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Structural Geotechnical Report

Route FAP 888 (IL-158) over Tributary to Loop Creek

Section 82-1

St. Clair County, Illinois

PTB 196-057

IDOT Job Number D-98-067-14

Proposed Structure 082-0276

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1.0 Project Description and Proposed Structure Information

1.1 Introduction

This report summarizes the results of a geotechnical investigation performed for the design of a new multiple span bridge structure carrying the IL-158 extension over the tributary to Loop Creek, in St. Clair County, Illinois. The purpose of this study was to provide a geotechnical assessment of the proposed bridge structure, based on subsurface conditions encountered during the field exploration performed by the Millennia Professional Services, Ltd. (Millennia). This report describes the exploration procedures used, presents the field and laboratory data, includes an assessment of the subsurface conditions in the area, and provides geotechnical recommendations for the construction.

1.2 Project Description

The project consists of the design and construction of a new multiple span bridge carrying the extension of IL-158 over a tributary to Loop Creek in St. Clair County, Illinois. The general site area is shown on the attached Vicinity Map, Figure 1 in Appendix A. A plan that shows the approximate locations of the borings performed for this study is presented as the Site and Boring Location Plan, Figure 2 in Appendix A.

The tributary to Loop Creek is oriented roughly east and west beneath the proposed bridge structure, and flows in a western direction. The project area is currently utilized as either cultivated fields or pastures. The abutment approach areas are understood to be within an existing floodplain. It is our understanding that the new structure will be a five-span bridge using integral abutments.

1.3 Proposed Structure Information

The proposed structure will consist of a five-span bridge supported by steel H-piles at the abutments and large diameter open-ended pipe (LDOEP) piles at the interior piers. The bridge length will be 553 feet-8 inches from abutment to abutment. The superstructures will be supported by integral abutments. It is our understanding that the roadway profile across the bridges will increase by as much as 10 feet along the embankments.

Factored loading for the bridges provided by Horner & Shifrin, Inc. and Lochmueller are presented in the following Table.

Table 1.1.: Factored Axial Loads by Foundation Location (kips)

North Abutment	Pier 1	Pier 2	Pier 3	Pier 4	South Abutment
1,798	3,489	3,513	3,513	3,489	1,798

2.0 Subsurface Exploration and Laboratory Testing

2.1 Subsurface Exploration

From November 18 to December 2, 2022, Millennia conducted a subsurface exploration for the proposed bridge structure, consisting of nine soil test borings, designated as Borings B-1 through B-9. The approximate locations of the borings are indicated on the Site and Boring Location Plan, Figure 2 of Appendix A. The ground surface elevations were estimated using topographic survey information provided by Lochmueller.

The borings were advanced using hollow-stem auger and mud rotary drilling methods. Samples were recovered using split-spoon samples initially obtained at 2.5-foot intervals until a depth of 30 feet, then at 5-foot intervals until boring termination. Split-spoon samples were recovered using a 2-inch outside-diameter, split-barrel sampler, driven by a CME automatic hammer, in accordance with ASTM D 1586. The hammer efficiency of the drill rig (CME 55) used for the project is approximately 94 percent. Shelby tube samples were obtained in accordance with ASTM D 1587. The split-spoon samples were placed in glass jars for later testing in the laboratory. Shelby tube samples were preserved by sealing the entire sample in the tube. The sampling sequence for each boring is summarized on the Boring Logs in Appendix B of this report.

The underlying bedrock at all of the borings was cored for lengths of approximately 10 to 19 feet. The core samples recovered were measured in the field for percent recovery and RQD value. Photographs were taken of the rock core samples and are attached in Appendix B.

Unconfined compression tests were performed on intact cohesive split-spoon samples using a Rimac field testing machine. The resulting unconfined compressive strengths are reported on the boring logs.

2.3 Field Tests and Measurements

The following field tests and measurements were performed, unless otherwise noted, during the course of the subsurface exploration:

- The boring locations were marked in the field by Millennia, based on information provided by Lochmueller.
- Standard penetration tests were performed and resistances recorded during the recovery of each split-barrel sample.
- Sample recovery measurements were made and recorded for each sampling attempt.
- A field classification by color and texture was made for each recovered sample.
- Observations for the presence of groundwater were made during drilling.

2.4 Laboratory Testing

The following laboratory tests were performed on selected samples recovered from the borings:

- Visual descriptions by color and texture of each sample (ASTM 2488).
- Natural moisture content of each cohesive sample (ASTM D 2216).
- Dry density of selected Shelby tube samples (ASTM D 7263).
- One dimensional consolidation test (ASTM D 2435).
- Atterberg limits of selected samples (ASTM D 4318).

2.5 Data

The results of the field tests and measurements were recorded on field logs and appropriate data sheets in the field. These data sheets and logs contain information concerning the drilling methods, samples attempted and recovered, indications of the presence of various subsurface materials, and the observation of groundwater. The field logs and data sheets also contain the engineer's interpretations of the conditions between samples, based on the performance of the equipment and cuttings brought to the surface by the drilling tools.

Data and observations from laboratory tests were recorded on laboratory data sheets during the course of the testing program. The results of the tests are summarized on the Boring Logs in Appendix B and on the Laboratory Test Results in Appendix C.

The boring logs are an interpretation of the subsurface conditions based on a combination of the field and laboratory data. The analyses and conclusions contained in this report are based on these field and laboratory test results, and on the interpretations of the subsurface conditions, as reported in the Boring Logs. Only data pertinent to the objectives of this report have been included on the logs, therefore, these records should not be used for other purposes.

The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at the boring locations on the dates shown; the reported conditions may be different at other locations and at other times.

The rock core samples were taken back to the laboratory and photographs were taken of each box. The photographs are also attached in Appendix B of this report.

3.0 Subsurface Conditions

Details of the subsurface conditions encountered at the borings are shown on the boring logs. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at the boring locations on the dates shown; the reported conditions may differ at other locations and at other times.

3.1 Generalized Subsurface Profile

The soils at the site are predominantly made up of cohesive materials, with occasional layers of more granular behaving material. The cohesive soils generally consist of silty clay, silty clay loam, silty loam, clay loam, clay, and silt, with variable amounts of sand seams, organics and gravel. Moisture contents vary from 13 to 33 percent, with a majority of the moisture contents below a depth of about 30 feet consisting of moisture contents below 20 percent. The standard penetration test (N) values range from weight-of-hammer (0) to 18 blows per foot (bpf). Rimac unconfined compression test values on samples range from an estimated 0.6 to 2.9 tons per square foot (tsf) and hand penetrometer readings that vary from 0.3 to 4.5 tsf.

Sand was encountered at Boring B-2 at a depth range of approximately 23 to 26 feet, sandy clay at Boring B-4 from about 42 to 48 feet, and sand at Boring B-6 from approximately 42 to 44 feet. N-values vary from 6 to 33 bpf in the granular soil.

Bedrock consisting of shale and limestone was encountered at elevations ranging from 383.3 to 389.7 feet, approximately 47.0 to 52.0 feet below the natural ground surface. Portions of the upper shale bedrock were soft enough to penetrate using hollow stem augers and N-values in the shale vary from 50 blows for 4 inches of penetration to 50 blows for 1 inch of penetration. The bedrock was cored below auger refusal at all of the boring locations. Core recoveries range from 56 to 100 percent were observed, with corresponding rock quality designation (RQD) values varying from 0 to 90 percent. Areas of low recovery are due to the shale washing away during the coring process. Uniaxial compressive strength tests performed on selected limestone samples vary from 4,530 to 10,570 pounds per square inch (psi), while uniaxial compressive strength tests performed on shale samples vary from 230 to 770 psi.

Table 3.1 on the next page shows the depth and elevation of bedrock encountered at each boring location.

Table 3.1:
Elevation and Depth of Bedrock Encountered by Boring Location

Boring Location	Approximate Bedrock Depth (ft.)	Approximate Bedrock Elevation (ft.)
B-1	52.0	383.3
B-2	48.0	387.4
B-3	48.0	387.6
B-4	48.0	387.5
B-5	47.0	389.7
B-6	48.0	387.5
B-7	48.0	388.3
B-8	48.0	388.3
B-9	48.0	387.3

3.2 Groundwater

Groundwater was observed during the drilling at all of the borings, at depths ranging from 13 (Elevation 422.5) to 27 feet (Elevation 409.3). Delayed groundwater readings were not available due to the introduction of drilling fluids to advance the borings and core the underlying bedrock. The presence or absence of groundwater at a particular location does not necessarily indicate that groundwater will be present or absent at that location at other times. Groundwater levels may vary significantly over time due to the effect of seasonal variations in precipitation, water levels in the tributary to Loop Creek, or other factors not evident at the time of exploration. Based on information provided by the design team, we understand the estimated water surface elevation (EWSE) is 427.37 feet.

Table 3.2 below displays the depth and elevation of groundwater encountered at the boring locations.

Table 3.2:
Elevation and Depth of Groundwater Encountered by Boring Location

Boring Location	Approximate Groundwater Depth (ft.)	Approximate Groundwater Elevation (ft.)
B-1	15.0	420.3
B-2	22.0	413.4
B-3	16.0	419.6
B-4	13.0	422.5
B-5	24.0	412.7
B-6	21.0	414.5
B-7	27.0	409.3
B-8	26.0	410.3
B-9	24.0	411.3

4.0 Geotechnical Evaluations

4.1 Earthwork and Slope Stability

Millennia does not anticipate slope instability to be an issue for this project based on the understanding new embankments will have a maximum height of 10 feet and will be constructed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction. End slopes are currently planned for 2H:1V inclinations. Millennia recommends new embankment side slopes be constructed no steeper than 3H:1V inclinations.

The existing creek banks located within the project area appear to have slope inclinations that are similar or in some cases might be steeper than those planned for this project. If the banks have not indicated signs of global stability failure or distress, then those slopes are stable, but could be at an equilibrium state just slightly above yield. The slope of any steep creek bank on most waterway systems located anywhere could slump during or soon after flooding due to scour and rapid drawdown effects.

The parameters used for the stability assessments were based on the results of the field and laboratory investigations, along with Millennia's experience in the area, and are shown on the Summary Stability Profiles provided in Appendix F.

The global stability assessments were conducted for both short term (undrained, or total stress), long term (drained, or effective stress), and seismic conditions using the program SLOPE/W. The results are summarized in the following table.

Table 4.1
Summary of Global Stability Results

Analysis Location		Minimum Computed Factor of Safety	
	Short Term	Long Term	Seismic
North abutment end slope (2H:1V)	3.7	1.8	3.1
North abutment side slope (3H:1V)	4.9	2.6	3.4
South abutment end slope (2H:1V)	3.8	1.9	3.5
South abutment side slope (3H:1V)	3.9	2.7	2.7

The minimum desired safety factor with regard to the potential for massive, global slope failure is 1.5 for static conditions and 1.0 for seismic conditions. On this basis, the results of the stability assessments at the seven sections summarized above are considered acceptable.

In addition, the geotechnical conditions between the boring locations are essentially unknown. If the contractor exposes conditions during excavation and other earthwork activities that differ from those indicated at the boring locations, Millennia should be notified to assess the effect (if any) of the unanticipated conditions upon the findings of the global slope stability assessment.

As with any drainage way, shallow, surficial slumps of the creek bank, including in the vicinity of the bridge, are possible, particularly during and soon after flood events. Riprap or other means of erosion protection should be considered to reduce the potential for surficial slope failures. The riprap size, thickness, and any bedding or filter requirements should be selected by a qualified designer considering the hydraulic conditions at the project site.

4.2 Settlement Induced by Fill Placement

Millennia understands fills for the bridge widening embankment will be as much as 10 feet near the northern and southern abutments. Consolidation testing for use in assessing the magnitude and rate of settlements was performed for the area receiving the embankment fill. Total settlements of up to approximately 4 inches are estimated under the weight of 10 feet of fill along the abutment embankments. Where the fills taper in thickness, the expected magnitude of settlement should reduce as well.

Settlements of this magnitude are expected to induce negative side resistance and downdrag forces on the pile foundations. Downdrag forces on the steel H-pile foundations are addressed in a later section of this report. Piles could be driven after the embankment has been constructed and 90% of the estimated settlements have occurred. Alternatively, precoring at the pile locations or oversizing the piles could be utilized to potentially reduce the effects of downdrag, should the time rate of settlement not coincide with the construction schedule.

Based on the test data, approximately 90% of the settlement is expected to be complete within about 6 months of placement. The remaining settlement is estimated to be less than 1 inch after 4 months.

Consolidation testing provides only general guidance for calculating the magnitude and rate of settlements. Therefore, Millennia recommends that settlement monitoring equipment such as settlement plates be installed at the base of proposed embankments, and that settlements be monitored by the contractor during and after fill placement. Based on the monitoring data, Millennia would assess the magnitude and rate of settlements for general comparison of the consolidation test trends. If the data reveals unanticipated magnitudes or rates, Millennia will confer with the designers to decide upon an appropriate course of action. If requested, Millennia can provide guidance for a settlement monitoring program. If settlement plate data indicates that settlements have dissipated prior to the estimated time-rate, then the piles may be installed sooner.

4.4 Mining Activity

A review of abandoned coal mines and industrial mineral mines was made using the Illinois State Geological Survey (ISGS) website for mapped mines in St. Clair County, Illinois. In some situations, mining continued after the “final” mine survey map was completed, and the precise location of the additional mining around the margins of the mapped boundaries is unknown. Based on this information, the project site is located within the underground mine buffer region, which suggests potential for undermining. Existing mine information indicates the mine is known as the Frost Mine (Mine Index 3488) which was mined by the Shiloh Valley Coal Company from 1939 to 1965.

The mining operations removed coal from the Herrin Coal Seam, which is approximately 90 feet below the ground surface. In this area, the coal seam thickness is about 6.0 feet. The mine was accessed through vertical or inclined shafts. Coal was removed using “modified” room-and-pillar methods, in which pillars of coal are left to support the roof as the mining process progresses. In general, the volume of coal extracted may be up to 75 percent, depending on how many pillars were pulled (if any) after the area was mined. Although the mines are abandoned, the voids (“rooms”) from which the coal was removed remain open until the roof eventually collapses or the pillars fail.

Subsidence is the surface manifestation of the collapse or failure of the structural support at the mine level. Subsidence may manifest itself as vertical movements ranging from a few inches to two or three feet and as lateral or rotational ground movements that can result in significant architectural or even structural damage. The risk of subsidence is difficult to quantify without extensive studies. A study of the mine workings would require drilling several borings into the mine and viewing the mine openings with a borehole camera. Soil and rock samples could be taken at each borehole and the engineering properties of the materials could be measured. Geophysical techniques, such as seismic reflection or refraction techniques, could also be used to help define the mine limits. A study of this type is costly and is rarely performed.

Residential and commercial development is common in the area of the project site. Many developers and owners in this area are unaware of, or ignore, the risks associated with subsidence and build without modifications to the design of their structures. Most owners manage the risk for damage through mine subsidence insurance policies.

4.5 Seismicity

Although several significant areas of seismic activity are present in the central United States, the site area is most directly affected by the Wabash Seismic Zone, located in south and east-central Illinois. An assessment of seismic criteria in accord with AASHTO 2009 Guide Specifications for LRFD Seismic Bridge Design has been performed for the site. The IDOT Spreadsheet “Seismic Site Class Determination” was used to determine a Soil Site Class D. We understand that IDOT utilizes the approximate fixity elevation as the point of reference. The AASHTO 2007 Guide Specifications for LRFD Seismic Bridge Design was used with the Site Class D classification to provide acceleration coefficient values S_{DS} and S_{D1}. The results of the Site Class determination are presented in Appendix D. Based on the guidelines in the current IDOT Geotechnical Manual, including Table 6.12.2.1.3-1 of that manual, the Seismic Performance Zone is 2.

Table 4.2
Summary of Seismic Data

Parameter	Value
Seismic Performance Zone	2
Spectral Response Acceleration, 0.2 Sec, S_{DS}	0.594g
Spectral Response Acceleration, 1.0 Sec, S_{D1}	0.257g
Soil Site Class	D

Based on published information and the IDOT Liquefaction Design Guide, liquefaction analyses are typically performed for the upper 60 feet of a soil profile, since the effects of liquefaction are unlikely to manifest below that depth. Some of the soils encountered at Borings B-3, B-7, B-8, and B-9 appear to be susceptible to the effects of liquefaction due to the silty nature of the soils and lack of cohesive properties. The potential for liquefaction should not be ignored through this zone unless additional boring information indicates otherwise.

Table 4.3
Liquefiable Layers by Boring Location

Boring Location	Approximate Elevation Range (ft)
B-3	408.1-400.6
B-7	411.3-408.8 and 406.3-401.3
B-8	413.8-406.3
B-9	412.8-407.8

Additional isolated layers were observed at all of the remaining borings. In our opinion, these layers are unlikely to liquefy due to the relatively thick cap of cohesive soils overlying the isolated layers.

Considerations for lateral spread induced by liquefaction at or near the foundation locations at the abutments are not included within this report and are beyond the scope of work. While there is evidence of liquefaction-induced sand boils and settlements within and near the bootheel of Missouri and the New Madrid Seismic Zone, there is little evidence of historic lateral spreading. Thus, the risk for lateral spreading is considered to be low.

4.6 Scour

Abutment slope protection should be included to protect against scour potential. Lining the abutment slopes with either Class A4 or A5 stone riprap appears to be appropriate scour protection for the new structures. Skin friction and lateral load design values for driven piles should be ignored in the scour zone. Because of the apparent stiffness of the cohesive soils encountered, we recommend using the scour depths with a 25% reduction. Based on information provided by Lochmueller, the design scour elevations for the 100-year and 200-year events for the bridges are shown in Table 4.3.

Table 4.4:
Summary of Design Scour Elevations

Event/Limit State	Design Scour Elevations (ft.)						Item 113
	North Abutment	Pier 1	Pier 2	Pier 3	Pier 4	South Abutment	
Q100	436.03	421	421	412	421	436.36	5
Q200	436.03	420	420	411	420	436.36	
Design	436.03	421	421	412	421	436.36	
Check	436.03	420	420	411	420	436.36	

5.0 Foundation Evaluations and Design Recommendations

5.1 Driven Pile Foundations

The bridge structures may be supported on driven pile foundations. Pile capacities and driving depths have been assessed using the IDOT pile design spreadsheet "Pile Capacity and Length Estimates," version 01/26/2021. Steel H-piles are considered to be feasible for the abutments at this site. Smaller diameter metal shell piles are not recommended because of the proximity of hard till and rock near maximum pile capacity where a possibility of pile damage during driving may occur. Hard driving is anticipated to penetrate a sufficient distance into the underlying limestone bedrock to achieve the maximum factored capacity, particularly for the heavier sections. Numerous available pile sections may be suitable, and final selection would be based on availability and structural requirements such as pile spacing, installation requirements, and other factors.

Millennia understands scour depth concerns related to unbraced pile lengths may preclude the use of traditional H-piles for the interior bents. Based on discussions with the structural designers, LDOEP piles are considered a feasible alternative at the interior bent locations. Drilled shafts were not considered at this time, due to the cost effectiveness of driven piles compared to drilled shafts when designing for axial loading. In addition, it is Millennia's understanding that the required lateral capacities can be achieved at the interior bent locations using the LDOEP piles.

Capacity reductions for liquefaction induced downdrag at specific structure element locations are identified in Sections 4.5 and 5.2. As mentioned previously, the effects of downdrag due to settlement at the abutment approach embankments could be mitigated either by precoring, oversizing the piles to accommodate the downdrag force, or utilizing the anticipated waiting period for the settlement to occur.

Integral abutments are being considered for the new bridge structures. The pile selections were determined using the Integral Abutment Feasibility Analysis spreadsheet. Due to the soil stiffness encountered at the borings, Millennia recommends precoring and backfilling with bentonite be performed at the abutments to utilize the integral abutment design. The piles at the abutments exhibited in the tables in Appendix E are the pile sections that are readily available in accordance with the IDOT Geotechnical Manual and in conjunction with the design team structural engineer. Tables 5.3 and 5.4 in this section of the report summarize the applicable information provided in Appendix E. Steel H-piles should be driven into rock to their maximum required bearing, as indicated on the IDOT pile design length spreadsheets. It should be noted that H-Piles driven into shale may run shorter (or longer) than the IDOT pile design length spreadsheets estimate.

Millennia understands the traditional static analysis spreadsheets for estimating pile lengths and nominal required bearing of piles are not suitable for analyzing LDOEP piles. A preliminary wave equation (WEAP) analysis was performed using the GRLWEAP 2010 program. The pile sections shown in Table 5.1 on the following page were then modeled using the relevant soil boring information for each of the interior pier locations, as well as various hammer sizes to estimate the nominal required bearing of each pile section. The models were also adjusted to limit the pile stresses to less than 90 percent of the yield strength. Millennia recommends the

contractor perform their own independent WEAP analysis to confirm values stated within this report. Pile driving analyzer (PDA) testing should be performed on every LDOEP pile for the project to monitor the driving stresses and to evaluate the nominal bearing of each pile during construction. LDOEP piles will achieve the required bearing resistance on or in the underlying bedrock.

Tables 5.5 through 5.8 display the nominal required bearing of the pile, the factored resistance available, and the estimated pile length for each pile section and pier location. A geotechnical resistance factor of 0.75 (per LRFD) was used with the assumption PDA testing would be performed on every LDOEP pile for the project. Assuming the piles are driven unplugged, the material accumulated within the pipe pile would need to be removed and replaced with concrete. Another option would be to install a rigid metal plate within the pile via weld to limit the potential for plugged material.

Table 5.1:
Typical LDOEP Pile Information

Diameter (in.)	Wall Thickness (in.)
30	0.500
36	0.625
42	0.750
48	0.750
54	0.875

The upper shale (where encountered) is highly weathered, resulting in the potential for a variable bedrock surface between and away from the boring locations. Piles may need to be driven a few feet into the bedrock surface before encountering refusal. Table 5.2 below provides the approximate elevations for top of bedrock and auger refusal encountered at each boring location.

Table 5.2:
Elevation and Depth of Bedrock Encountered by Boring Location

Boring Location	Approximate Top of Bedrock Elevation (ft.)	Approximate Auger Refusal Elevation (ft.)
B-1	383.3	381.8
B-2	387.4	381.4
B-3	387.6	386.6
B-4	387.5	386.5
B-5	389.7	388.7
B-6	387.5	386.5
B-7	388.3	387.3
B-8	388.3	387.3
B-9	387.3	386.3

The abutments have been assessed for selected H-pile and metal shell pile sections. Copies of a typical input spreadsheet giving the input parameters for each substructure, and the corresponding summary sheets for the various pile types that are analyzed by the spreadsheet, are included in Appendix E. These tables provide the pile embedment length to develop various capacities, up to that approaching the factored design capacity of the pile. Tables were prepared for pile lengths corresponding to selected depths of the input stratigraphy. Data for key assumptions such as pile cutoff elevation and ground surface elevation against pile driving were provided to Millennia by Lochmueller.

Table 5.3.
Estimated Pile Length Tables– North Abutment
(Pile Cutoff Elevation: 438.03) *assuming precored hole is at 1.5 tsf*

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 14x102	810	445	65
HP 14x117	929	511	66

Table 5.4.
Estimated Pile Length Tables– South Abutment
(Pile Cutoff Elevation: 438.36) *assuming precored hole is at 1.5 tsf*

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 14x102	810	445	54
HP 14x117	929	511	55

Table 5.5.
Estimated Pile Length Tables– Bent 1 (Boring B-2)
(Estimated Pile Cutoff Elevation: 443.15)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
Open Ended 30” Dia. w/0.50” Walls	1,410	1,058	62
Open Ended 36” Dia. w/0.625” Walls	2,000	1,500	62
Open Ended 42” Dia. w/0.75” Walls	2,900	2,175	62
Open Ended 48” Dia. w/0.75” Walls	3,700	2,775	62
Open Ended 54” Dia. w/0.875” Walls	4,400	3,300	62

Table 5.6.
Estimated Pile Length Tables– Bent 2 (Boring B-4)
(Estimated Pile Cutoff Elevation: 443.48)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
Open Ended 30” Dia. w/0.50” Walls	1,410	1,058	58
Open Ended 36” Dia. w/0.625” Walls	2,000	1,500	58
Open Ended 42” Dia. w/0.75” Walls	2,900	2,175	58
Open Ended 48” Dia. w/0.75” Walls	3,700	2,775	58
Open Ended 54” Dia. w/0.875” Walls	4,400	3,300	58

Table 5.7.
Estimated Pile Length Tables– Bent 3 (Boring B-6)
(Estimated Pile Cutoff Elevation: 443.55)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
Open Ended 30” Dia. w/0.50” Walls	1,410	1,058	57
Open Ended 36” Dia. w/0.625” Walls	2,000	1,500	57
Open Ended 42” Dia. w/0.75” Walls	2,900	2,175	57
Open Ended 48” Dia. w/0.75” Walls	3,700	2,775	57
Open Ended 54” Dia. w/0.875” Walls	4,400	3,300	57

Table 5.8.
Estimated Pile Length Tables– Bent 4 (Boring B-7)
(Estimated Pile Cutoff Elevation: 443.36)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
Open Ended 30” Dia. w/0.50” Walls	1,410	1,058	57
Open Ended 36” Dia. w/0.625” Walls	2,000	1,500	57
Open Ended 42” Dia. w/0.75” Walls	2,900	2,175	57
Open Ended 48” Dia. w/0.75” Walls	3,700	2,775	57
Open Ended 54” Dia. w/0.875” Walls	4,400	3,300	57

5.2 Lateral Load Capacity Considerations

Piles should be maintained at a spacing no closer than three pile diameters, center-to-center, so that stress overlap at the bearing level can be avoided, to reduce lateral capacity interaction, and so that possible installation problems associated with one structural member do not impact the integrity of the adjacent member.

Lateral load resistance and induced lateral deflection are typically assessed using finite difference computer models based on the lateral modulus-of-subgrade reaction, such as LPILE. Recommendations for use in the design of foundations are presented on the following tables.

****= Soils within the approximate elevation range are within the zone of scour.** The values for the soils within this elevation range should only be used in the seismic load condition. The LPILE parameters for soils within the zone of scour should be ignored in all other loading conditions.

Recommended Design Values for Driven Pile Foundations
Table 5.9.
Parameters for Use in LPILE Analysis at Boring B-1
North Abutment

Approx. Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Uniaxial Compressive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)	p-y Soil Modulus K_{cyclic} (pci)
435-416	Stiff Clay w/o Free Water	120	1,000	N/A	0.009	N/A	350	150
416-412	Stiff Clay w/o Free Water	63	1,300	N/A	0.008	N/A	425	175
412-395	Stiff Clay w/o Free Water	58	700	N/A	0.010	N/A	N/A	100
395-383	Stiff Clay w/o Free Water	63	2,000	N/A	0.006	N/A	N/A	650
383-371	SHALE: Stiff Clay w/o Free Water	135	7,000	N/A	0.004	N/A	2,000	800
371-362	LIMESTONE: Strong Rock	145	N/A	4,500	N/A	N/A	N/A	N/A

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 5.10.
Parameters for Use in LPILE Analysis at Boring B-2
Bent 1

Approx. Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Uniaxial Compressive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)	p-y Soil Modulus K_{cyclic} (pci)
435-420**	Stiff Clay w/o Free Water	120	1,400	N/A	0.007	N/A	500	200
420-412	Stiff Clay w/o Free Water	120	1,400	N/A	0.007	N/A	500	200
412-409	Sand (Reese)	58	N/A	N/A	N/A	30	26*	26*
409-407	Stiff Clay w/o Free Water	63	2,900	N/A	0.005	N/A	1,000	400
407-399	Stiff Clay w/o Free Water	58	600	N/A	0.012	N/A	75	N/A
399-387	Stiff Clay w/o Free Water	63	2,000	N/A	0.006	N/A	650	250
387-381	SHALE: Stiff Clay w/o Free Water	135	4,500	N/A	0.004	N/A	1,300	550
381-373	SHALE: Stiff Clay w/o Free Water	135	7,000	N/A	0.004	N/A	2,000	800
373-370	LIMESTONE: Strong Rock	145	N/A	4,500	N/A	N/A	N/A	N/A

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 5.11.
Parameters for Use in LPILE Analysis at Boring B-4
Bent 2

Approx. Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Uniaxial Compressive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)	p-y Soil Modulus K_{cyclic} (pci)
436-423**	Stiff Clay w/o Free Water	120	1,400	N/A	0.007	N/A	500	200
423-420**	Stiff Clay w/o Free Water	58	700	N/A	0.012	N/A	75	N/A
416-399	Stiff Clay w/o Free Water	58	700	N/A	0.012	N/A	75	N/A
399-394	Stiff Clay w/o Free Water	63	2,300	N/A	0.006	N/A	850	300
394-387	Sand (Reese)	63	N/A	N/A	N/A	34	72*	72*
387-382	LIMESTONE: Strong Rock	145	N/A	5,000	N/A	N/A	N/A	N/A
382-377	SHALE: Stiff Clay w/o Free Water	135	7,000	N/A	0.004	N/A	2,000	800

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value **=scour zone, ignore contribution

Table 5.12.
Parameters for Use in LPILE Analysis at Boring B-6
Bent 3

Depth (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Uniaxial Compressive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)	p-y Soil Modulus K_{cyclic} (pci)
435-430**	Stiff Clay w/o Free Water	120	1,000	N/A	0.009	N/A	350	150
430-420**	Stiff Clay w/o Free Water	120	700	N/A	0.010	N/A	100	N/A
420-411**	Stiff Clay w/o Free Water	58	1,250	N/A	0.008	N/A	425	175
411-399	Stiff Clay w/o Free Water	58	1,250	N/A	0.008	N/A	425	175
399-394	Stiff Clay w/o Free Water	58	3,000	N/A	0.005	N/A	1,000	400
394-391	Sand (Reese)	63	N/A	N/A	N/A	34	72*	72*
391-386	Stiff Clay w/o Free Water	63	3,500	N/A	0.005	N/A	1,100	450
386-381	LIMESTONE: Strong Rock	145	N/A	5,000	N/A	N/A	N/A	N/A
381-376	SHALE: Stiff Clay w/o Free Water	135	7,000	N/A	0.004	N/A	2,000	800

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value **=scour zone, ignore contribution

Table 5.13.
Parameters for Use in LPILE Analysis at Boring B-7
Bent 4

Depth (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Uniaxial Compressive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)	p-y Soil Modulus K_{cyclic} (pci)
436-420**	Stiff Clay w/o Free Water	120	1,400	N/A	0.007	N/A	500	200
420-406**	Stiff Clay w/o Free Water	58	700	N/A	0.010	N/A	75	N/A
406-399	Stiff Clay w/o Free Water	58	700	N/A	0.010	N/A	75	N/A
399-387	Stiff Clay w/o Free Water	63	2,000	N/A	0.006	N/A	650	250
387-380.5	LIMESTONE: Strong Rock	145	N/A	5,000	N/A	N/A	N/A	N/A
380.5-377	SHALE: Stiff Clay w/o Free Water	135	5,000	N/A	0.004	N/A	1,500	600

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value **=scour zone, ignore contribution

Table 5.14.
Parameters for Use in LPILE Analysis at Boring B-9
South Abutment

Depth (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Uniaxial Compressive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)	p-y Soil Modulus K_{cyclic} (pci)
435-429	Stiff Clay w/o Free Water	120	3,000	N/A	0.005	N/A	1,000	400
429-417	Stiff Clay w/o Free Water	120	1,300	N/A	0.008	N/A	425	175
417-412	Soft Clay (Matlock)	58	500	N/A	0.020	N/A	30	N/A
412-407	Stiff Clay w/o Free Water	58	1,000	N/A	0.009	N/A	350	150
407-399	Soft Clay (Matlock)	58	400	N/A	0.020	N/A	30	N/A
399-393	Stiff Clay w/o Free Water	58	1,400	N/A	0.008	N/A	500	200
393-386	Stiff Clay w/o Free Water	63	2,700	N/A	0.005	N/A	900	350
386-380	LIMESTONE: Strong Rock	145	N/A	5,000	N/A	N/A	N/A	N/A
380-376	SHALE: Stiff Clay w/o Free Water	135	7,000	N/A	0.004	N/A	2,000	800

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value **=scour zone, ignore contribution

The LPILE parameters provided above do not account for the temporary effects of liquefaction on the lateral capacity of the deep foundation elements. For lateral capacity reductions within the estimated liquefiable soils, the following tables should be referenced.

Table 5.15.
Parameters for Use in LPILE Analysis of Liquefiable Layers

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
See Table 4.2	Soft Clay (Matlock)	58*	150	0.02	N/A	30

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

6.0 Construction Considerations

6.1 Temporary Sheeting and Soil Retention

The construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction. Trenching, excavating, and bracing should be performed in accordance with Occupational Safety and Health Administration (OSHA) regulations, and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the soil at the site is considered to be Type C, which requires a side slope for excavations no steeper than 1.5H:1.0V. However, worker safety and classification of the excavation soil is the responsibility of the contractor. The excavation side slopes for structure foundations may interfere with existing utilities. This will require a temporary soil retention system such as a cantilever sheet pile wall, sheeting, or other temporary support.

Although not likely required during construction, it appears as though a temporary sheet pile would be feasible at the abutments. Cantilever sheet pile systems may be designed using IDOT Design Guide 3.13.1 – Temporary Sheet Piling Design. Temporary soil retention systems should be designed by an Illinois licensed structural engineer retained by the construction contractor.

6.2 Cofferdam

Based on the configuration of the bridge spans, no cofferdams are planned as part of the project.

6.3 Subgrade Water Protection

Groundwater seepage should be anticipated for excavations extending more than a few feet below the roadway level if construction occurs during periods when the water level approaches the design high water elevation. It is anticipated that excavations for the pile cap foundations may be adequately dewatered using sump and pump methods.

6.4 Driven Pile Installation

The driven piles are to be furnished and installed according to the requirements of Section 512 of the IDOT Standard Specifications, 2022. Millennia recommends that at least one test pile be driven at each substructure location, in accordance with Section 512.15. The piles should be fitted with reinforced tips or shoes to reduce the potential for damage during driving.

Millennia understands IDOT has developed a special provision for LDOEP piles. All construction activities related to LDOEP piles should be done in accordance with the special provision.

6.5 Subgrade, Fill, and Backfill

Earthwork activities including backfill and fill should be performed in accordance with Section 205 of the Standard Specifications.

7.0 Closing

This report has been prepared for the exclusive use of Lochmueller Group and the Illinois Department of Transportation for use in the design and construction of the proposed IL-158 extension over the tributary to Loop Creek bridge structures project in St. Clair County, Illinois. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made to the professional advice and recommendations included herein. This report is not for use by parties other than those named or for purposes other than those stated herein. It may not contain sufficient information for the use of other parties or for other purposes.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed by Millennia to determine the applicability of the analyses and recommendations considering the changed conditions and time lapse. The report should also be reviewed by Millennia if changes occur in structure location, size, and type, or in the planned loads, elevations, grading plans, and project concepts.

These analyses and recommendations are based on data obtained from site reconnaissance, the borings performed for this study and other pertinent information presented herein. This report does not reflect any variations between, beyond, or below the borings. Should such variations become evident, it may be necessary to re-evaluate the recommendations of this report after performing on-site observation during the construction period and noting the characteristics of any such variation.

We appreciate this opportunity to be of service to you and would be pleased to discuss any aspect of this report with you at your convenience.

Sincerely,

Millennia Professional Services, Ltd.

Jacob A. Schaeffer, P.E.
Geotechnical Services Manager

LICENSED PROFESSIONAL ENGINEER
JACOB ALLEN SCHAEFFER
062.068397
Exp. 11-30-23
STATE OF ILLINOIS

Joseph L. Olson, P.E.
Senior Geotechnical Engineer

11 Executive Drive, Suite 12, Fairview Heights, Illinois 62208 • 618-624-8610

Appendix A

Vicinity Map, Figure 1
Site and Boring Location Plan, Figure 2
Subsurface Profiles, Figures 3.1 and 3.2
Type, Size, and Location Plan, Figure 4

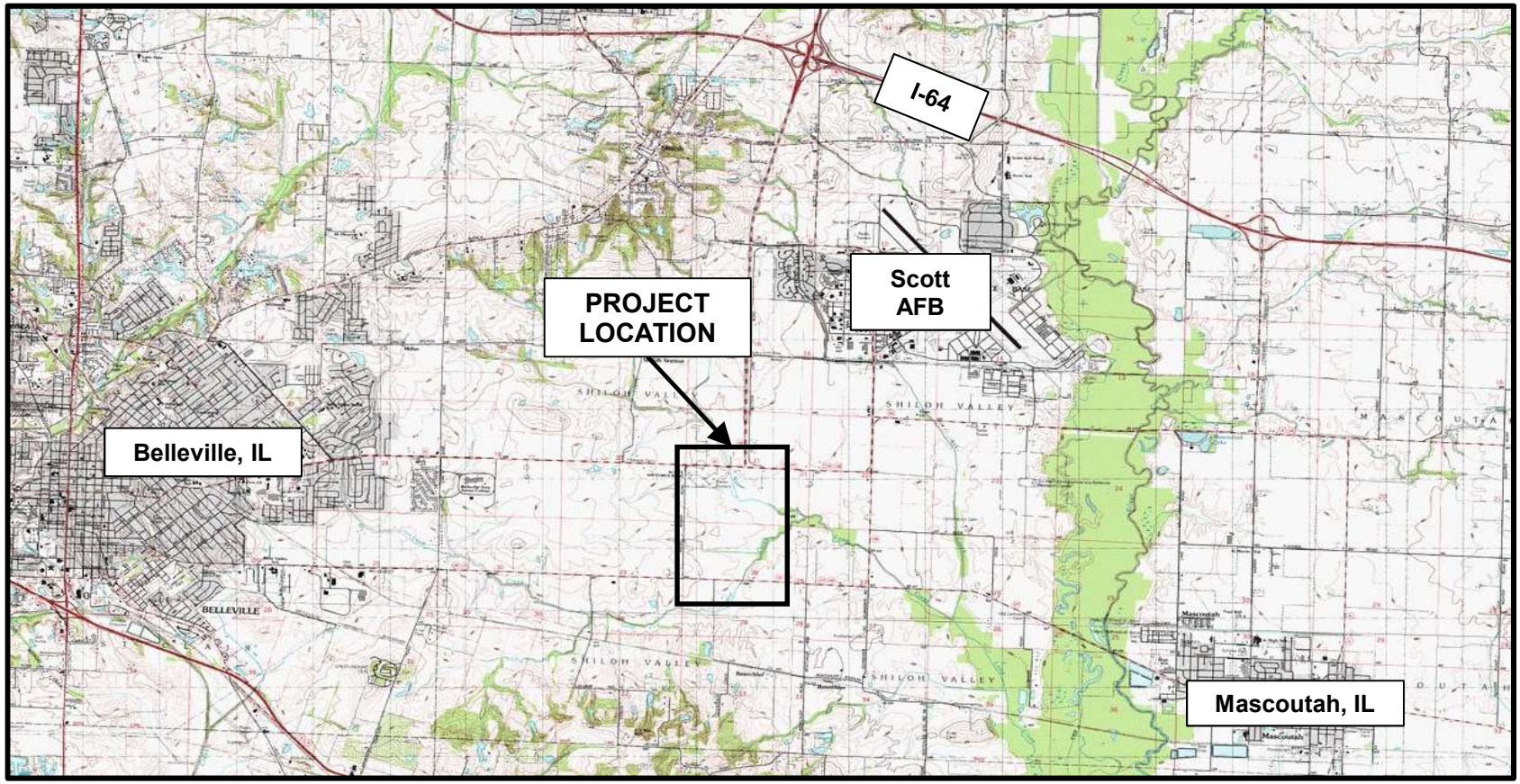
Millennia Professional Services

11 Executive Drive #12, Fairview Heights, IL

Phone: (618) 624-8610

Fax: (618) 624-8611

Project No.: MG22054



N

Image obtained from TopoQuest

*Not to scale

FIGURE 1: VICINITY MAP

PTB 196-057 D8_PH II_IL 158 Ext
Belleville, Illinois

Drawn by:	M. Jenkins	Checked by:	J. Schaeffer
Project No.:	MG22054	Date:	2/8/2023

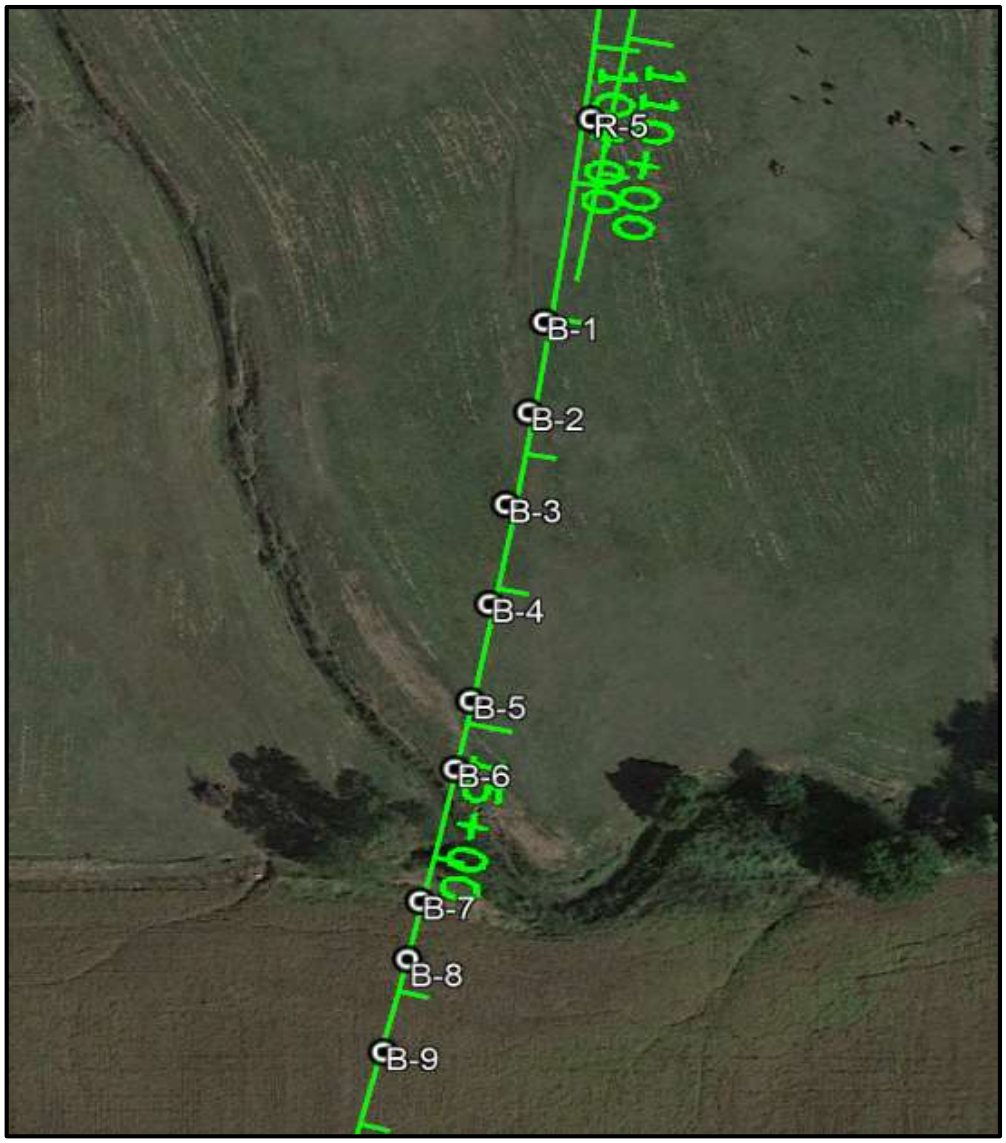
Millennia Professional Services

11 Executive Dr #12, Fairview Heights, IL 62208

Phone: (618) 624-8610

Fax: (618) 624-8611

Project No.: MG22054



N

Approximate Boring Location:

Image obtained from Google Earth

*Not to scale

FIGURE 2. Boring Location Plan

PTB 196-057 D8_PH II_IL 158 Ext
Belleville, Illinois

Drawn by:	M. Jenkins	Checked by:	J. Schaeffer
Project No.:	MG22054	Date:	2/8/2023

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www.millennia.pro

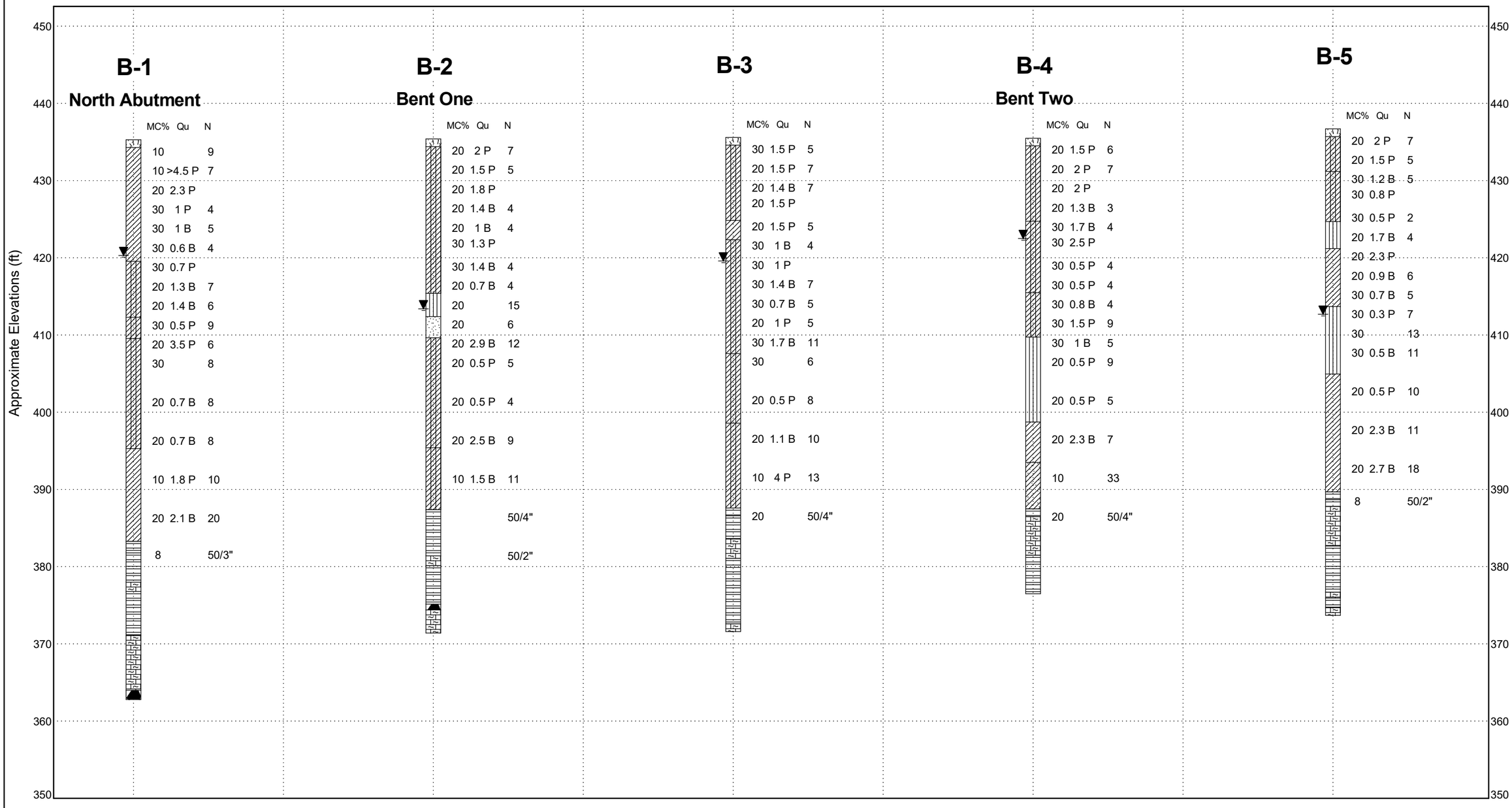
COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054

SUBSURFACE PROFILE

Figure 3.1

LEGEND
EL = Elevation (ft)
D = Depth Below Existing Ground Surface (ft)
N = SPT N-Value (AASHTO T206)
Qu = Unconfined compressive Strength (tsf)
Failure Mode (B= Bulge, S= shear, P= penetrometer)
MC% = Moisture Content Percentage

WATER TABLE LEGEND
▼ = First Encountered
▽ = Upon Completion
▼ = After __ hours



Horizontal Scale for Reference Only. Actual Conditions Between and Below Borings are Unknown, and are Subject to Change. "Material Graphics Key" is Attached for Reference.

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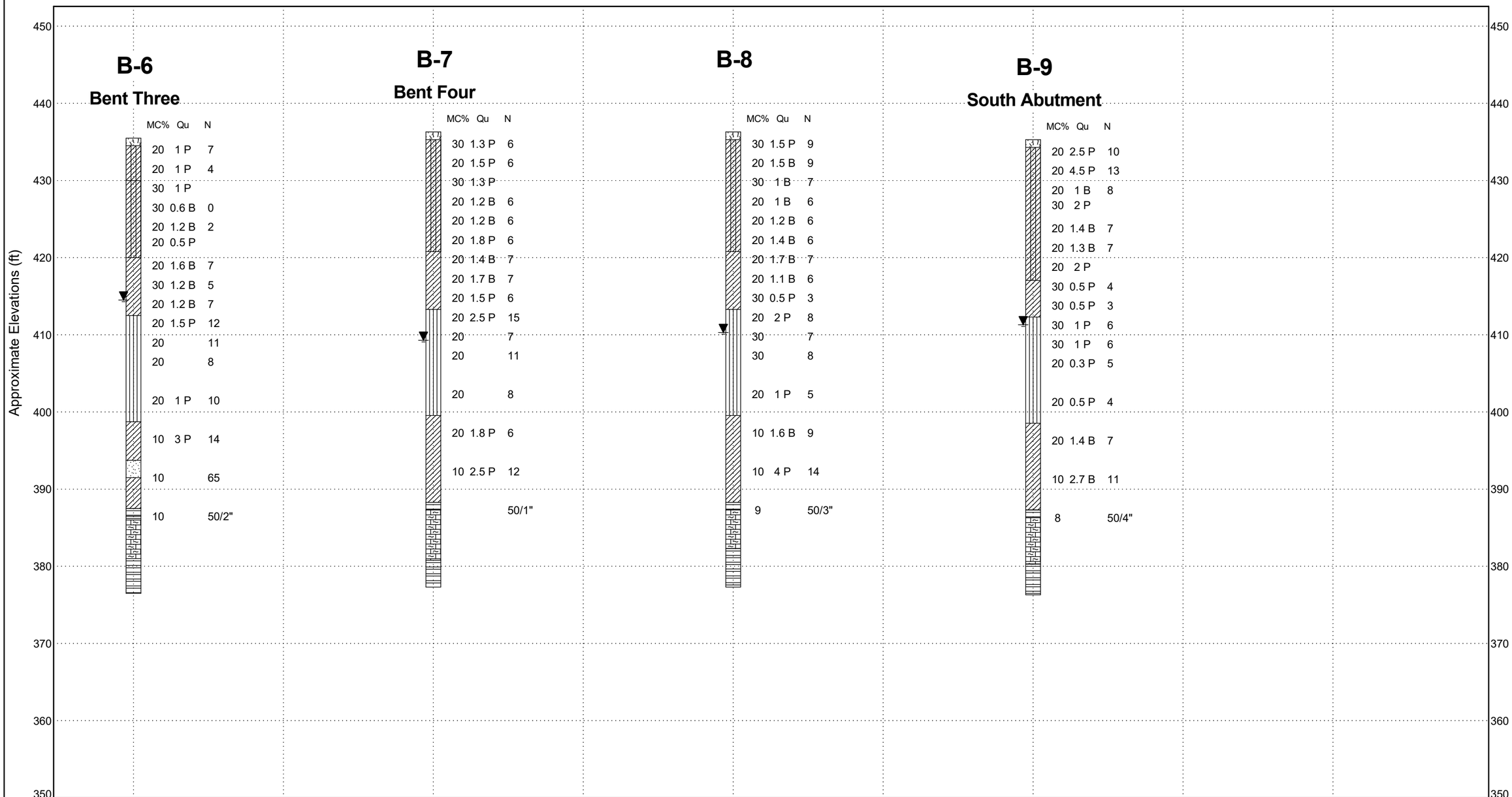
COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054

SUBSURFACE PROFILE

Figure 3.2

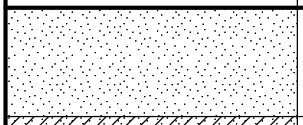
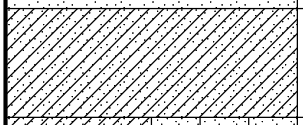
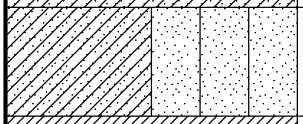
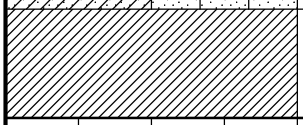
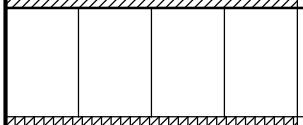
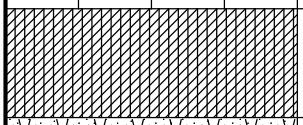
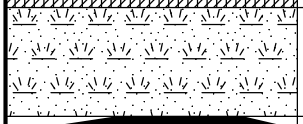
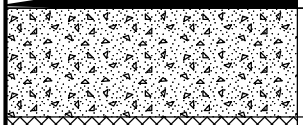
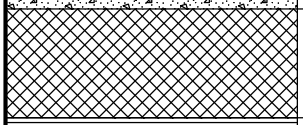
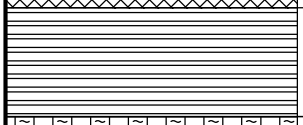
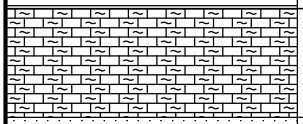
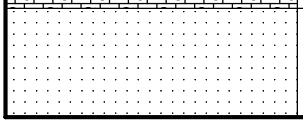
LEGEND
EL = Elevation (ft)
D = Depth Below Existing Ground Surface (ft)
N = SPT N-Value (AASHTO T206)
Qu = Unconfined compressive Strength (tsf)
Failure Mode (B= Bulge, S= shear, P= penetrometer)
MC% = Moisture Content Percentage

WATER TABLE LEGEND
▼ = First Encountered
▽ = Upon Completion
▼ = After __ hours



Horizontal Scale for Reference Only. Actual Conditions Between and Below Borings are Unknown, and are Subject to Change. "Material Graphics Key" is Attached for Reference.

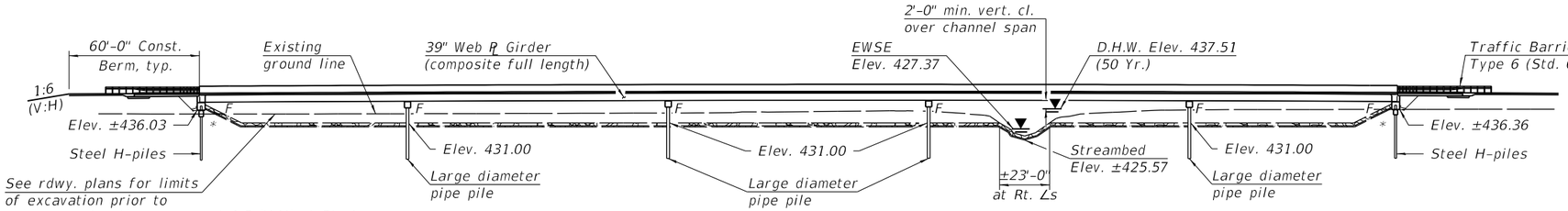
MATERIAL GRAPHICS KEY

GRAPHIC SYMBOLS	TYPICAL DESCRIPTIONS
	SAND, LOAMY SAND, SANDY LOAM
	SANDY CLAY, SANDY CLAY LOAM
	LOAM
	CLAY, CLAY LOAM
	SILT, SILT LOAM
	SILTY CLAY, SILTY CLAY LOAM
	TOPSOIL
	COAL
	CONCRETE
	EXISTING FILL, POSSIBLE FILL
	SHALE, WEATHERED SHALE
	LIMESTONE, WEATHERED LIMESTONE
	SANDSTONE, WEATHERED SANDSTONE

NOTE: CONDITIONS BETWEEN AND BELOW BORINGS ARE UNKNOWN. MATERIAL CLASSIFICAITONS ARE BASED UPON BORINGS PERFORMED FOR THIS SURVEY, AND ARE SUBJECT TO CHANGE.

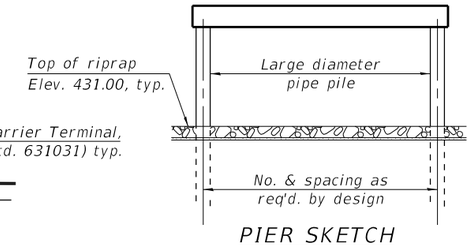
Bench Mark: RR spike in guypole at North side of IL 161/IL 158,
±0.25mi. East of intersection with Air Mobility Dr. (IL 158).
Elev. 439.359

Existing Structure: None.



** See roadway grading plans for slope.

ELEVATION



PIER SKETCH

Note: No webwalls or encasement.

HIGHWAY CLASSIFICATION

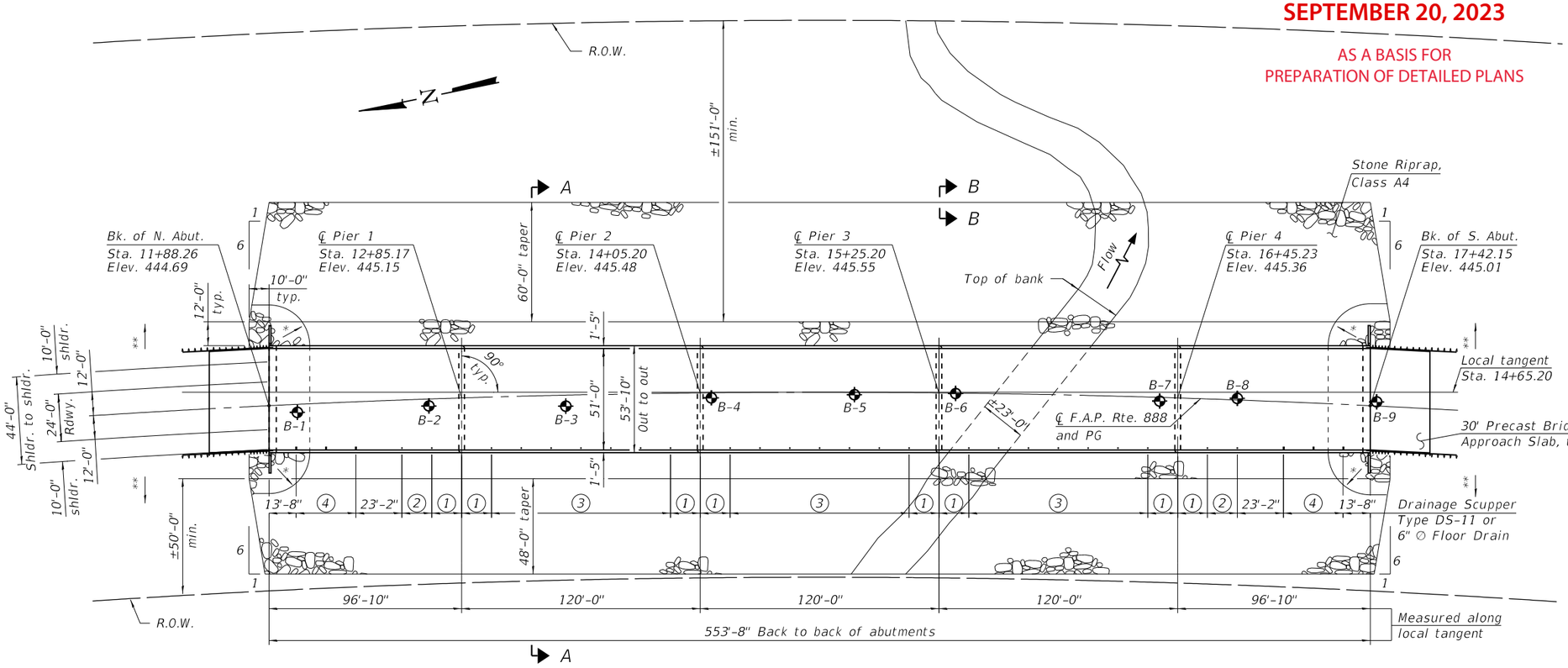
F.A.P. Rte. 888 – IL Rte. 158
Functional Class: Other Principal Arterial
ADT: N/A (2023); 3050 (2043)
ADTT: N/A (2023); 305 (2043)
DHV: 305
Design Speed: 70 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

APPROVED

SEPTEMBER 20, 2023

AS A BASIS FOR
PREPARATION OF DETAILED PLANS

The construction berm shown shall be the minimum that must be placed and compacted prior to construction of the abutments.



PLAN

(1) 15'-0"

(2) 6" ∅ Floor Drain, 1 space at 15'-0" center.

(3) 6" ∅ Floor Drain, 6 spaces at 15'-0" centers.

(4) Drainage Scupper Type DS-11, 2 spaces at 15'-0" centers.

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

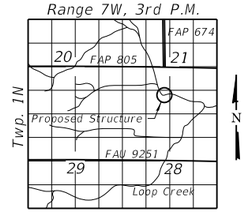
DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi (Substructure)
f'c = 4,000 psi (Superstructure)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)
All new steel shall be painted.



LOCATION SKETCH

SEISMIC DATA

Seismic Performance Zone (SPZ) = 2
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.257
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.594
Soil Site Class = D

GENERAL PLAN AND ELEVATION
IL RTE. 158 OVER
LOOP CREEK TRIBUTARY
F.A.P. RTE. 888 - SEC. 82-1
ST. CLAIR COUNTY
STATION 14+65.20
STRUCTURE NO. 082-0276

HORNER SHIFRIN
WWW. HORNERSHIFRIN .COM

USER NAME =		DESIGNED - SR	REVISED -
		CHECKED - JJD	REVISED -
PLOT SCALE =		DRAWN - SR	REVISED -
PLOT DATE =		CHECKED - JJD	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
888	82-1	ST. CLAIR		
		CONTRACT NO. 76H41		
	ILLINOIS	FED. AID PROJECT		

MODEL: Default
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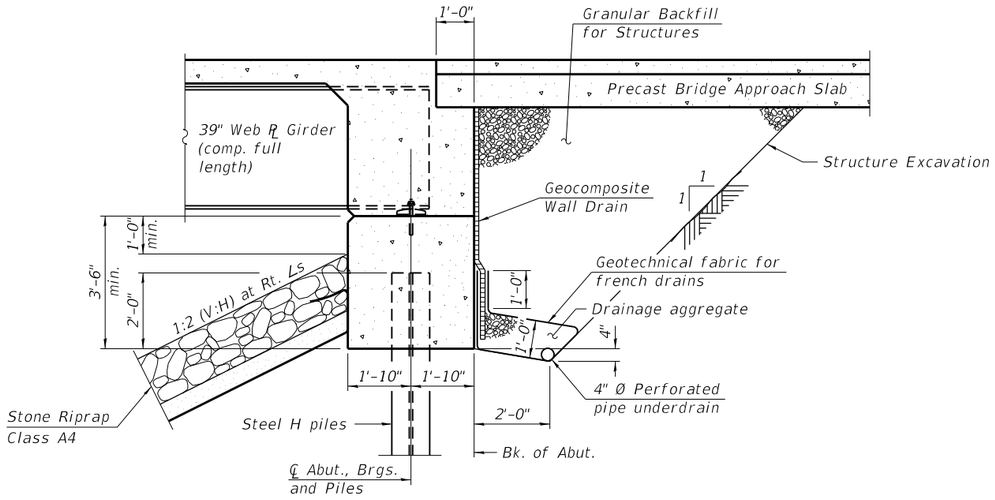
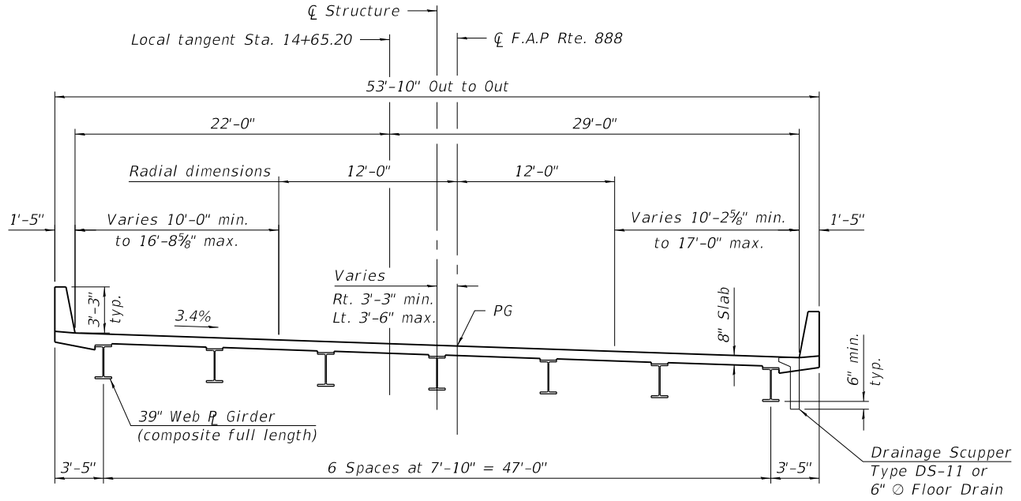


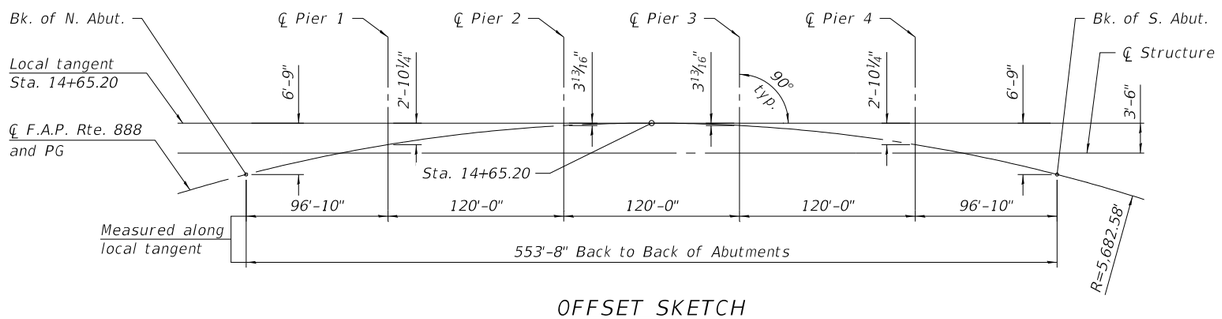
SECTION THRU INTEGRAL ABUTMENT

(Horiz. dim. at Rt. ∠s)



CROSS SECTION

(Looking South)



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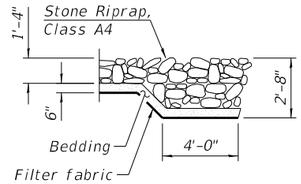
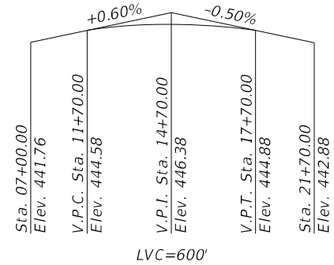


SECTION B-B



PROFILE GRADE

(Along ℄ F.A.P. Rte. 888)

DESIGN SCOUR ELEVATION TABLE

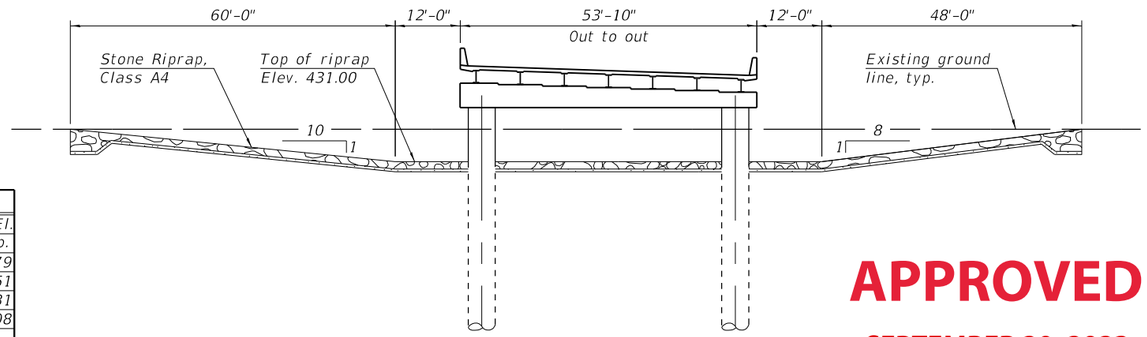
Event / Limit State	Design Scour Elevations (ft.)						
	N. Abut.	Pier 1	Pier 2	Pier 3	Pier 4	S. Abut.	Item 113
Q100	436.03	421	421	412	421	436.36	5
Q200	436.03	420	420	411	420	436.36	
Design	436.03	421	421	412	421	436.36	
Check	436.03	420	420	411	420	436.36	

WATERWAY INFORMATION

Drainage Area = 5.31 sq. mi. Low Grade Elev. 440.77 @ Sta. 3+75.00

Flood	Freq. Yr.	Q C.F.S.	Opening Ft²		Nat. H.W.E.	Head - Ft.		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
	10	1,880	NA	3,019	436.79	0.00	0.00	436.79	436.79
Design	50	3,010	NA	3,389	437.50	0.00	0.01	437.50	437.51
Base	100	3,520	NA	3,535	437.78	0.00	0.03	437.78	437.81
Scour Design Check	200	4,000	NA	3,671	438.04	0.00	0.04	438.04	438.08
Overtop Existing	NA								
Overtop Proposed	NA								
Max. Calc.	500	4,840	NA	3,897	438.47	0.00	0.05	438.47	438.52

10 year velocity through proposed bridge = 0.63 ft/s



SECTION A-A

CURVE DATA

P.I. Sta. = 11+96.54
Δ = 19°47'19" (RT)
D = 1°00'30"
R = 5,682.58'
T = 991.19'
L = 1,962.63'
E = 85.80'
e = 3.4%
T.R. = 45'
S.E. Run = 102'
P.C. Sta. = 2+05.36
P.T. Sta. = 21+67.99

APPROVED

SEPTEMBER 20, 2023

AS A BASIS FOR
PREPARATION OF DETAILED PLANS

DETAILS

IL RTE. 158 OVER
LOOP CREEK TRIBUTARY
F.A.P. RTE. 888 - SEC. 82-1
ST. CLAIR COUNTY
STATION 14+65.20
STRUCTURE NO. 082-0276

HORNER SHIFRIN
WWW. HORNERSHIFRIN .COM

USER NAME =	DESIGNED - SR	REVISED -
	CHECKED - JJD	REVISED -
PLOT SCALE =	DRAWN - SR	REVISED -
PLOT DATE =	CHECKED - JJD	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 2 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
888	82-1	ST. CLAIR		
		CONTRACT NO. 76H41		
		ILLINOIS FED. AID PROJECT		

MODEL: Default
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9/11/2023 9:15:07 AM

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Appendix B

Boring Logs
Rock Core Photographs

MILLENNIA PROFESSIONAL SERVICES
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B-1
SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/18/2022

DESCRIPTION: Bridge over tributary to Loop Creek
LOCATION: St. Clair County, Illinois
DRILLED BY: Terracon
DRILLING METHOD: HSA, Mud-Rotary, and Rock Core
DISTRICT: 8
CONSULTANT: Millennia Professional Services
LOGGED BY: C. Graham
RIG TYPE: CME 550
HAMMER TYPE: Auto
EFFICIENCY: 94.7%

NOTES
Station: 12+02.5
Offset: 3.7 ft West
Northing:
Easting:
Ground Surface Elev.: 435.3 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 420.3 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.:** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")	434.30	1			
			4		
Tan and grey, stiff, dry, CLAY LOAM			4 5		13
			2		
			3 4	>4.5 P	15
- Shelby tube sample obtained at 6.0 ft. - dry density at 6.0 ft. = 100.72 pcf				2.3 P	23
			2		
- grey and brown, medium stiff to stiff, moist, below 8.5 ft.			2 2	1.0 P	27
			2		
			2 3	1.0 B	31
			1		
- switched to Mud-Rotary below 15.0 ft. ▼			2 2	0.6 B	28
	419.55	15.75			
Grey, stiff, moist, SILTY CLAY - Shelby tube sample obtained at 16.0 ft. - dry density at 16.0 ft. = 96.3 pcf				0.7 P	27
			2		
			3 4	1.3 B	25

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, stiff, moist, SILTY CLAY *(continued)*			2		
			3 3	1.4 B	24
	412.30	23			
Grey, medium stiff, moist, SILTY LOAM			4		
			4 5	0.5 P	26
	409.55	25.75			
Grey, very stiff, moist, SILTY CLAY			2		
			3 3	3.5 P	24
			2		
- Atterberg Limits results: LL = 29, PI = 5			4 4		26
			3		
- medium stiff below 33.5 ft.			3 5	0.7 B	17
			2		
			4 4	0.7 B	16
	395.30	40			

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-1
SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/18/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services
DRILLED BY	Terracon	**LOGGED BY**	C. Graham
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto

RIG TYPE: CME 550
EFFICIENCY: 94.7%

NOTES: North Abutment
Station: 12+02.5
Offset: 3.7 ft West
Northing:
Easting:
Ground Surface Elev.: 435.3 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 420.3 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.**: N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, stiff to very stiff, moist, CLAY LOAM, trace gravel			3		
			3 7	1.8 P	15
			3		
			8 12	2.1 B	21
	383.30	52			
Grey, very hard, dry, clayey SHALE					
	381.80	53.5	50/3"		8
Auger refusal at 53.5 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-1
ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 11/18/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY C. Graham
RIG TYPE CME 550

NOTES North Abutment
Station 12+02.5
Offset 3.7 ft West
Latitude
Longitude
Ground Surface Elev. 435.30 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 381.80 ft
Begin Core Elev. 381.80 ft

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey SHALE, moderately hard, clayey	381.80	1	100	90	7.5	
	53.5					
	378.00					
Grey LIMESTONE, hard						
	376.80					
	58.5					
Grey SHALE		2	56	0	8.5	
	62.5					
		3	98	43		
- Uniaxial Compressive Strength = 9030 psi at 63.3 ft.						
	371.10					
Grey to dark grey LIMESTONE - Uniaxial Compressive Strength = 4530 psi at 64.3 ft. - shale seam from 65.4 to 65.8 ft.						
	364.00					
Black COAL						
	362.80					
End of Boring						

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

MILLENNIA PROFESSIONAL SERVICES
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B-2
SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/21/2022

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
DRILLING METHOD HSA, Mud-Rotary, and Rock Core
DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550
HAMMER TYPE Auto
EFFICIENCY 94.7%

NOTES
Station 12+68.7
Offset 3.2 ft West
Northing
Easting
Ground Surface Elev. 435.4 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 413.4 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")	434.40	1			
Brown and grey, medium stiff to stiff, moist, SILTY CLAY			3		
			4 3	2.0 P	23
			2		
			2 3	1.5 P	25
- Shelby tube sample obtained at 6.0 ft. - dry density at 6.0 ft. = 99.02 pcf				1.8 P	23
			1		
			2 2	1.4 B	25
			2		
			2 2	1.0 B	22
- Shelby tube sample obtained at 13.0 ft. - dry density at 13.0 ft. = 95.14 pcf				1.3 P	29
			1		
			2 2	1.4 B	30
			2		
	415.40	20	2 2	0.7 B	24

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, stiff, moist, SILTY LOAM			3		
		▼	6 9		21
	412.40	23			
Grey, loose, wet, SAND, trace gravel			3		
			3 3		19
- switched to Mud-Rotary below 25.0 ft.	409.65	25.75			
Grey, medium stiff to very stiff, moist, SILTY CLAY LOAM			4		
			4 8	2.9 B	20
			2		
			2 3	0.5 P	23
- trace gravel below 33.5 ft.			1		
			1 3	0.5 P	17
			3		
	395.40	40	3 6	2.5 B	16

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-2
SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/21/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto

RIG TYPE: CME 550
EFFICIENCY: 94.7%

NOTES
Station: 12+68.7
Offset: 3.2 ft West
Northing:
Easting:
Ground Surface Elev.: 435.4 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 413.4 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.**: N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, stiff, moist, SILTY CLAY, trace gravel			3		
			4 7	1.5 B	14
	387.40	48			
Grey, very hard, weathered SHALE			17		
			50/4"		
	381.40	54	50/2"		
Auger refusal at 54 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-2
ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 11/21/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES Bent One
Station 12+68.7
Offset 3.2 ft West
Latitude
Longitude
Ground Surface Elev. 435.40 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 381.40 ft
Begin Core Elev. 381.40 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey LIMESTONE, moderately weathered	381.40	54	1	82	49	18	
	380.15						
Grey SHALE, highly weathered							
- Uniaxial Compressive Strength = 770 psi at 58.0 ft.							
	375.15						
Black COAL							
	374.40						
Grey LIMESTONE, slightly to moderately weathered							
	371.40						
End of Boring							

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

MILLENNIA PROFESSIONAL SERVICES
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B-3
SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/21/2022

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
DRILLING METHOD HSA, Mud-Rotary, and Rock Core
DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550
HAMMER TYPE Auto
EFFICIENCY 94.7%

NOTES
Station 13+37.5
Offset 5.4 ft West
Northing
Easting
Ground Surface Elev. 435.6 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 419.6 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")	434.60	1			
			2		
Brown and grey, stiff, moist, SILTY CLAY			3 2	1.5 P	25
			3		
			3 4	1.5 P	24
			2		
			4 3	1.4 B	23
- Shelby tube sample obtained at 8.0 ft. - dry density at 8.0 ft. = 100.57 pcf				1.5 P	23
	424.85	10.75			
Brown, stiff, moist, CLAY LOAM, with sand seams			1		
			2 3	1.5 P	22
	422.35	13.25			
Brown, medium stiff to stiff, moist, SILTY CLAY			2		
			2 2	1.0 B	26
- Shelby tube sample obtained at 16.0 ft. - dry density at 16.0 ft. = 91.59 pcf				1.0 P	30
			3		
- switched to Mud-Rotary below 20.0 ft.			3 4	1.4 B	26

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Brown, medium stiff to stiff, moist, SILTY CLAY *(continued)*			1		
			2 3	0.7 B	33
			2		
			2 3	1.0 P	25
			2		
			2 9	1.7 B	26
	407.60	28			
Grey, medium stiff to stiff, wet, SILTY CLAY LOAM			5		
			3 3		26
			3		
			4 4	0.5 P	25
	398.60	37			
Grey, stiff, moist, SILTY CLAY, trace gravel			2		
			4 6	1.1 B	15

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-3
SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/21/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8		
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services		
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins	**RIG TYPE**	CME 550
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto	**EFFICIENCY**	94.7%

NOTES
Station 13+37.5
Offset 5.4 ft West
Northing
Easting
Ground Surface Elev. 435.6 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 419.6 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, stiff, moist, SILTY CLAY, trace gravel *(continued)*					
- very stiff to hard below 43.5 ft.			4		
			5 8	4.0 P	13
	387.60	48			
Grey, very hard, moist, weathered SHALE	386.60	49	50/4"		23
Auger refusal at 49 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-3
ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 11/21/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES
Station 13+37.5
Offset 5.4 ft West
Latitude
Longitude
Ground Surface Elev. 435.60 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 386.60 ft
Begin Core Elev. 386.60 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey SHALE with seams of limestone, moderately to highly weathered - low recovery due to shale washout, no voids were felt upon drilling - multiple vertical fractures in recovered limestone	386.60	49	1	60	17	25	
Grey LIMESTONE, moderately hard	383.60						
Grey SHALE with seams of limestone, moderately to highly weathered	381.10						
- dark grey, with seams of coal and limestone below 59.0 ft.		59	2	100	38	12	
Black LIMESTONE	372.60						
End of Boring	371.60						

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

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B-4
SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/22/2022

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
DRILLING METHOD HSA, Mud-Rotary, and Rock Core
DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550
HAMMER TYPE Auto
EFFICIENCY 94.7%

NOTES Bent Two
Station 14+10.7
Offset 2.5 ft West
Northing
Easting
Ground Surface Elev. 435.5 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 422.5 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")					
	434.50	1			
Brown, stiff, dry, SILTY CLAY			2		
			3 3	1.5 P	18
			4		
			3 4	2.0 P	20
- Shelby tube sample obtained at 6.0 ft. - dry density at 6.0 ft. = 103.52 pcf				2.0 P	21
- moist below 8.5 ft.			1		
			1 2	1.3 B	25
	424.75	10.75			
Tan and grey, medium stiff to stiff, moist, SILTY CLAY LOAM			2		
			1 3	1.7 B	25
▼ - Shelby tube sample obtained at 13.0 ft. - dry density at 13.0 ft. = 92.45 pcf				2.5 P	28
			1		
			1 3	0.5 P	27
			0		
			2 2	0.5 P	25
	415.50	20			

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Dark grey and brown, medium stiff to stiff, moist, SILTY CLAY			2		
			2 2	0.8 B	27
			0		
			3 6	1.5 P	27
- switched to Mud-Rotary below 25.0 ft.					
	409.75	25.75			
Grey, medium stiff, wet, SILT - Atterberg Limits results: Non-plastic			3		
			2 3	1.0 B	27
			4		
			3 6	0.5 P	25
			3		
			2 3	0.5 P	23
			2		
	398.75	36.75			
Grey, very stiff, moist, CLAY, trace gravel					
			3 4	2.3 B	22

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-4
SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/22/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto

RIG TYPE: CME 550
EFFICIENCY: 94.7%

NOTES
Station: 14+10.7
Offset: 2.5 ft West
Northing:
Easting:
Ground Surface Elev.: 435.5 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 422.5 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.**: N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, very stiff, moist, CLAY, trace gravel *(continued)*					
	393.50	42			
Brown, hard, moist, SANDY CLAY, trace gravel			8		
			15 18		10
	387.50	48			
Grey, very hard, weathered SHALE	386.50	49	50/4"		16
Auger refusal at 49 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 11/22/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES Bent Two
Station 14+10.7
Offset 2.5 ft West
Latitude
Longitude
Ground Surface Elev. 435.50 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 386.50 ft
Begin Core Elev. 386.50 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey LIMESTONE, with seams of shale, lightly to moderately weathered	386.50	49	1	100	75	12	
- Uniaxial Compressive Strength = 10570 psi at 52.5 ft.							
Grey SHALE, moderately to highly weathered	381.50	55	2	100	25	12	
End of Boring	376.50						

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

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SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/23/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto

RIG TYPE: CME 550
EFFICIENCY: 94.7%

NOTES
Station: 14+82.6
Offset: 1.2 ft West
Northing:
Easting:
Ground Surface Elev.: 436.7 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 412.7 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.:** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")					
	435.70	1			
Brown, stiff, dry, SILTY CLAY LOAM			3		
			3 4	2.0 P	18
			2		
			3 2	1.5 P	22
	431.20	5.5			
Dark brown to dark grey, soft to medium stiff, moist, SILTY CLAY			2		
			2 3	1.2 B	26
- Shelby tube sample obtained at 8.0 ft. - dry density at 8.0 ft. = 92.92 pcf				0.8 P	28
			0		
	424.70	12	1 1	0.5 P	28
Grey, stiff, moist, SILT LOAM			1		
			2 2	1.7 B	24
	421.20	15.5			
Grey and brown, medium stiff to stiff, moist, CLAY - Shelby tube sample obtained at 16.0 ft. - dry density at 16.0 ft. = 101.19 pcf				2.3 P	22
			2		
			3 3	0.9 B	23

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey and brown, medium stiff to stiff, moist, CLAY *(continued)*			2		
			2 3	0.7 B	29
	413.70	23			
Grey, soft to stiff, wet SILT LOAM ▼			2		
			3 4	0.3 P	30
- switched to Mud-Rotary below 25.0 ft.			7		
			6 7		26
			4		
			5 6	0.5 B	27
	404.95	31.75			
Grey, medium stiff to very stiff, moist, CLAY LOAM			2		
- sand seam at 34.0 ft.			4 6	0.5 P	16
			5		
			4 7	2.3 B	16

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/23/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto

RIG TYPE: CME 550
EFFICIENCY: 94.7%

NOTES
Station: 14+82.6
Offset: 1.2 ft West
Northing:
Easting:
Ground Surface Elev.: 436.7 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 412.7 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.**: N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, medium stiff to very stiff, moist, CLAY LOAM *(continued)*			5		
			8 10	2.7 B	16
	389.70	47			
Grey, very hard, weathered SHALE	388.70	48	50/2"		8
Auger refusal at 48 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 11/23/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES
Station 14+82.6
Offset 1.2 ft West
Latitude
Longitude
Ground Surface Elev. 436.70 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 388.70 ft
Begin Core Elev. 388.70 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey SHALE, moderately to highly weathered - low recovery due to shale washout, no voids were felt upon drilling	388.70 387.80	48	1	58	31	22	
Grey LIMESTONE - vertical fracture observed from 49.0 to 50.0 ft. - shale seam from 50.0 to 51.0 ft. - Uniaxial Compressive Strength = 4010 psi at 51.5 ft.	382.70						
Grey SHALE, moderately weathered		58	2	100	55	8	
Grey LIMESTONE	376.70 375.95						
Black SHALE	374.70						
Black LIMESTONE	373.70						
End of Boring							

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

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SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/23/2022

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
DRILLING METHOD HSA, Mud-Rotary, and Rock Core
DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550
HAMMER TYPE Auto
EFFICIENCY 94.7%

NOTES Bent Three
Station 15+33.5
Offset 0.3 ft West
Northing
Easting
Ground Surface Elev. 435.5 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 414.5 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")					
434.50		1			
Brown, medium stiff, dry, SILTY CLAY LOAM			3		
			4 3	1.0 P	17
			3		
			2 2	1.0 P	21
430.00		5.5			
Dark brown, very soft to stiff, SILTY CLAY - Shelby tube sample obtained at 6.0 ft. - dry density at 6.0 ft. = 95.68 pcf				1.0 P	25
			0		
			0 0	0.6 B	31
- brown and grey below 10.5 ft.			0		
			0 2	1.2 B	25
- Shelby tube sample obtained at 13.0 ft.				0.5 P	24
420.00		15.5			
Brown and grey, stiff, moist, CLAY			2		
			3 4	1.6 B	25
			2		
			2 3	1.2 B	26

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Brown and grey, stiff, moist, CLAY *(continued)* ▼			2		
			3 4	1.2 B	23
412.50		23			
Grey and brown, stiff, wet, SILT LOAM			5		
			6 6	1.5 P	24
- switched to Mud-Rotary below 25.0 ft. - grey below 25.5 ft.			5		
			5 6		24
			4		
			4 4		22
			4		
			5 5	1.0 P	20
398.75		36.75			
Grey, very stiff, CLAY LOAM			4		
			6 8	3.0 P	13

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 11/23/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto

RIG TYPE: CME 550
EFFICIENCY: 94.7%

NOTES: Bent Three
Station: 15+33.5
Offset: 0.3 ft West
Northing:
Easting:
Ground Surface Elev.: 435.5 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 414.5 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.**: N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, very stiff, CLAY LOAM *(continued)*					
	393.75	41.75			
Grey, medium dense, wet SAND, trace gravel					
	391.50	44	5		
Grey, stiff to very stiff, CLAY LOAM, with limestone fragments			48 17		13
	387.50	48			
Grey, very hard, weathered SHALE, with gravel	386.50	49	48		
Auger refusal at 49 ft.			50/2"		
Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 11/23/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES Bent Three
Station 15+33.5
Offset 0.3 ft West
Latitude
Longitude
Ground Surface Elev. 435.50 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 386.50 ft
Begin Core Elev. 386.50 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey SHALE	386.50	49	1	100	0	8	
Light grey LIMESTONE, lightly to moderately weathered, with shale seams	386.00						
		51					
- Uniaxial Compressive Strength = 5970 psi at 51.0 ft.			2	100	55	12	
	381.00						
Grey SHALE, moderately to highly weathered							
		56					
- Uniaxial Compressive Strength = 550 psi at 57.0 ft.			3	97	83	6	
	376.50						
End of Boring							

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

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SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 12/1/2022

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
DRILLING METHOD HSA, Mud-Rotary, and Rock Core
DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550
HAMMER TYPE Auto
EFFICIENCY 94.7%

NOTES
Station 16+36.1
Offset 2.1 ft West
Northing
Easting
Ground Surface Elev. 436.3 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 409.3 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")					
	435.30	1			
Brown, stiff, moist, SILTY CLAY			2		
			3 3	1.3 P	27
			2		
			3 3	1.5 P	24
- Shelby tube sample obtained at 6.0 ft. - dry density at 6.0 ft. = 97.46 pcf				1.3 P	25
			2		
			2 4	1.2 B	23
			2		
			3 3	1.2 B	24
			3		
			3 3	1.8 P	25
	420.80	15.5			
Brown and grey, stiff, moist, CLAY			3		
			3 4	1.4 B	24
			2		
			3 4	1.7 B	23

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Brown and grey, stiff, moist, CLAY *(continued)*			2		
			3 3	1.5 P	24
	413.30	23			
Brown to grey, medium stiff to stiff, SILT LOAM			4		
			7 8	2.5 P	20
			4		
		▼	4 3		23
			3		
			5 6		20
- switched to Mud-Rotary below 30.0 ft.					
			3		
			4 4		24
	399.55	36.75			
Grey, medium stiff to stiff, CLAY LOAM			0		
			3 3	1.8 P	18

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 12/1/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8		
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services		
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins	**RIG TYPE**	CME 550
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto	**EFFICIENCY**	94.7%

NOTES
Station 16+36.1
Offset 2.1 ft West
Northing
Easting
Ground Surface Elev. 436.3 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 409.3 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, medium stiff to stiff, CLAY LOAM *(continued)*			4		
- sand seam at 44.0 ft.			5 7	2.5 P	10
	388.30	48			
Grey, very hard, weathered SHALE	387.30	49	50/1"		
Auger refusal at 49 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 12/1/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES Bent Four
Station 16+36.1
Offset 2.1 ft West
Latitude
Longitude
Ground Surface Elev. 436.30 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 387.30 ft
Begin Core Elev. 387.30 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Grey LIMESTONE with layers of shale, moderately to highly weathered - low recovery due to shale washout, no voids were felt upon drilling - Uniaxial Compressive Strength = 7660 psi at 50.0 ft.	387.30	49	1	58	40	30	
	380.80						
- Likely SHALE, washed out below 55.5 ft.							
	377.30						
End of Boring							

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

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SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 12/1/2022

DESCRIPTION: Bridge over tributary to Loop Creek
LOCATION: St. Clair County, Illinois
DRILLED BY: Terracon
DRILLING METHOD: HSA, Mud-Rotary, and Rock Core
DISTRICT: 8
CONSULTANT: Millennia Professional Services
LOGGED BY: M. Jenkins
RIG TYPE: CME 550
HAMMER TYPE: Auto
EFFICIENCY: 94.7%

NOTES
Station: 16+75.1
Offset: 0.9 ft East
Northing:
Easting:
Ground Surface Elev.: 436.3 ft

Surface Water Elev.: N/A ft
Stream Bed Elev.: N/A ft
Groundwater Elev.:
First Encounter: 410.3 ft ▼
Upon Completion: N/A ft
After N/A **Hrs.:** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")	435.30	1			
Brown, stiff, dry, SILTY CLAY			3		
			4 5	1.5 P	27
			3		
			4 5	1.5 B	24
- moist below 6.0 ft.			3		
			3 4	1.0 B	26
			2		
			3 3	1.0 B	24
			3		
			3 3	1.2 B	24
			2		
			3 3	1.4 B	23
	420.80	15.5			
Brown and grey, medium stiff to stiff, moist, CLAY			2		
			3 4	1.7 B	23
			2		
			3 3	1.1 B	23
Brown and grey, medium stiff to stiff, moist, CLAY *(continued)*			2		
			1 2	0.5 P	31
	413.30	23			
Brown, soft to medium stiff, SILT LOAM			4		
			4 4	2.0 P	25
- grey below 25.5 ft. ▼			2		
- Atterberg Limits results: Non-plastic			3 4		25
			2		
			4 4		25
- switched to Mud-Rotary below 30.0 ft.			3		
			2 3	1.0 P	23
	399.55	36.75			
Grey, stiff, CLAY LOAM, trace gravel			3		
			4 5	1.6 B	15

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-8
SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 12/1/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8		
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services		
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins	**RIG TYPE**	CME 550
DRILLING METHOD	HSA, Mud-Rotary, and Rock Core	**HAMMER TYPE**	Auto	**EFFICIENCY**	94.7%

NOTES
Station 16+75.1
Offset 0.9 **ft** East
Northing
Easting
Ground Surface Elev. 436.3 **ft**

Surface Water Elev. N/A **ft**
Stream Bed Elev. N/A **ft**
Groundwater Elev.:
First Encounter 410.3 **ft** ▼
Upon Completion N/A **ft**
After N/A **Hrs.** N/A **ft**

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, stiff, CLAY LOAM, trace gravel *(continued)*			5		
			6 8	4.0 P	13
	388.30	48			
- Grey, very hard, weathered SHALE	387.30	49	50/3"		9
Auger refusal at 49 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

Printed 9/8/2023

MILLENNIA PROFESSIONAL SERVICES
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B-8
ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 12/1/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES
Station 16+75.1
Offset 0.9 ft East
Latitude
Longitude
Ground Surface Elev. 436.30 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 387.30 ft
Begin Core Elev. 387.30 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Light grey LIMESTONE, with shale seams, lightly to moderately weathered - Uniaxial Compressive Strength = 9010 psi at 50.0 ft.	387.30	49	1	100	57	10	
	382.30	54					
Grey SHALE, moderately to highly weathered - Uniaxial Compressive Strength = 230 psi at 54.5 ft.			2	100	48	10	
	377.30						
End of Boring							

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

MILLENNIA PROFESSIONAL SERVICES
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B-9
SOIL BORING LOG

Sheet 1 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 12/2/2022

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
DRILLING METHOD HSA and Rock Core
DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550
HAMMER TYPE Auto
EFFICIENCY 94.7%

NOTES South Abutment
Station 17+45.2
Offset 1.7 ft East
Northing
Easting
Ground Surface Elev. 435.3 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 411.3 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL (12")	434.30	1			
Brown, very stiff, dry, SILTY CLAY LOAM			2		
			3 7	2.5 P	20
			3		
			6 7	4.5 P	19
			2		
			3 5	1.0 B	24
- Shelby tube sample obtained at 8.0 ft. - dry density at 8.0 ft. = 99.5 pcf				2.0 P	25
			2		
			3 4	1.4 B	23
			2		
			3 4	1.3 B	24
- Shelby tube sample obtained at 16.0 ft. - dry density at 16.0 ft. = 101.28 pcf				2.0 P	22
	417.05	18.25			
Tan and grey, soft to medium stiff, moist, CLAY			1		
			2 2	0.5 P	30

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Tan and grey, soft to medium stiff, moist, CLAY *(continued)* - brown and grey below 20.5 ft.			0		
			1 2	0.5 P	31
	412.30	23			
Brown to grey, medium stiff, SILT LOAM ▼			2		
			3 3	1.0 P	27
- switched to Mud-Rotary below 25.0 ft.			3		
			3 3	1.0 P	26
			2		
			2 3	0.3 P	23
			2		
			2 2	0.5 P	22
	398.55	36.75			
Grey, medium stiff to stiff, CLAY LOAM, trace gravel			3		
			3 4	1.4 B	15

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-9
SOIL BORING LOG

Sheet 2 of 2

COUNTY: St. Clair
SECTION: 82-1
ROUTE: IL-158 (FAP 674)
MPS PROJECT NO.: MG22054
DATE: 12/2/2022

DESCRIPTION	Bridge over tributary to Loop Creek	**DISTRICT**	8		
LOCATION	St. Clair County, Illinois	**CONSULTANT**	Millennia Professional Services		
DRILLED BY	Terracon	**LOGGED BY**	M. Jenkins	**RIG TYPE**	CME 550
DRILLING METHOD	HSA and Rock Core	**HAMMER TYPE**	Auto	**EFFICIENCY**	94.7%

NOTES South Abutment
Station 17+45.2
Offset 1.7 ft East
Northing
Easting
Ground Surface Elev. 435.3 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft
Groundwater Elev.:
First Encounter 411.3 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

LITHOLOGY	ELEV (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Grey, medium stiff to stiff, CLAY LOAM, trace gravel *(continued)*			4		
			5 6	2.7 B	13
	387.30	48			
Grey, very hard, weathered SHALE	386.30	49	50/4"		8
Auger refusal at 49 ft. Borehole continued with rock coring					

LITHOLOGY

The Unconfined Compressive Strength (UCS) Qu column represents either the IDOT Rimac or AASHTO T 208 Test Procedure. The Qu failure mode is indicated by B for Bulge or S for Shear. P is a Pocket Penetrometer test. The Standard Penetration Test (SPT) N value is the sum of the second and third Blows /6 in. values in each sample using AASHTO T 206.

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B-9
ROCK CORE LOG

Sheet 1 of 1

COUNTY St. Clair
SECTION 82-1
ROUTE IL-158 (FAP 674)
MPS PROJECT NO. MG22054
DATE 12/2/22

DESCRIPTION Bridge over tributary to Loop Creek
LOCATION St. Clair County, Illinois
DRILLED BY Terracon
CORING METHOD NQ Rock Core

DISTRICT 8
CONSULTANT Millennia Professional Services
LOGGED BY M. Jenkins
RIG TYPE CME 550

NOTES South Abutment
Station 17+45.2
Offset 1.7 ft East
Latitude
Longitude
Ground Surface Elev. 435.30 ft

CORING BARREL TYPE & SIZE NQ
Core Diameter 2 in
Top of Rock Elev. 386.30 ft
Begin Core Elev. 386.30 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Light grey LIMESTONE, with shale seams, moderately weathered	386.30	49	1	100	71	8	
- Uniaxial Compressive Strength = 4640 psi at 52.5 ft.							
	380.30	55					
Dark grey to grey SHALE, moderately to highly weathered			2	100	50	8	
- Uniaxial Compressive Strength = 290 psi at 56.0 ft.							
	376.30						
End of Boring							

Color pictures of the cores Attached
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-1

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	53.8-58.8	100	90
2	58.8-62.8	56	0
3	62.8-72.8	98	43

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-2

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	54.0-64.0	82	49

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-3

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	49.0-59.0	60	17
2	59.0-64.0	100	38

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-4

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	49.0-55.0	100	75
2	55.0-59.0	100	25

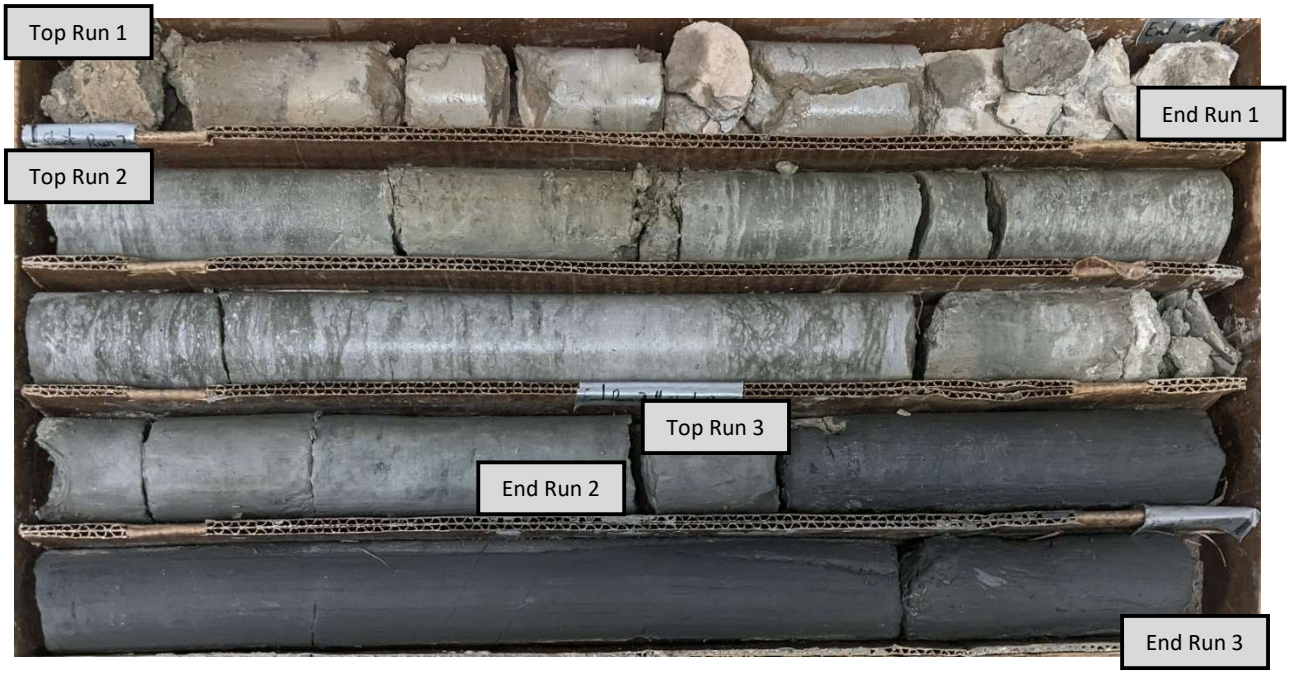
Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-5

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	48.0-58.0	58	31
2	58.0-63.0	100	55

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-6



Run	Depth (ft.)	Recovery (%)	RQD (%)
1	49.0-51.0	100	0
2	51.0-56.0	100	55
3	56.0-59.0	97	83

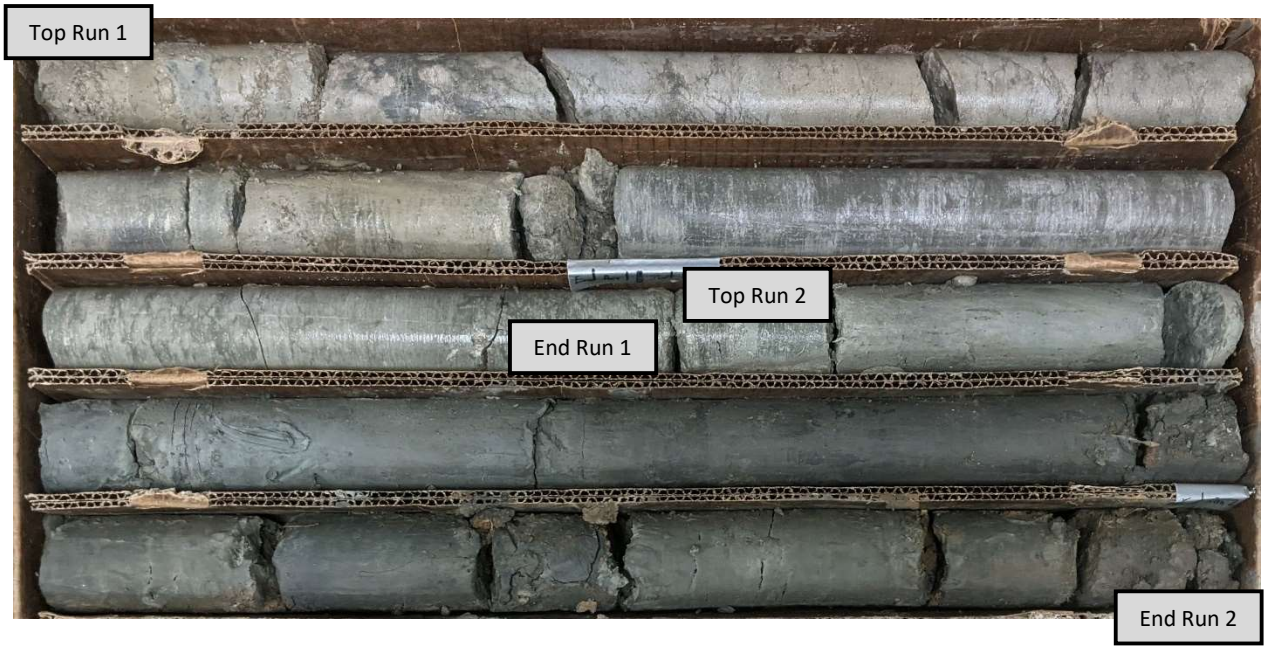
Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-7

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	49.0-59.0	58	40

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-8



Run	Depth (ft.)	Recovery (%)	RQD (%)
1	49.0-54.0	100	57
2	54.0-59.0	100	48

Rock Core Photographs
IL-158 Extension
Project No.: MG22054

Boring: B-9

Run	Depth (ft.)	Recovery (%)	RQD (%)
1	49.0-55.0	100	71
2	55.0-59.0	100	50

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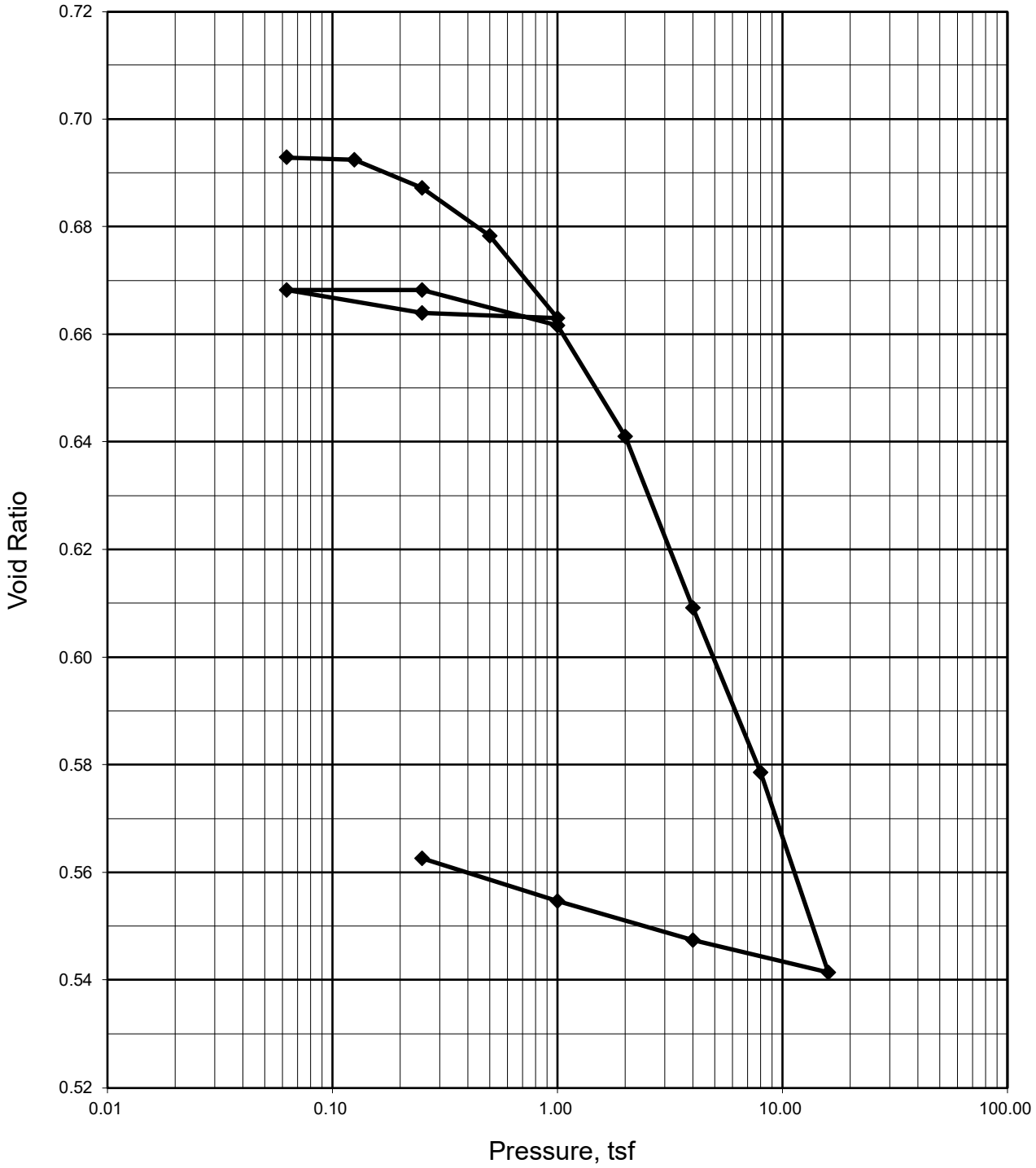
Appendix C

Laboratory Test Results

CONSOLIDATION TEST
IL-158 Extension
St. Clair County, Illinois

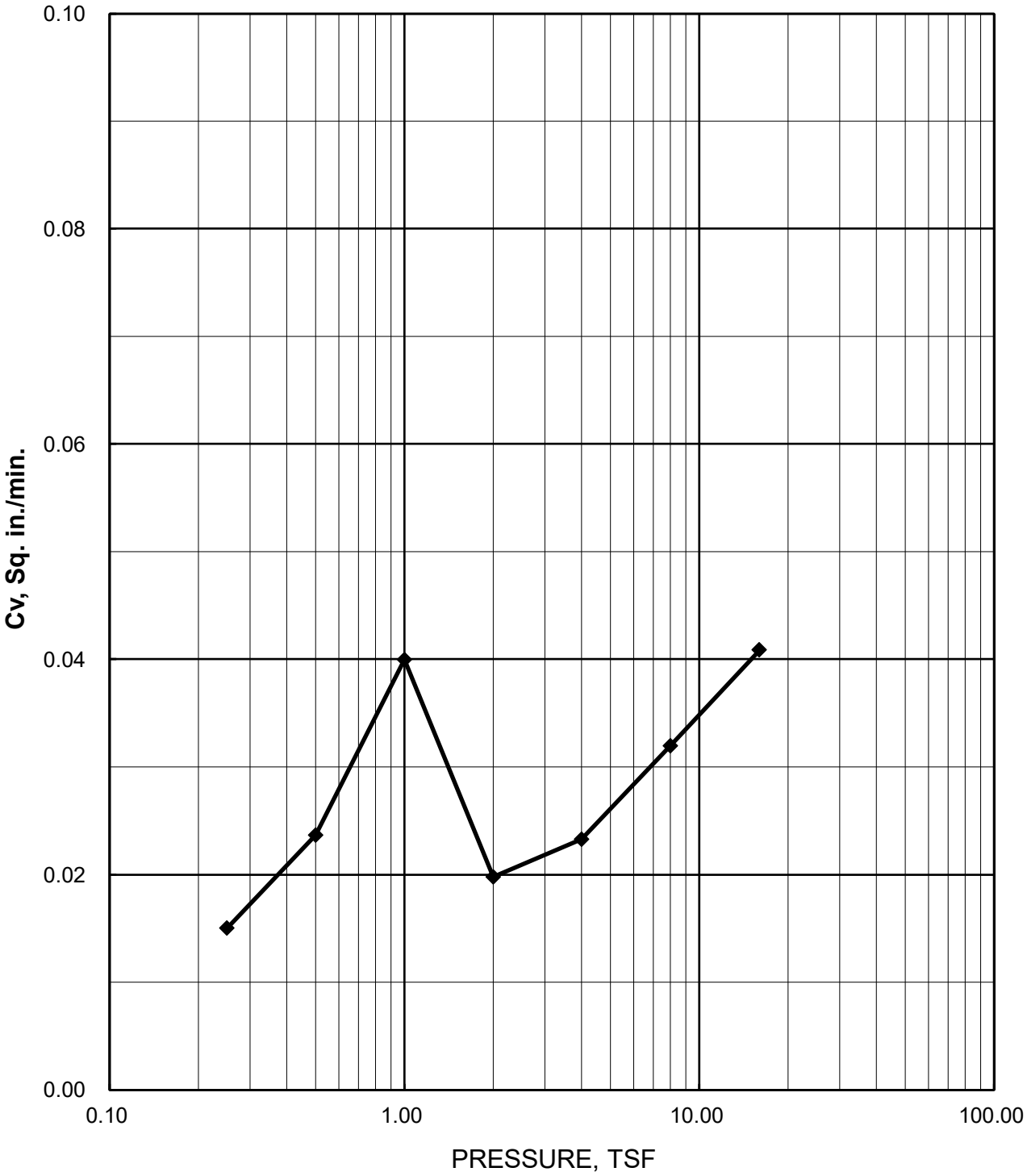
Boring B-9 Sample ST-4 at 8.0-10.0 Feet
Dry Unit Wt. = 99.5 pcf; Moisture Content = 24.6%



CONSOLIDATION TEST

IL-158 Extension
St. Clair Coutny, Illinois

Boring B-9, Sample ST-4 at 8.0-10.0 Feet
Dry Unit Wt. = 99.5 pcf; Moisture Content = 24.6%



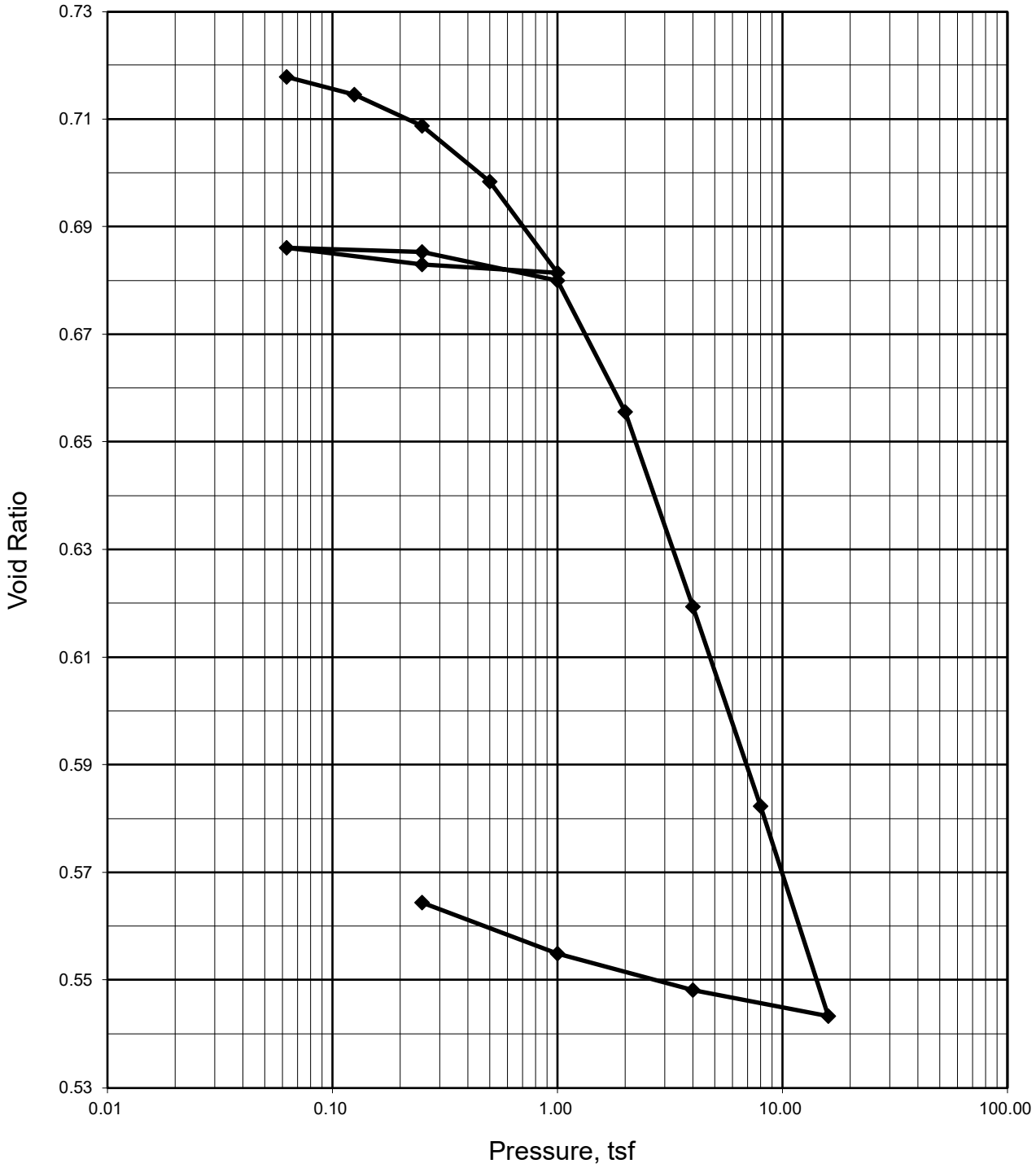
CONSOLIDATION
TEST DATA
Log of Time Method

JOB NUMBER:	J022300.04.6468	INITIAL MOISTURE:		FINAL MOISTURE:		INITIAL DATA:	
BORING NUMBER:	B-9	WET WT SPLE + RING	195.06	WET WT SPLE + RING	191.65	SAMPLE HT.:	0.743
SAMPLE NUMBER:	ST-4	DRY WT SPLE + RING	171.61	DRY WT SPLE + RING	171.61	SAMPLE DIA.:	2.500
DEPTH (Feet):	8.0-10.0	WT OF RING	76.39	WT OF RING	76.39	VOLUME:	59.727
		DRY WT OF SAMPLE	95.22	DRY WT OF SAMPLE	95.22	SPECIFIC GRAV.:	2.700
WET UNIT WT =	124.1	WT OF WATER	23.45	WT OF WATER	20.04	HT. OF SOLIDS:	0.438
DRY UNIT WT =	99.5	MOISTURE CONTENT	24.6	MOISTURE CONTENT	21.0	VOID RATIO:	0.694

PRESSURE (tsf)	D100 *0.0001"	MACHINE DEFLECTION *0.0001"	CORR. FACTOR	CORR. D100 *0.0001"	CONSOLIDATION (Percent)	VOID RATIO CHANGE	VOID RATIO	D 50 UNCORR	H 50 CORR	t 50 or ~~t 90~~	Cv (SQ IN/MIN)
0.000	0.0	0.0	0.0	0.0	0.00	0.0000	0.694				
0.063	3.0	0.0	0.0	3.0	0.04	0.0007	0.693				
0.125	17.0	12.0	0.0	5.0	0.07	0.0011	0.692				
0.250	53.0	25.0	0.0	28.0	0.38	0.0064	0.687	42.0	0.7408	1.80	0.0150
0.500	106.0	39.0	0.0	67.0	0.90	0.0153	0.678	91.0	0.7373	1.13	0.0237
1.000	188.0	54.0	0.0	134.0	1.80	0.0306	0.663	159.0	0.7320	0.66	0.0400
0.250	178.0	39.0	9.0	130.0	1.75	0.0297	0.664				
0.063	145.0	25.0	9.0	111.0	1.49	0.0253	0.668				
0.250	156.0	36.0	9.0	111.0	1.49	0.0253	0.668				
1.000	205.0	56.0	9.0	140.0	1.89	0.0319	0.662				
2.000	304.5	74.0	0.0	230.5	3.10	0.0526	0.641	268.8	0.7230	1.30	0.0198
4.000	463.0	93.0	0.0	370.0	4.98	0.0844	0.609	407.5	0.7111	1.07	0.0233
8.000	618.0	114.0	0.0	504.0	6.79	0.1150	0.579	560.0	0.6979	0.75	0.0320
16.000	803.0	136.0	0.0	667.0	8.98	0.1521	0.541	743.5	0.6818	0.56	0.0409
4.000	779.0	115.0	23.0	641.0	8.63	0.1462	0.547				
1.000	724.0	92.0	23.0	609.0	8.20	0.1389	0.555				
0.250	669.0	72.0	23.0	574.0	7.73	0.1309	0.563				

CONSOLIDATION TEST
IL-158 Extension
St. Clair County, Illinois

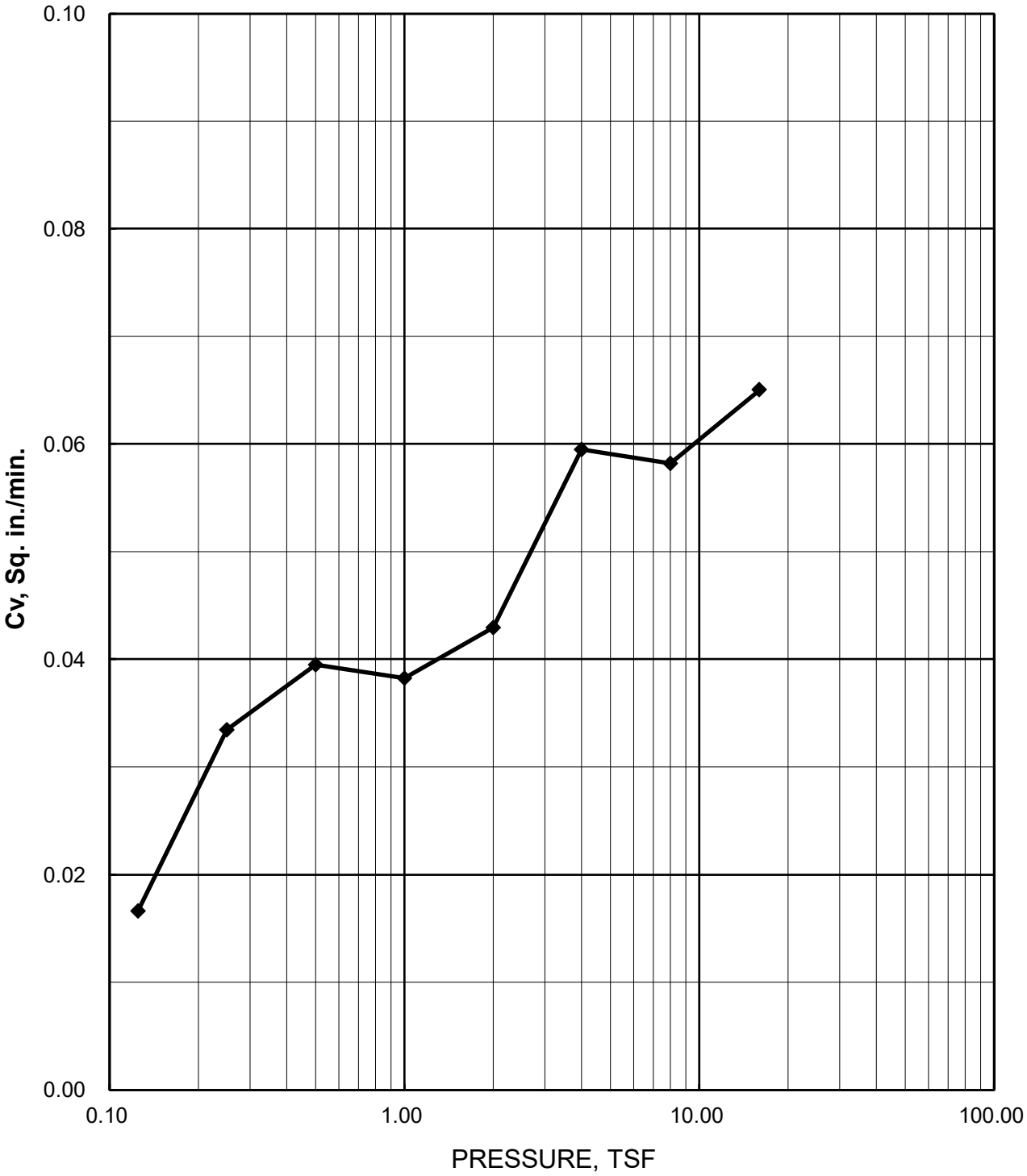
Boring B-1 Sample ST-7 at 16.0-18.0 Feet
Dry Unit Wt. = 96.3 pcf; Moisture Content = 26.9%



CONSOLIDATION TEST

IL-158 Extension
St. Clair Coutny, Illinois

Boring B-1, Sample ST-7 at 16.0-18.0 Feet
Dry Unit Wt. = 96.3 pcf; Moisture Content = 26.9 %



CONSOLIDATION
TEST DATA
Log of Time Method

JOB NUMBER:	J022300.04.6468	INITIAL MOISTURE:		FINAL MOISTURE:		INITIAL DATA:	
BORING NUMBER:	B-1	WET WT SPLE + RING	192.98	WET WT SPLE + RING	188.58	SAMPLE HT.:	0.740
SAMPLE NUMBER:	ST-7	DRY WT SPLE + RING	168.23	DRY WT SPLE + RING	168.23	SAMPLE DIA.:	2.500
DEPTH (Feet):	16.0-18.0	WT OF RING	76.39	WT OF RING	76.39	VOLUME:	59.550
		DRY WT OF SAMPLE	91.84	DRY WT OF SAMPLE	91.84	SPECIFIC GRAV.:	2.650
WET UNIT WT =	122.2	WT OF WATER	24.75	WT OF WATER	20.35	HT. OF SOLIDS:	0.431
DRY UNIT WT =	96.3	MOISTURE CONTENT	26.9	MOISTURE CONTENT	22.2	VOID RATIO:	0.718

PRESSURE (tsf)	D100 *0.0001"	MACHINE DEFLECTION *0.0001"	CORR. FACTOR	CORR. D100 *0.0001"	CONSOLIDATION (Percent)	VOID RATIO CHANGE	VOID RATIO	D 50 UNCORR	H 50 CORR	t 50 or ~~t 90~~	Cv (SQ IN/MIN)
0.000	0.0	0.0	0.0	0.0	0.00	0.0000	0.718				
0.063	2.0	0.0	0.0	2.0	0.03	0.0005	0.718				
0.125	28.0	12.0	0.0	16.0	0.22	0.0037	0.715	20.5	0.7395	1.62	0.0166
0.250	66.0	25.0	0.0	41.0	0.55	0.0095	0.709	57.5	0.7371	0.80	0.0334
0.500	125.0	39.0	0.0	86.0	1.16	0.0200	0.698	110.5	0.7332	0.67	0.0395
1.000	213.0	54.0	0.0	159.0	2.15	0.0369	0.681	189.0	0.7268	0.68	0.0383
0.250	204.0	39.0	13.0	152.0	2.05	0.0353	0.683				
0.063	177.0	25.0	13.0	139.0	1.88	0.0323	0.686				
0.250	191.0	36.0	13.0	142.0	1.92	0.0330	0.685				
1.000	234.0	56.0	13.0	165.0	2.23	0.0383	0.680				
2.000	344.0	74.0	0.0	270.0	3.65	0.0627	0.656	302.5	0.7175	0.59	0.0430
4.000	519.0	93.0	0.0	426.0	5.75	0.0989	0.619	457.5	0.7039	0.41	0.0595
8.000	700.0	114.0	0.0	586.0	7.92	0.1360	0.582	642.0	0.6875	0.40	0.0582
16.000	890.0	136.0	0.0	754.0	10.19	0.1750	0.543	838.0	0.6701	0.34	0.0650
4.000	882.0	115.0	34.0	733.0	9.90	0.1701	0.548				
1.000	830.0	92.0	34.0	704.0	9.51	0.1634	0.555				
0.250	769.0	72.0	34.0	663.0	8.96	0.1539	0.564				

MILLENNIA
PROFESSIONAL SERVICES

Compressive Strength of Cores

Report Date: 1/12/2023
Project Number: MG22054
Date Sampled 11/1/2022
Test Date: 1/11/2023

Client Name:	**Lochmueller Group**
Project Name:	**IL-158 Extension**
MPS Rep:	**J. Schaeffer**

Date Received:	**1/10/2023**
Tested By:	**E. Dela Cruz**
Date Tested:	**1/11/2023**

TEST RESULTS

Core No.	Depth (ft)	Original Length (in)	Diameter (in)	Saw cut Length (in)	Capped Length (in)	Length/Diameter Ratio	Max Load	Fracture Type	Compressive Strength (psi)
B1-R1	55.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B1-R2	63.3	2.80	2.00	2.1	2.5	1.23	28570	3	9030
B1-R3	64.3	7.30	1.97	3.7	4.1	2.08	13810	3	4530
B2	58.0	5.48	2.00	2.5	3.0	1.49	2420	3	770
B4	52.5	5.57	1.99	3.7	4.0	2.00	32870	3	10570
B5	51.5	8.30	1.98	3.7	4.1	2.05	12350	3	4010
B6	51.00	6.97	1.99	3.7	4.0	1.99	18560	3	5970
B6-R3	N/A	2.71	1.97	2.6	2.9	1.48	1660	3	550
B7	50.0	6.18	2.00	3.7	4.0	1.98	24070	3	7660
B8-R1	50.0	7.84	1.98	3.7	3.9	1.98	27730	3	9010
B8-R2	54.5	4.92	2.00	2.2	2.7	1.36	720	3	230
B9-R1	52.5	6.22	1.98	3.7	4.0	2.04	14280	3	4640
B9-R2	56.0	7.95	2.02	2.2	2.7	1.32	950	3	290

Test Method(s): **ASTM C39, ASTM C42**
Comment(s): Cores capped w/ sulfur.
Note: B-1 R-1 Was broken upon arrival we were not able to get a compressive strength on it. Cores highlighted in yellow were shale and had a lower compressive strength

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Appendix D

Seismic Site Class and Liquefaction Spreadsheets

Illinois Department of Transportation

SEISMIC SITE CLASS DETERMINATION

PROJECT TITLE=====IL-158 Extension - Bridge over Tributary to Loop Creek

Substructure 1

Base of Substruct. Elev. (or ground surf for bents	436	ft.
Pile or Shaft Dia.	14	inches
Boring Number	B-1 (N Abut)	
Top of Boring Elev.	435.3	ft.
Approximate Fixity Elev.	429	ft.

Individual Site Class Definition:

N (bar): 11 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.14 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	432.8	2.50	9		
	430.3	2.50	7	4.50	
1.2	427.8	2.50		2.30	
3.7	425.3	2.50	4	1.00	
6.2	422.8	2.50	5	1.00	
8.7	420.3	2.50	4	0.60	B
11.2	417.8	2.50		0.70	
13.7	415.3	2.50	7	1.30	
16.7	412.3	3.00	6	1.40	B
19.5	409.6	2.75	9	0.50	B
21.7	407.3	2.25	6	3.50	
24.2	404.8	2.50	8		
26.7	402.3	2.50	8		
29.2	399.8	2.50	8	0.70	
31.7	397.3	2.50	8	0.70	
33.7	395.3	2.00	8	0.70	B
38.7	390.3	5.00	10	1.80	
43.2	385.8	4.50	20	2.10	
45.7	383.3	2.50	20	2.10	B
100.0	329.0	54.30	50	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents	429	ft.
Pile or Shaft Dia.	42	inches
Boring Number	B-2 (Pier 1)	
Top of Boring Elev.	435.4	ft.
Approximate Fixity Elev.	408	ft.

Individual Site Class Definition:

N (bar): 26 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 3.44 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	432.9	2.50	7	2.00	
	430.4	2.50	5	1.50	
	427.9	2.50		1.80	
	425.4	2.50	4	1.40	
	422.9	2.50	4	1.00	
	420.4	2.50		1.30	
	417.9	2.50	4	1.40	
	415.4	2.50	4	0.70	B
	412.4	3.00	15		B
	409.7	2.75	6		B
0.6	407.4	2.25	12	2.90	
3.1	404.9	2.50	5	0.50	
8.1	399.9	5.00	4	0.50	
12.6	395.4	4.50	9	2.50	B
16.6	391.4	4.00	11	1.50	
20.6	387.4	4.00	11	1.50	B
100.0	308.0	79.40	50	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents	429	ft.
Pile or Shaft Dia.	42	inches
Boring Number	B-4 (Pier 2)	
Top of Boring Elev.	435.5	ft.
Approximate Fixity Elev.	408	ft.

Individual Site Class Definition:

N (bar): 25 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 48 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 2.8 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	433.0	2.50	6	1.50	
	430.5	2.50	7	2.00	
	428.0	2.50		2.00	
	426.0	2.00	3	1.30	
	424.8	1.25	3	1.30	B
	422.0	2.75	4	1.70	
	419.5	2.50		2.50	
	417.0	2.50	4	0.50	
	415.5	1.50	4	0.50	B
	413.0	2.50	4	0.80	
	409.8	3.25	9	1.50	B
0.5	407.5	2.25	5	1.00	
3.0	405.0	2.50	9	0.50	
5.5	402.5	2.50	5	0.50	
8.0	400.0	2.50	5	0.50	
9.3	398.8	1.25	5	0.50	B
12.5	395.5	3.25	7	2.30	
14.5	393.5	2.00	7	2.30	B
17.5	390.5	3.00	33		
20.5	387.5	3.00	33		B
100.0	308.0	79.50	50	5.00	R

Substructure 4

Base of Substruct. Elev. (or ground surf for bents	429	ft.
Pile or Shaft Dia.	42	inches
Boring Number	B-6 (Pier 3)	
Top of Boring Elev.	435.5	ft.
Approximate Fixity Elev.	408	ft.

Individual Site Class Definition:

N (bar): 33 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 51 (Blows/ft.) Soil Site Class C <----Controls
s_u (bar): 2.98 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	433.0	2.50	7	1.00	
	430.0	3.00	4	1.00	B
	427.5	2.50		1.00	
	425.0	2.50	0	0.60	
	422.5	2.50	2	1.20	
	420.0	2.50		0.50	B
	417.5	2.50	7	1.60	
	415.0	2.50	5	1.20	
	412.5	2.50	7	1.20	B
	410.0	2.50	12	1.50	
0.5	407.5	2.50	11		
3.0	405.0	2.50	8		
5.5	402.5	2.50	8		
8.0	400.0	2.50	10	1.00	
9.3	398.8	1.25	10	1.00	B
11.8	396.3	2.50	14	3.00	
14.3	393.8	2.50	14	3.00	B
16.5	391.5	2.25			B
20.5	387.5	4.00	65		B
100.0	308.0	79.50	50	5.00	R

Global Site Class Definition: Substructures 1 through 6

N (bar): 22 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 47 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 2.86 (ksf) Soil Site Class C

Illinois Department of Transportation

SEISMIC SITE CLASS DETERMINATION

PROJECT TITLE=====

Substructure 5

Base of Substruct. Elev. (or ground surf for bents	429	ft.
Pile or Shaft Dia.	42	inches
Boring Number	B-7 (Pier 4)	
Top of Boring Elev.	436.3	ft.
Approximate Fixity Elev.	408	ft.

Individual Site Class Definition:

N (bar):	27 (Blows/ft.)	Soil Site Class D	
N_{ch} (bar):	36 (Blows/ft.)	Soil Site Class D	<----Controls
s_u (bar):	4.3 (ksf)	Soil Site Class C	

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	433.8	2.50	6	1.30	
	431.3	2.50	6	1.50	
	428.8	2.50		1.30	
	426.3	2.50	6	1.20	
	423.8	2.50	6	1.20	
	420.8	3.00	6	1.80	B
	418.3	2.50	7	1.40	
	415.8	2.50	7	1.70	
	413.3	2.50	6	1.50	B
	410.8	2.50	15	2.50	
	408.3	2.50	7		
2.2	405.8	2.50	11		
4.7	403.3	2.50	11		
7.2	400.8	2.50	8		
8.4	399.6	1.25	8		B
11.0	397.1	2.50	6	1.80	
13.5	394.6	2.50	6	1.80	
16.0	392.1	2.50	12	2.50	
19.7	388.3	3.75	12	2.50	B
100.0	308.0	80.30	50	5.00	R

Substructure 6

Base of Substruct. Elev. (or ground surf for bents	436	ft.
Pile or Shaft Dia.	14	inches
Boring Number	B-9 (S Abut)	
Top of Boring Elev.	435.3	ft.
Approximate Fixity Elev.	429	ft.

Individual Site Class Definition:

N (bar):	11 (Blows/ft.)	Soil Site Class E	
N_{ch} (bar):	NA (Blows/ft.)	NA	
s_u (bar):	1.65 (ksf)	Soil Site Class D	<----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	432.8	2.50	10	2.50	
	430.3	2.50	13	4.50	
1.2	427.8	2.50	8	1.00	
3.7	425.3	2.50		2.00	
6.2	422.8	2.50	7	1.40	
8.9	420.1	2.75	7	1.30	
12.0	417.1	3.00		2.00	B
14.5	414.6	2.50	4	0.50	
16.7	412.3	2.25	3	0.50	B
19.2	409.8	2.50	6	1.00	
21.7	407.3	2.50	6	1.00	
24.2	404.8	2.50	5	0.30	
26.0	403.1	1.75	5	0.30	
28.0	401.1	2.00	4	0.50	
30.5	398.6	2.50	4	0.50	B
33.0	396.1	2.50	7	1.40	
36.0	393.1	3.00	7	1.40	
38.7	390.3	2.75	11	2.70	
41.7	387.3	3.00	11	2.70	B
100.0	329.0	58.30	50	5.00	R

Substructure 7

Base of Substruct. Elev. (or ground surf for bents)		ft.
Pile or Shaft Dia.		inches
Boring Number		
Top of Boring Elev.		ft.
Approximate Fixity Elev.		ft.

Individual Site Class Definition:

N (bar):	(Blows/ft.)	NA
N_{ch} (bar):	(Blows/ft.)	NA
s_u (bar):	(ksf)	NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Substructure 8

Base of Substruct. Elev. (or ground surf for bents)		ft.
Pile or Shaft Dia.		inches
Boring Number		
Top of Boring Elev.		ft.
Approximate Fixity Elev.		ft.

Individual Site Class Definition:

N (bar):	(Blows/ft.)	NA
N_{ch} (bar):	(Blows/ft.)	NA
s_u (bar):	(ksf)	NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-1 N. Abut.
ELEVATION OF BORING GROUND SURFACE ========== 435.30 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 15.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 10.00 FT. (Fill Height)
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **467** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (K_S)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
432.8	2.5	9	1		15	35	13	0.122	0.305	23.085	23.085	0.258	0.060	1.350	1.381	1.152	**0.297**	0.877	**0.164**	**N.L. (2)**
430.3	5	7	1		15	35	15	0.122	0.610	15.599	15.599	0.166	0.060	1.500	1.687	1.097	**0.182**	0.842	**0.174**	**N.L. (2)**
427.8	7.5	7	1		15	35	23	0.122	0.915	14.271	14.271	0.153	0.060	1.650	1.993	1.067	**0.163**	0.805	**0.178**	**N.L. (2)**
425.3	10	4	1		15	35	27	0.122	1.220	8.091	8.091	0.097	0.060	1.800	2.299	1.037	**0.100**	0.767	**0.180**	**N.L. (2)**
422.8	12.5	5	1		15	35	31	0.122	1.525	9.871	9.871	0.112	0.060	1.950	2.605	1.019	**0.114**	0.730	**0.179**	**N.L. (2)**
420.3	15	4	0.6		15	35	28	0.116	1.815	7.656	7.656	0.093	0.178	2.395	3.206	0.974	**0.091**	0.694	**0.170**	**N.L. (2)**
417.8	17.5	7	1.3		15	35	25	0.062	1.970	13.287	13.287	0.143	0.062	2.550	3.517	0.955	**0.137**	0.660	**0.167**	**N.L. (2)**
415.3	20	7	1.3		15	35	25	0.062	2.125	13.089	13.089	0.141	0.062	2.705	3.828	0.941	**0.133**	0.630	**0.163**	**N.L. (2)**
412.8	22.5	6	1.4		15	35	24	0.063	2.283	10.998	10.998	0.122	0.063	2.863	4.142	0.931	**0.114**	0.604	**0.160**	**N.L. (2)**
410.3	25	9	0.5		8	29	26	0.051	2.410	16.224	16.224	0.173	0.051	2.990	4.425	0.911	**0.157**	0.581	**0.158**	**0.994 (D)**
407.8	27.5	6	3.5		8	29	24	0.074	2.595	10.498	10.498	0.118	0.074	3.175	4.766	0.910	**0.107**	0.562	**0.155**	**N.L. (2)**
405.3	30	8	0.7		8	29	26	0.055	2.733	13.703	13.703	0.147	0.055	3.313	5.060	0.893	**0.131**	0.546	**0.153**	**0.856 (D)**
400.3	35	8	0.7		15	35	17	0.055	3.008	13.126	13.126	0.142	0.055	3.588	5.647	0.876	**0.124**	0.523	**0.151**	**N.L. (2)**
395.3	40	8	0.7		15	35	16	0.055	3.283	12.585	12.585	0.137	0.055	3.863	6.234	0.862	**0.118**	0.509	**0.150**	**N.L. (2)**
390.3	45	10	1.8		15	35	15	0.066	3.613	14.972	14.972	0.160	0.066	4.193	6.876	0.836	**0.134**	0.499	**0.150**	**N.L. (2)**
385.3	50	20	2.1					0.068	3.953	29.641	29.641	0.444	0.068	4.533	7.528	0.764	**0.340**	0.494	**0.150**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c/LL \leq 0.85$
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-2 Bent 1
ELEVATION OF BORING GROUND SURFACE ========== 435.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 15.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **406** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
432.9	2.5	7	2		15	35	23	0.130	0.325	17.309	17.309	0.184	0.130	0.325	0.325	1.500	**0.276**	0.972	**0.178**	**N.L. (1)**
430.4	5	5	1.5		15	35	25	0.126	0.640	11.002	11.002	0.122	0.126	0.640	0.640	1.329	**0.162**	0.939	**0.172**	**N.L. (1)**
427.9	7.5	5	2		15	35	25	0.130	0.965	10.048	10.048	0.114	0.130	0.965	0.965	1.200	**0.136**	0.902	**0.165**	**N.L. (1)**
425.4	10	4	1.4		15	35	25	0.125	1.278	7.969	7.969	0.096	0.125	1.278	1.278	1.117	**0.107**	0.861	**0.158**	**N.L. (1)**
422.9	12.5	4	1		15	35	22	0.122	1.583	7.787	7.787	0.094	0.060	1.428	1.459	1.090	**0.103**	0.818	**0.153**	**N.L. (2)**
420.4	15	4	1.5		15	35	22	0.126	1.898	7.514	7.514	0.092	0.188	1.898	2.085	1.024	**0.094**	0.774	**0.156**	**N.L. (2)**
417.9	17.5	4	1.4		15	35	30	0.063	2.055	7.452	7.452	0.091	0.063	2.055	2.398	1.007	**0.092**	0.730	**0.156**	**N.L. (2)**
415.4	20	4	0.7		15	35	24	0.055	2.193	7.373	7.373	0.091	0.055	2.193	2.692	0.993	**0.090**	0.688	**0.155**	**N.L. (2)**
412.9	22.5	15						0.065	2.355	28.141	28.141	0.375	0.065	2.355	3.010	0.964	**0.361**	0.649	**0.152**	**N.L. (3)**
410.4	25	6						0.057	2.498	10.628	10.628	0.119	0.057	2.498	3.309	0.962	**0.114**	0.613	**0.149**	**0.765 (C)**
407.9	27.5	12	2.9		12	30	20	0.072	2.678	20.799	20.799	0.226	0.072	2.678	3.645	0.933	**0.210**	0.582	**0.145**	**N.L. (2)**
405.4	30	5	0.5		8	29	23	0.051	2.805	8.448	8.448	0.100	0.051	2.805	3.928	0.940	**0.094**	0.556	**0.143**	**N.L. (2)**
400.4	35	4	0.5		12	30	17	0.051	3.060	6.501	6.501	0.084	0.051	3.060	4.495	0.926	**0.077**	0.514	**0.139**	**N.L. (2)**
395.4	40	9	2.5		12	30	16	0.070	3.410	13.855	13.855	0.149	0.070	3.410	5.157	0.886	**0.132**	0.487	**0.135**	**N.L. (2)**
390.4	45	11	1.5		15	35	14	0.064	3.730	16.160	16.160	0.172	0.064	3.730	5.789	0.859	**0.148**	0.470	**0.134**	**N.L. (2)**
387.4	48	50						0.076	3.958	84.018	84.018	0.597	0.076	3.958	6.204	0.779	**0.465**	0.463	**0.133**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c/LL \leq 0.85$
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==========B-3
ELEVATION OF BORING GROUND SURFACE ========== 435.60 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 15.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD==========Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **438** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
433.1	2.5	5	1.5		15	35	25	0.126	0.315	12.253	12.253	0.134	0.126	0.315	0.315	1.500	**0.200**	0.978	**0.179**	**N.L. (1)**
430.6	5	7	1.5		15	35	24	0.126	0.630	15.492	15.492	0.165	0.126	0.630	0.630	1.381	**0.228**	0.952	**0.174**	**N.L. (1)**
428.1	7.5	7	1.4		15	35	23	0.125	0.943	14.158	14.158	0.152	0.125	0.943	0.943	1.232	**0.187**	0.922	**0.169**	**N.L. (1)**
425.6	10	7	1		15	35	23	0.122	1.248	14.056	14.056	0.151	0.122	1.248	1.248	1.146	**0.173**	0.888	**0.163**	**N.L. (1)**
423.1	12.5	5	1.5		15	35	22	0.126	1.563	9.781	9.781	0.111	0.064	1.408	1.439	1.099	**0.122**	0.851	**0.159**	**N.L. (2)**
420.6	15	4	1		15	35	26	0.122	1.868	7.565	7.565	0.092	0.184	1.868	2.055	1.028	**0.095**	0.811	**0.164**	**N.L. (2)**
418.1	17.5	4	0.5		15	35	26	0.051	1.995	7.551	7.551	0.092	0.051	1.995	2.338	1.013	**0.093**	0.770	**0.166**	**N.L. (2)**
415.6	20	7	1.4		15	35	26	0.063	2.153	13.013	13.013	0.141	0.063	2.153	2.652	0.996	**0.140**	0.730	**0.165**	**N.L. (2)**
413.1	22.5	5	0.7		15	35	33	0.055	2.290	9.151	9.151	0.106	0.055	2.290	2.945	0.983	**0.104**	0.691	**0.163**	**N.L. (2)**
410.6	25	5	1		15	35	25	0.059	2.438	8.963	8.963	0.104	0.059	2.438	3.249	0.969	**0.101**	0.655	**0.160**	**N.L. (2)**
408.1	27.5	11	1.7		15	35	26	0.065	2.600	19.228	19.228	0.206	0.065	2.600	3.567	0.943	**0.194**	0.623	**0.157**	**N.L. (2)**
405.6	30	6	0.5		5	28	26	0.051	2.728	10.287	10.287	0.116	0.051	2.728	3.851	0.943	**0.109**	0.594	**0.154**	**0.708 (C)**
400.6	35	8	0.5		8	29	25	0.051	2.983	13.185	13.185	0.142	0.051	2.983	4.418	0.918	**0.131**	0.548	**0.149**	**0.879 (D)**
395.6	40	10	1.1		15	35	15	0.060	3.283	15.731	15.731	0.167	0.060	3.283	5.030	0.890	**0.149**	0.517	**0.145**	**N.L. (2)**
390.6	45	13	4		15	35	13	0.076	3.663	19.306	19.306	0.207	0.076	3.663	5.722	0.854	**0.177**	0.497	**0.142**	**N.L. (2)**
387.6	48	50						0.076	3.891	84.899	84.899	0.604	0.076	3.891	6.137	0.784	**0.474**	0.488	**0.141**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-4 Bent 2
ELEVATION OF BORING GROUND SURFACE ========== 435.50 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 12.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **385** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
433	2.5	6	1.5		15	35	18	0.126	0.315	14.703	14.703	0.157	0.126	0.315	0.315	1.500	**0.236**	0.967	**0.177**	**N.L. (1)**
430.5	5	7	2		15	35	20	0.130	0.640	15.439	15.439	0.164	0.130	0.640	0.640	1.374	**0.226**	0.929	**0.170**	**N.L. (1)**
428	7.5	3	1.3		15	35	20	0.125	0.953	6.050	6.050	0.080	0.125	0.953	0.953	1.180	**0.095**	0.887	**0.163**	**N.L. (1)**
425.5	10	3	1.3		15	35	25	0.125	1.265	5.996	5.996	0.080	0.125	1.265	1.265	1.113	**0.089**	0.843	**0.154**	**N.L. (1)**
423	12.5	4	1.7		12	30	25	0.065	1.428	8.091	8.091	0.097	0.065	1.428	1.459	1.091	**0.105**	0.796	**0.149**	**N.L. (2)**
420.5	15	4	1		12	30	25	0.059	1.575	8.102	8.102	0.097	0.059	1.575	1.762	1.067	**0.103**	0.749	**0.154**	**N.L. (2)**
418	17.5	4	0.5		12	30	27	0.051	1.703	8.071	8.071	0.097	0.051	1.703	2.046	1.049	**0.101**	0.704	**0.155**	**N.L. (2)**
415.5	20	4	0.5		12	30	25	0.051	1.830	7.984	7.984	0.096	0.051	1.830	2.329	1.033	**0.099**	0.661	**0.154**	**N.L. (2)**
413	22.5	4	0.8		15	35	27	0.057	1.973	7.835	7.835	0.095	0.057	1.973	2.628	1.016	**0.096**	0.622	**0.152**	**N.L. (2)**
410.5	25	9	1.5		15	35	27	0.064	2.133	17.186	17.186	0.183	0.064	2.133	2.944	0.998	**0.183**	0.588	**0.149**	**N.L. (2)**
408	27.5	5	1		5	25	27	0.059	2.280	9.320	9.320	0.107	0.059	2.280	3.247	0.984	**0.105**	0.558	**0.146**	**0.719 (C)**
405.5	30	9	0.5		5	25	25	0.051	2.408	16.428	16.428	0.175	0.051	2.408	3.531	0.966	**0.169**	0.533	**0.143**	**1.182 (D)**
400.5	35	5	0.5		8	29	23	0.051	2.663	8.747	8.747	0.102	0.051	2.663	4.098	0.950	**0.097**	0.494	**0.139**	**N.L. (2)**
395.5	40	7	2.3		15	40	22	0.069	3.008	11.557	11.557	0.127	0.069	3.008	4.755	0.919	**0.117**	0.469	**0.136**	**N.L. (2)**
390.5	45	33						0.072	3.368	58.955	58.955	0.392	0.072	3.368	5.427	0.831	**0.326**	0.453	**0.134**	**N.L. (3)**
387.5	48	40						0.074	3.590	71.253	71.253	0.496	0.074	3.590	5.836	0.810	**0.402**	0.447	**0.133**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-5
ELEVATION OF BORING GROUND SURFACE ========== 436.70 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 24.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **429** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
434.2	2.5	7	2				18	0.130	0.325	17.309	17.309	0.184	0.130	0.325	0.325	1.500	**0.276**	0.976	**0.179**	**N.L. (1)**
431.7	5	5	1.5				22	0.126	0.640	11.002	11.002	0.122	0.126	0.640	0.640	1.329	**0.162**	0.948	**0.174**	**N.L. (1)**
429.2	7.5	5	1.2				26	0.124	0.950	10.091	10.091	0.114	0.124	0.950	0.950	1.205	**0.137**	0.916	**0.168**	**N.L. (1)**
426.7	10	5	0.5				26	0.114	1.235	10.073	10.073	0.114	0.114	1.235	1.235	1.134	**0.129**	0.881	**0.161**	**N.L. (1)**
424.2	12.5	2	0.5		12	30	28	0.114	1.520	3.953	3.953	0.065	0.052	1.365	1.396	1.092	**0.071**	0.842	**0.158**	**N.L. (2)**
421.7	15	4	1.7		12	30	24	0.128	1.840	7.612	7.612	0.093	0.066	1.530	1.717	1.073	**0.099**	0.801	**0.165**	**N.L. (2)**
419.2	17.5	4	2		20	45	24	0.130	2.165	7.278	7.278	0.090	0.068	1.700	2.043	1.048	**0.094**	0.759	**0.167**	**N.L. (2)**
416.7	20	6	0.9		20	45	23	0.120	2.465	10.458	10.458	0.117	0.058	1.845	2.344	1.033	**0.121**	0.719	**0.167**	**N.L. (2)**
414.2	22.5	5	0.7		20	45	29	0.117	2.758	8.344	8.344	0.099	0.055	1.983	2.638	1.015	**0.100**	0.679	**0.166**	**N.L. (2)**
411.7	25	7	0.3		5	25	30	0.046	2.873	11.541	11.541	0.127	0.046	2.098	2.909	1.003	**0.127**	0.643	**0.164**	**0.774 (D)**
409.2	27.5	13	0.3		5	25	26	0.046	2.988	21.316	21.316	0.232	0.046	2.213	3.180	0.987	**0.230**	0.611	**0.161**	**1.429 (D)**
406.7	30	11	0.5		5	25	27	0.051	3.115	17.568	17.568	0.187	0.051	2.340	3.463	0.973	**0.182**	0.583	**0.158**	**1.152 (D)**
401.7	35	10	0.5		15	35	16	0.051	3.370	15.401	15.401	0.164	0.051	2.595	4.030	0.948	**0.156**	0.539	**0.153**	**N.L. (2)**
396.7	40	11	2.3		15	35	16	0.069	3.715	16.108	16.108	0.171	0.069	2.940	4.687	0.916	**0.157**	0.509	**0.149**	**N.L. (2)**
391.7	45	18	2.7					0.071	4.070	25.699	25.699	0.306	0.071	3.295	5.354	0.865	**0.265**	0.489	**0.146**	**N.L. (3)**
388.7	48	50						0.076	4.298	79.843	79.843	0.565	0.076	3.523	5.769	0.816	**0.461**	0.481	**0.144**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-6 Bent 3
ELEVATION OF BORING GROUND SURFACE ========== 435.50 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 7.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 6.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **349** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
433	2.5	7	1				17	0.122	0.305	17.443	17.443	0.186	0.122	0.305	0.305	1.500	**0.278**	0.957	**0.175**	**N.L. (1)**
430.5	5	4	1				21	0.122	0.610	8.885	8.885	0.103	0.122	0.610	0.610	1.323	**0.137**	0.911	**0.167**	**N.L. (1)**
428	7.5	1	0.5		15	35	21	0.051	0.738	2.149	2.149	0.054	0.051	0.738	0.831	1.235	**0.066**	0.861	**0.178**	**N.L. (2)**
425.5	10	1	0.6		15	35	31	0.053	0.870	2.230	2.230	0.054	0.053	0.870	1.120	1.195	**0.065**	0.809	**0.191**	**N.L. (2)**
423	12.5	2	1.2		15	35	25	0.061	1.023	4.505	4.505	0.068	0.061	1.023	1.428	1.157	**0.079**	0.757	**0.194**	**N.L. (2)**
420.5	15	1	0.5		15	35	25	0.051	1.150	2.259	2.259	0.054	0.051	1.150	1.712	1.130	**0.061**	0.707	**0.193**	**N.L. (2)**
418	17.5	7	1.6		20	40	25	0.065	1.313	15.553	15.553	0.166	0.065	1.313	2.030	1.136	**0.188**	0.660	**0.187**	**N.L. (2)**
415.5	20	5	1.2		20	40	26	0.061	1.465	10.889	10.889	0.121	0.061	1.465	2.339	1.092	**0.132**	0.617	**0.181**	**N.L. (2)**
413	22.5	7	1.2		20	40	23	0.061	1.618	14.881	14.881	0.159	0.061	1.618	2.647	1.073	**0.171**	0.580	**0.174**	**N.L. (2)**
410.5	25	12	1.5		8	29	24	0.064	1.778	25.463	25.463	0.301	0.064	1.778	2.963	1.060	**0.319**	0.547	**0.167**	**N.L. (2)**
408	27.5	11	0.2		5	25	24	0.042	1.883	22.667	22.667	0.252	0.042	1.883	3.224	1.038	**0.261**	0.520	**0.163**	**1.601 (D)**
405.5	30	8	0.2		5	25	22	0.042	1.988	15.956	15.956	0.170	0.042	1.988	3.485	1.017	**0.173**	0.497	**0.160**	**1.081 (D)**
400.5	35	10	1		5	25	20	0.059	2.283	18.872	18.872	0.202	0.059	2.283	4.092	0.979	**0.198**	0.463	**0.152**	**N.L. (2)**
395.5	40	14	3		15	35	13	0.072	2.643	25.324	25.324	0.298	0.072	2.643	4.764	0.930	**0.278**	0.442	**0.146**	**N.L. (2)**
390.5	45	65						0.078	3.033	######	126.971	0.925	0.078	3.033	5.466	0.867	**0.801**	0.428	**0.142**	**N.L. (3)**
387.5	48	50						0.076	3.261	94.114	94.114	0.676	0.076	3.261	5.881	0.842	**0.569**	0.423	**0.140**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-7 Bent 4
ELEVATION OF BORING GROUND SURFACE ========== 436.30 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 7.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 6.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **459** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
433.8	2.5	6	1.3				27	0.125	0.313	14.716	14.716	0.157	0.125	0.313	0.313	1.500	**0.236**	0.981	**0.180**	**N.L. (1)**
431.3	5	6	1.5				24	0.126	0.628	13.255	13.255	0.143	0.126	0.628	0.628	1.359	**0.194**	0.959	**0.176**	**N.L. (1)**
428.8	7.5	6	1		15	35	24	0.059	0.775	12.748	12.748	0.138	0.059	0.775	0.869	1.284	**0.177**	0.933	**0.192**	**N.L. (2)**
426.3	10	6	1.2		15	35	23	0.061	0.928	13.158	13.158	0.142	0.061	0.928	1.177	1.231	**0.175**	0.903	**0.210**	**N.L. (2)**
423.8	12.5	6	1.2		15	35	24	0.061	1.080	13.300	13.300	0.143	0.061	1.080	1.486	1.185	**0.170**	0.869	**0.219**	**N.L. (2)**
421.3	15	6	1.8		15	35	25	0.066	1.245	13.211	13.211	0.143	0.066	1.245	1.807	1.143	**0.163**	0.833	**0.222**	**N.L. (2)**
418.8	17.5	7	1.4		20	40	24	0.063	1.403	15.198	15.198	0.162	0.063	1.403	2.120	1.115	**0.181**	0.795	**0.220**	**N.L. (2)**
416.3	20	7	1.7		20	40	23	0.065	1.565	14.873	14.873	0.159	0.065	1.565	2.439	1.083	**0.172**	0.757	**0.216**	**N.L. (2)**
413.8	22.5	6	1.5		20	40	24	0.064	1.725	12.434	12.434	0.135	0.064	1.725	2.755	1.052	**0.142**	0.719	**0.210**	**N.L. (2)**
411.3	25	15	2.5		5	25	20	0.070	1.900	31.716	31.716	0.668	0.070	1.900	3.086	1.041	**0.696**	0.682	**0.203**	**N.L. (2)**
408.8	27.5	7	0.5		5	25	23	0.051	2.028	13.768	13.768	0.148	0.051	2.028	3.369	1.011	**0.150**	0.649	**0.198**	**0.758 (D)**
406.3	30	11	0.5		5	25	20	0.051	2.155	21.334	21.334	0.233	0.051	2.155	3.653	0.995	**0.232**	0.619	**0.192**	**N.L. (2)**
401.3	35	8	0.5		5	25	24	0.051	2.410	14.709	14.709	0.157	0.051	2.410	4.220	0.967	**0.152**	0.571	**0.183**	**0.831 (D)**
396.3	40	6	1.8		15	35	18	0.066	2.740	10.408	10.408	0.117	0.066	2.740	4.862	0.942	**0.110**	0.538	**0.175**	**N.L. (2)**
391.3	45	12	2.5		15	35	10	0.070	3.090	19.632	19.632	0.211	0.070	3.090	5.524	0.896	**0.189**	0.515	**0.169**	**N.L. (2)**
388.3	48	50						0.076	3.318	93.191	93.191	0.668	0.076	3.318	5.939	0.836	**0.559**	0.506	**0.166**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-8
ELEVATION OF BORING GROUND SURFACE ========== 436.30 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 26.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== FT.
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **444** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
433.8	2.5	9	1.5				27	0.126	0.315	22.994	22.994	0.257	0.126	0.315	0.315	1.500	**0.385**	0.979	**0.179**	**N.L. (1)**
431.3	5	9	1.5				24	0.126	0.630	20.449	20.449	0.221	0.126	0.630	0.630	1.434	**0.317**	0.954	**0.175**	**N.L. (1)**
428.8	7.5	7	1				26	0.122	0.935	14.189	14.189	0.152	0.122	0.935	0.935	1.235	**0.188**	0.925	**0.169**	**N.L. (1)**
426.3	10	6	1				24	0.122	1.240	12.072	12.072	0.132	0.122	1.240	1.240	1.140	**0.150**	0.892	**0.163**	**N.L. (1)**
423.8	12.5	6	1.2		15	35	24	0.124	1.550	11.773	11.773	0.129	0.062	1.395	1.426	1.107	**0.143**	0.855	**0.160**	**N.L. (2)**
421.3	15	6	1.4		15	35	23	0.125	1.863	11.360	11.360	0.125	0.063	1.553	1.740	1.078	**0.135**	0.817	**0.168**	**N.L. (2)**
418.8	17.5	7	1.7		20	45	23	0.128	2.183	12.690	12.690	0.138	0.066	1.718	2.061	1.054	**0.145**	0.777	**0.171**	**N.L. (2)**
416.3	20	6	1.1		20	45	23	0.123	2.490	10.406	10.406	0.117	0.061	1.870	2.369	1.030	**0.120**	0.737	**0.171**	**N.L. (2)**
413.8	22.5	3	0.5		20	45	31	0.114	2.775	4.990	4.990	0.072	0.052	2.000	2.655	1.012	**0.073**	0.698	**0.170**	**N.L. (2)**
411.3	25	8	2		8	29	25	0.130	3.100	12.658	12.658	0.137	0.068	2.170	2.981	0.994	**0.137**	0.662	**0.167**	**0.820 (D)**
408.8	27.5	7	0.5		5	25	25	0.051	3.228	10.905	10.905	0.121	0.051	2.298	3.265	0.981	**0.119**	0.629	**0.164**	**0.726 (C)**
406.3	30	8	0.5		5	25	25	0.051	3.355	12.257	12.257	0.134	0.051	2.425	3.548	0.968	**0.129**	0.600	**0.161**	**0.801 (D)**
401.3	35	5	1		8	29	23	0.059	3.650	7.353	7.353	0.091	0.059	2.720	4.155	0.948	**0.086**	0.554	**0.155**	**N.L. (2)**
396.3	40	9	1.6		12	30	15	0.065	3.975	12.654	12.654	0.137	0.065	3.045	4.792	0.914	**0.125**	0.522	**0.151**	**N.L. (2)**
391.3	45	14	4		12	30	13	0.076	4.355	18.704	18.704	0.200	0.076	3.425	5.484	0.872	**0.174**	0.501	**0.147**	**N.L. (2)**
388.3	48	50						0.076	4.583	76.650	76.650	0.539	0.076	3.653	5.899	0.804	**0.434**	0.493	**0.146**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-9 S. Abutment
ELEVATION OF BORING GROUND SURFACE ========== 435.30 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 24.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 12.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.282
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 10.00 FT. (Fill Height)
HAMMER EFFICIENCY========== 95 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **469** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 170
Ground Motion Prediction Equations = NMSZ
PGA = **0.085**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
432.8	2.5	10	2.5				20	0.133	0.333	25.733	25.733	0.307	0.071	1.378	1.409	1.153	**0.354**	0.878	**0.165**	**N.L. (3)**
430.3	5	13	4.5				19	0.140	0.683	30.485	30.485	0.506	0.078	1.573	1.760	1.113	**0.563**	0.843	**0.173**	**N.L. (3)**
427.8	7.5	8	1		15	35	24	0.122	0.988	16.057	16.057	0.171	0.060	1.723	2.066	1.058	**0.181**	0.807	**0.177**	**N.L. (2)**
425.3	10	8	2		15	35	24	0.130	1.313	15.793	15.793	0.168	0.068	1.893	2.392	1.031	**0.173**	0.769	**0.178**	**N.L. (2)**
422.8	12.5	7	1.4		15	35	23	0.125	1.625	13.488	13.488	0.145	0.063	2.050	2.705	1.009	**0.146**	0.732	**0.177**	**N.L. (2)**
420.3	15	7	1.3		15	35	24	0.125	1.938	13.032	13.032	0.141	0.063	2.208	3.019	0.990	**0.139**	0.696	**0.174**	**N.L. (2)**
417.8	17.5	7	1		15	35	24	0.122	2.243	12.531	12.531	0.136	0.060	2.358	3.325	0.974	**0.133**	0.662	**0.171**	**N.L. (2)**
415.3	20	4	0.5		20	45	30	0.114	2.528	6.886	6.886	0.087	0.052	2.488	3.611	0.967	**0.084**	0.632	**0.168**	**N.L. (2)**
412.8	22.5	3	0.5		20	45	31	0.114	2.813	4.955	4.955	0.072	0.052	2.618	3.897	0.959	**0.069**	0.606	**0.165**	**N.L. (2)**
410.3	25	6	1		8	29	27	0.059	2.960	9.735	9.735	0.111	0.059	2.765	4.200	0.941	**0.104**	0.583	**0.162**	**0.642 (C)**
407.8	27.5	6	1		8	29	26	0.059	3.108	9.546	9.546	0.109	0.059	2.913	4.504	0.930	**0.101**	0.564	**0.160**	**0.631 (C)**
405.3	30	5	0.3		8	29	23	0.046	3.223	7.837	7.837	0.095	0.046	3.028	4.775	0.925	**0.087**	0.548	**0.158**	**N.L. (2)**
400.3	35	4	0.5		15	35	22	0.051	3.478	6.051	6.051	0.080	0.051	3.283	5.342	0.914	**0.073**	0.525	**0.157**	**N.L. (2)**
395.3	40	7	1.4		15	35	15	0.063	3.793	10.125	10.125	0.114	0.063	3.598	5.969	0.884	**0.101**	0.510	**0.155**	**N.L. (2)**
390.3	45	11	2.7		15	35	13	0.071	4.148	15.152	15.152	0.162	0.071	3.953	6.636	0.849	**0.137**	0.501	**0.154**	**N.L. (2)**
387.3	48	50						0.076	4.376	78.949	78.949	0.558	0.076	4.181	7.051	0.762	**0.425**	0.497	**0.154**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c/LL \leq 0.85$
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

11 Executive Drive, Suite 12, Fairview Heights, Illinois 62208 618-624-8610

Appendix E

Estimated Pile Length Spreadsheets

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== North Abutment
REFERENCE BORING ========== B-01
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 438.03 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 436.03 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1798 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 53.83 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 7
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 38.17 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 14.31 KIPS

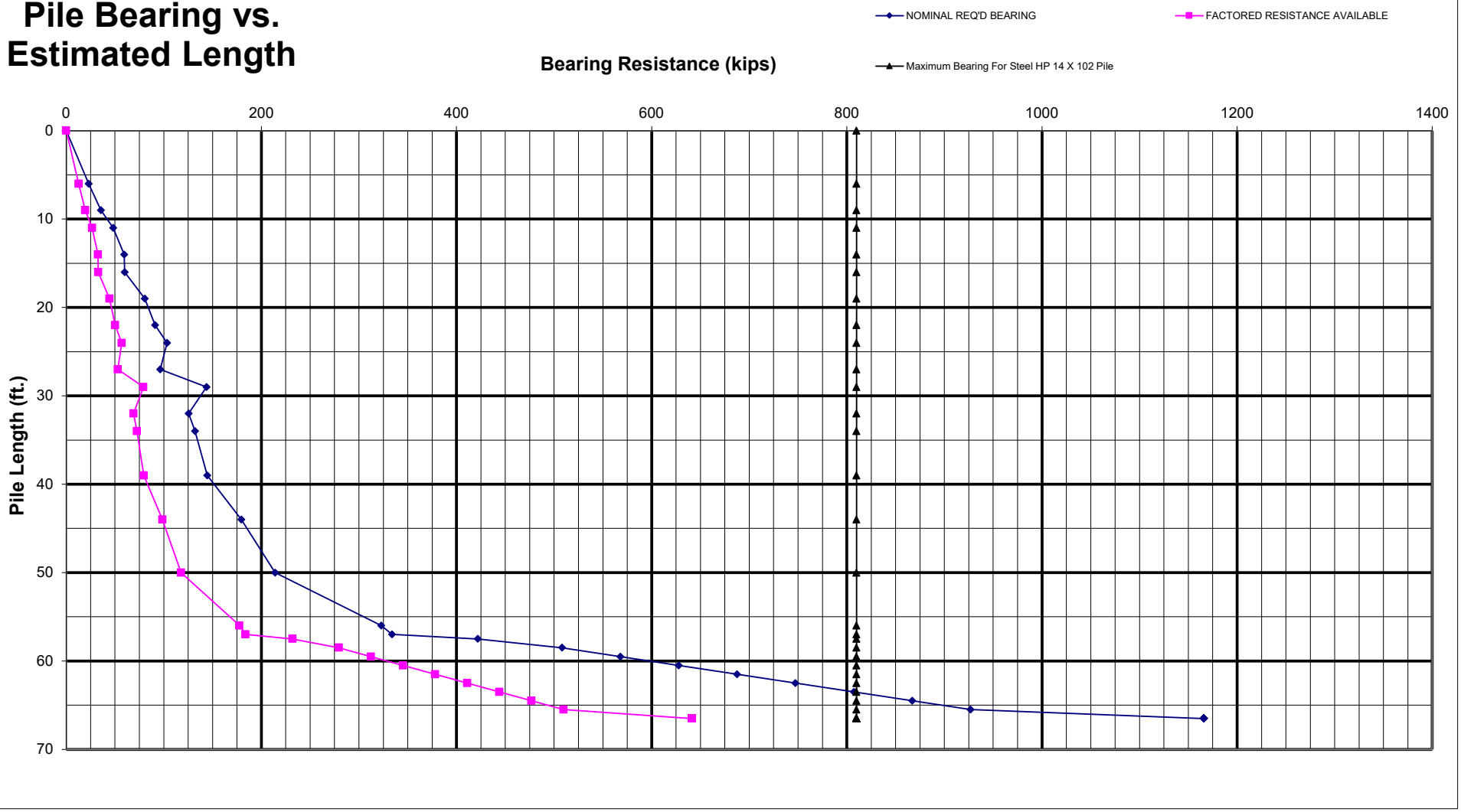
MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
810 KIPS	**810** KIPS	**445** KIPS	**65** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 102
Plugged Pile Perimeter========== 4.800 FT. Unplugged Pile Perimeter========== 7.058 FT.
Plugged Pile End Bearing Area========== 1.439 SQFT. Unplugged Pile End Bearing Area========= 0.208 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
432.03	4.00	1.00			13.6		33.8	20.1		***23.0***	23	0	0	13	6
429.53	2.50	1.00			8.5	20.2	42.3	12.5	2.9	***35.5***	36	0	0	20	9
427.03	2.50	1.00			8.5	20.2	50.9	12.5	2.9	***48.1***	48	0	0	26	11
424.53	2.50	1.00			8.5	20.2	***59.4***	12.5	2.9	60.6	59	0	0	33	14
422.03	2.50	1.00			8.5	20.2	***59.8***	12.5	2.9	72.0	60	0	0	33	16
419.03	3.00	0.60			6.6	12.1	***80.6***	9.7	1.8	83.7	81	0	0	44	19
416.53	2.50	1.30			10.4	26.2	***91.0***	15.3	3.8	99.1	91	0	0	50	22
414.03	2.50	1.30			10.4	26.2	***103.5***	15.3	3.8	114.7	103	0	0	57	24
411.53	2.50	1.40			11.0	28.2	***96.3***	16.2	4.1	128.3	96	0	0	53	27
409.03	2.50	0.50			4.7	10.1	161.5	6.9	1.5	***143.9***	144	0	0	79	29
406.53	2.50	3.50	6		20.6	70.6	***125.6***	30.2	10.2	166.0	126	0	0	69	32
404.03	2.50	0.70			6.3	14.1	***131.9***	9.3	2.0	175.3	132	0	0	73	34
399.03	5.00	0.70			12.6	14.1	***144.5***	18.6	2.0	193.8	145	0	0	79	39
394.03	5.00	0.70			12.6	14.1	***179.4***	18.6	2.0	215.6	179	0	0	99	44
388.53	5.50	1.80			28.7	36.3	***214.1***	42.2	5.3	258.7	214	0	0	118	50
382.53	6.00	2.10			34.6	42.3	340.8	50.8	6.1	***322.9***	323	0	0	178	56
381.53	1.00		50	Hard Till	3.1	134.4	388.6	4.5	19.5	***333.9***	334	0	0	184	57
380.53	1.00			Shale	59.8	179.2	448.4	87.9	25.9	***421.8***	422	0	0	232	57.5
379.53	1.00			Shale	59.8	179.2	***508.2***	87.9	25.9	509.7	508	0	0	280	58.5
378.53	1.00			Shale	59.8	179.2	***568.0***	87.9	25.9	597.6	568	0	0	312	59.5
377.53	1.00			Shale	59.8	179.2	***627.8***	87.9	25.9	685.6	628	0	0	345	60.5
376.53	1.00			Shale	59.8	179.2	***687.6***	87.9	25.9	773.5	688	0	0	378	61.5
375.53	1.00			Shale	59.8	179.2	***747.4***	87.9	25.9	861.4	747	0	0	411	62.5
374.53	1.00			Shale	59.8	179.2	***807.2***	87.9	25.9	949.4	807	0	0	444	63.5
373.53	1.00			Shale	59.8	179.2	***867.0***	87.9	25.9	1037.3	~~867~~	~~0~~	~~0~~	~~477~~	~~64.5~~
372.53	1.00			Shale	59.8	179.2	***926.8***	87.9	25.9	1125.2	~~927~~	~~0~~	~~0~~	~~510~~	~~65.5~~
371.53	1.00			Shale	59.8	179.2	***1165.8***	87.9	25.9	1239.1	~~1166~~	~~0~~	~~0~~	~~641~~	~~66.5~~
370.53	1.00			Limestone		358.5			51.9						

Pile Bearing vs. Estimated Length



Pile Design Table for North Abutment utilizing Boring #B-01

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 16"Φ w/.312" walls		
34	19	6
46	25	9
57	31	11
69	38	14
74	41	16
94	52	19
108	60	22
124	68	24
125	69	27
163	90	32
172	94	34
189	104	39
223	123	44
267	147	50
611	336	56
Metal Shell 16"Φ w/.375" walls		
34	19	6
46	25	9
57	31	11
69	38	14
74	41	16
94	52	19
108	60	22
124	68	24
125	69	27
163	90	32
172	94	34
189	104	39
223	123	44
267	147	50
611	336	56
735	404	57

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 102		
23	13	6
36	20	9
48	26	11
59	33	14
60	33	16
81	44	19
91	50	22
96	53	27
126	69	32
132	73	34
145	79	39
179	99	44
214	118	50
323	178	56
334	184	57
810	445	65
Steel HP 14 X 117		
24	13	6
36	20	9
49	27	11
60	33	14
61	33	16
82	45	19
92	51	22
97	54	27
127	70	32
133	73	34
146	80	39
182	100	44
217	119	50
328	181	56
340	187	57
929	511	66

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== South Abutment
REFERENCE BORING ========== B-09
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 438.36 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 436.36 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1798 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 53.83 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 7
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 38.17 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 14.31 KIPS

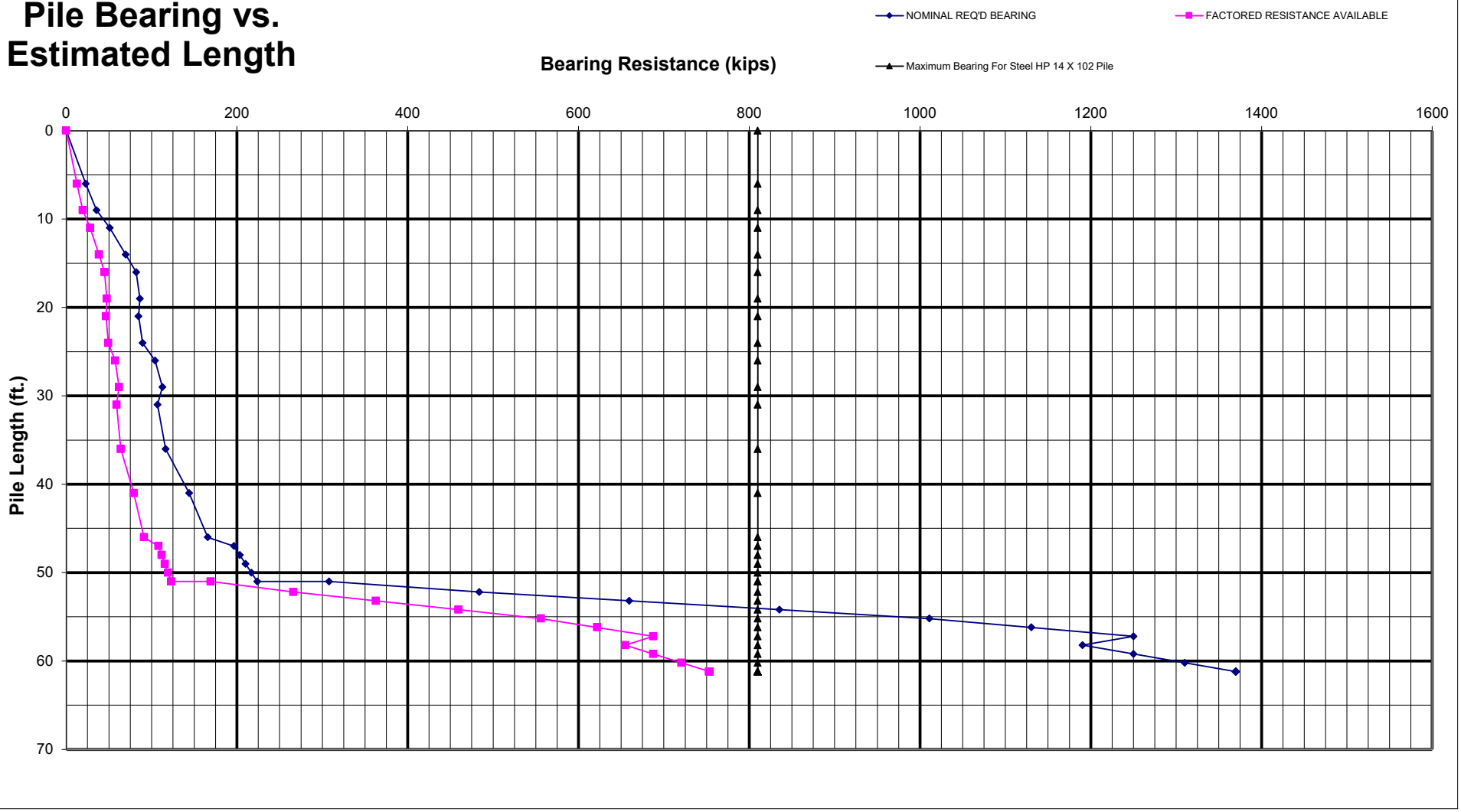
MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
810 KIPS	**810** KIPS	**445** KIPS	**54** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 102
Plugged Pile Perimeter========== 4.800 FT. Unplugged Pile Perimeter========== 7.058 FT.
Plugged Pile End Bearing Area========== 1.439 SQFT. Unplugged Pile End Bearing Area========= 0.208 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
432.36	4.00	1.00			13.6		33.8	20.1		***23.0***	23	0	0	13	6
429.86	2.50	1.00			8.5	20.2	42.3	12.5	2.9	***35.5***	36	0	0	20	9
427.36	2.50	1.00			8.5	20.2	71.0	12.5	2.9	***51.0***	51	0	0	28	11
424.86	2.50	2.00			14.0	40.3	72.9	20.5	5.8	***69.8***	70	0	0	38	14
422.36	2.50	1.40			11.0	28.2	***81.9***	16.2	4.1	85.7	82	0	0	45	16
419.86	2.50	1.30			10.4	26.2	***86.3***	15.3	3.8	100.1	86	0	0	47	19
417.36	2.50	1.00			8.5	20.2	***84.7***	12.5	2.9	111.2	85	0	0	47	21
414.86	2.50	0.50			4.7	10.1	***89.4***	6.9	1.5	118.1	89	0	0	49	24
412.36	2.50	0.50			4.7	10.1	***104.2***	6.9	1.5	126.4	104	0	0	57	26
409.86	2.50	1.00			8.5	20.2	***112.7***	12.5	2.9	139.0	113	0	0	62	29
407.36	2.50	1.00			8.5	20.2	***107.1***	12.5	2.9	149.5	107	0	0	59	31
402.86	4.50	0.30			5.2	6.0	***116.4***	7.7	0.9	157.7	116	0	0	64	36
397.86	5.00	0.50			9.4	10.1	***143.9***	13.8	1.5	174.1	144	0	0	79	41
392.86	5.00	1.40			22.0	28.2	***165.9***	32.4	4.1	206.5	166	0	0	91	46
391.86	1.00	1.40			4.4	28.2	***196.5***	6.5	4.1	216.7	196	0	0	108	47
390.86	1.00	2.70			6.8	54.4	***203.3***	10.0	7.9	226.8	203	0	0	112	48
389.86	1.00	2.70			6.8	54.4	***210.1***	10.0	7.9	236.8	210	0	0	116	49
388.86	1.00	2.70			6.8	54.4	***216.9***	10.0	7.9	246.8	217	0	0	119	50
387.86	1.00	2.70			6.8	54.4	***223.8***	10.0	7.9	256.8	224	0	0	123	51
387.16	0.70	2.70			4.8	54.4	532.6	7.0	7.9	***307.9***	308	0	0	169	51
386.16	1.00			Limestone	119.6	358.5	652.2	175.9	51.9	***483.7***	484	0	0	266	52.2
385.16	1.00			Limestone	119.6	358.5	771.7	175.9	51.9	***659.6***	660	0	0	363	53.2
384.16	1.00			Limestone	119.6	358.5	891.3	175.9	51.9	***835.4***	~~835~~	*~~0~~*	*~~0~~*	*~~459~~*	*~~54.2~~*
383.16	1.00			Limestone	119.6	358.5	***1010.9***	175.9	51.9	1011.3	~~1011~~	*~~0~~*	*~~0~~*	*~~556~~*	*~~55.2~~*
382.16	1.00			Limestone	119.6	358.5	***1130.5***	175.9	51.9	1187.1	~~1131~~	*~~0~~*	*~~0~~*	*~~622~~*	*~~56.2~~*
381.16	1.00			Limestone	119.6	358.5	***1250.1***	175.9	51.9	1363.0	~~1250~~	*~~0~~*	*~~0~~*	*~~688~~*	*~~57.2~~*
380.16	1.00			Limestone	119.6	358.5	***1190.4***	175.9	51.9	1512.9	~~1190~~	*~~0~~*	*~~0~~*	*~~655~~*	*~~58.2~~*
379.16	1.00			Shale	59.8	179.2	***1250.2***	87.9	25.9	1600.8	~~1250~~	*~~0~~*	*~~0~~*	*~~688~~*	*~~59.2~~*
378.16	1.00			Shale	59.8	179.2	***1310.0***	87.9	25.9	1688.8	~~1310~~	*~~0~~*	*~~0~~*	*~~721~~*	*~~60.2~~*
377.16	1.00			Shale	59.8	179.2	***1369.8***	87.9	25.9	1776.7	~~1370~~	*~~0~~*	*~~0~~*	*~~753~~*	*~~61.2~~*
376.16	1.00			Shale		179.2			25.9						

Pile Bearing vs. Estimated Length



Pile Design Table for South Abutment utilizing Boring #B-09

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 16"Φ w/.312" walls		
34	19	6
46	25	9
73	40	11
82	45	14
96	53	16
106	58	19
110	60	21
116	64	24
130	72	26
142	78	29
143	78	31
153	84	36
179	99	41
209	115	46
235	129	47
245	135	48
254	140	49
263	145	50
273	150	51
Metal Shell 16"Φ w/.375" walls		
34	19	6
46	25	9
73	40	11
82	45	14
96	53	16
106	58	19
110	60	21
116	64	24
130	72	26
142	78	29
143	78	31
153	84	36
179	99	41
209	115	46
235	129	47
245	135	48
254	140	49
263	145	50
273	150	51

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 102		
23	13	6
36	20	9
51	28	11
70	38	14
82	45	16
85	47	21
89	49	24
104	57	26
107	59	31
116	64	36
144	79	41
166	91	46
196	108	47
203	112	48
210	116	49
217	119	50
224	123	51
308	169	51
810	445	54
Steel HP 14 X 117		
24	13	6
36	20	9
52	29	11
71	39	14
83	46	16
86	47	21
90	50	24
105	58	26
108	60	31
118	65	36
146	80	41
168	92	46
199	110	47
206	113	48
213	117	49
220	121	50
227	125	51
318	175	51
929	511	55

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== South Abutment
REFERENCE BORING ========== B-09
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 438.36 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 436.36 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 407.80 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 412.80 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 1798 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 53.83 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 7
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 38.17 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 14.31 KIPS

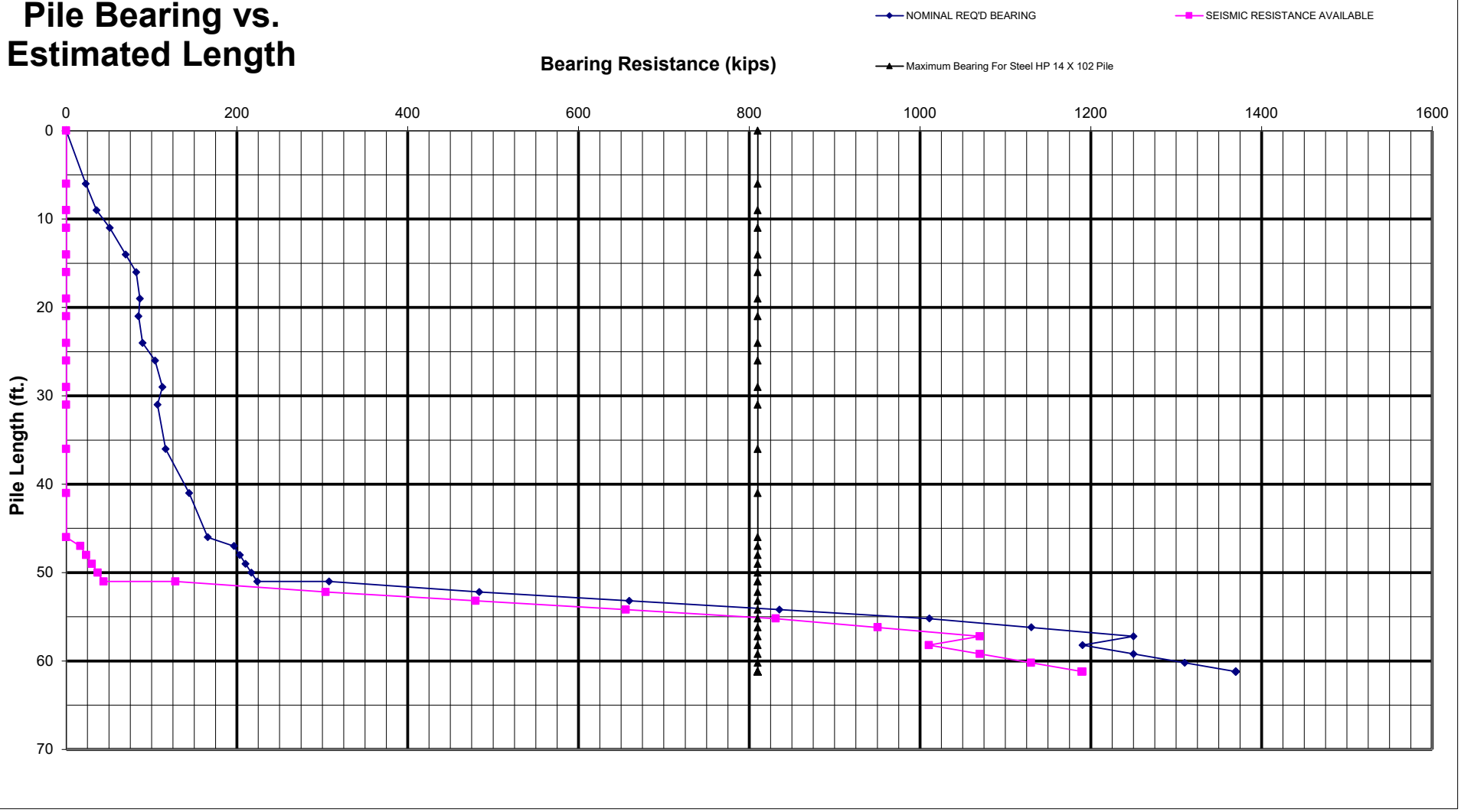
MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
810 KIPS	**810** KIPS	**630** KIPS	**54** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 102
Plugged Pile Perimeter========== 4.800 FT. Unplugged Pile Perimeter========== 7.058 FT.
Plugged Pile End Bearing Area========== 1.439 SQFT. Unplugged Pile End Bearing Area========= 0.208 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE PLUGGED SIDE RESIST. (KIPS)	ULTIMATE PLUGGED END BRG. RESIST. (KIPS)	ULTIMATE PLUGGED TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
432.36	4.00	1.00			13.6		33.8	20.1		***23.0***	23	14	15	-6	6
429.86	2.50	1.00			8.5	20.2	42.3	12.5	2.9	***35.5***	36	22	24	-11	9
427.36	2.50	1.00			8.5	20.2	71.0	12.5	2.9	***51.0***	51	31	34	-14	11
424.86	2.50	2.00			14.0	40.3	72.9	20.5	5.8	***69.8***	70	45	49	-24	14
422.36	2.50	1.40			11.0	28.2	***81.9***	16.2	4.1	85.7	82	56	61	-35	16
419.86	2.50	1.30			10.4	26.2	***86.3***	15.3	3.8	100.1	86	66	73	-53	19
417.36	2.50	1.00			8.5	20.2	***84.7***	12.5	2.9	111.2	85	75	82	-72	21
414.86	2.50	0.50			4.7	10.1	***89.4***	6.9	1.5	118.1	89	79	87	-77	24
412.36	2.50	0.50			4.7	10.1	***104.2***	6.9	1.5	126.4	104	84	87	-67	26
409.86	2.50	1.00			8.5	20.2	***112.7***	12.5	2.9	139.0	113	93	87	-67	29
407.36	2.50	1.00			8.5	20.2	***107.1***	12.5	2.9	149.5	107	93	87	-73	31
402.86	4.50	0.30			5.2	6.0	***116.4***	7.7	0.9	157.7	116	93	87	-64	36
397.86	5.00	0.50			9.4	10.1	***143.9***	13.8	1.5	174.1	144	93	87	-36	41
392.86	5.00	1.40			22.0	28.2	***165.9***	32.4	4.1	206.5	166	93	87	-14	46
391.86	1.00	1.40			4.4	28.2	***196.5***	6.5	4.1	216.7	196	93	87	17	47
390.86	1.00	2.70			6.8	54.4	***203.3***	10.0	7.9	226.8	203	93	87	23	48
389.86	1.00	2.70			6.8	54.4	***210.1***	10.0	7.9	236.8	210	93	87	30	49
388.86	1.00	2.70			6.8	54.4	***216.9***	10.0	7.9	246.8	217	93	87	37	50
387.86	1.00	2.70			6.8	54.4	***223.8***	10.0	7.9	256.8	224	93	87	44	51
387.16	0.70	2.70			4.8	54.4	532.6	7.0	7.9	***307.9***	308	93	87	128	51
386.16	1.00			Limestone	119.6	358.5	652.2	175.9	51.9	***483.7***	484	93	87	304	52.2
385.16	1.00			Limestone	119.6	358.5	771.7	175.9	51.9	***659.6***	660	93	87	480	53.2
384.16	1.00			Limestone	119.6	358.5	891.3	175.9	51.9	***835.4***	~~835~~	~~93~~	~~87~~	~~655~~	~~54.2~~
383.16	1.00			Limestone	119.6	358.5	***1010.9***	175.9	51.9	1011.3	~~1011~~	~~93~~	~~87~~	~~831~~	~~55.2~~
382.16	1.00			Limestone	119.6	358.5	***1130.5***	175.9	51.9	1187.1	~~1131~~	~~93~~	~~87~~	~~951~~	~~56.2~~
381.16	1.00			Limestone	119.6	358.5	***1250.1***	175.9	51.9	1363.0	~~1250~~	~~93~~	~~87~~	~~1070~~	~~57.2~~
380.16	1.00			Limestone	119.6	358.5	***1190.4***	175.9	51.9	1512.9	~~1190~~	~~93~~	~~87~~	~~1010~~	~~58.2~~
379.16	1.00			Shale	59.8	179.2	***1250.2***	87.9	25.9	1600.8	~~1250~~	~~93~~	~~87~~	~~1070~~	~~59.2~~
378.16	1.00			Shale	59.8	179.2	***1310.0***	87.9	25.9	1688.8	~~1310~~	~~93~~	~~87~~	~~1130~~	~~60.2~~
377.16	1.00			Shale	59.8	179.2	***1369.8***	87.9	25.9	1776.7	~~1370~~	~~93~~	~~87~~	~~1190~~	~~61.2~~
376.16	1.00			Shale		179.2			25.9						

Pile Bearing vs. Estimated Length



Pile Design Table for South Abutment utilizing Boring #B-09

Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 16"Φ w/.312" walls		
254	8	49
263	17	50
273	27	51
Metal Shell 16"Φ w/.375" walls		
254	8	49
263	17	50
273	27	51

Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)

Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 102		
166	-14	46
196	17	47
203	23	48
210	30	49
217	37	50
224	44	51
308	128	51
810	630	54
Steel HP 14 X 117		
168	-14	46
199	17	47
206	24	48
213	31	49
220	38	50
227	45	51
318	136	51
929	747	55

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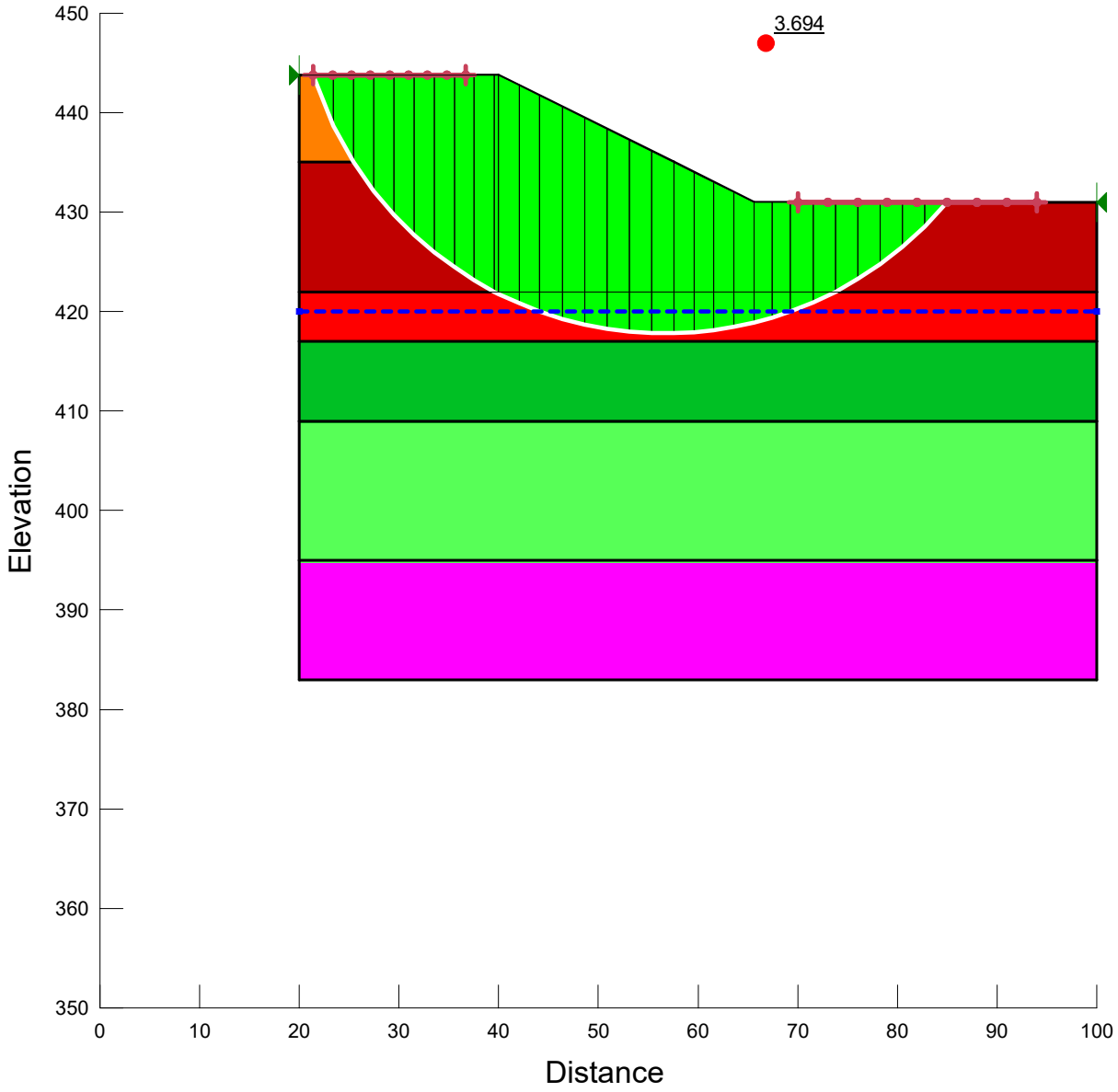
Appendix F

Global Stability Profiles

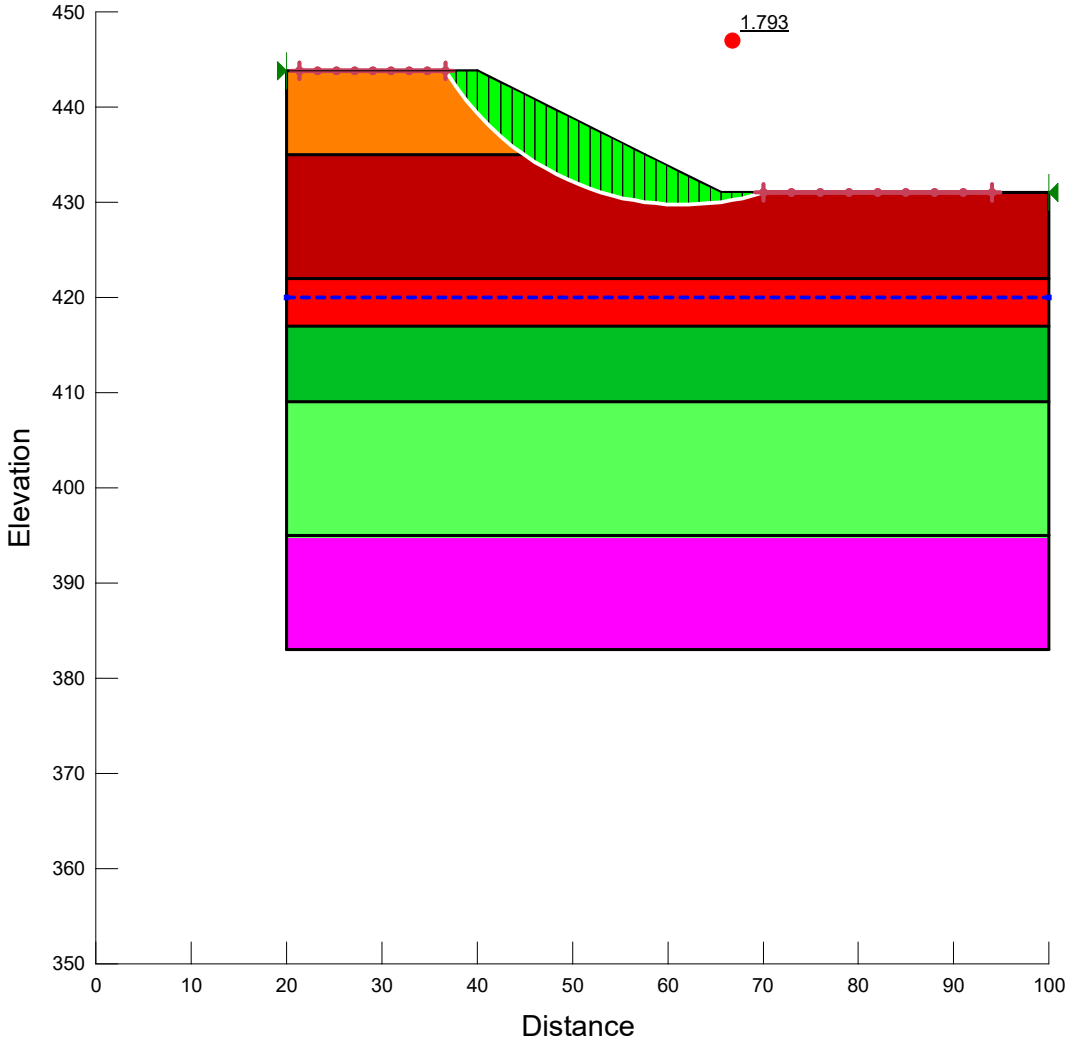
North Abutment - Undrained



Referecnce Boring: B-1

Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM 1	120	1,000
	CLAY LOAM 2	120	750
	CLAY LOAM 3	120	2,000
	FILL	120	1,500
	SILTY CLAY 1	120	1,300
	SILTY CLAY 2	120	1,000

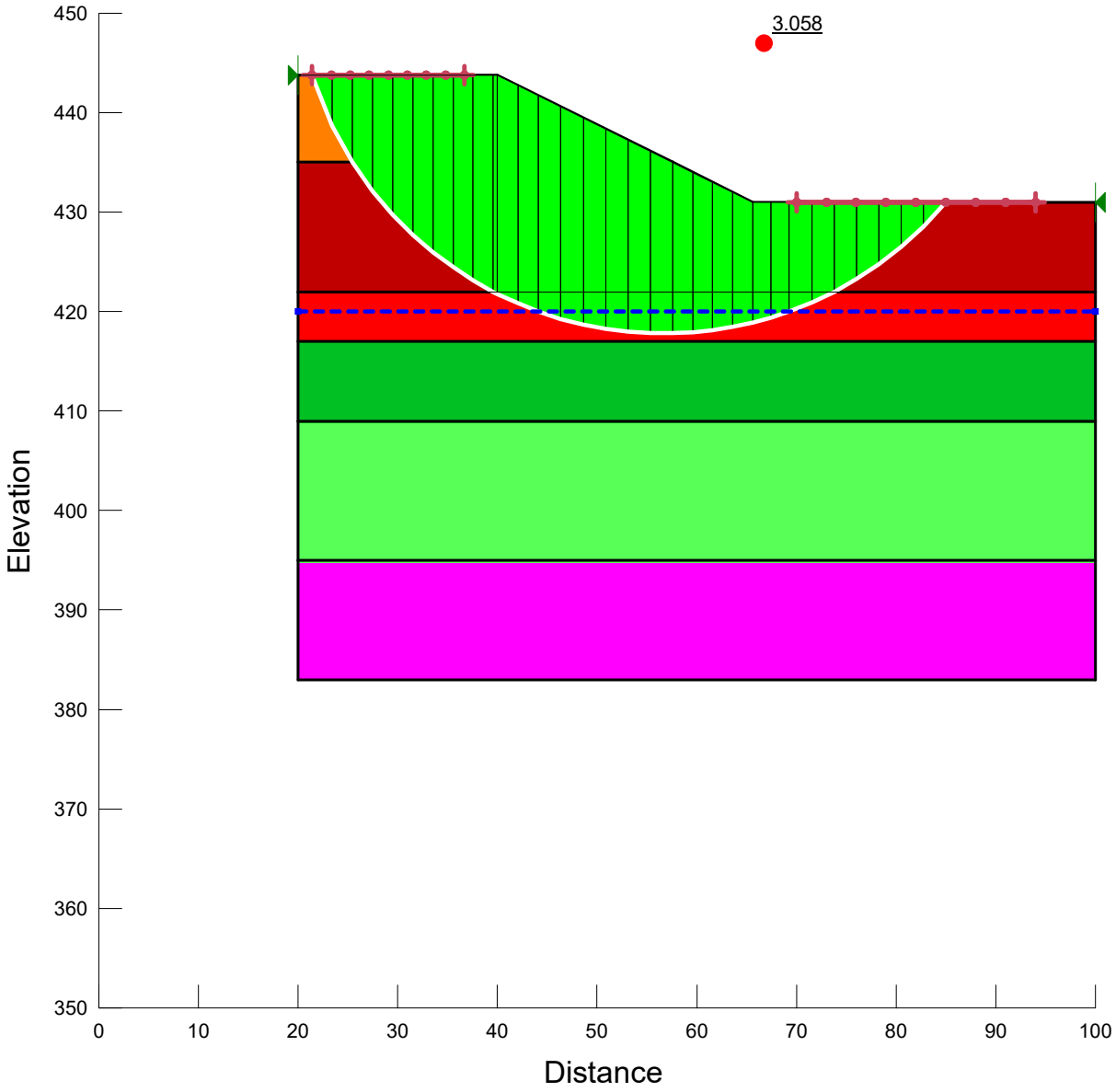
North Abutment - Drained



Referecnce Boring: B-1

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Phi-B (°)
	CLAY LOAM 1	120	75	26	0
	CLAY LOAM 2	120	75	26	0
	CLAY LOAM 3	120	100	28	0
	FILL	120	100	28	0
	SILTY CLAY 1	120	100	28	0
	SILTY CLAY 2	120	100	28	0

North Abutment - Seismic Undrained



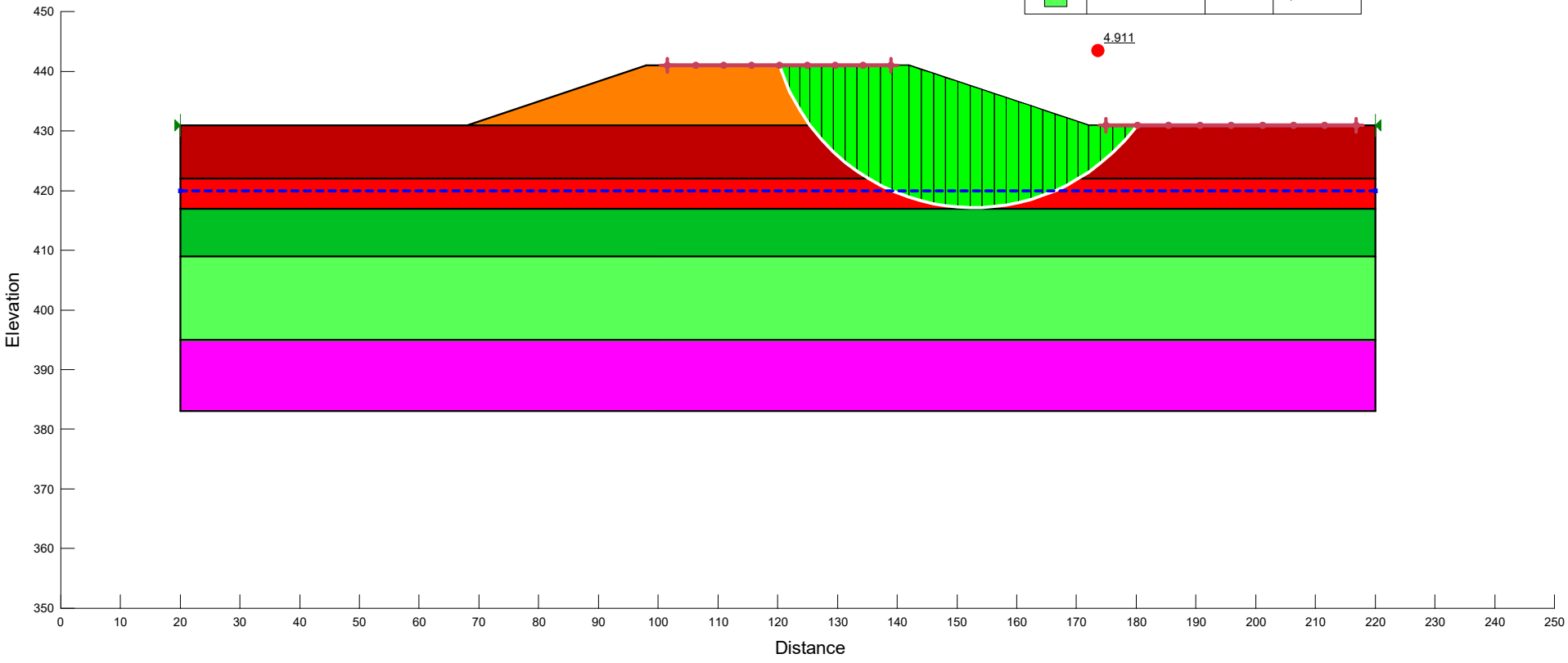
Referecnce Boring: B-1

Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM 1	120	1,000
	CLAY LOAM 2	120	750
	CLAY LOAM 3	120	2,000
	FILL	120	1,500
	SILTY CLAY 1	120	1,300
	SILTY CLAY 2	120	1,000

North Abutment Side Slope - Undrained

Referecnce Boring: B-1

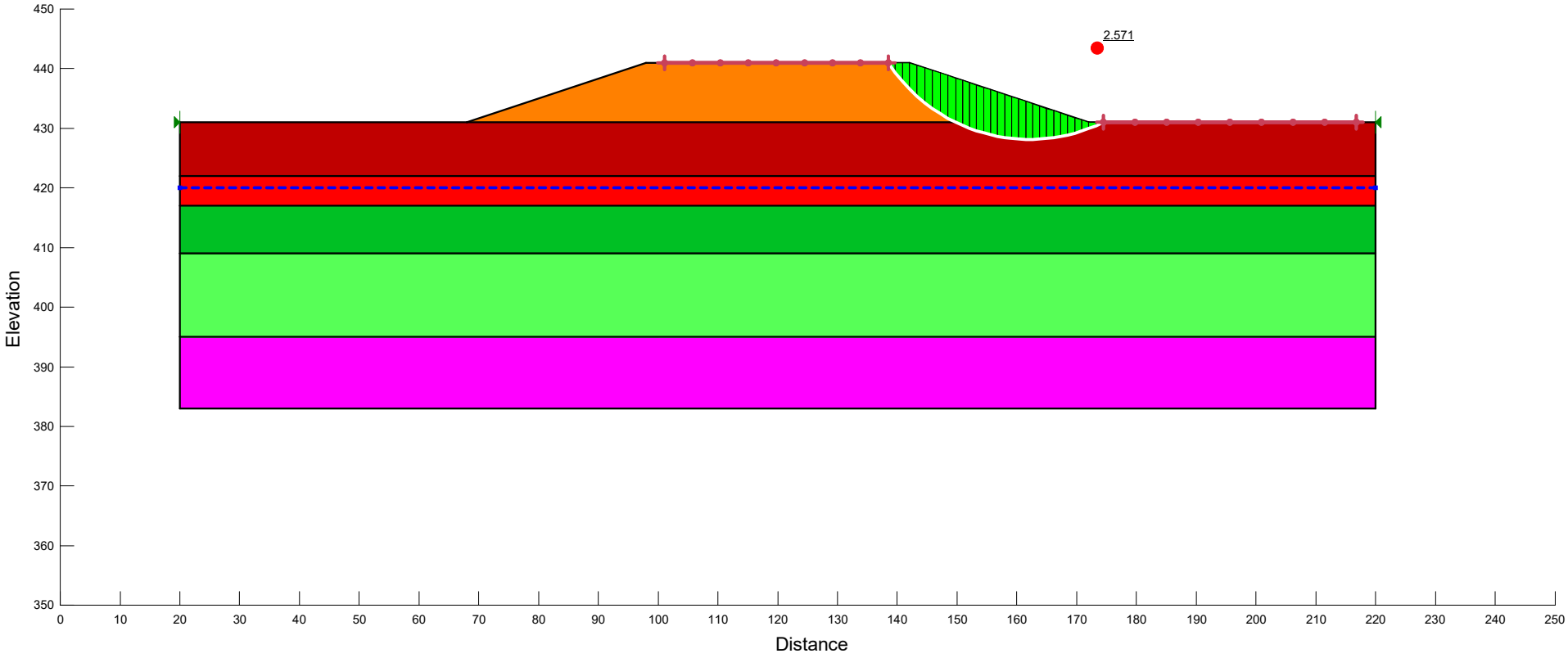
Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM 1	120	1,000
	CLAY LOAM 2	120	750
	CLAY LOAM 3	120	2,000
	FILL	120	1,500
	SILTY CLAY 1	120	1,300
	SILTY CLAY 2	120	1,000



North Abutment Side Slope - Drained

Referecnce Boring: B-1

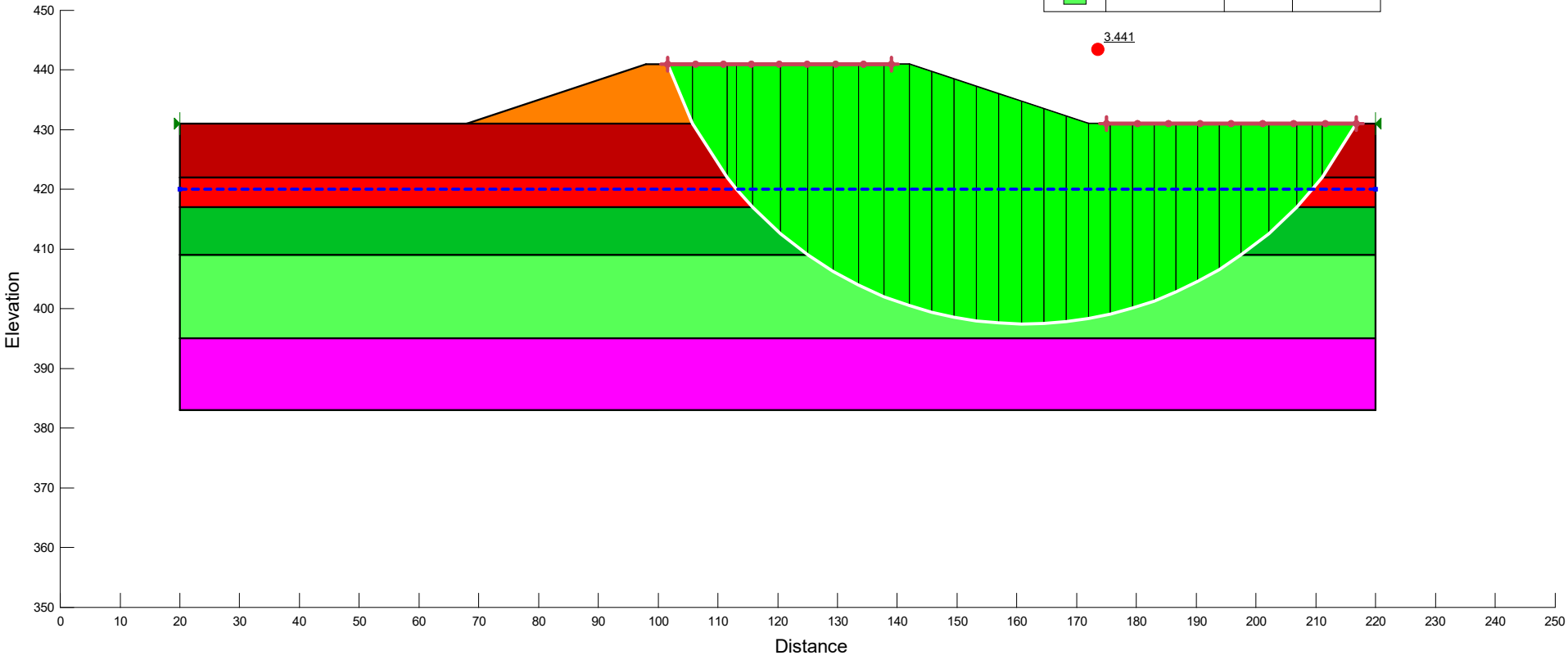
Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CLAY LOAM 1	120	75	26
	CLAY LOAM 2	120	75	26
	CLAY LOAM 3	120	100	28
	FILL	120	100	28
	SILTY CLAY 1	120	100	28
	SILTY CLAY 2	120	100	28



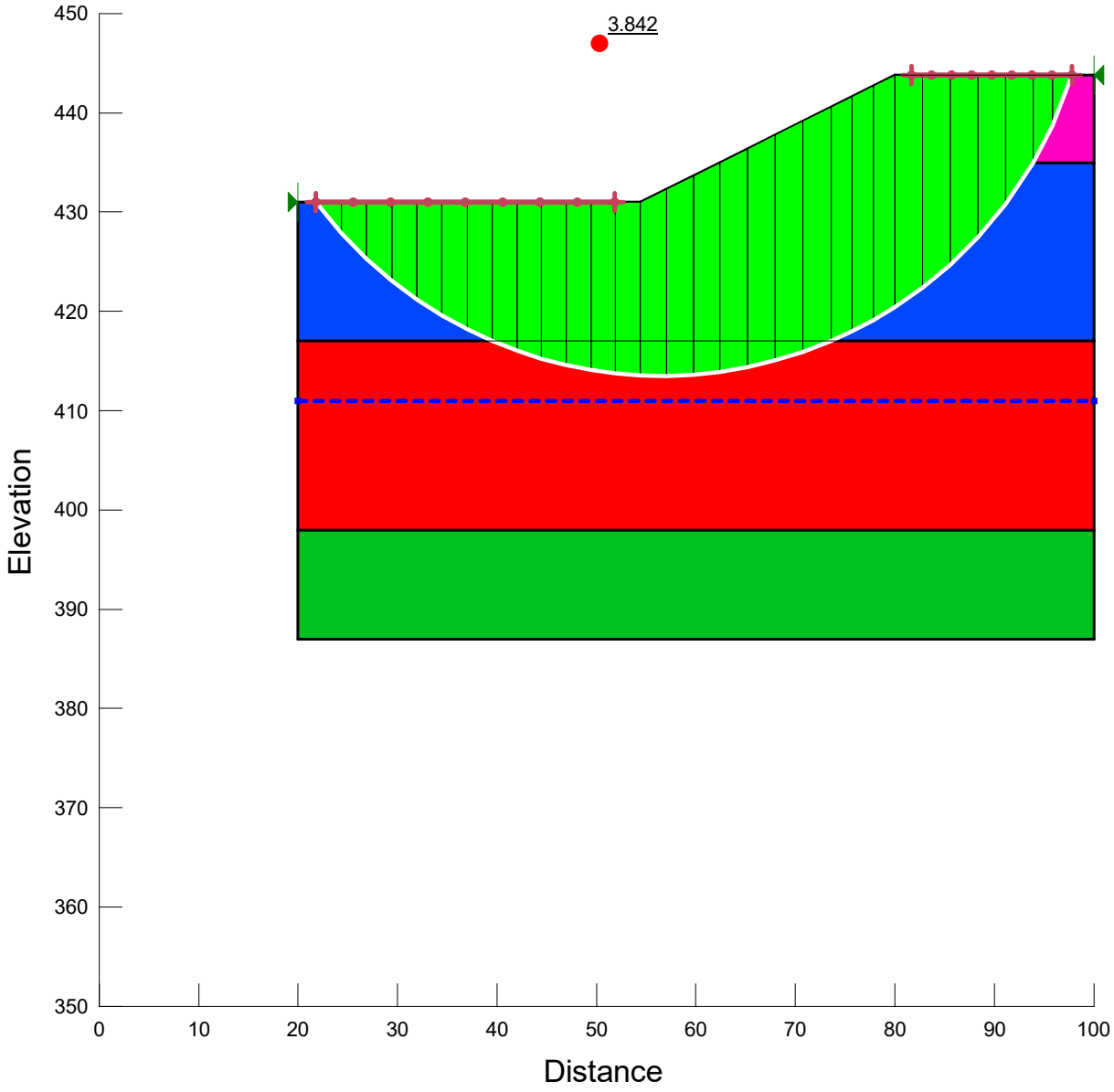
North Abutment Side Slope - Seismic Undrained

Referecnce Boring: B-1

Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM 1	120	1,000
	CLAY LOAM 2	120	750
	CLAY LOAM 3	120	2,000
	FILL	120	1,500
	SILTY CLAY 1	120	1,300
	SILTY CLAY 2	120	1,000



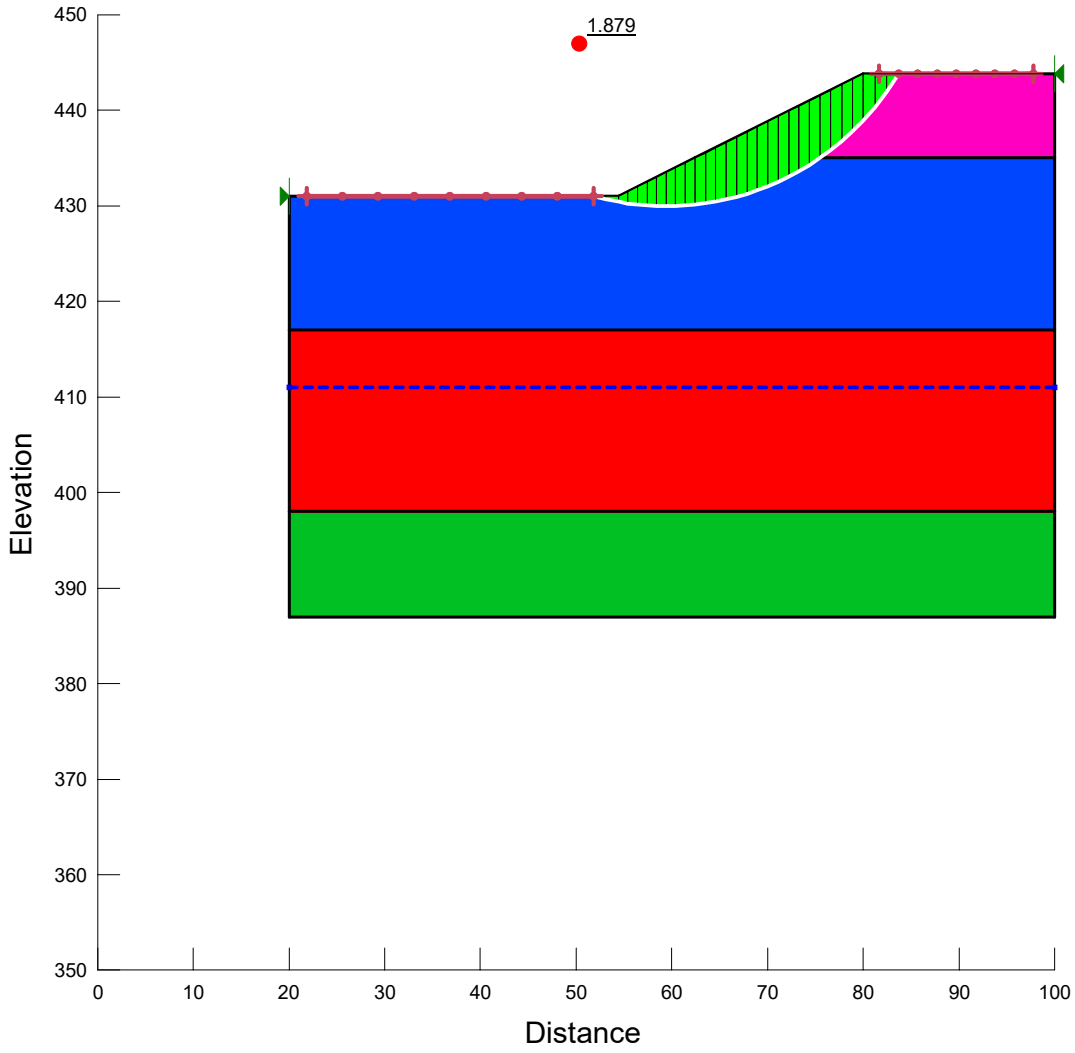
South Abutment - Undrained



Reference Boring: B-9

Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM	120	1,800
	FILL	120	1,500
	SILT LOAM	120	700
	SILTY CLAY LOAM	120	1,000

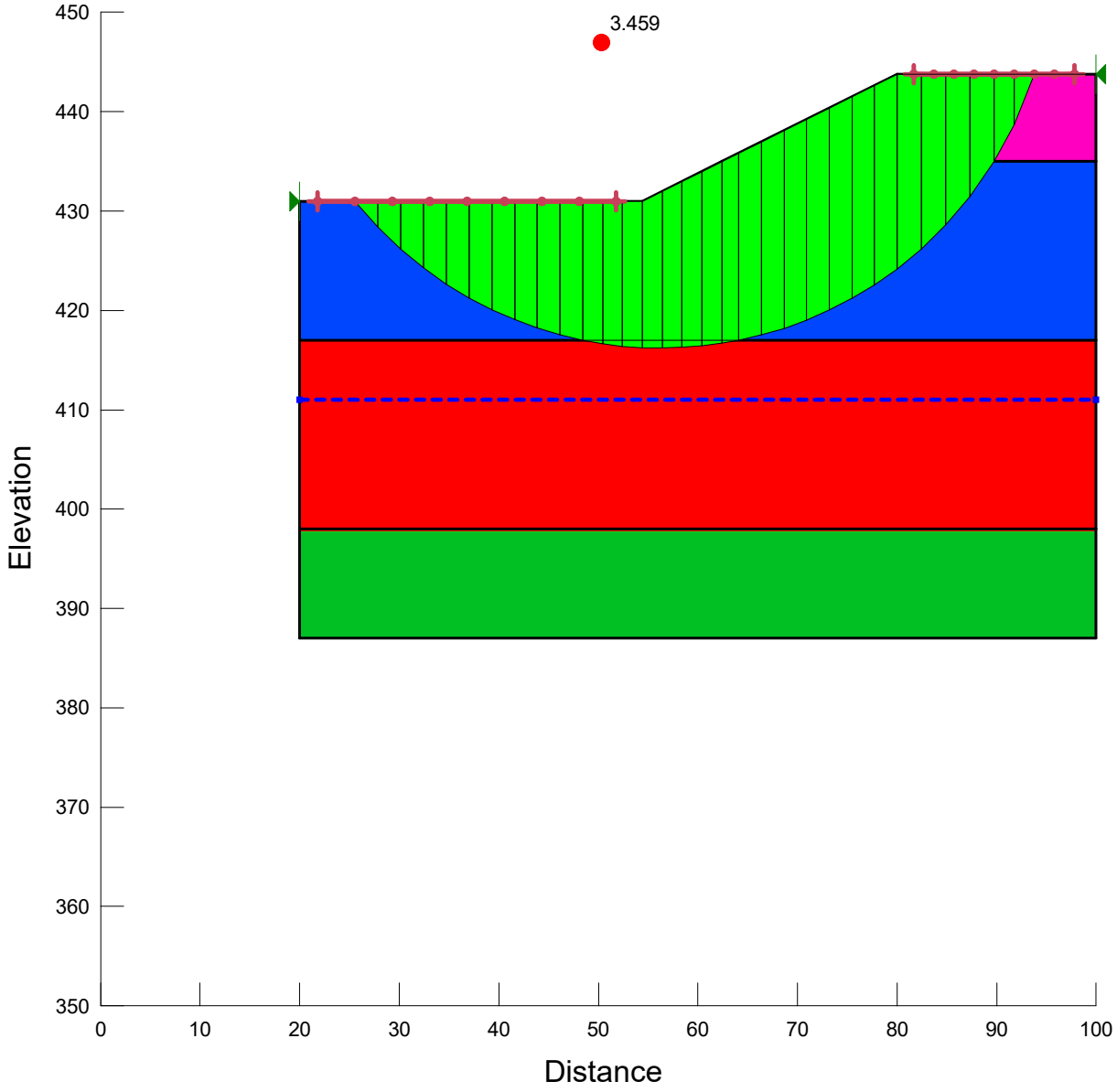
South Abutment - Drained



Reference Boring: B-9

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)	Phi-B (°)
	CLAY LOAM	120	100	28	0
	FILL	120	100	28	0
	SILT LOAM	120	75	26	0
	SILTY CLAY LOAM	120	100	26	0

South Abutment - Seismic Undrained



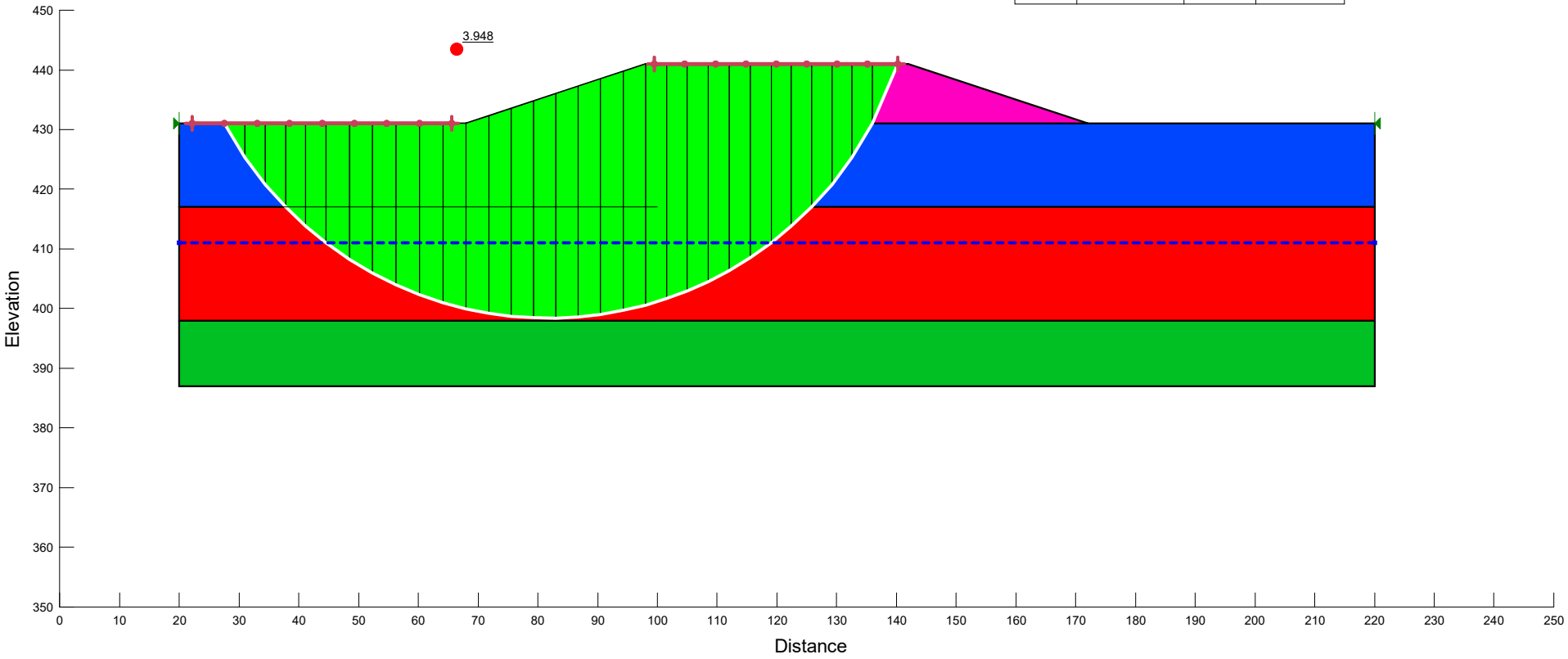
Reference Boring: B-9

Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM	120	1,800
	FILL	120	1,500
	SILT LOAM	120	700
	SILTY CLAY LOAM	120	1,000

South Abutment Side Slope - Undrained

Reference Boring: B-9

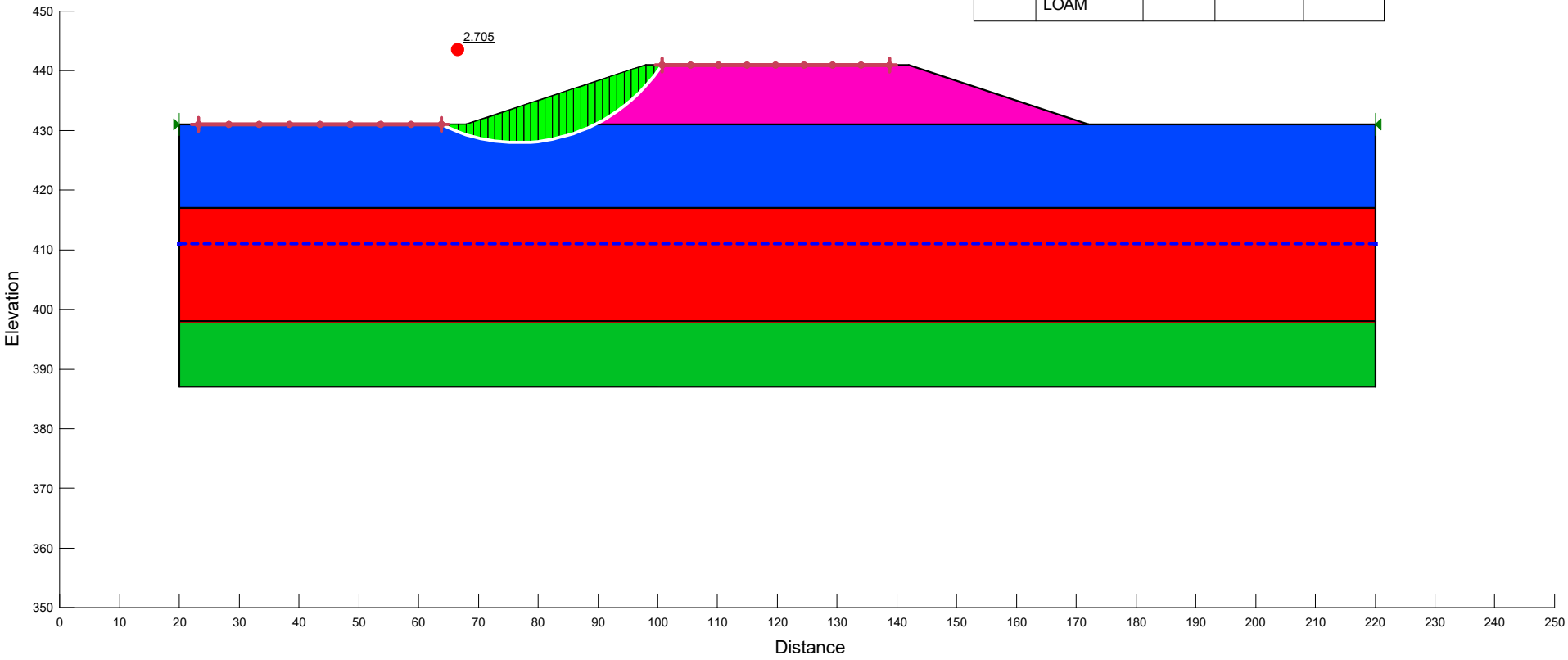
Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM	120	1,800
	FILL	120	1,500
	SILT LOAM	120	700
	SILTY CLAY LOAM	120	1,000



South Abutment Side Slope - Drained

Reference Boring: B-9

Color	Name	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	CLAY LOAM	120	100	28
	FILL	120	100	28
	SILT LOAM	120	75	26
	SILTY CLAY LOAM	120	100	26



South Abutment Side Slope - Seismic Undrained

Reference Boring: B-9

Color	Name	Unit Weight (pcf)	Total Cohesion (psf)
	CLAY LOAM	120	1,800
	FILL	120	1,500
	SILT LOAM	120	700
	SILTY CLAY LOAM	120	1,000