PRELIMINARY REPORT
STRUCTURE FOUNDATION EXPLORATION
BRIDGE ROS-772-0764 (CROSSING RALSTON RUN)
ROS-772-7.64, PID#: 118518
ROSS COUNTY, OHIO

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NEAS PROJECT 24-0004

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National Engineering & Architectural Services Inc.

EXECUTIVE SUMMARY

The Ohio Department of Transportation (ODOT) District 9 has proposed a bridge replacement project (ROS-772-7.64 PID# 118518) for the planned replacement of the existing bridge carrying SR 772 over Ralston Run, Ross County, Ohio. It is our understanding that this project entails replacing the existing bridge with a single span composite deck on beam superstructure. The proposed bridge spans 77 ft 4 inches from abutment to abutment, with a span length of 75 ft and a roadway width of 36 ft.

National Engineering and Architectural Services Inc. (NEAS) has been contracted to perform geotechnical engineering services for the project. The purpose of the geotechnical engineering services is to perform geotechnical explorations within the project limits to obtain information concerning the subsurface soil and groundwater conditions relevant to the design and construction of the project. As part of the referenced explorations, NEAS advanced 2 project borings and conducted laboratory testing to characterize the soils for engineering purposes. The report presents a summary of the encountered surficial and subsurface conditions and our recommendations for bridge foundation design and construction.

The subsurface profile at the referenced site is generally consistent with the geological model for the project in regard to the materials encountered. The subsurface profile at the proposed bridge replacement site generally consists of primarily very stiff to hard cohesive fine materials and some medium dense to very dense granular materials. Bedrock was encountered in both the project and historical borings. In the project borings, bedrock was encountered at a depth of 17.5 feet below ground surface (757.3 feet above mean sea level) at the forward abutment, and at 8.7 feet below ground surface (768.2 feet above mean sea level) at the rear abutment. Additionally, bedrock was discovered in the historical borings between depths of 3.5 feet and 7.0 feet below ground surface (with elevations ranging from 761.3 feet to 762.7 feet above mean sea level).

A foundation review was completed for a deep foundation system for the referenced replacement bridge based on the following design information: 1) the Site Plan for the bridge conducted by Woolpert; 2) historical plans and subsurface exploration. Bedrock elevations ascend from west to east and from south to north. At the forward abutment, bedrock was encountered at depths ranging from 762.7 ft (west) to 768.2 ft amsl (east), whereas at the rear abutment, it was found at depths ranging 757.3 ft (west) to 761.3 ft amsl (east). NEAS recommends utilizing “HP” piles for both abutments, placed in prebored holes to penetrate 10 feet below the footing.

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1. INTRODUCTION

1.1. General

National Engineering and Architectural Services Inc. (NEAS) presents our Structure Foundation Exploration Report for the planned replacement of the existing bridge carrying SR 772 over Ralston Run, Ross County, Ohio. The report presents a summary of the encountered surficial and subsurface conditions and our recommendations for bridge foundation design and construction, and reinforced slope design and construction. Our recommendations are in accordance with ODOT's 2020 LRFD Bridge Design Manual (BDM) (ODOT, 2024), ODOT’s 2024 Geotechnical Design Manual (GDM) (ODOT, 2024).

The exploration was conducted in general accordance with NEAS, Inc.’s proposal to Woolpert dated November 17, 2023, and with the provisions of ODOT’s *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2024).

The scope of work performed included: 1) a review of published geotechnical information; 2) performing 2 total test borings; 3) laboratory testing of soil samples in accordance with the SGE; 4) performing geotechnical engineering analysis to assess foundation design and construction considerations; and 5) development of this summary report.

1.2. Proposed Construction

The existing ROS-772-7.64 bridge is a three (3) span non-composite prestressed concrete box beam superstructure supported on reinforced concrete substructure on spread footing. The existing bridge is approximately 96 ft in length with an approximate roadway width of 38 ft.

It is our understanding that this project entails replacing the existing bridge with a single span composite deck on beam superstructure. The proposed bridge spans 77 ft 4 inches from abutment to abutment, with a span length of 75 ft and a roadway width of 36 ft.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The project site is located within the Columbus Lowland Till Plains, a subdivision of the Southern Ohio Loamy Till Plain. This is a moderately low relief (25 ft) lowland surrounded in all directions by relative uplands, having a broad regional slope toward the Scioto Valley, containing many larger streams. Elevations of the region range from 600 to 850 ft above mean sea level (amsl) (950 ft amsl near Powell Moraine). The geology within this region is described as Wisconsinan-age till that is high lime in the west to medium-lime in the east. The geology is also described as containing extensive outwash in Scioto Valley overlying deep Devonian- to Mississippian-age carbonate rocks, shales and siltstones (ODGS, 1998).

Based on the Quaternary geology map of Ohio, the geology at the project site is mapped as Dissected ground moraine occurs on ridgetops and mixed with weathered bedrock as colluvium on slopes (Pavey, et al 1999).

Based on the Bedrock Geologic Units Map of Ohio (USGS & ODGS, 2006), bedrock within the project area consists of shale and sandstone, of the Sunbury Shale, Berea Sandstone and Bedford Shale formation. The upper 10 to 50 feet shale; black to brown, weathers light brown; carbonaceous; thin, planar bedding. Underlain by 10 to 50 feet sandstone; brown, weathers light brown to reddish brown; thin to thick bedded, planar to lenticular bedding; minor shale interbeds. Basal 80 to 100 feet shale and interbedded sandstone; gray to brown, weathers light gray to light brown; thin to medium bedded, planar to lenticular bedding; thick. Interval thickness ranges from 100 to 200 feet. The bedrock is relatively level throughout the project (ODGS, 2003). Based on the ODNR bedrock topography map of Ohio, bedrock elevations at the project site can be expected to be around 750 to 850 ft amsl, putting bedrock at depths of between 20 and 70 ft below ground surface (bgs).

The soils at the project site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as primarily Clifty silt loam series. The Clifty silt loam series is comprised of both coarse- and fine-grained soils and classifies as A-1, A-2, and A-4, type soils according to the AASHTO method of soil classification.

2.2. Hydrology/Hydrogeology

Groundwater at the project site can be expected at an elevation consistent with that of the nearby Ralston Run as it is the most dominant hydraulic influence in the vicinity of the project's boundaries. The water level of the Ralston Run may be generally representative of the local groundwater table. However, it should be noted that perched groundwater systems may be existent in areas due to the presence of fine-grained soils making it difficult for groundwater to permeate to the phreatic surface.

The project is located within a special flood hazard area (Zone A), by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2016). Mining and Oil/Gas Production

2.3. Mining and Oil/Gas Production

No abandoned underground mines are noted on ODNR's Abandoned Underground Mine Locator within the immediate vicinity of the project site (ODNR [1], 2024).

According to the ODNR's Ohio Oil & Gas Locator map, no oil or gas wells are located in the immediate vicinity of the project site (ODNR [2], 2024).

2.4. Historical Records and Previous Phases of Project Exploration

A historic record search was performed through ODOT's Transportation Information Management System (TIMS). The following report/plans were available for review and evaluation for this report:

- Bridge design foundation report and project Boring Log for ROS-772-7.85, dated August 29, 1973.
- Bridge design foundation report Project Boring Logs for ROS-772-0778, dated May 21, 1973.

Two historical soil borings (B-002-0-73, and B-007-0-73) that were drilled as part of the 1973 Structure Exploration for ODOT project ROS-772-7.78 were reviewed and are utilized in our report and analysis. A summary of the historic borings and previous project borings information (location, elevation, etc.) is provided in Table 1, and their locations are depicted on the Boring Location Plan provided in Appendix A. The historic borings and previous project borings utilized within this report are provided in Appendix

B. It should be noted that the elevations in NAVD 88 are typically lower than they are in NGVD 29; herein the elevations in NAVD 88 are 0.5 feet lower than they are in NGVD 29.

Table 1: Historic Boring and Previou Project Boring Summary

Boring Number	Location (Sta/offset)	Latitude	Longitude	Elevation (NGVD 29) (ft)	Elevation (NAVD 88) (ft)	Existing Substructure	Elevation of Top of Bedrock (NGVD 29) (ft)	Elevation of Top of Bedrock (NAVD 88) (ft)
B-002-0-73	416+00, 10' RT	39.255912	-83.049509	765.3	764.8	Rear Abutment	761.8	761.3
B-007-0-73	417+05, 27' LT	39.256177	-83.049705	770.2	769.7	Forward Abutment	763.2	762.7

3. GEOTECHNICAL EXPLORATION

3.1. Field Exploration Program

The project subsurface exploration was conducted by NEAS on February 28, 2024, and included 2 borings drilled to depths range between 29.5 ft to 38.7 ft below ground surface. The boring locations were selected by NEAS in general accordance with the guidelines contained in the SGE with the intent to evaluate subsurface soil and groundwater conditions. Borings were typically located within the planned project construction areas that were not restricted by underground utilities or dictated by terrain (e.g. steep embankment slopes). Project boring locations were in the field after drilling by project surveyor. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude location and the corresponding ground surface elevation (surveyed by the project surveyors). The boring locations are depicted on the Boring Location Plan provided in Appendix A. Latitude/Longitude, elevations and stationing and offsets of the borings are shown on Table 2 below.

Table 2: Project Boring Summary

Boring Number	Location (Sta/offset)	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)	Substructure	Elevation of Top of Bedrock (NAVD 88) (ft)
B-001-0-23	415+73, 24' LT	39.255803	-83.049606	774.8	38.7	Rear Abutment	757.3
B-002-0-23	417+33, 17' RT	39.256257	-83.049566	776.9	29.5	Forward Abutment	768.2

Project borings were drilled using a CME 45B truck-mounted drilling rig utilizing 3.25-inch (inner diameter) hollow stem auger. In general, soil samples were recovered continuously to end of boring, using an 18-inch split spoon sampler (AASHTO T-206 “Standard Method for Penetration Test and Split Barrel Sampling of Soils.”). The soil samples obtained from the exploration program were visually observed in the field by the NEAS field representative and preserved for review by a Geologist for possible laboratory testing. Standard penetration tests (SPT) were conducted using a CME auto hammer calibrated to be 72.6% efficient on January 24, 2022, as indicated on the boring logs.

Field /boring logs were prepared by drilling personnel, and included lithological description, SPT results recorded as blows per 6-inch increment of penetration and estimated unconfined shear strength values on specimens exhibiting cohesion (using a hand-penetrometer). Groundwater level observations were recorded both during and after the completion of drilling. These groundwater level observations are included on the individual boring logs. After completing the borings, the boreholes were backfilled with bentonite grout, and patched with cold patch asphalt and/or quickset concrete where necessary and appropriate.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing, moisture content determinations and unconfined compressive strength testing. Data from the laboratory testing program was incorporated onto the boring logs (Appendix B).

3.2.1. Classification Testing

Representative soil samples were selected for index properties (Atterberg Limits) and gradation testing for classification purposes on approximately 33% of the samples. At each boring location, samples were selected for testing with the intent of identification and classification of all significant soil units. Soils not selected for testing were compared to laboratory tested samples/strata and classified visually. Moisture content testing was conducted on all samples. The laboratory testing was performed in general accordance with applicable AASHTO specifications.

A final classification of the soil strata was made in accordance with AASHTO M-145 "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," as modified by ODOT "Classification of Soils" once laboratory test results became available. The results of the soil classification are presented on the boring logs provided in Appendix B.

3.2.2. Standard Penetration Test Results

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils were performed at varying intervals (i.e., continuous, 2.5-ft, or 5.0-ft intervals) in the project borings performed. To account for the high efficiency (automatic) hammers used during SPT sampling, field SPT N-values were converted based on the calibrated efficiency (energy ratio) of the specific drill rig's hammer. Field N-values were converted to an equivalent rod energy of 60% (N_{60}) for use in analysis or for correlation purposes. The resulting N_{60} values are shown on the boring logs provided in Appendix B.

3.2.3. D_{50} Values for Scour Evaluation

Grain size distribution testing was performed on the obtained streambed samples to develop D_{50} values (i.e., the diameter in the particle-size distribution curve corresponding to 50 % finer). The calculated D_{50} values are shown in Table 3 below and the developed particle-size distribution curves are included with the associated boring log within Appendix B.

Table 3: D_{50} Values for Scour Evaluation

Boring Number	Specimen ID	Specimen Elevation (ft)	ODOT (Modified AASHTO) ~ USCS Classification	D_{50} (mm)	Scour Critical Shear Stress, τc (psf)	$D_{50, equiv}$ (mm)	Erosion Category (EC)
B-001-0-23	SS-10	761.3' - 759.8'	A-2-6 CLAYEY SAND with GRAVEL (SC)	0.8800	0.0822	3.9380	3.075

The rock scour design parameters are also included in Appendix B.

4. GEOTECHNICAL FINDINGS

The subsurface conditions encountered during NEAS's explorations are described in the following subsections and/or on each boring log presented in Appendix B. The boring logs represent NEAS's interpretation of the subsurface conditions encountered at each boring location based on our site observations, field logs, visual review of the soil samples by NEAS's geologist, and laboratory test results. The lines designating the interfaces between various soil strata on the boring logs represent the approximate interface location; the actual transition between strata may be gradual and indistinct. The subsurface soil and groundwater characterizations included herein, including summary test data, are based on the subsurface findings from the geotechnical explorations performed by NEAS as part of the referenced project, and consideration of the geological history of the site.

4.1. Subsurface Conditions

The subsurface profile at the referenced site is generally consistent with the geological model for the project in regard to the materials encountered. The subsurface profile at the proposed bridge widening site generally consists of primarily very stiff to hard cohesive fine materials and some medium dense to very dense granular materials. Bedrock was encountered in both project borings and historic borings,, ranging from depths of 3.5 ft to 17.5 ft below ground surface (with elevations between 757.3 ft and 768.2 ft above mean sea level).

4.1.1. Overburden Soil

At the proposed rear abutment, the subsurface soils encountered generally consisted of cohesive fine-grained soils underlain by non-cohesive coarse-grained soils. The cohesive fine-grained soils, classified as Sand Silt (A-4a), extend to 770.3 ft amsl. Underneath this layer, the stratum of granular soils ranges from elevations of 770.3 feet to 757.3 feet above mean sea level (amsl), classified as Gravel with Sand (A-1-b), Stone Fragments with Sand and Silt (A-2-4), and Stone Fragments with Sand, Silt, and Clay (A-2-6). The cohesive soils can be described as having a hard consistency based on N_{60} values between 16 and 38 bpf and unconfined compressive strengths (estimated by means of hand penetrometer) between approximately 4.25 and 4.50 tsf. Natural moisture contents of the cohesive soils ranged from 14 to 15 percent. The non-cohesive soils at the rear abutment location are described as having a relative compactness of medium dense to very dense correlating to N_{60} values between 16 and 54. The natural moisture content of the non-cohesive soils ranged from 7 to 14 percent.

At the proposed forward abutment, the subsurface soils encountered primarily consisted cohesive fine-grained soils extending to 768.2 ft. The cohesive soils are classified on the boring logs as Silt (A-4a), Silt and Clay (A-6a), and Clay (A-7-6). The cohesive soils can be described as having a very stiff to hard consistency based on N_{60} values between 11 and 31 bpf and unconfined compressive strengths (estimated by means of hand penetrometer) between approximately 2.50 and 4.50 tsf. Natural moisture contents of the cohesive soils ranged from 13 to 18 percent.

4.1.2. Groundwater

Groundwater measurements were taken during the drilling procedures and/or immediately following the completion of each borehole. Groundwater was not encountered in any of the project borings during drilling.

It should be noted that groundwater is affected by many hydrologic characteristics in the area and may vary from those measured at the time of the exploration.

4.1.3. Bedrock

Bedrock was discovered in the two project borings at terminating depths of 38.7 feet for the Rear abutment and 29.5 feet for the forward abutment. At the forward abutment, bedrock was encountered at a depth of 17.5 feet below ground surface (757.3 feet above mean sea level), while at the rear abutment, it was found at 8.7 feet below ground surface (768.2 feet above mean sea level). Additionally, bedrock was encountered in the historical borings between depths of 3.5 feet and 7.0 feet below ground surface (with elevations ranging from 761.3 feet to 762.7 feet above mean sea level).

Based on the exploration and testing conducted, bedrock at the project site was classified as slightly to moderately weathered, weak to slightly strong, fractured - highly fractured to intact, narrow to tight Shale. Recovery of the bedrock core performed ranged from 95 to 100 percent while the Rock Quality Designation (RQD) values ranged from 53 to 100 percent.

Additionally, sandstone was encountered on the historical borings above shale, which was described as buff, firm, very fine-grained, joined with core loss ranging from 66 % to 72%.

5. ANALYSES AND RECOMMENDATIONS

We understand that this project entails replacing the existing bridge with a single span composite deck on beam superstructure. The proposed bridge spans 77 ft 4 inches from abutment to abutment, with a span length of 75 ft and a roadway width of 36 ft. The summary and results of our evaluation as well as recommendations presented in subsequent sections.

5.1. Soil Profile for Analysis

For analysis purposes, each boring log was reviewed, and a generalized material profile was developed for analysis. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on their field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil and rock properties (with cited correlation/reference material) used in our evaluation is summarized per boring within Tables 4 and 5 below.

Table 4: B-001-0-23 Soil Profile

Rear Abutment : Soil Profile B-001-0-23							
Soil Description	Unit Weight(1) (pcf)	Moist Unit Weight(1) (pcf)	Saturated Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)	Setup Factor (f_{su})
Sandy Silt Depth (774.8 ft - 770.3 ft)	115	115	125	2950	250	26	1.50
Gravel with Sand Depth (770.3 ft - 768.8 ft)	122	122	132	-	-	45	1.00
Gravel with Sand and Silt Depth (768.8 ft - 761.3 ft)	115	115	125	-	-	35	1.20
Gravel with Sand, Silt and Clay Depth (761.3 ft - 757.3 ft)	115	115	125	-	-	33	1.20

Notes:
1. *Values interpreted from ODOT Geotechnical Design Manual (GDM) Section 405.*
2. *Values calculated from Terzaghi and Peck (1967) if N160<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from LRFD BDS Table 10.4.6.2.4-1 and ODOT GDM Table 400-3.*

Table 5: B-002-0-23 Soil Profile

Forward Abutment: Soil Profile B-002-0-23							
Soil Description	Unit Weight(1) (pcf)	Moist Unit Weight(1) (pcf)	Saturated Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)	Setup Factor (f_{su})
Clay Depth (776.9 ft - 775.4 ft)	110	110	120	1350	150	22	2.00
Sandy Silt Depth (775.4 ft - 770.9 ft)	115	115	125	2600	250	26	1.50
Silt and Clay Depth (770.9 ft - 768.2 ft)	115	115	125	3400	250	26	1.50

Notes:
1. *Values interpreted from ODOT Geotechnical Design Manual (GDM) Section 405.*
2. *Values calculated from Terzaghi and Peck (1967) if N160<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from LRFD BDS Table 10.4.6.2.4-1 and ODOT GDM Table 400-3.*

5.2. Bridge Foundation Analysis and Recommendations

A foundation review was completed for a deep foundation system for the referenced Replacement bridge based on the following design information: 1) the Site Plan for the Bridge conducted by Woolpert; 2) historical plans and subsurface exploration. Bedrock elevations ascend from west to east and from south to north. At the forward abutment, bedrock was encountered at depths ranging from 762.7 ft (west) to 768.2 ft amsl (east), whereas at the rear abutment, it was found at depths ranging 757.3 ft (west) to 761.3 ft amsl (east). NEAS recommends utilizing "HP" piles for both abutments, placed in prebored holes to penetrate 10 feet below the footing. **Additional information regarding the bridge foundation analysis and recommendations will be furnished upon determination of the preferred structure type.**

Further details of the bridge foundation analysis and recommendations will be provided when the preferred structure type is determined.

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions at the site of the proposed ROS-772-7.64 (PID# 118518), Ross County, Ohio. This report has been prepared for Woolpert, ODOT and their design consultants to be used solely in evaluating the soils underlying the indicated structures and presenting geotechnical engineering recommendations specific to this project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory test results from representative soil samples, geotechnical engineering analyses and historical information. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes occur in the nature, design or location of the proposed structural work, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed and have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to Woolpert in performing this geotechnical exploration for the ROS-772-7.64 (PID# 118518) Replacement project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

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APPENDIX A

BORING LOCATION PLAN

ROS-772-7.64 PID 118518

TARGET BORING PLAN

APPENDIX B

BORING LOGS

PROJECT: ROS-772-7.64	DRILLING FIRM / OPERATOR: CS / TS	DRILL RIG: CME 45B	STATION / OFFSET: 415+73, 24' LT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / LR	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 118518 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 1/24/22	ELEVATION: 774.8 (MSL) EOB: 38.7 ft.
START: 2/8/24 END: 2/8/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 72.6	LAT / LONG: 39.255803, -83.049606

EXPLORATION ID B-001-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 774.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
10.0" ASPHALT AND 6.0" BASE	773.5	1	3 5 8	16	33	SS-1	4.25	-	-	-	-	-	-	-	-	15	A-4a (V)	
HARD, BROWN AND DARK BROWN, **SANDY SILT**, LITTLE TO SOME GRAVEL, LITTLE TO SOME CLAY, CONTAINS ASPHALT FRAGMENTS, DAMP **(FILL)**		2	6 6 8	17	78	SS-2	4.50	28	10	7	38	17	30	20	10	14	A-4a (4)	
	770.3	3–4	2 10 21	38	72	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-4a (V)	
VERY DENSE, DARK BROWN, **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, CONTAINS ASPHALT FRAGMENTS, DAMP **(FILL)**	768.8	5	15 17 28	54	94	SS-4	-	55	17	12	13	3	NP	NP	NP	7	A-1-b (0)	
MEDIUM DENSE, ORANGISH BROWN AND BROWN, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, IRON STAINING, DAMP TO MOIST		6–7	10 12 8	24	94	SS-5	-	37	24	13	20	6	NP	NP	NP	10	A-2-4 (0)	
		8	9 8 9	21	11	SS-6	-	-	-	-	-	-	-	-	-	9	A-2-4 (V)	
		9–10	10 8 6	17	22	SS-7	-	-	-	-	-	-	-	-	-	11	A-2-4 (V)	
		11	5 5 8	16	56	SS-8	-	-	-	-	-	-	-	-	-	12	A-2-4 (V)	
	761.3	12–13	15 7 8	18	50	SS-9	-	-	-	-	-	-	-	-	-	13	A-2-4 (V)	
MEDIUM DENSE, BROWN, **STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, DAMP		14	6 7 7	17	78	SS-10	-	38	23	7	18	14	33	22	11	14	A-2-6 (0)	
	757.3	15–17 TR																
SHALE, BLACK, SLIGHTLY TO MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, LAMINATED TO VERY THIN BEDDED, FISSILE, PYRITIC, BEDDING DISCONTINUITIES: LOW ANGLE, JOINT DISCONTINUITIES: HIGH ANGLE FROM 21.5'-23.3', 30.5'-30.8', AND 32.8'-33.1', FRACTURED TO INTACT, NARROW TO TIGHT, SLIGHTLY ROUGH, BLOCKY TO INTACT, GOOD SURFACE CONDITION; RQD 99.6%, REC 89.8%.		18–19	50/3"	-	100	SS-11	-	-	-	-	-	-	-	-	-	5	Rock (V)	
		20–24	67		100	NQ2-1											CORE	
		25–29	98		98	NQ2-2											CORE	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 5/8/24 10:29 - P:\OHDOT_V2\WORKSETS\118518\400-ENGINEERING\GEOTECHNICAL\BASEMAPS\GINT\ROS-772-7.64.GPJ

PID: 118518	SFN:	PROJECT: ROS-772-7.64	STATION / OFFSET: 415+73, 24' LT.	START: 2/8/24	END: 2/8/24	PG 2 OF 2	B-001-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 744.8	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
SHALE, BLACK, SLIGHTLY TO MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, LAMINATED TO VERY THIN BEDDED, FISSILE, PYRITIC, BEDDING DISCONTINUITIES: LOW ANGLE, JOINT DISCONTINUITIES: HIGH ANGLE FROM 21.5'-23.3', 30.5'-30.8', AND 32.8'-33.1', FRACTURED TO INTACT, NARROW TO TIGHT, SLIGHTLY ROUGH, BLOCKY TO INTACT, GOOD SURFACE CONDITION; RQD 99.6%, REC 89.8%. *(continued)*	736.1	31 32 33 34 35 36 37 38 EOB	98		100	NQ2-3											CORE	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 50 GAL. BENTONITE GROUT

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-001-0-23

Run #:	Depth		Recovery		RQD	
NQ2-1	18.7’	24.2’	66”	100%	44.5”	67%

ROS-772-7.64

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-001-0-23

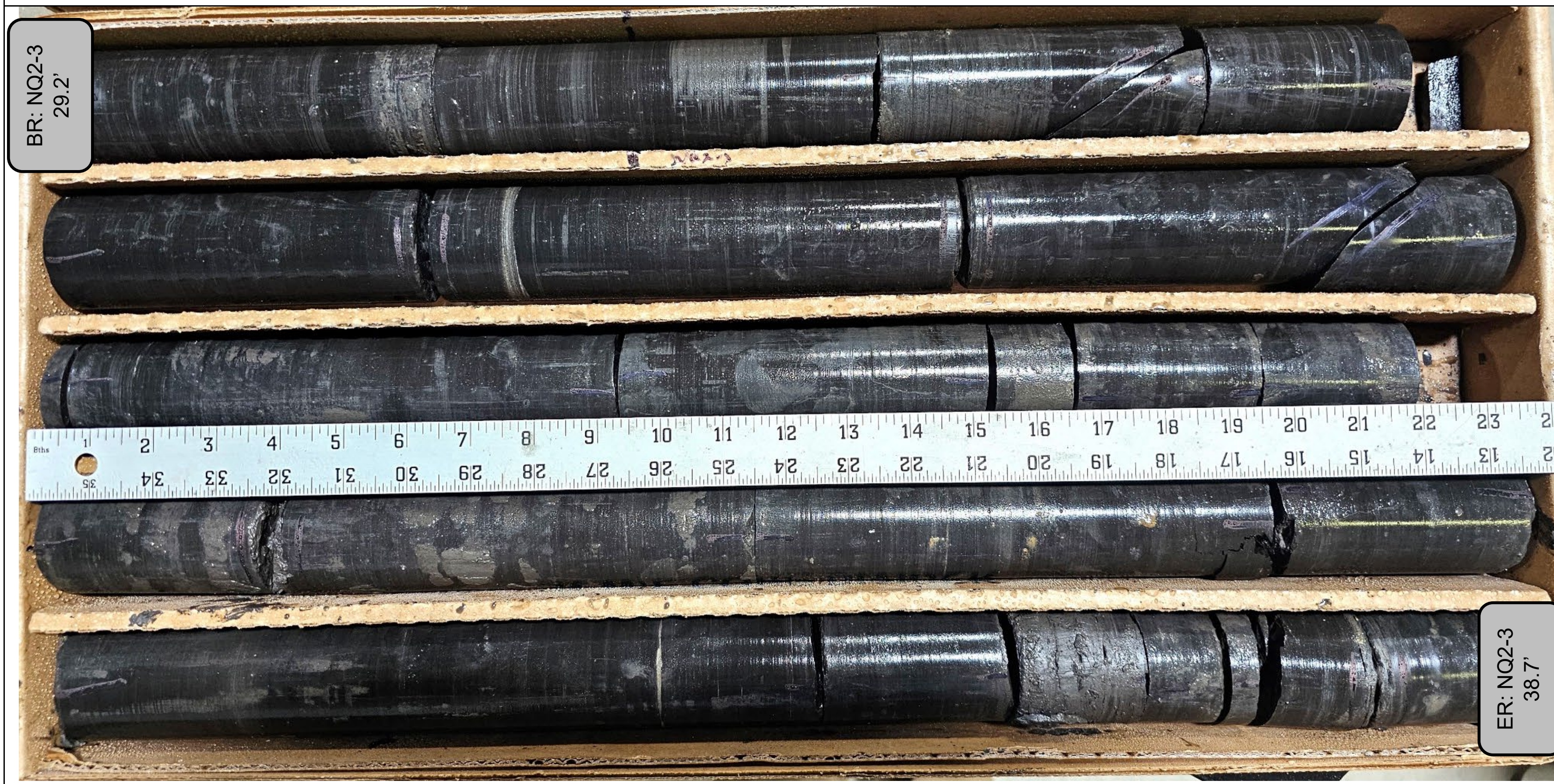
Run #:	Depth		Recovery		RQD	
NQ2-2	24.2'	29.2'	59"	98%	59"	98%

ROS-772-7.64

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-001-0-23



Run #:	Depth		Recovery		RQD	
NQ2-3	29.2'	38.7'	114"	100%	112"	98%

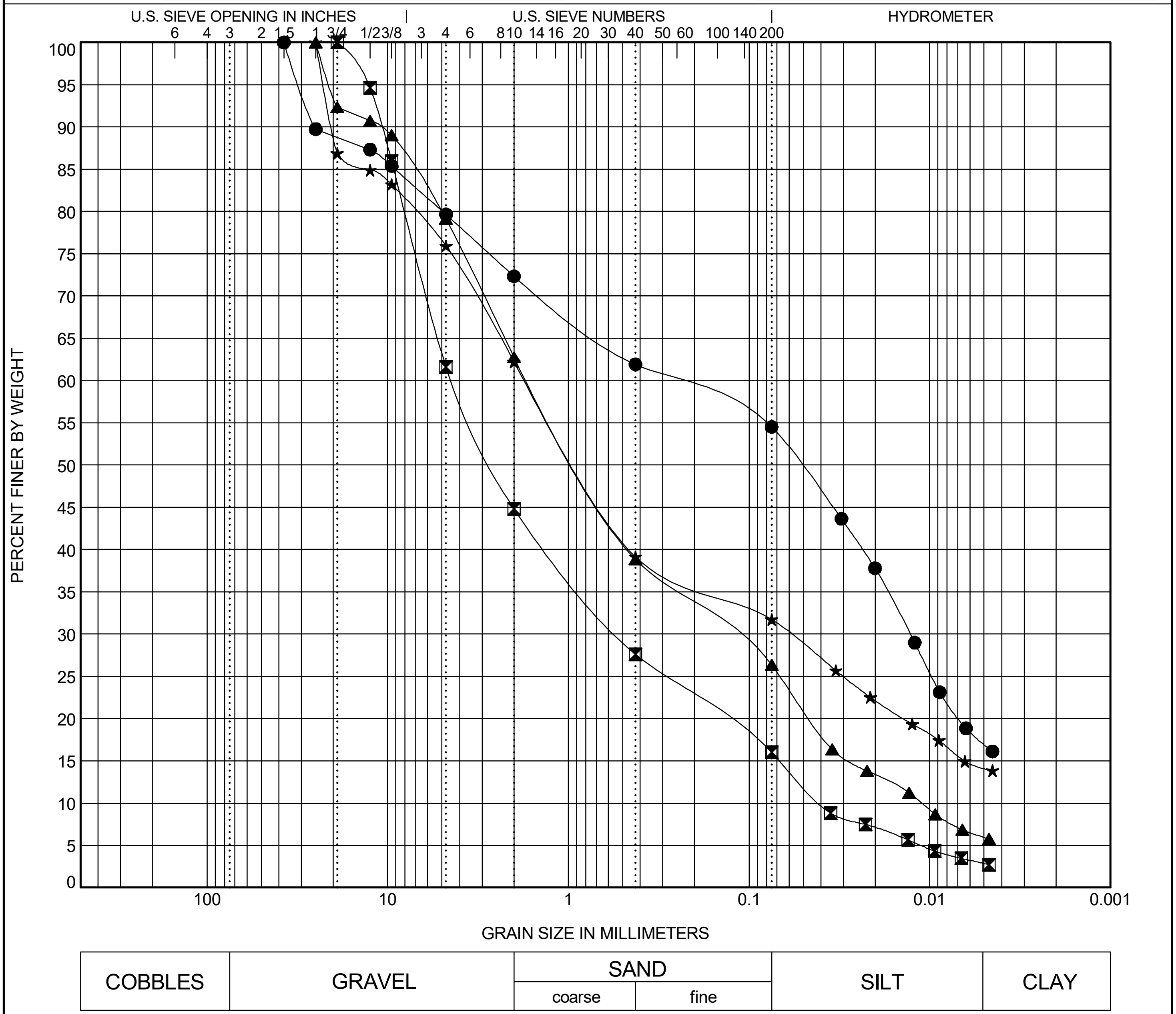
ROS-772-7.64

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT ROS-772-7.64 **PID**

OGE NUMBER 0 **PROJECT TYPE**



Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
● B-001-0-23	1.5	**A-4a ~ SANDY LEAN CLAY with GRAVEL(CL)**	30	20	10
⊠ B-001-0-23	4.5	**A-1-b ~ SILTY SAND with GRAVEL(SM)**	NP	NP	NP
▲ B-001-0-23	6.0	**A-2-4 ~ SILTY SAND with GRAVEL(SM)**	NP	NP	NP
★ B-001-0-23	13.5	**A-2-6 ~ CLAYEY SAND with GRAVEL(SC)**	33	22	11

Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
● B-001-0-23	1.5	25.247	0.052	0.013		28	10	7	38	17		
⊠ B-001-0-23	4.5	10.792	2.611	0.527	0.04	55	17	12	13	3	1.58	109.14
▲ B-001-0-23	6.0	11.123	0.875	0.124	0.011	37	24	13	20	6	0.84	151.29
★ B-001-0-23	13.5	20.282	0.88	0.059		38	23	7	18	14		

GRAIN SIZE - OH DOT.GDT - 3/18/24 08:16 - X:\ACTIVE SOIL PROJECTS\ROS-772-7.64\GINT FILES\ROS-772-7.64.GPJ

Objective: **To estimate depth of rock scour for foundations (shallow foundations/drilled shafts) in rock per direction of ODOT.**

Method: **In accordance with FHWA Publication No. FHWA-HIF-12-003, Hydraulic Engineering Circular No. 18 (HEC-18) and ODOT's BDM Section 305.2.1.2.b**

Erodibility Index (K):

Givens:

$RQD := 67$ Rock Quality Designation, Unit: Percentage

$J_n := 2.73$ Rock Joint Set Number (Boring Logs, HEC-18 Table 4.23)

Per ODOT BDM: If Jn, cannot be determined from observation or bore hole data, then assume Jn = 5.

$J_r := 2.0$ Joint Roughness Number (Boring Logs, HEC-18 Table 4.24)

Per ODOT BDM: If Jr, cannot be determined from observation or bore hole data, then assume Jn = 1.

$J_a := 1.0$ Joint Alteration Number (Boring Logs, HEC-18 Table 4.25)

Per ODOT BDM: If Ja, cannot be determined from observation or bore hole data, then assume Jn = 5.

$J_s := 0.6$ Relative Joint Orientation Parameter (Boring Logs, HEC-18 Table 4.26)

Per ODOT BDM: If Js, cannot be determined from observation or bore hole data, then assume Jn = 0.4.

$M_s := 8.39$ Intact Rock Mass Strength Parameter (ODOT BDM, Sect. 305.2.1.2.b.B.6.b)

Analysis:

$K_b := \frac{RQD}{J_n} = 24.54$ Block Size Parameter (HEC-18, Eq. 4.18)

$K_d := \frac{J_r}{J_a} = 2$ Shear Strength Parameter (HEC-18, Eq. 4.19)

$K := M_s \cdot K_b \cdot K_d \cdot J_s = 247.09$ Erodibility Index (HEC-18, Eq. 4.17)

Approach Flow Stream Power (Pa):

Givens:

$\rho := 1000$ — Mass Density of Water (kg/m^3)

Analysis:

$$\tau c\_Pa := \rho \cdot \left(\frac{1000 \cdot K^{0.75}}{7.853 \cdot \rho} \right)^{\frac{2}{3}}$$ $\tau c\_Pa = 3978.7$ — Critical shear stress (Pa)

$$\tau c\_psf := \tau c\_Pa \cdot \frac{1}{47.88} \; psf$$ $\tau c\_psf = 83.1 \; psf$ — Critical shear stress (Psf)

$$D_{50\_equivalent} := \tau c\_Pa$$ $D_{50\_equivalent} = 3978.7$ — Equivalent D50 (mm)

PROJECT: ROS-772-7.64	DRILLING FIRM / OPERATOR: CS / TS	DRILL RIG: CME 45B	STATION / OFFSET: 417+33, 17' RT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / LR	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 118518 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 1/24/22	ELEVATION: 776.9 (MSL) EOB: 29.5 ft.
START: 2/8/24 END: 2/8/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 72.6	LAT / LONG: 39.256257, -83.049566

EXPLORATION ID B-002-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 776.9	DEPTHS
10.0" ASPHALT AND 6.0" BASE	775.6	
VERY STIFF, BROWN AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, IRON STAINING, DAMP	775.4	
VERY STIFF TO HARD, BROWN AND ORANGISH BROWN, **SANDY SILT**, TRACE TO SOME GRAVEL, LITTLE TO SOME CLAY, IRON STAINING, SS-2 AND SS-3 CONTAIN NO INTACT SOIL FOR HP READINGS, DAMP	770.9	
VERY STIFF TO HARD, BROWN AND ORANGISH BROWN, **SILT AND CLAY**, LITTLE STONE FRAGMENTS, LITTLE SAND, IRON STAINING, DAMP TO MOIST	768.2	TR
SHALE, BLACK, SLIGHTLY TO MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, LAMINATED TO VERY THIN BEDDED, FISSILE, PYRITIC, BEDDING DISCONTINUITIES: LOW ANGLE, JOINT DISCONTINUITIES: HIGH ANGLE FROM 11.5'-12.1' AND 21.3'-21.6', HIGHLY FRACTURED TO INTACT, NARROW TO TIGHT, SLIGHTLY ROUGH, BLOCKY TO INTACT, GOOD SURFACE CONDITION; RQD 85.3%, REC 97.6%.	747.4	EOB

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
4 5 4	11	78	SS-1	2.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
6 10 9	23	72	SS-2	-	28	8	17	32	15	24	18	6	13	A-4a (2)	
7 5 11	19	56	SS-3	-	25	10	11	34	20	26	18	8	15	A-4a (4)	
8 6 11	21	89	SS-4	4.50	10	7	18	43	22	28	19	9	17	A-4a (6)	
6 9 11	24	89	SS-5	3.25	20	5	13	37	25	30	17	13	16	A-6a (7)	
5 9 17	31	67	SS-6	4.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
29 50/3"	-	111	SS-7	-	-	-	-	-	-	-	-	-	14	Rock (V)	
53		100	NQ2-1											CORE	
93		95	NQ2-2											CORE	
100		100	NQ2-3											CORE	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 45 GAL. BENTONITE GROUT

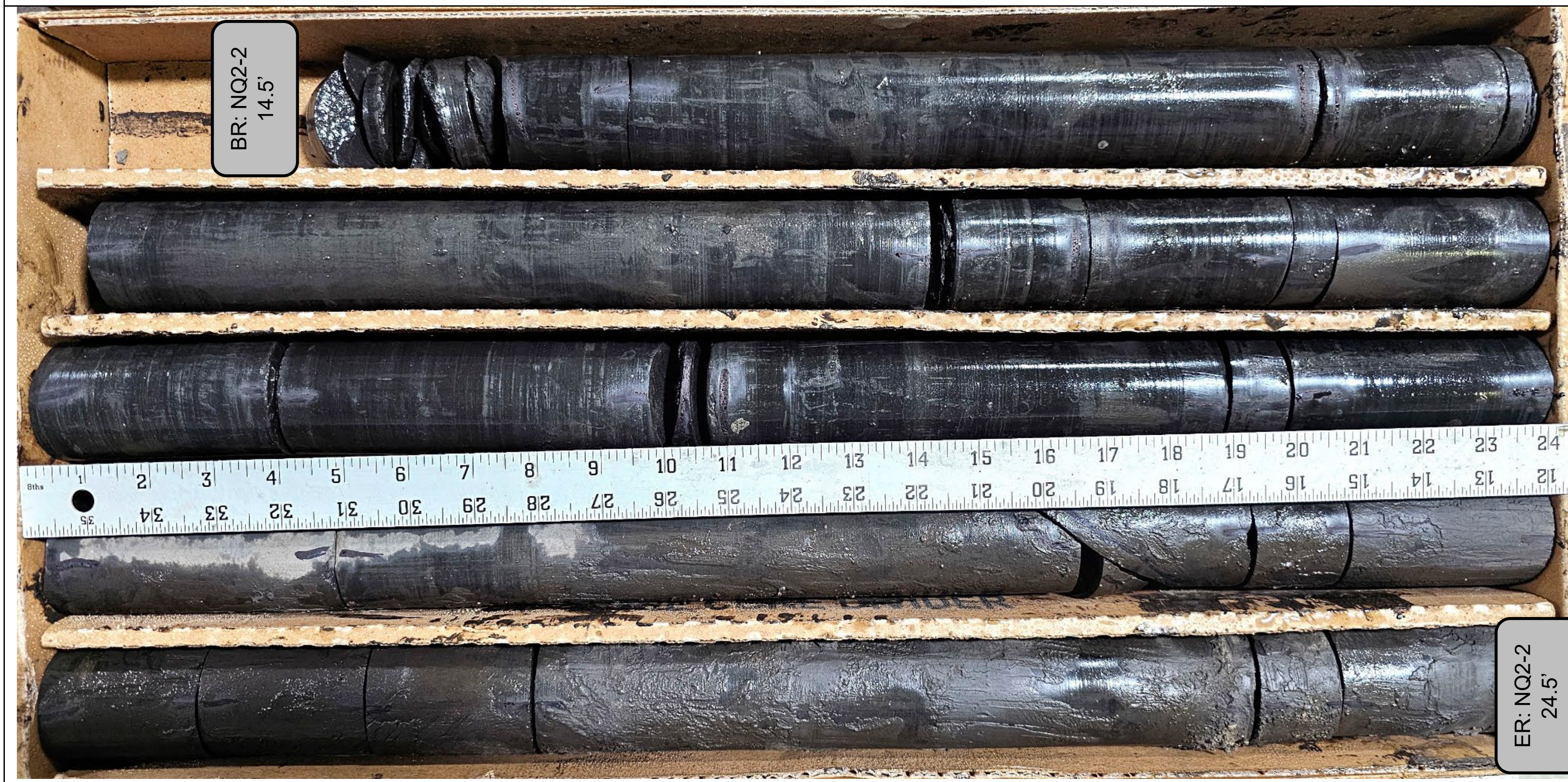
B-002-0-23

Run #:	Depth		Recovery		RQD	
NQ2-1	10.0’	14.5’	54”	100%	28.5”	53%
ROS-772-7.64						

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-002-0-23



Run #:	Depth		Recovery		RQD	
NQ2-2	14.5'	24.5'	114.5"	95%	111"	93%
ROS-772-7.64						

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-002-0-23

Run #:	Depth		Recovery		RQD	
NQ2-3	24.5’	29.5’	60”	100%	60”	100%

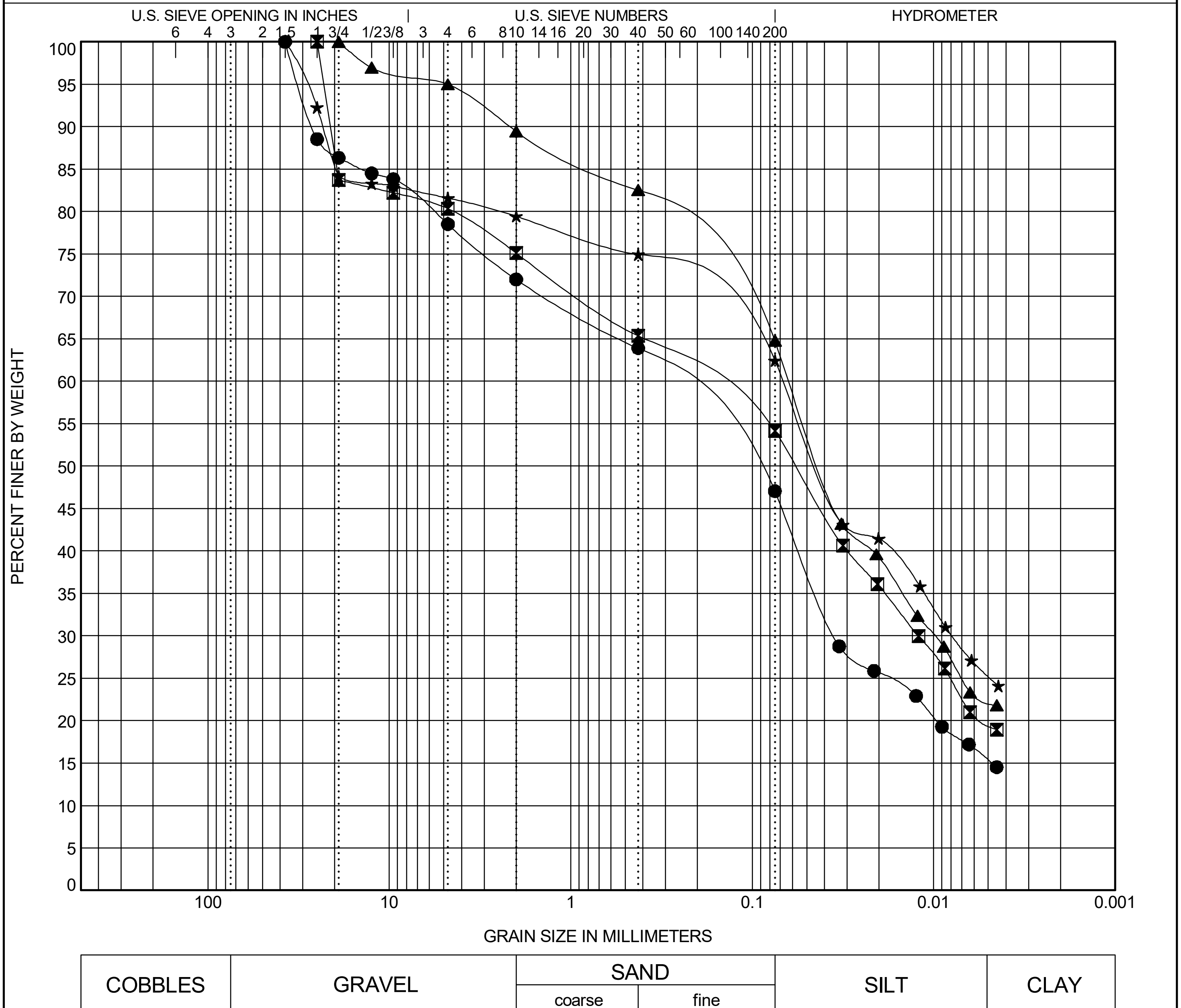
ROS-772-7.64

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT ROS-772-7.64 **PID**

OGE NUMBER 0 **PROJECT TYPE**



	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	B-002-0-23	1.5	A-4a ~ SILTY, CLAYEY SAND with GRAVEL(SC-SM)	24	18	6
⧗	B-002-0-23	3.0	A-4a ~ SANDY LEAN CLAY with GRAVEL(CL)	26	18	8
▲	B-002-0-23	4.5	A-4a ~ SANDY LEAN CLAY(CL)	28	19	9
★	B-002-0-23	6.0	A-6a ~ SANDY LEAN CLAY with GRAVEL(CL)	30	17	13

	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	B-002-0-23	1.5	26.329	0.102	0.035		28	8	17	32	15		
⧗	B-002-0-23	3.0	21.121	0.058	0.012		25	10	11	34	20		
▲	B-002-0-23	4.5	2.183	0.042	0.01		10	7	18	43	22		
★	B-002-0-23	6.0	23.139	0.043	0.008		20	5	13	37	25		

Objective: **To estimate depth of rock scour for foundations (shallow foundations/drilled shafts) in rock per direction of ODOT.**

Method: **In accordance with FHWA Publication No. FHWA-HIF-12-003, Hydraulic Engineering Circular No. 18 (HEC-18) and ODOT's BDM Section 305.2.1.2.b**

Erodibility Index (K):

Givens:

$RQD := 85$ Rock Quality Designation, Unit: Percentage

$J_n := 2.73$ Rock Joint Set Number (Boring Logs, HEC-18 Table 4.23)

Per ODOT BDM: If Jn, cannot be determined from observation or bore hole data, then assume Jn = 5.

$J_r := 2.0$ Joint Roughness Number (Boring Logs, HEC-18 Table 4.24)

Per ODOT BDM: If Jr, cannot be determined from observation or bore hole data, then assume Jn = 1.

$J_a := 1.0$ Joint Alteration Number (Boring Logs, HEC-18 Table 4.25)

Per ODOT BDM: If Ja, cannot be determined from observation or bore hole data, then assume Jn = 5.

$J_s := 0.6$ Relative Joint Orientation Parameter (Boring Logs, HEC-18 Table 4.26)

Per ODOT BDM: If Js, cannot be determined from observation or bore hole data, then assume Jn = 0.4.

$M_s := 8.39$ Intact Rock Mass Strength Parameter (ODOT BDM, Sect. 305.2.1.2.b.B.6.b)

Analysis:

$K_b := \frac{RQD}{J_n} = 31.14$ Block Size Parameter (HEC-18, Eq. 4.18)

$K_d := \frac{J_r}{J_a} = 2$ Shear Strength Parameter (HEC-18, Eq. 4.19)

$K := M_s \cdot K_b \cdot K_d \cdot J_s = 313.47$ Erodibility Index (HEC-18, Eq. 4.17)

Approach Flow Stream Power (Pa):

Givens:

$\rho := 1000$ Mass Density of Water (kg/m^3)

Analysis:

$\tau c\_Pa := \rho \cdot \left(\frac{1000 \cdot K^{0.75}}{7.853 \cdot \rho}\right)^{\frac{2}{3}}$ $\tau c\_Pa = 4481.4$ Critical shear stress (Pa)

$\tau c\_psf := \tau c\_Pa \cdot \frac{1}{47.88}$ ***psf*** $\tau c\_psf = 93.6$ ***psf*** Critical shear stress (Psf)

$D_{50\_equivalent} := \tau c\_Pa$ $D_{50\_equivalent} = 4481.4$ Equivalent D50 (mm)