Subgrade Exploration Report – Final Revision #1
LOR-20-2.05 Roundabout
Lorain County, Ohio
S&ME Project No. 22170250B

PREPARED FOR:

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August 7, 2024

August 7, 2024

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Attention: Mr. Michael Ciotola, P.E.
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Reference: **Subgrade Exploration Report – Final Revision #1**
LOR-20-2.05 Roundabout
Camden Township, Lorain County, Ohio
S&ME Project No. 22170250B

Mr. Ciotola:

In accordance with our proposal dated April 24, 2023, which was authorized on May 31, 2023, by Mead & Hunt, Inc., Service Work Order No. 001-LOR-20-2.05 PE & EE and the Mead & Hunt, Inc. Master Services Agreement executed with S&ME, Inc. (S&ME) on November 15, 2022, S&ME has completed a Subgrade Exploration for the proposed roundabout to be constructed at the intersection of US 20 and SR 511 in western Lorain County, Ohio. The approximate location of this project is illustrated on the Vicinity Map included as Plate 1 in Appendix I of this report.

In accordance with Section 701 of the ODOT *Specifications for Geotechnical Explorations* (*SGE*), S&ME submitted a "draft" version of this report dated October 6, 2023, followed by a final report dated March 26, 2024. In May 2024, Stage 2 review comments from ODOT District 3 indicated that the subgrade should be globally chemically stabilized instead of using excavate and replace remediation. Accordingly, S&ME has prepared this revised final report to address the request from District 3 that global chemical stabilization be implemented on this project. S&ME has also prepared ODOT Geotechnical Profile Sheets which have been submitted under separate cover.

We appreciate the opportunity to be of service. Please do not hesitate to contact us if you have any questions concerning this report.

Respectfully,

S&ME, Inc.

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1.0 Executive Summary

A roundabout is proposed to improve safety at the existing intersection of US 20 and SR 511 in western Lorain County, Ohio. Available drawings from Mead & Hunt (M&H) indicate the roundabout will be shifted slightly north of the current intersection, with some realignment of the approach roadways extending to approximately 500 to 600 feet from the center of the roundabout.

Pavement probe borings were advanced through the existing US 20 pavement near the subgrade borings performed adjacent to the east and west approach legs to measure the thickness of the existing pavement materials. Probe Borings X-001-1-23 and X-003-1-23 encountered 16 inches asphalt over 4 and 6 inches of concrete, respectively, and 6 inches of granular base. Borings B-004-0-23 and B-005-0-23 were advanced through the existing SR 511 pavement and encountered 15 and 16 inches of asphalt over 6 inches of granular base respectively.

The subgrade exploration program consisted of five (5) subgrade borings, with a boring performed on each roadway approach leg, and a boring located near the proposed roundabout. Borings B-001-0-23 and B-002-0-23 were drilled in the grass area just outside the existing pavement and encountered 4 and 6 inches of rootmat, respectively. Boring B-003-0-23 was drilled in the gravel shoulder and encountered 6 inches of granular shoulder fill. Beneath these surficial materials, all five borings encountered existing fill or possible fill to depths of 3.0 to 5.0 feet deep. These fill materials consisted of very-stiff or medium-dense brown SANDY SILT (A-4a), stiff to hard brown/gray SILT AND CLAY (A-6a), or medium-dense gray GRAVEL (A-1-a).

The natural soil encountered below the fill consisted predominantly of cohesive soils including very-stiff to hard brown/gray SANDY SILT (A-4a), very-stiff to hard (with few medium-stiff zones) brown/gray SILT AND CLAY (A-6a), very-stiff to hard brown/gray SILTY CLAY (A-6b), and stiff brown CLAY (A-7-6). Loose or dense brown COARSE AND FINE SAND (A-3a) was encountered at a depth of 6 feet in Borings B-001-0-23 and B-003-0-23, respectively. Bedrock was not encountered at any of the borings.

Based on conditions encountered in the borings and the available information provided to date, a summary of the recommendations provided in this report is provided below.

- Using the ODOT Subgrade Analysis spreadsheet (Ver. 14.6, dated 2/11/2022), the average California Bearing Ratio (CBR) of the existing subgrade soils encountered during this exploration is 6%.
- The ODOT Subgrade Analysis spreadsheet indicates that potentially unstable subgrade materials requiring remediation were only encountered in Boring B-003-0-23, on the east leg of the roundabout. However, S&ME understands that ODOT District 3 desires the subgrade for this roundabout project to be globally chemically stabilized.
- Based on the results of the Subgrade Analysis spreadsheet, 14 inches of global chemical stabilization using cement is recommended for this project.
- Based upon observations made at the time of this investigation, significant groundwater problems are not anticipated in connection with the proposed roadway improvements.

2.0 Introduction

A roundabout is proposed to be constructed to improve safety at the existing intersection of US 20 and SR 511 in western Lorain County, Ohio. Available plan information provided by M&H indicates that the roundabout will be shifted slightly north of the current intersection, with some realignment of the approach roadways stretching approximately 500 to 600 feet from the center of the roundabout. At the time of our proposal, available information provided by ODOT indicated that the length of work on the approach roadways would be less than 400 to 500 feet.

This exploration was performed in general accordance with the January 2024 updates to the ODOT *Specifications for Geotechnical Explorations* (*SGE*) and ODOT *Geotechnical Design Manual* (*GDM*).

2.1 Geology and Hydrogeology

The project site is within a previously glaciated portion of the state in Berea Headlands of the Central Ohio Clayey Till Plain, where the soils consist of thin, clayey, medium-lime Wisconsinan-age till over resistant Mississippian-age Berea Sandstone. The Ohio Department of Natural Resources (ODNR) online *Ohio Geology Interactive Map* indicates that the surficial soil on the eastern portion of the site consists of alluvial deposits over glacial till, whereas the overburden on the western portion of the site is predominantly glacial till with discontinuous granular zones. Groundwater mapping indicates that a groundwater yield of 5 to 25 gallons per minute may be obtained from the sand and gravel deposits.

The site generally slopes downward to the southeast, with ground surface elevations near the intersection that range from EL. 836 on the east side of the project to El. 847 on the western side. The ODNR mapping suggests the uppermost bedrock near this site consists of Berea Sandstone and Bedford Shale at depths varying from 40 to 60 feet below the ground surface. ODNR mapping also indicates this site is not in a probable karst area, that no mapped abandoned underground mines are near the project site, and that the site is in an area of Ohio with low incidence and low susceptibility to landslides.

2.2 Site Reconnaissance

S&ME personnel visited this site on June 19, 2023, to observe the conditions at this project site with respect to traffic and site access, and to mark the planned boring locations. The existing pavement on US 20 appeared to be in fair to good condition with infrequent longitudinal and occasional transverse cracking. Some edge cracking was also noted. The existing pavement on SR 511 appeared to be in fair condition, with frequent transverse cracks, and occasional longitudinal and block cracking. Gravel shoulders are present along both roadways.

Some utility markings (gas and communication) and storm sewer catch basins were observed, predominantly on the south side of US 20 and the east side of SR 511. Overhead power and communication wires are present on both sides of US 20 and the east side of SR 511. Shallow ditches were observed on both sides of SR 511 to the north of US 20, and on the north side of US 20 to the east of SR 511.

The northeast quadrant is predominantly farmland with active crops, with a convenience store located along US 20 near the eastern limit of the project. The southeast quadrant is open grass pastureland where livestock were observed to be grazing. The southwest quadrant is occupied by a series of greenhouse buildings with a grass lawn

in between the buildings and the roadways. The northwest quadrant is unused and uncultivated land, with evidence of past structures (concrete) or parking areas being observed.

3.0 Exploration

3.1 Available Information

S&ME accessed the on-line ODOT Transportation Information Mapping System (TIMS) to determine if historic boring information was available for this area. We located historic soil information and/or boring logs for explorations performed in 1938, 1960 and 1985; however, this information did not meet current *SGE* requirements and was therefore not suitable for use to reduce the scope of the current geotechnical exploration report or to be incorporated into our assessment.

3.2 Field Exploration

On July 21, 2023, S&ME performed five (5) Type A subgrade borings and two (2) pavement probes within the originally anticipated limits of the proposed project. The subgrade borings, designated as B-001-0-23 through B-005-0-23 and hereafter referred to as B-001 through B-005, were located near the originally anticipated limits of each leg of the roundabout and one near the intersection of US 20 and SR 511. The pavement probes were designated as X-001-1-23 and X-003-1-23, hereafter referred to as X-001-1 and X-003-1, and were performed near the west and east limits of the project, respectively, to determine the thickness of the existing US 20 pavement. The locations (latitude/longitude) of these explorations were obtained by S&ME using a sub-meter GPS unit. These coordinates were provided to M&H, who provided S&ME with the existing ground surface elevations and the stationing/offset at these locations. The approximate locations of these borings are shown on the Plan of Borings included in Appendix I.

The borings were performed by a truck-mounted drill rig using 2¼-inch I.D. hollow-stem augers to advance the borings between sampling attempts. Beginning at the approximate bottom of the existing subgrade level, 6 feet of continuous soil SPT sampling was attempted by a drill rig using a 2-inch O.D. split-barrel sampler driven by blows from a 140-pound hammer freely falling 30 inches (AASHTO T206 - Standard Penetration Test, SPT). The drill rig used for this exploration was calibrated on December 22, 2022, in accordance with ASTM D4633, with a drill rod energy of 83.2%.

At the completion of drilling, the borings were backfilled with soil cuttings mixed with bentonite gravel. Where borings were advanced through existing pavement, the pavement was repaired with an approximately equivalent thickness of cold patch asphalt.

In the field, experienced S&ME personnel performed the following: 1) examined all samples recovered from the borings; 2) preserved representative portions of all samples in airtight glass jars; 3) prepared a log of each boring; 4) made seepage and groundwater observations; 5) made hand-penetrometer measurements in soil specimens exhibiting cohesion; and, 6) provided liaison between the field work and the Project Manager so that the exploration program could be modified in the event unusual or unexpected subsurface conditions were encountered. All samples were transported to S&ME's laboratory for further identification and testing.

3.3 Laboratory Testing Program

In the laboratory, all soil samples were visually identified and tested for natural moisture content. Liquid/plastic limit determinations and grain-size analyses were performed on a minimum of two (2) selected samples from each boring. Sulfate testing was also performed on a soil sample recovered from within 3 feet of the approximate proposed subgrade level in each boring. The results of all tests are reported numerically on the individual boring logs.

Based on the results of the laboratory testing program, soil descriptions contained on the field logs of the borings were modified, if necessary, and laboratory-corrected boring logs are included as Plates 4 through 10 in Appendix I. Shown on these logs are: descriptions of the soil stratigraphy encountered; depths from which samples were preserved; sampling efforts (blow-counts) required to obtain the specimens in the borings; calculated N_{60} values; laboratory testing results; seepage and groundwater observations; and, values of hand-penetrometer measurements made in soil samples exhibiting cohesion. For your reference, hand-penetrometer values are roughly equivalent to the unconfined compressive strength of the cohesive fraction of the soil sample.

Soils have been classified in general accordance with Section 603 of the ODOT *SGE* and described in general accordance with Section 602. An explanation of the symbols and terms used on the boring logs, definitions of the special adjectives used to denote the minor soil components, and information pertaining to sampling and identification are presented on Plate 3 of Appendix I. Group Indices determined from the results of the laboratory testing program are also provided on the boring logs.

4.0 Findings

4.1 General Subsurface Conditions

A summary of the soil and groundwater conditions encountered in the borings is provided in the following sections. Please refer to the boring logs (Plates 4 through 10 in Appendix I) for more detailed information at each boring location. Inferences should not be made to the subsurface conditions in the areas between or away from the borings without performance of additional borings or other field verifications.

4.2 Surficial Materials

Table 4-1 below summarizes the type and thickness (in inches) of existing pavement materials encountered in the subgrade borings and pavement probes performed within existing pavement.

Table 4-1 – Summary of Encountered Pavement Materials

Boring/Probe	Asphalt	Concrete	Granular Base
X-001-1-23	16	4	6
X-003-1-23	16	6	6
B-004-0-23	15	-	6
B-005-0-23	16	-	6

B-001 and B-002, drilled along in the grass areas just outside the pavement encountered 4 and 6 inches of topsoil/rootmat, respectively. B-003, drilled in the shoulder, encountered 6 inches of granular shoulder fill.

4.3 Fill or Possible Fill

Existing fill or probable fill extending to depths ranging from 3 to 5 feet below the ground surface at each boring location. The fill/possible fill materials encountered were described as medium-dense gray GRAVEL (A-1-a), medium-dense dark-brown or very-stiff brown SANDY SILT (A-4a), and stiff to hard brown SILT AND CLAY (A-6a).

4.4 Natural Soil

The natural soil encountered below the fill consisted predominantly of cohesive soil described as very-stiff to hard brown mottled with gray SANDY SILT (A-4a), very-stiff to hard brown mottled with gray SILT AND CLAY (A-6a) with a few medium-stiff to stiff zones in Boring B-004, very-stiff to hard brown mottled with gray SILTY CLAY (A-6b), and stiff brown CLAY (A-7-6). Borings B-001 and B-003 were terminated after encountering loose and dense brown COARSE AND FINE SAND (A-3a), respectively, at a depth of 6 feet. Bedrock was not encountered at any of the borings.

4.5 Groundwater Observations

Seepage and groundwater were not observed during drilling and the boreholes were "dry" at completion, meaning no measurable groundwater had accumulated at the bottom of the boring, in all borings except Boring B-005. In Boring B-005, seepage was observed at 3.0 feet during drilling and water was measured at 5.4 feet in the hollow stem augers at completion. No long-term groundwater measurements were obtained in any of the borings.

4.6 Soil Sulfate Test Results

Sulfate content testing (ODOT Supplement 1122) was performed on soil samples obtained from the approximate proposed pavement subgrade level in all borings. The results of these tests indicated sulfate contents of 180 to 2,853 ppm. These results are below the threshold value of 5,000 ppm identified by the ODOT *GDM* as the sulfate content concentration above which chemical stabilization should not be performed. The results of these tests are provided on the log of each boring and on Plate 11 in Appendix I.

5.0 Analyses and Recommendations

5.1 Geotechnical Evaluation

Design drawings from M&H show the proposed roundabout being shifted slightly north of the current intersection, with some realignment of the approach roadways. Based on the available plan information dated August 31, 2023, and provided by M&H, the project limits on the roadway approach embankments will extend approximately 500 to 600 feet from the center of the proposed roundabout. This distance is as much as 200 feet beyond that anticipated at the time this exploration program was scoped. Available profile information indicates that the proposed roadway profile will be raised slightly (approximately 12 to 18 inches) on the east and west legs and in the immediate vicinity of the roundabout (US 20) but will remain at approximately the same elevation as the existing roadways on the north and south legs (SR 511).

5.2 Subgrade Analyses

5.2.1 ODOT Subgrade Analysis

Section 600 of the ODOT *GDM* provides a standard approach to performing explorations and assessing roadway subgrades. The associated spreadsheet (Ver. 14.6, updated 2/11/2022) created by the ODOT Office of Geotechnical Engineering (OGE) is used to estimate roadway subgrade support parameters and identify areas requiring remediation. The spreadsheet (see Appendix II) summarizes the soil type (by ODOT/HRB classification), group indices, depth, blow-counts, Atterberg Limit, and sulfate content values of the proposed subgrade soils encountered in the borings drilled for this project. Using this data, this spreadsheet computes an average of the estimated values of the California Bearing Ratio (CBR) for the soils encountered at or below the anticipated subgrade level of the proposed roadway profile.

The ODOT Subgrade Analysis spreadsheet also identifies subgrade soils which are "unsuitable" either by classification (A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b) or if the Liquid Limit value is greater than 65%. The spreadsheet also determines if a subgrade soil may be potentially "unstable" and possibly require subgrade remediation by comparing the lab-measured moisture content to the estimated optimum moisture content of the subgrade soil, and/or by comparing the normalized blow-count (N_{60}) and the lowest N value (N_{60L}) from SPT sampling.

Based on these comparisons and correlations, the Subgrade Analysis spreadsheet provides alternative approaches to remediate and establish a stable soil subgrade using either "excavate and replace" (ODOT *Construction and Material Specifications* (*CMS*) Item 204) or chemical stabilization (*CMS* Item 206 and Supplement 1120). However, soils with a sulfate content above 5,000 ppm are generally prohibited from being chemically stabilized.

The subgrade remediation depths identified by the Subgrade Analysis spreadsheet presented in Appendix II are based on the conditions encountered in the borings during this subsurface investigation. However, because the required amount of remediation is dependent on the moisture content of the subgrade soil at the time of construction, Section 600 of the ODOT *GDM* states that the ultimate decision on required remediation depths and limits should be based on observations during either proofrolling or test-rolling operations.

5.2.2 Subgrade Support Parameters

The ODOT Subgrade Analysis spreadsheet (a printout of which is included in Appendix II) computes an average of the estimated California Bearing Ratio (CBR) value for the soils encountered at or below the anticipated subgrade level of the proposed roadway profile.

Based on the available profile elevation data provided by M&H for the reconstructed pavement, the following average California Bearing Ratio (CBR) has been computed by the ODOT Subgrade Analysis spreadsheet for use during new pavement design based on the anticipated subgrade soils encountered in the borings performed for this project.

$$CBR = 6\%$$

Based on this average CBR value and Section 203.1 of the current ODOT *Pavement Design Manual* (*PDM*), the following value of Resilient Modulus (M_R) correlates to this average CBR value.

$$M_R = 7{,}200 \text{ psi}$$

These subgrade support values may be used during new pavement thickness design for this project provided that the entire proposed pavement subgrade is prepared in strict accordance with Item 204 of the ODOT *CMS*, and that all borrow soil placed within 3 feet of the final subgrade elevation of the new pavement provides average subgrade support parameters which meet or exceed the above values. This subgrade evaluation also assumes that the subgrade for the new roadway and roundabout pavements is composed of the materials encountered in the borings. If, at the time of construction, it is determined that the subgrade consists of materials different than those encountered in the borings, the pavement design subgrade criteria should be reviewed and, if necessary, modified.

However, as ODOT desires a global chemical subgrade stabilization program be performed for this project, Section 203.4.1 of the ODOT *PDM* states when the entire subgrade is chemically stabilized, the resilient modulus of the subgrade soil may be increased by a factor of 1.36 during pavement thickness design. This increase in the design Resilient Modulus value would enable ODOT to use a thinner pavement section to carry the same volume of traffic. Therefore, provided a **global** chemical subgrade stabilization program is implemented, the following value of Resilient Modulus ($M_{R\text{-}GCS}$) may be considered for use during replacement pavement design:

$$M_{R\text{-}GCS} = 9{,}800 \text{ psi}$$

Additional discussions and recommendations pertaining to a chemical subgrade remediation program are presented in the following sections of this report.

5.2.3 Unsuitable Soils

None of the borings performed during this exploration encountered soil within 3 feet of the proposed subgrade level which ODOT GB1 considers to be unsuitable either by classification (A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b), or which has a Liquid Limit value exceeding 65%. However, because of the wide spacing of the explorations, it is possible that areas of unsuitable organic, elastic, or silt materials not encountered in any of the borings may be

encountered during earthwork and proofrolling operations. If such materials are encountered, they should be either completely overexcavated and replaced, or removed to a depth of 3 feet below proposed subgrade.

5.2.4 Subgrade Remediation Recommendations

As ODOT desires the proposed subgrade soils for this project to be chemically stabilized, S&ME recommends that 14 inches of **cement** stabilized subgrade be constructed beneath the proposed roadway pavement on this project. The lateral limits of chemical stabilization should extend to at least 18 inches outside the outside edge of the proposed pavement or paved shoulder, including beneath any curbs and gutters.

The Subgrade Analysis spreadsheet indicates that cement should be the chemical additive, based on the average PI of the soils tested in the uppermost 3 feet below the anticipated subgrade. To utilize the improved Resilient Modulus value for a globally stabilized soil subgrade ($M_{R\text{-}GCS}$) discussed in Section 5.2.2 of this report, S&ME recommends that the mixture design for the soil-cement subgrade be performed in accordance with ODOT *CMS* Item 206, including Item 206.06, "Mixture Design for Chemically Stabilized Soils." Section 609 of the ODOT *GDM* presents additional pay items for the chemical stabilization which should be included in the project plans.

Implementation of a chemical subgrade stabilization program will place restrictions on the type of acceptable borrow soil which may be utilized where the roadway is to be widened or where the profile is to be raised. With a global cement subgrade stabilization program, all soil placed as borrow within 2 feet of the proposed pavement subgrade elevation must be tested in the laboratory to determine that the Plasticity Index of the borrow soil is less than 20. We also recommend that lab testing of the borrow soils be performed prior to importing the borrow to the site.

S&ME recommends that construction traffic be minimized once the required subgrade level has been attained. Construction traffic resulting from cyclical haul routes or limited access points may increase the quantity of soil identified by final proof rolling as requiring removal, particularly during periods of moist weather.

5.2.5 Additional Subgrade Remediation Considerations

We also note that four of the five borings (B-001 and B-003 to B-005) had elevated moisture contents compared to the estimated optimum moisture content for the respective soil types, indicating the need to maintain positive drainage during construction.

The estimated subgrade remediation depths are based on conditions encountered in the borings during this subsurface exploration. However, because the required amount of remediation is dependent on the materials encountered and moisture content of the subgrade soil at the time of construction, the ultimate decision on required remediation depths and limits should be based on observations during either proof rolling or test-rolling operations.

As underground utilities are anticipated to be present near this intersection project, the depths of the known utilities should be taken into consideration prior to commencing subgrade remediation within the project alignment. Utilities near the proposed bottom of subgrade stabilization depth should be removed/relocated prior to commencing subgrade remediation operations.

5.3 Earthen Embankment Construction

The available profile information provided by M&H indicates the proposed roadway profile will be raised slightly (approximately 12 to 18 inches) on the east and west legs and in the immediate vicinity of the roundabout but will remain at approximately the same elevation as the existing roadways on the north and south legs.

5.3.1 Embankment Foundation Preparation

Before commencing earthwork operations, it is recommended that all existing pavement, granular base, grass, topsoil, vegetation, and other miscellaneous materials be completely removed from the entire footprint of the proposed roadway subgrade and embankment realignment/widening areas. Following the removal of these materials, it is recommended that the entire exposed subgrade and embankment foundation surface be examined by the Geotechnical Engineer of Record or their designated representative to identify any weak, wet, organic, or otherwise unsuitable soils that were not encountered during the subsurface exploration, especially in widened areas. Any such materials identified should be removed and replaced with suitable compacted fill (Item 203, or Item 204 when within 12 inches of the proposed subgrade).

Existing underground utility lines may be present beneath and adjacent to the existing roadway, and the type of material used and the relative compactness of backfill within any such utility trenches are unknown. S&ME recommends any planned utility relocation be performed prior to proofrolling. Some instability of utility trench backfill may occur during earthwork operations and/or proofrolling, and some recompaction of granular utility trench backfill may become necessary. Additionally, if water has accumulated within the utility backfill, the subgrade soil in the vicinity of any saturated utility trenches may have become sufficiently weak, soft, and/or wet that proofrolling may identify these additional areas as requiring overexcavation and replacement. In any case, care should be taken not to disturb any shallow utilities during proofrolling or overexcavation activities.

5.3.2 Borrow Requirements and Compaction Criteria

Soil used as fill/backfill should consist of inorganic soil free of all miscellaneous materials, cobbles, and boulders, which is placed in uniform, thin layers and then compacted in accordance with:

- *CMS* Item 203 when more than 12 inches below the proposed subgrade
- *CMS* Item 206 when constructing a chemically stabilized subgrade

Borrow materials should not be placed in a frozen condition or upon a frozen surface, and any sloping surfaces on which new fill is to be placed should first be benched in accordance with either ODOT *CMS* Item 203.05 or Section 800 of the ODOT *GDM*, depending on the slope of the existing ground surface at each location.

Borrow materials to be used as new fill or backfill within 3 feet of the proposed subgrade level should be tested in the laboratory to determine that the borrow materials exhibit subgrade support characteristics that are no less than the CBR value used during the pavement design (see Section 5.2.2). Additionally, as indicated in Section 5.2.4, if the subgrade is chemically stabilized, since cement is recommended for use based on site soils, any borrow materials within 2 feet of the proposed subgrade level should have a PI of less than 20.

Compaction requirements (based on the dry unit weight of the type of soil fill being placed as borrow) for the construction of embankment/subgrade materials are based on:

- *CMS* Item 203.07.B when more than 12 inches below the proposed subgrade
- *CMS* Item 206.05.C when constructing a chemically stabilized subgrade

S&ME also recommends that once the source of borrow for this project is determined, sampling and testing of this borrow material be performed prior to construction to verify that the borrow soils are suitable for the planned construction.

5.3.3 Compaction/Moisture Conditioning Concerns

The cohesive soils encountered in the borings performed for this project, if exposed to inclement weather or rainfall, may rapidly absorb additional moisture, and weaken. It is imperative that these soil types not be exposed to rainfall while in a loosened state (such as during discing and drying for moisture conditioning during fill placement). Should these materials become sufficiently saturated that additional moisture conditioning is impractical, the material should be wasted. Therefore, it is recommended that moisture conditioning only be performed when extended periods of suitable weather are anticipated, and that only the amount of borrow soil be exposed that may be moisture conditioned and properly compacted during suitable weather periods.

Moisture conditioning and protection of the chemically stabilized subgrade, including the application of a curing coat, should be performed in accordance with *CMS* Item 206.05.D & 206.05.F.

5.3.4 Final Subgrade Preparation and Protection

The final proofrolling of the chemically stabilized subgrade should be performed in accordance with *CMS* Item 206.05.E, with any weak or unstable areas being repaired. Additionally, refer to Section 609 in the ODOT *GDM* regarding pay items for chemical stabilization.

S&ME recommends that construction traffic be completely prohibited during the curing period of a chemically stabilized subgrade, and minimized following the curing period. Construction traffic resulting from cyclical haul routes or limited access points may increase the quantity of cement stabilized soil identified by final proof rolling as requiring removal.

5.4 Groundwater Considerations for Roadway Subgrade

Based upon observations made at the time of this investigation, significant groundwater problems are not anticipated in connection with the proposed roundabout construction. The new roundabout subgrade should be graded to prevent surface runoff from pooling on the cohesive soils during construction as exposure of cohesive soils to moisture will result in a decrease in strength and an increase in compressibility. Soil softened by standing water or disturbed by construction activities should be removed before proceeding with construction.

In addition to proper subgrade preparation, we recommend that the pavement construction include surface and subsurface drainage measures. Water which infiltrates the pavement and remains trapped within the pavement components during traffic loading is one of the leading causes of premature pavement failure. Effective design measures include the use of perforated underdrain pipes or finger drains below pavements and/or the use of perimeter swales, perimeter edge drains, curbs, or a combination of these features to collect surface water runoff from areas adjacent to the pavement. Cohesive subgrade soils should be crowned or sloped to promote drainage of infiltrating water towards subsurface drainage collection systems.

6.0 Considerations and Report Limitations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty, either expressed or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information, if necessary.

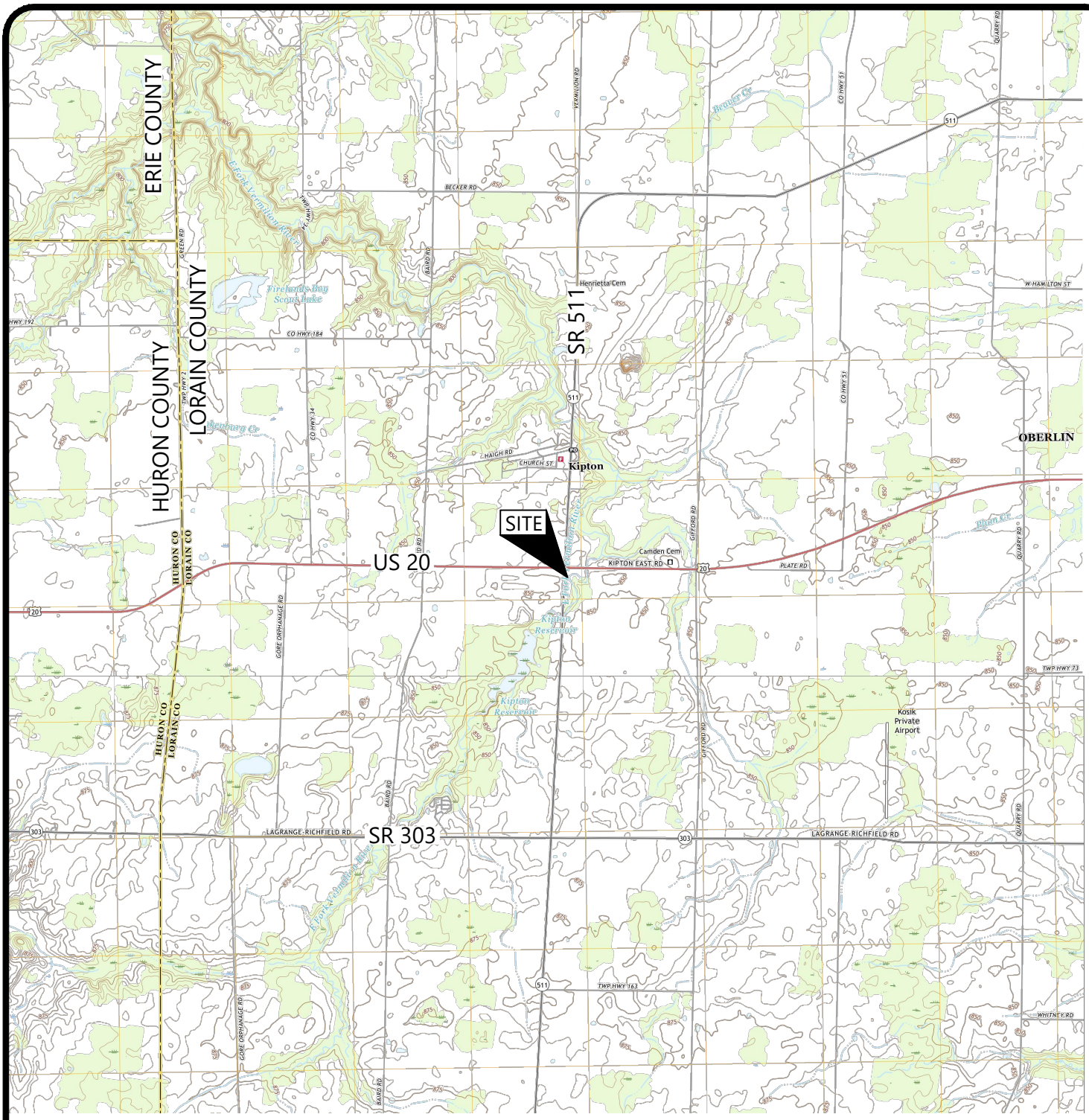
Our conclusions and recommendations are based on limited data from a field exploration program. Subsurface conditions can vary widely between explored areas. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested.

S&ME should be retained to review the final plans and specifications to confirm that earthwork, foundation, and other recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME's review of final plans and specifications followed by our observation and monitoring of earthwork and foundation construction activities.

Appendices

Appendix I – General Project Information



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Project Location
Lorain County, Ohio

USGS Mapping:
Kipton & Brighton USGS Quads

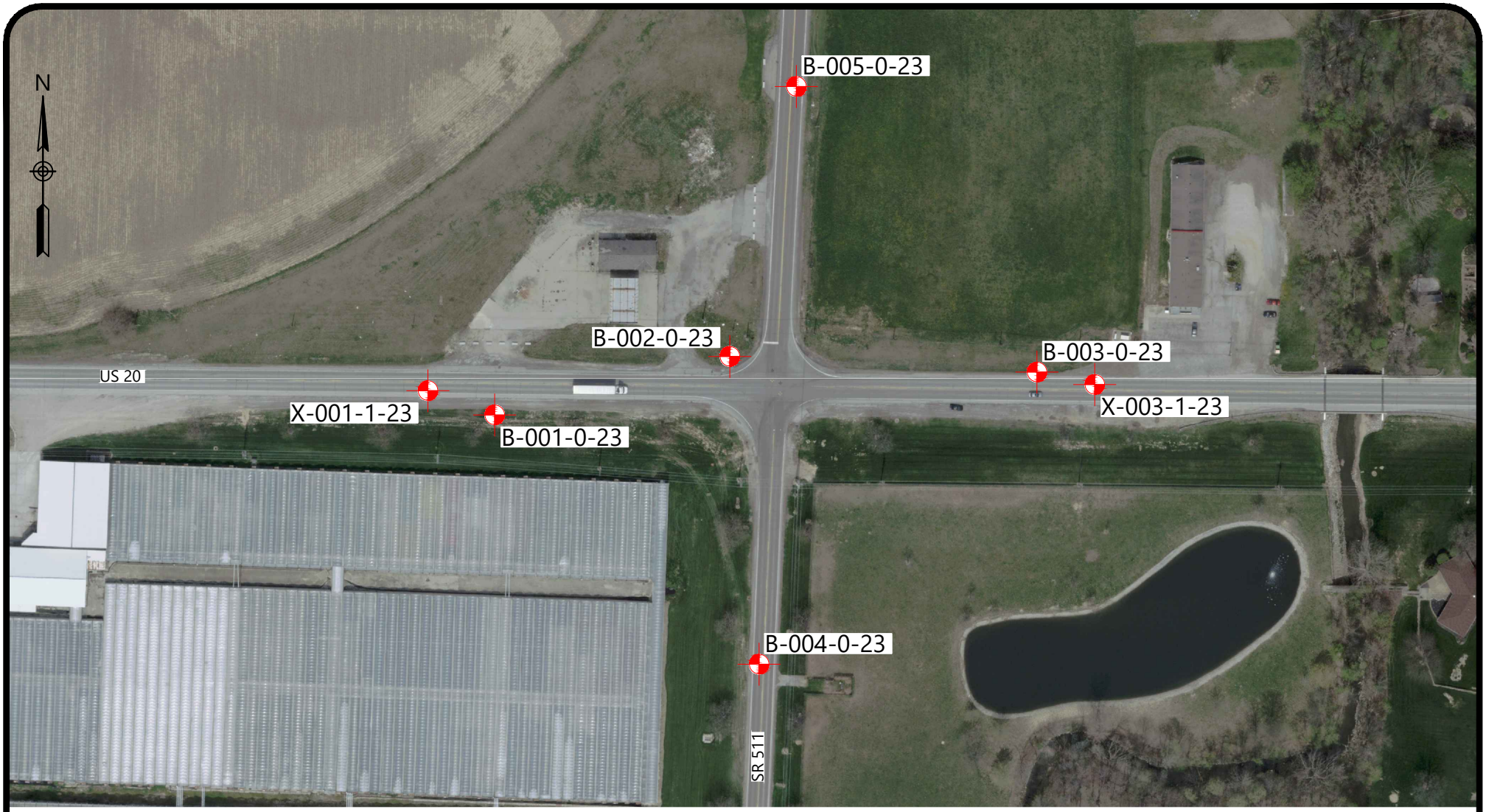
0 4000 8000
GRAPHIC SCALE (IN FEET)

Vicinity Map

Subgrade Geotechnical Exploration
LOR-20-2.05 Roundabout
Camden Township, Lorain County, Ohio

SCALE:	FIGURE NO.
GRAPHIC	1
DATE:	
09-28-2023	
PROJECT NUMBER	
22170250B	

Drawing Path: T:\Columbus-1170\Projects\2022\22170250B_Mead & Hunt_LOR-20-2.05 Roundabout_LOR Co OH\GEO\CAD\Construction\Plan of Borings & VMAP.dwg



NOTES: AERIAL IMAGERY COURTESY OF OGRIP, OBTAINED SPRING 2017.

LEGEND

B-001-0-23 S&ME BORING NUMBER AND LOCATION

X-001-0-23 S&ME PAVEMENT PROBE NUMBER AND LOCATION

0 150 300

GRAPHIC SCALE (IN FEET)

PLAN OF BORINGS

Subgrade Geotechnical Exploration
LOR-20-2.05 Roundabout
Camden Township, Lorain County, Ohio

SCALE:	FIGURE NO.
GRAPHIC	2
DATE:	
09-28-2023	
PROJECT NUMBER	
22170250B	

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF SOIL

SAMPLING DATA

- ▯ - Indicates sample was attempted within this depth interval.
- 2 3 5 - The number of blows required for each 6-inch increment of penetration of a "Standard" 2-inch O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches (SPT). The raw "blowcount" or "N" is equal to the sum of the second and third 6-inch increments of penetration.
- N_{60} - Corrected Blowcount = [(Drill Rod Energy Ratio) / (0.60 Standard)] X N
- 90* - Calibrated energy ratio exceeds 90% but is limited to 90% per ODOT SGE.
- SS - Split-barrel sampler, any size.
- ST - Shelby tube sampler, 3″ O.D., hydraulically pushed.
- R - Refusal of sampler in very-hard or dense soil, or on a resistant surface.
- 50-4" - Number of blows (50) to drive a split-barrel sampler a certain distance (4 inches), other than the normal 6-inch increment.

DEPTH DATA

- W - Depth of water or seepage encountered during drilling.
- ▽ - Depth to water in boring at the end of drilling (EOD).
- ▼ 5 days - Depth to water in monitoring well or piezometer in boring a certain number of days (5) after termination of drilling.
- TR - Depth to top of rock.

SOIL DESCRIPTIONS

Soils have been classified in general accordance with Section 603 of the most recent ODOT SGE, and described in general accordance with Section 602, including the use of special adjectives to designate approximate percentages of minor components as follows:

Adjective	Percent by Weight
trace	1 to 10
little	10 to 20
some	20 to 35
"and"	35 to 50

The following terms are used to describe density and consistency of soils:

Term (Granular Soils)	Blows per foot (N_{60})
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0.25
Soft	0.25 to 0.5
Medium-stiff	0.5 to 1.0
Stiff	1.0 to 2.0
Very-stiff	2.0 to 4.0
Hard	Over 4.0

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 105+03, 17' RT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20 CL RW
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 845.7 (MSL) EOB: 7.5 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 83.2	LAT / LONG: 41.258412 N, 82.303958 W

EXPLORATION ID **B-001-0-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 845.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ROOTMAT - 4 INCHES	845.4																		
POSSIBLE FILL: Hard brown **SILT AND CLAY**, some fine to coarse sand, trace fine gravel, damp.	842.7	1	7 8 8	22	78	SS-1	4.5	3	7	14	30	46	30	18	12	13	A-6a (9)	180	
Very-stiff to hard brown mottled with gray **SILT AND CLAY**, some fine to coarse sand, trace fine gravel, damp.	839.7	2 3 4	3 6 8	19	89	SS-2	3.0-4.5	2	5	16	34	43	29	18	11	17	A-6a (8)	-	
		5	4 6 8	19	100	SS-3	3.5-4.5	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
Loose brown **COARSE AND FINE SAND**, little to some silt, trace to little clay, trace fine gravel, damp to moist.	838.2	6 EOB 7	1 2 2	6	50	SS-4	-	-	-	-	-	-	-	-	-	14	A-3a (V)	-	

NOTES:
- No groundwater noted.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS MIXED WITH BENTONITE

S&ME ODOT SULFATE (8.5X11) - SGE 01/2019 - OH DOT.GDT - 3/11/24 16:30 - R:\SERVICE LINES\CS-2557\COLUMBUS\GINTW\PROJECTS\22170250B.GPJ

PLATE 4

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 107+55, 38' LT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20 CL RW
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 841.8 (MSL) EOB: 7.5 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 83.2	LAT / LONG: 41.258552 N, 82.303038 W

EXPLORATION ID **B-002-0-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 841.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ROOTMAT - 6 INCHES	841.3																		
POSSIBLE FILL: Hard brown and dark brown **SILT AND CLAY**, little fine to coarse sand, trace fine gravel, iron oxide staining, damp.	838.8	1	3 6 6	17	72	SS-1	4.5	5	5	12	48	30	33	22	11	18	A-6a (8)	200	
Very-stiff to hard brown mottled with gray **SILTY CLAY**, little fine to coarse sand, trace fine gravel, few stiff zones, damp to moist.		2	4 5 7	17	67	SS-2	4.0-4.5	4	5	13	31	47	40	20	20	18	A-6b (12)	-	
		3	4 5 7	17	78	SS-3	3.0-4.5	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
		4	2 3 4	10	89	SS-4	1.0-2.5	-	-	-	-	-	-	-	-	23	A-6b (V)	-	
	834.3	5 EOB																	
		6																	
		7																	

NOTES:
- No groundwater noted.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS MIXED WITH BENTONITE

PLATE 5

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 111+07, 21' LT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20 CL RW
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 837.7 (MSL) EOB: 7.5 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 83.2	LAT / LONG: 41.258498 N, 82.301760 W

EXPLORATION ID **B-003-0-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 837.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
GRANULAR SHOULDER FILL - 6 INCHES	837.2																		
POSSIBLE FILL: Very-stiff brown **SANDY SILT**, some clay, trace fine gravel, damp.	834.7	1																	
		2	2 3 5	11	94	SS-1	2.5-3.5	10	10	23	30	27	22	15	7	14	A-4a (4)	260	
Very-stiff to hard brown mottled with gray **SANDY SILT**, some clay, trace fine gravel, damp.	831.7	3	4 5 6	15	100	SS-2	2.0-4.5	4	6	16	41	33	25	16	9	15	A-4a (8)	-	
		4	4 7 7	19	94	SS-3	2.0-4.5	-	-	-	-	-	-	-	-	14	A-4a (V)	-	
Dense brown **COARSE AND FINE SAND**, little to some silt, little clay, trace to little fine gravel, damp.	830.2	5	10 13 11	33	83	SS-4	-	-	-	-	-	-	-	-	-	7	A-3a (V)	-	
		6																	
		7 EOB																	

NOTES:
- No groundwater noted.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS MIXED WITH BENTONITE

S&ME ODOT SULFATE (8.5X11) - SGE 01/2019 - OH DOT.GDT - 3/11/24 16:30 - R:\SERVICE LINES\CS-2557\COLUMBUS\GINTW\PROJECTS\22170250B.GPJ

PLATE 6

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 7+32, 4' LT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 511 CL
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 841.2 (MSL) EOB: 8.0 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 83.2	LAT / LONG: 41.257670 N, 82.302912 W

EXPLORATION ID **B-004-0-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 841.2	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
ASPHALT - 15 INCHES	839.9																		
GRANULAR BASE - 6 INCHES	839.4																		
POSSIBLE FILL: Medium-dense dark brown **SANDY SILT**, little clay, trace fine gravel, iron oxide staining, damp.	837.7	1	14 10 8	25	72	SS-1	-	5	7	26	43	19	20	16	4	11	A-4a (5)	2853	
Stiff brown **CLAY**, "and" silt, trace fine to coarse sand, trace fine gravel, damp.	836.2	2	2 3 4	10	83	SS-2	1.5-2.0	1	2	6	51	40	45	19	26	22	A-7-6 (15)	-	
Medium-stiff becoming very-stiff brown mottled with gray **SILT AND CLAY**, little to some fine to coarse sand, trace fine gravel, damp to moist.	833.2	3	2 2 4	8	94	SS-3	0.5-1.0	-	-	-	-	-	32	17	15	21	A-6a (V)	-	
		4	1 2 3	7	89	SS-4	2.5-3.0	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
		EOB 5																	
		6																	
		7																	
		8																	

NOTES:
- No groundwater noted.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; SOIL CUTTINGS MIXED WITH BENTONITE

PLATE 7

S&ME ODOT SULFATE (8.5X11) - SGE 01/2019 - OH DOT.GDT - 3/11/24 16:30 - R:\SERVICE LINES\CS-2557\COLUMBUS\GINT\WPROJECTS\22170250B.GPJ

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 13+36, 8' RT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: SR 511 CL
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 843.6 (MSL) EOB: 8.0 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 83.2	LAT / LONG: 41.259326 N, 82.302755 W

EXPLORATION ID **B-005-0-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 843.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 16 INCHES	842.3																		
GRANULAR BASE - 6 INCHES	841.8																		
FILL: Medium-dense gray **GRAVEL**, little fine to coarse sand, trace silt, trace clay, dry to damp.	840.1	W 840.6	7 13 8	29	44	SS-1	-	78	10	4	6	2	NP	NP	NP	3	A-1-a (0)	500	
POSSIBLE FILL: Stiff brown mottled with gray **SILT AND CLAY**, some fine to coarse sand, trace fine gravel, damp.	838.6		2 3 3	8	72	SS-2	1.0-2.0	3	5	16	43	33	31	20	11	22	A-6a (8)	-	
Very-stiff brown mottled with gray **SILTY CLAY**, little to some fine to coarse sand, trace fine gravel, damp to moist.	835.6		3 4 6	14	72	SS-3	2.5-3.0	-	-	-	-	-	34	17	17	23	A-6b (V)	-	
		EOB	5 6 7	18	28	SS-4	4.0	-	-	-	-	-	-	-	-	19	A-6b (V)	-	

NOTES:
- Seepage encountered at 3.0'.
- Water measured at 5.4' upon completion in HSA.
- SS-2 through SS-4 obtained from offset boring 18' north of original boring due to no recovery of these samples in the original boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; SOIL CUTTINGS MIXED WITH BENTONITE

PLATE 8

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 104+37, 2' RT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20 CL RW
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 847.1 (MSL) EOB: 2.2 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: CUTTINGS	ENERGY RATIO (%): 83.2	LAT / LONG: 41.258455 N, 82.304195 W

EXPLORATION ID **X-001-1-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 847.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 16 INCHES	845.8	1																	
CONCRETE - 4 INCHES	845.4																		
GRANULAR BASE - 6 INCHES	844.9	EOB 2																	

NOTES:
- Auger probe to determine pavement section near project limits. No samples attempted.

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; SOIL CUTTINGS

S&ME ODOT SULFATE (8.5X11) - SGE 01/2019 - OH DOT.GDT - 3/11/24 16:30 - R:\SERVICE LINES\CS-2557\COLUMBUS\GINTW\PROJECTS\22170250B.GPJ

PLATE 9

S&ME JOB: 22170250B

PROJECT: LOR-20-2.05 ROUNDABOUT	DRILLING FIRM / OPERATOR: OTB / J. MINCHAK	DRILL RIG: OTB SIMCO TRUCK	STATION / OFFSET: 111+53, 8' LT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / P. LEITER	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20 CL RW
PID: 118318 BR ID: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 12/22/22	ELEVATION: 837.6 (MSL) EOB: 2.3 ft.
START: 7/21/23 END: 7/21/23	SAMPLING METHOD: CUTTINGS	ENERGY RATIO (%): 83.2	LAT / LONG: 41.258472 N, 82.302750 W

EXPLORATION ID **X-003-1-23**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 837.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 16 INCHES	836.3	1																	
CONCRETE - 6 INCHES	835.8																		
GRANULAR BASE - 6 INCHES	835.3	2 EOB																	

NOTES:
- Auger probe to determine pavement section near project limits. No samples attempted.

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; SOIL CUTTINGS

S&ME ODOT SULFATE (8.5X11) - SGE 01/2019 - OH DOT.GDT - 3/11/24 16:30 - R:\SERVICE LINES\CS-2557\COLUMBUS\GINTW\PROJECTS\22170250B.GPJ

PLATE 10

Corporate Office
6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Cleveland Office
9885 Rockside Road
Cleveland, OH 44125
Telephone (216) 573-0955
Fax Number: (216) 573-0963

Cincinnati Office
4480 Lake Forest Drive
Cincinnati, Ohio 45242
Telephone (513) 769-6998
Fax Number: (513) 769-7055

PROJECT	Oberlin, Ohio
JOB NO.	22-17-0250B
DATE TESTED	8/11/2023
TESTED BY	EM/KL

DETERMINING SULFATE CONTENT IN SOILS
COLORIMETRIC METHOD
ODOT SUPPLEMENT 1122

Sample ID	Depth	Date Sampled	State Plane Coordinates		Sample Number	Soaking Time (hr)	Dilution Ratio	Replicate Sample Readings			Average Reading	Sulfate Content (ppm)
			Northing	Easting				1	2	3		
B-001-0-23	1.5'-2.7'	7/21/23			S-1X	24	20	9	9	9	9.00	180
B-002-0-23	1.5'-2.6'	7/21/23			S-1X	24	20	10	10	10	10.00	200
B-003-0-23	1.5'-2.9'	7/21/23			S-1X	24	20	13	13	13	13.00	260
B-004-0-23	1.5'-3.1'	7/21/23			S-1X	24	40	72	71	71	71.33	2853
B-005-0-23	3.5'-4.6'	7/21/23			S-1X	24	20	25	25	25	25.00	500

Important Information About Your
Geotechnical Engineering Report

Variations in subsurface conditions can be a principal cause of construction delays, cost overruns and claims. The following information is provided to assist you in understanding and managing the risk of these variations.

Geotechnical Findings Are Professional Opinions

Geotechnical engineers cannot specify material properties as other design engineers do. Geotechnical material properties have a far broader range on a given site than any manufactured construction material, and some geotechnical material properties may change over time because of exposure to air and water, or human activity.

Site exploration identifies subsurface conditions at the time of exploration and only at the points where subsurface tests are performed or samples obtained. Geotechnical engineers review field and laboratory data and then apply their judgment to render professional opinions about site subsurface conditions. Their recommendations rely upon these professional opinions. Variations in the vertical and lateral extent of subsurface materials may be encountered during construction that significantly impact construction schedules, methods and material volumes. While higher levels of subsurface exploration can mitigate the risk of encountering unanticipated subsurface conditions, no level of subsurface exploration can eliminate this risk.

Scope of Geotechnical Services

Professional geotechnical engineering judgment is required to develop a geotechnical exploration scope to obtain information necessary to support design and construction. A number of unique project factors are considered in developing the scope of geotechnical services, such as the exploration objective; the location, type, size and weight of the proposed structure; proposed site grades and improvements; the construction schedule and sequence; and the site geology.

Geotechnical engineers apply their experience with construction methods, subsurface conditions and exploration methods to develop the exploration scope. The scope of each exploration is unique based on available project and site information. Incomplete project information or constraints on the scope of exploration increases the risk of variations in subsurface conditions not being identified and addressed in the geotechnical report.

Services Are Performed for Specific Projects

Because the scope of each geotechnical exploration is unique, each geotechnical report is unique. Subsurface conditions are explored and recommendations are made for a specific project.

Subsurface information and recommendations may not be adequate for other uses. Changes in a proposed structure location, foundation loads, grades, schedule, etc. may require additional geotechnical exploration, analyses, and consultation. The geotechnical engineer should be consulted to determine if additional services are required in response to changes in proposed construction, location, loads, grades, schedule, etc.

Geo-Environmental Issues

The equipment, techniques, and personnel used to perform a geo-environmental study differ significantly from those used for a geotechnical exploration. Indications of environmental contamination may be encountered incidental to performance of a geotechnical exploration but go unrecognized. Determination of the presence, type or extent of environmental contamination is beyond the scope of a geotechnical exploration.

Geotechnical Recommendations Are Not Final

Recommendations are developed based on the geotechnical engineer's understanding of the proposed construction and professional opinion of site subsurface conditions. Observations and tests must be performed during construction to confirm subsurface conditions exposed by construction excavations are consistent with those assumed in development of recommendations. It is advisable to retain the geotechnical engineer that performed the exploration and developed the geotechnical recommendations to conduct tests and observations during construction. This may reduce the risk that variations in subsurface conditions will not be addressed as recommended in the geotechnical report.

Appendix II – Subgrade Analysis

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

LOR-20-2.05 Roundabout
118318

PROJECT DESCRIPTION - Roundabout with 5 soil borings

S&ME, Inc.

Prepared By: Brian K. Sears, PE
Date prepared: Wednesday, August 7, 2024

Brian Sears
6190 Enterprise Court
Dublin, OH 43016

614-793-2226
bsears@smeinc.com

NO. OF BORINGS: 5

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	US 20 CL RW	105+03	17	RT	OTB Simco Truck	83	845.7	845.6	0.1 C
2	B-002-0-23	US 20 CL RW	107+55	38	LT	OTB Simco Truck	83	841.8	842.2	0.4 F
3	B-003-0-23	US 20 CL RW	111+07	21	LT	OTB Simco Truck	83	837.7	836.9	0.8 C
4	B-004-0-23	SR 511 CL RW	7+32	4	LT	OTB Simco Truck	83	841.2	839.7	1.5 C
5	B-005-0-23	SR 511 CL RW	13+36	8	RT	OTB Simco Truck	83	843.6	842.7	0.9 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

#	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	1	1.5	3.0	1.4	2.9	22		4.5	30	18	12	30	46	76	13	14	A-6a	9	180					14" Cement Stab.
	001-0	2	3.0	4.5	2.9	4.4	19		3	29	18	11	34	43	77	17	14	A-6a	8						
	23	3	4.5	6.0	4.4	5.9	19		3.5							17	14	A-6a	10						
		4	6.0	7.5	5.9	7.4	6	6								14	8	A-3a							
2	B	1	1.5	3.0	1.9	3.4	17		4.5	33	22	11	48	30	78	18	17	A-6a	8	200					14" Cement Stab.
	002-0	2	3.0	4.5	3.4	4.9	17		4	40	20	20	31	47	78	18	16	A-6b	12						
	23	3	4.5	6.0	4.9	6.4	17		3							20	16	A-6b	16						
		4	6.0	7.5	6.4	7.9	10	17	1							23	16	A-6b							
3	B	1	1.5	3.0	0.7	2.2	11		2.5	22	15	7	30	27	57	14	10	A-4a	4	260		N_{60} & Mc		12''	14" Cement Stab.
	003-0	2	3.0	4.5	2.2	3.7	15		2	25	16	9	41	33	74	15	11	A-4a	8						
	23	3	4.5	6.0	3.7	5.2	19		2							14	10	A-4a	8						
		4	6.0	7.5	5.2	6.7	33	11								7	8	A-3a							
4	B	1	2.0	3.5	0.5	2.0	25			20	16	4	43	19	62	11	11	A-4a	5	2853					14" Cement Stab.
	004-0	2	3.5	5.0	2.0	3.5	10		1.5	45	19	26	51	40	91	22	18	A-7-6	15						
	23	3	5.0	6.5	3.5	5.0	8		0.75	32	17	15				21	14	A-6a	10						
		4	6.5	8.0	5.0	6.5	7	7	2.5							17	14	A-6a							
5	B	1	2.0	3.5	1.1	2.6	29			NP	NP	NP	6	2	8	3	6	A-1-a	0	500					14" Cement Stab.
	005-0	2	3.5	5.0	2.6	4.1	8		1	31	20	11	43	33	76	22	15	A-6a	8						
	23	3	5.0	6.5	4.1	5.6	14		2.5	34	17	17				23	16	A-6b	11						
		4	6.5	8.0	5.6	7.1	18	8	4							19	16	A-6b							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

PID: 118318

County-Route-Section: LOR-20-2.05 Roundabout

No. of Borings: 5

Geotechnical Consultant: S&ME, Inc.

Prepared By: Brian K. Sears, PE

Date prepared: 8/7/2024

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	14''

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 3 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	16%	0.5 < HP ≤ 1	5%
$12 \leq N_{60} < 15$	0%	1 < HP ≤ 2	11%
$N_{60} \geq 20$	16%	HP > 2	21%
M+	5%		
Rock	0%		
Unsuitable Soil	0%		

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

% Proposed Subgrade Surface	
Unstable & Unsuitable	13%
Unstable	13%
Unsuitable (Soil & Rock)	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	16	10	2.64	31	18	13	36	32	68	16	13	9
Maximum	33	17	4.50	45	22	26	51	47	91	23	18	16
Minimum	6	6	0.75	20	15	4	6	2	8	3	6	0

Classification Counts by Sample

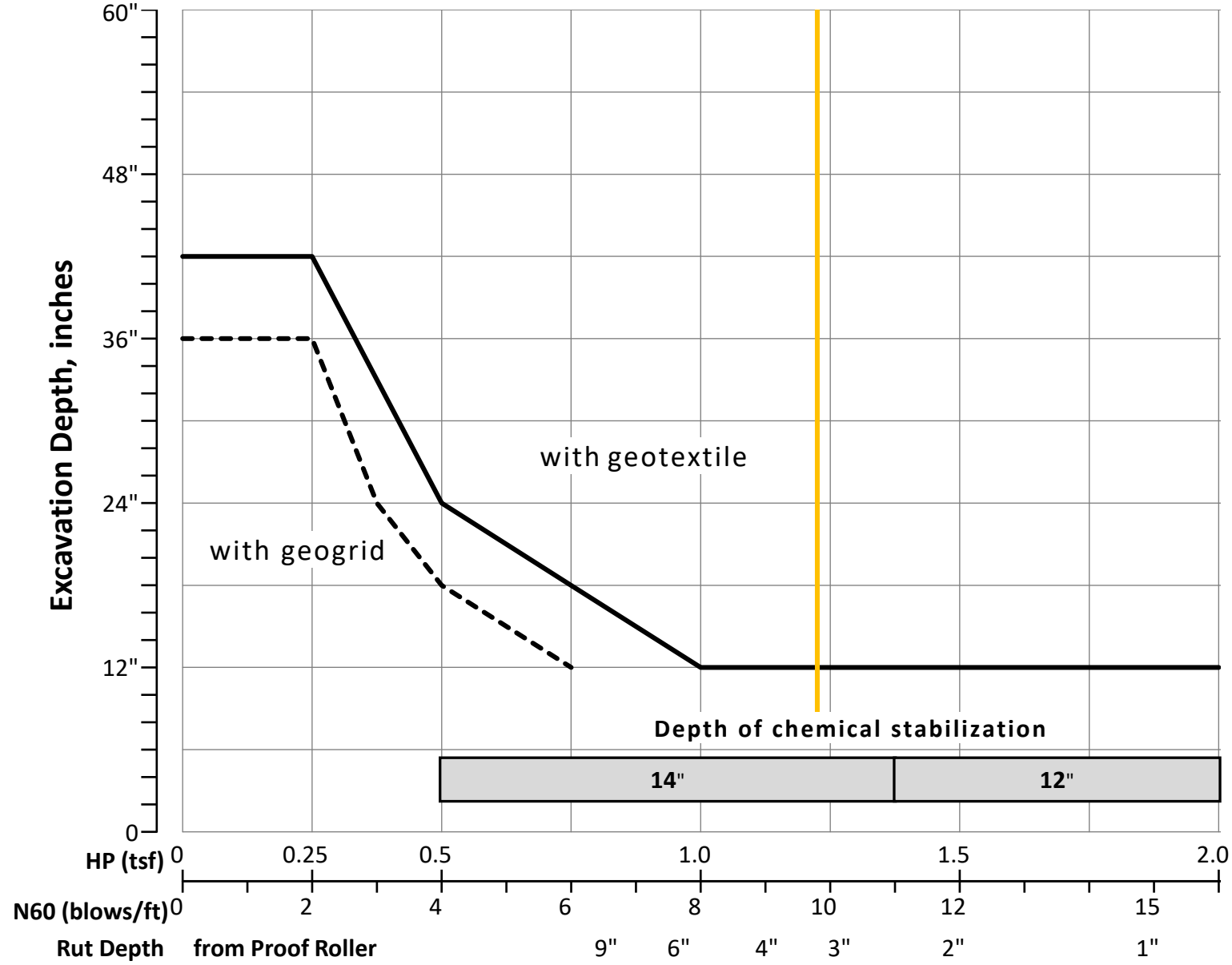
ODOT Class	UCF	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	1	0	0	0	0	0	0	2	4	0	0	7	5	0	1	0	0	20
Percent	0%	0%	5%	0%	0%	0%	0%	0%	0%	10%	20%	0%	0%	35%	25%	0%	5%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%	35%									65%								100%
Surface Class Count	0	0	1	0	0	0	0	0	0	0	3	0	0	3	0	0	1	0	0	8
Surface Class Percent	0%	0%	13%	0%	0%	0%	0%	0%	0%	0%	38%	0%	0%	38%	0%	0%	13%	0%	0%	100%

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
2.64		☐ HP
9.80		☐ N60L

Average HP

Average N_{60L}

PLATE 5

Appendix III – OGE Geotechnical Design Checklists

I. Geotechnical Design Checklists	
Project: LOR-20-2.05 Roundabout	**PDP Path:**
PID: 118318	**Review Stage: 3**

Checklist	Included in This Submission
II. Reconnaissance and Planning	✓
III. A. Centerline Cuts III. B. Embankments III. C. Subgrade	✓
IV. A. Foundations of Structures IV. B. Retaining Wall	
V. A. Landslide Remediation V. B. Rockfall Remediation V. C. Wetland or Peat Remediation V. D. Underground Mine Remediation V. E. Surface Mine Remediation V. F. Karst Remediation	
VI. A. Geotechnical Profile VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S: LOR-20-2.05 Roundabout	PID: 118318	Reviewer: BKS	Date: 8/7/2024

Reconnaissance		(Y/N/X)	Notes:
1	Based on Section 302.1 in the SGE, have the necessary plans been developed in the following areas prior to the commencement of the subsurface exploration reconnaissance:	X	Plans by others.
	Roadway plans		
	Structures plans		
	Geohazards plans		
2	Have the resources listed in Section 302.2.1 of the SGE been reviewed as part of the office reconnaissance?	Y	
3	Have all the features listed in Section 302.3 of the SGE been observed and evaluated during the field reconnaissance?	Y	
4	If notable features were discovered in the field reconnaissance, were the GPS coordinates of these features recorded?	X	

Planning - General		(Y/N/X)	Notes:
5	In planning the geotechnical exploration program for the project, have the specific geologic conditions, the proposed work, and historic subsurface exploration work been considered?	Y	
6	Has the ODOT Transportation Information Mapping System (TIMS) been accessed to find all available historic boring information and inventoried geohazards?	Y	Some historic information was found but could not be incorporated into the exploration or design.
7	Have the borings been located to develop the maximum subsurface information while using a minimum number of borings, utilizing historic geotechnical explorations to the fullest extent possible?	Y	
8	Have the topography, geologic origin of materials, surface manifestation of soil conditions, and any other special design considerations been utilized in determining the spacing and depth of borings?	Y	
9	Have the borings been located so as to provide adequate overhead clearance for the equipment, clearance of underground utilities, minimize damage to private property, and minimize disruption of traffic, without compromising the quality of the exploration?	Y	

II. Reconnaissance and Planning Checklist

Planning - General	(Y/N/X)	Notes:
10 Have the scaled boring plans, showing all project and historic borings, and a schedule of borings in tabular format, been submitted to the District Geotechnical Engineer?	Y	
The schedule of borings should present the following information for each boring:		
a. exploration identification number	Y	
b. location by station and offset	Y	
c. estimated amount of rock and soil, including the total for each for the entire program.	Y	
Planning – Exploration Number	(Y/N/X)	Notes:
11 Have the coordinates, stations and offsets of all explorations (borings, soundings, test pits, etc.) been identified?	Y	Project stationing, offset and elevations provided by M&H.
12 Has each exploration been assigned a unique identification number, in the following format X-ZZZ-W-YY, as per Section 303.2 of the SGE?	Y	
13 When referring to historic explorations that did not use the identification scheme in 12 above, have the historic explorations been assigned identification numbers according to Section 303.2 of the SGE?	X	

II. Reconnaissance and Planning Checklist

Planning – Boring Types		(Y/N/X)	Notes:
14	Based on Sections 303.3 to 303.7.6 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?	Y	
	Check all boring types utilized for this project:		
	Existing Subgrades (Type A)	✓	
	Roadway Borings (Type B)		
	Embankment Foundations (Type B1)		
	Cut Sections (Type B2)		
	Sidehill Cut Sections (Type B3)		
	Sidehill Cut-Fill Sections (Type B4)		
	Sidehill Fill Sections on Unstable Slopes (Type B5)		
	Geohazard Borings (Type C)		
	Lakes, Ponds, and Low-Lying Areas (Type C1)		
	Peat Deposits, Compressible Soils, and Low Strength Soils (Type C2)		
	Uncontrolled Fills, Waste Pits, and Reclaimed Surface Mines (Type C3)		
	Underground Mines (C4)		
	Landslides (Type C5)		
	Rock Slope (Type C6)		
	Karst (Type C7)		
	Proposed Underground Utilities (Type D)		
	Structure Borings (Type E)		
	Bridges (Type E1)		
	Culverts (Type E2 a,b,c)		
	Retaining Walls (Type E3 a and b)		
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

III.C. Subgrade Checklist

C-R-S: LOR-20-2.05 Roundabout	PID: 118318	Reviewer: BKS	Date: 8/7/2024

Use this Checklist in conjunction with the Subgrade design guidance in GDM Section 600
If you do not have any subgrade work on the project, you do not have to fill out this checklist.

Subgrade	(Y/N/X)	Notes:
1 Has the subsurface exploration adequately characterized the soil or rock according to GDM Section 600?	Y	
a. Has each sample been visually classified and inspected for the presence of gypsum? Has a moisture content been performed on each sample?	Y	
b. Has mechanical classification (Plastic Limit (PL), Liquid Limit (LL), and gradation testing) been done on at least two samples from each boring within six feet of the proposed subgrade?	Y	
c. Has the sulfate content of at least one sample from each boring within 3 feet of the proposed subgrade been determined, per Supplement 1122, Determining Sulfate Content in Soils?	Y	
d. Has the sulfate content of all samples that exhibit gypsum crystals been determined?	X	
e. Have A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b soils within the top 3 feet of the proposed subgrade been mechanically classified?	X	
2 If soils classified as A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b, or having a LL>65, are present at the proposed subgrade (geotechnical profile), do the plans specify that these materials need to be removed and replaced or chemically stabilized?	X	
a. If these materials are to be removed and replaced, have the station limits, depth, and lateral limits for the planned removal been provided?	X	
3 If there is any rock, shale, or coal present at the proposed subgrade (C&MS 204.05), do the plans specify the removal of the material?	X	
a. If removal of any rock, shale, or coal is required, have the station limits, depth, and lateral limits for the planned removal of the material at proposed subgrade been provided?	X	

III.C. Subgrade Checklist

Subgrade	(Y/N/X)	Notes:
4 In accordance with GDM Section 600, do the SPT (N_{60})/HP values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	Y	Remediation is required, at a minimum, on the east leg (B-003-0-23)
a. If removal and replacement is applicable, has the detail of subgrade removal been shown on the plans, including depth of removal, station limits, lateral extent, replacement material, and plan notes (Item 204 - Subgrade Compaction and Proof Rolling)?	X	
b. If chemical stabilization is applicable, has the detail of this treatment been shown on the plans, including depth, percentage of chemical, station limits, lateral extent, and plan notes?	Y	As requested by ODOT District 3, global chemical stabilization will be performed. Recommendations provided in report for depth of chemical stabilization.
Indicate type of chemcial stabilization specified:		
cement stabilization	✓	
lime stabilization		
5 If removal and replacement has been specified, do the plans include Plan Note G121 from L&D3?	X	
6 If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	X	
7 Has an appropriate quantity of Proof Rolling (C&MS 204.06) and has Plan Note G111 from L&D3 been included in the plans?	X	Test and/or proof rolling is recommended. Plans being prepared by others.
8 Has a design CBR value been provided?	Y	

VI.B. Geotechnical Reports

C-R-S: LOR-20-2.05 Roundabout	PID: 118318	Reviewer: BKS	Date: 8/7/2024

General		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	Y	
2	Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	Y	
3	Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	Y	
4	Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files meet this demand?	Y	
5	Does the report cover format follow ODOT's Brand and Identity Guidelines Report Standards found at http://www.dot.state.oh.us/brand/Pages/default.aspx ?	Y	
6	Have all geotechnical reports being submitted been titled correctly as prescribed in Section 706.1 of the SGE?	Y	
Report Body		(Y/N/X)	Notes:
7	Do all geotechnical reports being submitted contain the following:	Y	
a.	an Executive Summary as described in Section 706.2 of the SGE?	Y	
b.	an Introduction as described in Section 706.3 of the SGE?	Y	
c.	a section titled "Geology and Observations of the Project," as described in Section 706.4 of the SGE?	Y	
d.	a section titled "Exploration," as described in Section 706.5 of the SGE?	Y	
e.	a section titled "Findings," as described in Section 706.6 of the SGE?	Y	
f.	a section titled "Analyses and Recommendations," as described in Section 706.7 of the SGE?	Y	
Appendices		(Y/N/X)	Notes:
8	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 706.8 of the SGE?	Y	
9	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 706.8.1 of the SGE?	Y	

VI.B. Geotechnical Reports

Appendices		(Y/N/X)	Notes:
10	Do the Appendices include boring logs and color pictures of rock, if applicable, as described in Section 706.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 706.8.3 of the SGE?	X	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 706.8.4 of the SGE?	Y	