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July 8, 2025

BG Engineering Group, LLC
5960 Wilcox Place, Suite C
Dublin, OH 43016

Attention: Greg Boyer P.E. – Principal

Reference: Structure Foundation Exploration Report – Final
HIG-73-21.11 Bridge Replacement
PID No. 119769, Agreement No. 40928
Jackson Township, Highland County, Ohio
CTL Project No. 25050005COL

Dear Mr. Boyer:

CTL Engineering, Inc. (CTL) has completed the geotechnical exploration report for the above referenced project. We are providing an electronic version (PDF file) of the Final Report via email.

Thank you for the opportunity to be of service to you on this project. If you have any questions, please contact me at our office.

Respectfully Submitted,

CTL Engineering, Inc.

Sastry Malladi, P. E.
Project Engineer

STRUCTURE FOUNDATION EXPLORATION – FINAL

HIG-73-21.11 BRIDGE REPLACEMENT
PID NO. 119769, AGREEMENT NO. 40928
JACKSON TOWNSHIP, HIGHLAND COUNTY, OHIO

CTL PROJECT NO. 25050005COL

PREPARED FOR:

BG ENGINEERING GROUP, LLC
5960 WILCOX PLACE, SUITE C
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PREPARED BY:

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July 8, 2025

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I. EXECUTIVE SUMMARY

The project, designated as HIG-73-21.11, involves the replacement of an existing three-span bridge with a single-span, prestressed concrete I-beam bridge, with composite reinforced concrete deck on semi-integral abutments on drilled shafts.

Two test borings (Type E1) were performed for this project. Beneath the surface cover, the test borings encountered soils described as A-1-b, A-2-6, A-4a, A-4b, A-6a, A-6b, or A-7-6 extending down to the top of rock. Upon achieving auger refusal, borings B-001-0-25 and B-002-0-25 were cored to an additional depth of 17 feet and 24 feet, respectively. The recovered rock from coring operations was described as shale or limestone.

Groundwater was encountered in boring B-001-0-25 at a depth of 11.5 feet below existing grade which corresponds to an elevation of 798.1 feet.

Based upon the soil and rock information obtained from the test borings, it is CTL's opinion that the proposed bridge can be supported onto drilled shafts socketed into the underlying bedrock. Please refer to *Paragraph VI. Analyses and Recommendation*s for additional details.

II. INTRODUCTION

The project involves the replacement of the existing State Route 73 (HIG-73-21.11) bridge over the Ohio Brush Creek in Jackson Township, Highland County, Ohio. It is understood that the existing three-span, continuous concrete slab bridge (Structure File Number 3601749) will be replaced with a single-span, prestressed concrete I-beam bridge, with composite reinforced concrete deck on semi-integral abutments on drilled shafts.

This is a Final Structure Foundation Exploration Report.

III. GEOLOGY AND OBSERVATIONS OF THE PROJECT

A. Geology

According to the Ohio Department of Natural Resources (ODNR) Physiographic Regions of Ohio Map (1998), the project site is located within the Illinoian Till Plain physiographic region. This physiographic region is described hilltops of high-lime Illinoian-age till with loess cap; slopes of bedrock- and till-derived colluvium underlain by Ordovician- and Silurian-age bedrock. Geologic mapping (Surficial Geology of the Ohio Portions of the Hillsboro 30 x 60 Minute Quadrangle, *ODNR Division of Geological Survey, 2016*) indicates that the overburden soils are mapped to consist of Holocene-age alluvium underlain by Illinoian-age sand and gravel.

According to the mapping of bedrock geology in the area, (Preliminary Bedrock Geology of the Belfast, Ohio, Quadrangle, *ODNR Division of Geological Survey, 1994*), the surficial soil deposits on the site are underlain by two sedimentary bedrock

formations identified as the Silurian-age Dayton Limestone, Noland Formation and Brassfield Undivided, and the Ordovician-age Drakes Formation and Waynesville Formation Undivided.

According to the mapping of karst features (Karst Interactive Map, *ODNR Division of Geological Survey*, date accessed April 1, 2025), there are no mapped karst features in the general vicinity of the project area. Additionally, karst features were not observed at the ground surface during our field exploration. However, it should be noted that there is are significant amounts of field verified karst features within half a mile of the project site, specifically about 1,400 feet to the southwest.

According to the mapping of historic and active mines (Mines of Ohio, *ODNR Division of Mineral Resources*, date accessed April 1, 2025), there are no documented mines in the general vicinity of the project area.

B. Observations

The existing State Route 73 Bridge (SFN 3601749) is a 2-lane, three-span bridge. It is located approximately 1,700 feet southeast of the intersection of State Route 73 and State Route 785. The existing bridge was constructed in 1955 and has a total length of approximately 138 feet with a width of approximately 32 feet. Field reconnaissance was completed by CTL personnel on July 5, 2024, and on February 13, 2025.

State Route 73 is a two-lane, bi-directional road that runs generally northwest to southeast, and the Ohio Brush Creek generally flows southwest to northeast beneath State Route 73. The topography in the surrounding area consists of rolling terrain, relatively flat to moderately sloping, while the ground surface immediately adjacent to the creek slopes steeply downward along the banks. The area along the creek is covered by vegetation consisting of weeds, small brush and trees. The surrounding land usage consists of rural residential, agricultural, and wooded.

At the time of the site reconnaissance, the roadway asphalt pavement surface was observed to have minor cracking with some vertical deformations. Deterioration of the existing bridge deck was observed, which included exposed steel rebar. Erosion along the southern edge (forward abutment) of the creek to the east and west of the bridge was observed. Additionally, at the forward abutment, exposed bedrock was observed at the ground surface and consisted of weathered brown and gray shale.

According to ODOT TIMS, no historic soil test borings were performed for this bridge. However, historic core drive rod soundings records were available. According to the drive rod soundings, the top of rock was encountered between elevations 795.1 to 808.1 feet (corrected to the datum shift from NGVD 29 to NAVD 88). It is our opinion that these historic core drive rod soundings are not useful for this project, and should not replace the project borings. Therefore, the information for the core drive rod soundings were not shown on the soil profile sheets.

IV. SUBSURFACE EXPLORATION

A total of two (2) soil test borings (identified in *Table 1*) were drilled for this project. Each of the test borings were drilled within the existing roadway pavement near the existing abutments. A summary of approximate test boring locations, ground surface elevations and coordinates along with the depths are presented in *Table 1*.

Table 1. Boring Locations, Depths, Elevations, and Coordinates

Boring No.	Station & Offset	Ground Surface Elevation (feet)	Latitude (°)	Longitude (°)	Borehole Depth (feet)
B-001-0-25	1112+41, 6’ RT.	809.6	39.059346	-83.529358	30.0
B-002-0-25	1113+95, 8’ LT.	812.9	39.059076	-83.528948	30.7

Ground surface elevations, Northings, Eastings, latitude, longitude, Station, and Offset information were provided by personnel from BG Engineering, LLC.

The test borings were drilled by CTL on March 3, 2025 and March 5, 2025, utilizing 3-¼ inch inside diameter hollow-stem augers powered by track-mounted rotary drill rigs. Split-barrel (spoon) samples and Standard Penetration Tests (SPTs) were performed in the test borings using a 140-pound automatic hammer falling 30 inches to drive 2-inch O.D. split barrel samplers for 18 inches. The automatic hammers were calibrated on November 4, 2022 and November 8, 2024 and had energy ratios of 81.9 percent and 80.7 percent, respectively. Rock coring was performed in both test borings using wireline casing with an NQ2-size, double tube core barrel with a diamond bit.

Soil samples obtained were preserved in glass jars, visually classified in the field and laboratory, and tested for natural moisture content. Representative soil samples were subjected to laboratory testing including grain size distribution and Atterberg limits.

Rock from the coring operation was visually classified. The Rock Quality Designation (RQD) and percent core loss values were determined. Representative samples of the recovered rock were subjected to compressive strength testing.

Drilling, sampling, field and laboratory testing were performed according to standard geotechnical engineering practices and current ASTM International and/or AASHTO procedures. Results from field and laboratory tests are shown on the test boring records in *Appendix B* of this report. The results of the laboratory tests are presented in *Appendix C* of this report.

V. FINDINGS

A. Soil Stratigraphy

At the ground surface, the two (2) test borings drilled encountered four (4) inches of asphalt underlain by eight (8) inches of concrete. Beneath the surficial materials, the

test borings encountered both fine-grained, cohesive soils and coarse-grained, granular soils before encountering weathered bedrock.

The fine-grained cohesive soils were described as medium stiff to very stiff, brown, sandy silt (A-4a), silt (A-4b), silt and clay (A-6a), silty clay (A-6b), and clay (A-7-6). SPT N_{60}-values determined within the fine-grained soils ranged from 5 blows per foot (bpf) to 16 bpf, with natural moisture content values ranging from 14 percent to 23 percent. The N_{60}-value is the SPT blow count corrected for the hammer efficiency delivered by the hammer system utilized, normalized to 60 percent efficiency in bpf.

The coarse-grained soils encountered in the test borings were described as loose to very dense, brown gravel and/or stone fragments with sand (A-1-b) and gravel and/or stone fragments with sand, silt and clay (A-2-6). SPT N_{60}-values determined within the coarse-grained soils ranged from 7 bpf to 50 blows for no penetration, with natural moisture content values ranging from 10 percent to 29 percent.

Beneath the soil overburden, the test borings exhibited bedrock described as limestone or interbedded shale and limestone. Upon achieving auger refusal, borings B-001-0-25 and B-002-0-25 were cored to an additional depth of 17 feet and 24 feet, respectively. The shale was described as gray and red, highly weathered, very weak to slightly strong, and calcareous. The limestone was described as gray and brown, highly to moderately weathered, and slightly to moderately strong. RQD values were determined and ranged from 0 to 50 percent with core loss values ranging from 0 to 77 percent. Photographs of the recovered rock core are presented in *Appendix B* of this report.

B. Results of Laboratory Tests

Selected soil samples were tested in the laboratory for Atterberg Limits and grain size distribution. The results of the soil laboratory tests are presented on the Test Boring Records in *Appendix A* and *Appendix B* and are summarized in *Table 2*.

Table 2. Soil Laboratory Test Results

Boring No.	Sample No.	Depth (feet)	ODOT	Atterberg Limits (%)		Grain-Size Distribution (%)			
				LL	PI	Gr	Sa	Silt	Clay
B-001-0-25	SS-1	1.0 – 2.5	A-7-6	52	34	7	26	28	39
B-001-0-25	SS-4	5.5 – 7.0	A-6b	32	16	22	41	16	21
B-001-0-25	SS-5	7.0 – 8.5	A-6a	33	15	5	20	40	35
B-001-0-25	SS-6	8.5 – 10.0	A-4a	24	8	0	33	44	23
B-001-0-25	SS-7	11.0 – 12.5	A-4b	27	10	0	19	55	26
B-002-0-25	SS-1	1.0 – 2.5	A-1-b	NP	NP	44	38	4	14
B-002-0-25	SS-2	2.5 – 4.0	A-1-b	40	1	50	25	9	16
B-002-0-25	SS-3	4.0 – 5.5	A-2-6	38	20	42	23	18	17

SS-#: Split-Spoon Sample Number
LL = Liquid Limit; PI = Plasticity Index
NP = Non-Plastic
Silt Fraction (particle size < 0.075 mm
Clay Fraction (particle size < 0.005 mm)
Gr = Gravel; Sa = Sand

Samples of the rock core from borings B-001-0-25 and B-002-0-25 were tested for uniaxial compressive strength utilizing ASTM D7012, Method C. The test results are summarized in *Table 3* below.

Table 3. Summary of Rock Compressive Strength Tests

Boring No.	Sample No.	Sample Depth (feet)	Sample Description	Unit Weight (pcf)	Uniaxial Compressive Strength (psi)(1)
B-001-0-24	NQ2-1	13.9 – 14.4	Limestone	160.1	4,200
B-001-0-24	NQ2-2	15.8 – 16.2	Shale	155.1	550
B-002-0-25	NQ2-3	21.2 – 21.9	Limestone	163.5	5,520
B-002-0-25	NQ2-3	29.1 – 29.7	Shale	159.6	1,520

(1) Uniaxial Compressive Strength of Intact Rock Core Testing conducted in accordance with ASTM D7012, Method C.

C. Groundwater

Groundwater was encountered during drilling in test boring B-001-0-25 at elevation 798.1 (depth of 11.5 feet). It should be noted that the groundwater depths encountered during this subsurface exploration may not be a reliable indication of long-term groundwater levels. Fluctuations in the level of the groundwater table (or saturated soils/perched water levels) will occur due to seasonal variances in rainfall, drainage, types of soils present and other factors. We caution that groundwater can be perched at various elevations above the general static groundwater level after periods of rainfall, especially in the lower elevations and natural drainage paths of the site.

VI. ANALYSES AND RECOMMENDATIONS

A. Bridge Scour

For the purpose of scour analysis, the mean particle grain size (D_{50}), critical shear stress (τ_c) and erosion category (EC) were determined according to ODOT Geotechnical Design Manual (GDM) Section 1302. The scour data for the proposed structure is shown in *Table 4*.

Table 4. Scour Data

Boring (Structure)	Sample No.	Elevation (feet)	D_{50} (mm)	τ_c (psf)	$D_{50, equiv}$ (mm)	Erosion Category (EC)
B-001-0-25 (Rear Abutment)	SS-1	808.6 - 807.1	0.0132	0.2787	13.3435	4.199
	SS-4	804.1 - 802.6	0.2059	0.1324	6.3384	3.484
	SS-5	802.6 - 801.1	0.0122	0.2067	9.8952	3.413
	SS-6	801.1 - 799.6	0.0271	0.0634	3.0378	2.754
	SS-7	799.6 - 798.1	0.0174	0.1404	6.7224	2.975
	NQ2-1	796.6 - 794.6	-	116.1751	5561.2782	3.761
	NQ2-2/NQ2-3	794.6 - 779.6	-	10.8577	519.7548	3.761
B-002-0-25 (Forward Abutment)	SS-1	811.9 - 810.4	1.3291	0.0278	1.3291	2.348
	SS-2	810.4 - 808.9	2.0312	0.0424	2.0312	2.569
	SS-3	808.9 - 807.4	0.4942	0.0103	0.4942	1.833
	NQ2-1	806.2 – 804.2	-	188.3532	9016.4279	3.973
	NQ2-1/NQ2-2	804.2 – 794.4	-	63.5441	3041.8443	3.761
	NQ2-2/NQ2-3	794.4 – 789.9	-	162.0275	7756.2245	3.761
	NQ2-3	789.9 – 782.2	-	47.0564	2252.5819	3.761

B. Bridge Foundation Support

According to the Stage 3 bridge site plans, the proposed abutments are planned to be supported onto 3-foot diameter drilled shaft foundations, socketed into the underlying bedrock. The drilled shaft foundations may be proportioned using a nominal unit tip resistance value not exceeding those provided in the *Table 5*. The socket length should be determined by the structural engineer. Bottom of pier cap elevations and rock socket lengths were taken from Stage 3 plans.

Table 5. Nominal Unit Tip Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Top of Bedrock Elevation (feet)	Nominal Unit Tip Resistance, q_p (ksf)
Rear Abutment	797.30	B-001-0-25	796.6	198.0
Forward Abutment	799.20	B-002-0-25	806.2	547.2

Per ODOT BDM 305.4.1.1, the shaft sockets should extend a minimum of 10 feet below the controlling scour elevation into the bedrock.

The socket tip should extend at least 1.5 times the socket diameter into the bedrock per ODOT BDM 305.4.2 (AASHTO LRFD 10.8.3.5.4c).

A resistance factor of 0.5 should be used for Tip Resistance. The resistance factor wase obtained from AASHTO Table 10.5.5.2.4-1.

Per ODOT GDM 1306.4.2, the drilled shafts should be designed for tip resistance or side resistance, but not both. If both tip and side resistance are used, then each value should be modified according to deflection and mobilization of resistance in accordance with ODOT GDM 1306.3.2. Unfactored unit side resistance values are provided in *Table 6*.

Table 6. Unfactored Unit Side Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Elevation (feet)	Nominal Unit Side Resistance, q_p (ksf)
Rear Abutment	797.30	B-001-0-25	796.6 to 794.6	34.9
			794.6 to 787.3	19.8
Forward Abutment	799.20	B-002-0-25	799.2 to 794.4	18.5
			794.4 to 789.9	34.9
			789.9 to 789.2	21.5

Per ODOT BDM 305.4.1.1, the shaft resistance should be neglected within the soils or non-scour resistant bedrock within the scour zone.

Side resistance within the soil overburden and upper portion of the rock socket should be neglected as outlined in ODOT BDM section 305.4.2.

The resistance factors in *Table 7* should be used for Shaft Side Resistance. The resistance factors were obtained from AASHTO Table 10.5.5.2.4-1.

The drilled shaft tip and side resistance calculations are provided in *Appendix D*.

Table 7. Resistance Factors for Shaft Side Resistance

Material Type	Resistance Factors	
	Compressive	Uplift
Rock	0.55	0.40

C. Lateral Parameters

Please refer to *Appendix E* for the Lpile parameters which can be utilized while performing lateral pile analysis.

D. General Construction and Earthwork

1. Site preparation, earthwork and installation of structures should be performed in accordance with the ODOT Construction and Material Specifications, and applicable Geotechnical Design Manual.

2. Embankment side slopes should be seeded and vegetation growth permitted to limit sloughing and slope failure.

3. Temporary excavations more than 4.0 feet in depth should be sloped or shored in accordance with OSHA regulations.

VII. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL should be notified so that our recommendations can be modified, if required.

VIII. TESTING AND OBSERVATION

During the design process, it is recommended that CTL work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on this project. If CTL is not retained for these services, CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.

IX. CLOSING

This report has been prepared for the exclusive use by the client for use only on this project. Our services have been performed in accordance with generally accepted Geotechnical Engineering principles and practices. No warranty is either expressed or implied.

CTL Engineering's assignment does not include, nor does this geotechnical report address the environmental aspects of this particular site.

Specific design and construction recommendations have been provided in this report. Therefore, the report should be used in its entirety.

Respectfully Submitted,

CTL ENGINEERING, INC.

Christopher D. Carey, E.I.
Project Engineer

Sastry Malladi, P.E.
Project Engineer

Joe Grani, P.E.
Project Engineer

APPENDIX A

GEOTECHNICAL PROFILE - BRIDGE

PROJECT DESCRIPTION

THE PROJECT INVOLVES THE REPLACEMENT OF THE EXISTING STATE ROUTE 73 (HIG-73-21.11) BRIDGE OVER THE OHIO BRUSH CREEK IN JACKSON TOWNSHIP, HIGHLAND COUNTY, OHIO. IT IS UNDERSTOOD THAT THE EXISTING THREE-SPAN, CONTINUOUS CONCRETE SLAB BRIDGE (STRUCTURE FILE NUMBER 3601749) WILL BE REPLACED WITH A SINGLE-SPAN, PRESTRESSED CONCRETE I-BEAM BRIDGE, WITH COMPOSITE REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS ON DRILLED SHAFTS.

HISTORIC RECORDS

ACCORDING TO ODOT TIMS, NO HISTORIC SOIL TEST BORINGS WERE PERFORMED FOR THIS BRIDGE. HOWEVER, HISTORIC CORE DRIVE ROD SOUNDINGS RECORDS WERE AVAILABLE. ACCORDING TO THE DRIVE ROD SOUNDINGS, THE TOP OF ROCK WAS ENCOUNTERED BETWEEN ELEVATIONS 795.1 TO 808.1 FEET (CORRECTED TO THE DATUM SHIFT FROM NGVD 29 TO NAVD 88). IT IS OUR OPINION THAT THESE HISTORIC CORE DRIVE ROD SOUNDINGS ARE NOT USEFUL FOR THIS PROJECT, AND SHOULD NOT REPLACE THE PROJECT BORINGS. THEREFORE, THE INFORMATION FOR THE CORE DRIVE ROD SOUNDINGS WERE NOT SHOWN ON THE SOIL PROFILE SHEETS.

GEOLOGY

THE PROJECT SITE IS LOCATED WITHIN THE DISSECTED ILLINOIAN TILL PLAIN PHYSIOGRAPHIC REGION THAT IS DESCRIBED AS HILLTOPS OF HIGH-LIME ILLINOIAN-AGE TILL WITH LOESS CAP; SLOPES OF BEDROCK- AND TILL-DERIVED COLLUVIUM UNDERLAIN BY ORDOVICIAN- AND SILURIAN-AGE BEDROCK. THE PROJECT SITE IS COVERED BY HOLOCENE-AGE ALLUVIUM UNDERLAIN BY ILLINOIAN- AGE SAND AND GRAVEL. THE UNDERLYING BEDROCK CONSISTS OF TWO SEDIMENTARY BEDROCK FORMATIONS IDENTIFIED AS THE SILURIAN-AGE DAYTON LIMESTONE, NOLAND FORMATION AND BRASSFIELD UNDIVIDED AND THE ORDOVICIAN-AGE DRAKES FORMATION AND WAYNESVILLE FORMATION UNDIVIDED.

RECONNAISSANCE

FIELD RECONNAISSANCE WAS COMPLETED BY CTL PERSONNEL ON JULY 5, 2024 AND FEBRUARY 13, 2025. STATE ROUTE 73 IS A TWO-LANE, BI-DIRECTIONAL ROAD THAT RUNS GENERALLY NORTHWEST TO SOUTHEAST, AND THE OHIO BRUSH CREEK GENERALLY FLOWS SOUTHWEST TO NORTHEAST BENEATH STATE ROUTE 73. THE TOPOGRAPHY IN THE SURROUNDING AREA CONSISTS OF ROLLING TERRAIN WITH RELATIVELY FLAT TO MODERATELY SLOPING WHILE THE GROUND SURFACE IMMEDIATELY ADJACENT TO THE CREEK SLOPES STEEPLY DOWNWARD ALONG THE BANKS. THE AREA ALONG THE CREEK IS COVERED BY VEGETATION CONSISTING OF WEEDS, SMALL BRUSH AND TREES WITH THE SURROUNDING LAND USAGE CONSISTS OF RURAL RESIDENTIAL, AGRICULTURAL, AND WOODED. AT THE TIME OF THE SITE RECONNAISSANCE, THE ROADWAY ASPHALT PAVEMENT SURFACE WAS OBSERVED TO HAVE MINOR CRACKING WITH SOME VERTICAL DEFORMATIONS; THEREFORE, THE PAVEMENT WAS OBSERVED TO BE IN FAIR CONDITION. DETERIORATION OF THE EXISTING BRIDGE DECK WAS OBSERVED, WHICH INCLUDED EXPOSED STEEL REBAR; THEREFORE, THE EXISTING BRIDGE WAS OBSERVED TO BE IN FAIR TO POOR CONDITION. EROSION ALONG THE SOUTHERN EDGE (FORWARD ABUTMENT) OF THE CREEK TO THE EAST AND WEST OF THE BRIDGE WAS OBSERVED. ADDITIONALLY AT THE FORWARD ABUTMENT, EXPOSED BEDROCK WAS OBSERVED AT THE GROUND SURFACE AND CONSISTED OF WEATHERED BROWN AND GRAY SHALE.

SUBSURFACE EXPLORATION

TWO (2) SOIL TEST BORINGS, IDENTIFIED AS B-001-0-25 AND B-002-0-25, WERE COMPLETED FOR THIS SUBSURFACE EXPLORATION AND WERE DRILLED WITHIN THE EXISTING ROADWAY APPROACH SLAB PAVEMENT. THE TEST BORINGS WERE DRILLED AND SAMPLED TO DEPTHS RANGING FROM 30.0 FEET TO 30.7 FEET BELOW THE EXISTING GROUND SURFACE. THE TEST BORINGS WERE DRILLED ON MARCH 3, 2025 AND MARCH 5, 2025 UTILIZING 3-1/4 INCH I.D. HOLLOW-STEM AUGERS POWERED BY TRACK-MOUNTED ROTARY DRILL RIGS. SPLIT-BARREL (SPOON) DISTURBED SOIL SAMPLES AND STANDARD PENETRATION TEST WERE PERFORMED IN ACCORDANCE WITH AASHTO T206 AT 1.5-FOOT INTERVALS. THE AUTOMATIC HAMMERS WERE CALIBRATED ON NOVEMBER 4, 2022 AND NOVEMBER 8, 2024 AND HAD ENERGY RATIOS OF 81.9 PERCENT AND 80.7 PERCENT, RESPECTIVELY. ROCK CORING WAS PERFORMED IN BOTH TEST BORINGS USING WIRELINE CASING WITH AN NQ2-SIZE, DOUBLE TUBE CORE BARREL WITH A DIAMOND BIT.

EXPLORATION FINDINGS

AT THE GROUND SURFACE, THE TWO (2) TEST BORINGS DRILLED ENCOUNTERED FOUR (4) INCHES OF ASPHALT UNDERLAIN BY EIGHT (8) INCHES OF CONCRETE. BENEATH THE SURFICIAL MATERIALS, THE TEST BORINGS ENCOUNTERED BOTH FINE-GRAINED, COHESIVE SOILS AND COARSE-GRAINED, GRANULAR SOILS BEFORE ENCOUNTERING WEATHERED BEDROCK. THE FINE-GRAINED, COHESIVE SOILS WERE DESCRIBED AS MEDIUM STIFF TO VERY STIFF HARD SANDY SILT (A-4a), SILT (A-4b), SILT AND CLAY (A-6a), SILTY CLAY (A-6b), AND CLAY (A-7-6). THE COARSE-GRAINED, GRANULAR SOILS WERE DESCRIBED AS LOOSE TO VERY DENSE GRAVEL AND/OR STONE FRAGMENTS WITH SAND (A-1-b) AND GRAVEL AND/OR STONE FRAGMENTS WITH SAND, SILT, AND CLAY (A-2-6).

BELOW THE NATIVE SOIL MATERIAL, THE TEST BORINGS ENCOUNTERED LAYERS OF WEATHERED SHALE AND LIMESTONE BEDROCK. THE SHALE WAS DESCRIBED AS GRAY AND RED, HIGHLY WEATHERED, VERY WEAK TO SLIGHTLY STRONG, AND CALCAREOUS. THE LIMESTONE WAS DESCRIBED AS GRAY AND BROWN, HIGHLY TO MODERATELY WEATHERED, AND SLIGHTLY TO MODERATELY STRONG. GROUNDWATER WAS ENCOUNTERED DURING DRILLING WITHIN B-001-0-25 AT A DEPTH OF 11.5 FEET.

LEGEND

	DESCRIPTION	ODOT CLASS	CLASSIFIED MECH./VISUAL	
	GRAVEL AND/OR STONE FRAGMENTS WITH SAND	A-1-b (0)	2	1
	GRAVEL AND/OR STONE FRAGMENTS W/SAND, SILT & CLAY	A-2-6 (2)	1	0
	SANDY SILT	A-4a (6)	1	0
	SILT	A-4b (8)	1	0
	SILT AND CLAY	A-6a (10)	1	0
	SILTY CLAY	A-6b (2)	1	1
	CLAY	A-7-6 (16)	1	2
		TOTAL	8	4
	INTERBEDDED SHALE AND LIMESTONE	VISUAL		
	LIMESTONE	VISUAL		
	SHALE	VISUAL		
	PAVEMENT OR BASE = X = APPROXIMATE THICKNESS	VISUAL		

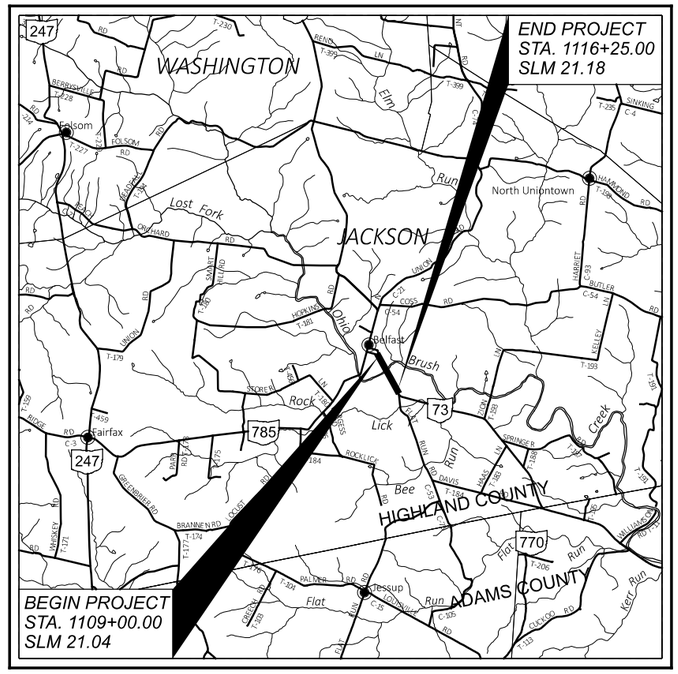
	EXPLORATION LOCATION - PLAN VIEW
	DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.
WC	INDICATES WATER CONTENT IN PERCENT.
N_{60}	INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.
X/Y/Z/D"	NUMBER OF BLOWS FOR STANDARD PENETRATION TEST (SPT): X = NUMBER OF BLOWS FOR 6 INCHES (UNCORRECTED). Y = NUMBER OF BLOWS FOR SECOND 6 INCHES (UNCORRECTED). Z/D" = NUMBER OF BLOWS (UNCORRECTED) FOR D" OF PENETRATION AT REFUSAL.
W——	INDICATES FREE WATER ELEVATION.
NP	INDICATES A NON-PLASTIC SAMPLE.
SS	INDICATES A SPLIT SPOON SAMPLE.
TR	INDICATES TOP OF ROCK ELEVATION.
NQ2	INDICATES ROCK CORE SAMPLE.
Qu	INDICATES UNCONFINED COMPRESSION TEST, ASTM D7012.
RQD	INDICATES ROCK QUALITY DESIGNATION.
Tc	INDICATES CRITICAL SHEAR STRESS.
D_{50}	INDICATES AVERAGE PARTICLE SIZE OF SOIL.
●	INDICATES A PLASTIC MATERIAL WITH A MOISTURE CONTENT EQUAL TO OR GREATER THAN THE LIQUID LIMIT MINUS 3.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, DATED JANUARY 2025.

AVAILABLE INFORMATION

THE SOIL, BEDROCK, AND GROUNDWATER INFORMATION COLLECTED FOR THIS SUBSURFACE EXPLORATION THAT CAN BE CONVENIENTLY DISPLAYED ON THE GEOTECHNICAL PROFILE SHEETS HAS BEEN PRESENTED. GEOTECHNICAL REPORTS, IF PREPARED, ARE AVAILABLE FOR REVIEW ON THE OFFICE OF CONTRACT SALES WEBSITE.



LOCATION MAP

SCALE IN MILES

0 1 2 3 4

N

PARTICLE SIZE DEFINITIONS

12"	3"	2.0 mm	0.42 mm	0.074 mm	0.005 mm
BOULDERS	COBBLES	GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY
		No. 10 SIEVE	No. 40 SIEVE	No. 200 SIEVE		

RECON. - CC 07/05/2024 & 02/13/2025

DRILLING - CTL 03/03/2025 & 03/05/2025

DRAWN - N.K.S 07/08/2025

REVIEWED - SM 07/08/2025

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11
SR-73 OVER OHIO BRUSH CREEK

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S

REVIEWER SM 07-08-25

PROJECT ID 119769

SUBSET 1 | TOTAL 7

SHEET P.58 | TOTAL 64

HIG-73-21.11

MODEL: Sheet PAPERSIZE: 17X11 (in.) DATE: 08-07-2025 TIME: 09:28:12 USER: hp
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BRIDGE SCOUR ANALYSIS						
SCOUR DATA						
BORING NO.	SAMPLE ID	ELEVATION (FEET)	D_{50} (mm)	T_C (PSF)	D_{50} equi. (mm)	EROSION CATEGORY (EC)
B-001-0-25 (REAR ABUTMENT)	SS-1	808.6 - 807.1	0.0132	0.2787	13.3435	4.199
	SS-4	804.1 - 802.6	0.2059	0.1324	6.3384	3.484
	SS-5	802.6 - 801.1	0.0122	0.2067	9.8952	3.413
	SS-6	801.1 - 799.6	0.0271	0.0634	3.0378	2.754
	SS-7	799.6 - 798.1	0.0174	0.1404	6.7224	2.975
	NQ2-1	796.6 - 794.6	-	116.1751	5561.2782	3.761
	NQ2-2/NQ2-3	794.6 - 779.6	-	10.8577	519.7548	3.761
B-002-0-25 (FORWARD ABUTMENT)	SS-1	811.9 - 810.4	1.3291	0.0278	1.3291	2.348
	SS-2	810.4 - 808.9	2.0312	0.0424	2.0312	2.569
	SS-3	808.9 - 807.4	0.4942	0.0103	0.4942	1.833
	NQ2-1	806.2 - 804.2	-	188.3532	9016.4279	3.973
	NQ2-1 / NQ2-2	804.2 - 794.4	-	63.5441	3041.8443	3.761
	NQ2-2 / NQ2-3	794.4 - 789.9	-	162.0275	7756.2245	3.761
	NQ2-3	789.9 - 782.2	-	47.0564	2252.5819	3.761

BEDROCK TEST SUMMARY				
BORING ID	SAMPLE ELEVATION (FEET)	SAMPLE DEPTH (FEET)	Qu (PSI)	LITHOLOGY
B-001-0-25	795.7 - 795.2	13.9 - 14.4	4,200	LIMESTONE
B-001-0-25	793.8 - 793.4	15.8 - 16.2	550	SHALE
B-002-0-25	791.7 - 791.0	21.2 - 21.9	5,520	LIMESTONE
B-002-0-25	783.8 - 783.2	29.1 - 29.7	1,520	SHALE

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11
SR-73 OVER OHIO BRUSH CREEK

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S
REVIEWER SM 07-08-25
PROJECT ID 119769
SUBSET 2 TOTAL 7
SHEET P.59 TOTAL 64

HIG-73-21.11

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 08-07-2025 TIME: 09:30:18 USER: hp
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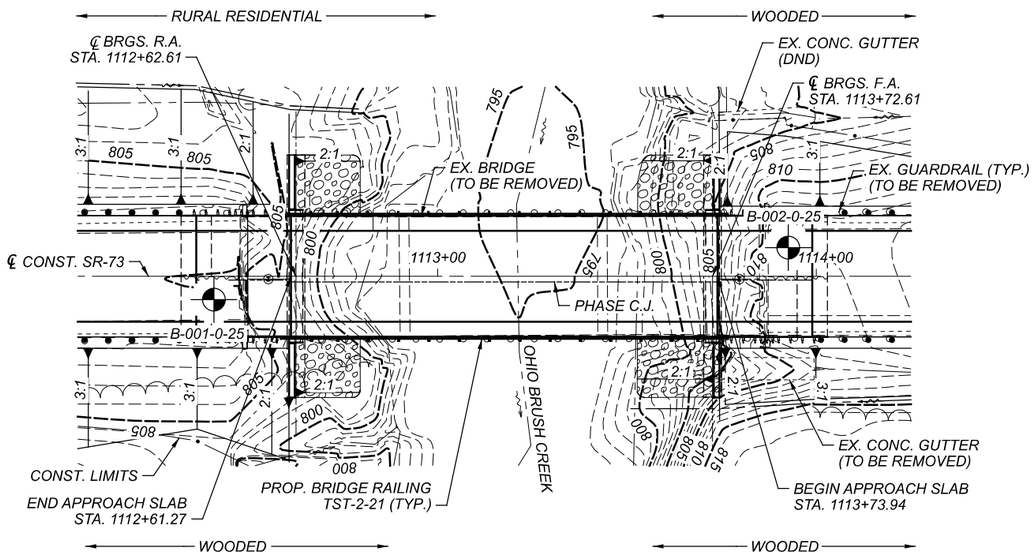

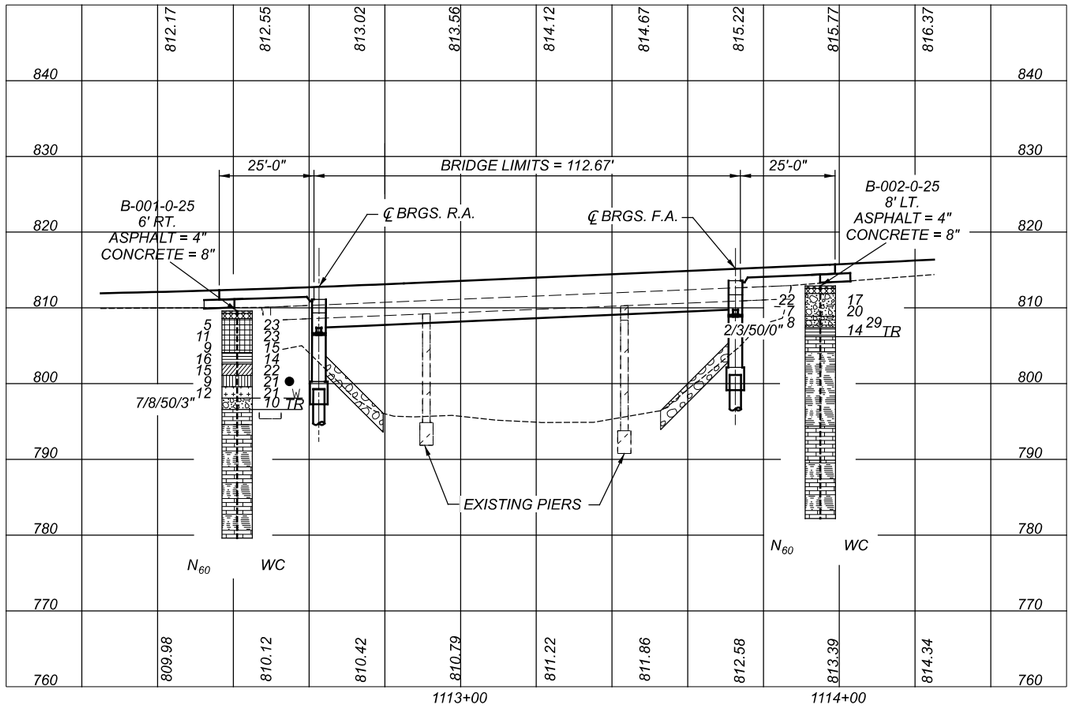

HIG-73-21.11

MODEL: GLX_1 - Plan 1=1 PAPERSIZE: 17x11 (in.) DATE: 08-07-2025 TIME: 09:33:58 USER: hp
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HORIZONTAL
SCALE IN FEET
0 10 20 40

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11
SR-73 OVER OHIO BRUSH CREEK

DESIGN AGENCY
GTL ENGINEERING INC
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 07-08-25
PROJECT ID	119769
SUBSET / TOTAL	3 / 7
SHEET / TOTAL	P.60 / 64

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 08-07-2025 TIME: 09:36:44 USER: hp
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PROJECT: HIG-73-21.11	DRILLING FIRM / OPERATOR: CTL / J.CARTE	DRILL RIG: CME 55 #393	STATION / OFFSET: 1112+41, 6' RT.	EXPLORATION ID B-001-0-25
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / J.CARTE	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-73	
PID: 119769 SFN: 3601750	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 11-4-22	ELEVATION: 809.6 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 3-3-25 END: 3-3-25	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 79.3	LAT / LONG: 39.059346, -83.529358	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT (4")	809.6																		
CONCRETE (8")	809.3																		
STIFF, BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, MOIST @2.5'; MEDIUM STIFF	808.6		2 1 3	5	39	SS-1	1.25	7	8	18	28	39	52	18	34	23	A-7-6 (16)	-	
@4.0'; VERY STIFF, DAMP	804.1		3 3 5	11	67	SS-2	0.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
VERY STIFF, BROWN, **SILTY CLAY**, "AND" SAND, SOME GRAVEL, DAMP	802.6		9 3 4	9	67	SS-3	2.25	-	-	-	-	-	-	-	-	15	A-7-6 (V)	-	
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	801.1		4 6 6	16	78	SS-4	2.50	22	23	18	16	21	32	16	16	14	A-6b (2)	-	
MEDIUM STIFF, BROWN, **SANDY SILT**, SOME CLAY, MOIST	799.6		4 5 6	15	89	SS-5	2.75	5	7	13	40	35	33	18	15	22	A-6a (10)	-	
VERY STIFF, BROWN, **SILT**, SOME CLAY, LITTLE SAND, MOIST	798.1	W 798.1	4 2 5	9	78	SS-6	0.75	0	2	31	44	23	24	16	8	21	A-4a (6)	-	
VERY DENSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, WET	796.6	TR	3 4 5	12	83	SS-7	2.25	0	1	18	55	26	27	17	10	21	A-4b (8)	-	
LIMESTONE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG. @ 13.9' - 14.4' (LIMESTONE); γ = 160.1 pcf, **Qu**= 4,200 psi	794.6		7 8 50/3"	-	67	SS-8	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	-	
INTERBEDDED SHALE (80%) AND LIMESTONE (20%), RQD 3%, REC. 31%; **SHALE**, GRAY, HIGHLY WEATHERED, VERY WEAK, CALCAREOUS; **LIMESTONE**, GRAY, HIGHLY WEATHERED, SLIGHTLY STRONG. @ 15.8' - 16.2' (SHALE); γ = 155.1 pcf, **Qu**= 550 psi	779.6	EOB	25		83	NQ2-1											CORE		
			4		29	NQ2-2											CORE		
			0		33	NQ2-3											CORE		

NOTES: CAVED AT 11.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 2-4-25 20:03 - G:\2025\MARCH\28\25050005COL\25050005COL.GPJ

B-001-0-25

Run #:	Depth		Recovery		RQD	
NQ2-1	13.0'	15.0'	20"/24"	83%	6"/24"	25%
NQ2-2	15.0'	25.0'	35"/120"	29%	5"/120"	4%
NQ2-3	25.0'	30.0'	20"/60"	33%	0"/60"	0%

HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek

CTL ENGINEERING INC

SHEET	SUBSET	PROJECT ID	REVIEWER	DESIGNER	DESIGN AGENCY
P 61 / TOTAL 64	4 / TOTAL 7	119769	SM 07-08-25	N.K.S	CTL ENGINEERING INC 6 COLUMBUS, OHIO 43204 PHONE:(614)276-8123 FAX:(614)276-6373

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11 OVER OHIO BRUSH CREEK
BORING LOG & ROCK CORE PHOTO FOR B-001-0-25

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 08-07-2025 TIME: 09:39:23 USER: hp
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PROJECT: HIG-73-21.11	DRILLING FIRM / OPERATOR: CTL / J.CARTE	DRILL RIG: DIEDRICH D-70	STATION / OFFSET: 1113+95, 8' LT.	EXPLORATION ID B-002-0-25
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / J.CARTE	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR-73	
PID: 119769 SFN: 3601750	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 11-8-24	ELEVATION: 812.9 (MSL) EOB: 30.7 ft.	PAGE 1 OF 1
START: 3-5-25 END: 3-5-25	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 80.7	LAT / LONG: 39.059076, -83.528948	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
ASPHALT (4")	812.6																		
CONCRETE (8")	811.9																		
MEDIUM DENSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, LITTLE CLAY, TRACE SILT, DAMP @2.5'; LOOSE	808.9		5 8 8	22	56	SS-1	3.00	44	25	13	4	14	NP	NP	NP	17	A-1-b (0)	-	
			6 3 2	7	28	SS-2	0.50	50	14	11	9	16	40	39	1	20	A-1-b (0)	-	
LOOSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, DAMP	807.4		8 4 2	8	67	SS-3	1.00	42	9	14	18	17	38	18	20	29	A-2-6 (2)	-	
MEDIUM STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP	806.2		2 3 50/0"	-	33	SS-4	1.00	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
		TR																	
LIMESTONE, BROWN AND GRAY, MODERATELY WEATHERED, MODERATELY STRONG; RQD 50%, REC 100%.	804.2		50		50	NQ2-1											CORE		
SHALE, GRAY, HIGHLY WEATHERED, SLIGHTLY STRONG, CALCAREOUS; RQD 31%, REC 93%.	794.4		20		93	NQ2-2											CORE		
LIMESTONE, GRAY, HIGHLY WEATHERED, MODERATELY STRONG; RQD 37%, REC 100%. @ 21.2' - 21.9' (LIMESTONE); γ = 163.5 pcf, **Qu** = 5,520 psi	789.9		30		100	NQ2-3											CORE		
INTERBEDDED SHALE (85%) AND LIMESTONE (15%), RQD 17%, REC. 100%; **SHALE**, RED, HIGHLY WEATHERED, SLIGHTLY STRONG, CALCAREOUS; **LIMESTONE**, GRAY, HIGHLY WEATHERED, SLIGHTLY STRONG. @ 29.1' - 29.7' (SHALE); γ = 159.6 pcf, **Qu** = 1,520 psi	782.2	EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH BENTONITE GROUT

SHEET	SUBSET	PROJECT ID	REVIEWER	DESIGNER	DESIGN AGENCY
P 62 / TOTAL 64	5 / TOTAL 7	119769	SM 07-08-25	N.K.S	GTL ENGINEERING, INC. 6175 HUNTLEY ROAD COLUMBUS, OHIO 43054 PHONE (614) 575-6500 FAX (614) 575-6577

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11 OVER OHIO BRUSH CREEK
BORING LOG B-002-0-25

B-002-0-25

Run #:	Depth		Recovery		RQD	
NQ2-1	6.7'	10.7'	24"/48"	50%	24"/48"	50%

HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek

CTL ENGINEERING INC

B-002-0-25

Run #:	Depth		Recovery		RQD	
NQ2-2	10.7'	20.7'	111"/120"	93%	24"/120"	20%

HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek

CTL ENGINEERING INC

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11 OVER OHIO BRUSH CREEK
ROCK CORE PHOTO FOR B-002-0-25

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 08-07-2025 TIME: 09:45:07 USER: hp
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B-002-0-25

Run #:	Depth		Recovery		RQD	
NQ2-3	20.7'	30.7'	120"/120"	100%	36"/120"	30%

HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek

CTL ENGINEERING INC

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. HIG-00073-21.11 OVER OHIO BRUSH CREEK
ROCK CORE PHOTO FOR B-002-0-25 CONTINUED

APPENDIX B

TEST BORING RECORDS
AND
ROCK CORE PHOTOSHEETS

KEY TO SYMBOLS

CTL ENGINEERING, INC.
WWW.CTLENG.COM

PROJECT HIG-73-21.11 **PID** 119769
CTL NUMBER 25050005COL **PROJECT TYPE** STRUCTURE FOUNDATION

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)


A-1-B: Ohio DOT: A-1-b, gravel and/or stone fragments with sand


A-2-6: Ohio DOT: A-2-6, gravel and/or stone fragments with sand, silt and clay


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


A-4B: Ohio DOT: A-4b, silt


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


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


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


INTERBEDDED SHALE AND LIMESTONE: Ohio DOT: Interbedded Shale and Limestone


LIMESTONE: Ohio DOT: Limestone


PAVEMENT OR BASE: Ohio DOT: Pavement or Aggregate base


SHALE: Ohio DOT: Shale

SAMPLER SYMBOLS

WELL CONSTRUCTION SYMBOLS


Bentonite: Bottom of hole


Asphalt or Concrete Pavement Patch

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)

EXPLANATION OF TERMS AND SOIL DESCRIPTIONS
(ODOT Specifications of Geotechnical Explorations)

CONSISTENCY AND RELATIVE DENSITY DESCRIPTIONS

Descriptors for soil consistency used in this report are based upon the Standard Penetration Test (SPT), ASTM D 1587, with the penetration (N) values corrected to N_{60}, based upon the efficiency of the SPT Hammer (Energy Ratio) used for the soil sampling.

NON-COHESIVE SOILS

Consistency	SPT-N_{60} (bpf)
Very Loose	< 5
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 - 50
Very Dense	> 50

COHESIVE SOILS

Consistency	SPT-N_{60} (bpf)	Qu (tsf)
Very Soft	< 2	< 0.25
Soft	2 – 4	0.25 – 0.5
Medium Stiff	5 – 8	0.5 – 1.0
Stiff	9 – 15	1.0 – 2.0
Very Stiff	16 – 30	2.0 – 4.0
Hard	> 30	> 4.0

COMPONENT MODIFIERS

SOIL MODIFIERS

Modifier	% by Weight
Trace	0 – 10
Little	10 – 20
Some	20 – 35
"And"	35 – 50

ORGANIC CONTENT

Modifier	% by Weight
Organic	LL_{oven}/LL_{air} < 0.75
Slightly	2 – 4
Moderately	4 – 10
Highly	> 10

MOISTURE DESCRIPTIONS

Terms	Non-Cohesive Soils	Cohesive Soils
Dry	Moisture Absent	Powdery
Damp	Some Moisture	Below Plastic Limit
Moist	Damp to the Touch	Between Plastic and Liquid Limits
Wet	Visible Water	Above Liquid Limit

PARTICLE SIZE DESCRIPTIONS

Component	AASHTO Particle Size
Boulders	≥ 12-in. (300 mm)
Cobbles	< 12-in. (300 mm) to 3-in. (75 mm)
Coarse Gravel	< 3-in. (75 mm) to ¾-in. (19 mm)
Fine Gravel	< ¾-in. (19 mm) to #10 Sieve (2.0 mm)
Coarse Sand	< #10 Sieve (2.0 mm) to #40 Sieve (0.42 mm)
Fine Sand	< #40 Sieve (0.42 mm) to #200 Sieve (0.074 mm)
Silt	< #200 Sieve (0.074 mm) to 0.005 mm
Clay	< 0.005 mm

GTL ENGINEERING

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 too 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: 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″

5: RELATIVE STRENGTH

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

6: BEDDING

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

7: DESCRIPTORS

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

Quick Reference Guide for Rock Description

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.

11: Recovery

$$Run\ \text{Recovery} = \left(\frac{R_R}{L_R}\right) * 100$$

L_R = Run Length
R_R – Run Recovery

$$Unit\ \text{Recovery} = \left(\frac{R_U}{L_U}\right) * 100$$

L_U = Rock Unit Length
R_U – Rock Unit Recovery

9: GSI Description

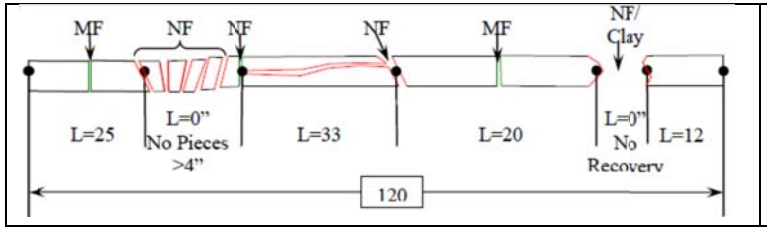
a: Structure

Description	Parameters
Intact or Massive	Intact rock with few widely spaced discontinuities
Blocky	Well interlocked undisturbed rock mass consisting of cubical blocks formed by three interesting discontinuity sets
Very Blocky	Interlocked, partially disturbed mass with multi-faceted angular blocks formed by 4 or more joint sets
Blocky/Disturbed/ Seamy	Angular blocks formed by many intersecting discontinuity sets, Persistence of bedding planes
Disintegrated	Poorly interlocked, heavily broken rock mass with mixture of angular and rounded rock pieces
Laminated/Sheared	Lack of blockiness due to close spacing of weak shear planes

b: Surface Condition

Description	Parameters
Very Good	Very rough, fresh unweathered surfaces
Good	Rough, slightly weathered, iron stained surface
Fair	Smooth, moderately weathered and altered surfaces
Poor	Slickensided, highly weathered surface with compact coatings or fillings or angular fragments
Very Poor	Slickensided, highly weathered surfaces with soft clay coating or fillings

10: RQD



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

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

PROJECT: HIG-73-21.11	DRILLING FIRM / OPERATOR: CTL / J.CARTE	DRILL RIG: CME 55 #393	STATION / OFFSET: 1112+41, 6' RT.	EXPLORATION ID B-001-0-25
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / J.CARTE	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-73	
PID: 119769 SFN: 3601750	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 11/4/22	ELEVATION: 809.6 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 3/3/25 END: 3/3/25	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 79.3	LAT / LONG: 39.059346, -83.529358	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT (4")	809.6																	
CONCRETE (8")	809.3																	
STIFF, BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, MOIST	808.6	1	2 1 3	5	39	SS-1	1.25	7	8	18	28	39	52	18	34	23	A-7-6 (16)	
@2.5'; MEDIUM STIFF		2																
		3	3 3 5	11	67	SS-2	0.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
@4.0'; VERY STIFF, DAMP		4																
	804.1	5	9 3 4	9	67	SS-3	2.25	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
VERY STIFF, BROWN, **SILTY CLAY**, "AND" SAND, SOME GRAVEL, DAMP	802.6	6	4 6 6	16	78	SS-4	2.50	22	23	18	16	21	32	16	16	14	A-6b (2)	
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	801.1	7	4 5 6	15	89	SS-5	2.75	5	7	13	40	35	33	18	15	22	A-6a (10)	
MEDIUM STIFF, BROWN, **SANDY SILT**, SOME CLAY, MOIST	799.6	8	4 2 5	9	78	SS-6	0.75	0	2	31	44	23	24	16	8	21	A-4a (6)	
VERY STIFF, BROWN, **SILT**, SOME CLAY, LITTLE SAND, MOIST	798.1	9	3 4 5	12	83	SS-7	2.25	0	1	18	55	26	27	17	10	21	A-4b (8)	
VERY DENSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, WET	796.6	10	7 8 50/3"	-	67	SS-8	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
LIMESTONE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG; RQD 25%, REC 83%. @ 13.9' - 14.4' (LIMESTONE); γ = 160.1 pcf, **Qu** = 4,200 psi	794.6	11	25		83	NQ2-1											CORE	
INTERBEDDED SHALE (80%) AND LIMESTONE (20%), RQD 3%, REC. 31%; **SHALE**, GRAY, HIGHLY WEATHERED, VERY WEAK, CALCAREOUS; **LIMESTONE**, GRAY, HIGHLY WEATHERED, SLIGHTLY STRONG. @ 15.8' - 16.2' (SHALE); γ = 155.1 pcf, **Qu** = 550 psi		12	4		29	NQ2-2											CORE	
		13																
		14																
		15																
		16																
		17																
		18																
		19																
		20	0		33	NQ2-3											CORE	
	779.6	21																
		22																
		23																
		24																
		25																
		26																
		27																
		28																
		29																

W 798.1 — TR — EOB

NOTES: CAVED AT 11.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/2/25 07:53 - O:\PROJECT\2025\COL-05\2505005COL_BG ENGINEERING GROUP LLC_HIG-73-21-11 BRIDGE REPLACEMENT\REPORT

PROJECT: HIG-73-21.11	DRILLING FIRM / OPERATOR: CTL / J.CARTE	DRILL RIG: DIEDRICH D-70	STATION / OFFSET: 1113+95, 8' LT.	EXPLORATION ID B-002-0-25
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / J.CARTE	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR-73	
PID: 119769 SFN: 3601750	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 11/8/24	ELEVATION: 812.9 (MSL) EOB: 30.7 ft.	PAGE 1 OF 2
START: 3/5/25 END: 3/5/25	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 80.7	LAT / LONG: 39.059076, -83.528948	

MATERIAL DESCRIPTION AND NOTES	ELEV. 812.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT (4")	812.6																	
CONCRETE (8")	811.9																	
MEDIUM DENSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, LITTLE CLAY, TRACE SILT, DAMP @2.5'; LOOSE	808.9	1	5 8 8	22	56	SS-1	3.00	44	25	13	4	14	NP	NP	NP	17	A-1-b (0)	
		2																
		3	6 3 2	7	28	SS-2	0.50	50	14	11	9	16	40	39	1	20	A-1-b (0)	
		4																
LOOSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, DAMP	807.4	5	8 4 2	8	67	SS-3	1.00	42	9	14	18	17	38	18	20	29	A-2-6 (2)	
MEDIUM STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP	806.2	6	2 3 50/0"	-	33	SS-4	1.00	-	-	-	-	-	-	-	-	14	A-6b (V)	
		TR																
LIMESTONE, BROWN AND GRAY, MODERATELY WEATHERED, MODERATELY STRONG; RQD 50%, REC 100%.	804.2	7	50		50	NQ2-1											CORE	
		8																
		9																
		10																
SHALE, GRAY, HIGHLY WEATHERED, SLIGHTLY STRONG, CALCAREOUS; RQD 31%, REC 93%.		11																
		12																
		13																
		14																
		15																
		16	20		93	NQ2-2											CORE	
		17																
		18																
	794.4	19																
LIMESTONE, GRAY, HIGHLY WEATHERED, MODERATELY STRONG; RQD 37%, REC 100%.		20																
		21																
@ 21.2' - 21.9' (LIMESTONE); γ = 163.5 pcf, **Qu** = 5,520 psi		22																
		23																
	789.9	24																
INTERBEDDED SHALE (85%) AND LIMESTONE (15%), RQD 17%, REC. 100%; **SHALE**, RED, HIGHLY WEATHERED, SLIGHTLY STRONG, CALCAREOUS; **LIMESTONE**, GRAY, HIGHLY WEATHERED, SLIGHTLY STRONG.		25																
		26	30		100	NQ2-3											CORE	
		27																
		28																
@ 29.1' - 29.7' (SHALE); γ = 159.6 pcf, **Qu** = 1,520 psi		29																

PID: 119769	SFN: 3601750	PROJECT: HIG-73-21.11	STATION / OFFSET: 1113+95, 8' LT.	START: 3/5/25	END: 3/5/25	PG 2 OF 2	B-002-0-25

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	782.9																	
	782.2	EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH BENTONITE GROUT

B-001-0-25

Run #:	Depth		Recovery		RQD	
NQ2-1	13.0'	15.0'	20"/24"	83%	6"/24"	25%
NQ2-2	15.0'	25.0'	35"/120"	29%	5"/120"	4%
NQ2-3	25.0'	30.0'	20"/60"	33%	0"/60"	0%
HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek						

CTL ENGINEERING INC

B-002-0-25

Run #:	Depth		Recovery		RQD	
NQ2-1	6.7'	10.7'	24"/48"	50%	24"/48"	50%
HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek						

GTL ENGINEERING INC

B-002-0-25

Run #:	Depth		Recovery		RQD	
NQ2-2	10.7'	20.7'	111"/120"	93%	24"/120"	20%

HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek

GTL ENGINEERING INC

B-002-0-25

Run #:	Depth		Recovery		RQD	
NQ2-3	20.7'	30.7'	120"/120"	100%	36"/120"	30%
HIG-73-21.11; PID 119769; State Route 73 over the Ohio Brush Creek						

GTL ENGINEERING INC

APPENDIX C

LABORATORY TEST RESULTS

PROJECT NO:	25050005COL
DATE:	3/13/2025

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

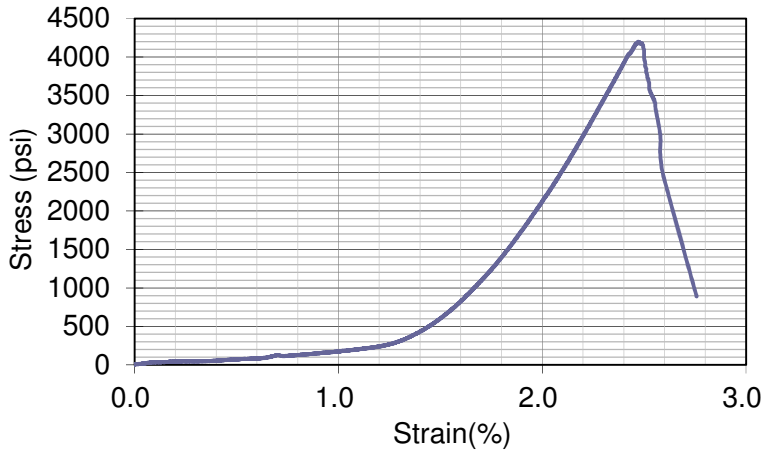
BORING NUMBER	B-001-0-25	TOP DEPTH(FT)	13.9	BOTTOM DEPTH(FT)	14.4
SAMPLE NUMBER	NQ2-1	DISTRICT	9	PID NO.	119769
COUNTY	HIG	ROUTE	SR 73	SECTION	21.11

FORMATION	Drakes Formation and Waynesville Formation Undivided
DESCRIPTION	Limestone, Gray, Moderately Weatherd, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.039	1.959
2	4.041	1.963
3	4.040	1.967
AVERAGE	4.040	1.963

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	513.7
UNIT WEIGHT(LBS/FT^3)	160.1

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
4,200
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.03
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	25050005COL
DATE:	3/13/2025

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

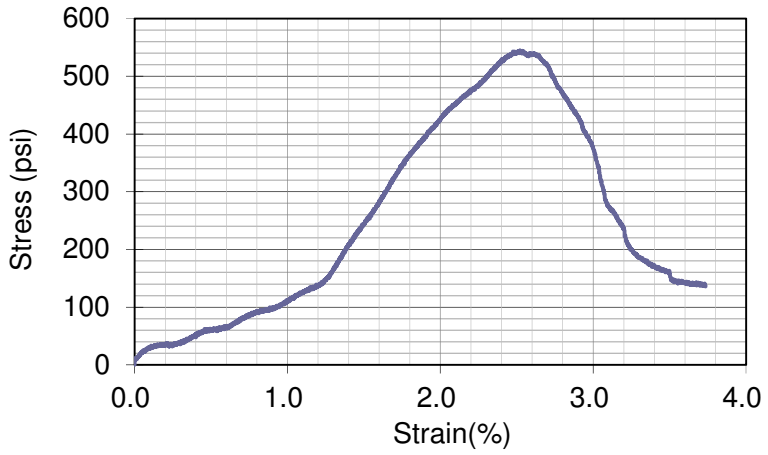
BORING NUMBER	B-001-0-25	TOP DEPTH(FT)	15.8	BOTTOM DEPTH(FT)	16.2
SAMPLE NUMBER	NQ2-2	DISTRICT	9	PID NO.	119769
COUNTY	HIG	ROUTE	SR 73	SECTION	21.11

FORMATION	Drakes Formation and Waynesville Formation Undivided
DESCRIPTION	Shale, Red, Highly Weatherd, Very Weak, Calcareous
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.888	1.974
2	3.885	1.958
3	3.892	1.963
AVERAGE	3.888	1.965

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	480.1
UNIT WEIGHT(LBS/FT^3)	155.1

RATE OF LOADING (in/min)
0.11
COMPRESSIVE STRENGTH (PSI)
550
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.34
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	25050005COL
DATE:	3/13/2025

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

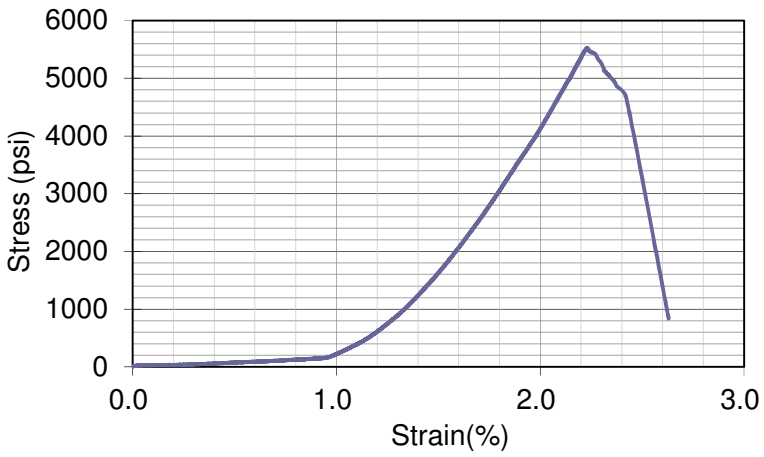
BORING NUMBER	B-002-0-25	TOP DEPTH(FT)	21.2	BOTTOM DEPTH(FT)	21.9
SAMPLE NUMBER	NQ2-3	DISTRICT	9	PID NO.	119769
COUNTY	HIG	ROUTE	SR 73	SECTION	21.11

FORMATION	Drakes Formation and Waynesville Formation Undivided
DESCRIPTION	Limestone, Gray, Moderately Weatherd, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.014	1.967
2	4.024	1.965
3	4.030	1.961
AVERAGE	4.023	1.964

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	523.2
UNIT WEIGHT(LBS/FT^3)	163.5

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
5,520
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.03
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	25050005COL
DATE:	3/13/2025

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

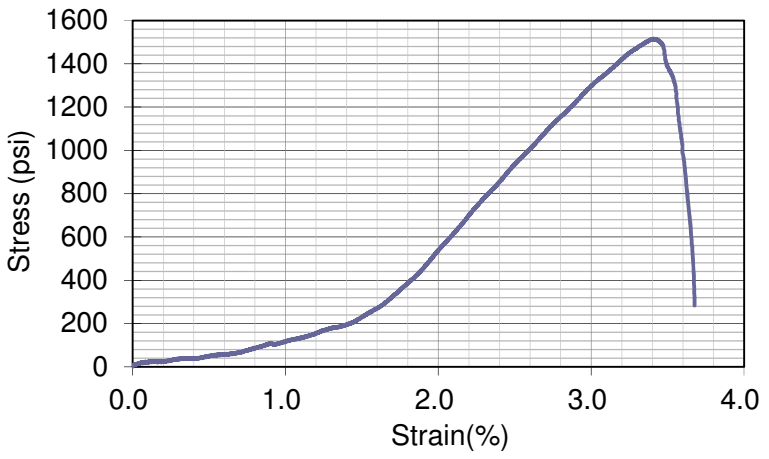
BORING NUMBER	B-002-0-25	TOP DEPTH(FT)	29.1	BOTTOM DEPTH(FT)	29.7
SAMPLE NUMBER	NQ2-3	DISTRICT	9	PID NO.	119769
COUNTY	HIG	ROUTE	SR 73	SECTION	21.11

FORMATION	Drakes Formation and Waynesville Formation Undivided
DESCRIPTION	Shale, Red and Gray, Highly Weatherd, Slightly Strong, Calcareous
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.037	1.962
2	4.030	1.959
3	4.025	1.964
AVERAGE	4.031	1.962

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	510.2
UNIT WEIGHT(LBS/FT^3)	159.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
1,520
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.47
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

APPENDIX D

CALCULATIONS

Drilled Shaft - Side Resistance in Rock

HIG-73-21.11
Rear Abutment

Boring No	B-001-0-25		
Bottom of Pier Cap Elevation	797.3	feet	(From Plans)
Top of Rock Elevation	796.6	feet	(From Boring)

LRFD Side Resistance

									Compressive		Uplift	
Top Elevation	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
796.6	Rock	604.8	2.12	1.00	576	**35.8**	34.9	**No Good**	0.55	19.2	0.4	14.0
794.6	Rock	184.3	2.12	1.00	576	**19.8**	34.9	**OK**	0.55	10.9	0.4	7.9

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per ODOT BDM Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

$q_{u\,1}$ (ksf)= 604.8 ksf **Compressive Strength of Limestone (psi)= 4,200**
(B-001-0-25, Compressive Strength Test Result, NQ2-1, 13.9'-14.4')

$q_{u\,2}$ (ksf)= 184.3 ksf **(Composite strength of interbedded shale (80%) and limestone (20%) per BDM 2020, Section 305.4.2)**
Compressive Strength of shale (psi)= 550 (Compressive strength test result B-001-0-25, NQ2-2)
Compressive Strength of limestone (psi)= 4,200 (Compressive strength test result B-001-0-25, NQ2-1)

Drilled Shaft - Tip Resistance

HIG-73-21.11
Rear Abutment

Boring No	B-001-0-25		
Bottom of Pier Cap Elevation	797.3	feet	(From Plans)
Top of Rock Elevation	796.6	feet	(From Boring)

LRFD Tip Resistance

Unconfined Compressive Strength, q_u (1) (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p (2) (ksf)	Resistance Factor, Tip Resistance (3)	Factored Unit Tip Resistance, q_p (ksf)
550	79.2	198.0	0.50	99.0

Reference Key

(1)	Compressive Strength of shale (psi)=	550	(Compressive strength test result B-001-0-25, NQ2-2)
(2)	AASHTO 10.8.3.5.4c-1		
(3)	AASHTO Table 10.5.5.2.4-1		

Drilled Shaft - Side Resistance in Rock

HIG-73-21.11
Forward Abutment

Boring No	B-002-0-25		
Bottom of Pier Cap Elevation	799.2	feet	(From Plans)
Top of Rock Elevation	806.2	feet	(From Boring)

LRFD Side Resistance

									Compressive		Uplift	
Top Elevation	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
799.2	Rock	162.0	2.12	1.00	576	**18.5**	34.9	**OK**	0.55	10.2	0.4	7.4
794.4	Rock	794.9	2.12	1.00	576	**41.1**	34.9	**No Good**	0.55	19.2	0.4	14.0
789.9	Rock	218.9	2.12	1.00	576	**21.5**	34.9	**OK**	0.55	11.8	0.4	8.6

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

$q_{u\,1}$ (ksf)= 162.0 ksf **Compressive Strength of Shale (psi)= 1,125**
GDM Table 400-6, Weak to Slightly Strong Rock

$q_{u\,2}$ (ksf)= 794.9 ksf **Compressive Strength of Limestone (psi)= 5,520**
(B-002-0-25, Compressive Strength Test Result, NQ2-3, 21.2'-21.9')

$q_{u\,3}$ (ksf)= 218.9 ksf **Compressive Strength of Limestone (psi)= 1,520**
(B-002-0-25, Compressive Strength Test Result, NQ2-3, 29.1'-29.9')

Drilled Shaft - Tip Resistance

HIG-73-21.11
Forward Abutment

Boring No	B-002-0-25		
Bottom of Pier Cap Elevation	799.2	feet	(From Plans)
Top of Rock Elevation	806.2	feet	(From Boring)

LRFD Tip Resistance

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p (2) (ksf)	Resistance Factor, Tip Resistance (3)	Factored Unit Tip Resistance, q_p (ksf)
1520	218.9	547.2	0.50	273.6

Reference Key

(1)	Compressive Strength of shale (psi)=	1520	(Compressive strength test result B-001-0-25, NQ2-3)
(2)	AASHTO 10.8.3.5.4c-1		
(3)	AASHTO Table 10.5.5.2.4-1		

APPENDIX E

L-PILE PARAMETERS

L-PILE Soil and Rock Parameters

HIG-73-21.11 (PID No. 119769)
State Route 73 Bridge over Ohio Brush Creek

Rear Abutment (B-001-0-25)

Boring No.	B-001-0-25		
Boring Elevation:	809.6	feet	(From BG Engineering)
Bottom of Foundation Elevation:	797.3	feet	(Obtained from Stage 3 Plans)
Top of Coreable Rock Elevation:	796.6	feet	(From Geotechnical Exploration)

Below Bottom of Foundation to 794.6 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	98	pcf	Laboratory Test of B-001-0-25, NQ2-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	4,200	psi	Laboratory Test of B-001-0-24, NQ2-1
Initial Rock Modulus =	320,000	psi	GDM Table 400-6, Moderately Strong Rock
RQD =	25%		B-001-0-25, NQ2-1 RQD

Below 794.6 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	93	pcf	Laboratory Test of B-001-0-25, NQ2-2
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	550	psi	Laboratory Test of B-001-0-25, NQ2-2
Initial Rock Modulus =	32,000	psi	GDM Table 400-6, Very Weak to Weak Rock
RQD =	3%		B-001-0-25, Average RQD from NQ2-2 and NQ2-3

Forward Abutment (B-002-0-25)

Boring No.	B-002-0-25		
Boring Elevation:	812.9	feet	(From BG Engineering)
Bottom of Pile Cap Elevation:	799.2	feet	(Obtained from Stage 3 Plans)
Top of Coreable Rock Elevation:	806.2	feet	(From Geotechnical Exploration)

Below Bottom of Foundation to 794.4 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	93	pcf	Laboratory Test of B-001-0-25, NQ2-2
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	1,125	psi	GDM Table 400-6, Weak to Slightly Strong Rock
Initial Rock Modulus =	100,000	psi	GDM Table 400-6, Weak to Slightly Strong Rock
RQD =	20%		B-002-0-25, NQ2-2 RQD

From 794.4 to 789.9 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	101	pcf	Laboratory Test of B-002-0-25, NQ2-3
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	5,520	psi	Laboratory Test of B-002-0-25, NQ2-3 (Limestone)
Initial Rock Modulus =	450,000	psi	GDM Table 400-6, Moderately Strong to Strong Rock
RQD =	37%		B-002-0-25, NQ2-2 / NQ2-3 RQD

Below 789.9 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	97	pcf	Laboratory Test of B-002-0-25, NQ2-3
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	1,520	psi	Laboratory Test of B-002-0-25, NQ2-3 (Shale)
Initial Rock Modulus =	140,000	psi	GDM Table 400-6, Slightly Strong Rock
RQD =	17%		B-002-0-25, NQ2-3 RQD

APPENDIX F

RESPONSE TO STAGE 2 COMMENTS

Department of Transportation
transportation.ohio.gov

Mike DeWine, *Governor*
Jon Husted, *Lt. Governor*
Pamela Boratyn, *Director*

May 28th, 2025

Greg Boyer, P.E.
BG Engineering Group, LLC
269 Dovetail Drive
Lewis Center, Ohio 43035

Subject: HIG-73-21.11
PID 119769
Stage 2 submission

Dear Mr. Boyer:

We have completed our review of the subject. The following are our comments:

1. General
   a. Please complete the attached TAF Checklist. Along with the checklist, please be sure to include all other items required by the L&D Vol. 2 section 1010 including the TAF worksheet. The length of temporary impact was removed from the form, but we still need this information for our application of the waterway permit. Please include the length of impact as well.

Temporary+Construction+Access+and+

   b. Please incorporate the following Environmental Commitments to a plan note on sheet 7:
      i. A plan note alerting the Contractor to the possible presence of boating traffic and requiring the Contractor to be alert to boaters and accommodate safe travel through the project area.
      ii. The Contractor shall place appropriate signage/buoys/markers 300 feet upstream and 300 feet downstream of the project area to alert paddlers/boaters of construction activity and for wayfinding purposes.
      iii. The Project Engineer or Contractor shall notify ODNR at kyla.maunz@dnr.ohio.gov, 14 calendar days prior to the start of construction activities to allow ODNR to post notice of the impending project construction on the appropriate ODNR webpages and associated online boating maps.
      iv. The Contractor shall closely coordinate the construction schedule (including access restrictions) with ODOT and ODNR prior to the start of construction activities.
      v. If on-the-water law enforcement is needed during any portion of the construction activities, the Project Engineer or Contractor shall contact the ODNR Division of

Parks and Watercraft Law Enforcement Supervisor, Lt. Jason Gantt at Jason.Gantt@dnr.ohio.gov or 513-515-4313.

vi. While it is anticipated that the stream will need to be closed to complete portions of the project, unnecessary closing of the stream during construction of this project is prohibited. Furthermore, boater traffic under the bridge shall be maintained at all times from Fridays at 6 PM through Mondays at 6 AM and all Federal holidays from 12:00 AM to 11:59 PM. All work that will require closing the stream to boater access shall be scheduled outside of these hours.

c. Add the Asbestos plan note:

OEPA Demo Reno plan note.docx

d. Add the in-stream work restrictions note:

In-Stream Work Restrictions – Ohio Brush Creek
No work or fill, permanent or temporary, is permitted below the Ordinary High Water Mark (OHWM) of Ohio Brush Creek from April 15 to June 30. Fills placed within Ohio Brush Creek (outside of the work restriction dates) can continue to be worked from during the work restriction dates, but cannot be expanded, removed, or otherwise modified (below ordinary high water) until once again outside of the work restriction dates

2. Stage 2 Plans:
   a. Sheet P.7 (General Notes):
      i. Remove the "Endangered Bat Habitat Removal" plan note as it does not apply to this project.
   b. Sheets P.8,10 & 11 (MOT):
      i. The initial controller timing table on Sheet P.8 shows field drives, but the field drives shown around station 1108+10 and station 114+70 on sheet P. 10 & 11 do not show signal heads for the drives.
      ii. The district has concerns with the sight distance to the temporary signals and potential stopped traffic. Consider adding supplemental signing to warn drivers of the zone.
   c. Sheet P.26 (Traffic Control):
      i. Use 642 everywhere.
   d. Sheet P.27 (Structure Site Plan)
      i. Update the top of rock elevations to be consistent with elevations reported in geotechnical report and boring logs.
      ii. Turf reinforcing mat, type 1 is specified. Provide ditch calculations. These should also be shown on the plan and profile sheet if warranted.
      iii. The proposed structure should be shaded in the profile view.
   e. Sheet P.29 (Structure General Notes)
      i. The factored tip resistance should be updated to match the factored tip resistance provided in the geotechnical report for the forward and rear abutments.
      ii. Under "The proposed work" change three span rolled beams to three span concrete slab bridge to match the title block.

f. Sheet P.30 (Structure General Notes)
    i. Under the abbreviation title remove the abbreviations that do not pertain to this project such as cvn, expansion joint etc.
    ii. Remove the existing abutment at least 18" below the bottom of the approach slab.
g. Sheet P. 35 (Structure Shoring Wall Details)
    i. Typical Wall Section Details see comment #2.d.ii above for the approach slab not to be in contact with the wall.
    ii. View A-A installing the 0.5"x8" A325 bolt anchored into the concrete will not work. Provide a mechanical anchor or an adhesive anchor. See Hilti or other products that are available for this application.
    iii. For the temporary sheet pile wall, specify minimum length and minimum section modulus per unit width in conformance with GDM Section 1509.3.
    iv. For the temporary soldier pile lagging wall, please provide design basis for this.
    v. Should the Drilled Shaft Above the Rock be 6 inches larger in diameter than the one below the rock?
    vi. What do "A" and "B" refer to in the "Rear Abutment Section?"
    vii. It is not clear how far the excavation bracing (sheet piling) needs to extend to support the roadway profile change. The structure site plan appears to show it stopping at the approach slabs, but the MOT section views show sheet piling outside the limits of the bridge and approach slabs. Please advise.
h. Sheet P. 38 & 40 (Structure Rear and Forward Abutment Details)
    i. Extend the R602 above the construction joint lapping the R509. Easier to construct.
i. Sheet P. 37 and 39 (Structure Rear and Forward Abutment Plan and Elevation)
    i. Provide the elevation of the beam seat.
j. Sheet P.44 (Structure Beam Sections & Details)
    i. Please provide documentation from a fabricator requesting that F'ci of 7 ksi can be delivered.

3. Geotechnical Comments:
    a. Upon Stage 3 submittal, please include a letter of review for the Plans from the Geotechnical Engineer of Record.

CTL Response: CTL received the Stage 3 plans on June 30, 2025. CTL reviewed and included a letter of review within the Appendices of the Final Structure Foundation Exploration Report.

    b. Note, the Qu was taken above where the drilled shaft will bear. Is there sufficient sample to run one additional compressive strength test nearer to the bearing elevation of the drilled shaft?

CTL Response: Assuming that this comment is referring to the unconfined compression (Qu) test performed on the shale sample obtained from 15.8'-16.2' in boring B-001, unfortunately, there is no additional rock sample from this boring that was suitable for Qu testing. The tested shale sample is from the layer that extended from 15.0 feet to the bottom of the boring. It is our opinion that the compressive strength value (550 psi) is representative of the strength of the shale rock for that layer, and can be utilized to determine the tip and side resistance.

Additionally, the shale rock encountered between 789.9 and 782.2 in boring B-002 exhibited a much higher compressive strength value of 1,520 psi. Therefore, utilizing 550 psi to determine the tip and side resistance for the rear abutment is acceptable.

c. The LPILE compressive strength reported for use on pp. 46 of the geotechnical report is a weighted average assuming 80% shale and 20% limestone. In the event there were a higher proportion of shale present would this be a sufficiently conservative Qu?

CTL Response: CTL ignored the 20% limestone and provided updated lateral parameters within the Appendices of the Final Structure Foundation Exploration Report.

d. Please provide the LPILE outputs for District review upon submittal of Stage 3.

CTL Response: BG Engineering is performing the Lpile analyses and should address the above comment.

e. Geotechnical Report pp. 26 and pp. 29 – the rock core run for boring B-001 was labeled as "NQ-2." The rock core run was also "NQ-2" for boring B-002. Consider updating label for rock core run in boring B-001 as "NQ-1."

CTL Response: The NQ2 refers to the core bit size that was utilized during the rock coring operations. The rock core runs in boring B-001 were identified as NQ2-1 through NQ2-3. This identification is consistent with example logs included in the SGE.

f. The interbedded Shale and limestone rock is highly weathered at B-001-0-25, with the shale being reported as "very weak" with an RQD in this range of 4%. While the factored unit tip resistance (based on the calculations) is adequate for the rear abutment loading, is the designer comfortable with tip resistance and factors of safety here with 10' rock socket based on one tested Qu of 550 psi?

CTL Response: See response to comment 3.b.

4. Load Rating (Office of Structural Engineering)

HIG-73-21.11 SFN 3601750 (PID 119769

Nothing in these comments is to be construed as authorizing extra work for which additional compensation may be claimed. If you believe that these comments require work outside the limits of the Scope of Services for this project, please contact this office before proceeding.

Sincerely,

Matt McClellan, P.E.

APPENDIX G

CERTIFICATION OF GEOTECHNICAL PLAN REVIEW - STAGE 3

CTL Engineering, Inc.
2860 Fisher Road, P.O. Box 44548, Columbus, Ohio 43204-3538
Phone: 614/276-8123 • Fax: 614/276-6377
Email: ctl@ctleng.com

July 8, 2025

BG Engineering Group, LLC
5960 Wilcox Place, Suite C
Dublin, OH 43016

Attention: Mr. Greg Boyer, P.E. – Principal

Subject: **Certification of Geotechnical Plan Review – Stage 3**
HIG-73-21.11 Bridge Replacement
PID No. 119769, Agreement No. 40928
Jackson Township, Highland County, Ohio
CTL Project No. 25050005COL

Dear Mr. Boyer:

As the Geotechnical Engineer of Record for the subject project, I certify that I have reviewed the Stage 3 plans for the subject project.

If you have any questions or need further information, please feel free to contact our office.

Respectfully Submitted,

CTL ENGINEERING, INC.

Sastry Malladi, P.E
Project Manager