FINAL REPORT
SUBGRADE EXPLORATION REPORT
WAY-57-10.32
WAYNE COUNTY, OHIO
PID#: 116212

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NEAS PROJECT 22-0049

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National Engineering & Architectural Services Inc.

EXECUTIVE SUMMARY

The Ohio Department of Transportation (ODOT) has proposed an intersection improvement project (WAY-57-10.32, PID 116212) for the State Route (SR) 57 and SR-604 within Chippewa township, Wayne County, Ohio. The project consists of the construction of a single lane roundabout at the intersection of SR-57 and SR-604. The overall project objective is to reconfigure and improve the safety of the existing SR-57 / SR-604 intersection. Improvements will be limited to the immediate area of the intersection required to construct the roundabout approaches.

National Engineering & Architectural Services, Inc. (NEAS) has been contracted to perform geotechnical engineering services for the project. The purpose of the geotechnical engineering services was 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. Between December 30, 2022 and January 10, 2023, NEAS performed the site reconnaissance and exploration program for the project. The project included 5 borings drilled to a depth of 7.5 ft below ground surface (bgs) for subgrade characterization purposes.

The subgrade conditions in the project area are relatively consistent and are generally comprised of topsoil underlain by natural overburden soils. The natural overburden soils encountered within the project limits consist of primarily cohesive soils classified as A-4b, A-6a, A-6b, and A-7-6 soil and minor non-cohesive soils classified as A-1-b, A-2-4 and A-4a. With respect to sulfate within the subgrade soil, based on the project laboratory testing program, each subgrade soil sample tested was determined to have a sulfate content of less than 3,000 parts per million (i.e., lower than the level which ODOT considers high and may prevent the use of chemical stabilization).

Unsuitable soils A-4b were encountered in one boring B-001-0-22 within 3 feet of top of proposed subgrade. Unstable subgrade conditions, including areas of weak soils and high moisture content soils, were encountered in two borings B-001-0-22 and B-005-0-22. The subgrade soils can be locally stabilized in the form of Excavate and Replace or globally chemically stabilized. Excavate and Replace will extend to a depth of 12 inches below the proposed subgrade along SR-57, starting at STA 38+90 and continuing to the end of SR-57. Along SR-604, it will extend 36 inches below the proposed subgrade, starting at the beginning of SR-604 and continuing to STA 13+95. Global chemical stabilization utilizing cement as the stabilization agent will extend to a depth of 14 inches below the proposed subgrade. The designer should perform a cost analysis of the stabilization options using bid tabs. Stabilization limits should extend 18-inches beyond the edge of the proposed paved roadway, shoulder or median and it is recommended removing any topsoil, existing pavement materials or abandoned structure foundation materials.

NEAS's opinion that the subgrade soils will provide adequate pavement support assuming it is designed and constructed in accordance with the recommendations provided within this report, as well as all applicable ODOT standards and specifications.

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1. INTRODUCTION

1.1. General

National Engineering & Architectural Services, Inc. (NEAS) presents our Subgrade and Roadway Exploration Report for the proposed roundabout project (WAY-57-10.32, PID 116212) for the intersection between State Route (SR) 57 and SR-604 approximately 2.5 miles south of Rittman, Wayne County, Ohio. The overall project objective is to reconfigure and improve the safety of the existing SR-57 / SR-604 intersection. The intersection improvements proposed to accomplish this objective consist of the construction of a roundabout to replace the existing intersection. This report presents a summary of the project encountered surficial and subsurface conditions and our recommendations for subgrade stabilization and pavement design parameters for: 1) the construction of a roundabout where SR-57 and SR-604 meet; and 2) the construction/realignment of SR-57 and SR-604 in the project area to meet up with the aforementioned roundabout. The analysis performed as part of this report has been performed in accordance with ODOT's July 16, 2021 revision of *Geotechnical Bulletin 1* (GB1) (ODOT [1], 2021) and *Pavement Design Manual* (PDM) (ODOT, 2022).

The exploration was conducted in general accordance with NEAS's proposal to Strand Associates, dated July 22, 2022, and with the provisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2022).

The scope of work performed by NEAS as part of the referenced project included: a review of published geotechnical information; performing 5 total test borings (all of which were utilized within this report as part of the roadway exploration); laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis to assess subgrade stabilization requirements and recommended pavement design parameters; and development of this summary report.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The project site is located within the Killbuck-Glaciated Pittsburgh Plateau part of the Glaciated Allegheny (Southern New York Plateaus) with portions located near lake basin/deposits outside of the Huron-Erie Lake Plains. The Killbuck-Glaciated Pittsburgh Plateau region is characterized by ridges and flat uplands of moderate relief generally above 1,200 ft, covered with thin drift and dissected by steep valleys. Valley segments alternate between broad drift-filled and narrow rock-walled reaches. Elevations of the region ranges from 600 to 1,505 ft amsl, with moderate relief (200 ft). The geology within this region is described as thin to thick Wisconsinan-age clay to loam till over Mississippian- and Pennsylvanian-age shales, sandstones, conglomerates, and coals. The lake basin/deposits are characterized as extremely flat plains often comprised of sandy beach ridges and dunes formed along the shore of ancient lakes. (ODGS, 1998).

The geology at the project site is mapped as an average of 20 ft of Wisconsinan-age ice-contact deposits underlain by an average of 110 ft of Wisconsinan-age silt and clay, followed by an average of 30 ft of Wisconsinan-age sand and gravel, followed by an average of 190 ft of Wisconsinan-age till, all underlain by Mississippian-age sandstone and shale bedrock (ODGS, 2005). The ice-contact deposits are described as highly variable deposits of poorly sorted gravel and sand with inclusions of silt, clay, and till lenses. The silt and clay is described as laminated to interbedded and may contain thin fine sand or gravel layers. The sand and gravel is described as interbedded, commonly containing thin discontinuous layers of silt and clay, grains moderately to well sorted, moderately to well rounded, finely stratified to massive, and may locally

contain organics. Sand and gravel in deep buried valleys is noted as potentially being older than Wisconsinan. The till is described as an unsorted mix of clay, silt, sand, gravel, and boulders. May contain silt, sand, and gravel lenses. Till in deep buried valleys is noted as potentially being older than Wisconsinan.

Based on the Bedrock Geologic Units Map of Ohio (USGS & ODGS, 2006), bedrock within the project area consists of shale, sandstone, and limestone of the Maxville Limestone; Rushville, Logan, and Cuyhoga formations, Undivided. This undivided formation is comprised of Mississippian-age bedrock. The shale, sandstone, and limestone in this formation is described as interbedded, various shades of gray, yellow to brown and weathers to similar in color. The sandstone is silty to granular, with local stringers of quartz pebbles. The shale is clayey to silty, locally fossiliferous, and thin to thick bedded. The limestone is locally at the top of the formation in the southern half of Ohio. The bedrock does not appear to follow the natural topography of the site which is relatively flat. The bedrock at the site rises from northwest to southeast. (ODGS, 2003). Based on the ODNR bedrock topography map of Ohio, bedrock elevations at the project site can be expected to be between 700 to 800 ft amsl, putting bedrock at a depth of about 192 ft below ground surface (bgs) to about 277 ft bgs.

The soils at the project site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as primarily Glenford silt loam with just the very center of the intersection mapped as Fitchville silt loam. Soils in the Glenford series are characterized as very deep, moderately well drained soils formed in stratified Wisconsinan-age glaciolacustrine or stream sediments on terraces in valleys, on till plains, lake plains and outwash plains. The Glenford series is comprised of primarily fine-grained soils and classifies as A-4, A-6, and A-7 type soils according to the AASHTO method of soil classification. Soils in the Fitchville series are characterized as very deep, somewhat poorly drained soils formed in stratified Wisconsinan-age glaciolacustrine or stream sediments on terraces in valleys, on till plains, lake plains and outwash plains. The Fitchville series is comprised of primarily fine-grained soils and classifies as A-4, A-6, and A-7 type soils according to the AASHTO method of soil classification

2.2. Hydrology/Hydrogeology

There is not much historical information about groundwater at the project site. The nearest water well logs are from the 2007's. Water well (ID# 2011610) located about 430 ft due southwest of the intersection between Wadsworth Rd. and E Easton Rd. shows a static water level of 917 ft amsl. The water level of the aforementioned water well 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 site is not located within a regulatory flood hazard area based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2019).

2.3. Mining and Oil/Gas Production

One surface mine (ID# IM-0398) was noted on ODNR's Mine Locator surrounding the project site to the southwest, southeast, and northeast. (ODNR [1], 2016).

One oil and gas well (ID#3416924564) was noted on ODNR's Oil and Gas Well 800 ft due southwest of the intersection between Wadsworth Rd. and E Easton Rd. (ODNR [1], 2020).

2.4. Historical Records and Previous Phases of Project Exploration

No reports/plans were available for review or evaluation from the ODOT Transportation Information Mapping System (TIMS), and as such, none are referenced or presented within this report.

2.5. Field Reconnaissance

A field reconnaissance visit for the overall project area was conducted on December 30, 2022, inside the project limits. Site conditions, including the existing land conditions and pavement conditions, were noted, and photographed during the visit. Photographs of notable features and a summary of our observations by road segment are provided below. The land use of most of the project area consists of agricultural property, and residential properties (i.e., single family homes, apartments, etc.).

2.5.1. SR-604

In general, the pavement condition along this section of SR-604 was observed to be good with some signs of surface wear. Moderate severity longitudinal cracking was observed along this section as well as edge cracking and crack sealing deficiencies (Photograph 1). The roadway in this section is situated at near the grade of the surrounding land. The roadway in this section rises gently to both the east and west with the low point being the intersection between SR-604 and SR-57. The roadway drains to drainage ditches on the outside shoulders of the roadway as well as a culvert at the southwest corner of the intersection. The area was lightly vegetated for the most part with signs of standing water observed, such as heavy vegetation in the area around the culvert and drainage ditches north of SR-57 (Photograph 2). Some minor erosion due to runoff was observed in the drainage ditches north of SR-57. The area appeared to be stable with no signs of geotechnical instability aside from the aforementioned erosion.

Photograph 1: Overall Pavement Condition of SR-604

Photograph 2: Signs of Standing Water in Drainage Ditches

2.5.2. SR-57

The pavement condition along the section of SR-57 was observed to be fair with signs of surface wear. Moderate severity longitudinal and transverse cracking was observed along this section as well as edge cracking, occasional map cracking and crack sealing deficiencies (Photograph 3). The roadway in this section is situated near the grade of the surrounding land. The roadway gently rises from north to south. The roadway drains to drainage ditches on the outside shoulders of the roadway. The area is moderately vegetated for the most part with only minor signs of standing water such as cattails in the drainage ditches. The area appeared to be stable with no signs of geotechnical instability.

Photograph 3: Overall Pavement Condition of SR-57

Photograph 4: Minor Signs of Standing Water in Drainage Ditch East of SR-57

3. GEOTECHNICAL EXPLORATION

3.1. Exploration Program

The subsurface exploration for the roadway portion of the project was conducted by NEAS on January 10, 2023, and included 5 borings drilled to a depth 7.5 ft. 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. Target boring locations were located in the field by NEAS prior to drilling utilizing handheld GPS equipment and the boring locations were drilled in areas that were not restricted by underground utilities or dictated by terrain (i.e., steep embankment slopes). Each as-drilled project boring location and corresponding ground surface elevation was surveyed in the field following drilling. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude location (based on the surveyed Ohio State Plane North, NAD83, location) and the corresponding ground surface elevation, as summarized in Table 1.

Table 1: Project Boring Infomation

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Alignment	Station	Offest	Depth	Type
B-001-0-22	39.345260	-82.976167	626.5	SR-604	11+85	11' LT	7.5	Subgrade
B-002-0-22	39.346234	-82.976354	622.5	SR-604	16+05	36' RT	7.5	Subgrade
B-003-0-22	39.346753	-82.976718	621.8	SR-604	20+71	12' RT	7.5	Subgrade
B-004-0-22	39.347655	-82.976470	621.3	SR-57	33+54	8' RT	7.5	Subgrade
B-005-0-22	39.348349	-82.976562	619.8	SR-57	41+15	14' LT	7.5	Subgrade
Notes:	*1. Boring locations and corresponding ground surface elevation were surveyed in the field.*							

Borings were drilled using a CME 45B track-mounted drilling rig utilizing 3.25-inch (inner diameter) hollow stem augers. Soil samples for subgrade borings were typically recovered continuously to a depth of 7.5 ft bgs, each 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 CME auto hammer that has been calibrated to be 72.6 % efficient on January 24, 2022, as indicated on the boring logs (Appendix B).

Field boring logs were prepared by drilling personnel and included pavement description (where present), 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 (provided in Appendix B). After completing the borings, the boreholes were backfilled with either auger cuttings, bentonite chips, or a combination of these materials and patched accordingly with the shoveled soil cuttings.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing, moisture content determinations and sulfate content testing. Data from the laboratory testing program were incorporated onto the boring logs (Appendix B). Soil samples are retained at the laboratory for 60 days following report submittal, after which time they will be discarded.

3.2.1. Classification Testing

Representative soil samples were selected for index property (Atterberg Limits) and gradation testing for classification purposes on approximately 50% of the samples. At each boring location, the upper two samples obtained below the proposed top of subgrade elevation were generally tested while additional samples were selected for testing with the intent of properly classifying the subsurface soil and groundwater conditions within the planned project limits. 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 and ODOT Supplements.

Final classification of soil strata in accordance with AASHTO M-145 “Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes,” as modified by ODOT “Classification of Soils” was made once laboratory test results became available. The results of the soil classification are presented on the boring logs 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 continuously 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. Sulfate testing

Sulfate testing was generally performed on one sample from each subgrade/roadway boring performed for pavement/subgrade design purposes. The selected samples were tested in accordance with ODOT Supplement 1122, “Determining Sulfate Content in Soils” dated July 17, 2015. In general, the upper most sample (within 3 ft of the proposed subgrade elevation) from each boring was tested when feasible. Testing results are summarized in Table 2 below, and presented on the boring logs within Appendix B.

Table 2: Sulfate Test Summary by Boring

Boring ID	Sample	Depth (ft)	Dilution Ratio	Average Sulfate Content (ppm)
B-001-0-22	SS-1	0.0 - 1.5	20	0
B-003-0-22	SS-1	0.0 - 1.5	20	20
B-004-0-22	SS-1	0.0 - 1.5	20	200
B-005-0-22	SS-1A	0.0 - 1.2	20	100

4. 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. It should be noted that for the purposes of this report and our analysis the term 'subgrade' has been assumed to represent soils and/or soil conditions from 1.5 ft below proposed final pavement grades to a depth of 7.5 ft below the proposed pavement grades.

4.1. Subgrade Conditions

The subgrade conditions in the project area are relatively consistent and are generally comprised of topsoil underlain by natural overburden soils. The natural overburden soils encountered within the project limits consist of primarily cohesive soils classified as A-4b, A-6a, A-6b, and A-7-6 soil and minor non-cohesive soils classified as A-1-b, A-2-4 and A-4a. A brief summary of the subgrade conditions encountered along the project site is below.

4.1.1. SR-604

Along SR-604, eighty-two percent (82%) of the soil samples were identified as fine-grained soils and were comprised of: 1) Silt (A-4b, 9% of samples); 2) Silt and Clay (A-6a, 64% of samples); and 3) Silty Clay (A-6b, 9%). With respect to the consistency of the fine-grained soils, the descriptions varied from very stiff to hard correlating to N_{60} values between 11 and 34 bpf. Natural moisture contents ranged from 14 to 19 percent. Based on Atterberg Limit tests performed on representative samples of the fine-grained subgrade soils obtained along the project portions of SR-604, the liquid and plastic limits ranged from 29 to 35 percent and from 18 to 20 percent, respectively.

Eighteen percent (18%) of the soil samples were identified as coarse-grained, non-cohesive soils and where comprised of: 1) Gravel with Sand (A-1-b, 1 sample); 2) Gravel and Stone Fragments with Sand and Silt (A-2-4, 1 sample); and 3) non-cohesive Sandy Silt (A-4a, 1 sample). With respect to the relative density of the coarse-grained soils, it can be described as medium dense correlating N_{60} values between 13 and 18 bpf. Natural Moisture contents ranged from 8 to 23 percent.

4.1.2. SR-57

Along SR-57, sixty-seven percent (67%) of the soil samples were identified as fine-grained soils and were comprised of: 1) cohesive Sandy Silt (A-4a, 1 sample); 2) Silt and Clay (A-6a, 33% of samples); and 3) Clay (A-7-6, 25%). With respect to the consistency of the fine-grained soils, the descriptions varied from

very stiff to hard correlating to N_{60} values between 11 and 25 bpf. Natural moisture contents ranged from 12 to 22 percent. Based on Atterberg Limit tests performed on representative samples of the fine-grained subgrade soils obtained along the project portions of SR-57, the liquid and plastic limits ranged from 29 to 43 percent and from 18 to 20 percent, respectively.

Thirty-three percent (33%) of the soil samples were identified as coarse-grained, non-cohesive soils and where comprised of non-cohesive Sandy Silt (A-4a, 33% of samples). With respect to the relative density of the coarse-grained soils, it can be described as medium dense correlating N_{60} values between 11 and 22 bpf. Natural Moisture contents ranged from 10 to 15 percent.

4.1.3. Groundwater

Groundwater was not encountered during drilling and after drilling in all the project borings performed as part of the referenced project. 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.

5. ANALYSES AND RECOMMENDATIONS

We understand that the WAY-57-10.32 project consists of the construction of a single lane roundabout at the intersection of SR-604 and SR-57. Improvements will be limited to the immediate area of the intersection required to construct the roundabout approaches. For this purpose, a roadway exploration and subsequent analysis was completed for the referenced project. The analysis completed for the proposed roadway improvements included a subgrade (GB1) analysis. The subgrade analysis was performed in accordance with ODOT's GB1 criteria utilizing the ODOT provided *GB1: Subgrade Analysis Spreadsheet* (GB1_SubgradeAnalysis.xls, Version 14.5 dated February 11, 2022). Input information for the spreadsheet was based on the soil characteristics gathered during NEAS's subgrade exploration (i.e., SPT results, laboratory test results, etc.). A GB1 analysis was performed for the entire project as well as for each of the referenced mainline and ramp segments individually.

Based on our evaluation of the subsurface conditions and our geotechnical engineering analyses of the proposed interchange improvement project, it is our opinion that the subgrade conditions encountered need remediation. The following sections provide further detail about the analysis performed and the recommended remediation.

5.1. Subgrade Analysis

A GB1 analysis was performed to identify the method, location, and dimensions (including depth) of required subgrade stabilization for the project. In addition to identifying stabilization recommendations, pavement design parameters are also determined to aid in pavement section design. The subsections below present the results of our GB1 analysis including pavement design parameters and unsuitable subgrade conditions identified within the project limits. GB1 analysis spreadsheets are provided in Appendix C.

5.1.1. Pavement Design Recommendations

It is our understanding that pavement analysis and design is to be performed to determine the proposed pavement sections for the segments within the project limits to undergo full depth replacement. A GB1 analysis was performed using the subgrade soil data obtained during our field exploration program to evaluate the soil characteristics and develop pavement parameters for use in pavement design. The subgrade analysis parameters recommended for use in pavement design are presented in Table 4 below. Provided in the table are ranges of maximum, minimum and average N_{60L} values for the indicated segments as well as the design CBR value recommended for use in pavement design.

Table 4: Pavement Design Parameters

Segment	Maximum N_{60L}	Minimum N_{60L}	Average N_{60L}	Average PI Values	Design CBR*
SR 604	18	11	14	13	7
SR 57	21	11	15	16	7
Entire Project	**21**	**11**	**15**	**15**	**6**

5.1.2. Unsuitable Subgrade

Unsuitable soil types per the GB1 include A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, and soils with liquid limits greater than 65. Unsuitable soils A-4b were encountered in one boring B-001-0-22 within 3 feet of top of proposed subgrade of the referenced project roadway segments. The summary of unsuitable A-4b soils and stabilization recommendations are presented in Table 5 below.

5.1.2.1. Rock

Rock was not encountered at or close to subgrade elevation at the boring locations performed within the project limits. Per ODOT's GB1, if rock is encountered within 24 inches of the bottom of the proposed asphalt or concrete pavement it is to be removed in accordance with 204.05 of the ODOT CMS and replaced with Item 204 Embankment.

5.1.2.2. Prohibited Soils

Prohibited soil types per the GB1, which include A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, and soils with liquid limits greater than 65. Unsuitable soils A-4b were encountered in one boring B-001-0-22 within 3 feet of top of proposed subgrade of the referenced project roadway segments. The summary of unsuitable A-4b soils and stabilization recommendations are presented in Table 5 below.

Table 5: Summary of unsuitable soils and stabilization recommendations

Boring ID	Prohibited Soil Type	Depth Below Subgrade (ft)	Remediation Depth (inches)		
			Excavate and Replace (Item 204 w/ Geotextile)	Excavate and Replace (Item 204 w/ Geogrid - SS 861)	Chemical Stabilization (Item 206)
B-001-0-22	A-4b	1.5 - 3.0	36		14

5.1.3. Unstable Soils

The GB1 recommends subgrade stabilization for soils in which the N_{60} value of a particular soil sample (SS) at a referenced boring location is less than 12 bpf and in some cases less than 15 bpf (i.e., where moisture content is greater than optimum plus 3 percent). Based on the specific N_{60} value at the subject boring, *Figure B - Subgrade Stabilization* within the GB1 recommends a depth of subgrade stabilization for ODOT standard stabilization methods. For the purposes of this report the term 'weak soils' has been assumed to represent subgrade soils of these conditions. It should be noted that although a soil sample's N_{60} value may meet the criteria to be considered a weak soil, the depth in which the weak soil is encountered in relation to the proposed subgrade is considered when each individual subgrade boring is analyzed. For example, if the GB1 recommends an excavate and replace of 12 inches within a weak soil underlying 18 inches of stable material, it would be unreasonable to recommend the removal of both the stable and unstable material for a total of 30 inches of excavate and replace.

Based on N_{60} values encountered within the project borings, our GB1 analysis suggests the need for 12 inches of either chemical treatment or excavate and replace at select locations. A summary of the boring locations where unstable soils were encountered and determined to have a potential impact on subgrade performance are shown in Table 6 below, per the roadway segment for which they were encountered. Also included is the associated GB1 recommended remediation depth at that location.

Table 6: Unstable (Weak) Soils Location Summary

Boring ID	Sample ID	N_{60}	Moisture Above Optimum (%)	Depth Below Subgrade (ft)	Remediation Depth (inches)		
					Excavate and Replace (Item 204 w/ Geotextile)	Excavate and Replace (Item 204 w/ Geogrid - SS 861)	Chemical Stabilization (Item 206)
SR-604							
B-001-0-22	SS-2	11	4	0.0 - 1.5	12	-	12
SR-57							
B-005-0-22	SS-1A	11	4	(- 0.8) - 0.4	12		12
B-005-0-22	SS-2	11	0	0.4 - 0.7	12		12
B-005-0-22	SS-3	11	0	0.7 - 2.2	12		12

It should be noted that *Figure B - Subgrade Stabilization* does not apply to soil types A-1-a, A-1-b, A-3, or A-3a, nor to soils with N_{60L} values of 15 or more. Per GB1 guidance, *these soils should be reworked to stabilize the subgrade.*

5.1.3.1. High Moisture Content Soils

High moisture content soils are defined by the GB1 as soils that exceed the estimated optimum moisture content (per *Figure A - Optimum Moisture Content* within the GB1) for a given classification by 3 percent or more. Per the GB1, soils determined to be above the identified moisture content levels are a likely indication of the presence of an unstable subgrade and may require some form of subgrade stabilization. Similar to our analysis of weak soils, although a soil sample's moisture content may meet the criteria to be considered high, the depth in which the high moisture soil is encountered in relation to the proposed subgrade is considered when each individual subgrade boring is analyzed for stabilization recommendations. Based on the subsurface exploration performed, a high moisture content soils within the proposed subgrade of the project were encountered as shown in Table 7 below.

Table 7: High Moisture Soils Summary

Boring ID	Sample ID	Moisture Content (%)	Optimum Moisture Content (%)	Moisture Above Optimum (%)	Depth Below Subgrade (ft)
SR-604					
B-001-0-22	SS-2	18	14	4	0.0 - 1.5
SR-57					
B-005-0-22	SS-1	15	11	4	(- 0.8) - 0.4

5.2. Stabilization Recommendations

5.2.1. Subgrade Stabilization

Based on the results of our analysis, subgrade soils designated by ODOT's GB1 as "unstable" were present throughout the project as mentioned in section 5.1.3 of this report. Also, Subgrade soils designated as "unstable" via high moisture content were encountered in two borings described in section 5.1.3.1 in this report. In addition, "unsuitable" soil was encountered in one boring within 3 feet of top of proposed subgrade. The subgrade soils can be locally stabilized in the form of Excavate and Replace or globally chemically stabilized. The designer should perform a cost analysis of the stabilization options using bid tabs. Excavate and Replace will extend to a depth of 12 inches below the proposed subgrade along SR-57, starting at STA 38+90 and continuing to the end of SR-57. Along SR-604, it will extend 36 inches below the proposed subgrade, starting at the beginning of SR-604 and continuing to STA 13+95. Excavation limits and depths for each roadway which needs stabilization are summarized in Table 8 below the proposed subgrade with the excavated material being replaced with Item 204 "Excavate and Replace (Item 204)" of ODOT GB1.

Table 8: Stabilization Recommendation Summary

Start Station	End Station	Excavate and Replace with Geotextile (inches)	Unsuitable / Unstable Subgrade Conditions	Borings Considered
SR-604				
Begin of SR-604	Sta. 13+95	36 inch	A-4b	B-001-0-22
SR-57				
Sta. 38+90	End of SR-57	12 inch	N_{60} & Mc	B-005-0-22

The global chemical stabilization of the subgrade soils should be performed to a minimum depth of 14 inches utilizing cement as the stabilizing chemical. The mix design should be conducted in accordance with ODOT's CMS Supplement 1120 (Mixture Design for Chemically Stabilized Soils). For design purposes it may be assumed that the cement addition will be 5% using the following formula.

$$\text{Cement: } C = 0.75 \times T \times 115 \times 0.05$$

Where:

C = amount of chemical in pounds / square yard and

T = thickness of the treatment zone in inches

A dry density of 115-pounds per cubic foot (pcf) is assumed.

Stabilization limits should extend 18-inches beyond the edge of the proposed paved roadway, shoulder or median and it is recommended removing any topsoil, existing pavement materials or abandoned structure foundation materials.

The subgrade conditions encountered along the proposed roadway segments include areas of identified "prohibited soils" and "weak soils". It is NEAS's opinion based on: 1) samples obtained from borings performed; 2) the depth and composition of the "prohibited soils" and "weak soils" encountered; and, 3) the relative density (compactness) of overlying soils, that the recommended 14 inches of global chemical stabilization would be sufficient in stabilizing the subgrade at all locations.

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions along the referenced portions of roadways. This report has been prepared for Strand Associates, ODOT and their design consultants to be used solely in evaluating the subgrade soils within the project limits 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 tests results from representative soil samples, and geotechnical engineering analyses. 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 improvement 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 Strand Associates, Inc., in performing this geotechnical exploration for the WAY-57-10.32 Roadway improvement project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Chunmei (Melinda) He, Ph.D., P.E.
Geotechnical Engineer

Derar Tarawneh, Ph.D., E.I.
Staff Engineer

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APPENDIX A

BORING LOCATION PLAN

P:\PROPOSALS\WAY-57-10.32 (Strand)\Geotechnical Fee Proposal\Target Boring Plan\WAY-57_604-Boring Plan.dgn Sheet 7/21/2022 5:56:33 PM mjasiewicz

1 / 1	WAY-57-10.32	TARGET BORING PLAN	DRAWN / CHECKED	0 50 100 200 HORIZONTAL SCALE IN FEET

APPENDIX B

SOIL BORING LOGS

PROJECT: WAY-57-10.32	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 11+85, 11' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-604
PID: 116212 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 991.2 (MSL) EOB: 7.5 ft.
START: 1/10/23 END: 1/10/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.946255, -81.765204

EXPLORATION ID B-001-0-22

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 991.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
3.0" TOPSOIL (DRILLERS DESCRIPTION)	990.9																		
MEDIUM DENSE, WHITE AND GRAY, **STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, CONTAINS LIME, WET	989.7	1	4 6 7	16	56	SS-1	-	45	27	15	10	3	NP	NP	NP	23	A-1-b (0)	0	
VERY STIFF, BROWN MOTTLED WITH GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	988.2	2	4 5 4	11	56	SS-2	2.75	4	7	14	45	30	34	19	15	18	A-6a (10)	-	
HARD, BROWN, **SILT**, SOME CLAY, LITTLE SAND, TRACE GRAVEL, DAMP	986.7	3	4 5 5	12	44	SS-3	4.50	2	5	13	51	29	30	20	10	17	A-4b (8)	-	
STIFF TO VERY STIFF, BROWN WITH GRAY MOTTLES BECOMING ORANGISH BROWN AND DARK BROWN, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, SS-5 CONTAINS HEAVY IRON STAINING, DAMP TO MOIST	983.7	4	3 6 5	13	61	SS-4	3.00	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
	EOB	5	4 5 4	11	72	SS-5	1.50	-	-	-	-	-	-	-	-	24	A-6b (V)	-	
		6																	
		7																	

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: WAY-57-10.32	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 16+05, 36' RT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-604
PID: 116212 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 980.6 (MSL) EOB: 7.5 ft.
START: 1/10/23 END: 1/10/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.945916, -81.763748

EXPLORATION ID B-002-0-22

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	BACK FILL
5.0" TOPSOIL (DRILLERS DESCRIPTION)	980.2																		
MEDIUM DENSE, BROWN AND LIGHT BROWN, **SANDY SILT**, SOME GRAVEL, LITTLE CLAY, DAMP	979.1	1	4 5 6	13	50	SS-1	-	23	21	15	27	14	NP	NP	NP	12	A-4a (1)	-	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP		2	5 7 7	17	33	SS-2	4.50	7	12	12	43	26	29	18	11	15	A-6a (7)	-	
		3	6 8 11	23	50	SS-3	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
	974.6	4 5	7 10 11	25	33	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
DENSE, BROWN, **SILT**, LITTLE CLAY, TRACE SAND, TRACE GRAVEL, DAMP	973.1	6	8 14 15	35	39	SS-5	-	-	-	-	-	-	-	-	-	16	A-4b (V)	-	
		EOB 7																	

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: WAY-57-10.32	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 20+71, 12' RT.	EXPLORATION ID B-003-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-604	
PID: 116212 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 991.4 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 1/10/23 END: 1/10/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.945787, -81.762059	

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	BACK FILL
3.0" TOPSOIL (DRILLERS DESCRIPTION)	991.4																		
MEDIUM DENSE, BROWN AND GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, LITTLE CLAY, DAMP	991.1		7 7 8	18	39	SS-1	-	36	13	19	19	13	NP	NP	NP	8	A-2-4 (0)	20	
HARD, BROWN BECOMING GRAYISH BROWN MOTTLED WITH GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	989.9	1	6 10 18	34	44	SS-2	4.50	8	7	9	36	40	35	20	15	15	A-6a (10)	-	
		2																	
		3	7 9 10	23	67	SS-3	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
		4																	
		5	8 10 9	23	61	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
		6																	
	983.9	7 EOB	9 10 9	23	61	SS-5	4.50	-	-	-	-	-	-	-	-	19	A-6a (V)	-	

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: WAY-57-10.32	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 33+54, 8' RT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-57
PID: 116212 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 986.7 (MSL) EOB: 7.5 ft.
START: 1/10/23 END: 1/10/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.945063, -81.763523

EXPLORATION ID B-004-0-22

PAGE 1 OF 1

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	BACK FILL
3.0" TOPSOIL (DRILLERS DESCRIPTION)	986.4																		
MEDIUM DENSE, BROWN, **SANDY SILT**, SOME GRAVEL, LITTLE CLAY, DAMP	985.2	1	5 7 10	21	50	SS-1	-	21	19	22	26	12	NP	NP	NP	10	A-4a (1)	200	
HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP	983.7	2 3	6 8 9	21	67	SS-2	4.50	17	9	10	38	26	33	19	14	12	A-6a (7)	-	
MEDIUM DENSE, BROWN, **SANDY SILT**, SOME GRAVEL, LITTLE CLAY, DAMP	982.2	4	7 8 10	22	39	SS-3	-	-	-	-	-	-	-	-	-	12	A-4a (V)	-	
HARD, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP		5	8 8 9	21	61	SS-4	4.50	-	-	-	-	-	-	-	-	13	A-4a (V)	-	
	979.2	6 7 EOB	6 8 9	21	67	SS-5	4.50	-	-	-	-	-	-	-	-	15	A-4a (V)	-	

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: WAY-57-10.32	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 41+15, 14' LT.	EXPLORATION ID B-005-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-57	
PID: 116212 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 976.2 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 1/10/23 END: 1/10/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.947144, -81.763673	

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	BACK FILL
976.2																			
5.0" TOPSOIL (DRILLERS DESCRIPTION)	975.8																		
MEDIUM DENSE, BROWN, **SANDY SILT**, LITTLE CLAY, LITTLE GRAVEL, MOIST	975.1	1	5 4 5	11	67	SS-1A	-	15	23	18	28	16	NP	NP	NP	15	A-4a (2)	100	
						SS-1B	4.25	-	-	-	-	-	-	-	-	17	A-7-6 (V)	-	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, "AND" SILT, LITTLE SAND, TRACE GRAVEL, IRON STAINING, SS-3 IS SLIGHTLY ORGANIC, DAMP TO MOIST		2	4 4 5	11	61	SS-2	4.25	4	4	11	44	37	43	20	23	19	A-7-6 (14)	-	
		3	4 5 4	11	56	SS-3	2.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
		4																	
		5	5 6 6	15	56	SS-4	2.25	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	
	970.2	6																	
HARD, GRAYISH BROWN WITH GRAY MOTTLES, **CLAY**, "AND" SILT, TRACE SAND, TRACE GRAVEL, DAMP	968.7	7 EOB	6 5 7	15	78	SS-5	4.25	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

APPENDIX C

GEOTECHNICAL BULLETIN 1 (GB1) ANALYSIS SPREADSHEETS

ENTIRE PROJECT

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

WAY-57-10.32-Entire Project
116212

Intersection Improvement: converting two-way stop-controlled intersection into a single lane roundabout

NEAS, INC

Prepared By: Derar M. Tarawneh, Ph.D., E.I.
Date prepared: Thursday, January 19, 2023

Chunmei (Melinda) He, Ph.D., P.E.
2800 Corporate Exchange Drive
Suite 240
Columbus, OH 43231
614.714.0299 Ext 111
che@neasinc.com

NO. OF BORINGS: 5

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-22	SR-604	11+85	11	LT	CME 45B	73	991.2	989.7	1.5 C
2	B-002-0-22	SR-604	16+05	36	RT	CME 45B	73	980.6	982.2	1.6 F
3	B-003-0-22	SR-604	20+71	12	RT	CME 45B	73	991.4	990.5	0.9 C
4	B-004-0-22	SR-57	33+54	8	RT	CME 45B	73	986.7	985.7	1.0 C
5	B-005-0-22	SR-57	41+15	14	LT	CME 45B	73	976.2	975.4	0.8 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	0.0	1.5	-1.5	0.0	16			NP	NP	NP	10	3	13	23	6	A-1-b	0	0					
	001-0	SS-2	1.5	3.0	0.0	1.5	11		2.75	34	19	15	45	30	75	18	14	A-6a	10			N_{60} & Mc		**12"**	
	22	SS-3	3.0	4.5	1.5	3.0	12		4.5	30	20	10	51	29	80	17	15	A-4b	8		A-4b		**36"**		
		SS-4	4.5	6.0	3.0	4.5	13	11	3							19	16	A-6b	16						
2	B	SS-1	0.0	1.5	1.6	3.1	13			NP	NP	NP	27	14	41	12	11	A-4a	1						
	002-0	SS-2	1.5	3.0	3.1	4.6	17		4.5	29	18	11	43	26	69	15	14	A-6a	7						
	22	SS-3	3.0	4.5	4.6	6.1	23		4.5							16	14	A-6a	10						
		SS-4	4.5	6.0	6.1	7.6	25	13	4.5							14	14	A-6a							
3	B	SS-1	0.0	1.5	-0.9	0.6	18			NP	NP	NP	19	13	32	8	10	A-2-4	0	20					
	003-0	SS-2	1.5	3.0	0.6	2.1	34		4.5	35	20	15	36	40	76	15	15	A-6a	10						
	22	SS-3	3.0	4.5	2.1	3.6	23		4.5							17	14	A-6a	10						
		SS-4	4.5	6.0	3.6	5.1	23	18	4.5							14	14	A-6a	10						
4	B	SS-1	0.0	1.5	-1.0	0.5	21			NP	NP	NP	26	12	38	10	11	A-4a	1	200					
	004-0	SS-2	1.5	3.0	0.5	2.0	21		4.5	33	19	14	38	26	64	12	14	A-6a	7						
	22	SS-3	3.0	4.5	2.0	3.5	22									12	10	A-4a	8						
		SS-4	4.5	6.0	3.5	5.0	21	21	4.5							13	10	A-4a	8						
5	B	SS-1A	0.0	1.2	-0.8	0.4	11			NP	NP	NP	28	16	44	15	11	A-4a	2	100		N_{60} & Mc		**12"**	
	005-0	SS-1B	1.2	1.5	0.4	0.7	11		4.25							17	18	A-7-6	16			N_{60}		**12"**	
	22	SS-2	1.5	3.0	0.7	2.2	11		4.25	43	20	23	44	37	81	19	18	A-7-6	14			N_{60}		**12"**	
		SS-3	3.0	4.5	2.2	3.7	11	11	2.5							22	18	A-7-6	16						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 116212

County-Route-Section: WAY-57-10.32-Entire Project
No. of Borings: 5

Geotechnical Consultant: NEAS, INC
Prepared By: Derar M. Tarawneh, Ph.D., E.I.
Date prepared: 1/19/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12"
Average(HP):	0"
Global Geogrid Average(N60L):	0"
Average(HP):	0"

Design CBR	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	28%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	17%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	44%	HP > 2	72%
M+	11%		
Rock	0%		
Unsuitable	5%		

Excavate and Replace at Surface	
Average	0"
Maximum	0"
Minimum	0"

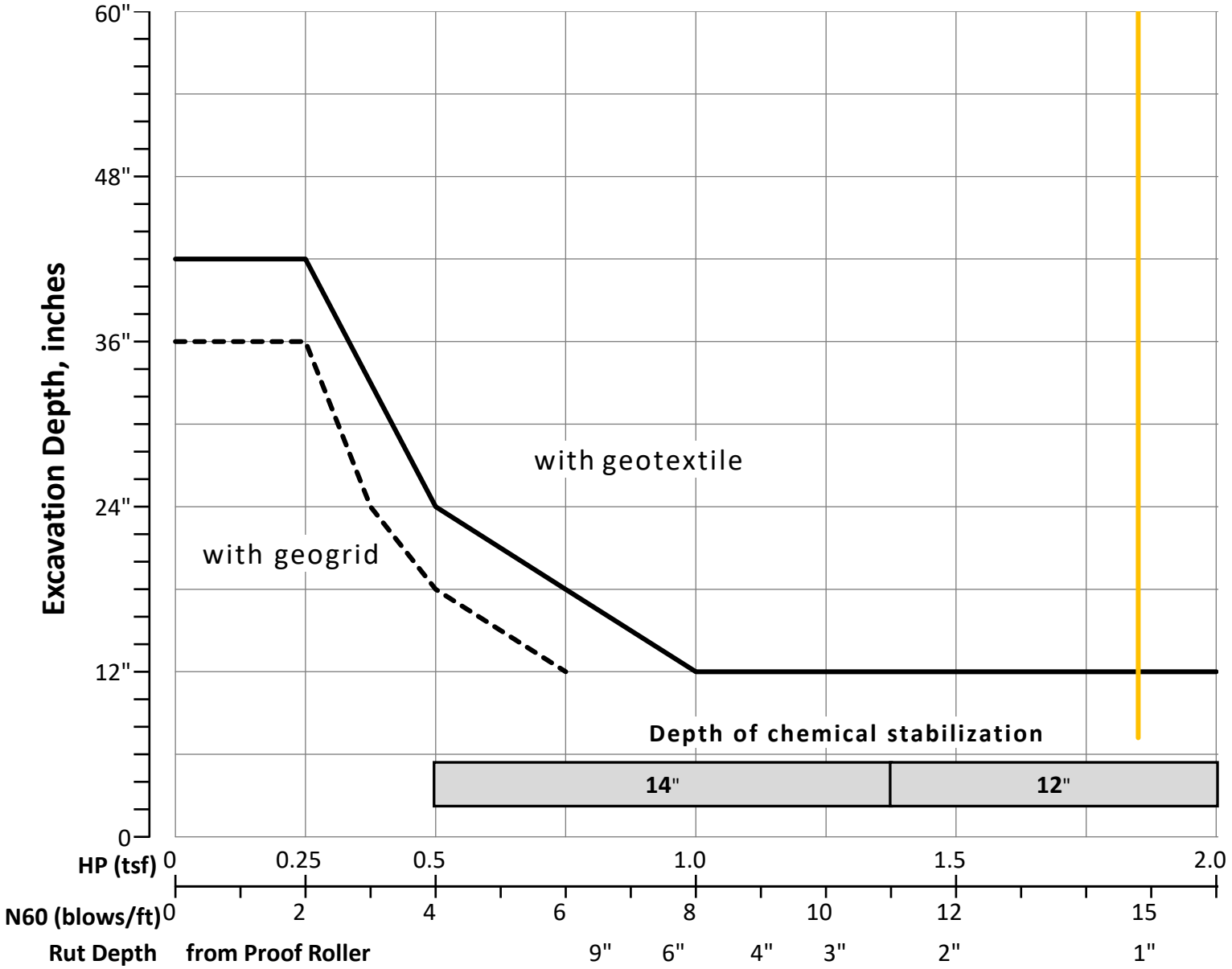
% Proposed Subgrade Surface	
Unstable & Unsuitable	36%
Unstable	29%
Unsuitable	7%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	18	15	4.09	34	19	15	36	24	60	15	14	9
Maximum	34	21	4.50	43	20	23	51	40	81	23	18	16
Minimum	11	11	2.50	29	18	10	10	3	13	8	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	1	0	0	0	0	0	5	1	0	8	1	0	3	0	0	19
Percent	0%	0%	0%	5%	0%	0%	0%	0%	0%	26%	5%	0%	42%	5%	0%	16%	0%	0%	100%
% Rock|Granular|Cohesive	0%	32%									68%								100%
Surface Class Count	0	0	1	1	0	0	0	0	0	4	1	0	4	0	0	3	0	0	14
Surface Class Percent	0%	0%	7%	7%	0%	0%	0%	0%	0%	29%	7%	0%	29%	0%	0%	21%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
4.09	0.50	☐ HP
14.80	6.00	☐ N60L

Average HP
Average N_{60L}

SR-604

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

WAY-57-10.32-SR-604 Segment 116212

Intersection Improvement: converting two-way stop-controlled intersection into a single lane roundabout

NEAS, INC

Prepared By: Derar M. Tarawneh, Ph.D., E.I.
Date prepared: Thursday, January 19, 2023

Chunmei (Melinda) He, Ph.D., P.E.
2800 Corporate Exchange Drive
Suite 240
Columbus, OH 43231
614.714.0299 Ext 111
che@neasinc.com

NO. OF BORINGS: 3

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-22	SR-604	11+85	11	LT	CME 45B	73	991.2	989.7	1.5 C
2	B-002-0-22	SR-604	16+05	36	RT	CME 45B	73	980.6	982.2	1.6 F
3	B-003-0-22	SR-604	20+71	12	RT	CME 45B	73	991.4	990.5	0.9 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	0.0	1.5	-1.5	0.0	16			NP	NP	NP	10	3	13	23	6	A-1-b	0	0					
	001-0	SS-2	1.5	3.0	0.0	1.5	11		2.75	34	19	15	45	30	75	18	14	A-6a	10			N_{60} & Mc		**12''**	
	22	SS-3	3.0	4.5	1.5	3.0	12		4.5	30	20	10	51	29	80	17	15	A-4b	8		A-4b		**36''**		
		SS-4	4.5	6.0	3.0	4.5	13	11	3							19	16	A-6b	16						
2	B	SS-1	0.0	1.5	1.6	3.1	13			NP	NP	NP	27	14	41	12	11	A-4a	1						
	002-0	SS-2	1.5	3.0	3.1	4.6	17		4.5	29	18	11	43	26	69	15	14	A-6a	7						
	22	SS-3	3.0	4.5	4.6	6.1	23		4.5							16	14	A-6a	10						
		SS-4	4.5	6.0	6.1	7.6	25	13	4.5							14	14	A-6a							
3	B	SS-1	0.0	1.5	-0.9	0.6	18			NP	NP	NP	19	13	32	8	10	A-2-4	0	20					
	003-0	SS-2	1.5	3.0	0.6	2.1	34		4.5	35	20	15	36	40	76	15	15	A-6a	10						
	22	SS-3	3.0	4.5	2.1	3.6	23		4.5							17	14	A-6a	10						
		SS-4	4.5	6.0	3.6	5.1	23	18	4.5							14	14	A-6a	10						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 116212

County-Route-Section: WAY-57-10.32-SR-604 Segment
No. of Borings: 3

Geotechnical Consultant: NEAS, INC
Prepared By: Derar M. Tarawneh, Ph.D., E.I.
Date prepared: 1/19/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12"
Average(HP):	0"
Global Geogrid Average(N60L):	0"
Average(HP):	0"

Design CBR	7

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	10%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	30%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	40%	HP > 2	80%
M+	10%		
Rock	0%		
Unsuitable	9%		

Excavate and Replace at Surface	
Average	0"
Maximum	0"
Minimum	0"

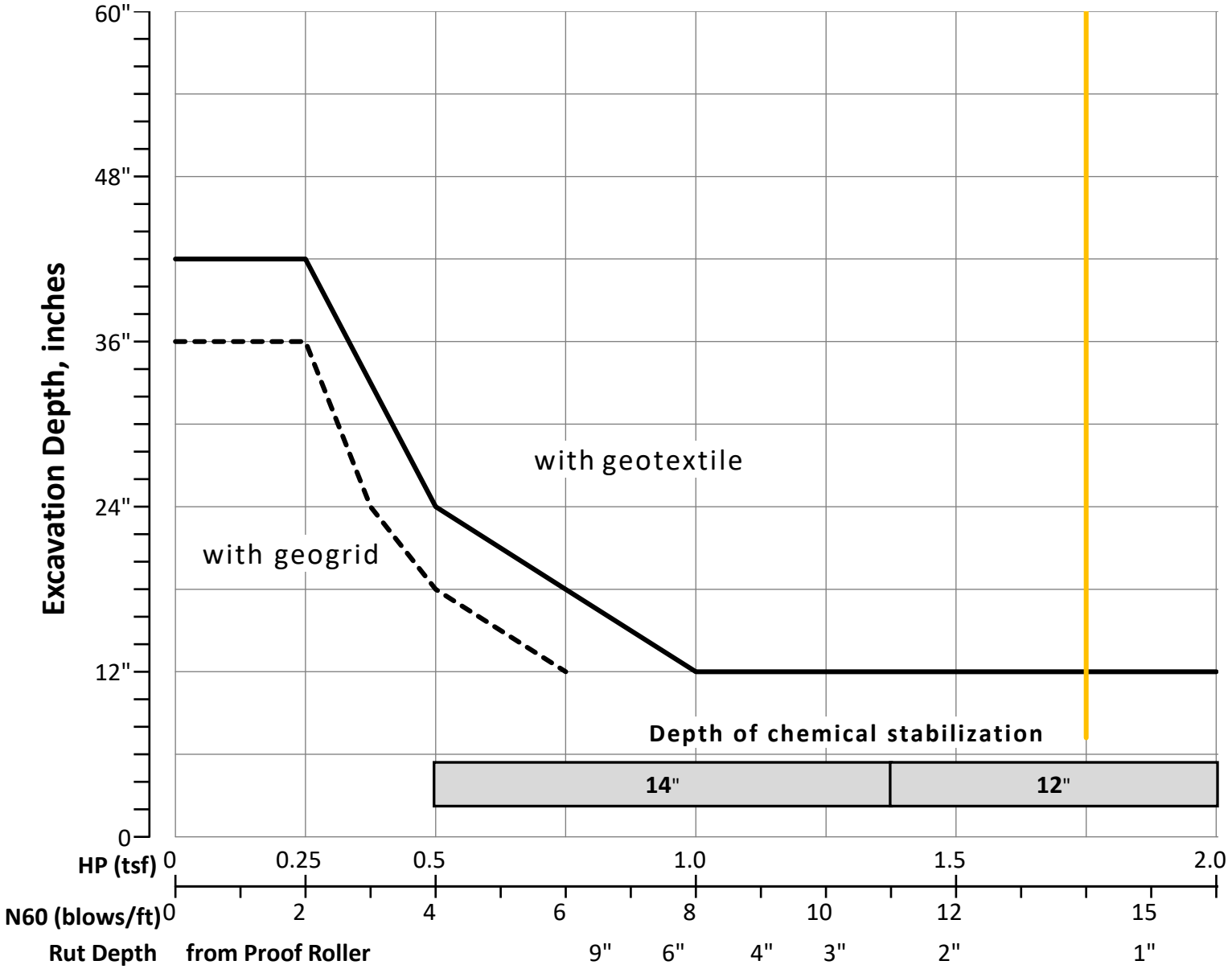
% Proposed Subgrade Surface	
Unstable & Unsuitable	29%
Unstable	14%
Unsuitable	14%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	19	14	4.14	32	19	13	37	25	62	15	14	8
Maximum	34	18	4.50	35	20	15	51	40	80	23	16	16
Minimum	11	11	2.75	29	18	10	10	3	13	8	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	1	0	0	0	0	0	1	1	0	7	1	0	0	0	0	11
Percent	0%	0%	0%	9%	0%	0%	0%	0%	0%	9%	9%	0%	64%	9%	0%	0%	0%	0%	100%
% Rock|Granular|Cohesive	0%	18%									82%								100%
Surface Class Count	0	0	1	1	0	0	0	0	0	1	1	0	3	0	0	0	0	0	7
Surface Class Percent	0%	0%	14%	14%	0%	0%	0%	0%	0%	14%	14%	0%	43%	0%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
4.14	0.50	☐ HP
14.00	6.00	☐ N60L

Average HP
Average N_{60L}

SR-57

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

WAY-57-10.32-SR-57 Segment 116212

Intersection Improvement: converting two-way stop-controlled intersection into a single lane roundabout

NEAS, INC

Prepared By: Derar M. Tarawneh, Ph.D., E.I.
Date prepared: Thursday, January 19, 2023

Chunmei (Melinda) He, Ph.D., P.E.
2800 Corporate Exchange Drive
Suite 240
Columbus, OH 43231
614.714.0299 Ext 111
che@neasinc.com

NO. OF BORINGS: 3

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-004-0-22	SR-57	33+54	8	RT	CME 45B	73	986.7	985.7	1.0 C
2	B-002-0-22	SR-57	36+64	44	LT	CME 45B	73	980.6	981.1	0.5 F
3	B-005-0-22	SR-57	41+15	14	LT	CME 45B	73	976.2	975.4	0.8 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	0.0	1.5	-1.0	0.5	21			NP	NP	NP	26	12	38	10	11	A-4a	1	200					
	004-0	SS-2	1.5	3.0	0.5	2.0	21		4.5	33	19	14	38	26	64	12	14	A-6a	7						
	22	SS-3	3.0	4.5	2.0	3.5	22									12	10	A-4a	8						
		SS-4	4.5	6.0	3.5	5.0	21	21	4.5							13	10	A-4a	8						
2	B	SS-1	0.0	1.5	0.5	2.0	13			NP	NP	NP	27	14	41	12	11	A-4a	1						
	002-0	SS-2	1.5	3.0	2.0	3.5	17		4.5	29	18	11	43	26	69	15	14	A-6a	7						
	22	SS-3	3.0	4.5	3.5	5.0	23		4.5							16	14	A-6a	10						
		SS-4	4.5	6.0	5.0	6.5	25	13	4.5							14	14	A-6a	10						
3	B	SS-1A	0.0	1.2	-0.8	0.4	11			NP	NP	NP	28	16	44	15	11	A-4a	2	100		N_{60} & Mc		**12"**	
	005-0	SS-1B	1.2	1.5	0.4	0.7	11		4.25							17	18	A-7-6	16			N_{60}		**12"**	
	22	SS-2	1.5	3.0	0.7	2.2	11		4.25	43	20	23	44	37	81	19	18	A-7-6	14			N_{60}		**12"**	
		SS-3	3.0	4.5	2.2	3.7	11	11	2.5							22	18	A-7-6	16						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 116212

County-Route-Section: WAY-57-10.32-SR-57 Segment
No. of Borings: 3

Geotechnical Consultant: NEAS, INC
Prepared By: Derar M. Tarawneh, Ph.D., E.I.
Date prepared: 1/19/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	12''

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12''
Average(HP):	0''
Global Geogrid Average(N60L):	0''
Average(HP):	0''

Design CBR	7

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	33%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	8%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	50%	HP > 2	67%
M+	8%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	0''
Maximum	0''
Minimum	0''

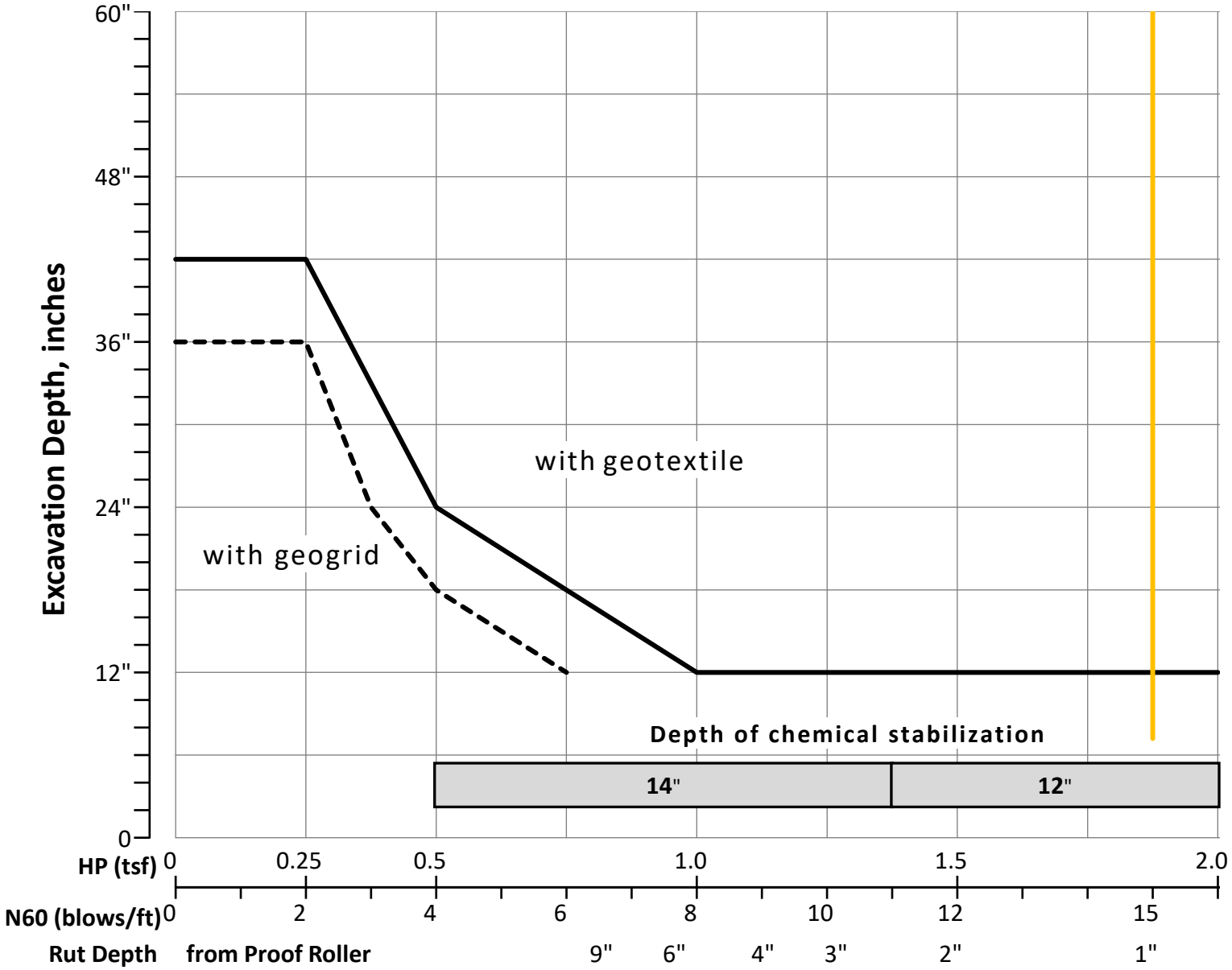
% Proposed Subgrade Surface	
Unstable & Unsuitable	33%
Unstable	33%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	17	15	4.19	35	19	16	34	22	56	15	14	8
Maximum	25	21	4.50	43	20	23	44	37	81	22	18	16
Minimum	11	11	2.50	29	18	11	26	12	38	10	10	1

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	5	0	0	4	0	0	3	0	0	12
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	42%	0%	0%	33%	0%	0%	25%	0%	0%	100%
% Rock|Granular|Cohesive	0%	42%									58%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	3	0	0	9
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	44%	0%	0%	22%	0%	0%	33%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
4.19	0.50	☐ HP
15.00	6.00	☐ N60L

Average HP
Average N_{60L}