have the need, locations, type, plan notes, and reading schedule for settlement platforms or cells been determined?	X	
12	Have the effects of the predicted settlement and the chosen solution been determined and accounted for on the construction schedule?	X	
13	Has the effect of any foundation soil consolidation (including differential settlement) been evaluated with regard to adjacent structures (e.g., bridges, buildings, culverts, utilities) which will also undergo settlement and be subject to stresses induced by the consolidation of the surrounding soil?	Y	

Stability		(Y/N/X)	Notes:
14	If soil conditions and project requirements warrant, have stability issues been addressed? If not applicable (X), go to Question 29	X	
15	Has the total (short term) and effective (long term) shear strength of the foundation soils been determined?		
	Check method used:		
	laboratory shear tests		
	estimation from SPT or field tests		
16	Have the values of shear strength for proposed embankment fill material, as determined from GDM Section 500, been used in the stability analyses?		

III.B. Embankments Checklist

Stability		(Y/N/X)	Notes:
17	Have calculations been performed to determine the F.S. for stability? Indicate which program and which analysis method (Spencer, Bishop, etc) was used.		
18	Have the following F.S. been met or exceeded, as determined by the calculations, for the given stability conditions:		
a.	1.30 for short term (undrained) condition		
b.	1.30 for long term (drained) condition		
c.	1.10 for rapid drawdown, flood condition		
d.	1.50 for embankment containing or supporting a structural element		
19	When differing soil or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate the stability at locations representative of the most critical conditions?		
20	If the F.S. was not met or exceeded, have the stations and lateral extent of the problem areas been defined?		
21	Has a method been chosen as a solution to the stability issues?		
	Check the method(s) used:		
	flattening slopes		
	counterberm		
	lightweight embankment		
	reinforced soil slope		
	soil nailing		
	drainage blanket and wick drains		
	removal of soft soil, adding shear key		
	reduced grade / change alignment		
	staged construction		
	controlled rate of fill placement		
	drilled shaft slope stabilization		
	other (describe other methods)		
22	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?		
23	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?		

III.B. Embankments Checklist

Stability		(Y/N/X)	Notes:
24	Have all necessary notes, specifications, and details for the chosen solution been determined?		
25	Have the need, location, type, plan notes, and reading schedule for piezometers and inclinometers been determined?		
26	If piezometers will be used, has the critical pressure value been determined and the appropriate information included in the plans?		
27	Have the effects of the stability solution been determined and accounted for on the construction schedule?		
28	Has the effect of the stability solution been evaluated with regard to structures (e.g., bridges, buildings, culverts, utilities) which may be subject to unusual stresses or require special construction considerations?		

Sidehill Fills		(Y/N/X)	Notes:
29	If soil conditions and project requirements warrant, have sidehill fill issues been addressed? If not applicable (X), go to Question 34	Y	
30	In accordance with GDM Section 800, have sidehill fills been evaluated to determine if special benching or shear keys are needed?	Y	
31	In accordance with GDM Section 800, if special benching or shear keys are required,		
a.	has Plan Note G109 from L&D3 been included in the General Notes?	X	Plans to be prepared by others
b.	have quantities for both excavation and embankment been calculated for the benched areas and added to the plan General Quantities?	X	Plans to be prepared by others
c.	have the special benching or shear keys been indicated on the appropriate cross sections?	X	Plans to be prepared by others
32	Have water bearing zones been identified and their impact addressed?	X	
33	Have subsurface drainage controls been adequately addressed?	X	

III.B. Embankments Checklist

Special		(Y/N/X)	Notes:
34	Have all of the environmental factors, including wetlands, stream mitigation, and landfills, been considered and incorporated prior to design and analysis of embankment settlement and stability, including EPA or other government agencies' involvement, mitigation, or special design or construction considerations?	X	
35	If an embankment is to be placed through standing water or over weak, wet soils (with or without a fabric separator), the fill should be placed by the method of end dumping to a given height above the standing water or until compaction is achievable over the soft soil. If end dumping is to be specified,	X	
a.	has the material type for the fill to be end dumped been specified?		
b.	has the need for a fabric separator or filter layer been determined?		
c.	has the height of fill to be end dumped been determined?		
d.	have all notes and specifications for end dumping been developed?		

III.C. Subgrade Checklist

C-R-S:	WOO-75-29.93	PID:	119007	Reviewer:	KCH	Date:	8/22/2023

Use this Checklist in conjunction with the Subgrade design guidance in GDM Section 600
If you do not have any subgrade work on the project, you do not have to fill out this checklist.

Subgrade		(Y/N/X)	Notes:
1	Has the subsurface exploration adequately characterized the soil or rock according to GDM Section 600?	Y	
a.	Has each sample been visually classified and inspected for the presence of gypsum? Has a moisture content been performed on each sample?	Y	
b.	Has mechanical classification (Plastic Limit (PL), Liquid Limit (LL), and gradation testing) been done on at least two samples from each boring within six feet of the proposed subgrade?	Y	
c.	Has the sulfate content of at least one sample from each boring within 3 feet of the proposed subgrade been determined, per Supplement 1122, Determining Sulfate Content in Soils?	Y	
d.	Has the sulfate content of all samples that exhibit gypsum crystals been determined?	X	
e.	Have A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b soils within the top 3 feet of the proposed subgrade been mechanically classified?	X	
2	If soils classified as A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b, or having a LL>65, are present at the proposed subgrade (geotechnical profile), do the plans specify that these materials need to be removed and replaced or chemically stabilized?	X	
a.	If these materials are to be removed and replaced, have the station limits, depth, and lateral limits for the planned removal been provided?	X	
3	If there is any rock, shale, or coal present at the proposed subgrade (C&MS 204.05), do the plans specify the removal of the material?	X	
a.	If removal of any rock, shale, or coal is required, have the station limits, depth, and lateral limits for the planned removal of the material at proposed subgrade been provided?	X	

III.C. Subgrade Checklist

Subgrade		(Y/N/X)	Notes:
4	In accordance with GDM Section 600, do the SPT (N_{60})/HP values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	N	
a.	If removal and replacement is applicable, has the detail of subgrade removal been shown on the plans, including depth of removal, station limits, lateral extent, replacement material, and plan notes (Item 204 - Subgrade Compaction and Proof Rolling)?	X	
b.	If chemical stabilization is applicable, has the detail of this treatment been shown on the plans, including depth, percentage of chemical, station limits, lateral extent, and plan notes?	X	
	Indicate type of chemcial stabilization specified:		
	cement stabilization	✓	
	lime stabilization		
5	If removal and replacement has been specified, do the plans include Plan Note G121 from L&D3?	X	Plans to be prepared by others
6	If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	X	
7	Has an appropriate quantity of Proof Rolling (C&MS 204.06) and has Plan Note G111 from L&D3 been included in the plans?	X	Plans to be prepared by others
8	Has a design CBR value been provided?	Y	

IV.A Foundations of Structures Checklist

C-R-S: WOO-75-29.93	PID: 119007	Reviewer: KCH	Date: 8/22/2023

Use this Checklist in conjunction with the bridge foundation design guidance in GDM Section 1300
If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

Soil and Bedrock Strength Data		(Y/N/X)	Notes:
1	Has the shear strength of the foundation soils been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
2	Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?	Y	
3	Has the shear strength of the foundation bedrock been determined?	X	
	Check method used:		
	laboratory shear tests		
	other (describe other methods)		
Spread Footings		(Y/N/X)	Notes:
4	Are there spread footings on the project? If no, go to Question 11	N	
5	Have the recommended bottom of footing elevation and reason for this recommendation been provided?		
a.	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?		
6	Were representative sections analyzed for the entire length of the structure for the following:		
a.	factored bearing resistance?		
b.	factored sliding resistance?		
c.	eccentric load limitations (overturning)?		
d.	predicted settlement?		
e.	overall (global) stability?		
7	Has the need for a shear key been evaluated?		
a.	If needed, have the details been included in the plans?		
8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?		
9	Have the Service I and Maximum Strength Limit States for bearing pressure on soil or rock been provided?		

IV.A Foundations of Structures Checklist

Spread Footings		(Y/N/X)	Notes:
10	If weak soil is present at the proposed foundation level, has the removal / treatment of this soil been developed and included in the plans?		
a.	Have the procedure and quantities related to this removal / treatment been included in the plans?		
Pile Structures		(Y/N/X)	Notes:
11	Are there piles on the project? If no, go to Question 17	Y	
12	Has an appropriate pile type been selected?		
	Check the type selected:		
	H-pile (driven)	✓	
	H-pile (prebored)		
	Cast In-place Reinforced Concrete Pipe		
	Micropile		
	Continuous Flight Auger (CFA)		
	other (describe other types)		
13	Have the estimated pile length or tip elevation and section (diameter) based on either the Ultimate Bearing Value (UBV) or the depth to top of bedrock been specified? Indicate method used.	Y	
14	If scour is predicted, has pile resistance in the scour zone been neglected?	X	
15	Has a wave equation drivability analysis been performed as per BDM 305.3.1.2 to determine whether the pile can be driven to either the UBV, the pile tip elevation, or refusal on bedrock without overstressing the pile?	Y	
16	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:	Y	
a.	Nominal unit tip resistance and maximum settlement of the piles?	Y	
b.	Nominal unit side resistance for each contributing soil layer and maximum deflection of the piles?	X	
c.	Downdrag load on piles driven through new embankment or compressible soil layers, as per BDM 305.3.2.2?	X	
d.	Potential for and impact of lateral squeeze from soft foundation soils?	X	

IV.A Foundations of Structures Checklist

Pile Structures		(Y/N/X)	Notes:
17	If piles are to be driven to strong bedrock (Q_u >7.5 ksi) or through very dense granular soils or overburden containing boulders, have “pile points” been recommended in order to protect the tips of the steel piling, as per BDM 305.3.5.6?	X	
18	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	X	
19	If piles will be driven through 15 feet or more of new embankment, has preboring been specified as per BDM 305.3.5.7?	X	

IV.A Foundations of Structures Checklist

Drilled Shafts		(Y/N/X)	Notes:
20	Are there drilled shafts on the project? If no, go to the next checklist.	N	
21	Have the drilled shaft diameter and embedment length been specified?		
22	Have the recommended drilled shaft diameter and embedment been developed based on the nominal unit side resistance and nominal unit tip resistance for vertical loading situations?		
23	For shafts undergoing lateral loading, have the following been determined:		
a.	total factored lateral shear?		
b.	total factored bending moment?		
c.	maximum deflection?		
d.	reinforcement design?		
24	If a bedrock socket is required, has a minimum rock socket length equal to 1.5 times the rock socket diameter been used, as per BDM 305.4.2?		
25	Generally, bedrock sockets are 6" smaller in diameter than the soil embedment section of the drilled shaft. Has this factor been accounted for in the drilled shaft design?		
26	If scour is predicted, has shaft resistance in the scour zone been neglected?		
27	Has the site been assessed for groundwater influence?		
a.	If yes, and if artesian flow is a potential concern, does the design address control of groundwater flow during construction?		
28	Have all the proper items been included in the plans for integrity testing?		
29	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?		
30	If necessary, have wet construction methods been specified?		
General		(Y/N/X)	Notes:
31	Has the need for load testing of the foundations been evaluated?		
a.	If needed, have details and plan notes for load testing been included in the plans?		

VI.B. Geotechnical Reports

C-R-S: WOO-75-29.93	PID: 119007	Reviewer: KCH	Date: 8/22/2023

General		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	Y	
2	Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	Y	
3	Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	Y	
4	Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files meet this demand?	Y	
5	Does the report cover format follow ODOT's Brand and Identity Guidelines Report Standards found at http://www.dot.state.oh.us/brand/Pages/default.aspx ?	Y	
6	Have all geotechnical reports being submitted been titled correctly as prescribed in Section 706.1 of the SGE?	Y	
Report Body		(Y/N/X)	Notes:
7	Do all geotechnical reports being submitted contain the following:		
a.	an Executive Summary as described in Section 706.2 of the SGE?	Y	
b.	an Introduction as described in Section 706.3 of the SGE?	Y	
c.	a section titled "Geology and Observations of the Project," as described in Section 706.4 of the SGE?	Y	
d.	a section titled "Exploration," as described in Section 706.5 of the SGE?	Y	
e.	a section titled "Findings," as described in Section 706.6 of the SGE?	Y	
f.	a section titled "Analyses and Recommendations," as described in Section 706.7 of the SGE?	Y	
Appendices		(Y/N/X)	Notes:
8	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 706.8 of the SGE?	Y	
9	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 706.8.1 of the SGE?	Y	

VI.B. Geotechnical Reports

Appendices		(Y/N/X)	Notes:
10	Do the Appendices include boring logs and color pictures of rock, if applicable, as described in Section 706.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 706.8.3 of the SGE?	Y	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 706.8.4 of the SGE?	Y	