Subsurface Investigation - Revised
FRA-CR84-1.36 Northeast Gateway
Worthington, Ohio
S&ME Project No. 1117-16-031A

PREPARED FOR:

EMH&T, Inc.
5500 New Albany Road
Columbus, Ohio 43054

PREPARED BY:

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Dublin, OH 43016

December 10, 2018

May 15, 2018

EMH&T, Inc.
5500 New Albany Road
Columbus, Ohio 43054

Attention: Mr. Michael Brehm, P.E.

Reference: **Subsurface Investigation – Revised**
FRA-CR84-1.36 Northeast Gateway
Worthington, Ohio
S&ME Project No. 1117-16-031A

Dear Mr. Brehm:

In accordance with our revised proposal dated December 2, 2015, which was authorized on June 17, 2016, with Task Order No. 1 to our Service Agreement with EMH&T dated February 17, 2015, and in accordance with modification of scope and fee request on June 5, 2017, which was authorized with Task Order No. 2 on June 8, 2017, S&ME, Inc. (S&ME) has completed a subsurface investigation for the above referenced project. For this project, 16 borings were performed in the field for roadway improvements at the intersection of Huntley Road, E. Wilson Bridge Road, and Worthington-Galena Road in Worthington, Franklin County, Ohio. This work has not been performed in strict accordance with ODOT Specifications for Geotechnical Exploration (SGE). The approximate site location is depicted on the Vicinity Map presented as Plate 1 in Appendix A of the report. The results from our field investigation, laboratory testing, and our recommendations associated with this subsurface investigation are herewith submitted. Preliminary culvert and retaining wall recommendations were provided in a letter dated June 19, 2017.

This revised report has been updated based on ODOT review comments on the Stage 2 plans, which were provided to S&ME by your office on September 25, 2017, and discussed between September 2017 and May 2018 with Mr. Tyler Adam, P.E. from your office. The second report revision was made to include an update to the modular block wall calculations. 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.

Sincerely,

S&ME, Inc.

STATE OF OHIO
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REGISTERED PROFESSIONAL ENGINEER

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1.0 Project Information

S&ME, Inc. (S&ME) has completed the subsurface investigation for the proposed roadway improvements at the intersection of Huntley Road, E. Wilson Bridge Road, and Worthington-Galena Road in Worthington, Franklin County, Ohio. The work was performed in general accordance with our proposal dated December 2, 2015 and our Mod #1 dated June 5, 2017. The purpose of this investigation was to obtain subsurface information to allow us to characterize the subsurface conditions and to evaluate pavement subgrade conditions for pavement design, and for the design of three box culverts and two gravity block retaining walls, to be performed by others. This report describes our understanding of the project, presents the results of the field exploration and laboratory testing, and discusses our conclusions and recommendations.

As requested by EMH&T, this investigation was not performed in strict accordance with ODOT's Specifications for Geotechnical Explorations (SGE). S&ME understands that the project documents will reference ODOT specifications for roadway construction; therefore, we have included reference to ODOT Construction and Materials Specifications (CMS) in our report.

2.0 Project Description

Based on a Stage 1 plans prepared by EMH&T, dated December 19, 2016, and provided to S&ME on May 12, 2017, we understand that the project includes about 6,000 feet of roadway construction and improvements, including the following:

- E. Wilson Bridge Road
  - Pavement widening;
  - Pavement reconstruction;
  - Widening of the 9'x5' box culvert at Rush Run Creek on both ends and adding new wing walls;
  - Adding a signaled intersection at the proposed Worthington-Galena Road (south) new alignment;
  - Realigning and lengthening E. Wilson Bridge Road for a new intersection at Huntley Road and Worthington Galena Rd (north); and,
  - Sidewalks and shared use path.
- Worthington-Galena Road
  - Adding new alignment north and west of the existing Huntley/E. Wilson Bridge/Worthington-Galena intersection;
  - Replacing a 7' x 5' box culvert carrying a private drive over Rush Run; and,
  - Sidewalk and shared use path construction including two (2) precast block gravity retaining walls underneath IR-270.
- Huntley Road
  - Widening; and,
  - Resurfacing.

Based on the Stage 1 plans prepared by EMH&T and dated December 19, 2016, it is anticipated that proposed roadway cut and fill on this project will not exceed three feet, excluding the construction of two wet retention basins which are approximately 6 and 10 feet deep.

3.0 Regional Geology

Geologic references indicate that this site is located in a portion of Ohio which has been glaciated. The Columbus Lowland area is surrounded in all directions by relative uplands, having a broad regional slope toward the Scioto Valley with many larger streams. The overburden soils consist of predominantly loamy Wisconsinan-age till and extensive outwash in the Scioto Valley over Devonian to Mississippian-age carbonate rocks, shales, and siltstones. Based on geologic mapping, bedrock is present at depths greater than 50 feet below the ground surface at the project area.

A review of the ODNR "Abandoned Underground Mines of Ohio" map reveals that no mapped abandoned underground mines are present in the vicinity of the site. A review of the ODNR "Ohio Karst Areas" map indicates the project site is not located in an area known to contain karst features.

4.0 Exploration

4.1 Existing Information

S&ME accessed the ODOT Office of Geotechnical Engineering's on-line Geotechnical Document Management System (GeoMS) to search for existing historical geotechnical explorations within the limits of this project. Existing boring information was found in the area of the Worthington-Galena Road/IR-270 overpass and was used for design recommendations for the two precast block gravity retaining walls. The existing boring information is included in Appendix B.

Five (5) existing borings obtained from ODOT's GeoMS system are in close proximity (less than 50 feet) to the planned precast block retaining walls beneath IR-270; however, these borings do not satisfy ODOT SGE requirements for structure boring spacing, sampling, or depth. During the proposal stage, the design team decided that existing boring information would be utilized for design of the retaining walls instead of performing new borings because performing additional borings would require substantial costs associated with closing lanes on IR-270. Therefore, no new borings were performed for the precast block retaining walls, and the City of Worthington should be made aware that the existing structure borings do not satisfy ODOT specifications with respect to spacing, sampling, or depth.

4.2 Field Work

Between June 20, 2016 and June 27, 2016 and on June 19, 2017, S&ME was on-site and performed a total of sixteen (16) soil borings (designated as Borings B-1 through B-16) on or adjacent to E. Wilson Bridge Rd, Worthington-Galena Rd, and Huntley Rd. The borings were located as near to the proposed location as existing utilities and other obstructions would allow. The ground surface elevations at the boring locations were provided by EMH&T based on GPS coordinates obtained by S&ME using a sub-meter hand-held GPS unit. The approximate locations of the borings are shown on the Plan of Borings included as Plate 2 in Appendix A of this report.

The borings were performed using all-terrain vehicle (ATV) mounted drilling rigs. Each of the borings was advanced through the soil overburden and between sampling attempts using either a 4 ½-inch outside diameter (O.D.) continuous-flight auger (CFA) or a 3 ¼-inch inside diameter (I.D.) hollow-stem auger (HSA). At regular intervals, disturbed but representative soil samples were obtained by lowering a 2-inch outside diameter split-barrel sampler 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). Split-barrel samples were examined immediately after recovery and representative portions of each sample were placed in air-tight jars and retained for subsequent laboratory testing. Particular attention was given to the texture, moisture content, and consistency of each sample. Additionally, the borings were checked for the presence of groundwater during sampling and at the completion of the drilling operations. Following the completion of the groundwater level readings, the borings were backfilled with soil cuttings mixed with bentonite chips and the pavement surface was repaired with an equivalent thickness of cold-patch asphalt. The samples collected during the field exploration were returned to the laboratory for visual examination and selected laboratory testing.

4.3 Laboratory Testing

In the laboratory, the samples were visually identified and, on selected representative samples, moisture contents, liquid and plastic limit determinations, and grain size analyses were performed. Results of these tests permit an evaluation of strength and subgrade support characteristics of the soil by comparison with similar soils for which these characteristics have been previously determined.

Based upon the results of the laboratory testing program, soil descriptions contained on the field logs were modified, if necessary, and laboratory-corrected logs are submitted as Plates 4 through 22 of Appendix A. Results of the laboratory tests are shown graphically on the individual boring logs and a summary of test results is presented on Plates 23 and 24 of Appendix A. Results of Atterberg limits and grain size analyses are presented on Plates 25 through 33.

Soils described in this report have been classified generally in accordance with the Unified Soil Classification System. However, the system has been augmented by the use of special adjectives to designate the approximate percentages of minor soil components. An explanation of the symbols and terms used on the boring logs and definitions of the special adjectives used to denote the minor soil components are presented on Plate 3 of Appendix A. In addition, ODOT modified AASHTO soil classifications have been included on the logs for each soil stratum.

4.3.1 Results of Soil Classification Testing

Atterberg limits testing was performed to provide engineering classifications of the on-site soils exhibiting cohesion. A total of thirty two (32) Atterberg limits tests were performed. Liquid limits typically ranged from 21 to 45 percent, with one as high as 52 percent. Plasticity indices ranged from 6 to 31 percent.

4.3.2 *Results of Moisture Testing*

Natural moisture content testing was performed on a total of thirty two (32) soil samples. The moisture contents of the on-site soils tested ranged from 11 to 25 percent. These values varied from 5 percent below to 7 above their corresponding plastic limit.

5.0 Findings

Please refer to the boring logs submitted in Appendices A and B for information on the subsurface conditions encountered at the boring locations. 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 encountered during construction vary from those discussed in this report, S&ME should be notified immediately so that we may evaluate the effects, if any, on design and construction.

5.1 Existing Pavement

Table 5-1 provides a summary of the existing pavement and granular base thicknesses recorded at each boring location.

Table 5-1 – Summary of Pavement Thickness

Location	Asphalt Thickness (Inches)	Granular Base Thickness (Inches)
B-1(1)	12	6
B-2	12	6
B-3	12	6
B-4	12	6
B-6(1)	7	4
B-9(1)	10(2)	8
B-10	12	6
B-11	12	6
B-14	12	6
B-15(3)	3	4

(1) Pavement coring performed
(2) Core thickness 5 inches
(3) Boring performed in shoulder

5.2 General Subsurface Stratigraphy

Beneath the existing pavement or 4 to 6½ inches of topsoil/rootmat, Borings B-3, B 15, and B-16 encountered existing fill or possible fill described as stiff to very-stiff silty clay to depths ranging from 2.8 to 5.5 feet. Below the existing fill, the borings typically encountered natural soil consisting of SILT AND CLAY (A-6a), SILTY CLAY (A-6b), and SANDY SILT (A-4a). The consistency of these materials ranged from medium-stiff to hard, with a seam of soft to medium-stiff silty clay in B-7 from 5.5 to 8.0 feet and a seam of very-soft silty clay in B-16 from 5.5 to 7.0 feet. A few zones of medium-dense to very-dense gravel and sand were encountered in Borings B-3, B-4, B-6, and B-15. Cobbles were also noted in some of the borings.

5.2.1 *Historic Boring Information*

Historic boring information from past ODOT investigations near the IR-270 overpass over Worthington Galena Rd indicate the presence of stiff to hard SILT AND CLAY (A-6a) below the proposed subgrade of Worthington Galena Rd (North) and the proposed modular block wall leveling pads. Fill material, including concrete, was noted in the historic ODOT Borings B-09-0-05 and B-12-0-05, below the proposed Wall #2 leveling pad elevation.

5.3 Groundwater Observations

During drilling, seepage and/or groundwater was noted in six (6) of the sixteen (16) borings, at depths ranging from 2.5 to 29.8 feet below the ground surface. At the completion of drilling and prior to backfilling of these six (6) borings, groundwater had accumulated in the borings to depths ranging from 2.0 to 29.3 feet below the ground surface. No groundwater was noted during drilling of the remaining borings, and these borings were also noted as being “dry” at the completion of drilling, which is to say, no measurable amount of groundwater had collected in the borehole.

6.0 Analysis and Recommendations

6.1 General Discussion

S&ME understands it is proposed to realign and widen portions of E. Wilson Bridge Rd, Worthington Galena Rd, and Huntley Rd in Worthington, Franklin County, Ohio. The realignment involves the addition of an intersection along E Wilson Bridge Rd and the relocation of the Huntley Rd, E Wilson Bridge Rd, and Worthington Galena Rd. The project also includes the extension of a box culvert carrying Rush Run under E Wilson Bridge Rd, a new box culvert carrying Rush Run under the southern portion of the realigned Worthington Galena Rd, the replacement of a culvert carrying Rush Run under a private drive entrance with a larger box culvert, and two precast block gravity retaining walls under IR-270 along Worthington Galena Rd. Additionally, two wet detention basins will be added. Based on the Stage 1 plans, the proposed realigned profiles will require minor fills, less than 3 feet, and the detention basins will be approximately 6 and 10 feet deep.

6.2 Subgrade Support Parameters

It is anticipated that the subgrade for the pavements will consist of natural stiff to very-stiff SILT AND CLAY (A-6a) and SILTY CLAY (A-6b) deemed suitable for pavement support following favorable proofrolling, newly placed controlled fill, or chemically stabilized soils (see Section 6.3). Given the variable nature of the subgrade soils and based on laboratory tests performed on the near surface soils, along with ODOT Group Index correlations, it is recommended that the following California Baring Ratio (CBR) value be used to design the new pavement sections:

CBR: 5%

Based on this average value, and Section 203.1 of the 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 pavement subgrade support values may be used during pavement design on this project provided that the entire proposed pavement subgrade is prepared in accordance with Item 204 of the 2016 ODOT 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.

In addition to proper subgrade preparation, we recommend that the pavement design and construction include surface and subsurface drainage measures. Water which infiltrates the pavement and remains trapped within the pavement components during traffic loading is one of the leading causes of premature pavement failure. Effective design measures include the use of perimeter swales, perimeter edge drains, curbs, or a combination of these features to collect surface water runoff from areas adjacent to the pavement. Cohesive subgrade soils should be crowned or sloped to promote drainage of infiltrating water towards subsurface drainage collection systems. S&ME noted that the Stage 1 plans submitted by EMH&T include underdrains and curb and gutter systems along both sides of the alignments.

6.3 Subgrade Remediation Recommendations

The following recommendations provide a summary of the anticipated subgrade remediation approach for the specified areas of the project. A plan sheet showing the approximate areas and types of subgrade remediation is included in Appendix C.

E. Wilson Bridge Rd

- Sta 349+30 to Sta 359+10:
  Remove unsuitable materials (soil/roots/structures/existing pavement), compact top 12 inches of subgrade per Item 204.03, and then proof roll subgrade in widening areas in accordance with Item 204.06. Proof roll areas should extend 18" past the outside edge of curb line. Where unstable/soft soils are noted during proofrolling, undercut/replace per Item 204.04 using Item 204 Granular Material Type B or C. Consider placement of Item 712.09 Type D geotextile at the bottom of the overexcavation. Overexcavations should be drained where possible. Particular attention should be paid to Station 350+00 to 353+25 where a 12-inch undercut may be necessary.

- Sta 359+10 to Sta 364+05 (proposed Huntley Road/Worthington Galena Rd Intersection)
  Remove all existing pavement/granular base. Once proposed subgrade has been attained, recommend Item 206 Chemical Stabilization, 14" in depth using Cement as the chemical additive. All fill/borrow soil

placed within 14 inches of the proposed subgrade in areas of chemical stabilization should have a plastic index (PI) no greater than 20.

Huntly Rd/Worthington Galena Road (North)

- Sta 396+35 to Sta 404+90
  Remove unsuitable materials (soil/roots/structures/existing pavement), compact top 12 inches of subgrade per Item 204.03, and then proof roll subgrade in widening areas in accordance with Item 204.06. Proof roll areas should extend 18" past the outside edge of curb line. Where unstable/soft soils are noted during proofrolling, undercut/replace per Item 204.04 using Item 204 Granular Material Type B or C. Consider placement of Item 712.09 Type D geotextile at the bottom of the overexcavation. Overexcavations should be drained where possible.

- Sta 404+90 to Sta 424+05 (Lakeview Plaza Blvd/Sancus Blvd Intersection)
  Remove all existing pavement/granular base. Once proposed subgrade has been attained, recommend Item 206 Chemical Stabilization, 14" in depth using Cement as the chemical additive. All fill/borrow soil placed within 14 inches of the proposed subgrade in areas of chemical stabilization should have a plastic index (PI) no greater than 20.

Worthington Galena Road (South)/Old Worthington Galena Rd Connector

- Sta 202+82 to Sta 213+10 (Edge of E. Wilson Bridge Rd Intersection) and Connector
  Once unsuitable surficial materials have been removed (topsoil/roots/structures/existing pavement), scarify and recompact the entire exposed embankment foundation. Perform Item 206.04 Test Rolling on the compacted embankment foundation to identify any weak areas of the embankment foundation. After test rolling, place new embankment fill in accordance with Item 203, or Item 204 when within 12 inches of the proposed subgrade. Do not allow a bridge lift per Item 203.05 due to the thinness of the new fill. Proof roll per Item 204.06 after attaining subgrade.

6.4 Roadway Embankment Construction

Preliminary profile information provided by EMH&T indicates that less than 3 feet of cut and new fill will be necessary to attain the desired profile for the realigned portion of this project. Stability analyses were not performed for the proposed embankments.

6.4.1 Embankment Foundation/Subgrade Preparation

Prior to commencing earthwork operations and excluding pavement salvage areas, it is recommended that all existing pavement, structures, topsoil, existing trees including their entire root mass, vegetation, and other miscellaneous materials be completely removed from the entire footprint of the proposed roadway/embankment. S&ME recommends that the Geotechnical Engineer of Record or his/her designated representative be present at the time of proofrolling, as visual observation of these procedures may result in a partial reduction of undercutting of unsuitable soils.

6.4.2 *"Fill" Areas*

S&ME recommends that test rolling (ODOT CMS Item 204.06 be performed on the entire exposed embankment foundation prior to commencing fill placement. Test rolling performed in accordance with ODOT CMS Item 204.06 and Item 204 of the ODOT CIMP, 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 CMS Item 203.07, or be removed and the overexcavation filled in a controlled manner with compacted, suitable embankment material (Item 203.02) and with the recommendations presented in 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, or wet 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.

In new embankment areas or embankment widening areas 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.

6.4.3 *"At-Grade" and "Cut" Areas*

Once the desired subgrade elevation has been attained in "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 CMS Item 204.03. During recompaction, the moisture content of the subgrade soil should be maintained or adjusted in accordance with ODOT CMS Item 203.07.A.

Following the completion of the scarification and recompaction of the subgrade for cut and at-grade areas, it is 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.

Final subgrade proofrolling should be performed in accordance with ODOT CMS Item 204.06, and Section 204 of the ODOT Construction Administration Manual of Procedures. If weak, wet, or soft zones are present, it is recommended that the materials contained in these zones be removed and replaced in accordance with Item 204.04. It is recommended, however, that the maximum depth of any necessary overexcavation be limited to 4 feet, even where the bottom remains unstable. In these cases, it is recommended that a geotextile (ODOT Item 712.09, Type D) be placed at the bottom of the overexcavation and then the undercut area backfilled with compacted granular material (ODOT Item 703.16.C Type C or D Granular Material). To assist the paving process, it may be desirable to top this granular backfill with a few inches of Item 703.16.C.2 (Type B).

6.4.4 *Borrow Requirements/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 or, when within 12 inches of the proposed subgrade level, Item 204 of the ODOT CMS. Additionally, borrow soil placed as new fill within 3 feet of the final subgrade level of an embankment must be capable of providing an average CBR value of 5% (see Section 6.2 of this document). Fill 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 ODOT CMS Item 203.05 or ODOT Geotechnical Bulletin GB2, depending on the slope of the existing ground surface at each location.

Based on soil types encountered in the borings performed in areas of proposed cut (i.e., detention basins), it is anticipated that these soils will generally be suitable for use as borrow for the fill embankment areas. Moisture conditioning of some of these soils may, however, be required. While no unsuitable soils types were encountered in the cut area borings, it is possible that unsuitable soils may be encountered between the borings. Particular attention should be given to the drainage areas and wooded areas where thicker deposits of organic soil and root matter may be present, and which should not be allowed to be placed in new embankment fill.

6.4.5 *Compaction /Moisture Conditioning Concerns*

The cohesive soils encountered in the 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 disking and drying for moisture conditioning). Should these materials become sufficiently saturated that additional moisture conditioning is impractical, the material should be removed and 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.

6.5 Structure Recommendations

Stage 1 plans provided by EMH&T on May 12, 2017, indicate that the following structures are proposed for this project:

- New 9' x 4' extensions to both ends of an existing box culvert carrying E. Wilson Bridge Road over Rush Run, including the addition of wing walls on both the inlet and outlet extensions;
- A new 7' x 5' box culvert carrying the realigned Worthington Galena Road over Rush Run:
- A replacement 7' x 5' box culvert carrying a private drive at the south end of the project over Rush Run (7029 Huntley Road); and,
- Two modular block walls (Wall #1 and Wall #2) located beneath the IR-270 overpass along Worthington Galena Road. Wall # 1 is on the west side of Worthington Galena Road (max height of 6 feet) and Wall #2 is on the east side (max wall height of 4.5 feet).

6.5.1 *Spread Foundation Bearing Resistance*

We understand that the design of the planned structures will be performed utilizing Load Factor Resistance Design (LRFD) methods. Table 6-1 on the following page, summarizes the recommended nominal and factored unit bearing resistances (q_n and q_R) at the service and strength limit states for spread foundations.

Table 6-1: Recommended Bearing Capacities

Structure Location	Bearing Stratum	Limit State	Est. Bearing Elevation (ft)	Recommended Nominal Bearing Resistance, q_n (ksf)*	Resistance Factor, φ	Recommended Factored Bearing Resistance, q_R (ksf)*
Box Culverts and Wing Walls						
E. Wilson Bridge Rd. over Rush Run	Very-stiff silty clay (B-3)	Service	908	6.0	1.0**	6.0
		Strength		13.3	0.5***	6.7
S. Worth-Galena Rd. over Rush Run	Medium-stiff to stiff silty clay (B-7)****	Service	908	3.0	1.0**	3.0
		Strength		5.3	0.5***	2.6
Private Drive over Rush Run	Stiff to very-stiff silty clay (B-15)	Service	907	5.0	1.0	5.0
		Strength		8.0	0.5	4.0
Modular Block Walls						
Wall #1	Very-stiff silty clay	Service	926	6.0	1.0**	6.0
		Strength (Undrained)		10.9	0.5***	5.4
		Strength (Drained)		10.4	0.5***	5.2
Wall #2	Stiff silty clay	Service	926	4.0	1.0**	4.0
		Strength (Undrained)		8.2	0.5***	4.1
		Strength (Drained)		8.9	0.5***	4.4

*For vertical loading only. Foundations may need to extend deeper to generate passive pressure to resist lateral loads or to extend below the scour depth.

**Article 10.5.5.1 of the 2014 AASHTO LRFD Bridge Design Specifications.

***Table 10.5.5.2.2-1 of 2014 AASHTO LRFD Bridge Design Specifications.

****Overexcavation below the plan bearing elevation may be required to reach acceptable bearing materials.

If weaker soils or existing uncontrolled fill are present at or just below the proposed culvert or wall foundation elevation, the material should be overexcavated and the foundation lowered to more suitable soils or the overexcavation below plan foundation bearing elevation should be backfilled in accordance with the most current ODOT CMS Item 503. Particular attention should be given to the following locations based on the conditions observed in the available borings:

- Culvert beneath Worthington Galena Road, which may have soft to medium-stiff silty clay present near the proposed bearing elevation; and,
- Wall #2 which may have existing fill overlying buried concrete pavement.

Based on the foundation sizes provided in the Stage 1 plans, settlements are expected to be less than 1-inch for the culverts and retaining walls, provided the footings bear on competent material and the site preparation and foundation construction are performed in accordance with the recommendations provided in this report. S&ME also recommends that spread foundations for the wing-walls for the culverts bear at least 12 inches below any rip rap placed as scour protection, and that sufficient longitudinal reinforcing steel be provided to strengthen continuous footings against any abrupt differential settlements.

The portion of the sidewalls of the foundation excavations should be either sloped back or braced in accordance with the most recent OSHA excavation guidelines. Any surface water will need to be diverted away from the foundation excavation area during excavation and construction of the culvert foundations. The foundation bearing surfaces should be kept dry and free from standing water during all construction activities.

6.5.2 Eccentricity (Overturning)

Proposed spread foundations for the structures which are subjected to eccentric loadings should be designed to account for such loading. For reference, Articles 10.6.1.3, 10.6.3.3 and 11.6.3 of the latest AASHTO LRFD Bridge Design Specifications (BDS) provide guidance on designing for eccentric loading. Once the footing design has been finalized, it is recommended that the structural designer confirm that the eccentricity of the foundation is less than one-third (1/3) of the appropriate footing dimension (width and/or length) for footings on soils (AASHTO Article 10.6.3.3).

6.5.3 Sliding Resistance

The factored resistance against failure by sliding (R_R) should be determined using Eq. 10.6.3.4-1 of the AASHTO LRFD BDS. The following recommendations are for precast concrete box culverts bearing on natural soils, cast-in-place wingwalls and head walls bearing on natural soils, and precast modular blocks bearing on a granular leveling pad of ODOT CMS Item 304 or equivalent crushed stone. Where proposed foundations bear on natural cohesive soils, S&ME recommends that the nominal sliding resistance ($R\tau$) between the soil and the foundation be taken as the lesser of:

1. Nominal sliding resistance ($R\tau$) calculated using an undrained shear strength (S_u) value as follows:
    - 2,500 psf of the foundation area for the culvert extensions carrying E. Wilson Bridge Road over Rush Run;

- 1,000 psf of the foundation area for the culvert carrying the realigned Worthington Galena Road over Rush Run;
- 1,500 psf of the foundation area for the culvert carrying a private drive over Rush Run;
- 2,000 psf of the foundation area for Wall #1; and,
- 1,500 psf of the foundation area for Wall #2.

2. 50% of the vertical effective stress (ksf) on the bottom of the foundation, as shown in Figure 10.6.3.4-1 of the AASHTO LRFD BDS, if the footing is supported on at least 6 inches of compacted granular material.

As shown in AASHTO Figure 10.6.3.4-1, variations in the distribution of the applied vertical effective stress across the width and/or length of the footing must also be considered, as the method which computes the lesser value of R_τ may change based on the distribution of stress to the base of the footing. The factored resistance to sliding may then be computed using a resistance factor for shear resistance between soil and foundation (φ_τ) as specified in Table 10.5.5.2.1-1.

ODOT requested that sliding resistance be evaluated for drained soil conditions. S&ME recommends that for this scenario, the nominal sliding resistance (R_τ) between the soil and the foundation should be determined using AASHTO Eq. 10.6.3.4-2 with an internal friction angle (Φ) of 28° for the natural soils and an internal friction angle (Φ) of 34° for granular base below the wall.

Additional resistance to sliding of spread footings could be derived from increasing the width of the footing, adding a shear key, or from passive pressure developed along the inside toe of the footing or a shear key. A nominal passive resistance of 200 psf per foot of effective embedment depth into the natural soils should be used for the footings provided that the footings will bear at or below the anticipated bearing elevation shown in Table 6-1 of this report, and provided the footing concrete is placed flush ("neat") against the face of the excavation. Passive resistance should be neglected above the anticipated depth of scour and/or frost. S&ME recommends a resistance factor for passive resistance (φ_{ep}) of 0.50 be used to compute the factored passive resistance. It is important that all loosened soil be removed from the face of the foundation excavation that will provide the passive resistance.

6.5.4 Lateral Earth Pressures

The proposed modular block walls, box culverts, and wingwalls must be designed to withstand lateral earth pressures, as well as hydrostatic pressures, that may develop behind the structure. 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 headwalls and culvert 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 structures for a minimum thickness of 24 inches 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 the pressure to be used for structural design. 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.

It is recommended that granular backfill be used behind the modular block walls, box culverts, and wingwalls. The backfill should be placed in a wedge formed by the back of the structure 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 of the most recent CMS. Overcompaction in areas directly behind the walls should be avoided as this might cause damage to the structure.

If proper drainage (ODOT CMS Item 518.05) is used and the granular backfill is placed and compacted in the wedge described previously, an equivalent fluid unit weight of 55 pounds per cubic foot (pcf) (corresponding to Φ = 34°) may be used considering an at-rest earth pressure condition, meaning wall movements less than 0.25 percent of the wall height is permitted. If proper drainage is not provided, an "at rest" equivalent fluid unit weight of 90 pcf (corresponding to Φ = 20°) is recommended for use during design.

If proper drainage is incorporated and granular backfill is provided and compacted as specified, an equivalent fluid unit weight of 35 pcf (corresponding to Φ = 34°) may be used if a wall movement equivalent to 0.25 percent the height of the wall (H) is allowed to occur. Such movement is considered sufficient to mobilize an active earth pressure condition. Without proper drainage, but with granular backfill and permissible wall movement, an equivalent fluid unit weight of 80 pcf (corresponding to Φ = 34°) should be used.

Compacted cohesive materials tend alternatively to shrink, expand and creep over periods of time and create significant lateral pressures on any adjacent structures. Cohesive materials also require a greater amount of movement to mobilize an active earth pressure condition. Because of the long-term adverse effects, it is recommended that, if proper drainage (ODOT Item 518.03) is provided, an equivalent fluid unit weight of 90 pcf (at-rest) and 65 pcf (active) (corresponding to Φ = 20°) be used for design of the structure resisting the lateral loads imparted by drained, cohesive backfill. Without proper drainage, S&ME recommends that the structural design be performed using equivalent fluid unit weights of 110 pcf (at-rest) and 95 pcf (active) (corresponding to Φ = 20°).

The structure must also be designed to withstand the vertical load resulting from the weight of any fill and pavement that may be placed over the structure in addition to traffic surcharge loads. Additionally, the recommended lateral earth pressure values above should be increased to account for sloping backfill. To estimate vertical loading, a total unit weight of 130 pcf may be used for soil and granular fill materials.

6.5.5 Global Stability – Modular Block Wall

S&ME performed slope stability analyses of a transverse cross-section of Wall 1 using the 2-D limit equilibrium computer program SLIDE v.7.0 developed by Rocscience, Inc. This cross section is considered to be representative of both Walls 1 and 2. The program computed factors of safety utilizing the Spencer method for circular failure surfaces. Based on the results of the analyses, S&ME anticipates that the minimum Factor of Safety with respect to global stability for Walls 1 and 2 will be no less than 1.5, which is the minimum value required by the ODOT "Geotechnical Engineering Design Checklists".

6.6 Retention Basin Recommendations

According to the Stage 1 plans, two detention basins are planned. The first is located along Worthington-Galena Road (South) near Sta. 206+00, 70' RT and has a proposed depth of 6 feet (bottom elevation of El. 909). Boring B-

7 was located in the vicinity of this basin. The second basin is located near Sta. 363+00, 100' RT along Wilson Bridge Road and has a proposed depth of 10 feet (bottom elevation of El. 908). Boring B-16 was performed within the footprint of this basin. Both basins are planned to have 3H:1V side slope inclinations.

A very-soft to medium-stiff cohesive layer (A-6b and A-7-6) was encountered in Boring B-7 near the bottom of the proposed basin, and in Boring B-17 about 2 feet above the bottom of the basin. Depending on conditions encountered, slopes with similar weak or marginal soils may be susceptible to instability and/or failure. Slope stability was not included in our scope of work for this project; however, based on the height and proposed grade, considering soil conditions encountered in Borings B-7 and B-16, and given the anticipated loading conditions at the top of the slope, a slope of 3H:1V should have an acceptable factor of safety against slope failure. The long term stability of a slope can be affected by water, grade changes, added loads, and loss of vegetation. It is recommended that the slope be vegetated as soon as practicable to guard against soil erosion from surface runoff and that the slope be inspected periodically for signs of any erosion or slope movement.

Where natural cohesive soil having a PI greater than 8 (i.e., silty clay or clayey silt) is exposed in the bottom or sides, it is recommended that a minimum thickness of 12-inches be disced, appropriately moisture adjusted, and recompacted. Any granular zones exposed in the bottom or sides should be removed to a minimum thickness of 2 feet and be replaced with a 2-foot thick soil liner. If maintaining the normal pool level is critical and to greatly reduce the risk of seepage losses, consideration should be given to constructing a minimum 2-foot thick soil liner over the entire basin bottom and along the sides.

All soil that is to be used for the construction of the liner should be free of organic and miscellaneous materials, contain at least 50% fines by weight (% passing the 200 sieve) and have a Plastic Index Value (PI) greater than 12. Fill for the liner should be placed in uniform lifts not exceeding a loose thickness of 8 inches, and be compacted on relatively horizontal surfaces, no steeper than 4 horizontal on 1 vertical. The fill should be compacted to a unit dry weight equal to no less than 95 percent of the maximum unit dry weight as determined in the laboratory by the Standard Proctor Test (ASTM Designation D 698). The moisture content of all new fill used for the liner should be maintained between the optimum moisture content and 4 percentage points above optimum.

Bulk soil samples should be obtained in advance of construction so compaction criteria and a determination of suitability can be established prior to placing any liner material. Based on the soils encountered, the portions of the upper cut material may be reusable as basin liner material.

Based on water levels obtained during and after drilling, the encountered water level is below the proposed basin bottom elevation in this area of the site. However, no long term groundwater levels were taken and borings were backfilled immediately following completion. It is possible that the groundwater table maybe higher, or may fluctuate between seasons, and that the construction of the basin may require pumping from sumps installed outside the limits of the basin excavation. Any sumps excavated during construction should be filled with compacted cohesive soil or grout at the completion of construction.

Of equal importance in minimizing seepage losses from the basin is the proper backfilling of influent and effluent pipes and headwalls adjacent to the basin. If storm sewers or irrigation pipes will be inundated when the basin is at the normal pool elevation, it is important that precautions be taken to prevent water losses/infiltration through the trench backfill or through joints in the pipes. In these areas, trenches should be backfilled with properly compacted cohesive soil. Water-tight pipe/joints should be used for pipes below the normal pool level.

S&ME recommends that the construction of the basin be observed and any liner material tested by personnel from our office. Ultimately, the critical factor in achieving the desired long-term performance of the basin is proper construction and field control.

6.7 Groundwater Considerations

6.7.1 Groundwater Considerations Roadway Subgrade Preparation

Based on observations made during the field work, it is not anticipated that significant quantities of groundwater will be encountered during construction activities for the roadway realignment and pavement widening. Shallow excavations, such as subgrade overexcavations, extending through only cohesive soil may encounter small amounts of seepage. Deeper excavations, such as excavations for any utilities, extending through granular seams, pockets/lenses, or layers may encounter larger groundwater flows. The quantities of groundwater encountered are anticipated to be controllable by bailing or pumping from temporary sumps. If pumping from sump pits is not effectively keeping the groundwater below excavation levels, then S&ME should be retained to provide additional recommendations.

During construction, surface runoff and precipitation should not be permitted to collect and stand in excavations as the soil will absorb water. Soils softened by standing water or disturbed by construction activities should be removed from excavations before pavement is placed. Additionally, all excavations should be either sloped back or braced in accordance with the most recent OSHA excavation guidelines.

6.7.2 Groundwater Considerations for Culvert Construction

During this investigation, Borings B-3, B-7, and B-15 located near the proposed culverts did not encounter groundwater at a depths above or near the planned foundation elevations. It is anticipated, however, the long term groundwater level in the immediate vicinity of the proposed culverts will be approximately the same as, and vary with, the level of water in Rush Run.

It is recommended that groundwater, surface water runoff, and stream flows 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 culvert construction. If the soil at the bottom of an excavation becomes 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 groundwater flows that may be encountered in excavations extending below the level of water in the stream.

Some water seepage may also emanate from any granular seams or zones that are encountered in excavations performed above the level of water in the stream; however, the quantity of water is anticipated to be limited and may likely be controlled by bailing or with portable pumps. Excavations extending below the stream level will likely encounter larger quantities of groundwater if granular seams or layers are encountered. Additionally, all excavations should be either sloped back or braced in accordance with the most recent OSHA excavation guidelines.

7.0 Final Considerations

The analyses, conclusions and recommendations presented in this report are based on project information provided by EMH&T. S&ME should be retained to review the final design plans and specifications to determine 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, perform fill/backfill testing, and observe construction 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 we are 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 are encountered during construction that vary from those discussed in this report, S&ME should be notified immediately so that we may evaluate the effects, if any, on design and construction.

This report was written for our client, EMH&T, Inc. This report may not be relied upon for use in other projects, additions to the current project, or any other purpose for which the material was not strictly intended by S&ME without S&ME’s express written permission.

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.

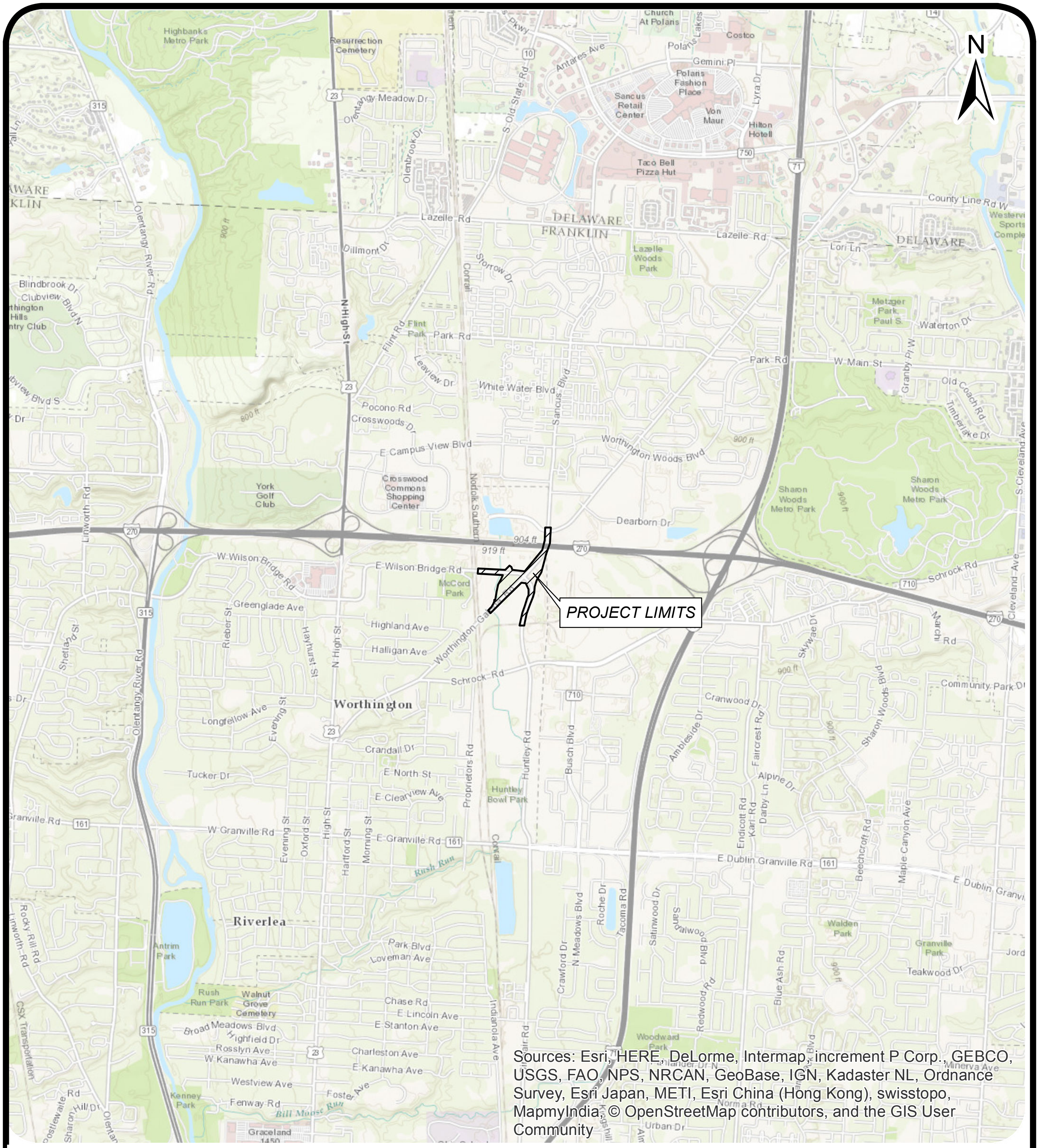
Geotechnical Recommendations Are Not Final

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

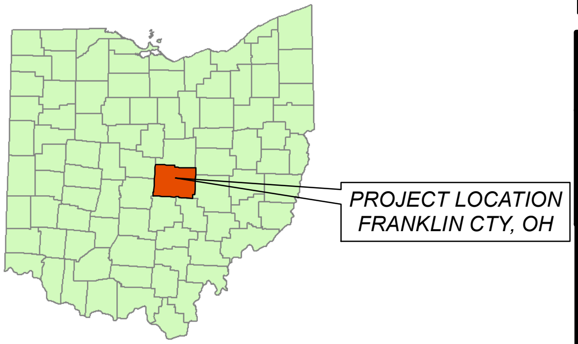
Appendices

Appendix A



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 2,000 4,000 8,000 Feet



VICINITY MAP

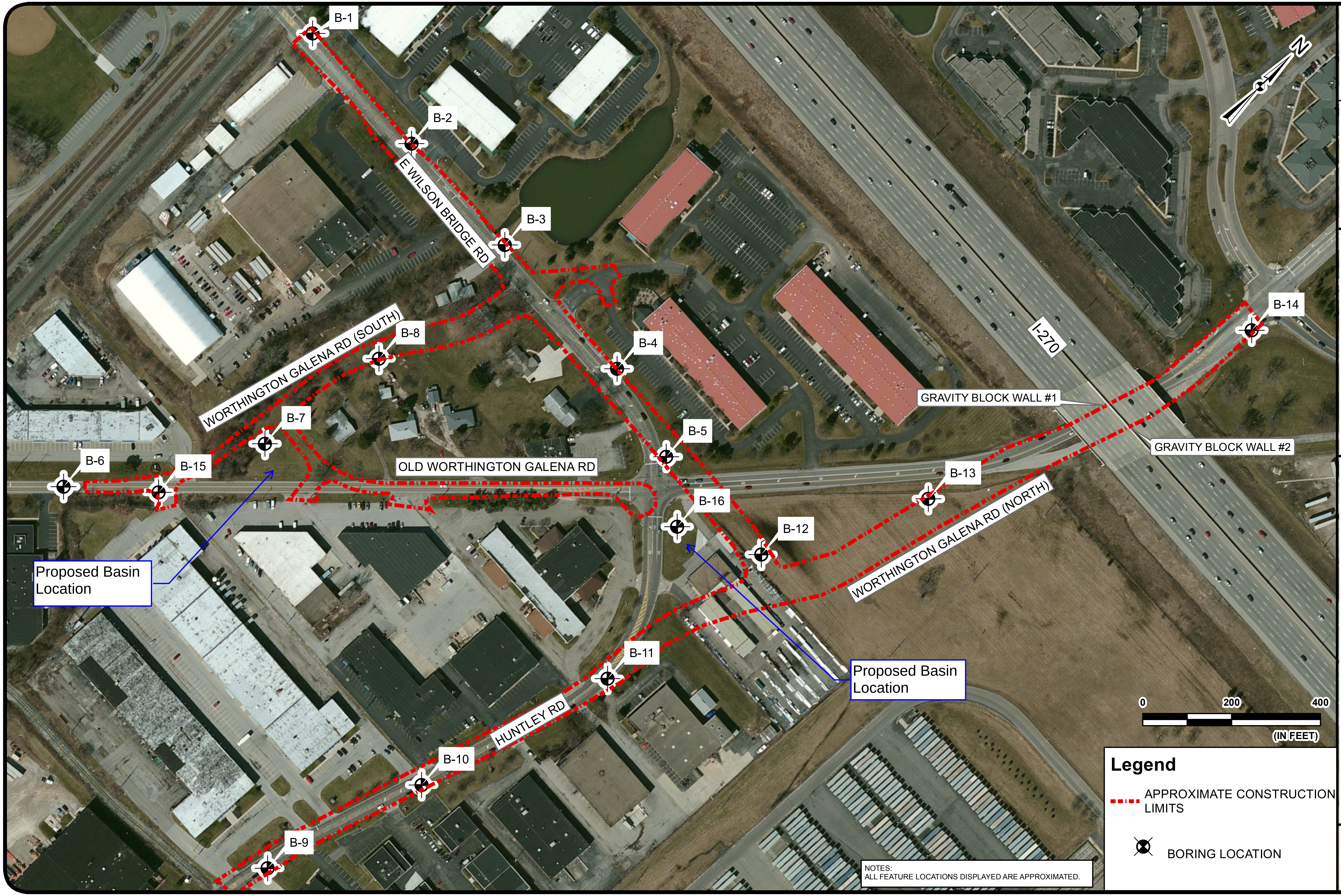
NORTHEAST GATEWAY
WORTHINGTON, FRANKLIN COUNTY, OHIO

PLATE NO.
1

SCALE:	1 inch = 4,000 feet
DATE:	7/6/2017
DRAWN BY:	CRW
PROJECT NO:	1117-16-031

S&ME
WWW.SMEINC.COM

Document Path: R:\Projects\2016\GEO\1117-16-031\1117-17-031_V-Map.mxd



NOTES:
ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED.

DATE:
7-13-2017

DRAWN BY:
CRW

SCALE:
1 " = 200 '

PROJECT NO.
1117-16-031

S&ME

PLAN OF BORINGS
FRA-CR84-1.36
NORTHEAST GATEWAY
WORTHINGTON, FRANKLIN COUNTY, OHIO

PLATE NO.
2

R:\Projects\2016\GEO\1117-16-031\1117-16-031_Plan of Borings.mxd plotted by cwest 07-13-2017

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

SAMPLING DATA

▮ - Blocked-in “SAMPLES” column indicates sample was attempted and recovered within this depth interval.

▯ - Sample was attempted within this interval but not recovered.

2/5/9 - 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. The raw “blowcount” or “N” is equal to the sum of the second and third 6-inch increments of penetration. Addition of one of the following symbols indicates the use of a split-barrel other than the 2” O.D. sampler:

$\boxed{2S}$ - 2½"O.D. split-barrel sampler

$\boxed{3S}$ - 3" O.D. split-barrel sampler

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

P - Shelby tube sampler, 3” O.D., hydraulically pushed.

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

50-2” - Number of blows (50) to drive a split-barrel sampler a certain number of inches (2), other than the normal 6-inch increment.

SD - Split-barrel sampler (S) advanced by weight of drill rods (D).

SH - Split-barrel sampler (S) advanced by combined weight of rods and drive Hammer (H).

SOIL DESCRIPTIONS

All soils have been classified basically in accordance with the Unified Soil Classification System, but this system has been augmented by the use of special adjectives to designate the approximate percentages of minor components, as follows:

Adjective	Percent by Weight
trace	1 to 10
little	11 to 20
some	21 to 35
“and”	36 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

LOG OF BORING NO. B-1
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

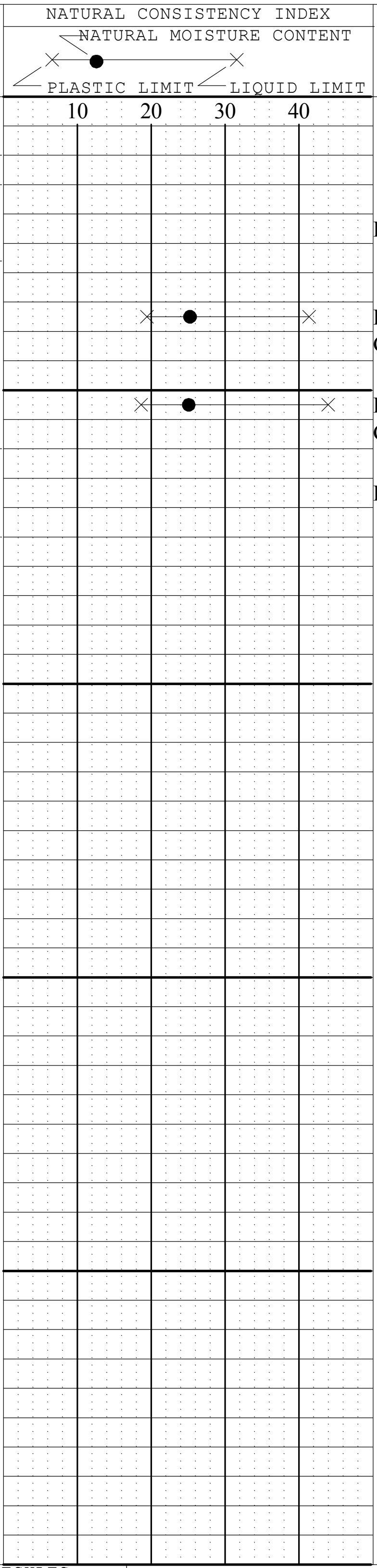
LOCATION: **40.109298N, 83.002933W** ELEVATION: **923.1** DATE: **6/27/16**

DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **7.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	0					ASPHALT - 12 INCHES	
922.1						GRANULAR BASE - 6 INCHES	
921.6		1	3/3/5	12	67	Very-stiff to hard brown mottled with dark-gray SILTY CLAY, little to some fine to coarse sand, trace fine gravel. (A-6b)	H=2.7-4.5
920.3		2	6/7/8	22	73	Stiff to very-stiff dark-brown and dark-gray CLAY, little fine to coarse sand, trace fine gravel, contains odor. (A-7-6)	H=1.5-2.2 G
	5	3	2/3/4	10	100		H=1.2-2.2 G
917.1		4	4/4/3	10	67	Stiff to very-stiff brown mottled with gray SILTY CLAY, little fine to coarse sand. (A-6b)	H=1.5-2.7
915.6							
	10						
	15						
	20						
	25						

- Encountered seepage at 7.0'.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.



2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL: ▽ "Dry" ▼
WATER NOTE: At Completion
DATE: 6/27/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation, Q - Uncon Comp, T - Triax Comp, C - Consol.: See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

JOB: 1117-16-031

Page 1 of 1

LOG OF BORING NO. B-2
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

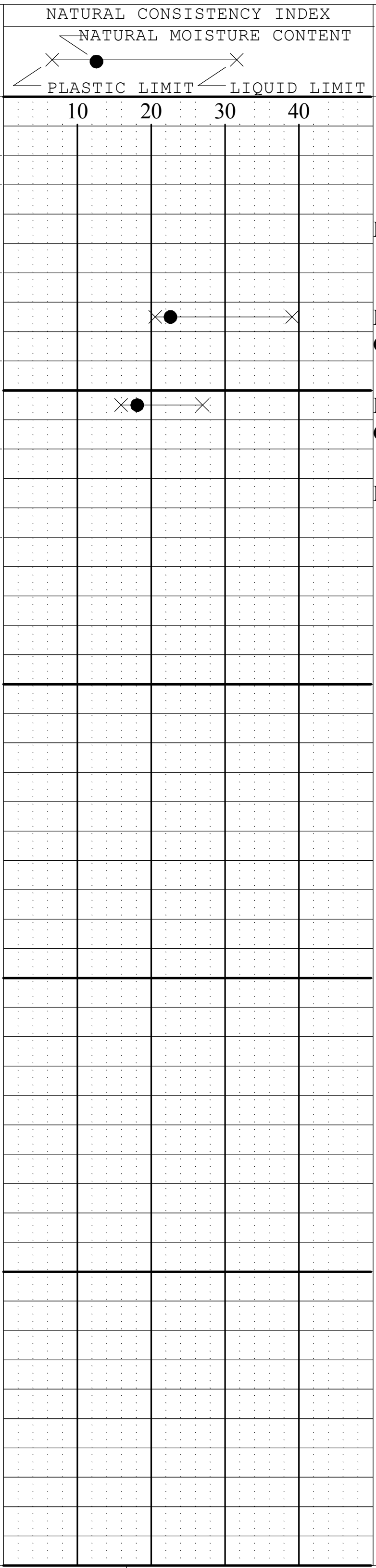
LOCATION: **40.109252N, 83.001746W** ELEVATION: **915.5** DATE: **6/24/16**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **7.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
914.5	0					ASPHALT - 12 INCHES	
914.0						GRANULAR BASE - 6 INCHES	
912.5		1	2/3/4	10	67	Very-stiff brown mottled with gray SILTY CLAY, little fine to coarse sand. (A-6b)	H=2.7-3.5
911.0		2	3/5/6	16	60	Stiff to very-stiff brown mottled with gray SITLY CLAY, some fine to coarse sand, trace fine gravel. (A-6b)	H=1.5-3.5 G
909.5	5	3	5/5/3	12	53	Medium-stiff to stiff brown SILT AND CLAY, some fine to coarse sand, trace fine gravel. (A-6a)	H=0.7-2.0 G
908.0		4	3/7/9	24	53	Very-stiff to hard dark-brown SILTY CLAY, some fine to coarse sand, little fine to coarse gravel. (A-6b)	H=-2.2-4.5
	10						
	15						
	20						
	25						

- No seepage encountered.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.



WATER LEVEL: "Dry"
WATER NOTE: At Completion
DATE: 6/24/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

JOB: 1117-16-031

LOG OF BORING NO. B-3
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

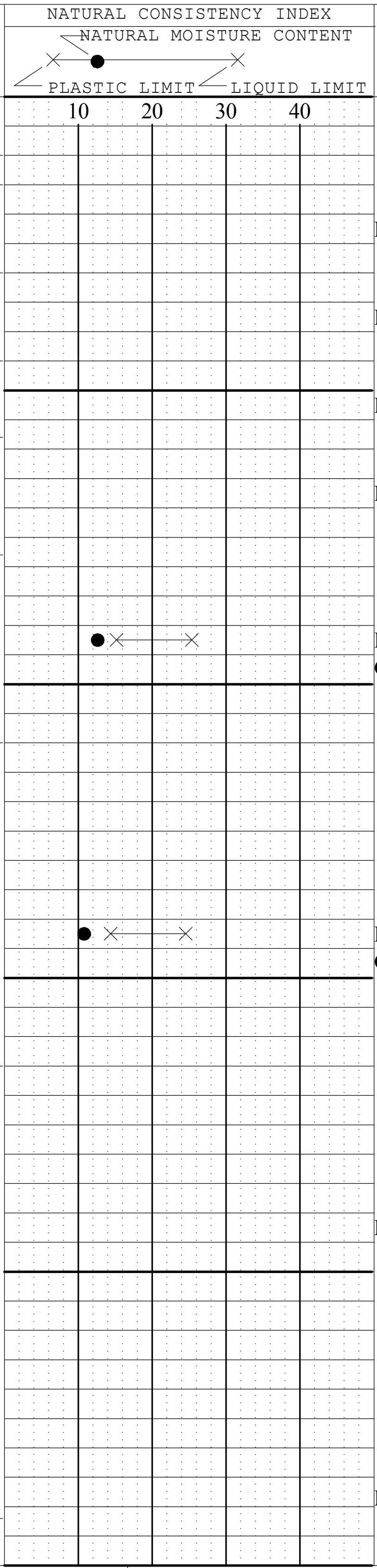
LOCATION: **40.109229N, 83.000631W** ELEVATION: **916.5** DATE: **6/24/16**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **35.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	0					ASPHALT - 12 INCHES	
915.5						GRANULAR BASE - 6 INCHES	
915.0		1	3/4/4	12	67	POSSIBLE FILL: Very-stiff greenish brown and dark-gray SILTY CLAY, little to some fine to coarse sand, trace fine to coarse gravel. (A-6b)	H=2.2-2.7
913.5		2	5/5/5	15	60	Stiff greenish-brown and dark-brown SILTY CLAY, some fine to coarse sand, trace fine gravel. (A-6b)	H=1.5
912.0	5	3	2/3/5	12	60	Stiff to very-stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, trace fine gravel. (A-6b)	H=2.0-2.5
910.7		4	3/4/4	12	80	Very-stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, little fine gravel, contains roots. (A-6b)	H=3.0-3.5
908.7	10	5	2/5/6	16	100	Very-stiff to hard brown SANDY SILT, some fine to coarse sand, trace fine gravel, contains roots. (A-4a)	H=3.0-3.5 G
905.5	15	6	3/6/8	21	80	Hard brown and gray SILT AND CLAY, some fine to coarse sand, trace fine gravel (A-6a).	H=4.5+ G
900.0	20	7	4/9/12	31	100	Hard brown and gray SILTY CLAY, some fine to coarse sand, little fine gravel. (A-6b)	H=4.5+
		8A	7/17/27	65	100		H=4.0-4.5+
892.3	25	8B				Very-dense brown GRAVEL WITH SAND, trace	



WATER LEVEL:	▽ 29.3	▼
WATER NOTE:	At Completion	Caved at 25.7
DATE:	6/24/2016	6/24/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

-CONTINUED-

LOG OF BORING NO. B-3
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

LOCATION: **40.109229N, 83.000631W** ELEVATION: **916.5** DATE: **6/24/16**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **35.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT (10 20 30 40)	TEST RESULTS
	25						silt. (A-1-b)		
889.5							Very-dense gray GRAVEL WITH SAND, trace silt. (A-1-b)		
887.6		9A ∇ 9B	■	50/49/37	128	100	Very-dense brown and gray FINE AND COARSE SAND, some fine to coarse gravel, little silt, trace clay. (A-3a)		
	30								
885.2							Hard brown SILTY CLAY, some fine to coarse sand, little fine gravel. (A-4b)		
		10	■	7/27/35	92	100			H=4.5+
881.5	35								
	40								
	45								
	50								

- No seepage encountered.
- Encountered water at 29.8'.
- Encountered cobbles at 29.5'.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.

2010 NEW DEFAULT BORING LOG-W/ N60

	∇	▼
WATER LEVEL:	29.3	
WATER NOTE:	At Completion	Caved at 25.7
DATE:	6/24/2016	6/24/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

LOG OF BORING NO. B-4
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

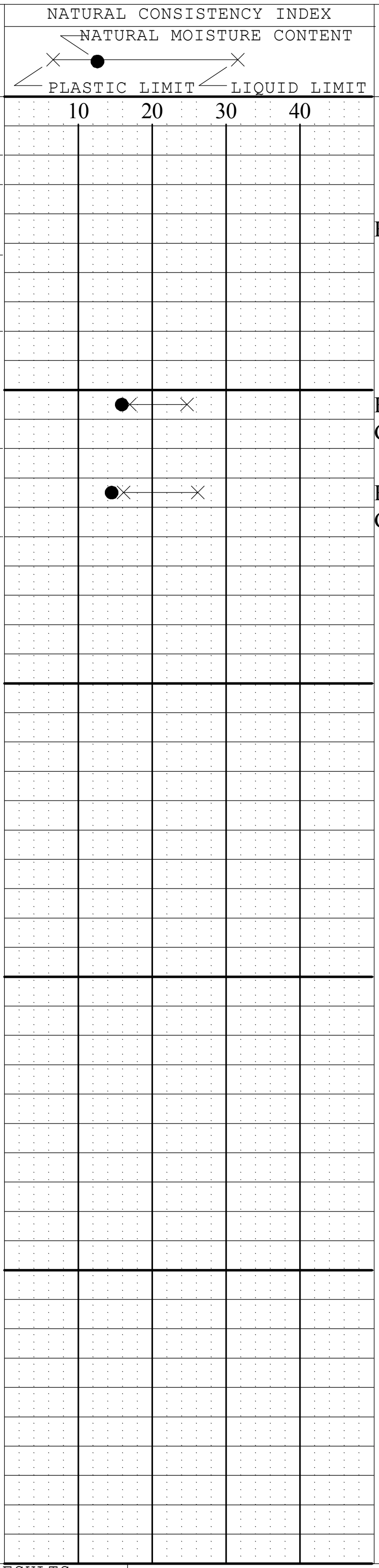
LOCATION: **40.109183N, 82.99929W** ELEVATION: **915.6** DATE: **6/24/16**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **6.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
914.6	0						ASPHALT - 12 INCHES	
914.1							GRANULAR BASE - 6 INCHES	
912.9	▽	1	■	2/4/8	18	67	Stiff to very-stiff brown mottled gray SILTY CLAY, some fine to coarse sand, trace fine to coarse gravel. (A-6b)	H=1.5-3.0
911.6		2	■	9/5/3	12	33	Medium-dense brown GRAVEL, little fine to coarse sand, trace silt. (A-1-a)	
909.6	5	3	■	4/4/4	12	87	Stiff to very-stiff brown SANDY SILT, trace fine gravel. (A-4a)	H=2.0-3.0 G
908.1		4	■	3/5/8	19	87	Very-stiff to hard brown and gray SANDY SILT, some fine to coarse sand, trace fine to coarse gravel. (A-4a)	H=3.0-4.5 G
	10							
	15							
	20							
	25							

- No seepage encountered.
- Encountered water at 2.5'.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.



WATER LEVEL:	▽ 2.0	▼
WATER NOTE:	At Completion	
DATE:	6/24/2016	

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

2010 NEW DEFAULT BORING LOG-W/ N60

JOB: 1117-16-031

PLATE 8

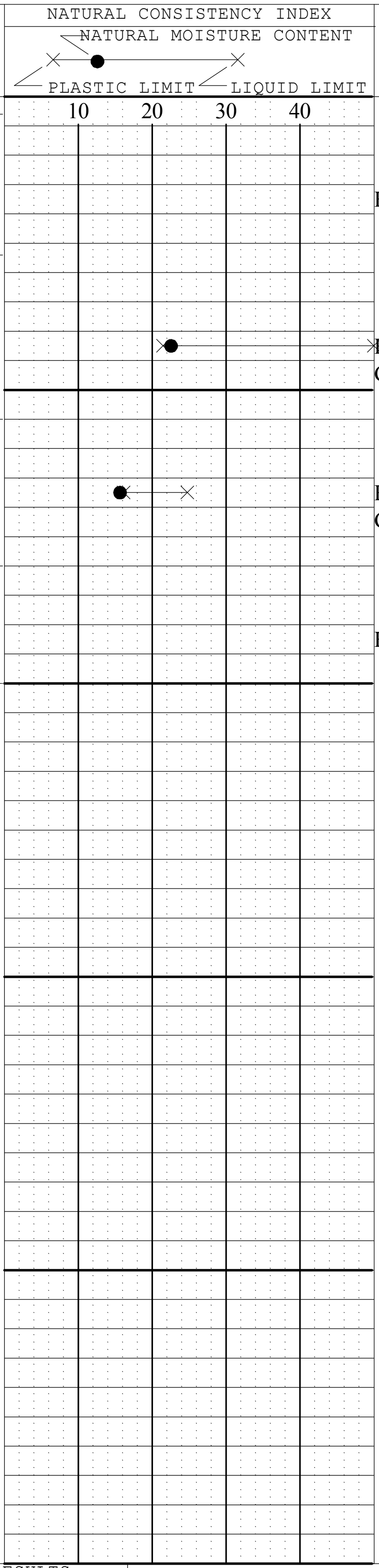
LOG OF BORING NO. B-5
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

LOCATION: **40.109015N, 82.998509W** ELEVATION: **918.6** DATE: **6/24/16**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **10.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
918.3	0						TOPSOIL - 4 INCHES	
915.9		1		4/8/6	21	87	Hard brown mottled with gray SILTY CLAY, some fine to coarse sand, little fine gravel. (A-6b)	H=4.0-4.5
913.1	5	2		3/5/11	24	93	Very-stiff brown, yellow, and dark-gray CLAY, some fine to coarse sand, trace fine gravel. (A-7-6)	H=2.5-3.5 G
910.6		3		3/4/3	10	100	Stiff to very-stiff brown SANDY SILT, some clay trace fine gravel. (A-4a)	H=2.0-3.7 G
908.6	10	4		6/8/11	28	100	Hard brown SILTY CLAY, little fine to coarse gravel. (A-6b)	H=4.0-4.5
	15							
	20							
	25							



- No seepage encountered.
- Boring backfilled with soil cuttings and bentonite chips.

WATER LEVEL: ▽ "Dry" ▼

WATER NOTE: At Completion

DATE: 6/24/2016

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891

Last Calibration Date : 9/21/2015

Drill Rig Number : S&ME CME 550-A

JOB: 1117-16-031

LOG OF BORING NO. B-6
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

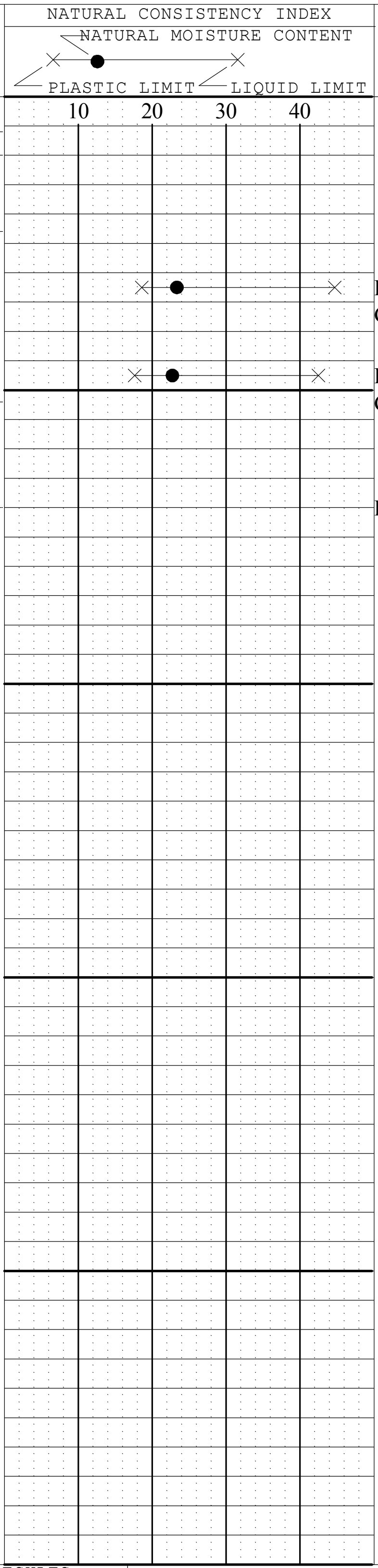
LOCATION: **40.106235N, 83.001753W** ELEVATION: **920.6** DATE: **6/26/16**

DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **7.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
920.0	0					ASPHALT - 7 INCHES	
919.6						GRANULAR BASE - 4 INCHES	
918.3		1	14/3/5	12	60	Medium-dense gray COARSE AND FINE SAND, some fine to coarse gravel, little silt, trace clay. (A-3a)	
		2	5/3/3	9	47	Stiff to very-stiff brown and gray CLAY, "and" silt, little fine to coarse sand. (A-7-6)	H=2.0-3.0 G
915.4	5	3	2/3/4	10	60		H=2.0-3.0 G
		4	5/3/3	9	0	Stiff to very-stiff brown mottled with gray SILTY CLAY, little fine to coarse sand, trace fine gravel, contains roots. (A-6b)	
913.6		2S	4/4/3	10	100		H=1.5-2.2
	10						
	15						
	20						
	25						

- No seepage encountered.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.



WATER LEVEL: ▽ "Dry" ▼
WATER NOTE: At Completion
DATE: 6/26/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

LOG OF BORING NO. B-7
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

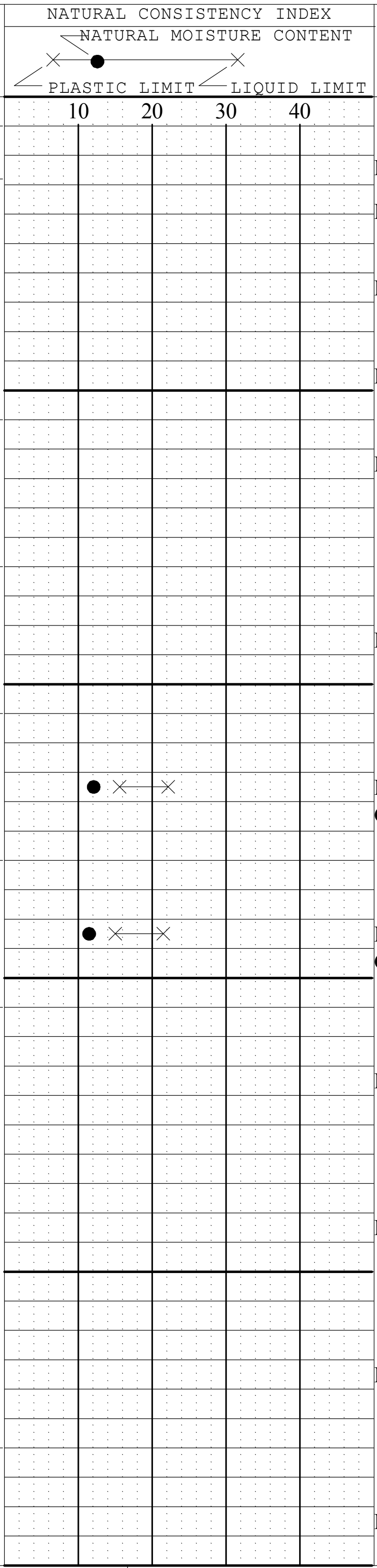
LOCATION: **40.107312N, 83.000849W** ELEVATION: **914.2** DATE: **6/20/16**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **34.9'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
913.7	0					TOPSOIL - 6 INCHES	
912.8		1A	1/2/4	8	100	Stiff to very-stiff dark-gray SILTY CLAY, little fine to coarse sand, trace fine gravel. (A-6b)	H=1.5-2.7
		1B				Stiff to very-stiff orange-brown mottled with gray SILTY CLAY, little fine to coarse sand, trace fine gravel. (A-6b)	H=1.7-2.2
		2	3/3/5	11	47		H=1.5-2.5
908.7	5	3	1/2/3	7	33		H=2.0-2.5
		4	3/3/3	8	47	Soft to medium-stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, little fine gravel. (A-6b)	H=0.5-1.0
906.2		5	4/5/6	16	80	Stiff to very-stiff brown SILTY CLAY, some fine to coarse sand, little fine gravel. (A-6b)	H=1.7-4.0
903.7	10 ▽	6	2/4/7	16	73	Very-stiff to hard gray SANDY SILT, little clay, trace fine gravel. (A-4a)	H=2.5-4.2 G
901.2		7	4/6/7	18	47	Very-stiff dark-brown SANDY SILT, some clay, trace fine gravel. (A-3a)	H=3.0-4.0 G
898.7	15	8	3/4/7	16	87	Very-stiff to hard gray SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=3.7-4.5
		9	4/5/7	17	80		H=3.7-4.5
	20	10	3/6/28	48	100		H=2.7-4.5
891.2		11	8/12/21	47	100	Hard brown SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=4.5+
	25						



	▽	▼
WATER LEVEL:	10.7	
WATER NOTE:	At Completion	Caved at 34.0
DATE:	6/20/2016	6/20/2016

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.

See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .847
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME D-50 Track

-CONTINUED-

LOG OF BORING NO. B-7
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

LOCATION: **40.107312N, 83.000849W** ELEVATION: **914.2** DATE: **6/20/16**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **34.9'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX / NATURAL MOISTURE CONTENT / PLASTIC LIMIT / LIQUID LIMIT (10 20 30 40)	TEST RESULTS
	25						Hard gray SILTY CLAY, some fine to coarse sand, trace fine gravel. (A-6b) (Continued)		
		12	■	12/13/23	51	80			H=4.5+
	30								
881.7							Hard brown SILT AND CLAY, some fine to coarse sand, some fine gravel. (A-6a)		
		13	■	12/28/50-5"R		86			H=4.5+
879.3	35								
	40								
	45								
	50								

- No seepage encountered.
- Encountered water at 11.0'.
- Encountered cobbles at 22.0'.
- Boring backfilled with soil cuttings and bentonite chips.

2010 NEW DEFAULT BORING LOG-W/ N60

	▽	▼
WATER LEVEL:	10.7	
WATER NOTE:	At Completion	Caved at 34.0
DATE:	6/20/2016	6/20/2016

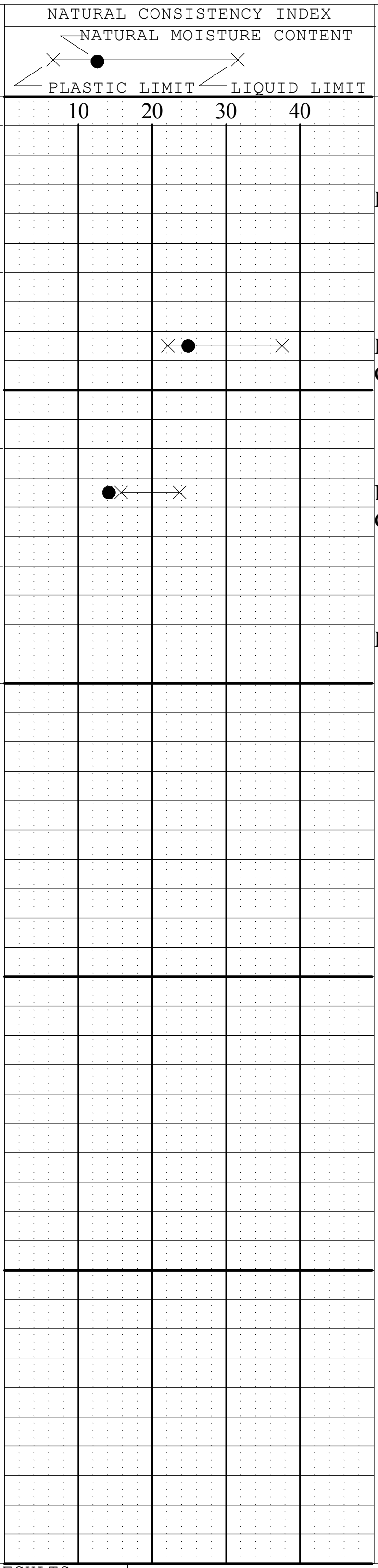
SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : **.847**
Last Calibration Date : **9/21/2015**
Drill Rig Number : **S&ME D-50 Track**

LOG OF BORING NO. B-8
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

LOCATION: **40.108179N, 83.000693W** ELEVATION: **915.3** DATE: **6/20/16**
DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **10.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
914.8	0						TOPSOIL - 6 INCHES	
912.3		1	■	1/2/4	8	33	Very-stiff brown mottled with dark-gray SILTY CLAY, little fine to coarse sand, trace fine gravel, contains few roots. (A-6b)	H=2.0-2.5
909.3	5	2	▽ ■	2/2/4	8	53	Stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, trace fine gravel. (A-6b)	H=1.0-2.0 G
907.3		3	■	1/4/3	10	73	Medium-stiff to stiff dark-brown and light-brown SANDY SILT, some clay, trace fine to coarse gravel. (A-4a)	H=0.7-1.2 G
905.3	10	4	■	2/6/7	18	73	Very-stiff to hard brown SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=3.5-4.5
	15							
	20							
	25							



- Encountered seepage at 3.5'.
- Encountered water at 6.0'.
- Boring backfilled with soil cuttings and bentonite chips.

	▽	▼
WATER LEVEL:	3.5	
WATER NOTE:	At Completion	Caved at 8.5
DATE:	6/20/2016	6/20/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : **.847**
Last Calibration Date : **9/21/2015**
Drill Rig Number : **S&ME D-50 Track**

JOB: 1117-16-031

PLATE 13

2010 NEW DEFAULT BORING LOG-W/ N60

LOG OF BORING NO. B-9
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

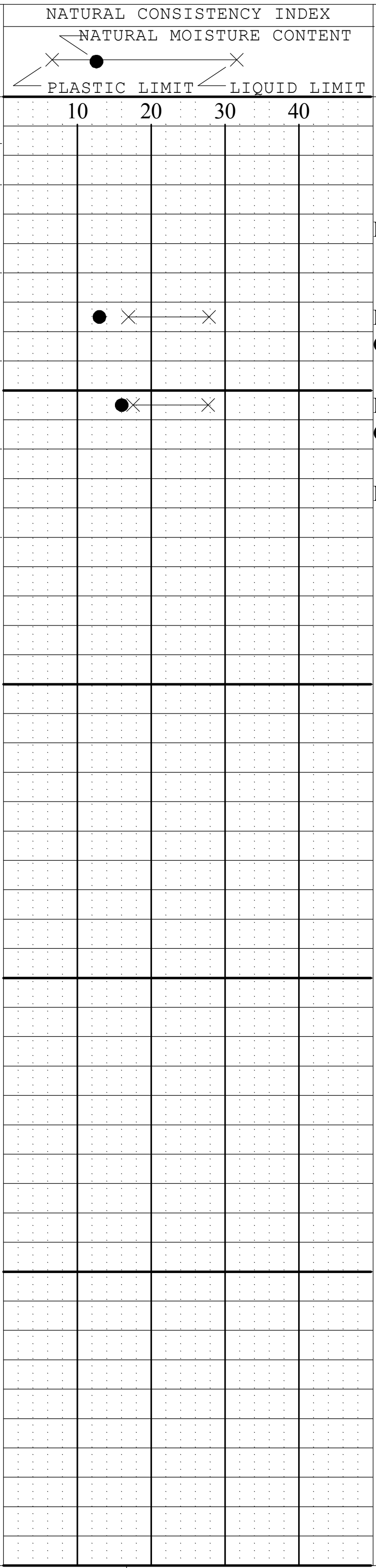
LOCATION: **40.105476N, 82.998409W** ELEVATION: **918.0** DATE: **6/27/16**

DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **7.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
917.2	0						ASPHALT - 10 INCHES	
916.5							GRANULAR BASE - 8 INCHES	
915.0		1		3/5/6	16	53	Very-stiff brown mottled with gray SILTY CLAY, little fine to coarse sand, trace fine gravel. (A-6b)	H=2.5-3.0
913.5		2		7/7/8	22	60	Very-stiff to hard brown SILT AND CLAY, some fine to coarse sand, little fine gravel. (A-6a)	H=3.0-4.5 G
912.0	5	3		3/4/5	13	100	Very-stiff to hard brown and gray SANDY SILT, some clay, trace fine gravel. (A-4a)	H=3.5-4.5 G
910.5		4		3/10/11	31	67	Very-stiff to hard brown SILTY CLAY, some fine to coarse sand, trace fine gravel. (A-6b)	H=3.0-4.5
	10							
	15							
	20							
	25							

- No seepage encountered.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.



WATER LEVEL: ▽ **"Dry"** ▼

WATER NOTE: **At Completion**

DATE: **6/27/2016**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .891
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

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LOG OF BORING NO. B-10
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

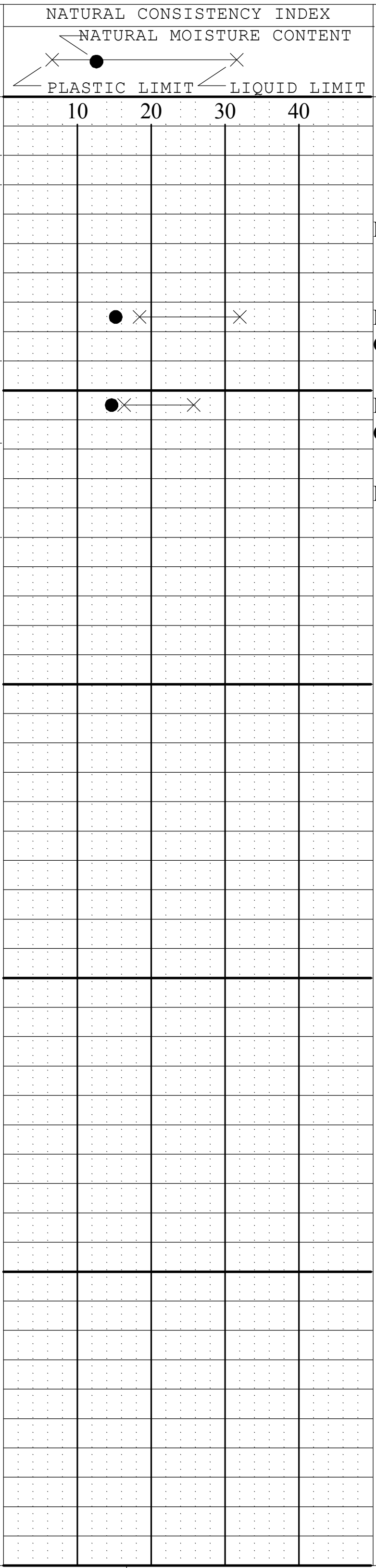
LOCATION: **40.106515N, 82.998015W** ELEVATION: **917.1** DATE: **6/27/16**

DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **7.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	0						ASPHALT - 12 INCHES	
916.1								
915.6							GRANULAR BASE - 6 INCHES	
		1		11/5/3	12	53	Very-stiff to hard brown mottled with gray SILT AND CLAY, some fine to coarse sand, trace to little fine gravel. (A-6a)	H=3.5-4.5
		2		5/7/8	22	100		H=4.0-4.5 G
912.6								
	5	3		4/4/5	13	87	Very-stiff brown SANDY SILT, some clay, trace fine gravel. (A-4a)	H=2.5-3.5 G
911.2								
		4		5/6/7	19	100	Very-stiff to hard brown SILTY CLAY, some fine to coarse sand, little fine gravel. (A-6b)	H=3.5-4.5
909.6								
							- No seepage encountered. - Boring backfilled with soil cuttings and bentonite chips. - Pavement patched with cold patch asphalt.	
	10							
	15							
	20							
	25							



WATER LEVEL: ▽ **"Dry"** ▼

WATER NOTE: **At Completion**

DATE: **6/27/2016**

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation Q - Uncon Comp T - Triax Comp C - Consol.	See Separate Curves	H - Penetrometer (tsf) W - Unit Dry Wt (pcf) D - Relative Dens (%)

Drill Rod Energy Ratio : **.891**

Last Calibration Date : **9/21/2015**

Drill Rig Number : **S&ME CME 550-A**

JOB: 1117-16-031

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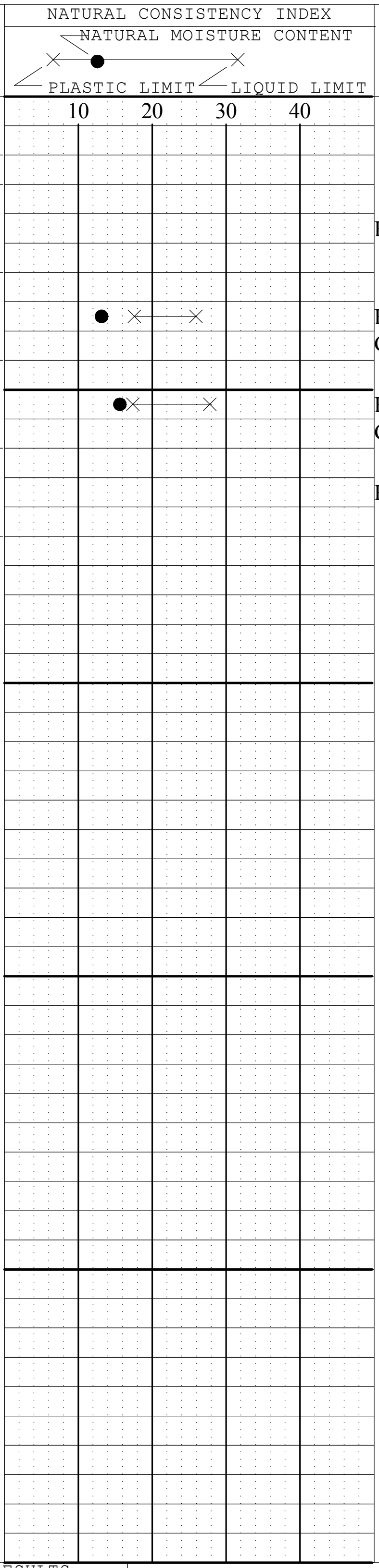
LOG OF BORING NO. B-11
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

LOCATION: **40.107793N, 82.99757W** ELEVATION: **918.2** DATE: **6/27/16**

DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **7.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
	0						ASPHALT - 12 INCHES	
917.2							GRANULAR BASE - 6 INCHES	
916.7								
915.2		1	■	10/7/5	18	47	Hard brown mottled with gray SILTY CLAY, some fine to coarse sand, some fine gravel (A-6b).	H=4.0-4.5+
913.7		2	■	7/7/8	22	80	Hard brown SANDY SILT, some clay, trace fine gravel. (A-4a)	H=4.0-4.5 G
912.2	5	3	■	4/4/5	13	87	Very-stiff brown mottled with gray SILT AND CLAY, some fine to coarse sand, trace fine gravel. (A-6a)	H=3.0-3.5 G
910.7		4	■	6/6/8	21	100	Very-stiff to hard brown SILTY CLAY some fine to coarse sand, some fine gravel. (A-6b)	H=2.5-4.5
	10						- No seepage encountered. - Boring backfilled with soil cuttings and bentonite chips. - Pavement patched with cold patch asphalt.	
	15							
	20							
	25							



WATER LEVEL: ▽ "Dry" ▼

WATER NOTE: At Completion

DATE: 6/27/2016

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : **.891**
Last Calibration Date : **9/21/2015**
Drill Rig Number : **S&ME CME 550-A**

JOB: 1117-16-031

PLATE 16

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LOG OF BORING NO. B-12
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

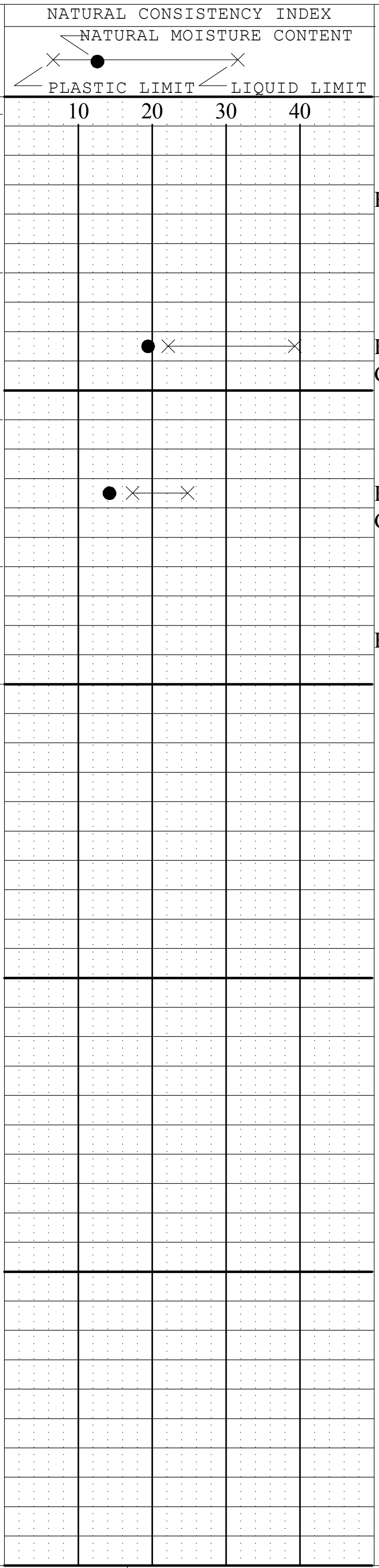
LOCATION: **40.109007N, 82.99741W** ELEVATION: **919.0** DATE: **6/20/16**

DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **10.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
918.7	0					TOPSOIL - 4-1/2 INCHES	
		1	1/2/4	8	33	Stiff to very-stiff orange-brown and dark-gray SILTY CLAY, little fine to coarse sand, trace fine gravel. (A-6b)	H=2.0-2.5
916.0		2	2/3/5	11	80	Very-stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, trace fine gravel. (A-6b)	H=3.0-3.5 G
913.5	5	3	2/3/5	11	87	Very-stiff to hard brown SILTY SAND, some clay, trace fine gravel. (A-4a)	H=2.5-4.5 G
911.0		4	4/8/12	28	100	Hard brown SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=4.5+
909.0	10						

- No seepage encountered.
- Encountered cobbles at 7.5'.
- Boring backfilled with soil cuttings and bentonite chips.



2010 NEW DEFAULT BORING LOG-W/ N60

WATER LEVEL:	"Dry"	
WATER NOTE:	At Completion	Caved at 7.7
DATE:	6/20/2016	6/20/2016

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .847
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME D-50 Track

JOB: 1117-16-031

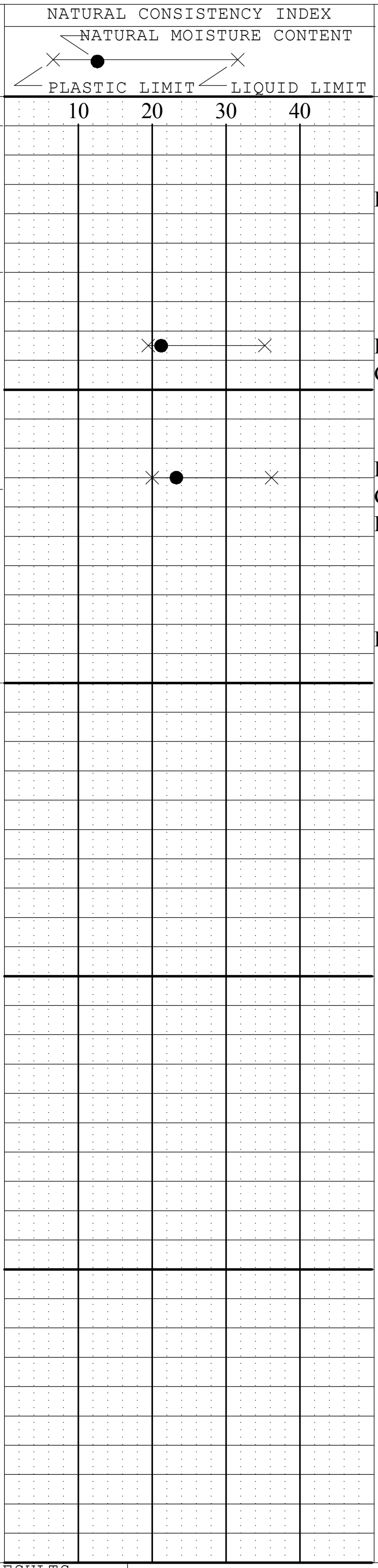
PLATE 17

LOG OF BORING NO. B-13
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

LOCATION: **40.109984N, 82.996784W**
ELEVATION: **920.8**
DATE: **6/20/16**
DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger**
COMPLETION DEPTH: **10.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
920.3	0						TOPSOIL - 6-1/2 INCHES	
		1		2/3/4	10	47	Stiff to very-stiff brown and dark-gray SILTY CLAY, little fine to coarse sand, trace fine gravel. (A-6b)	H=1.7-2.7
917.8		2		2/3/4	10	73	Stiff to very-stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, trace fine gravel, contains few roots. (A-6b)	H=2.0-2.7 G
	5							
		3A		SH/2/5	10	100		H=1.0-2.0 G
914.1		3B					Very-stiff to hard brown SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=3.0-3.5
		4		5/10/10	28	87		H=3.0-4.5
910.8	10						- No seepage encountered. - Encountered cobbles at 7.5'. - Boring backfilled with soil cuttings and bentonite chips.	
	15							
	20							
	25							



WATER LEVEL:	∇ "Dry"	▼
WATER NOTE:	At Completion	Caved at 8.1
DATE:	6/20/2016	6/20/2016

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .847
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME D-50 Track

JOB: 1117-16-031

PLATE 18

LOG OF BORING NO. B-14
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

LOCATION: **40.112136N, 82.995918W** ELEVATION: **927.6** DATE: **6/27/16**

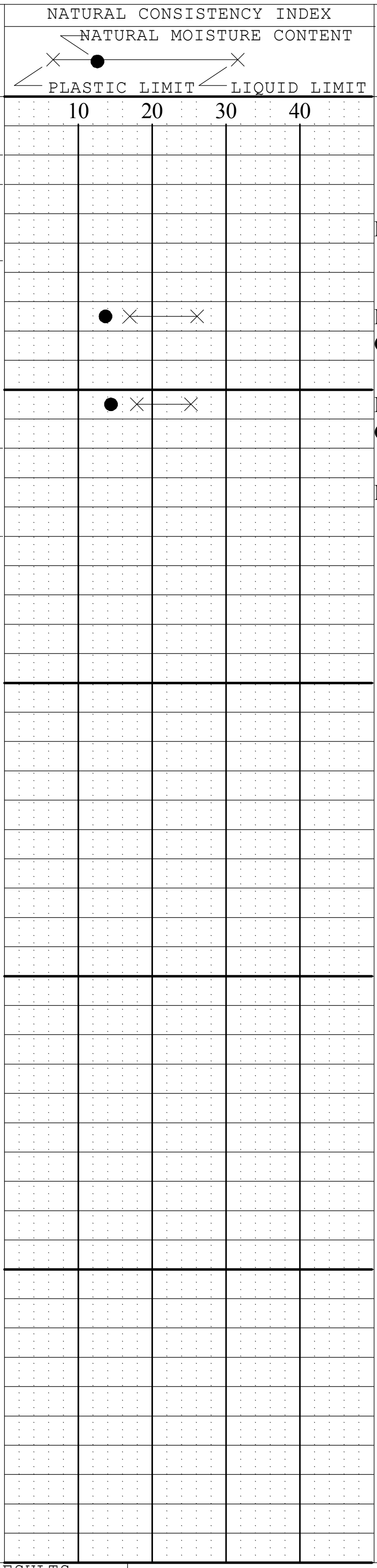
DRILLING METHOD: **4-1/2" O.D. Continuous-flight Auger** COMPLETION DEPTH: **7.5'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
926.6	0						ASPHALT - 12 INCHES	
926.1							GRANULAR BASE - 6 INCHES	
924.8		1		5/7/10	24	47	Hard brown mottled with gray SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=4.0-4.5
		2 2S		10/10/8	25	67	Very-stiff to hard brown SANDY SILT, some clay, trace fine gravel. (A-4a)	H=2.0-4.2 G
921.6	5	3		4/6/6	17	47		H=2.7-4.5 G
920.1		4		9/12/13	35	73	Hard brown SILTY CLAY, some fine to coarse sand, some fine gravel. (A-6b)	H=4.5+
	10							
	15							
	20							
	25							

- No seepage encountered.
- Boring backfilled with soil cuttings and bentonite chips.
- Pavement patched with cold patch asphalt.



WATER LEVEL: "Dry"
WATER NOTE: At Completion
DATE: 6/27/2016

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : 0.847
Last Calibration Date : 9/21/2015
Drill Rig Number : S&ME CME 550-A

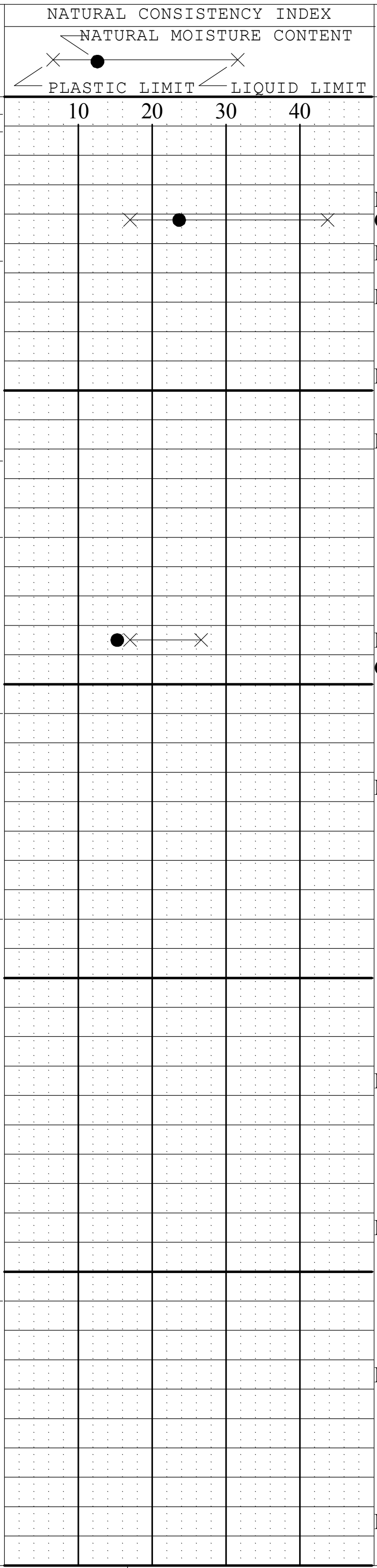
JOB: 1117-16-031

LOG OF BORING NO. B-15
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

S&ME

LOCATION: **40.108765N, 82.998004W** ELEVATION: **918.9** DATE: **6/19/17**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **35.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N60	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
918.6	0					ASPHALT - 3 INCHES	
918.3						GRANULAR BASE - 4 INCHES	
		1	3/3/3	9	80	FILL: Very-stiff dark-brown mottled with gray CLAY, "and" silt, little fine to coarse sand, trace fine gravel. (A-7-6)	H=2.0-2.7 G
916.1		2A	3/2/3	8	100	Medium-stiff to stiff brown mottled with gray CLAY, "and" silt, little to some fine to coarse sand. (A-7-6)	H=1.5
		2B					H=1.5-1.7
	5	3	3/3/5	12	60		H=1.0-2.0
		4A	2/2/3	8	100		H=0.5-0.7
912.7		4B				Medium-dense COARSE AND FINE SAND, "and" silty clay, little fine gravel. (A-3a)	
911.4						Stiff to very-stiff brown SANDY SILT, some clay, trace fine gravel. (A-4a)	
		5	4/4/6	15	100		H=1.5-2.5 G
908.4	10					Stiff to very-stiff gray SANDY SILT, some clay, trace fine gravel. (A-4a)	
		6	3/5/7	18	100		H=1.5-2.5
904.9		7	4/6/10	24		Very-stiff to hard gray SILTY CLAY, little fine to coarse sand, some fine to coarse gravel. (A-6b)	
	15						
		8	4/6/8	21	87		H=3.0-3.5
		9	5/7/9	24	87		H=4.0-4.5
898.4	20					Hard brown SILTY CLAY, some fine to coarse sand, little fine to coarse gravel. (A-6b)	
		10	6/9/11	30	100		H=4.5+
		11	5/9/14	35	100		H=4.5+
	25						



WATER LEVEL:	▽ "Dry"	▼
WATER NOTE:	At Completion	Caved at 31.4
DATE:	6/19/2017	6/19/2017

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .91
Last Calibration Date : 3/25/2016
Drill Rig Number : Env Mobile

2010 NEW DEFAULT BORING LOG-W/ N60

-CONTINUED-

Page 2 of 2

LOG OF BORING NO. B-15
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

LOCATION: **40.108765N, 82.998004W** ELEVATION: **918.9** DATE: **6/19/17**
DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **35.0'**
SAMPLER(S): **2" O.D. Split-barrel Sampler**

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	NATURAL CONSISTENCY INDEX NATURAL MOISTURE CONTENT PLASTIC LIMIT – LIQUID LIMIT 10 20 30 40	TEST RESULTS
	25						Hard brown SILTY CLAY, some fine to coarse sand, little fine to coarse gravel. (A-6b) (Continued)		
889.9		12A	■	5/13/15	42	100			
		12B	■				Hard gray mottled with brown SANDY SILT, some clay, little fine gravel. (A-4a)		H=4.0
	30								
		13	■	10/22/29	77	100			H=4.5+
883.9	35								
							- No seepage or groundwater encountered during drilling. - Boring backfilled with soil cuttings and bentonite chips. - Pavement patched with cold patch asphalt.		
	40								
	45								
	50								

2010 NEW DEFAULT BORING LOG-W/ N60

	▽	▼
WATER LEVEL:	**"Dry"**	
WATER NOTE:	**At Completion**	**Caved at 31.4**
DATE:	**6/19/2017**	**6/19/2017**

SYMBOLS USED TO INDICATE TEST RESULTS
G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves
H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : **.91**
Last Calibration Date : **3/25/2016**
Drill Rig Number : **Env Mobile**

JOB: 1117-16-031

LOG OF BORING NO. B-16
FRA-CR 84-1.36 - NORTHEAST GATEWAY
WORTHINGTON, OH

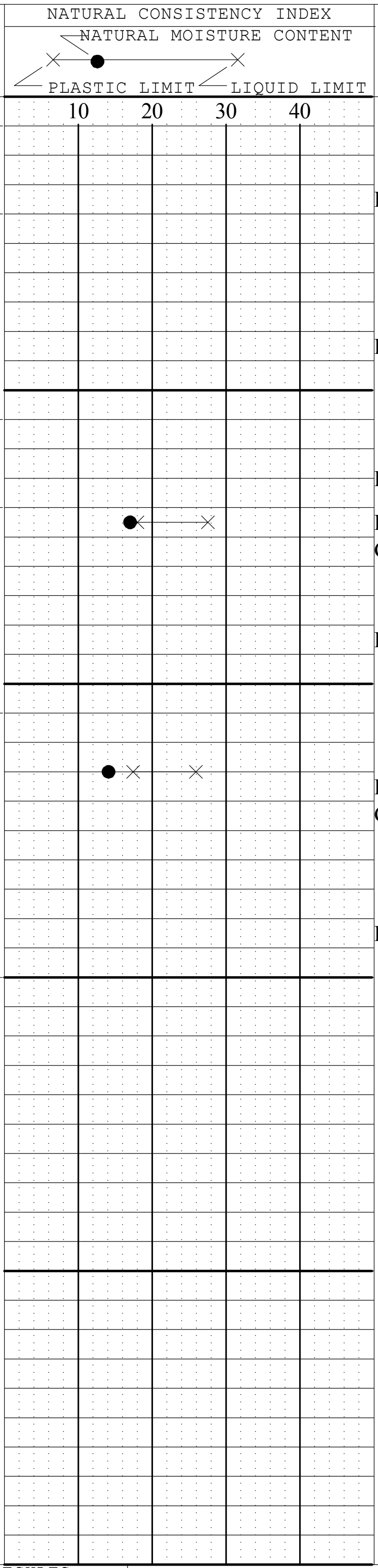
LOCATION: **40.106609N, 83.001210W** ELEVATION: **916.8** DATE: **6/19/17**

DRILLING METHOD: **3-1/4" I.D. Hollow-stem Auger** COMPLETION DEPTH: **15.0'**

SAMPLER(S): **2" O.D. Split-barrel Sampler**

2010 NEW DEFAULT BORING LOG-W/ N60

ELEV.	DEPTH, FEET	SAMPLE NUMBER	SAMPLE EFFORT	N_{60}	SAMPLE REC-%	DESCRIPTION	TEST RESULTS
916.3	0					TOPSOIL - 6 INCHES	
914.8		1	4/4/5	14	20	POSSIBLE FILL: Very-stiff dark-gray and brown SILTY CLAY, some fine to coarse sand. (A-6b)	H=4.0
		2	2/2/2	6	67	POSSIBLE FILL: Stiff brown mottled with gray SILTY CLAY, some fine to coarse sand, contains few roots. (A-6b)	H=1.0
911.3	5						
909.8		3A	SH/SH/5		100	Very-soft brown CLAY, some silt, some fine to coarse sand, trace fine gravel. (A-7-6)	H=0.0
		3B				Very-stiff to hard brown SANDY SILT, some clay, little fine gravel. (A-4a)	H=3.0 G
		4	4/9/10	29	100		H=4.5+
906.3	10						
		5	6/9/9	27	67	Very-stiff dark-gray SANDY SILT, "and" clay, trace fine to coarse gravel, slightly organic. (A-4a)	H=4.0 G
	▽	6	5/10/12	33	100		H=4.0
901.8	15						
	20						
	25						



- Encountered seepage at 6.0' during drilling.
- No groundwater encountered during drilling.
- Boring backfilled with soil cuttings and bentonite chips.

	▽	▼
WATER LEVEL:	13.5	
WATER NOTE:	Inside HSA	Caved at 11.9
DATE:	6/19/207	6/19/2017

SYMBOLS USED TO INDICATE TEST RESULTS

G - Gradation
Q - Uncon Comp
T - Triax Comp
C - Consol.
See Separate Curves

H - Penetrometer (tsf)
W - Unit Dry Wt (pcf)
D - Relative Dens (%)

Drill Rod Energy Ratio : .91
Last Calibration Date : 3/25/2016
Drill Rig Number : Env Mobile

JOB: 1117-16-031

SUMMARY OF LABORATORY TEST RESULTS

BORING	G'int Id.	MC	LL	PL	PI	GRADATION			COMPACTION		TRIAXIAL			DIRECT SHEAR			UNCONFIN COMPRESS	CONSOLID.	SPECIFIC GRAVITY	UNIT DRY WEIGHT	REMOLDED	PERMEABILITY				RELATIVE DENSITY	LOI	ROCK CORE	SHELBY TUBE	pH
						sieve	Hydrometer short	Hydrometer long	standard	modified	uncons. undrain	consolid undrain w/pores	drained	drained	undrain	residual						cohesive	non/cohes	rigid wall	flexible wall					
		%	%	%	%	* SEE INDIVIDUAL TEST CURVES														PCF						%	%			
B-1	3.75	25	41	19	22	*	*																							
B-1	5.25	25	44	19	25	*	*																							
B-2	3.75	23	39	21	18	*	*																							
B-2	5.25	18	27	16	11	*	*																							
B-3	9.25	13	25	15	10	*	*																							
B-3	14.25	11	25	14	11	*	*																							
B-4	5.25	16	25	17	8	*	*																							
B-4	6.75	15	26	16	10	*	*																							
B-5	4.25	23	52	21	31	*	*																							
B-5	6.75	16	25	16	9	*	*																							
B-6	3.25	23	45	19	26	*	*																							
B-6	4.75	23	43	18	25	*	*																							
B-7	11.75	12	22	16	6	*	*																							
B-7	14.25	11	21	15	6	*	*																							
B-8	4.25	25	38	22	16	*	*																							
B-8	6.75	14	24	16	8	*	*																							
B-9	3.75	13	28	17	11	*	*																							
B-9	5.25	16	28	18	10	*	*																							
B-10	3.75	15	32	18	14	*	*																							
B-10	5.25	15	26	16	10	*	*																							

SUM REG 111716031.GPJ BBCM.GDT 7/13/17

S&ME

TESTING SUMMARY - STANDARD

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031
DATE 7/13/17

SUMMARY OF LABORATORY TEST RESULTS

BORING	G'int Id.	MC	LL	PL	PI	GRADATION			COMPACTION		TRIAXIAL			DIRECT SHEAR			UNCONFIN COMPRESS	CONSOLID.	SPECIFIC GRAVITY	UNIT DRY WEIGHT	REMOLDED	PERMEABILITY				RELATIVE DENSITY	LOI	ROCK CORE	SHELBY TUBE	pH
							Hydrometer																							
						sieve	short	long	standard	modified	uncons. undrain	consolid undrain w/pores	drained	drained	undrain	residual						cohesive	non/cohes	rigid wall	flexible wall					
		%	%	%	%	* SEE INDIVIDUAL TEST CURVES														PCF						%	%			
B-11	**3.75**	**13**	**26**	**18**	**8**	*	*																							
B-11	**5.25**	**16**	**28**	**17**	**11**	*	*																							
B-12	**4.25**	**19**	**39**	**22**	**17**	*	*																							
B-12	**6.75**	**14**	**25**	**17**	**8**	*	*																							
B-13	**4.25**	**21**	**35**	**19**	**16**	*	*																							
B-13	**6.50**	**23**	**36**	**20**	**16**	*	*																							
B-14	**3.75**	**14**	**26**	**17**	**9**	*	*																							
B-14	**5.25**	**14**	**25**	**18**	**7**	*	*																							
B-15	**2.10**	**24**	**44**	**17**	**27**	*	*																							
B-15	**9.25**	**15**	**27**	**17**	**10**	*	*																							
B-16	**7.25**	**17**	**28**	**18**	**10**	*																								
B-16	**11.50**	**14**	**26**	**17**	**9**	*																								

SUM REG 111716031.GPJ BBCM.GDT 7/13/17

S&ME

TESTING SUMMARY - STANDARD

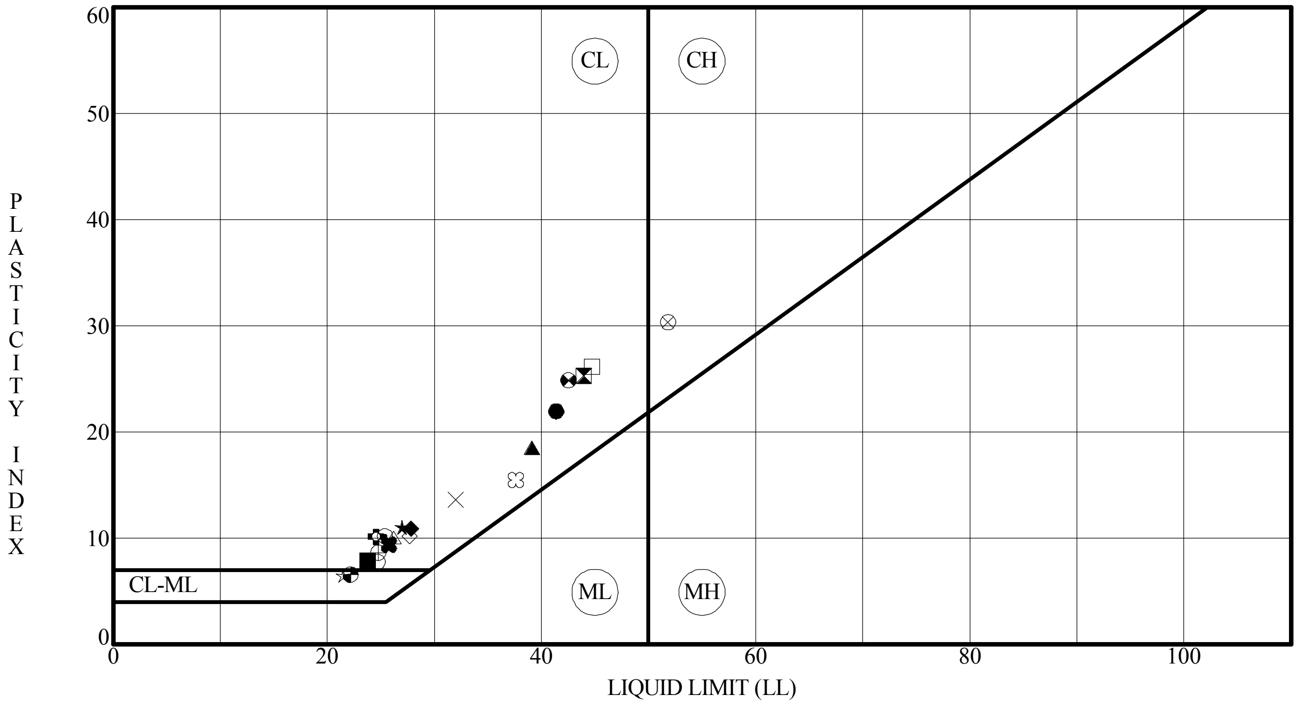
PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY

LOCATION WORTHINGTON, OH

JOB NO. 1117-16-031 **DATE** 7/13/17

PLATE 24

ATTERBERG LIMITS RESULTS

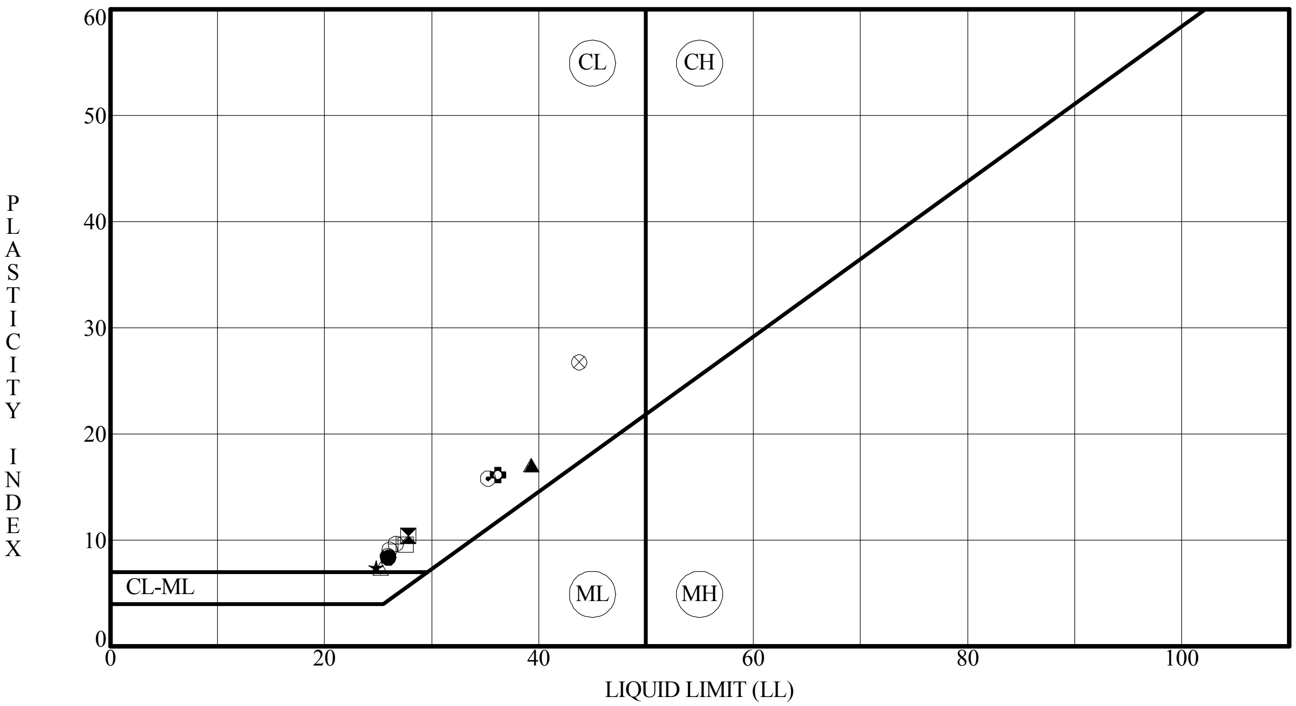


	Specimen Id.	Depth	MC	LL	PL	PI	Fines	ASTM Classification
●	**B-1**	**3.75**	**25**	**41**	**19**	**22**	**79.4**	**LEAN CLAY with SAND CL**
⧗	**B-1**	**5.25**	**25**	**44**	**19**	**25**	**81.5**	**LEAN CLAY with SAND CL**
▲	**B-2**	**3.75**	**23**	**39**	**21**	**18**	**74.9**	**LEAN CLAY with SAND CL**
★	**B-2**	**5.25**	**18**	**27**	**16**	**11**	**61.9**	**SANDY LEAN CLAY CL**
⊙	**B-3**	**9.25**	**13**	**25**	**15**	**10**	**64.2**	**SANDY LEAN CLAY CL**
✤	**B-3**	**14.25**	**11**	**25**	**14**	**11**	**63.8**	**SANDY LEAN CLAY CL**
○	**B-4**	**5.25**	**16**	**25**	**17**	**8**	**59.4**	**SANDY LEAN CLAY CL**
△	**B-4**	**6.75**	**15**	**26**	**16**	**10**	**59.2**	**SANDY LEAN CLAY CL**
⊗	**B-5**	**4.25**	**23**	**52**	**21**	**31**	**72.9**	**FAT CLAY with SAND CH**
⊕	**B-5**	**6.75**	**16**	**25**	**16**	**9**	**62.0**	**SANDY LEAN CLAY CL**
□	**B-6**	**3.25**	**23**	**45**	**19**	**26**	**90.0**	**LEAN CLAY CL**
⊛	**B-6**	**4.75**	**23**	**43**	**18**	**25**	**89.3**	**LEAN CLAY CL**
◕	**B-7**	**11.75**	**12**	**22**	**16**	**6**	**63.2**	**SANDY SILTY CLAY CL-ML**
☆	**B-7**	**14.25**	**11**	**21**	**15**	**6**	**60.3**	**SANDY SILTY CLAY CL-ML**
⌘	**B-8**	**4.25**	**25**	**38**	**22**	**16**	**77.2**	**LEAN CLAY with SAND CL**
■	**B-8**	**6.75**	**14**	**24**	**16**	**8**	**52.5**	**SANDY LEAN CLAY CL**
◆	**B-9**	**3.75**	**13**	**28**	**17**	**11**	**56.0**	**SANDY LEAN CLAY with GRAVEL CL**
◇	**B-9**	**5.25**	**16**	**28**	**18**	**10**	**65.2**	**SANDY LEAN CLAY CL**
×	**B-10**	**3.75**	**15**	**32**	**18**	**14**	**69.0**	**SANDY LEAN CLAY CL**
✖	**B-10**	**5.25**	**15**	**26**	**16**	**10**	**60.8**	**SANDY LEAN CLAY CL**

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

ALPI-REG 111716031.GPJ BBCM.GDT 7/13/17

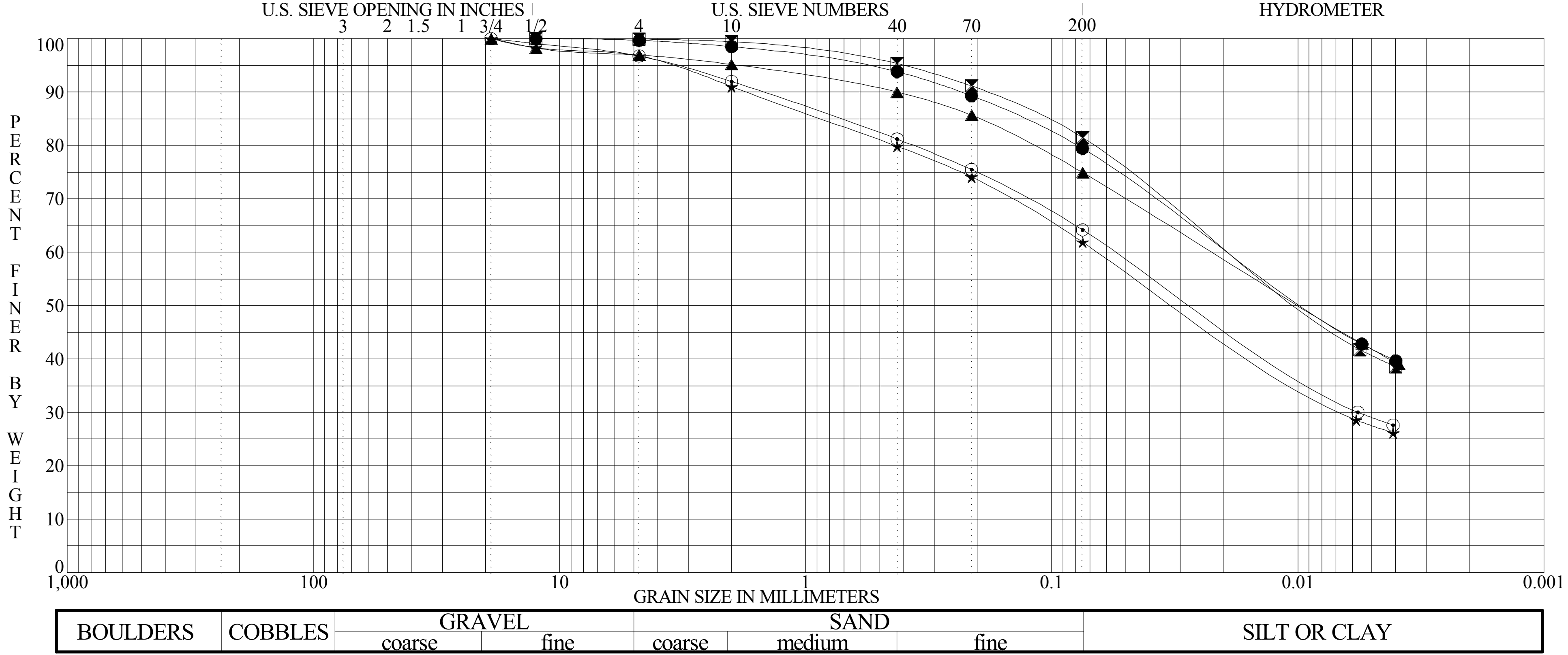
ATTERBERG LIMITS RESULTS



Specimen Id.		Depth	MC	LL	PL	PI	Fines	ASTM Classification
●	B-11	3.75	13	26	18	8	63.8	SANDY LEAN CLAY CL
⧗	B-11	5.25	16	28	17	11	63.8	SANDY LEAN CLAY CL
▲	B-12	4.25	19	39	22	17	71.3	LEAN CLAY with SAND CL
★	B-12	6.75	14	25	17	8	61.1	SANDY LEAN CLAY CL
⊙	B-13	4.25	21	35	19	16	76.2	LEAN CLAY with SAND CL
✜	B-13	6.50	23	36	20	16	73.8	LEAN CLAY with SAND CL
○	B-14	3.75	14	26	17	9	58.3	SANDY LEAN CLAY CL
△	B-14	5.25	14	25	18	7	60.9	SANDY SILTY CLAY CL-ML
⊗	B-15	2.10	24	44	17	27	85.4	LEAN CLAY CL
⊕	B-15	9.25	15	27	17	10	57.5	SANDY LEAN CLAY CL
□	B-16	7.25	17	28	18	10	59.9	SANDY LEAN CLAY CL
◍	B-16	11.50	14	26	17	9	75.4	LEAN CLAY with SAND CL

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

ALPI-REG 11171603l.GPJ BBCM.GDT 7/13/17



Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
● **B-1 S-2 3.0' to 4.3'**		**25**	**41**	**19**	**22**		
⧗ **B-1 S-3 4.5' to 6.0'**		**25**	**44**	**19**	**25**		
▲ **B-2 S-2 3.0' to 4.7'**		**23**	**39**	**21**	**18**		
★ **B-2 S-3 4.5' to 5.3'**		**18**	**27**	**16**	**11**		
☉ **B-3 S-5 8.5' to 10.0'**		**13**	**25**	**15**	**10**		

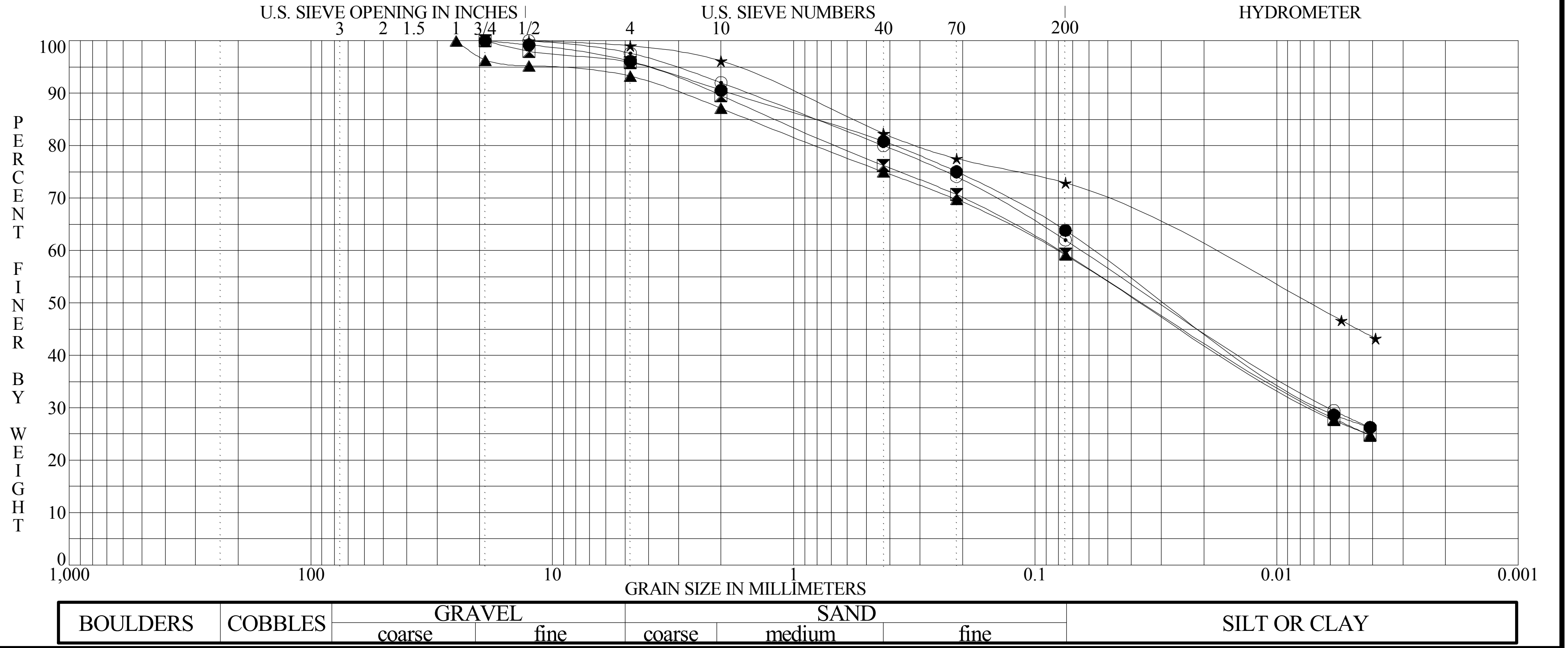
Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **B-1 S-2 3.0' to 4.3'**	**12.5000**	**0.6262**	**0.0187**	**0.0092**		**0.32**	**20.23**	**37.59**	**41.86**
⧗ **B-1 S-3 4.5' to 6.0'**	**12.5000**	**0.4019**	**0.0184**	**0.0096**		**0.09**	**18.39**	**40.84**	**40.69**
▲ **B-2 S-2 3.0' to 4.7'**	**19.0000**	**1.8976**	**0.0222**	**0.0098**		**3.07**	**21.99**	**33.13**	**41.81**
★ **B-2 S-3 4.5' to 5.3'**	**19.0000**	**3.6373**	**0.0648**	**0.0301**		**3.23**	**34.86**	**34.36**	**27.55**
☉ **B-3 S-5 8.5' to 10.0'**	**19.0000**	**3.4523**	**0.0546**	**0.0257**		**3.24**	**32.56**	**35.13**	**29.07**

ASTM D422

GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

S&ME



Specimen Identification - Depth				Classification	MC%	LL	PL	PI	Cc	Cu
●	**B-3**	**S-6**	**13.5' to 14.7'**		**11**	**25**	**14**	**11**		
⧗	**B-4**	**S-3**	**4.5' to 5.8'**		**16**	**25**	**17**	**8**		
▲	**B-4**	**S-4**	**6.0' to 7.3'**		**15**	**26**	**16**	**10**		
★	**B-5**	**S-2**	**3.5' to 4.9'**		**23**	**52**	**21**	**31**		
☉	**B-5**	**S-3**	**6.0' to 7.5'**		**16**	**25**	**16**	**9**		

Specimen Identification - Depth				D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-3**	**S-6**	**13.5' to 14.7'**	**19.0000**	**4.0063**	**0.0567**	**0.0274**		**3.91**	**32.25**	**36.22**	**27.62**
⧗	**B-4**	**S-3**	**4.5' to 5.8'**	**19.0000**	**4.2031**	**0.0796**	**0.0350**		**4.11**	**36.54**	**32.78**	**26.57**
▲	**B-4**	**S-4**	**6.0' to 7.3'**	**25.0000**	**11.3503**	**0.0813**	**0.0356**		**6.73**	**34.09**	**32.76**	**26.42**
★	**B-5**	**S-2**	**3.5' to 4.9'**	**12.5000**	**1.7584**	**0.0206**	**0.0075**		**0.95**	**26.15**	**27.05**	**45.85**
☉	**B-5**	**S-3**	**6.0' to 7.5'**	**12.5000**	**3.1754**	**0.0641**	**0.0292**		**2.39**	**35.61**	**33.93**	**28.07**

ASTM D422

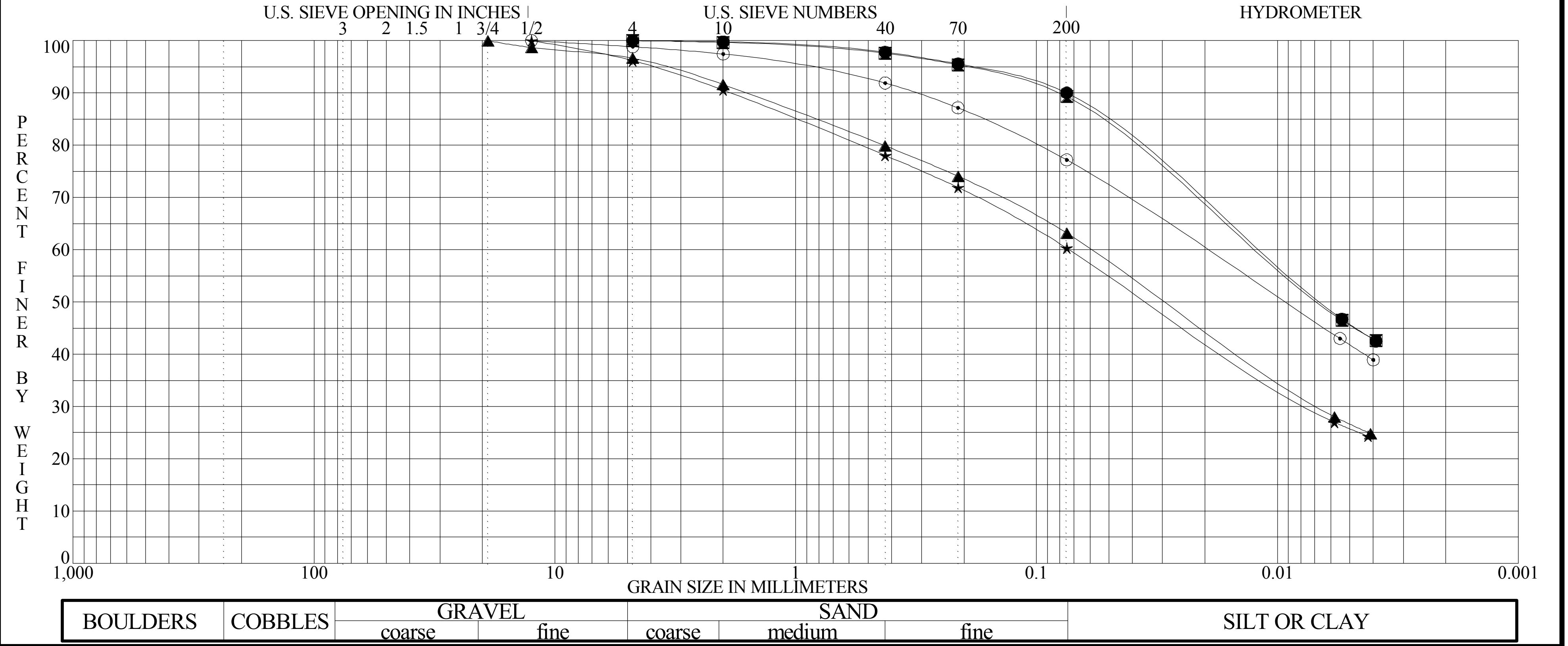
GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

PLATE 28

GRN-GG

S&ME



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	**B-6 S-2 2.5' to 3.2'**		**23**	**45**	**19**	**26**		
⧗	**B-6 S-3 4.0' to 4.9'**		**23**	**43**	**18**	**25**		
▲	**B-7 S-6 11.0' to 12.1'**		**12**	**22**	**16**	**6**		
★	**B-7 S-7 13.5' to 14.2'**		**11**	**21**	**15**	**6**		
⊙	**B-8 S-2 3.5' to 4.3'**		**25**	**38**	**22**	**16**		

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-6 S-2 2.5' to 3.2'**	**4.7500**	**0.1904**	**0.0121**	**0.0066**		**0.00**	**9.98**	**44.29**	**45.73**
⧗	**B-6 S-3 4.0' to 4.9'**	**4.7500**	**0.1977**	**0.0124**	**0.0067**		**0.00**	**10.67**	**43.75**	**45.58**
▲	**B-7 S-6 11.0' to 12.1'**	**19.0000**	**3.5813**	**0.0594**	**0.0287**		**3.35**	**33.45**	**36.54**	**26.66**
★	**B-7 S-7 13.5' to 14.2'**	**12.5000**	**3.9665**	**0.0731**	**0.0339**		**3.83**	**35.84**	**34.58**	**25.76**
⊙	**B-8 S-2 3.5' to 4.3'**	**12.5000**	**1.0102**	**0.0202**	**0.0094**		**1.16**	**21.65**	**35.40**	**41.79**

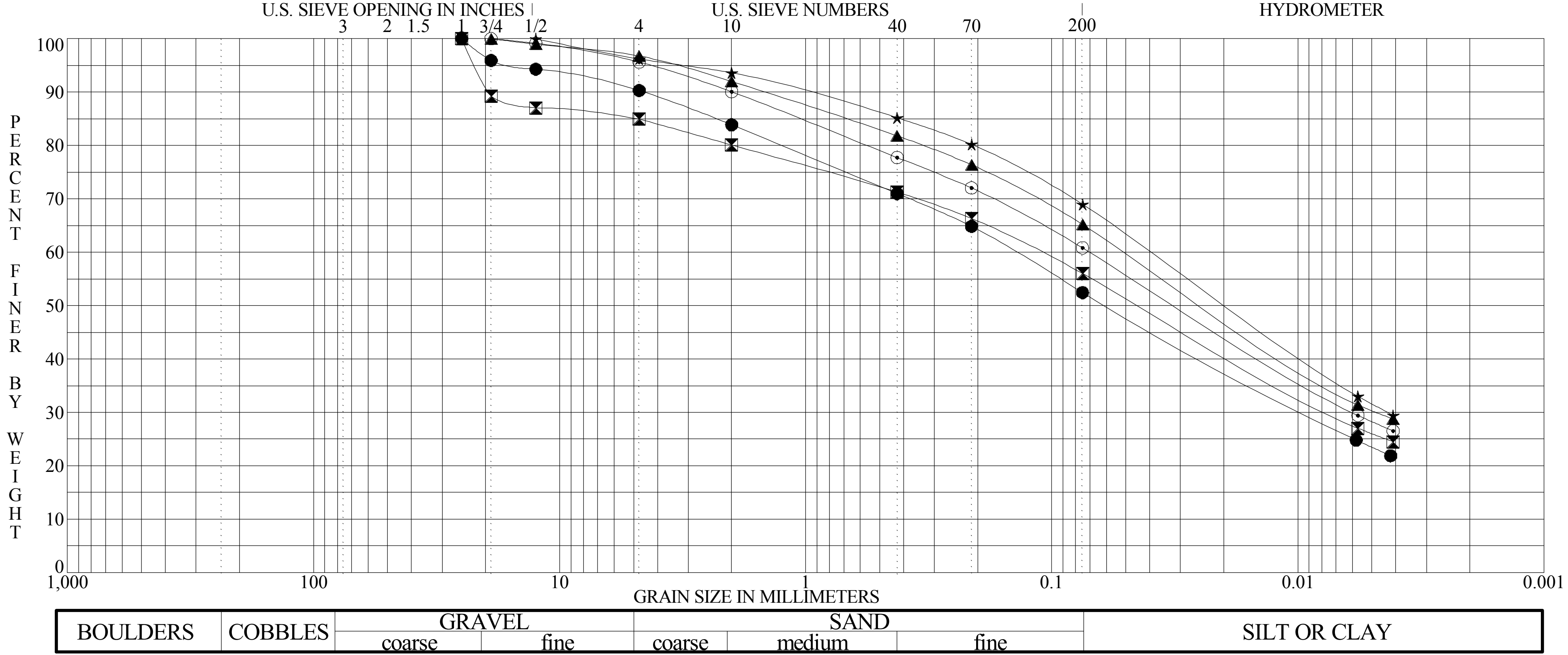
ASTM D422

GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

GRN-SGS

S&ME



Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
● **B-8 S-3 6.0' to 7.1'**		**14**	**24**	**16**	**8**		
⧗ **B-9 S-2 3.0' to 3.9'**		**13**	**28**	**17**	**11**		
▲ **B-9 S-3 4.5' to 6.0'**		**16**	**28**	**18**	**10**		
★ **B-10 S-2 3.0' to 4.5'**		**15**	**32**	**18**	**14**		
⊙ **B-10 S-3 4.5' to 5.8'**		**15**	**26**	**16**	**10**		

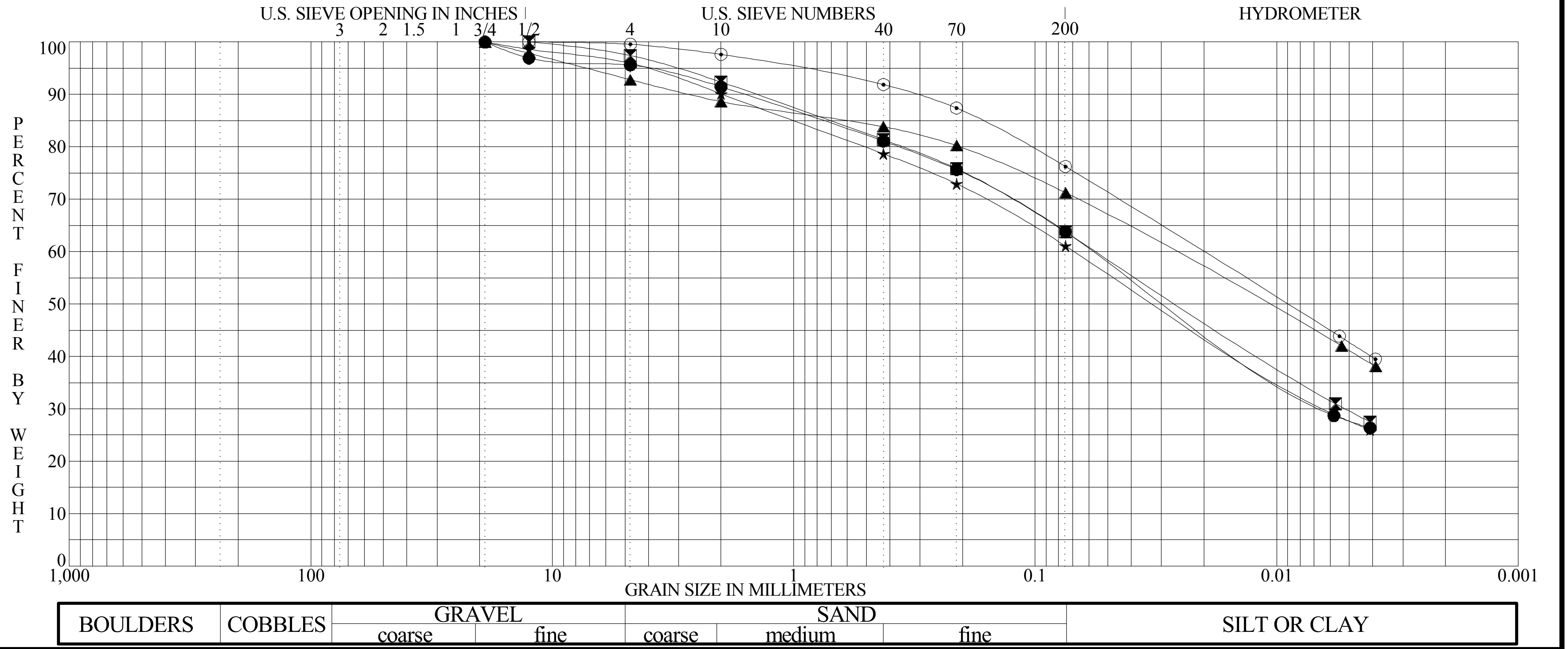
Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
● **B-8 S-3 6.0' to 7.1'**	**25.0000**	**14.9735**	**0.1411**	**0.0597**		**9.70**	**37.84**	**28.98**	**23.48**
⧗ **B-9 S-2 3.0' to 3.9'**	**25.0000**	**22.0109**	**0.1121**	**0.0440**		**15.07**	**28.93**	**29.98**	**26.02**
▲ **B-9 S-3 4.5' to 6.0'**	**19.0000**	**3.4497**	**0.0504**	**0.0235**		**3.24**	**31.56**	**34.87**	**30.34**
★ **B-10 S-2 3.0' to 4.5'**	**12.5000**	**3.1806**	**0.0394**	**0.0193**		**3.79**	**27.23**	**37.37**	**31.60**
⊙ **B-10 S-3 4.5' to 5.8'**	**19.0000**	**4.3132**	**0.0701**	**0.0309**		**4.38**	**34.80**	**32.55**	**28.27**

ASTM D422

GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

PLATE 30



Specimen Identification - Depth				Classification	MC%	LL	PL	PI	Cc	Cu
●	**B-11**	**S-2**	**3.0' to 4.2'**		**13**	**26**	**18**	**8**		
⧗	**B-11**	**S-3**	**4.5' to 5.8'**		**16**	**28**	**17**	**11**		
▲	**B-12**	**S-2**	**3.5' to 4.7'**		**19**	**39**	**22**	**17**		
★	**B-12**	**S-3**	**6.0' to 7.3'**		**14**	**25**	**17**	**8**		
⊙	**B-13**	**S-2**	**3.5' to 4.6'**		**21**	**35**	**19**	**16**		

Specimen Identification - Depth				D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-11**	**S-2**	**3.0' to 4.2'**	**19.0000**	**4.1876**	**0.0567**	**0.0274**		**4.39**	**31.77**	**36.13**	**27.70**
⧗	**B-11**	**S-3**	**4.5' to 5.8'**	**12.5000**	**3.1423**	**0.0558**	**0.0254**		**2.58**	**33.66**	**34.18**	**29.58**
▲	**B-12**	**S-2**	**3.5' to 4.7'**	**19.0000**	**7.2441**	**0.0272**	**0.0111**		**7.19**	**21.56**	**30.16**	**41.09**
★	**B-12**	**S-3**	**6.0' to 7.3'**	**19.0000**	**4.1298**	**0.0688**	**0.0310**		**4.05**	**34.86**	**33.43**	**27.66**
⊙	**B-13**	**S-2**	**3.5' to 4.6'**	**12.5000**	**0.9856**	**0.0202**	**0.0090**		**0.43**	**23.33**	**33.59**	**42.65**

ASTM D422

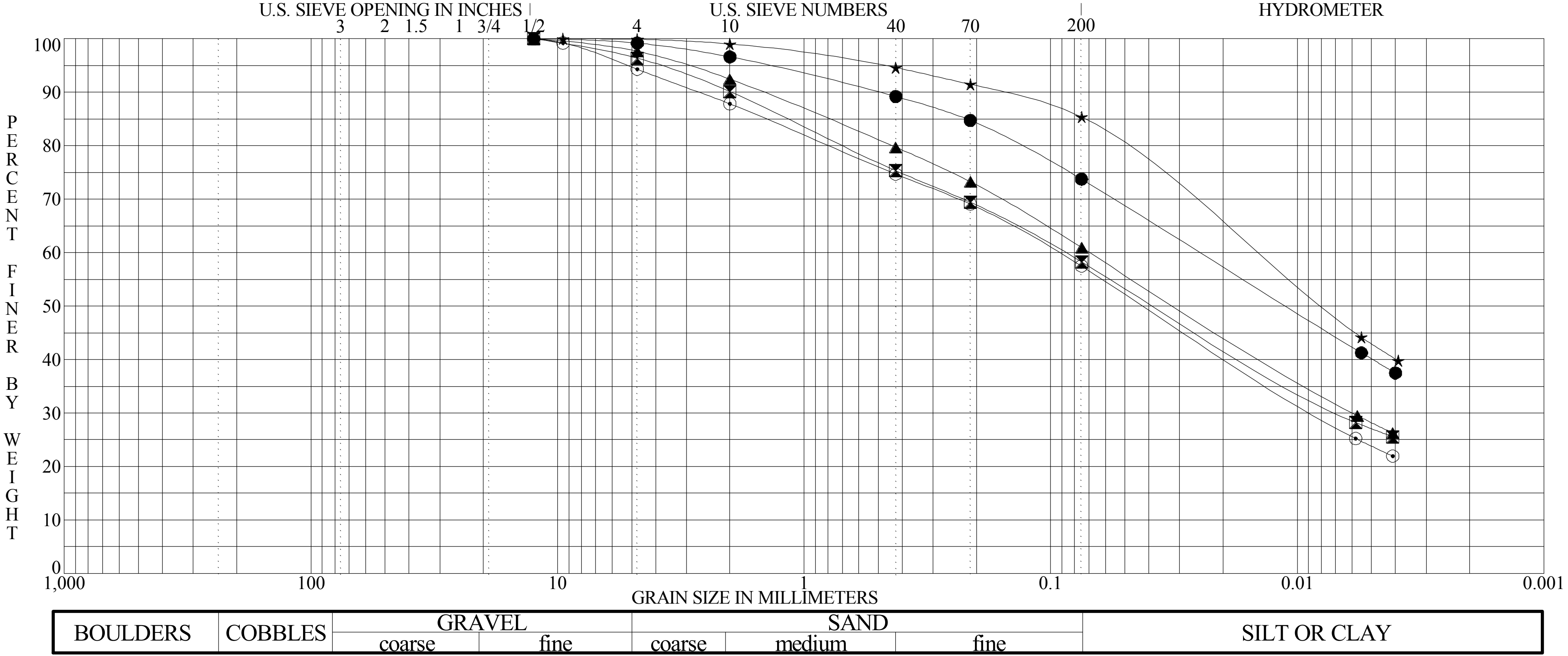
GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

PLATE 31

GRN-REGS

S&ME



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	**B-13 S-3A 6.0' to 6.7'**		**23**	**36**	**20**	**16**		
⧗	**B-14 S-2 3.0' to 4.0'**		**14**	**26**	**17**	**9**		
▲	**B-14 S-3 4.5' to 5.2'**		**14**	**25**	**18**	**7**		
★	**B-15 S-1 1.5' to 2.7'**		**24**	**44**	**17**	**27**		
☉	**B-15 S-5 8.5' to 10.0'**		**15**	**27**	**17**	**10**		

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-13 S-3A 6.0' to 6.7'**	**12.5000**	**1.4267**	**0.0248**	**0.0111**		**0.81**	**25.44**	**33.61**	**40.14**
⧗	**B-14 S-2 3.0' to 4.0'**	**12.5000**	**3.9257**	**0.0878**	**0.0370**		**3.63**	**38.06**	**31.22**	**27.09**
▲	**B-14 S-3 4.5' to 5.2'**	**12.5000**	**3.0551**	**0.0694**	**0.0306**		**2.34**	**36.71**	**32.74**	**28.20**
★	**B-15 S-1 1.5' to 2.7'**	**9.5000**	**0.4879**	**0.0150**	**0.0080**		**0.09**	**14.52**	**42.43**	**42.96**
☉	**B-15 S-5 8.5' to 10.0'**	**12.5000**	**5.2373**	**0.0938**	**0.0414**		**5.69**	**36.81**	**33.68**	**23.82**

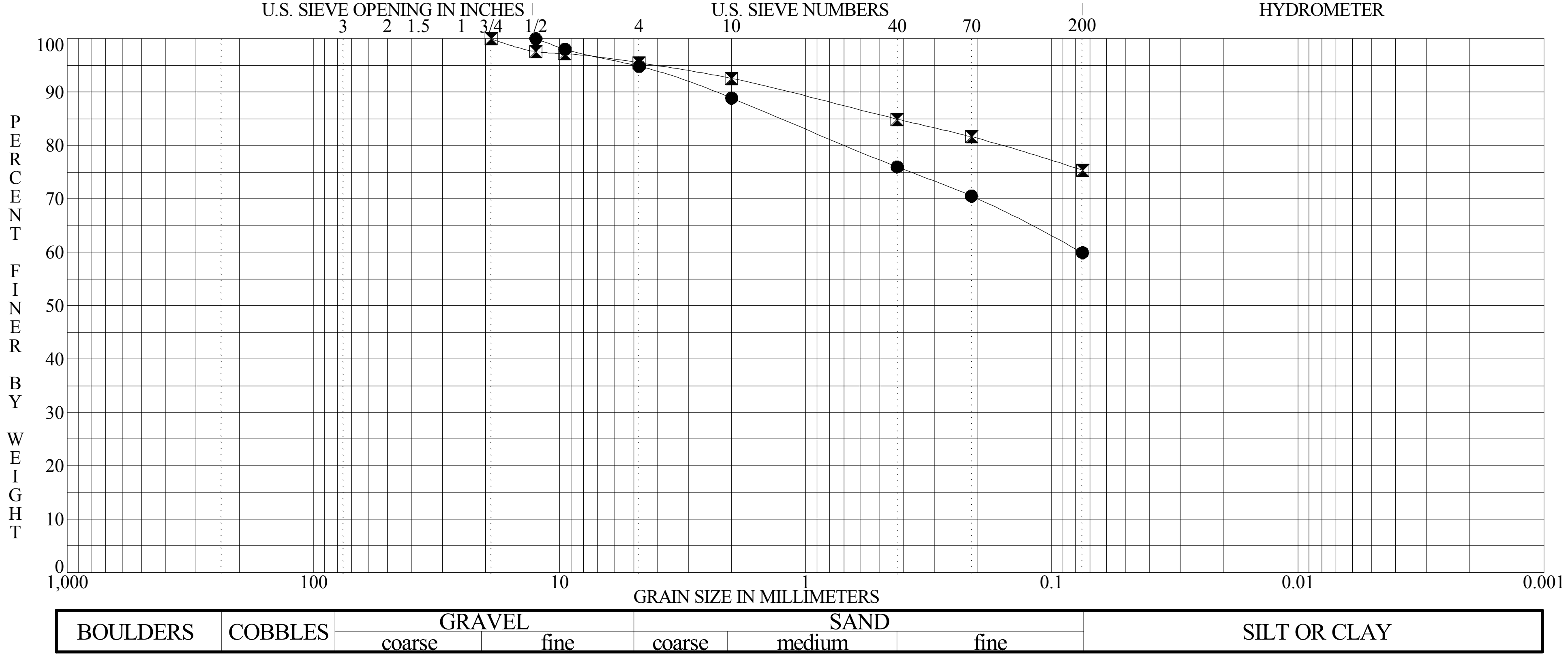
ASTM D422

GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

PLATE 32

GRN-REGS



	Specimen Identification - Depth	Classification	MC%	LL	PL	PI	Cc	Cu
●	**B-16 S-3B 7.0' to 7.5'**		**17**	**28**	**18**	**10**		
☒	**B-16 S-5 11.0' to 12.0'**		**14**	**26**	**17**	**9**		

	Specimen Identification - Depth	D100	D95	D60	D50	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-16 S-3B 7.0' to 7.5'**	**12.5000**	**4.9104**	**0.0755**			**5.15**	**34.92**	**59.93**	
☒	**B-16 S-5 11.0' to 12.0'**	**19.0000**	**4.1098**				**4.51**	**20.11**	**75.38**	

ASTM D422

GRADATION CURVE

PROJECT FRA-CR 84-1.36 - NORTHEAST GATEWAY
LOCATION WORTHINGTON, OH
JOB NO. 1117-16-031 **DATE** 7/13/17

Date: 11/18/2016

Photographer: C. Pickering

1	**Location / Orientation**	B-1A
	Remarks	11.5″ minimum thickness

Date: 11/18/2016

Photographer: C. Pickering

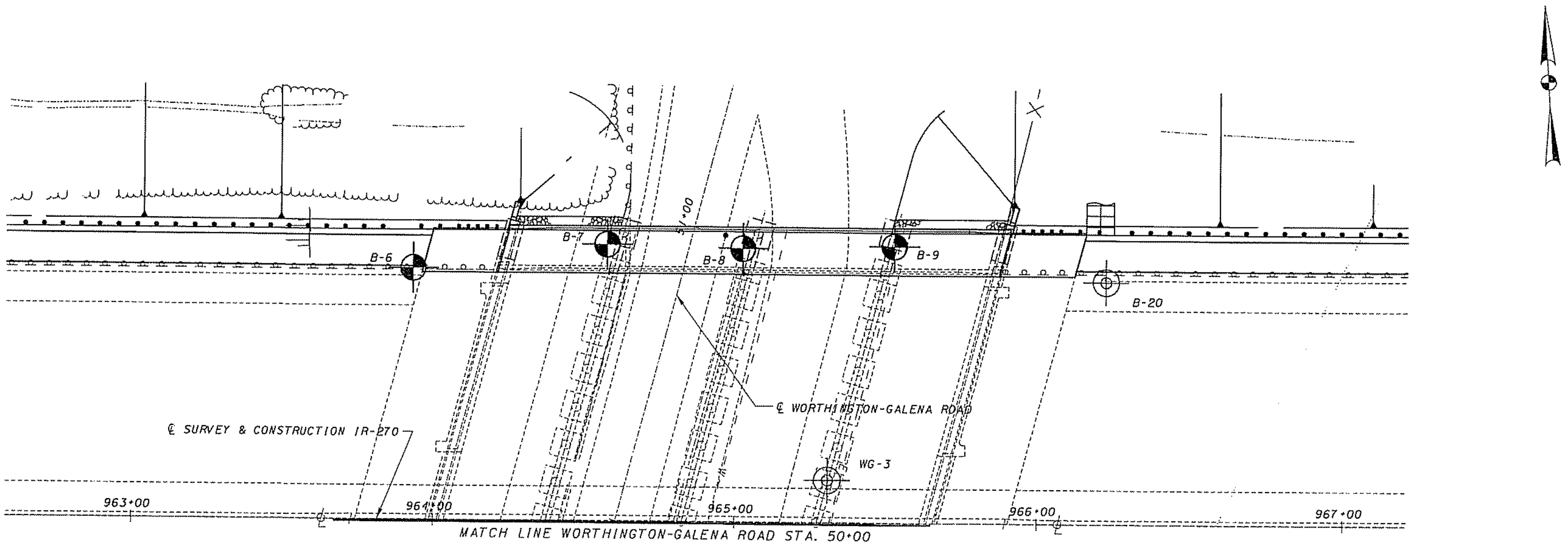
2	**Location / Orientation**	B-6
	Remarks	7″ minimum thickness

Date: 11/18/2016

Photographer: C. Pickering

3	**Location / Orientation**	B-9
	Remarks	5” minimum thickness

Appendix B



BRIDGE FRA-270-2486 L ONLY SHOWN FOR CLARITY
BORINGS B-20 AND WG-3 NOT SHOWN FOR CLARITY

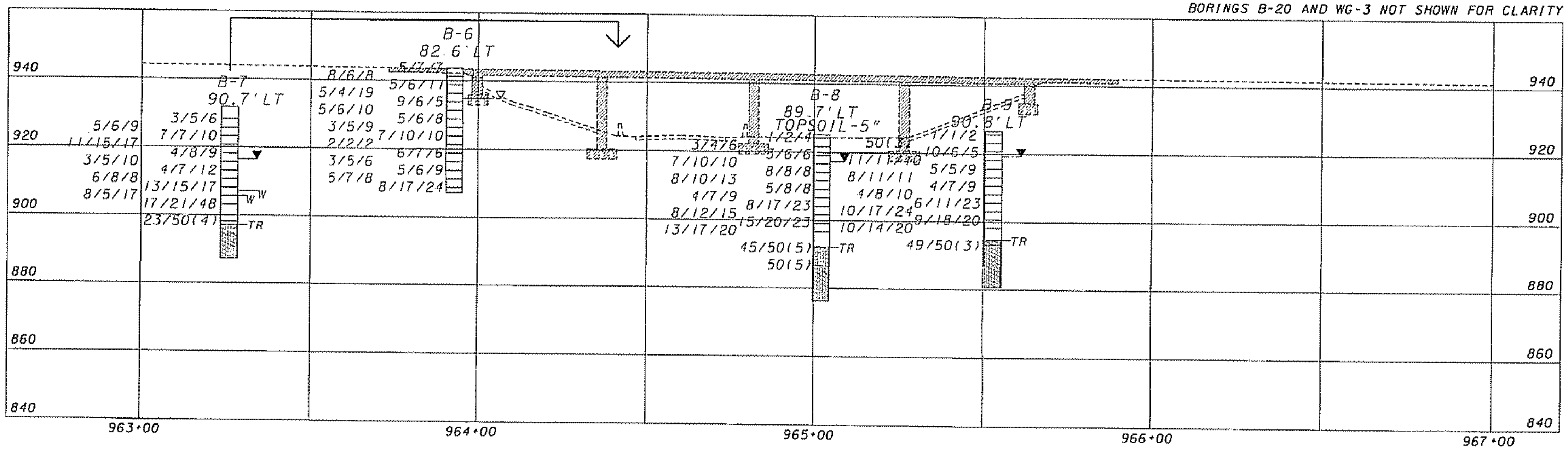


PLATE 1

DESIGNED RJH
CHECKED DAA
DRAWN RJH
REVISED
REVIEWED AEN
DATE 3/4/05
STRUCTURE FILE NUMBER
2511169 (L)
2511193 (R)

DLZ
1000 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 4413

STRUCTURE FOUNDATION INVESTIGATION

BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

2/9

11/14/2005
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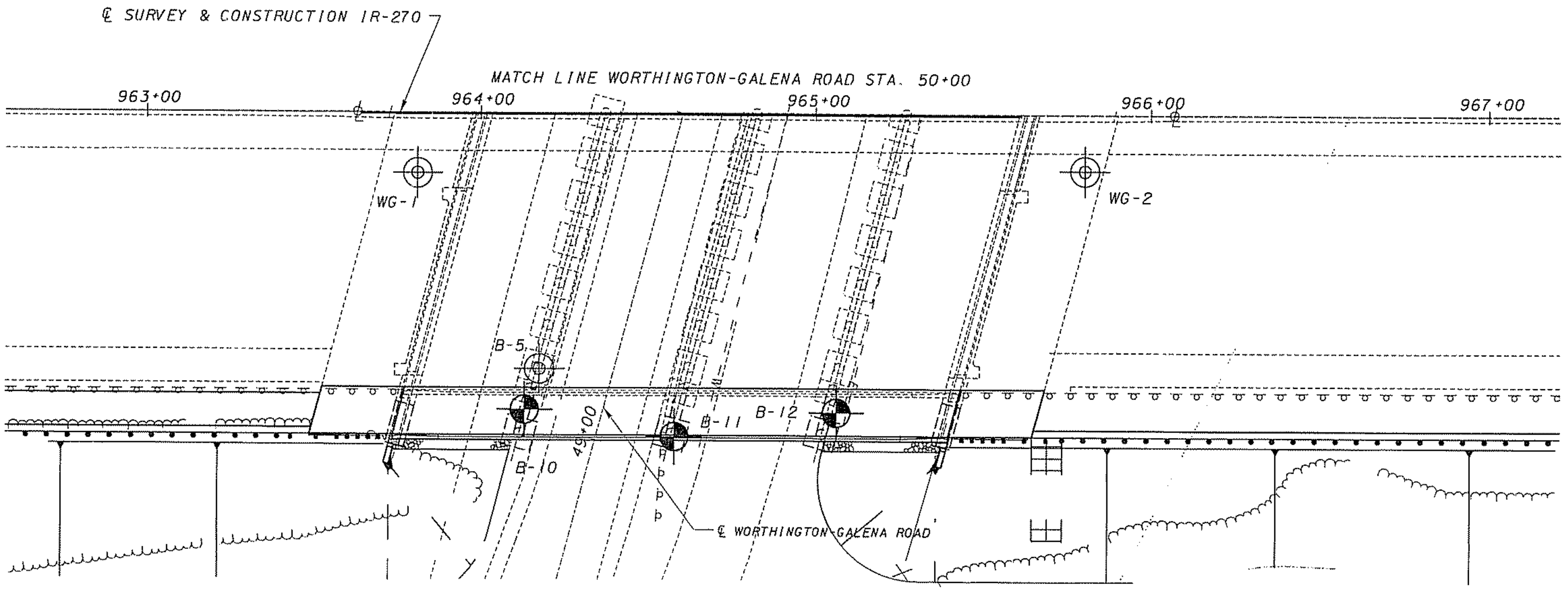

BRIDGE FRA-270-2486 R ONLY SHOWN FOR CLARITY
BORINGS B-5, WG-1, AND WG-2 NOT SHOWN FOR CLARITY

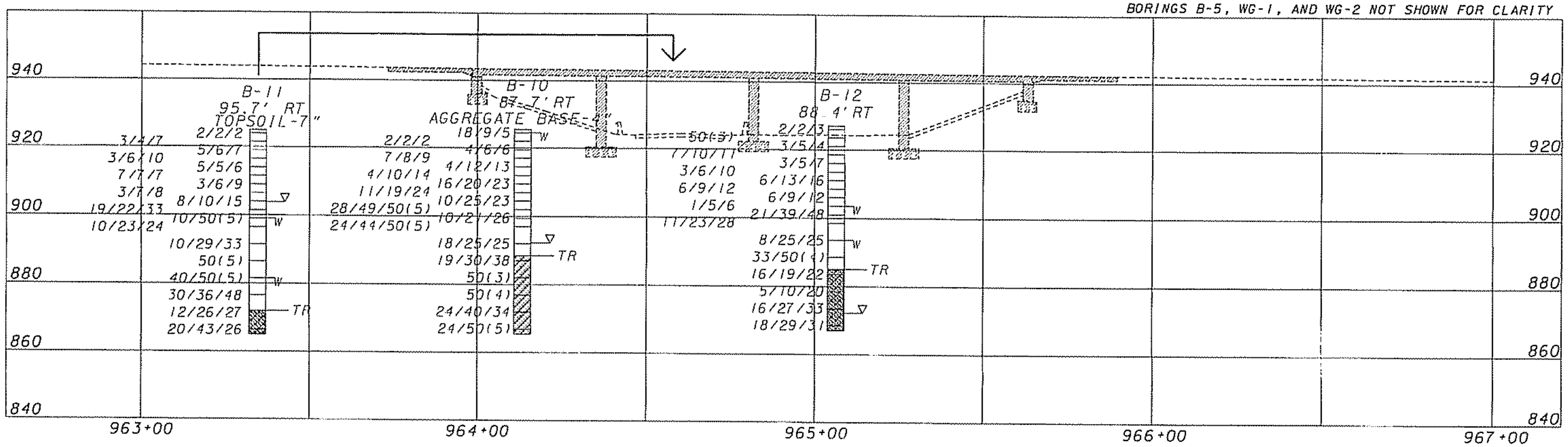

PLATE 2

DLZ
1300 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED	DRAWN	REVIEWED	DATE
RJH	RJH	AEN	3/4/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DAA		2511169 (L) 2511193 (R)	

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

3/9

11/14/2005
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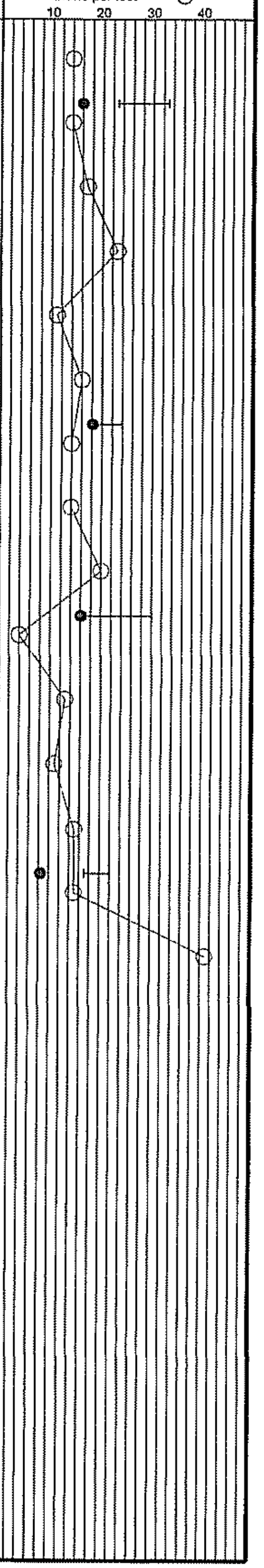
DLZ OHIO INC. • 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 • (614)888-0040

Client: Lockwood, Lanier, Mathias and Noland, Inc.
Project: FRA-270-24.47, I-270/I-71 Interchange
Job No. 0421-3004-00
LOG OF: Boring B-6
Location: As per plan
Date Drilled: 6-2-2004

WATER OBSERVATIONS: Water seepage at: None observed.
Water level at completion: 9.0' (measured inside the auger).

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	943.8	5 7 7	18	S-1		4.5	Fill: Hard brown SILT AND CLAY (A-6a). little to some fine to coarse sand, trace gravel; damp.						
1 5	942.3	8 6 8	18	S-2		1.75	FILL: Stiff brown SILT AND CLAY (A-6a). trace fine sand; damp.	37	25	–	16	8	14
5		5 6 11	18	S-3		1 75	@ 5.0'-6.5'; gray						
7 5	936 3	5 4 19	18	S-4		3 5	Very stiff brown SILT AND CLAY (A-6a). trace to little fine to coarse sand; damp.						
10		9 6 5	18	S-5		3.5	@ 10.0'-11 5'; dark gray						
		5 6 10	18	S-6		3.5							
15		5 6 8	18	S-7		3.25	@ 15 0'-16.5'; moist	18	12	–	12	23	35
		3 5 9	18	S-8		3.25							
20		7 10 10	18	S-9		4.25	@ 20 0'-21 5'; damp						
21 5	922.3	2 2 2	18	S-10		2.25	Very stiff to hard dark gray SILT AND CLAY (A-6a). trace fine sand; moist.	2	12	–	19	36	30
25		6 7 6	18	S-11		4.25	@ 25.0'-26.5'; damp						
26.5	917 3	3 5 6	18	S-12		3.75	Hard to very stiff brown SILT AND CLAY (A-6a), trace fine sand; damp.						
30 30.0	913.8	5 6 9	18	S-13		4 0	Very stiff to hard dark gray SILT AND CLAY (A-6a). trace fine sand; damp.						
		5 7 8	18	S-14		4.0		37	22	–	14	17	11
34.0 35	909.8	8 17 24	18	S-15			Dense brown fine to coarse GRAVEL WITH SAND. SILT & CLAY (A-2-6); damp						
36.5	907 3						Bottom of Boring - 36 5'						
40													
45													
50													
55													
60													

STANDARD PENETRATION (N)
Natural Moisture Content. % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0421-3004-00b (4/1/2005 3:50 PM)

DLZ OHIO INC. • 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 • (614)888-0040

Client: Lockwood, Lanier, Mathias and Noland, Inc.
Project: FRA-270-24.47, I-270/I-71 Interchange
Job No. 0421-3004-00
LOG OF: Boring B-7
Location: As per plan.
Date Drilled: 6-4-2004

WATER OBSERVATIONS: Water seepage at: 24 5'. 26.0'
Water level at completion: 15.2' (measured inside the auger).

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	931.7						FILL: COBBLES						
2.5	929.2	3 5 6	18	S-1		1 75	FILL: Stiff to very stiff mottled brown and dark gray SILT AND CLAY (A-6a). trace to little fine to coarse sand. trace gravel; damp.						
5		5 6 9	18	S-2		2.5		1	8	–	12	57	21
10		7 7 10	18	S-3		2.75							
		11 15 17	18	S-4		4.5+	@ 11.0'-12 5'; hard						
12.5	910.2	4 8 9	18	S-5		3.5	Very stiff dark gray SILT AND CLAY (A-6a). trace to little fine to coarse sand. trace gravel; moist.						
15		3 5 10	14	S-6		2.25							
17 5	914.2	4 7 12	18	S-7		4 5	Hard brown SILT AND CLAY (A-6a); damp-moist	10	18	–	19	29	24
20.0	911 7	6 8 8	18	S-8		3.5	Very stiff dark gray SILT AND CLAY (A-6a); damp.						
24.0	907 7	13 15 17	16	S-9		2.25	Dense gray COARSE AND FINE SAND (A-3a). little to some clay, little silt, little gravel; moist-wet.						
24.5 25	907.2						Hard SILT AND CLAY (A-6a). little to some fine to coarse sand, trace gravel; damp.						
26.0	905.7	8 5 17	16	S-10									
27 5	904 2						Medium dense gray FINE SAND (A-3). trace clay. trace silt; moist-wet.						
30		17 21 48	16	S-11		4 5+	Hard gray SILT AND CLAY (A-6a) . little fine to coarse sand. trace gravel; damp.	6	19	–	58	17	
33.0	898.7	23 50/4"	10	S-12			Hard dark gray moderately weathered CLAYSHALE	2	7	–	20	37	34
35													
40		Core 120"	Rec 114"	RQD 41 6%									
44.5 45	887 2						Bottom of Boring - 44 5'						
50													
55													
60													

STANDARD PENETRATION (N)
Natural Moisture Content. % - ●
PL ├──┤ LL
Blows per foot - ○

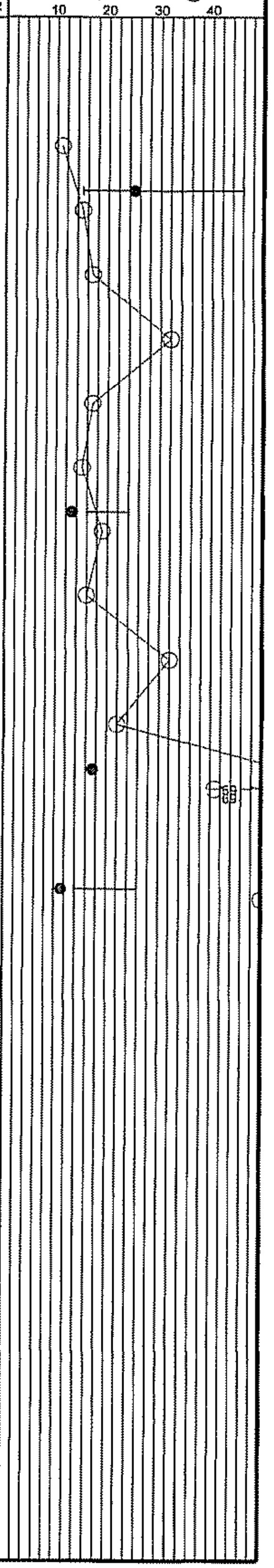


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PLATE 3

DLZ
1000 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED	DRAWN	REVIEWED	DATE
RJH	RJH	AEN	3/4/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DAA		2511169 (L) 2511193 (R)	

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

4 / 9

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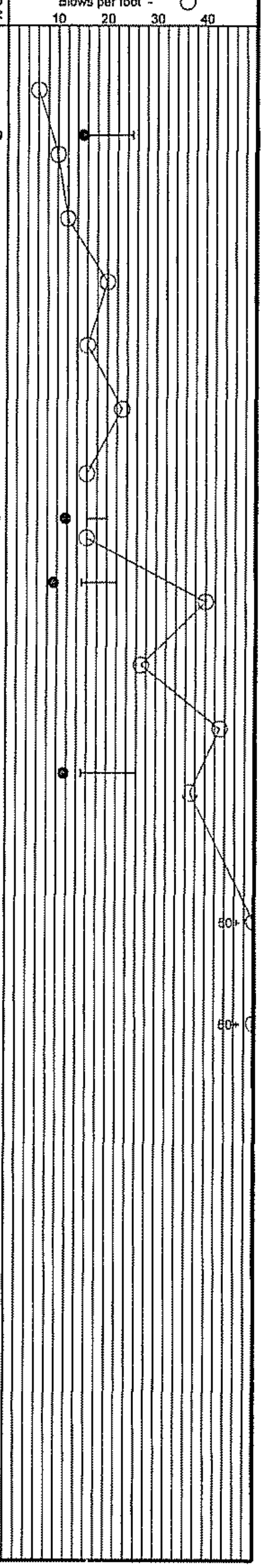
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Lockwood, Lanier, Mathlas and Noland, Inc.
Project: FRA-270-24.47, I-270/I-71 Interchange
Job No. 0421-3004-00
LOG OF: Boring B-8
Location: As per plan.
Date Drilled: 5-14-2004

WATER OBSERVATIONS:
Water seepage at: None observed.
Water level at completion: 7.8' (measured inside the auger).

Depth (ft)	Elev (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	925.2												
0.4	924.8						Topsoil-5".						
		1 2 4	18	S-1		2.75	FILL: Very stiff to hard brown SILT AND CLAY (A-6a). trace fine to coarse sand. trace gravel; moist.						
5		3 4 6	18	S-2		4.5	@ 3.5'-5.0'; trace to little fine to coarse sand; damp-moist.	4	11	–	18	38	29
		3 6 6	18	S-3		3.25							
7.5	917.7						Hard dark gray SILT AND CLAY (A-6a). little fine to coarse sand, trace gravel; damp.						
10		7 10 10	18	S-4		4.5+							
		8 8 8	18	S-5		4.5+							
15		8 10 13	18	S-6		4.5+	@ 13.5'-15.0'; brown						
		5 8 8	18	S-7		4.5+							
20		4 7 9	18	S-8		4.5+		7	11	–	22	40	19
		6 17 23	18	S-9		4.5+		13	17	–	19	33	18
25		8 12 15	18	S-10		4.5+							
		15 20 23	18	S-11		4.5+							
30		13 17 20	18	S-12		4.5+		7	6	–	15	39	33
33.0	892.2						Hard dark gray highly weathered CLAY-SHALE.						
35		45 50/5"	11	S-13									
		50/5"	5	S-14									
40		Core 120"	Rec 120"	RQD 25.8%			@ 39.0'-49.0'; moderately weathered						
49.0	876.2						Bottom of Boring - 49.0'						

STANDARD PENETRATION (N)
Natural Moisture Content. % - ●
PL ├──┤ LL
Blows per foot - ○



DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Lockwood, Lanier, Mathlas and Noland, Inc.
Project: FRA-270-24.47, I-270/I-71 Interchange
Job No. 0421-3004-00
LOG OF: Boring B-9
Location: As per plan.
Date Drilled: 5-17-2004

WATER OBSERVATIONS:
Water seepage at: None observed.
Water level at completion: 7.4' (measured inside the auger)

Depth (ft)	Elev (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	926.7						FILL: Stiff mottled brown and gray SILT AND CLAY (A-6a). trace fine to coarse sand. trace gravel; moist.						
		1 1 2	14	S-1		1.25							
3.0	923.7						Concrete.						
5		50/3"	3	S-2									
5.5	921.2						Fill: Medium dense brown GRAVEL AND STONE FRAGMENTS (A-1-a). trace fine to coarse sand. trace clay; damp.						
		10 6 5	2	S-3									
7.5	919.2						FILL: Medium dense brown COARSE AND FINE SAND (A-3a). little silt. trace gravel; damp.						
10		11 11 10	2	S-4				43	29	–	19	9	
10.5	916.2						Hard dark gray SILT AND CLAY (A-6a). trace to little fine to coarse sand. trace gravel; damp-moist.						
		5 5 9	18	S-5		4.5							
15		8 11 11	18	S-6		4.5+	@ 13.5'-15.0'; brown	6	8	–	16	39	32
		4 7 9	18	S-7		4.5+	@ 16.0'-17.5'; dark gray						
20		4 8 10	18	S-8		4.5+	@ 18.5'-20.0'; brown						
		6 11 23	18	S-9		4.5+	@ 21.0'-22.5'; dark gray						
25		10 17 24	18	S-10		4.5+		6	6	–	18	37	34
		9 18 20	18	S-11		4.5+							
30		10 14 20	18	S-12		4.5+							
							Hard dark gray moderately weathered CLAY-SHALE.						
35		49 50/3"	18	S-13				58	18	–	11	14	
40		Core 120"	Rec 114"	RQD 70%									
46.0	880.7						Bottom of Boring - 46.0'						

STANDARD PENETRATION (N)
Natural Moisture Content. % - ●
PL ├──┤ LL
Blows per foot - ○

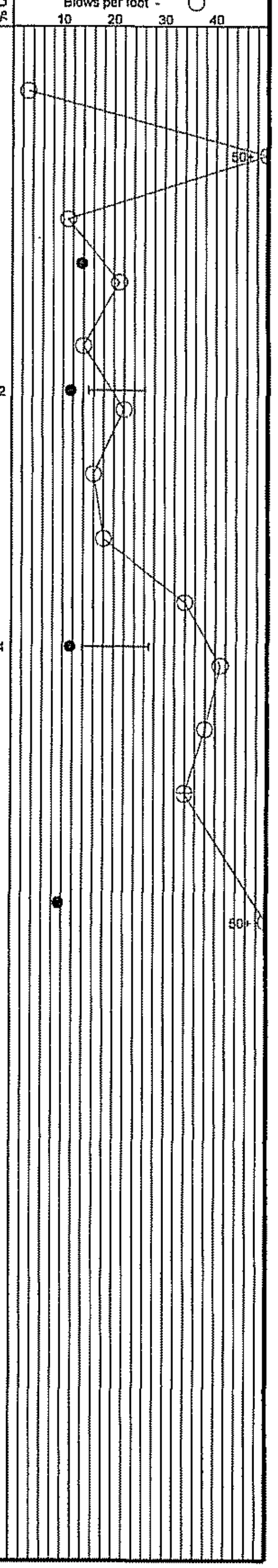


PLATE 4

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DLZ
1200 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED	DRAWN	REVIEWED	DATE
RJH	RJH	AEN	3/4/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DAA		2511169 (L) 2511193 (R)	

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

5/9

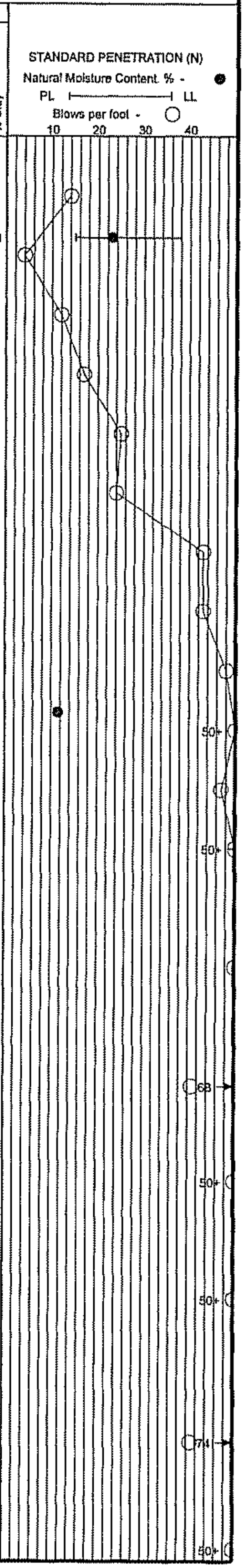
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Lockwood, Lanier, Mathias and Noland, Inc. | Project: FRA-270-24.47, I-270/I-71 Interchange | Job No. 0421-3004-00

LOG OF: Boring B-10 | Location: Sta. 964+13.46, 87.69 ft Rt. | Date Drilled: 5-18-2004

WATER OBSERVATIONS:
Water seepage at: 1.0'
Water level at completion: 33.2' (measured inside augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	925.5												
0.3	925.2						Aggregate Base- 4"						
		18 9 5	7	S-1			FILL: Medium dense gray COARSE AND FINE SAND (A-3a), trace to little gravel, trace silt, trace clay; wet.						
2.5	923.0	2 2 2	5	S-2		1.75	FILL: Medium stiff brown SILT AND CLAY (A-6a). trace to little fine to coarse sand. trace gravel; moist.	13	13	–	16	29	30
5.8	920.5	4 6 6	12	S-3		4.5+	Hard brown SILT AND CLAY (A-6a). little to some sand, trace gravel; damp-moist.						
		7 8 9	18	S-4		4 5+							
10.0	915.5	4 12 13	3	S-5		1.25	Stiff brown SILT AND CLAY (A 6a). trace fine to medium sand; moist						
		4 10 14	2	S-6		1 0							
15.0	910.5	16 20 23	18	S-7		4.5+	Hard brown SILT AND CLAY (A-6a). trace to little fine to coarse sand; damp-moist.						
		11 19 24	18	S-8		4 5+							
20		10 25 23	18	S-9		4.5+							
22.5	903.0	28 49 50/5"	17	S-10			Very dense gray and brown COARSE AND FINE SAND (A-3a), trace silt. trace clay; moist.	38	21	–	17	26	
25		10 21 26	18	S-11			@ 26.0'-27 5'; little clay. moist-wet.						
		24 44 50/5"	18	S-12									
30.0	895.5						Hard dark gray SILT AND CLAY (A-6a). trace to little fine to coarse sand. trace gravel; damp						
35		18 25 25	18	S-13		4 5+							
37.0	888.5						Medium hard moderately weathered to highly weathered brown and gray fine to coarse grained SANDSTONE						
40		19 30 38	18	S-14									
45		50/3"	5	S-15									
50		50/4"	4	S-16									
55		24 40 34	18	S-17			@ 53 5'-55.0'; moist.						
60.0	865.5	24 50/5"	11	S-18			Bottom of Boring - 60.0'						



FILE: 0421-3004-005 [4/1/2005 3:50 PM]

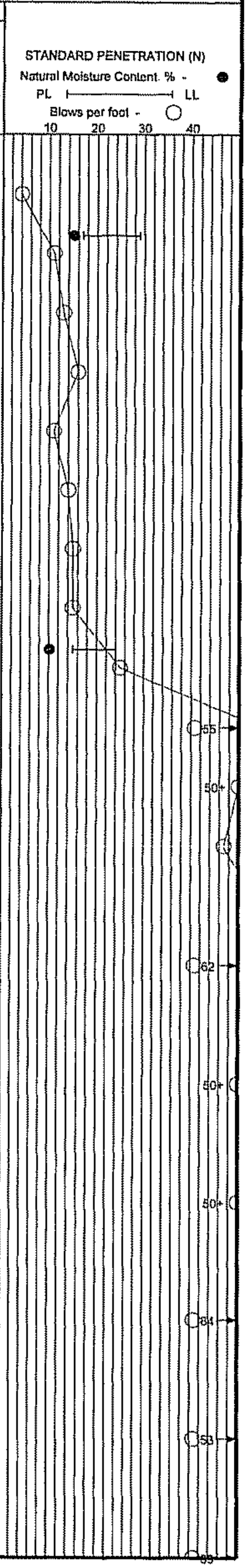
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: Lockwood, Lanier, Mathias and Noland, Inc. | Project: FRA-270-24.47, I-270/I-71 Interchange | Job No. 0421-3004-00

LOG OF: Boring B-11 | Location: Sta. 964+57.74 | Date Drilled: 5-13-2004

WATER OBSERVATIONS:
Water seepage at: 26.0'. 43.5'
Water level at completion: 21.1' (measured inside augers)

Depth (ft)	Elev (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	925.0												
0.6	924.4						Topsoil- 7"						
		2 2 2	16	S-1		1 0	FILL: Medium stiff to stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand. trace gravel. contains organics; moist.						
2.5	922.5	3 4 7	18	S-2		4 5	FILL: Hard brown SILT AND CLAY (A-6a). little to some fine to coarse sand. trace gravel; moist.	5	12	–	18	36	28
5		5 6 7	18	S-3		4 5+							
7.5	917.5	3 6 10	18	S-4		4 5+	Hard dark gray SILT AND CLAY (A-6a). trace to little fine to coarse sand. trace gravel; damp-moist.						
10		5 6 8	18	S-5		4 5							
15		7 7 7	16	S-6		4 5							
		3 6 9	18	S-7		4.5+							
20		3 7 8	18	S-8		4 5							
		8 10 15	18	S-9		4.5+		6	12	–	22	37	23
22.5	902.5	19 22 33	18	S-10			Very dense gray COARSE AND FINE SAND (A-3a). little to some clay. trace gravel; moist.						
25		10 50/5"	11	S-11			@ 26 0'-27 5'; wet						
30		10 23 24	18	S-12									
35		10 29 33	18	S-13									
40		50/5"	5	S-14			@ 38.5'-40 0'; little gravel moist						
		40 50/5"	11	S-15									
45.0	880.0						Hard dark gray SILT AND CLAY (A-6a). little to some fine to coarse sand, trace gravel; damp.						
50		30 36 48	18	S-16									
53.0	872.0						Very stiff to stiff mottled brown and gray decomposed CLAY-SHALE. trace sand, trace gravel; moist						
55		12 26 27	18	S-17		3.5							
60.0	865.0	20 43 26	18	S-18		1 25	Bottom of Boring - 60.0'						



FILE: 0421-3004-005 [4/1/2005 3:50 PM]

DLZ
1000 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED	DRAWN	REVIEWED	DATE
RJH	RJH	AEN	3/4/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DAA		2511169 (L) 2511193 (R)	

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

PLATE 5

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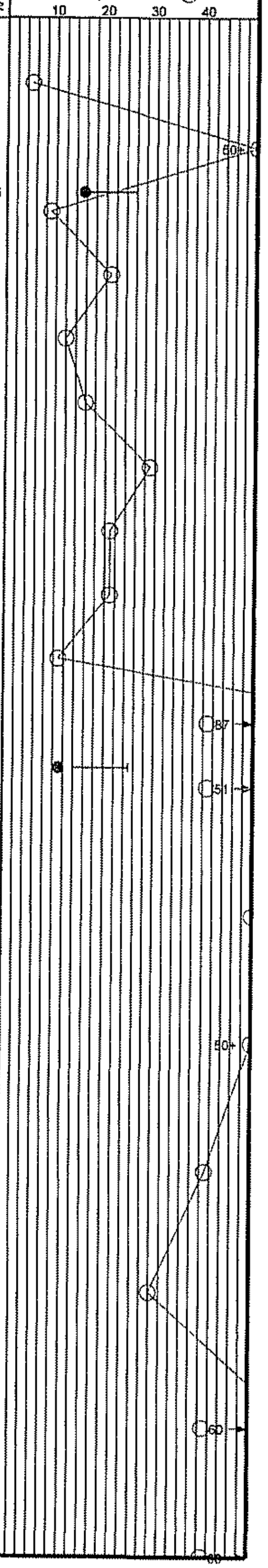
DLZ OHIO INC. • 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 • (614)888-0040

Client: Lockwood, Lanier, Mathias and Noland, Inc.
Project: FRA-270-24.47, I-270/I-71 Interchange
Job No. 0421-3004-00
LOG OF: Boring B-12
Location: Sta. 965+06.32, 88.41 ft Rt.
Date Drilled: 5-17-2004 to 5-18-2004

WATER OBSERVATIONS:
Water seepage at: 23.5', 33.5'
Water level at completion: 54 8' (measured inside augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	927.1												
		2 2 3	5	S-1		0.5	FILL: Soft to medium stiff brown SILT AND CLAY (A-6a). little to some fine to coarse sand. trace gravel; moist.						
3.0	924 1	50/3"	3	S-2			Concrete.						
5 5.5	921 6												
		3 5 4	18	S-3		4 25	FILL: Hard brown SILT AND CLAY (A-6a). little to some fine to coarse sand. trace gravel; moist.	7	12	–	20	36	26
		7 10 11	18	S-4									
10.0	917 1						Hard dark gray SILT AND CLAY (A-6a). little to some fine to coarse sand, trace gravel; moist.						
		3 5 7	18	S-5		4 5+							
15		3 6 10	18	S-6		4.5+							
		6 13 16	18	S-7		4 5+	@ 16.0'-17 5'; brown; damp.						
20		6 9 12	18	S-8		4 5+	@ 18 5'-20 0'; dark gray; damp.						
		6 9 12	18	S-9		4.5	@ 21 0'-22 5'; moist.						
22.5	904.6						Medium dense to very dense gray and brown FINE SAND (A-3). little to some clay. little silt. trace gravel; wet.						
25		1 5 6	18	S-10									
		21 39 48	16	S-11									
27 5	899.6						Hard brown SILT AND CLAY (A-6a), little to some fine to coarse sand. trace gravel; damp						
30		11 23 26	18	S-12		4.5+		5	9	–	20	45	20
30.0	897 1						Very dense gray COARSE AND FINE SAND (A-3a). trace clay. trace silt. trace gravel; wet.						
35		8 25 25	7	S-13									
40		33 50/4"	10	S-14									
42.0	885.1						Very stiff to hard brown decomposed CLAYSHALE, trace fine to medium sand. trace gravel; moist						
45		16 19 22	18	S-15		3.75							
50		5 10 20	18	S-16		4 5							
55		16 27 33	18	S-17		4.5+							
60.0	867.1	18 29 31	16	S-18		4 5+	Bottom of Boring - 60.0'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0421-3004-00 [4/1/2005 3:50 PM]

BORING LOG: WG-1

STATION AND OFFSET: 32+980.2, 5M Rt
SURFACE ELEVATION: 287.4M
WATER ENCOUNTERED: N/A •
DATE STARTED: 12/1/95
DATE FINISHED: 12/1/95
SAMPLER TYPE: HSA/WD

ELEV	SAMPLE NUMBER	BLOWS PER 15 cm	REC (%)	DEPTH	SOIL DESCRIPTION	WC	ATT LIMITS LL	ATT LIMITS PI	PHYSICAL CHARACTERISTIC % AGG	% CS	% FS	% SI	% CL	ODOT CLASS
					DARK BROWN SILTY CLAY, SOME SAND AND GRAVEL. SOME ORGANICS. (TOPSOIL) 0.3M									
286.6	SS-1	5/10/12	89	1	BROWN TO BROWN AND GRAY GRAVEL, SOME SAND, SOME CLAY. LITTLE SILT. (EMBANKMENT FILL)	14								VISUAL
285.9	SS-2	11/7/8	56			14	30	17	40	20	7	11	22	A-2-6
285.1	SS-3	4/4/9	94	2		19								VISUAL
284.3	SS-4	6/8/7	94	3		15								VISUAL
283.6	SS-5	5/8/13	67	4		18								VISUAL
282 8	SS-6	4/7/8	78		4.9M	27								VISUAL
282.1	SS-7	4/7/12	94	5	BROWN TO DARK BROWN CLAY AND GRAVEL. LITTLE SILT, LITTLE SAND. (EMBANKMENT FILL)	22	43	25	38	10	8	–44–		A-7-6
281.3	SS-8	4/6/8	89	6	6.4M BLACK ORGANIC SILTY CLAY 6.9M	21								VISUAL
280.5	SS-9	5/7/19	78	7	BROWN SILT AND CLAY, SOME SAND, LITTLE GRAVEL	26								VISUAL
279.8	SS-10	3/6/7	94	8		21								VISUAL
278.3	SS-11	4/9/15	100	9 10		13	27	11	16	12	17	25	30	A-6a
276.8	SS-12	6/8/15	100	11		12								VISUAL
275.2	SS-13	9/18/16	94	12 13		15								VISUAL
273.7	SS-14	19/19/24	89	14		9								VISUAL
272.2	SS-15	42/50–10cm	56	15 16	16.4M	14								VISUAL
270.7	SS-16	16/15/27	100	17	BROWN TO GRAY SILTY CLAY. SOME SAND. TRACE GRAVEL	17								VISUAL
269.1	SS-17	13/16/31	83	18 19		18	33	16	7	18	14	–61–		A-6b
267 6	SS-18	28/15/21	89	20		20								VISUAL
266.1	SS-19	14/22/34	100	21		20								VISUAL

BOTTOM OF BORING = 21 3M

BORING WG-1 DRILLED BY RESOURCE INTERNATIONAL, INC.

PLATE 6

DLZ
1000 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED RJH
DRAWN RJH
REVIEWED AEN
DATE 3/4/05
CHECKED DAA
REVISED
STRUCTURE FILE NUMBER

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

7/9

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BORING LOG: WG-2

STATION AND OFFSET: 33+042.2, 5M Rt
SURFACE ELEVATION: 287.0M
WATER ENCOUNTERED: N/A *

DATE STARTED: 12/11/95
DATE FINISHED: 12/11/95
SAMPLER TYPE: HSA/RC

ELEV.	SAMPLE NUMBER	BLOWS PER 15 cm	REC (%)	DEPTH	SOIL DESCRIPTION	WC	ATT LIMITS		PHYSICAL CHARACTERISTIC					ODOT CLASS
							LL	PI	% AGG	% CS	% FS	% SI	% CL	
286.2	SS-1	9/12/11	78	1	DARK BROWN SILTY CLAY, SOME ORGANICS (TOPSOIL) 0.2M BROWN SILTY CLAY, SOME SAND AND GRAVEL. (EMBANKMENT FILL)	16								VISUAL
285.5	SS-2	9/8/14	78											VISUAL
284.7	SS-3	7/12/15	94	2	2.4M BROWN CLAY, LITTLE GRAVEL. TRACE SILT. TRACE SAND. (EMBANKMENT FILL)	16								VISUAL
283.9	SS-4	7/9/12	100	3	3.4M	22	54	32	14	1	2	8	76	A-7-6
283.2	SS-5	12/18/11	89	4	BROWN TO GRAY CLAY, SOME SILT, LITTLE SAND, LITTLE GRAVEL. (EMBANKMENT FILL)	20								VISUAL
282.4	SS-6	7/12/50~15cm	94		4.9M	15	46	25	15	5	8	26	46	A-7-6
281.7	SS-7	17/10/11	89	5	DARK GRAY CLAYEY SILT. LITTLE SAND AND GRAVEL, LITTLE ORGANICS. 5.5M BROWN TO GRAY SILTY CLAY. SOME SAND AND GRAVEL.	11								VISUAL
280.9	AS-8	9/15/21	0	6		20								VISUAL
280.1	SS-9	15/20/27	89	7		13								VISUAL
279.4	SS-10	7/15/21	89	8		13								VISUAL
277.9	SS-11	5/11/12	100	9		13								VISUAL
276.3	SS-12	14/11/12	89	10 11		13								VISUAL
274.8	SS-13	20/35/34	100	12		10								VISUAL
273.3	SS-14	18/16/38	100	13 14		12								VISUAL
271.8	SS-15	23/24/50~8cm	83	15		12								VISUAL
270.2	SS-16	50~10cm	22	16	16.1M DARK GRAY INDURATED CLAY AND SHALE FRAGMENTS. 16.8M	6								VISUAL
	RC-1		70	17	SHALE: BLACK. FIRM, FISSILE, FRACTURED. - CORE LOSS = 0.38 M - RQD = 0%									
268.8				18										

BOTTOM OF BORING = 18.2M

* THE GROUNDWATER LEVEL UPON COMPLETION OF THE DRILLING PROCESS COULD NOT BE DETERMINED DUE TO THE USE OF WASH WATER DURING THE DRILLING PROCESS.

BORING LOG: WG-3

STATION AND OFFSET: 33+026.2. 4.6M Lt
SURFACE ELEVATION: 281.9M
WATER ENCOUNTERED: SEEPAGE @ 7.2M *

DATE STARTED: 12/18/95
DATE FINISHED: 12/18/95
SAMPLER TYPE: HSA/RC

ELEV.	SAMPLE NUMBER	BLOWS PER 15 cm	REC (%)	DEPTH	SOIL DESCRIPTION	WC	ATT LIMITS		PHYSICAL CHARACTERISTIC					ODOT CLASS
							LL	PI	% AGG	% CS	% FS	% SI	% CL	
281.1	SS-1	4/7/8	89	1	DARK BROWN SILTY CLAY, SOME ORGANICS, TRACE SAND AND GRAVEL. (TOPSOIL) 0.3M BROWN TO GRAY SILT AND CLAY, SOME SAND, LITTLE TO TRACE GRAVEL.	23								VISUAL
280.4	SS-2	2/3/5	22			16								VISUAL
279.6	SS-3	5/7/11	100	2		15	29	12	11	11	16	-62-		A-6a
278.8	SS-4	6/10/16	94	3		13								VISUAL
278.1	SS-5	4/7/10	100	4		12								VISUAL
277.3	SS-6	6/6/9	89			13								VISUAL
276.6	SS-7	6/10/14	100	5		13	28	13	8	8	14	29	41	A-6a
275.8	SS-8	5/8/11	100	6		13								VISUAL
275.1	SS-9	5/11/14	94	7	7.2M	12								VISUAL
274.3	SS-10	11/15/20	94	8	GRAY SAND. SOME CLAYEY SILT.	17			0	1	65	18	16	VISUAL
272.8	SS-11	8/32/50~13cm	56	9	8.5M GRAY SILTY CLAY. SOME SAND AND GRAVEL.	14								VISUAL
271.6	SS-12	50~10cm	22	10	10.2M DARK GRAY WEATHERED SHALE FRAGMENTS.									VISUAL
270.2	SS-13	50~5cm	6	11	11.7M									VISUAL
	RC-1		81	12	SHALE: BLACK, FIRM, BROKEN, JOINTED, GRITTY TEXTURE, CARBONACEOUS, SPARSELY FOSSILIFEROUS. - CORE LOSS = 0.28 M - RQD = 0%									
268.6				13										

BOTTOM OF BORING = 13.3M

PLATE 7

BORINGS WG-2 AND WG-3 DRILLED BY RESOURCE INTERNATIONAL, INC.

DLZ
1000 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED	DRAWN	REVIEWED	DATE
RJH	RJH	AEN	3/4/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DAA		2511169 (L) 2511193 (R)	

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

LOG OF BORING

Date Started 2/13/64 Sampler: Type SS Dia. 1 3/8" Water Elev
Date completed 2/13/64 Casing: Length Dia.
Boring No. B-5 Station & Offset 964+15, 75' Rt (REAR PIER) Surface Elev. 923.7'

Elev.	Depth	Std. Pen.	Rec.	Loss	Description	Sample No.	Physical Characteristics Agg	C.S.	F.S.	Silt	Clay	L.L.	P.I.	W.C.	SHTL Class
923.7	0														
	2														
	4														
918.7															
	6	6/13			Brown and Gray Gravelly Silt	1	31	5	10	25	29	23	7	32	
916.2															
	8	8/43			Brownish-Gray Sandy Gravelly Clay	2	27	10	14	23	26	30	12	16	
913.7	10														
		10/15			Grayish-Brown Sandy Gravelly Silt	3	33	11	12	24	20	23	7	14	
	12														
911.2															
	14	6/14			Gray Sandy Gravelly Silt	4	29	11	12	28	20	22	6	12	
908.7															
	16	7/14			Gray Silty Sandy Gravel	5	52	17	8	13	10	PL	15	11	
906.2	18														
		32/58			Gray Gravelly Sandy Silt	6	20	8	12	31	29	23	7	12	
903.7	20														
		29/50			Gray Sandy Gravelly Silt	7	22	13	18	29	18	21	4	12	
	22														
901.2															
	24	25/50			Brown Silty Sandy Gravel	8	48	9	11	18	14	27	9	13	
898.7															
	26	15/38			Brownish-Gray Silty Sandy Gravel	9	46	8	10	22	14	26	8	16	
	28														
893.7	30														
		16/32			Gray Sandy Gravelly Silt	10	41	5	12	24	18	24	10	11	
	32														
	34														
888.7															
	36	65/*			Brown Silty Sandy Gravel	11	50	6	10	22	12	NP	NP	4	
	38														
883.7	40														
883.2		70/*			Reddish-Brown and Gray Silty Gravel	12	62	2	4	21	11	NP	NP	17	

BOTTOM OF BORING

*REFUSAL

LOG OF BORING

Date Started 2/11/64 Sampler: Type SS Dia. 1 3/8" Water Elev.
Date completed 2/13/64 Casing: Length 45' Dia. 3 1/2"
Boring No B-20 Station & Offset 966+11, 75' Lt (FORWARD ABUTMENT) Surface Elev. 928.4'

Elev.	Depth	Std. Pen.	Rec.	Loss	Description	Sample No.	Physical Characteristics Agg	C.S.	F.S.	Silt	Clay	L.L.	P.I.	W.C.	SHTL Class
928.4	0														
	2														
	4	4/6			Brown Sandy Clay	1	9	3	11	29	48	43	23	21	
923.4															
	6	5/9			Brown Sandy Silt	2	11	8	15	32	34	25	9	17	
920.9															
	8														
		7/14			Brown Silty Gravel	3	54	8	7	15	16	PL	16	15	
918.4	10														
		11/16			No Sample Recovered - Boulder		V	I	S	U	A	L			
	12														
915.9															
	14	23/60			Gray Silty Sandy Gravel	4	45	18	12	11	14	20	5	11	
913.4															
	16	16/12			Brown Gravelly Sandy Silt	5	V	I	S	U	AL	24	9	12	
910.9															
	18														
		7/16			Gray Gravelly Sandy Silt	6	V	I	S	U	AL	21	6	13	
908.4	20														
		16/55			Gray Silty Sandy Gravel	7	47	8	13	15	17	20	6	15	
	22														
	24														
898.7		17/50 (0.1')			Gray Silty Sandy Gravel	8	52	14	24	-1	0-	NP	NP	14	
	26														
	28														
898.4	30														
		23/46			Gray Silty Sandy Gravel	9	45	21	18	6	10	NP	NP	13	
	32														
	34														
893.4															
	36	60/*			Gray Silty Sandy Gravel	10	61	16	10	-1	3-	NP	NP	12	
	38														
888.4	40														
		18/42			Gray Silty Sandy Gravel	11	60	19	10	-1	-	NP	NP	14	
	42														
	44														
883.4		75* (0.2')			No Sample Recovered - Boulder										
883.2	46														

BOTTOM OF BORING

*REFUSAL

BORING LOGS FOR BORINGS B-5 AND B-20 WERE FAITHFULLY REPRODUCED FROM ORIGINAL COPIES PREPARED BY THE OHIO STATE HIGHWAY TESTING LABORATORY

PLATE 8

11/14/2005
12:44:35 PM
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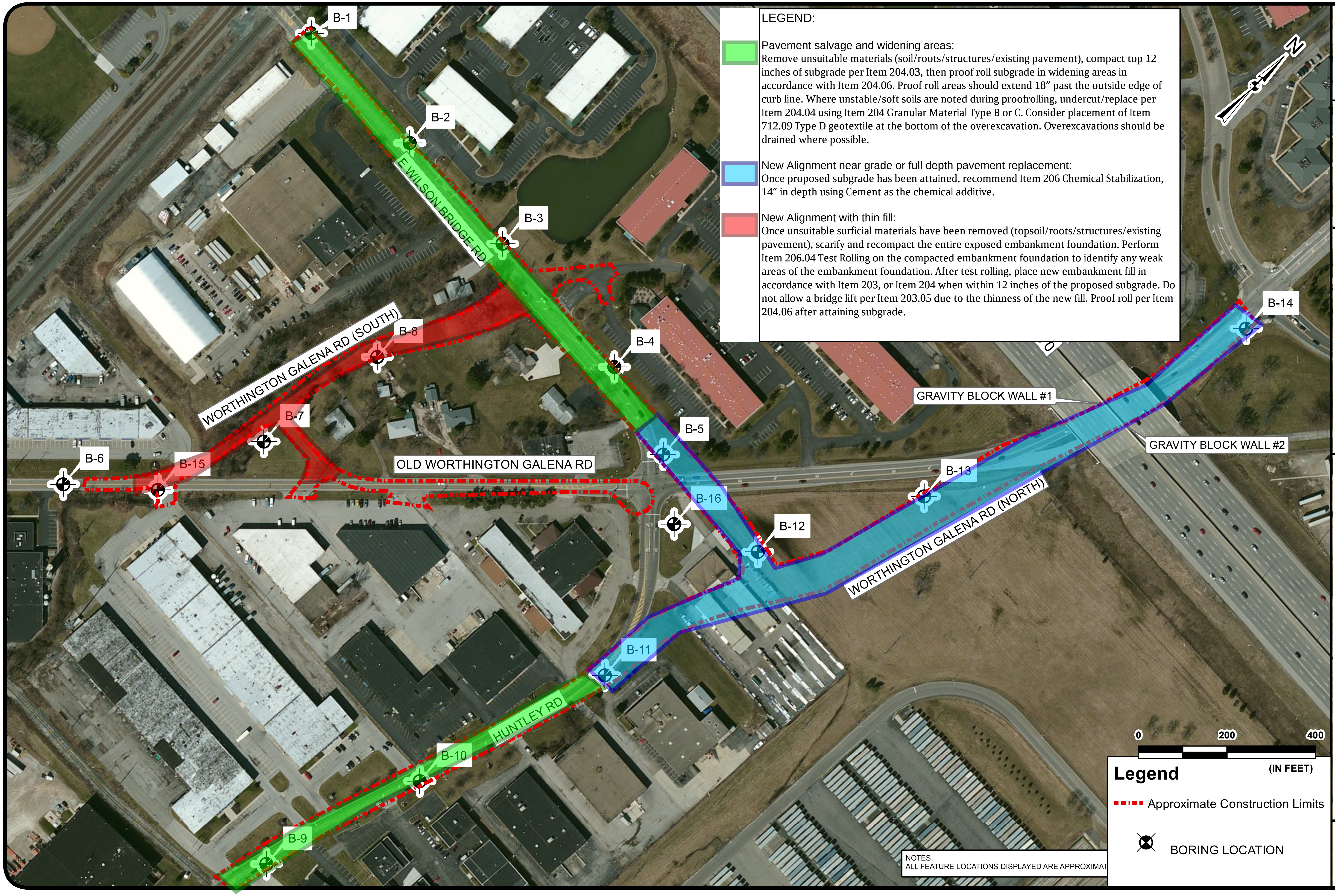
DLZ
1000 ROCKEFELLER BLDG • 614 W SUPERIOR AVE • CLEVELAND, OH 44113

DESIGNED	DRAWN	REVIEWED	DATE
RJH	RJH	AEN	3/4/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DAA		2511169 (L) 2511193 (R)	

STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. FRA-270-2486 L/R
IR-270 OVER WORTHINGTON-GALENA ROAD

FRA-270-24.47

Appendix C



LEGEND:

🟩 Pavement salvage and widening areas:
Remove unsuitable materials (soil/roots/structures/existing pavement), compact top 12 inches of subgrade per Item 204.03, then proof roll subgrade in widening areas in accordance with Item 204.06. Proof roll areas should extend 18″ past the outside edge of curb line. Where unstable/soft soils are noted during proofrolling, undercut/replace per Item 204.04 using Item 204 Granular Material Type B or C. Consider placement of Item 712.09 Type D geotextile at the bottom of the overexcavation. Overexcavations should be drained where possible.

🟦 New Alignment near grade or full depth pavement replacement:
Once proposed subgrade has been attained, recommend Item 206 Chemical Stabilization, 14″ in depth using Cement as the chemical additive.

🟥 New Alignment with thin fill:
Once unsuitable surficial materials have been removed (topsoil/roots/structures/existing pavement), scarify and recompact the entire exposed embankment foundation. Perform Item 206.04 Test Rolling on the compacted embankment foundation to identify any weak areas of the embankment foundation. After test rolling, place new embankment fill in accordance with Item 203, or Item 204 when within 12 inches of the proposed subgrade. Do not allow a bridge lift per Item 203.05 due to the thinness of the new fill. Proof roll per Item 204.06 after attaining subgrade.

Legend

Approximate Construction Limits

BORING LOCATION

NOTES:
ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMAT

DATE: 7-6-2017
DRAWN BY: CRW
SCALE: 1 " = 200 '
PROJECT NO. 1117-16-031

S&ME

SUMMARY OF SUBGRADE REMEDIATION
NORTHEAST GATEWAY
WORTHINGTON, FRANKLIN COUNTY, OHIO

PLATE NO.
1

R:\Projects\2016\GEO\1117-16-031\1117-16-031_Plan of Borings.mxd plotted by cwest 07-10-2017

Appendix D

S&ME
ENGINEERING INTEGRITY

Version 2.0 (7/7/15)

Project No 1117-16-031
Client EMH&T
Project FRA-CR84-1.36 NE Gateway
Desc. E. Willson Bridge Road
Over Rush Run

Sheet 1 of 1
Calc. By CRW **Date** 6/14/17
Check By CJN **Date** 6/14/17

LRFD BEARING RESISTANCE CALCULATION

SOIL PARAMETERS

Structure	Boring ID	Soil Layer	Depth (ft)	Description	SPT N (lb/ft)	D_w (ft)	γ_m (pcf)	w_n (%)	Φ (deg.)	C (psf)
Inlet	B-3	4	6	Very stiff brown Silty Clay	8	2	120	n/a	0	2500
Outlet	B-3	4	6	V-stiff brown Silty Clay	8	2	120	n/a	0	2500

FOOTING / BEARING RESISTANCE COEFFICIENTS

Structure	D_f (ft)	B (ft)	L (ft)	Nc (1)	Nq (1)	Nγ (1)	Sc (2)	Sq (2)	Sγ (2)	Dq (3)	Cwq (4)	Cwγ (4)
Inlet	4	1.5	8	5.14	1.00	0.00	1.036	1.000	1.000		0.5	0.5
Outlet	4	1.5	8	5.14	1.00	0.00	1.036	1.000	1.000		0.5	0.5

NOMINAL BEARING RESISTANCE

Structure	q_N (ksf)
Inlet	13.3
Outlet	13.3

$$q_N = cN_c s_c i_c + \gamma D_f N_q s_q d_q i_q C_{wq} + \frac{1}{2}\gamma B N_\gamma s_\gamma i_\gamma C_{w\gamma}$$

BEARING RESISTANCE FACTORS

Limit State	Resistance Factor	
Service	1.0	Article 10.5.5.1
Strength	0.5	Table 10.5.5.2.2-1 (cohesive)
Strength	0.45	Table 10.5.5.2.2-1 (non-cohesive)

FACTORED BEARING RESISTANCE

Limit State	q_R (ksf)	
	Inlet Headwall	Outlet Headwall
Service	6.0	6.0
Strength	6.7	6.7

Table C10.6.2.6.1-1

REFERENCES

AASHTO LRFD Bridge Design Specifications, 6th Edition, Section 10: Foundations.

1. Bearing Capacity Factors Nc, Nq, and Nγ obtained from Table 10.6.3.1.2a-1.
2. Shape Correction Factors Sc, Sq, and Sγ obtained from Table 10.6.3.1.2a-3.
3. Depth Correction Factor Dq obtained from Table 10.6.3.1.2a-4.
4. Groundwater Correction Coefficients Cwq and Cwγ obtained from Table 10.6.3.1.2a-2.

S&ME ENGINEERING INTEGRITY

Version 2.0 (7/7/15)

Project No	1117-16-031		Sheet	1	of 1
Client	EMH&T	**Calc. By**	CRW	**Date**	6/14/17
Project	FRA-CR84-1.36 NE Gateway	**Check By**	CJN	**Date**	6/14/17
Desc.	S Worthington Galena Rd Over Rush Run				

LRFD BEARING RESISTANCE CALCULATION

SOIL PARAMETERS

Structure	Boring ID	Soil Layer	Depth (ft)	Description	SPT N (lb/ft)	D_w (ft)	γ_m (pcf)	w_n (%)	Φ (deg.)	C (psf)
Inlet	B-7	3	5.5	Mst-Stiff brown Silty Clay	6	0	120		0	1000
Outlet	B-7	3	6	Mst-Stiff brown Silty Clay	6	0	120		0	1000

	FOOTING		BEARING RESISTANCE COEFFICIENTS									
Structure	D_f (ft)	B (ft)	L (ft)	Nc (1)	Nq (1)	Nγ (1)	Sc (2)	Sq (2)	Sγ (2)	Dq (3)	Cwq (4)	Cwγ (4)
Inlet	4	1.5	10	5.14	1.00	0.00	1.029	1.000	1.000		0.5	0.5
Outlet	4	1.5	10	5.14	1.00	0.00	1.029	1.000	1.000		0.5	0.5

NOMINAL BEARING RESISTANCE

Structure	q_N (ksf)
Inlet	5.3
Outlet	5.3

$$q_N = cN_c s_c i_c + \gamma D_f N_q s_q d_q i_q C_{wq} + \frac{1}{2}\gamma B N_\gamma s_\gamma i_\gamma C_{w\gamma}$$

BEARING RESISTANCE FACTORS

Limit State	Resistance Factor	
Service	1.0	Article 10.5.5.1
Strength	0.5	Table 10.5.5.2.2-1 (cohesive)
Strength	0.45	Table 10.5.5.2.2-1 (non-cohesive)

FACTORED BEARING RESISTANCE

Limit State	q_R (ksf)		
	Inlet Headwall	Outlet Headwall	
Service	4.0	4.0	Table C10.6.2.6.1-1
Strength	2.6	2.6	

REFERENCES

AASHTO LRFD Bridge Design Specifications, 6th Edition, Section 10: Foundations.

1. Bearing Capacity Factors Nc, Nq, and Nγ obtained from Table 10.6.3.1.2a-1.
2. Shape Correction Factors Sc, Sq, and Sγ obtained from Table 10.6.3.1.2a-3.
3. Depth Correction Factor Dq obtained from Table 10.6.3.1.2a-4.
4. Groundwater Correction Coefficients Cwq and Cwγ obtained from Table 10.6.3.1.2a-2.

PLATE 2

S&ME
ENGINEERING INTEGRITY

Version 2.0 (7/7/15)

Project No 1117-16-031
Client EMH&T
Project FRA-CR84-1.36 NE Gateway
Desc. Private Drive
Over Rush Run

Sheet 1 of 1
Calc. By CRW **Date** 7/10/17
Check By CJN **Date** 7/12/17

LRFD BEARING RESISTANCE CALCULATION

SOIL PARAMETERS

Structure	Boring ID	Soil Layer	Depth (ft)	Description	SPT N (lb/ft)	D_w (ft)	γ_m (pcf)	w_n (%)	Φ (deg.)	C (psf)
Inlet	B-15	4-5	5.5	Stiff to V-stiff silty clay	10	0	120		0	1500
Outlet	B-15	4-5	6	Stiff to V-stiff silty clay	10	0	120		0	1500

FOOTING / BEARING RESISTANCE COEFFICIENTS

	FOOTING		BEARING RESISTANCE COEFFICIENTS									
Structure	D_f (ft)	B (ft)	L (ft)	Nc (1)	Nq (1)	Nγ (1)	Sc (2)	Sq (2)	Sγ (2)	Dq (3)	Cwq (4)	Cwγ (4)
Inlet	4	1.5	8	5.14	1.00	0.00	1.036	1.000	1.000		0.5	0.5
Outlet	4	1.5	8	5.14	1.00	0.00	1.036	1.000	1.000		0.5	0.5

NOMINAL BEARING RESISTANCE

Structure	q_N (ksf)
Inlet	8.0
Outlet	8.0

$$q_N = cN_c s_c i_c + \gamma D_f N_q s_q d_q i_q C_{wq} + \frac{1}{2}\gamma B N_\gamma s_\gamma i_\gamma C_{w\gamma}$$

BEARING RESISTANCE FACTORS

Limit State	Resistance Factor	
Service	1.0	Article 10.5.5.1
Strength	0.5	Table 10.5.5.2.2-1 (cohesive)
Strength	0.45	Table 10.5.5.2.2-1 (non-cohesive)

FACTORED BEARING RESISTANCE

Limit State	q_R (ksf)	
	Inlet Headwall	Outlet Headwall
Service	5.0	5.0
Strength	4.0	4.0

Table C10.6.2.6.1-1

REFERENCES

AASHTO LRFD Bridge Design Specifications, 6th Edition, Section 10: Foundations.

1. Bearing Capacity Factors Nc, Nq, and Nγ obtained from Table 10.6.3.1.2a-1.
2. Shape Correction Factors Sc, Sq, and Sγ obtained from Table 10.6.3.1.2a-3.
3. Depth Correction Factor Dq obtained from Table 10.6.3.1.2a-4.
4. Groundwater Correction Coefficients Cwq and Cwγ obtained from Table 10.6.3.1.2a-2.

PLATE 3

S&ME
ENGINEERING INTEGRITY

Version 2.0 (7/7/15)

Project No 1117-16-031
Client EMH&T
Project FRA-CR84-1.36 NE Gateway
Desc. Modular Block Wall #1

Sheet 1 of 1
Calc. By CRW **Date** 6/14/17
Check By CJN **Date** 6/15/17

LRFD BEARING RESISTANCE CALCULATION

SOIL PARAMETERS

Structure	Boring ID	Soil Layer	Depth (ft)	Description	SPT N (lb/ft)	D_w (ft)	γ_m (pcf)	w_n (%)	Φ (deg.)	C (psf)
Inlet	B-6-0-04*	3	18.5	V-Stiff brown Silty Clay	14	2	120	n/a	0	2000
Outlet	B-6-0-04*	3	18.5	V-Stiff brown Silty Clay	8	2	120	n/a	0	2000

*Historic B-6 boring from FRA-270-24.47 Investigation

FOOTING **BEARING RESISTANCE COEFFICIENTS**

Wall Sta	D_f (ft)	B (ft)	L (ft)	Nc (1)	Nq (1)	Nγ (1)	Sc (2)	Sq (2)	Sγ (2)	Dq (3)	Cwq (4)	Cwγ (4)
Sta 0+00	0	3	10	5.14	1.00	0.00	1.058	1.000	1.000		0.5	0.5
Sta 2+70	0	3	10	5.14	1.00	0.00	1.058	1.000	1.000		0.5	0.5

NOMINAL BEARING RESISTANCE

Structure	q_N (ksf)
Inlet	10.9
Outlet	10.9

$$q_N = cN_c s_c i_c + \gamma D_f N_q s_q d_q i_q C_{wq} + \frac{1}{2}\gamma B N_\gamma s_\gamma i_\gamma C_{w\gamma}$$

BEARING RESISTANCE FACTORS

Limit State	Resistance Factor	
Service	1.0	Article 10.5.5.1
Strength	0.5	Table 10.5.5.2.2-1 (cohesive)
Strength	0.45	Table 10.5.5.2.2-1 (non-cohesive)

FACTORED BEARING RESISTANCE

Limit State	q_R (ksf) Inlet Headwall	q_R (ksf) Outlet Headwall
Service	6.0	6.0
Strength	5.4	5.4

Table C10.6.2.6.1-1

REFERENCES

AASHTO LRFD Bridge Design Specifications, 6th Edition, Section 10: Foundations.

1. Bearing Capacity Factors Nc, Nq, and Nγ obtained from Table 10.6.3.1.2a-1.
2. Shape Correction Factors Sc, Sq, and Sγ obtained from Table 10.6.3.1.2a-3.
3. Depth Correction Factor Dq obtained from Table 10.6.3.1.2a-4.
4. Groundwater Correction Coefficients Cwq and Cwγ obtained from Table 10.6.3.1.2a-2.

PLATE 4

Version 2.0 (7/7/15)

Project No	1117-16-031		Sheet	1	of 1
Client	EMH&T	**Calc. By**	CRW	**Date**	6/14/17
Project	FRA-CR84-1.36	**Check By**	CJN	**Date**	6/15/17
Desc.	Modular Block Wall #2				

LRFD BEARING RESISTANCE CALCULATION

SOIL PARAMETERS

Structure	Boring ID	Soil Layer	Depth (ft)	Description	SPT N (lb/ft)	D_w (ft)	γ_m (pcf)	w_n (%)	Φ (deg.)	C (psf)
Inlet	B-20,WG-2*			Stiff brown Silty Clay	14	2	120	n/a	0	1500
Outlet	B-20,WG-2*			Stiff brown Silty Clay	8	2	120	n/a	0	1500

*Historic borings

FOOTING **BEARING RESISTANCE COEFFICIENTS**

Wall Sta	D_f (ft)	B (ft)	L (ft)	Nc (1)	Nq (1)	Nγ (1)	Sc (2)	Sq (2)	Sγ (2)	Dq (3)	Cwq (4)	Cwγ (4)
Sta 0+00	0	3	10	5.14	1.00	0.00	1.058	1.000	1.000		0.5	0.5
Sta 2+70	0	3	10	5.14	1.00	0.00	1.058	1.000	1.000		0.5	0.5

NOMINAL BEARING RESISTANCE

Structure	q_N (ksf)
Inlet	8.2
Outlet	8.2

$$q_N = cN_c s_c i_c + \gamma D_f N_q s_q d_q i_q C_{wq} + \frac{1}{2}\gamma B N_\gamma s_\gamma i_\gamma C_{w\gamma}$$

BEARING RESISTANCE FACTORS

Limit State	Resistance Factor	
Service	1.0	Article 10.5.5.1
Strength	0.5	Table 10.5.5.2.2-1 (cohesive)
Strength	0.45	Table 10.5.5.2.2-1 (non-cohesive)

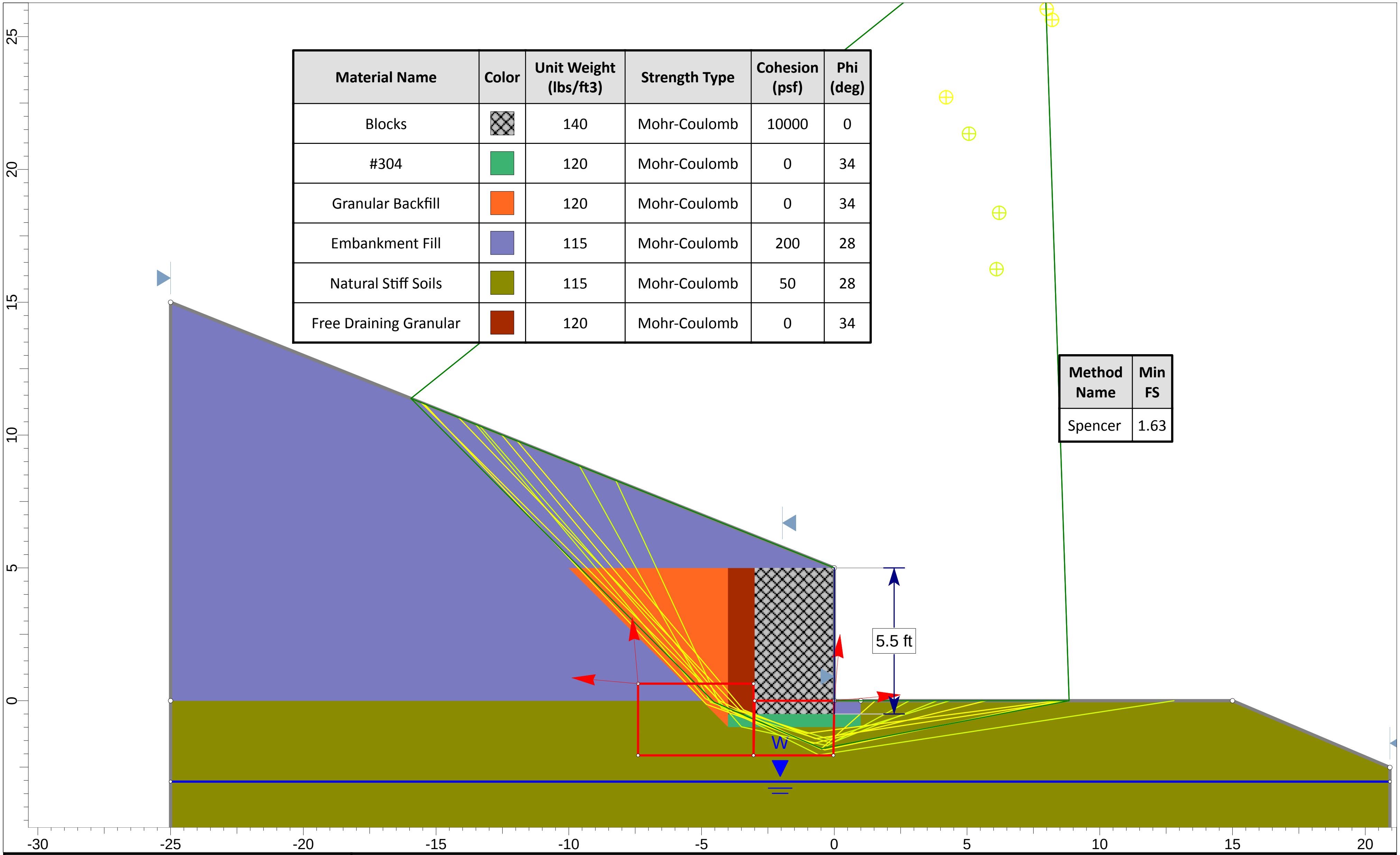
FACTORED BEARING RESISTANCE

Limit State	q_R (ksf)		
	Inlet Headwall	Outlet Headwall	
Service	4.0	4.0	Table C10.6.2.6.1-1
Strength	4.1	4.1	

REFERENCES

AASHTO LRFD Bridge Design Specifications, 6th Edition, Section 10: Foundations.

1. Bearing Capacity Factors Nc, Nq, and Nγ obtained from Table 10.6.3.1.2a-1.
2. Shape Correction Factors Sc, Sq, and Sγ obtained from Table 10.6.3.1.2a-3.
3. Depth Correction Factor Dq obtained from Table 10.6.3.1.2a-4.
4. Groundwater Correction Coefficients Cwq and Cwγ obtained from Table 10.6.3.1.2a-2.



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Blocks	▨	140	Mohr-Coulomb	10000	0
#304	🟩	120	Mohr-Coulomb	0	34
Granular Backfill	🟧	120	Mohr-Coulomb	0	34
Embankment Fill	🟪	115	Mohr-Coulomb	200	28
Natural Stiff Soils	🟨	115	Mohr-Coulomb	50	28
Free Draining Granular	🟫	120	Mohr-Coulomb	0	34

Method Name	Min FS
Spencer	1.63

S&ME
ENGINEERING INTEGRITY.

SLIDEINTERPRET 7.023

Project	FRA-CR84-1.36 NE Gateway
Analysis Description	Modular Block Wall, Critical Section
Drawn By	CRW
Scale	1:60
Company	S&ME, Inc
Date	6/16/2017
File Name	Wall 1&2.slim

PLATE 6

EMHT

Made by: **TDA** Date: **4/18/2018** Job No: **20160403**
Checked by: **CAS** Date: **4/18/2018** Sheet No: **1**
Project: **NE Gateway** PID: **95516**
Subject: **Modular Block Wall 1 - West Side of Worthington Galena Rd**

Modular Block Wall 1 - West Side of Worthington Galena Rd

Block Dimensions:

Block Width 1 = 1.93 ft ✓
Block Width 2 = 3.00 ft
β = 93 Degrees

Footing (leveling pad) Dimensions:

Toe = 0.50 ft
Stem (at Footing) = 3.00 ft ✓
Heel = 0.50 ft
Footing Width, B = 4.00 ft

*Assume "footing" limits extend at a 1:1 through granular leveling pad.

Block Height 1 + Cap = 2.00 ft
Block Height 2 = 6.00 ft
Design Height Wall = 7.00 ft
*Assumes Soil is Placed 1' up Block 1
Individual Block Ht = 1.50 ft
Number of Blocks= 5.00
Wall Batter Angle σ = 5.16 degrees

Earth over Block = 1.00 ft ✓
Earth on Toe Height = 0.50 ft

Footing (Granular Base) Height = 0.50 ft
Total Height of Wall = 7.50 ft

Design Height Foundation = 7.50 ft
Water Table Height Above Bottom Footing= 3.00 ft

Backfill Material Properties:

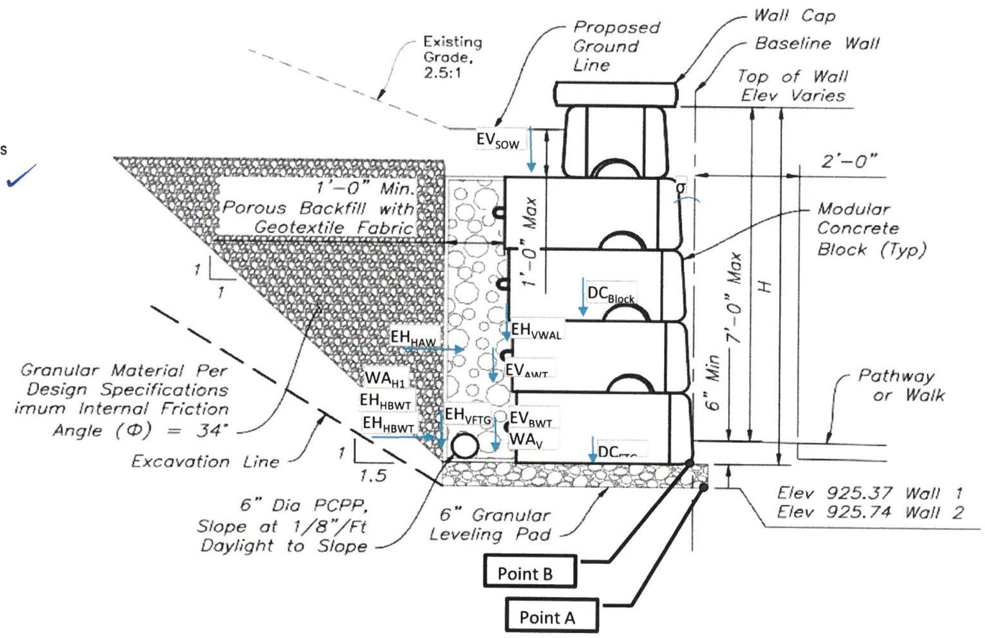
Concrete Unit Wt. = 0.142 kips/ft^3
***Accounts for voids filled with aggregate material**
Soil Unit Weight = 0.130 kips/ft^3
Soil Sat. Unit Weight = 0.145 kips/ft^3 ✓
Φ (degrees) = 34 degrees
δ (degrees) = 22.67 degrees
α (degrees) = 21.80 degrees
K_a = 0.33 (Coulomb)

Live Load Surcharge:

Does Wall Parallel Traffic (Yes/No): Yes
Back of wall to edge of traffic= 15.00 ft
Live Ld. Surcharge Height, heq= 0

Foundation Soil Data:

Undercut depth = 0.00 ft
Foundation Soil Unit Weight = 0.130 kips/ft^3
nt. Friction Angle of Leveling Pad Material, $Φ_f$ = 34 degrees ✓
Int. Friction Angle of Existing Soil, $Φ_f$ = 28 degrees
Undrained Shear Strength, S_u = 2.00 ksf
Nom. Bearing Resistance (undrained) q_n = 10.90 ksf
Nom. Bearing Resistance (drained) q_n = 10.40 ksf
FoundationSupport Material Type (Rock/Soil)= soil



CJN
5/8/18

Sum of the UNFACTORED moment, Counter Clockwise is positive.....

					About "A"		About "B"		
Vertical Loads	**Height (ft)**	**Width (ft)**	**Unit Weight (kip/ft^3)**	**P_V (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**	**P_V (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**
Concrete (DC)									
Block 1 + Cap	2.00	1.93	0.142	**0.55**	2.14	**1.17**	0.55	1.64	**0.90**
Block 2	6.00	3.00	0.142	**2.56**	2.27	**5.80**	2.56	1.77	**4.53**
Footing	0.50	4.00	0.130	**0.26**	2.00	**0.52**	-	-	-
Earth Load (EV)									
Soil Above Toe	0.50	0.50	0.130	**0.03**	0.25	**0.01**	-	-	-
Soil Above Water Table (AWT)	2.50	0.23	0.130	**0.07**	3.73	**0.28**	-	-	-
Soil Below Water Table (BWT)	2.50	0.50	0.083	**0.10**	3.75	**0.39**	-	-	-
Soil Over Wall (Average) (SOW	1.00	1.07	0.130	**0.14**	3.64	**0.51**	0.14	3.14	**0.44**
Water Load (WA v)									
Water Table	2.50	0.50	0.062	**0.08**	3.75	**0.29**	-	-	-
Vertical Component of Horizontal Earth Pressure from Soil Friction (EH_V)									
Acting on Wall EH_v	7.00	-	0.130	**0.40**	-	**-**	0.40	3.00	**1.20**
Acting on Footing EH_v	7.50	-	0.130	**0.46**	3.77	**1.73**	-	-	-
Live Load (LSv)									
Live Load Surcharge	0.00	0.50	0.130	**0.00**	3.75	**0.00**	-	-	-
Horizontal Loads	**Height (ft)**	**Width (ft)**	**Unit Weight (kip/ft^3)**	**P_H (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**	**P_H (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**
Earth Load (EH_H)									
Active Earth Pressure Above Water Table (AWT)	4.50	-	0.130	**-0.40**	4.50	**-1.78**	-0.40	4.00	**-1.58**
Active Earth Pressure Below Water Table 1 (BWT1)	3.00	-	-	**-0.53**	1.50	**-0.79**	-0.44	1.25	**-0.55**
Active Earth Pressure Below Water Table 2 (BWT2)	3.00	-	0.083	**-0.11**	1.00	**-0.11**	-0.08	0.83	**-0.06**
Water Load (WA H)									
Water Pressure	3.00	-	0.062	**-0.28**	1.00	**-0.28**	-0.20	0.83	**-0.16**
Live Load (LSh)									
Live Load Surcharge	7.50	0.00	0.130	**0.00**	3.75	**0.00**	0.00	1.00	**0.00**
Passive Pressure									
Passive Earth Press.	0.00	1.00	0.130	**0.00**	0.00	**0.00**	-	-	-

Ignored for modular block walls

CSN
5/8/18

Sheet No: **2**

AASHTO LRFD Load Factors

Reference Tbl. 3.4.1-1 & 3.4.1-2

Limit State	Vertical Loads					Horizontal Loads		
	DC	EV	EH_V	WAv	LSv	EH_H	WAH	LSH
Service I	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Strength I.a-Sliding & Eccent.	0.90	1.00	1.50	1.00	0.00	1.50	1.00	1.75
Strength I.b-Bearing	1.25	1.35	1.50	1.00	1.75	1.50	1.00	1.75
Strength IV.a-Sliding & Eccent.	0.90	1.00	1.50	1.00	0.00	1.50	1.00	1.75
Strength IV.b Bearing	1.50	1.35	1.50	1.00	0.00	1.50	1.00	0.00

Eccentricity Check (About "A")

Reference Sections 10.6.4.2 and 11.6.3.3

0.33 B 1.32 ft

Limit State	Per Foot of Wall					
	$\sum P_V$ (kips)	$\sum M_A$ (ft-k)	$\sum P_H$ (kips)	e	Is e OK?	$\sigma_{v\ max}$ (ksf)
Service I	4.25	7.74	-1.31	0.18	OK	1.17
Strength I.a-Sliding & Eccent.	4.11	6.50	-1.83	0.42	OK	1.30
Strength I.b-Bearing	5.44	9.55	-1.83	0.25	OK	1.55
Strength IV.a-Sliding & Eccent.	4.11	6.50	-1.83	0.42	OK	1.30
Strength IV.b Bearing	6.28	11.43	-1.83	0.18	OK	1.73

Eccentricity Check (About "B")

Reference Sections 10.6.4.2 and 11.6.3.3

0.33 B 0.99 ft

Limit State	Per Foot of Wall					
	$\sum P_V$ (kips)	$\sum M_A$ (ft-k)	$\sum P_H$ (kips)	e	Is e OK?	$\sigma_{v\ max}$ (ksf)
Service I	3.64	4.71	-1.11	0.21	OK	1.41
Strength I.a-Sliding & Eccent.	3.53	3.66	-1.56	0.46	OK	1.70
Strength I.b-Bearing	4.67	5.72	-1.56	0.27	OK	1.90
Strength IV.a-Sliding & Eccent.	3.53	3.66	-1.56	0.46	OK	1.70
Strength IV.b Bearing	5.44	7.07	-1.56	0.20	OK	2.09

Bearing Capacity Check (About "A"): Bearing Stress = ΣV/(B-2e)

Reference Sections 10.5.5.2.2 and 11.6.3.2

Limit State	Φ_B	$\Phi_B * q_n$	≥ Bearing Stress?	Bearing Stress (ksf)
Service I	1.00	6.00	OK	1.17
Strength I.b-Bearing	0.50	5.20	OK	1.55
Strength IV.b Bearing	0.50	5.20	OK	1.73

Bearing Capacity Check (About "B"): Bearing Stress = ΣV/(B-2e)

Reference Sections 10.5.5.2.2 and 11.6.3.2

Limit State	Φ_B	$\Phi_B * q_n$	≥ Bearing Stress?	Bearing Stress (ksf)
Service I	1.00	6.00	OK	1.41
Strength I.b-Bearing	0.50	5.20	OK	1.90
Strength IV.b Bearing	0.50	5.20	OK	2.09

Sliding Check (About "A"): $R_{R\ Granular}$= V*tanΦf $R_{R\ Cohesive}$= Min(S_u,.5*$\sigma_{v\ max}$)

Reference Sections 10.5.5.2.2 and 10.6.3.4

Limit State	Φ_T	Φ_{ep}	Sliding Resistance					
			$R_{R\ Granular}$	$R_{R\ Cohesive}$	R_R	≥ $\sum P_H$	$\sum P_H$ (kips)	$\sum P_V$ (kips)
Strength I.a-Sliding & Eccent.	0.90	0.50	1.97	2.34	1.97	OK	-1.83	4.11
Strength IV.a-Sliding & Eccent.	0.90	0.50	1.97	2.34	1.97	OK	-1.83	4.11

Sliding Check (About "B"): $R_{R\ Granular}$= 0.8V*tanΦf $R_{R\ Cohesive}$= Min(S_u,.5*$\sigma_{v\ max}$)

Reference Sections 10.5.5.2.2 and 10.6.3.4

Limit State	Φ_T	Φ_{ep}	Sliding Resistance					
			$R_{R\ Granular}$	$R_{R\ Cohesive}$	R_R	≥ $\sum P_H$	$\sum P_H$ (kips)	$\sum P_V$ (kips)
Strength I.a-Sliding & Eccent.	0.90	0.50	1.72	-	1.72	OK	-1.56	3.53
Strength IV.a-Sliding & Eccent.	0.90	0.50	1.72	-	1.72	OK	-1.56	3.53

CJN
5/8/18

Made by:	TDA	Date:	4/18/2018	Job No:	20160403
Checked by:	CAS	Date:	4/18/2018	Sheet No:	1
Project:	NE Gateway	PID:	95516		
Subject:	Modular Block Wall 2 - East Side of Worthington Galena Rd				

Modular Block Wall 2 - East Side of Worthington Galena Rd

Block Dimensions:

Block Width 1 = 1.93 ft
Block Width 2 = 3.00 ft
β = 93 Degrees

Footing (leveling pad) Dimensions:

Toe = 0.50 ft
Stem (at Footing) = 3.00 ft
Heel = 0.50 ft
Footing Width, B = 4.00 ft
*Assume "footing" limits extend at a 1:1 through granular leveling pad.

Block Height 1 + Cap = 2.00 ft
Block Height 2 = 4.50 ft
Design Height Wall = 5.50 ft
*Assumes Soil is Placed 1' up Block 1
Individual Block Ht = 1.50 ft
Number of Blocks = 4.00
Wall Batter Angle σ = 5.16 degrees

Earth over Block = 1.00 ft
Earth on Toe Height = 0.50 ft

Footing (Granular Base) Height = 0.50 ft
Total Height of Wall = 6.00 ft

Design Height Foundation = 6.00 ft
Water Table Height Above Bottom Footing= 3.00 ft

✓ ✓

Backfill Material Properties:

Concrete Unit Wt. = 0.142 kips/ft^3
***Accounts for voids filled with aggregate material**
Soil Unit Weight = 0.130 kips/ft^3
Soil Sat. Unit Weight = 0.145 kips/ft^3
Φ (degrees) = 34 degrees
δ (degrees) = 22.67 degrees
α (degrees) = 21.80 degrees
K_a = 0.33 (Coulomb)

✓

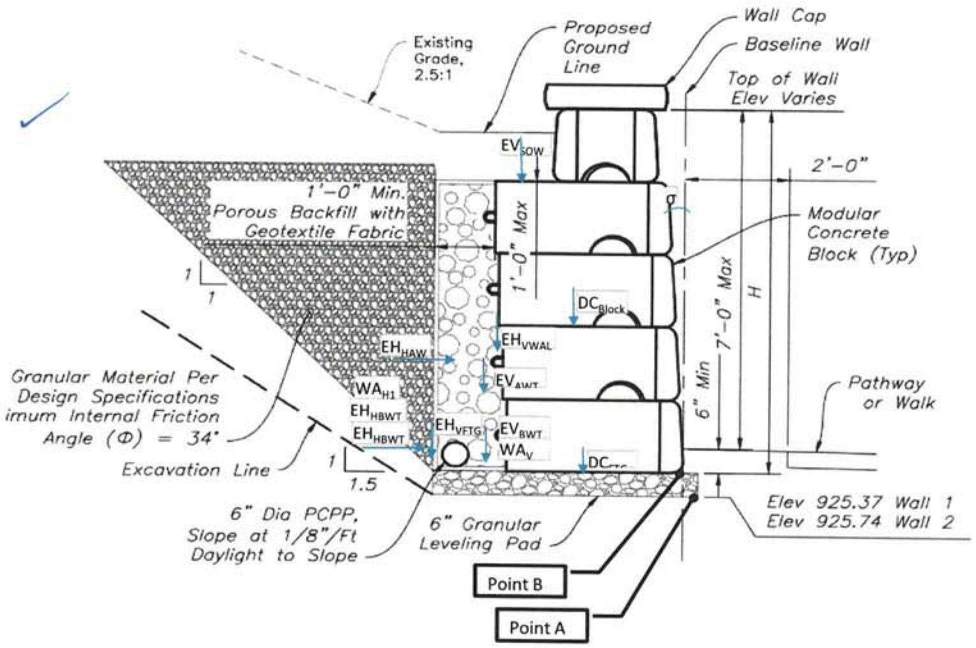
Live Load Surcharge:

Does Wall Parallel Traffic (Yes/No): Yes
Back of wall to edge of traffic= 15.00 ft
Live Ld. Surcharge Height, heq= 0

Soil Foundation Data:

Undercut depth = 0.00 ft
Foundation Soil Unit Weight = 0.130 kips/ft^3
nt. Friction Angle of Leveling Pad Material, $Φ_f$ = 34 degrees
Int. Friction Angle of Existing Soils, $Φ_f$ = 28 degrees
Undrained Shear Strength, S_u = 1.50 ksf
Nom. Bearing Resistance (Undrained) q_n = 8.20 ksf
Nom. Bearing Resistance (Drained) q_n = 8.90 ksf
FoundationSupport Material Type (Rock/Soil)= soil

✓



CJN
12/10/18

Sum of the UNFACTORED moment, Counter Clockwise is positive.....

					About "A"		About "B"			
Vertical Loads	**Height (ft)**	**Width (ft)**	**Unit Weight (kip/ft^3)**	**P_V (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**	**P_V (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**	
Concrete (DC)										
Block 1 + Cap	2.00	1.93	0.142	**0.55**	2.01	**1.10**	0.55	1.51	**0.83**	
Block 2	4.50	3.00	0.142	**1.92**	2.20	**4.22**	1.92	1.70	**3.27**	
Footing	0.50	4.00	0.130	**0.26**	2.00	**0.52**	-	-	-	
Earth Load (EV)										
Soil Above Toe	0.50	0.50	0.130	**0.03**	0.25	**0.01**	-	-	-	
Soil Above Water Table (AWT)	1.00	0.23	0.130	**0.03**	3.73	**0.11**	-	-	-	
Soil Below Water Table (BWT)	2.50	0.50	0.083	**0.10**	3.75	**0.39**	-	-	-	
Soil Over Wall (Average) (SOW	1.00	1.07	0.130	**0.14**	3.51	**0.49**	0.14	3.01	**0.42**	
Water Load (WA_V)										
Water Table	2.50	0.50	0.062	**0.08**	3.75	**0.29**	-	-	-	
Vertical Component of Horizontal Earth Pressure from Soil Friction (EH_V)										
Acting on Wall EH_v	5.50	-	0.130	**0.25**	-	**-**	0.25	3.00	**0.74**	
Acting on Footing EH_v	6.00	-	0.130	**0.29**	3.77	**1.11**	-	-	-	
Live Load (LSv)										
Live Load Surcharge	0.00	0.50	0.130	**0.00**	3.75	**0.00**	-	-	-	
Horizontal Loads	**Height (ft)**	**Width (ft)**	**Unit Weight (kip/ft^3)**	**P_H (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**	**P_H (kips)**	**Moment Arm (ft.)**	**Moment (kip-ft)**	
Earth Load (EH_H)										
Active Earth Pressure Above Water Table (AWT)	3.00	-	0.130	**-0.18**	4.00	**-0.70**	-0.18	3.50	**-0.61**	
Active Earth Pressure Below Water Table 1 (BWT1)	3.00	-	-	**-0.35**	1.50	**-0.53**	-0.29	1.25	**-0.37**	
Active Earth Pressure Below Water Table 2 (BWT2)	3.00	-	0.083	**-0.11**	1.00	**-0.11**	-0.08	0.83	**-0.06**	
Water Load (WA_H)										
Water Pressure	3.00	-	0.062	**-0.28**	1.00	**-0.28**	-0.20	0.83	**-0.16**	
Live Load (LSh)										
Live Load Surcharge	6.00	0.00	0.130	**0.00**	3.00	**0.00**	0.00	1.00	**0.00**	
Passive Pressure										
Passive Earth Press.	0.00	1.00	0.130	**0.00**	0.00	**0.00**	-	-	-	Ignored for modular block walls

CJN
12/10/18

AASHTO LRFD Load Factors

Reference Tbl. 3.4.1-1 & 3.4.1-2

	Vertical Loads					Horizontal Loads		
Limit State	DC	EV	EH_V	WAv	LSv	EH_H	WAH	LSH
Service I	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Strength I.a-Sliding & Eccent.	0.90	1.00	1.50	1.00	0.00	1.50	1.00	1.75
Strength I.b-Bearing	1.25	1.35	1.50	1.00	1.75	1.50	1.00	1.75
Strength IV.a-Sliding & Eccent.	0.90	1.00	1.50	1.00	0.00	1.50	1.00	1.75
Strength IV.b Bearing	1.50	1.35	1.50	1.00	0.00	1.50	1.00	0.00

Eccentricity Check (About "A")

Reference Sections 10.6.4.2 and 11.6.3.3

0.33 B 1.32 ft

	Per Foot of Wall					
Limit State	$\sum P_V$ (kips)	$\sum M_A$ (ft-k)	$\sum P_H$ (kips)	e	Is e OK?	$\sigma_{v\,max}$ (ksf)
Service I	3.40	6.61	-0.92	0.06	OK	0.87
Strength I.a-Sliding & Eccent.	3.24	5.90	-1.24	0.18	OK	0.89
Strength I.b-Bearing	4.34	8.31	-1.24	0.08	OK	1.13
Strength IV.a-Sliding & Eccent.	3.24	5.90	-1.24	0.18	OK	0.89
Strength IV.b Bearing	5.02	9.77	-1.24	0.05	OK	1.29

Eccentricity Check (About "B")

Reference Sections 10.6.4.2 and 11.6.3.3

0.33 B 0.99 ft

	Per Foot of Wall					
Limit State	$\sum P_V$ (kips)	$\sum M_A$ (ft-k)	$\sum P_H$ (kips)	e	Is e OK?	$\sigma_{v\,max}$ (ksf)
Service I	2.85	4.04	-0.74	0.08	OK	1.01
Strength I.a-Sliding & Eccent.	2.73	3.48	-1.01	0.22	OK	1.07
Strength I.b-Bearing	3.64	5.06	-1.01	0.11	OK	1.31
Strength IV.a-Sliding & Eccent.	2.23	3.48	-1.01	-0.06	OK	0.77
Strength IV.b Bearing	4.26	6.08	-1.01	0.07	OK	1.49

Bearing Capacity Check (About "A"): Bearing Stress = ΣV/(B-2e)

Reference Sections 10.5.5.2.2 and 11.6.3.2

Limit State	Φ_B	$\Phi_B * q_n$	≥ Bearing Stress?	Bearing Stress (ksf)
Service I	1.00	4.00	OK	0.87
Strength I.b-Bearing	0.50	4.10	OK	1.13
Strength IV.b Bearing	0.50	4.10	OK	1.29

Bearing Capacity Check (About "B"): Bearing Stress = ΣV/(B-2e)

Reference Sections 10.5.5.2.2 and 11.6.3.2

Limit State	Φ_B	$\Phi_B * q_n$	≥ Bearing Stress?	Bearing Stress (ksf)
Service I	1.00	4.00	OK	1.01
Strength I.b-Bearing	0.50	4.10	OK	1.31
Strength IV.b Bearing	0.50	4.10	OK	1.49

Sliding Check (About "A"): $R_{R\,Granular}$= V*tanΦf $R_{R\,Cohesive}$= Min(S_u,.5*$\sigma_{v\,max}$)

Reference Sections 10.5.5.2.2 and 10.6.3.4

			Sliding Resistance					
Limit State	Φ_τ	Φ_{ep}	$R_{R\,Granular}$	$R_{R\,Cohesive}$	R_R	≥ $\sum P_H$	$\sum P_H$ (kips)	$\sum P_V$ (kips)
Strength I.a-Sliding & Eccent.	0.90	0.50	1.55	1.60	1.55	OK	-1.24	3.24
Strength IV.a-Sliding & Eccent.	0.90	0.50	1.55	1.60	1.55	OK	-1.24	3.24

Sliding Check (About "B"): $R_{R\,Granular}$= 0.8*V*tanΦf $R_{R\,Cohesive}$= Min(S_u,.5*$\sigma_{v\,max}$)

Reference Sections 10.5.5.2.2 and 10.6.3.4

			Sliding Resistance					
Limit State	Φ_τ	Φ_{ep}	$R_{R\,Granular}$	$R_{R\,Cohesive}$	R_R	≥ $\sum P_H$	$\sum P_H$ (kips)	$\sum P_V$ (kips)
Strength I.a-Sliding & Eccent.	0.90	0.50	1.32	-	1.32	OK	-1.01	2.73
Strength IV.a-Sliding & Eccent.	0.90	0.50	1.08	-	1.08	OK	-1.01	2.23

CJN
12/10/18