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April 6, 2015

Mr. Naiel Hussein, P.E.
Parsons Brinckerhoff
2545 Farmers Drive, Suite 350
Columbus, Ohio 43235

Reference: **Final Structure Foundation Exploration Report for HAN-75-14.39**
Bridge No. HAN-75-1540 L&R over Norfolk Southern Railroad
Findlay, Hancock County, Ohio
PID No. 87005
PGI Project No. G13011G

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 January 16, 2013. 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/4/6/2015

FINAL
STRUCTURE FOUNDATION EXPLORATION REPORT
FOR HAN-75-14.39
BRIDGE NO. HAN-75-1540 L&R OVER NORFOLK SOUTHERN RR

HANCOCK COUNTY, OHIO
PGI PROJECT NO. G13011G
PID NO. 87005

PREPARED FOR:

PARSONS BRINCKERHOFF

PREPARED BY:

PRO GEOTECH, INC.

APRIL 6, 2015

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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-75-1540 Left & Right over Norfolk Southern Railroad in Findlay, Hancock County, Ohio. Three (3) historic test borings identified as B-1 (B-001-0-87), B-2 (B-002-0-87), and B-4 (B-004-0-87) were obtained from the subsurface geotechnical exploration completed on April 1987. A total of six (6) project test borings identified as B-021-1-13, B-021-2-13, B-022-1-13, B-023-0-13, B-024-0-13, and B-025-0-13 were advanced for bridge and MSE wall foundations design purposes. However, the bridge design configuration was changed from a single span to three (3) spans and the construction of the MSE Wall at the rear and forward abutment locations was eliminated after drilling operations were completed. These project test borings were advanced to approximate depths ranging from 17.5 to 36.5 feet below the existing ground surface. Project test borings B-021-1-13 and B-021-2-13 and historic test boring B-001-0-87 are located in the vicinity of the proposed rear abutment, project test boring B-022-1-13 and historic test boring B-002-0-87 are located in the vicinity of the proposed Pier 1, project test borings B-023-0-13, B-024-0-13, and B-025-0-13 are located in the vicinity of the proposed Pier 2, and historic test boring B-003-0-87 is located in the vicinity of the proposed forward abutment..

Findings: The subsurface soil conditions in the vicinity of this proposed bridge were determined from the soil information obtained from project test borings B-021-1-13, B-021-2-13, B-022-1-13, B-023-0-13, B-024-0-13, and B-025-0-13 and historic test borings B-001-0-87, B-002-0-87 and B-004-0-87.

The subsurface soils encountered in the project test borings consisted of both fill materials and natural soils. Fill materials were encountered in all of the project test borings and consisted of gravel and stone fragments (A-1-a), stone fragments with sand and silt (A-2-4), non-plastic sandy silt (A-4a), silt and clay (A-6a), silty clay (A-6b), and clay (A-7-6). Fill materials encountered to approximate depths ranging from 3.5 feet in test borings B-021-1-13, B-022-1-13, B-023-0-13, and B-025-0-13 to 15.5 feet in test boring B-021-2-10 and averaging 5.9 feet in thickness. Natural soils encountered below the fill material consisted of both cohesive and non-cohesive/granular soils in all of the test borings. Natural soils encountered above bedrock consisted of coarse and fine sand (A-3a), both plastic and non-plastic sandy silt (A-4a), silt (A-4b), silt and clay (A-6a), silty clay (A-6b), and clay (A-7-6). Bedrock consisting of gray dolomite was encountered in all of the structural test borings at depths ranging from 10.0 feet in B-023-0-13 to 26.0 feet in B-021-2-13 and at an average depth of 14.5 feet. The consistency of these cohesive soils ranged from "medium stiff" to "very stiff", but was predominately “stiff” and the relative densities of these non-cohesive soils ranged from "loose” to “dense".

The subsurface soils encountered in historic test borings B-001-0-87, B-002-0-87 and B-004-0-87 were generally cohesive soils, but non-cohesive soils were also encountered above bedrock in test borings B-001-0-87 and B-002-0-87. The cohesive soils encountered consisted of silt and clay (A-6a), sandy silt (A-4a), and silty clay (A-6b), and the non-cohesive soils encountered consisted of non-plastic sandy silt (A-4a). Bedrock was encountered in historic boring B-001-0-87 at an approximate depth of 39.5 feet below the asphalt pavement while bedrock was encountered in historic boring B-004-0-87 at an approximate depth of 38.5 feet below the asphalt pavement. Bedrock was encountered in project test boring B-002-0-87 at an approximate depth of 12.5 feet below the ground surface. The consistency ranged from "medium stiff" to "hard", but was predominately “very stiff” and the relative density ranged from “loose” to “dense”.

Bedrock was encountered in all of the test borings. The core samples consisted of dolomite of the Tymochtee/Greenfield Group. The dolomite was gray to light gray, highly to slightly weathered, and strong to very strong. Bedding within the dolomite was generally very thin to thin and was highly to moderately fractured with few angular fractures. No slickensides were observed and the fractures were typically tight and slightly rough. The compressive strength of the core specimens ranged from 14,244 psi in test boring B-021-1-13 to 24,649 psi in test boring B-025-0-13 which characterizes them as “strong” to “very strong”, respectively. The Rock Quality Designation (RQD) for the core samples ranged from 18% to 60% and averaged 41% based on individual runs in the project test borings. The Rock Mass Rating obtained for the bedrock core samples according to LRFD Table 10.4.6.4-1 varied from 42 to 49 and are classified as “Fair Rock” for the project test borings.

Recommendations: Site plans provided by PB personnel indicates that the proposed superstructure design loads will be transferred to the underlying bedrock by means of piles at the rear and forward abutment locations and by means of drilled piers at the proposed Pier 1 and Pier 2 locations. Since the top of bedrock at the abutment locations was encountered at approximate depths ranging from 38.5 feet to 39.5 feet below the existing pavement, the proposed superstructure loads may be transferred to the underlying bedrock by means of end bearing piles at the abutment locations. Since the top of bedrock at the pier locations was encountered at approximate depths ranging from 10.0 feet to 13.5 feet below the existing ground surface, the proposed superstructure loads may be transferred to the underlying bedrock by means of drilled shafts at the pier locations.

Design information provided by PB personnel indicates that the maximum compression factored loads along a vertical axial direction at the Strength and Service Limit will be 1113 kips per shaft and 858 kips, respectively and lateral loads will control the drilled shaft design at Pier 1 and Pier 2 locations. Based on the rock mass rating, laboratory compressive strength test results and our local experience with similar projects, unit side resistance of 10.0 ksf and unit tip resistance of 5120 ksf were estimated for the bedrock at project test borings B-022-1-13, B-023-0-13, B-024-0-13, B-025-0-13 and historic test boring B-002-0-87. Table 6.1.1 summarizes total factored resistance for the selected diameters and socket length at the abutment and pier boring locations. Side resistance from the soil overburden and upper two (2) feet of the shallow bedrock can be ignored. Based on the factored axial compression resistance for the selected shaft socket length and diameter, the estimated maximum total settlement and differential settlement will not exceed one inch and one half inch, respectively.

Table 6.1.1 – Estimated Design Parameters for Drilled Shafts

Boring No.	Top of Bedrock Elevation (feet)	Shaft Tip Elevation (feet)	Socket Diameter (feet)	Socket Length (feet)	Total Factored Resistance (kips)
Pier 1					
B-022-1-13	766.8±	762.3	3.0	4.50	18,000
B-002-0-87	767.2±	762.7	3.0	4.50	18,000
Pier 2					
B-023-0-13	768.8±	764.3	3.0	4.50	18,000
B-024-0-13	768.0±	763.5	3.0	4.50	18,000
B-025-0-13	766.8±	762.3	3.0	4.50	18,000

The drilled shaft supported piers may experience horizontal movement caused by lateral loads and overturning moments. Table 6.1.3 summarizes the weak rock parameters to perform lateral load analyses by PB personnel.

Table 6.1.3 - Estimated Weak Rock Parameters for Lateral Load Analyses

Boring No.	Top Bedrock Elevation(ft)	Effective Unit Weight (pci)	Youngs's Modulus (psi)	Compressive Strength (psi)	RQD (%)	K_rm
Piers						
B-022-1-13	766.8±	0.059	200000	14224	48	0.00005
B-002-0-87	767.2±	0.059	200000	14224	NA	0.00005
B-023-0-13	768.8±	0.059	200000	14224	37	0.00005
B-024-0-13	768.0±	0.059	200000	14224	36	0.00005
B-025-0-13	766.8±	0.059	200000	14224	22	0.00005

Design information provided by PB personnel indicates that the maximum factored loads along a vertical direction will be 288 kips and 306 kips per pile at the rear abutment and forward abutment, respectively for the left bridge and 306 kips and 305 kips per pile at the rear abutment and forward abutment, respectively for the right bridge. The end bearing piles must be steel H-piles driven to refusal on the underlying dolomite bedrock. H-pile sizes HP-10X42 or HP-12X53 may be selected for the rear and forward abutment locations. The estimated pile parameters for end bearing piles at each boring location are summarized in Table 6.1.4. The pile cut-off elevations at the abutments were extracted from the final structure site plan provided by PB personnel.

Table 6.1.4 - 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-001-0-87	798.6	767.5	35.0	H-Pile	10X42	310 kips
B-001-0-87	798.6	767.5	35.0	H-Pile	12X53	380 kips
B-004-0-87	797.9	768.4	30.0	H-Pile	10X42	310 kips
B-004-0-87	797.9	768.4	30.0	H-Pile	12X53	380 kips

Consolidation of the foundation soils above the bedrock caused by construction of the proposed embankment will be on the order of 1.0 to 1.5 inches at the rear and forward abutment locations. Therefore negative skin friction will develop along the pile section between the top of the proposed embankment and the top of bedrock due to the 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 178 kips per pile and 218 kips per pile may be assumed for pile sizes HP-10X42 and HP-12X53, respectively at the B-001-0-87 boring location and 140 kips per pile and 171 kips per pile may be assumed for pile sizes HP-10X42 and HP-12X53, respectively at the B-004-0-87 boring location. These down drag loads were calculated using Total Stress Method (α Method). 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.

It is assumed that the proposed approach slab pavement will be constructed on the fill subgrade soils with the similar character encountered in project and historic test borings. It is anticipated that on-site sandy silt (A-4a), silt and clay (A-6a), clay (A-7-6), and silty clay (A-6b) fill soils will be encountered within the project limits based on the project and historic boring logs. The pavement design parameter information is summarized in Table 6.3.1.

Table 6.3.1 – Summary of Approach Slab Design Parameters

Parameter	Fill Soils
Group Index (Avg.)	8.38
CBR	7
Soil Support Value (SSV)	4.8
Resilient Modulus (psi)	8,400
Modulus of Subgrade Reaction (K, pci)	160

2.0 INTRODUCTION

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-75-1540 Left & Right over Norfolk Southern 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-75-1540 Left & Right which carry IR-75 vehicular traffic over Norfolk Southern Railroad. The design information provided by PB personnel indicates that the proposed bridge was originally to be designed as a single span with an approximate total length of 173 feet. As originally proposed a Mechanically Stabilized Earth (MSE) Wall System was to be used to retain the abutment fill at both rear and forward abutments. However, the proposed bridge configuration was changed after completing the field exploration for this bridge and the number of spans was changed to three (3) with an approximate total length of 266 feet. The Mechanically Stabilized Earth (MSE) Wall System will be replaced with semi-integral abutments and spill-through slopes. The proposed superstructures will be continuous wide flanged pre-stressed concrete I-beams with reinforced concrete deck on abutments and piers. The sub-structure units will be supported on reinforced concrete spill-through abutments on capped piles and cap and column piers on drilled shafts. The bridge is to be designed based on HL-93 loading criteria with future wearing surface of 0.060 kips per foot and the ODOT Bridge Design Manual, issued in 2007 which includes LRFD Bridge Design Specifications. 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.

2.2 Scope of Services

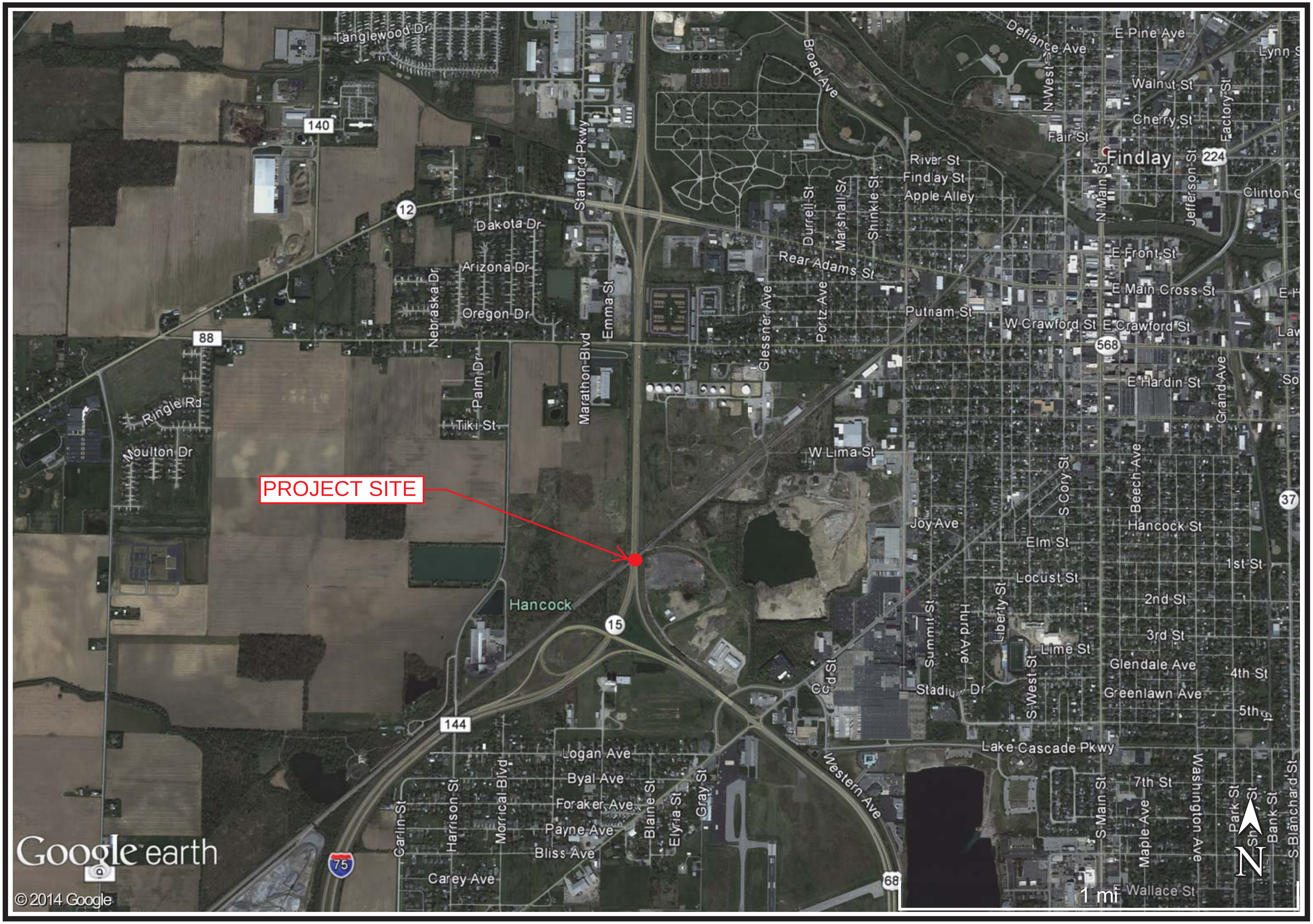
The scope of services for this project was in accordance with Pro Geotech, Inc. (PGI) Proposal No. PG12067 dated January 16, 2013 and governed by ODOT's *Specifications for Geotechnical Explorations* dated January 2007 and updated January 20, 2012 and ODOT's Bridge Design Manual, issued 2007 and AASHTO LRFD Bridge Design Specifications, 6th 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 seven (7) test borings in the vicinity of existing Bridge No. HAN-75-1540 Left & Right over Norfolk Southern Railroad for structural foundation design purposes. These structural test borings for the bridge were advanced to approximate depths ranging from 20.0 feet to 50.0 feet below the existing ground or bridge deck surface, and included obtaining 5 to 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.



PROJECT: HAN-75-14.39
BRIDGE NO. HAN-75-1540 OVER NORFOLK SOUTHERN RAILROAD
SITE LOCATION MAP (FIGURE 2.1)

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 bridge 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 775 feet to 810 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) ranging from 5 feet to 100 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 site 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 occurs 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 the 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 a magnitude of 2.3 Richter Scale and another in 2011 with a 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 July and August 2013. The project site is located in an area surrounded by farms with the closest building located approximately 850 feet from the bridge site. The existing left and right structures are three-span continuous steel beam concrete decks on abutments and piers. The total span length of each bridge is approximately 265 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. The concrete pier columns generally appeared to be in fair condition with the some exposed rebars locations on the piers north of railroad track. Longitudinal and traverse cracks with areas of spalling concrete, very light in frequency were observed on the exposed abutment surfaces. Surface cracks, very light in frequency, were visible along the bottom of the concrete deck surface. Spalling of the concrete, very light to light in frequency was observed on the underside of the concrete deck surface. Efflorescence, very light in frequency, was observed along the bottom of the concrete deck surface. Asphalt overlay placed on the top deck concrete surface.

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 three (3) boring logs from the subsurface geotechnical exploration completed on April 1987 identified as B-1 (B-001-0-87), B-2 (B-002-0-87) and B-4 (B-004-0-87). 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 July and August 2013. A total of six (6) project test borings identified as B-021-1-13, B-021-2-13, B-022-1-13, B-023-0-13, B-024-0-13, and B-025-0-13 were advanced for bridge and MSE wall foundations design purposes. However, the bridge design configuration was changed from a single span to three (3) spans and the construction of the MSE Wall at the rear and forward abutment locations was eliminated after drilling operations were completed. After the reconfiguration of the bridge, project test borings B-021-1-13 and B-021-2-13 and historic test boring B-001-0-87 are located in the vicinity of the proposed rear abutment, project test boring B-022-1-13 and historic test boring B-002-0-87 are located in the vicinity of the proposed Pier 1, project test borings B-023-0-13, B-024-0-13, and B-025-0-13 are located in the vicinity of the proposed Pier 2, and historic test boring B-003-0-87 is located in the vicinity of the proposed forward abutment. These project test borings were advanced to approximate depths ranging from 17.5 to 36.5 feet below the existing ground surface. Project test boring B-022-0-13 was not drilled between the rear abutment and Pier 1 due to unsafe area where IR 75 NB and Ramp US 68 NB to IR 75 NB traffic merge.

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 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 Diedrich D 90 ATV-mounted drilling rig was used to advance the test borings. All 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, all test borings were advanced and the rock was sampled using a type NX series core barrel, water method. All test borings were monitored for the presence of groundwater during drilling operations and upon completion. All test borings were backfilled with soil cuttings or bentonite/soil cutting mix upon completion of drilling operations for safety purposes. Test boring B-021-2-13 which was advanced through the IR 75 bridge deck was patched with Set 45 non-shrink concrete.

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 and soil samples for the purpose of soil classification and for analysis of engineering characteristics. These tests consisted of Particle-Size Analysis, Liquid and Plastic Limit, Plasticity Index Determination of Soils, and 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 and rock 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 bridge were determined from the soil information obtained from project test borings B-021-1-13, B-021-2-13, B-022-1-13, B-023-0-13, B-024-0-13, and B-025-0-13 and historic test borings B-001-0-87, B-002-0-87 and B-004-0-87. Project test boring B-021-2-13 was advanced through the IR 75 bridge deck and consisted of 3.25 inches of asphalt over an 8.5 inch concrete slab. Project test borings B-021-1-13, B-023-0-13, B-024-0-13, and B-025-0-13 were advanced through topsoil ranging in thickness from 3.0 to 12.0 inches and averaging 8.75 inches thick. Project test boring B-022-1-13 was located along the abutment embankment and was advanced through 18.0 inches of coarse stone fragments and slag. Due to thick brush and brick and cobble debris a dozer was used to clear the vicinity of project test boring B-023-0-13 location where thickness of topsoil was estimated to be 8.0 inches. The subsurface soils encountered in the project test borings consisted of both fill materials and natural soils. Fill materials were encountered in all of the project test borings and consisted of gravel and stone fragments (A-1-a), stone fragments with sand and silt (A-2-4), non-plastic sandy silt (A-4a), silt and clay (A-6a), silty clay (A-6b), and clay (A-7-6). Fill materials encountered to approximate depths ranging from 3.5 feet in test borings B-021-1-13, B-022-1-13, B-023-0-13, and B-025-0-13 to 15.5 feet in test boring B-021-2-10 and averaging 5.9 feet in thickness. Natural soils encountered below the fill material consisted of both cohesive and non-cohesive/granular soils in all of the test borings. Natural soils encountered above bedrock consisted of coarse and fine sand (A-3a), both plastic and non-plastic sandy silt (A-4a), silt (A-4b), silt and clay (A-6a), silty clay (A-6b), and clay (A-7-6). Bedrock consisting of gray dolomite was encountered in all of the structural test borings at depths ranging from 10.0 feet in B-023-0-13 to 26.0 feet in B-021-2-13 and at an average depth of 14.5 feet.

The laboratory test results indicated that the moisture contents of the tested cohesive soil samples obtained from the structure test borings ranged from 10% to 27% and the consistency of these cohesive soils ranged from "medium stiff" to "very stiff", but was predominately "stiff". The laboratory test results indicated that the moisture contents of the tested non-cohesive soils ranged from 9% to 24% and the relative densities of these non-cohesive soils ranged from "loose" to "dense". Of the six (6) cohesive soil samples that were tested for Atterberg limits, four (4) had natural moisture contents greater than or equal to their plastic limits.

The subsurface soils encountered in historic test borings B-001-0-87, B-002-0-87 and B-004-0-87 were generally cohesive soils, but non-cohesive soils were also encountered above bedrock in test borings B-001-0-87 and B-002-0-87. The cohesive soils encountered consisted of silt and clay (A-6a), sandy silt (A-4a), and silty clay (A-6b), and the non-cohesive soils encountered consisted of non-plastic sandy silt (A-4a). Bedrock was encountered in historic boring B-001-0-87 at an approximate depth of 39.5 feet below the asphalt pavement while bedrock was encountered in historic boring B-004-0-87 at an approximate depth of 38.5 feet below the asphalt pavement. Bedrock was encountered in project test boring B-002-0-87 at an approximate depth of 12.5 feet below the ground surface. The laboratory test results indicated that the moisture contents of the tested cohesive soil samples obtained from the historic test borings ranged from 13% to 23% and the consistency ranged from "medium stiff" to "hard", but was predominately "very stiff". The moisture contents of the tested non-cohesive soils ranged from 17% to 24% and the relative density ranged from "loose" to "dense".

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 in all of the test borings and 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 to light gray, highly to slightly weathered, and strong to very strong. Bedding within the dolomite was generally very thin to thin and was highly to moderately fractured with few angular fractures. No slickensides were observed and the fractures were typically tight and slightly rough. The compressive strength of the core specimens ranged from 14,244 psi in test boring B-021-1-13 to 24,649 psi in test boring B-025-0-13 which characterizes them as "strong" to "very strong", respectively.

The Rock Quality Designation (RQD) for the core samples ranged from 18% to 60% and averaged 41% based on individual runs in the project test borings. The results of these measurements are summarized in Table 5.2.1 for project and historic test borings. Table 5.2.2 summarizes the results of compressive strength tests performed at the laboratory on the rock core specimens at various depths for the project test borings. The Rock Mass Rating obtained for the bedrock core samples according to LRFD Table 10.4.6.4-1 varied from 42 to 49 and are classified as "Fair Rock" for the project test borings. The Rock Mass Rating spreadsheets are 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-021-1-13	Run-1	767.1	766.6	3.1	100	51
B-021-1-13	Run-2		763.5	1.9	100	48
B-021-2-13	Run-1	765.5	765.0	10.0	100	60
B-022-1-13	Run-1	766.8	765.6	5.0	100	48
B-023-0-13	Run-1	768.8	767.3	10.0	96	37
B-024-0-13	Run-1	768.0	767.0	9.5	100	33
B-024-0-13	Run-2		757.5	2.5	100	23
B-024-0-13	Run-3		755.0	2.5	100	60
B-025-0-13	Run-1	766.8	766.3	3.3	100	18
B-025-0-13	Run-2		763.0	1.7	80	30
B-001-0-87	Run-1	768.1	767.5	5.0	84	NA
B-002-0-87	Run-1	767.2	764.7	2.5	100	NA
B-002-0-87	Run-2		759.7	5.0	100	NA
B-002-0-87	Run-3		754.7	5.0	100	NA
B-004-0-87	Run-1	768.9	768.4	4.0	98	NA

Elevations were provided by PB personnel for project test borings, NA – Not Available

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-021-1-13	14.7	Dolomite	167.77	14,244
B-021-2-13	32.9	Dolomite	173.57	17,412
B-022-1-13	15.7	Dolomite	176.73	17,946
B-023-0-13	17.0	Dolomite	170.48	21,643
B-024-0-13	21.0	Dolomite	167.47	22,223
B-025-0-13	15.8	Dolomite	163.76	24,649

5.3 Groundwater Conditions

Groundwater levels were measured at the project test boring locations during drilling operations. Groundwater levels were not recorded upon completion of drilling operations due to water used for rock coring. Table 5.3.1 summarizes the groundwater measurements in the test boring locations where groundwater was encountered. Note that trapped water was observed flowing through stone in the upper layer (draining from the embankment) into the borehole of test boring B-024-0-13. It should be noted that groundwater elevations are subject to seasonal fluctuations. All test borings were backfilled immediately upon completion for safety purposes.

Table 5.3.1 – Groundwater Information

Boring Number	Surface Elevation (ft.)	Groundwater Depth (ft.)		Groundwater Elevation (ft.)	
		D.D.	U.C.	D.D.	U.C.
B-021-1-13	779.1	6.0	NR	773.1	NR
B-021-2-13	791.5	16.5	NR	775.0	NR
B-022-1-13	779.1	12.0	NR	767.1	NR
B-023-0-13	778.8	DRY	NR	DRY	NR
B-024-0-13	782.0	3.5*	NR	778.5	NR
B-025-0-13	779.3	11.0	NR	768.3	NR

Elevations were provided by PB personnel D.D. – During Drilling, U.C. – Upon Completion of drilling prior to rock coring operations.
* Runoff water was observed flowing into borehole, NR – No Reading taken

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 the design and construction of IR 75 Mainline Bridge No. HAN-75-1540 L&R over Norfolk Southern Railroad. Site plans provided by PB personnel indicates that the proposed superstructure design loads will be transferred to the underlying bedrock by means of piles at the rear and forward abutment locations and by means of drilled piers at the proposed Pier 1 and Pier 2 locations. Elevations of the bottom of the proposed pile caps at the rear and forward abutment locations will be 797.61 and 796.85 feet, respectively. Additional embankment fill with a maximum height of 8.4 feet at the rear abutment and 4.3 feet at the forward abutment will be placed on top of existing IR 75 embankment to raise the existing grade to the proposed profile grade due to vertical realignment of IR 75. Also additional embankment fill with the approximate thickness of 30 feet will be constructed on both left and right of IR-75 baseline in the vicinity of abutments. The foundation recommendations are provided in accordance with the ODOT *Bridge Design Manual* issued in 2007 using *LRFD Bridge Design Specifications.*

6.1 Bridge Foundation Systems

Soil and rock information obtained from proposed project test borings B-021-1-13, B-021-2-13, B-022-1-13, B-023-0-13, B-024-0-13, and B-025-0-13 and historic project test borings B-001-0-87, B-002-0-87, and B-004-0-87 was used to provide foundation recommendations for this proposed replacement bridge. Project test borings B-021-1-13 and B-021-2-13 and historic test boring B-001-0-87 were advanced in the vicinity of the proposed rear abutment while historic test boring B-003-0-87 was advanced in the vicinity of the proposed forward abutment. Project test boring B-022-1-13 and historic test boring B-002-0-87 were advanced in the vicinity of the proposed Pier 1 while project test borings B-023-0-13, B-024-0-13, and B-025-0-13 were advanced in the vicinity of the proposed Pier 2. As outlined in Section 5.1 - "Subsurface Soil Conditions", the top of bedrock was encountered at approximate depths ranging from 10.0 feet to 39.5 feet below the existing pavement or ground surface in all historic and project test borings. Bedrock at these boring locations consists of dolomite and was encountered to termination depth in all historic and project test borings. The Rock Mass Rating obtained for the bedrock core samples according to LRFD Table 10.4.6.4-1 varied from 42 to 49 and are classified as “Fair Rock”. Therefore the proposed bridge superstructure loads may be transferred to the underlying bedrock by means of piles or drilled shafts foundations. Since the top of bedrock at the abutment locations was encountered at approximate depths ranging from 38.5 feet to 39.5 feet below the existing pavement, the proposed superstructure loads may be transferred to the underlying bedrock by means of end bearing piles at the abutment locations. Since the top of bedrock at the pier locations was encountered at approximate depths ranging from 10.0 feet to 13.5 feet below the existing ground surface, the proposed superstructure loads may be transferred to the underlying bedrock by means of drilled shafts at the pier locations.

Piers: Design information provided by PB personnel indicates that the maximum compression factored loads along a vertical axial direction at the Strength and Service Limits will be 1113 kips per shaft and 858 kips, respectively. Drilled shaft foundation system may be used to transfer the proposed superstructure loads to the underlying bedrock at the pier locations. The shafts can be reinforced concrete columns designed to carry their maximum factored load at the Strength Limit State. Based on the rock mass rating, laboratory compressive strength test results and our local experience with similar projects, unit side resistance of 10.0 ksf and unit tip resistance of 5120 ksf were estimated for the bedrock at project test borings B-022-1-13, B-023-0-13, B-024-0-13, B-025-0-13 and historic test boring B-002-0-87. The nominal shaft tip resistance can be calculated for the selected shaft diameter by multiplying the unit tip resistance and the shaft cross-sectional area. The nominal shaft side resistance can be calculated for the selected shaft diameter and socket length by multiplying the unit side resistance and the shaft length surface area. The tip resistance portion of the factored axial compression resistance is calculated by multiplying the nominal shaft tip resistance and the resistance factor of 0.50. The side resistance portion of the factored axial compression resistance is calculated by multiplying the nominal shaft side resistance and the resistance factor of 0.55. Table 6.1.1 summarizes total factored resistance for the selected diameters and socket length at the abutment and pier boring locations. Side resistance from the soil overburden and upper two (2) feet of the shallow bedrock can be ignored. Based on the factored axial compression resistance for the selected shaft socket length and diameter, the estimated maximum total settlement and differential settlement will not exceed one inch and one half inch, respectively. The shaft factored resistance and settlement calculation spreadsheets are included in Appendix B.

Table 6.1.1 – Estimated Design Parameters for Drilled Shafts

Boring No.	Top of Bedrock Elevation (feet)	Shaft Tip Elevation (feet)	Socket Diameter (feet)	Socket Length (feet)	Total Factored Resistance (kips)
Pier 1					
B-022-1-13	766.8±	762.3	3.0	4.50	18,000
B-002-0-87	767.2±	762.7	3.0	4.50	18,000
Pier 2					
B-023-0-13	768.8±	764.3	3.0	4.50	18,000
B-024-0-13	768.0±	763.5	3.0	4.50	18,000
B-025-0-13	766.8±	762.3	3.0	4.50	18,000

Drilled shaft socket diameters less than 36 inches are not recommended. The drilled shafts should be spaced at a minimum of 2.5 shaft diameters on center. If drilled shafts are spaced less than four (4) shaft diameters on center, the group effect between shafts must be evaluated in accordance with Article 10.8.1.2 of the *AASHTO LRFD Bridge Design Specifications*. However, if drilled shafts are socketed into bedrock, group effect between shafts may be neglected. The diameter of bedrock sockets must be 6 inches less than the diameter of the shaft above bedrock elevation in accordance with Section 303.4.3 of the *2007 ODOT Bridge Design Manual*. The drilled shaft supported piers may experience horizontal movement caused by lateral loads and overturning moments. Vertical and lateral design loads and overturning moments information at the Strength and Service Limits provided by the PB personnel are summarized Table 6.1.2. A lateral load analysis should be performed using LPILE computer program by Ensoft or similar computer program for selected shaft diameter and socket length to check whether lateral resistance is adequate to support lateral loads and overturning moments. Table 6.1.3 summarizes the weak rock parameters to perform lateral load analyses by PB personnel. In lateral load analysis, the bedrock socket length used in vertical axial compression capacity analyses should be optimized to find the minimum length necessary to resist the applied lateral load based on serviceability and structural requirements and selected the maximum bedrock socket length between above value and 1.5 times the bedrock socket diameter.

Table 6.1.2 – Lateral Design Load Information for Drilled Shafts

Load	Service		Strength	
	Max (kips)	Min (kips)	Max (kips)	Min (kips)
F_x (k)	36.5	5.9	40.9	4.1
F_y (k)	858.2	286.0	1113.0	197.5
F_z (k)	25.9	4.2	31.1	2.2
M_x (k-ft)	1188.0	320.3	1505.0	317.9
M_y (k-ft)	6.3	2.1	8.0	2.8
M_z (k-ft)	395.3	108.4	434.5	89.8

Table 6.1.3 - Estimated Weak Rock Parameters for Lateral Load Analyses

Boring No.	Top Bedrock Elevation(ft)	Effective Unit Weight (pci)	Youngs's Modulus (psi)	Compressive Strength (psi)	RQD (%)	K_rm
Piers						
B-022-1-13	766.8±	0.059	200000	14224	48	0.00005
B-002-0-87	767.2±	0.059	200000	14224	NA	0.00005
B-023-0-13	768.8±	0.059	200000	14224	37	0.00005
B-024-0-13	768.0±	0.059	200000	14224	36	0.00005
B-025-0-13	766.8±	0.059	200000	14224	22	0.00005

Selecting the construction method for installing the drilled shafts is the responsibility of the contractor. Seepage of water into the drilled shaft holes will occur within the soil overburden during installation. If water is encountered at the bottom of the hole due to seepage, care should be taken to remove all water before placing concrete. The successful performance of a drilled shaft depends on the construction method used as well as the quality of workmanship during installation. Therefore, qualified geotechnical personnel should be present during construction for inspection in order to assure the quality of the drilled shafts and to verify that the rock conditions are as per boring logs. Drilled shaft bottoms should be free of all loose material prior to placement of concrete. For detailed drilled shaft construction, refer to Item 524 – "Drilled Shafts" of the ODOT *Construction and Material Specifications* issued in January 2013.

Abutments: Driven piles consisting of end bearing steel piles may be used to transfer the proposed superstructure loads to the underlying bedrock at the rear and forward abutment locations. These end bearing piles must be driven through the existing embankment. Design information provided by PB personnel indicates that the maximum factored loads along a vertical direction will be 288 kips and 306 kips per pile at the rear abutment and forward abutment, respectively for the left bridge and 306 kips and 305 kips per pile at the rear abutment and forward abutment, respectively for the right bridge. The end bearing piles must be steel H-piles driven to refusal on the 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. H-pile sizes HP-10X42 or HP-12X53 may be selected for the rear and forward abutment locations. The total factored load on each HP-10X42 pile and HP-12X53 pile should not exceed the corresponding maximum factored structural resistance of 310 kips and 380 kips, respectively as per the ODOT *Bridge Design Manual* Section 202.2.3.2.a. Note that the above mentioned structural resistance values can be used only on the axial loaded piles that have a negligible bending moment. The estimated pile parameters for end bearing piles at each boring location are summarized in Table 6.1.4. The pile cut-off elevations at the abutments were extracted from the final structure site plan provided by PB personnel.

Table 6.1.4 - 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-001-0-87	798.6	767.5	35.0	H-Pile	10X42	310 kips
B-001-0-87	798.6	767.5	35.0	H-Pile	12X53	380 kips
B-004-0-87	797.9	768.4	30.0	H-Pile	10X42	310 kips
B-004-0-87	797.9	768.4	30.0	H-Pile	12X53	380 kips

If it is assured that the piles are driven to refusal on bedrock, then neither a static load test nor a dynamic pile bearing capacity test will be necessary. In order to protect the tip of the H piles from damage during pile driving, steel pile points should be installed as per the ODOT *Bridge Design Manual* Section 202.2.3.2.a. It is recommended that the piles be spaced a minimum of three (3) pile diameters on center. If additional lateral resistance is required, larger size piles should be considered at the rear abutment location and 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. Based on the settlement calculations included in Appendix B, consolidation of the foundation soils above the bedrock caused by construction of the proposed embankment will be on the order of 1.0 to 1.5 inches at the rear and forward abutment locations. Therefore negative skin friction will develop along the pile section between the top of the proposed embankment and the top of bedrock due to the 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 178 kips per pile and 218 kips per pile may be assumed for pile sizes HP-10X42 and HP-12X53, respectively at the B-001-0-87 boring location and 140 kips per pile and 171 kips per pile may be assumed for pile sizes HP-10X42 and HP-12X53, respectively at the B-004-0-87 boring location. These down drag loads were calculated using Total Stress Method (α Method). The Pile Bearing Graphs for pile sizes HP-10X42 and HP-12X53 are included in Appendix B for calculating vertical axial load capacity and down drag forces.

Based on the settlement calculations, the length of waiting period after completing the proposed embankment is estimated to be 30 days. Settlement plates should be installed within the proposed embankment area, on both left and right sides of each abutment will be required to measure the amount and rate of consolidation settlement. The settlement plates should be installed at the top of the existing foundation soils before any fill is being placed. PGI recommends installing settlement devices to measure the settlement in the vicinity of Stations 812+50, left and 813+50, right at the rear abutment location and 816+00, Left and 817+00, Right at the Forward abutment location. Offset distance for the device locations will be selected in such a way that settlement devices will have minimal disturbance from construction traffic. The survey should be performed weekly to measure the settlement. The final survey will be considered complete when the settlement readings have shown 90% or more of the predicted total consolidation, or that there be a change of 0.05 inches or less between two consecutive readings.

Temporary shoring systems may be required to support the embankments at the proposed abutment locations on the median side during staged construction. Sheet piles shoring systems may be used to support the embankments and can be installed into the ground above the bedrock using a vibratory hammer. Sheet pile shoring systems must be designed to resist lateral pressures exerted by the embankment fill and vehicle traffic. The earth pressure from cohesive soils on the temporary walls should be based in terms of effective stress (drained condition) due to the likelihood that the construction schedule may extend long enough to achieve dissipation of excess (or negative) pore water pressure in the retained soils. If additional support is required, installation of deadmen may be installed on the far side of the embankment.

The soil parameters obtained from project test borings B-021-2-13 and B-024-0-13 and historic test borings B-001-0-87 and B-004-0-87 are provided below for designing of temporary shoring systems.

Rear Abutment

Sandy silt (A-4a)/Silt and clay (A-6a)/clay (A-7-6)

Bulk Unit Weight:	125 pcf
Undrained Shear Strength	2000 psf
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

Non-Plastic Silt (A-4b)

Bulk Unit Weight:	125 pcf
Average Friction Angle (Phi):	28 degrees
At Rest Coefficient (K_o):	0.531
Active Pressure Coefficient (K_a):	0.361
Passive Pressure Coefficient (K_p):	2.770

Forward Abutment

Silty clay (A-6b)/Sandy silt (A-4a)

Bulk Unit Weight:	125 pcf
Undrained Shear Strength	2000 psf
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

Non-Plastic Silt (A-4b)

Bulk Unit Weight:	125 pcf
Average Friction Angle (Phi):	28 degrees
At Rest Coefficient (K_o):	0.531
Active Pressure Coefficient (K_a):	0.361
Passive Pressure Coefficient (K_p):	2.770

6.2 Lateral Earth Pressures and Abutment Drainage

The bridge abutments must be designed to resist lateral pressures exerted by both dead and live loads. The active lateral earth pressures exerted behind the bridge abutments may be approximated by an equivalent fluid weighing 40 pcf above the water table and 80 pcf below the water table; provided that level ground exists behind the abutments and that no surcharge loads are placed behind the walls. Freely draining material must be placed behind the abutments and 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 Approach Slab Design Parameters

It is assumed that the proposed approach slab pavement will be constructed on the fill subgrade soils with the similar character encountered in project and historic test borings. It is anticipated that on-site sandy silt (A-4a), silt and clay (A-6a), clay (A-7-6), and silty clay (A-6b) fill soils will be encountered within the project limits based on the project and historic 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 Approach Slab Design Parameters

Parameter	Fill Soils
Group Index (Avg.)	8.38
CBR	7
Soil Support Value (SSV)	4.8
Resilient Modulus (psi)	8,400
Modulus of Subgrade Reaction (K, pci)	160

6.4 Groundwater Management

Based on the groundwater conditions described in Section 5.3, "Groundwater Conditions," groundwater problems may be anticipated during excavation of structure foundations. If the bottom depth of the excavation for the structure piers abutment extends 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 excavation and backfilling operations should be conducted in accordance with ODOT's "Construction and Materials Specifications," Item 503 - "Excavation for Structures" issued in January 2013 and under the supervision of competent geotechnical personnel. 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). If proposed cut slopes for the structure foundation are to be exposed for an extended period of time, they must be constructed using a two (2) horizontal to one (1) vertical slope for excavation above the water table and a three (3) horizontal to one (1) vertical slope for excavation below the water table. Prior to any backfill placement against the abutments, exposed subgrade under the approach slabs should be subjected to inspection under the direction of competent 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 soil being inspected. All removed soils should be replaced with compacted, engineered fill materials.

Soil and rock excavations are expected during construction of the project. It is expected that some harder, less weathered bedrock will be present in the drilled shaft holes. Therefore special drilling equipment may be required. 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.

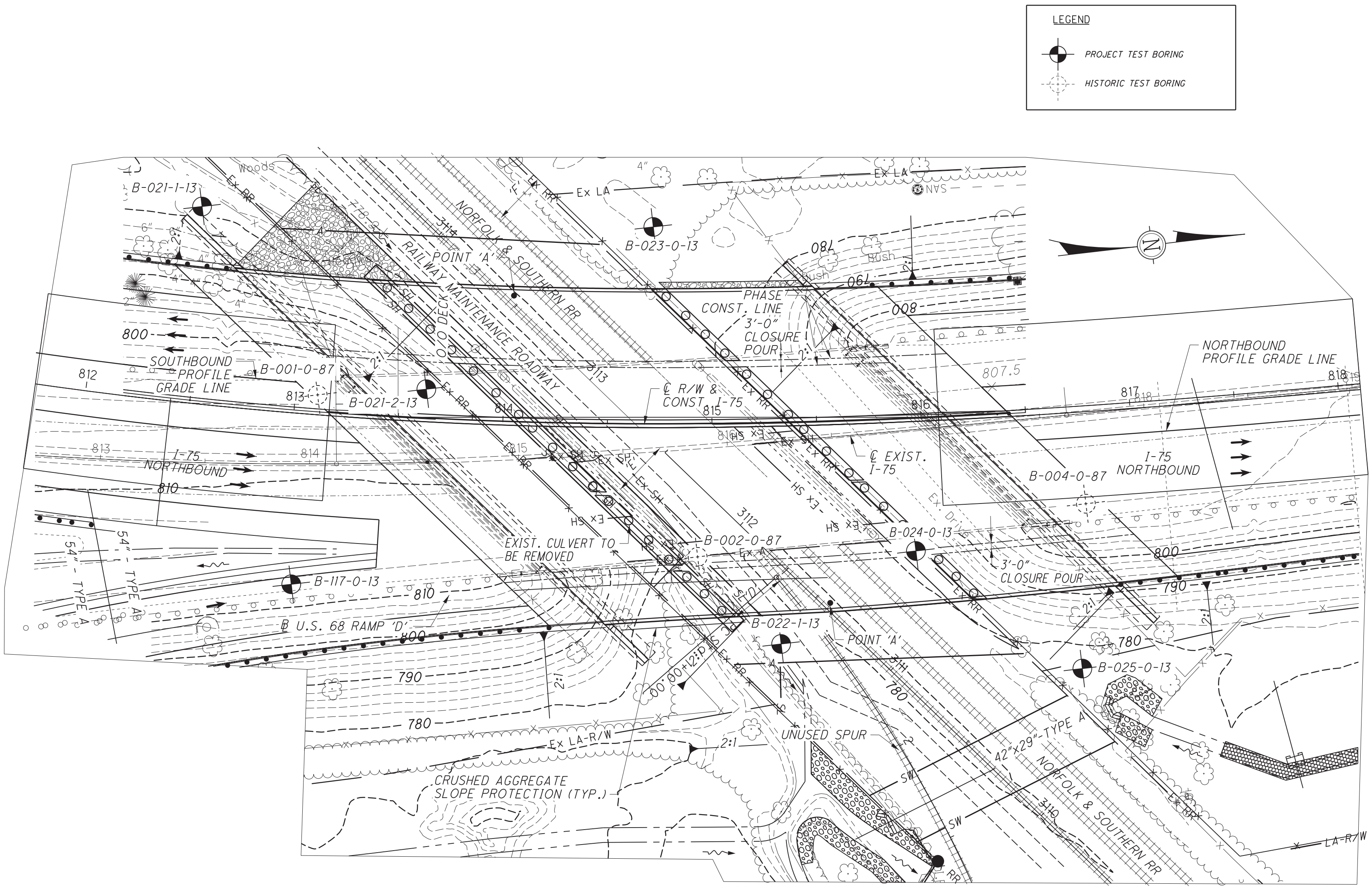
7.3 All earthwork and foundation construction must be performed under the supervision of a Professional Engineer in accordance with ODOT Construction Specifications.

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

I-75 BRIDGE NO. HAN-075-1540 L/R OVER NORFOLK SOUTHERN RAILROAD

HAN-75-14.39

PID No. 87005

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN	DRILL RIG: DIEDRICH D-90 ATV	STATION / OFFSET: 812+45.8, 92.7' LT	EXPLORATION ID B-021-1-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / F.BUSHER	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: IR 75 BASELINE	
PID: 87005 BR ID: HAN-75-1540	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 9/18/12	ELEVATION: 779.1 (MSL) EOB: 17.5 ft.	PAGE 1 OF 1
START: 8/24/13 END: 8/24/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 80.2	COORD: 41.028494030, 83.673417980	

MATERIAL DESCRIPTION AND NOTES	ELEV. 779.1	DEPTHS
TOPSOIL (12" THICK)	778.1	0.0–1.0
STIFF, DARK BROWN, **CLAY**, LITTLE SAND, TRACE ROOTS, FILL, DAMP	775.6	1.0–3.5
MEDIUM STIFF, MOTTLED BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, TRACE ROOTS, DAMP	773.1	3.5–6.0 (W at 6.0)
MEDIUM DENSE, BROWN AND GRAY, **COARSE AND FINE SAND**, SOME FINES, WET	770.6	6.0–8.5
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP TO MOIST @11.0'; MOIST	767.1	8.5–12.0 (TR at 12.0)
LIGHT GRAY DOLOMITE BEDROCK @12.5'; AUGER REFUSAL AND STARTED CORING BEDROCK	766.6	12.0–12.5
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH. @14.7'; COMPRESSIVE STRENGTH = 14,224 PSI	763.5	12.5–15.6
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	761.6	15.6–17.5 (EOB)

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
2-3-5	11	56	SS-1	2.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)
2-3-3	8	100	SS-2	2.00	-	-	-	-	-	-	-	-	25	A-6b (V)
3-3-6	12	100	SS-3	-	-	-	-	-	-	-	-	-	23	A-3a (V)
6-8-8	21	100	SS-4	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)
4-12-50/2"	-	100	SS-5	1.50	2	2	16	39	41	34	19	15	25	A-6a (10)
51		100	NX-1											CORE
48		100	NX-2											CORE

NOTES: GROUNDWATER WAS ENCOUNTERED AT 6.0' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION OF DRILLING DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH 1 BAG SOIL CUTTINGS/BENTONITE PELLETS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT GDT - 7/27/14 13:11 - \\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN	DRILL RIG: DIEDRICH D-90 ATV	STATION / OFFSET: 813+62.7, 14.2' LT	EXPLORATION ID B-021-2-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / W. NAJJAR	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: IR 75 BASELINE	
PID: 87005 BR ID: HAN-75-1540	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 9/18/12	ELEVATION: 791.5 (MSL) EOB: 36.5 ft.	PAGE 1 OF 1
START: 8/16/13 END: 8/16/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 80.2	COORD: 41.028762300, 83.673063350	

MATERIAL DESCRIPTION AND NOTES	ELEV. 791.5	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
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, FILL, DAMP	786.0	3 – 5	3 5 8	17	89	SS-1	3.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
STIFF, BROWN AND DARK BROWN, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, FILL, MOIST	783.5	6 – 7	4 5 6	15	100	SS-2	2.75	-	-	-	-	-	-	-	-	21	A-6b (V)	
STIFF, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, FILL, DAMP		8 – 10	3 4 7	15	89	SS-3	3.75	-	-	-	-	-	-	-	-	16	A-4a (V)	
		11 – 12	6 5 4	12	11	SS-4	-	-	-	-	-	-	-	-	-	16	A-4a (V)	
@14.5'; BOULDER ENCOUNTERED	776.0	13 – 15	3 4 50/3"	-	53	SS-5	3.50	-	-	-	-	-	-	-	-	17	A-4a (V)	
STIFF, BROWN, MOTTLED GRAY, **CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	773.5	16 – 17 (W)	3 5 6	15	61	SS-6	0.75	-	-	-	-	-	-	-	-	26	A-7-6 (V)	
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, MOIST	771.0	18 – 20	3 5 7	16	72	SS-7	2.25	-	-	-	-	-	-	-	-	19	A-4a (V)	
MEDIUM DENSE, BROWN AND GRAY, **NON-PLASTIC SILT**, LITTLE SAND, MOIST	768.5	21 – 22	5 7 9	21	94	SS-8	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
VERY STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP	765.5	23 – 25	7 11 14	33	100	SS-9	-	-	-	-	-	-	-	-	-	18	A-6a (V)	
LIGHT GRAY DOLOMITE BEDROCK	765.0	26 (TR)	18 50/4"	-	80	SS-10	-	60	7	3	13	17	28	17	11	14	A-6a (V)	
NOTE: AUGERED TO 26.5 FEET AND STARTED CORING BEDROCK																		
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY TO MODERATELY FRACTURED WITH FEW ANGULAR FRACTURES, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH. @32.9'; COMPRESSIVE STRENGTH = 17,412 PSI	755.0	27 – 36 (EOB)	60		100	NX-1											CORE	

NOTES: GROUNDWATER WAS ENCOUNTERED AT 16.5' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION OF DRILLING DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BACKFILLED WITH 1.0 BAG SOIL CUTTINGS/BENTONITE PELLETS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/27/14 13:11 - \\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

PROJECT: HAN-75-14.39 TYPE: BRIDGE REPLACEMENT PID: 87005 BR ID: HAN-75-1540 START: 7/26/13 END: 7/26/13	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN SAMPLING FIRM / LOGGER: PGI / W. NAJJAR DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT/NX	DRILL RIG: DIEDRICH D-90 ATV HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 9/18/12 ENERGY RATIO (%): 80.2	STATION / OFFSET: 815+30.7, 105.6' RT ALIGNMENT: IR 75 BASELINE ELEVATION: 779.1 (MSL) EOB: 18.5 ft. COORD: 41.029191180, 83.672561280	EXPLORATION ID B-022-1-13 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 779.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
COARSE STONE FRAGMENTS AND SLAG (18" THICK, THROUGH ABUTMENT SLOPE) FILL	777.6																	
MEDIUM STIFF, DARK BROWN, **CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, FILL, DAMP	775.6	1 – 3	5 3 4	9	56	SS-1	3.00	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
MEDIUM STIFF, BROWN, MOTTLED GRAY, **CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP	773.1	4 – 5	2 3 3	8	61	SS-2	2.25	3	2	14	44	37	41	17	24	24	A-7-6 (14)	
LOOSE, BROWN, **NON-PLASTIC SILT**, LITTLE SAND, MOIST	770.6	6 – 8	2 2 2	5	100	SS-3	-	-	-	-	-	-	-	-	-	23	A-4b (V)	
MEDIUM DENSE, GRAY, **SILT AND CLAY**, TRACE SAND, DAMP		9 – 10	6 8 10	24	100	SS-4	4.5+	0	0	1	44	55	30	19	11	17	A-6a (8)	
	766.8	11 – 12 (W, TR)	2 3 21	32	89	SS-1	2.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
LIGHT GRAY DOLOMITE BEDROCK	765.6	13																
@13.5'; AUGER REFUSAL AND STARTED CORING BEDROCK																		
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH. @15.7'; COMPRESSIVE STRENGTH = 17,946 PSI	760.6	14 – 18 (EOB)	48		100	NX-1											CORE	

NOTES: GROUNDWATER WAS ENCOUNTERED AT 12.0' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION OF DRILLING DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH 0.5 BAG SOIL CUTTINGS/BENTONITE PELLETS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT GDT - 7/27/14 13:11 - \\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

PROJECT: HAN-75-14.39 TYPE: BRIDGE REPLACEMENT PID: 87005 BR ID: HAN-75-1540 START: 7/23/13 END: 7/23/13	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN SAMPLING FIRM / LOGGER: PGI / F.BUSHER DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT/NX	DRILL RIG: DIEDRICH D-90 ATV HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 9/18/12 ENERGY RATIO (%): 80.2	STATION / OFFSET: 814+71.9, 94.5' LT ALIGNMENT: IR 75 BASELINE ELEVATION: 778.8 (MSL) EOB: 21.5 ft. COORD: 41.029080290, 83.673302840

EXPLORATION ID B-023-0-13

MATERIAL DESCRIPTION AND NOTES	ELEV. 778.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
BRICKS AND BRUSH CLEARED WITH DOZER, BEGIN DRILLING AFTER GRADING APPROXIMATELY 8", TOPSOIL (8" THICK)	778.1																	
STIFF, DARK BROWN, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, FILL, MOIST	775.3	1–3	3 4 4	11	44	SS-1	2.75	-	-	-	-	-	-	-	-	19	A-6b (V)	
STIFF, BROWN, MOTTLED GRAY, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	772.8	4–6	3 3 4	9	56	SS-2	1.75	-	-	-	-	-	-	-	-	22	A-6b (V)	
LOOSE TO DENSE, BROWN, **NON-PLASTIC SANDY SILT**, TRACE STONE FRAGMENTS, MOIST TO DAMP		6–8	1 3 3	8	61	SS-3	-	1	1	35	49	14	NP	NP	NP	22	A-4a (6)	
@8.5'; DENSE, DAMP	768.8	9–10 (TR)	11 12 15	36	44	SS-4	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
LIGHT GRAY DOLOMITE BEDROCK	767.3	11																
@11.5'; AUGER REFUSAL AND STARTED CORING BEDROCK **DOLOMITE**, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY TO MODERATELY FRACTURED WITH FEW ANGULAR FRACTURES, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH. @17.0'; COMPRESSIVE STRENGTH = 21,643 PSI	757.3	12–21 (EOB)	37		96	NX-1											CORE	

NOTES: NO GROUNDWATER WAS ENCOUNTERED DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION OF DRILLING DUE TO ROCK CORING OPERATIONS.

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

STANDARD ODOT SOIL BORING LOG (8.5 X 11)-OH DOT GDT-7/27/14 13:11-\\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN	DRILL RIG: DIEDRICH D-90 ATV	STATION / OFFSET: 815+94.7, 63.3' RT	EXPLORATION ID B-024-0-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / F.BUSHER	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: IR 75 BASELINE	
PID: 87005 BR ID: HAN-75-1540	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 9/18/12	ELEVATION: 782.0 (MSL) EOB: 29.5 ft.	PAGE 1 OF 1
START: 7/23/13 END: 7/23/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 80.2	COORD: 41.029379550, 83.672697720	

MATERIAL DESCRIPTION AND NOTES	ELEV. 782.0	DEPTHS
TOPSOIL (3" THICK)	781.8	
BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS**, FILL	781.0	
LOOSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, FILL, MOIST @ 3.5'; NO RECOVERY, SPOON TIP BLOCKED WITH STONE FROM ABOVE @3.5', TRAPPED WATER IN STONE ABOVE DRAINING FROM EMBANKMENT INTO THE HOLE	776.0	W (3.5)
STIFF, MOTTLED BROWN AND GRAY TO GRAY, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	771.0	
DENSE, GRAY, **NON-PLASTIC SILT**, LITTLE SAND, TRACE STONE FRAGMENTS, MOIST	768.5	
STIFF, GRAY, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, DAMP	768.0	TR (14)
LIGHT GRAY DOLOMITE BEDROCK @14.5'; AUGER REFUSAL AND STARTED CORING BEDROCK	767.0	
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY TO MODERATELY FRACTURED WITH FEW ANGULAR FRACTURES, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH. @21.0'; COMPRESSIVE STRENGTH = 22,223 PSI	757.5	
DOLOMITE, LIGHT GRAY, HIGHLY TO MODERATELY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	755.0	
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	752.5	EOB (29.5)

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
5 4 3	9	56	SS-1	-	-	-	-	-	-	-	-	-	9	A-2-4 (V)	
3 5 3	11	0	SS-2	-	-	-	-	-	-	-	-	-	-		
2 3 4	9	56	SS-3	3.00	-	-	-	-	-	-	-	-	25	A-6b (V)	
3 3 4	9	100	SS-4	2.50	2	2	13	34	49	38	22	16	26	A-6b (10)	
1 6 24	40	17	SS-5	-	-	-	-	-	-	-	-	-	18	A-4b (V)	
7 50/1"	-	71	SS-6	-	-	-	-	-	-	-	-	-	18	A-4a (V)	
33		100	NX-1											CORE	
23		100	NX-2											CORE	
60		100	NX-3											CORE	

NOTES: GROUNDWATER WAS ENCOUNTERED AT 3.5' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION OF DRILLING DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH 1 BAG SOIL CUTTINGS/BENTONITE PELLETS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/27/14 13:11 - \\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT GDT - 7/27/14 13:11 - \\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

PROJECT: HAN-75-14.39	DRILLING FIRM / OPERATOR: B-M / JOSH DEAN	DRILL RIG: DIEDRICH D-90 ATV	STATION / OFFSET: 816+69.2, 123.9' RT	EXPLORATION ID B-025-0-13
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: PGI / F.BUSHER	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: IR 75 BASELINE	PAGE
PID: 87005 BR ID: HAN-75-1540	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 9/18/12	ELEVATION: 779.3 (MSL) EOB: 18.0 ft.	1 OF 1
START: 7/23/13 END: 7/23/13	SAMPLING METHOD: SPT/NX	ENERGY RATIO (%): 80.2	COORD: 41.029581060, 83.672465560	

MATERIAL DESCRIPTION AND NOTES	ELEV. 779.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (12"THICK)	778.3	1																
MEDIUM DENSE, GRAY, **NON-PLASTIC SANDY SILT**, TRACE STONE FRAGMENTS, FILL, MOIST	775.8	2–3	7 6 7	17	78	SS-1	4.5+	-	-	-	-	-	-	-	-	16	A-4a (V)	
STIFF, MOTTLED BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, MOIST	773.3	4–6	3 4 3	9	67	SS-2	1.00	-	-	-	-	-	-	-	-	20	A-6b (V)	
VERY STIFF, BROWN, **SILT AND CLAY**, TRACE SAND, DAMP		7–8	2 2 2	5	83	SS-3	1.00	-	-	-	-	-	-	-	-	19	A-6a (V)	
	768.3	9–10 (W)	5 6 8	19	83	SS-4	2.00	0	0	1	49	50	30	19	11	19	A-6a (8)	
LOOSE, GRAY, **COARSE AND FINE SAND**, LITTLE FINES, WET	766.8	11–12 (TR)	3 2 4	8	56	SS-5	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
POSSIBLE LIGHT GRAY DOLOMITE BEDROCK @12.5'; AUGER REFUSAL AND STARTED CORING BEDROCK	766.3	13																
DOLOMITE, LIGHT GRAY, HIGHLY TO SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, HIGHLY TO MODERATELY FRACTURED WITH FEW ANGULAR FRACTURES, TIGHT TO NARROW APERTURE WIDTH, SLIGHTLY ROUGH. @15.8'; COMPRESSIVE STRENGTH = 24,649 PSI	763.0	14–16	18		100	NX-1											CORE	
DOLOMITE, LIGHT GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY THIN TO THIN BEDDED, FRACTURED TO MODERATELY FRACTURED, TIGHT APERTURE WIDTH, SLIGHTLY ROUGH.	761.3	17–18 (EOB)	30		80	NX-2											CORE	

NOTES: GROUNDWATER WAS ENCOUNTERED AT 11.0' DURING DRILLING AND NO READING WAS TAKEN UPON COMPLETION OF DRILLING DUE TO ROCK CORING OPERATIONS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: HOLE WAS BACKFILLED WITH 0.5 BAG SOIL CUTTINGS/BENTONITE PELLETS

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

Historic Boring B-001-0-87 Page 1
813+10.69, 8.1' LT

1/5

LOG OF BORING

Date Started 5/7/87 Sampler: Type SS Dia. 1 3/8" Water Elev. ______
Date Completed 5/12/87 Casing: Length ______ Dia. ______

Project Identification: HANCOCK COUNTY
HAN-75-1543
OVER NORFOLK & WESTERN RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-1 Station & Offset 814+04, 33' LT. (SOUTH ABUTMENT) Surface Elev. 807.6'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTL Class
807.6	0	AUGERED			ASPHALT	-	-	-	-	-	-	-	-	-	-	VISUAL
	2	AUGERED			GRAVEL (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	-	VISUAL
802.6	4, 6	6/7/7			GRAY SANDY SILT	1	49641	10	3	8	44	35	22	7	16	A-4a
797.6	8, 10, 12	8/11/12			GRAY SANDY GRAVELLY SILT	2	49642	16	4	12	25	43	25	7	15	A-4a
792.6	14, 16	24/12/30			BROWN AND GRAY SANDY SILT	3	49643	0	5	27	29	39	27	8	13	A-4a
790.6	18	AUGERED			BOULDERY ZONE (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	-	VISUAL
787.6	20, 22	8/9/20			BROWN SANDY GRAVELLY CLAY WITH BOULDERS	4	49644	27	4	13	23	33	28	13	14	A-6a
782.6	24, 26, 28	8/12/17			BROWN AND GRAY GRAVELLY CLAY	5	49645	25	4	10	29	32	30	13	20	A-6a
777.6	30, 32	7/12/18			BROWN AND GRAY GRAVELLY SANDY CLAY	6	49694	15	3	15	29	38	35	22	15	A-6b
772.6	34, 36	10/14/17			GRAY GRAVELLY SILT	7	49695	14	0	11	45	30	20	2	24	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

Boring No. B-1 Station & Offset 814+04, 33' LT. Surface Elev. 807.6' Project: HAN-75-1543

Elev.	Depth	Std. Pen (N)	Rec. ft	Loss ft.	Description	Field No.	Lab. Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
	38				TOP OF ROCK											
768.1 767.6	40	50(0.1)			GRAY BROKEN LIMESTONE	8	49696	–	–	–	–	–	–	–	12	VISUAL
767.5 762.5	42 44		4.2	0.7	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED AND VUGGY, BROKEN AND JOINTED. CORE LOSS 13%.											
	46				BOTTOM OF BORING											
	48															
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

Historic Boring B-001-0-87 Page 2

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

Historic Boring B-002-0-87 Page 1
814+92.65, 63.3' RT

LOG OF BORING

Date Started 5/21/87 Sampler: Type SS Dia. 1 3/8" Water Elev. ______
Date Completed 5/21/87 Casing: Length ______ Dia. ______

Project identification: HANCOCK COUNTY
HAN-75-1543
OVER NORFOLK & WESTERN RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-2 Station & Offset 815+82, 52' RT. (NORTH PIER) Surface Elev. 779.7'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. So.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
779.7	0															
777.7	2	AUGERED			BROWN SANDY CLAY W/GRAVEL (DRILLER'S DSCPTN)	-	-	-	-	-	-	-	-	-	-	VISUAL
774.7	6	1/1/3			BROWN SANDY SILT	1	49772	2	3	44	31	20	NP	NP	19	A-4a
769.7	12	7/18/25			GRAY SANDY SILT	2	49773	10	5	21	32	32	17	4	17	A-4a
767.2					TOP OF ROCK											
	14		2.5	0.0	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED AND VUGGY, BROKEN AND JOINTED. NO CORE LOSS.											
	18		5.0	0.0												
	22		5.0	0.0												
754.7	25				BOTTOM OF BORING											

Form TE-163 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

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

Historic Boring B-004-0-87 Page 1
816+75.92, 43.0' RT

4/5

LOG OF BORING

Date Started 4/27/87 Sampler: Type SS Dia. 1 3/8" Water Elev.
Date Completed 4/28/87 Casing: Length Dia.

Project Identification: HANCOCK COUNTY
HAN-75-1543
OVER NORFOLK & WESTERN RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-4 Station & Offset 817+68, 43' RT. (NORTH ABUTMENT) Surface Elev. 807.4'

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
807.4	0															VISUAL
806.9		AUGERED			ASPHALT											
	2															
	4															
802.4	6	10/8/10			GRAY AND BROWN SANDY SILT	1	49556	8	6	15	32	39	26	8	14	A-4a
	8															
797.4	10															
	12	5/6/10			BROWN SANDY SILT	2	49557	6	6	16	32	40	24	5	17	A-4a
	14															
792.4	16	10/11/15			GRAY CLAYEY SILT	3	49558	5	5	7	34	49	23	9	16	A-4a
	18															
787.4	20															
	22	10/8/14			GRAY SANDY SILT	4	49559	6	6	16	34	38	24	8	13	A-4a
	24															
782.4	26	6/9/18			BROWN AND GRAY CLAYEY SILT	5	49560	0	2	15	30	53	25	8	15	A-4a
	28															
777.4	30															
	32	7/12/18			GRAY AND BROWN SANDY SILT	6	49561	0	1	41	31	27	25	7	23	A-4a
	34															
772.4	36	9/18/20			BROWN SANDY SILT	7	49562	8	5	19	33	35	24	7	23	A-4a

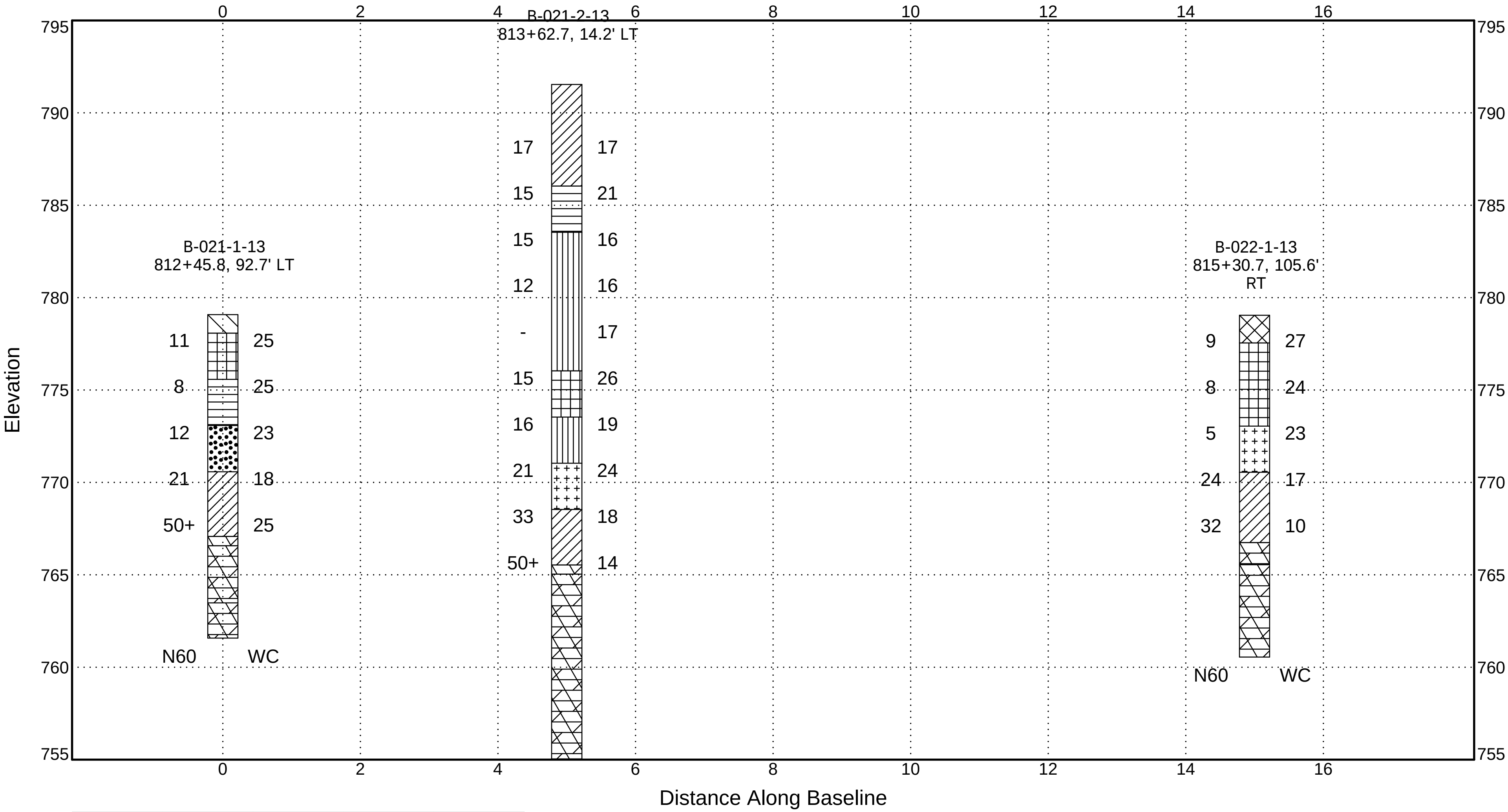
 Particle Sizes: Agg= >2.00mm, Coarse Sand=2.00-0.42mm, Fine Sand=0.42-0.074mm, Silt=0.074-0.005mm, Clay=< 0.005mm

Boring No. B-4 Station & Offset 817+68, 43' RT. Surface Elev 807.4' Project: HAN-75-1543

Elev	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Field No	Lab. Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
768.9	38				BROKEN DOLOMITIC LIMESTONE — TOP OF ROCK	–	–	–	–	–	–	–	–	–	–	VISUAL
768.4	40, 42		3.9	0.1	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, EXTREMELY VUGGY AND VERY BADLY BROKEN AND JOINTED. CORE LOSS 2%.											
764.4	44				BOTTOM OF BORING											
	46															
	48															
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

Historic Boring B-004-0-87 Page 2

PROFILE ODOT-PRIMENG.GDT-8/25/14 19:18-\\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ



Borehole	North	East	Elev.	Depth
B-021-1-13			779.1	17.5
B-021-2-13			791.5	36.5
B-022-1-13			779.1	18.5

DISTANCES:
Beginning 0
Ending 16
VIEWING ANGLES (degrees):
Horizontal 0.0
Vertical 0.0

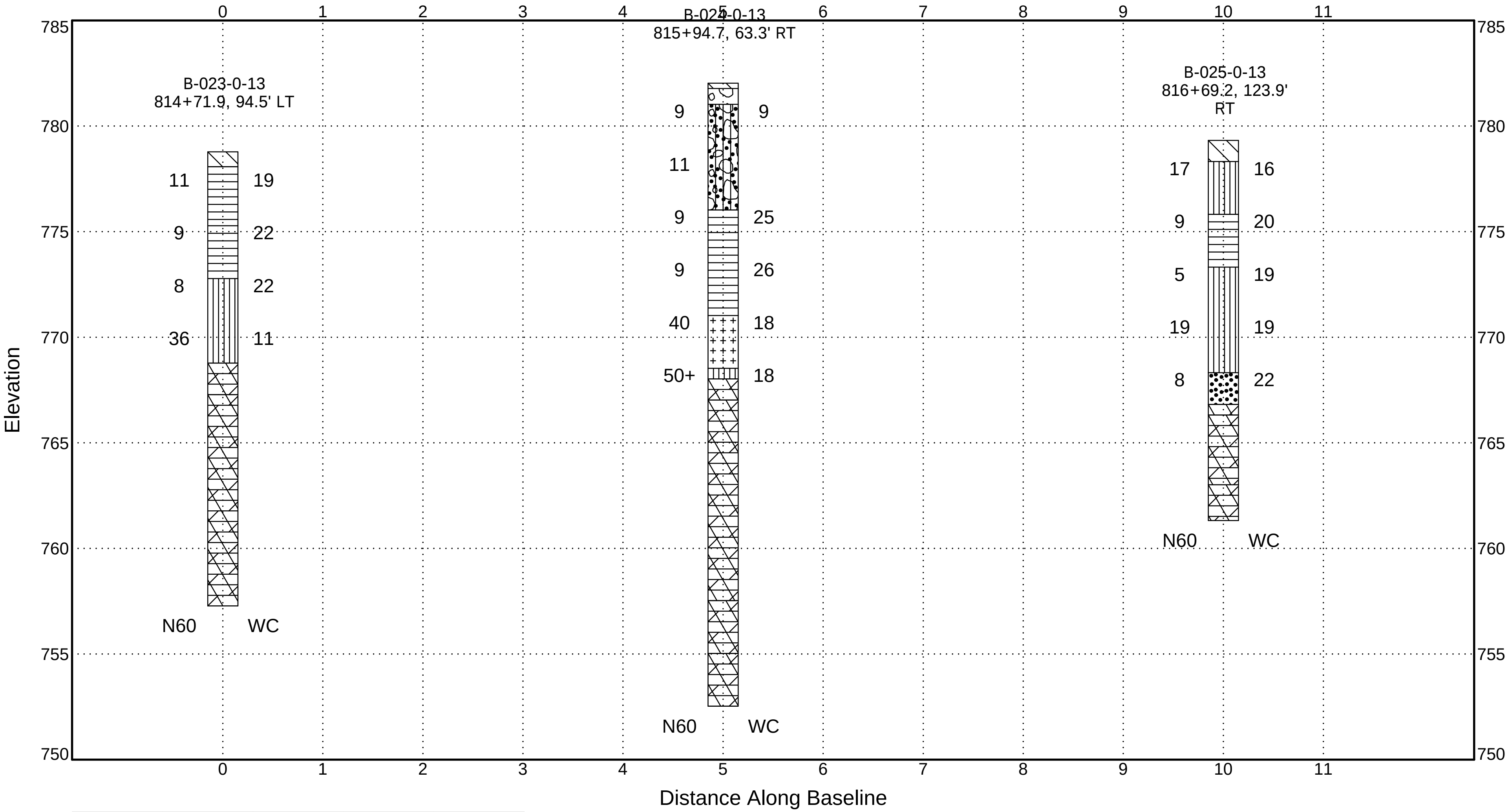
Position		
Left, Front		
Right, Front		
Left, Back		
Right, Back		

SOIL BORINGS PROFILE
BRIDGE NO. HAN-75-1540

HAN-75-14.39

FINDLAY, HANCOCK COUNTY, OHIO

PROJECT #	DATE	PLATE
87005	Aug 14	1



Borehole	North	East	Elev.	Depth
B-023-0-13			778.8	21.5
B-024-0-13			782.0	29.5
B-025-0-13			779.3	18.0

DISTANCES:

Beginning 0

Ending 11

VIEWING ANGLES (degrees):

Horizontal 0.0

Vertical 0.0

Position		
Left, Front		
Right, Front		
Left, Back		
Right, Back		

SOIL BORINGS PROFILE
BRIDGE NO. HAN-75-1540

HAN-75-14.39

FINDLAY, HANCOCK COUNTY, OHIO

PROJECT #	DATE	PLATE
87005	Aug 14	2

PROFILE ODOT-PRIMENG.GDT-8/25/14 19:24-\\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

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-021-1-13	SS-1	1.0	25											DARK BROWN CLAY, LITTLE SAND, TRACE ROOTS	A-7-6 (V)
B-021-1-13	SS-2	3.5	25											BROWN, MOTTLED GRAY SILTY CLAY, LITTLE SAND, TRACE STONE FRAGS & ROOTS	A-6b (V)
B-021-1-13	SS-3	6.0	23											BROWN AND GRAY COARSE AND FINE SAND, SOME FINES	A-3a (V)
B-021-1-13	SS-4	8.5	18											GRAY SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6a (V)
B-021-1-13	SS-5	11.0	25	34	19	15		2	2	16	39	80	41	GRAY SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6a (10)
B-021-2-13	SS-1	3.0	17											BROWN SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6a (V)
B-021-2-13	SS-2	5.5	21											BROWN AND DARK BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (V)
B-021-2-13	SS-3	8.0	16											BROWN AND GRAY SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS (FILL)	A-4a (V)
B-021-2-13	SS-4	10.5	16											BROWN AND GRAY SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS (FILL)	A-4a (V)
B-021-2-13	SS-5	13.0	17											BROWN AND GRAY SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS (FILL)	A-4a (V)
B-021-2-13	SS-6	15.5	26											BROWN, MOTTLED GRAY, CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-7-6 (V)
B-021-2-13	SS-7	18.0	19											BROWN SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS	A-4a (V)
B-021-2-13	SS-8	20.5	24											BROWN AND GRAY, NON-PLASTIC SILT, LITTLE SAND	A-4b (V)
B-021-2-13	SS-9	23.0	18											GRAY SILT AND CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6a (V)
B-021-2-13	SS-10	25.5	14	28	17	11		60	7	3	13	30	17	GRAY SILT AND CLAY, LITTLE SAND WITH DOLOMITE FRAGMENTS	A-6a (V)
B-022-1-13	SS-1	1.0	27											DARK BROWN CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-7-6 (V)
B-022-1-13	SS-2	3.5	24	41	17	24		3	2	14	44	81	37	BROWN, MOTTLED GRAY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-7-6 (14)
B-022-1-13	SS-3	6.0	23											BROWN, NON-PLASTIC SILT, LITTLE SAND	A-4b (V)
B-022-1-13	SS-4	8.5	17	30	19	11		0	0	1	44	99	55	GRAY SILT AND CLAY, TRACE SAND	A-6a (8)
B-022-1-13	SS-5	11.0	10											GRAY SILT AND CLAY, TRACE SAND WITH DOLOMITE FRAGMENTS	A-6a (V)
B-023-0-13	SS-1	1.0	19											DARK BROWN SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS (FILL)	A-6b (V)
B-023-0-13	SS-2	3.5	22											BROWN, MOTTLED GRAY SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (V)
B-023-0-13	SS-3	6.0	22	NP	NP	NP		1	1	35	49	63	14	BROWN, NON-PLASTIC SANDY SILT, TRACE STONE FRAGMENTS	A-4a (6)
B-023-0-13	SS-4	8.5	11											GRAY, NON-PLASTIC SANDY SILT WITH DOLOMITE FRAGMENTS	A-4a (V)
B-024-0-13	SS-1	1.0	9											GRAY STONE FRAGMENTS WITH SAND AND SILT	A-2-4 (V)
B-024-0-13	SS-2	3.5												NO RECOVERY	
B-024-0-13	SS-3	6.0	25											MOTTLED BROWN AND GRAY SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (V)
B-024-0-13	SS-4	8.5	26	38	22	16		2	2	13	34	83	49	GRAY SILTY CLAY, LITTLE SAND, TRACE STONE FRAGMENTS	A-6b (10)
B-024-0-13	SS-5	11.0	18											GRAY, NON-PLASTIC SILT, LITTLE SAND, TRACE STONE FRAGMENTS	A-4b (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 BRINKERHOFF
Project: HAN-75-14.39 - HAN-75-1540
Location: FINDLAY, HANCOCK COUNTY, OHIO
PID Number: 87005

PRO US LAB ODOT SUMMARY ODOT-OH DOT.GDT-7/27/14 14:59-\\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

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-024-0-13	SS-6	13.5	18											GRAY SANDY SILT, SOME CLAY, TRACE STONE FRAGMENTS	A-4a (V)
B-025-0-13	SS-1	1.0	16											GRAY, NON-PLASTIC SANDY SILT, TRACE STONE FRAGMENTS (FILL)	A-4a (V)
B-025-0-13	SS-2	3.5	20											MOTTLED BROWN AND GRAY SILTY CLAY, LITTLE SAND	A-6b (V)
B-025-0-13	SS-3	6.0	19											BROWN SILT AND CLAY, TRACE SAND	A-6a (V)
B-025-0-13	SS-4	8.5	19	30	19	11		0	0	1	49	99	50	BROWN SILT AND CLAY, TRACE SAND	A-6a (8)
B-025-0-13	SS-5	11.0	22											GRAY COARSE AND FINE SAND, LITTLE FINES	A-3a (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 BRINKERHOFF
Project: HAN-75-14.39 - HAN-75-1540
Location: FINDLAY, HANCOCK COUNTY, OHIO
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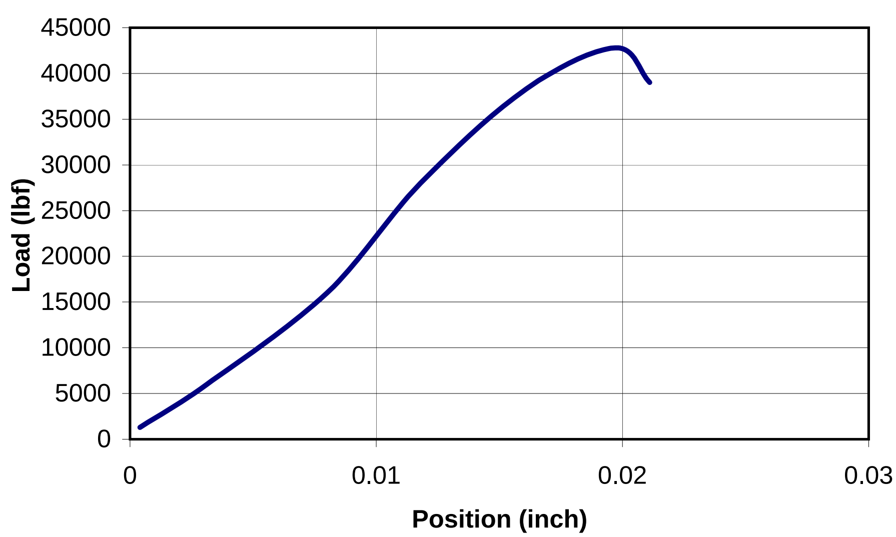
PRO US LAB ODOT SUMMARY ODOT-OH DOT.GDT-7/27/14 14:59-\\CLEDC01\PUBLIC\PROJECT FILES\13 PROJECTS\G13011G HAN-75\LAB DATA SHEETS\BRIDGES\1540 RAILROAD BR.GPJ

Pro Geotech, Inc.			**Compressive Strength of Rock ASTM D 7012**		
PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/17/2013
	STRUCTURE	IR 75 Bridge No. HAN-75-1540 over NS Railroad			
BORING NUMBER	B-021-1-13	TOP DEPTH (FT)	14.7	BOTTOM DEPTH (FT)	15.0
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	IR 75	SECTION	1540
STATION	812+45.8	OFFSET	92.7'	OFFSET DIRECTION	LT
FORMATION	TYMOCHTEE / GREENFIELD GROUP				
DESCRIPTION	Dolomite, light gray, slightly weathered, strong.				

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)			
1	3.945	1.960		LENGTH/DIAMETER	2.02
2	3.952	1.960		CORRECTION FACTOR	1.00
3	3.950	1.952		AREA (SQ. INCH)	3.009
				MASS (GRAMS)	523.30
AVERAGE	3.949	1.957		UNIT WEIGHT (LBS/FT^3)	167.77

MAXIMUM LOAD (LBS)	42801
COMPRESSIVE STRENGTH (PSI)	14224
TIME OF TEST (MINUTES)	2:10
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER




BEFORE TESTING


AFTER FAILURE

Pro Geotech, Inc.

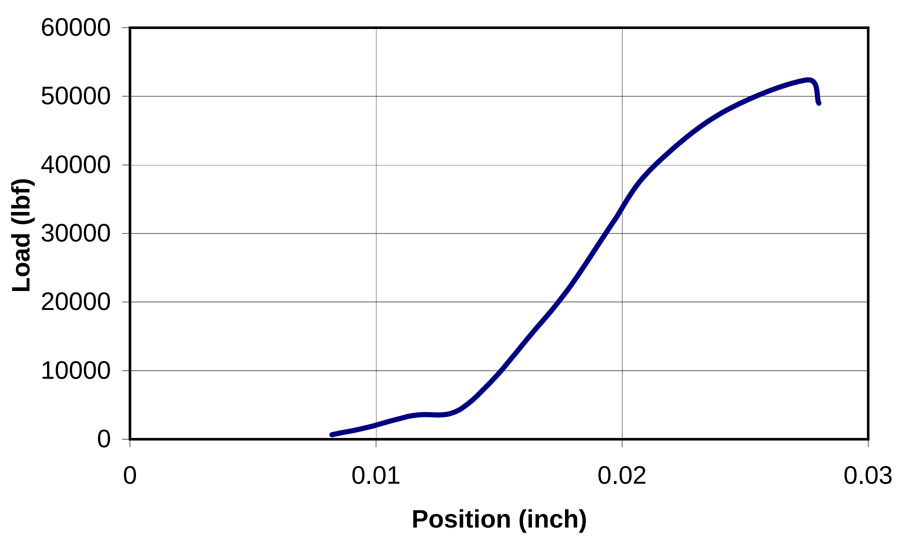
Compressive Strength of Rock
ASTM D 7012

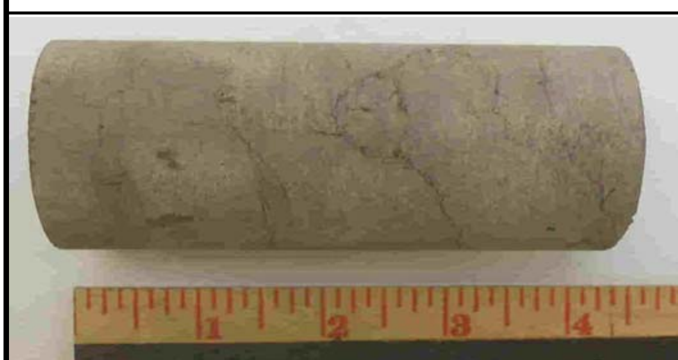
PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/17/2013
	STRUCTURE	IR 75 Bridge No. HAN-75-1540 over NS Railroad			
BORING NUMBER	B-021-2-13	TOP DEPTH (FT)	48.4	BOTTOM DEPTH (FT)	48.7
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	IR 75	SECTION	1540
STATION	813+62.7	OFFSET	14.2'	OFFSET DIRECTION	LT

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

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)			
				LENGTH/DIAMETER	2.04
1	3.990	1.962		CORRECTION FACTOR	1.00
2	3.986	1.954		AREA (SQ. INCH)	3.010
3	3.987	1.957		MASS (GRAMS)	546.88
AVERAGE	3.988	1.958		UNIT WEIGHT (LBS/FT^3)	173.57

MAXIMUM LOAD (LBS)	52409
COMPRESSIVE STRENGTH (PSI)	17412
TIME OF TEST (MINUTES)	3:20
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER





BEFORE TESTING

AFTER FAILURE

Pro Geotech, Inc.

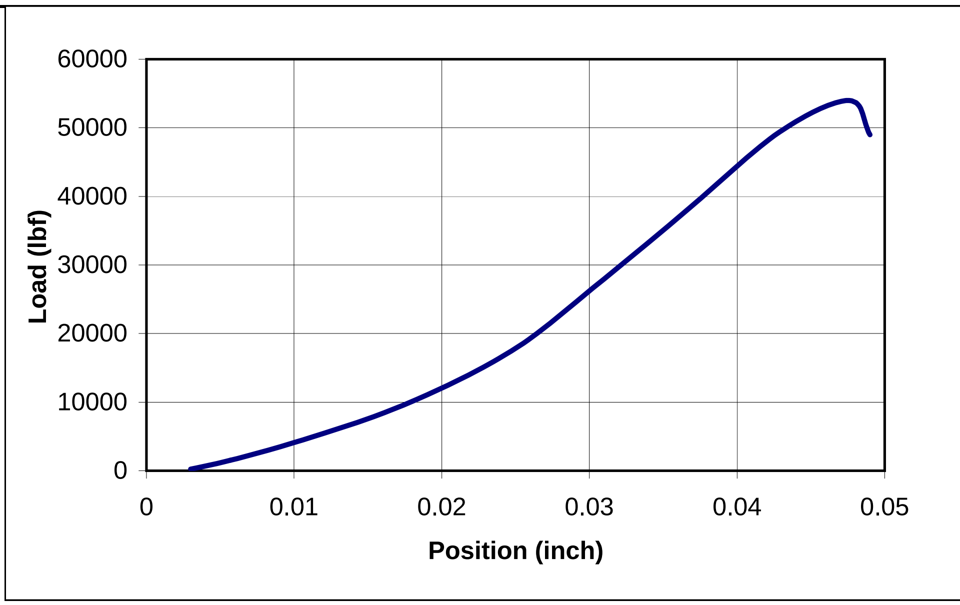
Compressive Strength of Rock
ASTM D 7012

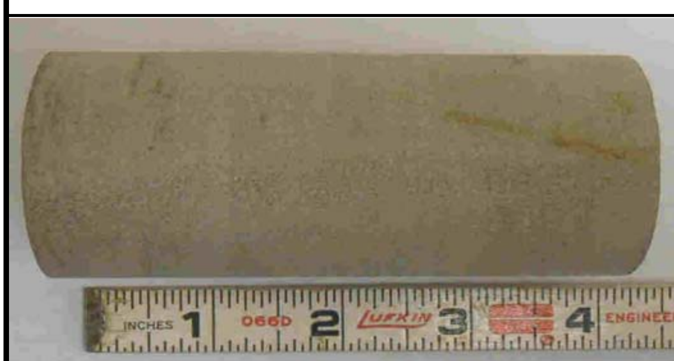
PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/17/2013
STRUCTURE	IR 75 Bridge No. HAN-75-1540 over NS Railroad				
BORING NUMBER	B-022-1-13	TOP DEPTH (FT)	15.7	BOTTOM DEPTH (FT)	16.0
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	IR 75	SECTION	1540
STATION	815+30.7	OFFSET	105.6'	OFFSET DIRECTION	RT

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

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	4.001	1.957	LENGTH/DIAMETER	2.04
2	3.996	1.954	CORRECTION FACTOR	1.00
3	3.998	1.960	AREA (SQ. INCH)	3.008
			MASS (GRAMS)	557.92
AVERAGE	3.998	1.957	UNIT WEIGHT (LBS/FT^3)	176.73

MAXIMUM LOAD (LBS)	53982
COMPRESSIVE STRENGTH (PSI)	17946
TIME OF TEST (MINUTES)	3:00
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER





BEFORE TESTING

AFTER FAILURE

Pro Geotech, Inc.

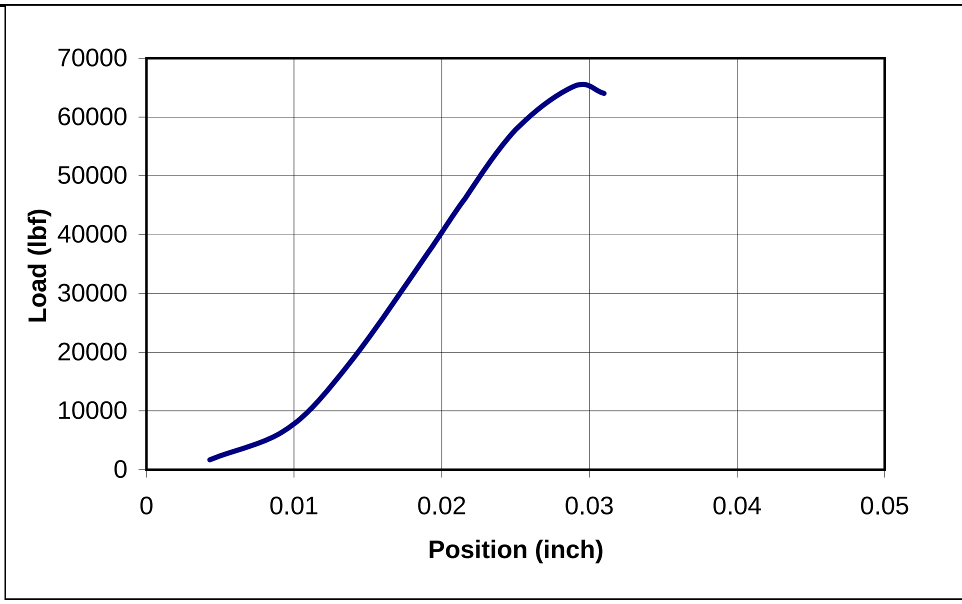
Compressive Strength of Rock
ASTM D 7012

PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/17/2013
STRUCTURE	IR 75 Bridge No. HAN-75-1540 over NS Railroad				
BORING NUMBER	B-023-0-13	TOP DEPTH (FT)	17.0	BOTTOM DEPTH (FT)	17.3
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	IR 75	SECTION	1540
STATION	814+71.9	OFFSET	94.5'	OFFSET DIRECTION	LT

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

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	3.914	1.958	LENGTH/DIAMETER	2.00
2	3.913	1.960	CORRECTION FACTOR	1.00
3	3.908	1.959	AREA (SQ. INCH)	3.014
			MASS (GRAMS)	527.60
AVERAGE	3.912	1.959	UNIT WEIGHT (LBS/FT^3)	170.48

MAXIMUM LOAD (LBS)	65248
COMPRESSIVE STRENGTH (PSI)	21643
TIME OF TEST (MINUTES)	2:30
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER



BEFORE TESTING

AFTER FAILURE

Pro Geotech, Inc.

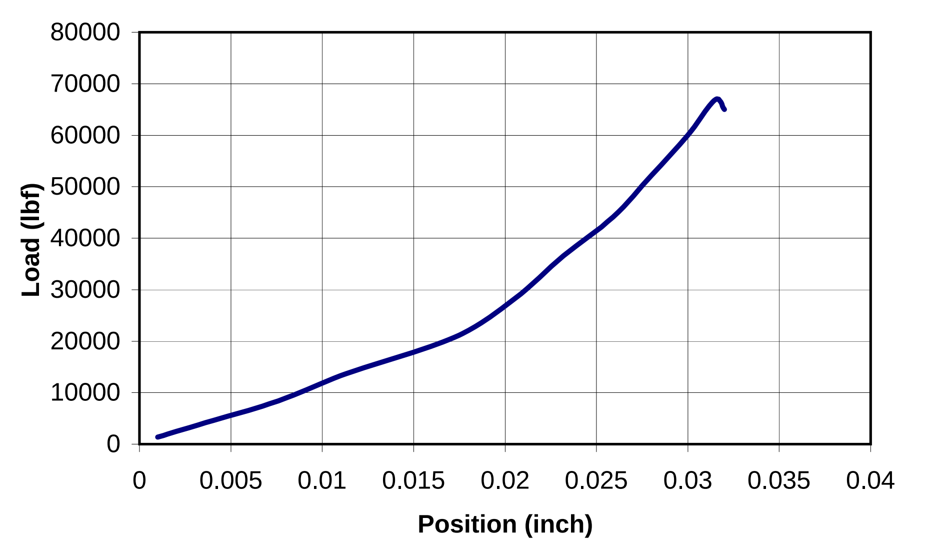
Compressive Strength of Rock
ASTM D 7012

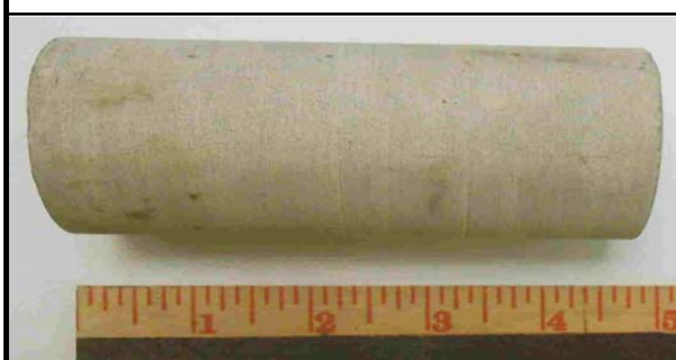
PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/6/2013
	STRUCTURE	IR 75 Bridge No. HAN-75-1540 over NS Railroad			
BORING NUMBER	B-024-0-13	TOP DEPTH (FT)	21	BOTTOM DEPTH (FT)	21.3
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	IR 75	SECTION	1540
STATION	815+94.7	OFFSET	63.3'	OFFSET DIRECTION	RT

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

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		LENGTH/DIAMETER	2.28
1	4.474	1.957		CORRECTION FACTOR	1.00
2	4.472	1.958		AREA (SQ. INCH)	3.010
3	4.464	1.958		MASS (GRAMS)	591.48
AVERAGE	4.470	1.958		UNIT WEIGHT (LBS/FT^3)	167.47

MAXIMUM LOAD (LBS)	66891
COMPRESSIVE STRENGTH (PSI)	22223
TIME OF TEST (MINUTES)	3:30
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER





BEFORE TESTING

AFTER FAILURE

Pro Geotech, Inc.

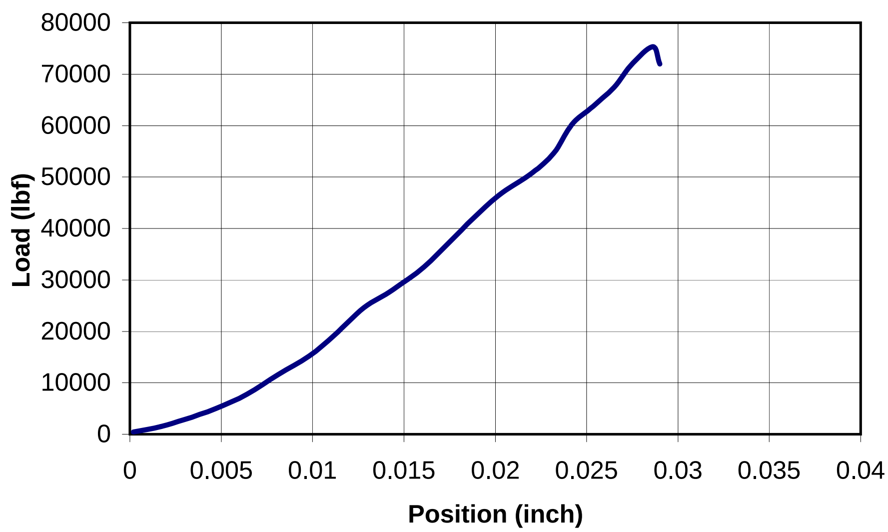
Compressive Strength of Rock
ASTM D 7012

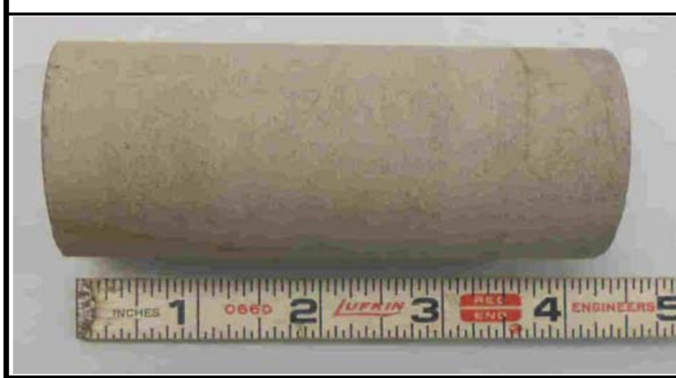
PROJECT	HAN-75-14.39	PGI PROJECT NO.	G13011G	DATE	9/6/2013
STRUCTURE	IR 75 Bridge No. HAN-75-1540 over NS Railroad				
BORING NUMBER	B-025-0-13	TOP DEPTH (FT)	15.8	BOTTOM DEPTH (FT)	16.2
SAMPLE NUMBER	NX-1	DISTRICT	1	PID NO.	87005
COUNTY	HANCOCK	ROUTE	IR 75	SECTION	1540
STATION	816+69.5	OFFSET	123.9'	OFFSET DIRECTION	RT

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

MEASUREMENT	LENGTH (INCH)	DIAMETER (INCH)		
1	4.011	1.975	LENGTH/DIAMETER	2.03
2	4.006	1.971	CORRECTION FACTOR	1.00
3	4.010	1.971	AREA (SQ. INCH)	3.055
			MASS (GRAMS)	526.51
AVERAGE	4.009	1.972	UNIT WEIGHT (LBS/FT^3)	163.76

MAXIMUM LOAD (LBS)	75308
COMPRESSIVE STRENGTH (PSI)	24649
TIME OF TEST (MINUTES)	7:10
LOADING DIRECTION	PERPENDICULAR TO BEDDING
TECHNICIAN	FBUSHER





BEFORE TESTING

AFTER FAILURE

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1540 over NS Railroad.
BORING: B-021-1-13 BOX 1/1
DATE of CORING: 8/24/13

RUN-1: 12.5' - 15.6'	RUN-1: 15.6' - 17.5'
REC: 100% RQD: 51%	REC: 100% RQD: 48%

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1540 over NS Railroad.
BORING: B-021-2-13 BOX 1/1
DATE of CORING: 8/16/13
RUN-1: 26.5' - 36.5'
REC: 100% RQD: 60%

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1540 over NS Railroad.
BORING: B-022-1-13 BOX 1/1
DATE of CORING: 7/26/13
RUN-1: 13.5' - 18.5'
REC: 100% RQD: 48%

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1540 over NS Railroad.
BORING: B-023-0-13 BOX 1/1
DATE of CORING: 7/23/13
RUN-1: 11.5' - 21.5'
REC: 96% RQD: 37%

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1540 over NS Railroad
BORING: B-024-0-13 BOX 1/2
DATE of CORING: 7/23/13
RUN-1: 15.0' - 24.5'
REC: 100% RQD: 33%

COMPANY: PGI	DRILLED BY: B-M
PROJECT: HAN-75-14.39	
BRIDGE NO.: HAN-75-1540 over NS Railroad.	
BORING: B-024-0-13 BOX 2/2	
DATE of CORING: 7/23/13	
RUN-2: 24.5' - 27.0'	RUN-3: 27.0' - 29.5'
REC: 100% RQD: 23%	REC: 100% RQD: 60%

COMPANY: PGI DRILLED BY: B-M
PROJECT: HAN-75-14.39
BRIDGE NO.: HAN-75-1540 over NS Railroad
BORING: B-025-0-13 BOX 1/1
DATE of CORING: 7/23/13
RUN-1: 13.0' - 16.3' RUN-2: 16.3' - 18.0'
REC: 100% RQD: 18% REC: 80% RQD: 30%

ROCK MASS RATING From Table 10.4.6.4-1	
Project: HAN-75-14.39	**Project No.:** G13011G
Structure: IR-75 Mainline Bridge No. HAN-75-15.40 over Norfolk Southern RR	
Boring No.: B-021-2-13	**Substructure Unit:** Rear Abutment
Strength of Intact Rock Material	
Uniaxial Compressive Strength	2507
Relative Rating	8
Drill Core Quality RQD	
RQD	60%
Relative Rating	10
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	8
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	4
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	49
Class No	III
Description	Fair Rock
Boring No.: B-024-0-13	**Substructure Unit:** Pier 2
Strength of Intact Rock Material	
Uniaxial Compressive Strength	3200
Relative Rating	10
Drill Core Quality RQD	
RQD	36%
Relative Rating	5
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	6
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	4
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	44
Class No	III
Description	Fair Rock

ROCK MASS RATING From Table 10.4.6.4-1	
Project: HAN-75-14.39	**Project No.:** G13011G
Structure: IR-75 Mainline Bridge No. HAN-75-15.40 over Norfolk Southern RR	
Boring No.: B-021-1-13	**Substructure Unit:** Rear Abutment
Strength of Intact Rock Material	
Uniaxial Compressive Strength	2048
Relative Rating	7
Drill Core Quality RQD	
RQD	50%
Relative Rating	8
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	8
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	4
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	46
Class No	III
Description	Fair Rock
Boring No.: B-022-1-13	**Substructure Unit:** Pier 1
Strength of Intact Rock Material	
Uniaxial Compressive Strength	2584
Relative Rating	8
Drill Core Quality RQD	
RQD	48%
Relative Rating	8
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	8
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	4
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	47
Class No	III
Description	Fair Rock

ROCK MASS RATING From Table 10.4.6.4-1	
Project: HAN-75-14.39	**Project No.:** G13011G
Structure: IR-75 Mainline Bridge No. HAN-75-15.40 over Norfolk Southern RR	
Boring No.: B-023-0-13	**Substructure Unit:** Pier 2
Strength of Intact Rock Material	
Uniaxial Compressive Strength	3116
Relative Rating	10
Drill Core Quality RQD	
RQD	37%
Relative Rating	7
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	7
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	19
Ground water Conditions	
Relative Rating	4
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	47
Class No	III
Description	Fair Rock
Boring No.: B-025-0-13	**Substructure Unit:** Pier 2
Strength of Intact Rock Material	
Uniaxial Compressive Strength	3550
Relative Rating	11
Drill Core Quality RQD	
RQD	22%
Relative Rating	3
Joint Conditions	
Spacing of Joints	2" to 1'
Relative Rating	7
Conditions of Joints	Slightly Rough Surfaces, Separation < 0.05", and Hard Joint Wall
Relative Rating	17
Ground water Conditions	
Relative Rating	4
Strike & Dip Orientation of Joint	
Relative Rating	0
Total Mass Rating	42
Class No	III
Description	Fair Rock

EMBANKMENT SETTLEMENT ANALYSIS - Rear Abutment						
Project:	HAN-75-14.39 - Bridge No. HAN-75-1540		**Project #**	G13011G	**Test Boring #**	B-001-0-87
Type of Foundation	Compression Index (Cc) (From Lab Test)			Depth of Ground Water Level below footing (feet)		39.5
Shallow Foundation (Strip)	Recompression Index (Cr) (From Lab Test)			Unit Weight of Water (pcf)		62.4
Length =	Depth of Footing (D_f) below ground (feet)		8.4	Specific Gravity of Soil Solids (G)		
Width = 160.0'	Applied Design Pressure (psf)		1,300	Unit Weight of Soil above the base of foundation (pcf)		125
Depth Below the Foundation (Z)	**AVERAGE PROPERTIES**		**CALCULATIONS**			**Total**
D_f=0.0' & Z=0.0'	Thickness of Layer (feet)	18.5	OB Pressure at the top Layer(psf)		0	**Setlement**
	Ave. Corrected SPT Value (N_{60})	19	OB Pressure at the center Layer (psf)		1156	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad		1229	
(above the Water Table)	Moisture content (%)	15	Compression Index (C_c)		0.15	
Z=9.25' (At Centre of Layer)	Liquid Limit (%)	25	Recompression Index (C_r)		0.015	0.015
	Plastic Limit (%)	18	Initial Void Ratio (e_0)		0.55	
	Plasticity Index (%)	7	Settlement due to compression (inches)		6.76	
	Unit Weight of soil (pcf)	125	Settlement due to recompression (inches)		0.68	**0.68**
D_f=18.5' & Z=18.5'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)		2313	
D_f=18.5' & Z=18.5'	Thickness of Layer (feet)	12.5	OB Pressure at the top Layer(psf)		2313	**Setlement**
	Ave. Corrected SPT Value (N_{60})	29	OB Pressure at the center Layer (psf)		3156	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad		1126	
(above the Water Table)	Moisture content (%)	17	Compression Index (C_c)		0.17	
Z=24.75' (At Centre of Layer)	Liquid Limit (%)	29	Recompression Index (C_r)		0.017	0.017
	Plastic Limit (%)	16	Initial Void Ratio (e_0)		0.46	
	Plasticity Index (%)	13	Settlement due to compression (inches)		2.31	
	Unit Weight of soil (pcf)	135	Settlement due to recompression (inches)		0.23	**0.23**
D_f=31.0' & Z=31.0'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)		4000	
D_f=31.0' & Z=31.0'	Thickness of Layer (feet)	4	OB Pressure at the top Layer(psf)		4000	**Setlement**
	Ave. Corrected SPT Value (N_{60})	30	OB Pressure at the center Layer (psf)		4270	**(inches)**
	Specific Gravity of Soil Solids (G)	2.75	Excess Pressure At Center Due to appliedLoad		1078	
(above the Water Table)	Moisture content (%)	15	Compression Index (C_c)		0.15	
Z=33.0' (At Centre of Layer)	Liquid Limit (%)	35	Recompression Index (C_r)		0.015	0.015
	Plastic Limit (%)	19	Initial Void Ratio (e_0)		0.46	
	Plasticity Index (%)	16	Settlement due to compression (inches)		0.48	
	Unit Weight of soil (pcf)	135	Settlement due to recompression (inches)		0.05	**0.05**
D_f=35.0' & Z=35.0'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)		4540	

Project:	HAN-75-14.39 - Bridge No. HAN-75-1540		Project #	G13011G	Test Boring #	B-001-0-87
D_f=35.0' & Z=35.0'	Thickness of Layer (feet)	4.5	OB Pressure at the top Layer(psf)		4540	**Setlement**
	Ave. Corrected SPT Value (N_{60})	31	OB Pressure at the center Layer (psf)		4833	**(inches)**
	Specific Gravity of Soil Solids (G)	2.65	Excess Pressure At Center Due to appliedLoad		1054	
(above the Water Table)	Moisture content (%)	24	Bearing Capacity Index (C)		110	
Z=37.25' (At Centre of Layer)	Liquid Limit (%)	NP	Immediate Settlement in Foundation Soil (inches)		0.04	**0.04**
	Plastic Limit (%)	NP	Initial Void Ratio (e_0)		0.58	
	Plasticity Index (%)	NP				
	Unit Weight of soil (pcf)	130				
D_f=39.5' & Z=39.5'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)		5125	
					Total Settlement:	**1**
					Consolidation Settlement:	**0.96**
					Immediate Settlement:	**0.04**

EMBANKMENT SETTLEMENT ANALYSIS - Rear Abutment					
Project:	HAN-75-14.39 - Bridge No. HAN-75-1540	**Project #**	G13011G	**Test Boring #**	B-004-0-87
Type of Foundation	Compression Index (Cc) (From Lab Test)		Depth of Ground Water Level below footing (feet)		38.5
Shallow Foundation (Strip)	Recompression Index (Cr) (From Lab Test)		Unit Weight of Water (pcf)		62.4
Length =	Depth of Footing (D_f) below ground (feet)	4.3	Specific Gravity of Soil Solids (G)		
Width = 160.0'	Applied Design Pressure (psf)	790	Unit Weight of Soil above the base of foundation (pcf)		125
Depth Below the Foundation (Z)	**AVERAGE PROPERTIES**		**CALCULATIONS**		**Total**
D_f=0.0' & Z=0.0'	Thickness of Layer (feet)	15	OB Pressure at the top Layer(psf)	0	**Setlement**
	Ave. Corrected SPT Value (N_{60})	17	OB Pressure at the center Layer (psf)	923	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	755	
(above the Water Table)	Moisture content (%)	16	Compression Index (C_c)	0.16	
Z=7.5' (At Centre of Layer)	Liquid Limit (%)	25	Recompression Index (C_r)	0.016	0.016
	Plastic Limit (%)	18	Initial Void Ratio (e_0)	0.59	
	Plasticity Index (%)	7	Settlement due to compression (inches)	4.71	
	Unit Weight of soil (pcf)	123	Settlement due to recompression (inches)	0.47	**0.47**
D_f=15.0' & Z=15.0'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	1845	
D_f=15.0' & Z=15.0'	Thickness of Layer (feet)	15	OB Pressure at the top Layer(psf)	1845	**Setlement**
	Ave. Corrected SPT Value (N_{60})	25	OB Pressure at the center Layer (psf)	2820	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	693	
(above the Water Table)	Moisture content (%)	15	Compression Index (C_c)	0.15	
Z=22.5' (At Centre of Layer)	Liquid Limit (%)	24	Recompression Index (C_r)	0.015	0.015
	Plastic Limit (%)	16	Initial Void Ratio (e_0)	0.49	
	Plasticity Index (%)	8	Settlement due to compression (inches)	1.73	
	Unit Weight of soil (pcf)	130	Settlement due to recompression (inches)	0.17	**0.17**
D_f=30.0' & Z=30.0'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	3795	
D_f=30.0' & Z=30.0'	Thickness of Layer (feet)	8.5	OB Pressure at the top Layer(psf)	3795	**Setlement**
	Ave. Corrected SPT Value (N_{60})	34	OB Pressure at the center Layer (psf)	4390	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	651	
(above the Water Table)	Moisture content (%)	23	Compression Index (C_c)	0.23	
Z=34.25' (At Centre of Layer)	Liquid Limit (%)	25	Recompression Index (C_r)	0.023	0.023
	Plastic Limit (%)	18	Initial Void Ratio (e_0)	0.48	
	Plasticity Index (%)	7	Settlement due to compression (inches)	0.95	
	Unit Weight of soil (pcf)	140	Settlement due to recompression (inches)	0.10	**0.10**
D_f=38.5' & Z=38.5'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	4985	

Project:	HAN-75-14.39 - Bridge No. HAN-75-1540		**Project #**	G13011G	**Test Boring #**	B-004-0-87
D_f=' & Z=0'	Thickness of Layer (feet)		OB Pressure at the top Layer(psf)			**Setlement**
	Ave. Corrected SPT Value (N_{60})		OB Pressure at the center Layer (psf)			**(inches)**
	Specific Gravity of Soil Solids (G)		Excess Pressure At Center Due to appliedLoad			
(above the Water Table)	Moisture content (%)		Bearing Capacity Index (C)			
Z=' (At Centre of Layer)	Liquid Limit (%)		Immediate Settlement in Foundation Soil (inches)			
	Plastic Limit (%)		Initial Void Ratio (e_0)			
	Plasticity Index (%)					
	Unit Weight of soil (pcf)					
D_f=' & Z='	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)			
					Total Settlement:	**0.74**
					Consolidation Settlement:	**0.74**
					Immediate Settlement:	**0**

EMBANKMENT SETTLEMENT ANALYSIS - Rear Abutment					
Project:	HAN-75-14.39 - Bridge No. HAN-75-1540	**Project #**	G13011G	**Test Boring #**	B-021-1-13
Type of Foundation	Compression Index (Cc) (From Lab Test)		Depth of Ground Water Level below footing (feet)		6
Shallow Foundation (Strip)	Recompression Index (Cr) (From Lab Test)		Unit Weight of Water (pcf)		62.4
Length =	Depth of Footing (D_f) below ground (feet)	30.0	Specific Gravity of Soil Solids (G)		
Width = 160.0'	Applied Design Pressure (psf)	3,750	Unit Weight of Soil above the base of foundation (pcf)		125
Depth Below the Foundation (Z)	**AVERAGE PROPERTIES**		**CALCULATIONS**		**Total**
D_f=0.0' & Z=0.0'	Thickness of Layer (feet)	3.5	OB Pressure at the top Layer(psf)	0	**Setlement**
	Ave. Corrected SPT Value (N_{60})	11	OB Pressure at the center Layer (psf)	228	**(inches)**
	Specific Gravity of Soil Solids (G)	2.75	Excess Pressure At Center Due to appliedLoad	3709	
(above the Water Table)	Moisture content (%)	25	Compression Index (C_c)	0.25	
Z=1.75' (At Centre of Layer)	Liquid Limit (%)	41	Recompression Index (C_r)	0.025	0.025
	Plastic Limit (%)	17	Initial Void Ratio (e_0)	0.65	
	Plasticity Index (%)	24	Settlement due to compression (inches)	7.88	
	Unit Weight of soil (pcf)	130	Settlement due to recompression (inches)	0.79	**0.79**
D_f=3.5' & Z=3.5'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	455	
D_f=3.5' & Z=3.5'	Thickness of Layer (feet)	2.5	OB Pressure at the top Layer(psf)	455	**Setlement**
	Ave. Corrected SPT Value (N_{60})	8	OB Pressure at the center Layer (psf)	611	**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3642	
(above the Water Table)	Moisture content (%)	25	Compression Index (C_c)	0.25	
Z=4.75' (At Centre of Layer)	Liquid Limit (%)	38	Recompression Index (C_r)	0.025	0.025
	Plastic Limit (%)	22	Initial Void Ratio (e_0)	0.68	
	Plasticity Index (%)	16	Settlement due to compression (inches)	3.75	
	Unit Weight of soil (pcf)	125	Settlement due to recompression (inches)	0.38	**0.38**
D_f=6.0' & Z=6.0'	Submerged Unit Weight of Soil (pcf)		OB Pressure at the bottom Layer (psf)	768	
D_f=6.0' & Z=6.0'	Thickness of Layer (feet)	2.5	OB Pressure at the top Layer(psf)	768	**Setlement**
	Ave. Corrected SPT Value (N_{60})	12	OB Pressure at the center Layer (psf)	840	**(inches)**
	Specific Gravity of Soil Solids (G)	2.65	Excess Pressure At Center Due to appliedLoad	3587	
(below the Water Table)	Moisture content (%)	23	Bearing Capacity Index (C)	110	
Z=7.25' (At Centre of Layer)	Liquid Limit (%)	NP	Immediate Settlement in Foundation Soil (inches)	0.20	**0.20**
	Plastic Limit (%)	NP	Initial Void Ratio (e_0)	0.69	
	Plasticity Index (%)	NP			
	Unit Weight of soil (pcf)	120			
D_f=8.5' & Z=8.5'	Submerged Unit Weight of Soil (pcf)	57.6	OB Pressure at the bottom Layer (psf)	912	

Project:	HAN-75-14.39 - Bridge No. HAN-75-1540		Project #	G13011G	Test Boring #	B-021-1-13
D_f=8.5' & Z=8.5'	Thickness of Layer (feet)	3.5	OB Pressure at the top Layer(psf)	912		**Setlement**
	Ave. Corrected SPT Value (N_{60})	21	OB Pressure at the center Layer (psf)	1039		**(inches)**
	Specific Gravity of Soil Solids (G)	2.7	Excess Pressure At Center Due to appliedLoad	3524		
below the Water Table)	Moisture content (%)	21	Compression Index (C_c)	0.21		
Z=10.25' (At Centre of Layer)	Liquid Limit (%)	34	Recompression Index (C_r)	0.021		0.021
	Plastic Limit (%)	19	Initial Void Ratio (e_0)	0.51		
	Plasticity Index (%)	15	Settlement due to compression (inches)	3.75		
	Unit Weight of soil (pcf)	135	Settlement due to recompression (inches)	0.38		**0.38**
D_f=12.0' & Z=12.0'	Submerged Unit Weight of Soil (pcf)	72.6	OB Pressure at the bottom Layer (psf)	1166		
					Total Settlement:	**0.74**
					Consolidation Settlement:	**1.54**
					Immediate Settlement:	**0.2**

HAN-75-14.39 - BRIDGE NO. HAN-75-1540
Stress Distribution using 2 V : 1 H Slope Method for Strip Footing

Boring No.: B-001-0-87

Width of the footing B (feet)	**160**	**Applied Design Pressure (psf)**			**1300**				
Depth (Z) below the footing (feet)	9.25	24.75	33	37.25					
Vertical Stress Intensity at Z q (psf)	1229	1126	1078	1054					

Boring No.: B-004-0-87

Width of the footing B (feet)	**160**	**Applied Design Pressure (psf)**			**790**				
Depth (Z) below the footing (feet)	7.5	22.5	34.25						
Vertical Stress Intensity at Z q (psf)	755	693	651						

Boring No.: B-021-1-13

Width of the footing B (feet)	**160**	**Applied Design Pressure (psf)**			**3750**				
Depth (Z) below the footing (feet)	1.75	4.75	7.25	10.25					
Vertical Stress Intensity at Z q (psf)	3709	3642	3587	3524					

Estimation of Drilled Shaft Resistence and Settlement in Jointed Rock

Project: HAN-75-14.39 **Project No.:** G13011G

Structure: IR-75 Mainline Bridge over Norfolk Southern Railroad

Boring No.: B-022-1-13 **Substructure Unit:** Pier 1

Unit Side Resistence (q_s): 0.65*(Reduction Factor α_E)*P_a*Sqrt(q_u/P_a) <7.8*Pa*Sqrt(f'_c/P_a) (Eq. 10.8.3.5.4b-1)

Uniaxial Comp.Strength of Intact Rock, q_u (ksf): 2048 Atmospheric Pressure P_a(ksf): 2.12

Reduction Factor α_E: 0.45 (Table 10.8.3.5.4b-1) Concrete Compressive Strength f'_c(ksf): 576

Unit Side Resistence, qs (ksf): 10.22 <272.57 ksf (From Eq 10.8.3.5.4b-1

Unit Side Resistence (ksf): 10.00

Unit Tip Resistence (q_p): (Sq.root(s)+Sq.root(m*Sq.root(s)+s))*qu (Eq. 10.8.3.5.4c-2)

Fractured Rock Mass Parameters "s" and "m" m = s =

(From Table 10.4.6.4-4)

Unit Tip Resistence, q_p (ksf):

Unit Tip Resistence (q_p): 2.5*qu (Eq. 10.8.3.5.4c-1)

Unit Tip Resistence, q_p (ksf): 5120

Calculation of Nominal Resistence of Side and Tip

Shaft Socket Diameter, Br (feet):	**3**	**4**	**5**	**6**
Length of Socket, Dr (feet) :	4.5	6	7.5	9
Perimeter Area of Socket As (Sq. ft)	23.56	50.27	86.39	131.95
Cross-Sectional Area of Socket, Ap (Sq. ft)	7.07	12.57	19.63	28.27
Nominal Shaft Side Resistence, Rs (kips):	240.8	513.8	883.1	1348.7
Nominal Shaft Tip Resistence, Rp (kips):	36191.1	64339.8	100531.0	144764.6
Resistence Factor for Side from T. 10.5.5.2.4-1	0.55	0.55	0.55	0.55
Resistence Factor for Tip from T. 10.5.5.2.4-1	0.50	0.50	0.50	0.50
Factored Resistance from Side (kips)	132.5	282.6	485.7	741.8
Factored Resistance from Tip (kips)	18095.6	32169.9	50265.5	72382.3

Butt settlement of drilled Shaft : Q((Dr/Ap*Ec)+(Ips/Br*Em))

Note: Applied Axial load per shaft is obtained by limiting factored resistence to 0.4 inch of elastic settlement

Applied Axial Load on Top of Socket, Q (kips)	858	858	858	858
Concrete Young's Modulus, Ec (kci)	3800	3800	3800	3800
Shortening of Drilled Shaft (Inches)	0.144	0.108	0.086	0.072
Rock Mass Modulus, Em (kci)	200.0	200.0	200.0	200.0
Ec/Em	19.0	19.0	19.0	19.0
Dr/Br	1.50	1.50	1.50	1.50
Influence Coefficient (Ips) from Fig 4.6.5.5.2A	0.30	0.30	0.30	0.30
(Modified after Pells and Turner (1979))				
Settlement of Base (inches)	0.429	0.322	0.257	0.215
Total Butt Settlement of Shaft (inches)	0.573	0.430	0.344	0.286

Estimation of Drilled Shaft Resistence and Settlement in Jointed Rock

Project: HAN-75-14.39 **Project No.:** G13011G

Structure: IR-75 Mainline Bridge over Norfolk Southern Railroad

Boring No.: B-023-0-13 **Substructure Unit:** Pier 2

Unit Side Resistence (q_s): 0.65*(Reduction Factor α_E)*P_a*Sqrt(q_u/P_a) <7.8*Pa*Sqrt(f'_c/P_a) (Eq. 10.8.3.5.4b-1)

Uniaxial Comp.Strength of Intact Rock, q_u (ksf): 2048 Atmospheric Pressure P_a(ksf): 2.12

Reduction Factor α_E: 0.45 (Table 10.8.3.5.4b-1) Concrete Compressive Strength f'_c(ksf): 576

Unit Side Resistence, qs (ksf): 10.22 <272.57 ksf (From Eq 10.8.3.5.4b-1

Unit Side Resistence (ksf): 10.00

Unit Tip Resistence (q_p): (Sq.root(s)+Sq.root(m*Sq.root(s)+s))*qu (Eq. 10.8.3.5.4c-2)

Fractured Rock Mass Parameters "s" and "m" m = s =

(From Table 10.4.6.4-4)

Unit Tip Resistence, q_p (ksf):

Unit Tip Resistence (q_p): 2.5*qu (Eq. 10.8.3.5.4c-1)

Unit Tip Resistence, q_p (ksf): 5120

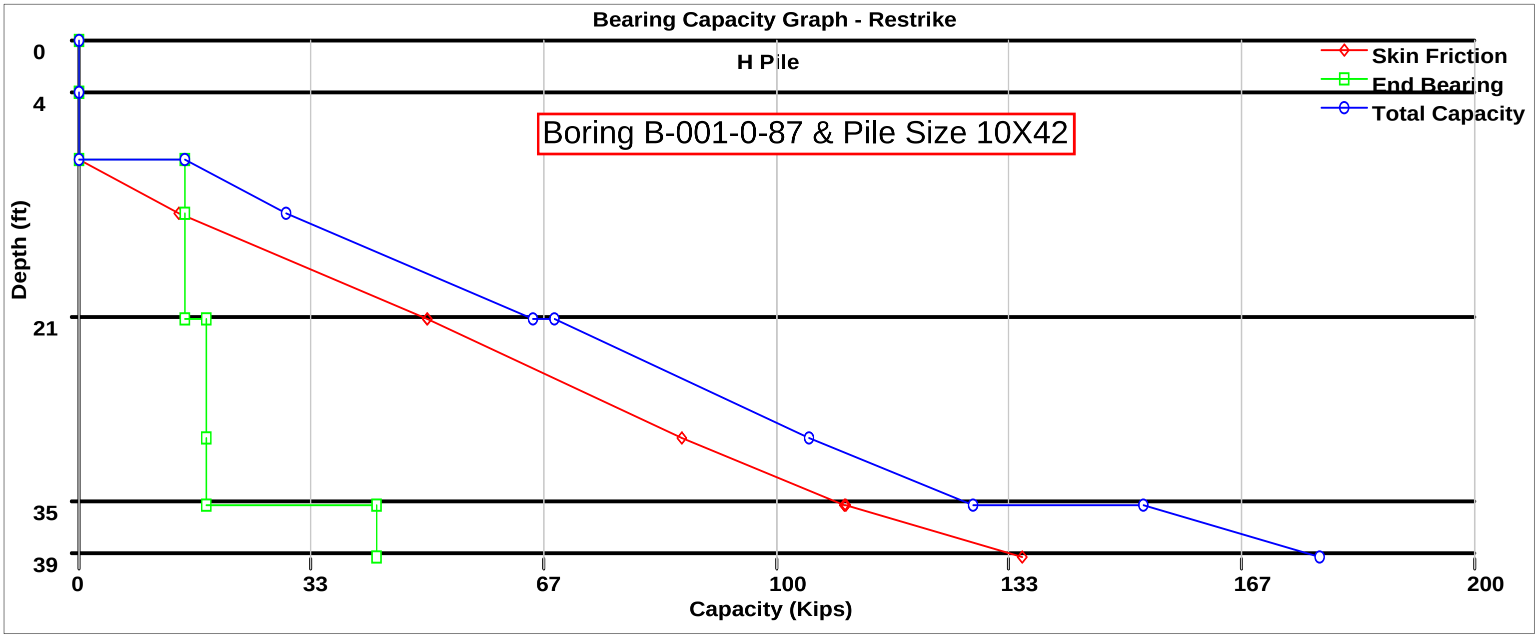
Calculation of Nominal Resistence of Side and Tip

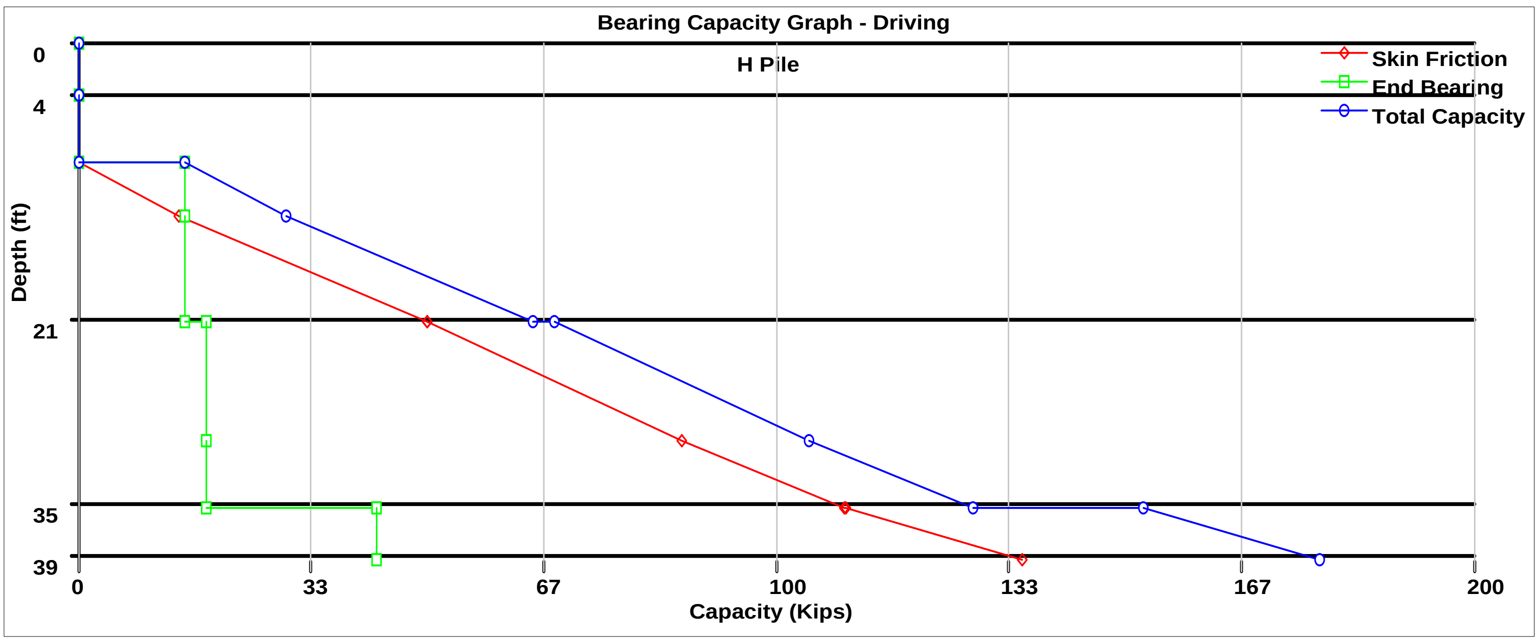
Shaft Socket Diameter, Br (feet):	**3**	**4**	**5**	**6**
Length of Socket, Dr (feet) :	4.5	6	7.5	9
Perimeter Area of Socket As (Sq. ft)	23.56	50.27	86.39	131.95
Cross-Sectional Area of Socket, Ap (Sq. ft)	7.07	12.57	19.63	28.27
Nominal Shaft Side Resistence, Rs (kips):	240.8	513.8	883.1	1348.7
Nominal Shaft Tip Resistence, Rp (kips):	36191.1	64339.8	100531.0	144764.6
Resistence Factor for Side from T. 10.5.5.2.4-1	0.55	0.55	0.55	0.55
Resistence Factor for Tip from T. 10.5.5.2.4-1	0.50	0.50	0.50	0.50
Factored Resistance from Side (kips)	132.5	282.6	485.7	741.8
Factored Resistance from Tip (kips)	18095.6	32169.9	50265.5	72382.3

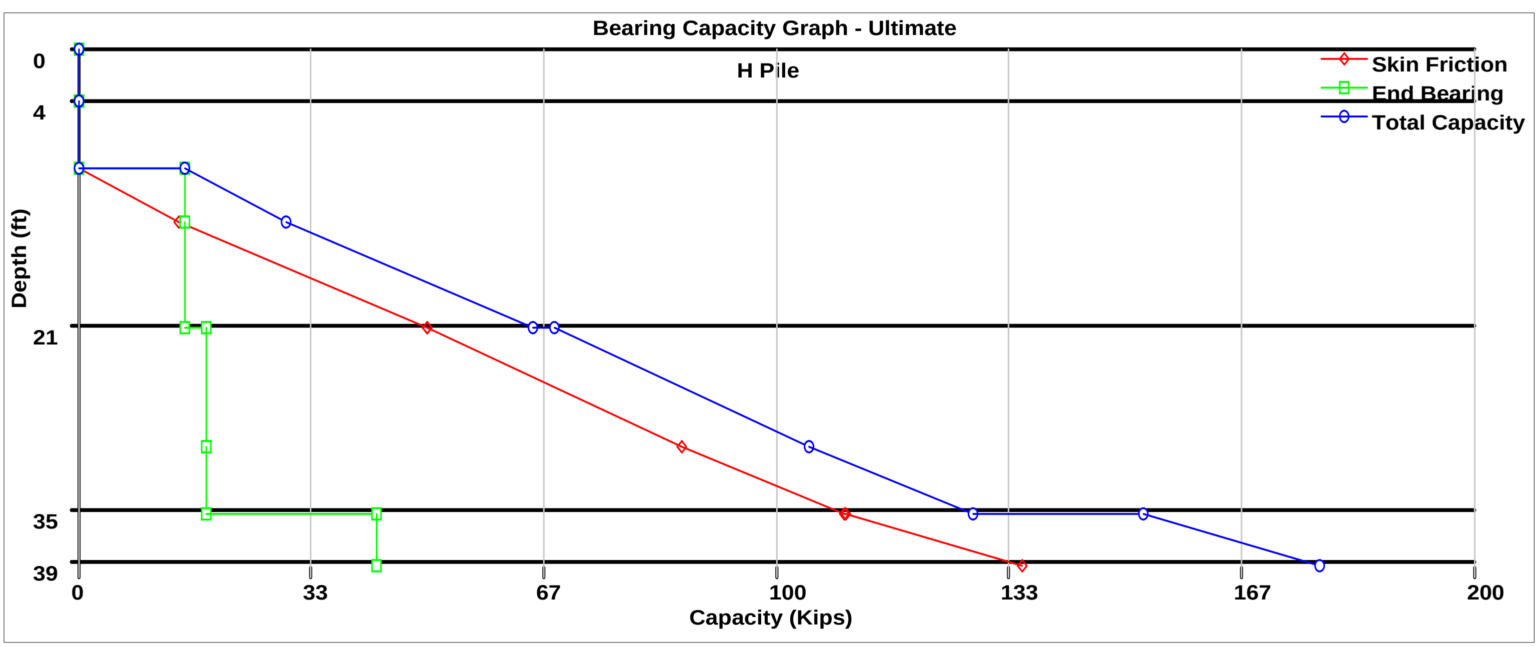
Butt settlement of drilled Shaft : Q((Dr/Ap*Ec)+(Ips/Br*Em))

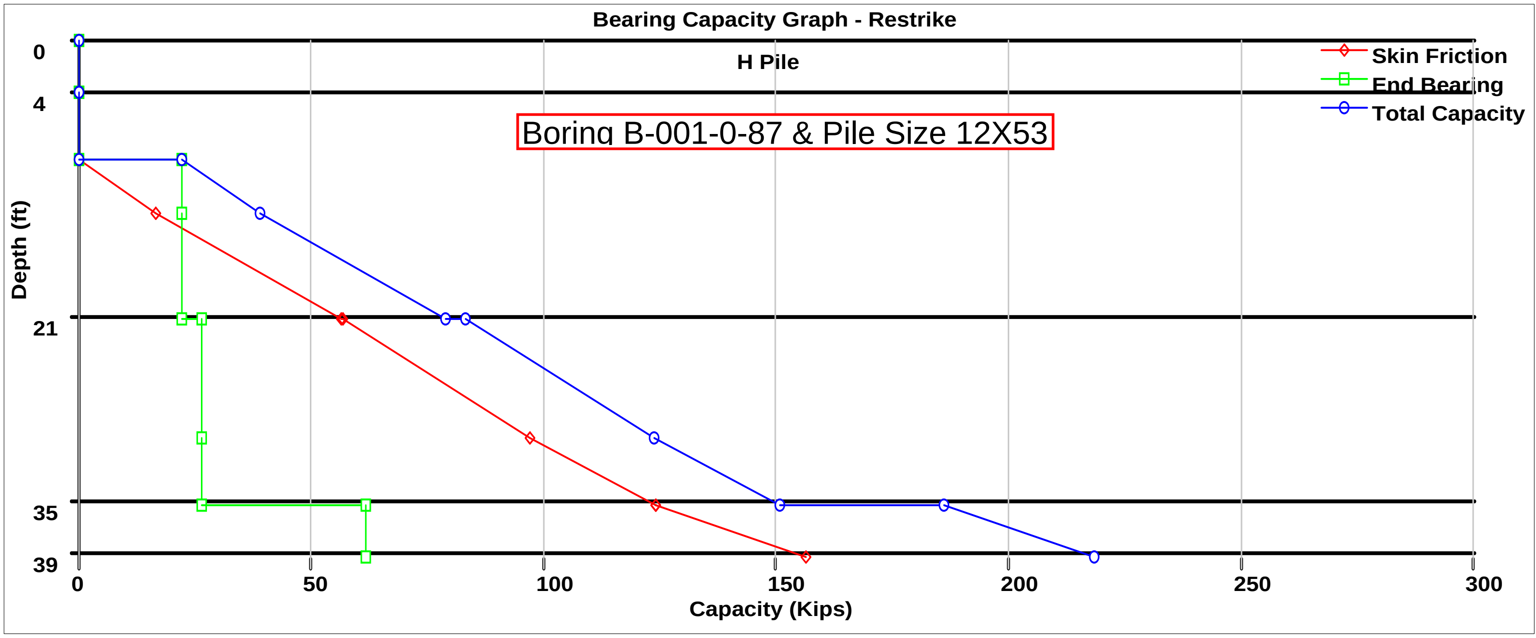
Note: Applied Axial load per shaft is obtained by limiting factored resistence to 0.4 inch of elastic settlement

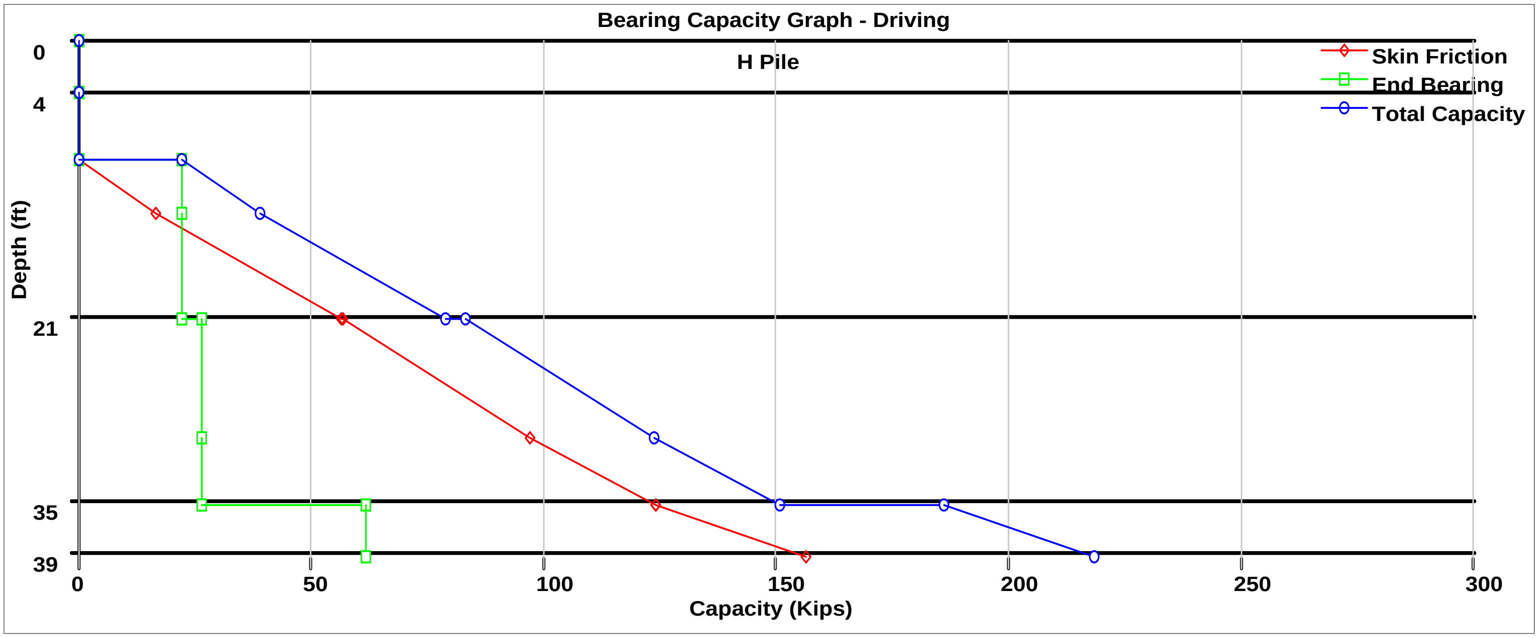
Applied Axial Load on Top of Socket, Q (kips)	858	858	858	858
Concrete Young's Modulus, Ec (kci)	3800	3800	3800	3800
Shortening of Drilled Shaft (Inches)	0.144	0.108	0.086	0.072
Rock Mass Modulus, Em (kci)	200.0	200.0	200.0	200.0
Ec/Em	19.0	19.0	19.0	19.0
Dr/Br	1.50	1.50	1.50	1.50
Influence Coefficient (Ips) from Fig 4.6.5.5.2A	0.30	0.30	0.30	0.30
(Modified after Pells and Turner (1979))				
Settlement of Base (inches)	0.429	0.322	0.257	0.215
Total Butt Settlement of Shaft (inches)	0.573	0.430	0.344	0.286

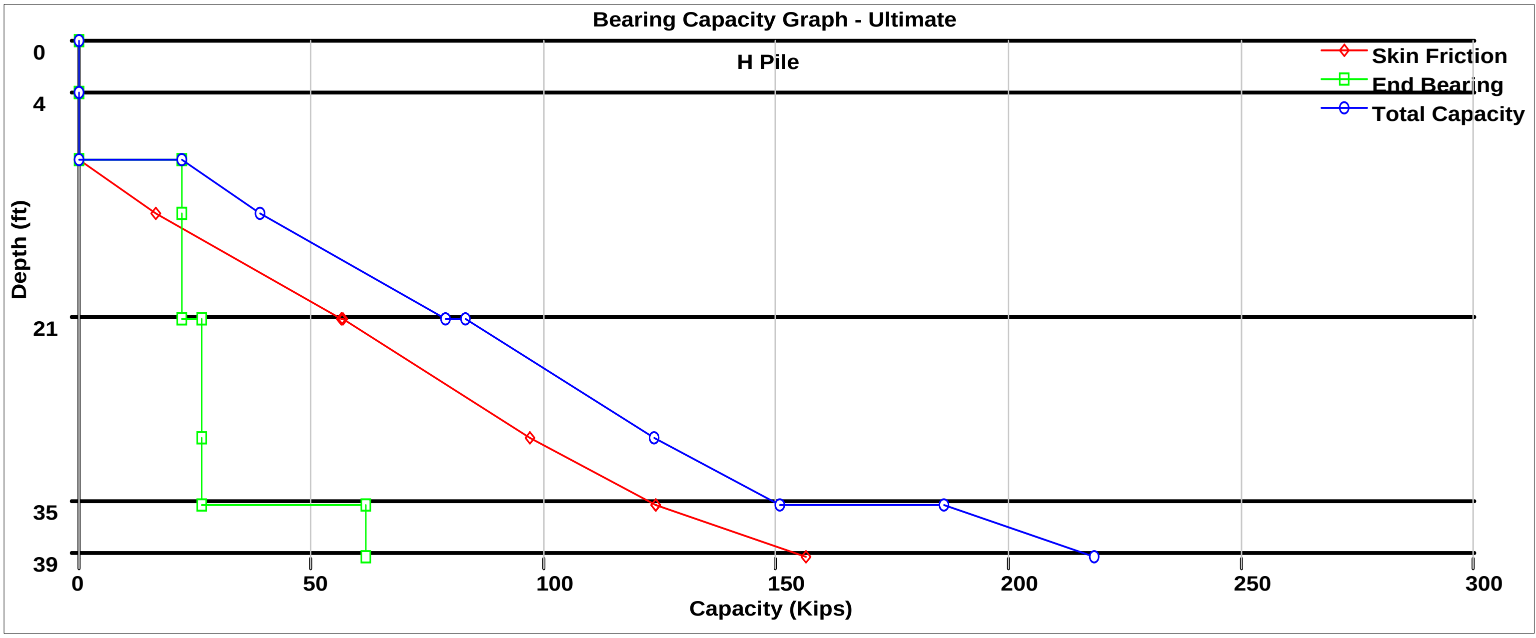

Bearing Capacity Graph - Restrike
H Pile
Boring B-001-0-87 & Pile Size 10X42
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
4
21
35
39
0
33
67
100
133
167
200
Capacity (Kips)

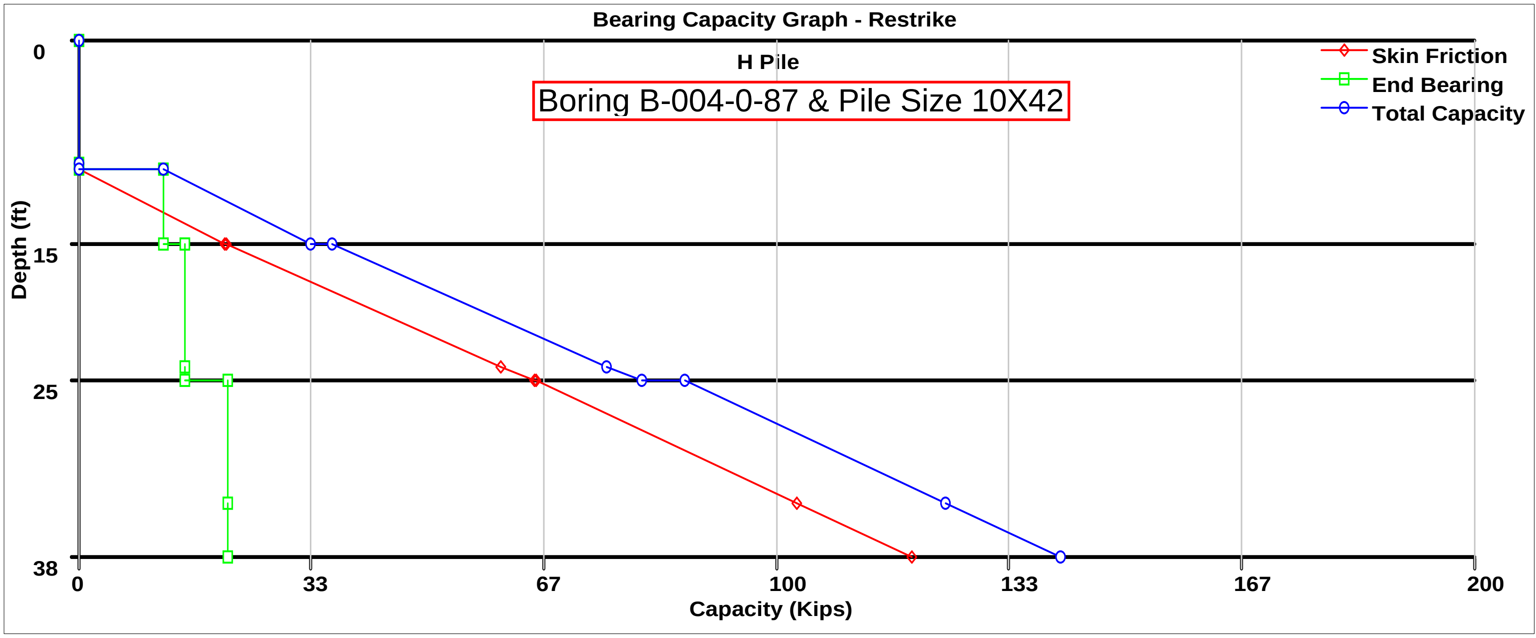

Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
4
21
35
39
0
33
67
100
133
167
200
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
4
21
35
39
0
33
67
100
133
167
200
Capacity (Kips)

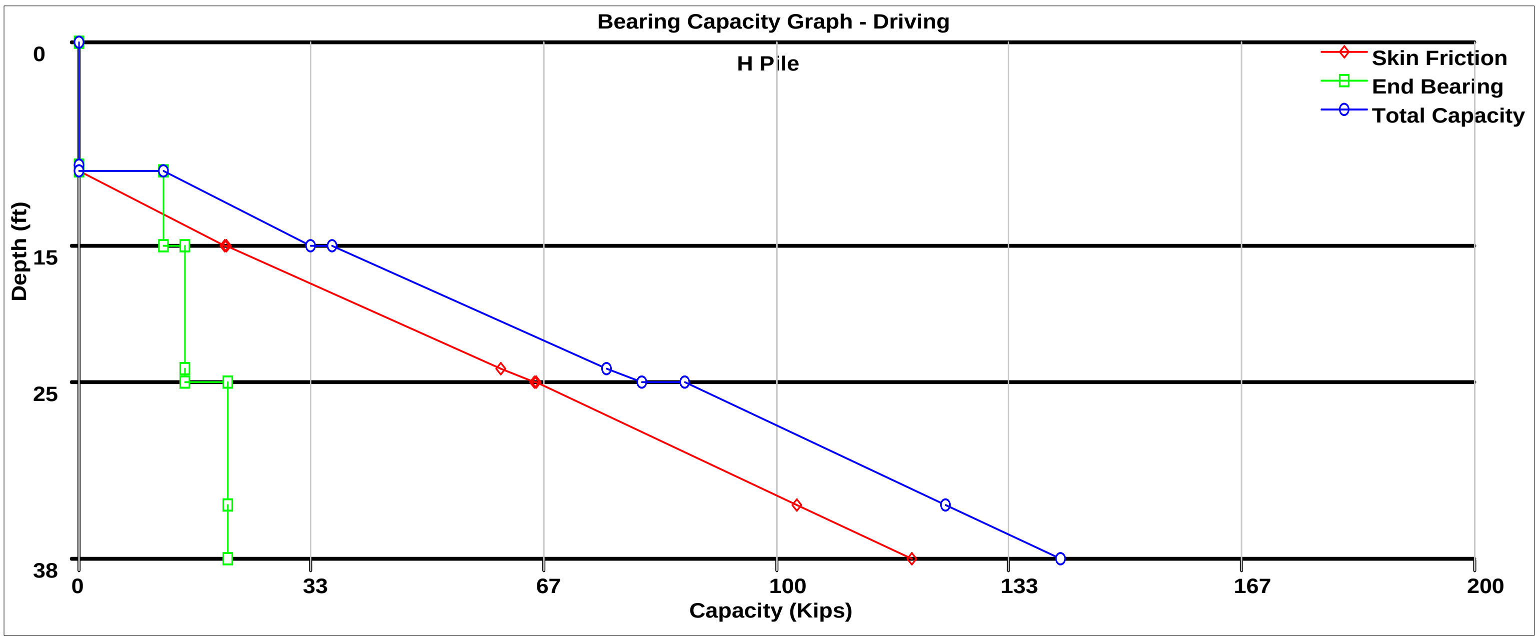

Bearing Capacity Graph - Restrike
H Pile
Boring B-001-0-87 & Pile Size 12X53
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
4
21
35
39
0
50
100
150
200
250
300
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
4
21
35
39
0
50
100
150
200
250
300
Capacity (Kips)

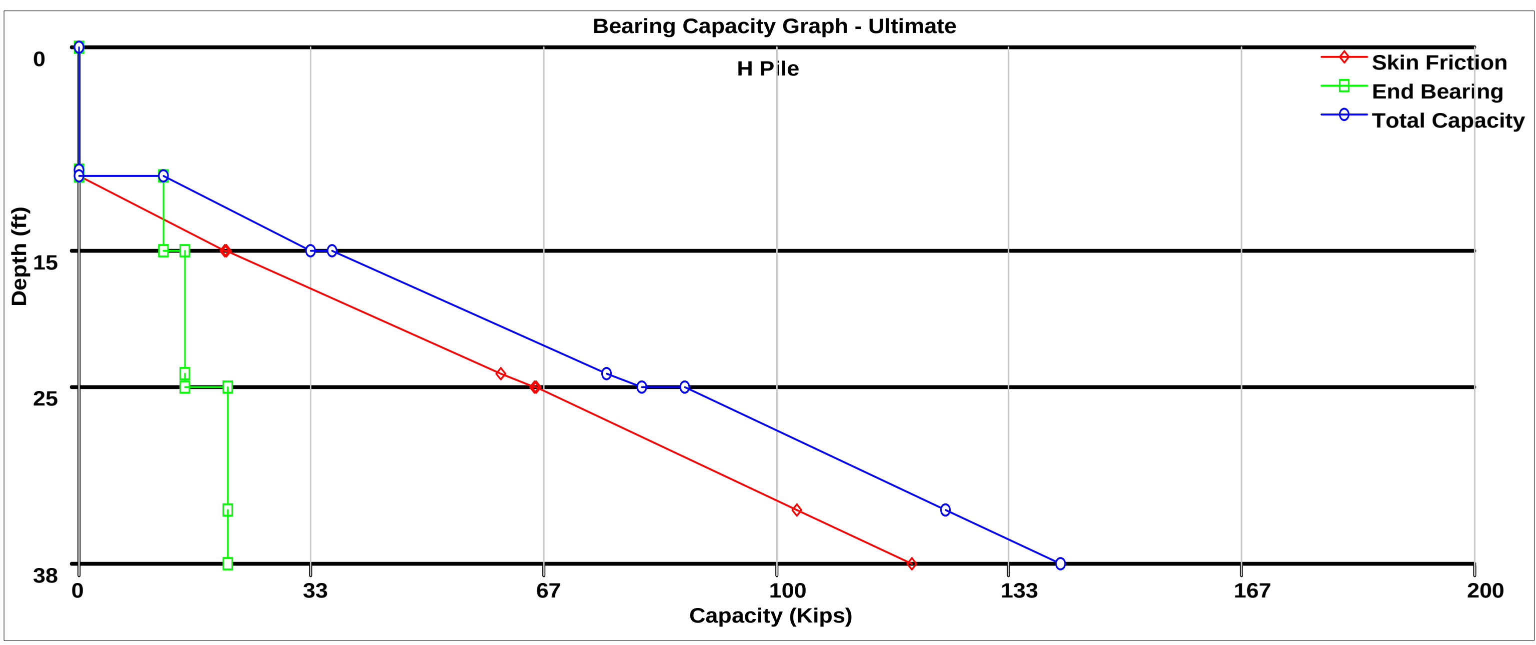

Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
4
21
35
39
0
50
100
150
200
250
300
Capacity (Kips)



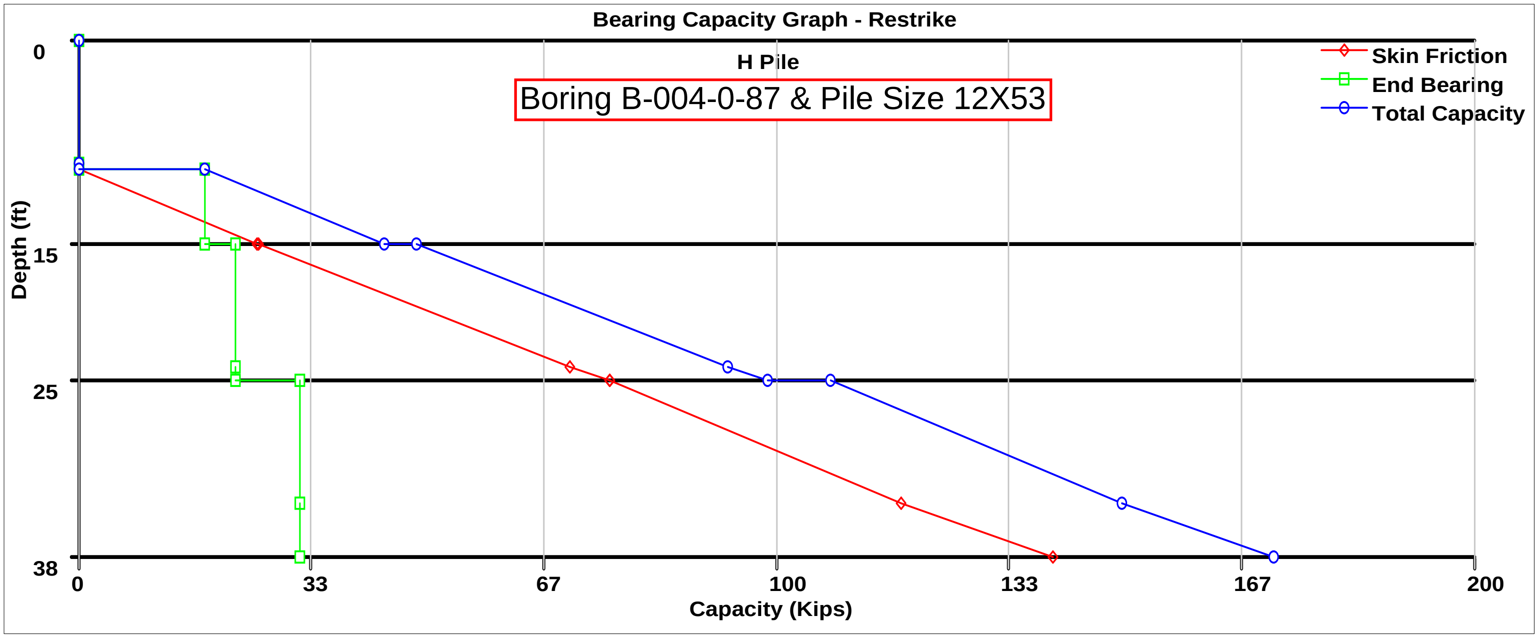
Bearing Capacity Graph - Restrike
H Pile
Boring B-004-0-87 & Pile Size 10X42
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
15
25
38
0
33
67
100
133
167
200
Capacity (Kips)

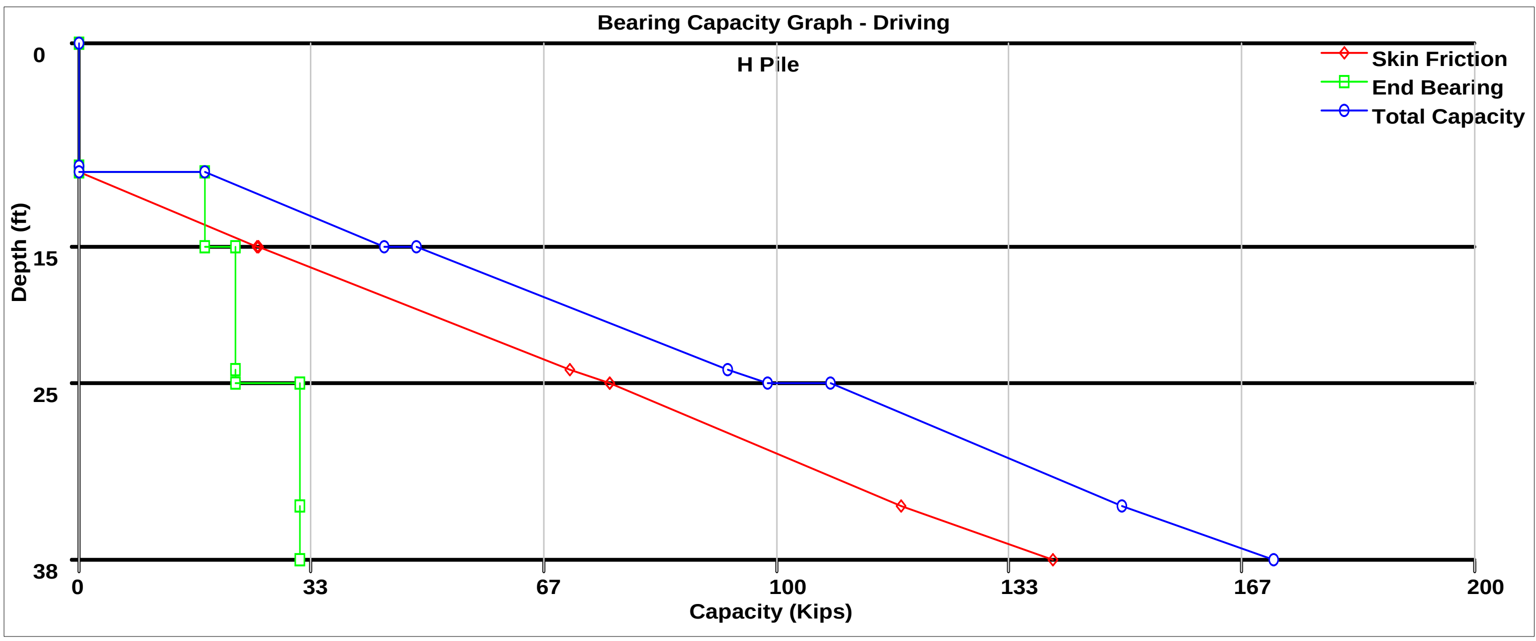


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
15
25
38
0
33
67
100
133
167
200
Capacity (Kips)



Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
15
25
38
0
33
67
100
133
167
200
Capacity (Kips)


Bearing Capacity Graph - Restrike
H Pile
Boring B-004-0-87 & Pile Size 12X53
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
15
25
38
0
33
67
100
133
167
200
Capacity (Kips)


Bearing Capacity Graph - Driving
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
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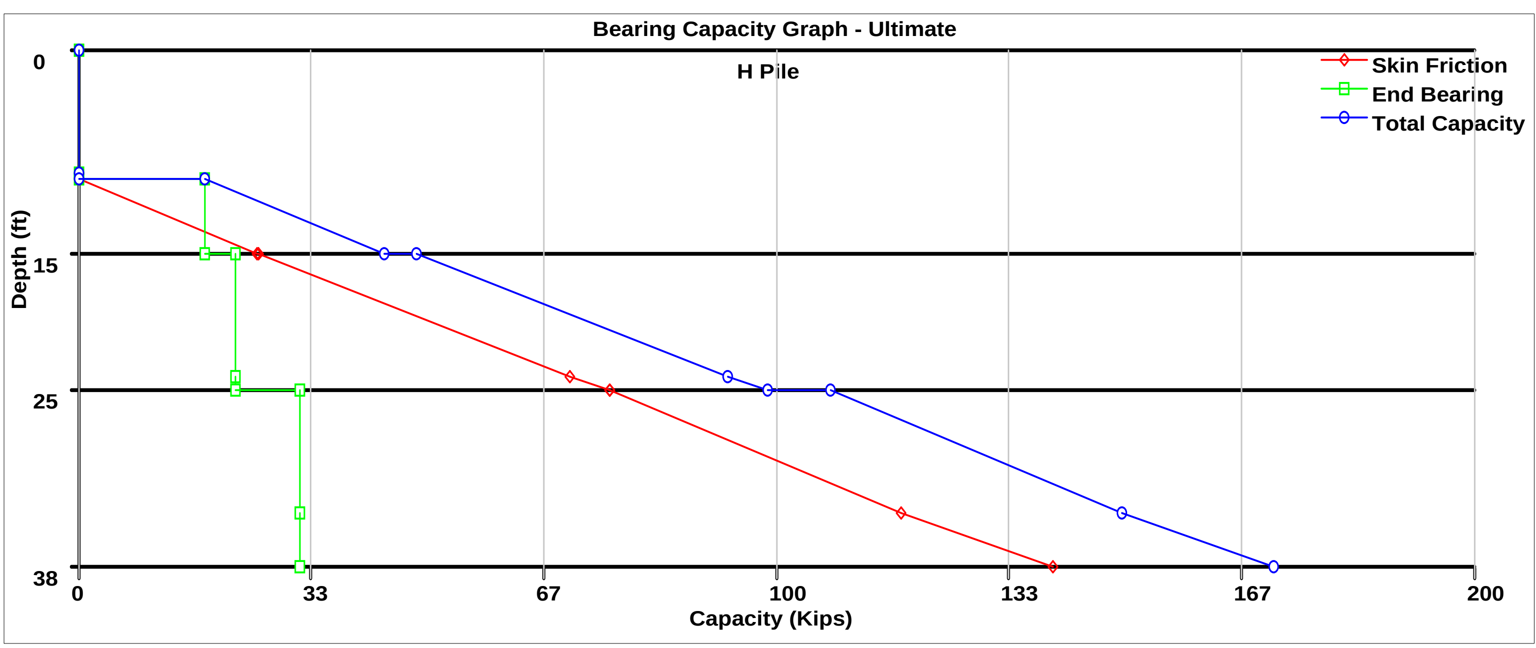
15
25
38
0
33
67
100
133
167
200
Capacity (Kips)


Bearing Capacity Graph - Ultimate
H Pile
Skin Friction
End Bearing
Total Capacity
Depth (ft)
0
15
25
38
0
33
67
100
133
167
200
Capacity (Kips)

Subgrade Analysis

V. 12.00 12/30/11

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

Design CBR 7

Total Borings	5
PID	87005
Location	FINDLAY, HANCOCK CO.

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	4	0	0	2	1	0	1	0	0
									50%			25%	13%		13%		
0%	0%								100%								

Surface Class		
2-5	0	
4b	0	
5	0	
7-5	0	
7-6	1	20%
8a	0	
8b	0	
R	0	

% Borings	
N_{60L}<= 5	0%
<=10	0%
>=20	0%
M+	80%
R	0%

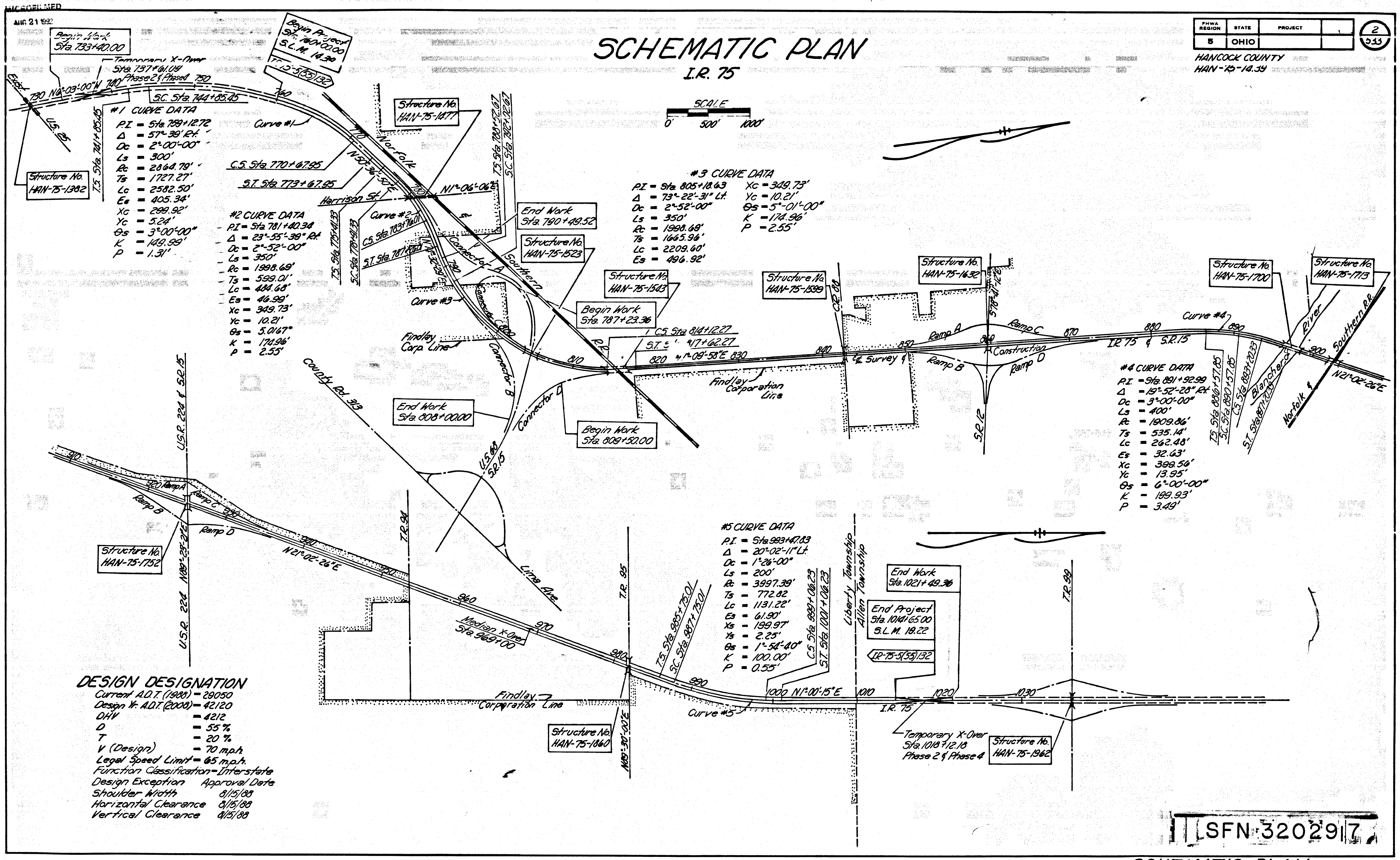
% Surface	
80%	
0%	80%

UC @ Surface
12.0
12
12

Rig	ER
A	60
B	
C	
D	
E	
F	
G	
H	

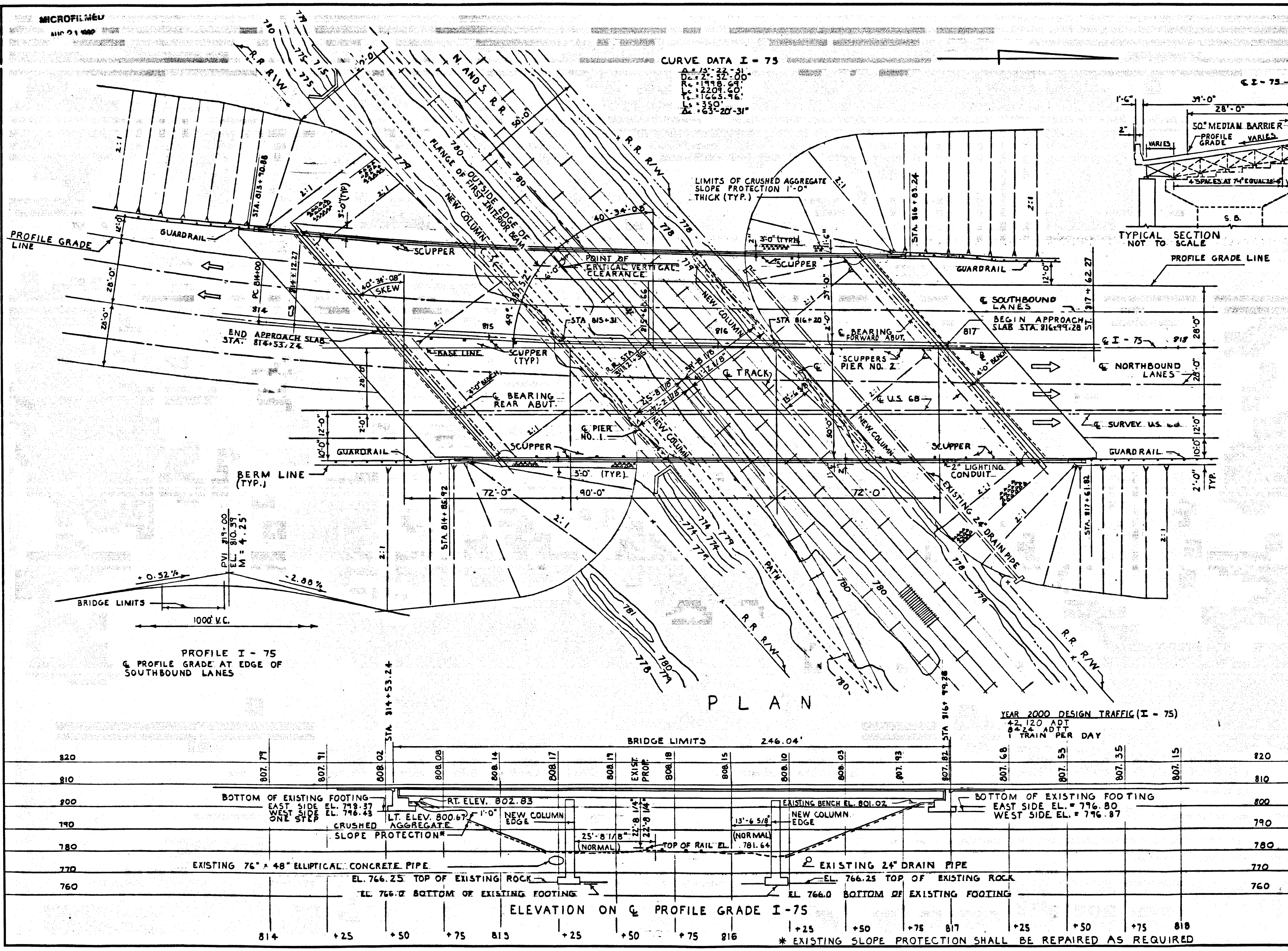
	N_{60}	N_{60L}	LL	PL	PI	% Silt	Clay	P 200	M	M_{OPT}	GI
Average					11.6		40.8		19.3	14.1	8.38
Maximum			41	22	24	44	55	99	26	18	14
Minimum			22	15	5	25	22	57	14	10	4

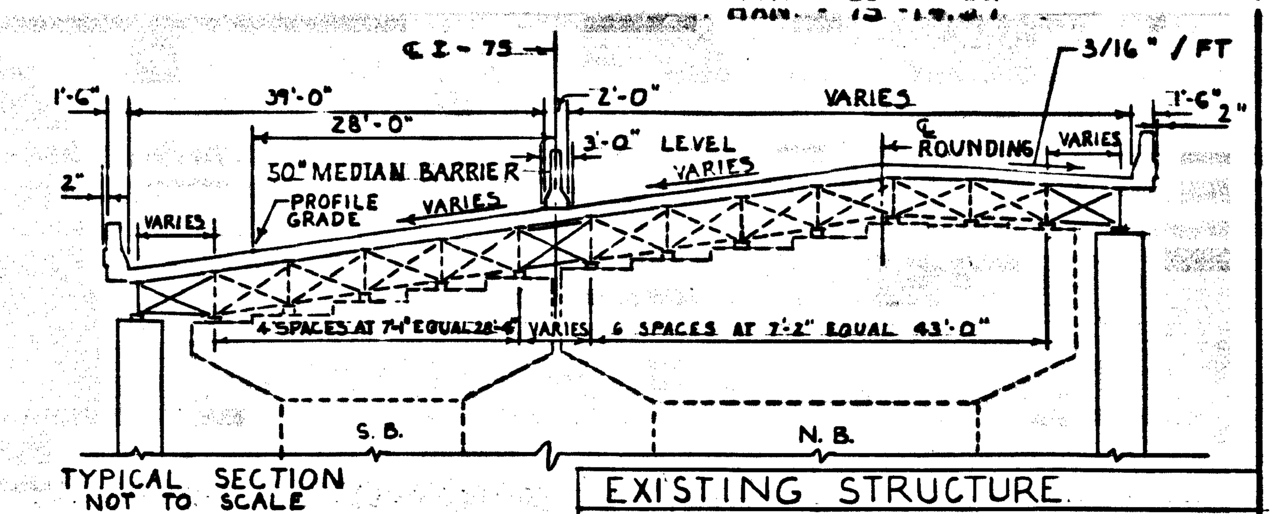
	Boring				Cut	Subgrade		Standard Penetration						Physical Characteristics						Moisture		Class		Comments	Problem		Undercuts		Analysis
#	B #	Boring Location	Depth	To	Fill	Depth	To	n_2	n_3	N	Rig	N_{60}	N_{60L}	LL	PL	PI	% Silt	% Clay	P 200	M	M_{OPT}	Ohio DOT	GI		w/ Class	w/ MN	UC Class	UC MN	
1	B-001-0-87	813+10.7, 8.1' LT	6.0	7.5	-5.0	1.0	2.5				A			22	15	7	35	22	57	16	10	4a	4			M		12	
			11.0	12.5		4.0	5.5							25	18	7	25	43	68	15	13	4a	7						
2	B-004-0-87	816+75.9, 43.0' RT	6.0	7.5	-5.0	1.0	2.5				A			26	18	8	32	39	71	14	13	4a	7						
			11.0	12.5		4.0	5.5							24	19	5	32	40	72	17	14	4a	7						
3	B-021-1-13	812+45.8, 92.7.0' LT	11.0	12.2	-10.0	1.0	2.2				A			34	19	15	39	41	80	25	14	6a	10			M		12	
4	B-022-1-13	815+30.7, 105.6.0' RT	3.5	5.0	0.0	3.5	5.0				A			41	17	24	44	37	81	24	18	7-6	14			M		12	
			8.5	10.0		4.0	5.5							30	19	11	44	55	99	17	14	6a	8						
5	B-024-0-13	815+94.7, 63.3' RT	8.5	10.0	-5.0	3.5	5.0				A			38	22	16	34	49	83	26	17	6b	10			M		12	
6					0.0						A																		
7					0.0						A																		
8					0.0						A																		
9					0.0						A																		
10					0.0						A																		
11					0.0						A																		



SCHEMATIC PLAN

FHWA REGION	STATE	PROJECT
5	OHIO	





EXISTING STRUCTURE

TYPE: 3 SPAN CONTINUOUS STEEL BEAM WITH REINFORCED CONCRETE SLAB AND REINFORCED CONCRETE SUBSTRUCTURE
SPANS: 72-90-72 C/C BEARINGS
ROADWAY: VARIES - WITH 2'-6" MEDIAN BARRIER
LOAD FREQUENCY: CF = 2000 (SI)
SKEW: 40°-34'-08" RF TO ℄
WEARING SURFACE: 1 1/4" LATEX CONCRETE OVERLAY
APPROACH SLABS: AS-1-54 (25'-0" LONG)
ALIGNMENT: I - 75, 2°-52' CURVE LEFT U.S. 68, TANGENT
SUPERELEVATION: VARIES.
NO. OF TRACKS: 3

PROPOSED STRUCTURE MODIFICATION

TYPE: NEW CONCRETE DECK AND WIDENING OF 5'-3" ON NORTH BOUND SIDE AND 7'-3" ON SOUTH BOUND SIDE, AND TURNBACK WING ABUTMENTS.
SPANS: 72-90-72 C/C BEARINGS
ROADWAY: VARIES WITH 2'-0" 50 INCH MEDIAN BARRIER
LOADING: HS20-44 AND ALTERNATE MILITARY LOADING, CASE I
SKEW: 40°-34'-08" RF TO ℄
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (25'-0" LONG)
ALIGNMENT: SAME AS EXISTING
SUPERELEVATION: VARIES.

NO. OF TRACKS: 3
DECK DESIGN: NON-COMPOSITE
TYPE OF STEEL: PAINTED A572

* EXISTING SLOPE PROTECTION SHALL BE REPAIRED AS REQUIRED

SFN 3202917

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES AND STRUCTURAL DESIGN

1 / 33

SITE PLAN

BRIDGE NO. HAN-75-1543
OVER N. AND S. RAILROAD

HANCOCK CO. STA. 814 + 53.24
SEC. HAN-75-14.41 816 + 99.28

DESIGNED	DRAWN	TRACED	CHECKED	REVIEWED	DATE	REVISED
SAH	SAH		ULH	MJR	7-15-87	11-17-87

MICROFILMED

GEOLOGY OF THE SITE

THE STRUCTURE SITE IS LOCATED IN THE RELATIVELY FLAT GLACIATED PORTION OF THE MISSISSIPPI VALLEY PLAIN REGION AT THE EDGE OF THE OLD MAUMEE BEACH RIDGE, IN AN AREA WHERE RELATIVELY THIN TO DEEP GLACIAL-DERIVED MATERIAL AND ALLUVIAL DEPOSITS OVERLIE DOLOMITIC LIMESTONE BEDROCK, OF THE MONROE FORMATION.

EXPLORATION

THE EXPLORATION CONSISTED OF THREE DRIVE SAMPLE-CORE BORINGS MADE BY MEANS OF A MECHANICALLY-POWERED HOLLOW STEM ROTARY AUGER MOUNTED ON A MOBILE PLATFORM, PERFORMED BETWEEN APRIL 27 AND MAY 21, 1987.

INVESTIGATIONAL FINDINGS AND OBSERVATIONS

THE TEST BORINGS DISCLOSED THAT INTERVALS OF EXTREMELY LOOSE TO DENSE UNSTRATIFIED BASIC SILTS AND CLAYS MODIFIED WITH SAND, GRAVEL AND VARYING PERCENTAGES OF EACH OTHER THAT GRADUALLY INCREASE (ERRATIC AT TIMES) IN DENSITY WITH INCREASE IN DEPTH OVERLIE VERY GENTLY SLOPING BEDROCK SURFACE. TEST BORING NO. B-1 (MADE IN THE GENERAL VICINITY OF THE REAR ABUTMENT) ENCOUNTERED BEDROCK SURFACE AT 39.5-FOOT DEPTH, ELEVATION 768.1 FEET AND CONTINUED TO ADVANCE TO A TOTAL DEPTH OF 45.0 FEET, ELEVATION 762.5 FEET WHERE THE BORING WAS TERMINATED AFTER HAVING PENETRATED 5.5 FEET BELOW BEDROCK SURFACE. MATERIAL LADEN WITH BOULDERS WAS ENCOUNTERED IN TEST BORING NO. B-1 AT 17.0 TO 25.0-FOOT DEPTH, ELEVATION 790.6 TO 782.6 FEET. TEST BORING NO. B-2 (MADE IN THE GENERAL VICINITY OF THE REAR PIER) ENCOUNTERED BEDROCK SURFACE AT 12.5-FOOT DEPTH, ELEVATION 767.2 FEET AND CONTINUED TO ADVANCE TO A TOTAL DEPTH OF 25.0 FEET, ELEVATION 754.7 FEET WHERE THE BORING WAS TERMINATED AFTER HAVING PENETRATED 12.5 FEET BELOW BEDROCK SURFACE. TEST BORING NO. B-3 (MADE IN THE GENERAL VICINITY OF THE FORWARD ABUTMENT) ENCOUNTERED BEDROCK SURFACE AT 38.5-FOOT DEPTH, ELEVATION 768.9 FEET AND CONTINUED TO ADVANCE TO A TOTAL DEPTH OF 43.0 FEET, ELEVATION 764.4 FEET WHERE THE BORING WAS TERMINATED AFTER HAVING PENETRATED 4.5 FEET BELOW BEDROCK SURFACE.

CRUSHING STRENGTH TESTS PERFORMED ON THE UNDERLYING DOLOMITIC LIMESTONE THROUGHOUT THE AREA AVERAGED 13,300.50 POUNDS PER SQUARE INCH.

NO FREE WATER OBSERVATIONS WERE MADE IN ANY OF THE TEST BORINGS PERFORMED DURING, OR AT THE CONCLUSION OF DRILLING OPERATIONS.

LEGEND

Auger Boring Location - Plan View.

Press and / or Drive Sample and / or Core Boring Location - Plan View.

Drive Rod Penetration Resistance Sounding Location - Plan View.

Capped Pile

Footing

Footing on Pile

TR — Top of Rock

Horizontal Bar on Boring Log Indicates the Depth the Sample Was Taken.

X/Y/Z — Figures beside the Boring Log in Profile Indicate the Number of Blows for Standard Penetration Test.
X = Number of Blows for First 6 inches.
Y = Number of Blows for Second 6 inches.
Z = Number of Blows for Third 6 inches.

Drive Rod Penetration Resistance Sounding Log - Profile

Casing

Resistance "R" < 10,000 lbs.

Resistance "R" > 10,000 lbs.

Z — Indicates Final Measurement of Penetration, in Inches.

W — Indicates Free Water Elevation.

Indicates Static Water Elevation.

SYMBOLS OF ROCK TYPES

Coal

Weathered Mudstone or Claystone

Mudstone or Claystone

Weathered Shale

Shale

Weathered Siltstone

Siltstone

Weathered Sandstone

Sandstone

Leached Dolomite

Dolomite

Leached Limestone

Limestone

Boulders or Cobbles

GENERAL INFORMATION

Drive Rod Penetration Sounding Tests

Drive rod penetration resistance tests constitute driving a 1.315-inch diameter steel rod, with a 45° cone point, into the ground, using a 122-pound drop-hammer with a free fall of five feet. At one or two-foot depth intervals, a measurement is taken to determine the amount of penetration achieved in three hammer drops. This reading is converted to an empirical value for capacity "R", in thousands of pounds (which is a measure of both the point resistance and frictional resistance on the rod), by using charts prepared by the Ohio Department of Highways, Bureau of Bridges, on the basis of correlation study of rod penetration with past performance of pile driving. For interpretation, a graph is prepared by plotting the value "R" against the depth at which the reading was taken, and connecting the plotted points. The curve so obtained reflects the density of subsurface materials in a manner that can be readily compared with data from similar tests at other locations on the structure site. From this comparison, the overall uniformity of subsurface condition may be evaluated.

Drive Sample Borings - Drive-Press Sample Borings

Drive sample borings are made by means of a rotary-type drill rig, employing a 2" O.D., 1-3/8" I.D. sampler, at 2-1/2 and / or 5-foot depth intervals, driven by means of a 140 - pound drop-hammer with a free fall of 30 inches. The number of blows required to drive the sampler 6 inches is considered the standard penetration test.

Drive-press sample borings are made by means of a rotary-type drill rig, employing a 2" O.D., 1-3/8" I.D. drive sampler, and 3" O.D. thin-wall press sampler. The press sampler is advanced by continuous [illegible] pressure, applied by the drill rig.

The boring log sheets show a graphic plot of the information obtained, including depth and elevation of the sample, number of blows for the standard penetration tests in three 6-inch increments, depth of press samples, field sample number, sample description - based on laboratory tests and the Casagrande AC classification system - and gradation, plasticity, and moisture content determinations. Results of strength and consolidation testing, if performed, appear on separate enclosures.

At depths where materials are bouldery or gravelly to the extent that the sampler can not be driven, a wash sample is procured for visual classification, in order to determine the general character of the material. These samples are not considered sufficiently representative to warrant laboratory testing.

Particle Size Definitions

Boulders | 12" | Cobbles | 3" | Gravel | 2.0mm (No. 10 sieve) | Coarse Sand | 0.42mm (No. 40 sieve) | Fine Sand | 0.074mm (No. 200 sieve) | Silt | 0.005mm | Clay

NOTE - ALL AVAILABLE SOIL AND BEDROCK INFORMATION WHICH CAN BE CONVENIENTLY SHOWN ON THE STRUCTURE FOUNDATION INVESTIGATION SHEETS HAS BEEN SO REPORTED. ADDITIONAL SUBSURFACE INVESTIGATIONS MAY HAVE BEEN MADE TO STUDY SOME SPECIAL ASPECT OF THE PROJECT. COPIES OF THIS DATA, IF ANY, MAY BE INSPECTED IN THE DISTRICT DEPUTY DIRECTOR'S OFFICE, THE BUREAU OF TESTS AT 1600 WEST BROAD STREET, THE PAVEMENT AND SOILS SECTION OF THE BUREAU OF LOCATION AND DESIGN OR IN THE BRIDGE BUREAU AT 25 SOUTH FRONT STREET.

Revised 8/17/87

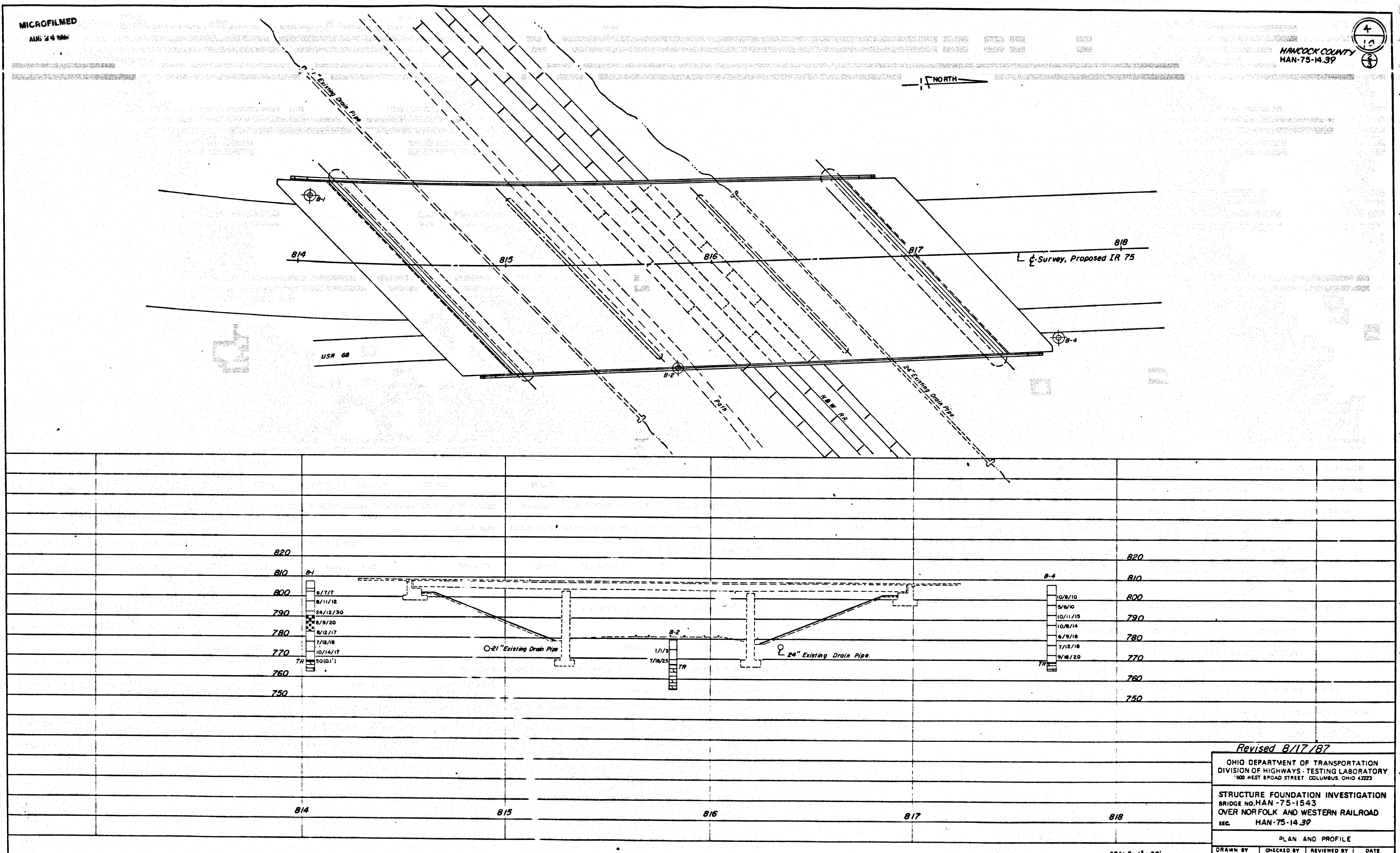
NOTE: [illegible]

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

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. HAN-75-1543
OVER NORFOLK AND SOUTHERN RAILROAD
SEC. HAN-75-14.39

CHECKED BY	REVIEWED BY	DATE
L.N.L.	R.D.R.	6/4/87

SFN 3202917



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Revised 8/17/87

OHIO DEPARTMENT OF TRANSPORTATION DIVISION OF HIGHWAYS - TESTING LABORATORY 1600 WEST BROAD STREET COLUMBUS, OHIO 43223			
STRUCTURE FOUNDATION INVESTIGATION BRIDGE NO. HAN-75-1543 OVER NORFOLK AND WESTERN RAILROAD SEC. HAN-75-14.39			
PLAN AND PROFILE			
DRAWN BY	CHECKED BY	REVIEWED BY	DATE
A.F.	L.N.L.	R.D.R.	6/4/87

SFN 3202917

MICROFILMED
AUG 24 1992

HANCOCK COUNTY
HAN-75-14.39

5/10

3/3

LOG OF BORING

Date Started 5/7/87 Sampler Type SS Dia. 1 3/8" Water Elev.
Date Completed 5/12/87 Casing: Length Dia.
Boring No. B-1 Station & Offset 814+06, 33' LT. (REAR ABUTMENT) Surface Elev. 807.6'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
807.6	0	AUGERED			ASPHALT	-	-	-	-	-	-	-	-	-	VISUAL
	2	AUGERED			GRAVEL (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	VISUAL
802.6	6	6/7/7			GRAY SANDY SILT	1	10	3	8	44	35	22	7	16	A-4a
797.6	12	8/11/12			GRAY SANDY GRAVELLY SILT	2	16	4	12	25	43	25	7	15	A-4a
792.6	16	24/12/30			BROWN AND GRAY SANDY SILT	3	0	5	27	29	39	27	8	13	A-4a
790.6	18	AUGERED			BOULDERY ZONE (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	VISUAL
787.6	22	8/9/20			BROWN SANDY GRAVELLY CLAY WITH BOULDERS	4	27	4	13	23	33	28	13	14	A-6a
782.6	26	8/12/17			BROWN AND GRAY GRAVELLY CLAY	5	25	4	10	29	32	30	13	20	A-6a
777.6	32	7/12/28			BROWN AND GRAY GRAVELLY SANDY CLAY	6	15	3	15	29	38	35	22	15	A-6b
772.6	36	18/14/17			GRAY GRAVELLY SILT	7	14	0	11	45	30	20	2	24	A-4a
768.1					TOP OF ROCK										
767.6	40	50(0.1')			GRAY BROKEN LIMESTONE	8	-	-	-	-	-	-	-	12	VISUAL
767.5	42		4.2	0.7	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED AND VUGGY, BROKEN AND JOINTED. CORE LOSS 13%.										
762.5	44				BOTTOM OF BORING										

LOG OF BORING

Date Started 5/21/87 Sampler Type SS Dia. 1 3/8" Water Elev.
Date Completed 5/21/87 Casing: Length Dia.
Boring No. B-2 Station & Offset 815+82, 52' RT. (FORWARD ABUTMENT) Surface Elev. 779.7'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
779.7	0														
777.7	2	AUGERED			BROWN SANDY CLAY W/GRAVEL (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	VISUAL
774.7	6	1/1/3			BROWN SANDY SILT	1	2	3	44	31	20	NP	NP	19	A-4a
769.7	12	7/18/25			GRAY SANDY SILT	2	10	5	21	32	32	17	4	17	A-4a
767.2					TOP OF ROCK										
	14		2.5	0.0											
	18		5.0	0.0	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED AND VUGGY, BROKEN AND JOINTED. NO CORE LOSS.										
	22		5.0	0.0											
754.7					BOTTOM OF BORING										

LOG OF BORING

Date Started 4/27/87 Sampler Type SS Dia. 1 3/8" Water Elev.
Date Completed 4/28/87 Casing: Length Dia.
Boring No. B-4 Station & Offset 817+68, 43' RT. (FORWARD ABUTMENT) Surface Elev. 807.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Sample No.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class.
807.4	0														
806.9		AUGERED			ASPHALT	-	-	-	-	-	-	-	-	-	VISUAL
802.4	6	10/8/10			GRAY AND BROWN SANDY SILT	1	8	6	15	32	39	26	8	14	A-4a
797.4	12	5/6/10			BROWN SANDY SILT	2	6	6	16	32	40	24			A-4a
792.4	16	10/11/15			GRAY CLAYEY SILT	3	5	5	7	34	49	23	9	16	A-4a
787.4	22	10/8/14			GRAY SANDY SILT	4	6	6	16	34	38	24	8	13	A-4a
782.4	26	6/9/18			BROWN AND GRAY CLAYEY SILT	5	0	2	15	30	53	25	8	15	A-4a
777.4	32	7/12/18			GRAY AND BROWN SANDY SILT	6	0	1	41	31	27	25	7	23	A-4a
772.4	36	9/18/20			BROWN SANDY SILT	7	8	5	19	33	35	24	7	23	A-4a
768.9					TOP OF ROCK										
768.4	40				BROKEN DOLOMITIC LIMESTONE	-	-	-	-	-	-	-	-	-	VISUAL
	42		3.9	0.1	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, EXTREMELY VUGGY AND VERY BADLY BROKEN AND JOINTED. CORE LOSS 2%.										
764.4					BOTTOM OF BORING										

SFN 3202917

Revised 8/17/87

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

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. HAN-75-1543
OVER NORFOLK AND SOUTHERN RAILROAD
SEC. HAN-75-14.39

BORING DATA

TYPED BY	CHECKED BY	REVIEWED BY	DATE
S.M.G.	L.N.L.	R.D.R.	6/4/87

MICROFILMED BY THE O.D.O.T. MICROFILM SECTION. DOCUMENT IS OF VERY POOR QUALITY.

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 4/27/87 Sampler: Type SS Dia. 1 3/8" Water Elev.
Date Completed 4/28/87 Casing: Length Dia.

Project Identification: HANCOCK COUNTY
HAN-75-1543
OVER NORFOLK & WESTERN RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-4 Station & Offset 817+68, 43' RT. (NORTH ABUTMENT) Surface Elev. 807.4'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTL Class
								Physical Characteristics								
807.4	0															VISUAL
806.9		AUGERED			ASPHALT											
	2															
	4															
802.4	6	10/8/10			GRAY AND BROWN SANDY SILT	1	49556	8	6	15	32	39	26	8	14	A-4a
	8															
797.4	10															
	12	5/6/10			BROWN SANDY SILT	2	49557	6	6	16	32	40	24	5	17	A-4a
	14															
792.4	16	10/11/15			GRAY CLAYEY SILT	3	49558	5	5	7	34	49	23	9	16	A-4a
	18															
787.4	20															
	22	10/8/14			GRAY SANDY SILT	4	49559	6	6	16	34	38	24	8	13	A-4a
	24															
782.4	26	6/9/18			BROWN AND GRAY CLAYEY SILT	5	49560	0	2	15	30	53	25	8	15	A-4a
	28															
777.4	30															
	32	7/12/18			GRAY AND BROWN SANDY SILT	6	49561	0	1	41	31	27	25	7	23	A-4a
	34															
772.4	36	9/18/20			BROWN SANDY SILT	7	49562	8	5	19	33	35	24	7	23	A-4a

Form TE-163 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

Boring No. B-4 Station & Offset 817+68, 43' RT. Surface Elev 807.4' Project: HAN-75-1543

Elev	Depth	Std. Pen (N)	Rec. ft.	Loss ft.	Description	Field No	Lab. Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL. Class
768.9	38				BROKEN DOLOMITIC LIMESTONE — TOP OF ROCK	-	-	-	-	-	-	-	-	-	-	VISUAL
768.4	40		3.9	0.1	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED, EXTREMELY VUGGY AND VERY BADLY BROKEN AND JOINTED. CORE LOSS 2%.											
	42															
764.4					BOTTOM OF BORING											
	44															
	46															
	48															
	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

LOG OF BORING

Date Started 5/21/87 Sampler: Type SS Dia. 1 3/8" Water Elev. ______
Date Completed 5/21/87 Casing: Length ______ Dia. ______

Project identification: HANCOCK COUNTY
HAN-75-1543
OVER NORFOLK & WESTERN RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-2 Station & Offset 815+82, 52' RT. (NORTH PIER) Surface Elev. 779.7'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. So.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTL Class
779.7	0															
777.7	2	AUGERED			BROWN SANDY CLAY W/GRAVEL (DRILLER'S DSCPTN)	-	-	-	-	-	-	-	-	-	-	VISUAL
774.7	6	1/1/3			BROWN SANDY SILT	1	49772	2	3	44	31	20	NP	NP	19	A-4a
769.7	12	7/18/25			GRAY SANDY SILT	2	49773	10	5	21	32	32	17	4	17	A-4a
767.2					TOP OF ROCK											
	14		2.5	0.0	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED AND VUGGY, BROKEN AND JOINTED. NO CORE LOSS.											
	18		5.0	0.0												
	22–24		5.0	0.0												
754.7					BOTTOM OF BORING											

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

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 5/7/87 Sampler: Type SS Dia. 1 3/8" Water Elev. ____
Date Completed 5/12/87 Casing: Length ____ Dia. ____

Project Identification: HANCOCK COUNTY
HAN-75-1543
OVER NORFOLK & WESTERN RAILROAD
STRUCTURE FOUNDATION INVESTIGATION

Boring No. B-1 Station & Offset 814+04, 33' LT. (SOUTH ABUTMENT) Surface Elev. 807.6'

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab Nos. So.	% Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTL Class
807.6	0	AUGERED			ASPHALT	-	-	-	-	-	-	-	-	-	-	VISUAL
	2	AUGERED			GRAVEL (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	-	VISUAL
	4															
802.6	6	6/7/7			GRAY SANDY SILT	1	49641	10	3	8	44	35	22	7	16	A-4a
	8															
797.6	10															
	12	8/11/12			GRAY SANDY GRAVELLY SILT	2	49642	16	4	12	25	43	25	7	15	A-4a
	14															
792.6	16	24/12/30			BROWN AND GRAY SANDY SILT	3	49643	0	5	27	29	39	27	8	13	A-4a
790.6	18	AUGERED			BOULDERY ZONE (DRILLER'S DESCRIPTION)	-	-	-	-	-	-	-	-	-	-	VISUAL
787.6	20															
	22	8/9/20			BROWN SANDY GRAVELLY CLAY WITH BOULDERS	4	49644	27	4	13	23	33	28	13	14	A-6a
	24															
782.6	26	8/12/17			BROWN AND GRAY GRAVELLY CLAY	5	49645	25	4	10	29	32	30	13	20	A-6a
	28															
777.6	30															
	32	7/12/18			BROWN AND GRAY GRAVELLY SANDY CLAY	6	49694	15	3	15	29	38	35	22	15	A-6b
	34															
772.6	36	10/14/17			GRAY GRAVELLY SILT	7	49695	14	0	11	45	30	20	2	24	A-4a

Form TE-53 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

Boring No. B-1 Station & Offset 814+04, 33' LT. Surface Elev. 807.6' Project: HAN-75-1543

Elev.	Depth	Std. Pen (N)	Rec. ft	Loss ft.	Description	Field No.	Lab. Nos. So.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL Class
	38				TOP OF ROCK											
768.1	40															
767.6		50(0.1)			GRAY BROKEN LIMESTONE	8	49696	–	–	–	–	–	–	–	12	VISUAL
767.5	42															
	44		4.2	0.7	DOLOMITIC-LIMESTONE, GRAY, HARD, DENSE, SOMEWHAT LEACHED AND VUGGY, BROKEN AND JOINTED. CORE LOSS 13%.											
762.5					BOTTOM OF BORING											
	46															
	48															
	50															
	52															
	54															
	56															
	58															
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

VI.D. Geotechnical Reports

C-R-S: HAN-75-14.39-Bridge No. HAN-75-1540	PID:87005	Reviewer:SS	Date:8/25/2014

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-Bridge No. HAN-75-1540	PID:87005	Reviewer:SS	Date:8/25/2014

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	Bridge Foundations will bear on bedrock
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 Strength Test of Bedrock

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:	Lateral Load Analysis will be performed by PB
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?	To be estimated by PB
[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

LABORATORY TEST STANDARDS

STANDARD	REFERENCE NUMBER
I. Soil/Rock Testing	
Description and Identification of Soils (Visual-Manual Procedures)	ASTM D 2488
Classification of Soils for Engineering Purposes (USCS).	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
Compressive Strength of Intact Rock Core Specimens	ASTM D 7012
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

STANDARD	REFERENCE NUMBER
Compressive Strength for 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 AASHTO	Classifcation OHIO	LL_O/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
	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

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

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

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.

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.

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.

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"

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.

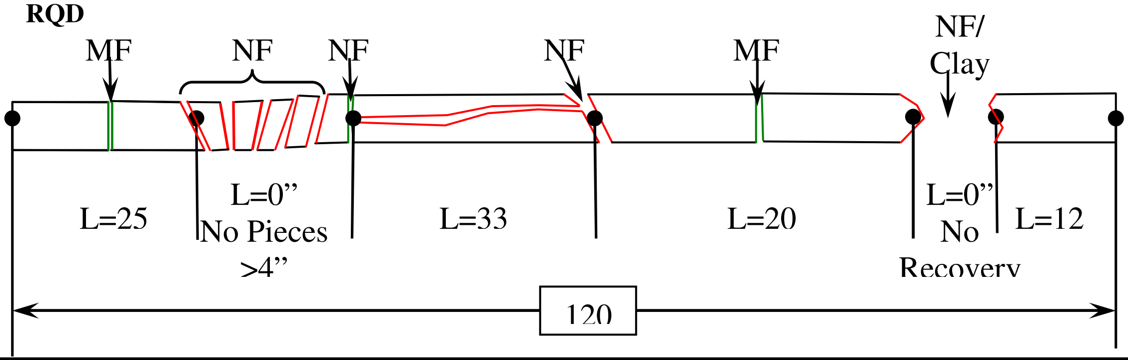
10) LOSS

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

L_R=Run Length R_R=Run Recovery

L_U=Rock Unit Length R_U=Rock Unit Recovery

9) RQD



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

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