Subgrade Exploration
Smothers Road Roundabout
Franklin/Delaware County, Ohio
S&ME Project No. 1117-16-018

Prepared for:
AECOM
277 West Nationwide Boulevard
Columbus, OH 43215-2566

Prepared by:
S&ME, Inc.
6190 Enterprise Court
Dublin, OH 43016

May 13, 2016

May 13, 2016

AECOM
277 West Nationwide Boulevard
Columbus, OH 43215-2566

Attention: Mr. Ed Kisiel, PE

Reference: **Subgrade Exploration**
Smothers Road Roundabout
Franklin & Delaware County, Ohio
S&ME Project No. 1117-16-018

Mr. Kisiel:

In accordance with our proposal dated November 20, 2015, which was authorized by AECOM Task Order No. 73961 dated April 7, 2016, S&ME, Inc. (S&ME) has completed a Subgrade Exploration for the proposed roundabout planned at the intersection of Smothers Road, Schott Road, and Red Bank Road located in both Franklin and Delaware County, Ohio. The project location is illustrated on the Vicinity Map included as Plate 1 in the Appendix of this report. Our report of this investigation is herewith submitted.

We appreciate having been given the opportunity to be of service on this project. If you require additional assistance or have any questions, please feel free to contact our office at any time.

Respectfully,

S&ME, Inc.

Richard S. Weigand, PE
Senior Engineer

Bethanie L. Meek, PE
Senior Reviewer

Attachments: Appendix (17 sheets)

Submitted: 1 Email Copy

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Appendix

1.0 Introduction

S&ME understands that improvements, including the construction of a roundabout, are being planned for the intersection of Smothers, Schott, and Red Bank Roads which is in both Franklin and Delaware County, Ohio. The planned realignment of the legs of the intersection are planned to extend approximately 325 feet west, 475 feet east, 425 feet north, and 525 feet south of the intersection of the existing roadway centerlines, with the new roundabout centered roughly 80 east of the existing intersection. Although preliminary profile information was not available at the time of this report, AECOM has indicated that the vertical alignment will be raised approximately 1 to 1.5 feet at the roundabout, with the majority of the approach roadways remaining at approximately the same elevation as the existing grade.

This geotechnical exploration program was performed in general accordance with the ODOT Specifications for Geotechnical Explorations (SGE) including the January 2016 updates, and ODOT Geotechnical Bulletin GB1, "Plan Subgrades", revised January 15, 2016.

2.0 Geology and Observations of the Project

2.1 Geology

The project site is located in a portion of Ohio which was glaciated, and is within the Galion Glaciated Low Plateau physiographic region. This site is located just east of Hoover Reservoir in a transitional area of rolling uplands with a layer of Wisconsin-aged glacial till overlying Mississippian-aged, Berea formation sandstones over Bedford formation shale. Ohio Department of Natural Resources (ODNR) bedrock topography mapping indicates that bedrock is located within roughly 5 to 15 feet of the existing ground surface near this intersection. The ODNR "Ohio Karst Areas" map indicates that karst features are not known to be present in the general area of the site.

2.2 Reconnaissance

A site reconnaissance visit was made on April 8, 2016, prior to the field exploration program. The land usage along the majority of the project is either rural residential or agricultural, and the terrain is primarily flat. Overhead wires were observed along the south side of Smothers Road, and an area with several utility boxes was present just northeast of the existing intersection. The existing pavement condition of all three roadways was generally noted to be in fair to good condition.

S&ME selected and marked the proposed boring locations during this site visit. Boring locations were either painted on the existing pavement or staked using wooden lath and surveying ribbon in the farm field to the southeast of the existing intersection (Boring B-002-0-16).

3.0 Exploration

3.1 Field Investigation

On April 14, 2016, a total of six (6) roadway borings were performed to investigate the subgrade soil for the proposed intersection improvement. These borings were numbered B-001-0-16 through B-006-0-16, and are hereinafter referred to as B-001 through B-006. The approximate locations of the borings are shown on the Plan of Borings included as Plate 3 of the Appendix. Surveyed state plane coordinates and ground surface elevations at the boring locations were provided to S&ME by AECOM.

The borings were performed by an ATV-mounted drilling rig using a 2¼-inch I.D. hollow-stem auger to advance the borings between sampling attempts. At regular intervals, 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). Continuous SPT sampling was performed in the four borings advanced through the existing pavement as little to no profile adjustment was anticipated at these locations. The borings performed near the proposed roundabout were sampled at 2½-foot intervals, as the final profile of the roundabout pavement was not known at the time of the field work. In accordance with the current ODOT SGE, the hammer system on the drilling rig had been calibrated in accordance with ASTM D 4633 to determine the drill rod energy ratio. This value (91%) is included on each boring log.

At the completion of drilling, the borings were backfilled or sealed in accordance with Appendix F of the ODOT SGE. Where borings were advanced through existing pavement, the surface of the pavement was repaired using cold-patch asphalt. All recovered samples were transported to the soils laboratory of S&ME for further examination and testing.

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

3.2 Laboratory Testing

In the laboratory, all recovered soil samples were visually identified and tested for natural moisture content. In addition, two (2) liquid and plastic limit determinations and gradation analyses were performed on selected samples retrieved at or just below the anticipated subgrade level. The results of these tests are reported numerically on the individual boring logs.

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 6 through 11 of the Appendix. 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; seepage and groundwater observations; and, values of hand-penetrometer

measurements made in soil samples exhibiting cohesion. For your reference, hand-penetrometer values are roughly equivalent to the unconfined compressive strength of the cohesive fraction of the soil sample.

Soils have been classified in general accordance with Section 603 of the ODOT SGE, and described in general accordance with Section 602. Bedrock descriptions in general accordance with Section 605 of the SGE are also provided. An explanation of the symbols and terms used on the boring logs and the definitions of the special adjectives used to denote the minor soil components is presented on Plates 3 and 4 of the Appendix.

4.0 Findings

4.1 Existing Pavement

Four (4) of the six (6) borings performed as part of this investigation were performed within the existing pavement of Smothers, Schott, or Red Bank Roads. Borings B-001 and B-004, advanced through Schott and Red Bank Roads, respectively, encountered 11 and 10.5 inches of asphalt over 6 and 7.5 inches of granular base. Borings B-005 and B-006 were drilled through the existing Smothers Road pavement and encountered 13 and 10 inches of asphalt over 5 and 7 inches of granular base. Boring B-003, which was drilled just north and east of the existing intersection in the partially paved area adjacent to the utility boxes, encountered 6 inches of asphalt over 7 inches of granular base.

4.2 Subsurface Stratigraphy

Beneath 8 inches of topsoil and rootmat in Boring B-002, and beneath the pavement sections in Borings B-001, B-003, B-004, and B-006, the borings encountered cohesive soil consisting of medium-stiff to very-stiff brown mottled with gray CLAY (A-7-6) and SILTY CLAY (A-6b). N_{60} values in these materials generally ranged from 8 to 18, and Group Index values ranged from 10 to 20. In Boring B-006, this cohesive layer was overlain by 1.1 feet of slightly organic SILT (A-4b). Boring B-005 also encountered cohesive soil (A-6a and A-6b); however, this soil was described as existing fill.

Beneath this upper cohesive soil, Borings B-001 and B-003 encountered a granular layer consisting of very-dense SANDY SILT (A-4a) containing numerous sandstone fragments and described as being similar to severely weathered sandstone, and Boring B-005 encountered very-dense GRAVEL WITH SAND. Boring B-005 was terminated within this layer.

Borings B-001 through B-004 and Boring B-006 were terminated after penetrating 1.5 to 6.2 feet into SANDSTONE which was described as being severely to highly weathered, very-weak to weak, and highly fractured and fragmented.

4.3 Groundwater Observations

During drilling, groundwater was noted in Borings B-001 and B-003 at the depths of 5.0 and 6.0 feet, respectively. At the completion of drilling, no measureable amount of water had accumulated in Boring B-001, but had accumulated inside the auger stem to a depth of 4.8 feet below the ground surface in Boring B-003. No groundwater seepage was noted in the remaining four borings.

5.0 Analyses and Recommendations

5.1 Geotechnical Evaluation

S&ME understands that it is proposed to improve the intersection of Smothers Road with Schott and Red Bank Roads in Franklin and Delaware County, Ohio, by providing a roundabout. Roadway improvements and reconstruction will extend approximately 325 feet west, 475 feet east, 425 feet north, and 525 feet south of the existing intersection, with the new roundabout centered approximately 80 feet east of the existing intersection. Preliminary information from AECOM indicates the proposed profile near the roundabout will be raised slightly (1 to 1.5 feet), with the majority of the approach roadways remaining at approximately the same elevation as the existing grade. New fill placement will also be required where the alignment crosses existing ditches that parallel the current roadways.

5.2 Subgrade Support Parameters

Plate 12 in the Appendix is an ODOT Geotechnical Bulletin GB1 spreadsheet (Ver. 13.00) created by the ODOT Office of Geotechnical Engineering (OGE) to summarize the soil type (by ODOT/HRB classification), group indices, depth, blow-counts, and Atterberg Limit values of the proposed subgrade soils encountered in the borings drilled for this project. This table also computes an average of the estimated values of the California Bearing Ratio (CBR) for the soils encountered at or below the anticipated subgrade level of the proposed roadway profile.

Based on the preliminary profile information provided verbally by AECOM at the time of this report, the following average California Bearing Ratio (CBR) is computed by the ODOT GB1 spreadsheet for the anticipated subgrade soils encountered during this investigation:

CBR: 5%

Based on this average value, and Section 203.1 of the current ODOT Pavement Design Manual, the following value of Resilient Modulus (M_R) may be used during new pavement section design for this project.

M_R: 6,000 psi

These subgrade support values may be used during pavement design for this project provided that the entire proposed pavement subgrade is prepared in strict accordance with Item 204 of the 2016 ODOT Construction and Materials Specifications (CMS), and that all borrow soil placed within 3 feet of the final subgrade level of a new fill embankment is capable of providing average subgrade support parameters which meet or exceed the above values. This subgrade evaluation also assumes 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 consists of materials different than those encountered in the borings, the pavement design subgrade criteria should be reviewed and, if necessary, modified.

5.3 Unsuitable Subgrade Materials

5.3.1 Silt

Boring B-006 encountered 1.1 feet of frost-susceptible silt soil with an ODOT classification of **A-4b** immediately beneath the existing granular base of Smothers Road. In accordance with Item 203.03.A of the 2016 ODOT CMS, soil with this classification (A-4b) is not permitted within 3 feet of the subgrade level. Therefore, it is recommended that this soil type be completely overexcavated where present to depths less than 3 feet, or be removed to a depth of at least 3 feet below the proposed subgrade level if thicker deposits are present, and the overexcavation replaced with acceptable borrow soil (see "Borrow Requirements and Compaction Criteria" section on page 9 of this report). This A-4b soil was also described as being slightly organic.

5.3.2 Bedrock

Five of the six borings performed for this project encountered very-weak to weak and severely weathered sandstone bedrock. In Borings B-001 and B-003, the sandstone was overlain by 1.2 to 2.5 feet of very-dense brown SANDY SILT which contained gravel consisting of sandstone fragments and was described as being similar to severely weathered and degraded sandstone. None of the borings, however, encountered either sandstone or the very-dense SANDY SILT containing sandstone fragments within 2 feet of the estimated roadway subgrade based on the estimated profile information provided by AECOM.

Because of the wide spacing of the explorations, however, it is possible that bedrock may be present at elevations higher than that encountered in the borings. If areas of bedrock are encountered where the rock is within 2 feet of the bottom of the pavement materials, it will be necessary to overexcavate the bedrock to a depth in accordance with ODOT CMS Item 204.05 (i.e., undercut to at least 2 feet below the bottom of asphalt or concrete pavement). This overexcavated material must be replaced with compacted, suitable embankment material (ODOT CMS Item 203.02) meeting the minimum subgrade support characteristics consistent with the design CBR for the pavement section (see Section 4.2).

Based on the results of the borings, S&ME recommends that provisions for encountering bedrock be made where excavations for utilities or other aspects of this project extend more than 2 to 3 feet below the proposed roadway subgrade level.

Although several of the borings were able to penetrate a few feet into the bedrock before encountering "auger refusal", it must be emphasized that **a direct correlation should not be made between the performance of the drilling rig and the ability of construction equipment to excavate the bedrock at this site**.

5.3.3 Other Materials/Conditions

None of the borings performed during this investigation encountered any other soil which ODOT GB1 considers to be unsuitable either by classification (A-2-5, A-5, A-7-5, A-8a, A-8b) or which has a Liquid Limit value in excess of 65%.

If deposits of unsuitable soils such as topsoil, silt, or organic materials are encountered during earthwork or proofrolling operations, S&ME recommends that test pits or hand sampling methods be used to further investigate and delineate the extent of these deposits.

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

Particular attention should also be given to the ditches and drainage swales adjacent to the existing roadways, as unstable or unsuitable (e.g., soft, saturated, possibly organic) soil requiring removal may be present in the ditches or swales. S&ME recommends that these areas be closely examined and the bottoms of the ditches probed prior to commencing earthwork operations, and all weak, wet, or organic soil should be removed prior to commencing fill placement. For this reason, AECOM may consider including a 1- to 2-foot deep overexcavation of existing ditches in the project excavation quantities. These ditch overexcavations should be backfilled with properly compacted soil (ODOT CMS Item 203, or Item 204 if within 12 inches of proposed subgrade).

Because of the variable nature of the wide spacing of the explorations, it is possible that other areas of unsuitable organic or silt materials that were not encountered in any of the borings may be encountered during earthwork and proofrolling operations. Visual observation of the proofrolling procedures by the Geotechnical Engineer of Record may potentially result in a reduction of overexcavation of unsuitable soils in these areas. Additionally, S&ME recommends that construction traffic be minimized or restricted once the planned soil subgrade level has been exposed or attained.

5.4 ODOT GB1 Subgrade Analysis

ODOT's Geotechnical Bulletin GB1 "Plan Subgrades" indicates that a comparison of the laboratory-measured moisture content to the estimated optimum moisture content of the subgrade soil, along with the normalized blow-count (N_{60}) from SPT sampling, may be used as an indicator of the potential need for subgrade treatment or remediation of unstable subgrade soil. The acceptable options presented by GB1 to remediate and establish a stable soil subgrade are either to "excavate and replace", or chemical stabilization.

Plate 12 in the Appendix summarizes the laboratory-measured moisture content of the samples obtained from each boring with respect to their estimated optimum moisture contents, along with the lowest N value (N_{60L}) obtained from the Standard Penetration Tests performed in each of these borings. This table also indicates the recommended Item 204 "excavate and replace" depths per GB1 at each boring location, along with an overall assessment of the suitability of various types of chemical stabilization on this project.

Plate 12 indicates that 67% (4 of 6) of the borings performed as part of this investigation encountered soil at or just below the proposed subgrade level with characteristics defined as problematic (excessive soil

moisture content or a low N_{60} value) by the procedures recommended in GB1. Additionally, a fifth boring indicates the presence of unsuitable A-4b SILT which must be removed where present within 3 feet of the proposed subgrade level. ODOT GB1 indicates that when 30% or more of the proposed subgrade requires remediation, global remediation/stabilization of the entire project subgrade should be considered.

Based on the types and thicknesses of soil encountered in the borings, S&ME recommends that a global subgrade remediation program consisting of 12 inches of "excavate and replace" be implemented on this project. The lateral limits of the subgrade remediation should extend to 18 inches outside the proposed pavement, paved shoulders, or paved median areas, including beneath curbs and gutters.

S&ME does not believe that chemical stabilization would be a cost effective method for this project, since as multiple remedial approaches would be required. The unsuitable A-4b SILT would require either cement stabilization or removal/replacement, whereas the high plasticity clay (A-7-6) soil would be receptive to lime stabilization.

The estimated GB1 subgrade remediation depths are based on the conditions encountered in the borings during this subsurface investigation. However, because the required amount of remediation is dependent on the moisture content of the subgrade soil at the time of construction, ODOT Geotechnical Bulletin GB1 states that the ultimate decision on required remediation depths and limits should be based on observations during either proofrolling or test-rolling operations.

5.5 Additional Subgrade Remediation Considerations

Because of the moisture sensitive nature of the cohesive soils (A-6b, A-7-6) encountered in the borings, S&ME recommends construction traffic be minimized once the required subgrade level has been attained. Construction traffic resulting from cyclical haul routes or limited access points may increase the quantity of soil identified by proofrolling as requiring removal, particularly during periods of moist weather.

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.

It is also recommended that overexcavated subgrade areas backfilled with granular soil be drained to an underdrain, catch basin, or pipe. Additionally, as "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. If, however, chemical stabilization is selected, additional pay items to be included in the plans are provided in Section G of ODOT Geotechnical Bulletin GB1.

5.6 Earthen Embankment Construction

Preliminary profile information provided verbally by AECOM indicates the majority of the proposed roadway will be constructed at approximately the same elevation as the existing. Some additional fill placement, however, is anticipated beneath the new roundabout to attain the proposed subgrade level.

5.6.1 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 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, especially in "at-grade" and fill areas. Any such materials identified should be removed and replaced with suitable compacted fill (Item 203, or Item 204 when within 12 inches of the proposed subgrade). Recommendations for existing ditches have been previously presented in Section 5.3, "Unsuitable Subgrade Materials" of this report.

5.6.1.1 "Fill" Areas

Because the realigned roadways will require a thin layer of new fill to be placed in a few areas, S&ME recommends that consideration be given to test rolling the exposed embankment foundation prior to commencing fill placement in these areas. This additional proofrolling, performed in accordance with Item 204.06 of the 2016 ODOT CMS and Section 204 of the 2013 ODOT Construction Inspection Manual of Procedures, would assist in identifying soft, wet or weak zones that may be present in areas where the thickness of new fill embankment is insufficient to "bridge" an underlying weak or wet soil. If any such zones are present, the materials contained in these zones should be either scarified, dried, and thoroughly recompacted in place in accordance with ODOT Item 203.07, or be removed and the overexcavation filled in a controlled manner with compacted, suitable embankment material (Item 203.02) and the recommendations presented in the following section of this report.

Although Item 203.05 permits the use of a "bridge lift" to aid in spanning soft or wet foundation areas, S&ME recommends that this practice not be permitted except where more than 3 feet of new embankment fill placement is required. Soft, weak, wet, or unsuitable soils that are not removed from beneath a thin layer of fill may result in significant difficulties in achieving the compaction percentages required for the new fill (Items 203.07 or 204.03) such that final subgrade acceptance proofrolling may require overexcavation of the new fill where weak soils were "bridged" by a minimal thickness of new fill. Additionally, even if more than 3 feet of new fill is required in existing roadway ditches, S&ME does not recommend that bridge lift be permitted in these areas because of the potential for organic soil in the existing ditches. Long term settlement within any organic soil left in the existing ditch lines may result in the development of a depression in the pavement surface.

5.6.1.2 "At-Grade" and "Cut" Areas

Once the desired subgrade elevation has been attained in all "cut" and "at-grade" areas, and after overexcavation of all existing unsuitable subgrade materials has been completed, the subgrade soil beneath the entire roadway and shoulder pavement area should be scarified and recompacted to a depth of 12 inches below the subgrade level in accordance with ODOT Item 204.03. During recompaction, the moisture content of the subgrade soil should be maintained or adjusted in accordance with ODOT Item 203.07.A.

Following the completion of the scarification and recompaction of the subgrade in these "cut" and "at-grade" areas, it is strongly recommended that construction traffic be restricted from traveling on the compacted subgrade until final acceptance proofrolling has been performed. Cohesive subgrade soils subjected to repeated moisture fluctuations, which may occur as a result of exposure to rainfall and/or surface water runoff, may exhibit subgrade instability.

5.6.2 Benching

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. However, at any locations where the existing ground surface is steeper than 4(H):1(V), "Special Benching" should be performed in accordance with the procedures outlined in the current ODOT Geotechnical Bulletin GB2, "*Special Benching and Sidehill Embankment Fills*", and the ODOT Construction Inspection Manual of Procedures.

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

5.6.3 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, as recommended in Section 5.2 of this report, any 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.

5.6.4 Compaction/Moisture Conditioning Concerns

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

moisture conditioning only be performed when extended periods of suitable weather are anticipated, and that only the amount of borrow soil be exposed that may be moisture conditioned and properly compacted during suitable weather periods.

5.6.5 Subgrade Preparation

Once the design subgrade elevation has been attained for the proposed roadway embankments, the subgrade should be compacted and proofrolled in accordance with Item 204 of the ODOT Construction and Material Specifications, with any weak or unsuitable areas repaired in accordance with Item 204.07.

5.7 Groundwater Considerations

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

The presence of water bearing granular layers or seams in the walls of any excavation may also result in caving or sloughing of the excavation walls. S&ME recommends that all excavations be braced, or sloped back at a safe angle, in accordance with current OSHA Excavation Regulations.

6.0 Final Considerations

The analyses, conclusions and recommendations presented in this report are based on project information provided by AECOM. We request that S&ME be retained to review the final design plans and specifications to verify that the intent of our engineering recommendations have been properly incorporated into the design documents. It is also recommended that S&ME be retained to observe the subgrade proofrolling and roadway subgrade construction for the project to confirm that our recommendations are valid or to modify them accordingly. S&ME cannot assume responsibility or liability for the adequacy of recommendations if S&ME is not retained to observe construction.

The contents of this report are also based on the subsurface conditions as they existed at the time of our field investigation, and further on the assumption that the exploratory borings are representative of actual subsurface conditions throughout the area investigated. It should be noted that actual subsurface conditions between and beyond the borings might differ from those encountered at the boring locations. If subsurface conditions varying from those discussed in this report are encountered during construction, S&ME should be notified immediately so that we may evaluate the effects, if any, on design and construction.

Appendix

Important Information About Your Geotechnical Engineering Report

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

Geotechnical Findings Are Professional Opinions

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

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

Scope of Geotechnical Services

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

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

Services Are Performed for Specific Projects

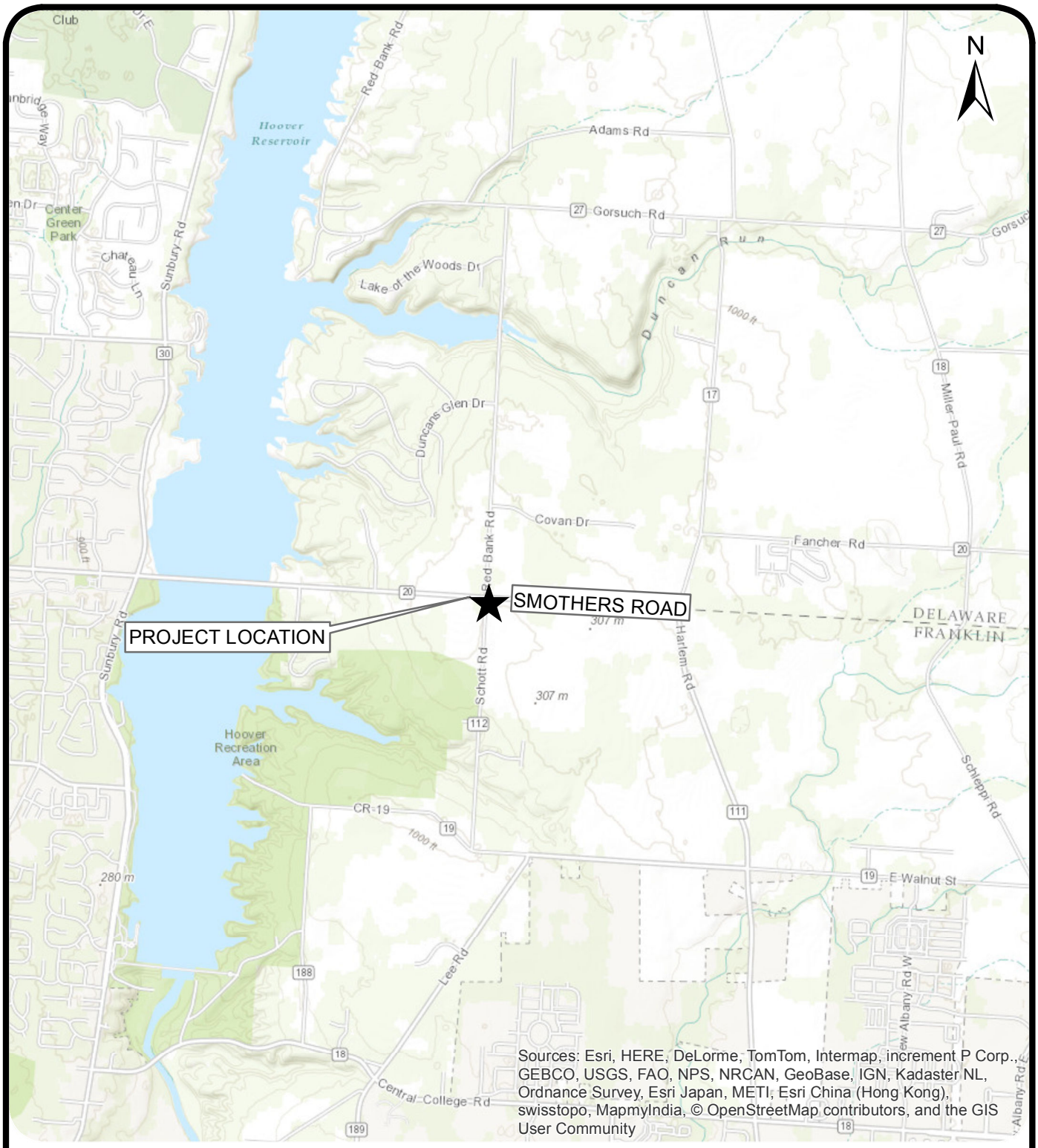
Because the scope of each geotechnical exploration is unique, each geotechnical report is unique. Subsurface conditions are explored and recommendations are made for a specific project. Subsurface information and recommendations may not be adequate for other uses. Changes in a proposed structure location, foundation loads, grades, schedule, etc. may require additional geotechnical exploration, analyses, and consultation. The geotechnical engineer should be consulted to determine if additional services are required in response to changes in proposed construction, location, loads, grades, schedule, etc.

Geo-Environmental Issues

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

Geotechnical Recommendations Are Not Final

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



0 2,000 4,000 6,000 8,000 Feet

VICINITY MAP

PLATE NO. 2

SMOTHERS ROAD ROUNDABOUT
FRANKLIN AND DELAWARE COUNTY, OHIO

SCALE:	1 inch = 4,000 feet
DATE:	05/03/2016
DRAWN BY:	CRW
PROJECT NO:	1117-16-018

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0 200 400 Feet

Legend

B-001-0-16 BORING LOCATION

REFERENCE:

AERIAL IMAGERY OBTAINED FROM THE OHIO GEOGRAPHICALLY REFERENCED INFORMATION PROGRAM'S (OGRIPS) 2014 OHIO STATEWIDE IMAGERY PROGRAM (OSIP II). ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED.

SCALE:	1 inch = 200 feet
DATE:	5/5/2016
DRAWN BY:	CRW
PROJECT NO:	1117-16-018

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PLAN OF BORINGS

SMOTHERS ROAD ROUNDABOUT
FRANKLIN AND DELAWARE COUNTY, OHIO

PLATE NO. 3

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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.

50-3" - Number of blows (50) to drive a split-barrel sampler a certain distance (3 inches) 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 teminated.

▼ 5 days - Depth to water in a monitoring well, or a piezometer in a 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

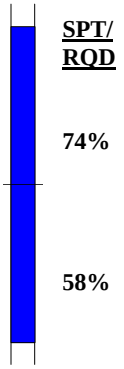
The following terms are used to describe density and consistency of soils:

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

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

SAMPLING DATA



When bedrock is encountered and rock core samples are attempted, the length of core recovered and lost during the core run is reported in the “REC” column. The type of rock core barrel utilized is recorded under the heading “Sampling Method” at the top of the boring log, and also in the “SAMPLE ID” column. Rock-core barrels can be of either single- or double-tube construction, and a special series of double-tube barrels, designated by the suffix M, may also be used to obtain maximum core recovery in very-soft or fractured rock. Four basic groups of barrels are used most often in subsurface investigations for engineering purposes, and these groups and the diameters of the cores obtained are as follows:

AX, AW, AXM, AWM	-	1-1/8 inches
BX, BW, BXM, BWM	-	1-5/8 inches
NX, NW, NXM, NWM	-	2-1/8 inches
NQ, NQ2	-	1-7/8 inches

Rock Quality Designation (RQD) is expressed as a percentage and is obtained by summing the total length of all core pieces which are at least 4 inches long and then dividing this sum by, either, the total length of core run or the length of the core run in a particular bedrock stratum. The RQD value is reported as a percentage in the “SPT/RQD” column. It has been found that there is a reasonably good relationship between the RQD value and the general quality of rock for engineering purposes. This relationship is shown as follows:

RQD - %	General Quality
0 - 25	Very-poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

ROCK HARDNESS

Recovered bedrock samples are described in general accordance with Section 605 of the 2007 ODOT SGE and subsequent revisions, where necessary. The following terms are used to describe rock hardness:

Term	Meaning
Very Weak	Rock can be excavated readily with the point of a pick and carved with a knife. Pieces 1 inch or greater in thickness can be broken by finger pressure. Can be scratched with a fingernail.
Weak	Rock can be grooved or gouged readily by a knife or pick, and can be excavated in small fragments with moderate blows from a pick point. Small, thin pieces may be broken with finger pressure.
Slightly Strong	Rock can be grooved or gouged 0.05 inches deep with firm pressure from a knife or pick point, and can be excavated in small chips to pieces of 1 inch maximum size using hard blows from the point of a geologist’s pick.
Moderately Strong	Rock can be scratched with a knife or pick. Grooves or gouges to ¼ inch deep can be excavated by hard blows of a geologist’s pick. Requires moderate hammer blows to detach a hand specimen.
Strong	Rock can be scratched with a knife or pick only with difficulty. Requires hard hammer blows to detach a hand specimen. Sharp and resistant edges are present on hand specimens.
Very Strong	Rock cannot be scratched by a knife or sharp pick. Breaking of hand specimens requires repeated hard blows of a geologist’s hammer.
Extremely Strong	Rock cannot be scratched by a knife or sharp pick. Chipping of hand specimens requires repeated hard blows of a geologist’s hammer.

S&ME JOB: 1117-16-018

S&ME

PROJECT: SMOTHERS ROUNDABOUT	DRILLING FIRM / OPERATOR: ENVIROCORE / ALEX	DRILL RIG: ENV B-57 TRACK	STATION / OFFSET: *
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / C. WEST	HAMMER: CME AUTOMATIC	ALIGNMENT: SCHOTT ROAD
PID: BR ID:	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 1/26/16	ELEVATION: 999.3 (MSL) EOB: 6.7 ft.
START: 4/14/16 END: 4/14/16	SAMPLING METHOD: SPT	ENERGY RATIO (%): 91	COORD: 775564.5 N, 1868313.2 E

EXPLORATION ID **B-001-0-16**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 999.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 11 INCHES	998.4																	
GRANULAR BASE - 6 INCHES	997.9																	
Stiff brown mottled with gray **CLAY**, trace fine to coarse sand, trace fine gravel, damp.	995.8	1 2 3 4 5 6	2 2 3	8	100	SS-1	1.0-2.0	2	2	6	33	57	61	23	38	30	A-7-6 (20)	
Very-dense brown **SANDY SILT**, some fine to coarse gravel (sandstone fragments), little clay, similar to severely weathered sandstone, dry.	994.6	W	12 17 50-3"	-	87	SS-2	-	34	16	10	28	12	26	22	4	11	A-4a (1)	
SANDSTONE, brown, severely to highly weathered, weak, highly fractured and fragmented.	992.6		50-2"	-	11	SS-3	-	-	-	-	-	-	-	-	-	9	Rock (V)	
		EOB	50-2"	-	11	SS-4	-	-	-	-	-	-	-	-	-	7	Rock (V)	

- Slight seepage encountered at 5.0'.

* Final alignment and stationing had not been determined at the time of this report. See Plate 3 for approximate location of this boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; PLASTIC HOLE PLUG; SOIL CUTTINGS

S&ME STANDARD ODOT LOG (8.5X11) - 2015 - OH DOT.GDT - 5/13/16 12:56 - T:\RESOURCES\CS\GINTW\PROJECTS\1117\16018.GPJ

PLATE 6

S&ME JOB: 1117-16-018

PROJECT: SMOTHERS ROUNDABOUT	DRILLING FIRM / OPERATOR: ENVIROCORE / ALEX	DRILL RIG: ENV B-57 TRACK	STATION / OFFSET: *
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / C. WEST	HAMMER: CME AUTOMATIC	ALIGNMENT: SCHOTT ROAD
PID: BR ID:	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 1/26/16	ELEVATION: 999.9 (MSL) EOB: 8.7 ft.
START: 4/14/16 END: 4/14/16	SAMPLING METHOD: SPT	ENERGY RATIO (%): 91	COORD: 775905.8 N, 1868389.2 E

EXPLORATION ID **B-002-0-16**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 999.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL - 8 INCHES	999.2																	
Medium-stiff to stiff brown mottled with gray **CLAY**, trace fine to coarse sand, trace fine gravel, damp.	997.4	1	2 2 6	12	61	SS-1	0.7-1.5	2	1	4	33	60	64	23	41	29	A-7-6 (20)	
SANDSTONE, brown, severely to highly weathered, very weak to weak, highly fractured and fragmented.		2																
		3																
		4	50-5"	-	80	SS-2	-	44	8	13	27	8	-	-	-	8	Rock (V)	
		5																
		6																
		7	50-3"	-	100	SS-3	-	-	-	-	-	-	-	-	-	8	Rock (V)	
	991.2	8 EOB	50-2"	-	100	SS-4	-	-	-	-	-	-	-	-	-	7	Rock (V)	

- No seepage noted.

* Final alignment and stationing had not been determined at the time of this report. See Plate 3 for approximate location of this boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLASTIC HOLE PLUG; SOIL CUTTINGS

PLATE 7

S&ME STANDARD ODOT LOG (8.5X11) - 2015 - OH DOT.GDT - 5/13/16 12:56 - T:\RESOURCES\CS\GINTW\PROJECTS\1117\16018.GPJ

S&ME JOB: 1117-16-018

S&ME

PROJECT: SMOTHERS ROUNDABOUT	DRILLING FIRM / OPERATOR: ENVIROCORE / ALEX	DRILL RIG: ENV B-57 TRACK	STATION / OFFSET: *
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / C. WEST	HAMMER: CME AUTOMATIC	ALIGNMENT: RED BANK ROAD
PID: BR ID:	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 1/26/16	ELEVATION: 1002.3 (MSL) EOB: 8.7 ft.
START: 4/14/16 END: 4/14/16	SAMPLING METHOD: SPT	ENERGY RATIO (%): 91	COORD: 776107.5 N, 1868357.3 E

EXPLORATION ID **B-003-0-16**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1002.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 6 INCHES	1001.8																	
GRANULAR BASE - 7 INCHES	1001.2																	
Stiff to very-stiff brown mottled with gray **CLAY**, little fine to coarse sand, trace fine gravel, damp.	999.3	1	2 3 5	12	56	SS-1	1.7-3.5	4	5	12	27	52	50	22	28	24	A-7-6 (17)	
Very-dense brown **SANDY SILT**, little fine to coarse gravel (sandstone fragments), some clay, similar to severely weathered sandstone, dry.	996.8	2 3 4 AD	50-4"	-	75	SS-2	-	15	6	16	42	21	26	24	2	13	A-4a (6)	
SANDSTONE, brown, severely to highly weathered, very weak to weak, highly fractured and fragmented, poorly cemented.	993.6	5 W 6 7 8 EOB	50-3"	-	33	SS-3	-	-	-	-	-	-	-	-	-	-	Rock (V)	
			50-3"	-	33	SS-4	-	-	-	-	-	-	-	-	-	-	Rock (V)	

- Encountered water at 6.0'.
- Water accumulated to 4.8' in HSA at completion of boring.

* Final alignment and stationing had not been determined at the time of this report. See Plate 3 for approximate location of this boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: 1 BAG BENTONITE CHIPS; PLASTIC HOLE PLUG; SOIL CUTTINGS

S&ME STANDARD ODOT LOG (8.5X11) - 2015 - OH DOT.GDT - 5/13/16 12:56 - T:\RESOURCES\CS\GINTW\PROJECTS\1117\16018.GPJ

PLATE 8

S&ME JOB: 1117-16-018

S&ME

PROJECT: SMOTHERS ROUNDABOUT	DRILLING FIRM / OPERATOR: ENVIROCORE / ALEX	DRILL RIG: ENV B-57 TRACK	STATION / OFFSET: *
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / C. WEST	HAMMER: CME AUTOMATIC	ALIGNMENT: RED BANK ROAD
PID: BR ID:	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 1/26/16	ELEVATION: 1003.3 (MSL) EOB: 6.0 ft.
START: 4/14/16 END: 4/14/16	SAMPLING METHOD: SPT	ENERGY RATIO (%): 91	COORD: 776399.9 N, 1868361.6 E

EXPLORATION ID **B-004-0-16**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1003.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 10.5 INCHES	1002.4																	
GRANULAR BASE - 7.5 INCHES	1001.8																	
Fill: Loose to medium-dense brown **GRAVEL WITH SAND**, trace silt, dry.	1001.3	1	5 4 3	11	11	SS-1	1.5-1.8	1	2	8	32	57	56	20	36	27	A-7-6 (19)	
Stiff brown mottled with gray **CLAY**, some silt, trace to little fine to coarse sand, trace fine gravel, few iron oxide stains, damp.	999.8	2																
	998.8	3	7 13 50-4"	-	56	SS-2	1.0-3.0	10	6	10	37	37	36	20	16	19	A-6b (10)	
Stiff to very-stiff brown mottled with gray **SILTY CLAY**, little fine to coarse sand, trace to little fine to coarse gravel, damp.	997.3	4	50-4"	-	75	SS-3	-	-	-	-	-	-	-	-	-	7	Rock (V)	
		5																
		EOB 6	50-1"	-	0	--	-	-	-	-	-	-	-	-	-	-		
SANDSTONE, brown, severely to highly weathered, very weak to weak, highly fractured and fragments.																		

- No seepage noted.
- Encountered auger refusal at 5.9'

* Final alignment and stationing had not been determined at the time of this report. See Plate 3 for approximate location of this boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; PLASTIC HOLE PLUG; SOIL CUTTINGS

PLATE 6

S&ME STANDARD ODOT LOG (8.5X11) - 2015 - OH DOT.GDT - 5/13/16 12:56 - T:\RESOURCES\CS\GINTW\PROJECTS\1117\16018.GPJ

S&ME JOB: 1117-16-018

S&ME

PROJECT: SMOTHERS ROUNDABOUT	DRILLING FIRM / OPERATOR: ENVIROCORE / ALEX	DRILL RIG: ENV B-57 TRACK	STATION / OFFSET: *
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / C. WEST	HAMMER: CME AUTOMATIC	ALIGNMENT: SMOTHERS ROAD
PID: BR ID:	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 1/26/16	ELEVATION: 1006.8 (MSL) EOB: 6.3 ft.
START: 4/14/16 END: 4/14/16	SAMPLING METHOD: SPT	ENERGY RATIO (%): 91	COORD: 776039.9 N, 1868019.5 E

EXPLORATION ID **B-005-0-16**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1006.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 13 INCHES	1005.7	1																
GRANULAR BASE - 5 INCHES	1005.3																	
Fill: Very-stiff to hard brown mottled with gray **SILTY CLAY**, little fine to coarse sand, trace fine gravel, damp.	1003.8	2	3 4 8	18	61	SS-1	3.0-4.5	5	4	10	38	43	36	19	17	19	A-6b (11)	
Fill: Very-stiff to hard brown, gray and red-brown **SILT AND CLAY**, little fine to coarse sand, trace fine gravel, dry.	1002.3	3 4	4 8 10	27	89	SS-2	4.0-4.5	8	7	9	33	43	34	20	14	14	A-6a (10)	
Very-dense gray and brown **GRAVEL WITH SAND**, little silt, few sandstone fragments, dry.	1000.5	5	11 50-5"	-	67	SS-3	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		EOB 6	50-4"	-	0	--	-	-	-	-	-	-	-	-	-	-		

- No seepage noted.

* Final alignment and stationing had not been determined at the time of this report. See Plate 3 for approximate location of this boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; PLASTIC HOLE PLUG; SOIL CUTTINGS

S&ME STANDARD ODOT LOG (8.5X11) - 2015 - OH DOT.GDT - 5/13/16 12:56 - T:\RESOURCES\CS\GINTW\PROJECTS\1117160018.GPJ

PLATE 10

S&ME JOB: 1117-16-018

PROJECT: SMOTHERS ROUNDABOUT	DRILLING FIRM / OPERATOR: ENVIROCORE / ALEX	DRILL RIG: ENV B-57 TRACK	STATION / OFFSET: *
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: S&ME / C. WEST	HAMMER: CME AUTOMATIC	ALIGNMENT: SMOTHERS ROAD
PID: BR ID:	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 1/26/16	ELEVATION: 1003.7 (MSL) EOB: 8.7 ft.
START: 4/14/16 END: 4/14/16	SAMPLING METHOD: SPT	ENERGY RATIO (%): 91	COORD: 775992.5 N, 1868721.9 E

EXPLORATION ID **B-006-0-16**

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1003.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 10 INCHES	1002.9																	
GRANULAR BASE - 7 INCHES	1002.3																	
Possible Fill: Medium-dense brown and gray **SILT**, some clay, little fine to coarse sand, trace fine gravel, slightly organic, dry.	1001.2	1	14 6 6	18	78	SS-1A	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
						SS-1B	2.5-4.0	1	6	8	54	31	28	20	8	19	A-4b (8)	
		2			40	SS-4	1.2-1.7	2	11	7	30	50	55	22	33	26	A-7-6 (19)	
Stiff to very-stiff brown mottled with gray **CLAY**, some silt, trace to little fine to coarse sand, trace fine gravel, damp.	998.7	3	2 2 3	8	17	SS-2	1.0-1.7	-	-	-	-	-	-	-	-	31	A-7-6 (V)	
Stiff brown mottled with gray **SILTY CLAY**, little to some fine to coarse sand, trace fine to coarse gravel, damp.	997.4	4			73	SS-5	1.2-2.0	-	-	-	-	-	-	-	-	19	A-6b (V)	
SANDSTONE, brown, highly weathered, very weak to weak, highly fractured and fragmented.	995.0	5	50-4"	-	100	SS-3	1.2-2.0	-	-	-	-	-	-	-	-	26	A-6b (V)	
		6																
		7																
		8	50-2"	-	0	--		-	-	-	-	-	-	-	-	-		
		EOB																

- Samples SS-4 and SS-5 were obtained from an offset boring located immediately adjacent to B-006-0-16.
- Sample SS-4: Driven from 2.5' - 4.0'; SPT = 2/2/4; N60 = 9
- Sample SS-5: Driven from 5.0' - 6.5'; SPT = 4/2/14; N60 = 24

- No seepage encountered.

* Final alignment and stationing had not been determined at the time of this report. See Plate 3 for approximate location of this boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; PLASTIC HOLE PLUG; SOIL CUTTINGS

S&ME STANDARD ODOT LOG (8.5X11) - 2015 - OH DOT.GDT - 5/13/16 12:56 - T:\RESOURCES\CS\GINTW\PROJECTS\1117116018.GPJ

PLATE 11

ODOT Geotechnical Bulletin GB-1 Subgrade Analysis Spreadsheet
Smothers Road Roundabout, Franklin/Delaware County, Ohio

Subgrade Analysis
V. 13.00 01/15/16

Design CBR **5**

Global Options		
320	R&R	No
206	CS	No
	LS	Option
206	Depth	12

Total Borings	6
PID	
Location	Smothers/Schott/Red Bank Roundabout

Classification Counts by Sample

R	1a	1b	3	3a	2-4	2-5	2-6	2-7	4a	4b	5	6a	6b	7-5	7-6	8a	8b
8	0	1	0	0	0	0	0	0	2	1	0	1	4	0	6	0	0
35%		4%							9%	4%		4%	17%		26%		
35%	4%								61%								

	N_{60}	N_{60L}	LL	PL	PI	% Silt	Clay	P 200	M	M_{OPT}	GI
Average	14.7	11.5			21.5		42.1		17.1	16.7	11.67
Maximum	27	18	64	24	41	54	60	93	31	20	20
Minimum	8	8	26	19	2	27	12	40	7	6	0

Surface Class		
2-5	0	
4b	1	17%
5	0	
7-5	0	
7-6	4	67%
8a	0	
8b	0	
R	0	

% Borings	
N_{60L}<= 5	0%
<=10	33%
>=20	0%
M+	83%
R	67%

% Surface	
83%	
17%	67%
UC @ Surface	
Undercut	
16.8	
36	
12	

Rig	ER
A	91
B	
C	
D	
E	
F	
G	
H	

#	B #	Boring Location	Depth	To	Cut Fill *	Subgrade Depth	To	n_2	n_3	N	Rig	N_{60}	N_{60L}	LL	PL	PI	% Silt	% Clay	P 200	M	M_{OPT}	Ohio DOT	GI	Sulfate		Problem w/ Class	Problem w/ MN	Undercuts UC Class	Undercuts UC MN	Analysis / Comments
1	B-001	Ex. Schott Road	2.0	3.5	-1.2	0.8	2.3	2	3	5	A	8		61	23	38	33	57	90	30	20	7-6	20				N		12	
		775564.5 N	3.5	4.6		2.3	3.4							26	22	4	28	12	40	11	17	4a	1							UC 12" or LS 14"
		1868313.2 E	5.0	5.1		3.8	3.9													9		R				BR		24		
			6.5	6.7		5.3	5.5						8							7		R				BR		24		
2	B-002	Prop. Schott Road	1.0	1.9	-0.2	0.8	1.7	2	6	8	A	12		64	23	41	33	60	93	29	20	7-6	20				MN		12	
		775905.8 N	3.5	3.8		3.3	3.6													8		R				BR		24		UC 12" or LS 12"
		1868389.2 E	6.5	6.8		6.3	6.6													8		R				BR		24		
			8.5	8.7		8.3	8.5						12							7		R				BR		24		
3	B-003	Prop. Red Bank Road	1.0	1.8	-0.2	0.8	1.6	3	5	8	A	12		50	22	28	27	52	79	24	19	7-6	17				MN		12	
		776107.5 N	3.5	3.7		3.3	3.5							26	24	2	42	21	63	13	19	4a	6							UC 12" or LS 12"
		1868357.3 E	6.0	6.1		5.8	5.9															R				BR		24		
			8.5	8.6		8.3	8.4						12									R				BR		24		
4	B-004	Ex. Red Bank Road	2.0	3.5	-1.2	0.8	2.3	4	3	7	A	11		56	20	36	32	57	89	27	18	7-6	19				N		12	
		776399.9 N	3.5	4.9		2.3	3.7							36	20	16	37	37	74	19	16	6b	10							UC 12" or LS 12"
		1868361.6 E	5.0	5.2		3.8	4.0						11							7		R				BR		24		
5	B-005	Ex. Smothers Road	1.5	2.9	-1.2	0.3	1.7	4	8	12	A	18		36	19	17	38	43	81	19	16	6b	11							
		776039.9 N	3.0	4.3		1.8	3.1	8	10	18		27		34	20	14	33	43	76	14	15	6a	10							
		1868019.5 E	4.5	5.1		3.3	3.9						18							7	6	1b	0							
6	B-006	Ex. Smothers Road	1.4	2.2	-1.2	0.2	1.0	6	6	12	A	18		28	20	8	54	31	85	19	15	4b	8			4b		36		Excavate and
		775992.5 N	2.5	3.1		1.3	1.9	2	4	6		9		55	22	33	30	50	80	26	19	7-6	19				N		12	Replace A-4b
		1868721.9 E	3.5	4.7		2.3	3.5	2	3	5		8								31	18	7-6	14				N		12	(approx. 12" below
			5.0	6.0		3.8	4.8	2	14	16		24								19	16	6b	10							proposed SG)
			6.0	6.3		4.8	5.1						8							26	16	6b	10				M		12	

* Cut/Fill Depth anticipates a 1.2-foot-thick proposed pavement section.

II. Reconnaissance and Planning Checklist

C-R-S: Smothers Rd. Roundabout	PID:	Reviewer: RSW	Date: 5/12/16

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	Conceptual alignment available.
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?	Reviewed S&ME Subgrade Exploration for roundabout at Smothers/Harlem Rds.
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?	County Project. Proposed plan was provided to Designer in advance of field work.
				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	
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?	Coordinates were surveyed by AECOM and provided to S&ME. Station/offset were not available at the time of this report.
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.C. Subgrade Checklist

C-R-S: Smothers Rd. Roundabout	PID:	Reviewer: RSW	Date: 5/12/16

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 Geotechnical Bulletin 1: Plan Subgrades (GB1)?	
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?	Removal should occur as part of recommended global subgrade remediation program.
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?	By others. See Section 5.3.2 of Subgrade Exploration Report.
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?	Rock not encountered within 2 feet of the estimated subgrade level.
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?	By others.
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 5.2

III.C. Subgrade Checklist

Notes:

Stage 1: