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July 18, 2016

Mr. Naiel Hussein, P.E.
Parsons Brinckerhoff
2 Miranova Place, Suite 450
Columbus, Ohio 43215

Reference: **Final Structure Foundation Exploration Report for HAN-75-14.39**
Bridge No. HAN-75-1713 over Abandoned Railroad
Findlay, Hancock County, Ohio
PID No. 87005
PGI Project No. G15004G

Dear Mr. Hussein:

Enclosed please find our Final Structure Foundation Exploration Report for the above referenced project. Our services included a geotechnical field exploration, laboratory testing, engineering analysis, and related design and construction recommendations. These services have been provided in accordance with our proposal dated December 10, 2014. It is important that the items under "**Limitations**" be precisely followed and complied with.

We appreciate the opportunity of working with you on this project and we invite you to contact us at (440) 717-1415 when we can be of further assistance.

Respectfully,

PRO GEOTECH, INC.

Shan Sivakumaran, P.E.
Project Manager/Geotechnical Engineer

Walid I. Najjar, P.E.
Senior Geotechnical Engineer

Enclosure
G13011Grpt/SS/7/18/2016

FINAL
STRUCTURE FOUNDATION EXPLORATION REPORT FOR HAN-75-14.39
BRIDGE NO. HAN-75-1713 OVER ABANDONED RAILROAD

HANCOCK COUNTY, OHIO
PGI PROJECT NO. G15004G
PID NO. 87005

PREPARED FOR:

PARSONS BRINCKERHOFF

PREPARED BY:

PRO GEOTECH, INC.

JULY 18, 2016

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1.0 EXECUTIVE SUMMARY

This report has been prepared for the HAN-75-14.39 project which calls for replacement of the existing Interstate Route 75 (IR-75) mainline Bridge No. HAN-75-1713 over Abandoned Railroad in Findlay, Hancock County, Ohio. Two (2) historic test borings identified as B-1 (B-001-2-87) and B-4 (B-004-2-87) were obtained from the subsurface geotechnical exploration completed on April 1987. A total of two (2) test borings identified as B-049-2-14 and B-049-3-14 were advanced for bridge foundations design purposes. These project test borings were advanced to approximate depths ranging from 31.0 to 32.9 feet below the existing ground surface. Test boring B-049-2-14 was advanced in the vicinity of proposed culvert outlet while test boring B-049-3-14 was advanced in the vicinity of proposed culvert inlet. Historic test borings B-001-2-87 and B-002-2-87 were advanced in the vicinity of the existing rear and forward abutments, respectively.

<u>Findings:</u> The surficial and subsurface soil conditions in the vicinity of this proposed bridge were determined from the soil information obtained from project test borings B-049-2-14 and B-049-3-14 and historic test borings B-001-2-87 and B-004-2-87. The subsurface soils encountered below the topsoil in these test borings were primarily cohesive in nature and consisted of both fill materials and natural soils. The fill material consisted of silt and clay (A-6a) and sandy silt (A-4a) and was encountered to approximate depths of 13.5 feet and 6.0 feet in the project test borings B-049-2-14 and B-049-3-14, respectively. Natural soils encountered above bedrock consisted of silty clay (A-6b), plastic silt (A-4b), non-plastic silt (A-4b), and sandy silt (A-4a). Bedrock was encountered in project test boring B-049-2-14 at an approximate depth of 19.5 feet below the ground surface while bedrock was encountered in project test boring B-049-3-14 at an approximate depth of 19.0 feet below the ground surface. The laboratory test results indicated that the moisture contents of the tested cohesive soil samples obtained from the structure test borings ranged from 6% to 29% and the consistency ranged from "medium stiff" to "hard", but was predominately “stiff”. The moisture contents of the tested non-cohesive soils ranged from 9% to 19% and the relative density was “medium dense”.

The subsurface soils encountered in historic test borings B-001-2-87 and B-004-2-87 were generally cohesive soils, but non-cohesive soils were also encountered above bedrock. The cohesive soils encountered consisted of silt and clay (A-6a), sandy silt (A-4a), silty clay (A6b), and silt (A-4b), and the non-cohesive soils encountered consisted of non-plastic sandy silt (A-4a). Bedrock was encountered in historic test boring B-001-2-87 at an approximate depth of 42.0 feet below the asphalt pavement while bedrock was encountered in historic test boring B-004-2-87 at an approximate depth of 39.5 feet below the asphalt pavement. The laboratory test results indicated that the moisture contents of the tested cohesive soil samples obtained from the historic test borings ranged from 12% to 20% and the consistency ranged from "stiff" to "hard", but was predominately "very stiff". The moisture content of the tested non-cohesive soil was 29% and the relative density was "loose".

Bedrock was encountered in all of the test boring locations. The core samples consisted of dolomite of the Tymochtee/Greenfield Group. The dolomite was gray, and highly to slightly weathered. Bedding within the dolomite was generally very thin to medium and was highly to moderately fractured. No slickensides were observed and the fractures were typically tight and slightly rough. The compressive strength of the core specimens ranged from 15,276 psi in test boring B-049-2-14 to 11,226 psi in test boring B-049-3-14 which characterizes them as "strong". The Rock Quality Designation (RQD) for the core samples ranged from 0% to 58%. The Rock Mass Strength; cohesion 473 psf and friction angle 27.5 degree was obtained for dolomite bedrock using Geological Strength Index according to LRFD 7th Edition Section 10.4.6.4.

Recommendations:

Since the top of bedrock at the project test boring locations was encountered at relatively shallow depths below existing ground surface, the proposed arch culvert (rest sections) and wingwalls design loads may be transferred to the underlying bedrock by means of end bearing H-piles. According to construction sequence for this project, the H-piles supporting proposed arch culvert should be installed before removing the existing bridge. Therefore these H-piles for the proposed arch culvert should be installed by pre-boring holes to underlying dolomite bedrock due to limited overhead clearance. These H-piles should be installed in pre-bored holes with a minimum embedment length of 3 feet into bedrock. Hole diameter size should be selected according to Item 507.11. The pre-bored holes in bedrock should be backfilled with Class C concrete and rest of the pre-hole should be backfilled with granular materials up to the bottom of pile cap. The H-piles supporting proposed wingwalls may be installed by driven to refusal on underlying dolomite bedrock. End bearing H-piles consisting pile size of HP12X53 may be selected for both arch culvert and wingwalls to transfer design load to underlying bedrock. The estimated pile parameters for end bearing piles at each boring location are summarized in Table 6.1.1.

Table 6.1.1 - Estimated Design Parameters for H-Piles

Boring No.	Pile Cut-off Elevation (ft.)	Pile Tip Elevation (ft.)	Estimated Effective Pile Length (ft.)	Pile Type	Pile Size	Maximum Factored Structural Resistance/pile
B-049-2-14	767.0	749.7	20.0	H-Pile	12X53	380 kips
B-049-3-14	767.0	750.7	20.0	H-Pile	12X53	380 kips

Embankment fill will be placed over the culvert and rest of the removed bridge area to be brought to proposed IR-75 subgrade. Consolidation settlement is expected in foundation soils caused by construction of the proposed embankment fill. Based on the settlement calculations included in Appendix B, consolidation settlement of the foundation soils above the bedrock will be on the order of 0.5 to 1.0 inches at the test boring locations. Therefore negative skin friction will develop along the section of piles for both arch culvert and wingwall above bedrock due to consolidation of the foundation soils caused by construction of the proposed embankment. The piles should be designed in accordance with section 202.2.3.2.c – “Down Drag Forces on Piles” of the *ODOT Bridge Design Manual* issued in January 2007. Unfactored down drag load of 70 kips per pile may be assumed for pile size HP12X53 at the B-049-2-14 boring location and 56 kips per pile may be assumed for pile size HP12X53 at the B-049-3-14 boring location. Since most of the down drag forces were calculated using Total Stress Method (α Method), a Load Factor (γ_p) of 1.40 should be used to compute the Factored load at the Strength Limit State.

It is assumed that the proposed pavement will be constructed on the fill subgrade soils with similar character to the soils encountered in test borings. It is anticipated that on-site sandy silt (A-4a), silt and clay (A-6a), and silty clay (A-6b) fill soils will be encountered within the project limits based on the boring logs. The subgrade CBR values and the resilient modulus of the subgrade soils were estimated based on the ODOT subgrade resilient modulus estimation method, illustrated in 203-3, "Pavement, Design & Rehabilitation Manual." The pavement design parameter information is summarized in Table 6.3.1.

Table 6.3.1 – Summary of Pavement Design Parameters

Parameter	Fill Soils
Group Index (Avg.)	7.00
CBR	7
Soil Support Value (SSV)	4.9
Resilient Modulus (psi)	8,400
Modulus of Subgrade Reaction (K, pci)	165

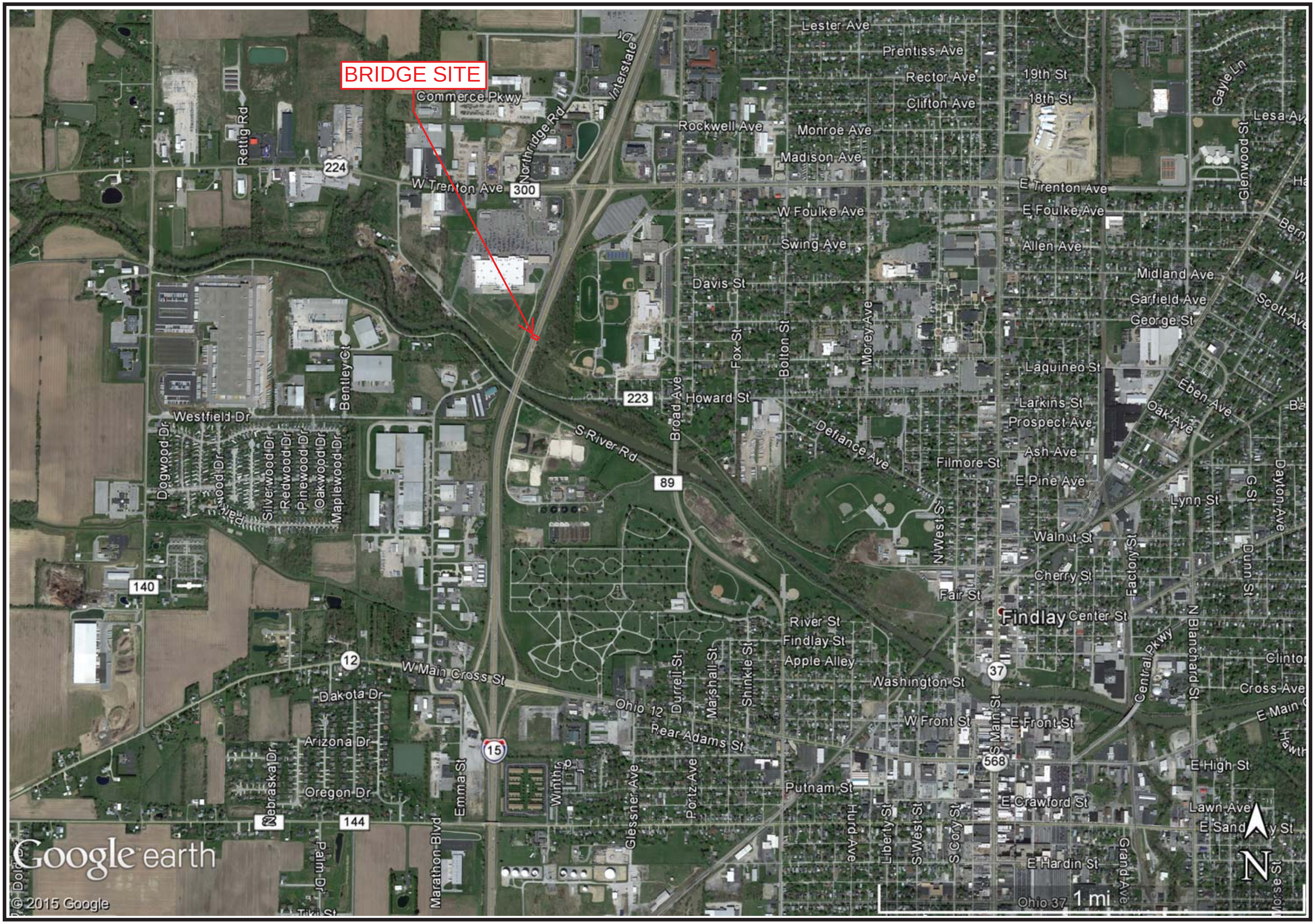
2.0 INTRODUCTION

This report has been prepared for HAN-75-14.39 project which calls for replacement of the existing Interstate Route 75 (IR-75) mainline Bridge No. HAN-75-1713 over Abandoned Railroad in Findlay, Hancock County, Ohio. It represents the intent of Parsons Brinckerhoff (PB) the design engineer, and the Ohio Department of Transportation (ODOT), the owner, to secure subsurface information at the selected locations in accordance with ODOT's *Specifications for Geotechnical Exploration*s, and to obtain recommendations regarding geotechnical factors pertaining to the design and construction of this project.

2.1 Project Description

Present plans call for the replacement of Bridge No. HAN-75-1713 which carry IR-75 vehicular traffic over Abandoned Railroad in Hancock County, Ohio. The proposed replacement structure is expected to be an arch culvert with wingwalls and will be constructed using structural plate corrugated steel conduits. The arch culvert length will be 167 feet and dimension will be 48 feet in width by 17.9 feet in height. This culvert will be constructed between existing pier foundations of the IR-75 Bridge. Existing piles from the bridge pier foundations will be used to support the section of the proposed arch culvert. The culvert is to be designed based on HL-3 and alternate military loading criteria and the ODOT Bridge Design Manual, issued in 2007 which includes current LRFD Bridge Design Specifications. Also, existing IR 75 profile grade will be realigned vertically and widened in the vicinity of the replacement bridges. Embankment (Item 203) fill will be placed over the arch culvert and the rest of the removed bridge area to construct the IR-75 roadway. The Site Location Map is shown in Figure 2.1.

This report has been developed based on the field exploration program, laboratory testing, and information secured for site-specific studies. It must be noted that, as with any exploration program, the site exploration identifies actual subsurface conditions only at those locations where samples were obtained. The data derived through sampling and laboratory testing is reduced by geotechnical engineers and geologists who then render an opinion regarding the overall subsurface conditions and their likely reaction on the site. The actual site conditions may differ from those inferred to exist. Therefore, although a fair amount of subsurface data has been assembled during this exploration, this report may not provide all of the geotechnical data needed for construction of this project. This report was prepared using English units.



PROJECT: HAN-75-14.39
BRIDGE NO. HAN-75-1713 OVER ABANDONED RAILROAD
SITE LOCATION MAP (FIGURE 2.1)

2.2 Scope of Services

The scope of services for this project was in accordance with Pro Geotech, Inc. (PGI) Proposal No. PG14044 dated December 10, 2014 and governed by ODOT's *Specifications for Geotechnical Explorations* dated January 2007 and updated January 20, 2012 and ODOT's Bridge Design Manual, issued 2007 and AASHTO LRFD Bridge Design Specifications, 7th Edition hereafter referred to as ODOT Specifications. Our scope of services consisted of the execution of the following tasks:

Phase I – Planning and Marking Test Borings, which primarily consisted of planning the field portion of our subsurface exploration, performing the site reconnaissance to evaluate the proposed project site from a geotechnical standpoint, reviewing and compiling all existing geology of the project site obtained from ODOT and ODNR sources, marking the test boring locations, obtaining necessary permits, and notifying the Ohio Utility Protection Services (OUPS) about the proposed drilling operations.

Phase II - Test Boring and Sampling Program, which primarily consisted of field verification of the test boring locations with regards to the underground utilities, advancing the test borings at the site, conducting field tests, sampling the subsurface materials, and preparing field drilling logs.

Our scope of services included advancing two (2) test borings in the vicinity of existing Bridge Nos. HAN-75-1713 Left & Right over Abandoned Railroad for structural foundation design purposes. The two (2) structural test borings for the bridge were to be advanced to approximate depth 50.0 feet each below the existing ground, and included obtaining 10 feet of rock core at each boring location. All test borings were advanced in accordance with the ODOT *Specifications for Geotechnical Explorations*. The groundwater conditions were monitored during and upon completion of the drilling operations. PGI provided all of the traffic control needed during the fieldwork.

Phase III - Testing Program, which consisted of performing soil classification and engineering properties tests on selected soil and rock samples, and classifying the soils in accordance with the ODOT Soil Classification System.

Phase IV - Geotechnical Exploration Report, which included the following:

- A brief description of the project and our exploration methods
- Typed drilling logs and laboratory test results
- A description of subsurface soil, rock, and groundwater conditions

- Discussions pertaining to earthwork considerations, groundwater management, and construction monitoring
- Foundation recommendations for the culvert structure including shallow and deep foundations
- Preparation of ODOT Geotechnical Design Checklists
- Geotechnical Exploration Plans are included in our scope of services for this project

The scope of services did not include any environmental assessments for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater or air, on, below, or around this site. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions is strictly for the client's information.

3.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

3.1 Geology

Based on information obtained from the Physiographic Regions of Ohio, the project site lies on the Huron-Erie Lake Plains and Till Plains Sections of the Central Lowland Province. The project site is located within the Central Ohio Clayey Till Plain Region of the Till Plains Section. The Columbus Escarpment separates the Findlay Embayment District from the Central Ohio Clayey Till Plain Region. The project site is located at approximate elevations ranging from 772 feet to 798 feet. According to Bulletin 44, *Geology of Water in Ohio* (issued in 1943 and reprinted in 1968), both the Illinoian and Wisconsin Glaciers passed over the area and left a coating of drift materials (largely till) less than 25 feet in thickness. The main geologic deposit of the project site consists of clayey, high-lime Wisconsinan-age till; lake-planed moraine, very flat, planed by waves in glacial lakes; small patches of sand, silt, or clay over Dolomite bedrock of Silurian-age. Based on the *Soil Survey of Hancock County, Ohio* and from the *U.S. Department of Agriculture, Natural Resource Conservation Service* website, the natural soils in the vicinity of the project area consist primarily of layers of silt loam, clay loam, silty clay, and silty clay loam. These soils are classified as A-4, A-6, and A-7 based on the AASHTO Soil Classification System. However, the project site has incurred cut and fill operations due to construction of existing IR-75. Thus the composition of the surface and subsurface soils has changed from natural in most areas.

Based on information obtained from the Ohio Geological Survey, bedrock in the vicinity of the project site was deposited during the Upper and Lower Silurian Period of the Paleozoic Era and is expected to consist of Tymochtee/Greenfield Group dolomite. Tymochtee Group dolomite is described as shades of gray and brown, very finely crystalline which occur as thin to massive beds with carbonaceous shale laminae and beds. Greenfield Group dolomite is described as shades of gray and brown; very finely to coarsely crystalline which occurs as massive beds to laminae; argillaceous and locally brecciated in the lower portion. According to ODNR's Ohio Gas and Oil Wells Locator website, many wells which are active and abandoned are located within the project site. According to ODNR's Ohio Mines Locator website, no abandoned underground or surface mines are present in the immediate vicinity of the project site. Based on the Ohio Division of Geological Survey Interactive Map of Ohio Mineral Industries, an active limestone industrial quarry is located approximately 0.4 miles southwest of the project site. According to ODNR, the project site is located outside of the "Probable Karst Regions" of Ohio and outside of the "Landslide-Prone Areas" of Ohio. According to ODNR website, two (2) earthquakes occurred within the Hancock County; one in 1990 with magnitude of 2.3 Richter Scale and another in 2011 with magnitude of 2.4 Richter Scale. Their epicenters were located approximately 8.8 miles to the northeast in Big Lick Township and 14.2 miles to the south in Delaware Township.

3.2 Observation of the Project

The reconnaissance of the project site was performed by one of PGI's geotechnical engineers in April 2015. The project site is located in a commercial area and includes buildings that are located greater than distance of 500 feet from the bridge site. The existing structure is three-span continuous pre-stressed concrete box beam with composite reinforced concrete deck on abutments and piers. The total span length of bridge is approximately 140 feet. The embankment section at the existing IR 75 mainline bridge approach generally appeared to be in good condition. No visible signs of embankment slope instability were observed and embankment settlement was not observed. Concrete on both edges of the bridge deck are severely deteriorated.

4.0 EXPLORATION

4.1 Historic and Project Exploration Program

Historical records of a geotechnical exploration performed in December 1987 were available for this bridge from the ODOT Geotechnical Documents Management System ftp site. These records consist of Structure Foundation Investigation sheets which included two (2) boring logs from the subsurface geotechnical exploration completed on April 1987 identified as B-1 (B-001-2-87) and B-4 (B-004-2-87). Historic test boring B-001-2-87 was drilled in the vicinity of the existing bridge rear abutment and historic test boring B-004-2-87 was drilled in the vicinity of the proposed forward abutment. These historic records are included in Appendix B.

In order to explore the subsurface conditions at the project site, drilling, sampling, and field testing operations were performed during April 2015. A total of two (2) test borings identified as B-049-2-14 and B-049-3-14 were advanced for bridge foundations design purposes. Test boring B-049-2-14 was advanced in the vicinity of proposed culvert outlet while test boring B-049-3-14 was advanced in the vicinity of proposed culvert inlet. These test borings were advanced to approximate depths ranging from 31.0 to 32.9 feet below the existing ground surface.

The test borings were marked in the field by PGI based on boring location plans developed by PGI personnel and after obtaining approval from PB and ODOT personnel. Site geometry, utility locations, overhead height, and accessibility were also taken into account when locating the test borings**.** At the time of test boring location selection, the vertical soil sampling intervals were determined based on the needs for design and construction of the project. A CME-45B truck mounted drilling rig was used to advance the test borings. Both test borings were advanced using 3.25-inch inside diameter continuous flight hollow stem augers (HSA). Representative disturbed samples of the soils were collected at intervals in accordance with the ODOT Specifications. A standard 2.0-inch outside diameter split-barrel sampler was driven into the soil by means of a 140-lb hammer falling freely through a distance of 30-inches in accordance with the Standard Penetration Test (ASTM D 1586). Where bedrock was encountered, both test borings were advanced and the rock was sampled using a type NX series core barrel, water method. Both test borings were monitored for the presence of groundwater during drilling operations. All test borings were backfilled with compacted soil cuttings at the end of drilling operations for safety purposes.

Northing and Easting coordinates, stations and offsets, and surface elevations at the drilled test boring locations were provided to PGI by PB personnel. The typed drilling logs are included in Appendix A. These logs show the SPT resistance values (N-values) for each soil sample taken in the test borings and present the classification and description of soils encountered at various depths in the test borings. The N-values as measured in the field have been corrected to an equivalent rod energy ratio of 60% (N_{60}) in accordance with ODOT's *Specifications for Geotechnical Explorations*. The sample depth shown on the logs and laboratory test results indicate the top of each sampling or testing interval. A Soil Profile and Boring Location Map are also included in Appendix A.

4.2 Laboratory Testing Program

All soil samples obtained during the drilling and sampling operations were returned to PGI's geotechnical soils laboratory in Cleveland, Ohio. Upon arrival, the samples were visually examined and classified by a geotechnical engineer and a geologist to verify the classifications made in the field and to note any additional characteristics, which may not have been observed in the field.

Moisture content determination tests were performed on all soil samples as per ODOT specifications. Additional laboratory soil tests were performed on selected rock core samples. These tests consisted of Compressive Strength of Rock Core Specimens. All laboratory tests were performed in accordance with the ASTM or other standards listed in "Laboratory Test Standards" located in Appendix B. The results of the laboratory tests are also included in Appendix B. The soils were classified in accordance with the ODOT Soil Classification System, a description of which is also included in Appendix B.

Upon completion of the laboratory testing, all samples were placed in storage at PGI's Cleveland facility. Unless otherwise requested in writing, the soil samples will be retained through completion and ODOT approval of Stage 2 Plans.

5.0 FINDINGS

5.1 Subsurface Soil Conditions

The surficial and subsurface soil conditions in the vicinity of this proposed arch culvert were determined from the soil information obtained from project test borings B-049-2-14 and B-049-3-14 and historic test borings B-001-2-87 and B-004-2-87. Project test borings B-049-2-14 and B-049-3-14 were advanced through 6.0 inches and 3.0 inches of topsoil, respectively. The subsurface soils encountered in these test borings were primarily cohesive in nature and consisted of both fill materials and natural soils above the bedrock. The fill material consisted of silt and clay (A-6a) and sandy silt (A-4a) and was encountered to approximate depths of 13.5 feet and 6.0 feet in project test borings B-049-2-14 and B-049-3-14, respectively. Natural soils encountered above bedrock in the test borings consisted of silty clay (A-6b), plastic silt (A-4b), non-plastic silt (A-4b), and sandy silt (A-4a). Bedrock was encountered in project test boring B-049-2-14 at an approximate depth of 19.5 feet below the ground surface while bedrock was encountered project in test boring B-049-3-14 at an approximate depth of 19.0 feet below the ground surface. The laboratory test results indicated that the moisture contents of the tested cohesive soil samples obtained from the structure test borings ranged from 6% to 29% and the consistency ranged from "medium stiff" to "hard", but was predominately “stiff”. The moisture contents of the tested non-cohesive soils ranged from 9% to 19% and the relative density was “medium dense”.

Historic test borings B-001-2-87 and B-004-2-87 were advanced through asphalt with the thickness of 8.5 inches each. The subsurface soils encountered in historic test borings B-001-2-87 and B-004-2-87 were generally cohesive soils, but non-cohesive soils were also encountered above bedrock. The cohesive soils encountered consisted of silt and clay (A-6a), sandy silt (A-4a), silty clay (A6b), and silt (A-4b), and the non-cohesive soils encountered consisted of non-plastic sandy silt (A-4a). Bedrock was encountered in historic test boring B-001-2-87 at an approximate depth of 42.0 feet below the asphalt pavement while bedrock was encountered in historic test boring B-004-2-87 at an approximate depth of 39.5 feet below the asphalt pavement. The laboratory test results indicated that the moisture contents of the tested cohesive soil samples obtained from the historic test borings ranged from 12% to 20% and the consistency ranged from "stiff" to "hard", but was predominately “very stiff”. The moisture content of the tested non-cohesive soil was 29% and the relative density was “loose”.

For specific conditions of the project and historic test borings at various depths, please refer to the individual test boring logs located in Appendix A of this report. For complete moisture contents and Atterberg limit test results for project test borings, refer to the laboratory test results located in Appendix B.

5.2 Bedrock Conditions

Bedrock was encountered at both test boring locations. Bedrock encountered was split spoon sampled until little or no penetration or recovery was encountered. Bedrock core samples were then obtained using an NX diamond impregnated core barrel. The coring operations were performed in accordance with the procedure for Diamond Core Drilling for Site Investigations (ASTM D 2113). The core samples consisted of dolomite of the Tymochtee/Greenfield Group. The dolomite was gray, and highly to slightly weathered. Bedding within the dolomite was generally very thin to medium and was highly to moderately fractured. No slickensides were observed and the fractures were typically tight and slightly rough. The compressive strength of the core specimens ranged from 15,276 psi in project test boring B-049-2-14 to 11,226 psi in project test boring B-049-3-14 which characterizes them as “strong”.

The Rock Quality Designation (RQD) for the core samples ranged from 0% to 58%. The results of these measurements are summarized in Table 5.2.1. Table 5.2.2 summarizes the results of compressive strength tests performed at the laboratory on the rock core specimens. The Rock Mass Strength of cohesion 473 psf and friction angle 27.5 degree was obtained for dolomite bedrock using Geological

Strength Index according to LRFD 7th Edition Section 10.4.6.4. The Rock Mass Strength computer output is included in Appendix B. Refer to the drilling logs in Appendix A and rock core photos in Appendix B for additional bedrock information. Also refer to "Bedrock Descriptions" in Appendix B for general bedrock information.

Table 5.2.1 – Bedrock Information

Boring Number	Rock Core Run No.	Top of Bedrock Elevations (ft)	Rock Core Run Elevations (ft)	Length of Core Run (ft)	Recovery (%)	RQD (%)
B-049-2-14	Run-1	752.7	749.7	4.0	54	35
	Run-2		745.7	4.0	96	17
	Run-3		741.7	1.3	100	27
	Run-4		740.4	1.1	100	0
B-049-3-14	Run-1	753.7	751.7	2.0	79	17
	Run-2		749.7	3.0	100	58
	Run-3		746.7	2.5	100	52
	Run-4		744.2	2.5	93	0

Elevations were provided by PB personnel for top of test borings

Table 5.2.2 –Compressive Strength Test Results of Rock Core Specimens

Boring Number	Specimen Depth (ft)	Rock Type	Unit Weight (pcf)	Compressive Strength (psi)
B-049-2-14	25.4	Dolomite	165.49	15,276
B-049-3-14	25.1	Dolomite	163.80	11,226

5.3 Groundwater Conditions

Groundwater was measured during drilling in both of the project test borings. The results of these measurements are summarized in Table 5.3.1. Groundwater levels were not recorded upon completion of rock coring operations due to water used for rock coring. It should be noted that groundwater elevations are subject to seasonal fluctuations. All test borings were backfilled immediately upon completion for safety purposes; therefore an extended groundwater level reading was not taken.

Table 5.3.1 – Groundwater Conditions

Boring Number	Elevation (feet)	Groundwater Depth (ft.) During Drilling	Groundwater Depth (ft.) Upon Completion	Groundwater Elevation (ft.) During Drilling	Groundwater Elevation (ft.) Upon Completion
B-049-2-14	772.2	17.3	NR	754.9	NR
B-049-3-14	772.7	9.3	NR	763.4	NR

6.0 ANALYSIS AND RECOMMENDATIONS

Based upon the findings of the field exploration program, laboratory testing, and subsequent engineering analysis, the following sections have been prepared to address the geotechnical aspects related to replacement of the IR 75 Mainline Bridge No. HAN-75-1713 over Abandoned Railroad. Site plans provided by PB personnel indicate that the above bridge will be replaced by installing new arch culvert between existing bridge pier locations and placing Item 203 embankment over the proposed arch culvert and the rest of the removed bridge area to construct the IR-75 roadway. Existing piles from bridge pier foundations will be used to support the section of the proposed arch culvert. The foundation recommendations are provided in accordance with the ODOT *Bridge Design Manual* issued in 2007 using current *LRFD Bridge Design Specifications*

6.1 Culvert and Wingwalls Foundation Systems

Soil and rock information obtained from project test borings B-049-2-14, B-049-3-14 was used to provide foundation recommendations for this proposed arch culvert and wingwalls. Test boring B-049-2-14 was advanced in the vicinity of proposed culvert outlet while test boring B-049-3-14 was advanced in the vicinity of proposed culvert inlet. As outlined in Section 5.1 - "Subsurface Soil Conditions", the top of bedrock was encountered in the vicinity of proposed culvert at depths ranging from 19.0 feet to 19.5 feet below the existing ground surface. Bedrock at these test boring locations consists of dolomite and was encountered to termination depth. The Rock Mass Strength; cohesion 473 psf and friction angle 27.5 degree was obtained for dolomite bedrock using Geological Strength Index according to LRFD 7th Edition Section 10.4.6.4. Since the top of bedrock at the project test boring locations was encountered at relatively shallow depths below existing ground surface, the proposed arch culvert (rest sections) and wingwalls design loads may be transferred to the underlying bedrock by means of end bearing H-piles at the project test boring locations.

According to construction sequence for this project, the H-piles supporting proposed arch culvert should be installed before removing the existing bridge. Therefore these H-piles for the proposed arch culvert should be installed by pre-boring holes to underlying dolomite bedrock due to limited overhead clearance. These H-piles should be installed in pre-bored holes with a minimum embedment length of 3 feet into bedrock. Hole diameter size should be selected according to Item 507.11. The pre-bored holes in bedrock should be backfilled with Class C concrete and rest of the pre-hole should be backfilled with granular materials up to the bottom of pile cap. The H-piles supporting proposed wingwalls may be installed by driven to refusal on underlying dolomite bedrock. Pile refusal can be considered when pile penetration is one inch or less after receiving at least 20 blows from the pile hammer during driving. End bearing H-piles consisting pile size of HP12X53 may be selected for both arch culvert and wingwalls to transfer design load to underlying bedrock. The total factored load on each HP-12X53 pile should not exceed the corresponding maximum structural resistance of 380 kips as per the ODOT *Bridge Design Manual* Section 202.2.3.2.a. Note that the above outlined structural resistance values can be used only on the axially loaded piles that have a negligible bending moment. The estimated pile parameters for end bearing piles at each boring location are summarized in Table 6.1.1. The pile cut-off elevations at the culvert inlet and outlet locations were extracted from the structure site plan provided by PB personnel.

Table 6.1.1 - Estimated Design Parameters for H-Piles

Boring No.	Pile Cut-off Elevation (ft)	Pile Tip Elevation (ft)	Estimated Effective Pile Length (ft)	Pile Type	Pile Size	Maximum Factored Structural Resistance/pile
B-049-2-14	767.0	749.7	20.0	H-Pile	12X53	380 kips
B-049-3-14	767.0	750.7	20.0	H-Pile	12X53	380 kips

It is recommended that the piles be spaced a minimum of three (3) pile diameters on center. In order to protect the tip of the H-piles from damage during pile driving for culvert wingwall structures, steel pile points should be installed as per the ODOT *Bridge Design Manual* Section 202.2.3.2.a. If additional lateral resistance is required for piles for culvert wingwall structures, these piles should be installed battered at the abutment locations in accordance with Section 303.4.2.4 - "Piles Battered", of the *ODOT Bridge Design Manual* issued in July 2007.

Embankment fill will be placed over the culvert and rest of the removed bridge area to be brought to proposed IR-75 subgrade. Consolidation settlement is expected in foundation soils caused by construction of the proposed embankment fill. Based on the settlement calculations included in Appendix B, consolidation settlement of the foundation soils above the bedrock will be on the order of 0.5 to 1.0 inches at the test boring locations. Therefore negative skin friction will develop along the section of piles for both arch culvert and wingwall above bedrock due to consolidation of the foundation soils caused by construction of the proposed embankment. The piles should be designed in accordance with section 202.2.3.2.c – "Down Drag Forces on Piles" of the *ODOT Bridge Design Manual* issued in January 2007. Unfactored down drag load of 70 kips per pile may be assumed for pile size HP12X53 at the B-049-2-14 boring location and 56 kips per pile may be assumed for pile size HP12X53 at the B-049-3-14 boring location. The Pile Bearing Graphs and first and last pages of the report are included in Appendix B for calculating vertical axial load capacity and down drag forces. Since most of the down drag forces were calculated using Total Stress Method (α Method), a Load Factor (γ_p) of 1.40 should be used to compute the Factored load at the Strength Limit State. All H-piles should be installed in accordance with ODOT Item 507 - *Bearing Piles*, of the ODOT *Construction and Material Specifications Manual* dated January 2013.

6.3 Lateral Earth Pressures and Culvert Wingwall Drainage

The culvert wingwalls must be designed to resist lateral earth pressures exerted by the backfill soils. Any surcharge load from traffic must be incorporated into the culvert wingwall design. The estimated soil parameters provided below can be used in calculations for the lateral earth pressures.

Sandy Silt (A-4a)/Silt and clay (A-6a)
Bulk Unit Weight: 125 pcf
Average Friction Angle (Phi): 25 degrees
At Rest Coefficient (K_o): 0.577
Active Pressure Coefficient (K_a): 0.406
Passive Pressure Coefficient (K_p): 2.464

Granular Material Type B
Bulk Unit Weight: 130 pcf
Average Friction Angle (Phi): 30 degrees
At Rest Coefficient (K_o): 0.500
Active Pressure Coefficient (K_a): 0.333
Passive Pressure Coefficient (K_p): 3.000

Freely draining material must be placed behind the culvert wing walls in accordance with ODOT Item 518 - "Drainage of Structures". The porous backfill should be placed a minimum of two (2) feet in thickness normal to these walls. It is suggested that filter fabric, ODOT Item 712.09, Type A, be placed between Item 518 porous backfill material and Item 203 embankment material. This will ensure that fine particles do not migrate into the voids of the porous backfill.

6.3 Pavement Design Parameters

It is assumed that the proposed IR-75 pavement will be constructed on the fill subgrade soils with the similar character to the soils encountered in test borings. It is anticipated that on-site sandy silt (A-4a), silt and clay (A-6a), and silty clay (A-6b) fill soils will be encountered within the project limits based on the boring logs. The subgrade CBR values and the resilient modulus of the subgrade soils were estimated based on the ODOT subgrade resilient modulus estimation method, illustrated in 203-3, "Pavement, Design & Rehabilitation Manual." The pavement design parameter information is summarized in Table 6.3.1.

Table 6.3.1 – Summary of Pavement Design Parameters

Parameter	Fill Soils
Group Index (Avg.)	7.00
CBR	7
Soil Support Value (SSV)	4.9
Resilient Modulus (psi)	8,400
Modulus of Subgrade Reaction (K, pci)	165

6.4 Groundwater Management

Based on the groundwater conditions described in Section 5.3, "Groundwater Conditions," groundwater was encountered during drilling at the boring locations. Because the bottom the pre-bored holes will be excavated below the water level at the boring locations, water infiltration is anticipated. Low to moderate volume pumping or dewatering may be required at the rear and forward abutments through the use of sump pumps. It must be noted that the groundwater levels during construction may vary due to seasonal fluctuations, and groundwater may occur where not encountered previously.

6.5 Earthwork and Construction Monitoring

All excavations should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration (OSHA). The proposed cut soil slopes for the culvert foundation excavations should be constructed using a two (2) horizontal to one (1) vertical slope on cohesive soils. Soil and rock excavations are expected during construction of this culvert. It is expected that some harder, less weathered bedrock will be present in the drilled shaft holes. Therefore special drilling equipment may be required. Seepage of water into the pre-bored holes will occur within the soil overburden during excavation. If water is encountered at the bottom of the hole due to seepage, care should be taken to remove all water before placing concrete. All excavations should be conducted in accordance with ODOT's "Construction and Materials Specifications," Item 503 - "Excavation for Structures". Prior to any embankment fill placement against the culvert walls, existing grade under the removed bridge should be subjected to inspection under the direction of geotechnical personnel. Any areas that exhibit an unacceptable subgrade reaction, local soft/loose soil zones, and areas of unacceptable material must be undercut to a minimum depth of two (2) feet below the elevation of the soils being inspected. All removed soils should be replaced with compacted, engineered-fill materials. Backfill should be placed simultaneously on both sides of culvert. All the structural backfill operations for the culvert structures should be conducted in accordance with Item 611 of the ODOT's "Construction and Materials Specifications" issued January 2013.

All fill material must be approved by a qualified geotechnical engineer prior to placement. The fill materials should be placed in lifts of eight (8) inches in thickness (loose measure) and be compacted to an unyielding condition in accordance with ODOT 203.07 “Compaction and Moisture Requirements” specifications. The top 12 inches of the fill in pavement subgrade areas should be placed in lifts of eight (8) inches in thickness (loose measure) and be compacted to an unyielding condition in accordance with ODOT 204.03 “Compaction of the Subgrade” specifications. All in-place density tests should be performed as per Supplement 1015 “Compaction Testing of Unbound Materials” during earthwork construction.

7.0 LIMITATIONS

This report is subject to the following conditions and limitations:

7.1 The subsurface conditions described are based on an examination of the soil and rock samples at the sampling intervals. Varying soil deposits, including fill material, may exist between the sampling intervals and between the test boring locations. Variation in subsurface conditions from those indicated in this report may become apparent during the earthwork and/or installation of the foundations. Such variations may require changes and/or modifications in our recommendations. Such changes may cause time delays and/or additional costs. Owners must be made aware of these limitations and must incorporate them in the design budget and scheduling of the project.

7.2 The design of the proposed project does not vary from the technical information provided and specified in this report. All changes in the design must be reviewed by our geotechnical engineers. PGI cannot assume any responsibility for interpretations made by others of the subsurface conditions and their behavior based on this report.

7.3 All earthwork and foundation construction must be performed under the supervision of a Professional Engineer in accordance with ODOT Construction Specifications.

7.4 The subsurface exploration for this project is strictly from a geotechnical standpoint. An environmental site assessment was not included in the scope of these geotechnical services.

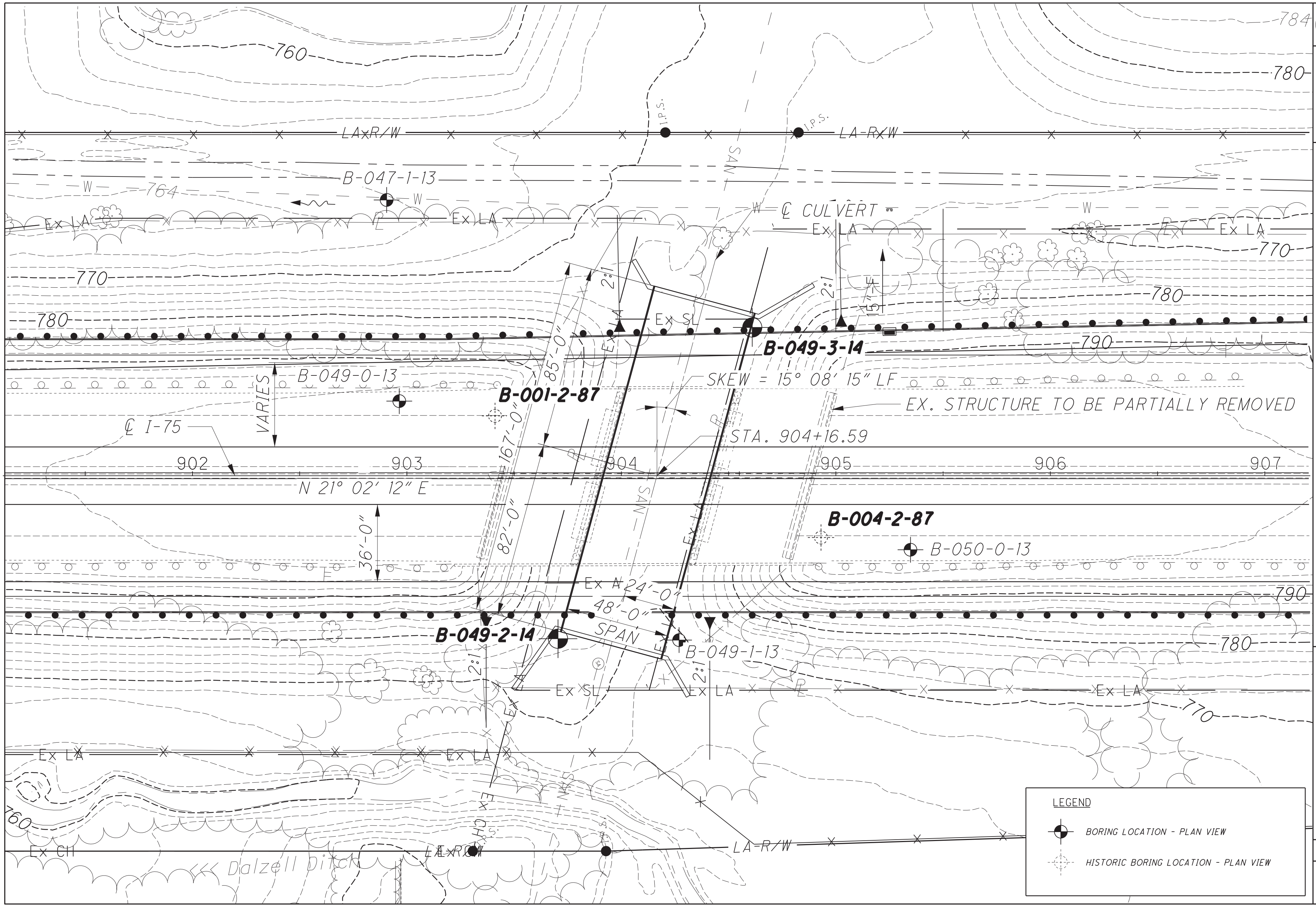
7.5 All sheeting, shoring, and bracing of trenches, pits and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration (OSHA).

APPENDICES

APPENDIX A

BORING LOCATION PLAN

BRIDGE NO. HAN-075-1713 I-75 OVER ABANDONED RAILROAD



HAN-75-14.39

X / X

PROJECT: HAN-75-14.39 - CULVERTS	DRILLING FIRM / OPERATOR: PGI / ZEKE	DRILL RIG: CME 45B TRUCK	STATION / OFFSET: 903+70, 76' RT.	EXPLORATION ID B-049-2-14
TYPE: CULVERT CONSTRUCTION	SAMPLING FIRM / LOGGER: PGI / ZEKE	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-75 BASELINE	
PID: 87005 STR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 2/20/14	ELEVATION: 772.2 (MSL) EOB: 32.9 ft.	PAGE 1 OF 2
START: 4/6/15 END: 4/6/15	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 61.8	COORD: 41.053209, 83.670858	

MATERIAL DESCRIPTION AND NOTES	ELEV. 772.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI			
TOPSOIL (6.0" THICK)	771.7																	
STIFF, BROWN, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, FILL, DAMP		1 2 3	5 4 6	10	89	SS-1	2.00	-	-	-	-	-	-	-	-	14	A-4a (V)	
	766.2	4 5	9 7 5	12	78	SS-2	1.50	8	6	15	45	26	26	17	9	16	A-4a (7)	
STIFF, DARK BROWN TO BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, FILL, MOIST @6.0'; NO SPLITSPOON RECOVERY AND AUGER SAMPLE WAS TAKEN		6 7 8	4 4 7	11	0	SS-3	--	-	-	-	-	-	-	-	-	17	A-6a (V)	
@9.5'; BROWN		9	3 5 7	12	100	SS-4A	2.00	11	8	9	29	43	30	17	13	29	A-6a (9)	
	761.2	10				SS-4B	3.75	-	-	-	-	-	-	-	-	20	A-6a (V)	
STIFF, DARK BROWN, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, FILL, MOIST	758.7	11 12 13	5 5 7	12	100	SS-5	2.25	-	-	-	-	-	-	-	-	25	A-4a (V)	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	756.2	14 15	4 5 6	11	100	SS-6	--	-	-	-	-	-	-	-	-	24	A-6b (V)	
STIFF, BROWN, **SILT**, SOME CLAY, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	754.9	16 W 17	4 7 4	11	89	SS-7	--	5	4	8	56	27	27	19	8	19	A-4b (8)	
MEDIUM DENSE, BROWN, **NON-PLASTIC SILT**, LITTLE STONE FRAGMENTS, TRACE SAND, MOIST	752.7	18 19 TR	4 17 28	46	56	SS-8	--	-	-	-	-	-	-	-	-	9	A-4b (V)	
DOLOMITE, GRAY, HIGHLY WEATHERED. NOTE: AUGERED TO 22.5 FEET AND BEGIN CORING BEDROCK.	749.7	20 21 22																
DOLOMITE, GRAY, MODERATELY TO SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO MEDIUM BEDDED, FRACTURED TO SLIGHTLY FRACTURED, TIGHT TO NARROW APERTURE WIDTH, SLIGHTLY ROUGH. U.C. STRENGTH @ 25.4' = 15,276 psi.	745.7	23 24 25 26	35		54	NX-1											CORE	
DOLOMITE, GRAY, HIGHLY TO MODERATELY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	741.7	27 28 29 30	17		96	NX-2											CORE	
DOLOMITE, GRAY, HIGHLY TO MODERATELY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	740.4	31	27		100	NX-3											CORE	
DOLOMITE, GRAY, HIGHLY TO MODERATELY WEATHERED, VERY STRONG, VERY THIN BEDDED, HIGHLY	739.3	32 EOB	0		100	NX-4											CORE	

PID: 87005	STR ID:	PROJECT: HAN-75-14.39 - CULVERTS	STATION / OFFSET: 903+70, 76' RT.	START: 4/6/15	END: 4/6/15	PG 2 OF 2	B-049-2-14

MATERIAL DESCRIPTION AND NOTES	ELEV. 737.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.																		

NOTES: GROUNDWATER WAS ENCOUNTERED AT A DEPTH OF 17.3' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION DUE TO WATER USED DURING ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH AUGER CUTTINGS

PROJECT: HAN-75-14.39 - CULVERTS
TYPE: CULVERT CONSTRUCTION
PID: 87005 STR ID:
START: 4/7/15 END: 4/7/15

DRILLING FIRM / OPERATOR: PGI / ZEKE
SAMPLING FIRM / LOGGER: PGI / ZEKE
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT/NX

DRILL RIG: CME 45B TRUCK
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 2/20/14
ENERGY RATIO (%): 61.8

STATION / OFFSET: 904+61, 69' LT.
ALIGNMENT: IR-75 BASELINE
ELEVATION: 772.7 (MSL) EOB: 31.0 ft.
COORD: 41.053580, 83.671237

EXPLORATION ID
B-049-3-14

PAGE
1 OF 1

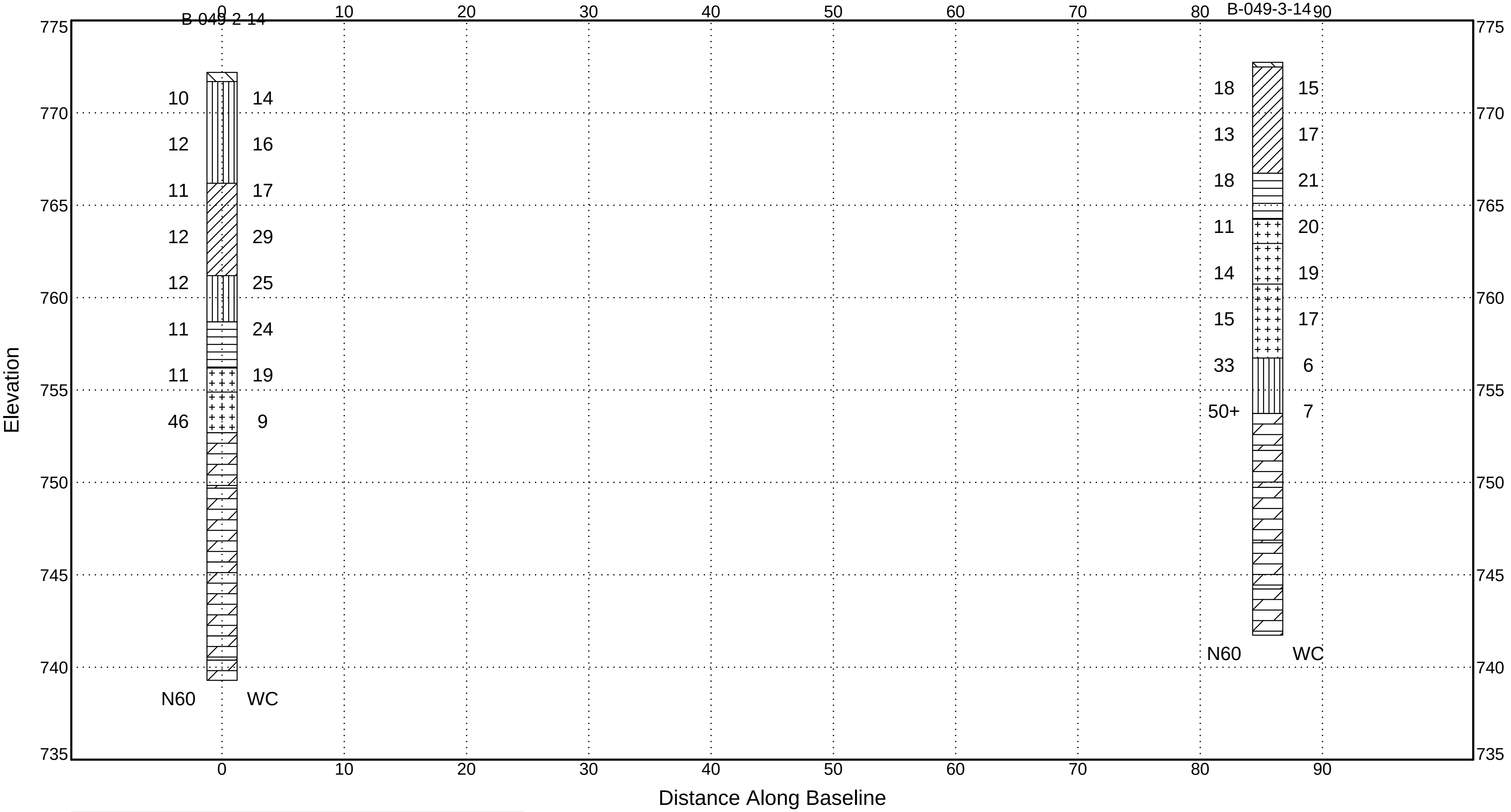
MATERIAL DESCRIPTION AND NOTES	ELEV. 772.7	DEPTHS
TOPSOIL (3.0" THICK)	772.5	
VERY STIFF TO STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, TRACE ROOTS, FILL, DAMP @3.5'; STIFF	766.7	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	764.2	
MEDIUM STIFF, GRAY, **SILT**, SOME CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	762.9	W
MEDIUM DENSE, GRAY, **NON-PLASTIC SILT**, TRACE SAND	760.7	
STIFF, GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE STONE FRAGMENTS, MOIST	756.7	
HARD, GRAY, **SANDY SILT**, SOME CLAY, LITTLE STONE FRAGMENTS, DAMP	753.7	TR (19)
DOLOMITE, GRAY, HIGHLY WEATHERED. @21.0'; AUGER REFUSAL AND BEGIN CORING BEDROCK.	751.7	
DOLOMITE, GRAY, HIGHLY TO MODERATELY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, HIGHLY FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	749.7	
DOLOMITE, GRAY, MODERATELY WEATHERED, STRONG, THIN BEDDED, MODERATELY TO SLIGHTLY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH. U.C. STRENGTH @ 25.1' = 11,226 psi.	746.7	
DOLOMITE, GRAY, HIGHLY TO MODERATELY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, HIGHLY FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	744.2	
DOLOMITE, GRAY, HIGHLY TO MODERATELY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, HIGHLY FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	741.7	EOB (31)

SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)
					GR	CS	FS	SI	CL	LL	PL	PI		
9 6 11	18	33	SS-1	--	-	-	-	-	-	-	-	-	15	A-6a (V)
9 6 7	13	44	SS-2	--	-	-	-	-	-	-	-	-	17	A-6a (V)
8 8 9	18	100	SS-3	4.00	1	3	10	26	60	35	18	17	21	A-6b (11)
3 4 7	11	100	SS-4	3.00	-	-	-	-	-	-	-	-	20	A-4b (V)
5 7 7	14	33	SS-5	2.50	-	-	-	-	-	-	-	-	19	A-4b (V)
5 6 9	15	100	SS-6	4.5+	1	1	2	71	25	23	19	4	17	A-4b (8)
4 12 20	33	89	SS-7	--	-	-	-	-	-	-	-	-	6	A-4a (V)
27 50/3"	-	100	SS-8	--	-	-	-	-	-	-	-	-	7	A-4a (V)
17		79	NX-1											CORE
58		100	NX-2											CORE
52		100	NX-3											CORE
0		93	NX-4											CORE

NOTES: GROUNDWATER WAS ENCOUNTERED AT A DEPTH OF 9.3' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION DUE TO WATER USED DURING ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH AUGER CUTTINGS

PROFILE ODOT - PRIMENG.GDT - 7/17/16 14:44 - \\GEOTECHSERVER\SHARED FOLDERS\COMPANY\PUBLIC\PROJECT FILES\15 PROJECTS\G15004G-(MOD-3 FOR HAN-75-14.39)\LAB DATA SHEETS\G15004G



Borehole	North	East	Elev.	Depth
B-049-2-14	507317	1645593	772.2	32.9
B-049-3-14	507453	1645491	772.7	31.0

DISTANCES:

Beginning	0
Ending	90

VIEWING ANGLES (degrees):

Horizontal	0.0
Vertical	0.0

Position	North	East
Left, Front	253658	822797
Right, Front	253730	822743
Left, Back	253658	822797
Right, Back	253730	822743

SOIL BORINGS PROFILE
HAN-75-14.39

Bridge No. HAN-75-1713 over Abandoned Railroad

FINDLAY, OH

PROJECT #	DATE	PLATE
87005	Jul 16	1

1/4

B-001-2-87 (B-1)

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 5/5/87 Sampler: Type SS Dia. 1 3/8" Water Elev.
Date Completed 5/5/87 Casing: Length Dia.

Project Identification: HANCOCK COUNTY
HAN-75-1713
OVER B. & O. RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-1 Station & Offset 904+35, 29' LT. (SOUTH ABUTMENT) Surface Elev. 797.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab Nos. So.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	PI.	W.C.	SHTL Class
797.4	0				ASPHALT											VISUAL
796.7		AUGERED														
	2															
	4															
792.4	6	3/3/6			BROWN SANDY SILT	1	49633	7	3	38	20	32	21	3	17	A-4a
	8															
787.4	10															
	12	4/5/6			GRAY SANDY CLAY	2	49634	13	6	16	23	42	27	11	17	A-6a
	14															
782.4	16	3/5/7			BROWN SANDY CLAY	3	49635	14	5	13	25	43	31	14	16	A-6a
	18															
777.4	20															
	22	6/9/14			BROWN SANDY SILT	4	49636	11	6	16	22	45	28	2	16	A-4a
	24															
772.4	26	7/14/19			BROWN SANDY SILT	5	49637	9	5	35	22	29	18	5	14	A-4a
	28															
767.4	30															
	32	4/7/14			GRAY SANDY SILT	6	49638	10	4	12	18	56	27	7	16	A-4a
	34															
762.4	36	3/7/13			BROWN SILT	7	49639	0	2	5	58	35	25	5	20	A-4b

Form TE-153 Particle Sizes: Agg= >2.00mm, Coarse Sand=2.00-0.42mm, Fine Sand=0.42-0.074mm, Silt=0.074-0.005mm, Clay=< 0.005mm

B-001-2-87 (B-1)

2/4

Boring No. B-1 Station & Offset 904+35, 29' LT. Surface Elev. 797.4' Project: HAN-75-1713

Elev	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. Sa.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
	38															
757.4	40				TOP OF ROCK											
755.4	42	10/24/30 (02)			GRAY SANDY GRAVELLY SILT	8	49640	21	7	10	37	25	18	4	12	A-4a
	44		4.5	0.5	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, SLIGHTLY VUGGY, BROKEN AND JOINTED. CORE LOSS 10%.											
	46															
750.4																
	48				BOTTOM OF BORING											
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

B-004-2-87 (B-4)

3/4

LOG OF BORING

Date Started 4/29/87 Sampler: Type SS Dia. 1 3/8" Water Elev. ______
Date Completed 4/30/87 Casing: Length ______ Dia. ______

Project Identification: HANCOCK COUNTY
HAN-75-1713
OVER B. & O. RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-4 Station & Offset 905+87, 30' RT. (NORTH ABUTMENT) Surface Elev. 797.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft	Loss ft	Description	Field No.	Lab. Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	PI.	W.C.	SHTL Class
797.4	0															
796.7		AUGERED			ASPHALT											VISUAL
	2															
	4															
792.4	6	8/9/11			BROWN SANDY CLAY	1	49542	6	6	16	28	44	28	11	15	A-6a
	8															
787.4	10															
	12	6/10/13			BROWN SANDY CLAY	2	49543	9	5	17	25	44	33	15	16	A-6a
	14															
782.4	16	4/7/11			BROWN SANDY CLAY	3	49544	3	5	15	28	49	34	16	19	A-6b
	18															
777.4	20															
	22	7/9/12			BROWN-GRAY SANDY CLAY	4	49545	13	5	16	25	41	31	13	20	A-6a
	24															
772.4	26	9/15/24			BROWN SANDY CLAY	5	49546	4	5	13	28	50	34	15	18	A-6a
	28															
767.4	30															
	32	2/3/5			BROWN SANDY SILT	6	49547	4	0	19	53	24	NP	NP	29	A-4b
	34															
762.4	36	8/10/12			GRAY SANDY SILT	7	49548	0	8	19	33	40	21	4	15	A-4a

Form TE-153 Particle Sizes: Agg= >2.00mm, Coarse Sand=2.00-0.42mm, Fine Sand=0.42-0.074mm, Silt=0.074-0.005mm, Clay=< 0.005mm

B-004-2-87 (B-4)

*Boring No. B-4 Station & Offset 905+87, 30' RT. Surface Elev. 797.4' Project: HAN-75-1713

Elev	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. Sa.	Physical Characteristics % Agg	% C.S	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
	38				TOP OF ROCK											
757.9	40				BROKEN DOLOMETIC LIMESTONE		-	-	-	-	-	-	-	-	-	VISUAL
757.4	42		2.0	2.0	DOLOMETIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, EXTREMELY VUGGY AND VERY BADLY BROKEN AND JOINTED. CORE LOSS 50%.											
753.4	44				BOTTOM OF BORING											
	46															
	48															
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

APPENDIX B

Boring Number	Sample Number	Depth (ft)	Water Content %	Liquid Limit %	Plastic Limit %	Plast. Index	Specific Gravity	Agg. %	Coarse Sand %	Fine Sand %	Silt %	Silt&Clay Comb. %	Clay %	Soil Description	Class. Symbol
B-049-2-14	SS-1	1.0	14											BROWN SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS (FILL)	A-4a (V)
B-049-2-14	SS-2	3.5	16	26	17	9		8	6	15	45	71	26	BROWN SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS (FILL)	A-4a (7)
B-049-2-14	SS-3	6.0	17											DARK BROWN SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6a (V)
B-049-2-14	SS-4A	8.5	29	30	17	13		11	8	9	29	72	43	DARK BROWN SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6a (9)
B-049-2-14	SS-4B	9.5	20											BROWN SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6a (V)
B-049-2-14	SS-5	11.0	25											DARK BROWN SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS (FILL)	A-4a (V)
B-049-2-14	SS-6	13.5	24											BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (V)
B-049-2-14	SS-7	16.0	19	27	19	8		5	4	8	56	83	27	BROWN SILT, SOME CLAY, LITTLE SAND, TRACE STONE FRAGS WITH NP SILT LAYER	A-4b (8)
B-049-2-14	SS-8	18.5	9											BROWN NP SILT, TRACE SAND, LITTLE S/F W/DOLOMITE FRAGS	A-4b (V)
B-049-3-14	SS-1	1.0	15											BROWN SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGS & ROOTS (FILL)	A-6a (V)
B-049-3-14	SS-2	3.5	17											BROWN SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGS & ROOTS (FILL)	A-6a (V)
B-049-3-14	SS-3	6.0	21	35	18	17		1	3	10	26	86	60	BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (11)
B-049-3-14	SS-4	8.5	20											GRAY SILT, SOME CLAY LITTLE SAND, TRACE STONE FRAGS, WITH NP SILT LAYER	A-4b (V)
B-049-3-14	SS-5	11.0	19											GRAY NP SILT, TRACE SAND WITH PLASTIC SILT LAYER	A-4b (V)
B-049-3-14	SS-6	13.5	17	23	19	4		1	1	2	71	96	25	GRAY SILT, SOME CLAY, TRACE SAND, TRACE STONE FRAGMENTS	A-4b (8)
B-049-3-14	SS-7	16.0	6											GRAY SANDY SILT, SOME CLAY, LITTLE STONE FRAGMENTS	A-4a (V)
B-049-3-14	SS-8	18.5	7											GRAY SANDY SILT, SOME CLAY W/DOLOMITE FRAGMANTS	A-4a (V)

Pro Geotech, Inc.

TR.-TRACE, BR.-BROWN, LI.-LITTLE,
S/F-STONE FRAGMENTS, SO.-SOME,
RB-ROADBASE, NP-NON-PLASTIC,
POSS-POSSIBLE, MOD-MODERATELY

Summary of Laboratory Results

Client: PARSONS BRINCKERHOFF
Project: HAN-75-14.39
Location: FINDLAY, OH
PID Number: 87005

Sheet 1 of 1

Pro Geotech, Inc.

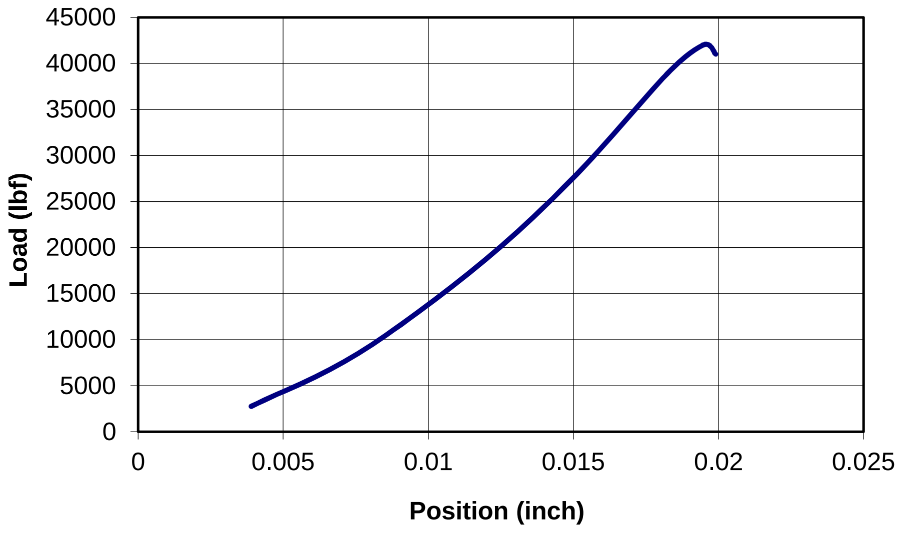
Compressive Strength of Rock
ASTM D 7012

PROJECT	HAN-75-14.39	PGI PROJECT NO.	G15004G	DATE	5/12/15
	STRUCTURE	Bridge No. HAN-75-1713 over Abandoned Railroad			
BORING NUMBER	B-049-2-14	TOP DEPTH (FT)	25.4	BOTTOM DEPTH (FT)	25.7
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	75	SECTION	1713
STATION	903+70.5	OFFSET	76.0'	OFFSET DIRECTION	Right

FORMATION	TYMOCHTEE / GREENFIELD GROUP
DESCRIPTION	Dolomite, gray, moderately weathered, very strong.

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		LENGTH/DIAMETER	2.17
1	4.060	1.875		CORRECTION FACTOR	1.00
2	4.050	1.870		AREA (SQ. INCH)	2.751
3	4.062	1.870		MASS (GRAMS)	484.92
AVERAGE	4.057	1.872		UNIT WEIGHT (LBS/FT^3)	165.49

MAXIMUM LOAD (LBS)	42029
COMPRESSIVE STRENGTH (PSI)	15276
TIME OF TEST (MINUTES)	1:50
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	SS & SP




BEFORE TESTING


AFTER FAILURE

Pro Geotech, Inc.

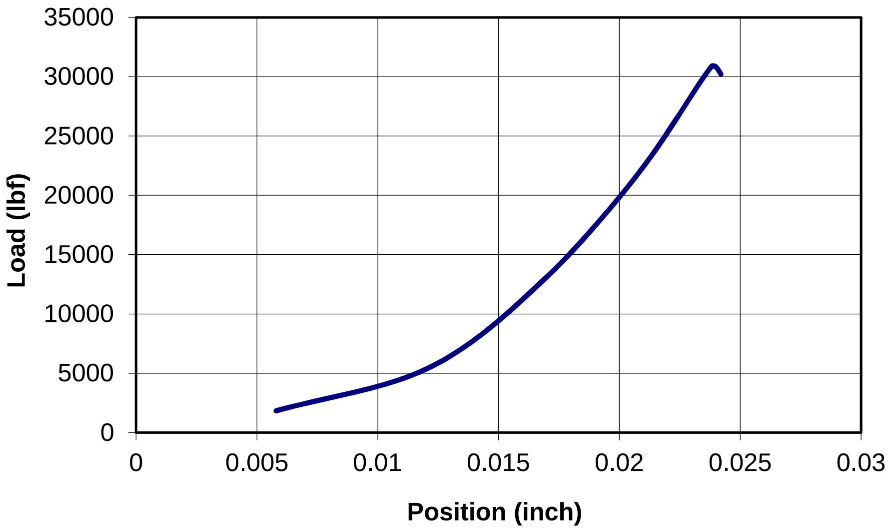
Compressive Strength of Rock
ASTM D 7012

PROJECT	HAN-75-14.39	PGI PROJECT NO.	G15004G	DATE	5/12/15
	STRUCTURE	Bridge No. HAN-75-1713 over Abandoned Railroad			
BORING NUMBER	B-049-3-14	TOP DEPTH (FT)	25.1	BOTTOM DEPTH (FT)	25.4
SAMPLE NUMBER	NX-2	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	75	SECTION	1713
STATION	904+61.0	OFFSET	69.1'	OFFSET DIRECTION	Left

FORMATION	TYMOCHTEE / GREENFIELD GROUP
DESCRIPTION	Dolomite, gray, moderately weathered, strong.

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	3.942	1.870	LENGTH/DIAMETER	2.11
2	3.943	1.870	CORRECTION FACTOR	1.00
3	3.944	1.870	AREA (SQ. INCH)	2.746
			MASS (GRAMS)	465.62
AVERAGE	3.943	1.870	UNIT WEIGHT (LBS/FT^3)	163.80

MAXIMUM LOAD (LBS)	30833
COMPRESSIVE STRENGTH (PSI)	11226
TIME OF TEST (MINUTES)	1:37
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	SS & SP



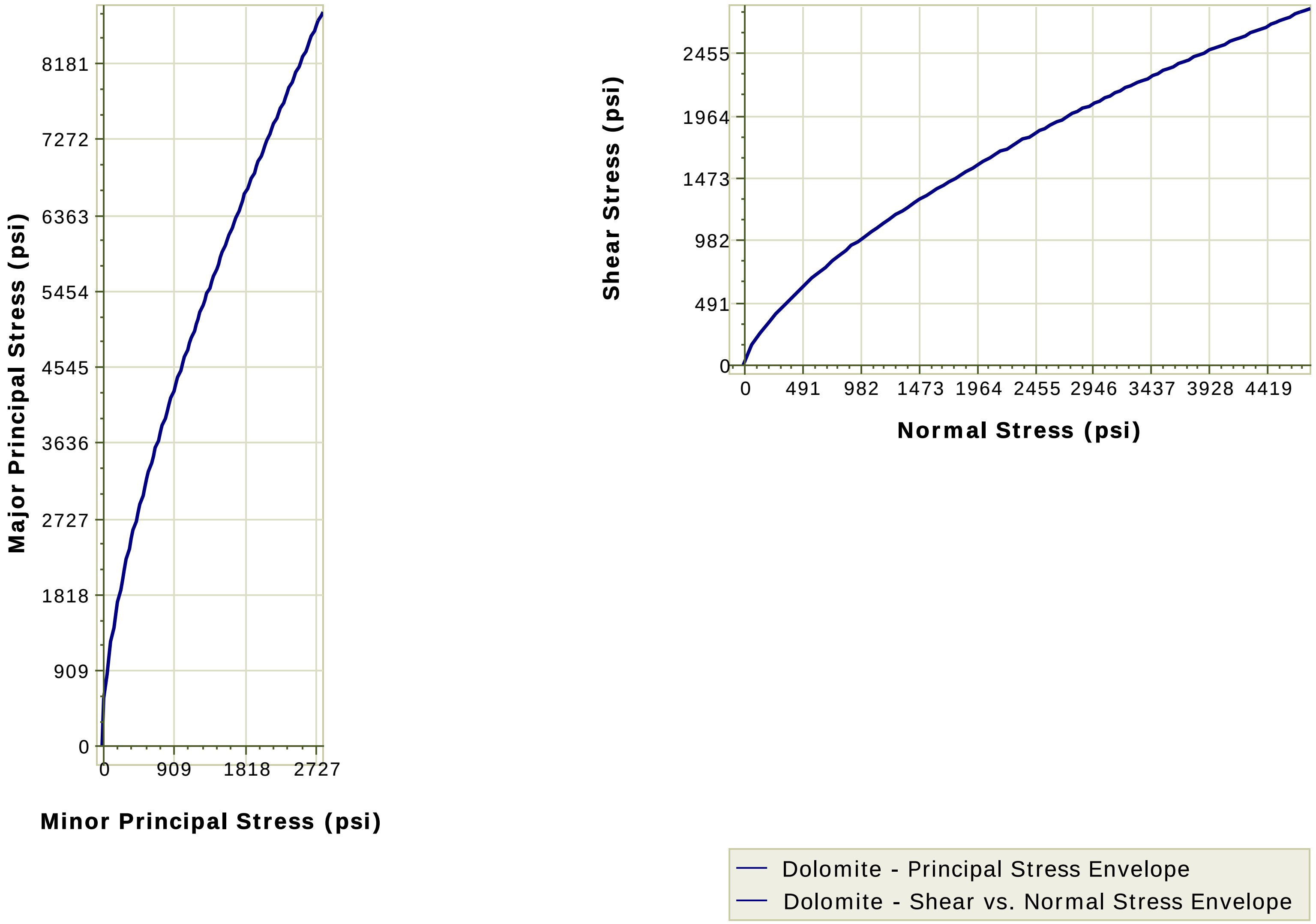
BEFORE TESTING

AFTER FAILURE

COMPANY: PGI DRILLED BY: PGI
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1713
BORING: B-049-2-14 BOX 1/1
DATE of CORING: 4/6/15
RUN-1: 22.5' - 26.5' REC: 54% RQD: 35%
RUN-2: 26.5' - 30.5' REC: 96% RQD: 17%
RUN-3: 30.5' - 31.8' REC: 100% RQD: 27%
RUN-4: 31.8' - 32.9' REC: 100% RQD: 0%

COMPANY: PGI DRILLED BY: PGI
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1713
BORING: B-049-3-14 BOX 1/1
DATE of CORING: 4/7/15
RUN-1: 21.0' - 23.0' REC: 79% RQD: 17%
RUN-2: 23.0' - 26.0' REC: 100% RQD: 58%
RUN-3: 26.0' - 28.5' REC: 100% RQD: 52%
RUN-4: 28.5' - 31.0' REC: 93% RQD: 0%

Rock Mass Strength



Dolomite	
Hoek Brown Classification	
intact uniaxial compressive strength	11000 psi
GSI	43
mi	9
disturbance factor	0
Hoek Brown Criterion	
mb	1.175
s	0.002
a	0.509
Failure Envelope Range	
application	general
sig3max	2750 psi
Mohr Coulomb Fit	
cohesion	472.9 psi
friction angle	27.582 deg
Rock Mass Parameters	
tensile strength	-16.623 psi
uniaxial compressive strength	437.151 psi
global strength	1561.151 psi
modulus of deformation	844183.484 psi

Project	HAN-75-14.39-Bridge No. HAN-75-1713 - Determining Rock Mass Strength using GSI Method		
Analysis Description	GSI Method as per LRFD Section 10.4.6.4		
Drawn By	SS	*Company*	Pro Geotech, Inc.
Date	7/4/2016, 2:57:51 PM	*File Name*	Dolomite RocData3.roc5

ROCDATA 5.006

SETTLEMENT ANALYSIS

Project:	HAN-75-14.39 - HAN-75-1713	**Project #**	G15004G	**Test Boring #**	B-049-2
Type of Foundation	Compression Index (Cc) (From Lab Test)		Depth of Ground Water Level (feet)		17.3
Strip Foundation	Recompression Index (Cr) (From Lab Test)		Unit Weight of Water (pcf)		62.4
	Depth of Footing (D_f) below ground (feet)	29.0	Specific Gravity of Soil Solids (G)		
Width of Embankment = 50'	Applied Design Pressure (psf)	3,625	Ave.Unit Weight of Soil above the base of foundation (pcf)		125
Depth Below the Foundation (Z)	**AVERAGE PROPERTIES**		**CALCULATIONS**		**Total**
D_f=6.2' & Z=0.0'	Thickness of Layer (feet)	4.8	OB Pressure at the top Layer(psf)	744	**Setlement**
	Ave. Corrected SPT Value (N_{60})	12	OB Pressure at the center Layer (psf)	1032	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3459	
(Above the Water Table)	Moisture content (%)	22	Compression Index (C_c)	0.22	
Z=2.4' (At Centre of Layer)	Liquid Limit (%)	30	Recompression Index (C_r)	0.022	0.022
	Plastic Limit (%)	17	Initial Void Ratio (e_0)	0.71	
	Plasticity Index (%)	13	Settlement due to compression (inches)	4.72	
	Unit Weight of soil (pcf)	120	Settlement due to recompression (inches)	0.47	**0.47**
D_f=11.0' & Z=4.8'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	1320	
D_f=11.0' & Z=4.8'	Thickness of Layer (feet)	2.5	OB Pressure at the top Layer(psf)	1320	**Setlement**
	Ave. Corrected SPT Value (N_{60})	12	OB Pressure at the center Layer (psf)	1476	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3234	
(Above the Water Table)	Moisture content (%)	25	Compression Index (C_c)	0.25	
Z=6.05' (At Centre of Layer)	Liquid Limit (%)		Recompression Index (C_r)	0.025	0.025
	Plastic Limit (%)		Initial Void Ratio (e_0)	0.68	
	Plasticity Index (%)		Settlement due to compression (inches)	2.24	
	Unit Weight of soil (pcf)	125	Settlement due to recompression (inches)	0.22	**0.22**
D_f=13.5' & Z=7.3'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	1633	
D_f=13.5' & Z=7.3'	Thickness of Layer (feet)	2.5	OB Pressure at the top Layer(psf)	1633	**Setlement**
	Ave. Corrected SPT Value (N_{60})	11	OB Pressure at the center Layer (psf)	1789	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3096	
Above the Water Table)	Moisture content (%)	24	Compression Index (C_c)	0.24	
Z=8.55' (At Centre of Layer)	Liquid Limit (%)		Recompression Index (C_r)	0.024	0.024
	Plastic Limit (%)		Initial Void Ratio (e_0)	0.67	
	Plasticity Index (%)		Settlement due to compression (inches)	1.88	
	Unit Weight of soil (pcf)	125	Settlement due to recompression (inches)	0.19	**0.19**
D_f=16.0' & Z=9.8'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	1945	

Project:	HAN-75-14.39 - HAN-75-1713		**Project #** G15004G	**Test Boring #**	B-049-2
D_f=16.0' & Z=9.8'	Thickness of Layer (feet)	1.3	OB Pressure at the top Layer(psf)	1945	**Setlement**
	Ave. Corrected SPT Value (N_{60})	11	OB Pressure at the center Layer (psf)	2026	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	2998	
(Above the Water Table)	Moisture content (%)	19	Compression Index (C_c)	0.19	
Z=10.45' (At Centre of Layer)	Liquid Limit (%)	27	Recompression Index (C_r)	0.019	0.019
	Plastic Limit (%)	19	Initial Void Ratio (e_0)	0.60	
	Plasticity Index (%)	8	Settlement due to compression (inches)	0.73	
	Unit Weight of soil (pcf)	125	Settlement due to recompression (inches)	0.07	**0.07**
D_f=17.3' & Z=11.1'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	2108	
D_f=17.3' & Z=11.1'	Thickness of Layer (feet)	2.2	OB Pressure at the top Layer(psf)	2108	**Setlement**
	Ave. Corrected SPT Value (N_{60})	34	OB Pressure at the center Layer (psf)	2182	**(inches)**
	Specific Gravity of Soil Solids (G)	2.65	Excess Pressure At Center Due to appliedLoad	2914	
(Below the Water Table)	Moisture content (%)	9	Bearing Capacity Index (C)	75	
Z=12.2' (At Centre of Layer)	Liquid Limit (%)	NP	Immediate Settlement in Foundation Soil (inches)	0.13	**0.13**
	Plastic Limit (%)	NP	Initial Void Ratio (e_0)	0.39	
	Plasticity Index (%)	NP			
	Unit Weight of soil (pcf)	130			
D_f=19.5' & Z=13.3'	Submerged Unit Weight of Soil (pcf)	67.6	OB Pressure at the bottom Layer (psf)	2256	

Total Settlement: **1.09**
Consolidation Settlement: **0.96**
Immediate Settlement: **0.13**

SETTLEMENT ANALYSIS

Project:	HAN-75-14.39 - HAN-75-1713	**Project #**	G15004G	**Test Boring #**	B-049-3
Type of Foundation	Compression Index (Cc) (From Lab Test)		Depth of Ground Water Level (feet)		9.8
Strip Foundation	Recompression Index (Cr) (From Lab Test)		Unit Weight of Water (pcf)		62.4
	Depth of Footing (D_f) below ground (feet)	28.0	Specific Gravity of Soil Solids (G)		
Width of Embankment = 50'	Applied Design Pressure (psf)	3,500	Ave.Unit Weight of Soil above the base of foundation (pcf)		125
Depth Below the Foundation (Z)	**AVERAGE PROPERTIES**		**CALCULATIONS**		**Total**
D_f=6.7' & Z=0.0'	Thickness of Layer (feet)	1.8	OB Pressure at the top Layer(psf)	804	**Setlement**
	Ave. Corrected SPT Value (N_{60})	18	OB Pressure at the center Layer (psf)	921	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3438	
(Above the Water Table)	Moisture content (%)	21	Compression Index (C_c)	0.21	
Z=0.9' (At Centre of Layer)	Liquid Limit (%)	35	Recompression Index (C_r)	0.021	0.021
	Plastic Limit (%)	18	Initial Void Ratio (e_0)	0.57	
	Plasticity Index (%)	17	Settlement due to compression (inches)	1.95	
	Unit Weight of soil (pcf)	130	Settlement due to recompression (inches)	0.20	**0.20**
D_f=8.5' & Z=1.8'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	1038	
D_f=8.5' & Z=1.8'	Thickness of Layer (feet)	1.3	OB Pressure at the top Layer(psf)	1038	**Setlement**
	Ave. Corrected SPT Value (N_{60})	13	OB Pressure at the center Layer (psf)	1116	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3337	
(Above the Water Table)	Moisture content (%)	20	Compression Index (C_c)	0.2	
Z=2.45' (At Centre of Layer)	Liquid Limit (%)		Recompression Index (C_r)	0.02	0.02
	Plastic Limit (%)		Initial Void Ratio (e_0)	0.68	
	Plasticity Index (%)		Settlement due to compression (inches)	1.11	
	Unit Weight of soil (pcf)	120	Settlement due to recompression (inches)	0.11	**0.11**
D_f=9.8' & Z=3.1'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	1194	
D_f=9.8' & Z=3.1'	Thickness of Layer (feet)	2.2	OB Pressure at the top Layer(psf)	1194	**Setlement**
	Ave. Corrected SPT Value (N_{60})	12	OB Pressure at the center Layer (psf)	1268	**(inches)**
	Specific Gravity of Soil Solids (G)	2.65	Excess Pressure At Center Due to appliedLoad	3229	
(Below the Water Table)	Moisture content (%)	19	Bearing Capacity Index (C)	40	
Z=4.2' (At Centre of Layer)	Liquid Limit (%)	NP	Immediate Settlement in Foundation Soil (inches)	0.36	**0.36**
	Plastic Limit (%)	NP	Initial Void Ratio (e_0)	0.51	
	Plasticity Index (%)	NP			
	Unit Weight of soil (pcf)	130			
D_f=12.0' & Z=5.3'	Submerged Unit Weight of Soil (pcf)	67.6	OB Pressure at the bottom Layer (psf)	1343	

Project:	HAN-75-14.39 - HAN-75-1713		**Project #** G15004G	**Test Boring #**	B-049-3
D_f=12.0' & Z=5.3'	Thickness of Layer (feet)	4	OB Pressure at the top Layer(psf)	1343	**Setlement**
	Ave. Corrected SPT Value (N_{60})	15	OB Pressure at the center Layer (psf)	1468	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3054	
(Below the Water Table)	Moisture content (%)	18	Compression Index (C_c)	0.18	
Z=7.3' (At Centre of Layer)	Liquid Limit (%)	23	Recompression Index (C_r)	0.018	0.018
	Plastic Limit (%)	19	Initial Void Ratio (e_0)	0.59	
	Plasticity Index (%)	4	Settlement due to compression (inches)	2.65	
	Unit Weight of soil (pcf)	125	Settlement due to recompression (inches)	0.27	**0.27**
D_f=16.0' & Z=9.3'	Submerged Unit Weight of Soil (pcf)	62.6	OB Pressure at the bottom Layer (psf)	1593	
D_f=16.0' & Z=9.3'	Thickness of Layer (feet)	3	OB Pressure at the top Layer(psf)	1593	**Setlement**
	Ave. Corrected SPT Value (N_{60})	33	OB Pressure at the center Layer (psf)	1702	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	2878	
(Below the Water Table)	Moisture content (%)	6	Compression Index (C_c)	0.06	
Z=10.8' (At Centre of Layer)	Liquid Limit (%)		Recompression Index (C_r)	0.006	0.006
	Plastic Limit (%)		Initial Void Ratio (e_0)	0.32	
	Plasticity Index (%)		Settlement due to compression (inches)	0.70	
	Unit Weight of soil (pcf)	135	Settlement due to recompression (inches)	0.07	**0.07**
D_f=19.0' & Z=12.3'	Submerged Unit Weight of Soil (pcf)	72.6	OB Pressure at the bottom Layer (psf)	1811	

Total Settlement: **1.01**
Consolidation Settlement: **0.65**
Immediate Settlement: **0.36**

HAN-75-14.39 - HAN-75-1713

Boring B-049-2-14

Stress Distribution using 2 V : 1 H Slope Method for Strip Footing

Width of the footing B (feet)	**50**	**Applied Design Pressure (psf)**	**3625**			

Depth (Z) below the footing (feet)	2.4	6.05	8.55	10.45	12.2				
Vertical Stress Intensity at Z q (psf)	3459	3234	3096	2998	2914				

Boring B-049-3-14

Stress Distribution using 2 V : 1 H Slope Method for Strip Footing

Width of the footing B (feet)	**50**	**Applied Design Pressure (psf)**	**3500**			

Depth (Z) below the footing (feet)	0.9	2.45	4.2	7.3	10.8				
Vertical Stress Intensity at Z q (psf)	3438	3337	3229	3054	2878				

Subgrade Analysis

V. 12.00 12/30/11

Design CBR	**7**

Global Options		
320	**R&R**	**?**
206	**CS**	**Option**
	LS	**No**
	LKD	**Option**
206	**Depth**	**NA**

Classification Counts by Sample																
R	1a	1b	3	3a	2-4	2-5	2-6	2-7	4a	4b	5	6a	6b	7-5	7-6	8a	8b
0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0
									33%			33%	33%				
0%	0%								100%								

Surface Class	
2-5	0
4b	0
5	0
7-5	0
7-6	0
8a	0
8b	0
R	0

% Borings	
N_{60L}<= 5	0%
<=10	0%
>=20	0%
M+	100%
R	0%

% Surface	
0%	
0%	0%

UC @ Surface
0.0
0
0

Rig	ER
A	60
B	
C	
D	
E	
F	
G	
H	

Total Borings	2
PID	87005
Location	HAN-75-14.39 - HAN-75-1713

	N_{60}	N_{60L}	LL	PL	PI	% Silt	Clay	P 200	M	M_{OPT}	GI
Average					13.0		43.0		22.0	14.0	7.00
Maximum			35	18	17	45	60	86	29	16	7
Minimum			26	17	9	26	26	71	16	12	7

	Boring					Subgrade		Standard Penetration						Physical Characteristics						Moisture		Class		Comments	Problem		Undercuts		Analysis
#	B #	Boring Location	Depth	To	Cut Fill	Depth	To	n_2	n_3	N	Rig	N_{60}	N_{60L}	LL	PL	PI	% Silt	% Clay	P 200	M	M_{OPT}	Ohio DOT	GI		w/ Class	w/ MN	UC Class	UC MN	
1	B-049-2-14	812+45.8, 92.7.0' LT	3.5	5.0	0.0	3.5	5.0				A			26	17	9	45	26	71	16	12	4a	7						
			8.5	10.0		8.5	10.0							30	17	13	29	43	72	29	14	6a				M		12	
2	B-049-2-14	812+45.8, 92.7.0' LT	6.0	7.5	0.0	6.0	7.5				A			35	18	17	26	60	86	21	16	6b							
3					0.0						A																		
4					0.0						A																		
5					0.0						A																		
6					0.0						A																		
7					0.0						A																		
8					0.0						A																		
9					0.0						A																		
10					0.0						A																		
11					0.0						A																		

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Boring B-049-2-14 - Pile HP 12X53

Filename: K:\B0492.DVN
Project Name: HAN-75-1713
Project Date: 05/19/2015
Project Client: PB
Computed By: SS
Project Manager: SS

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 6.00 ft
Perimeter Analysis: Pile
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

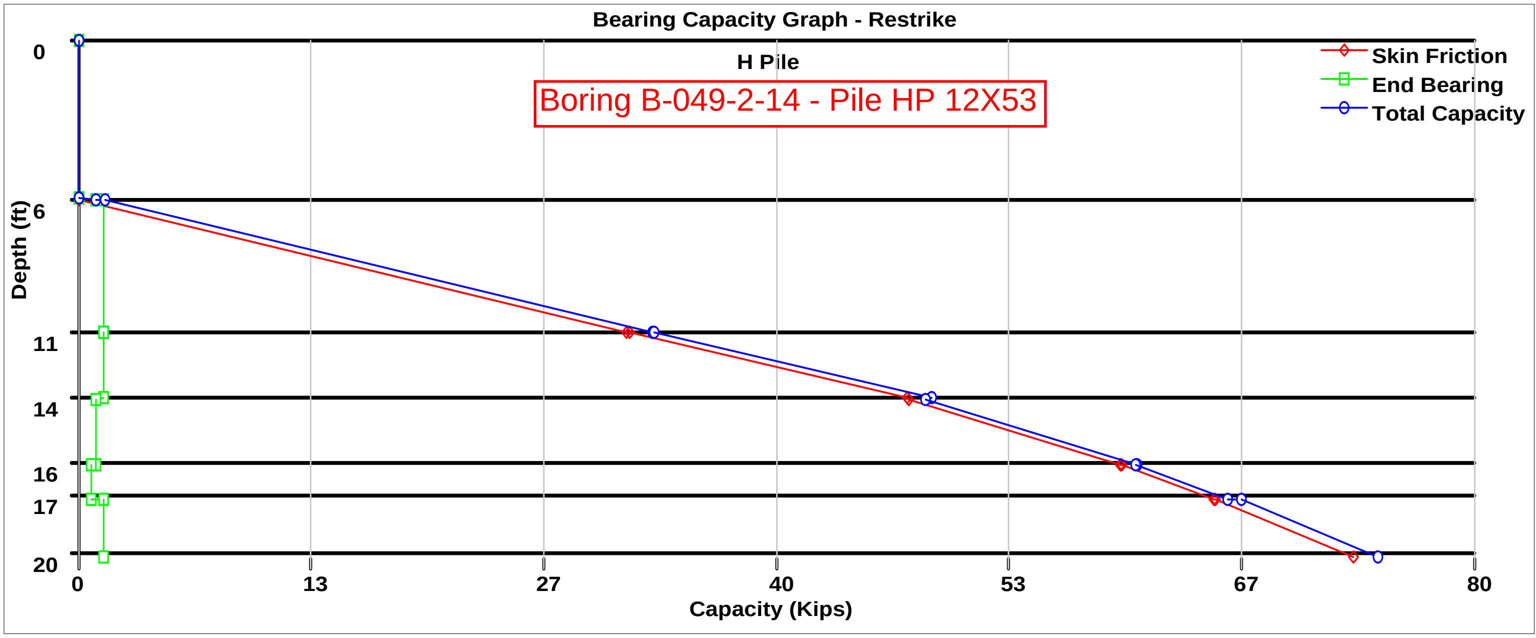
Water Table Depth At Time Of:	- Drilling:	17.30 ft
	- Driving/Restrike	17.30 ft
	- Ultimate:	17.30 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

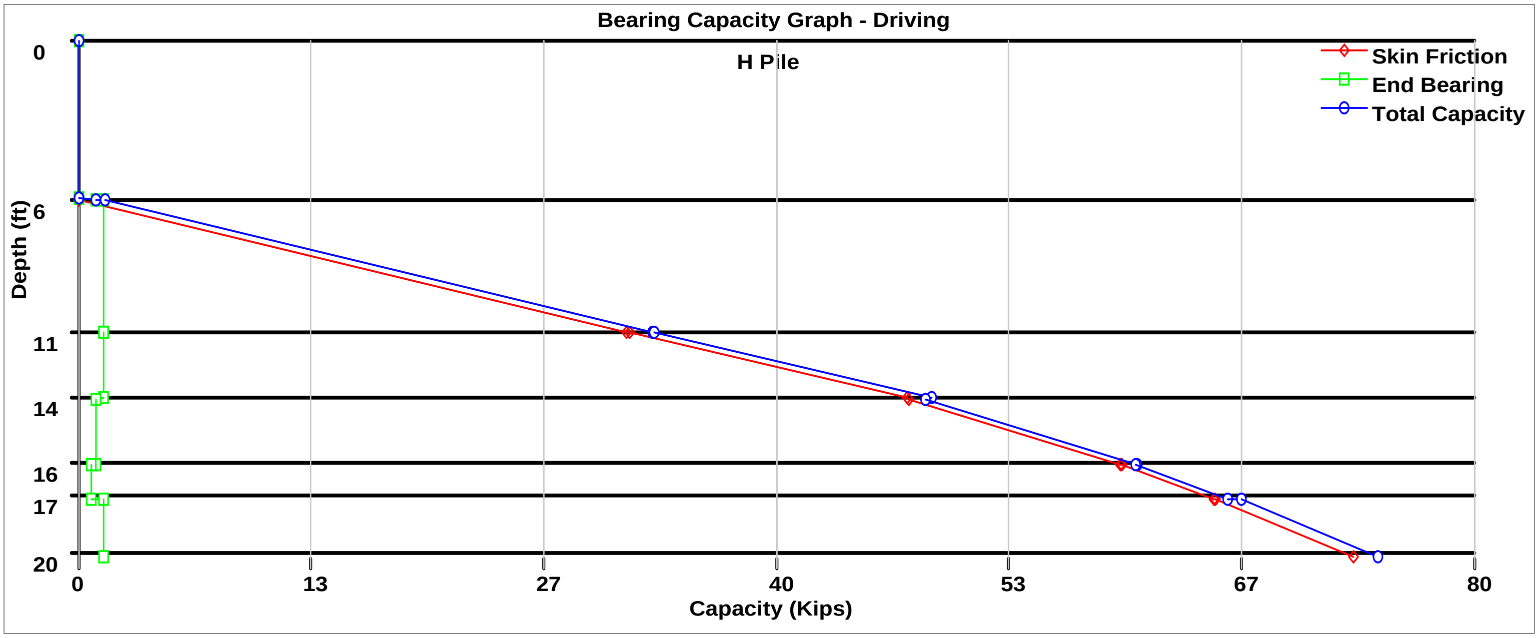
ULTIMATE PROFILE

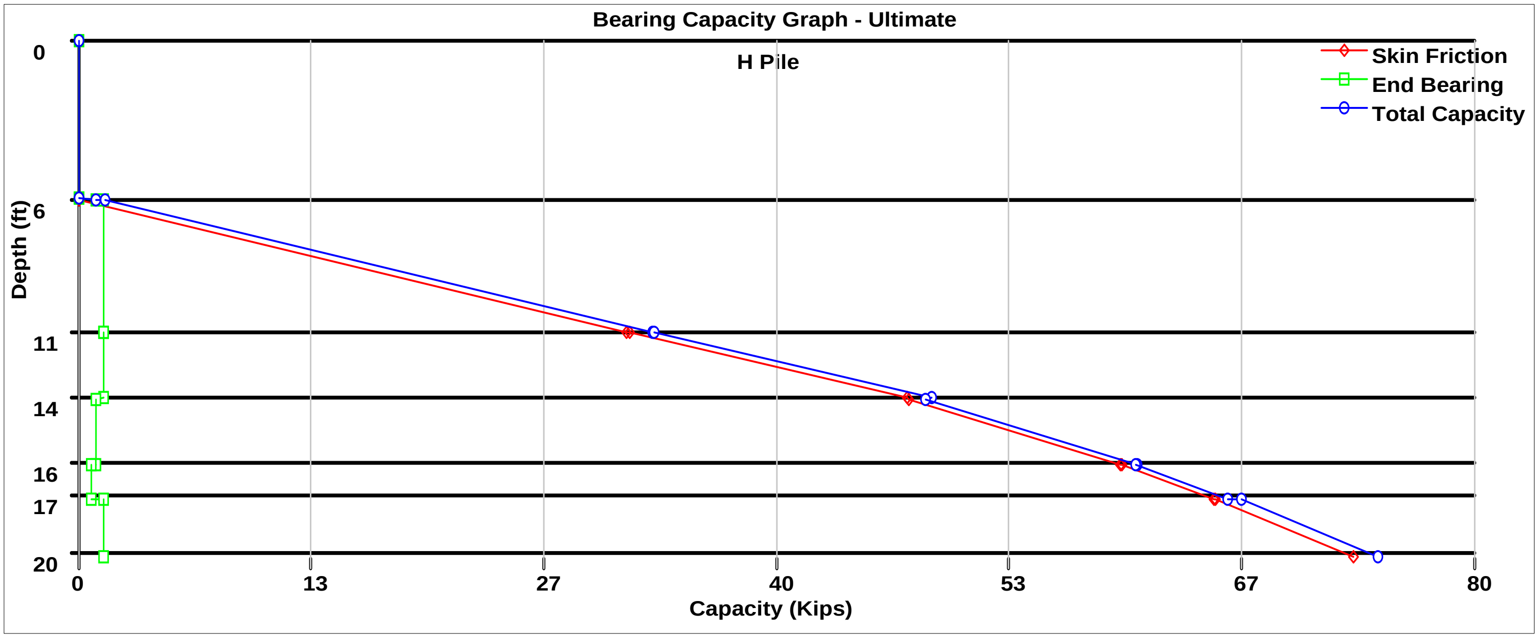
Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	6.00 ft	0.00%	115.00 pcf	1000.00 psf	T-79 Steel
2	Cohesive	5.00 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
3	Cohesive	2.50 ft	0.00%	120.00 pcf	1500.00 psf	T-79 Steel
4	Cohesive	2.50 ft	0.00%	125.00 pcf	1000.00 psf	T-79 Steel
5	Cohesive	1.30 ft	0.00%	125.00 pcf	800.00 psf	T-79 Steel
6	Cohesionless	2.20 ft	0.00%	125.00 pcf	29.2/29.2	Nordlund

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.00 ft	0.00 Kips	0.97 Kips	0.97 Kips
6.01 ft	0.06 Kips	1.45 Kips	1.52 Kips
10.99 ft	31.46 Kips	1.45 Kips	32.91 Kips
11.01 ft	31.59 Kips	1.45 Kips	33.04 Kips
13.49 ft	47.51 Kips	1.45 Kips	48.96 Kips
13.51 ft	47.62 Kips	0.97 Kips	48.59 Kips
15.99 ft	59.77 Kips	0.97 Kips	60.74 Kips
16.01 ft	59.86 Kips	0.77 Kips	60.64 Kips
17.29 ft	65.14 Kips	0.77 Kips	65.91 Kips
17.31 ft	65.21 Kips	1.43 Kips	66.65 Kips
19.49 ft	73.06 Kips	1.43 Kips	74.50 Kips


Bearing Capacity Graph - Restrike
H Pile
Boring B-049-2-14 - Pile HP 12X53
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
6
11
14
16
17
20
0
13
27
40
53
67
80
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
6
11
14
16
17
20
0
13
27
40
53
67
80
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
6
11
14
16
17
20
0
13
27
40
53
67
80
Capacity (Kips)

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Boring B-049-3-14 - Pile HP 12X53

Filename: K:\B0493.DVN
Project Name: HAN-75-1713
Project Date: 05/19/2015
Project Client: PB
Computed By: SS
Project Manager: SS

PILE INFORMATION

Pile Type: H Pile - HP12X53
Top of Pile: 6.00 ft
Perimeter Analysis: Pile
Tip Analysis: Pile Area

ULTIMATE CONSIDERATIONS

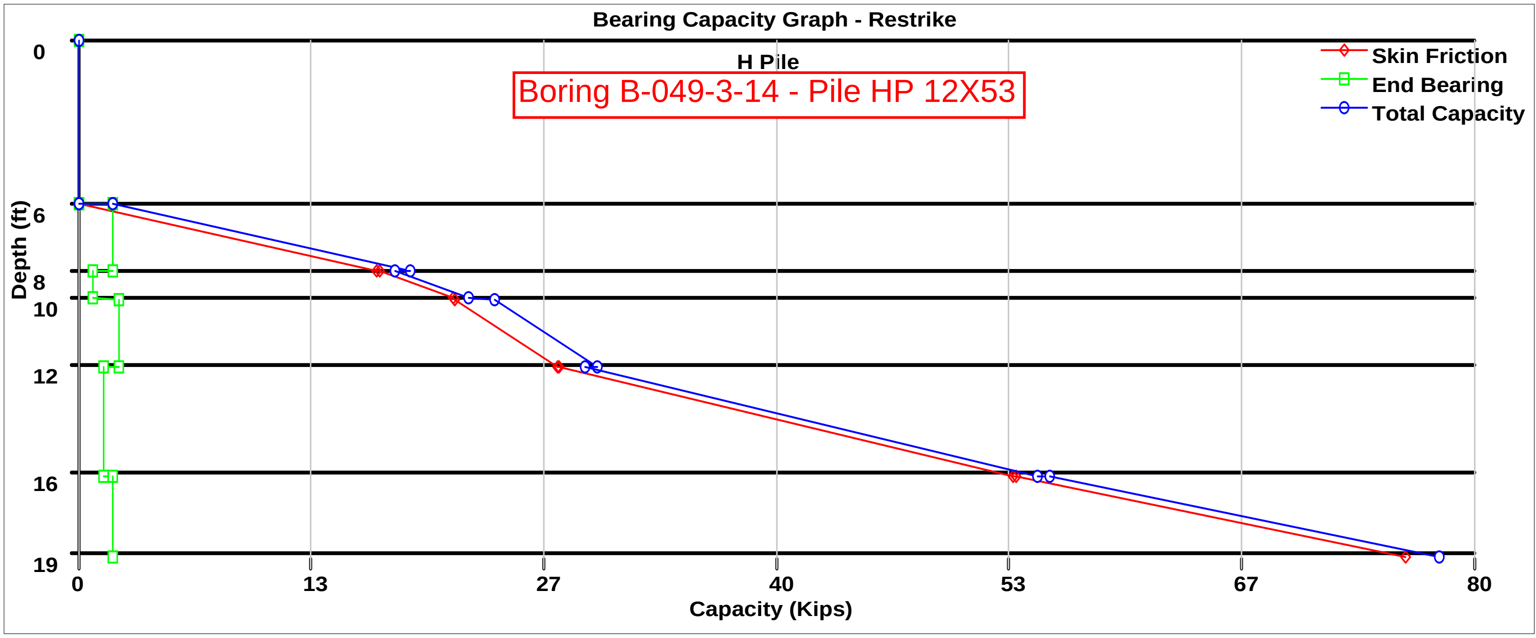
Water Table Depth At Time Of:	- Drilling:	9.30 ft
	- Driving/Restrike	9.30 ft
	- Ultimate:	9.30 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

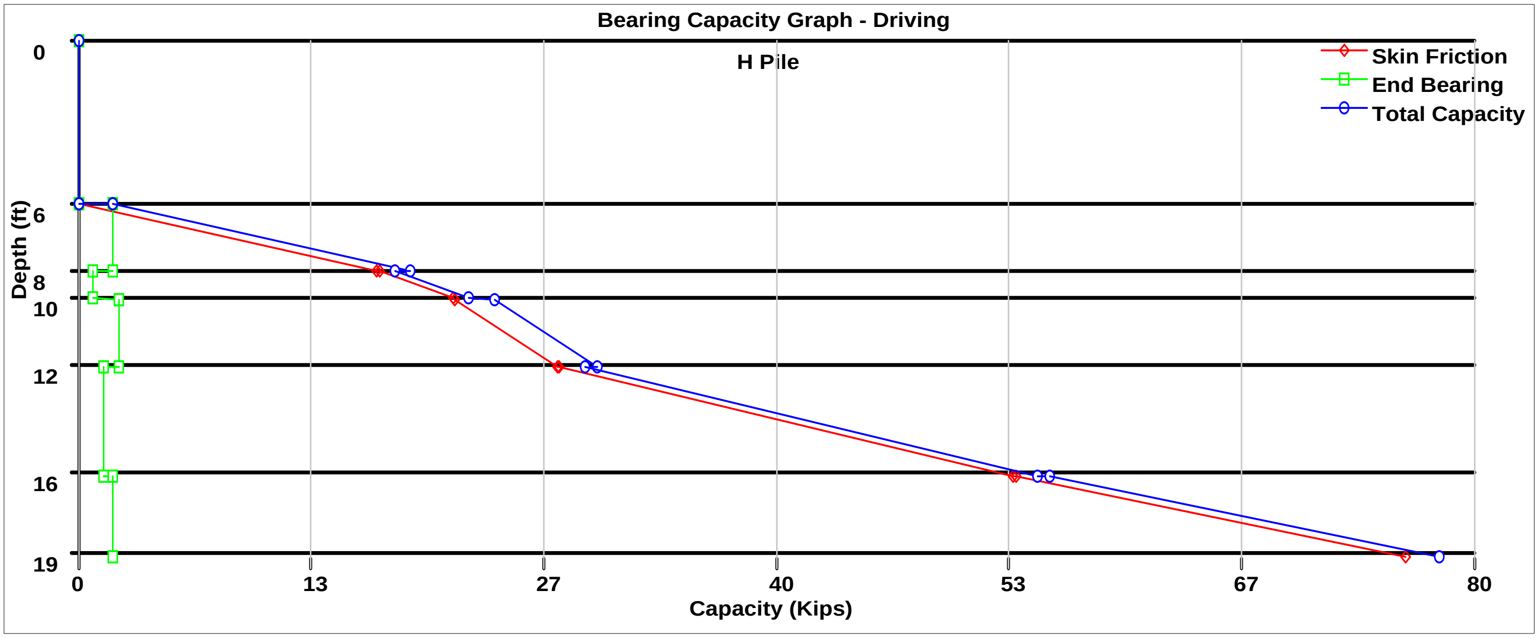
ULTIMATE PROFILE

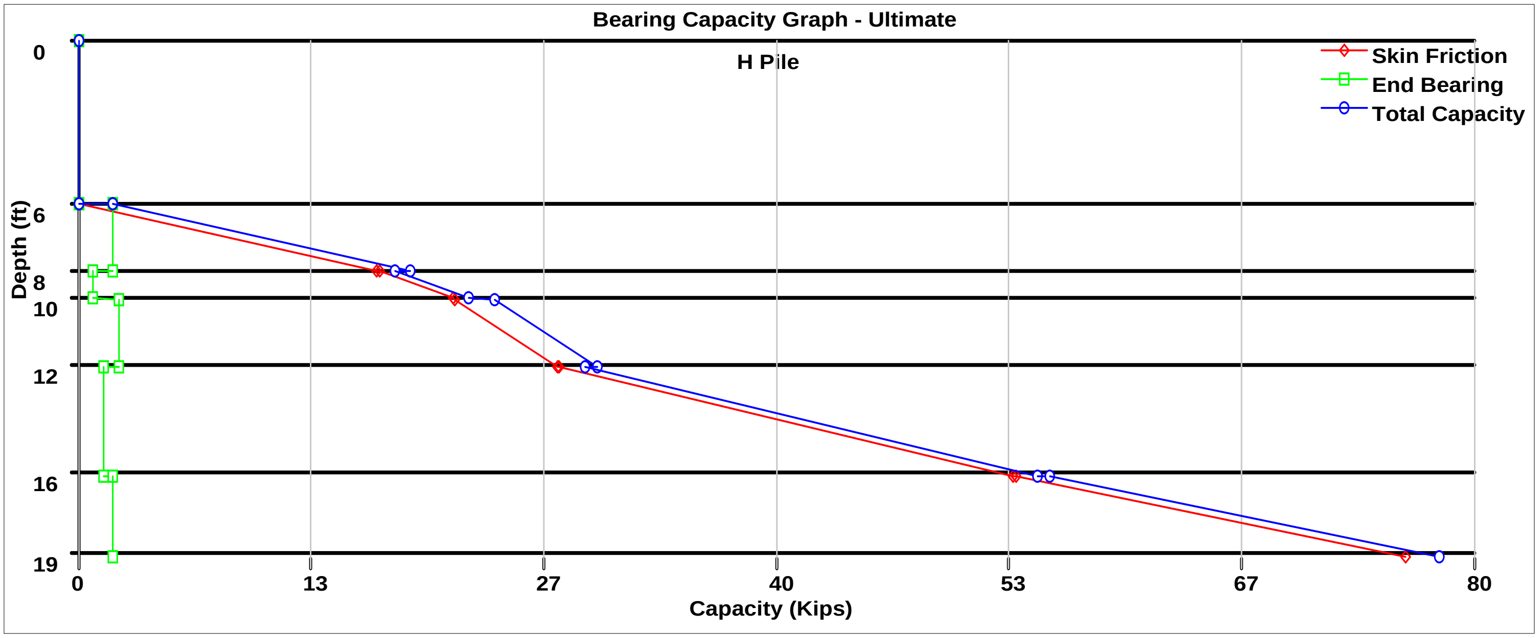
Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	6.00 ft	0.00%	120.00 pcf	2000.00 psf	T-79 Steel
2	Cohesive	2.50 ft	0.00%	125.00 pcf	2000.00 psf	T-79 Steel
3	Cohesive	1.00 ft	0.00%	120.00 pcf	900.00 psf	T-79 Steel
4	Cohesionless	2.50 ft	0.00%	120.00 pcf	31.1/31.1	Nordlund
5	Cohesive	4.00 ft	0.00%	125.00 pcf	1500.00 psf	T-79 Steel
6	Cohesive	3.00 ft	0.00%	130.00 pcf	2000.00 psf	T-79 Steel

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.00 ft	0.00 Kips	1.94 Kips	1.94 Kips
6.01 ft	0.07 Kips	1.94 Kips	2.01 Kips
8.49 ft	17.13 Kips	1.94 Kips	19.07 Kips
8.51 ft	17.24 Kips	0.87 Kips	18.12 Kips
9.49 ft	21.48 Kips	0.87 Kips	22.36 Kips
9.51 ft	21.55 Kips	2.32 Kips	23.87 Kips
11.99 ft	27.48 Kips	2.32 Kips	29.80 Kips
12.01 ft	27.57 Kips	1.45 Kips	29.02 Kips
15.99 ft	53.58 Kips	1.45 Kips	55.03 Kips
16.01 ft	53.72 Kips	1.94 Kips	55.66 Kips
18.99 ft	76.06 Kips	1.94 Kips	77.99 Kips


Bearing Capacity Graph - Restrike
H Pile
Boring B-049-3-14 - Pile HP 12X53
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
6
8
10
12
16
19
0
13
27
40
53
67
80
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
6
8
10
12
16
19
0
13
27
40
53
67
80
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
6
8
10
12
16
19
0
13
27
40
53
67
80
Capacity (Kips)

VI.D. Geotechnical Reports

C-R-S: HAN-75-14.39- HAN-75-1713	PID:87005	Reviewer:SS	Date:7/18/2016

General

Y N [✓ X] 1 Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?

[✓ Y] N X 2 Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?

[✓ Y] N X 3 Have all geotechnical reports being submitted been titled correctly as prescribed in Section 705.1 of the SGE?

Report Body

[✓ Y] N X 4 Do all geotechnical reports being submitted contain an Executive Summary as described in Section 705.2 of the SGE?

[✓ Y] N X 5 Do all geotechnical reports being submitted contain an Introduction as described in Section 705.3 of the SGE?

[✓ Y] N X 6 Do all geotechnical reports being submitted contain a section titled "Geology and Observations of the Project," as described in Section 705.4 of the SGE?

[✓ Y] N X 7 Do all geotechnical reports being submitted contain a section titled "Exploration," as described in Section 705.5 of the SGE?

[✓ Y] N X 8 Do all geotechnical reports being submitted contain a section titled "Findings," as described in Section 705.6 of the SGE?

[✓ Y] N X 9 Do all geotechnical reports being submitted contain a section titled "Analyses and Recommendations," as described in Section 705.7 of the SGE?

VI.D. Geotechnical Reports

Appendices		
[✓ Y] N X 10	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 705.8 of the SGE?	
[✓ Y] N X 11	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 705.8.1 of the SGE?	
[✓ Y] N X 12	Do the Appendices include boring logs as described in Section 705.8.2 of the SGE?	
[✓ Y] N X 13	Do the Appendices present reports of undisturbed test data as described in Section 705.8.3 of the SGE?	
[✓ Y] N X 14	Do the Appendices present calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	

Notes:

IV.A Foundations/Structures - Non-bridge Applications

C-R-S: HAN-75-14.39-HAN-75-1713	PID:87005	Reviewer:SS	Date:7/18/2016

If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

Soil and Bedrock Strength Data

[✓ Y] N X 1 Has the shear strength of the foundation soils been determined?

Check method used:

☐ laboratory shear tests

☑ estimation from SPT or field tests

[✓ Y] N X 2 Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?

[✓ Y] N X 3 Has the shear strength of the foundation bedrock been determined?

Check method used:

☐ laboratory shear tests

☑ other List Other items: Compression Test

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Spread Footings			
Y [✓ N]	4	Are there spread footings on the project?	
		If no, go to Question **11**	
Y N X	5	Has the recommended bottom of footing elevation and reason for this recommendation been provided?	
Y N X		a Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?	
	6	Were representative sections analyzed for the entire length of the structure for the following:	
Y N X		a bearing capacity?	
Y N X		b sliding?	
Y N X		c overturning?	
Y N X		d settlement?	
Y N X	7	Has the need for a shear key been evaluated?	
Y N X		a If needed, have the details been included in the plans?	
Y N X	8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?	
Y N X	9	Has the recommended allowable soil or rock bearing pressure been provided?	
Y N X	10	If weak soil is present at the proposed foundation level, has the removal / treatment of this soil been developed and included in the plans?	
Y N X		a Have the procedure and quantities related to this removal / treatment been included in the plans?	

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Pile Structures

[✓ Y] N	11	Are there piles on the project? If no, go to Question **17**	
[✓ Y] N	12	Has an appropriate pile type been selected? Check the type selected: ☑ H-pile (driven) ☑ H-pile (drilled) ☐ Cast In-place Concrete ☐ other List Other items:	
[✓ Y] N X	13	Have the estimated pile length or tip elevation and section (diameter) been specified? Check method used: ☑ SPILE, DRIVEN, or equivalent software ☐ hand calculations	
	14	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:	
Y [✓ N] X		a Lateral load capacity and maximum deflection of the piles?	Lateral Load Analysis will be performed by PB
[✓ Y] N X		b Vertical load capacity and maximum settlement of the piles?	
[✓ Y] N X		c Negative skin friction on piles driven through new embankment or soft foundation layers?	
Y N [✓ X]		d Potential for and impact of lateral squeeze from soft foundation soils?	
[✓ Y] N X	15	If piles are to be driven to bedrock, have “pile points” been recommended to assure secure contact with the rock surface, as per BDM 202.2.3.2.a?	
Y N [✓ X]	16	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	

Notes:

Stage 1:

IV.A Foundations/Structures - Non-bridge Applications

Drilled Shafts

Y [✓ N]	17	Are there drilled shafts on the project? If no, go to the next checklist.	
Y N X	18	Have the drilled shaft diameter and embedment length been specified?	
Y N X	19	Have the recommended drilled shaft diameter and embedment been developed based on side friction and end bearing for vertical loading situations?	
	20	For shafts undergoing lateral loading, have the following been determined:	
Y N X		a. maximum lateral shear	
Y N X		b. maximum bending moment	
Y N X		c. maximum deflection	
Y N X		d. reinforcement design	
Y N X	21	Generally, bedrock sockets are 6" smaller in diameter than the soil embedment section of the drilled shaft. Has this factor been accounted for in the drilled shaft design?	
Y N X	22	If a bedrock socket is required below soil embedment, have separate quantities been estimated based on shaft diameters and materials to be excavated?	
Y N X	23	Has the site been assessed for groundwater influence?	
Y N X		a If yes, if artesian flow is a potential concern, does the design address control of groundwater flow during construction?	
Y N X	24	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?	

Notes:

Stage 1

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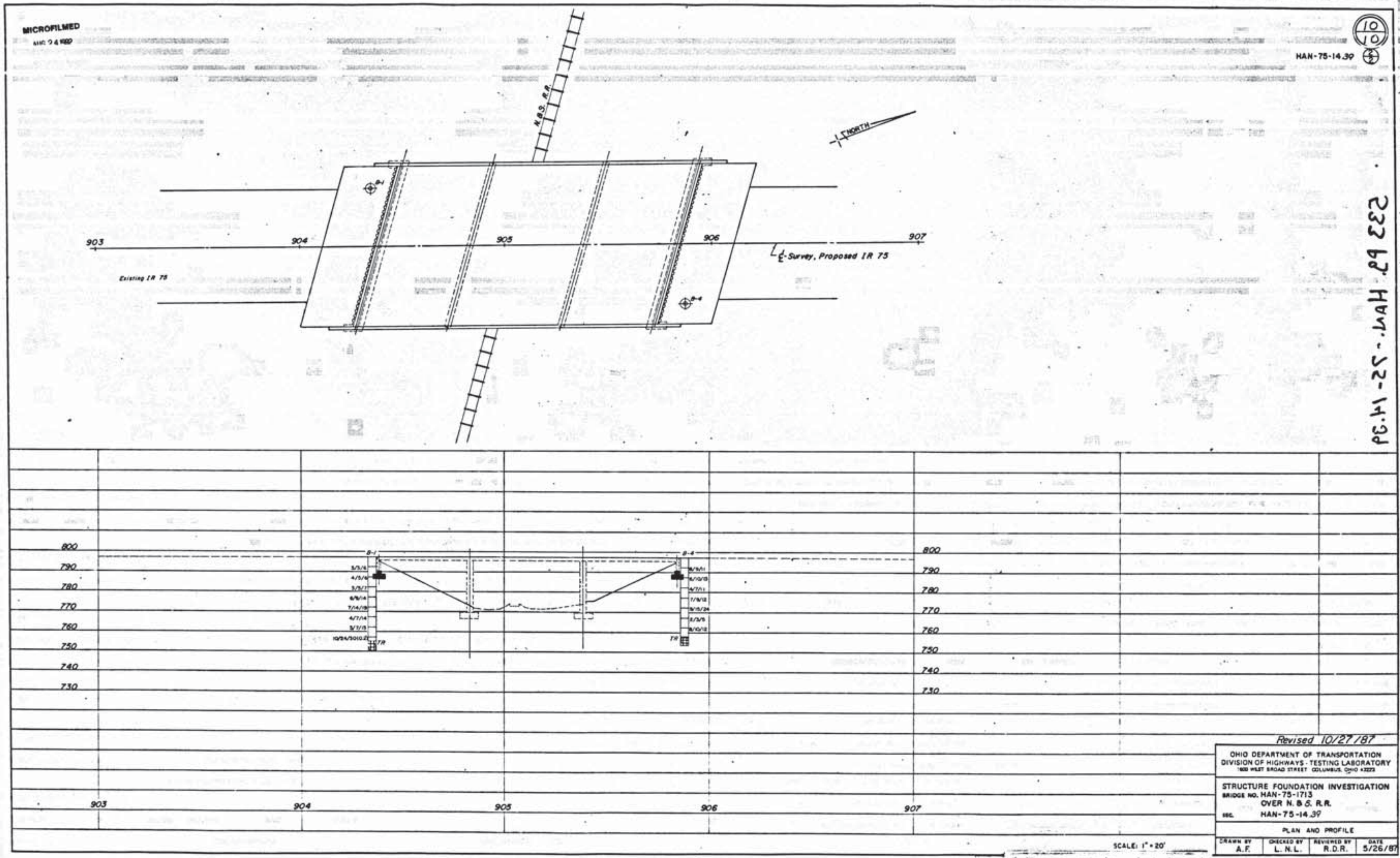
HAN-75-14.39

10/10



533 P9. HAN-75-14.39

SCALE: 1" = 20'

Revised 10/27/87

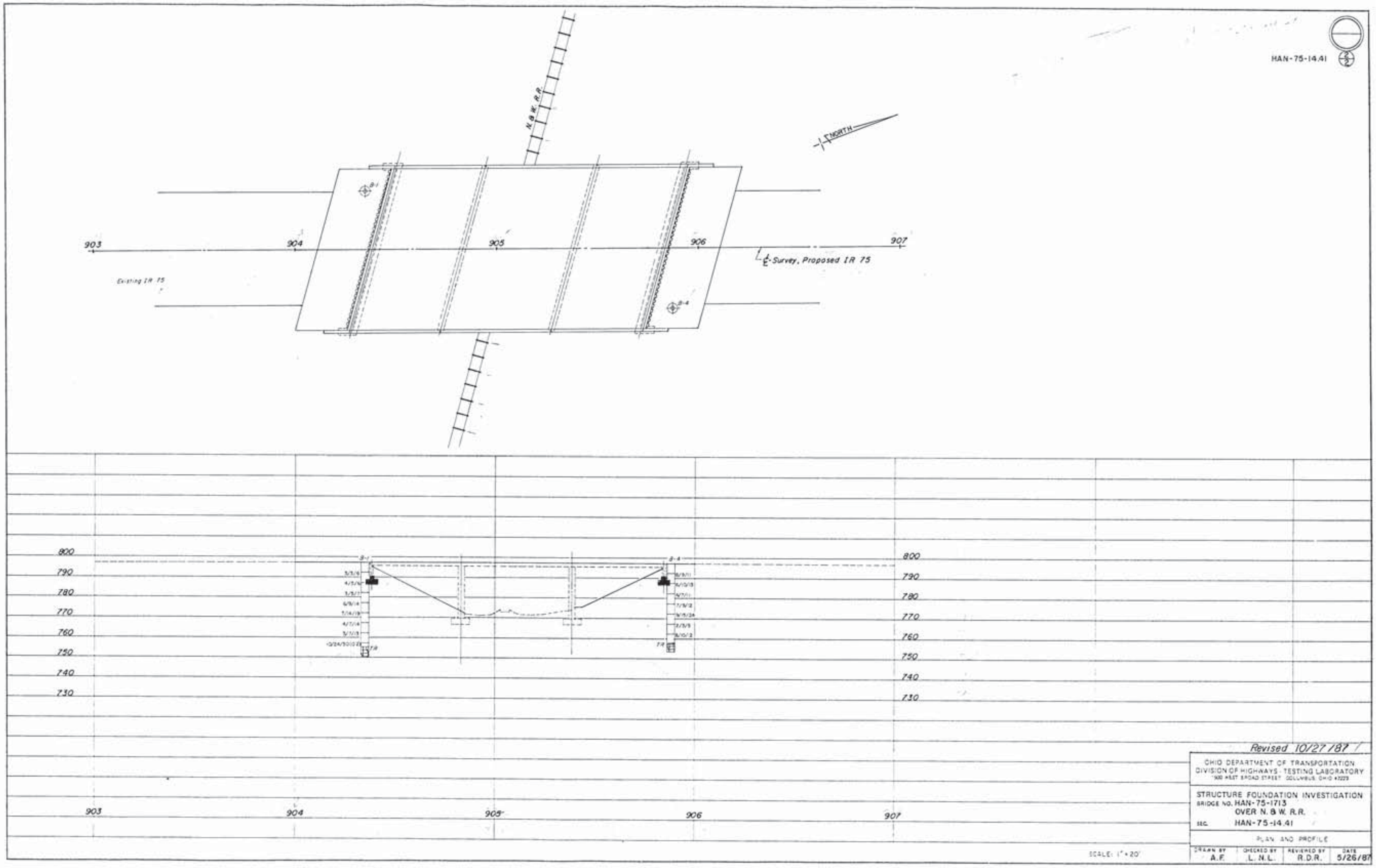
OHIO DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS - TESTING LABORATORY
1600 WEST BROAD STREET COLUMBUS, OHIO 43223

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. HAN-75-1713
OVER N. & S. R.R.
SEC. HAN-75-14.39

PLAN AND PROFILE

DRAWN BY	CHECKED BY	REVIEWED BY	DATE
A.F.	L.N.L.	R.D.R.	5/26/87

SFN 3203069



Revised 10/27/87

OHIO DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS - TESTING LABORATORY
1600 WEST BROAD STREET COLUMBUS, OHIO 43223

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. HAN-75-1713
OVER N. & W. R.R.
SEC. HAN-75-14.41

PLAN AND PROFILE

DRAWN BY	CHECKED BY	REVIEWED BY	DATE
A.F.	L. N. L.	R.D.R.	5/26/87

1/4

B-001-2-87 (B-1)

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 5/5/87 Sampler: Type SS Dia. 1 3/8" Water Elev.
Date Completed 5/5/87 Casing: Length Dia.

Project Identification: HANCOCK COUNTY
HAN-75-1713
OVER B. & O. RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-1 Station & Offset 904+35, 29' LT. (SOUTH ABUTMENT) Surface Elev. 797.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab Nos. So.	Physical Characteristics								SHTL Class
								% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	PI.	W.C.	VISUAL
797.4	0															
796.7		AUGERED			ASPHALT											
	2															
	4															
792.4	6	3/3/6			BROWN SANDY SILT	1	49633	7	3	38	20	32	21	3	17	A-4a
	8															
787.4	10															
	12	4/5/6			GRAY SANDY CLAY	2	49634	13	6	16	23	42	27	11	17	A-6a
	14															
782.4	16	3/5/7			BROWN SANDY CLAY	3	49635	14	5	13	25	43	31	14	16	A-6a
	18															
777.4	20															
	22	6/9/14			BROWN SANDY SILT	4	49636	11	6	16	22	45	28	2	16	A-4a
	24															
772.4	26	7/14/19			BROWN SANDY SILT	5	49637	9	5	35	22	29	18	5	14	A-4a
	28															
767.4	30															
	32	4/7/14			GRAY SANDY SILT	6	49638	10	4	12	18	56	27	7	16	A-4a
	34															
762.4	36	3/7/13			BROWN SILT	7	49639	0	2	5	58	35	25	5	20	A-4b

Form TE-153 Particle Sizes: Agg= >2.00mm, Coarse Sand=2.00-0.42mm, Fine Sand=0.42-0.074mm, Silt=0.074-0.005mm, Clay=< 0.005mm

B-001-2-87 (B-1)

Boring No. B-1 Station & Offset 904+35, 29' LT. Surface Elev. 797.4' Project: HAN-75-1713

Elev	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. Sa.	Physical Characteristics								SHTL Class
								% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	
	38															
757.4	40				TOP OF ROCK											
755.4	42	10/24/30 (02)			GRAY SANDY GRAVELLY SILT	8	49640	21	7	10	37	25	18	4	12	A-4a
	44		4.5	0.5	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, SLIGHTLY VUGGY, BROKEN AND JOINTED. CORE LOSS 10%.											
750.4	46															
	48				BOTTOM OF BORING											
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

3/4

B-004-2-87 (B-4)

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 4/29/87 Sampler: Type SS Dia. 1 3/8" Water Elev.
Date Completed 4/30/87 Casing: Length Dia.

Project Identification: HANCOCK COUNTY
HAN-75-1713
OVER B. & O. RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-4 Station & Offset 905+87, 30' RT. (NORTH ABUTMENT) Surface Elev. 797.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft	Loss ft	Description	Field No.	Lab Nos. So.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	PI.	W.C.	SHTL Class
797.4	0															
796.7		AUGERED			ASPHALT											VISUAL
	2															
	4															
792.4																
	6	8/9/11			BROWN SANDY CLAY	1	49542	6	6	16	28	44	28	11	15	A-6a
	8															
787.4	10															
	12	6/10/13			BROWN SANDY CLAY	2	49543	9	5	17	25	44	33	15	16	A-6a
	14															
782.4	16	4/7/11			BROWN SANDY CLAY	3	49544	3	5	15	28	49	34	16	19	A-6b
	18															
777.4	20															
	22	7/9/12			BROWN-GRAY SANDY CLAY	4	49545	13	5	16	25	41	31	13	20	A-6a
	24															
772.4																
	26	9/15/24			BROWN SANDY CLAY	5	49546	4	5	13	28	50	34	15	18	A-6a
	28															
767.4	30															
	32	2/3/5			BROWN SANDY SILT	6	49547	4	0	19	53	24	NP	NP	29	A-4b
	34															
762.4	36	8/10/12			GRAY SANDY SILT	7	49548	0	8	19	33	40	21	4	15	A-4a

Form TE-153 Particle Sizes: Agg= >2.00mm, Coarse Sand=2.00-0.42mm, Fine Sand=0.42-0.074mm, Silt=0.074-0.005mm, Clay=< 0.005mm

B-004-2-87 (B-4)

Boring No. B-4 Station & Offset 905+87, 30' RT. Surface Elev. 797.4' Project: HAN-75-1713

Elev	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. Sa.	Physical Characteristics								SHTL Class
								% Agg	% C.S	% F.S	% Silt	% Clay	L.L.	P.I.	W.C.	
	38				TOP OF ROCK											
757.9	40				BROKEN DOLOMETIC LIMESTONE		-	-	-	-	-	-	-	-	-	VISUAL
757.4	42		2.0	2.0	DOLOMETIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, EXTREMELY VUGGY AND VERY BADLY BROKEN AND JOINTED. CORE LOSS 50%.											
753.4	44				BOTTOM OF BORING											
	46															
	48															
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

LABORATORY TEST STANDARDS

STANDARDS	REFERENCE NUMBER
I. Soil/Rock Testing	
Description and Identification of Soils (Visual-Manual Procedures)	ASTM D 2488
Classification of Soils for Engineering Purposes (U.S.C.S.)	ASTM D 2487
Laboratory Determination of Water (Moisture) Content of Soil and Rock	ASTM D 2216
Classification for Sizes of Aggregate for Road and Bridge Construction	ASTM D 488
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318
Shrinkage Factors of Soils by Mercury Method	ASTM D 427
Moisture, Ash, and Organic Matter of Peat and Other Organic Soils	ASTM D 2974
Specific gravity of Soils	ASTM D 854
Direct Shear Test of Soils under Consolidated Drained Conditions	ASTM D 3080
Particle-Size Analysis of Soils	ASTM D 422
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
Unconfined Compressive Strength of Intact Rock Core Specimens	ASTM D 2938
Slake Durability Index of Shale/Similar Weak Rock Test	ASTM D 4644
Point Load Test of Rock Core Specimens	ISRM*/ASTM D5731
CBR (California Bearing Ration) of Laboratory-Compacted Soils	ASTM D 1883
Laboratory Compaction Characteristics of Soil using Standard Effort	ASTM D 698
Laboratory Compaction Characteristics of Soil using Modified Effort	ASTM D 1557
One-Dimensional Consolidation Properties of Soils	ASTM D 2435
One-Dimensional Swell or Settlement Potential of Cohesive Soils	ASTM D 4546
pH of Soil	ASTM D 4972

* ISRM - International Society for Rock Mechanics

II. Concrete Testing

Compressive Strength of Cylindrical Concrete Specimens	ASTM C 39
Acid-Soluble Chloride in Mortar and Concrete	ASTM C 1152

CLASSIFICATION OF SOILS

Ohio Department of Transportation

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

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

MATERIAL CLASSIFIED BY VISUAL INSPECTION

▧ Sod and Topsoil

▩ Pavement or Base

∧ Uncontrolled Fill (Describe)

▪ Bouldery Zone

● Peat, S-Sedimentary W-Woody F-Fibrous L-Loamy & etc

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

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

1) STRENGTH OF SOIL:

Non-Cohesive (granular) Soils - Compactness

Description	Blows Per Ft.
Very Loose	≤ 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

2) COLOR :

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

3) PRIMARY COMPONENT

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

Cohesive (fine grained) Soils - Consistency

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

4) COMPONENT MODIFIERS:

Description	Percentage By Weight
Trace	0% - 10%
Little	10% - 20%
Some	20% - 35%
“And”	35% -50%

5) Soil Organic Content

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

6) Relative Visual Moisture

Description	Criteria	
	Cohesive Soil	**Non-cohesive Soils**
Dry	Powdery; Cannot be rolled; Water content well below the plastic limit	No moisture present
Damp	Leaves very little moisture when pressed between fingers; Crumbles at or before rolled to $^{1}/_{8}$”; Water content below plastic limit	Internal moisture, but no to little surface moisture
Moist	Leaves small amounts of moisture when pressed between fingers; Rolled to $^{1}/_{8}$” or smaller before crumbling; Water content above plastic limit to -3% of the liquid limit	Free water on surface, moist (shiny) appearance
Wet	Very mushy; Rolled multiple times to $^{1}/_{8}$” or smaller before crumbles; Near or above the liquid limit	Voids filled with free water, can be poured from split spoon.

SOIL AND ROCK SYMBOLOGY

Ohio Department of Transportation

SOIL

SYMBOL	DESCRIPTION	Classifcation	
		AASHTO	OHIO
○	Gravel and/or Stone Fragments	A-1-a	
⁘	Gravel and/or Stone Fragments with Sand	A-1-b	
F S	Fine Sand	A-3	
●	Coarse and Fine Sand	--	A-3a
▥	Gravel and/or Stone Fragments with Sand and Silt	A-2-4 A-2-5	
▤	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6 A-2-7	
▥	Sandy Silt	A-4	A-4a
+	Silt	A-4	A-4b
▤	Elastic Silt and Clay	A-5	
▨	Silt and Clay	A-6	A-6a
▤	Silty Clay	A-6	A-6b
▥	Elastic Clay	A-7-5	
▦	Clay	A-7-6	
+	Organic Silt	A-8	A-8a
▦	Organic Clay	A-8	A-8b

VISUALLY CLASSIFIED MATERIALS

⌃	Uncontrolled Fill (Describe)	▧	Sod and Topsoil
		▩	Pavement or Base
■	Bouldery Zone	P	Peat

ROCK

▩	Anhydrite	▤	Limestone
⁘	Breccia	▨	Mudstone
▩	Chert	⁘	Sandstone
▨	Claystone	▤	Shale
C	Coal	▤	Siltstone
⁘	Conglomerate	▦	Underclay
▤	Dolomite		
▦	Fireclay		
▩	Flint		
▩	Gypsum		
▩	Halite		
▤	Interbedded Shale and Limestone		
▩	Ironstone		

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

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

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

3) WEATHERING

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

5) TEXTURE

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

4) RELATIVE STRENGTH

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

6) BEDDING

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

7) DESCRIPTORS

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

8) DISCONTINUITIES

a) Discontinuity Types

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

b) Degree of Fracturing

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

c) Aperture Width

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

d) Surface Roughness

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

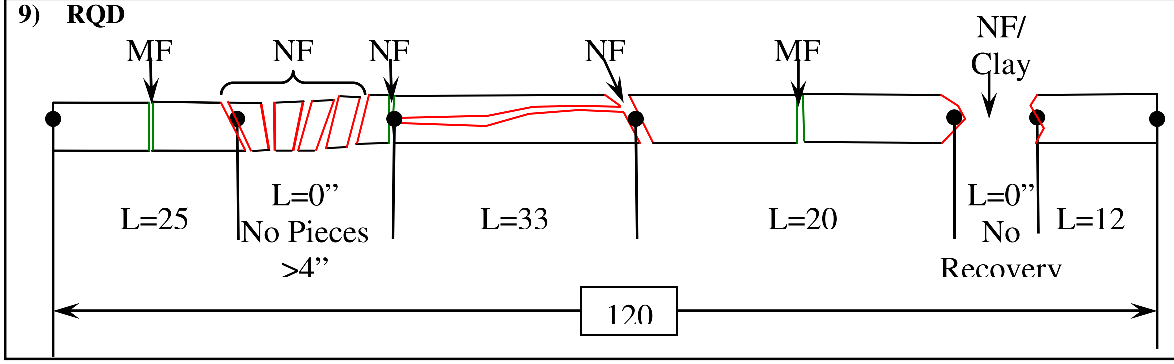
10) LOSS

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

L_R=Run Length R_R=Run Recovery

L_U=Rock Unit Length R_U=Rock Unit Recovery

9) RQD



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

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

References

Publications – ODOT (www.dot.state.oh.us/drrc/)

CADD Engineering Standards Manual, Office of Production

Construction and Material Specifications, Office of Construction Administration

Pavement Design & Rehabilitation Manual, Morse, Miller, et al., Office of Pavement Engineering

Specifications for Geotechnical Explorations, Office of Geotechnical Engineering

Geotechnical Bulletins – ODOT

GB1 Plan Subgrades

Bridge Design Manual 2007

AASHTO, (2014), AASHTO LRFD Bridge Design Specifications, Seventh Edition, 2014,
AASHTO, Washington, D.C.

Publications – ODNR (www.dnr.state.oh.us/)

Bedrock Geology Map, DGS
Bedrock Structure Map, DGS
Bedrock Topography Map, DGS
Geologic Map of Ohio, DGS
Known and Probable Karst in Ohio, DGS
Ohio Wetland Inventory Map (DSWC)
National Wetland Inventory Mao (DSWC)
Quaternary Geology of Ohio, DGS
Soil Survey, DSWC
USGS Open File Map Series #78-1057 Landslides and Related Features, DGS

Other publications or information available from ODNR: bulletins, boring logs, measured geologic regions(s), information circulars, water well logs, report of investigations