Structure Foundation Exploration - Final
MAD-62-2.79 Bridge Replacement
(PID 102577)
Madison County, Ohio
S&ME Project No. 1179-17-005

PREPARED FOR:

Euthenics, Inc.
8235 Mohawk Dr.
Strongsville, OH 44136

PREPARED BY:

S&ME, Inc.
8400 Sweet Valley Dr., Suite 404
Valley View, OH 44125-4210

March 7, 2018

March 7, 2018

Euthenics, Inc.
8235 Mohawk Dr.
Strongsville, OH 44136

Attention: Mr. Luke Baker, P.E., S.I.

Reference: **Structure Foundation Exploration - Final**
MAD-62-2.79 Bridge Replacement (PID No. 102577)
Madison County, Ohio
S&ME Project No. 1179-17-005

Mr. Baker:

In accordance with our revised proposal dated April 25, 2017, which was authorized by Euthenics, Inc., on May 22, 2017, S&ME has completed a Structure Foundation Exploration for the proposed replacement bridge (No. MAD-62-0279) carrying SR 62 over Deer Creek in Madison County, Ohio. The approximate location of this project is shown on the Vicinity Map submitted as Plate 1 in the Appendix of this report.

In accordance with Section 701 of the current ODOT Specifications for Geotechnical Explorations (SGE), S&ME is herewith submitting a "final" version of this report, which is also to be provided to the ODOT District Geotechnical Engineer. On January 19, 2018, you indicated that ODOT District 6 had no comments on our "draft" structure foundation exploration report dated September 25, 2017. Structure Foundation Exploration plan sheets for the selected structure alternative have been prepared and are included in Appendix D of this report.

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

Respectfully,

S&ME, Inc.

Kyle J. Dohlen, P.E.
Project Engineer

Richard S. Weigand, P.E.
Senior Engineer

STATE OF OHIO
Richard
S.
Weigand
E-56910
REGISTERED
PROFESSIONAL ENGINEER

Submitted: Email (labaker@euthenics-inc.com)
ec: A. Piatak, Euthenics, Inc. (arpiatak@euthenics-inc.com)

S&ME, Inc. | 8400 Sweet Valley Dr, Suite 404 | Valley View, OH 44125 | p 216.901.1000 | www.smeinc.com

Table of Contents

Appendix A

Appendix B

Appendix C

Appendix D

1.0 Executive Summary

S&ME understands that ODOT District 6 desires to replace the existing 4-span bridge (No. MAD-62-0279) carrying US 62 over Deer Creek in Madison County, Ohio. Based on information from Euthenics, the proposed structure will consist of a 3-span pre-stressed concrete I-beam structure on roughly the same horizontal and vertical alignment as the existing bridge. Some minor widening of the earthen approach embankments is anticipated. Plan and profile information for the proposed bridge indicates that both abutments will be located behind the existing abutments.

It should be noted that the authorized scope of work for this investigation included performing three (3) borings for an anticipated 2-span replacement bridge. As such, the structure borings were positioned just behind the existing abutments and as near as practical to the existing center bridge pier. No borings were performed near the potential locations of intermediate piers for a 3-span structure.

Beneath 9 to 10 inches of existing asphalt over 14 to 15 inches of granular base, abutment Borings B-001 and B-003 encountered 11 to 15 feet of existing fill and probable fill consisting of predominantly medium-stiff to stiff SILT AND CLAY (A-6a), CLAY (A-7-6), SANDY SILT (A-4a). The lower portions of these fill materials were dark-brown, contained pockets of topsoil and a few very-soft to soft zones, and were described as slightly organic to moderately organic, with Loss-on-Ignition (LOI) test results ranging from 1.5 to 8.3%. Beneath these fill materials, the abutment borings encountered 1.3 to 5 feet of soft to stiff SILTY CLAY (A-6b), ELASTIC CLAY (A-7-5), and CLAY (A-7-6) which was also slightly to moderately organic. Beneath these organic soils, both abutment borings encountered 9 to 9.3 feet of medium-dense to very-dense GRAVEL (A-1-a) and GRAVEL WITH SAND (A-1-b) which were underlain by very-stiff to hard gray SILT AND CLAY (A-6a), SILTY CLAY (A-6b) and CLAY (A-7-6) becoming hard gray SANDY SILT (A-4a).

Boring B-002 was performed near the center of the existing creek channel and near the existing center bridge pier. After penetrating through 2½ inches of asphalt and an 8½-inch-thick concrete deck, Boring B-002 encountered the stream bed at a depth of 23 feet below the deck. From the stream bed to its termination depth of 80 feet, Boring B-002 encountered 22.5 feet of very-stiff to hard gray SILTY CLAY (A-6b) and CLAY (A-7-6) over 34.5 feet of hard brown becoming gray SANDY SILT (A-4a).

The proposed bridge plan information from Euthenics indicates the new bridge abutment for the selected 3-span replacement bridge will be positioned behind the existing abutments. As no change in roadway profile is proposed, no significant change in existing overburden pressure is anticipated on the existing approach embankment soils. Therefore, significant settlement is not expected beneath these proposed bridge abutments, and no downdrag forces are anticipated to act on the new abutment piles for these bridge alternates.

Based on information provided by Euthenics, S&ME considered that 6.2 feet of local scour would occur at the intermediate piers, but that no scour was anticipated at the abutments, as spill-through, rip-rapped abutment slopes would be provided in front of each abutment.

S&ME performed static pile computations for 12 and 16-inch diameter closed-end, cast-in-place (CIP) pipe piles to estimate the pile tip elevation necessary to develop an Ultimate Bearing Value (UBV) exceeding the maximum factored axial (vertical) pile loads provided by Euthenics for each bridge substructure element (see Section 6.4.3).

Based on soil encountered at the subgrade level in the approach embankments, S&ME recommends a CBR value of 6% be used for design of new pavement at this bridge site. Based on ODOT Geotechnical Bulletin GB1 procedures, subgrade remediation consisting of roughly 12 to 15 inches of "excavate and replace" remediation may be required. Additional discussion regarding pavement subgrade remediation is presented in Section 6.2 of this report.

2.0 Introduction

S&ME understands that ODOT District 6 desires to replace the existing bridge (No. MAD-62-0279) which carries US-62 over Deer Creek, just northeast of Mount Sterling, in Madison County, Ohio (see Plate 1 of Appendix A).. Based on information provided on February 12, 2018, by Euthenics, S&ME understands the proposed replacement structure will be a three-span bridge with pre-stressed concrete I-Beams, integral abutments, constructed along horizontal and vertical alignments which are approximately the same as the existing. The integral abutments will have a single row of vertical piles, and the intermediate piers will be supported on two rows of battered piles.

This Structure Foundation Exploration was performed in general accordance with the ODOT <u>Specifications for Geotechnical Explorations</u> (<u>SGE</u>), including July 2017 updates, for a two-span bridge. Following the completion of the field work, Euthenics indicated that 3-span structures were being considered. S&ME advised Euthenics that the Structure Foundation Exploration program, as completed, would not meet ODOT <u>SGE</u> requirements for the number of structure borings.

3.0 Geology and Observations of the Project

3.1 Geology and Hydrogeology

The project site is located in the Darby Plain physiographic region. The Darby Plain is characterized by broadly hummocky ground with several broad, recessional moraines. The geology can be further described as Wisconsinan-age loam till over Silurian and Devonian-age carbonate bedrock. The Madison County Soil Survey (accessed through the USDA Web Soil Survey website) information indicates that the near surface soils in the project area are currently classified as Ross silt loam. Available ODNR water well logs and bedrock topography mapping indicates that the bedrock surface is near approximately Elevation 750 (MSL) in the area of this site. The existing roadway surface of US 62 bridge is at approximate Elevation 864 (MSL).

A review of the ODNR "Ohio Karst Areas" map reveals that the site lies in an area not known to contain karst features. A review of the ODNR "Landslides in Ohio" map reveals that Madison County lies in an area of low incidence and low susceptibility to landslides. A review of the ODNR "Abandoned

Underground Mines of Ohio" map reveals that the site lies in an area of non-coal-bearing rock and does not have mapped abandoned mines in the area of the site.

3.2 Site Reconnaissance

A site reconnaissance visit was made by S&ME personnel on May 26, 2017, to observe the existing bridge and project vicinity and to field mark the borings. Some concrete deterioration was noted on portions of the concrete abutments and center pier.

3.3 Historic Information

Euthenics provided bridge plan sheets dated 1941 indicating that the existing bridge is supported on timber piling. Euthenics also provided the Impact Study and Inspection Finding Report which was submitted to ODOT February of 2017. S&ME also reviewed additional existing information located during a search of the ODOT website, including a Bridge Inspection Report, a Bridge Inventory Report, and Bridge Inventory Information.

4.0 Exploration

4.1 Field Investigation

During the period of June 5 through June 9, 2017, S&ME performed a total of three (3) borings, designated B-001-0-17 through B-003-0-17 and hereafter referred to as B-001 through B-003, at this site. The borings were drilled to depths ranging from 75 feet to 80 feet below the existing roadway or bridge deck surface, and were terminated after encountering 30 feet of 30 blow-count soil. The borings were advanced in the westbound lane of US 62, and the approximate locations of the borings are shown on the Plan of Borings included as Plate 2 of Appendix I. Surveyed locations and ground surface elevations of the completed borings were provided to S&ME by Euthenics.

The borings were performed using a truck-mounted drilling rig using 3¼-inch I.D. hollow-stem augers. Disturbed (but representative) soil samples were obtained by lowering a 2-inch O.D. split-barrel sampler through the auger stem to the bottom of the boring and then driving the sampler into the soil with blows from a 140-pound hammer freely falling 30 inches (ASTM D1586 - Standard Penetration Test, SPT). In accordance with the current ODOT SGE, the hammer system on the drill rig was calibrated in accordance with ASTM D 4633 to determine the drill rod energy ratio, and this value is provided on the boring logs. Continuous (SPT) sampling was performed in the uppermost 6 feet of soil below the approach pavements, and in the scour zone from the approximate streambed level to 6 feet below the streambed level in all 3 borings. Beneath the continuous sampling, the borings were sampled at 2½-foot intervals to 20 feet below the foundation level. The remainder of the borings were sampled at 5-foot intervals. Two (2) undisturbed Shelby tubes samples were attempted by hydraulically pressing a seamless steel (Shelby) tube into the soil; however, one of these Shelby tube attempts encountered refusal in a sand and gravel layer. The recovered Shelby tube samples were sealed in the tubes with wax.

In the field, experienced personnel performed the following duties: 1) examined and preserved all recovered samples; 2) prepared a log of each boring; 3) recorded seepage and groundwater observations and measurements; 4) obtained hand penetrometer measurements in soil samples exhibiting cohesion; and, 5) provided liaison between the field work and the project Engineer so that any modifications to the exploration program could be expeditiously implemented in the event that unusual or unanticipated conditions were encountered. All recovered samples were transported to the soils laboratory of S&ME for further examination and testing.

4.2 Laboratory Testing

In the laboratory, all soil samples were visually identified and tested for natural moisture content. Liquid/plastic limit determinations and grain-size analyses were performed on selected representative specimens. Loss-on-Ignition (LOI) tests were performed on four (4) samples to evaluate the organic content of the soils. Unconfined Compression tests (UC) were performed on portions of the recovered Shelby tube samples. The results of the laboratory index tests are recorded numerically on the individual boring logs. Graphical results of the unconfined compression tests are presented on Plates 14 and 15 in Appendix A.

Based upon the results of the laboratory testing program, the field logs were modified, if necessary, and copies of the laboratory corrected boring logs are submitted as Plates 4 through 12 of Appendix A. Shown on these logs are: descriptions of the soil stratigraphy encountered; depths from which samples were preserved; sampling efforts (blow-counts) required to obtain the specimens in the borings; calculated N_{60} values; laboratory testing results; seepage and groundwater observations made at the time of drilling; and, values of hand-penetrometer measurements made in soil samples exhibiting cohesion. For your reference, hand-penetrometer values are roughly equivalent to the unconfined compressive strength of the cohesive fraction of the soil sample. Plate 16 of Appendix A includes a summary of the grain-size data obtained from the testing performed on the continuous SPT samples obtained from the scour zone in the borings.

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

5.0 Findings

5.1 Existing Pavement Thicknesses and Surficial Materials

Borings B-001 and B-003 were performed through the roadway behind the existing bridge abutments, and Boring B-002 was advanced through the existing bridge deck. Table 1 summarizes the thicknesses of existing pavement and bridge deck materials encountered at each boring location.

Table 1: Summary of Pavement Section Materials

Location	Asphalt Thickness	Granular Base	Concrete Bridge Deck Thickness
B-001	10″	14″	--
B-002	2½″	-	8½″
B-003	9″	15″	-

Beneath the bridge deck, Boring B-002 encountered roughly 18 feet of clear space and 4 feet of water before encountering the creek bed at a depth of 23 feet below the surface of the bridge deck.

5.2 General Subsurface Conditions

The general subsurface stratigraphy encountered in abutment Borings B-001 and B-003 may be described in descending order as follows:

- 3.0 feet of existing fill consisting of stiff to very-stiff brown SILT AND CLAY (A-6a) and SANDY SILT (A-4a). In Boring B-001, this fill was underlain by an additional 4.3 feet of fill which was described as becoming soft to stiff.
- 7.7 to 8.0 feet of probable fill described as medium-stiff to stiff dark-brown and brown CLAY (A-7-6) and which contained pockets of topsoil, a few very-soft to soft zones, and were described as slightly to moderately organic with Loss-on-Ignition (LOI) test results ranging from 1.5 to 8.3%.
- 1.3 to 5.0 feet of soft to stiff brown and dark-brown SILTY CLAY (A-6b), ELASTIC CLAY (A-7-5), and CLAY (A-7-6) which was also slightly to moderately organic.
- 9 to 9.3 feet of medium-dense to very-dense GRAVEL (A-1-a) and GRAVEL WITH SAND (A-1-b)
- 47.7 to 52.3 of very-stiff to hard gray SILT AND CLAY (A-6a), SILTY CLAY (A-6b) and CLAY (A-7-6) becoming hard gray SANDY SILT (A-4a).

Boring B-002 was performed near the center of the existing creek channel and near the existing center bridge pier. After encountering the stream bed at a depth of 23 feet below the existing bridge deck, Boring B-002 encountered 22.5 feet of very-stiff to hard gray SILTY CLAY (A-6b) and CLAY (A-7-6) over 34.5 feet of hard brown becoming gray SANDY SILT (A-4a) prior to being terminated at a depth of 80 feet.

5.3 Groundwater Observations

Groundwater was initially encountered at a depth of 19 feet in Boring B-001, at 23 feet (creek level) in Boring B-002, at a depth of 18.5 feet in Boring B-003. In the abutment borings, water or water mixed with bentonite powder was introduced into the auger stem during drilling to reduce the potential for heaving of soil into the auger stem.

All groundwater levels and seepage measurements should be considered as temporary, short-term observations and should not be assumed to be representative of the long-term static groundwater level.

5.4 Scour Zone Grain Size Test Results

Plate 16 of Appendix A summarized the D_{50} and D_{95} particle sizes determined from the results of the gradation testing performed on the soil samples recovered from the continuously sampled scour zone in the abutment and intermediate pier borings drilled for the proposed MAD-62-2.79 replacement bridge over Deer Creek. This information was provided to Euthenics on July 24, 2017, for use during scour analyses for the proposed replacement structure.

6.0 Analyses and Recommendations

6.1 General Discussion

S&ME understands that ODOT District 6 desires to replace the existing 4-span bridge (No. MAD-62-0279) carrying US 62 over Deer Creek in Madison County, Ohio. Based on information from Euthenics, the proposed structure will consist of a 3-span pre-stressed concrete I-beam structure on roughly the same horizontal and vertical alignment as the existing bridge. Some minor widening of the earthen approach embankments is anticipated. Plan and profile information for the proposed bridge indicates that both abutments will be located behind the existing abutments.

The authorized scope of work for this Structure Foundation Exploration included performing only 3 borings for a proposed 2-span bridge, with one boring positioned near the mid-span of the existing creek channel. As such, no borings were performed at the approximate locations of potential intermediate piers for a 3-span bridge.

6.2 Pavement Subgrade

6.2.1 Subgrade Support Parameters

Based on the results of the Atterberg Limits and grain-size analyses performed on samples from the upper portion of the soils encountered in the borings and the corresponding ODOT/HRB classifications of A-4a, A-6a, and A-7-6, the following California Bearing Ratio (CBR) value is recommended for the design of new pavement:

CBR: 6 %

With this value, and using equation 203.1 of Section 203.1 of the July 2016 ODOT Pavement Design Manual, the following Resilient Modulus (M_R) may be used during new pavement section design:

M_R: 7,200 psi

This subgrade evaluation also considers that the subgrade for the new roadways is composed of the materials encountered in the borings. If, at the time of construction, it is determined that the subgrade may consist of materials significantly different than those encountered, the pavement design subgrade criteria should be reviewed and, if necessary, modified. The proposed pavement subgrade should be prepared in accordance with Item 204 "Subgrade Compaction and Proofrolling" of the 2016 ODOT CMS.

6.2.2 *Subgrade Remediation*

Based on the laboratory test results, and utilizing the ODOT Geotechnical Bulletin GB1 subgrade analyses spreadsheet (Ver. 13.0), S&ME estimates that 12 to 15 inches of remediation of unstable subgrade may be required where new pavement is planned on the approach embankments. Because of the minimal amount of approach work anticipated, S&ME recommends that subgrade remediation consist of excavate and replace. The actual location of subgrade soil requiring excavate and replace remediation should be based on observations made at the time of construction and the results of the final subgrade proof-rolling completed in accordance with Item 204.

In accordance with Section F of ODOT GB1, where "excavate and replace" is used for subgrade remediation, Item 712.09 Geotextile Fabric Type D is to be placed at the bottom of the undercuts, and Item 204 Granular Material is to be used to backfill the overexcavations. S&ME recommends that Item 204 Granular Material, Type B or C be utilized. It should also be noted, however, that ODOT GB1 specifies that Item 204 Granular Material Type B without a geotextile fabric be utilized to backfill undercuts performed in the vicinity of any underdrains. Additionally, if "excavate and replace" is to be used for remediation, Plan Note G121 from the ODOT L&D Manual, Vol. 3, should be used in the General Notes.

6.3 Earthen Approach Embankments

Plan information for the replacement bridge provided on March 5, 2018, shows the proposed bridge abutments being positioned behind (back-station) the existing rear abutment, and behind (up-station) of the existing forward abutment. Additionally, the final vertical profile of US 62 is anticipated to be essentially unchanged.

6.3.1 *Settlement*

Since the new abutments are to be located behind (outside) the existing abutments, and as no significant amount of new fill placement is anticipated on the approaches, minimal settlement of the existing approach embankments is anticipated for these bridge alternates. Some long term secondary compression of the existing slightly to moderately organic embankment foundation soils is anticipated to occur over the life of the bridge, but this amount is anticipated to be relatively minor (an inch or less) provided additional fill weight is not added to the embankment.

6.3.2 *Embankment Foundation Preparation*

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

If weak, wet, or soft zones are present, it is recommended that the materials contained in these zones should be either scarified, moisture conditioned, and thoroughly recompacted in place or be removed and the overexcavation filled in a controlled manner with compacted, suitable embankment material prior to attempting to place and compact any new fill.

6.3.3 Embankment Widening

S&ME understands that some additional fill may be required on the sides of the existing US 62 approach embankments behind the new abutments to accommodate a slight widening of the embankment. Where new fill is to be placed to widen the earthen approach embankments, S&ME recommends that all vegetation, topsoil, pavement, and miscellaneous materials be removed from the sides and top of the existing roadway embankment, and also from the footprint of any embankment widening areas. Prior to the placement of any new fill in embankment widening areas, S&ME recommends that consideration be given to specifying the entire exposed embankment foundation in the widening areas at the base of the embankment be test rolled in accordance with ODOT Construction and Material Specifications (CMS) Item 204.06 to detect any unstable (e.g., soft, wet or weak) zones or unsuitable zones beneath the new fill area.

After all unstable or unsuitable materials have been removed during the site preparation process, and prior to commencing fill placement, it is recommended that horizontal benches be cut into the existing sloping embankment sides to permit placement and compaction of new fill in horizontal lifts. S&ME anticipates that any potential embankment widening will likely require a small horizontal width of new fill soil to be placed on the sides of the existing roadway embankments. These small amounts of fill material, commonly referred to as “sliver fills”, are susceptible to sloughing and instability if the new fill soils are placed and compacted on a sloping existing ground surface without benching.

Because the sides of the existing roadway embankments are generally sloped steeper than 4(H):1(V), S&ME recommends that Special Benching be performed in accordance with ODOT Geotechnical Bulletin GB2, “Special Benching and Sidehill Embankment Fills” (ODOT GB2) dated April 19, 2017, where sidehill “sliver” fills are required. Sketches illustrating several Special Benching configurations for sidehill “sliver” fills on various slopes are included in Figures 1, 2 and 3 on pages 3 and 6 of the ODOT GB2 document. These configurations require a minimum distance of 8 feet between the crest of the bench back-slopes and the face of the new slope to permit compaction and grading equipment to work on a horizontal surface.

To minimize the amount of the existing roadway embankment fill that must be removed to provide sufficient width (minimum 8-foot width) for the compaction equipment during Special Benching, S&ME recommends that consideration be given to utilizing the approach outlined in Figure 1A of the GB2 document to construct an over-steepened slope of temporary fill near the top of the embankment. Once this over-steepened fill has been placed and properly compacted (ODOT CMS Items 203 and 204) to the top of new embankment, the excess portion of the temporary fill may then be “shaved” off to the final designed embankment configuration. The use of smaller (narrower) compaction equipment may be considered to reduce the minimum width (8 feet) between the crest of the bench back-slopes and the face of the new slope.

As stated in the ODOT GB2, wherever "Special Benching" is used, Plan Note G109 from the ODOT L&D Manual, Vol. 3, should be included in the General Notes.

S&ME recommends that the final, completed side slopes of the widened embankments be constructed no steeper than 2(H):1(V). During "Special Benching" procedures, S&ME also recommends the following: 1) only one bench be exposed at any given time and that excavation of the next bench not be permitted until embankment fill placement and compaction have been completed to the top of the backslope of the previous bench; and, 2) the length of any given bench that is exposed should not exceed the quantity of embankment fill which may be properly placed and compacted in one day.

Where new fill is to be placed on an existing ground surface with a slope that is between 4(H):1(V) and 8(H):1(V), benching of the existing ground surface should be performed in accordance with Item 203.05 of the ODOT CMS.

6.3.4 Borrow Requirements and Compaction Criteria

New fill should consist of inorganic soil free of all miscellaneous materials, cobbles, and boulders, which is placed in uniform, thin layers and then compacted in accordance with either Item 203, *"Roadway Excavation and Embankment"*, or when within 12 inches of the proposed subgrade level, Item 204 *"Subgrade Compaction and Proofrolling"*, of the ODOT CMS. Borrow materials should not be placed in a frozen condition or upon a frozen surface, and any sloping surfaces on which new fill is to be placed should first be benched in accordance with either Item 203.05 or ODOT GB2, depending on the slope of the existing ground surface at each location. Also, borrow materials to be used as new fill or backfill within 3 feet of the proposed subgrade level be tested in the laboratory to determine that the borrow materials are capable of exhibiting subgrade support characteristics that are no less than the CBR value used during the pavement design.

Compaction requirements for the construction of earthen embankments are based on ODOT CMS Item 203.07.B (or Item 204.03 when within 12 inches of subgrade level), which specifies a minimum percent compaction based on the dry unit weight of the type of soil fill being placed as borrow. At the time of this submittal, it is unknown if a borrow source will be required for this project. S&ME recommends that, if a borrow site is required, that sampling and testing of this borrow material be performed prior to construction to verify that the borrow soils are suitable for the planned construction.

6.3.5 Compaction/Moisture Conditioning Concerns

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

6.4 Replacement Bridge Foundations

6.4.1 Bridge Type Information

S&ME understands that proposed replacement structure will be a 3-span bridge with precast, pre-stressed concrete I-beams, a reinforced concrete deck, and integral abutments which will be located behind the existing bridge abutments. Plan information from Euthenics indicates that the bottom of the abutment pile caps will be at El. 851 and El. 850.3 at the rear and forward abutments, respectively, and the bottom of the intermediate pier footing will be at El. 835.

The integral abutments will be supported using a single row of vertical 12-inch-diameter, cast-in-place (CIP), reinforced concrete “pipe” piles, whereas the intermediate piers would be supported using two rows of 16-inch-diameter, cast-in-place (CIP), reinforced concrete “pipe” piles where all the piles would be battered outward at a 1(H):4(V) inclination. Euthenics also advised S&ME that 6.2 feet of local scour was anticipated at the intermediate piers, but that no scour was anticipated at the abutments, as spill-through, rip-rapped abutment slopes would be provided in front of each abutment.

6.4.2 Available Geotechnical Exploration

S&ME was authorized to perform three (3) borings at this bridge replacement site. These borings were located behind the existing abutments and near the existing central intermediate pier, which is also near the center of the existing creek channel. No borings were located in the immediate vicinity of proposed intermediate piers for a three-span bridge. Therefore, S&ME used the findings from the borings drilled on either side of each intermediate pier to estimate the required pile foundation length at each pier.

6.4.3 Axial Pile Resistance Analyses

On February 9, 2018, Euthenics provided S&ME with maximum factored axial (vertical) pile loads of 223.3 kips at the integral bridge abutments and 239.2 kips at both intermediate piers. As discussed in Section 6.4.1 above, the proposed substructure units will be supported on extended foundations consisting of vertical 12-inch nominal diameter cast-in-place (CIP) pipe piles at the integral abutments and 1(H):4(V) battered 16-inch nominal diameter cast-in-place (CIP) pipe piles at both intermediate piers.

Plan information from Euthenics indicates that the abutments will be positioned at or slightly behind the current abutments. Therefore, as significant embankment widening is not being planned, downdrag loads acting on the piles supporting the new bridge abutment foundations are not anticipated.

With this pile load information and using the FHWA computer program DRIVEN (Ver. 1.2), S&ME has estimated the pile tip elevations necessary to develop the **unfactored** axial resistance (Ultimate Bearing Value, or R_{ndr}) required to resist the maximum factored axial load per pile anticipated at each substructure unit for the replacement bridge. Table 2 presents a summary of these estimated tip elevations for the piles at each substructure unit and, for the intermediate piers, includes the additional driving resistance necessary to overcome the friction developed by the scour zone soil (R_{ssc}) during intermediate pier pile installation.

Table 2: Summary of Static CIP Pipe Pile Capacity Analyses for Axial Loads

Foundation Element	Proposed CIP Pipe Pile Diam.	Max. Factored Axial Load per pile (kips)	Scour Zone Side Friction (R_{ssc}) (kips) during Pile Installation	UBV (Rndr) Required (kips) During Installation*	Est. Pile Tip Elev. (Static Analysis)
Rear Abutment	12"	223.3	--	319	El. 800
Intermediate Pier #1	16"	239.2	4	346	El. 794-795
Intermediate Pier #2	16"	239.2	4	346	El. 794-797
Forward Abutment	12"	223.3	--	319	El. 798

* UBV = {Factored Load / (ϕ_{DYN}=0.7) } + R_{ssc}

The ODOT Bridge Design Manual specifies that the Ultimate Bearing Value (UBV) for all piles at each substructure unit is to be developed using the highest total factored load anticipated on any pile supporting that substructure unit. Additionally, if the piles are to be subjected to a bending moment, S&ME recommends that the ultimate structural capacity of the piles be evaluated to determine the reduced maximum axial structural capacity of the pile section. This reduced value should not exceed the maximum UBV value used in design.

S&ME estimates that settlement of individual piles will be less than one inch provided the piles are designed and installed in accordance with ODOT specifications and the recommendations presented in this report. All piles should be installed at a center-to-center spacing no closer than 2.5 pile diameters in accordance with AASHTO specifications.

6.4.4 Estimated Pay and Order Lengths for Driven Piles

In accordance with Section 303.4.2.1 of the ODOT Bridge Design Manual, the "Estimated Length" for piling should be estimated by subtracting the estimated pile tip elevation from the estimated pile cut-off elevation (including embedment into the pile cap), and then be rounded up to the nearest 5-foot increment. Pile "Order Length" is the "Estimated Length" plus 5 feet. S&ME recommends that the lowest tip elevation provided for each substructure unit in Table 2 be used to compute these lengths.

At the intermediate piers, however, the Pay and Order lengths must also be increased to accommodate the additional length of the pile required because of the planned 1(H):4(V) batter.

6.4.5 Group Effects and Lateral Loading

All piles should be installed at a center-to-center spacing not be less than 2.5 pile diameters in accordance with AASHTO *LRFD* specification 10.7.1.2. The distance from the side of any pile to the nearest edge of the pile cap shall not be less than 9 inches. The tops of piles shall project at least 12 inches into the pile cap after all damaged material has been removed.

In accordance with Article 10.7.3.9 of the AASHTO *LRFD* manual, if the pile cap is in firm contact with the ground, no reduction in group efficiency is required when piles are installed in cohesive soils with the proper 2.5 diameter center-to-center spacing. In cohesionless soils, no reduction in efficiency factor is anticipated if the piles are spaced no closer than 2.5 diameters apart (center-to-center). It is anticipated that a group efficiency of 1.0 would be applicable if the proper pile spacing is achieved as noted above.

A laterally-loaded (L-Pile) analysis was not part of the authorized scope of work for this exploration. If it is determined that "significant" lateral loading will be applied to the proposed piles, then such analysis should be performed to determine if the piles will be overstressed or if excessive deflections will occur.

6.4.6 Pile Installation and Construction Recommendations

The estimated pile tip elevations in Table 2 were determined using information obtained from the soil borings in conjunction with static pile analysis methods. The actual depths to which individual piles are driven in the field should be a function of the driving criteria determined in accordance with 2016 ODOT Construction and Material Specifications (CMS) Item 523, "Dynamic Load Test".

The ODOT BDM requires a dynamic load test (Item 523) for each required Ultimate Bearing Value for each pile size or type. Item 523 consists of performing dynamic load tests on at least two piles for each UBV at the beginning of construction, and performing subsequent CAPWAP analyses (wave matching) on the data obtained from at least one of the dynamic tests for each UBV. Establishment of the pile driving criteria (final blow count as modified by specific pile hammer ram stroke, bounce chamber pressure, etc.) used for the production piles should be based on the results of the PDA testing and CAPWAP analyses performed during the test pile phase.

The piles, pile driving equipment, and pile installation procedures should conform to ODOT CMS Item 507. The hammer type should be selected in accordance with ODOT CMS Item 507.04, so as to avoid over-stressing the piles. Prior to the commencement of pile driving, the contractor should be required to submit equipment specifications to the state such that the proposed pile hammer, along with the induced stresses in the pile, can be evaluated by wave equation analysis. If excessive compressive or tensile stresses are predicted (FHWA limits driving stresses to 90 percent of F_y) with this method, steps should be taken prior to pile installation to investigate alternative pile hammers or cushions in order to reduce the possibility of damage to the pile. Pile driving may also result in slight heave of previously driven piles. To avoid detrimental effects, all piles should be re-tapped prior to the completion of pile driving activities.

If the abutment or pier locations or bottom of pile cap elevations change, the proposed bridge structure is reconfigured, or the bearing capacity is attained before penetration of 80% of the estimated depth (see

ODOT CMS Item 507.04), S&ME should be given the opportunity to review and revise our foundation recommendations, if warranted.

Because of the presence of existing piling supporting the existing bridge, consideration should be given to positioning the new substructure units in locations which reduce the potential for interference with the piling for the new bridge. Consideration may also be given to providing a contingency for installation of additional new piles to replace piles that are deflected "out-of-plumb" on existing piling, or which refuse at shallow depths on possible former substructure units, timber piling, or other underground obstructions.

In areas where existing piles do not conflict with proposed piling, existing piles may be left in place. S&ME has assumed that no existing piles will be incorporated into or carry load from the new bridge. S&ME also recommends that existing piles left in place be cut off a minimum of two (2) feet below the bottom of any portions of the new structure.

6.4.7 *Additional Pile Driving Considerations - Battered Piles at Intermediate Piers*

For the battered piles at the intermediate piers, determination of the minimum blow count for the battered piles shall be performed in accordance with Item 507.05 of the ODOT CMS. This approach is based on a reduction of the blow count determined by Item 523 for a vertical pile at the same location. However, at the time of this report, Euthenics indicated that all of the piles to be installed at the intermediate piers would be battered. As such, either driving an additional pile at each intermediate pier will be required to determine the driving criteria for the battered piles, or Euthenics may consider re-evaluating the structural design of the intermediate piers to determine whether at least one pile per pier may be driven vertically.

6.4.8 *Pile Foundation Plan Notes*

For the piles at the proposed rear and forward abutments, Note 606.2-2 from the ODOT Bridge Design Manual should be included in the project plans.

> PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value is 319 kips per pile for the vertical rear and forward abutment piles. The Ultimate Bearing Value is 346 kips per pile for the intermediate pier piles, which includes an additional 4 kips per pile of Ultimate Bearing Value due to the possibility of losing 6.2 feet of frictional resistance due to scour.

These Ultimate Bearing Values will need to be reviewed if any of the maximum factored axial loads per pile are revised from those presented in Table 2, or if the anticipated depth of scour changes at any of the substructure elements.

6.4.9 *Scour Considerations*

Information provided by Euthenics indicates that the proposed abutments will be protected from channel flow such that no abutment scour is anticipated. Rip-rap used for this purpose should be properly sized based on the anticipated channel velocities. However, rip-rap is not a permanent countermeasure against, nor does it totally eliminate the potential for scour. For this reason, it is strongly recommended that the project plans and specifications also contain provisions for routine maintenance of the rip-rap blanket to ensure that the design blanket thickness is preserved over the design life of the bridge. Additionally, in all cases where rip-rap is used for scour protection, the bridge must be monitored during and inspected after periods of high flow.

6.5 Lateral Earth Pressures

The proposed bridge must be designed to withstand lateral earth pressures, as well as hydrostatic pressures, that may develop behind the abutments. The magnitude of the lateral earth pressures varies on the basis of soil type, permissible wall movement, and the configuration of the backfill.

To minimize lateral earth pressures, the zone behind the abutments should be backfilled with granular soil, and the backfill should be effectively drained. For effective drainage, a zone of free-draining gravel (ODOT CMS Item 518.03) should be used directly behind the structure for a minimum thickness of 2 feet in accordance with ODOT CMS Item 518.05. This granular zone should drain to either weepholes or a pipe, so that hydrostatic pressures do not develop against the walls.

The type of backfill beyond the free-draining granular zone will govern the magnitude of earth pressure to be used for structural design. Lateral pressures of a relatively low magnitude will be developed by the use of granular backfill, whereas a cohesive (clay) backfill will result in the development of much higher pressures.

To minimize lateral pressures, it is recommended that granular backfill be used behind the walls. The backfill should be placed in a wedge formed by the back of the wall and a line rising from the base of the structure at an angle no greater than 60 degrees from the horizontal. Granular backfill behind the structure should be compacted in accordance with ODOT Item 203, "Roadway Excavation and Embankment", of the most recent CMS. Overcompaction in areas directly behind the wall should be avoided as this might cause damage to the structure.

If proper drainage is provided and compacted granular backfill is provided as described above, an equivalent fluid unit weight of 40 lb/ft^3 (pcf) may be used for abutment design provided a wall movement equivalent to 0.25 percent of the height of the retaining walls (H) is allowed to occur. Such movement is considered sufficient to mobilize an active earth pressure condition. In this case, the resultant lateral force should be taken as acting at 0.33H (AASHTO LRFD Article 3.11.5). If this movement is not anticipated or cannot occur, it is recommended that an "at-rest" equivalent fluid unit weight of 50 pcf be used.

Compacted cohesive materials tend alternatively to shrink, expand and creep over periods of time and create significant lateral pressures on any adjacent structure. Cohesive materials also require a greater amount of movement to mobilize an active earth pressure condition. For these reasons, if proper drainage (ODOT Item 518) is provided and a wall movement in excess of 1.0 percent of the height of the retaining wall (H) is allowed to occur, an equivalent fluid unit weight of 65 pcf may be used for design of the retaining wall to resist the lateral loads imparted by drained cohesive backfill. If this amount of movement is not anticipated or cannot occur, it is recommended that an "at-rest" equivalent fluid unit weight of 90 pcf be used.

The abutments must also be designed to withstand the surcharge effect of traffic in addition to the vertical load resulting from the weight of any fill and pavement to be placed over the structures. To estimate vertical loading, total unit weights of 125 pcf and 135 pcf may be used for compacted cohesive and granular soil, respectively.

6.6 Groundwater Considerations

S&ME believes that the long term groundwater level at this site will be approximately the same as, and vary with, the level of water in Deer Creek. Some water seepage may emanate from granular seams or zones encountered above the level of water in the creek; however, the quantity of water is expected to be limited and may potentially be controlled by bailing or using portable pumps. Provisions for continuous pumping from sumps should be made for the larger groundwater flows that may be encountered in excavations extending below the level of water in the stream.

It is recommended that groundwater and surface water runoff be controlled during construction, as soil in excavation walls or at the proposed foundation level may exhibit instability in the presence of water and construction vibrations. S&ME recommends that the sides and bottoms of all excavations be closely monitored by the Geotechnical Engineer of Record or their designated representative during construction. If the soils at the bottom of an excavation become disturbed by construction activity or channel flow, it is recommended that the disturbed material be undercut and replaced in accordance with the recommendations provided in this report, or be removed and the footing elevation lowered to more suitable soils.

Localized sheeting and continuous dewatering, in conjunction with stream diversion, may aid in minimizing disturbance of the soil at the foundation bearing elevation, and it is recommended that all excavations for the proposed structure foundations be protected from stream, groundwater, and storm water flow. Even with stream flow diversion, provisions for continuous pumping from sumps should be made for the expected larger groundwater flows that may be encountered in excavations extending below the level of water in the stream and into the underlying granular soil.

Additionally, all excavations should be either sloped back or braced in accordance with the most recent OSHA excavation guidelines.

7.0 Final Considerations

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

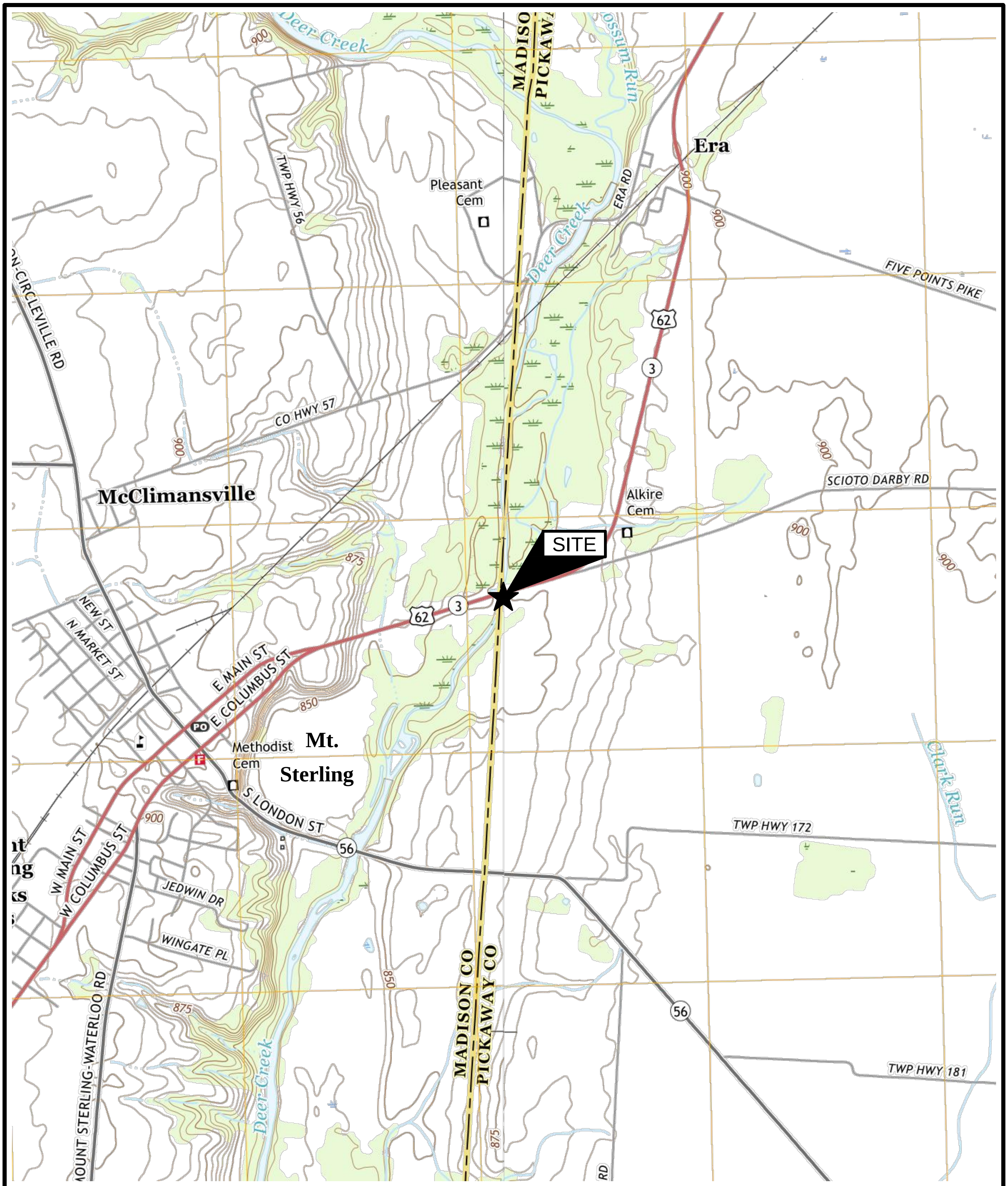
We relied on project information given to us to develop our conclusions and recommendations. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional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

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

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

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

APPENDIX A



USGS Mapping:
Mt. Sterling and
Five Points, Ohio

0 2000 4000

SCALE IN FEET

VICINITY MAP

MAD-62-2.79 - BRIDGE REPLACEMENT
MT. STERLING, OHIO

Project: 1179-17-005		
Drawing Date: 6-20-2017		
Last Updated: 7-12-2017		
Drawn By: KJD		
Approved By: EAA		
Scale: GRAPHIC	1:1	ENGINEERING FIRM. 03530

PLATE 1

Images: ~ Aerial View.jpg ~ s1755625.tif
Xrefs:
File Last Updated: Jul 12, 2017
Plot Info: 7-12-2017 @ 4:48pm By: kdohlen
S&ME Filename: Q:\DEPTS\CADD\Drawings\Projects - BST\2017\1179-17-005-MAD-62\dwg\Construction\POB and VMAP.dwg Layout: V-Map

LEGEND

B-001-0-17 BORING NUMBER AND LOCATION

0 100 200

SCALE IN FEET

PLAN OF BORINGS

MAD-62-2.79 - BRIDGE REPLACEMENT
MT. STERLING, OHIO

Project: 1179-17-005
Drawing Date: 7-12-2017
Last Updated: 7-12-2017
Drawn By: KJD
Approved By: EAA
Scale: GRAPHIC 1:1

ENGINEERING FIRM. 03530

PLATE 2

Images: ~ Aerial View.jpg ~ s1755625.tif
Xrefs:
File Last Updated: Jul 12, 2017
Plot Info: 7-12-2017 @ 4:47pm By: kdohlen
S&ME Filename: Q:\DEPTS\CADD\Drawings\Projects - BST\2017\1179-17-005-MAD-62\dwg\Construction\POB and VMAP.dwg Layout: 8.5x11P

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

SAMPLING DATA

▮ - Indicates sample was attempted within this depth interval.

2 3 5 - The number of blows required for each 6-inch increment of penetration of a “Standard” 2-inch O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches (SPT). The raw “blowcount” or “N” is equal to the sum of the second and third 6-inch increments of penetration.

N_{60} - Corrected Blowcount = [(Drill Rod Energy Ratio) / (0.60 Standard)] X N

SS - Split-barrel sampler, any size.

ST - Shelby tube sampler, 3″ O.D., hydraulically pushed.

R - Refusal of sampler in very-hard or dense soil, or on a resistant surface.

50-0.3′ - Number of blows (50) to drive a split-barrel sampler a certain distance (0.3 feet), other than the normal 6-inch increment.

DEPTH DATA

W - Depth of water or seepage encountered during drilling.

▼ AD - Depth to water in boring after drilling (AD) is terminated.

▼ 5 days - Depth to water in monitoring well or piezometer in boring a certain number of days (5) after termination of drilling.

TR - Depth to top of rock.

SOIL DESCRIPTIONS

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

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

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

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

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

PLATE 3

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/5/17 END: 6/6/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 12+94, 10' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 862.9 (MSL) EOB: 75.0 ft.
LAT / LONG: 39.725119 N, 83.250567 W

EXPLORATION ID
B-001-0-17

PAGE
1 OF 3

MATERIAL DESCRIPTION AND NOTES	ELEV. 862.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT - 10 INCHES	862.1																	▨
GRANULAR BASE - 14 INCHES	860.9	1																
FILL: Stiff to very-stiff brown **SILT AND CLAY**, little fine to coarse sand, trace fine gravel, few medium-stiff zones, damp.	859.4	2 3	2 2 3	8	33	SS-1	0.5-2.5	-	-	-	-	-	-	-	-	14	A-6a (V)	
FILL: Stiff light-brown **SANDY SILT**, some clay, little fine gravel, damp.	857.9	4 5	2 2 2	7	56	SS-2	1.5-1.75	11	9	18	40	22	24	15	9	14	A-4a (5)	
FILL: Medium-stiff to stiff brown **SILT AND CLAY**, some fine to coarse sand, trace fine gravel, damp to moist.	856.4	6	2 2 2	7	56	SS-3	0.5-1.5	3	8	18	43	28	28	15	13	20	A-6a (8)	
FILL: Soft to stiff brown **SANDY SILT**, some clay, trace fine gravel, moist.	853.6	7 8	1 2 1	5	61	SS-4	0.7-1.1	-	-	-	-	-	-	-	-	15	A-6a (V)	
PROBABLE FILL: Medium-stiff to stiff brown becoming dark-brown **CLAY**, "and" silt, little fine to coarse sand, trace fine gravel, slightly organic (SS-6/SS-8A) to moderately organic (SS-7), few pockets of topsoil, moist. - Sample SS-7: LOI = 8.3%. - Sample SS-8A: LOI = 1.5%.		9 10	1 1 1	3	89	SS-5A	0.25-0.6	10	12	18	39	21	24	15	9	17	A-4a (5)	
						SS-5B	0.25	-	-	-	-	-	-	-	-	22	A-4a (V)	
		11 12	1 2 2	7	72	SS-6	0.5-1.5	4	2	17	46	31	48	25	23	31	A-7-6 (15)	
		13 14 15	3 2 3	8	67	SS-7	1.0-2.0	-	-	-	-	-	-	-	-	41	A-7-6 (V)	
	845.9	16 17	2 2 3	8	100	SS-8A	1.6-1.7	0	1	24	36	39	48	21	27	32	A-7-6 (16)	
Soft to medium-stiff brown **SILTY CLAY**, some fine to coarse sand, trace fine gravel, slightly organic, damp.	844.6					SS-8B	0.6	-	-	-	-	-	-	-	-	30	A-6b (V)	
		18			98	ST-9	0.25-0.75	7	4	23	37	29	36	18	18	29	A-6b (9)	
Dense brown **GRAVEL WITH SAND**, little silt, little clay, wet.		W 19 20 21	8 12 13	42	100	SS-10	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
	839.9	22	8 12 16	47	78	SS-11	-	42	28	12	14	4	NP	NP	NP	12	A-1-b (0)	
Dense to very-dense gray fine to coarse **GRAVEL**, some fine to coarse sand, trace silt, trace clay, wet.		23 24	9 14 13	45	72	SS-12	-	60	19	9	10	2	NP	NP	NP	9	A-1-a (0)	
		25 26	7 15 15	50	67	SS-13	-	65	18	7	8	2	NP	NP	NP	9	A-1-a (0)	
	835.6	27	7 5 5	17	0	--	-	-	-	-	-	-	-	-	-	-		
Very-stiff to hard gray **SILTY CLAY**, little fine to coarse sand, trace fine gravel, slightly organic, damp.		28 29	4 7 11	30	100	SS-14	3.5-4.5+	5	5	15	38	37	33	15	18	14	A-6b (11)	

PID: 102577 | BR ID: | PROJECT: MAD-62-2.79 | STATION / OFFSET: 12+94, 10' LT | START: 6/5/17 | END: 6/6/17 | PG 2 OF 3 | **B-001-0-17**

MATERIAL DESCRIPTION AND NOTES	ELEV. 832.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Very-stiff to hard gray **SILTY CLAY**, little fine to coarse sand, trace fine gravel, slightly organic, damp. *(continued)*	830.9	31 32																
Very-stiff to hard gray **CLAY**, some silt, trace fine to coarse sand, trace fine gravel, damp.		33 34 35	5 9 12	35	100	SS-15	2.75- 4.5+	-	-	-	-	-	-	-	-	14	A-7-6 (V)	
		36 37 38 39 40	4 5 9	23	100	SS-16	3.25- 4.5+	1	1	11	34	53	52	19	33	22	A-7-6 (18)	
	821.4	41																
Hard brown mottled with gray **SILTY CLAY**, little fine to coarse gravel, little fine to coarse sand, damp.		42 43 44 45	12 14 19	55	100	SS-17	4.5	-	-	-	-	-	-	-	-	13	A-6b (V)	
	816.4	46																
Hard gray **SANDY SILT**, some silt, some clay, little fine to coarse gravel, damp.		47 48 49 50	11 15 20	58	100	SS-18	4.5+	12	9	17	36	26	23	13	10	11	A-4a (5)	
		51 52 53 54 55	12 17 25	70	100	SS-19	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		56 57 58 59 60	15 22 29	85	100	SS-20	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		61																

PID: 102577 | BR ID: | PROJECT: MAD-62-2.79 | STATION / OFFSET: 12+94, 10' LT | START: 6/5/17 | END: 6/6/17 | PG 3 OF 3 | **B-001-0-17**

MATERIAL DESCRIPTION AND NOTES	ELEV. 800.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Hard gray **SANDY SILT**, some silt, some clay, little fine to coarse gravel, damp. *(continued)*		63																
		64 – 65	12 22 39	102	100	SS-21	4.5+	13	9	14	38	26	24	14	10	10	A-4a (6)	
		66 – 68																
		69 – 70	12 24 34	97	100	SS-22	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		71 – 73																
	787.9	74 – 75 EOB	14 20 30	83	100	SS-23	4.5+	8	8	14	43	27	24	15	9	11	A-4a (7)	

NOTES:
- Groundwater encountered at 19.0' during drilling.
- From 17.5' to 18.0': Unconfined Compression Test = 1,123 psf.
- Water and bentonite powder added at 26.0' to prevent sand heave.
- After removal of augers, boring caved at 16.0' and was observed to be dry.
- Borehole sealed with bentonite and cement grout.

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; 12 LB. BENTONITE POWDER; 94 LB. CEMENT; 1 PLASTIC HOLE PLUG DEVICE; 35 GAL. WATER

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/8/17 END: 6/9/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 14+28, 9' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 863.1 (MSL) EOB: 80.0 ft.
LAT / LONG: 39.725220 N, 83.250109 W

EXPLORATION ID
B-002-0-17

PAGE
1 OF 3

MATERIAL DESCRIPTION AND NOTES	ELEV. 863.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 2-1/2 INCHES	862.9																	▩
CONCRETE - 8-1/2 INCHES	862.1																	
AIR - 18 FEET	844.1																	
WATER - 4 FEET	840.1	W																
Very-stiff to hard gray **SILT AND CLAY**, some fine to coarse gravel, some fine to coarse sand, damp.			1 4 3	12	44	SS-1	2.5-4.1	17	9	16	33	25	25	14	11	13	A-6a (5)	
	837.1		1 3 2	8	56	SS-2	3.1	22	10	15	31	22	26	15	11	13	A-6a (4)	
Very-stiff to hard gray **SILTY CLAY**, some fine to coarse sand, trace fine gravel, damp.			4 4 8	20	72	SS-3	4.5	6	5	14	48	27	31	14	17	14	A-6b (11)	
			4 4 9	22	83	SS-4	3.75	4	6	14	49	27	33	14	19	14	A-6b (12)	

DEPTHS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

PID: 102577	BR ID:	PROJECT: MAD-62-2.79	STATION / OFFSET: 14+28, 9' LT	START: 6/8/17	END: 6/9/17	PG 2 OF 3	**B-002-0-17**

MATERIAL DESCRIPTION AND NOTES	ELEV. 833.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Very-stiff to hard gray **SILTY CLAY**, some fine to coarse sand, trace fine gravel, damp. *(continued)*		31 32	4 8 12	33	72	SS-5	4.5+	-	-	-	-	-	-	-	-	14	A-6b (V)	
		34 35	4 8 13	35	100	SS-6	4.5+	-	-	-	-	-	-	-	-	13	A-6b (V)	
	825.1	36 37	5 8 14	37	67	SS-7	4.5+	3	6	17	49	25	31	14	17	13	A-6b (11)	
Very-stiff to hard gray **CLAY**, some "and" silt, little fine to coarse sand, trace fine gravel, damp.		39 40	4 7 10	28	100	SS-8	3.5- 4.5+	0	2	13	50	35	43	16	27	19	A-7-6 (15)	
		41 42	4 8 9	28	100	SS-9	3.1- 4.1	1	2	13	35	49	49	19	30	20	A-7-6 (18)	
	817.6	44 45	4 7 15	37	67	SS-10	2.75- 4.5+	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
Hard brown **SANDY SILT**, some clay, trace fine gravel, damp.		46 47	7 15 18	55	100	SS-11	4.5+	9	8	17	41	25	22	14	8	11	A-4a (6)	
		49 50	5 17 18	58	100	SS-12	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	
	811.1	51 52																
Hard gray **SANDY SILT**, some clay, little fine to coarse gravel, damp.		54 55	8 14 19	55	100	SS-13	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
		59 60	10 15 18	55	100	SS-14	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		61																

PID: 102577 | BR ID: | PROJECT: MAD-62-2.79 | STATION / OFFSET: 14+28, 9' LT | START: 6/8/17 | END: 6/9/17 | PG 3 OF 3 | **B-002-0-17**

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Hard gray **SANDY SILT**, some clay, little fine to coarse gravel, damp. *(continued)*	801.0	63																
		64–65	7 14 17	52	100	SS-15	4.5+	14	7	14	37	28	25	15	10	11	A-4a (6)	
		66–68																
		69–70	7 10 13	38	100	SS-16	4.5	-	-	-	-	-	-	-	-	12	A-4a (V)	
		71–73																
		74–75	10 17 26	72	100	SS-17	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		76–78																
	783.1	79–80 EOB	10 15 21	60	100	SS-18	4.5+	10	8	14	41	27	24	15	9	12	A-4a (7)	

NOTES:

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/6/17 END: 6/7/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 15+80, 8' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 862.3 (MSL) EOB: 80.0 ft.
LAT / LONG: 39.725336 N, 83.249588 W

EXPLORATION ID
B-003-0-17
PAGE
1 OF 3

MATERIAL DESCRIPTION AND NOTES	ELEV. 862.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI			
ASPHALT - 9 INCHES	861.5																	
GRANULAR BASE - 15 INCHES	860.3																	
FILL: Stiff-very stiff brown **SILT AND CLAY**, some fine to coarse sand, trace to little fine gravel, few pockets of fine to coarse sand, few roots, damp.			1 2 3	8	78	SS-1A SS-1B	1.0-3.5 1.5-4.25	- 11	- 11	- 18	- 36	- 24	- 25	- 14	- 11	12 14	A-6a (V) A-6a (5)	
	857.3		2 1 3	7	67	SS-2	1.6-2.1	10	9	21	33	27	29	15	14	17	A-6a (7)	
PROBABLE FILL: Medium-stiff to stiff dark-brown **CLAY**, some silt, little to some fine to coarse sand, trace to little fine to coarse gravel, slightly becoming moderately organic, few very-soft zones, damp.			2 1 2	5	22	SS-3	0.5-0.75	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
			1 2 3	8	11	SS-4	0.5	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
- From 8.0' to 8.5': Unconfined Compression Test = 1,209 psf.					88	ST-5	0.1-0.6	14	3	11	37	35	51	27	24	33	A-7-6 (15)	
- SS-6: LOI = 6.5% OD/AD LL Ratio = 0.80.	849.3		2 2 3	8	67	SS-6	0.5-1.25	0	3	17	44	36	55	29	26	37	A-7-6 (17)	
Stiff dark-brown **ELASTIC CLAY**, "and" silt, little fine to coarse sand, trace fine gravel, moderately organic, damp. - SS-7: LOI = 7.4%.	846.8		1 2 3	8	78	SS-7	1.0-1.6	1	2	11	47	39	54	30	24	37	A-7-5 (16)	
Medium-stiff dark-brown **CLAY**, "and" silt, some fine sand, trace coarse sand, trace fine gravel, moderately organic. - SS-8: OD/AD LL Ratio = 0.76.	844.3		2 4 11	25	56	SS-8	0.6-1.75	5	6	20	37	32	51	26	25	33	A-7-6 (15)	
Medium-dense brown **GRAVEL WITH SAND**, little silt, trace clay, wet.	841.8	W	3 5 4	15	33	SS-9	-	49	27	9	13	2	NP	NP	NP	14	A-1-b (0)	
Dense to very-dense brown fine to coarse **GRAVEL**, some fine to coarse sand, trace silt, trace clay, wet.			7 10 13	38	67	SS-10	-	69	15	6	8	2	-	-	-	11	A-1-a (V)	
			11 15 15	50	78	SS-11	-	62	18	8	9	3	NP	NP	NP	9	A-1-a (0)	
			11 24 14	63	67	SS-12	-	66	17	6	8	3	NP	NP	NP	8	A-1-a (0)	
	834.6		4 16 17	55	78	SS-13	-	58	21	9	9	3	NP	NP	NP	10	A-1-a (0)	
Very-stiff to hard gray **SANDY SILT**, little fine gravel, little clay, damp.			3 11 13	40	56	SS-14	2.4-4.5+	17	13	17	35	18	21	14	7	12	A-4a (4)	

PID: 102577 | BR ID: | PROJECT: MAD-62-2.79 | STATION / OFFSET: 15+80, 8' LT | START: 6/6/17 | END: 6/7/17 | PG 2 OF 3 | **B-003-0-17**

MATERIAL DESCRIPTION AND NOTES	ELEV. 832.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Very-stiff to hard gray **SANDY SILT**, little fine gravel, little clay, damp. *(continued)*	829.6	31 32																
Very-stiff to hard gray **CLAY**, some silt, little fine to coarse sand, trace fine gravel, damp.		33																
		34	5 8 10	30	100	SS-15	4.5+	-	-	-	-	-	-	-	-	13	A-7-6 (V)	
		35 36 37 38																
		39	4 7 10	28	100	SS-16	3.1-4.5	1	2	13	35	49	46	17	29	19	A-7-6 (17)	
	820.3	40 41 42																
Hard gray **SILT AND CLAY**, little fine to coarse sand, trace fine gravel, damp.		43																
		44	9 14 15	48	100	SS-17	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
	815.3	45 46 47																
Hard gray **SANDY SILT**, some fine to coarse gravel, little clay, damp.		48																
		49	4 15 24	65	44	SS-18	4.5+	23	15	22	27	13	18	13	5	9	A-4a (1)	
	811.3	50 51																
Hard gray **SILT AND CLAY**, some fine to coarse sand, little fine to coarse gravel, damp.		52 53																
		54	16 18 25	72	100	SS-19	4.5+	14	8	13	38	27	25	14	11	11	A-6a (6)	
		55 56 57 58																
		59	9 14 20	57	67	SS-20	4.5+	-	-	-	-	-	-	-	-	11	A-6a (V)	
	800.3	60 61																

S&ME JOB: 1179-17-005

PID: 102577	BR ID:	PROJECT: MAD-62-2.79	STATION / OFFSET: 15+80, 8' LT	START: 6/6/17	END: 6/7/17	PG 3 OF 3	**B-003-0-17**

MATERIAL DESCRIPTION AND NOTES	ELEV. 800.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Hard gray **SANDY SILT**, some fine to coarse gravel, some fine to coarse sand, damp. *(continued)*		63																
		64 65	13 18 26	73	100	SS-21	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		66 67 68																
		69 70	13 16 17	55	100	SS-22	4.5	21	9	12	36	22	23	14	9	11	A-4a (5)	
		71 72 73																
		74 75	14 16 26	70	100	SS-23	4.5+	-	-	-	-	-	-	-	-	13	A-4a (V)	
		76 77 78																
	782.3	79 EOB 80	12 16 27	72	78	SS-24	4.5	9	8	13	41	29	25	15	10	12	A-4a (7)	

<u>NOTES</u>:
- Groundwater encountered at 18.5' during drilling.
- Water added at 21.0' to prevent sand heave.
- Borehole sealed with bentonite and cement grout.

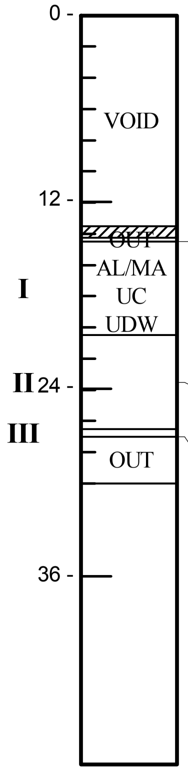
NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; 15 LB. BENTONITE POWDER; 94 LB. CEMENT; PLASTIC HOLE PLUG DEVICE; 35 GAL. WATER

JOB NUMBER : **1179-17-005**
PROJECT : **MAD-62-2.79**
LOCATION : **Mt. Sterling, Ohio**

LABORATORY LOG OF SHELBY TUBES

Boring : **B-001-0-17** Sample : **S-7**
Depth : **17.5' -18.8'** Recovery : **15.25"**



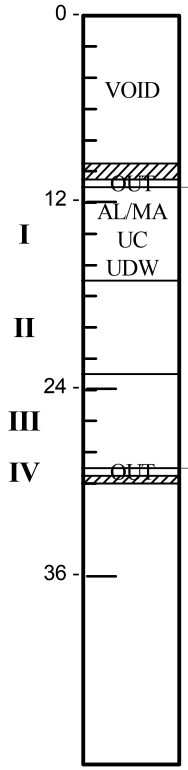
Soft to medium-stiff dark gray **SILTY CLAY**,some fine to coarse sand, trace fine to coarse gravel, damp.

H = 0.25
H = 0.75

Dark-gray GRAVEL WITH SAND, little silt, little clay, damp.

30" Shelby Tube

Boring : **B-003-0-17** Sample : **S-5**
Depth : **8.0' - 9.8'** Recovery : **19"**



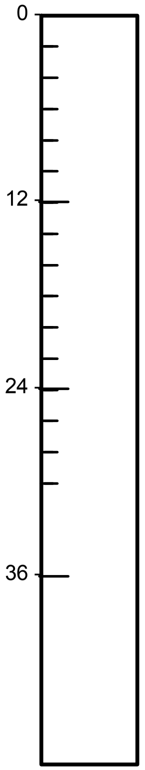
Very-soft to medium-stiff dark-gray **SILT AND CLAY** , little fine to coarse sand, little fine to coarse gravel, slightly organic, damp.

H = 0.1 - .25
H = 0.5 - 0.6

H = 0.5 - 0.65

30" Shelby Tube

Boring : Sample :
Depth : Recovery :



LEGEND

■ - Consolidation, Incremental
C R S - Consolidation, C R S
P P - Permeability, Vertical / Horizontal
☐ Swelling, Test
▨ - Wax
◪ - Unconfined Compression Test
☒ - Triaxial Compression Test

H - Hand Penetrometer (tsf)
Ds - Direct Shear
LOI - Loss on Ignition
AL - Atterberg Limits
MA - Sieve/Hydrometer
SG - Specific Gravity

TV - Torvane (tsf)
POR - Porosity
UDW - Unit Dry Weight
MC - Moisture Content
D_R - Relative Density
S - Sieve

UNCONFINED COMPRESSION TEST REPORT

ASTM D2166

PROJECT INFORMATION

CLIENT: Euthenics, Inc.
PROJECT NUMBER: 1179-17-005
PROJECT NAME: MAD-62-2.79
PROJECT LOCATION: Mount Sterling, Ohio

SAMPLE INFORMATION

BORING ID: B-001-0-17
SAMPLE NUMBER: S-9
SAMPLE DEPTH: 17.5' - 18.0'
DATE OF TEST: 7/6/2017

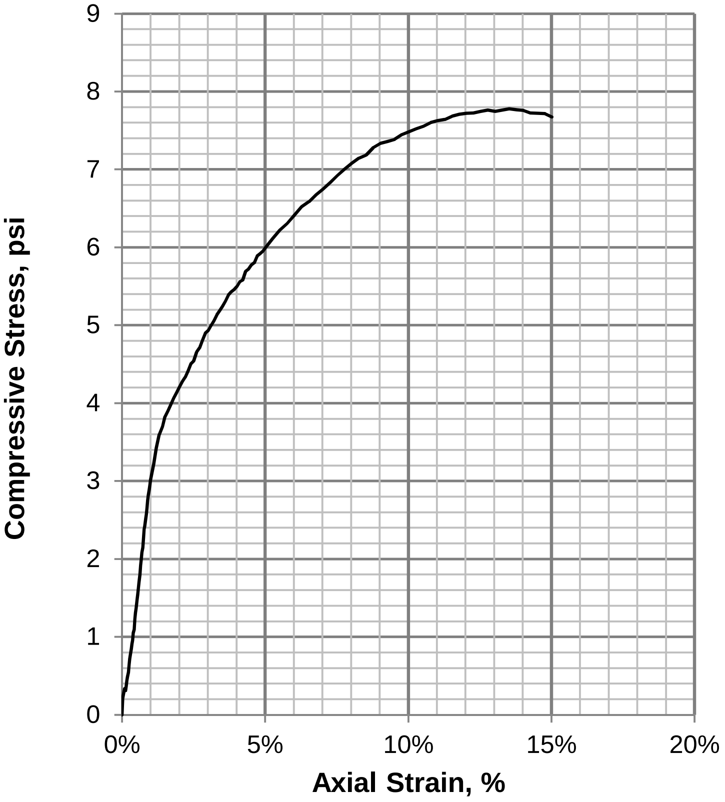
SAMPLE DESCRIPTION: Very soft to medium-stiff, dark brown, SILTY CLAY, some fine to coarse sand, trace fine gravel

SPECIMEN MEASUREMENTS

MOISTURE CONTENT:	30.71%	
AVERAGE DIAMETER:	2.8082	in.
AVERAGE HEIGHT:	5.6012	in.
HEIGHT/DIAMETER RATIO:	1.99	
WET DENSITY:	115.17	pcf
DRY DENSITY:	88.11	pcf
SPECIFIC GRAVITY:	2.75	(est.)
SATURATION:	89.04%	(est.)
VOID RATIO:	0.9485	(est.)

TEST RESULTS

MAXIMUM LOAD:	**56**	lbs
UNCONFINED STRENGTH:	**7.8**	psi
STRAIN RATE:	**1%**	%/min
STRAIN AT FAILURE:	**13.53%**	%



ADDITIONAL TESTING REMARKS:

TESTED BY: KJD

CHECKED BY: RSW

SPECIMEN BEFORE TESTING

NO PHOTO AVAILABLE

SPECIMEN AFTER TESTING

NO PHOTO AVAILABLE

UNCONFINED COMPRESSION TEST REPORT

ASTM D2166

PROJECT INFORMATION

CLIENT: Euthenics, Inc.
PROJECT NUMBER: 1179-17-005
PROJECT NAME: MAD-62-2.79
PROJECT LOCATION: Mount Sterling, Ohio

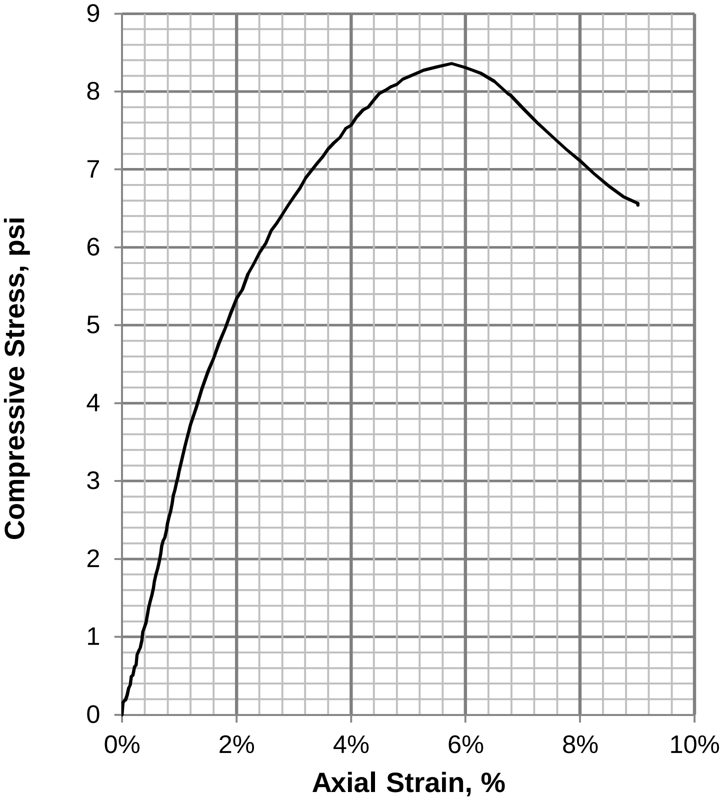
SAMPLE INFORMATION

BORING ID: B-003-0-17
SAMPLE NUMBER: S-5
SAMPLE DEPTH: 8.0' - 8.5'
DATE OF TEST: 7/6/2017

SAMPLE DESCRIPTION: Very-soft to medium-stiff, dark brown, CLAY, some silt, little fine to coarse gravel, little fine to coarse sand.

SPECIMEN MEASUREMENTS

MOISTURE CONTENT:	39.05%	
AVERAGE DIAMETER:	2.8342	in.
AVERAGE HEIGHT:	5.5940	in.
HEIGHT/DIAMETER RATIO:	1.97	
WET DENSITY:	113.08	pcf
DRY DENSITY:	81.33	pcf
SPECIFIC GRAVITY:	2.75	(est.)
SATURATION:	96.65%	(est.)
VOID RATIO:	1.1110	(est.)



TEST RESULTS

MAXIMUM LOAD:	**56**	lbs
UNCONFINED STRENGTH:	**8.4**	psi
STRAIN RATE:	**1%**	%/min
STRAIN AT FAILURE:	**5.76%**	%

ADDITIONAL TESTING REMARKS:

TESTED BY: KJD

CHECKED BY: RSW

SPECIMEN BEFORE TESTING

NO PHOTO AVAILABLE

SPECIMEN AFTER TESTING

NO PHOTO AVAILABLE

Scour Zone Grain-Size Information
Abutment and Pier Borings
MAD-62-2.79 over Deer Creek
Madison County, Ohio

Boring Number	Location	Sample Depth	Sample Elevation (MSL)	D50 (mm)	D95 (mm)
B-001-0-17	Rear Abutment	21.5 - 23.0	839.9 - 841.4	1.3922	29.9007
		23.0 - 24.5	838.4 - 839.9	3.9326	30.5077
		24.5 - 26.0	836.9 - 838.4	5.1922	32.2722
		26.0 - 27.5	No Recovery		
		28.5 - 30.0	832.9 - 834.4	0.0128	1.5060
B-002-0-17	Center Pier	23.0 - 24.5	838.6 - 840.1	0.0376	13.7463
		24.5 - 26.0	837.1 - 838.6	0.0558	8.4188
		26.0 - 27.5	835.6 - 837.1	0.0189	2.4746
		27.5 - 29.0	834.1 - 835.6	0.0182	1.4140
B-003-0-17	Forward Abutment	21.0 - 22.5	839.8 - 841.3	6.0284	28.7310
		22.5 - 24.0	838.3 - 839.8	4.3005	29.5872
		24.0 - 25.5	836.8 - 838.3	6.3713	26.8127
		25.5 - 26.0	835.3 - 836.8	3.7968	26.6974
		28.5 - 30.0	832.3 - 833.8	0.0618	8.1744

Important Information About Your
Geotechnical Engineering Report

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

Geotechnical Findings Are Professional Opinions

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

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

Geotechnical Findings Are Professional Opinions

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

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

Services Are Performed for Specific Projects

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

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

Geo-Environmental Issues

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

Geotechnical Recommendations Are Not Final

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

Portion obtained with permission from "Important Information About Your Geotechnical Engineering Report", ASFE, 2004

APPENDIX B

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Rear Abutment
Boring B-001
12" ϕ pipe pile

Filename: P:\TEMPOR~1\DRIVEN~1.2\MAD-62\2RAG12RW.DVN
Project Name: MAD-62-2.79 Project Date: 03/05/2018
Project Client: Euthenics
Computed By: RSW
Project Manager: RSW

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft (EL. 851) (Bottom of Abut. Cap)
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	5.40 ft
	- Driving/Restrike	5.40 ft
	- Ultimate:	5.40 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	5.40 ft	0.00%	115.00 pcf	1000.00 psf	T-79 Steel
2	Cohesionless	9.00 ft	0.00%	130.00 pcf	36.0/36.0	Nordlund
3	Cohesive	14.20 ft	0.00%	120.00 pcf	3000.00 psf	T-80 Sand
4	Cohesive	5.00 ft	0.00%	125.00 pcf	4500.00 psf	T-79 Steel
5	Cohesionless	28.50 ft	0.00%	130.00 pcf	35.0/35.0	Nordlund

- Info from Euthenics (2/9/18):
  - No DD (New Abut Behind Existing
  - Rear Abut Bottom EL. = 851.0
  - Max. Factored Axial Load (vertical) (Integral Abut.) = 223.3 kips

Rndr (UBV) Req'd = $\frac{223.3}{0.7}$ = 319 kips (Integral)

- Max. Factored Axial Load (Vert.) (Semi-Integral Abut) = 111.7 kips

Rndr (UBV) Req'd = $\frac{111.7}{0.7}$ = $159.6^k \Rightarrow 160^k$ (Semi-Integral)

- No Scour (Riprapped Foreslope)

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.03 Kips	7.07 Kips	7.09 Kips
5.39 ft	13.55 Kips	7.07 Kips	20.62 Kips
5.41 ft	13.58 Kips	26.27 Kips	39.85 Kips
14.39 ft	26.92 Kips	51.92 Kips	78.84 Kips
14.41 ft	27.03 Kips	21.21 Kips	48.24 Kips
23.41 ft	111.86 Kips	21.21 Kips	133.06 Kips
28.59 ft ← x_2	146.67 Kips	21.21 Kips	167.87 Kips ← 160^k
28.61 ft	146.75 Kips	31.81 Kips	178.56 Kips
33.59 ft	164.83 Kips	31.81 Kips	196.64 Kips
33.61 ft	164.90 Kips	79.23 Kips	244.13 Kips
42.61 ft	198.37 Kips	84.51 Kips	282.87 Kips
51.61 ft ← x_1	239.47 Kips	84.51 Kips	323.98 Kips ← 319^k
60.61 ft	288.22 Kips	84.51 Kips	372.72 Kips
62.09 ft	296.96 Kips	84.51 Kips	381.47 Kips

Find x_1 for Integral Abutment

$$\frac{319-282.87}{323.98-282.87} = \frac{36.13}{41.11} = 0.88$$

then, $x_1 = 42.61 + 0.88[51.61-42.61] = 42.61 + 7.92 = 50.53'$ Say 51 feet $= x_1$

So, Est. Tip Elevation = Bot. Abut Cap − x_1

= El.851 − 51' = EL. 800 (12"ϕ CIP Pile)(Integral Abut.)

Est. Pay 51 + 2' $\overset{cap}{\text{embedm}}$ = 53 round to 55'

Order Length = Pay + 5 = 60'

Find x_2 for Semi-Integral Abutment

$x_2 = 27.42'$ Say 28'

Est. Tip = 851 − 28' = $\overset{\sim EL}{823}$

→ EL. 823 = Est. Tip Elevation (Semi-integral) (12"ϕ CIP Pile)

Check Available Soil Info Below Integral Abut Pile Tip

Bot. of Info = 62.09
Est Tip = 51
11.09 feet of Boring Info Below Tip

Does this exceed 5D? Yes ✓

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: P:\TEMPOR~1\DRIVEN~1.2\MAD-62\B1P116RW.DVN
Project Name: MAD-62-2.79 Project Date: 03/05/2018
Project Client: Euthenics
Computed By: RSW
Project Manager: RSW

- Intermed Pier #1
- Boring B-001
- 16" ϕ pipe Pile
- Scour = 6.2'
- Ex. Channel ≅ EL. 840

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 5.00 ft (EL. 835)
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	6.20 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.40 ft	0.00%	130.00 pcf	36.0/36.0	Nordlund
2	Cohesive	14.20 ft	0.00%	120.00 pcf	3000.00 psf	T-79 Steel
3	Cohesive	5.00 ft	0.00%	125.00 pcf	4500.00 psf	T-79 Steel
4	Cohesionless	28.50 ft	0.00%	130.00 pcf	35.0/35.0	Nordlund

-From Euthenics (2/9/18):

Bottom of Pier Ftg = EL. 835

MAX. Factored Axial (Vertical) Load per pile ⇒ 239.2 kips

R_{ndr} (UBV) Req'd ⇒ 239.2/0.7 = 341.7^k ⇒ 342 kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.39 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.41 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	37.70 Kips	37.70 Kips
13.41 ft	27.86 Kips	37.70 Kips	65.56 Kips
18.59 ft	48.79 Kips	37.70 Kips	86.49 Kips
18.61 ft	48.86 Kips	56.55 Kips	105.41 Kips
23.59 ft	67.55 Kips	56.55 Kips	124.10 Kips
23.61 ft	67.63 Kips	86.84 Kips	154.47 Kips
32.61 ft	112.38 Kips	122.99 Kips	235.38 Kips
41.61 ft	172.84 Kips	150.24 Kips	323.08 Kips ←
50.61 ft	249.01 Kips	150.24 Kips	399.24 Kips
52.09 ft	263.03 Kips	150.24 Kips	413.27 Kips

Calculate Skin Friction in Scour Zone (6.2 feet)

$$\frac{6.2-5.0}{13.41-5.0} = \frac{1.2}{8.41} = 0.143$$

then, $0 + 0.143(27.86-0) = 0 + 3.98^k = 3.98^k \Rightarrow$ **4 kips** skin friction during driving in scour zone

Next Sheet

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.39 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.41 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.19 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.20 ft	0.00 Kips	37.70 Kips	37.70 Kips
13.41 ft	23.89 Kips	37.70 Kips	61.59 Kips
18.59 ft	44.48 Kips	37.70 Kips	82.18 Kips
18.61 ft	44.56 Kips	56.55 Kips	101.10 Kips
23.59 ft	63.24 Kips	56.55 Kips	119.79 Kips
23.61 ft	63.32 Kips	86.84 Kips	150.16 Kips
32.61 ft	108.07 Kips	123.81 Kips	231.88 Kips
41.61 ft ← x	168.53 Kips	150.24 Kips	318.77 Kips ← 346^k
50.61 ft	244.70 Kips	150.24 Kips	394.93 Kips
52.09 ft	258.73 Kips	150.24 Kips	408.96 Kips

Rndr (UBV) required during installation

Rndr + Scour Zone Friction $= 342^k + 4^k \Rightarrow \boxed{346^k = \text{Rndr}}$

So, $\dfrac{346^k - 318.77}{394.93 - 318.77} = \dfrac{27.23}{76.16} = 0.358$

then, $41.61 + 0.358[50.61 - 41.61] = 41.61 + 3.222$

$= 44.83' \Longrightarrow$ Say 45'!

Est. Tip El. $\Longrightarrow$ EL. 840 − 45' $\Rightarrow$ EL. 795 = Est. Tip Elevation (16"φ CIP Pile)

(Est. Pile Length = 835 − 795 = 40'
plus 2' cutoff = 42' $\Longrightarrow$ Est. Length = 45'

Order Length = 50'

Check Remaining Soil/Boring Info Below Tip

Max. Depth of Info = 52.09'
− 45
7.09'

Is 7.09' > 5 x D? Yes ✓

5 x 1.33 = 6.65'

Now, check Pier #1 Pile Depth Req'd using Boring B-002

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: P:\TEMPOR~1\DRIVEN~1.2\MAD-62\B2PS16RW.DVN
Project Name: MAD-62-2.79 Project Date: 03/05/2018
Project Client: Euthenics
Computed By: RSW
Project Manager: RSW

- Intermediate Pier #1 & #2
- Boring B-002
- 16"ϕ pipe pile
- Scour = 6.2'
- Ex. Channel @ ~EL. 840

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 5.00 ft
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	6.20 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	0.00%	120.00 pcf	2500.00 psf	T-79 Steel
2	Cohesive	4.00 ft	0.00%	120.00 pcf	4000.00 psf	T-79 Steel
3	Cohesive	8.00 ft	0.00%	125.00 pcf	4500.00 psf	T-79 Steel
4	Cohesive	7.40 ft	0.00%	120.00 pcf	3250.00 psf	T-79 Steel
5	Cohesionless	34.50 ft	0.00%	130.00 pcf	35.0/35.0	Nordlund

From Euthenics (2/9/18):

- Bottom of Pier / Top of Pile = EL 835
- Max. Factored Axial (Vert.) Load/pile => 239.2 kips

Rndr Req'd = 342 kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	50.27 Kips	50.27 Kips
6.99 ft	6.42 Kips	50.27 Kips	56.68 Kips
7.01 ft	6.48 Kips	56.55 Kips	63.03 Kips
14.99 ft	32.90 Kips	56.55 Kips	89.45 Kips
15.01 ft	32.97 Kips	40.84 Kips	73.81 Kips
22.39 ft	60.21 Kips	40.84 Kips	101.05 Kips
22.41 ft	60.29 Kips	80.87 Kips	141.16 Kips
31.41 ft	102.50 Kips	117.23 Kips	219.73 Kips
40.41 ft	160.43 Kips	150.24 Kips	310.67 Kips
49.41 ft	234.06 Kips	150.24 Kips	384.30 Kips
56.89 ft	307.21 Kips	150.24 Kips	457.45 Kips

Calculate Scour Zone Friction during Driving

$$\frac{6.2 - 5.0}{6.99 - 5.0} = \frac{1.2^k}{1.99^k} = 0.603$$

So, $0 + 0.603(6.42 + 0) = 3.87^k \Rightarrow$ Say 4 kips friction during driving in scour zone

Next Sheet

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.19 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.20 ft	0.00 Kips	50.27 Kips	50.27 Kips
6.99 ft	2.55 Kips	50.27 Kips	52.81 Kips
7.01 ft	2.61 Kips	56.55 Kips	59.16 Kips
14.99 ft	29.03 Kips	56.55 Kips	85.58 Kips
15.01 ft	29.10 Kips	40.84 Kips	69.94 Kips
22.39 ft	56.34 Kips	40.84 Kips	97.18 Kips
22.41 ft	56.42 Kips	80.87 Kips	137.29 Kips
31.41 ft	98.63 Kips	117.84 Kips	216.48 Kips
40.41 ft ← x	156.56 Kips	150.24 Kips	306.79 Kips ← 346^k
49.41 ft	230.19 Kips	150.24 Kips	380.43 Kips
56.89 ft	303.34 Kips	150.24 Kips	453.58 Kips

Rndr required during installation

$= R_{ndr}$ + Scour Zone Friction during driving $= 342^k + 4^k =$ 346^k Rndr required

So, $\dfrac{346-306.79}{380.43-306.79} = \dfrac{40.79^k}{73.64^k} = 0.554$

then, $40.41 + 0.554[49.41-40.41] = 40.41 + 4.986 = 45.396'$ say 46 feet

Est. Tip Elevation ⇒ El. 840 − 46 => Est. Tip @ El. 794 (16"φ CIP pile)

Est. Pile Length => 2' cutoff + (835−794) = 43' Round to Est. Pay Length = 45'
Est. order Length = 50'

Check Remaining Soil Info
Below Tip for Load Transfer

Max Depth Info = 57'
− 46'
11' Remaining ?>5D? Yes ✓

Est. Tip El. Deeper
for Int. Pier #1
using B-002 than B-001

use B-002
↓
El. 794 (16"φ)
(Pay Length = 45'
Order Length = 50')

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: P:\TEMPOR~1\DRIVEN~1.2\MAD-62\B3P216RW.DVN
Project Name: MAD-62-2.79 Project Date: 03/05/2018
Project Client: Euthenics
Computed By: RSW
Project Manager: RSW

-Intermediate Pier #2
-Boring B-003
-16" ϕ Pipe Pile
-Scour = 6.2'
-Ex. Channel = ~842

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 7.00 ft (EL. 835)
Diameter of Pile: 16.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	0.00 ft
	- Driving/Restrike	0.00 ft
	- Ultimate:	0.00 ft
Ultimate Considerations:	- Local Scour:	6.20 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	7.40 ft	0.00%	130.00 pcf	36.0/36.0	Nordlund
2	Cohesive	14.30 ft	0.00%	120.00 pcf	3000.00 psf	T-79 Steel
3	Cohesive	5.00 ft	0.00%	125.00 pcf	4500.00 psf	T-79 Steel
4	Cohesionless	33.00 ft	0.00%	130.00 pcf	35.0/35.0	Nordlund

From Euthenics (2/9/18):

Bottom of Pier Ftg = EL. 835

Max. Factored Axial (Vert.) Load/pile = 239.2 kips

Rndr Req'd => 342 kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.00 ft	0.00 Kips	35.55 Kips	35.55 Kips
7.39 ft	0.64 Kips	37.53 Kips	38.16 Kips
7.41 ft	0.69 Kips	37.70 Kips	38.38 Kips
16.41 ft	31.95 Kips	37.70 Kips	69.65 Kips
21.69 ft	54.32 Kips	37.70 Kips	92.02 Kips
21.71 ft	54.40 Kips	56.55 Kips	110.95 Kips
26.69 ft	73.88 Kips	56.55 Kips	130.43 Kips
26.71 ft	73.97 Kips	99.50 Kips	173.47 Kips
35.71 ft	124.10 Kips	135.12 Kips	259.22 Kips
44.71 ft	189.94 Kips	150.24 Kips	340.18 Kips
53.71 ft	271.49 Kips	150.24 Kips	421.73 Kips
59.69 ft	334.37 Kips	150.24 Kips	484.60 Kips

No Scour Zone Friction since cap at 7'
and scour only to 6.2'

Rndr Req'd = 342^k

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.00 ft	0.00 Kips	35.55 Kips	35.55 Kips
6.19 ft	0.00 Kips	0.00 Kips	0.00 Kips
6.20 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.39 ft	0.64 Kips	37.53 Kips	38.16 Kips
7.41 ft	0.69 Kips	37.70 Kips	38.38 Kips
16.41 ft	31.95 Kips	37.70 Kips	69.65 Kips
21.69 ft	54.32 Kips	37.70 Kips	92.02 Kips
21.71 ft	54.40 Kips	56.55 Kips	110.95 Kips
26.69 ft	73.88 Kips	56.55 Kips	130.43 Kips
26.71 ft	73.97 Kips	99.51 Kips	173.47 Kips
35.71 ft	124.10 Kips	136.05 Kips	260.15 Kips
44.71 ft ← x	189.94 Kips	150.24 Kips	340.18 Kips ← 342^k
53.71 ft	271.49 Kips	150.24 Kips	421.73 Kips
59.69 ft	334.37 Kips	150.24 Kips	484.60 Kips

Rndr (req'd) = 342^k

$$\frac{342-340.18}{421.73-340.18} = \frac{1.82}{81.55} = 0.022$$

then, $x = 44.71' + 0.022(53.71 - 44.71) = 44.71' + 0.200' = 44.91'$ ⇒ say 45'

Est. Tip El. ⇒ El. 842 − 45' = ~El. 797

Since is higher than that estimated using Boring B-002, Base Pier #2 estimates on info using Boring B-002

Avail. Soil Info Below tip

$$\begin{array}{r} 59.69 \\ -45 \\ \hline 14.69' \end{array} > 5D?$$ Yes ✓

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: P:\TEMPOR~1\DRIVEN~1.2\MAD-62\3FAG12RW.DVN
Project Name: MAD-62-2.79 Project Date: 03/05/2018
Project Client: Euthenics
Computed By: RSW
Project Manager: RSW

– Fwd. Abut
— Boring B-003
— 12" ϕ pipe pile

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 0.00 ft (~EL. 850)
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of: - Drilling: 5.50 ft
- Driving/Restrike 5.50 ft
- Ultimate: 5.50 ft

Ultimate Considerations: - Local Scour: 0.00 ft
- Long Term Scour: 0.00 ft
- Soft Soil: 0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	7.50 ft	0.00%	115.00 pcf	800.00 psf	T-79 Steel
2	Cohesionless	9.70 ft	0.00%	130.00 pcf	36.0/36.0	Nordlund
3	Cohesive	14.30 ft	0.00%	120.00 pcf	3000.00 psf	T-80 Sand
4	Cohesive	5.00 ft	0.00%	125.00 pcf	4500.00 psf	T-79 Steel
5	Cohesionless	33.00 ft	0.00%	130.00 pcf	35.0/35.0	Nordlund

Info from Euthenics (2/9/18):

—No DD. Plan View shows new abutment upstation (behind) the existing abutment.

– ~ Bottom of Abutment Elevation = ~ EL. 850

–Max. Factored Axial (Vertical) Load/pile (Integral Abutment) = 223.3 kips

$$R_{ndr} \text{ Required} = \frac{223.3}{0.7} = \underline{\underline{319.0 \text{ kips}}} \text{ (Integral)}$$

—Max. Factored Axial (Vert.) Load/pile (Semi-Integral) = 111.7 kips

$$R_{ndr} \text{ Req'd} = \frac{111.7}{0.7} = 159.6 \text{ kips} \Longrightarrow \text{say } 160 \text{ kips}$$

—No Scour (Rip-rapped Abutment Foreslopes)

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.02 Kips	5.65 Kips	5.68 Kips
7.49 ft	15.65 Kips	5.65 Kips	21.30 Kips
7.51 ft	15.68 Kips	31.20 Kips	46.88 Kips
16.51 ft	30.74 Kips	56.91 Kips	87.65 Kips
17.19 ft	32.24 Kips	58.85 Kips	91.09 Kips
17.21 ft	32.35 Kips	21.21 Kips	53.56 Kips
26.21 ft	117.18 Kips	21.21 Kips	138.38 Kips
31.49 ft ← X_2	152.50 Kips	21.21 Kips	173.70 Kips ← 160 kips
31.51 ft	152.58 Kips	31.81 Kips	184.39 Kips
36.49 ft	171.40 Kips	31.81 Kips	203.21 Kips
36.51 ft	171.48 Kips	84.51 Kips	255.98 Kips
45.51 ft	207.07 Kips	84.51 Kips	291.58 Kips
54.51 ft ← x_1	250.31 Kips	84.51 Kips	334.82 Kips ← 319 kips
63.51 ft	301.19 Kips	84.51 Kips	385.69 Kips
69.49 ft	339.21 Kips	84.51 Kips	423.72 Kips

$$\frac{319 - 291.58}{334.82 - 291.58} = \frac{27.42}{43.24} = 0.634$$

then, $x_1 = 45.51 + 0.634(54.51 - 45.51) = 45.51 + 5.707 = 51.2' \Rightarrow$ say 52'

Est. Tip Elev. = El. 850 − 52' ⇒ ~El. 798 for Integral Abutment

52' + 2' into Abut = 54' → round up to nearest 5' = 55' Est. Pay Length

Est. Order Length ≈ 60'

Check Avail Soil Info
Below Tip Elev.

$$\begin{array}{r} 69.49' \\ -52' \\ \hline 15+\text{ ft.} \end{array}$$ OK ✓

Check Semi-Integral Est. Pile Length

$$\frac{160 - 138.38}{173.70 - 138.38} = \frac{21.62}{35.32} = 0.612$$

$X_2 = 26.21 + 0.612(31.49 - 26.21) = 26.21 + 3.23 = 29.44' \rightarrow$ say 30'

Est. Tip Elev. = ~850 − 30 = ~El. 820

APPENDIX C

II. Reconnaissance and Planning Checklist

C-R-S: MAD-62-02.79	PID: 102577	Reviewer: RSW	Date: 9/23/17

Reconnaissance	
[✓ Y] N X 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: ☐ Roadway plans ■ Structures plans ☐ Geohazards plans	
[✓ Y] N X 2 Based on Section 302.2 in the SGE, has the Geotechnical Red Flag Summary, or in its absence, the resources listed in Section 202 of the SGE, been reviewed as part of the office reconnaissance?	
[✓ Y] N X 3 Have all the features listed in Section 302.3 of the SGE been observed and evaluated during the field reconnaissance?	
Y N [✓ X] 4 If notable features were discovered in the field reconnaissance, were the GPS coordinates of these features recorded?	

II. Reconnaissance and Planning Checklist

Planning - General

[✓ Y] N X	5	In planning the geotechnical exploration program for the project, have the specific geologic conditions, the proposed work, and existing subsurface exploration work been considered?	
[✓ Y] N X	6	Have the borings been located to develop the maximum subsurface information while using a minimum number of borings?	
[✓ Y] N X	7	Has 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] N X	8	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 N [✓ X]	9	Have any previous geotechnical explorations been utilized to the fullest extent possible?	
[✓ Y] N X	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?	By others
		The schedule of borings should present the following information for each boring:	
[✓ Y] N X		☐ exploration identification number	
Y N [✓ X]		☐ location by station and offset	Not available at time of proposal
[✓ Y] N X		☐ estimated amount of rock and soil, including the total for each for the entire program.	

Planning – Exploration Number

[✓ Y] N X	11	Have the coordinates, stations and offsets of all explorations (borings, probes, test pits, etc.) been identified?	
[✓ Y] N X	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 N [✓ X]	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?	

Notes:

II. Reconnaissance and Planning Checklist

Planning – Boring Types

[✓ Y] N X 14 Based on Sections 303.3 to 303.76 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?

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)
☐ Karst (Type C6)
☐ 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)
☐ High Mast Lighting Towers (Type E5)
☐ Buildings and Salt Domes (Type E6)

Notes:

III.B. Embankments Checklist

C-R-S: MAD-62-02.79	PID: 102577	Reviewer: RSW	Date: 3/6/18

Settlement			
Y N [✓ X]	1	If soil conditions and project requirements warrant, have settlement issues been addressed? If not applicable (X), go to Question **14**	New Abutments relocated behind existing abutments, and no vertical profile change.
Y N X	2	Have consolidation properties of the foundation soils been determined? Check methods used: ☐ laboratory consolidation tests ■ empirical correlations with moisture content and Atterberg values ■ other	
Y N X	3	Have calculations been performed to estimate the total expected embankment settlement and the time of consolidation? Check method used: ☐ EMBANK or equivalent software ■ hand calculations	
Y N X	4	If differing foundation soil and/or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate consolidation at locations representative of the most critical conditions?	
Y N X	5	Have the total settlement and the time of consolidation analyses indicated acceptable values at all locations for the scope of the embankment work?	
Y N X	6	If total settlement or time of consolidation is unacceptable, have the stations and lateral extent of the problem areas been defined?	
Y N X	7	Has a method been chosen as a solution to the settlement issues? Check methods used: ☐ waiting periods with monitoring ☐ drainage blanket and wick drains ☐ surcharge (preloading) ☐ removal and replacement of weak soil ☐ lowering proposed grade / change alignment ☐ lightweight fill ☐ other List Other items:	

III.B. Embankments Checklist

Y N X	8	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?	
Y N X	9	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?	
Y N X	10	Have all necessary notes, specifications, and details for the chosen solution been determined?	
Y N X	11	Have the need, locations, type, plan notes, and reading schedule for settlement platforms been determined?	
Y N X	12	Have the effects of the predicted settlement and the chosen solution been determined and accounted for on the construction schedule?	
[✓ Y] N X	13	Has the effect of any foundation soil consolidation (including differential settlement) been evaluated with regard to adjacent structures (e.g., bridges, buildings, culverts, utilities) which will also undergo settlement and be subject to stresses induced by the consolidation of the surrounding soil?	Relocating abutment and not adding new fill mitigates downdrag on piles.

Notes :

Stage 1:

III.B. Embankments Checklist

Stability

Y N X 14 If soil conditions and project requirements warrant, have stability issues been addressed?

If not applicable (X), go to Question **29**

Y N X 15 Has the total (short term) and effective (long term) shear strength of the foundation soils been determined?

Check method used:

☐ laboratory shear tests

☐ estimation from SPT or field tests

Y N X 16 Have the values of shear strength for proposed embankment fill material, as determined from <u>Geotechnical Bulletin 6 Shear Strength of Proposed Embankments</u> (GB 6), been used in the stability analyses?

Y N X 17 Have calculations been performed to determine the F.S. for stability?

Check method used:

☐ GSTABL7, or equivalent software

☐ hand calculations

18 Have the following F.S. been met or exceeded, as determined by the calculations, for the given stability conditions:

Y N X a 1.30 for short term condition

Y N X b 1.30 for long term condition

Y N X c 1.10 for rapid drawdown, flood condition

Y N X d 1.50 for embankment supporting bridge abutments (not on deep foundations)

Y N X 19 When differing soil or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate the stability at locations representative of the most critical conditions?

Y N X 20 If the F.S. was not met or exceeded, have the stations and lateral extent of the problem areas been defined?

Y N X 21 Has a method been chosen as a solution to the stability issues?

Check the method(s) used:

☐ flattening slopes

☐ counterberm

III.B. Embankments Checklist

- ☐ lightweight embankment
- ☐ reinforced soil slope
- ☐ soil nailing
- ☐ drainage blanket and wick drains
- ☐ removal of soft soil, adding shear key
- ☐ reduced grade / change alignment
- ☐ stage construction
- ☐ controlled rate of fill placement
- ☐ drilled shaft slope stabilization
- ☐ other List Other items:

Y N X 22 Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?

Y N X 23 Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?

Y N X 24 Have all necessary notes, specifications, and details for the chosen solution been determined?

Y N X 25 Have the need, location, type, plan notes, and reading schedule for piezometers and inclinometers been determined?

Y N X 26 If piezometers will be used, has the critical pressure value been determined and the appropriate information included in the plans?

Y N X 27 Have the effects of the stability solution been determined and accounted for on the construction schedule?

Y N X 28 Has the effect of the stability solution been evaluated with regard to structures (e.g., bridges, buildings, culverts, utilities) which may be subject to unusual stresses or require special construction considerations?

Notes:

Stage 1:

III.B. Embankments Checklist

Sidehill Fills			
[✓ Y] N X	29	If soil conditions and project requirements warrant, have sidehill fill issues been addressed?	Section 6.3.3
		If not applicable (X), go to Question **34**	
[✓ Y] N X	30	In accordance with <u>Geotechnical Bulletin 2: Special Benching and Sidehill Embankment Fills (GB 2),</u> have sidehill fills been evaluated to determine if special benching or shear keys are needed?	
	31	In accordance with GB 2, if special benching or shear keys are required, has	
Y N [✓ X]		a Plan Note G110 from L&D3 been included in the General Notes?	By others
Y N [✓ X]		b quantities for both excavation and embankment been calculated for the benched areas and added to the plan General Quantities?	By others
Y N [✓ X]		c the special benching or shear keys been indicated on the appropriate cross sections?	By others
[✓ Y] N X	32	Have water bearing zones been identified and their impact addressed?	
[✓ Y] N X	33	Have subsurface drainage controls been adequately addressed?	

Notes:

Stage 1:

III.B. Embankments Checklist

Special	
Y N [✓ X] 34 Have all of the environmental factors, including wetlands, stream mitigation, and landfills, been considered and incorporated prior to design and analysis of embankment settlement and stability, including EPA or other government agencies' involvement, mitigation, or special design or construction considerations?	By others
35 If an embankment is to be placed through standing water or over weak, wet soils (with or without a fabric separator), the fill should be placed by the method of end dumping to a given height above the standing water or until compaction is achievable over the soft soil. If end dumping is to be specified,	
Y N [✓ X] a has the material type for the fill to be end dumped been specified?	
Y N [✓ X] b has the need for a fabric separator or filter layer been determined?	
Y N [✓ X] c has the height of fill to be end dumped been determined?	
Y N [✓ X] d have all notes and specifications for end dumping been developed?	

Notes:

Stage 1:

III.C. Subgrade Checklist

C-R-S: MAD-62-02.79	PID: 102577	Reviewer: RSW	Date: 9/23/17

If you do not have any subgrade work on the project, you do not have to fill out this checklist.

[✓ Y] N X	1	Has the subsurface investigation adequately characterized the soil or rock according to <u>Geotechnical Bulletin 1: Plan Subgrades (GB1)?</u>	
Y N [✓ 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?	
Y N [✓ 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?	
Y N [✓ X]	3	If there is any rock, shale, or coal present at the proposed subgrade (CMS 204.05), do the plans specify the removal of the material?	
Y N [✓ 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?	
[✓ Y] N X	4	In accordance with GB1, do the SPT values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	
Y N [✓ X]		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)?	By others
Y N [✓ X]		b If chemical stabilization is applicable, has the detail of this treatment been shown on the plans, including depth, percentage of chemical, station limits, lateral extent, and plan notes? Indicate type of subgrade treatment specified: ☐ cement treatment ☐ lime treatment ☐ lime kiln dust ☐ other	
Y N [✓ X]	5	If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	
Y N [✓ X]	6	Has an appropriate quantity of Proof Rolling been included in the plans (CMS 204.06)?	By others
[✓ Y] N X	7	Has a design CBR value been provided?	Section 6.2.1

III.C. Subgrade Checklist

Notes:

Stage 1:

VI.B. Structure Foundation Exploration Checklist

C-R-S: MAD-62-2,79	PID: 102577	Reviewer: RSW	Date: 3/6/18

General Presentation

[✓ Y] N X	1	Has the geotechnical information for explorations involving structures only (no roadway) been presented as plan drawings in the form of a Structure Foundation Exploration?	
Y N [✓ X]	2	Have structures explored as part of the same construction project been presented together under the same cover sheet?	
[✓ Y] N X	3	Has a paper copy and electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	By others
[✓ Y] N X	4	Has the geotechnical specification (title and date) under which the work was performed been clearly identified on every submission (reports, plans, etc.)?	
[✓ Y] N X	5	Has the first complete version of all documents being submitted been labeled as ‘Draft’?	
[✓ Y] N X	6	Subsequent to ODOT’s review and approval, has the complete version of the revised documents being submitted been labeled as ‘Final’?	
Y [✓ N] X	7	Have the electronic copies of the final geotechnical plan sheets been submitted as TIFF images?	As PDF
[✓ Y] N X	8	Have the plan sheets been prepared using the size, lettering, format, file management, and CADD standards as prescribed in the applicable sections of the ODOT CADD Engineering Standards Manual?	
[✓ Y] N X	9	Has a scale of 1”=1’ been used for cover sheets and laboratory test data sheets?	

VI.B. Structure Foundation Exploration Checklist

Cover Sheet

10 Has the following general information been provided on the cover sheet

[✓ Y] N X a. Brief description of the project?

[✓ Y] N X b. Brief presentation of geological and topographical information? Include comments on structure and pavement conditions.

[✓ Y] N X c. Brief presentation of boring and sampling methods? Include date of last calibration and drill rod energy ratio as a percent for the hammer systems used.

[✓ Y] N X d. Summary of general soil, bedrock, and groundwater conditions, including a generalized interpretation of findings?

[✓ Y] N X e. Statement of where original drawings and data may be inspected?

Y [✓ N] X f. Statement of where soil or rock samples may be inspected, if applicable?

[✓ Y] N X g. Initials of personnel and dates they performed field reconnaissance, subsurface exploration and preparation of the soil profile?

[✓ Y] N X 11 Has a Legend been provided on the cover sheet?

12 Have the following items been included in the Legend:

[✓ Y] N X a. Symbols and usual descriptions for only the soil and bedrock types encountered, as per the Soil and Rock Symbology Chart in Appendix D of the SGE?

[✓ Y] N X b. All miscellaneous symbols and acronyms, used on any of the sheets, defined?

[✓ Y] N X c. The number of soil samples for each classification that were mechanically classified and visually described?

[✓ Y] N X 13 Has a Location Map, showing the beginning and end stations for the project, been shown on the cover sheet, sized per the L&D Manual?

[✓ Y] N X 14 If sampling and testing for a scour analysis was performed, has this data been shown in tabular form?

VI.B. Structure Foundation Exploration Checklist

Plan and Profile

[✓ Y] N X 15 Has the plan and profile view been shown at the same scale as the Site Plan for the proposed structure (when possible)?

[✓ Y] N X 16 Has the plan and profile been presented along the flowline for culverts?

17 Has the following information been shown in a roadway plan drawing:

- [✓ Y] N X a Existing surface features described in Section 702.5.1?
- Y N [✓ X] b Proposed construction items, as described in Section 702.5.2?
- [✓ Y] N X c Project and historic boring locations, with appropriate exploration targets and exploration identification numbers?
- Y N [✓ X] d Notes regarding observations not readily shown by drawings?

[✓ Y] N X 18 Have the existing ground surface contours been presented?

[✓ Y] N X 19 Has all the subsurface data been presented in the form of a profile along the centerline or baseline?

20 Have the graphical boring logs been correctly shown, as follows:

- [✓ Y] N X a. Location and depth of boring indicated by a heavy dashed vertical line?
- [✓ Y] N X b. Exploration identification number above the boring
- [✓ Y] N X c. Logs indicate soil and bedrock layers with symbols 0.4” wide and centered on the heavy dashed vertical line where possible?
- Y N [✓ X] d. Bedrock exposures with 0.4” wide symbols, but without a heavy dashed vertical line.
- [✓ Y] N X e. Soil and bedrock symbols as per ODOT Soil and Rock Symbology chart (SGE - Appendix D)?
- Y N [✓ X] f. Historical borings shown in same manner with the exploration identification number above the boring?

[✓ Y] N X 21 Have the proposed profile and existing groundline been shown on the profile view, according to ODOT CADD standards?

VI.B. Structure Foundation Exploration Checklist

[✓ Y] N X 22 Have the locations of the proposed structure foundation elements been shown on the profile view?

[✓ Y] N X 23 Have the offsets from centerline or baseline been indicated above the borings in the profile view?

24 Has the following information been provided adjacent to the graphical logs or bedrock exposure:

- [✓ Y] N X a. Thickness, to the nearest 0.1’, of sod/topsoil or other shallow surface material written above the boring (with corresponding symbology at top of log)?
- [✓ Y] N X b. Moisture content, to nearest whole percent, with the text aligned with the bottom of the sample? Label this column as ‘WC’ at bottom of boring.
- [✓ Y] N X c. N_{60}, aligned with bottom of sample? Label this column as ‘N_{60}’ at bottom of boring.
- [✓ Y] N X d. Free water indicated by a horizontal line with a ‘w’ attached, and static water indicated by a shaded equilateral triangle, point down?
- Y N [✓ X] e. Visual description of any uncontrolled fill or interval not adequately defined by a graphical symbol?
- [✓ Y] N X f. Organic content with modifiers, per 603.5?
- Y N [✓ X] g. Designate a plastic soil with moisture content equal to or greater than the liquid limit minus three with a 1/8” solid black circle adjacent to the moisture content?
- Y N [✓ X] h. Designate a non-plastic soil with moisture content exceeding 25% or exceeding 19% but appearing wet initially, with a 1/8” open circle with a horizontal line through it adjacent to the moisture content?
- Y N [✓ X] i. The reason for discontinuing a boring prior to reaching the planned depth indicated immediately below the boring?

VI.B. Structure Foundation Exploration Checklist

Boring Logs

[✓ Y] N X 25 Have the boring logs of all structure borings been shown on the sheet(s) following the plan and profile views?

[✓ Y] N X 26 Has a scale of 1”=1’ been used for the boring log sheets?

[✓ Y] N X 27 Have the boring logs been developed by integrating the driller’s field logs, laboratory test data, and visual descriptions?

28 Has the following boring information been included in the heading of each boring log:

- [✓ Y] N X a. Exploration identification number?
- [✓ Y] N X b. Project designation (C-R-S) and PID?
- [✓ Y] N X c. Bridge identification (if applicable)?
- [✓ Y] N X d. Centerline or baseline name, station, offset, and surface elevation?
- [✓ Y] N X e. Coordinates?
- [✓ Y] N X f. Method of drilling?
- [✓ Y] N X g. Static and free water-level observations?
- [✓ Y] N X h. Date started and date completed?
- [✓ Y] N X i. Method and material (including quantity) used for backfilling or sealing, including type of instrumentation, if any?
- [✓ Y] N X j. Date of last calibration and drill rod energy ratio (ER) in percent for the hammer system(s) used?

29 Has the following boring information been included in each boring log:

- [✓ Y] N X a. A depth and elevation scale?
- [✓ Y] N X b. Indication of stratum change?
- [✓ Y] N X c. Description of material in each stratum?
- [✓ Y] N X d. Depth of bottom of boring?
- Y N [✓ X] e. Depth of boulders or cobbles, if encountered?
- Y N [✓ X] f. Caving depth?
- Y N [✓ X] g. Artesian water level and height of rise?
- Y N [✓ X] h. Running sand?
- Y N [✓ X] i. Cavities or other unusual conditions?
- [✓ Y] N X j. Depth interval represented by sample?
- [✓ Y] N X k. Sample number and type?

VI.B. Structure Foundation Exploration Checklist

[✓ Y] N X l. Percent recovery for each sample?

[✓ Y] N X m. Measured blow counts for each 6 inches of drive for split spoon samples?

[✓ Y] N X n. N_{60} to the nearest whole number?

[✓ Y] N X o. Particle-size analysis?

[✓ Y] N X p. Liquid limit, plastic limit, plasticity index?

[✓ Y] N X q. Water content?

[✓ Y] N X r. ODOT soil classifications, with ‘Visual’ in parentheses for those samples visually classified?

Y N [✓ X] s. Bedrock descriptions?

Y N [✓ X] t. Run rock core percent recovery?

Y N [✓ X] u. Run RQD?

Y N [✓ X] v. Unit rock core percent recovery?

Y N [✓ X] w. Unit RQD?

Y N [✓ X] x. SDI, if applicable?

Y N [✓ X] y. Rock compressive strength test results, if applicable?

[✓ Y] N X 30 Have all undisturbed test results been displayed in graphical format on the sheet(s) following the boring log sheet(s)?

Notes:

Stage 1:

VI.D. Geotechnical Reports

C-R-S: MAD-62-02.79	PID: 102577	Reviewer: RSW	Date: 3/6/18

General	
[✓ Y] N X 1 Has the first complete version of a geotechnical report being submitted been labeled as ‘Draft’?	
[✓ Y] N X 2 Subsequent to ODOT’s review and approval, has the complete version of the revised geotechnical report being submitted been labeled ‘Final’?	
[✓ Y] N X 3 Have all geotechnical reports being submitted been titled correctly as prescribed in Section 705.1 of the SGE?	

Report Body	
[✓ Y] N X 4 Do all geotechnical reports being submitted contain an Executive Summary as described in Section 705.2 of the SGE?	
[✓ Y] N X 5 Do all geotechnical reports being submitted contain an Introduction as described in Section 705.3 of the SGE?	
[✓ Y] N X 6 Do all geotechnical reports being submitted contain a section titled "Geology and Observations of the Project," as described in Section 705.4 of the SGE?	
[✓ Y] N X 7 Do all geotechnical reports being submitted contain a section titled "Exploration," as described in Section 705.5 of the SGE?	
[✓ Y] N X 8 Do all geotechnical reports being submitted contain a section titled "Findings," as described in Section 705.6 of the SGE?	
[✓ Y] N X 9 Do all geotechnical reports being submitted contain a section titled "Analyses and Recommendations," as described in Section 705.7 of the SGE?	

VI.D. Geotechnical Reports

Appendices			
[✓ Y] N X	10	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 705.8 of the SGE?	
[✓ Y] N X	11	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 705.8.1 of the SGE?	
[✓ Y] N X	12	Do the Appendices include boring logs as described in Section 705.8.2 of the SGE?	
[✓ Y] N X	13	Do the Appendices present reports of undisturbed test data as described in Section 705.8.3 of the SGE?	
[✓ Y] N X	14	Do the Appendices present calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	

Notes:

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

MAD-62-2.79

PID 102577

PROJECT DESCRIPTION - Structure Foundation Exploration - Three (3) structure borings, lab testing, and report

S&ME, Inc.

Prepared By: **Kyle J. Dohlen, P.E.**

Date prepared: **February 28, 2018**

BORING LOG LOCATION SUMMARY

Boring ID	Latitude	Longitude	Filename Log	Filename Plan	Filename Profile
B-001-0-17	39.725119	-83.250567	102577_ZL001 & 002	102577_IP001	102577_ZP001
B-002-0-17	39.725220	-83.250109	102577_ZL002 & 003	102577_IP001	102577_ZP001
B-003-0-17	39.725336	-83.249588	102577_ZL004 & 005	102577_IP001	102577_ZP001

APPENDIX D

PROJECT DESCRIPTION

IT IS PROPOSED TO REPLACE THE EXISTING BRIDGE (NO. MAD-62-0279) WHICH CARRIES US-62 OVER DEER CREEK, JUST NORTHEAST OF MOUNT STERLING, IN MADISON COUNTY, OHIO. THE PROPOSED REPLACEMENT STRUCTURE WILL BE A THREE-SPAN BRIDGE WITH PRE-STRESSED CONCRETE I-BEAMS AND INTEGRAL ABUTMENTS AND BE CONSTRUCTED ALONG HORIZONTAL AND VERTICAL ALIGNMENTS WHICH ARE APPROXIMATELY THE SAME AS THE EXISTING BRIDGE.

HISTORIC RECORDS

AVAILABLE HISTORIC BRIDGE PLAN SHEETS DATED 1941 INDICATE THAT THE EXISTING BRIDGE IS SUPPORTED ON TIMBER PILING. NO HISTORIC BORING LOGS WERE LOCATED FOR THE EXISTING BRIDGE.

GEOLOGY

THE PROJECT SITE IS LOCATED IN THE DARBY PLAIN PHYSIOGRAPHIC REGION. THE DARBY PLAIN IS CHARACTERIZED BY BROADLY HUMMOCKY GROUND WITH SEVERAL BROAD, RECESSIONAL MORAINES AND WISCONSINAN-AGE LOAMY TILL OVER SILURIAN AND DEVONIAN-AGE CARBONATE ROCKS. BASED ON AVAILABLE WELL LOGS, THE UPPERMOST BEDROCK NEAR THIS SITE IS LOCATED AT APPROXIMATE EL. 750.

RECONNAISSANCE

A SITE RECONNAISSANCE VISIT WAS MADE BY S&ME PERSONNEL ON MAY 26, 2017, TO OBSERVE THE EXISTING BRIDGE AND PROJECT VICINITY AND TO FIELD MARK THE BORINGS. SOME CONCRETE DETERIORATION WAS NOTED ON PORTIONS OF THE CONCRETE ABUTMENTS AND CENTER PIER.

SUBSURFACE EXPLORATION

DURING THE PERIOD OF JUNE 5 THROUGH JUNE 9, 2017, S&ME PERFORMED A TOTAL OF THREE (3) BORINGS AT THIS SITE. THE BORINGS WERE DRILLED TO DEPTHS RANGING FROM 75 FEET TO 80 FEET BELOW THE EXISTING ROADWAY OR BRIDGE DECK SURFACE, AND WERE TERMINATED AFTER ENCOUNTERING 30 FEET OF 30 BLOW-COUNT SOIL.

THE BORINGS WERE PERFORMED USING A TRUCK-MOUNTED DRILLING RIG USING 3-1/4-INCH I.D. HOLLOW-STEM AUGERS. DISTURBED (BUT REPRESENTATIVE) SOIL SAMPLES WERE OBTAINED BY LOWERING A 2-INCH O.D. SPLIT-BARREL SAMPLER THROUGH THE AUGER STEM TO THE BOTTOM OF THE BORING AND THEN DRIVING THE SAMPLER INTO THE SOIL WITH BLOWS FROM A 140-POUND HAMMER FREELY FALLING 30 INCHES (ASTM D1586 - STANDARD PENETRATION TEST, SPT). IN ACCORDANCE WITH THE CURRENT ODOT SPECIFICATIONS, THE HAMMER SYSTEM ON THE DRILL RIG WAS CALIBRATED IN ACCORDANCE WITH ASTM D 4633 TO DETERMINE THE DRILL ROD ENERGY RATIO (99.9%). CONTINUOUS (SPT) SAMPLING WAS PERFORMED IN THE UPPERMOST 6 FEET OF SOIL BELOW THE APPROACH PAVEMENTS, AND IN THE SCOUR ZONE FROM THE APPROXIMATE STREAMBED LEVEL TO 6 FEET BELOW THE STREAMBED LEVEL IN ALL 3 BORINGS. BENEATH THE CONTINUOUS SAMPLING, THE BORINGS WERE SAMPLED AT 2-1/2-FOOT INTERVALS TO 20 FEET BELOW THE FOUNDATION LEVEL. THE REMAINDER OF THE BORINGS WERE SAMPLED AT 5-FOOT INTERVALS. TWO (2) UNDISTURBED SHELBY TUBES SAMPLES WERE ATTEMPTED BY HYDRAULICALLY PRESSING A SEAMLESS STEEL (SHELBY) TUBE INTO THE SOIL; HOWEVER, ONE OF THESE SHELBY TUBE ATTEMPTS ENCOUNTERED REFUSAL IN A SAND AND GRAVEL LAYER. THE RECOVERED SHELBY TUBE SAMPLES WERE SEALED IN THE TUBE WITH WAX. AT COMPLETION, THE ABUTMENT BORINGS WERE SEALED IN ACCORDANCE WITH ODOT SPECIFICATIONS.

EXPLORATION FINDINGS

IN BORINGS B-001 AND B-003, BETWEEN 9 AND 10 INCHES OF ASPHALT AND BETWEEN 14 AND 15 INCHES OF GRANULAR BASE WAS ENCOUNTERED. BENEATH THE SURFICIAL MATERIALS BETWEEN 3.0 AND 11.0 FEET OF FILL AND/OR PROBABLE FILL WAS ENCOUNTERED. A LAYER OF SLIGHLTY TO MODERATELY ORGANIC CLAY (A-7-6) WAS ENCOUNTERED BELOW THE FILL IN BOTH BORINGS. SOILS DESCRIBED AS GRAVEL (A-1a), GRAVEL WITH SAND (A-1b), SANDY SILT (A-4a), SILT AND CLAY (A-6A), SILTY CLAY (A-6B), ELASTIC CLAY (A-7-5), CLAY (A-7-6)

BORING B-002 WAS PERFORMED NEAR THE CENTER OF THE EXISTING CREEK CHANNEL AND NEAR THE EXISTING CENTER BRIDGE PIER. AFTER ENCOUNTERING THE STREAM BED AT A DEPTH OF 23 FEET BELOW THE EXISTING BRIDGE DECK, BORING B-002 ENCOUNTERED 22.5 FEET OF VERY-STIFF TO HARD GRAY SILTY CLAY (A-6B) AND CLAY (A-7-6) OVER 34.5 FEET OF HARD BROWN BECOMING GRAY SANDY SILT (A-4A) PRIOR TO BEING TERMINATED AT A DEPTH OF 80 FEET.

WATER WAS ENCOUNTERED IN ALL OF THE BORINGS. THE DEPTHS WHERE THE INITIAL SEEPAGE WAS NOTED RANGED FROM 18.5 FEET TO 23 FEET BELOW THE APPROXIMATE EXISTING ROADWAY SURFACE. NO LONG TERM GROUNDWATER MEASUREMENTS WERE OBTAINED IN ANY OF THESE EXPLORATIONS.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, DATED JULY 2017.

AVAILABLE INFORMATION

ALL AVAILABLE SOIL AND BEDROCK INFORMATION THAT CAN BE CONVENIENTLY SHOWN ON THE GEOTECHNICAL EXPLORATION SHEETS HAS BEEN SO REPORTED. ADDITIONAL EXPLORATIONS MAY HAVE BEEN MADE TO STUDY SOME SPECIAL ASPECT OF THE PROJECT. COPIES OF THIS DATA, IF ANY, MAY BE INSPECTED IN THE DISTRICT DEPUTY DIRECTOR'S OFFICE OR THE OFFICE OF GEOTECHNICAL ENGINEERING AT 1980 WEST BROAD STREET, COLUMBUS, OHIO.

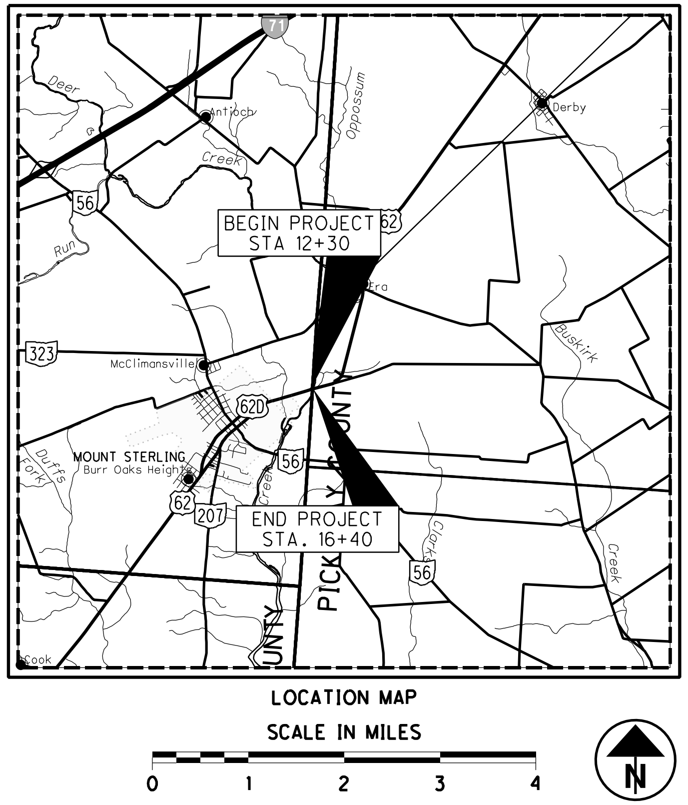
LEGEND

	DESCRIPTION	ODOT CLASS	CLASSIFIED MECH.	CLASSIFIED VISUAL
░	GRAVEL	*A-1-a*	*5*	*1*
▒	GRAVEL WITH SAND	*A-1-b*	*2*	*1*
▥	SANDY SILT	*A-4a*	*12*	*11*
▨	SILT AND CLAY	*A-6a*	*6*	*5*
▤	SILTY CLAY	*A-6b*	*5*	*4*
▧	ELASTIC CLAY	*A-7-5*	*1*	*-*
▦	CLAY	*A-7-6*	*9*	*6*
		TOTAL	*40*	*28*

☒	PAVEMENT OR BASE = X = APPROXIMATE THICKNESS *VISUAL*
⊕	BORING LOCATION - PLAN VIEW.
┊	DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.
WC	INDICATES WATER CONTENT IN PERCENT.
N_{60}	INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.
X/Y/Z	NUMBER OF BLOWS FOR STANDARD PENETRATION TEST (SPT): X= NUMBER OF BLOWS FOR FIRST 6 INCHES. Y= NUMBER OF BLOWS FOR SECOND 6 INCHES. Z= NUMBER OF BLOWS FOR THIRD 6 INCHES.
W—	INDICATES FREE WATER ELEVATION.
SS	INDICATES A SPLIT SPOON SAMPLE.
ST	INDICATES A SHELBY TUBE SAMPLE.
NP	INDICATES A NON-PLASTIC SAMPLE.
UCS	INDICATES AN UNCONFINED COMPRESSION TEST (SOIL)

SCOUR ZONE GRAIN SIZE INFORMATION

BORING NUMBER	LOCATION	SAMPLE DEPTH	SAMPLE ELEVATION (MSL)	D50 (mm)	D95 (mm)
B-001-0-17	REAR ABUTMENT	21.5 - 23.0	839.9 - 841.4	1.3922	29.9007
		23.0 - 24.5	838.4 - 839.9	3.9326	30.5077
		24.5 - 26.0	836.9 - 838.4	5.1922	32.2722
		26.0 - 27.5	NO RECOVERY		
		28.5 - 30.0	832.9 - 834.4	0.0128	1.5060
B-002-0-17	BRIDGE MID-SPAN	23.0 - 24.5	838.6 - 840.1	0.0376	13.7463
		24.5 - 26.0	837.1 - 838.6	0.0558	8.4188
		26.0 - 27.5	835.6 - 837.1	0.0189	2.4746
		27.5 - 29.0	834.1 - 835.6	0.0182	1.4140
B-003-0-17	FORWARD ABUTMENT	21.0 - 22.5	839.8 - 841.3	6.0284	28.7310
		22.5 - 24.0	838.3 - 839.8	4.3005	29.5872
		24.0 - 25.5	836.8 - 838.3	6.3713	26.8127
		25.5 - 26.0	835.3 - 836.8	3.7968	26.6974
		28.5 - 30.0	832.3 - 833.8	0.0618	8.1744



LOCATION MAP

SCALE IN MILES

PARTICLE SIZE DEFINITIONS

12″ | 3″ | 2.0 mm | 0.42 mm | 0.074 mm | 0.005 mm

BOULDERS | COBBLES | GRAVEL | COARSE SAND | FINE SAND | SILT | CLAY

No. 10 SIEVE No. 40 SIEVE No. 200 SIEVE

INDEX OF SHEETS				
LOCATION FROM STA. TO STA.	PLAN VIEW SHEET	PROFILE SHEET	CROSS-SECTION SHEET	EMBANKMENT CUT/FILL (MAX)
MAD-62 12+30 16+40	2	2	-	0 FT

RECON. - RSW (5-26-2017)
DRILLING - KJD (6-5-2017 - 6-9-2017)
DRAWN - KJD (2-20-2018 - 3-7-2018)
REVIEWED - RSW (3-7-2018)

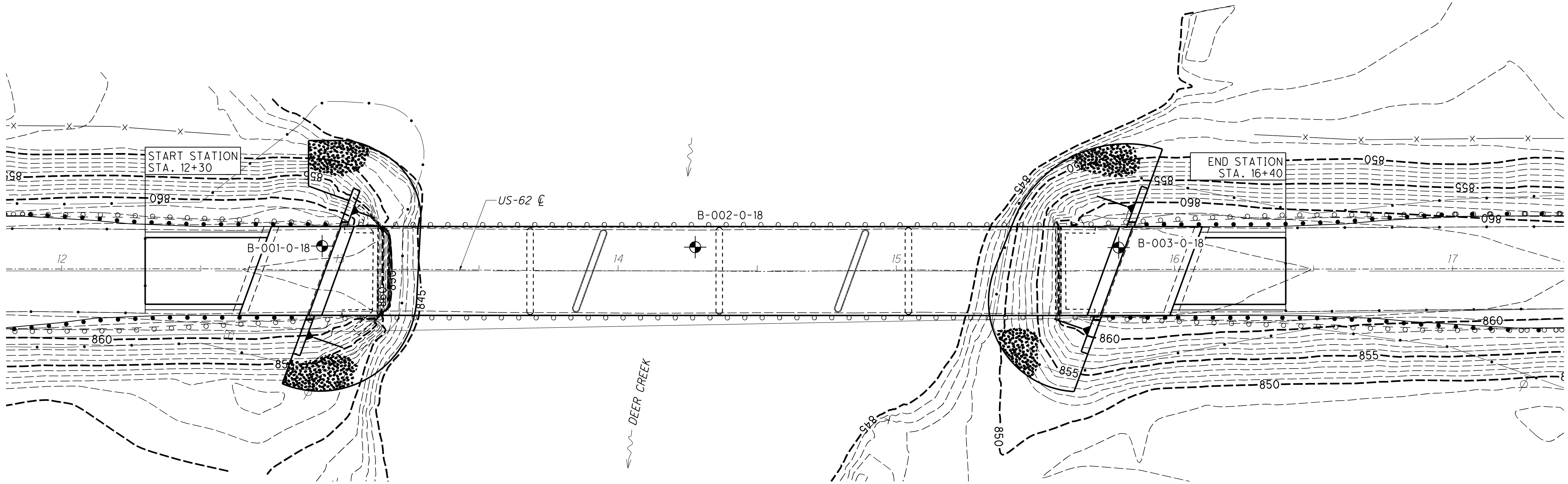
Richard S. Weigand E-56910

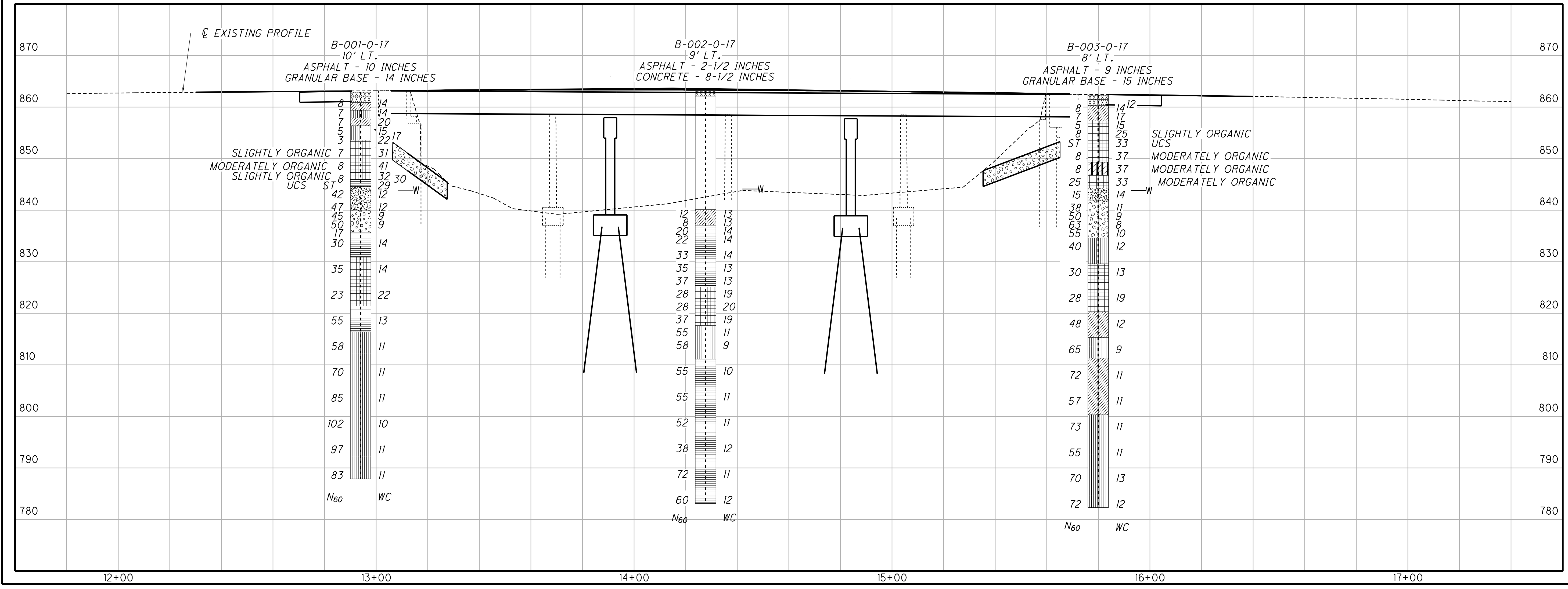
S&ME, Inc.
8400 Sweet Valley Drive
Valley View, OH 44125

PID NO.
102577

STRUCTURE FOUNDATION EXPLORATION

MAD-62-2.79





HORIZONTAL
SCALE IN FEET
0 10 20 40

DRAWN
KJD

CHECKED
RSW

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK

MAD-62-2.79

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/5/17 END: 6/6/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 12+94, 10' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 862.9 (MSL) EOB: 75.0 ft.
LAT / LONG: 39.725119 N, 83.250567 W

EXPLORATION ID
B-001-0-17

PAGE
1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
	862.9							GR	CS	FS	SI	CL	LL	PL	PI			
ASPHALT - 10 INCHES	862.1																	
GRANULAR BASE - 14 INCHES	860.9	1																
FILL: Stiff to very-stiff brown SILT AND CLAY, little fine to coarse sand, trace fine gravel, few medium-stiff zones, damp.	859.4	2 3	2 2 3	8	33	SS-1	0.5–2.5	–	–	–	–	–	–	–	–	14	A-6a (V)	
FILL: Stiff light-brown SANDY SILT, some clay, little fine gravel, damp.	857.9	4 5	2 2 2	7	56	SS-2	1.5–1.75	11	9	18	40	22	24	15	9	14	A-4a (5)	
FILL: Medium-stiff to stiff brown SILT AND CLAY, some fine to coarse sand, trace fine gravel, damp to moist.	856.4	6	2 2 2	7	56	SS-3	0.5–1.5	3	8	18	43	28	28	15	13	20	A-6a (8)	
FILL: Soft to stiff brown SANDY SILT, some clay, trace fine gravel, moist.	853.6	7 8	1 2 1	5	61	SS-4	0.7–1.1	–	–	–	–	–	–	–	–	15	A-6a (V)	
PROBABLE FILL: Medium-stiff to stiff brown becoming dark-brown CLAY, "and" silt, little fine to coarse sand, trace fine gravel, slightly organic (SS-6/SS-8A) to moderately organic (SS-7), few pockets of topsoil, moist. - Sample SS-7: LOI = 8.3%. - Sample SS-8A: LOI = 1.5%.	845.9	9	1 1 1	3	89	SS-5A	0.25–0.6	10	12	18	39	21	24	15	9	17	A-4a (5)	
		10				SS-5B	0.25	–	–	–	–	–	–	–	–	22	A-4a (V)	
		11 12 13	1 2 2	7	72	SS-6	0.5–1.5	4	2	17	46	31	48	25	23	31	A-7-6 (15)	
		14 15	3 2 3	8	67	SS-7	1.0–2.0	–	–	–	–	–	–	–	–	41	A-7-6 (V)	
		16 17	2 2 3	8	100	SS-8A	1.6–1.7	0	1	24	36	39	48	21	27	32	A-7-6 (16)	
Soft to medium-stiff brown SILTY CLAY, some fine to coarse sand, trace fine gravel, slightly organic, damp.	844.6					SS-8B	0.6	–	–	–	–	–	–	–	–	30	A-6b (V)	
		18			98	ST-9	0.25–0.75	7	4	23	37	29	36	18	18	29	A-6b (9)	
Dense brown GRAVEL WITH SAND, little silt, little clay, wet.	839.9	W 19 20 21	8 12 13	42	100	SS-10	–	–	–	–	–	–	–	–	–	12	A-1-b (V)	
		22	8 12 16	47	78	SS-11	–	42	28	12	14	4	NP	NP	NP	12	A-1-b (0)	
Dense to very-dense gray fine to coarse GRAVEL, some fine to coarse sand, trace silt, trace clay, wet.	835.6	23 24	9 14 13	45	72	SS-12	–	60	19	9	10	2	NP	NP	NP	9	A-1-a (0)	
		25	7 15 15	50	67	SS-13	–	65	18	7	8	2	NP	NP	NP	9	A-1-a (0)	
		26 27	7 5 5	17	0	--	–	–	–	–	–	–	–	–	–	–		
Very-stiff to hard gray SILTY CLAY, little fine to coarse sand, trace fine gravel, slightly organic, damp.	830.9	28 29 30	4 7 11	30	100	SS-14	3.5–4.5+	5	5	15	38	37	33	15	18	14	A-6b (11)	
Very-stiff to hard gray CLAY, some silt, trace fine to coarse sand, trace fine gravel, damp.	821.4	31 32 33 34 35	5 9 12	35	100	SS-15	2.75–4.5+	–	–	–	–	–	–	–	–	14	A-7-6 (V)	
		36 37 38 39 40	4 5 9	23	100	SS-16	3.25–4.5+	1	1	11	34	53	52	19	33	22	A-7-6 (18)	
Hard brown mottled with gray SILTY CLAY, little fine to coarse gravel, little fine to coarse sand, damp.	816.4	41 42 43 44 45	12 14 19	55	100	SS-17	4.5	–	–	–	–	–	–	–	–	13	A-6b (V)	
Hard gray SANDY SILT, some silt, some clay, little fine to coarse gravel, damp.		46 47 48 49 50	11 15 20	58	100	SS-18	4.5+	12	9	17	36	26	23	13	10	11	A-4a (5)	
		51 52 53 54 55	12 17 25	70	100	SS-19	4.5+	–	–	–	–	–	–	–	–	11	A-4a (V)	
		56 57 58 59 60	15 22 29	85	100	SS-20	4.5+	–	–	–	–	–	–	–	–	11	A-4a (V)	

- Continued on Next Sheet -

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK
BORING LOG B-001-0-17

DRAWN KJD
CHECKED RSW

PROJECT:	MAD-62-2.79	DRILLING FIRM / OPERATOR:	OTB / A. FAY	DRILL RIG:	OTB MOBILE B-57	STATION / OFFSET:	12+94, 10' LT	EXPLORATION ID B-001-0-17
TYPE:	BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER:	S&ME / K. DOHLEN	HAMMER:	CME AUTOMATIC	ALIGNMENT:	US 62 CENTERLINE	
PID:	102577 BR ID:	DRILLING METHOD:	3.25" HSA	CALIBRATION DATE:	5/22/17	ELEVATION:	862.9 (MSL) EOB: 75.0 ft.	PAGE
START:	6/5/17 END: 6/6/17	SAMPLING METHOD:	SPT	ENERGY RATIO (%):	99.9	LAT / LONG:	39.725119 N, 83.250567 W	2 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Hard gray SANDY SILT, some silt, some clay, little fine to coarse gravel, damp.	772.9	60																
		61																
		62																
		63																
		64	12 22 39	102	100	SS-21	4.5+	13	9	14	38	26	24	14	10	10	A-4a (6)	
		65																
		66																
		67																
		68																
		69	12 24 34	97	100	SS-22	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		70																
		71																
		72																
		73																
		74	14 20 30	83	100	SS-23	4.5+	8	8	14	43	27	24	15	9	11	A-4a (7)	
	787.9	EOB 75																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; 12 LB. BENTONITE POWDER; 94 LB. CEMENT; 1 PLASTIC HOLE PLUG DEVICE; 35 GAL. WATER

NOTES:
- Groundwater encountered at 19.0' during drilling.
- From 17.5' to 18.0': Unconfined Compression Test = 1,123 psf.
- Water and bentonite powder added at 26.0' to prevent sand heave.
- After removal of augers, boring caved at 16.0' and was observed to be dry.
- Borehole sealed with bentonite and cement grout.

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK
CONTINUED BORING LOG B-001-0-17

DRAWN KJD
CHECKED RSW

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/8/17 END: 6/9/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 14+28, 9' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 863.1 (MSL) EOB: 80.0 ft.
LAT / LONG: 39.725220 N, 83.250109 W

EXPLORATION ID B-002-0-17
PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 863.1
ASPHALT - 2-1/2 INCHES	862.9
CONCRETE - 8-1/2 INCHES	862.1
AIR - 18 FEET	844.1
WATER - 4 FEET	840.1
Very-stiff to hard gray SILT AND CLAY, some fine to coarse gravel, some fine to coarse sand, damp.	837.1
Very-stiff to hard gray SILTY CLAY, some fine to coarse sand, trace fine gravel, damp.	825.1
Very-stiff to hard gray CLAY, some "and" silt, little fine to coarse sand, trace fine gravel, damp.	817.6
Hard brown SANDY SILT, some clay, trace fine gravel, damp.	811.1
Hard gray SANDY SILT, some clay, little fine to coarse gravel, damp.	

W

SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)
1 4 3	12	44	SS-1	2.5-4.1	17	9	16	33	25	25	14	11	13	A-6a (5)
1 3 2	8	56	SS-2	3.1	22	10	15	31	22	26	15	11	13	A-6a (4)
4 4 8	20	72	SS-3	4.5	6	5	14	48	27	31	14	17	14	A-6b (11)
4 4 9	22	83	SS-4	3.75	4	6	14	49	27	33	14	19	14	A-6b (12)
4 8 12	33	72	SS-5	4.5+	-	-	-	-	-	-	-	-	14	A-6b (V)
4 8 13	35	100	SS-6	4.5+	-	-	-	-	-	-	-	-	13	A-6b (V)
5 8 14	37	67	SS-7	4.5+	3	6	17	49	25	31	14	17	13	A-6b (11)
4 7 10	28	100	SS-8	3.5-4.5+	0	2	13	50	35	43	16	27	19	A-7-6 (15)
4 8 9	28	100	SS-9	3.1-4.1	1	2	13	35	49	49	19	30	20	A-7-6 (18)
4 7 15	37	67	SS-10	2.75-4.5+	-	-	-	-	-	-	-	-	19	A-7-6 (V)
7 15 18	55	100	SS-11	4.5+	9	8	17	41	25	22	14	8	11	A-4a (6)
5 17 18	58	100	SS-12	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)
8 14 19	55	100	SS-13	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)
10 15 18	55	100	SS-14	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)

DEPTHS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

BACK FILL

- Continued on Next Sheet -

MAD-62-2.79

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK
CONTINUED BORING B-002-0-17

DRAWN KJD
CHECKED RSW

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/8/17 END: 6/9/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 14+28, 9' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 863.1 (MSL) EOB: 80.0 ft.
LAT / LONG: 39.725220 N, 83.250109 W

EXPLORATION ID
B-002-0-17
PAGE
2 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI			
Hard gray SANDY SILT, some clay, little fine to coarse gravel, damp.	763.1	60																
		64	7 14 17	52	100	SS-15	4.5+	14	7	14	37	28	25	15	10	11	A-4a (6)	
		69	7 10 13	38	100	SS-16	4.5	-	-	-	-	-	-	-	-	12	A-4a (V)	
		74	10 17 26	72	100	SS-17	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		79	10 15 21	60	100	SS-18	4.5+	10	8	14	41	27	24	15	9	12	A-4a (7)	
	783.1	EOB 80																

Depth scale: 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK
CONTINUED BORING B-002-0-17

DRAWN KJD
CHECKED RSW

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/6/17 END: 6/7/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 15+80, 8' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 862.3 (MSL) EOB: 80.0 ft.
LAT / LONG: 39.725336 N, 83.249588 W

EXPLORATION ID
B-003-0-17
PAGE
1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 862.3	DEPTHS
ASPHALT - 9 INCHES	861.5	
GRANULAR BASE - 15 INCHES	860.3	
FILL: Stiff-very stiff brown SILT AND CLAY, some fine to coarse sand, trace to little fine gravel, few pockets of fine to coarse sand, few roots, damp.	857.3	
PROBABLE FILL: Medium-stiff to stiff dark-brown CLAY, some silt, little to some fine to coarse sand, trace to little fine to coarse gravel, slightly becoming moderately organic, few very-soft zones, damp. - From 8.0' to 8.5': Unconfined Compression Test = 1,209 psf. - SS-6: LOI = 6.5% and OD/AD LL Ratio = 0.80.	849.3	
Stiff dark-brown ELASTIC CLAY, "and" silt, little fine to coarse sand, trace fine gravel, moderately organic, damp. - SS-7: LOI = 7.4%.	846.8	
Medium-stiff dark-brown CLAY, "and" silt, some fine sand, trace coarse sand, trace fine gravel, moderately organic. - SS-8: OD/AD LL Ratio = 0.76.	844.3	
Medium-dense brown GRAVEL WITH SAND, little silt, trace clay, wet.	841.8	W
Dense to very-dense brown fine to coarse GRAVEL, some fine to coarse sand, trace silt, trace clay, wet.	834.6	
Very-stiff to hard gray SANDY SILT, little fine gravel, little clay, damp.	829.6	
Very-stiff to hard gray CLAY, some silt, little fine to coarse sand, trace fine gravel, damp.	820.3	
Hard gray SILT AND CLAY, little fine to coarse sand, trace fine gravel, damp.	815.3	
Hard gray SANDY SILT, some fine to coarse gravel, little clay, damp.	811.3	
Hard gray SILT AND CLAY, some fine to coarse sand, little fine to coarse gravel, damp.		

SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)
					GR	CS	FS	SI	CL	LL	PL	PI		
1 2 3	8	78	SS-1A	1.0–3.5	–	–	–	–	–	–	–	–	12	A-6a (V)
			SS-1B	1.5–4.25	11	11	18	36	24	25	14	11	14	A-6a (5)
2 1 3	7	67	SS-2	1.6–2.1	10	9	21	33	27	29	15	14	17	A-6a (7)
2 1 2	5	22	SS-3	0.5–0.75	–	–	–	–	–	–	–	–	15	A-7-6 (V)
1 2 3	8	11	SS-4	0.5	–	–	–	–	–	–	–	–	25	A-7-6 (V)
		88	ST-5	0.1–0.6	14	3	11	37	35	51	27	24	33	A-7-6 (15)
2 2 3	8	67	SS-6	0.5–1.25	0	3	17	44	36	55	29	26	37	A-7-6 (17)
1 2 3	8	78	SS-7	1.0–1.6	1	2	11	47	39	54	30	24	37	A-7-5 (16)
2 4 11	25	56	SS-8	0.6–1.75	5	6	20	37	32	51	26	25	33	A-7-6 (15)
3 5 4	15	33	SS-9	–	49	27	9	13	2	NP	NP	NP	14	A-1-b (0)
7 10 13	38	67	SS-10	–	69	15	6	8	2	–	–	–	11	A-1-a (V)
11 15 15	50	78	SS-11	–	62	18	8	9	3	NP	NP	NP	9	A-1-a (0)
11 24 14	63	67	SS-12	–	66	17	6	8	3	NP	NP	NP	8	A-1-a (0)
4 16 17	55	78	SS-13	–	58	21	9	9	3	NP	NP	NP	10	A-1-a (0)
3 11 13	40	56	SS-14	2.4–4.5+	17	13	17	35	18	21	14	7	12	A-4a (4)
5 8 10	30	100	SS-15	4.5+	–	–	–	–	–	–	–	–	13	A-7-6 (V)
4 7 10	28	100	SS-16	3.1–4.5	1	2	13	35	49	46	17	29	19	A-7-6 (17)
9 14 15	48	100	SS-17	4.5+	–	–	–	–	–	–	–	–	12	A-6a (V)
4 15 24	65	44	SS-18	4.5+	23	15	22	27	13	18	13	5	9	A-4a (1)
16 18 25	72	100	SS-19	4.5+	14	8	13	38	27	25	14	11	11	A-6a (6)
9 14 20	57	67	SS-20	4.5+	–	–	–	–	–	–	–	–	11	A-6a (V)

HOLE SEALED

- Continued on Next Sheet -

MAD-62-2.79

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK
CONTINUED BORING B-003-0-17

DRAWN KJD
CHECKED RSW

PROJECT: MAD-62-2.79
TYPE: BRIDGE REPLACEMENT
PID: 102577 BR ID:
START: 6/6/17 END: 6/7/17

DRILLING FIRM / OPERATOR: OTB / A. FAY
SAMPLING FIRM / LOGGER: S&ME / K. DOHLEN
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: OTB MOBILE B-57
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 5/22/17
ENERGY RATIO (%): 99.9

STATION / OFFSET: 15+80, 8' LT
ALIGNMENT: US 62 CENTERLINE
ELEVATION: 862.3 (MSL) EOB: 80.0 ft.
LAT / LONG: 39.725336 N, 83.249588 W

EXPLORATION ID B-003-0-17
PAGE 2 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 762.3	DEPTHS	SPT/ RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Hard gray SILT AND CLAY, some fine to coarse sand, little fine to coarse gravel, damp.	800.3	60 – 62																
Hard gray SANDY SILT, some fine to coarse gravel, some fine to coarse sand, damp.		64	13 18 26	73	100	SS-21	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		69	13 16 17	55	100	SS-22	4.5	21	9	12	36	22	23	14	9	11	A-4a (5)	
		74	14 16 26	70	100	SS-23	4.5+	-	-	-	-	-	-	-	-	13	A-4a (V)	
	782.3	79	12 16 27	72	78	SS-24	4.5	9	8	13	41	29	25	15	10	12	A-4a (7)	
		EOB 80																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; 15 LB. BENTONITE POWDER; 94 LB. CEMENT; PLASTIC HOLE PLUG DEVICE; 35 GAL. WATER

NOTES:
- Groundwater encountered at 18.5' during drilling.
- Water added at 21.0' to prevent sand heave.
- Borehole sealed with bentonite and cement grout.

MAD-62-2.79

STRUCTURE FOUNDATION EXPLORATION
BRIDGE NO. MAD-62-0279 OVER DEER CREEK
CONTINUED BORING B-003-0-17

DRAWN KJD
CHECKED RSW

UNCONFINED COMPRESSION TEST REPORT

ASTM D2166

PROJECT INFORMATION

CLIENT: Euthenics, Inc.
PROJECT NUMBER: 1179-17-005
PROJECT NAME: MAD-62-2.79
PROJECT LOCATION: Mount Sterling, Ohio

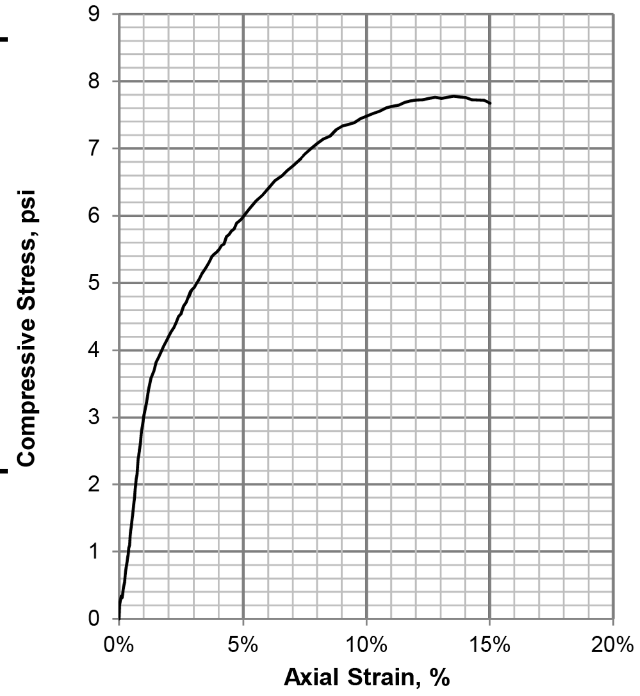
SAMPLE INFORMATION

BORING ID: B-001-0-17
SAMPLE NUMBER: S-9
SAMPLE DEPTH: 17.5' - 18.0'
DATE OF TEST: 7/6/2017

SAMPLE DESCRIPTION: Very soft to medium-stiff, dark brown, SILTY CLAY, some fine to coarse sand, trace fine gravel

SPECIMEN MEASUREMENTS

MOISTURE CONTENT: 30.71%
AVERAGE DIAMETER: 2.8082 in.
AVERAGE HEIGHT: 5.6012 in.
HEIGHT/DIAMETER RATIO: 1.99
WET DENSITY: 115.17 pcf
DRY DENSITY: 88.11 pcf
SPECIFIC GRAVITY: 2.75 (est.)
SATURATION: 89.04% (est.)
VOID RATIO: 0.9485 (est.)



TEST RESULTS

MAXIMUM LOAD: **56** lbs
UNCONFINED STRENGTH: **7.8** psi
STRAIN RATE: **1%** %/min
STRAIN AT FAILURE: **13.53%** %

ADDITIONAL TESTING REMARKS:

TESTED BY: KJD
CHECKED BY: RSW

SPECIMEN BEFORE TESTING

NO PHOTO AVAILABLE

SPECIMEN AFTER TESTING

NO PHOTO AVAILABLE

UNCONFINED COMPRESSION TEST REPORT

ASTM D2166

PROJECT INFORMATION

CLIENT: Euthenics, Inc.
PROJECT NUMBER: 1179-17-005
PROJECT NAME: MAD-62-2.79
PROJECT LOCATION: Mount Sterling, Ohio

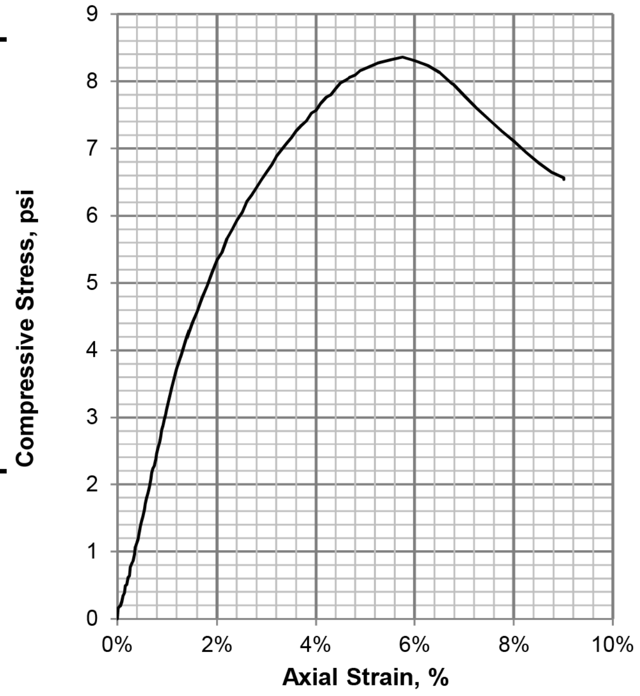
SAMPLE INFORMATION

BORING ID: B-003-0-17
SAMPLE NUMBER: S-5
SAMPLE DEPTH: 8.0' - 8.5'
DATE OF TEST: 7/6/2017

SAMPLE DESCRIPTION: Very-soft to medium-stiff, dark brown, CLAY, some silt, little fine to coarse gravel, little fine to coarse sand.

SPECIMEN MEASUREMENTS

MOISTURE CONTENT: 39.05%
AVERAGE DIAMETER: 2.8342 in.
AVERAGE HEIGHT: 5.5940 in.
HEIGHT/DIAMETER RATIO: 1.97
WET DENSITY: 113.08 pcf
DRY DENSITY: 81.33 pcf
SPECIFIC GRAVITY: 2.75 (est.)
SATURATION: 96.65% (est.)
VOID RATIO: 1.1110 (est.)



TEST RESULTS

MAXIMUM LOAD: **56** lbs
UNCONFINED STRENGTH: **8.4** psi
STRAIN RATE: **1%** %/min
STRAIN AT FAILURE: **5.76%** %

ADDITIONAL TESTING REMARKS:

TESTED BY: KJD
CHECKED BY: RSW

SPECIMEN BEFORE TESTING

NO PHOTO AVAILABLE

SPECIMEN AFTER TESTING

NO PHOTO AVAILABLE

DRAWN KJD
CHECKED RSW

STRUCTURE FOUNDATION EXPLORATION COMPRESSIVE STRENGTH TEST RESULTS

MAD-62-2.79

9/9

0:\DEPTS\CADD\Drawings\Projects - BST\2017\1179-17-005-MAD-62\102577_MAD-62-0279\Design\Roadway\Sheets\102577_ZD001.dgn Sheet 3/7/2018 16:50:39 kdohlen