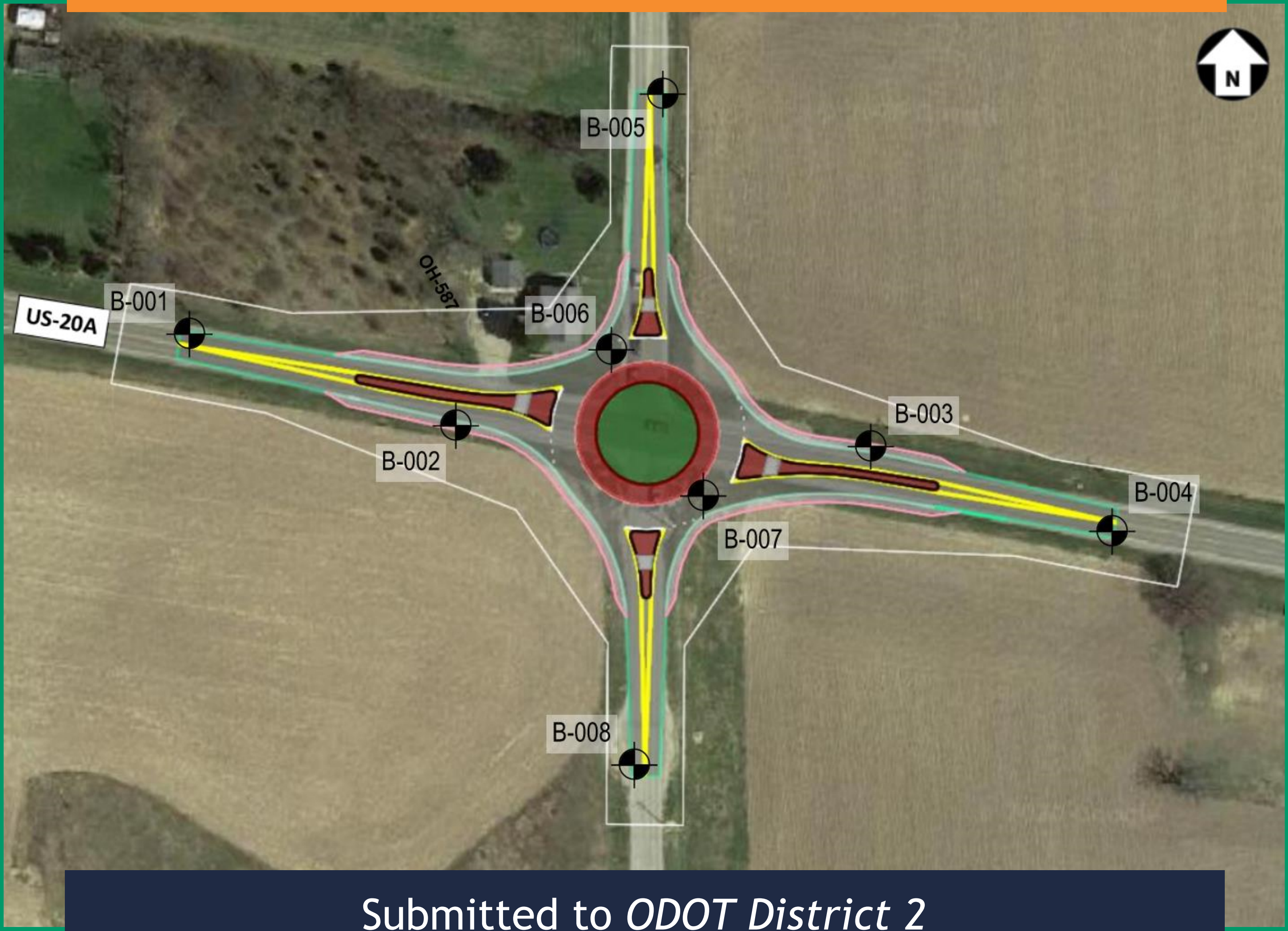
SOIL PROFILE

LUC-20A-9.75, PID 116068

Proposed Roundabout

Maumee, Lucas County, Ohio



Submitted to *ODOT District 2*
Date *October 2022*

Prepared by

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October 21, 2022

TTL Project No. 2260801

Ms. Jorey Summersett, P.E.
ODOT District 2
317 East Poe Road
Bowling Green, Ohio 43402

Final Report
Geotechnical Subsurface Exploration
LUC-20A-9.75, PID 116068
Proposed Roundabout
Maumee, Lucas County, Ohio

Dear Ms. Summersett:

Following is the report of our Geotechnical Subsurface Exploration performed by TTL Associates, Inc. (TTL) for the referenced project. This study was performed in accordance with TTL Proposal No. 2260801, dated May 20, 2022, and was authorized by you via email on May 23, 2022, with Encumbrance number 739143.

This report contains the results of our studies, our engineering interpretation of the results with respect to the project characteristics, and our recommendations for design and construction of pavements as well as potential modifications to subgrade soils. Subgrade evaluations were performed in accordance with ODOT GB-1 "Plan Subgrades." In accordance with ODOT protocol, this report is being submitted as "Draft" pending questions and comments by ODOT. However, the report is considered complete and comprehensive with respect to the requested scope of work. Following a "DRAFT" submittal of this report to ODOT District 2 on September 16, 2022, the report now incorporates clarifications regarding planned subgrades. As such, we are now submitting the report as "FINAL" in accordance with ODOT protocol.

Should you have any questions regarding this report or require additional information, please contact our office.

Sincerely,

TTL Associates, Inc.

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REGISTERED
PROFESSIONAL ENGINEER

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FINAL REPORT
LUC-20A-9.75, PID NO. 116068
PROPOSED ROUNDABOUT
MAUMEE, LUCAS COUNTY, OHIO

FOR

OHIO DEPARTMENT OF TRANSPORTATION DISTRICT 2
317 EAST POE ROAD
BOWLING GREEN, OHIO 43402

SUBMITTED

OCTOBER 21, 2022
TTL PROJECT NO. 2260801

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EXECUTIVE SUMMARY

This subsurface exploration report has been prepared for the construction of a roundabout along US Highway 20A (US 20A), at the intersection with Strayer Road, in Maumee, Lucas County, Ohio. This exploration included eight test borings for the evaluation of existing pavement sections and subgrade conditions in areas of proposed roadway construction. Subgrade evaluations were performed in accordance with ODOT GB-1 "Plan Subgrades" (January 2021). A summary of the conclusions and recommendations of this study are as follows:

1. Borings B-001, B-004, B-005, and B-008 were performed in existing pavements. The encountered surface materials consisted of asphalt ranging in thickness from approximately 4 to 11¼ inches, underlain by concrete (US 20A) or aggregate base materials (Strayer Road) varying in thickness from approximately 6 to 8 inches. The remaining borings were performed off-road, and encountered topsoil on the order of 4 to 5 inches in thickness.

2. Underlying the surface materials in Borings B-003 and B-005, cohesive existing **fill** materials were encountered to depths ranging from 2½ to 3½ feet below existing grades (approximate Elevs. 636 to 635). The cohesive existing fill material consisted of silty clay with trace sand, as well as clay with little silt and trace sand. Non-soil materials in the existing fill materials consisted of asphalt fragments, in trace quantities.

3. Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials can generally be characterized as predominantly medium stiff to stiff native cohesive soils. The native cohesive soils consisted of clay (ODOT A-7-6), silt and clay (ODOT A-6a), silty clay (ODOT A-6b), silt (ODOT A-4b), as well as sandy silt (ODOT A-4a).

4. Groundwater was not initially encountered during drilling nor observed upon completion of drilling operations in any of the borings. Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that the "normal" groundwater level can generally be expected below the exploration depths (greater than 8 to 10 feet below existing grades) of this investigation. Based on the predominantly clayey soil profile at the site, adequate control of seasonal groundwater seepage, perched water, and surface water run-off into shallow excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps.

5. Based on the GB-1 analysis, a design CBR value of 5 percent was determined for the project. It should be noted that the CBR determination by the GB-1 spreadsheet is based on the average Group Index of all the evaluated samples, which was 12. Group indices for the tested samples ranged from 8 to 16, which would correlate with a CBR value of 4 to 7 percent. Based on the average design value calculations from GB-1, it does not appear to be unconservative to use the GB-1 design CBR value of 5 percent for new pavement sections throughout the project area.

6. The GB-1 analysis indicates options for “planned” subgrade modification of either global chemical stabilization to a depth of 14 inches, or over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill. Based on the GB-1 analysis results, it is anticipated that global chemical stabilization to a depth of 14 inches will be more economical compared to over-excavation and replacement with new granular engineered fill. As indicated in Section 5.1, cement should be considered for chemical stabilization of the project.

This executive summary highlights our evaluations and recommendations and should only be utilized in conjunction with the accompanying report, including the detailed findings, analysis and recommendations, and qualifications presented herein.

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1.0 INTRODUCTION

This subsurface exploration report has been prepared for the construction of a roundabout along US Highway 20A (US 20A), at the intersection with Strayer Road, in Maumee, Lucas County, Ohio. The project site is shown on the Site Location Map (Plate 1.0).

This study was performed in accordance with TTL Proposal No. 2260801, dated May 20, 2022, and was authorized by Ms. Jorey Summersett of Ohio Department of Transportation (ODOT) District 2 via email on May 23, 2022, with Encumbrance number 739143.

1.1 Purpose and Scope of Exploration

The purpose of this exploration was to evaluate the subsurface conditions and laboratory data relative to the design and construction of pavements for the referenced project. To accomplish this, TTL performed 8 test borings, laboratory soil testing, a geotechnical engineering evaluation of the test results, and review of available geologic and soils data for the project area.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures utilized to evaluate the subsurface conditions at the site, and presents our findings from the field and laboratory testing. This report also presents our evaluations and conclusions in accordance with ODOT GB-1 "Plan Subgrades" (January 2021) and provides our design and construction recommendations for pavements.

This report includes:

- A description of the existing surface materials, subsurface soils, and groundwater conditions encountered in the borings.
- Design recommendations for pavements.
- Recommendations concerning soil and groundwater-related construction procedures such as subgrade preparation in accordance with ODOT GB-1 criteria, earthwork, pavement construction, and related field testing.

1.2 Proposed Construction

The project includes construction of a roundabout along US Highway 20A (US 20A), at the intersection with Strayer Road, in Maumee, Lucas County, Ohio.

Information regarding traffic loads was not provided at the time of this report. New pavements are anticipated to consist of flexible (asphalt) sections for roadways. The proposed subgrade is assumed to be 18 inches below the existing road profile.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 General Geology and Hydrogeology

Published geologic maps from the Ohio Department of Natural Resources (ODNR) indicate that the project site is located within the Maumee Lake Plains Physiographic Region of the Huron-Erie Lake Plains Section of Ohio. Within this region, the predominant geologic deposits consist of Pleistocene-age silt, clay, and wave-planed clayey till over Silurian-age and Devonian-age carbonate bedrock and shale. The glacial till, also referred to as moraine, was deposited by the advance and retreat of glacial ice. Due to the weight of the ice mass, the till deposits are moderately to highly over-consolidated, that is, the existing soil deposits have experienced a previous vertical stress significantly higher than the present effective vertical stress due to the remaining overlying soil strata in the profile. The till may contain cobbles and/or boulders left in the till soil matrix. Additionally, seams of granular soils may also be encountered within glacial tills.

Bedrock in the project area is broadly mapped on the "Geologic Map of Ohio" as Silurian-age Monroe limestone. Specific to the project site, the uppermost carbonate rock formation is mapped as Tymochtee dolomite. Bedrock is mapped at depths ranging from 70 to 75 feet below existing grades (approximate Elevs. 565 to 560).

2.1.1 Generalized Near-Surface Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey indicates that soils in the project area are mapped as Del Rey loam (sandy substratum) and Lenawee Silty Clay Loam.

The Del Rey loam (sandy substratum) soils consist of lacustrine deposits formed on till plains, and are considered somewhat poorly drained, with moderately low to moderately high permeability.

The Lenawee silty clay loam soils consist of clayey lacustrine deposits formed on lakebeds, and are considered poorly drained, with very low to low permeability.

2.2 Site Reconnaissance

TTL performed a site reconnaissance on June 16, 2022. Existing pavements along US Highway 20A (US 20A) and Strayer Road south of US 20A appeared to be in generally fair condition, while existing pavements along Strayer Road north of US 20A appeared to be in generally poor condition. US 20A had some horizontal cracking and Strayer Road north of US 20A had frequent alligator cracking. No meaningful pavement distresses were observed along Strayer Road south of US 20A.

Surrounding land usage included rural residential developments with a wooded area in the northwest corner, and agricultural fields at the remaining corners, with flat grades that where generally level with or slightly below the top of pavement.

3.0 EXPLORATION

3.1 Historic Borings

Based on our research, historic boring information was not available for the alignment of US 20A within the vicinity of either project location.

3.2 Project Exploration Program

This exploration included eight test borings, designated as Borings B-001-0-22 through B-008-0-22, performed by TTL on August 9, 2022. The borings have been identified in accordance with ODOT protocol, but the "-0-22" portion of the nomenclature is generally omitted for discussion in this report. The test borings were located in the field by TTL based on the proposed boring location plan provided with our proposal dated May 20, 2022. The approximate locations of the borings are shown on the Test Boring Location Plan (Plate 2.0).

Latitude, Longitude, and ground surface elevations at the as-drilled boring locations were surveyed by TTL. Stationing and offsets were not available at the time of preparing this report. The Latitude, Longitude, and ground surface elevations, are shown on the Logs of Test Borings.

In accordance with the ODOT Specifications for Geotechnical Explorations (SGE), Borings B-001, B-004, B-005, and B-008 were performed as ODOT Type A subgrade borings to a depth of at least 6 feet below top of subgrade, and were extended to a depth of 7½ or 9½ feet below top of existing pavement. The remaining four borings were performed as ODOT Type B roadway borings to a depth of 10 feet below existing grades.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation and pavement construction phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.3 Boring Methods

The test borings performed during this exploration were drilled with an ATV-mounted drilling rig. The borings were extended utilizing 3¼-inch inside diameter hollow stem augers. For the Type A subgrade borings, samples were generally obtained continuously using 18-inch split-spoon (SS) sample drives, and using a 24-inch split-spoon sample drive over the final sample drive. For the Type B roadway borings, samples were obtained at 2½-foot intervals using 18-inch sample drives. The samples were sealed in jars and transported to our laboratory for further classification and testing.

Split-spoon soil samples were obtained by the Standard Penetration Test Method (ASTM D 1586). The Standard Penetration Test (SPT) consists of driving a 2-inch outside diameter split-spoon sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three or four successive 6-inch increments, with the number of blows per increment being recorded. The number of blows per increment was recorded at each depth interval, and these data are presented under the "SPT" column on the Logs of Test Borings attached to this report. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance, or N_m-value, and is typically reported in blows per foot (bpf). The N_m-values were corrected to an equivalent rod energy ratio of 60 percent, N_{60}. The hammer/rod energy ratio for the CME 550X drilling rig was 78.1 percent, and was last calibrated on March 15, 2021. The N_{60}-values are presented on the attached Logs of Test Borings and Tabulation of Test Data sheets.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. In conjunction with published data and typical correlations, the N_{60}-values can be evaluated as a measure of soil compactness/consistency as well as shear strength.

Field and laboratory data were incorporated into gINT™ software for presentation purposes. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

3.4 Laboratory Testing Program

All samples were visually classified in accordance with the ODOT Soil Classification System. All recovered samples of the subsoils were also tested in our laboratory for moisture content (ASTM D 2216). Unconfined compressive strength estimates were obtained for the intact cohesive samples using a calibrated hand penetrometer.

Laboratory testing was performed in accordance with GB-1 "Plan Subgrades" criteria, including mechanical soil classification consisting of an Atterberg limits test (ASTM D 4318) [for cohesive samples] and a particle size analysis (ASTM D 6913 and D 7928) for at least two samples from each boring typically within 6 feet of the proposed subgrade.

Sulfate content determinations (ODOT Supplement 1122) were performed on at least one sample from each boring typically within 3 feet of the proposed subgrade.

Organic content determinations by the loss-on-ignition (LOI) method (ASTM D 2974) were performed on samples from Borings B-002 (SS-1 and SS-2), B-55 (SS-2), B-007 (SS-1), and B-008 (SS-1).

These test results are presented on the Logs of Test Borings.

4.0 FINDINGS

4.1 General Site Conditions

At the time of this investigation, the project vicinity consisted of rural residential developments with a wooded area in the northwest corner, and agricultural fields at the remaining corners, with flat grades that where generally level with or slightly below the top of pavement.

Borings B-001, B-004, B-005, and B-008 were performed in existing pavements. The encountered surface materials consisted of asphalt ranging in thickness from approximately 4 to 11¼ inches, underlain by concrete (US 20A) or aggregate base materials (Strayer Road) varying in thickness from approximately 6 to 8 inches.

The following tables contain a summary of the encountered pavement section, as well as the subgrade soils.

Table 4.1.A. Summary of Encountered Pavement Section and Subgrade Soils

Boring Number	Asphalt Thickness (inches)	Concrete Thickness (inches)	Aggregate Base Thickness (inches)	Subgrade Soil Type
B-001	11	6	N.E.	A-7-6
B-004	11¼	6¾	N.E.	A-6b
B-005	7	N.E.	6	Fill - A-7-6
B-008	4	N.E.	8	A-7-6

N.E. – Not Intact

The remaining borings were performed off-road, and encountered topsoil on the order of 4 to 5 inches in thickness.

Underlying the surface materials in Borings B-003 and B-005, cohesive existing **fill** materials were encountered to depths ranging from 2½ to 3½ feet below existing grades (approximate Elevs. 636 to 635). The cohesive existing fill material consisted of silty clay with trace sand, as well as clay with little silt and trace sand. Non-soil materials in the existing fill materials consisted of asphalt fragments, in trace quantities. SPT N_{60}-values generally varied from 7 to 8 blows per foot (bpf), indicating medium stiff consistency. Moisture contents varied from 23 to 24 percent.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials can generally be characterized as predominantly medium stiff to stiff native cohesive soils. The native soils were encountered underlying the surface materials in Borings B-001, B-002, B-004, and B-006 through B-008, as well as the fill materials in Borings B-003 and B-005. Each of the borings were terminated within the predominantly medium stiff to stiff native cohesive soils. The native cohesive soils consisted of clay (ODOT A-7-6) with varying amounts of silt, trace to little sand, and trace gravel, silt and clay (ODOT A-6a) with trace to little sand and trace or less gravel, silty clay (ODOT A-6b) with trace to little sand and trace or less gravel, silt (ODOT A-4b) with varying amounts of clay and trace sand, as well as sandy silt (ODOT A-4a) "and" clay.

SPT N_{60}-values generally varied from 7 to 14 blows per foot (bpf). Unconfined compressive strengths were on the order of 2,000 pounds per square foot (psf) or greater, with the relatively high strengths likely affected by desiccation. Moisture contents varied from 19 to 39 percent. Organic contents varied from 3.3 to 9.1 percent, indicating to slightly to moderately organic soil, where organics were encountered. Moderately organic soils were encountered in Borings B-002 (0.3 to 6 feet), B-005 (2½ to 4 feet), and B-008 (1 to 2½ feet).

Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

4.3 Groundwater Conditions

Groundwater was not initially encountered during drilling nor observed upon completion of drilling operations in any of the borings. It should be noted that the boreholes were drilled and backfilled within the same day, and stabilized water levels may not have occurred over this limited time period.

Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that the "normal" groundwater level can generally be expected below the exploration depths (greater than 8 to 10 feet below existing grades) of this investigation. However, groundwater elevations can fluctuate with seasonal and climatic influences. In particular, "perched" water may be encountered in aggregate base materials or existing fill materials that are underlain by relatively impermeable cohesive soils. Therefore, groundwater conditions may vary at different times of the year from those encountered during our exploration.

4.4 Remedial Measures

The GB-1 "Subgrade Analysis" worksheet (V14.5, 01/18/19) indicates options for "planned" subgrade modification of either global chemical stabilization to a depth of 14 inches, or over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill.

Based on the GB-1 analysis results, it is anticipated that global chemical stabilization to a depth of 14 inches will be more economical compared to over-excavation and replacement with new granular engineered fill. It is our understanding that recent projects in Northwest Ohio, which included similar cohesive soils to those at this project site, were planned to include global lime stabilization for subgrade modification. It was indicated that, for some of those projects, suitable strength could not be achieved with lime stabilization mix designs using a typical/economical lime percentage. As such, cement should be considered for chemical stabilization of the project.

If the current cement shortage precludes the use of cement for chemical stabilization, subgrade modification should consider over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill.

The placement of fill within existing ditches should be performed in accordance with Section Sections 5.3 and 5.6 of this report. For properly placed and compacted fill, considering the relatively shallow ditches at this site (on the order of 1 foot below existing grades), settlement is expected to be negligible.

The scope of this study did not include an environmental assessment of the surface or subsurface materials at this site.

5.0 ANALYSES AND RECOMMENDATIONS

The following analysis and recommendations are based on our understanding of the proposed construction and on the data obtained during our field exploration. If the project alignment or subgrade depth should change significantly, a review of these recommendations should be made by TTL.

5.1 GB-1 "Plan Subgrades" Evaluation

An evaluation of the subgrade soils was completed in general accordance with ODOT Geotechnical Bulletin GB-1 "Plan Subgrades" (January 2021). As part of this evaluation, the ODOT "Subgrade Analysis" worksheet (V14.5, 01/18/19) was completed and is attached to this report.

Final pavement grades are assumed to approximate existing grades. Based on the existing pavement cross-sections encountered in the borings, the proposed subgrade is presumed to be 18 inches below the existing top of pavement grades (represented as a cut of 1.5 feet in the ODOT "Subgrade Analysis" worksheet).

Based on GB-1, soils classified as ODOT A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, or rock have been designated as being problematic with respect to pavement subgrade support. None of these soil types were encountered at planned subgrade elevations in the borings performed for this exploration.

Based on GB-1 criteria, subgrade soils with moisture contents greater than 3 percent above optimum likely indicate the presence of unstable subgrade that may require some form of subgrade modification. For this site, approximately 88 percent of tested cohesive subgrade soil samples was greater than 3 percent above the optimum as determined using GB-1 criteria.

It should be noted that 27 of the 28 evaluated samples with moisture contents greater than 3 percent above optimum had moisture contents greater than or equal to 5 percent above optimum. Thus, where moisture contents were wet of optimum, they were more likely to be appreciably wet of optimum. These data indicate that scarification and aeration methods may not be feasible to achieve satisfactory proof rolling and stabilization of the predominantly cohesive subgrades.

The type and thickness of subgrade modification is determined by GB-1 criteria based on the average, low SPT N_{60}-value (N_{60L}) of the subgrade soils in a particular portion of the project area, hand penetrometer values, soil type, and moisture content. Based on these criteria, approximately 88 percent of the borings contained subgrade soils which indicated subgrade modification is likely to be required. Possible alternatives for those areas where modification of the subgrade soils is indicated could include the following, using GB-1 criteria based on the encountered conditions:

- undercut and replacement with granular engineered fill, or
- global chemical stabilization to a depth of 14 inches.

The GB-1 spreadsheet indicates lime or cement stabilization as an option of this project. It is our understanding that recent projects in Northwest Ohio, which included similar cohesive soils to those at this project site, were planned to include global lime stabilization for subgrade modification. It was indicated that, for some of those projects, suitable strength could not be achieved with lime stabilization mix designs using a typical/economical lime percentage.

As such, cement should be considered for chemical stabilization of the project. Based on GB-1 guidelines, 5 percent cement may be specified to estimate the quantity of cement required for the project. Based on the GB-1 prescribed method (using a dry density of 115 pounds per cubic foot), the quantity of cement for a depth of 14 inches would be 60.375 pounds per square yard. When performing chemical stabilization design, use the dry density of the soil on the project as determined in the field.

As prescribed by GB-1 criteria, chemical stabilization must extend 18 inches beyond the edge of the pavement surface (on both sides), and where appropriate, 18 inches beyond paved shoulders or paved medians, including under new curbs and gutters.

GB-1 indicates that, if it is determined that 30 percent or more of the subgrade area must be stabilized, consideration should be given to stabilizing the entire project (global chemical stabilization).

If it is planned to use the undercut and replacement option, a summary of the depths of undercut and replacement indicated by GB-1 analyses based on the borings are presented in the following tables. Shaded boring numbers indicate that they are historic borings, and subgrade conditions may have been modified as part of previous construction activities.

Table 5.1.A. GB-1 Subgrade Analysis Indicated Undercut Depths – US 20A			
Boring Number(s)	**GB-1 Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)**	**Recommended Subgrade Modification Extents**	**Approximate Project Segment Length (feet)**
B-001-0-22 and B-002-0-22	12	Start of Project to midway between B-002 and B-003	350
B-003-0-22	15	Midway between B-002 and B-003 to midway between B-003 and B-004	250
B-004-0-22	12	Midway between B-003 and B-004 to End of Project	100

Table 5.1.B. GB-1 Subgrade Analysis Indicated Undercut Depths – Strayer Road			
Boring Number(s)	**GB-1 Recommended Depth of Undercut and Replacement with Granular Engineered Fill (inches)**	**Recommended Subgrade Modification Extents**	**Approximate Project Segment Length (feet)**
B-005-0-22	12	End of Project to midway between B-005 and B-006	100
B-006-0-22	15	Midway between B-005 and B-006 to midway between B-006 and B-007	50
B-007-0-22	No treatment indicated by GB-1	Midway between B-006 and B-007 to midway between B-007 and B-008	150
B-008-0-22	12	Midway between B-007 and B-008 to Start of Project	100

Where undercut and replacement is utilized, all fill should consist of ODOT Item 304 Aggregate Base or Item 703.16C, Granular Material Type B or Type C. As prescribed by GB-1 criteria, excavate unstable subgrades to 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians, including under new curbs and gutters. Always drain the excavation to an underdrain, catch basin, or pipe. It is recommended that geotextile fabric (referenced in ODOT Item 204, and specified as ODOT Item 712.09, Type D) be utilized on the subgrade at the bottom of the undercut zone. Although not anticipated to be required based on the conditions encountered in the borings and the proposed sections and grades, if particularly unstable subgrades are encountered during construction, or undercuts exceed approximately 18 inches, a geogrid could be used to reduce the total undercut and replacement of the unsuitable soils by 6 inches. Do not use geotextile or geogrid in the areas of underdrains.

The total estimated length for the undercuts outlined in Tables 5.1.A and 5.1.B is 850 feet, which equates to approximately 0.15 mile. As such, for projects where the total length of required undercuts is equal to or greater than 0.1 mile, **it is anticipated that global chemical stabilization to a depth of 14 inches will be more economical compared to over-excavation and replacement with new granular engineered fill.** If the current cement shortage precludes the use of cement for chemical stabilization, subgrade modification should consider over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill.

It should be noted that GB-1 analyses are used as a pre-construction tool to plan subgrade modification alternatives. **Actual subgrade modification will depend on field observations of proof-rolling conditions at the time of construction.** Changes in soil moisture content could create more or less favorable subgrade conditions that may result in adjustments to subgrade modification or soil stabilization requirements at the time of construction.

As required by GB-1, sulfate content tests (ODOT Supplement 1122) were performed on a sample typically within the upper 3 feet of each boring. The sulfate content test results are summarized in the following table.

Table 5.1.C. Sulfate Content	
Boring Number	**Sulfate Content (mg/kg)**
B-001-0-22	270
B-002-0-22	280
B-003-0-22	270
B-004-0-22	270
B-005-0-22	270
B-006-0-22	270
B-007-0-22	270
B-008-0-22	270

GB-1 indicates that chemical stabilization cannot be utilized when sulfate contents for the majority of the samples exceed 3,000 parts per million (ppm), or individual soil samples exhibit sulfate contents of greater than 5,000 ppm. Based on the tested samples, sulfate content will not preclude the use of chemical stabilization for this project.

5.2 Flexible (Asphalt) Pavement Design

Based on the GB-1 analysis, a design CBR value of 5 percent was determined for the project. It should be noted that the CBR determination by the GB-1 spreadsheet is based on the **average** Group Index of all the evaluated samples, which was 12. Group indices for the tested samples ranged from 8 to 16, which would correlate with a CBR value of 4 to 7 percent. Based on the average design value calculations from GB-1, it does not appear to be unconservative to use the GB-1 design CBR value of 5 percent for new pavement sections throughout the project area.

Additionally, it was indicated that consideration was being given to cement stabilization and that ODOT requested a modified design CBR for the cement stabilized soils. Based on Section 203.4.1 of the Pavement Design Manual (PDM), the subgrade resilient modulus (proportional to the CBR) may be increased by 36 percent when using global chemical stabilization. The design CBR values determined by the GB-1 analysis and a modified design CBR per the increase described in the PDM are summarized in the following table.

Table 5.2 GB-1 CBR Results by Intersection	
Stabilization	**Design CBR (Percent)**
Undercut and replacement with granular engineered fill per Tables 5.1.A. and 5.1.B.	5 *(GB-1 Calculated)*
Global cement stabilization to a depth of 14 inches.	7 *(PDM Modified)*

It should also be noted that the design CBR value is based on subgrades compacted to at least 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor) or verified as stable through proof-rolling in accordance with Section 5.3 of this report.

All pavement design and paving operations should conform to ODOT specifications. The pavement and subgrade preparation procedures outlined in this report should result in a reasonably workable and satisfactory pavement. It should be recognized, however, that all pavements need repairs or overlays over time as a result of progressive yielding under repeated loading for a prolonged period.

It is recommended that proof rolling, placement of aggregate base, and placement of asphalt be performed within as short a time period as possible. Exposure of the aggregate base to rain, snow, or freezing conditions may lead to deterioration of the subgrade and/or base materials due to excessive moisture conditions and to difficulties in achieving the required compaction.

5.3 Site and Subgrade Preparation

Site and subgrade preparation activities should conform to ODOT Construction and Materials Specifications (CMS) Item 201 and 204 specifications. Site preparation activities should include the removal of vegetation, topsoil, root mats, pavements, and other deleterious non-soil materials from all proposed roadway areas. The actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative.

Upon completion of the clearing and undercutting activities, all areas that are to receive fill, or that have been excavated to proposed final subgrade elevation, should be inspected by a geotechnical engineer. Prior to performing undercutting or subgrade stabilization, pavement subgrades should be proof rolled in accordance with ODOT CMS 204.06 to confirm the depth and extent of subgrade modifications required, followed by subgrade modification in accordance with ODOT CMS 204.06.

The GB-1 analysis indicates options for "planned" subgrade modification of either global stabilization to a depth of 14 inches or over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill. Based on the GB-1 analysis, the majority of the project area is indicated to require subgrade treatment. As such, it is anticipated that global chemical stabilization to a depth of 14 inches will be more economical compared to over-excavation and replacement with new granular engineered fill. As indicated in Section 5.1, it is planned to use cement for chemical stabilization.

5.4 Groundwater Control

As previously mentioned, groundwater was not initially encountered during drilling nor observed upon completion of drilling operations in any of the borings. Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the "normal" groundwater level can generally be expected below the exploration depths (greater than 8 to 10 feet below existing grades) of this investigation. However, "perched" water may be encountered in aggregate base materials or existing fill materials that are underlain by relatively impermeable cohesive soils.

Based on the predominantly clayey soil profile at the site, adequate control of seasonal groundwater seepage, perched water, and surface water run-off into shallow excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps.

5.5 Excavations and Slopes

The sides of temporary excavations for construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed.

Based on the test borings, the soils likely to be encountered in shallow excavations may include:

- OSHA Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- OSHA Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than or equal to 3,000 psf), and
- OSHA Type C soils (existing fill materials).

Temporary excavations in Type A, B, and C soils should be constructed no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

5.6 Fill

Material for engineered fill or backfill required to achieve design grades should meet ODOT Item 203 “Embankment Fill” placement and compaction requirements. In general, suitable fills may consist of any non-organic soils having a maximum dry density as determined by the Standard Proctor (ASTM D 698) of 90 pounds per cubic foot (pcf) or greater. On-site soils may be used as engineered fill materials provided that they are free of organic matter, debris, excessive moisture, and rock or stone fragments larger than 3 inches in diameter. Depending on seasonal conditions, the on-site soils may be wet of optimum and may require scarification and aeration to achieve satisfactory compaction. If the construction schedule does not allow for scarification and aeration activities, it may be more practical or economical to utilize imported granular fill.

Fill should be placed in uniform layers not more than 8 inches thick (loose measure) and adequately keyed into stripped and scarified soils. All fill placed within pavement areas should be compacted to a dry density consistent with the requirements of ODOT Item 203, based on the maximum dry density as determined by ASTM D 698.

The on-site soils consist of cohesive soils. For the cohesive soils, a sheepsfoot roller should provide the most effective soil compaction. For granular fill or dense-graded aggregate pavement base materials, a vibratory smooth-drum roller would be required to provide effective compaction.

Scarified subgrade soils and all fill material should be within 3 percent of the optimum moisture content to facilitate compaction. Furthermore, fill material should not be frozen or placed on a frozen base. It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a qualified geotechnical testing firm.

6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of the pavement design and construction conditions has been based on the data obtained during our field exploration, as well as the criteria in ODOT Geotechnical Bulletin GB-1 "Plan Subgrades" (January 2021). The general subsurface conditions were based on interpretation of the subsurface data at specific boring locations. Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions at the time of construction are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should observe earthwork and pavement construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, TTL should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. TTL is not responsible for the conclusions, opinions, or recommendations of others based on this data.

PLATES

LEGEND

APPROXIMATE SITE LOCATION

N

APPROXIMATE SCALE – FEET

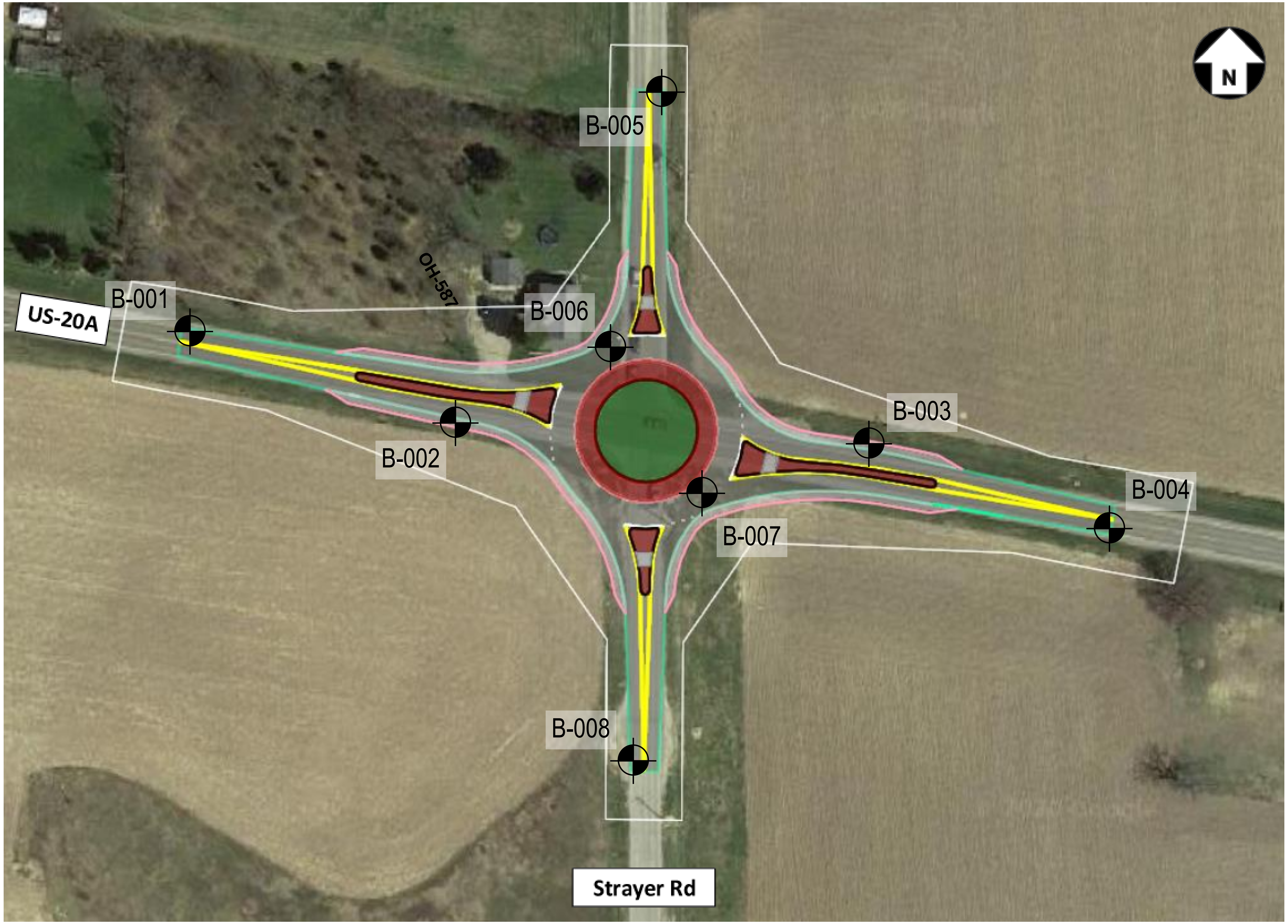
0 800 1,600

PLATE 1.0
SITE LOCATION MAP
LUC–20A–9.75, PID 116068
PROPOSED ROUNDABOUT
MAUMEE, LUCAS COUNTY, OHIO

PREPARED FOR
ODOT DISTRICT 2
BOWLING GREEN, OHIO

DRAWN	TRR/9–16–22	CHECKED	KCH/9–16–22
REVISED		APPROVED	
JOB NO.	2260801		
DRAWING NUMBER	**2260801–01G**		

TTL associates inc
Environmental, Geotechnical Engineering & Testing



Legend:

B-001 Approximate Boring Location

APPROXIMATE SCALE – FEET

0 85 170

Test Boring Location Map

LUC-20A-9.75, PID 116068
Proposed Roundabout
Maumee OH

PREPARED FOR

ODOT District 2

DRAWN IEH/05-20-2022	CHECKED
REVISED KCH/09-16-2022	APPROVED
JOB NO. 2260801	
DRAWING NUMBER Plate 2.0	

TTL associates inc
Environmental, Geotechnical Engineering & Testing

FIGURES

PROJECT: LUC-20A-09.75 TYPE: SUBGRADE PID: 116068 SFN: START: 8/9/22 END: 8/9/22	DRILLING FIRM / OPERATOR: TTL / JW SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: CME 550X ATV HAMMER: CME AUTOMATIC CALIBRATION DATE: 3/15/21 ENERGY RATIO (%): 78.1	STATION / OFFSET: ALIGNMENT: US 20A ELEVATION: 638.5 (NAVD88) EOB: 9.5 ft. LAT / LONG: 41.573525, -83.704899	EXPLORATION ID B-001-0-22 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 11 INCHES	637.6																		
CONCRETE - 6 INCHES	637.1																		
STIFF TO VERY STIFF, BROWN, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST		2 – 3.5	3 4 5	12	72	SS-1	3.00	4	3	3	24	66	41	22	19	23	A-7-6 (12)	270	
		3.5 – 5	4 4 5	12	78	SS-2	3.25	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
	632.5																		
VERY STIFF, BROWN, **SILT AND CLAY**, TRACE SAND, MOIST		6 – 7.5	5 7 8	20	67	SS-3	3.25	0	2	7	23	68	32	21	11	24	A-6a (8)	-	
@7.5': STIFF TO VERY STIFF	629.0	7.5 – 9.5	5 8 7 9	20	50	SS-4	1.25	-	-	-	-	-	-	-	-	24	A-6a (V)	-	
		EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 9/16/22 10:17 - S:\PROJECTS\2260801.GPJ

PROJECT: LUC-20A-09.75	DRILLING FIRM / OPERATOR: TTL / JW	DRILL RIG: CME 550X ATV	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20A
PID: 116068 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 638.1 (NAVD88) EOB: 10.0 ft.
START: 8/9/22 END: 8/9/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.1	LAT / LONG: 41.573314, -83.704191

EXPLORATION ID B-002-0-22

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.1	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
TOPSOIL - 4 INCHES	637.8																		
MEDIUM STIFF TO STIFF, DARK BROWN, **CLAY**, SOME SILT, LITTLE SAND, MODERATELY ORGANIC, MOIST ORGANIC CONTENT = 9.1%	635.6	1–2.5	4 5 4	12	83	SS-1	1.00	0	5	12	24	59	47	25	22	39	A-7-6 (14)	-	
STIFF TO VERY STIFF, DARK BROWN/BROWN, **CLAY**, "AND" SILT, TRACE SAND, MODERATELY ORGANIC, DAMP TO MOIST ORGANIC CONTENT = 6.1%	632.1	3.5–5	2 4 4	10	39	SS-2	2.75	0	0	5	36	59	42	24	18	24	A-7-6 (12)	270	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST	629.6	6–7.5	4 5 5	13	78	SS-3	2.25	-	-	-	-	-	-	-	-	26	A-6b (V)	-	
STIFF TO VERY STIFF, BROWN, **SILT AND CLAY**, TRACE SAND, MOIST	628.1	8.5–10 (EOB 10)	2 4 3	9	72	SS-4	2.00	0	2	6	24	68	36	22	14	28	A-6a (10)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: LUC-20A-09.75	DRILLING FIRM / OPERATOR: TTL / JW	DRILL RIG: CME 550X ATV	STATION / OFFSET:	EXPLORATION ID B-003-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20A	
PID: 116068 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 638.3 (NAVD88) EOB: 10.0 ft.	PAGE 1 OF 1
START: 8/9/22 END: 8/9/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.1	LAT / LONG: 41.573286, -83.703013	

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.3	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
TOPSOIL - 5 INCHES	637.9																		
MEDIUM STIFF TO STIFF, BLACK/BROWN, **SILTY CLAY**, TRACE ASPHALT FRAGMENTS, TRACE SAND, SLIGHTLY ORGANIC, MOIST FILL ORGANIC CONTENT = 3.3%		1 – 2.5	2 2 3	7	72	SS-1	2.00	8	3	4	22	63	40	22	18	23	A-6b (11)	280	
	634.8																		
MEDIUM STIFF TO STIFF, BROWN, **CLAY**, SOME SILT, TRACE SAND, MOIST		3.5 – 5	2 2 4	8	78	SS-2	1.75	0	2	7	23	68	43	24	19	28	A-7-6 (12)	-	
		6 – 7.5	3 2 3	7	72	SS-3	1.00	-	-	-	-	-	-	-	-	29	A-7-6 (V)	-	
	629.8																		
MEDIUM STIFF TO STIFF, BROWN, **SILT**, SOME CLAY, TRACE SAND, MOIST		8.5 – 10	3 3 3	8	78	SS-4	1.25	-	-	-	-	-	-	-	-	27	A-4b (V)	-	
	628.3	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: LUC-20A-09.75	DRILLING FIRM / OPERATOR: TTL / JW	DRILL RIG: CME 550X ATV	STATION / OFFSET:	EXPLORATION ID B-004-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: US 20A	
PID: 116068 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 639.1 (NAVD88) EOB: 9.5 ft.	PAGE 1 OF 1
START: 8/9/22 END: 8/9/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.1	LAT / LONG: 41.573112, -83.702322	

MATERIAL DESCRIPTION AND NOTES	ELEV. 639.1	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 - 11.25 INCHES	638.2																		
CONCRETE - 6.75 INCHES	637.6	1																	
STIFF TO VERY STIFF, BROWN, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	635.6	2 – 3	3 4 4	10	83	SS-1	2.75	2	2	6	23	67	40	23	17	24	A-6b (11)	-	
MEDIUM STIFF TO STIFF, BROWN, **SANDY SILT**, "AND" CLAY, MOIST	633.1	4 – 5	3 2 2	5	72	SS-2	1.50	0	2	6	40	52	30	21	9	25	A-4a (8)	270	
MEDIUM STIFF TO STIFF, BROWN, **SILT**, SOME CLAY, TRACE SAND, MOIST	631.6	6 – 7	3 3 3	8	72	SS-3	1.25	-	-	-	-	-	-	-	-	30	A-4b (V)	-	
STIFF TO VERY STIFF, BROWN, **SILT**, "AND" CLAY, TRACE SAND, MOIST	629.6	8 – 9, EOB	3 5 5 4	13	63	SS-4	2.00	0	2	5	52	41	28	22	6	27	A-4b (8)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: LUC-20A-09.75	DRILLING FIRM / OPERATOR: TTL / JW	DRILL RIG: CME 550X ATV	STATION / OFFSET:	EXPLORATION ID B-005-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: STRAYER ROAD	
PID: 116068 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 638.7 (NAVD88) EOB: 7.5 ft.	PAGE 1 OF 1
START: 8/9/22 END: 8/9/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.1	LAT / LONG: 41.573970, -83.703629	

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.7	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
ASPHALT - 7 INCHES	638.1																		
AGGREGATE BASE - 6 INCHES	637.6	1																	
MEDIUM STIFF TO STIFF, GRAY/BROWN, **CLAY**, LITTLE SILT, TRACE SAND, TRACE ASPHALT FRAGMENTS, MOIST FILL	636.2	2	3 3 3	8	33	SS-1	1.50	7	7	3	19	64	42	22	20	24	A-7-6 (12)	270	
STIFF TO VERY STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MODERATELY ORGANIC, MOIST ORGANIC CONTENT = 4.1%	634.7	3	3 4 7	14	83	SS-2	2.00	-	-	-	-	-	-	-	-	24	A-6b (V)	-	
STIFF, BROWN, **SILT AND CLAY**, TRACE SAND, MOIST	633.2	4, 5	3 3 4	9	78	SS-3	1.25	0	2	6	24	68	34	23	11	26	A-6a (8)	-	
STIFF, BROWN, **SILT**, SOME CLAY, TRACE SAND, MOIST	631.2	6, 7, EOB	4 4 5 7	12	67	SS-4	1.25	-	-	-	-	-	-	-	-	27	A-4b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: LUC-20A-09.75	DRILLING FIRM / OPERATOR: TTL / JW	DRILL RIG: CME 550X ATV	STATION / OFFSET:	EXPLORATION ID B-006-0-22
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT: STRAYER ROAD	
PID: 116068 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/15/21	ELEVATION: 639.7 (NAVD88) EOB: 10.0 ft.	PAGE 1 OF 1
START: 8/9/22 END: 8/9/22	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.1	LAT / LONG: 41.573481, -83.703757	

MATERIAL DESCRIPTION AND NOTES	ELEV. 639.7	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
TOPSOIL - 4 INCHES	639.4																		
MEDIUM STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST	637.2	1 – 2.5	2 2 3	7	83	SS-1	3.00	-	-	-	-	-	-	-	-	25	A-6b (V)	-	
MEDIUM STIFF TO STIFF, BROWN, **SILT AND CLAY**, TRACE SAND, MOIST	633.7	3.5 – 5	2 2 3	7	78	SS-2	1.25	0	3	6	23	68	34	22	12	27	A-6a (9)	270	
STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST		6 – 7.5	4 3 4	9	72	SS-3	1.25	0	2	6	24	68	40	23	17	29	A-6b (11)	-	
@8.5': MEDIUM STIFF TO STIFF	629.7	8.5 – 10 (EOB)	3 2 3	7	78	SS-4	1.50	-	-	-	-	-	-	-	-	28	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: LUC-20A-09.75 TYPE: ROADWAY PID: 116068 SFN: START: 8/9/22 END: 8/9/22	DRILLING FIRM / OPERATOR: TTL / JW SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: CME 550X ATV HAMMER: CME AUTOMATIC CALIBRATION DATE: 3/15/21 ENERGY RATIO (%): 78.1	STATION / OFFSET: ALIGNMENT: STRAYER ROAD ELEVATION: 638.8 (NAVD88) EOB: 10.0 ft. LAT / LONG: 41.573190, -83.703486

EXPLORATION ID B-007-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 638.8	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
TOPSOIL - 4 INCHES	638.5																		
STIFF TO VERY STIFF, GRAY/BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, SLIGHTLY ORGANIC, DAMP ORGANIC CONTENT = 3.4%	635.3	1–2.5	4 5 4	12	72	SS-1	3.75	3	5	6	20	66	39	24	15	21	A-6a (10)	270	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST		3.5–5	4 5 5	13	39	SS-2	4.25	0	2	8	22	68	40	22	18	19	A-6b (11)	-	
@6': STIFF TO VERY STIFF	630.3	6–7.5	5 7 6	17	72	SS-3	2.00	-	-	-	-	-	-	-	-	26	A-6b (V)	-	
MEDIUM STIFF TO STIFF, BROWN, **SILT**, SOME CLAY, TRACE SAND, MOIST	628.8	8.5–10	3 2 3	7	83	SS-4	1.00	-	-	-	-	-	-	-	-	32	A-4b (V)	-	
		EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

PROJECT: LUC-20A-09.75 TYPE: SUBGRADE PID: 116068 SFN: START: 8/9/22 END: 8/9/22	DRILLING FIRM / OPERATOR: TTL / JW SAMPLING FIRM / LOGGER: TTL / KKC DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: CME 550X ATV HAMMER: CME AUTOMATIC CALIBRATION DATE: 3/15/21 ENERGY RATIO (%): 78.1	STATION / OFFSET: ALIGNMENT: STRAYER ROAD ELEVATION: 639.4 (NAVD88) EOB: 7.5 ft. LAT / LONG: 41.572639, -83.703692	EXPLORATION ID B-008-0-22 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 639.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT - 4 INCHES	639.1																		
AGGREGATE BASE - 8 INCHES	638.4	1																	
STIFF TO VERY STIFF, DARK BROWN, **CLAY**, SOME SILT, TRACE SAND, MOIST @1.0' TO 2.5': ORGANIC CONTENT = 4.9%, MODERATELY ORGANIC		2	6 5 5	13	67	SS-1	4.00	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
@2.5': BROWN		3	3 5 5	13	83	SS-2	3.25	0	2	7	23	68	43	23	20	23	A-7-6 (13)	270	
@4': VERY STIFF		4 5	6 6 7	17	83	SS-3	2.25	0	2	6	24	68	44	22	22	28	A-7-6 (14)	-	
@5.5': STIFF TO VERY STIFF	631.9	6 7 EOB	4 5 4 4	12	100	SS-4	2.50	-	-	-	-	-	-	-	-	27	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

Core Log For B-001-0-22

Project : LUC-20A-9 75 PID 116068 - Proposed Roundabout

Project Location: Maumee, Lucas County, Ohio

TTL Project No. 2260801

Core Date: August 9, 2022

ASPHALT THICKNESS (in)	=	11.00
CONCRETE (in.)	=	6.00
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

Apparent delamination at approximately 6.5 inches below top of pavement. Only 3 inches of concrete was recovered.

TTL associates inc
Environmental, Geotechnical Engineering & Testing

Core Log For B-004-0-22

Project : LUC-20A-9 75 PID 116068 - Proposed Roundabout

Project Location: Maumee, Lucas County, Ohio

TTL Project No. 2260801

Core Date: August 9, 2022

ASPHALT THICKNESS (in)	=	11.25
CONCRETE (in)	=	6.75
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

Asphalt core was intact.

Core Log For B-005-0-22

Project : LUC-20A-9 75 PID 116068 - Proposed Roundabout

Project Location: Maumee, Lucas County, Ohio

TTL Project No. 2260801

Core Date: August 9, 2022

ASPHALT THICKNESS (in)	=	7.00
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

Asphalt core was intact.

Core Log For B-008-0-22

Project : LUC-20A-9 75 PID 116068 - Proposed Roundabout

Project Location: Maumee, Lucas County, Ohio

TTL Project No. 2260801

Core Date: August 9, 2022

ASPHALT THICKNESS (in)	=	4.00
CORE BARREL DIAMETER (in.)	=	4.00

VISUAL DESCRIPTION:

Asphalt core was intact.

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

- A-4A: Ohio DOT: A-4a, sandy silt
- A-4B: Ohio DOT: A-4b, silt
- A-6A: Ohio DOT: A-6a, silt and clay
- A-6B: Ohio DOT: A-6b, silty clay
- A-7-6: Ohio DOT: A-7-6, clay
- PAVEMENT OR BASE: Ohio DOT: Pavement or Aggregate base
- TOPSOIL: Ohio DOT: Sod and Topsoil

SAMPLER SYMBOLS

WELL CONSTRUCTION SYMBOLS

- Soil Cuttings Backfill mixed with Bentonite Pellets or Chips
- Asphalt or Concrete Pavement Patch

ABBREVIATIONS

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

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
▽ Water Level at Time Drilling, or as Shown
▼ Water Level at End of Drilling, or as Shown
▼ Water Level After 24 Hours, or as Shown

Notes:

1. Exploratory borings were performed during on August 9, 2022, utilizing 3¼-inch inside diameter hollow stem augers.

2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.

3. Latitude, Longitude, and ground surface elevations at the as-drilled boring locations were surveyed by TTL Associates, Inc.

Appendix A:
Engineering Calculations
(Including GB-1 Spreadsheets)

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

LUC-20A-9.75
166068
Proposed Roundabout
Maumee, Lucas County, Ohio

TTL Associates, Inc.

Prepared By: Katherine C. Hennicken, P.E.
Date prepared: Wednesday, September 14, 2022

Katherine C. Hennicken, P.E.
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Toledo, Ohio 43604
419-214-5026
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NO. OF BORINGS: 8

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-22	US 20A				CME 550x ATV	78	638.5	637.0	1.5 C
2	B-002-0-22	US 20A				CME 550x ATV	78	638.1	636.6	1.5 C
3	B-003-0-22	US 20A				CME 550x ATV	78	638.3	636.8	1.5 C
4	B-004-0-22	US 20A				CME 550x ATV	78	639.1	637.6	1.5 C
5	B-005-0-22	Strayer Road				CME 550x ATV	78	638.7	637.2	1.5 C
6	B-006-0-22	Strayer Road				CME 550x ATV	78	639.7	638.2	1.5 C
7	B-007-0-22	Strayer Road				CME 550x ATV	78	638.8	637.3	1.5 C
8	B-008-0-22	Strayer Road				CME 550x ATV	78	639.4	637.9	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	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	1.4	3.5	-0.1	2.0	12		3	41	22	19	24	66	90	23	19	A-7-6	12	270		N_{60} & M_c		12''	12''
	001-0	SS-2	3.5	6.0	2.0	4.5	12		3.25							23	18	A-7-6	16						204 Geotextile
	22	SS-3	6.0	7.5	4.5	6.0	20		3.25	32	21	11	23	68	91	24	16	A-6a	8						
		SS-4	7.5	9.5	6.0	8.0	20	12	1.25							24	14	A-6a							
2	B	SS-1	0.3	2.5	-1.2	1.0	12		1	47	25	22	24	59	83	39	22	A-7-6	14			HP & Mc		12''	12''
	002-0	SS-2	2.5	6.0	1.0	4.5	10		2.75	42	24	18	36	59	95	24	21	A-7-6	12	270					204 Geotextile
	22	SS-3	6.0	8.5	4.5	7.0	13		2.25							26	16	A-6b	16						
		SS-4	8.5	10.0	7.0	8.5	9	10	2	36	22	14	24	68	92	28	17	A-6a							
3	B	SS-1	0.4	3.5	-1.1	2.0	7		2	40	22	18	22	63	85	23	17	A-6b	11	280		N_{60} & M_c		15''	15''
	003-0	SS-2	3.5	5.5	2.0	4.0	8		1.75	43	24	19	23	68	91	28	21	A-7-6	12						204 Geotextile
	22	SS-3	5.5	8.5	4.0	7.0	7		1							29	18	A-7-6	16						
		SS-4	8.5	10.0	7.0	8.5	8	7	1.25							27	10	A-4b							
4	B	SS-1	1.5	3.5	0.0	2.0	10		2.75	40	23	17	23	67	90	24	18	A-6b	11			N_{60} & M_c		12''	12''
	004-0	SS-2	3.5	6.0	2.0	4.5	5		1.5	30	21	9	40	52	92	25	16	A-4a	8	270					204 Geotextile
	22	SS-3	6.0	7.5	4.5	6.0	8		1.25							30	10	A-4b	8						
		SS-4	7.5	9.5	6.0	8.0	13	5	2	28	22	6	52	41	93	27	17	A-4b							
5	B	SS-1	1.1	2.5	-0.4	1.0	8		1.5	42	22	20	19	64	83	24	19	A-7-6	12	270		HP & Mc		12''	12''
	005-0	SS-2	2.5	4.0	1.0	2.5	14		2							24	16	A-6b	16			N_{60} & M_c		12''	204 Geotextile
	22	SS-3	4.0	5.5	2.5	4.0	9		1.25	34	23	11	24	68	92	26	18	A-6a	8						
		SS-4	5.5	7.5	4.0	6.0	12	8	1.25							27	10	A-4b	8						
6	B	SS-1	0.3	2.5	-1.2	1.0	7		3							25	16	A-6b	16			N_{60} & M_c		15''	15''
	006-0	SS-2	2.5	6.0	1.0	4.5	7		1.25	34	22	12	23	68	91	27	17	A-6a	9	270					204 Geotextile
	22	SS-3	6.0	8.5	4.5	7.0	9		1.25	40	23	17	24	68	92	29	18	A-6b	11						
		SS-4	8.5	10.0	7.0	8.5	7	7	1.5							28	16	A-6b							
7	B	SS-1	0.3	3.5	-1.2	2.0	12		3.75	39	24	15	20	66	86	21	19	A-6a	10	270					NONE
	007-0	SS-2	3.5	6.0	2.0	4.5	13		4.25	40	22	18	22	68	90	19	17	A-6b	11						
	22	SS-3	6.0	8.5	4.5	7.0	17		2							26	16	A-6b	16						
		SS-4	8.5	10.0	7.0	8.5	7	12	1							32	10	A-4b							
8	B	SS-1	1.0	2.5	-0.5	1.0	13		4							24	18	A-7-6	16			N_{60} & M_c		12''	12''
	008-0	SS-2	2.5	4.0	1.0	2.5	13		3.25	43	23	20	23	68	91	23	20	A-7-6	13	270		N_{60} & M_c		12''	204 Geotextile
	22	SS-3	4.0	5.5	2.5	4.0	17		2.25	44	22	22	24	68	92	28	19	A-7-6	14						
		SS-4	5.5	7.5	4.0	6.0	12	12	2.5							27	18	A-7-6	16						

PID: 166068

County-Route-Section: LUC-20A-9.75
No. of Borings: 8

Geotechnical Consultant: TTL Associates, Inc.
Prepared By: Katherine C. Hennicken, P.E.
Date prepared: 9/14/2022

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
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	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	4%	HP ≤ 0.5	0%
$N_{60} < 12$	43%	0.5 < HP ≤ 1	7%
$12 \leq N_{60} < 15$	43%	1 < HP ≤ 2	46%
$N_{60} \geq 20$	7%	HP > 2	46%
M+	32%		
Rock	0%		
Unsuitable	16%		

Excavate and Replace at Surface	
Average	13"
Maximum	15"
Minimum	12"

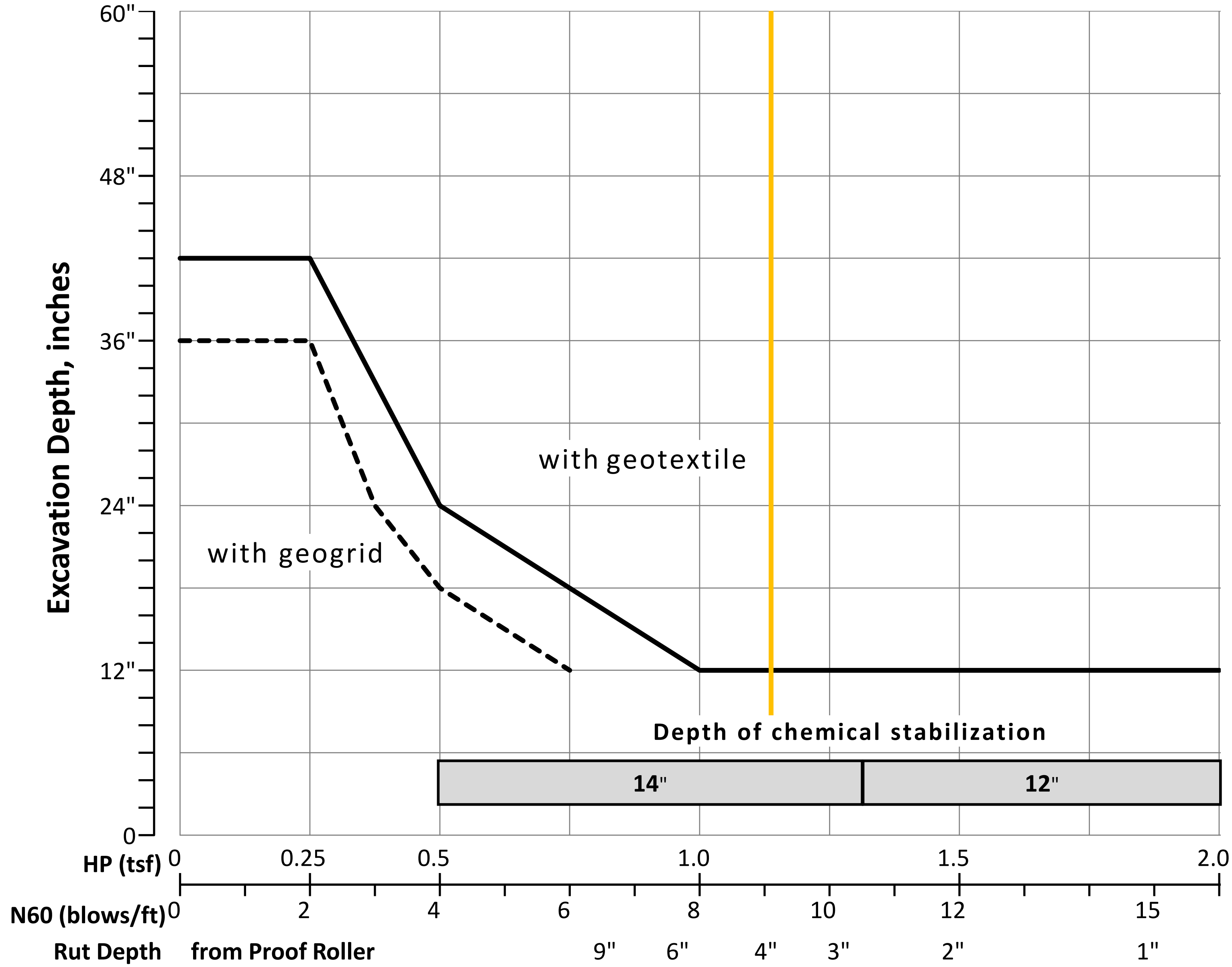
% Proposed Subgrade Surface	
Unstable & Unsuitable	50%
Unstable	50%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	11	9	2.13	39	23	16	26	64	90	26	17	12
Maximum	20	12	4.25	47	25	22	52	68	95	39	22	16
Minimum	5	5	1.00	28	21	6	19	41	83	19	10	8

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	1	5	0	6	9	0	11	0	0	32
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	16%	0%	19%	28%	0%	34%	0%	0%	100%
% Rock|Granular|Cohesive	0%	3%									97%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	1	0	0	3	5	0	9	0	0	18
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	17%	28%	0%	50%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
2.13		☐ HP
9.13		☐ N60L

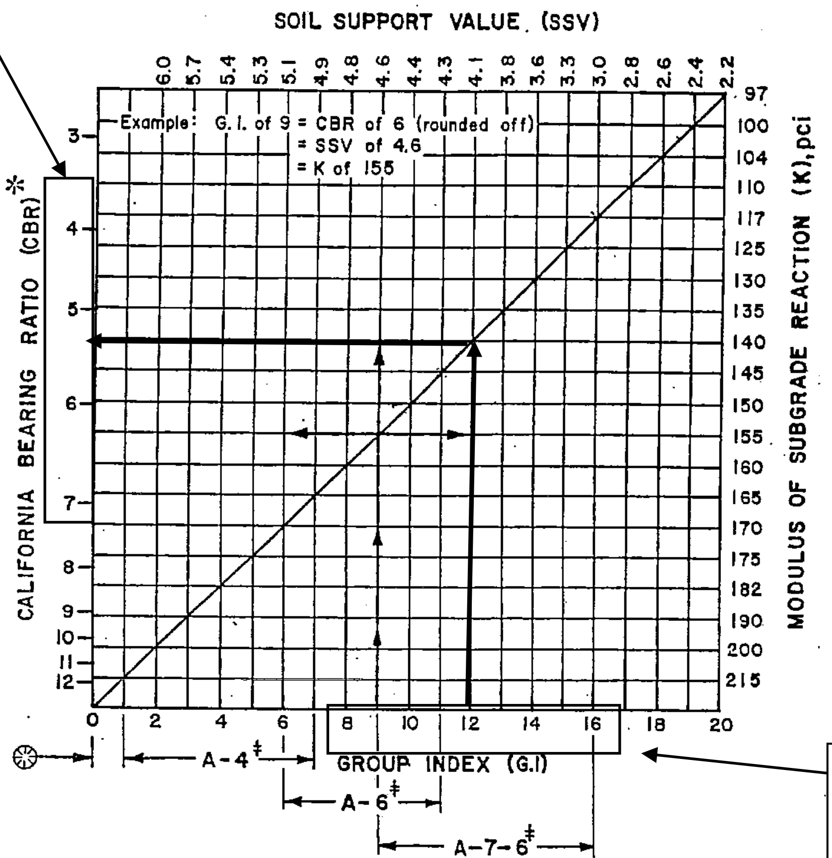
Average HP

Average N_{60L}

LUC-20A-9.75, PID 116068

Range of GI from 8 to 16 for pavement subgrade samples corresponds to CBR values ranging from 4 to 7 percent. Average GI of 12 corresponds with CBR of 5 percent.

Fig.1301-3
Feb.1978



Range of GI for pavement subgrade samples: 8 to 16 for A-4a, A-4b, A-6a, A-6b, and A-7-6 soils. Average GI was 12.

⊛ AASHTO Classes A-1, A-2 & A-3 lie below 0. SSV=6-10; K=200+.

‡ Usual range of AASHTO Classes.

✲ 5-1/2 Lb. hammer, 12" drop, 4 layers, 45 blows per layer, compacted at optimum moisture as determined by AASHTO T-99.

CORRELATION CHART FOR
SUBGRADE STRENGTHS

Based on the GB-1 analysis, a design CBR value of 5 percent was determined for the project. It should be noted that the CBR determination by the GB-1 spreadsheet is based on the **average** Group Index of all the evaluated samples, which was 12. Group indices for the tested samples ranged from 8 to 16, which would correlate with a CBR value of 4 to 7 percent. Based on the average design value calculations from GB-1, it does not appear to be unconservative to use the GB-1 design CBR value of 5 percent for new pavement sections throughout the project area.

for Geotechnical Explorations published by the Office of Geotechnical Engineering. Additional information on soil boring analysis, stabilization and treatment methods, and design procedures, can be found in Geotechnical Bulletin 1: Plan Subgrades (GB1) also published by the Office of Geotechnical Engineering.

General planning information about soil types and properties can be found in the Soil Survey books, which are published for every county in Ohio. Additional information on soils and proper construction practices can be found in the Construction Inspection Manual of Procedures published by the Office of Construction Administration. The ODOT soil classification method is presented in the Specifications for Geotechnical Exploration.

ODOT's pavement design procedure uses a statistical reliability factor (see Section 204) to account for variability in subgrade stiffness. Because of this, the average CBR is to be used for pavement design. Often designers want to use the lowest CBR value to add an additional safety factor but this results in unnecessarily thick, wasteful designs.

203.1 Subgrade Resilient Modulus

The subgrade resilient modulus is a measure of the ability of a soil to resist elastic deformation under repeated loading. Many soils are stress dependent. As the stress level increases, these soils will behave in a non-linear fashion. Fine-grained soils tend to be stress-softening, whereas granular soils tend to be stress-hardening. The laboratory resilient modulus test, AASHTO T 307 or NCHRP 1-28A, is designed to determine the strain due to a repeated load (deviator stress) which simulates the effect of loads passing over a section of pavement.

Based on limited research and several current publications, ODOT has adopted a standard relationship between modulus of resilience (M_r) and the California bearing ratio (CBR) shown below. The units for resilient modulus are pounds per square inch (psi).

$M_r = 1200 * CBR$

GB-1 Calculated CBR = 5 percent
$M_r = 1200 * CBR = 1200 * 5 = 6{,}000$ psi

203.2 California Bearing Ratio

The California bearing ratio (CBR) is a value representing a soil's resistance to shearing under a standard load, compared to the resistance of crushed stone subjected to the same load. The CBR is obtained by performing a laboratory penetration test of a soaked sample of soil. The load required to produce a penetration at each 0.1 inch depth in the soaked sample is divided by a standard, which has been developed for crushed stone, then multiplied by 100.

203.3 Group Index

In order to reduce the amount of laboratory testing required to characterize the soil stiffness, ODOT developed a relationship between CBR and group index. This relationship was developed in the 1950's by testing hundreds of soil samples. Group Index is a function of a soil's Atterberg Limits and gradation. The equation for group index is given in Appendix A of the Specifications for Geotechnical Exploration published by the Office of Geotechnical Engineering. Figure 203-1 contains a nomograph that solves the group index equation. Group index is then correlated to CBR using the chart in Figure 203-2.

203.4 Subgrade Stabilization

Undercutting or chemical stabilization of the subgrade should be determined in accordance with GB1. Questions regarding subgrade stabilization should be directed to the Office of Geotechnical Engineering.

203.4.1 Global Chemical Stabilization

When the entire subgrade is chemically stabilized without exception (global chemical stabilization), the subgrade resilient modulus of the native soil is increased. Research has shown that global chemical stabilization increases the stiffness of the subgrade and the effects are long lasting. The increased resilient modulus is calculated using the following formula:

$$M_{r\text{-}GCS} = 1.36 * M_r$$

M_r = 6,000 psi @ CBR = 5 percent
$M_{r\text{-}GCS}$ = 1.36 * M_r = 1.36 * 6,000 = 8,160 psi
CBR_{GCS} = $M_{r\text{-}GCS}$ / 1200 = 8,160 / 1,200 = 6.8 %
Design CBR_{GCS} = 7 percent

Where:

$M_{r\text{-}GCS}$ = Improved subgrade resilient modulus due to global chemical stabilization (psi)
M_r = Subgrade resilient modulus of the native soil (psi)

204 Reliability

AASHTO defines reliability as the probability that the load applications a pavement can withstand in reaching a specified minimum serviceability level is not exceeded by the number of load applications that are actually applied to the pavement. Reliability is a statistical tool used in pavement design that assumes a standard normal distribution exists for all pavement design parameters and allows the designer to account for deviation from the average equally for all parameters. Reliability can be thought of as a safety factor. Figure 201-1 lists the reliability factors to be used in pavement design for various classifications of highways.

204.1 Overall Standard Deviation

The overall standard deviation (variance) is a measure of the spread of the probability distribution for ESALs vs. Serviceability, considering all the parameters used to design a pavement. Figure 201-1 lists the overall standard deviation to be used in pavement design.

205 Subsurface Pavement Drainage

Subsurface pavement drainage is required on all projects greater than 0.5 miles (0.8 km) long that consist of constructing new pavement on subgrade or rubblizing the existing pavement. Subsurface drainage may be installed on any type of project and any length, if needed.

Lack of adequate pavement drainage is a primary cause of distress in many pavements. Excess moisture in the base and subgrade reduces the amount of stress the subgrade can tolerate without permanent strain. Strain in the subgrade transfers stress into the upper pavement layers resulting in deformation and ultimately distress. Trapped moisture in flexible pavement systems leads to stripping, raveling, debonding, and rutting. Excess moisture in rigid pavement systems leads to pumping, faulting, cracking, and joint failure.

205.1 Types of Drainage Systems

There are three means of draining the pavement subsurface - pipe underdrains, prefabricated edge underdrains, and aggregate drains. Pipe underdrains are the primary method to provide drainage and are generally used with paved shoulders and curbed sections. Occasionally, when an existing pavement is being overlaid, prefabricated edge underdrains are installed to provide drainage. Aggregate drains are generally used with aggregate shoulders, bituminous surface treated shoulders, and for spot improvements. In the past, another type of subsurface drainage, free draining base (FDB), was used but is no longer approved for use on ODOT projects and the specifications have been rescinded.

Figures 205-1 to 205-10 provide details on the placement of subsurface drainage systems. Additional examples are found in the Sample Plan Sheets.

Appendix B:
Geotechnical Engineering Design Checklists

I. Geotechnical Design Checklists

Project: LUC-20A-9.75	**PDP Path:**
PID: 116068	**Review Stage:**

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. Soil Profile	
VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S: LUC-20A-9.75	PID: 116068	Reviewer: KCH	Date: 10/21/2022

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:	Y	
	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	
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.	X	Plans to be prepared by others.

Planning – Exploration Number		(Y/N/X)	Notes:
11	Have the coordinates, stations and offsets of all explorations (borings, probes, test pits, etc.) been identified?	Y	Stations and offsets not provided
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	No historic records available

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)		
	Rockfall (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,b,c)		
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

III.C. Subgrade Checklist

C-R-S: LUC-20A-9.75	PID: 116068	Reviewer: KCH	Date: 7/8/2021

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 Geotechnical Bulletin 1: Plan Subgrades (GB1)?	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 (soil 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?		
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 GB1, do the SPT (N_{60})/HP values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	Y	
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	Plans to be prepared by others
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?	X	Plans to be prepared by others
	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	Plans to be prepared by others
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	Plans to be prepared by others
8	Has a design CBR value been provided?	Y	

VI.B. Geotechnical Reports

C-R-S: LUC-20A-9.75	PID: 116068	Reviewer: KCH	Date: 10/21/2022

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	This report is being submitted as "Final."
4	Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files may be used for this.	X	
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 705.1 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 705.2 of the SGE?	Y	
b.	an Introduction as described in Section 705.3 of the SGE?	Y	
c.	a section titled "Geology and Observations of the Project," as described in Section 705.4 of the SGE?	Y	
d.	a section titled "Exploration," as described in Section 705.5 of the SGE?	Y	
e.	a section titled "Findings," as described in Section 705.6 of the SGE?	Y	
f.	a section titled "Analyses and Recommendations," as described in Section 705.7 of the SGE?	Y	
Appendices		(Y/N/X)	Notes:
8	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 705.8 of the SGE?	Y	
9	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 705.8.1 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 705.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 705.8.3 of the SGE?	X	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	Y	