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DESIGN MEMORANDUM

Date: April 9, 2025

To: Mr. Vince Amato, Burgess & Niple, Inc.

From: Brendan P. Andrews P.E., NEAS Inc.

RE: **Geotechnical Design Memorandum**
Project HAM-75-1.05, PID 113361/122048
Retaining Wall 4
City of Cincinnati, Hamilton County, Ohio

INTRODUCTION

Per your request, this memorandum presents foundation design information for the proposed Retaining Wall 4 (RW-4) as part of the overall Ohio Department of Transportation (ODOT) HAM-75-1.05 (PID 113361/122048) project located in the City of Cincinnati, Hamilton County, Ohio. A summary of: 1) the proposed structure; 2) the existing site conditions; 3) the surficial and subsurface conditions via historical and project borings; and, 4) our recommendations for retaining foundation design is presented below.

NEAS's preliminary analyses have been performed in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication LRFD Bridge Design Specifications, 9th Edition (BDS) (AASHTO, 2020) and ODOT's 2021 LRFD Bridge Design Manual (BDM) (ODOT, 2022).

PROPOSED/EXISTING SITE CONDITIONS

Proposed Construction

The eastern limits of Interstate Route 75 (IR-75) northbound (NB) from Linn Street to the Freeman Avenue (Ave) Bridge is planned to be realigned and improved as part of the referenced project. The improvements at this location include the widening of IR-75 as well as the construction of a new pedestrian bridge over Winchell Ave located east and upslope of the newly widened IR-75. In order to facilitate the proposed improvements, RW-4 is planned to provide grade separation between the new widened IR-75 alignment and the upslope Winchell Ave and Ramp V.

Based on design information provided within the Retaining Wall 4, Stage 2/3 Plan Set developed by B&N, dated January 6, 2025, the proposed RW-4 will have a total wall length of approximately 195 ft and will be comprised of a tangent drilled shaft wall with a max exposed height of about 26 ft (top of wall to proposed finished grade). The tangent drilled shaft wall will be supported on deep foundation elements.

Historical Records

A historic record search was performed through ODOT's Transportation Information Mapping System (TIMS). However, no geotechnical data or information was available for review within the immediate vicinity of the proposed retaining wall site. Therefore, historic borings are not referenced within this report nor pictured within the associated developed Structure Foundation Exploration Sheets.

Site Reconnaissance

A field reconnaissance visit for the proposed RW-4 was conducted on January 13, 2022, during which site conditions were noted and photographed. During our field reconnaissance, no geohazards were observed within the immediate vicinity of the proposed retaining wall site. Land use of the area surrounding the proposed project site can be described as commercial property and ODOT right-of-way.

RW-4 is proposed to be constructed just east of the forward abutment of Bridge HAM-75-0125. In the area of the proposed retaining wall, IR-75 is located within a cut below the surrounding property with the an existing retaining wall connected to the abutment of Bridge HAM-75-0125 as well as an existing slope with grades of about 3 Horizontal to Vertical (3H:1V) providing a grade separation between IR-75 and the property above (Winchell Ave). The existing retaining wall near this location was observed to be in good condition with few signs of wear such as light cracking (Photograph 1). The area behind the existing retaining wall and immediately east of the existing retaining wall is moderately vegetated with moderately sized trees and brush. No signs of standing water observed, however freezing conditions during the site visit made this difficult to discern. The roadway drains to drainage basins on the eastern shoulder of the roadway. The area appeared to be stable with no signs of geotechnical instability.

Photograph 1: Bridge HAM-75-0125 existing forward abutment/retaining wall

SUBSURFACE EXPLORATION

The exploration for the RW-4 was conducted by NEAS between January 26, 2022 and March 7, 2022. The exploration for the referenced structure included 3 borings drilled to depths ranging from 85.0 to 105.5 ft below ground surface (bgs). Boring logs for the borings performed are attached. A summary of the exploration locations including latitude/longitude location information and elevations of the subject structure exploration are shown in Table 1 below. Additional information with respect to the subsurface exploration can be found in the Geotechnical Exploration Report for the overall project, HAM-75-1.05 (PID 113361).

Table 1: Structure Boring Summary

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)
B-024-0-21	39.106681	-84.531020	488.5	85.0
B-026-0-21	39.107057	-84.530375	505.6	85.0
B-027-0-21	39.107091	-84.530900	501.0	101.5
Notes: *1. As-drilled boring location and corresponding ground surface elevation was surveyed in the field by NEAS Inc.*				

SUBSURFACE CONDITIONS

At the site of the proposed structure, three different materials were encountered below the surficial material. In general, the three different overburden materials consisted of historical or embankment "man-made" fill soils, natural alluvial deposits, followed by natural sands. These materials and the general profile underlying the site is further described below.

Fill soils were encountered in each of the borings performed for the proposed structure. These fill soils were encountered immediately below the topsoil or pavement section and extended to depths ranging from 3.0 to 19.5 ft bgs (approximate elevations 486.1 to 484.0 ft above mean sea level (amsl)). Based on laboratory testing results and a visual review of the soil samples obtained, the fill at the site is comprised of both cohesive and non-cohesive material and is classified on the boring logs as Silt and Clay (A-6a), Clay (A-7-6), Silty Clay (A-6b), Silt (A-4b), Gravel with Sand (A-1-b), as well as cohesive and non-cohesive Sandy Silt (A-4a). With respect to the soil strength, the non-cohesive fill soils can be described as having a relative compactness of medium dense correlating to converted SPT N values (N_{60}) between 11 and 29 blows per foot (bpf). Natural moisture contents of the non-cohesive fill ranged from 2 to 22 percent. With respect to the soil strength of the cohesive fill, these soils can be described as having a consistency of stiff to hard correlating to N_{60} values between 10 and 24 bpf and unconfined compressive strengths (estimated by means of hand penetrometer) between approximately 1.25 and 4.5 tons per square foot (tsf). Natural moisture contents of the cohesive fill ranged from 15 to 28 percent. Based on Atterberg Limits tests performed on representative samples of the cohesive fill material, the liquid and plastic limits ranged from 24 to 45 percent and from 17 to 24 percent, respectively.

The stratum encountered immediately beneath the fill consisted of natural alluvial soils comprised predominantly of fine-grained cohesive and non-cohesive soils and extends to depths between 68.3 and 70.5 ft bgs (approximate elevations 417.7 and 435.1 ft amsl). Based on laboratory testing results and a visual review of the soil samples obtained within this stratum, these soils are comprised of both cohesive and non-cohesive material classified on the boring logs as Silt and Clay (A-6a), Silty Clay (A-6b), Fine Sand (A-3), Coarse and Fine Sand (A-3a) and cohesive and non-cohesive Silt (A-4b). With respect to the soil strength of the fine-grained cohesive material encountered within this stratum, these soils can be described as having a consistency of medium stiff to hard correlating to N_{60} values between 8 and 13 bpf and unconfined compressive strengths (estimated by means of hand penetrometer) between 1.00 and 2.75 tsf. Natural moisture contents of the cohesive soils ranged from 21 to 26 percent. Based on Atterberg Limits tests performed on representative samples of the cohesive alluvial material, the liquid and plastic limits ranged from 27 to 40 percent and from 19 to 21 percent, respectively. With respect to the soil strength of the non-cohesive alluvium, these soils can be described as having a relative compactness of very loose to medium dense correlating to N_{60} values between 4 and 27 bpf. Natural moisture contents of the non-cohesive soils ranged from 5 to 36 percent.

The stratum encountered immediately beneath the alluvium, consisted of a natural sand layer which extended to termination depth of the boring between 85.0 and 101.5 ft bgs (approximate elevations 420.6 and 399.5 ft amsl). Based on laboratory testing results and a visual review of the soil samples obtained within this stratum, these soils are comprised of granular material and are classified on the boring logs as Coarse and Fine Sand (A-3a) and non-cohesive Sandy Silt (A-4a). With respect to the soil strength, the natural sands can be described as having a relative compactness of medium dense to dense correlating to N_{60} values between 10 and 34 bpf. Natural moisture contents of the sands ranged from 12 to 27 percent.

Groundwater

Groundwater measurements were taken during the boring drilling procedures at each borehole location. Groundwater was encountered during drilling in 1 of the 3 project borings performed at the retaining wall site. Groundwater was encountered at a depth of 30.0 ft bgs (elevation 458.5 ft amsl) in boring B-024-0-21. 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. The specific groundwater readings are included on the attached boring logs.

ANALYSES AND RECOMMENDATIONS

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 was estimated based on their field (i.e., SPT N60 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 properties (with sited correlation/reference material) used in our analysis is summarized per boring location within Tables 2 through 4, below.

Table 2: Soil Profile and Estimated Engineering Properties - At Boring B-024-0-21

Retaining Wall 4: Profile for Analysis, B-024-0-21				
Soil Description	**Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Coarse and Fine Sand Elevation (482 ft - 480.5 ft)	112	-	-	31
Silt Elevation (480.5 ft - 475.5 ft)	112	-	-	31
Fine Sand Elevation (475.5 ft - 474 ft)	112	-	-	31
Silt Elevation (474 ft - 460.2 ft)	122	-	-	30
Fine Sand Elevation (460.2 ft - 440.2 ft)	122	-	-	29
Fine Sand Elevation (440.2 ft - 420.2 ft)	122	-	-	30
Coarse and Fine Sand Elevation (420.2 ft - 399.5 ft)	122	-	-	30

Notes:
1. *Values calculated per ODOT GDM Section 404/1304 and/or ODOT BDM Table 305-2.*

Table 3: Soil Profile and Estimated Engineering Properties - At Boring B-026-0-21

Retaining Wall 4: Profile for Analysis, B-026-0-21				
Soil Description	Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)
Sandy Silt Depth (503 ft - 497.1 ft)	122	-	-	33
Clay Depth (497.1 ft - 495.1 ft)	122	2350	200	24
Gravel with Sand Depth (495.1 ft - 492.6 ft)	125	-	-	35
Clay Depth (492.6 ft - 491.1 ft)	122	2350	200	24
Silt Depth (491.1 ft - 487.6 ft)	115	-	-	31
Fine Sand Depth (487.6 ft - 484.2 ft)	115	-	-	33
Silt Depth (484.2 ft - 472.3 ft)	115	-	-	30
Fine Sand Depth (472.3 ft - 467.3 ft)	115	-	-	30
Silt Depth (467.3 ft - 462.3 ft)	120	1500	150	24
Silt Depth (462.3 ft - 442.3 ft)	120	-	-	28
Silt Depth (442.3 ft - 435.1 ft)	125	-	-	30
Coarse and Fine Sand Depth (435.1 ft - 420.6 ft)	125	-	-	32

Notes:
1. *Values calculated per ODOT GDM Section 404/1304 and/or ODOT BDM Table 305-2.*

Table 4: Soil Profile and Estimated Engineering Properties - At Boring B-027-0-21

Retaining Wall 4: Profile for Analysis, B-027-0-21				
Soil Description	Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)
Sandy Silt Depth (507.2 ft - 497.1 ft)	125	-	-	38
Silty Clay Depth (497.1 ft - 494 ft)	115	1250	150	23
Sandy Silt Depth (494 ft - 491.5 ft)	125	-	-	31
Silt and Clay Depth (491.5 ft - 489 ft)	120	3000	250	25
Sandy Silt Depth (489 ft - 484 ft)	120	1250	150	24
Silty Clay Depth (484 ft - 470.5 ft)	110	1200	100	22
Fine Sand Depth (470.5 ft - 466.5 ft)	120	-	-	30
Silt Depth (466.5 ft - 457.7 ft)	125	-	-	30
Sandy Silt Depth (457.7 ft - 437.7 ft)	125	-	-	30
Silt Depth (437.7 ft - 427.7 ft)	120	-	-	27
Silt Depth (427.7 ft - 417.7 ft)	125	-	-	29
Sandy Silt Depth (417.7 ft - 407.7 ft)	128	-	-	31
Coarse and Fine Sand Depth (407.7 ft - 399.5 ft)	128	-	-	33

ıes calculated per ODOT GDM Section 404/1304 and/or ODOT BDM Table 305-2.

Tangent Drilled Shaft Retaining Wall Design Assumptions

As RW-4 is planned as tangent drilled shaft wall type with a reinforced concrete wall facing, ODOT's BDM and AASHTO's LRFD BDS dictate analysis parameters and design minimums/constraints to be used in the analysis and design process. The referenced parameters and design minimums/constraints that were significant to their analyses consist of the following:

- Measure the design retained height (H) of drilled shaft walls from the top of the retained earth to the design grade, according to LRFD Figures 3.11.5.6-1 through 3.11.5.6-7.
- Minimum embedment (D) for drilled shaft walls shall be equal to the retained height (H) such that the embedment-to-length ratio (D/L) shall not be less than 0.5.
- For drilled shaft walls with a cast-in-place concrete facing, provide a structural attachment between the facing and the exposed face of the discrete vertical wall elements.; and,
- For tangent drilled shaft walls with a permanent cast-in-place facing, place wall drainage between the permanent facing and the drilled shafts at the joints between the adjacent drilled shafts. Provide vertical drainage paths with a minimum width of 18-inch.

With respect to design constraints and assumptions specific to the RW-4, the geometry of the proposed walls (i.e., exposed wall heights, existing ground elevations, proposed final grade behind/at the toe of the wall, etc.) is assumed to be consistent with that shown in the available the Retaining Wall 4, Stage 2/3 Plan Set developed by B&N, dated January 6, 2025.

Parameters for Lateral Load Analysis

Deep foundation elements subjected to horizontal loads and/or moments should be analyzed for maximum bending moments and lateral deflections. The required lateral load capacity can be obtained by increasing the diameter or the embedment depth of the foundation element. The generalized soil parameters, including recommended lateral soil modulus, and soil strain to be used to analyze the laterally loaded shaft by the p-y curve method are presented in Table 5 below. Furthermore, a resistance factor of 1.0 should be used when estimating the lateral geotechnical resistance of a single shaft/pile or shaft/pile group in accordance with LRFD BDS Tables 10.5.5.2.3-1 and 10.5.5.2.4-1.

Table 5: Soil Parameters for Lateral Load Analysis - RW-4

LPILE Parameters Retaining Wall 4: B-024-0-21, B-026-0-21 & B-027-0-21							
Soil Type	p-y model	Elevation (ft amsl)	Effective Unit Weight (pcf)	Friction Angle	Undrained Shear Strength (psf)	Lateral Soil Modulus Parameter, k (pci)	Soil Strain Parameter, E_{50} (%)
Soil Type 1	Sand (Reese)	498.0 - 477.0	120	31	-	60	-
Soil Type 3	Sand (Reese)	477.0 - 421.0	67.6	29	-	25	-
Soil Type 4	Sand (Reese)	421.0 - 399.5	62.6	32	-	60	-

Tangent Drilled Shaft Retaining Wall Analyses

Internal and external stability analyses of the proposed RW-4 tangent drilled shaft wall including lateral load analysis of the proposed drilled shaft foundations has been performed by the project design team. These calculations will be provided to ODOT as part of a separate submission.

Global Stability

For purposes of evaluating the stability of the proposed RW-4, NEAS reviewed the available cross-sections that were interpreted to represent conditions that posed the greatest potential for slope instability. In general, cross-sections along the proposed wall alignment were reviewed to determine if the section would represent a combination of existing subsurface conditions and planned site grading that would be most critical to slope stability (i.e., maximum total wall height, maximum embankment height measured from toe of slope to top of wall coping, proposed cut into existing embankment slopes, weak or thick soil layer, etc.). Based on our review of the available information at the referenced locations and the associated soil properties, one (1) cross-section was estimated to be most "critical" and was analyzed for global stability. The cross-sections analyzed for global stability was the maximum total wall height section at approximate STA. 4+79.6 (RW-4 alignment).

For the referenced cross-section, NEAS developed a representative cross-sectional model to use as the basis for global stability analyses. The model was developed from NEAS's interpretation of the available information which included: 1) the available Retaining Wall 4, Stage 2/3 Plan Set developed by B&N, dated January 6, 2025; 2) a live load surcharge of 250 pounds per square foot (psf), accounting for traffic induced loads; and 3) test borings and laboratory data developed as part of this memo. With respect to the soil's engineering properties, the provided Soil Profile and Estimated Engineering Properties of boring B-026-0-21 presented in the *Soil Profile for Analysis* section of this memo were used in our analyses.

The above referenced slope stability model was analyzed for long-term (Effective Stress) and short-term (Total Stress) slope stability utilizing the software entitled Slide2 by Rocscience, Inc. Specifically, the Spencer analysis method was used to calculate a factor of safety (FOS) for circular and non-circular type slope failures. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.33 which equates to an AASHTO resistance factor less than 0.75 (per AASHTO's LRFD BDS the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs). For this analysis, a resistance factor of 0.75 or lower is targeted as the retaining wall does not contain or support a structural element.

Based on our slope stability analysis for the referenced retaining wall section, the minimum slope stability safety factor is about 1.72 (0.58 resistance factor). The graphical output of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) is attached.

Settlement

Settlement is not anticipated to be a concern at the proposed wall location as minimal amount of new fill is planned as part of the proposed construction of the wall and therefore the increase in loading is minimal.

Temporary Excavations

It is recommended that all temporary excavations comply with the most recent Occupational Safety and Health Administration (OSHA) Excavating and Trenching Standard, Title 29 of the Code of Federal Regulation (CFR) Part 1926, Subpart P. The contractor is responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. Per Title 29 CFR Part 1926, the contractor's competent person should evaluate the soil exposed in the excavations as part of their safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Based on the natural soils encountered at the site (Type C Soil), it is recommended that temporary excavation slopes (exceeding a depth of 3 ft and less than 20 ft) be laid back to at least 1.5H:1V and these slopes should be braced or backfilled if the excavation slope will be maintained for more than a day

SOIL BORING LOGS

PROJECT: HAM-75-1.05	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 64+57, 13' LT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-75
PID: 113361 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 488.5 (MSL) EOB: 85.0 ft.
START: 3/7/22 END: 3/8/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.9	LAT / LONG: 39.106681, -84.531020

EXPLORATION ID B-024-0-21

MATERIAL DESCRIPTION AND NOTES	ELEV. 488.5
12.0" ASPHALT AND 7.0" BASE (DRILLERS DESCRIPTION)	486.9
MEDIUM DENSE, BROWN, **STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, DAMP	485.5
LOOSE, LIGHT BROWN, **SILT**, LITTLE CLAY, LITTLE SAND, TRACE GRAVEL, WET	483.5
LOOSE TO MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, DAMP	480.5
MEDIUM DENSE, LIGHT BROWN BECOMING BROWN, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, WET	475.5
MEDIUM DENSE, BROWN, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, MOIST	474.0
MEDIUM DENSE, BROWN AND GRAYISH BROWN, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, WET	469.0
MEDIUM DENSE, BROWN AND GRAYISH BROWN, **SILT**, SOME SAND, LITTLE CLAY, TRACE GRAVEL, CONTAINS IRON STAINING, WET	465.5
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	464.5
MEDIUM DENSE, BROWN AND GRAYISH BROWN, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET	460.2
LOOSE TO MEDIUM DENSE, BROWN AND GRAY, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET	

DEPTHS: 1 – 29; W 458.5

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
4 6 7	18	39	SS-1	-	-	-	-	-	-	-	-	-	7	A-1-b (V)
4 3 3	8	100	SS-2	-	0	1	14	67	18	NP	NP	NP	21	A-4b (8)
3 2 5	10	100	SS-3A	-	-	-	-	-	-	-	-	-	19	A-4b (V)
			SS-3B	-	-	-	-	-	-	-	-	-	11	A-3a (V)
4 4 5	12	100	SS-4A	-	-	-	-	-	-	-	-	-	10	A-3a (V)
			SS-4B	-	-	-	-	-	-	-	-	-	24	A-4b (V)
5 5 6	15	100	SS-5	-	1	0	3	84	12	NP	NP	NP	22	A-4b (8)
3 4 4	11	100	SS-6A	-	-	-	-	-	-	-	-	-	25	A-4b (V)
			SS-6B	-	-	-	-	-	-	-	-	-	13	A-3 (V)
2 5 6	15	100	SS-7	-	-	-	-	-	-	-	-	-	24	A-4b (V)
3 4 5	12	100	SS-8	-	0	1	1	86	12	NP	NP	NP	26	A-4b (8)
4 4 6	14	100	SS-9	-	-	-	-	-	-	-	-	-	26	A-4b (V)
3 3 6	12	100	SS-10A	-	-	-	-	-	-	-	-	-	26	A-4b (V)
			SS-10B	1.00	-	-	-	-	-	-	-	-	25	A-6a (V)
2 4 6	14	100	SS-11	-	0	1	26	67	6	NP	NP	NP	25	A-4b (8)

HOLE SEALED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/10/25 12:05 - X:\1ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE\ARCHIVE BY YEAR\2024 ARCHIVE\HAM-75-1.05\GINT FILES\HA

MATERIAL DESCRIPTION AND NOTES	ELEV. 458.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE TO MEDIUM DENSE, BROWN AND GRAY, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET *(continued)*		31	2 3 4	10	100	SS-12	-	-	-	-	-	-	-	-	-	33	A-3 (V)	
		32																
		33																
		34																
		35																
		36	3 2 3	7	100	SS-13	-	-	-	-	-	-	-	-	-	30	A-3 (V)	
		37																
		38																
		39																
		40																
		41	3 4 3	10	100	SS-14	-	-	-	-	-	-	-	-	-	27	A-3 (V)	
		42																
		43																
		44																
		45																
FS		46	4 4 4	11	100	SS-15	-	0	6	88	6	0	NP	NP	NP	23	A-3 (0)	
		47																
		48																
		49																
		50																
		51	4 5 5	14	100	SS-16	-	-	-	-	-	-	-	-	-	23	A-3 (V)	
		52																
		53																
		54																
		55																
		56	3 5 7	16	100	SS-17	-	-	-	-	-	-	-	-	-	24	A-3 (V)	
		57																
		58																
		59																
		60																
		61	2 4 5	12	100	SS-18	-	-	-	-	-	-	-	-	-	23	A-3 (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/10/25 12:05 - X:\1ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE BY YEAR\2024 ARCHIVE\HAM-75-1.05\GINT FILES\HA

PID: 113361	SFN:	PROJECT: HAM-75-1.05	STATION / OFFSET: 64+57, 13' LT.	START: 3/7/22	END: 3/8/22	PG 3 OF 3	B-024-0-21

MATERIAL DESCRIPTION AND NOTES	ELEV. 426.4	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
LOOSE TO MEDIUM DENSE, BROWN AND GRAY, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET *(continued)*		63–64																
		65–66	4 5 6	15	100	SS-19	-	-	-	-	-	-	-	-	-	19	A-3 (V)	
	420.2	67–68																
LOOSE TO MEDIUM DENSE, BROWN AND GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE GRAVEL, WET		69																
		70–71	4 3 4	10	100	SS-20	-	0	3	86	11	0	NP	NP	NP	21	A-3a (0)	
		72–74																
		75–76	5 5 6	15	100	SS-21	-	-	-	-	-	-	-	-	-	27	A-3a (V)	
		77–79																
		80–81	4 6 6	16	100	SS-22	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
		82–83																
	403.5	84	3 5 7	16	100	SS-23	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
		EOB 85																

NOTES: GROUNDWATER ENCOUNTERED AT 30.0' DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 100 GAL. BENTONITE GROUT; SHOVELED SOIL CUTTINGS

PROJECT: HAM-75-1.05	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 65+05, 211' RT.	EXPLORATION ID B-026-0-21
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-75	
PID: 113361 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 505.6 (MSL) EOB: 85.0 ft.	PAGE 1 OF 3
START: 1/26/22 END: 1/27/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.9	LAT / LONG: 39.107057, -84.530375	

MATERIAL DESCRIPTION AND NOTES	ELEV. 505.6
MEDIUM DENSE, BROWN, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, CONTAINS COAL AND BRICK FRAGMENTS, MOIST **(FILL)**	497.1
HARD, BROWNISH GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST **(FILL)**	495.1
MEDIUM DENSE, BROWN AND GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, DAMP **(FILL)**	492.6
VERY STIFF, BROWN, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST **(FILL)**	491.1
MEDIUM DENSE, BROWN, **SILT**, LITTLE CLAY, LITTLE SAND, TRACE GRAVEL, WET **(FILL)**	487.6
MEDIUM DENSE, BROWN AND GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, CONTAINS BRICK FRAGMENTS, DAMP **(FILL)**	486.1
MEDIUM DENSE, BROWN AND ORANGISH BROWN, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP	484.2
MEDIUM DENSE, BROWN, **SILT**, TRACE CLAY, TRACE SAND, TRACE GRAVEL, WET	

SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
6 5 3	11	22	SS-1	-	-	-	-	-	-	-	-	-	14	A-4a (V)
1 5 6	15	39	SS-2	-	5	18	35	32	10	NP	NP	NP	16	A-4a (1)
8 5 9	19	100	SS-3A	-	-	-	-	-	-	-	-	-	15	A-4a (V)
			SS-3B	4.50	0	1	1	32	66	45	24	21	25	A-7-6 (13)
7 5 9	19	100	SS-4A	4.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)
			SS-4B	-	-	-	-	-	-	-	-	-	2	A-1-b (V)
8 5 9	19	100	SS-5A	-	-	-	-	-	-	-	-	-	6	A-1-b (V)
			SS-5B	4.00	-	-	-	-	-	-	-	-	28	A-7-6 (V)
3 6 7	18	100	SS-6	-	0	0	13	73	14	NP	NP	NP	22	A-4b (8)
3 11 10	29	100	SS-7A	-	-	-	-	-	-	-	-	-	21	A-4b (V)
			SS-7B	-	-	-	-	-	-	-	-	-	10	A-1-b (V)
3 8 7	20	100	SS-8	-	-	-	-	-	-	-	-	-	6	A-3 (V)
2 4 8	16	100	SS-9	-	-	-	-	-	-	-	-	-	27	A-4b (V)
2 4 5	12	100	SS-10	-	0	0	6	85	9	NP	NP	NP	24	A-4b (8)

DEPTHS: 1–29; GRADATION (%); ATTERBERG; HOLE SEALED

MATERIAL DESCRIPTION AND NOTES	ELEV. 475.6	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
MEDIUM DENSE, BROWN, **SILT**, TRACE CLAY, TRACE SAND, TRACE GRAVEL, WET *(continued)*		31	3 7 7	19	100	SS-11	-	-	-	-	-	-	-	-	-	24	A-4b (V)	
	472.3	32–33																
MEDIUM DENSE, BROWN, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, WET		35–36	4 4 4	11	100	SS-12	-	-	-	-	-	-	-	-	-	30	A-3 (V)	
	467.3	37–38																
VERY STIFF, GRAY, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, MOIST		40–41	3 4 5	12	100	SS-13	2.25	0	0	3	76	21	27	21	6	24	A-4b (8)	
	462.3	42–43																
VERY LOOSE TO MEDIUM DENSE, GRAY, **SILT**, TRACE TO LITTLE CLAY, TRACE SAND, TRACE GRAVEL, WET		45–46	2 3 4	10	100	SS-14	-	-	-	-	-	-	-	-	-	25	A-4b (V)	
		50–51	2 3 4	10	100	SS-15	-	-	-	-	-	-	-	-	-	30	A-4b (V)	
		55–56	0 2 3	7	100	SS-16	-	0	0	1	86	13	NP	NP	NP	28	A-4b (8)	
		60–61	0 0 3	4	100	SS-17	-	-	-	-	-	-	-	-	-	32	A-4b (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV. 443.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY LOOSE TO MEDIUM DENSE, GRAY, **SILT**, TRACE TO LITTLE CLAY, TRACE SAND, TRACE GRAVEL, WET *(continued)*		63–64																
		65–66	2 6 6	16	100	SS-18	-	0	0	8	85	7	NP	NP	NP	26	A-4b (8)	
	435.1	67–70																
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, MOIST		70–71	2 6 7	18	100	SS-19A	-	-	-	-	-	-	-	-	-	21	A-4b (V)	
						SS-19B	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
		72–74																
		75–76	4 6 7	18	100	SS-20	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
		77–79																
		80–81	6 7 8	20	100	SS-21	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
		82–83																
	420.6	84–85 EOB	7 7 9	22	56	SS-22	-	-	-	-	-	-	-	-	-	12	A-3a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 50 GAL. BENTONITE GROUT; SHOVELED SOIL CUTTINGS

PROJECT: HAM-75-1.05	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 65+82, 79' RT.	EXPLORATION ID B-027-0-21
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: IR-75	
PID: 113361 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 501.0 (MSL) EOB: 101.5 ft.	PAGE 1 OF 4
START: 2/10/22 END: 2/11/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 39.107091, -84.530900	

MATERIAL DESCRIPTION AND NOTES	ELEV. 501.0	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
5.0" ASPHALT AND 7.0" CONCRETE AND 6.0" BASE (DRILLERS DESCRIPTION)	499.5	1																
HARD, BROWN, **SANDY SILT**, LITTLE CLAY, LITTLE GRAVEL, CONTAINS BRICK FRAGMENTS, MOIST **(FILL)**	497.1	2, 3	7 10 11	24	67	SS-1	4.25	15	13	31	24	17	24	14	10	15	A-4a (1)	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, CONTAINS BRICK FRAGMENTS, DAMP **(FILL)**	494.0	4, 5, 6	8 5 4	10	61	SS-2	2.00	-	-	-	-	-	-	-	-	18	A-6b (V)	
STIFF, BROWNISH GRAY, **SANDY SILT**, LITTLE CLAY, LITTLE GRAVEL, DAMP **(FILL)**	491.5	7, 8, 9	6 6 8	16	56	SS-3	1.25	13	18	20	30	19	25	16	9	15	A-4a (3)	
VERY STIFF, BROWNISH GRAY AND BLACK, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, SLIGHTLY ORGANIC, DAMP **(FILL)**	489.0	10, 11	7 11 10	24	78	SS-4	3.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
HARD, BROWNISH GRAY AND BLACK, **SANDY SILT**, SOME CLAY, LITTLE STONE FRAGMENTS, CONTAINS BRICK AND GLASS FRAGMENTS, DAMP **(FILL)**	486.5	12, 13, 14	7 5 4	10	89	SS-5	4.25	14	13	21	31	21	29	20	9	18	A-4a (3)	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP **(FILL)**	484.0	15, 16	4 5 4	10	72	SS-6	3.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
STIFF TO VERY STIFF, BROWN MOTTLED WITH GRAY, **SILTY CLAY**, LITTLE SAND, TRACE TO LITTLE GRAVEL, MOIST		17, 18, 19	4 4 4	9	78	SS-7	2.50	-	-	-	-	-	-	-	-	26	A-6b (V)	
		20, 21	3 3 4	8	72	SS-8	2.75	-	-	-	-	-	-	-	-	21	A-6b (V)	
		22, 23, 24	3 4 4	9	67	SS-9	2.00	1	3	11	44	41	40	19	21	24	A-6b (12)	
		25, 26	3 5 6	13	78	SS-10	2.25	-	-	-	-	-	-	-	-	26	A-6b (V)	
		27, 28, 29	4 4 5	10	83	SS-11	1.25	-	-	-	-	-	-	-	-	26	A-6b (V)	

MATERIAL DESCRIPTION AND NOTES	ELEV. 471.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	470.5		4			SS-12A	2.25	-	-	-	-	-	-	-	-	22	A-6b (V)	
LOOSE TO MEDIUM DENSE, BROWN, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, DAMP		31	5 4	10	78	SS-12B	-	-	-	-	-	-	-	-	-	7	A-3 (V)	
		33	5 6 7	15	72	SS-13	-	-	-	-	-	-	-	-	-	5	A-3 (V)	
	466.5	34																
MEDIUM DENSE, BROWN AND GRAY, **SILT**, LITTLE SAND, LITTLE CLAY, TRACE GRAVEL, WET		35–36	5 6 9	17	89	SS-14	-	0	3	15	65	17	NP	NP	NP	23	A-4b (8)	
		38	5 7 7	16	78	SS-15	-	-	-	-	-	-	-	-	-	27	A-4b (V)	
		40–41	5 6 8	16	89	SS-16	-	0	0	11	78	11	NP	NP	NP	28	A-4b (8)	
	457.7	43																
MEDIUM DENSE, BROWN AND GRAY, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET		45–46	5 8 9	19	89	SS-17	-	-	-	-	-	-	-	-	-	36	A-4a (V)	
		50–51	6 9 11	23	100	SS-18	-	0	1	59	33	7	NP	NP	NP	26	A-4a (1)	
		55–56	6 7 10	19	100	SS-19	-	-	-	-	-	-	-	-	-	25	A-4a (V)	
		60–61	5 6 5	13	72	SS-20	-	-	-	-	-	-	-	-	-	32	A-4a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/10/25 12:05 - X:\1ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\1ARCHIVE\ARCHIVE BY YEAR\2024 ARCHIVE\HAM-75-1.05\GINT FILES\HA

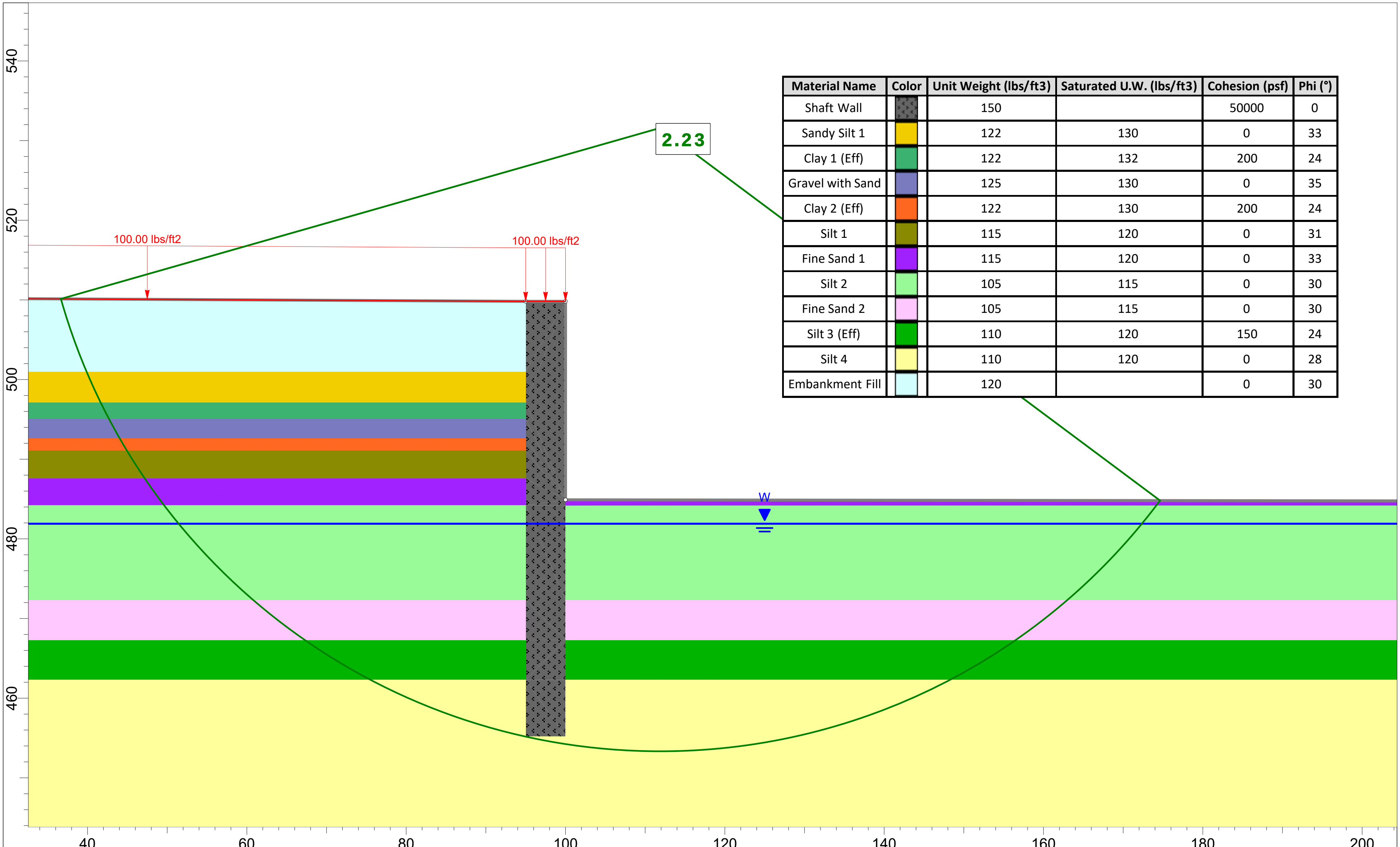
MATERIAL DESCRIPTION AND NOTES	ELEV. 438.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	437.7	63																
LOOSE TO MEDIUM DENSE, GRAY, **SILT**, SOME SAND, TRACE CLAY, TRACE GRAVEL, WET		64																
		65–66	4 3 4	8	78	SS-21	-	0	1	26	64	9	NP	NP	NP	27	A-4b (8)	
		67–69																
		70–71	3 3 4	8	83	SS-22	-	-	-	-	-	-	-	-	-	28	A-4b (V)	
		72–74																
		75–76	3 5 7	14	72	SS-23	-	-	-	-	-	-	-	-	-	25	A-4b (V)	
		77–79																
		80–81	4 6 9	17	89	SS-24	-	0	0	23	68	9	NP	NP	NP	26	A-4b (8)	
	417.7	82–83																
MEDIUM DENSE, GRAY, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET		84																
		85–86	7 9 11	23	100	SS-25	-	0	0	63	34	3	NP	NP	NP	23	A-4a (0)	
		87–89																
		90–91	10 11 13	27	100	SS-26	-	-	-	-	-	-	-	-	-	26	A-4a (V)	
	407.7	92–93																
		94																

MATERIAL DESCRIPTION AND NOTES	ELEV. 406.7	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
DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE GRAVEL, TRACE CLAY, WET *(continued)*		95 – 96	12 13 15	32	100	SS-27	-	-	-	-	-	-	-	-	-	22	A-3a (V)	
		97 – 99																
	399.5	100 – 101 (EOB)	14 14 16	34	100	SS-28	-	-	-	-	-	-	-	-	-	19	A-3a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 100 GAL. BENTONITE GROUT; POURED 2 BAGS HOLE PLUG; SHOVELED SOIL CUTTINGS

GLOBAL STABILITY ANALYSIS



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)
Shaft Wall		150		50000	0
Sandy Silt 1		122	130	0	33
Clay 1 (Eff)		122	132	200	24
Gravel with Sand		125	130	0	35
Clay 2 (Eff)		122	130	200	24
Silt 1		115	120	0	31
Fine Sand 1		115	120	0	33
Silt 2		105	115	0	30
Fine Sand 2		105	115	0	30
Silt 3 (Eff)		110	120	150	24
Silt 4		110	120	0	28
Embankment Fill		120		0	30

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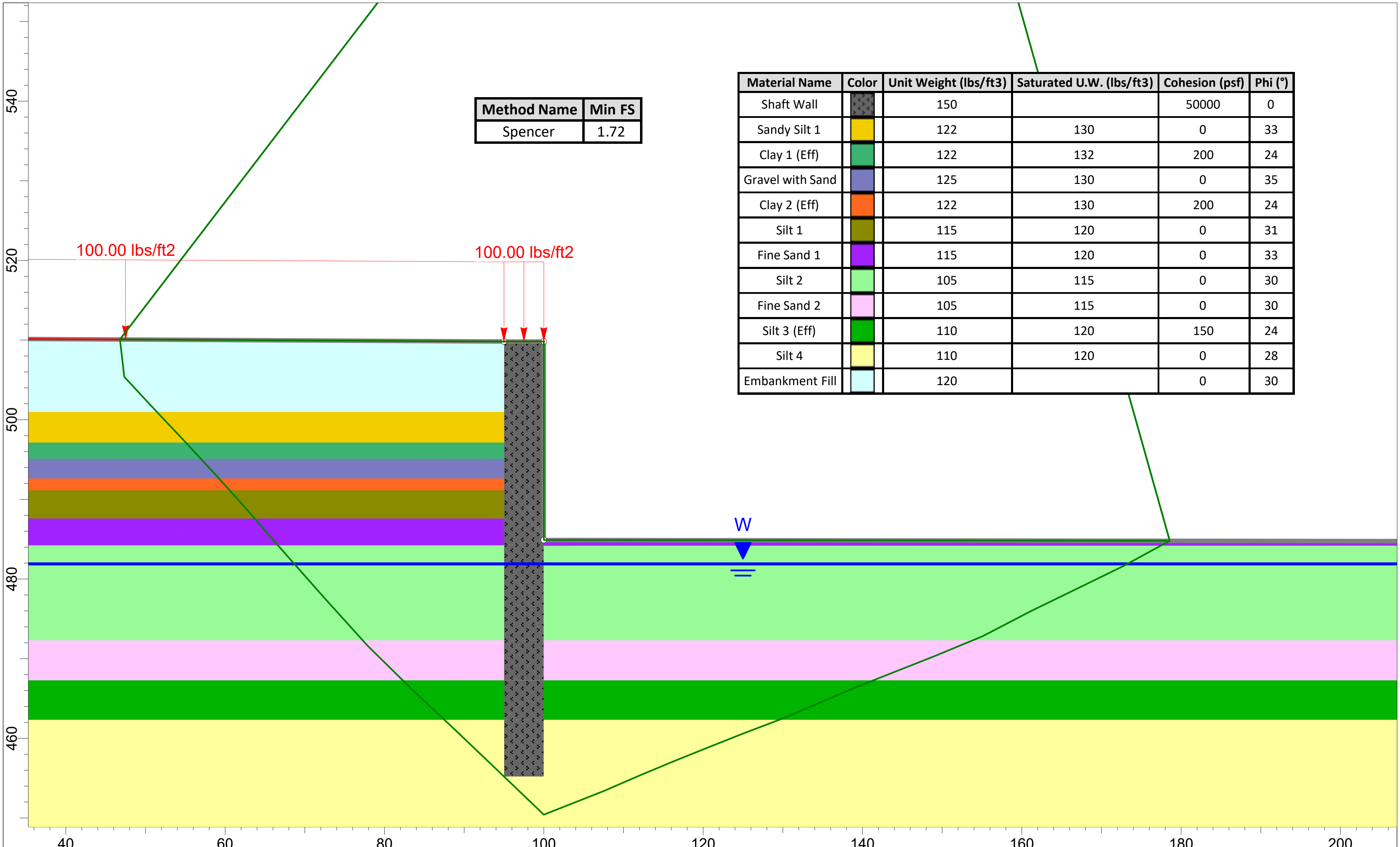
SLIDEINTERPRET 9.038

Project	HAM-75-1.05, PID 113361/122048		
Group	Effective - Circular	*Scenario*	STA. 4+79.6 (RW-4)
Drawn By	KCA	*Company*	NEAS Inc.
Date	3/20/2025, 4:15:08 PM	*File Name*	RW-4_STA4+79.6_032025_B-026.slmd



Method Name	Min FS
Spencer	1.72

Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)
Shaft Wall		150		50000	0
Sandy Silt 1		122	130	0	33
Clay 1 (Eff)		122	132	200	24
Gravel with Sand		125	130	0	35
Clay 2 (Eff)		122	130	200	24
Silt 1		115	120	0	31
Fine Sand 1		115	120	0	33
Silt 2		105	115	0	30
Fine Sand 2		105	115	0	30
Silt 3 (Eff)		110	120	150	24
Silt 4		110	120	0	28
Embankment Fill		120		0	30

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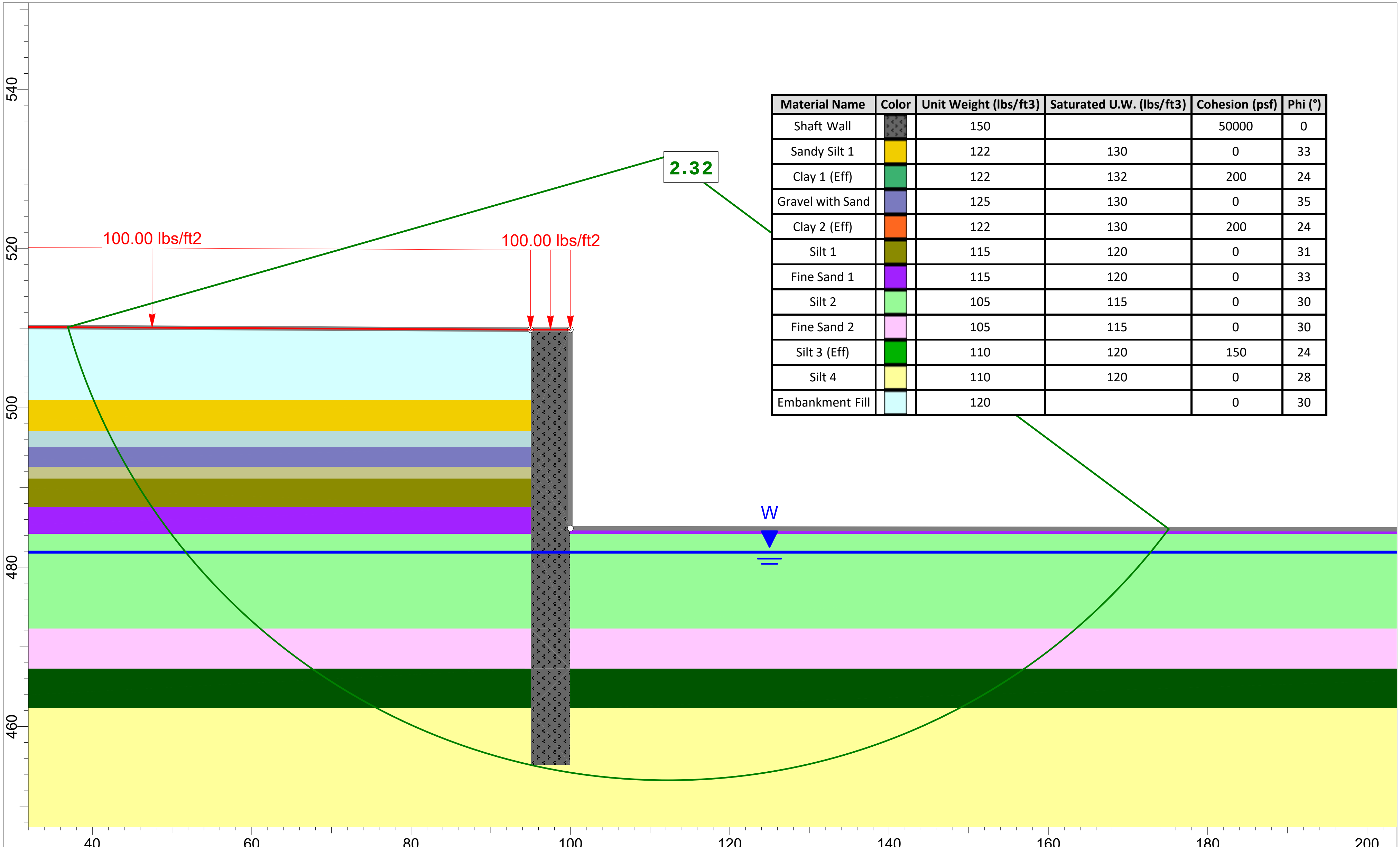
SLIDEINTERPRET 9.038

Project	HAM-75-1.05, PID 113361/122048		
Group	Effective - Non-Circular	*Scenario*	STA. 4+79.6 (RW-4)
Drawn By	KCA	*Company*	NEAS Inc.
Date	3/20/2025, 4:15:08 PM	*File Name*	RW-4_STA4+79.6_032025_B-026.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)
Shaft Wall		150		50000	0
Sandy Silt 1		122	130	0	33
Clay 1 (Eff)		122	132	200	24
Gravel with Sand		125	130	0	35
Clay 2 (Eff)		122	130	200	24
Silt 1		115	120	0	31
Fine Sand 1		115	120	0	33
Silt 2		105	115	0	30
Fine Sand 2		105	115	0	30
Silt 3 (Eff)		110	120	150	24
Silt 4		110	120	0	28
Embankment Fill		120		0	30

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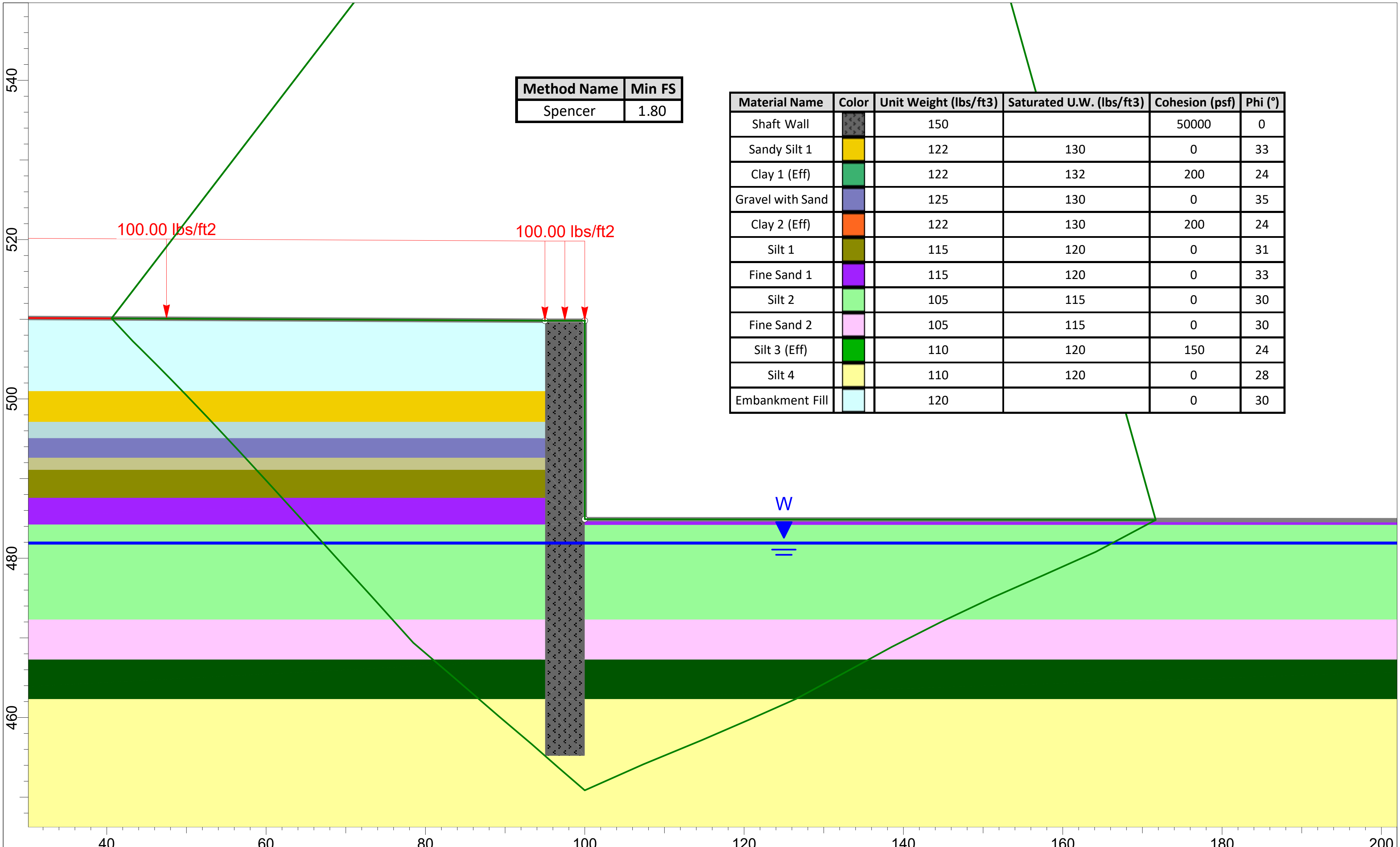
SLIDEINTERPRET 9.038

Project	HAM-75-1.05, PID 113361/122048		
Group	Total - Circular	*Scenario*	STA. 4+79.6 (RW-4)
Drawn By	KCA	*Company*	NEAS Inc.
Date	3/20/2025, 4:15:08 PM	*File Name*	RW-4_STA4+79.6_032025_B-026.slmd



Method Name	Min FS
Spencer	1.80

Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)
Shaft Wall		150		50000	0
Sandy Silt 1		122	130	0	33
Clay 1 (Eff)		122	132	200	24
Gravel with Sand		125	130	0	35
Clay 2 (Eff)		122	130	200	24
Silt 1		115	120	0	31
Fine Sand 1		115	120	0	33
Silt 2		105	115	0	30
Fine Sand 2		105	115	0	30
Silt 3 (Eff)		110	120	150	24
Silt 4		110	120	0	28
Embankment Fill		120		0	30

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SLIDEINTERPRET 9.038

Project	HAM-75-1.05, PID 113361/122048		
Group	Total - Non-Circular	*Scenario*	STA. 4+79.6 (RW-4)
Drawn By	KCA	*Company*	NEAS Inc.
Date	3/20/2025, 4:15:08 PM	*File Name*	RW-4_STA4+79.6_032025_B-026.slmd