STRUCTURE FOUNDATION EXPLORATION

Proposed Culvert Replacement

WOO 65-23.39, PID 107711

SR 65 over Grassy Creek

Rossford, Wood County, Ohio

Submitted to Tetra Tech, Inc.
Date April *2025*

Prepared by

TTL associates inc
Environmental, Geotechnical Engineering & Testing

OHIO DEPARTMENT OF TRANSPORTATION

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April 2, 2025

TTL Project No. 2130501

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Tetra Tech, Inc.
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Final Report
Structure Foundation Exploration
Proposed Culvert Replacement
WOO-65-23.39, PID 107711
SR 65 over Grassy Creek
Rossford, Wood County, Ohio

Dear Mr. Charville:

Following is the final report of our structure foundation exploration performed by TTL Associates, Inc. (TTL) for the referenced site. This study was performed in accordance with TTL Proposal No. 2130501R, dated August 22, 2021, and was authorized with a Tetra Tech, Inc. Subconsultant agreement signed by you on September 22, 2021, for which you referenced Tetra Tech Project No. 200-12914-21002, Task 003.A.

A "draft" version of this report was provided on May 26, 2022. This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, as well as our design and construction recommendations for the replacement culvert and associated pavements. We were notified in March 2025 that no changes to the report were requested after review of the draft submittal. Therefore, this submittal is considered final.

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

Sincerely,

TTL Associates, Inc.

STATE OF OHIO
CURTIS E. ROUPE
Reg # 59857
REGISTERED PROFESSIONAL ENGINEER

Imad El Hajjar, EI
Geotechnical Project Manager

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FINAL REPORT
STRUCTURE FOUNDATION EXPLORATION
PROPOSED CULVERT REPLACEMENT
WOO-65-23.39, PID 107711
SR 65 OVER GRASSY CREEK
ROSSFORD, WOOD COUNTY, OHIO

FOR

TETRA TECH
420 MADISON AVENUE, SUITE 1001
TOLEDO, OHIO 43604

SUBMITTED

APRIL 2, 2025
TTL PROJECT NO. 2130501

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EXECUTIVE SUMMARY

This structure foundation exploration report has been prepared for the proposed replacement of the culvert along State Route 65 (SR 65), in Rossford, Wood County, Ohio, designated as WOO-65-23.39, PID No. 107711. This exploration included two test borings. A summary of the conclusions and recommendations of this study are as follows:

1. The pavement section encountered in Borings B-005 consisted of 8.5 inches of asphalt and underlain by approximately 13 inches of concrete. The surface materials encountered in Borings B-006 consisted of approximately 9 inches of asphalt. A distinct layer of aggregate base was not encountered in both borings.

2. The subsoils encountered underlying the topsoil can be generally described as a stratum of native cohesive soils underlain by a stratum of native granular soils, which were underlain by three additional strata of cohesive soils exhibiting varying strength and moisture characteristics. The soils at the site were underlain by bedrock.

   Stratum I consisted of predominantly medium stiff to stiff cohesive soils encountered underlying the topsoil to depths of 20 feet and 26 feet (Elevs. 572± and 563±) in Borings B-005 and B-006, respectively. The Stratum I cohesive soils consisted of silt and clay (ODOT A-6a) with varying portions of sand and gravel, as well as sandy silt (ODOT A-4a) with trace clay and gravel.

   Stratum II consisted of possible cobble and/or boulder granular zone encountered underlying Stratum I in Boring B-005 to approximately 29 feet (Elev. 563±). The Stratum II granular soils consisted of gravel and stone fragments (ODOT A-2-6) with sand, silt, and clay.

   Stratum III consisted of consisted of hard cohesive soils encountered underlying Stratum I in Boring B-006 to approximately 32 feet (Elev. 557±). The Stratum III cohesive soils consisted of silt and clay (ODOT A-6a) with sand and little gravel, as well as clay (ODOT A-7-6) with some silt and trace sand.

   Stratum IV consisted of consisted of predominantly **very soft to soft** cohesive soils encountered underlying Stratum III in Boring B-005 and Stratum II in Boring B-006. Stratum IV soils extended to depths on the order of 42 feet and 38½ feet in Borings B-005 and B-006, respectively (Elev. 550±). The Stratum IV cohesive soils consisted of silt and clay (ODOT A-6a) with little sand and trace gravel, as well as clay (ODOT A-7-6) with some silt and trace sand.

   Stratum V consisted of predominantly stiff cohesive soils encountered underlying Stratum IV to a depth of 44 feet in Boring B-006 (Elev. 545±). The Stratum IV cohesive soils consisted of silty clay (ODOT A-6b) with little to some sand, trace to some gravel, as well as silt and clay (ODOT A-6a) with little sand and varying amounts of gravel.

Dolomite bedrock was encountered underlying the soils at the site at depths of approximately 47 feet and 47½ feet (Elevs. 545± and 542±) in Borings B-005 and B-006, respectively. Approximately 3 feet of weathered rock was penetrable by augers in both borings prior to encountering refusal on intact rock. Upon encountering auger refusal in Borings B-001 and B-002, the rock was cored for a total length of 5 feet. The cored bedrock consisted of slightly weathered dolomite.

3. Based on the soil characteristics and moisture conditions encountered in the borings, it is our opinion that "normal" groundwater levels at depths of approximately 22 to 26 feet below grades (Elevs. 567± to 566±), which roughly correspond with creek bottom grades.

4. The bridge abutments will bear on piles driven to bedrock. For piles end-bearing on bedrock, the ODOT Bridge Design Manual (BDM) indicates that piles should be specified as H-piles. We understand that the bridge will be designed using LRFD specifications. The factored resistance for piles driven to refusal on bedrock is typically governed by structural resistance. The total factored load for any single pile shall not exceed the maximum factored structural resistance (R_{Rmax}, or P_r). Maximum factored structural resistance for the three typical pile sizes prescribed by ODOT are as follows:

Table 1.0.B. Maximum Factored Structural Resistance

Pile Size	R_{Rmax} or Pr (kips)
HP 10x42	310
HP 12x53	380
HP 14x73	530

5. Based on the GB-1 analysis, a design CBR value of 8 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 5. Group indices for the tested samples ranged from 0 to 10, which would correlate with a CBR value of 4 to 12 percent. Cohesive subgrade soils classified as ODOT A-6a were present within 6 feet of the subgrade elevation in both borings. The average group index for these samples was 8. Based on the average design value calculations from GB-1, it appears to be un-conservative to use the GB-1 design CBR value of 8 percent for new pavement sections throughout the project area due to the influence from the granular fill material encountered in Boring B-006. A CBR of 7 percent is more representative of the on-site native cohesive soils and should be utilized for the pavement design.

6. The GB-1 analysis indicates that subgrade modification is not anticipated.

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 structure foundation exploration report has been prepared for the proposed replacement of the culvert along State Route 65 (SR 65) over Grassy Creek in Rossford, Wood County, Ohio, designated as WOO-65-23.39 PID No. 107711. The project is located between Eagle Point Road and Rossway Avenue, as shown on the attached Site Location Map (Plate 1.0).

This study was performed in accordance with TTL Proposal No. 2130501R, dated August 22, 2021, and was authorized with a Tetra Tech, Inc. Subconsultant agreement signed by Mr. David Charville, PE on September 22, 2021. The subconsultant agreement referenced Tetra Tech Project No. 200-12914-21002, Task 003.A.

1.1 Purpose and Scope of Exploration

The purpose of this exploration was to evaluate the subsurface conditions relative to installation and support of a culvert and associated pavement reconstruction at the referenced location. To accomplish this, TTL performed two test borings, one pavement core, field and laboratory soil testing, a geotechnical engineering evaluation of the test results, as well as 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 design and construction recommendations for culvert support, our evaluations and conclusions with respect to pavement subgrade conditions in accordance with ODOT GB-1 “Plan Subgrades” (January 15, 2021), as well as our design and construction recommendations for pavements.

This report includes:

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

Appendix B includes pertinent ODOT Geotechnical Engineering Design Checklists that apply to the scope of this report.

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

1.2 Proposed Construction

It is our understanding that the existing bridge/culvert will be replaced with a new single span concrete I-Beam bridge on integral abutments. Consideration was being given to use of a three-sided culvert supported on reinforced concrete pedestal walls. However, due to the relatively high bearing pressures and encountered marginal strength soils, it is now planned to replace the existing culvert with a bridge.

It is anticipated that the proposed bridge will be approximately 45 feet wide and 84 feet long supported on driven piles extending to bear on bedrock. It is also anticipated that HP 10x42, HP 12x53, or HP 14x73 piles are planned to be utilized. The bottoms of the abutments are planned at approximate Elev. 581 for both abutments. It is anticipated that there will be 2 feet of stickup into the abutments.

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. Within this region, the geologic deposits consist of Pleistocene-age, silt, clay, and wave-planed clayey glacial till.

The lacustrine soils are generally characterized as mostly soft to medium stiff clays, often with a desiccated stiffer layer within the upper portion of the profile. The lacustrine deposits generally do not exhibit significant overconsolidation, although the desiccation effects induce some apparent overconsolidation within the near-surface soils. In addition to the clayey lake bottom deposits, alluvial deposits may be encountered overlying the till.

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. These granular seams may or may not be water bearing. In the Maumee Lake Plains Physiographic Region, the surface of the glacial till has generally experienced some reworking from wave action of the historic lake.

Bedrock in the project area is broadly mapped on the “Geologic Map of Ohio” as upper and lower Silurian-age dolomite locally interbedded with shale of the Tymochtee and Greenfield undivided dolomite formations. Top of bedrock was encountered at depth of 47 feet and 47½ feet below existing grades (Elevs. 545± and 542±) in Borings B-005 and B-006, respectively.

Review of the ODNR “Ohio Karst Areas” map indicated that the site is not in an area of probable karst. A Review of the Ohio Department of Natural Resources (ODNR) Map of Mines indicated no historic mining activity in the vicinity of the site area.

The USDA Soil Conservation Service (SCS) “Soil Survey of Sandusky County, Ohio” indicates that the near-surface soils in the project area are mapped as Sloan silty clay loam (SpA) or St. Clair silty clay loam (SuE2) . The SpA soils are comprised of loamy silty and clayey alluvium deposited in flood plains and are considered very poorly drained with a very low permeability. The SuE2 soils are comprised of wave planed basal till and are considered moderately well drained with low to moderately high permeability.

2.2 Site Reconnaissance

TTL performed site reconnaissance on October 19, 2021. The site is located in a predominantly urban area with a residential development to the southwest, a children's academy to the southeast and small businesses to the north around State Route 65 (SR 65). The areas around the creek were generally wooded.

In the immediate area of the culvert, the pavement along SR 65 was observed to generally be in good condition. Significant distresses were not observed. The sidewalk and chain-link fence over the culvert on the eastern side were observed to have minor erosion of the supporting soils.

The western half of the existing culvert appeared to be made of corrugated metal sheets bolted together bearing on a concrete wall and was semi-circular in cross-sectional shape. The eastern half of the existing culvert appeared to be made of concrete arch sections was semi-circular in cross-sectional shape. The culvert dimensions were approximately 16 feet tall from the top most part of the culvert to ditch bottom, approximately 30 feet wide at the bottom, and is approximately 70 feet in length. The concrete portion of the culvert appeared to have numerous cracks. Numerous pipes areared to discharge at the western side of the culvert and a few on the eastern side.

Grades along SR 65 were slightly lower in the area of the culvert than surrounding road grades. The creek bottom was approximately 22 to 26 feet below the road surface with relatively steep slopes.

An above ground storm sewer pipe was observed along the western side of SR 65 with overhead utility lines observed along the eastern side.

At the time of this reconnaissance, water levels in the creek were approximately 4 to 6 feet deep.

3.0 EXPLORATION

3.1 Historic Borings

Review of ODOT records indicated that no historic test borings have been drilled within the project area.

3.2 Project Exploration Program

Two test borings, designated as Borings B-005-0-21 and B-006-0-21 were drilled by TTL on October 16 and 27, 2021. Pavement cores were also obtained at the boring locations These borings and pavement cores are fully designated as Borings B-005-0-21 and B-006-0-21 in accordance with ODOT protocol, but the -0-21 portion of the nomenclature is generally omitted in the discussions within this report. Borings B-005 and B-006 were located in the northbound and southbound lanes of SR 65, respectively, drilled near the inlet and outlet sides of the culvert, respectively. The existing site features and approximate locations of the borings are presented on the Test Boring Location Plan (Plate 2.0).

Stationing and offsets at the boring locations were provided by Tetra Tech, Inc. Latitude, Longitude, and ground surface elevations were surveyed by TTL via a hand-held GPS device. The accuracy from the handheld GPS device was generally found to be approximately 2 to 6 inches horizontal, and approximately 4 to 12 inches vertical. These data are presented on the logs of test borings as well as in the following table.

Table 3.2 General Boring Location Information

Boring Number	Centerline SR 65 Station (feet)	Offset (feet)	Ground Surface Elevation (feet)	Latitude (Degrees)	Longitude (Degrees)
B-001-0-21	Sta. 1234+79	35 Left	592.1	41.605682	-83.562348
B-002-0-21	Sta. 1235+53	51 Left	589.1	41.605881	-83.562340

The two culvert borings (B-005 and B-006) were planned as Type E2a box culvert with a diameter/span of greater than 10 feet and sampled to 6 feet as a ODOT type A Borings per geotechnical investigative procedures outlined in Ohio Department of Transportation (ODOT) “Specifications for Geotechnical Explorations” (SGE).

Borings B-005 and B-006 were terminated after encountering auger refusal at a depth of 50 and 47½ feet below existing grade, respectively, then coring 5 feet of rock.

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, excavation, and foundation 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 a CME 75 truck-mounted drilling rig utilizing 3¼-inch inside diameter hollow-stem augers. During auger advancement, split-spoon drive samples were generally taken continuously to 6 feet, at 2½-foot intervals to a depth of 30 feet and at 5-foot intervals thereafter. The samples were sealed in jars and transported to our laboratory for further classification and testing.

Two (2) pavement cores obtained in Borings B-005 and B-006 using a 4-inch diameter single-wall, diamond-tipped core barrel. After pavement coring was completed, a determination was made of the underlying aggregate base thickness. The recovered cores were photographed and retained by TTL.

Split-spoon (SS) 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 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 calibrated hammer/rod energy ratio for the CME 75 truck-mounted drill rig utilized in this project was 66.0 percent, based on calibration on March 15, 2021. The N_{60}-values are presented on the attached Logs of Test Borings.

Two Shelby tube sample, designated ST on the Log of Test Boring, were obtained from Borings B-005 (31 to 33 feet) and B-006 (8 to 10 feet). The Shelby tube samples were obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into undisturbed soil, in accordance with ASTM D 1587. The Shelby tube was then extracted from the subsoils, and the ends were capped and sealed. The sample was transported to our laboratory where it was extruded, classified, and tested.

Core samples of the bedrock were obtained from Borings B-005 and B-006, using an NQ2 diamond-bit core barrel and coring techniques in general accordance with ASTM D 2113. In each boring, one core run of five feet was completed immediately following auger refusal. Recovery of the core is expressed as the percentage ratio of the recovered rock length to the total length of the core run. The Rock Quality Designation (RQD) is the percentage ratio of the summed length of rock pieces 4 inches long and greater to the total length of the run. The rock core samples are designated as “NQ2” on the Logs of Test Borings. The recovered rock cores were visually classified using the ODOT Rock Classification System. The rock cores were also documented in a photographic core log, which is attached to this report.

Soil and rock 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 and rock.

3.4 Laboratory Testing Program

All samples were visually or manually classified in accordance with the ODOT Soil Classification System. All samples of the subsoils were also tested in our laboratory for moisture content (ASTM D 2216). Dry density determinations and unconfined compressive strength tests by the constant rate of strain method (ASTM D 2166) were performed on the recovered Shelby tube samples. Unconfined compressive strength estimates were obtained for the remaining intact cohesive samples using a calibrated hand penetrometer. Atterberg limits tests (ASTM D 4318) and particle size analyses (ASTM D 6913 & D 7928) were performed on selected samples to determine soil classification and index properties. These test results are presented on the Logs of Test Borings, Grain Size Distribution sheets, and Unconfined Compression Test sheet.

Compressive strength tests (ASTM D 7012, Method C) were performed for selected rock core specimens. The results of these tests are presented on the Logs of Test Borings and Compressive Strength of Rock sheets attached to this report.

4.0 FINDINGS

4.1 General Site Conditions

The site is located along SR 65 in the City of Rossford, between Eagle Point Road and Rossway Avenue. In the project area, grades along SR 64 were on the order of Elevs. 589 to 592. The creek bottom was observed to be of 22 to 26 feet below the top of pavement, corresponding to approximate Elev. 567 to 566.

The surface materials encountered in Borings B-005 consisted of approximately 8.5 inches of asphalt and underlain by approximately 13 inches of concrete. The surface materials encountered in Borings B-006 consisted of approximately 9 inches of asphalt. A distinct layer of aggregate base was not encountered in both borings. A layer a layer of granular fill material consisting of crushed stone with sand, some silt and trace clay were encountered underlying the surface asphalt and extending to 5 feet below existing grades was encountered in Boring B-006. This fill layer could be associated with the backfill of the exiting bridge/Culvert structure or a historic utility backfill.

As stated previously, granular **fill** materials were encountered underlying the pavement materials in Boring B-006 to a depth of approximately 5 feet below existing grades. The granular fill materials consisted of predominantly concrete fragments (ODOT A-2-4) mixed with sand and silt. Within the granular fill materials an SPT N_{60}-values of 40 and 20 blows per foot (bpf) were recorded, indicating medium dense to dense compactness. A localized layer of very loose (SPT N_{60}-value of 3 bpf) coarse and fine sand (ODOT A-3a) was encountered from 5 to 6 feet. Moisture content ranged from 7 to 16 percent.

Cohesive **fill** materials were encountered underlying the pavement materials in Boring B-005 to a depth of approximately 4 feet below existing grades. The cohesive fill materials consisted of predominantly stiff to hard silt and clay (ODOT A-6a) mixed with varying portions of sand, crushed stone and slag. Within the cohesive fill materials an SPT N_{60}-values of 14 and 12 bpf were recorded. Unconfined compressive strengths generally ranged from 3,500 to 9,000 pounds per square foot (psf) (the highest obtainable strength using a hand penetrometer). Moisture contents were on the order of 10 and 7 percent. A localized 8½ inch thick layer of slag fragments was encountered starting at 2 feet. Moisture contents were on the order of 16 percent.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the pavement materials can be generally described as predominantly lacustrine deposits characterized by multiple predominantly cohesive strata with varying strength and moisture conditions underlain by cohesive glacial till overlying bedrock. However, zones of granular soils were encountered within the soil profile in both borings.

Stratum I consisted of predominantly medium stiff to stiff cohesive soils encountered underlying the surface materials to depths of 20 feet and 26 feet (Elevs. 572± and 563±) in Borings B-005 and B-006, respectively. The Stratum I cohesive soils consisted of silt and clay (ODOT A-6a) with varying portions of sand and gravel, as well as sandy silt (ODOT A-4a) with trace clay and gravel. SPT N_{60}-values generally varied from 3 to 19 bpf. Unconfined compressive strengths generally ranged from 2,000 to 4,000 psf. Moisture contents ranged from 9 to 32 percent.

Seams of **very loose** to **loose** granular soils was encountered within Stratum I soils in Borings B-005 from 8½ and 13 feet and in Boring B-006 from 24½ and 26 feet. These soils consisted of coarse and fine sand (A-3a) with varying amounts of silt, clay and gravel. SPT N_{60}-values ranged from 4 to 7 bpf and moisture content ranged from 16 and 23 percent.

Stratum II consisted of possible cobble and/or boulder granular zone encountered underlying Stratum I in Boring B-005 to approximately 29 feet (Elev. 563±). The Stratum II granular soils consisted of gravel and stone fragments (ODOT A-2-6) with sand, silt, and clay. SPT N_{60}-values of 6 and 33 bpf and spoon refusal (SSR, 50 or more blows for 6 inches or less penetration) were determined for three samples obtained in this zone. Moisture contents ranged from 17 to 33 percent.

Stratum III consisted of consisted of hard cohesive soils encountered underlying Stratum I in Boring B-006 to approximately 32 feet (Elev. 557±). The Stratum III cohesive soils consisted of silt and clay (ODOT A-6a) with sand and little gravel, as well as clay (ODOT A-7-6) with some silt and trace sand. SPT N_{60}-values of 4 to 29 bpf were determined for two recovered samples from this stratum with unconfined compressive strength greater than 9,000 psf. Moisture contents ranged from 14 to 39 percent.

Stratum IV consisted of consisted of predominantly **very soft to soft** cohesive soils encountered underlying Stratum III in Boring B-005 and Stratum II in Boring B-006. Stratum IV soils extended to depths on the order of 42 feet and 38½ feet in Borings B-005 and B-006, respectively (Elev. 550±). The Stratum IV cohesive soils consisted of silt and clay (ODOT A-6a) with little sand and trace gravel, as well as clay (ODOT A-7-6) with some silt and trace sand. SPT N_{60}-values generally ranged from 2 to 8 bpf. Unconfined compressive strengths typically ranged from 500 to 1,000 psf. Moisture contents varied from 17 to 27 percent.

A zone of dense granular soils was encountered underlying the **very soft to soft** cohesive soils in Boring B-005 to a depth of 47 feet (Elev. 545±). These soils consisted of coarse and fine sand (ODOT A-3a) with little dolomite fragments, clay and silt. An SPT N_{60}-value of 47 and a moisture content of 7 percent were determined for one recovered sample from this zone.

Stratum V consisted of predominantly stiff cohesive soils encountered underlying Stratum IV to a depth of 44 feet in Boring B-006 (Elev. 545±). The Stratum IV cohesive soils consisted of silty clay (ODOT A-6b) with little to some sand, trace to some gravel, as well as silt and clay (ODOT A-6a) with little sand and varying amounts of gravel. An SPT N_{60}-value of 7, an unconfined compressive strengths of 3,000 psf and a moisture content of 16 percent were determined for one recovered Stratum V sample.

Dolomite bedrock was encountered underlying the soils at the site at depths of approximately 47 feet and 47½ feet (Elevs. 545± and 542±) in Borings B-005 and B-006, respectively. Approximately 3 feet of weathered rock was penetrable by augers in both borings prior to encountering refusal on intact rock. In each boring, the bedrock was cored for a total length of 5 feet, starting from the depth in the bedrock profile where auger refusal was encountered. The cored bedrock consisted of slightly weathered dolomite. The rock core data obtained from the borings are summarized as follows:

Table 4.3 Summary of Rock Core Data

Boring Number	Rock Core Number	Depth (feet)	Approximate Elevation (feet)	Recovery (%)	RQD (%)	Compressive Strength Specimen Depth (feet)	Compressive Strength (psi)
B-005	RC-1	50 to 55	542 to 537	97	92	51.6 to 52.0	18,180
B-006	RC-1	47.3 to 52.3	542 to 537	100	88	48.5 to 48.9	20,430

Based on RQD values ranging from 88 to 92 percent for upper portion of the cored rock, the apparent rock mass quality (within the zones of exploration) can generally be characterized as good to very good. Based on unconfined compressive strengths of 18,180 pounds per square inch (psi) and 20,430 psi for tested samples from Borings B-005 and B-006, respectively, the rock can be generally characterized as very strong.

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

4.3 Groundwater Conditions

During our site reconnaissance on October 19 reconnaissance, water levels in the creek were approximately 4 to 6 feet deep. The creek bottom was approximately 26 feet below the road surface in the vicinity of Boring B-005 and 22 in the vicinity of Boring B-006. Hence, based on our field observation water was observed at approximately 18 to 20 feet below the road surface (Elev. 572± to 571±).

Groundwater was initially encountered during drilling at a depth of 11 feet (Elev. 581±) in Boring B-005 and at a depth of 19 feet (Elev. 570±) in Boring B-006. Water was noted upon completion of drilling and rock coring operations at a depth of 12 feet (Elevs. 580± and 577±) in Borings B-001 and Boring B-002, respectively. It should be noted that the boreholes were drilled and sealed within the same day, and stabilized water levels may not have occurred over this limited time period.

Apart from streamflow influences in the creek, it is our opinion that the “normal” groundwater level can generally be expected at depths corresponding to the bottom of the creek, on the order of 22 to 26 feet (Elevs. 567± to 566±). It should be noted that groundwater elevations can also fluctuate with seasonal and climatic influences, as well as streamflow conditions in the creek. Additionally, “perched” groundwater may be encountered within the zones of granular soils or existing granular fill materials underlain by relatively impermeable native cohesive soils. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this exploration.

4.4 Remedial Measures

Cobbles or boulders were encountered between 20 and 29 feet (Elevs. 572± to 563±) within Boring B-005. It should be noted that the existence of cobbles or boulders within the glacial till subsoils is not unusual for this region. Similarly, Tera Tech, Inc. reported significant amounts of surface rock and concrete slabs upon completing a site visit. These conditions, if encountered, could hamper pile-driving operations and possibly damage some piles. If some piles are observed to meet refusal at depths markedly less than those indicated by the borings, boulder obstruction or pre-mature “fetching” may be indicated. If these conditions are indicated, a pile load test should be performed to evaluate the capacity of the pile. Alternately, for a modest-sized project such as this, one or more replacement piles could be driven, probably at less expense than the cost of a load test.

The GB-1 “Subgrade Analysis” worksheet (V14.5, 01/18/19) indicates that over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill are not anticipated.

5.0 ANALYSES AND RECOMMENDATIONS

The following analysis and recommendations are based on our understanding of the proposed construction and upon the data obtained during our field exploration. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by TTL.

5.1 Pile Foundations

For the culvert replacement WOO-65-23.39, it is planned to use a single span concrete I-Beam bridge on integral abutments. As mentioned previously, piles extending to bedrock are recommended for the replacement structure due to the marginal strength soils and relatively shallow bedrock that was encountered in the borings at depths on the order of 47 feet below pavement grades. The bottoms of the abutments are planned at approximate Elev. 581 for both abutments. It is anticipated that there will be 2 feet of stickup into the abutments.

For piles end-bearing on bedrock, the ODOT Bridge Design Manual (BDM) indicates that piles should be specified as H-piles. We understand that the bridge will be designed using LRFD specifications. The factored resistance for piles driven to refusal on bedrock is typically governed by structural resistance. The total factored load for any single pile shall not exceed the maximum factored structural resistance (R_{Rmax}, or P_r). Maximum factored structural resistance for the three typical pile sizes prescribed by ODOT are as follows:

Table 5.1.A Maximum Factored Structural Resistance

Pile Size	R_{Rmax} or Pr (kips)
HP 10x42	310
HP 12x53	380
HP 14x73	530

These R_{Rmax} or Pr values assume:

- an axially loaded pile with negligible moment;
- no appreciable loss of section due to deterioration throughout the life of the structure;
- a steel yield strength of 50 kips per square inch (ksi);
- a structural resistance factor for H-piles subject to damage due to severe driving conditions (AASHTO LRFD Bridge Design Specifications 6.5.4.2: $\phi_c = 0.50$); and
- a pile fully braced along its length.

The indicated R_{Rmax} value should not be used for piles that are subjected to significant bending moments or are not supported by soil for their entire length. Examples of the latter condition include piles for capped pile piers and piles in soils subject to scour. It was assumed that, for the wall-type abutments, potential scour is not a design consideration for the abutment piles.

Each pile must be driven to refusal as defined by ODOT as being met during driving when the pile penetration is 1 inch or less after receiving at least 20 blows from the pile hammer. ODOT indicates that, when estimating pile length, the depth to refusal shall be assumed as the elevation where the rock core begins in the nearest test boring. Rock coring began at approximately 50 feet (Elev. 542±) and 47.3 feet (Elev. 542±) below existing grades in Borings B-005 and B-006, respectively, at the southern abutment and northern abutment, respectively.

The following table includes the estimated pile length and order length for each substructure. The estimated pile length includes the calculated length from anticipated pile cut-off elevation (including embedment into pile cap) to pile tip elevation, rounded up to the nearest 5 feet. Although not applicable for the pile tip and cut off elevations for this project, if rounding up to the nearest 5 foot for estimated length adds less than one foot, ODOT BDM guidance indicates to increase to the next nearest 5 foot interval. The order length is the estimated length plus 5 feet. These lengths will be valid regardless of which type of H-pile is selected.

Table 5.1.B. H-Pile Estimated Lengths and Order Lengths

Location	**Boring Number**	**Bottom of Pile Cap Elevation (feet)**	**Pile Cut-Off Elevation (feet)**	**Recommended (Minimum) Pile Tip Elevation (feet)**	**Estimated Pile Length (feet)**	**Order Pile Length (feet)**
South Abutment	B-005	581	583	542	40	45
North Abutment	B-006	581	583	542	45	50

The maximum center-to-center spacing of driven piles should be 8 feet for capped pile abutments and the front row of stub abutments per ODOT BDM specifications. The maximum center-to-center spacing of driven piles should be 7 feet for the front row of wall-type abutments and retaining walls.

Cobbles or boulders were encountered within stratum II in Boring B-005 at depths of approximately 20 to 28½ feet. It should be noted that the existence of cobbles or boulders within the glacial till subsoils is not unusual for this region. Similarly, Tera Tech reported significant amounts of surface rock and concrete slabs upon completing a site visit. These conditions, if encountered, could hamper pile-driving operations and possibly damage some piles. If some piles are observed to meet refusal at depths markedly less than those indicated by the borings, boulder obstruction or pre-mature "fetching" may be indicated. If these conditions are indicated, a pile load test should be performed to evaluate the capacity of the pile. Alternately, for a modest-sized project such as this, one or more replacement piles could be driven, probably at less expense than the cost of a load test.

Based on the bedrock depth and strength, as well as potential for encountering cobbles/boulders and existing concrete rubble, steel pile points should be utilized for this project to protect the tips of the piles.

5.2 Subgrades and Pavements

5.2.1 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 15, 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 9 to 21½ inches below the existing top of pavement grades (represented as a 0.8 to 1.8 feet cut 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. Approximately 50 percent of the tested subgrade soil samples were greater than 3 percent above the optimum as determined using GB-1 criteria. Approximately 50 percent of the 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 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. However, scarification and aeration methods may be utilized if construction schedule will allow such soil modification.

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 value, soil type, and moisture content. Based on these criteria, subgrade modification is not anticipated.

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.

5.2.2 Flexible (Asphalt) Pavement Design

Based on the GB-1 analysis, a design CBR value of 8 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 5. Group indices for the tested samples ranged from 0 to 10, which would correlate with a CBR value of 4 to 12 percent. Cohesive subgrade soils classified as ODOT A-6a were present within 6 feet of the subgrade elevation in both borings. The average group index for these samples was 8. Based on the average design value calculations from GB-1, it appears to be un-conservative to use the GB-1 design CBR value of 8 percent for new pavement sections throughout the project area due to the influence from the granular fill material encountered in Boring B-006. A CBR of 7 percent is more representative of the on-site native cohesive soils and should be utilized for the pavement design.

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 5.3.2 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 Construction

5.3.1 Sedimentation and Erosion Control

In planning the implementation of earthwork operations, special consideration should be given to provide measures to prevent or reduce soil erosion and the subsequent sedimentation into nearby waterways. These measures may include some or all of the following:

1. Scheduling of earthwork operations such that erodible areas are kept as small as possible and are exposed for the shortest possible time.
2. Using special grading practices, along with diversion or interceptor structures, to reduce the amount of run-off water from an erodible area.
3. Providing vegetative buffer zones, filter berms, or sedimentation basins to trap sediment from surface run-off water.

A specific and detailed soil erosion and sedimentation control program and permits may be required by local, state, or federal regulatory agencies.

5.3.2 Site and subgrade Preparation

Site and subgrade preparation activities should conform to ODOT Construction and Materials Specifications (CMS) Item 204 specifications. Site preparation activities should include the removal of vegetation, topsoil, root mats, pavements, structures and other deleterious non-soil materials from all proposed bridge and roadway replacement 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. Pavement subgrades should be proof rolled in accordance with ODOT CMS 204.06.

Any unsuitable materials observed during the inspection and proof-rolling operations should be undercut and replaced with compacted fill, or stabilized in place utilizing conventional remedial measures such as discing, aeration, and recompaction. As stated previously, based on the conditions encountered during our exploration, where subgrade soil moisture contents were wet of optimum, they were significantly wet of optimum. As such, scarification and aeration methods may not be feasible to achieve satisfactory proof rolling and stabilization of the predominantly cohesive subgrades. However, scarification and aeration methods may be utilized in areas where granular subgrades wet of optimum are present, provided weather conditions and construction schedule will allow such soil modification.

The GB-1 analysis indicates that over-excavation unsuitable subgrade soils and replacement with new granular engineered fill is not anticipated.

However and as stated previously, 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.

5.3.3 Temporary Excavations and Permanent Slopes

The sides of the temporary excavations for culvert installation 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) standards must be followed. It is the responsibility of the installation contractor to develop appropriate installation methods and specify pertinent equipment prior to commencement of work, and to obtain the services of a geotechnical engineer to design or approve sloped or benched excavations and/or lateral bracing systems as required by OSHA criteria.

Although the encountered cohesive soils and anticipated “normal” groundwater level below the culvert invert should be generally conducive to stable excavation slopes, provisions should be made for the culvert installation to proceed as a sloped-bank excavation, or as a steeper trench-type cut with properly designed and installed lateral bracing. The latter system may include the use of a portable trench box or a sliding trench shield.

If the excavation is to be performed with sloped banks, adequate stable slopes must be provided in accordance with OSHA criteria. Based on the test borings, it is likely that excavations will encounter a range of soil conditions that include the following OSHA designations:

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

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required by the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction. For permanent excavations and slopes, we recommend that grades generally be no steeper than 3H:1V. It should be noted that ODOT routinely uses 2H:1V slopes for roadway embankments. These steeper slopes could be used, with recognition that the embankment faces are more prone to erosion and sloughing.

5.3.4 Construction Dewatering and Groundwater Control

Groundwater conditions encountered during our exploration are summarized in Section 4.3.

During construction, methods should be taken to divert the creek flow around the construction area.

Based on the soil characteristics and groundwater conditions encountered in the borings and apart from streamflow influences in the creek, it is our opinion that the “normal” groundwater level can generally be expected at depths corresponding to the bottom of the creek, on the order of 22 to 26 feet (Elevs. 567± to 566±).

If construction does not occur during a particularly wet period, adequate control of groundwater seepage into excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps. Even at depths a few feet below the “normal” groundwater level, control of groundwater using sumps should be feasible due to the predominantly cohesive nature of the encountered soils and their associated low permeability, but will require due diligence by the contractor to maintain a stable subgrade condition at the bottom of the excavation.

5.3.5 Fill

Material for engineered fill or backfill required to achieve design grades should meet ODOT Item 203 “Embankment Fill” placement and compaction requirements.

The upper profile on-site soils consist of predominantly granular and cohesive fill materials, and native cohesive soils. For the cohesive soils, a sheepsfoot roller should provide the most effective soil compaction. Where existing pavement base materials remain or new densegraded aggregate pavement base materials are placed, a vibratory smooth-drum roller would be required to provide effective compaction.

6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of design and construction conditions for the proposed culvert replacement and pavement re-construction has been based on our understanding of the site and project information and the data obtained during our field exploration. The general subsurface conditions were based on interpretation of the data obtained 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 are not as anticipated by the designers, or that the construction process has altered the soil conditions. This is especially true for previously developed sites. Therefore, experienced geotechnical engineers should observe earthwork and foundation 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, a qualified geotechnical engineer 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

Notes: Aerial Basemap obtained From Google Earth and dated 03/20/2021.

Site Location Map

WOO 65-23.39 – PID 107711

Rossford, Ohio

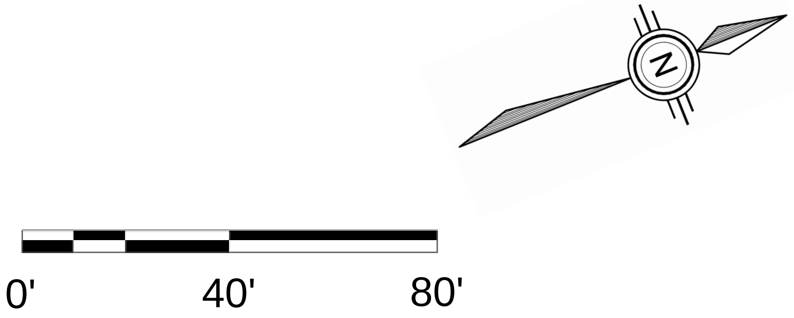
Tetra Tech, Inc.

DRAWN: IJH 05/20/22
REVISED: ---
Project No.: 2130501
Drawing No.: Plate 1.0

TTL associates inc
Environmental, Geotechnical Engineering & Testing

Legend:

B-003-0-21 ● Approximate Pavement Core/
Test Boring Location



Notes: Aerial Basemap obtained From Google Earth and dated 03/20/2021.

Test Boring Location Plan
WOO 65-23.39 – PID 107711
Rossford, Ohio

Tetra Tech, Inc.

DRAWN:	IJH 05/20/22
REVISED:	---
Project No.: 2130501	
Drawing No.: Plate 2.0	

TTL associates inc
Environmental, Geotechnical Engineering & Testing

Figures

Logs of Test Borings
Legend Key
Grain Size Distribution Curves
Undisturbed Sample Unconfined Compressive Strength Test Results
Pavement Core Photographic Logs
Rock Core Photographic Logs
Rock Core Unconfined Compressive Strength Test Results

PROJECT: WOO-65-23.39
TYPE: CULVERT
PID: 107711 SFN:
START: 10/27/21 END: 10/27/21

DRILLING FIRM / OPERATOR: TTL / TB
SAMPLING FIRM / LOGGER: TTL / KKC
DRILLING METHOD: 3.25" HSA / NQ2
SAMPLING METHOD: SPT / ST / NQ2

DRILL RIG: CME 75 TRUCK 844
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 3/15/21
ENERGY RATIO (%): 66

STATION / OFFSET: 1234+79, 35' LT.
ALIGNMENT: CL R/W SR 65
ELEVATION: 592.1 (NAVD88) EOB: 55.0 ft.
LAT / LONG: 41.605682, -83.562348

EXPLORATION ID
B-005-0-21

PAGE
1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 592.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI				
ASPHALT - 5.5 INCHES	591.6																		
CONCRETE - 7.5 INCHES	591.0																		
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE CRUSHED STONE, MOIST FILL	590.1	1 2	4 6 7	14	83	SS-1	4.50	6	7	19	25	43	28	17	11	16	A-6a (7)	480	
MEDIUM DENSE, BLACK, **SLAG FRAGMENTS**, MOIST FILL	589.4																		
STIFF, BLACK/BROWN, **SILT AND CLAY**, LITTLE CRUSHED STONE, LITTLE SLAG FRAGMENTS, LITTLE SAND, MOIST FILL	588.1	3 4	7 6 5	12	89	SS-2	1.75	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
STIFF, GRAY/BROWN, **SILT AND CLAY**, WITH GRAVEL, LITTLE SAND, MOIST @5.5': BROWN, LITTLE GRAVEL		5	5 5 3	9	28	SS-3	1.25	50	7	7	27	9	35	22	13	9	A-6a (1)	-	
		6 7	4 2 3	6	89	SS-4	1.50	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
	583.6	8																	
VERY LOOSE, GRAY, **COARSE AND FINE SAND**, SOME SILT, TRACE GRAVEL, TRACE CLAY, MOIST		9 10	3 2 2	4	100	SS-5	-	-	-	-	-	-	-	-	-	18	A-3a (V)	-	
		W 581.3																	
@11': LOOSE, SOME GRAVEL	579.1	11 ▼ 12	3 3 2	6	100	SS-6	-	-	-	-	-	-	-	-	-	16	A-3a (V)	-	
STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		13																	
		14 15	3 4 6	11	100	SS-7	1.75	-	-	-	-	-	-	-	-	23	A-6a (V)	-	
		16 17	8 9 8	19	100	SS-8	1.75	-	-	-	-	-	-	-	-	22	A-6a (V)	-	
		18																	
	572.3	19 20	3 3 5	9	100	SS-9	1.25	-	-	-	-	-	-	-	-	27	A-6a (V)	-	
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, MOIST (POSSIBLE COBBLE ZONE)		21 22	30 20 10	33	100	SS-10	-	-	-	-	-	-	-	-	-	17	A-2-6 (V)	-	
		23																	
@24': WET @24.5': POSSIBLE BOULDER		24 25	5 34 50/2"	-	86	SS-11	-	-	-	-	-	-	-	-	-	28	A-2-6 (V)	-	
@26': LOOSE, WET (FREE WATER NOTED)		26 27	6 3 2	6	22	SS-12	-	36	14	15	20	15	32	18	14	33	A-2-6 (1)	-	
	563.1	28																	
VERY SOFT TO SOFT, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, WET		29 30	2 1 1	2	100	SS-13	0.25	-	-	-	-	-	-	-	-	34	A-6a (V)	-	

PID: 107711 | SFN: | PROJECT: WOO-65-23.39 | STATION / OFFSET: 1234+79, 35' LT. | START: 10/27/21 | END: 10/27/21 | PG 2 OF 2 | B-005-0-21

MATERIAL DESCRIPTION AND NOTES	ELEV. 561.1	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	HOLE SEALED
VERY SOFT TO SOFT, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, WET *(continued)* @31': Qu = 3.8 PSI = 547 PSF		32 33			100	ST-14	0.25	8	3	8	25	56	33	20	13	27	A-6a (9)	-	
		34 35 36 37 38	0 1 1	2	100	SS-15	0.25	-	-	-	-	-	-	-	-	27	A-6a (V)	-	
@38.5': MOIST	550.1	39 40 41	5 4 3	8	100	SS-16	0.25	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE DOLOMITE FRAGMENTS, LITTLE CLAY, LITTLE SILT, MOIST	545.1	42 43 44 45 46	20 27 16	47	100	SS-17	-	-	-	-	-	-	-	-	-	7	A-3a (V)	-	
GRAY, **WEATHERED DOLOMITE**	542.1	TR 47 48 49	50/5"	-	100	SS-18	-	-	-	-	-	-	-	-	-	7	Rock (V)	-	
DOLOMITE, GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY FINE GRAINED, THINLY LAMINATED TO LAMINATED, JOINTED - SLIGHTLY TO MODERATELY FRACTURED, TIGHT. @51.3': 3-INCH FRACTURED ZONE @51.6': Qu = 18,180 PSI	537.1	50 51 52 53 54 EOB 55	92		97	NQ2											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 15 CF CEMENT-BENTONITE GROUT

PROJECT: WOO-65-23.39
TYPE: CULVERT
PID: 107711 SFN:
START: 10/26/21 END: 10/26/21

DRILLING FIRM / OPERATOR: TTL / TB
SAMPLING FIRM / LOGGER: TTL / KKC
DRILLING METHOD: 3.25" HSA / NQ2
SAMPLING METHOD: SPT / ST / NQ2

DRILL RIG: CME 75 TRUCK 844
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 3/15/21
ENERGY RATIO (%): 66

STATION / OFFSET: 1234+53, 51' LT.
ALIGNMENT: CL R/W SR 65
ELEVATION: 589.1 (NAVD88) EOB: 52.3 ft.
LAT / LONG: 41.605881, -83.562340

EXPLORATION ID
B-006-0-21

PAGE
1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 589.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI				
ASPHALT - 9 INCHES	588.3																		
DENSE, GRAY, **CRUSHED STONE WITH SAND**, SOME SILT, TRACE CLAY, MOIST FILL	584.1	1 2	12 16 20	40	89	SS-1	-	45	14	17	22	2	NP	NP	NP	10	A-1-b (0)	430	
@2.5': MEDIUM DENSE		3 4	12 12 6	20	89	SS-2	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	-	
VERY LOOSE, BROWN, **COARSE AND FINE SAND** , SOME CLAY, TRACE SILT, TRACE GRAVEL, MOIST FILL	583.1	5	2 2 1	3	89	SS-3	-	-	-	-	-	-	-	-	-	16	A-3a (V)	-	
MEDIUM STIFF TO STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST	578.1	6 7	2 2 3	6	100	SS-4	1.25	1	2	27	23	47	27	15	12	20	A-6a (8)	-	
@8': Qu - 5.3 PSI = 763 PSF		8 9 10			21	ST-5	1.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
MEDIUM STIFF, GRAY, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, WET	575.6	▼ 11 12	1 2 3	6	100	SS-6	-	1	2	46	42	9	23	16	7	23	A-4a (3)	-	
		13																	
STIFF, GRAY, **SILT AND CLAY**, TRACE GRAVEL, MOIST	564.8	14 15	0 1 2	3	100	SS-7	1.50	-	-	-	-	-	-	-	-	23	A-6a (V)	-	
		16 17	4 4 5	10	100	SS-8	2.00	-	-	-	-	-	-	-	-	20	A-6a (V)	-	
		18																	
@18.5': WET		W 570.3 19 20	2 3 4	8	100	SS-9	1.75	-	-	-	-	-	-	-	-	32	A-6a (V)	-	
@21': MOIST		21 22	6 7 5	13	100	SS-10	1.00	-	-	-	-	-	-	-	-	22	A-6a (V)	-	
		23																	
LOOSE, GRAY, **COARSE AND FINE SAND**, LITTLE SILT, TRACE GRAVEL, WET (FREE WATER NOTED)	563.1	24 25	1 3 3	7	100	SS-11	-	-	-	-	-	-	-	-	-	23	A-3a (V)	-	
HARD, GRAY, **SILT AND CLAY**, WITH SAND, LITTLE GRAVEL, MOIST	561.1	26 27	11 11 15	29	100	SS-12	4.5+	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
		28																	
HARD, GRAY, **CLAY**, SOME SILT, TRACE SAND, WET		29 30	1 2 2	4	100	SS-13	4.5+	-	-	-	-	-	-	-	-	39	A-7-6 (V)	-	

PID: 107711	SFN:	PROJECT: WOO-65-23.39	STATION / OFFSET: 1234+53, 51' LT.	START: 10/26/21	END: 10/26/21	PG 2 OF 2	B-006-0-21

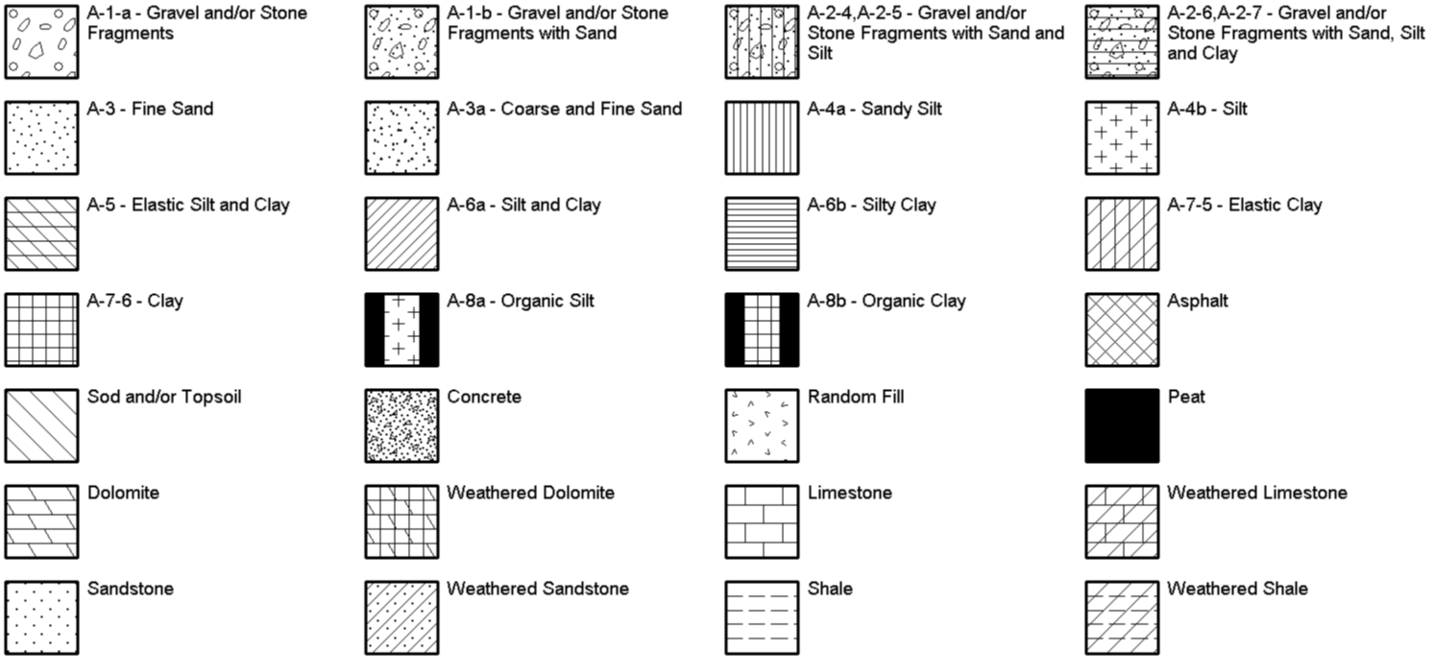
MATERIAL DESCRIPTION AND NOTES	ELEV. 558.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
HARD, GRAY, **CLAY**, SOME SILT, TRACE SAND, WET *(continued)*	557.1																		
SOFT, GRAY, **CLAY**, SOME SILT, TRACE SAND, MOIST		32 33																	
		34 35	2 1 2	3	83	SS-14	0.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	-	
	550.6	36 37 38																	
STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		39 40	1 2 4	7	100	SS-15	1.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	545.1	41 42 43																	
GRAY, **WEATHERED DOLOMITE**		44	23 50/5"	-	82	SS-16	-	34	11	20	33	2	16	14	2	9	A-2-4 (0)	-	
	541.8	45 46 47 TR																	
DOLOMITE, GRAY, SLIGHTLY WEATHERED, VERY STRONG, VERY FINE GRAINED, THINLY LAMINATED TO LAMINATED, JOINTED - FRACTURED TO MODERATLY FRACTURED, TIGHT. @48.5': MODERATELY FRACTURED Qu = 20,430 PSI @51.2': SLIGHTLY FRACTURED	536.8	48 49 50 51 52 EOB	88		100	NQ2											CORE		

NOTES: NONE

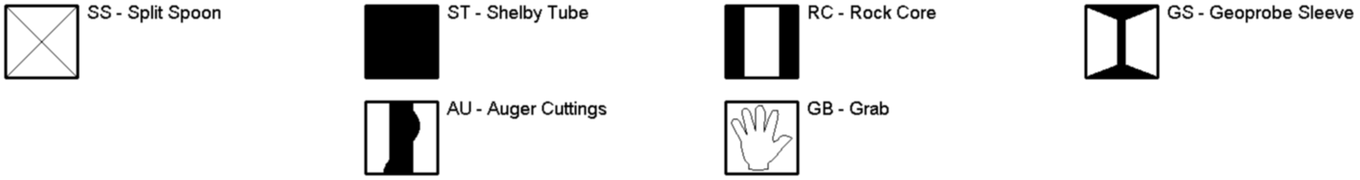
ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; PUMPED 15 CF CEMENT-BENTONITE GROUT

LEGEND KEY

Ohio Department of Transportation Soil Symbols



Sample Symbols



Notes:

1. Exploratory borings B-005-0-21 and B-006-0-21 were drilled on October 26 and 27, 2021, using 3¼-inch diameter hollow-stem augers. Pavement cores were obtained using a 4-inch inside diameter thin-wall core bit. Upon encountering auger refusal, a rock core run was performed using an NQ2 diamond-bit core barrel.

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

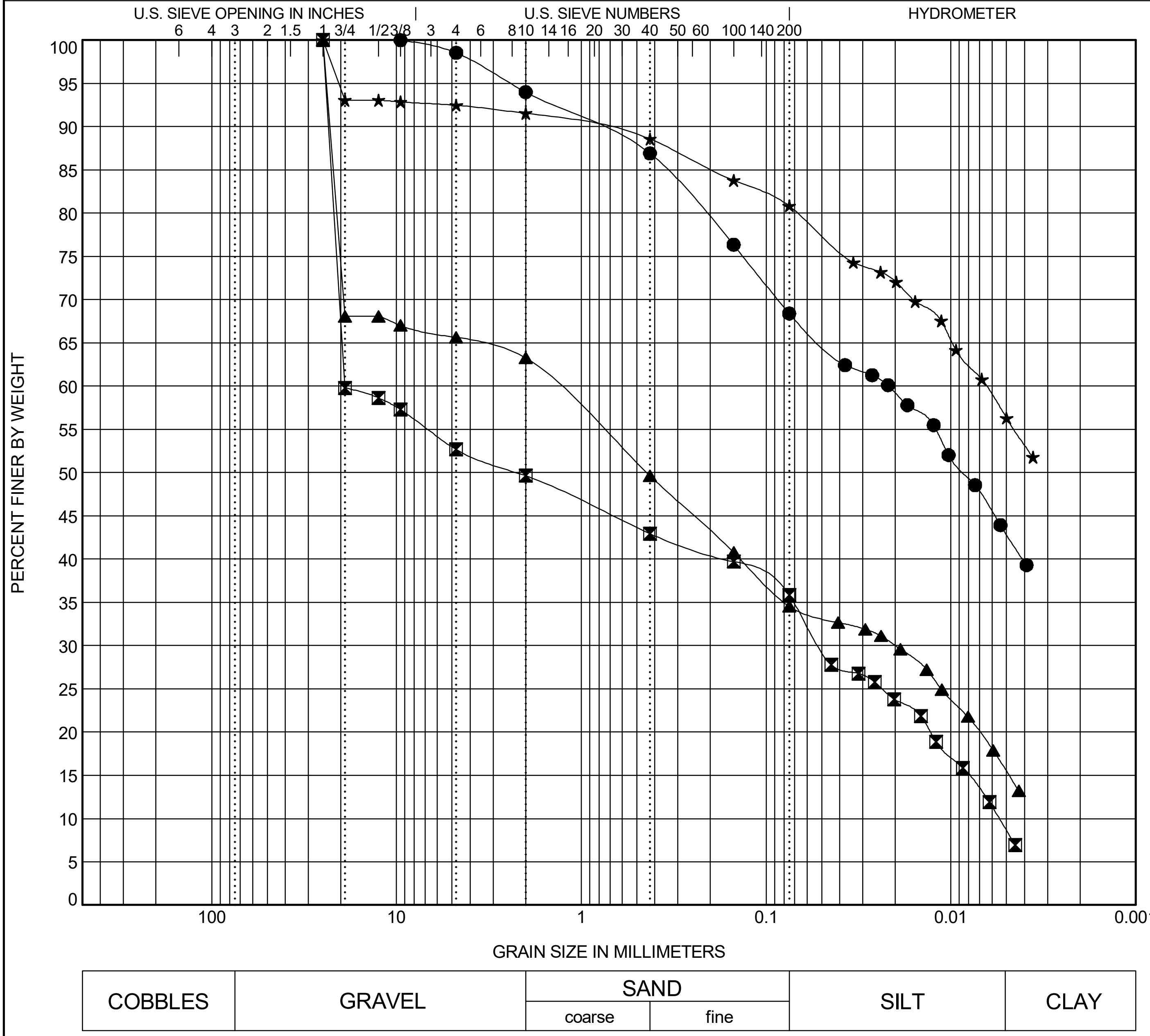
3. The borings were located in the field by TTL in accordance with the Proposed Boring Location Plan, attached to the proposal via a hand-held GPS. Stationing and offsets, were provided by Tera Tech, Inc. Latitude, Longitude, and ground surface elevations were surveyed by TTL via a hand-held GPS. The accuracy from the handheld GPS device was generally found to be approximately 2 to 6 inches horizontal, and approximately 4 to 12 inches vertical.

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-65-23.39 **PID** 107711

OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION



Specimen Identification			ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**B-005-0-21**	**1.0**	**A-6a ~ SANDY LEAN CLAY(CL)**	**28**	**17**	**11**
☒	**B-005-0-21**	**4.0**	**A-6a ~ CLAYEY GRAVEL with SAND(GC)**	**35**	**22**	**13**
▲	**B-005-0-21**	**26.0**	**A-2-6 ~ CLAYEY GRAVEL with SAND(GC)**	**32**	**18**	**14**
★	**B-005-0-21**	**31.0**	**A-6a ~ LEAN CLAY with SAND(CL)**	**33**	**20**	**13**

Specimen Identification			D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**B-005-0-21**	**1.0**	**0.834**	**0.008**			**6**	**7**	**19**	**25**	**43**		
☒	**B-005-0-21**	**4.0**	**23.35**	**2.217**	**0.051**	**0.005**	**50**	**7**	**7**	**27**	**9**	**0.03**	**3470.22**
▲	**B-005-0-21**	**26.0**	**22.941**	**0.443**	**0.02**		**36**	**14**	**15**	**20**	**15**		
★	**B-005-0-21**	**31.0**	**0.889**				**8**	**3**	**8**	**25**	**56**		

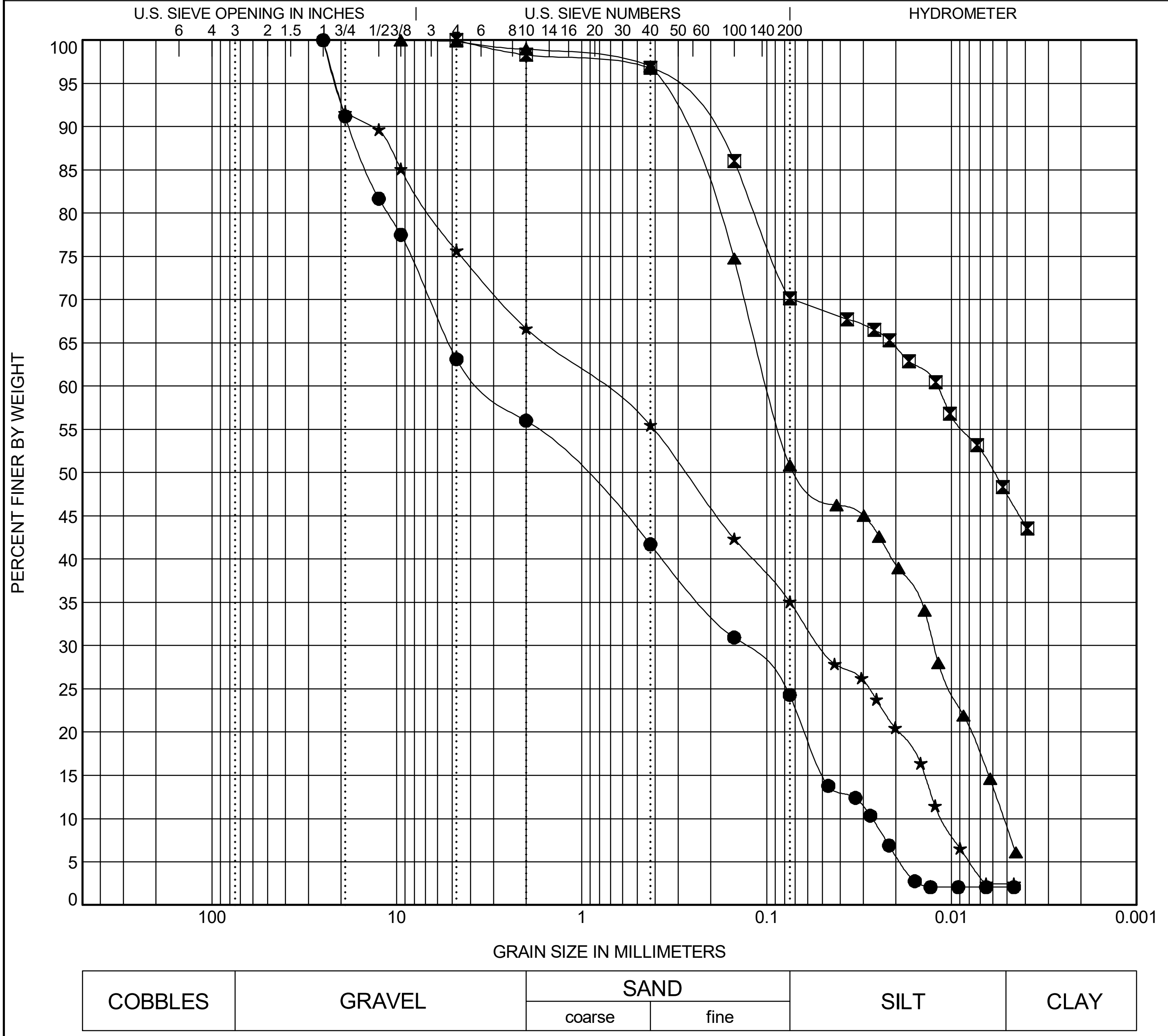
GRAIN SIZE - OH DOT.GDT - 5/23/22 20:31 - S:\PROJECTS\2130501SR65-23.39.GPJ

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-65-23.39 **PID** 107711

OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION



Specimen Identification			ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**B-006-0-21**	**1.0**	**A-1-b ~ SILTY SAND with GRAVEL(SM)**	**NP**	**NP**	**NP**
☒	**B-006-0-21**	**5.5**	**A-6a ~ LEAN CLAY with SAND(CL)**	**27**	**15**	**12**
▲	**B-006-0-21**	**11.0**	**A-4a ~ SANDY SILTY CLAY(CL-ML)**	**23**	**16**	**7**
★	**B-006-0-21**	**43.5**	**A-2-4 ~ SILTY SAND with GRAVEL(SM)**	**16**	**14**	**2**

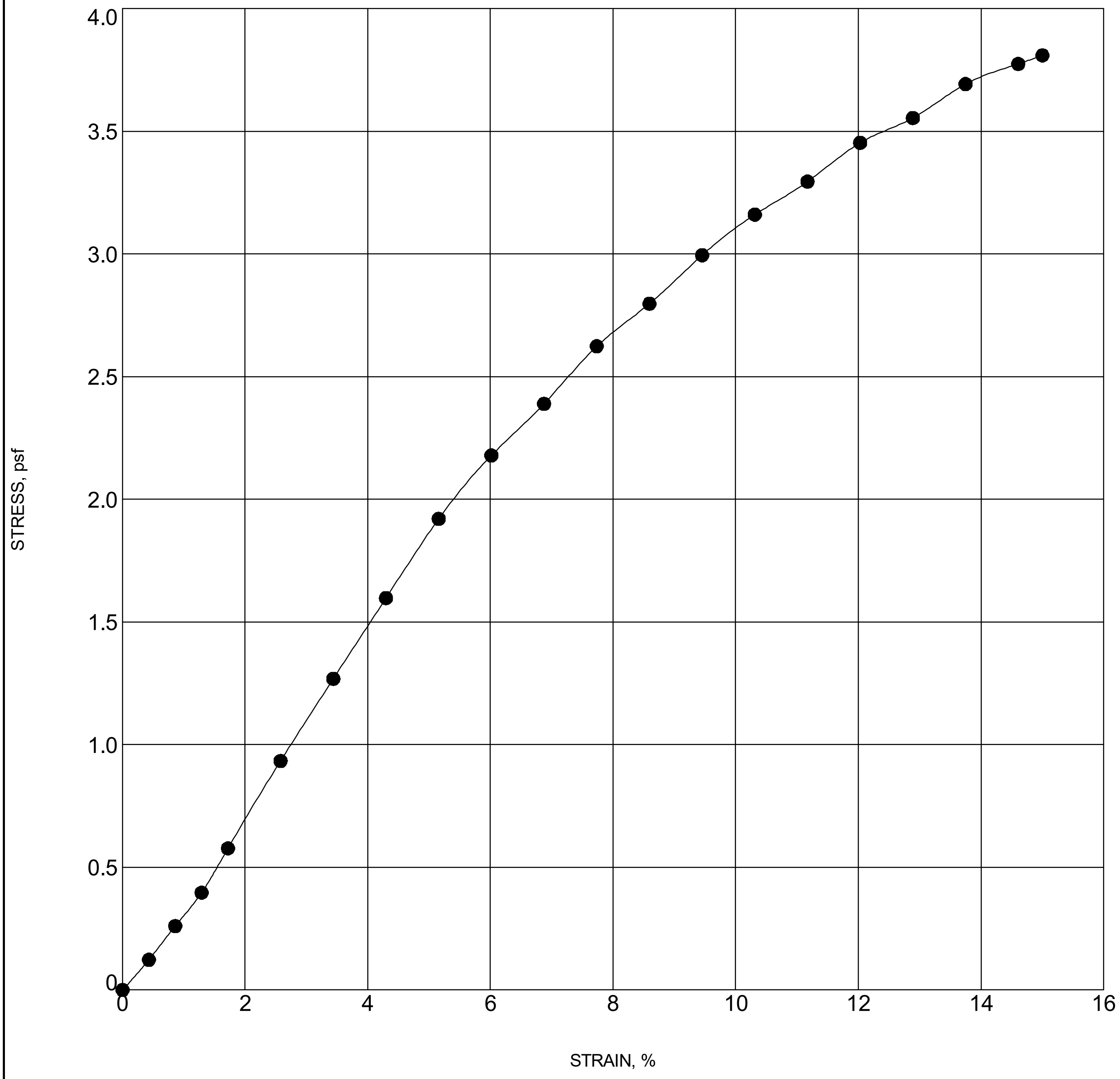
Specimen Identification			D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**B-006-0-21**	**1.0**	**18.028**	**1.043**	**0.136**	**0.027**	**45**	**14**	**17**	**22**	**2**	**0.21**	**120.91**
☒	**B-006-0-21**	**5.5**	**0.22**	**0.006**			**1**	**2**	**27**	**23**	**47**		
▲	**B-006-0-21**	**11.0**	**0.306**	**0.067**	**0.012**	**0.005**	**1**	**2**	**46**	**42**	**9**	**0.31**	**18.75**
★	**B-006-0-21**	**43.5**	**13.415**	**0.275**	**0.051**	**0.011**	**34**	**11**	**20**	**33**	**2**	**0.29**	**70.92**

GRAIN SIZE - OH DOT.GDT - 5/23/22 20:31 - S:\PROJECTS\2130501SR65-23.39.GPJ

UNCONFINED COMPRESSION TEST

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-65-23.39
PID 107711
OGE NUMBER N/A
PROJECT TYPE STRUCTURE FOUNDATION



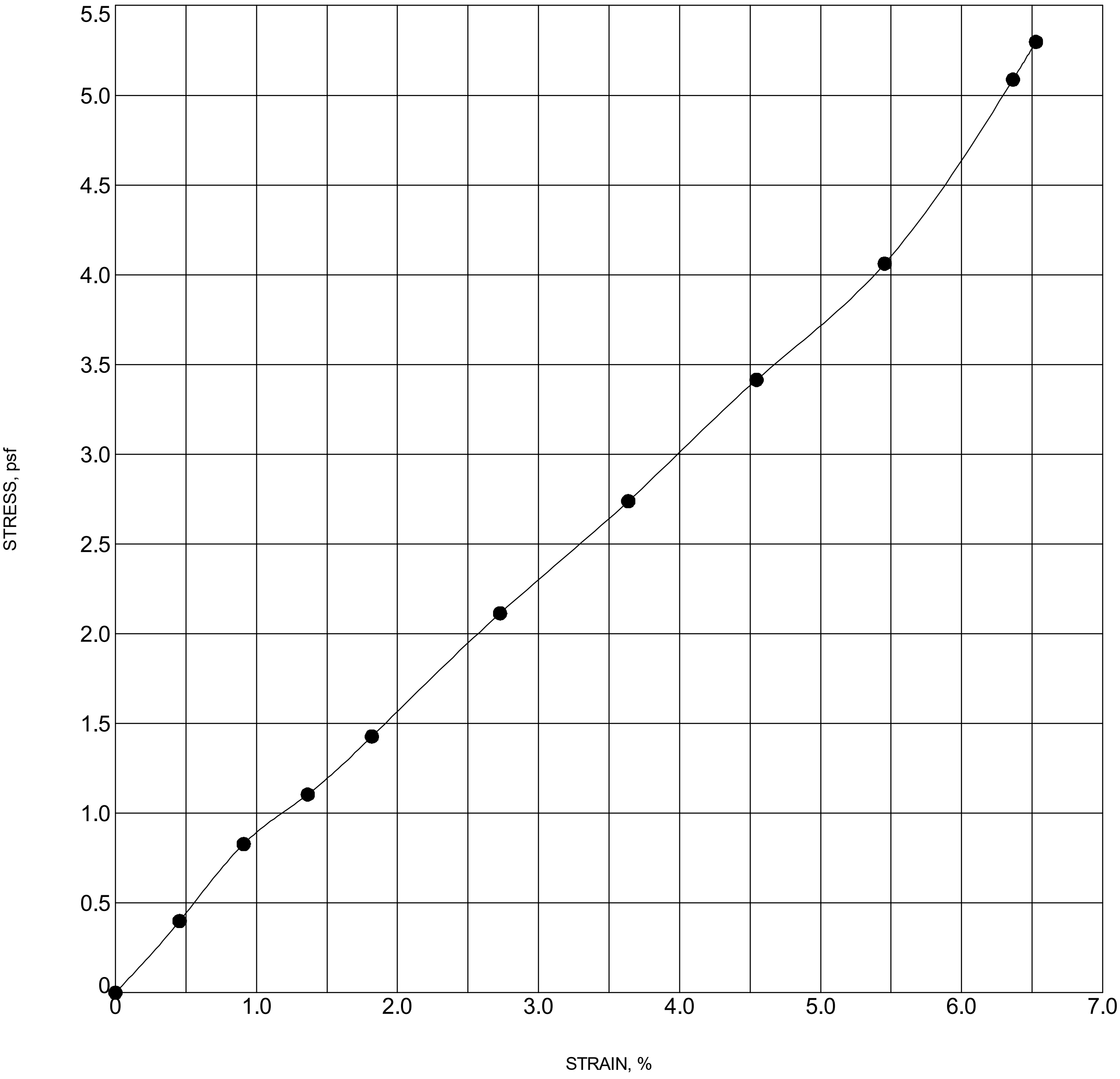
	Specimen Identification		Classification	γ_d	MC%
●	**B-005-0-21**	**31.0**	**A-6a**	**104**	**27**

UNCONFINED COMPRESSION TEST

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT WOO-65-23.39 **PID** 107711

OGE NUMBER N/A **PROJECT TYPE** STRUCTURE FOUNDATION



	Specimen Identification		Classification	γ_d	MC%
●	**B-006-0-21**	**8.0**		**110**	**16**

CORE LOG for B-005-0-21

Project: WOO 65-23.39 – PID 107711
Project Location: Plain Township, Ohio
TTL Project No. 2130501
Core Date: October 27, 2021

ASPHALT THICKNESS (in)	=	8.5
CONCRETE THICKNESS (in)	=	13.0
STONE THICKNESS (in)	=	N.E.
CORE BARREL DIAMETER (in)	=	4.0

N.E.: Stone Subbase not encountered.

VISUAL DESCRIPTION:

CORE LOG for B-006-0-21

Project: WOO 65-23.39 – PID 107711
Project Location: Plain Township, Ohio
TTL Project No. 2130501
Core Date: October 26, 2021

ASPHALT THICKNESS (in)	=	9
STONE THICKNESS (in)	=	N.E.
CORE BARREL DIAMETER (in)	=	4.0

N.E.: Stone Subbase not encountered.

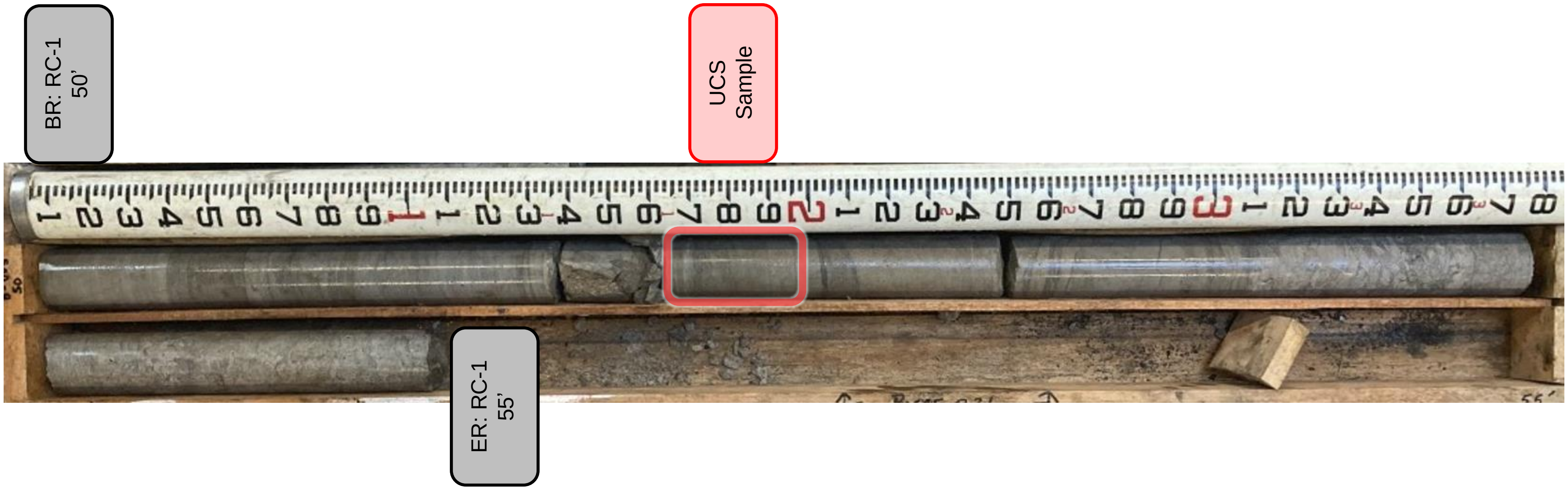
VISUAL DESCRIPTION:

A layer of granular fill material consisting of crushed stone with sand, some silt and trace clay were encountered underlying the surface asphalt. This layer extended to 5 below existing grades and could be associated with the backfill of the exiting bridge structure or a historic utility backfill.

OHIO DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING

Office of Geotechnical Engineering

B-005-0-21



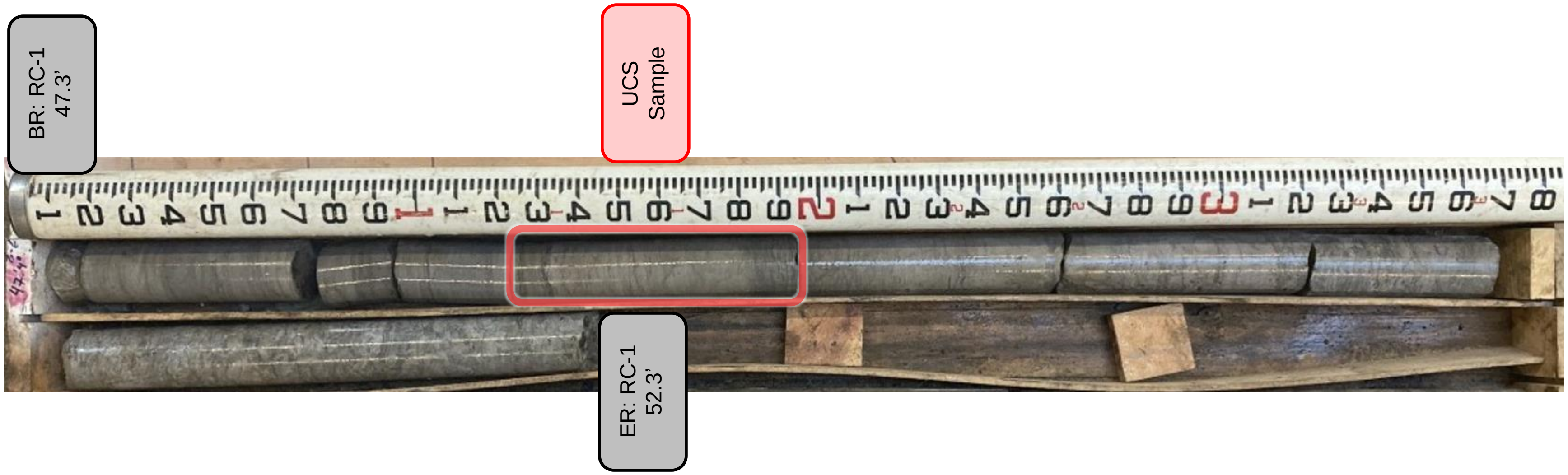
Core Date:	October 27, 2021				Ground Surface Elevation:	592.1 feet (NAVD88)		
Run #:	Depth		Elevation		Recovery		RQD	
RC-1	50’	55’	542.1	537.1	58/60	97%	55/60	92%
WOO-65-23.39, PID 107711								

Prepared by

TTL associates inc
Environmental, Geotechnical Engineering & Testing

TTL Project No.: 2130501

B-006-0-21



Core Date:	October 26, 2021				Ground Surface Elevation: 589.1 feet (NAVD88)			
Run #:	Depth		Elevation		Recovery		RQD	
RC-1	47.3’	52.3’	541.8	536.8	60/60	100%	53/60	88%
WOO-65-23.39, PID 107711								

Compressive Strength of Rock
ASTM D 7012, Method C

PROJECT	WOO-65-23.39, PID 107711	TTL PROJECT NUMBER	2130501
LOCATION	City of Rossford, Ohio		
CLIENT	Tetra Tech		
BORING NUMBER	B-005-0-21	SAMPLE NUMBER	5 (RC-1)
SAMPLE DEPTH (FEET)	50 – 55	SPECIMEN DEPTH (FEET)	51.6

ROCK DESCRIPTION	Dolomite, Gray, Slightly Weathered, Very Strong, Very Fine Grained, Thinly Laminated to Laminated, Jointed - Slightly to Moderately Fractured, Tight.

LENGTH (INCHES)	4.13
DIAMETER (INCHES)	1.99
LENGTH / DIAMETER	2.08
CORRECTION FACTOR	1.0
AREA (SQ. IN.)	3.11

MASS (GRAMS)	561.4
UNIT WEIGHT (LBS/CU. FT.)	166.5
MAXIMUM LOAD (LBS)	56,540
COMPRESSIVE STRENGTH (PSI)	18,180

TEST SPECIMEN PHOTO

TEST SPECIMEN PHOTO

Compressive Strength of Rock
ASTM D 7012, Method C

Project	WOO-65-23.39, PID 107711	TTL Project Number	2130501
Location	City of Rossford, Ohio		
Client	Tetra Tech		
Boring Number	B-006-0-21	Sample Number	6 (RC-1)
Sample Depth (feet)	47.3 – 52.3	Specimen Depth (feet)	48.5

Rock Description	Dolomite, Gray, Slightly Weathered, Very Strong, Very Fine Grained, Thinly Laminated to Laminated, Jointed – Moderately Fractured, Tight.

Length (inches)	4.07
Diameter (inches)	1.99
Length / Diameter	2.05
Correction Factor	1.0
Area (sq. in.)	3.11

Mass (grams)	553.8
Unit Weight (lbs/cu. ft.)	166.7
Maximum Load (lbs)	63,530
Compressive Strength (psi)	20,430

Test Specimen Photo

Test Specimen Photo

APPENDIX A

Engineering Calculations

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

WOO 65-23.39
107711
SR 65 over Grassy Creek
Proposed Culvert Replacement

TTL Associates, Inc

Prepared By: Imad El Hajjar, EI
Date prepared: Monday, May 23, 2022

Imad El Hajjar, EI
TTL Associates, Inc.
1915 North 12 Street
Toledo, Ohio 43604
216-217-5449
ihajjar@ttlassoc.com

NO. OF BORINGS: 2

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-005-0-21	SR-65	1234+79	35	Left	CME 75 Truck Mounted	66	592.1	590.3	1.8 C
2	B-006-0-21	SR-65	1234+53	51	Left	CME 75 Truck Mounted	66	589.1	588.4	0.8 C

#	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 005-0 21	SS-1	1.0	2.5	-0.8	0.7	14		4.5	28	17	11	25	43	68	16	14	A-6a	7	480					
		SS-2	2.5	4.0	0.7	2.2	12		1.75							16	14	A-6a	10						
		SS-3	4.0	5.5	2.2	3.7	9		1.25	35	22	13	35	22	57	9	17	A-6a	6						
		SS-4	5.5	7.0	3.7	5.2	6	6	1.5							17	14	A-6a	10						
2	B 006-0 21	SS-1	1.0	2.5	0.3	1.8	40		NP	NP	NP	NP	22	2	24	10	6	A-1-b	0	430					
		SS-2	2.5	4.0	1.8	3.3	20		NP							7	6	A-1-b	0						
		SS-3	4.0	5.5	3.3	4.8	3		NP							16	8	A-3a	0						
		SS-4	5.5	7.0	4.8	6.3	6	3	1.25	27	15	12	23	47	70	20	14	A-6a	8						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

PID: 107711

County-Route-Section: WOO 65-23.39
No. of Borings: 2

Geotechnical Consultant: TTL Associates, Inc
Prepared By: Imad El Hajjar, EI
Date prepared: 5/23/2022

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): Average(HP):	 24" 12"
Global Geogrid Average(N60L): Average(HP):	 18" 0"

Design CBR	8

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	13%	HP ≤ 0.5	0%
$N_{60} < 12$	50%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	25%	1 < HP ≤ 2	50%
$N_{60} \geq 20$	25%	HP > 2	13%
M+	0%		
Rock	0%		
Unsuitable	0%		

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

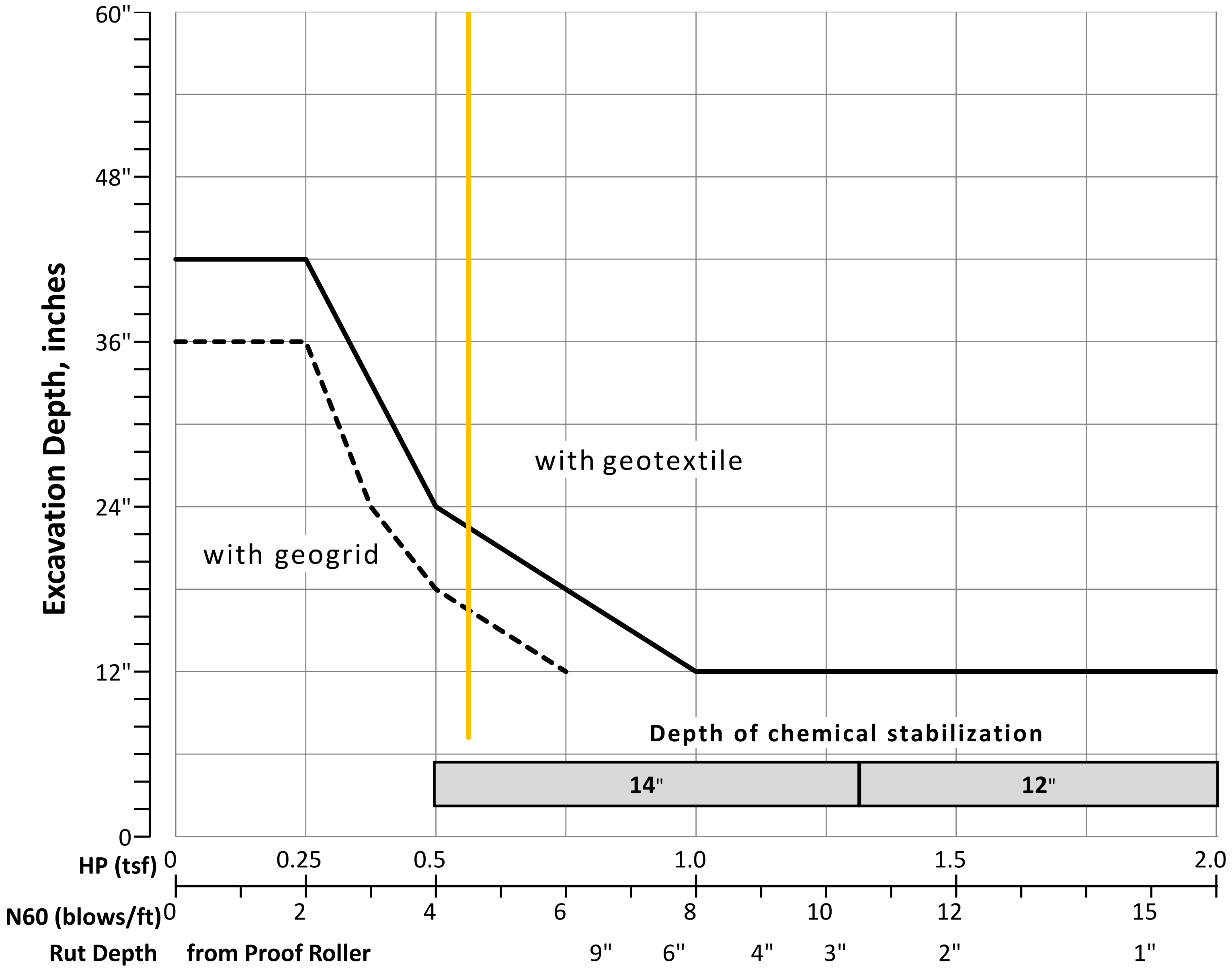
% Proposed Subgrade Surface	
Unstable & Unsuitable	0%
Unstable	0%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	14	5	2.05	30	18	12	26	29	55	14	12	5
Maximum	40	6	4.50	35	22	13	35	47	70	20	17	10
Minimum	3	3	1.25	27	15	11	22	2	24	7	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	2	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	8
Percent	0%	0%	25%	0%	0%	0%	0%	0%	13%	0%	0%	0%	63%	0%	0%	0%	0%	0%	100%
% Rock|Granular|Cohesive	0%	38%									63%								100%
Surface Class Count	0	0	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	5
Surface Class Percent	0%	0%	40%	0%	0%	0%	0%	0%	0%	0%	0%	0%	60%	0%	0%	0%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
2.05		☐ HP
4.50		☐ N60L

Average HP

Average N_{60L}

WOO 65-23.39

Fig.1301-3
Feb.1978

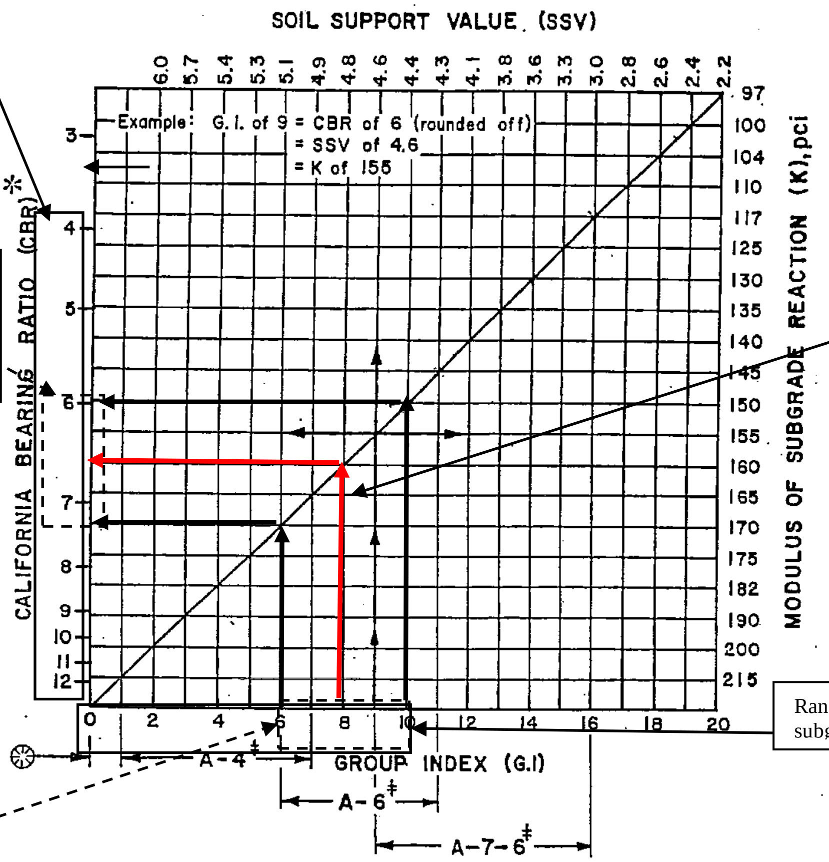
Range of GI from 0 to 10 for pavement subgrade samples corresponds to CBR values ranging from 4 to 12 percent.

Range of GI from 6 to 10 for **A-6a** pavement subgrade samples corresponds to CBR values of 6 to 8 percent.

CBR = 7 for the project based on AVG GI of 8 for all subgrade soils and tested A-6a soils.

Range of GI for all pavement subgrade samples: 0 to 10

Range of GI for **A-6a** pavement subgrade samples: 6 to 10



⊛ 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

APPENDIX B

Geotechnical Engineering Design Checklists

I. Geotechnical Design Checklists

Project: WOO-65-23.39 PDP Path:

PID: 107711 Review Stage: 1

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: WOO-65-23.39	PID: 107711	Reviewer: IJH	Date: 5/23/2022

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:	X	Plans to be prepared 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	
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	Included with proposal.
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	Y	
b.	location by station and offset	X	Station and offset were not available during planning.
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, probes, test pits, etc.) been identified?	y	
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)		
	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: WOO-65-23.39	PID: 107711	Reviewer: IJH	Date: 5/23/2022

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	This is the final Submittal
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	gINT project file is being provided with this final report Submittal
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	No gypsum observed in samples.
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	None present.
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	None present.
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	Rock deeper than 24 inches below anticipated subgrade elevation so removal not required.
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?		

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?	N	
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)?	N	Removal and replacement is not anticipated.
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?	N	
	Indicate type of chemical stabilization specified:		
	cement stabilization		
	lime stabilization		
5	If removal and replacement has been specified, do the plans include Plan Note G121 from L&D3?	N	
6	If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	X	Plans to be prepared by others.
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	

IV.A Foundations of Structures Checklist

C-R-S: WOO-65-23.39	PID: 107711	Reviewer: IJH	Date: 5/23/2022

If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

Soil and Bedrock Strength Data		(Y/N/X)	Notes:
1	Has the shear strength of the foundation soils been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
2	Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?	Y	
3	Has the shear strength of the foundation bedrock been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	other (describe other methods)		
Spread Footings		**(Y/N/X)**	**Notes:**
4	Are there spread footings on the project? If no, go to Question 11	N	
5	Have the recommended bottom of footing elevation and reason for this recommendation been provided?		
a.	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?		
6	Were representative sections analyzed for the entire length of the structure for the following:		
a.	factored bearing resistance?		
b.	factored sliding resistance?		
c.	eccentric load limitations (overturning)?		
d.	predicted settlement?		
e.	overall (global) stability?		
7	Has the need for a shear key been evaluated?		
a.	If needed, have the details been included in the plans?		
8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?		
9	Have the Service I and Maximum Strength Limit States for bearing pressure on soil or rock been provided?		

IV.A Foundations of Structures Checklist

Spread Footings		(Y/N/X)	Notes:
10	If weak soil is present at the proposed foundation level, has the removal / treatment of this soil been developed and included in the plans?		
a.	Have the procedure and quantities related to this removal / treatment been included in the plans?		
Pile Structures		(Y/N/X)	Notes:
11	Are there piles on the project? If no, go to Question 17	Y	
12	Has an appropriate pile type been selected?		
	Check the type selected:		
	H-pile (driven)	✓	
	H-pile (prebored)		
	Cast In-place Reinforced Concrete Pipe		
	Micropile		
	Continuous Flight Auger (CFA)		
	other (describe other types)		
13	Have the estimated pile length or tip elevation and section (diameter) based on either the Ultimate Bearing Value (UBV) or the depth to top of bedrock been specified? Indicate method used.	Y	Depth to bedorck
14	If scour is predicted, has pile resistance in the scour zone been neglected?		Scour is not anticipated
15	Has a wave equation drivability analysis been performed as per BDM 305.4.1.2 to determine whether the pile can be driven to either the UBV, the pile tip elevation, or refusal on bedrock without overstressing the pile?	X	
16	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:		
a.	Nominal unit tip resistance and maximum settlement of the piles?	X	
b.	Nominal unit side resistance for each contributing soil layer and maximum deflection of the piles?	X	
c.	Downdrag load on piles driven through new embankment or compressible soil layers, as per BDM 305.4.2.2?	X	
d.	Potential for and impact of lateral squeeze from soft foundation soils?	X	

IV.A Foundations of Structures Checklist

Pile Structures		(Y/N/X)	Notes:
17	If piles are to be driven to strong bedrock (Q_u >7.5 ksi) or through very dense granular soils or overburden containing boulders, have “pile points” been recommended in order to protect the tips of the steel piling, as per BDM 305.4.5.6?	Y	
18	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	X	
19	If piles will be driven through 15 feet or more of new embankment, has preboring been specified as per BDM 305.4.5.7?	X	

IV.A Foundations of Structures Checklist

Drilled Shafts		(Y/N/X)	Notes:
20	Are there drilled shafts on the project? If no, go to the next checklist.	N	
21	Have the drilled shaft diameter and embedment length been specified?		
22	Have the recommended drilled shaft diameter and embedment been developed based on the nominal unit side resistance and nominal unit tip resistance for vertical loading situations?		
23	For shafts undergoing lateral loading, have the following been determined:		
a.	total factored lateral shear?		
b.	total factored bending moment?		
c.	maximum deflection?		
d.	reinforcement design?		
24	If a bedrock socket is required, has a minimum rock socket length equal to 1.5 times the rock socket diameter been used, as per BDM 305.5.2?		
25	Generally, bedrock sockets are 6" smaller in diameter than the soil embedment section of the drilled shaft. Has this factor been accounted for in the drilled shaft design?		
26	If scour is predicted, has shaft resistance in the scour zone been neglected?		
27	Has the site been assessed for groundwater influence?		
a.	If yes, and if artesian flow is a potential concern, does the design address control of groundwater flow during construction?		
28	Have all the proper items been included in the plans for integrity testing?		
29	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?		
30	If necessary, have wet construction methods been specified?		

General		(Y/N/X)	Notes:
31	Has the need for load testing of the foundations been evaluated?	N	
a.	If needed, have details and plan notes for load testing been included in the plans?		

VI.B. Geotechnical Reports

C-R-S: WOO-65-23.39	PID: 107711	Reviewer: IJH	Date: 4/2/2025

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 is the final submittal
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.	Y	gINT project file is being provided with this final report submittal
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:		
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?	Y	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	Y	