FINAL REPORT
GEOTECHNICAL EXPLORATION REPORT
UNI-42-3.91/4.38
UNION COUNTY, OHIO
PID#: 107822/109519

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NEAS PROJECT 19-0041

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1. INTRODUCTION

1.1. General

National Engineering & Architectural Services, Inc. (NEAS) presents our Geotechnical Exploration Report for the UNI-42-3.91/4.38 project (PID 107822/109519) along portions of U.S. Route 42 (US-42), Industrial Parkway (Pkwy) and the US-33/US-42 interchange in Jerome Township, Union County, Ohio. The overall project objective is to reduce crash rates at the US-33/US-42 interchange as well as the US-42 and Industrial Pkwy intersection through the addition of dedicated turn lanes and new traffic signals as well as the widening of the project roadways. This report presents a summary of the project encountered surficial and subsurface conditions and our recommendations for: 1) subgrade stabilization, pavement design parameters, and embankment stability for the widening and/or full-depth replacement of US-42, Industrial Pkwy, and the US-33/US-42 interchange connecting Ramps B and D; 2) culvert foundation design for three culverts within the project limits that are planned to be either replaced or extended; and, 3) signal pole foundation design for the proposed new traffic signals. In general, structure analyses and recommendations presented within this report are in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication *LRFD Bridge Design Specifications, 8th Edition* (BDS) (AASHTO, 2017) and ODOT's Publication *2019 LRFD Bridge Design Manual* (ODOT, 2019). The pavement subgrade analysis and recommendations presented are in accordance with ODOT's *Geotechnical Bulletin 1* (GB1) (ODOT [1], 2019) and *Pavement Design Manual* (PDM) (ODOT, 2015).

The exploration was conducted in general accordance with NEAS's proposal to Strand Associates, Inc. (Strand), dated February 11, 2019 and with the provisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2019).

The scope of work performed by NEAS as part of the referenced project included: a review of published geotechnical information; performing 36 total test borings; laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis to assess subgrade stabilization requirements, pavement design parameters, and foundation design including construction considerations; and development of this summary report.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The project site is located within the Central Ohio Till Plain physiographic region which is characterized as well-defined moraines with intervening flat-lying ground moraine and intermorainal lake basins containing few large streams and limited sand and gravel outwash with surface soils consisting of clayey till. Elevations of the region ranges from 700 to 1,150 ft above mean sea level (amsl), with moderate relief (100 ft). The geology within this region is described as clayey, high-lime Wisconsinan-age till and lacustrine materials over Lower Paleozoic-age carbonate rocks (i.e., limestone or dolostone) and, in the east, shales. Loess in this region is thin to absent (ODGS, 1998).

The geology at the project site is mapped as an average of 120 ft of Wisconsinan-age till underlain by Silurian-age dolomite and shale bedrock (ODGS, 2005). The till is described as an unsorted mix of clay, silt, sand, gravel and boulders and is noted as containing silt, sand and gravel lenses. Till in buried valleys and thicker areas are noted as potentially being older than Wisconsinan.

Based on the Bedrock Geologic Units Map of Ohio (USGS & ODGS, 2006), bedrock within the project area consists of both dolomite and limestone of the Salina Group and Columbus Limestone formations,

respectively. The Salina Group formation is comprised of Silurian-age dolomite with occasional thin bed and laminae of dark shale and anhydrite and/or gypsum. The dolomite in this formation is described as gray, yellow-gray to olive-gray in color and laminated to thin bedded. The Columbus Limestone formation is comprised of Devonian-age limestone with a minor constituent of brown dolostone. The limestone in this formation can be described as gray weathering to brown and massively bedded. Based on the ODNR bedrock topography map of Ohio, bedrock elevations at the project site can be expected to be between elevations of 940 and 880 ft amsl, putting bedrock at a depth ranging from about 125 ft to about 70 ft below ground surface (bgs).

The soils at the project site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as predominantly Blount silt loam and Glynwood silt loam. Blount silt loam is the more dominant series mapped within the project limits while Glynwood silt loam is spatially intermixed throughout the site. The exception being the soils underlying and closely adjacent to Church Run that intersects both US-42 and Industrial Pkwy approximately 400 to 450 ft south of the US-42 and Industrial Pkwy intersection. The soils in these areas are mapped as Pewamo silty clay loam. The Blount series soils are described as very deep, somewhat poorly drained soils that are moderately deep or deep to dense till formed in till on till plains and near-shore zones. The soils in the Glynwood series are described as very deep, moderately well drained soils that are moderately deep or deep to dense till that formed in a thin layer of loess and the underlying till on ground and end moraines. The Pewamo series is described as very deep, very poorly drained soils formed in till on moraines, near-shore zones and lake plains. These series are comprised of predominantly fine-grained soils that classify as A-4, A-6 and A-7 type soils according to the AASHTO method of soil classification.

2.2. Hydrology/Hydrogeology

At the project site, groundwater (if present) can be expected at an elevation consistent with that of Church Run (approximate elevation 980 to 990 ft amsl), as it is the most dominant hydraulic influence in the area. The water level of the indicated stream may be generally representative of the local groundwater table, though perched groundwater systems may exist due to the presence of fine-grained soils making it difficult for groundwater to permeate to the natural phreatic surface.

The project site is not located within a 1% Annual Chance Flood Hazard area based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2016).

2.3. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR’s Abandoned Underground Mine Locator within the immediate vicinity of the project's boundaries (ODNR [1], 2016).

No oil or gas wells are noted on ODNR’s Ohio Oil & Gas Locator within the immediate vicinity of the project’s boundaries (ODNR [2], 2016).

2.4. Historical Records and Previous Phases of Project Exploration

A historical record search was performed through ODOT’s Geotechnical Data Management System (GeoMS). The following report/plans were available for review and evaluation for this report:

- Structure Foundation Exploration Report and Sheets for the original construction of bridge UNI-33 Under Relocated USR 42 as part of the State of Ohio Department of Highways project

UNI-33-12.04, prepared by Barrett Associated Engineers, Ltd., dated June 28, 1965 and April 7, 1965, respectively; and,

- Geotechnical Report and Soil Profile Sheets prepared as part of the State of Ohio Department of Highways project UNI-33-12.05, prepared by the Barrett Associated Engineers, Ltd., dated September 8, 1965 and January 22, 1965, respectively.

Historical soil borings associated with the above plans were reviewed, however, were not utilized for our evaluation of subsurface conditions for the roadway improvements or at proposed structure locations, and therefore, are not referenced or presented within this report.

2.5. Field Reconnaissance

A field reconnaissance visit for the overall project area was conducted on May 30, 2019 along US-42, Industrial Pkwy and the US-33/US-42 interchange connecting Ramps B and D. Site conditions, including the conditions of existing pavement, embankments and structures, were noted and photographed during the visit. Photographs of notable distress and a summary of our observations by roadway segment or structure are provided below.

2.5.1. Land Use and Cover

The land use of most of the project area consists of agricultural and rural residential properties. Other land uses of the area surrounding the project include: 1) institutional facilities (i.e., churches, public works, etc.); 2) commercial properties; and 3) a wooded residential neighborhood immediately to the west of the project limits.

2.5.2. U.S. Route 42

In general, the pavement condition along US-42 was observed to be fair to good with minor signs of weathering and surface wear. Occasional low to moderate severity longitudinal, edge and transverse cracking was observed along these sections. The exception to this is the section of US-42 from approximate STA 234+00 to STA. 247+00. The pavement along this section of US-42 was observed to be in fair condition with occasional to frequent moderate severity crack sealing deficiencies and longitudinal, edge, transverse and map cracking (Photograph 1). Portions of US-42 at or directly adjacent to the US-33/US-42 interchange are supported on embankments with side slopes of about 3 horizontal to 1 vertical (3H:1V) (Photograph 2). The referenced slopes were generally grass covered with no apparent signs of instability observed during the visit. With respect to drainage, the roadway appeared to be well-drained with no observable signs of ponding or standing water.

Photograph 1: US-42 pavement condition from STA 234+00 to STA 247+00

Photograph 2: Embankment slopes along US-42

2.5.3. Industrial Parkway

The condition of the pavement along Industrial Pkwy was observed to be fair to good with minor signs of weathering and surface wear. Frequent low to moderated severity longitudinal, edge and transverse cracking was observed along these sections as well as occasional low severity rutting and crack sealing deficiencies. In general, the pavement appeared to be well-drained with no observable signs of ponding or standing water on the roadway.

2.5.4. Ramps B and D

The pavement condition along the US-33/US-42 interchange ramps (i.e., Ramps B and D) was observed to be in fair condition with minor signs of weathering and surface wear. Frequent low to moderate severity longitudinal, edge and transverse cracking was observed along these sections as well as occasional low severity potholes and crack sealing deficiencies (Photograph 3). With respect to drainage, the pavement appeared to be well-drained with no observable signs of ponding or standing water on the roadway. Both existing ramps are supported on embankments with side slopes of about 4H:1V (Photograph 3). The existing ramp slopes were generally grass covered with no apparent signs of instability observed during the visit.

Photograph 3: Pavement condition and embankment slope along Ramp D

2.5.5. US Route 42 Culvert – Culvert US-42-4.061

Culvert US-42-4.061 carries US-42 over Church Run near approximate STA. 214+79 (US-42 alignment). The existing structure is a 72-inch wide by 48-inch tall reinforced concrete box culvert approximately 50 ft in length. The top of the existing culvert is located approximately 5 ft below the existing roadway grade and is located within a heavily vegetated area with numerous mature trees. Existing embankment slopes on either side appeared to be generally stable with an estimated inclination between 1.5H:1V to 3H:1V. In general, the culvert appeared to be in fair condition with no obvious signs of geotechnical distress.

2.5.6. US Route 42 Culvert – Culvert US-42-4.839

Culvert US-42-4.839 is a culvert which connects the drainage ditch located on the north side of US-42 to the drainage ditch on the south side of US-42 near approximate STA. 254+27 (US-42 alignment). The existing structure is a 24-inch corrugated plastic culvert approximately 50 ft in length. The top of the existing culvert is approximately 2.5 ft below the existing roadway grade and is located just east of Watkins California Road. Vegetation on the north side of the culvert consist of farm crops while vegetation on the south side consists of mature trees, bushes and grasses. In general, the culvert appeared to be in fair condition with no obvious signs of geotechnical distress.

2.5.7. Industrial Parkway Culvert – Culvert Industrial Parkway – 8.471

Culvert Industrial Parkway – 8.471 carries Industrial Pkwy over Church Run near approximate STA. 111+99 (Industrial Pkwy alignment). The existing structure is comprised of two 54-inch diameter reinforced concrete pipes with shared head walls (Photograph 4). The top of the existing culvert was measured to be about 3 ft below the existing roadway. This culvert also sits in a heavily vegetated area with many mature trees. Existing embankment slopes on either side appeared to be generally stable with an estimated inclination of about 3H:1V. In general, the culvert appeared to be in fair condition with no obvious signs of geotechnical distress.

Photograph 4: Industrial Parkway Culvert

3. GEOTECHNICAL EXPLORATION

3.1. Exploration Program

The subsurface exploration was conducted by NEAS between June 20, 2019 and July 8, 2019 and included 36 borings drilled to depths between 7.5 and 40 ft bgs. The boring locations were selected by NEAS in general accordance with the guidelines contained in the SGE with the intent to evaluate subsurface soil and groundwater conditions. Borings were typically located within the planned roadway/subgrade improvement areas and/or at or near proposed structure locations that were not restricted by underground utilities or dictated by terrain (i.e., steep embankment slopes). Target boring locations were located in the field by NEAS prior to drilling utilizing handheld GPS equipment. If the actual drilled location was relocated for drilling purposes, the as-drilled project boring location and corresponding ground surface elevation was again surveyed in the field following drilling utilizing a handheld GPS equipment. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude location (based on the surveyed Ohio State Plane North, NAD83, location) and the corresponding ground surface elevation. The boring locations are depicted on the Soil Profile Sheets provided in Appendix A. It should be noted that a number of borings were drilled for project structures but can serve as both structure and roadway borings.

Borings were drilled using a CME 55T truck-mounted drilling rig utilizing 3.25-inch (inner diameter) hollow stem augers. Soil samples for subgrade borings were typically recovered continuously to a depth of 7.5 ft bgs, while samples for joint subgrade/structure borings were typically recovered continuously to a depth of 7.5-ft bgs and at 2.5-ft intervals thereafter. Each boring type was sampled using an 18-inch split spoon sampler (AASHTO T-206 “Standard Method for Penetration Test and Split Barrel Sampling of Soils.”). The soil samples obtained from the exploration program were visually observed in the field by the NEAS field representative and preserved for review by a Geologist for possible laboratory testing. Standard penetration tests (SPT) were conducted using a CME auto hammer that has been calibrated to be 78% as indicated on the boring logs (Appendix B).

Field boring logs were prepared by drilling personnel and included pavement description (where present), lithological description, SPT results recorded as blows per 6-inch increment of penetration and estimated

unconfined shear strength values on specimens exhibiting cohesion (using a hand-penetrometer). Groundwater level observations were recorded both during and after the completion of drilling. These groundwater level observations are included on the individual boring logs (provided in Appendix B). After completing the borings, the boreholes were backfilled with either auger cuttings, bentonite chips, or a combination of these materials and patched accordingly with the cold patch asphalt and/or cement when drilling through the roadway.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing, moisture content determinations and sulfate content testing. Data from the laboratory testing program were incorporated onto the boring logs (Appendix B). Soil samples are retained at the laboratory for 60 days following report submittal, after which time they will be discarded.

3.2.1. Classification Testing

Representative soil samples were selected for index property (Atterberg Limits) and gradation testing for classification purposes on approximately 37% of the samples. At each boring location utilized for roadway purposes, the upper two samples obtained below the proposed top of subgrade elevation were generally tested while additional samples in each boring were selected for testing with the intent of properly classifying the subsurface soil and groundwater conditions within the planned project limits. Soils not selected for testing were compared to laboratory tested samples/strata and classified visually. Moisture content testing was conducted on all samples. The laboratory testing was performed in general accordance with applicable AASHTO specifications and ODOT Supplements.

Final classification of soil strata in accordance with AASHTO M-145 “Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes,” as modified by ODOT “Classification of Soils” was made once laboratory test results became available. The results of the soil classification are presented on the boring logs in Appendix B.

3.2.2. Standard Penetration Test Results

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils were performed at varying intervals (i.e., continuous, 2.5-ft, or 5.0-ft intervals) in the project borings performed. To account for the high efficiency (automatic) hammers used during SPT sampling, field SPT N-values were converted based on the calibrated efficiency (energy ratio) of the specific drill rig's hammer. Field N-values were converted to an equivalent rod energy of 60% (N_{60}) for use in analysis or for correlation purposes. The resulting N_{60} values are shown on the boring logs provided in Appendix B.

3.2.3. Sulfate Testing

Sulfate testing was generally performed on one sample for each subgrade or roadway boring performed for pavement/subgrade design purposes. These selected samples were commonly collected within 3 ft of the proposed top of subgrade elevation and were tested in accordance with ODOT Supplement 1122, “Determining Sulfate Content in Soils” dated July 17, 2015. Based on the testing results, each subgrade soil sample tested was determined to have a sulfate content of less than 5,000 parts per million (i.e., lower than the level which ODOT considers high and may prevent the use of chemical stabilization). Testing results are summarized in Table 1 below and in Appendix C.

Table 1: Sulfate Test Summary by Boring

Boring ID	Latitude	Longitude	Sample	Depth (ft)	Dilution Ratio	Reading 1	Reading 2	Reading 3	Average Sulfate Content (mg/kg)
B-001-0-18	40.153160	-83.239505	SS-1	1.5 - 3.0	20	2	1	2	33
B-002-0-18	40.153758	-83.239010	SS-2	3.0 - 4.5	20	7	5	6	120
B-003-0-18	40.154621	-83.238049	SS-1	1.5 - 3.0	20	7	7	8	147
B-004-0-18	40.155233	-83.237433	SS-2	3.0 - 4.5	20	6	6	6	120
B-005-0-18	40.155305	-83.237466	SS-1	1.5 - 3.0	20	13	13	12	253
B-006-0-18	40.155999	-83.236631	SS-2	3.0 - 4.5	20	9	10	7	173
B-008-0-18	40.156455	-83.236546	SS-1	1.0 - 2.5	20	7	6	5	120
B-009-0-18	40.157011	-83.235749	SS-1	1.5 - 3.0	20	12	11	12	233
B-010-0-18	40.157843	-83.234785	SS-3	3.0 - 4.5	20	9	7	7	153
B-011-0-18	40.158797	-83.234063	SS-2	1.5 - 3.0	20	7	6	7	133
B-012-0-18	40.159558	-83.233034	SS-1	1.5 - 3.0	20	8	7	7	147
B-016-0-18	40.160177	-83.232401	SS-1	1.5 - 3.0	20	6	7	7	133
B-019-0-18	40.162331	-83.230562	SS-1	1.5 - 3.0	20	17	15	16	320
B-020-0-18	40.163127	-83.229588	SS-1	1.5 - 3.0	20	9	9	10	187
B-021-0-18	40.163788	-83.228723	SS-1	1.5 - 3.0	20	44	50	47	940
B-022-0-18	40.164708	-83.227895	SS-1	1.5 - 3.0	20	6	5	5	107
B-023-0-18	40.154532	-83.233787	SS-2	3.0 - 4.5	20	13	9	9	207
B-024-0-18	40.155053	-83.234579	SS-2	3.0 - 4.5	20	8	7	8	153
B-026-0-18	40.155431	-83.235303	SS-1	1.5 - 3.0	20	15	14	15	293
B-027-0-18	40.156251	-83.236250	SS-1	1.5 - 3.0	20	4	4	4	80
B-028-0-18	40.156957	-83.237453	SS-2	3.0 - 4.5	20	48	47	49	960
B-029-0-18	40.157659	-83.238521	SS-1	1.5 - 3.0	20	11	13	14	253
B-030-0-18	40.158239	-83.239579	SS-1	0.0 - 1.5	20	1	1	1	20
B-031-0-18	40.161868	-83.230414	SS-1	1.5 - 3.0	20	13	9	11	220
B-032-0-18	40.160862	-83.230040	SS-2	1.5 - 3.0	20	6	7	5	120
B-033-0-18	40.159833	-83.229511	SS-1B	2.0 - 3.0	100	32	30	29	3033
B-034-0-18	40.162418	-83.233818	SS-1	1.5 - 3.0	20	4	6	4	93
B-035-0-18	40.161418	-83.233236	SS-1	0.0 - 1.5	40	0	3	2	33
B-036-0-18	40.160365	-83.232877	SS-2	3.0 - 4.5	20	3	3	1	47

4. FINDINGS

The subsurface conditions encountered during NEAS's explorations are described in the following subsections and/or on each boring log presented in Appendix B The boring logs represent NEAS's interpretation of the subsurface conditions encountered at each boring location based on our site observations, field logs, visual review of the soil samples by NEAS's geologist, and laboratory test results. The lines designating the interfaces between various soil strata on the boring logs represent the approximate interface location; the actual transition between strata may be gradual and indistinct. The subsurface soil and groundwater characterizations included herein, including summary test data, are based on the subsurface findings from the geotechnical explorations performed by NEAS as part of the referenced project. At the time of the composition of this report, proposed grade and pavement section information has been assumed to be consistent with the preliminary project Alternative 2 – Preferred Option roadway plans provided by Strand dated November 6, 2018. It should be noted that for the purposes of this report and our analysis, the term 'proposed subgrade' has been assumed to represent soils and/or soil conditions extending to a depth of 6 ft below the bottom of proposed pavement section (i.e., top of subgrade).

4.1. Existing Pavement

The pavement section thicknesses in terms of asphalt, concrete and granular base were measured at representative subgrade borings during the subsurface exploration and are recorded on the test boring logs provided in Appendix B. A summary of these measurements is provided in Table 2 below.

Table 2: Measured Pavement Thickness at Boring Locations

Boring ID	Existing Alignment	Asphalt thickness (in)	Concrete thickness (in)	Total Pavement Thickness (in)	Base (in)
B-001-0-18	US-42	4.0	-	4.0	10.0
B-002-0-18	US-42	3.0	-	3.0	11.5
B-003-0-18	US-42	4.0	-	4.0	8.0
B-004-0-18	US-42	4.0	8.0	12.0	4.0
B-005-0-18	US-42	-	8.0	8.0	6.0
B-006-0-18	US-42	7.5	-	7.5	5.5
B-009-0-18	US-42	3.5	-	3.5	-
B-016-0-18	US-42	8.5	-	8.5	8.0
B-017-0-18	US-42	7.0	-	7.0	10.0
B-018-0-18	US-42	4.0	-	4.0	-
B-019-0-18	US-42	4.0	-	4.0	-
B-022-0-18	US-42	13.0	-	13.0	-
B-023-0-18	Industrial Parkway	8.0	-	8.0	8.0
B-024-0-18	Industrial Parkway	8.0	-	8.0	8.0
B-026-0-18	Industrial Parkway	9.0	-	9.0	6.0

4.2. Subgrade Conditions

The subgrade conditions in the project area are relatively consistent and are generally comprised of either fill soils (i.e., embankment/roadway fill) or natural soils consisting of low to highly plastic silt/clay combinations. The subgrade soils encountered within the project limits are generally classified as A-2-4, A-4a, A-6a, A-6b or A-7-6. With respect to sulfate within the subgrade soil, based on the project laboratory testing program, each subgrade soil sample tested was determined to have a sulfate content of less than 5,000 parts per million (i.e., lower than the level which ODOT considers high and may prevent the use of chemical stabilization).

The following subsections present a brief summary of the subsurface conditions by ramp/roadway segment.

4.2.1. US Route 42

The project portion of US-42 is planned for full depth pavement replacement as well as widening from the southernmost limits of the project to approximately 210 ft south of the bridge carrying US-42 over US-33. Additionally, roadway resurfacing, widening and minimal amounts of full-depth replacement are planned for the project portion of US-42 from the intersection with Ramps A and B to approximately 350 ft north of the intersection with Watkins California Rd. The planned widening is to allow for the addition of turn lanes at the US-33/US-42 interchange and the US-42 intersection with Industrial Pkwy.

Along US-42, ninety-eight percent (98%) of the samples taken along the proposed roadway were classified as fine-grained, cohesive soils and were comprised of: 1) cohesive Sandy Silt (A-4a, 5% of samples); 2) Silt and Clay (A-6a, 15% of samples); 3) Silty Clay (A-6b, 56% of samples); and, 4) Clay (A-7-6, 21% of samples). With respect to the consistency of the cohesive soils, the descriptions varied from soft to hard correlating to converted SPT-N values (N_{60}) ranging from 3 to 36 blows per foot (bpf). Natural moisture contents ranged from 9 to 34 percent. Based on Atterberg Limits test performed on representative samples of the cohesive soils, the liquid and plastic limits were estimated to range from 25 to 58 percent and from 16 to 25 percent, respectively.

Two soil samples obtained within the borings performed along US-42 were identified as non-cohesive soils and were comprised of: 1) Gravel with Sand and Silt (A-2-4, 1 sample); and, 2) non-cohesive Sandy Silt (A-4a, 1 sample). With respect to the relative density of the non-cohesive soils, the two samples can be

described as medium dense correlating to N_{60} values of 29 and 18 bpf. Natural moisture contents of these samples were estimated to be 9 and 13 percent.

4.2.2. Industrial Parkway

The project portion of Industrial Pkwy is also planned for full depth pavement replacement and widening with the widened sections tapering down near the eastern and western limits of the project. Similar to the US-42 widening, the planned widening along Industrial Pkwy is to allow for the addition of turn lanes at the US-42 and Industrial Pkwy intersection.

Along Industrial Pkwy, ninety-one percent (91%) of the samples taken along the proposed roadway were classified as fine-grained, cohesive soils and were comprised of: 1) Silt and Clay (A-6a, 18% of samples); 2) Silty Clay (A-6b, 29% of samples); and, 3) Clay (A-7-6, 44% of samples). With respect to the consistency of the cohesive soils, the descriptions varied from soft to very stiff correlating to N_{60} values ranging from 4 to 24 bpf. Natural moisture contents ranged from 7 to 27 percent. Based on Atterberg Limits test performed on representative samples of the cohesive soils, the liquid and plastic limits were estimated to range from 29 to 52 percent and from 16 to 25 percent, respectively.

Three soil samples obtained within the borings performed along Industrial Pkwy were identified as non-cohesive, granular soils comprised of Gravel with Sand and Silt (A-2-4). With respect to the relative density of the granular soil, the descriptions ranged from loose to medium dense correlating to N_{60} values ranging from 7 to 17 bpf. Natural moisture contents of these samples were estimated to range from 7 to 20 percent.

4.2.3. Ramps B and D

Both Ramps B and D within the project limits are planned for full depth replacement and widening.

One hundred percent (100%) of the samples taken along the proposed ramps were classified as fine-grained, cohesive soils and were comprised of: 1) Silt and Clay (A-6a, 50% of samples); 2) Silty Clay (A-6b, 37% of samples); and, 3) Clay (A-7-6, 13% of samples). With respect to the consistency of the cohesive soils, the descriptions varied from medium stiff to hard correlating to N_{60} values ranging from 7 to 31 bpf. Natural moisture contents ranged from 15 to 27 percent. Based on Atterberg Limits test performed on representative samples of the cohesive soils, the liquid and plastic limits were estimated to range from 28 to 42 percent and from 17 to 21 percent, respectively.

4.2.4. Groundwater

Groundwater measurements were taken during the boring drilling procedures and/or immediately following the completion of each borehole. Groundwater was observed during and/or upon completion of drilling in 1 of the 36 project borings performed by NEAS. Groundwater was encountered within boring B-013-0-18 at a depth of 35 ft bgs (approximate elevation 983.9 ft amsl).

It should be noted that groundwater is affected by many hydrologic characteristics in the area and may vary from those measured at the time of the exploration. The specific groundwater readings are included on the individual test boring log located within Appendix B.

5. ANALYSES AND RECOMMENDATIONS

We understand that full depth pavement replacement and widening of US-42, Industrial Pkwy, Ramps B, and Ramp D is planned as part of the UNI-42-3.91/4.38 project (PID 107822/109519) to improve the safety of the referenced roadways and associated intersections. In order to facilitate the improvements proposed

for safety purposes, it is also our understanding that three culverts within the project limits are planned to be either replaced or extended and new signal pole foundation will be needed for new traffic signals at project intersections.

The following sub-sections present the analyses and recommendations for: 1) the subgrade stabilization and pavement design parameters for US-42, Industrial Pkwy, Ramps B and D; 2) proposed embankment alterations and constriction; 3) culvert foundation design for three culverts within the project limits that are planned to be either replaced or extended; and, 4) signal pole foundation design. In general, structure analyses and recommendations presented within this report are in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication *LRFD Bridge Design Specifications, 8th Edition* (BDS) (AASHTO, 2017) and ODOT's Publication *2019 LRFD Bridge Design Manual* (ODOT, 2019). The pavement subgrade analysis and recommendations presented are in accordance with ODOT's *Geotechnical Bulletin 1* (GB1) (ODOT [1], 2019) and *Pavement Design Manual* (PDM) (ODOT, 2015).

5.1. Subgrade Analysis

A GB1 analysis was performed to identify the method, location, and dimensions (including depth) of required subgrade stabilization for the project. In addition to identifying stabilization recommendations, pavement design parameters are also determined to aid in pavement section design. The subsections below present the results of our GB1 analysis including pavement design parameters and unsuitable subgrade conditions identified within the project limits. GB1 analysis spreadsheets are provided in Appendix D.

Again, it should be noted that for the purposes of this report and our analysis, the term 'proposed subgrade' has been assumed to represent soils and/or soil conditions extending to a depth of 6 ft below the bottom of proposed pavement section (i.e., top of subgrade).

5.1.1. Pavement Design Recommendations

It is our understanding that pavement analysis and design is to be performed to determine the proposed pavement sections for the segments within the project limits to undergo full depth replacement and widening. A GB1 analysis was performed using the subgrade soil data obtained during our field exploration program to evaluate the soil characteristics to develop pavement parameters for use in pavement design. The subgrade analysis parameters recommended for use in pavement design are presented in Table 3 below. Provided in the table are ranges of maximum, minimum and average N_{60L} values for the indicated segments as well as the design CBR value recommended for use in pavement design.

Table 3: Pavement Design Values

Segment	Maximum N_{60L}	Minimum N_{60L}	Average N_{60L}	Average PI Values	Design CBR
US-42	22	3	10	18	5
Industrial Parkway	12	4	8	20	5
Ramps B & D	18	7	12	16	5
Entire Project	**22**	**3**	**10**	**18**	**5**
Entire Project - Widened Sections	**17**	**3**	**9**	**20**	**5**

5.1.2. Unsuitable Subgrade

Per ODOT's GB1, the presence of select subgrade conditions are prohibited within the subgrade zone for new pavement construction. These prohibited subgrade conditions generally include the presence of rock, specific soil types, weak soil conditions, and overly moist soil conditions. With respect to the proposed pavement construction and widening project these subgrade conditions are further discussed in the following subsections.

5.1.2.1. Rock

Rock was not encountered at or close to subgrade elevation at the boring locations performed within the project limits. Per ODOT's GB1, if rock is encountered within 24 inches of the bottom of the proposed asphalt or concrete pavement it is to be removed in accordance with 204.05 of the ODOT CMS and replaced with Item 204 Embankment.

5.1.2.2. Prohibited Soils

Prohibited soil types per the GB1, which include A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, and soils with liquid limits greater than 65, were not encountered within the proposed subgrade limits of the referenced project roadway segments.

5.1.2.3. Weak Soils

The GB1 recommends subgrade stabilization for soils in which the N_{60} value of a particular soil sample (SS) at a referenced boring location is less than 12 bpf and in some cases less than 15 bpf (i.e., where moisture content is greater than optimum plus 3 percent). Based on the specific N_{60} value at the subject boring, *Figure B - Subgrade Stabilization* within the GB1 recommends a depth of subgrade stabilization for ODOT standard stabilization methods. For the purposes of this report the term 'weak soils' has been assumed to represent subgrade soils of these conditions. It should be noted that although a soil sample's N_{60} value may meet the criteria to be considered a weak soil, the depth in which the weak soil is encountered in relation to the proposed subgrade is considered when each individual subgrade boring is analyzed. For example, if the GB1 recommends an excavate and replace of 12 inches within a weak soil underlying 18 inches of stable material, it would be unreasonable to recommend the removal of both the stable and unstable material for a total of 30 inches of excavate and replace.

Based on N_{60} values encountered within the project borings, our GB1 analysis suggests the need for 12 to 14 inches of either chemical treatment or excavate and replace along the referenced project roadway segments. A summary of the boring locations where weak soils were encountered and determined to have a potential impact on subgrade performance are shown in Table 4 below, per the roadway segment for which they were encountered. Also included is the associated GB1 recommended remediation depth at that location.

Table 4: Weak Soil Locations Summary

Boring ID	Sample ID	N_{60}	Moisture Above Optimum (%)	Depth Below Subgrade (ft)	Remediation Depth (inches)		
					Excavate and Replace (Item 204 w/ Geotextile)	Excavate and Replace (Item 204 w/ Geogrid - SS 861)	Chemical Stabilization (Item 206)
Roadway Segment: US-42							
B-001-0-18	SS-1	9	4	0.0 - 1.5	12	-	14
B-005-0-18	SS-1	9	3	0.0 - 1.5	12	-	14
B-006-0-18	SS-1	10	4	0.0 - 1.5	12	-	14
B-008-0-18	SS-1	8	5	0.0 - 1.0	12	-	14
B-009-0-18	SS-1	8	5	0.0 - 1.5	12	-	14
B-010-0-18	SS-2	8	10	0.0 - 1.5	12	-	14
B-011-0-18	SS-2	8	9	0.0 - 1.5	12	-	14
B-014-0-18	SS-1	11	3	0.0 - 1.0	12	-	14
B-015-0-18	SS-1	11	-	0.0 - 1.0	12	-	14
B-016-0-18	SS-1	10	1	0.0 - 1.5	12	-	14
B-017-0-18	SS-1B	8	1	0.0 - 1.0	12	-	14
B-021-0-18	SS-1	6	1	0.0 - 1.5	18	-	14
B-022-0-18	SS-1	10	1	0.0 - 1.5	12	-	14
Roadway Segment: Industrial Parkway							
B-026-0-18	SS-1	12	10	0.0 - 1.5	12	-	12
B-027-0-18	SS-1	9	0	0.0 - 1.5	12	-	14
B-030-0-18	SS-2	7	-	0.0 - 1.5	15	-	14
Roadway Segment: Ramp B							
B-032-0-18	SS-1	7	3	0.0 - 0.2	12	-	12
Roadway Segment: Ramp D							
B-035-0-18	SS-2	7	4	0.0 - 1.2	15	-	14

It should be noted that *Figure B - Subgrade Stabilization* does not apply to soil types A-1-a, A-1-b, A-3, or A-3a, nor to soils with N_{60L} values of 15 or more. Per GB1 guidance, *these soils should be reworked to stabilize the subgrade.*

5.1.2.4. High Moisture Content Soils

High moisture content soils are defined by the GB1 as soils that exceed the estimated optimum moisture content (per *Figure A - Optimum Moisture Content* within the GB1) for a given classification by 3 percent or more. Per the GB1, soils determined to be above the identified moisture content levels are a likely indication of the presence of an unstable subgrade and may require some form of subgrade stabilization. Similar to our analysis of weak soils, although a soil sample's moisture content may meet the criteria to be considered high, the depth in which the high moisture soil is encountered in relation to the proposed subgrade is considered when each individual subgrade boring is analyzed for stabilization recommendations. Summaries of the boring locations where high moisture content conditions were encountered within the limits of each alignment are shown in Table 5 below.

Table 5: High Moisture Content Soil Locations

Boring ID	Moisture Content (%)	Optimum Moisture Content (%)	Moisture Above Optimum (%)	Depth Below Subgrade (ft)
Roadway Segment: US-42				
B-005-0-18	19	16	3	1.5 - 3.0
B-015-0-18	19	16	3	2.0 - 3.5

5.2. Stabilization Recommendations

5.2.1. Subgrade Stabilization

Unstable subgrade conditions that require stabilization per GB1 guidelines were encountered within the proposed roadway subgrade within the project limits. Unstable soils (i.e., weak soils), as previously indicated in Section 5.1. of this report, were encountered within the subgrade depths in various borings performed throughout the project. Based on our analyses, as unstable soils that require stabilization per GB1 guidelines were encountered throughout the project limits within more than approximately 30 percent of the total subgrade area, we recommend stabilization in the form of Chemical Stabilization (Item 206) be performed throughout the site. In areas where Chemical Stabilization (Item 206) may not be practical or economical, we recommend these areas be stabilized in the form of Excavate and Replace (Item 204 with geotextile).

Based on: 1) the results of our GB1 analysis; 2) the review of the unstable subgrade conditions as described in Section 5.1.1. of this report; and, 3) the subsequent conclusions regarding recommended stabilization, Table 6 below presents our recommendations for subgrade stabilization depths for each roadway segment included within the project.

Table 6: Summary of Stabilization

Segment(s)	Remediation Depth (inches)		
	Excavate and Replace (Item 204 w/ Geotextile)(1)	Excavate and Replace (Item 204 w/ Geogrid - SS 861)	Chemical Stabilization (Item 206)
US-42 and Industrial Parkway	12	-	14
Ramps B & D	12	-	12

Notes:
1. For areas within the project limits where chemical stabilization cannot be achieved.

Subgrade stabilization is estimated to extend to the depths indicated within Table 6 with any excavated material being replaced with material in accordance with Section F "Excavate and Replace (Item 204)" of the ODOT GB1. Stabilization limits should extend 18-inches beyond the edge of the proposed paved roadway, shoulder or median.

5.2.2. Chemical Stabilization

Where chemical stabilization is utilized as the method of subgrade stabilization, cement is recommended as the stabilizing chemical for the referenced roadways based on our conversation with ODOT and the average characteristics of the project subgrade soils. Additionally, the chemical stabilization of the subgrade soils of the above referenced roadways should be performed to the recommended depths provided in Table 6 above and extend a minimum of 18-inches beyond the edge of the paved roadway, shoulder or median. The mix design should be conducted in accordance with ODOT's CMS Supplement 1120 (Mixture Design for Chemically Stabilized Soils). For design purposes it may be assumed that the cement addition will be 5% using the following formula.

$$\text{Cement: } C = 0.75 \times T \times 115 \times 0.05$$

Where:

C = amount of chemical in pounds / square yard and

T = thickness of the treatment zone in inches

- A dry density of 115-pounds per cubic foot (pcf) is assumed.

It should be noted that per ODOT's GB1, *typical chemical stabilization equipment cannot stabilize areas less than 8 ft in width.* If it is anticipated that the project will require multiple maintenance of traffic phases, it is recommended that the roadway work is coordinated with the maintenance of traffic schemes in such a way that an 8-ft minimum width for chemical stabilization exists. If areas of less than 8 ft in width are anticipated, subgrade soils may be excavated out, mixed with stabilization chemical, and compacted in place, though this method is not practical for large areas

5.3. Embankment Stability Analysis

For purposes of evaluating stability of the planned roadway embankments proposed as part of the project, NEAS reviewed cross-sections along the length of the project roadway segments to identify sections that were interpreted to represent conditions that posed the greatest potential for slope instability as a result of the planned construction. In general, cross-sections along each of the proposed roadway alignments were reviewed to identify planned alterations that may present a combination of existing subsurface conditions and planned site grading (i.e., cutting and/or filling) that would potentially be critical to the stability of the existing and/or proposed slopes at the site. Based on our review of the available information along the referenced alignments and the associated soil properties, one cross-section was estimated to be most "critical" for the project and was analyzed for global stability. The cross-section selected to be evaluated is the proposed cross-section at approximate STA. 214+50 (existing US-42 alignment).

For the cross-section, NEAS developed a representative cross-sectional model to use as the basis for global stability analyses. The model was developed from NEAS's interpretation of the available information which included: 1) the project's preliminary Alternative 2 – Preferred Option roadway plans dated November 6, 2018 provided by Strand; 2) a live load surcharge of 240 pounds per square foot (psf) to account for traffic induced loads; and, 3) test borings and laboratory data developed as part of this report.

For analysis purposes, borings performed along or adjacent to the indicated proposed embankment section were reviewed and a generalized material profile was developed for analysis to represent worse case conditions at the cross-section location. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on the field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties for use in analysis (with sited correlation/reference material) is summarized within Table 7 below. The estimated engineering soil properties determined for Borings B-004-0-18 and B-005-0-18 were utilized in the development of the indicated cross-sectional model.

Table 7: Soil Profile and Estimated Engineering Properties – US-42 - STA. 214+50

Embankment Stability Analysis, B-004-0-18 and B-005-0-18				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Clay Elevation (990.5 ft - 975 ft)	110	1600	150	22
Silt and Clay Elevation (975 ft - 960.5 ft)	115	3000	250	27
Notes: *1. Values interpreted from Geotechnical Bulletin 7 Table 1.* *2. Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.* *3. Values interpreted from Geotechnical Bulletin 7 Table 2.*				

The above referenced slope stability model was analyzed for long-term (Effective Stress) and short-term (Total Stress) slope stability utilizing the software entitled *Slide 7.0* by Rocscience, Inc. Specifically, the Modified Bishop and Spencer analysis methods were used to calculate a factor of safety (FOS) for circular and block type slope failures, respectively. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.33 which equates to an AASHTO resistance

factor less than 0.75 (per AASHTO's LRFD BDS the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs). For this analysis, a resistance factor of 0.75 or lower is targeted as the slope does not contain or support a structural element.

Based on our slope stability analyses for the above referenced roadway embankment section, the minimum slope stability safety factor is about 2.17 (0.46 resistance factor) for the section analyzed along US-42 near STA. 214+50. The graphical output of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) for the analyzed section is presented in Appendix E.

5.4. Embankment Construction Recommendations

As indicated above, the embankment cross-section analyzed for slope stability was determined to be stable (i.e., FOS greater than about 1.33) as proposed in the project's preliminary Alternative 2 – Preferred Option roadway plans dated November 6, 2018 provided by Strand. Therefore, the proposed embankment slopes can be constructed in accordance with Item 203 "Roadway Excavation and Embankment" of the ODOT CMS.

In areas where additional embankment material is proposed along existing slopes that are steeper than 8 Horizontal to 1 Vertical (8H:1V) but flatter than 4H:1V, it is recommended that the proposed embankment be benched into the existing slopes in accordance with Item 203.05 "Embankment Construction Methods" of the ODOT CMS. For areas where additional embankment material is proposed along existing slopes that are steeper than 4H:1V, it is recommended that the proposed embankment be designed and constructed in accordance with GB2. For sidehill fills planned on existing slopes steeper than 4H:1V, ODOT's GB2 recommends that *the embankment slopes be constructed utilizing special benching in order to blend the new embankment with the existing slope to prevent the development of a weak shear plane at the interface between the proposed fill and existing slope material* (ODOT [2], 2017). As the project embankment fill slopes were determined to be stable as-proposed based on our embankment stability analysis, a special benching scheme similar to that shown in Figure 1 of the ODOT GB2 can be used in areas where special benching is recommended. The height and width dimensions of the special benching scheme shown in Figure 1 should be arranged to minimize the required cut and fill quantities, though the height of a single bench shall not exceed 20 ft without a stability analysis and design per OSHA requirements. Additionally, it may be appropriate to adjust the bench slope shown from a 1H:1V to a 1.75H:1V slope if the existing slope is made up of primarily granular materials. The benched material should be replaced with compacted engineered fill per Item 203 of the ODOT CMS, while proper lift thicknesses and material density should be maintained in the proposed fill per Item 203.06 of the ODOT CMS. In situations where it is not practical to extend the final bench through the existing roadway due to maintenance of traffic concerns, a benching scheme similar to that shown in Figure 1a of the ODOT GB2 can be used in order to avoid impacting the existing roadway, guardrail or shoulder. This scheme results in the placement of a temporary over-steepened fill that can later be "shaved-off" to bring the slope to the final proposed grade.

5.5. Culvert Foundation Analysis and Recommendations

5.5.1. US Route 42 Culvert – Culvert US-42-4.061

We understand that the existing 50 ft long culvert which directs Church Run from southeast (inlet) to northwest (outlet) at STA. 214+79 (also known as Culvert US-42-4.061), is planned to be extended. Based on the culvert detail plan sheet provided by Strand Associates on November 1, 2019, the existing structure at STA. 214+79 will be extended by 20 ft at both the existing inlet and outlet locations with the addition of a Type A headwall at each. The extension structures will likely be 6 ft by 4 ft pre-cast concrete box culvert extensions supported by the natural silt and clay soil through the use of a shallow foundation system. For analysis purposes, it is assumed that: 1) the culvert invert (flow line) elevation at the inlet location is

approximately 980.5 ft amsl while the culvert invert (flow line) elevation at the outlet location is approximately 978.6 ft amsl; 2) the groundwater elevation is above the bearing elevation; 3) the culvert headwalls will be supported on the natural silt and clay soil; and, 4) appropriate erosion control measures will be implemented to prevent scour of the soil.

To aid in design of the proposed extension of the referenced culvert, each boring log in the area was reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on their field (i.e., SPT N_{60} values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties for evaluation of referenced extension foundations (with sited correlation/reference material) are summarized within Tables 8 and 9, below.

Table 8: Culvert US-42-4.061 Inlet - Estimated Engineering Properties (B-004-0-18)

Culvert US-42-4.061: Foundation Evaluation, B-004-0-18				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Sandy Silt Elevation (990.3 ft - 987.3 ft)	115	-	-	35
Clay Elevation (987.3 ft - 977.3 ft)	120	1900	200	23
Silt and Clay Elevation (977.3 ft - 960.3 ft)	128	3850	300	28
Notes: *1. Values interpreted from Geotechnical Bulletin 7 Table 1.* *2. Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.* *3. Values interpreted from Geotechnical Bulletin 7 Table 2.*				

Table 9: Culvert US-42-4.061 Outlet - Estimated Engineering Properties (B-005-0-18)

Culvert US-42-4.061: Foundation Evaluation, B-005-0-18				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Clay Elevation (990.5 ft - 987.5 ft)	108	1100	100	21
Silty Clay Elevation (987.5 ft - 984.5 ft)	120	2650	250	26
Sandy Silt Elevation (984.5 ft - 982.5 ft)	122	-	-	30
Silt and Clay Elevation (982.5 ft - 977.5 ft)	120	1250	150	23
Silt and Clay Elevation (977.5 ft - 960.5 ft)	122	2350	200	25
Notes: *1. Values interpreted from Geotechnical Bulletin 7 Table 1.* *2. Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.* *3. Values interpreted from Geotechnical Bulletin 7 Table 2.*				

5.5.1.1. Bearing Resistance

Based on the referenced culvert detail plan sheets provided by Strand Associates and headwall foundation dimensions consistent with ODOT's HWDD-1 (Design Data for Concrete Headwalls for Precast Box Culverts) dated July 20, 2018 utilizing a Type A headwall with a 7.5 ft design height, the proposed headwall foundations are estimated to bear at an approximate elevations of 979.0 ft amsl (inlet) and 977.1 ft amsl (outlet). At the estimated bearing elevations, it is anticipated that the footings will bear on clay soil (A-7-6) at the inlet and silt and clay soil (A-6) at the outlet. The soils at these depths were found to exceed the minimum design criteria for bearing soils supporting a Type A headwall within ODOT's HWDD-1 (Design Data for Concrete Headwalls for Precast Box Culverts) dated July 20, 2018. Engineering soil properties used are provided in Tables 8 and 9. Therefore, assuming the backfill and construction techniques at the culvert site are consistent with the recommendations provided in HWDD-1 it is our opinion that the subsurface soils will provide adequate bearing resistance.

5.5.2. US Route 42 Culvert – Culvert US-42-4.839

We understand that the existing 50 ft long culvert which connects drainage ditches from southeast (inlet) to northwest (outlet) near approximate STA. 254+27 (also known as Culvert US-42-4.839), is planned to be replaced. Based on the culvert detail plan sheet provided by Strand Associates on November 1, 2019, the existing structure at approximate STA. 254+27 will be replaced with a 65.5 ft long culvert with standard HW-2.2 half height headwalls. The proposed structure will likely be 24-inch diameter Type B pipe supported by the natural silt and clay soil through the use of a shallow foundation system. For analysis purposes, it is assumed that: 1) the culvert invert (flow line) elevation at the inlet location is approximately 1012.6 ft amsl while the culvert invert (flow line) elevation at the outlet location is approximately 1012.4 ft amsl; 2) the groundwater elevation is above the bearing elevation; 3) the culvert headwalls will be supported on the natural soil; and, 4) appropriate erosion control measures will be implemented to prevent scour of the soil.

To aid in design of the proposed replacement of the referenced culvert, a boring log in the area was reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on their field (i.e., SPT N_{60} values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties for evaluation of replacement culvert foundations (with sited correlation/reference material) are summarized within Table 10, below.

Table 10: Culvert US-42-4.839 - Estimated Engineering Properties (B-021-0-18)

Culvert US-42-4.839: Foundation Evaluation, B-021-0-18				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Silty Clay Elevation (1018.9 ft - 1009.2 ft)	115	600	75	21

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2.*

5.5.2.1. Bearing Resistance

A shallow foundation bearing analysis was performed at the Culvert US-42-4.839 location in accordance with the LRFD BDS, Section 10.6.3.1.2a, utilizing the engineering soil properties presented in Table 10 of this report. Based on the referenced culvert detail plan sheets provided by Strand Associates, the proposed shallow foundation system was assumed to consist of a rectangular spread footing bearing approximately 2.5-ft below ground surface with dimensions constant with ODOT's HW-2.2 (Half-Height Headwalls for Concrete Pipe) dated July 20, 2018 utilizing a 24-inch diameter pipe. The proposed headwalls are estimated to bear at an approximate elevation of 1010.1 and 1009.8 ft amsl at the culvert inlet and outlet location, respectively. At the estimated bearing elevations, it is anticipated that the footings will bear on silty clay soil. Recommended nominal and factored bearing resistances for the proposed culvert headwall foundations are presented in Table 11 (Calculations for Bearing Resistance can be found in Appendix F). Engineering soil properties used to determine bearing resistance are provided in Table 10.

Table 11: Nominal and Factored Bearing Resistance - Culvert US-42-4.839

Culvert Structure	**Nominal Bearing Resistance (ksf) Drained / Undrained**	**LRFD Resistance Factor[1]**	**Factored Bearing Resistance (ksf) Drained / Undrained**
Culvert US-42-4.839	3.0 / 3.4	0.55	1.7 / 1.9

Notes:
1. *Per LRDF Bridge Design Table 11.5.7-1.*

5.5.3. Industrial Parkway Culvert – Culvert Industrial Parkway – 8.471

We understand that the existing approximately 47 ft long culvert which directs Church Run from northeast (inlet) to southwest (outlet) near approximate STA. 111+99 (also known as Culvert Industrial Parkway-8.471), is planned to be extended. Based on the culvert detail plan sheet provided by Strand Associates on November 1, 2019, the existing structure at STA. 111+99 will be extended by 35 ft at the inlet location with the addition of a Type C headwall. The extension structure will likely be twin 54-inch reinforced concrete pipe extensions supported by the natural clay soil through the use of a shallow foundation system. For analysis purposes, it is assumed that: 1) the culvert invert (flow line) elevation at the inlet location is approximately 987.2 ft amsl; 2) the groundwater elevation is above the bearing elevation; 3) the culvert headwalls will be supported on the natural clay soil; and, 4) appropriate erosion control measures will be implemented to prevent scour of the soil.

To aid in design of the proposed extension of the referenced culvert, each boring log was reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on their field (i.e., SPT N_{60} values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties for evaluation of proposed culvert extension foundation (with sited correlation/reference material) are summarized within Tables 12 and 13, below.

Table 12: Industrial Parkway – 8.471 Inlet - Estimated Engineering Properties (B-025-0-18)

Culvert at STA. 223+50 Industrial Pkwy: Foundation Evaluation, B-025-0-18				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Clay Elevation (990.8 ft - 986.3 ft)	108	900	100	21
Clay Elevation (986.3 ft - 982.8 ft)	120	1600	150	22
Silt and Clay Elevation (982.8 ft - 950.8 ft)	125	3000	250	27
Notes: *1. Values interpreted from Geotechnical Bulletin 7 Table 1.* *2. Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.* *3. Values interpreted from Geotechnical Bulletin 7 Table 2.*				

Table 13: Industrial Parkway – 8.471 Outlet - Estimated Engineering Properties (B-026-0-18)

Culvert at STA. 223+50 Industrial Pkwy: Foundation Evaluation, B-026-0-18				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Gravel with Sand and Silt Elevation (994.9 ft - 990.4 ft)	112	-	-	34
Silty Clay Elevation (990.4 ft - 981.9 ft)	108	850	100	22
Silt and Clay Elevation (981.9 ft - 966.9 ft)	122	2350	200	25
Silt and Clay Elevation (966.9 ft - 954.9 ft)	120	1400	150	23
Notes: *1. Values interpreted from Geotechnical Bulletin 7 Table 1.* *2. Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.* *3. Values interpreted from Geotechnical Bulletin 7 Table 2.*				

5.5.3.1. Bearing Resistance

Based on the referenced culvert detail plan sheets provided by Strand Associates and headwall foundation dimensions consistent with ODOT's HWDD-1 (Design Data for Concrete Headwalls for Precast Box Culverts) dated July 20, 2018 utilizing a Type C headwall with a 6.5 ft design height, the proposed headwall foundation is estimated to bear at an approximate elevation of 985.7 ft amsl (inlet). At the estimated bearing elevation, it is anticipated that the footing will bear on clay soil (A-7-6) at the inlet. The soil at this depth

was found to exceed the minimum design criteria for bearing soils supporting a Type C headwall within ODOT's HWDD-1 (Design Data for Concrete Headwalls for Precast Box Culverts) dated July 20, 2018. Engineering soil properties used are provided in Tables 11 and 12. Therefore, assuming the backfill and construction techniques at the culvert site are consistent with the recommendations provided in HWDD-1 it is our opinion that the subsurface soils will provide adequate bearing resistance.

5.6. Signal Pole Foundations Recommendations

It is our understanding that a total of ten (10) new traffic signal poles are proposed as part of the project consisting of three (3) signal poles at the US-42 intersection with Ramps A and B, three (3) at the US-42 intersection with Ramps C and D, and four (4) at the intersection of Industrial Pkwy and US-42. To aide in the evaluation of signal pole foundation design, the boring logs located adjacent to proposed signal pole locations were reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties (i.e., shear strength and unit weight) including properties for lateral load analysis (i.e., LPILE analysis) for each soil strata were estimated based on their field (i.e., SPT N_{60} values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties for evaluation of proposed signal pole foundations (with sited correlation/reference material) are summarized within Table 14 below.

Table 14: Shear Strength and LPILE Parameters at Signal Pole Locations

Shear Strength and LPILE Parameters							
Boring Number	p-y model	Elevation (ft-amsl)	Effective Unit Weight[(1)] (pcf)	Friction Angle[(2)] (degrees)	Undrained Shear Strength[(3)] (psf)	Lateral Soil Modulus Parameter, k (pci)	Soil Strain Parameter, E_{50} (%)
B-006-0-18	Stiff Clay w/o Water	998.2 - 990.2	122	25	2,100	700	0.0060
	Stiff Clay w/o Water	990.2 - 973.2	125	27	3,250	1,080	0.0049
B-007-0-18	Stiff Clay w/o Water	998.5 - 993.0	122	25	2,250	750	0.0059
	Stiff Clay w/o Water	993.0 - 973.5	125	27	3,450	1,150	0.0048
B-008-0-18	Stiff Clay w/o Water	997.6 - 989.6	120	22	2,500[(4)]	500	0.0073
	Stiff Clay w/o Water	989.6 - 972.6	125	26	2,950	990	0.0051
B-014-0-18	Stiff Clay w/o Water	1020.2 - 1014.7	122	25	2,250	750	0.0059
	Stiff Clay w/o Water	1014.7 - 995.2	125	27	3,100	1,080	0.0049
B-015-0-18	Stiff Clay w/o Water	1020.1 - 1007.1	122	25	2,100	700	0.0060
	Stiff Clay w/o Water	1007.1 - 995.1	125	27	3,100	1,040	0.0050
B-016-0-18	Stiff Clay w/o Water	1022.9 - 1012.4	122	24	2,100	700	0.0060
	Stiff Clay w/o Water	1012.4 - 997.9	122	25	2,350	790	0.0057
B-017-0-18	Stiff Clay w/o Water	1026.0 - 1023.0	122	24	4,000[(4)]	580	0.0067
	Stiff Clay w/o Water	1023.0 - 1020.5	122	30	-	40	-
	Stiff Clay w/o Water	1013.0 - 1001.0	122	25	2,350	790	0.0057
B-018-0-18	Stiff Clay w/o Water	1024.4 - 1013.9	125	27	3,000	1,000	0.0051
	Stiff Clay w/o Water	1013.9 - 1008.9	128	27	3,600	1,200	0.0047
	Stiff Clay w/o Water	1008.9 - 999.4	128	29	4,350	1,450	0.0044
B-019-0-18	Stiff Clay w/o Water	1024.2 - 1011.2	122	24	2,000	650	0.0062
	Stiff Clay w/o Water	1011.2 - 999.2	125	27	3,350	1,120	0.0048
B-027-0-18	Stiff Clay w/o Water	999.7 - 974.7	122	23	2,000	660	0.0062

Notes:

1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$ <52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2.*
4. *Based on the minimum unconfined compressive strength value obtained within subject layer, estimated by hand penetrometer.*

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface and groundwater conditions within the project limits. This report has been prepared for Strand Associates, Inc., ODOT and their design consultants to be used solely in evaluating the roadway subgrade soils and proposed structure foundation soils within the project limits and presenting geotechnical engineering recommendations specific to this project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory tests results from representative soil samples, and geotechnical engineering analyses. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes occur in the nature, design or location of the proposed roadway or structure foundation work, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed, and have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to Strand Associates, Inc. in performing this geotechnical exploration for the UNI-42-3.91/4.38 project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Brendan P. Andrews, P.E.
Project Manager/Sr. Geotechnical Engineer

Kevin C. Arens, P.E.
Geotechnical Engineer

REFERENCES

AASHTO. (2017). *LRFD Bridge Design Specifications.* Washington, D.C.: American Association of State Highway and Transportation Officials.

ODGS. (1998). Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey. page-size map with text, 2p., scale 1:2,100,00.

ODGS. (2005). Surficial geology of the western portion of the Lancaster 30 x 60-minute quadrangle: Ohio Division of Geological Survey Map SG-2 Lancaster. scale 1:100,000.

ODNR [1]. (2016). Ohio Abandoned Mine Locator Interactive Map. *Mines of Ohio*. Ohio Department of Natural Resources, Division of Geological Survey & Division of Mineral Resources. Retrieved from https://gis.ohiodnr.gov/MapViewer/?config= OhioMines

ODNR [2]. (2016). Ohio Oil & Gas Locator Interactive Map. *Ohio Oil & Gas Wells*. Ohio Department of Natural Resources, Division of Oil and Gas. Retrieved from https://gis.ohiodnr.gov/MapViewer/?config= oilgaswells

ODOT [1]. (2019). *Geotechnical Bulletin 1.* Columbus, Ohio: Ohio Department of Transportation: Office of Geotechnical Engineering. Retrieved from https://www.dot.state.oh.us/Divisions/Engineering/Geotechnical/Geotechnical_Documents/GB1_Plan_Subgrades.pdf

ODOT [2]. (2017). *Geotechnical Bulletin 2: Special Benching and Sidehill Embankment Fills.* Columbus, Ohio: Ohio Department of Transportation: Office of Geotechnical Engineering. Retrieved from http://www.dot.state.oh.us/Divisions/Engineering/Geotechnical/Pages/Manuals.aspx

ODOT. (2015). *Pavement Design Manual.* Columbus, Ohio: Ohio Department of Transportation: Office of Pavement Engineering. Retrieved from http://www.dot.state.oh.us/Divisions/Engineering/Pavement/Pavement%20Design%20%20Rehabilitation%20Manual/Complete_PDM_2015-07-17_version.pdf

ODOT. (2019). *2019 Bridge Design Manual.* Columbus, OH: Ohio Department of Transportation: Office of Structural Engineering.

ODOT. (2019). *Specifications for Geotechnical Explorations.* Ohio Department of Transportation: Office of Geotechnical Engineering.

USDA. (2015, September). Web Soil Survey. Retrieved from http://websoilsurvey.nrcs.usda.gov

USGS & ODGS. (2006, June). Geologic Units of Ohio. *ohgeol.kmz*. United States Geologic Survey.

APPENDIX A

BORING LOCATION PLAN

P:\19-0041 (107822 UNI-42-3.91-4.38)\107822\geotechnical\docs\Proposal\Target Boring Plan\DGNs\UNI-42-0391_0438 Target Boring Plan1.dgn Sheet1 12/13/2019 9:13:04 AM karens

PROJECT BORING LOCATION

3 / 1	UNI-42-3.91/ 4.38	BORING LOCATION PLAN	DRAWN KCA CHECKED BPA	0 100 50 200 HORIZONTAL SCALE IN FEET	

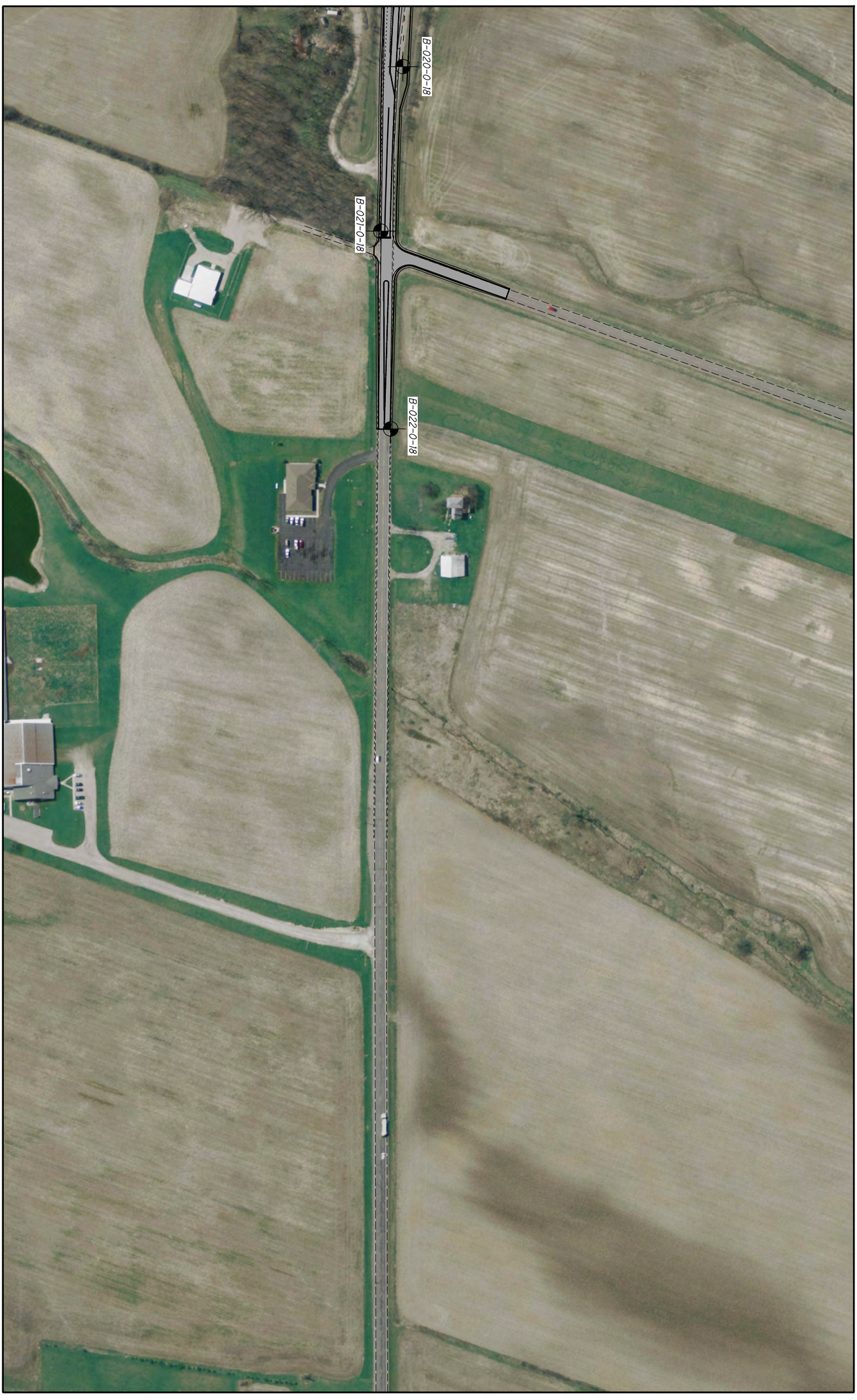
P:\19-0041 (107822 UNI-42-3.91-4.38)\107822\geotechnical\docs\Proposal\Target Boring Plan\DGNs\UNI-42-0391_0438 Target Boring Plan2.dgn Sheet1 12/13/2019 11:39:32 AM karens

PROJECT BORING LOCATION

3 2 1	UNI-42-3.91/ 4.38	BORING LOCATION PLAN	DRAWN KCA CHECKED BPA	0 100 50 200 HORIZONTAL SCALE IN FEET	

P:\19-0041 (107822 UNI-42-3.91-4.38)\107822\geotechnical\docs\Proposal\Target Boring Plan\DGNs\UNI-42-0391_0438 Target Boring Plan3.dgn Sheet1 12/13/2019 11:43:44 AM karens

PROJECT BORING LOCATION



3 / 3	UNI-42-3.91/ 4.38	BORING LOCATION PLAN	DRAWN KCA	0 100	
			CHECKED BPA	50 200 HORIZONTAL SCALE IN FEET	

APPENDIX B

BORING LOGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1003.1 (MSL) EOB: 7.5 ft.
START: 6/27/19 END: 6/27/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.153160, -83.239505

EXPLORATION ID B-001-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1003.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" ASPHALT AND 10.0" BASE (DRILLERS DESCRIPTION)	1001.9	1																
HARD, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP	1000.1	2	5 3 4	9	67	SS-1	4.5+	2	15	16	38	29	26	17	9	16	A-4a (6)	
VERY STIFF, BROWN MOTTLED WITH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST	998.6	3	3 3 3	8	56	SS-2	2.50	3	3	8	22	64	47	21	26	26	A-7-6 (16)	
VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP	997.1	4	4 4 5	12	78	SS-3	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
HARD, BROWN AND GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP	995.6	5 6 7	5 7 9	21	78	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1002.6 (MSL) EOB: 7.5 ft.
START: 6/27/19 END: 6/27/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.153758, -83.239010

EXPLORATION ID B-002-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1002.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
3.0" ASPHALT AND 11.5" BASE (DRILLERS DESCRIPTION)	1001.4	1																
MEDIUM DENSE, BROWN AND GRAY, **STONE FRAGMENTS WITH SAND AND SILT**, LITTLE CLAY, CONTAINS CONCRETE AND ASPHALT FRAGMENTS, DAMP **(FILL)**	999.6	2	12 10 12	29	22	SS-1	-	-	-	-	-	-	-	-	-	9	A-2-4 (V)	
HARD, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		3	7 13 13	34	78	SS-2	4.5+	6	8	10	31	45	36	19	17	15	A-6b (11)	
		4																
		5	5 8 9	22	78	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
		6																
	995.1	7 EOB	7 13 15	36	78	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 993.8 (MSL) EOB: 7.5 ft.
START: 6/27/19 END: 6/27/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.154621, -83.238049

EXPLORATION ID B-003-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" APSHALT AND 8.0" BASE (DRILLERS DESCRIPTION)	993.8 992.8	1																
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	990.8	2	5 7 5	16	67	SS-1	4.5+	10	13	16	34	27	29	18	11	16	A-6a (6)	
VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST		3 4	3 4 5	12	67	SS-2	3.50	-	-	-	-	-	-	-	-	26	A-6b (V)	
		4 5	5 3 5	10	100	SS-3	2.50	2	5	9	37	47	40	22	18	25	A-6b (11)	
	986.3	6 EOB 7	3 6 7	17	100	SS-4	3.00	-	-	-	-	-	-	-	-	26	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:	EXPLORATION ID B-004-0-18	
TYPE: CULVERT	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 990.3 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1	
START: 6/27/19 END: 6/27/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.155233, -83.237433		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" ASPHALT AND 8.0" CONCRETE AND 4.0" BASE (DRILLERS DESCRIPTION)	990.3																	
	989.0																	
MEDIUM DENSE, BROWN AND GRAY, **SANDY SILT**, SOME GRAVEL, SOME CLAY, CONTAINS TRACE ASPHALT FRAGMENTS, DAMP **(FILL)**	987.3	1	5 6 8	18	17	SS-1	-	35	6	6	21	32	NP	NP	NP	13	A-4a (4)	
HARD, BROWN AND GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, CONTAINS TRACE IRON STAINING AND ASPHALT FRAGMENTS, DAMP **(FILL)**		2	5 6 8	18	56	SS-2	4.5+	14	14	13	29	30	33	18	15	14	A-6a (7)	
		3	3 6 8	18	56	SS-3	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		4	5 5 5	13	17	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		5																
	979.8	6																
VERY STIFF, BROWN MOTTLED WITH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS TRACE ROOTS, MOIST	977.3	7	3 4 6	13	100	SS-5	3.75	2	3	9	32	54	42	20	22	21	A-7-6 (13)	
VERY STIFF TO HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		8																
		9	3 7 12	25	100	SS-6	4.5+	-	-	-	-	-	-	-	-	15	A-6a (V)	
		10																
		11	4 10 12	29	100	SS-7	3.25	7	8	10	40	35	34	20	14	18	A-6a (10)	
		12																
		13	5 11 13	31	100	SS-8A	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
@19.3' TO 20.0'; SS-9B BECOMES GRAY, SOME SAND		14				SS-8B	3.25	-	-	-	-	-	-	-	-	16	A-6a (V)	
		15																
		16	7 10 15	33	100	SS-9	4.25	-	-	-	-	-	-	-	-	16	A-6a (V)	
		17																
		18	5 9 13	29	100	SS-10	3.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
		19																
		20	5 13 13	34	100	SS-11	2.50	4	4	8	37	47	31	18	13	19	A-6a (9)	
		21																
		22	7 13 15	36	100	SS-12	2.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
	960.3	EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: CULVERT	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 990.5 (MSL) EOB: 30.0 ft.
START: 6/27/19 END: 6/27/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.155305, -83.237466

EXPLORATION ID B-005-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
8.0" CONCRETE AND 6.0" BASE (DRILLERS DESCRIPTION)	990.5																	
	989.3																	
VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST		1	1 3 4	9	56	SS-1	3.25	3	4	10	27	56	41	18	23	21	A-7-6 (13)	
	987.5	2																
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS ASPHALT FRAGMENTS, DAMP		3	4 7 11	23	67	SS-2	3.00	7	8	10	30	45	36	20	16	19	A-6b (10)	
	986.0	4																
VERY STIFF, BROWN, **SANDY SILT**, LITTLE GRAVEL, LITTLE CLAY, DAMP		5	4 7 8	20	44	SS-3	2.50	-	-	-	-	-	-	-	-	16	A-4a (V)	
		6	2 3 3	8	78	SS-4	2.50	18	22	16	27	17	25	16	9	14	A-4a (2)	
	982.5	7																
STIFF TO HARD, BROWN BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		8																
		9	2 2 3	7	22	SS-5	4.00	-	-	-	-	-	-	-	-	20	A-6a (V)	
		10																
		11	3 4 6	13	56	SS-6	1.25	-	-	-	-	-	-	-	-	20	A-6a (V)	
		12																
		13	5 5 6	14	78	SS-7	4.5+	-	-	-	-	-	-	-	-	19	A-6a (V)	
		14																
		15	6 7 6	17	78	SS-8	4.5+	3	4	9	38	46	34	20	14	17	A-6a (10)	
		16																
		17	5 7 11	23	100	SS-9	4.5+	-	-	-	-	-	-	-	-	14	A-6a (V)	
		18																
		19	7 8 10	23	100	SS-10	4.5+	-	-	-	-	-	-	-	-	15	A-6a (V)	
		20																
		21	5 5 7	16	78	SS-11	4.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
		22																
		23	5 7 8	20	100	SS-12	3.25	4	5	8	35	48	32	18	14	18	A-6a (10)	
		24																
		25	4 8 8	21	100	SS-13	2.25	-	-	-	-	-	-	-	-	19	A-6a (V)	
	960.5	EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 998.2 (MSL) EOB: 25.0 ft.
START: 7/2/19 END: 7/2/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.155999, -83.236631

EXPLORATION ID B-006-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 998.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
7.5" ASPHALT AND 5.5" BASE (DRILLERS DESCRIPTION)	997.1	1																
HARD, BLACK AND GRAY, **SANDY SILT**, LITTLE GRAVEL, LITTLE CLAY, CONTAINS ASPHALT FRAGMENTS, DAMP **(FILL)**	995.2	2	6 5 3	10	17	SS-1	4.5+	-	-	-	-	-	-	-	-	14	A-4a (V)	
VERY STIFF, BROWN MOTTLED WITH GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS TRACE ASPHALT FRAGMENTS, MOIST **(FILL)**	993.7	3 4	2 3 6	12	56	SS-2	3.75	3	5	10	30	52	40	20	20	21	A-6b (12)	
VERY STIFF TO HARD, BROWN WITH TRACE GRAY MOTTLES, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP		5 6	2 4 5	12	56	SS-3	4.50	10	9	12	29	40	34	19	15	17	A-6a (9)	
		7	2 4 6	13	78	SS-4	2.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
		8 9	4 6 9	20	100	SS-5	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		10 11	4 6 11	22	100	SS-6	4.5+	3	5	9	35	48	33	19	14	17	A-6a (10)	
	982.7	12 13	4 7 11	23	78	SS-7	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
HARD, BROWN, **SANDY SILT**, SOME GRAVEL, LITTLE CLAY, DAMP	979.7	14 15	6 10 15	33	67	SS-8	4.5+	25	16	19	24	16	23	16	7	11	A-4a (1)	
HARD, BROWN WITH TRACE GRAY MOTTLES, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP		16 17	2 7 10	22	67	SS-9	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
@21.0' TO 22.5'; SS-10 CONTAINS GYPSUM		18 19	3 8 14	29	100	SS-10	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
	973.2	20 21 EOB	4 10 15	33	100	SS-11	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 998.5 (MSL) EOB: 25.0 ft.
START: 7/2/19 END: 7/2/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.156228, -83.236678

EXPLORATION ID B-007-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
	998.5																	
4.0" TOPSOIL (DRILLERS DESCRIPTION)	998.2																	
HARD, BROWN, **SILTY CLAY**, SOME SAND, SOME GRAVEL, CONTAINS TRACE ROOT HAIRS, DAMP	995.5	1	7 5 5	13	33	SS-1	4.5+	21	13	10	27	29	34	18	16	13	A-6b (7)	
VERY STIFF TO HARD, BROWN BECOMING BROWNISH GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP		2 3 4 5	2 2 5	9	44	SS-2	4.5+	4	4	8	34	50	34	20	14	16	A-6a (10)	
		6 7 8	5 7 8	20	100	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
		9 10	3 7 8	20	100	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		11 12 13	3 7 13	26	78	SS-5	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
@13.5' TO 15.0'; SS-6 CONTAINS GYPSUM		14 15	4 8 13	27	78	SS-6	4.50	5	6	9	35	45	34	20	14	17	A-6a (10)	
		16 17	3 7 10	22	78	SS-7	4.25	-	-	-	-	-	-	-	-	16	A-6a (V)	
		18 19 20	7 9 15	31	100	SS-8	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
@21.0' TO 22.5'; SS-9 CONTAINS GYPSUM		21 22 23	7 11 17	36	100	SS-9	4.5+	-	-	-	-	-	-	-	-	20	A-6a (V)	
	973.5	EOB 24 25	6 13 17	39	100	SS-10	2.50	-	-	-	-	-	-	-	-	17	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-008-0-18
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:	
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 997.6 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 6/24/19 END: 6/24/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.156455, -83.236546	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" TOPSOIL (DRILLERS DESCRIPTION)	997.6 / 997.3																	
VERY STIFF, BROWNISH GRAY CHANGING TO BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **CLAY**, SOME TO "AND" SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST TO DAMP **(FILL)**		1 2	2 3 3	8	67	SS-1	3.50	1	5	10	38	46	47	25	22	27	A-7-6 (14)	
		3 4 5 6 7	3 3 3	8	100	SS-2	3.00	1	4	10	31	54	52	23	29	25	A-7-6 (18)	
	989.6		2 3 3	8	67	SS-3	2.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
HARD, BROWN, **SILT**, SOME CLAY, TRACE SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP	987.1	8 9 10	10 10 10	28	100	SS-4	4.5+	2	2	6	59	31	27	18	9	18	A-4b (8)	
HARD, BROWNISH GRAY BECOMING BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, CONTAINS TRACE ROOT HAIRS, DAMP TO MOIST		11 12 13	4 8 10	25	100	SS-5	4.5+	-	-	-	-	-	-	-	-	16	A-4a (V)	
		14 15	2 5 6	15	100	SS-6	4.5+	3	7	11	47	32	28	18	10	17	A-4a (8)	
@16.0' TO 17.5'; SS-7 CONTAINS GYPSUM	979.6	16 17	3 6 9	21	56	SS-7	4.5+	-	-	-	-	-	-	-	-	19	A-4a (V)	
VERY STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		18 19 20	4 6 10	22	100	SS-8	2.25	-	-	-	-	-	-	-	-	18	A-6b (V)	
		21 22 23	4 8 11	27	100	SS-9	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
	972.6	EOB 24 25	6 8 13	29	100	SS-10	2.75	-	-	-	-	-	-	-	-	18	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-009-0-18	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1004.8 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1	
START: 6/24/19 END: 6/24/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.157011, -83.235749		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
3.5" ASPHALT (DRILLERS DESCRIPTION)	1004.8																	
	1004.5																	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, SS-3 CONTAINS TRACE IRON STAINING, MOIST TO DAMP		1																
		2	2 3 3	8	67	SS-1	2.50	3	10	11	37	39	36	18	18	21	A-6b (11)	
		3	WOH 2 6	11	67	SS-2	2.25	-	-	-	-	-	-	-	-	21	A-6b (V)	
		4	3 5 8	18	100	SS-3	3.50	2	5	9	36	48	40	20	20	20	A-6b (12)	
		5																
		6	3 7 7	20	67	SS-4	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
	997.3	7 EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-010-0-18
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:	
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1011.2 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 7/3/19 END: 7/3/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.157843, -83.234785	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1011.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
18.0" TOPSOIL @0.0' TO 1.5'; SS-1 CONTAINS ONLY TOPSOIL, CONTAINS MANY ROOTS	1009.7	1	WOH 2 3	7	6	SS-1	-	-	-	-	-	-	-	-	-	52		
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, TRACE TO LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING AND TRACE ROOTS, MOIST TO DAMP @1.5' TO 3.0'; SS-2 CONTAINS WOOD FRAGMENTS		2	2 3 3	8	28	SS-2	2.50	1	3	7	31	58	54	23	31	30	A-7-6 (19)	
		3	2 3 6	13	56	SS-3	3.25	2	4	7	33	54	45	21	24	26	A-7-6 (15)	
		4																
		5	3 5 5	14	56	SS-4	4.5+	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		6																
	1003.7	7	5 6 6	17	33	SS-5	4.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1012.7 (MSL) EOB: 7.5 ft.
START: 6/24/19 END: 6/24/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.158797, -83.234063

EXPLORATION ID B-011-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1012.7																		
3.0" TOPSOIL (DRILLERS DESCRIPTION)	1012.4																	
HARD, BROWN, **SILTY CLAY**, TRACE TO LITTLE SAND, TRACE GRAVEL, CONTAINS ROOTS, DAMP TO MOIST		1	2 4 4	11	56	SS-1	4.5+	-	-	-	-	-	-	-	-	19	A-6b (V)	
	1009.7	2	2 3 3	8	67	SS-2	4.25	1	3	6	47	43	39	21	18	25	A-6b (11)	
VERY STIFF, BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **CLAY**, SOME SILT, TRACE TO LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST TO DAMP		3	2 2 3	7	67	SS-3	2.75	1	3	7	31	58	58	24	34	27	A-7-6 (20)	
		4	2 3 6	13	67	SS-4	3.00	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		5																
		6																
	1005.2	7	2 5 8	18	67	SS-5	2.25	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1017.0 (MSL) EOB: 7.5 ft.
START: 6/21/19 END: 6/21/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.159558, -83.233034

EXPLORATION ID B-012-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1017.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.5" ASPHALT MILLINGS AND GRAVEL (DRILLERS DESCRIPTION)	1016.2	1																
HARD, BROWN AND GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP		2	3 7 5	17	56	SS-1	4.5+	7	6	10	34	43	35	19	16	16	A-6b (10)	
		3	3 4 4	11	44	SS-2	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
	1011.0	4																
VERY STIFF, BROWN AND DARK GRAY, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, MOIST		5	3 5 6	15	72	SS-3	4.5+	20	13	12	27	28	34	18	16	15	A-6b (6)	
	1009.5	6	3 3 5	11	72	SS-4	2.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
	EOB	7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: CULVERT	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1018.9 (MSL) EOB: 40.0 ft.
START: 7/2/19 END: 7/2/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.159731, -83.232846

EXPLORATION ID B-013-0-18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
8.0" ASPHALT MILLINGS AND GRAVEL (DRILLERS DESCRIPTION)	1018.2																	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP TO MOIST		1	3 5 6	14	33	SS-1	4.5+	10	8	12	33	37	34	18	16	13	A-6b (9)	
		2																
		3																
		4	4 4 6	13	67	SS-2	4.5+	3	5	11	37	44	34	18	16	17	A-6b (10)	
		5																
		6																
		7	3 4 6	13	67	SS-3	3.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
	1010.9	8																
VERY STIFF TO HARD, BROWN BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, SS-4 AND SS-5 CONTAIN TRACE IRON STAINING, DAMP TO MOIST		9	4 7 10	22	67	SS-4	3.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
		10																
		11																
		12	3 8 11	25	78	SS-5	4.5+	4	7	11	33	45	33	20	13	16	A-6a (9)	
		13																
		14	3 8 10	23	78	SS-6	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		15																
		16																
		17	4 7 12	25	78	SS-7	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		18																
		19	4 7 11	23	78	SS-8	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
		20																
		21																
		22	5 7 11	23	100	SS-9	4.25	7	6	10	38	39	28	16	12	15	A-6a (9)	
		23																
@23.5' TO 40.0'; BECOMES GRAY		24	5 8 10	23	100	SS-10	3.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
		25																
		26																
		27	4 7 7	18	100	SS-11	4.25	-	-	-	-	-	-	-	-	17	A-6a (V)	
		28																
		29	4 8 7	20	100	SS-12	3.00	-	-	-	-	-	-	-	-	17	A-6a (V)	

PID: 107822	SFN:	PROJECT: UNI-42-03.91	STATION / OFFSET:	START: 7/2/19	END: 7/2/19	PG 2 OF 2	B-013-0-18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, BROWN BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, SS-4 AND SS-5 CONTAIN TRACE IRON STAINING, DAMP TO MOIST *(continued)*	988.9	31 32 33 34 35 36 37 38 39 40																
		W 983.9	6 9 7	21	100	SS-13	3.00	4	4	9	37	46	30	17	13	17	A-6a (9)	
	978.9	EOB	6 8 10	23	17	SS-14	3.00	-	-	-	-	-	-	-	-	17	A-6a (V)	

NOTES: GROUNDWATER ENCOUNTERED AT 35.0' DURING DRILLING. HOLE CAVED IN AT 14.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1020.2 (MSL) EOB: 25.0 ft.
START: 6/24/19 END: 6/24/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.160129, -83.232859

EXPLORATION ID B-014-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
10.0" GRAVEL AND ASPHALT MILLINGS (DRILLERS DESCRIPTION)	1020.2 / 1019.4																	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, SS-2 AND SS-3 CONTAIN TRACE IRON STAINING, DAMP TO MOIST		1 2 3 4 5 6 7 8 9 10	2 4 4	11	56	SS-1	4.50	2	4	9	36	49	39	21	18	19	A-6b (11)	
			2 3 5	11	89	SS-2	3.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
			4 6 10	22	100	SS-3	4.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
	1009.7		5 8 6	20	100	SS-4	4.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
HARD, GRAY AND BROWN BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	4 6 9	21	100	SS-5	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
			8 11 13	34	100	SS-6	4.5+	4	6	9	35	46	35	20	15	16	A-6a (10)	
			8 9 12	29	100	SS-7	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
@18.5' TO 20.0'; SS-8 CONTAINS GYPSUM			5 6 10	22	100	SS-8	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
			5 9 11	28	100	SS-9	4.5+	6	8	12	36	38	31	17	14	16	A-6a (9)	
	995.2 EOB		6 8 10	25	100	SS-10	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 8/21/19 15:04 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\UNI-42-3.91\GINT FILES\UNI-42-3.91.GPJ

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1020.1 (MSL) EOB: 25.0 ft.
START: 6/21/19 END: 6/21/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.159928, -83.232533

EXPLORATION ID B-015-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
11.0" BASE AND ASPHALT MILLINGS (DRILLERS DESCRIPTION)	1020.1																	
	1019.2																	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, SS-2 TO SS-6 CONTAINS IRON STAINING, DAMP TO MOIST		1	5 5 3	11	0	SS-1	-	-	-	-	-	-	-	-	-	-		
@1.0' TO 2.5'; SS-1 HAS NO RECOVERY		2																
		3																
		4	4 5 6	15	78	SS-2	4.5+	2	5	9	37	47	39	21	18	19	A-6b (11)	
		5																
		6																
		7	4 5 6	15	83	SS-3	4.00	-	-	-	-	-	-	-	-	22	A-6b (V)	
		8																
		9	3 4 6	14	67	SS-4	4.25	-	-	-	-	-	-	-	-	20	A-6b (V)	
		10																
		11																
		12	2 3 5	11	89	SS-5	3.25	-	-	-	-	-	-	-	-	24	A-6b (V)	
		13																
		14	4 7 8	21	72	SS-6	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
		15																
@16.0' TO 25.0'; BECOMES BROWN AND GRAY		16																
		17	5 10 12	31	83	SS-7	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
		18																
		19	5 5 8	18	100	SS-8	4.5+	5	6	10	38	41	33	17	16	16	A-6b (10)	
		20																
		21																
		22	6 10 12	31	100	SS-9	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
		23																
		24	7 9 12	29	100	SS-10	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
	995.1	EOB 25																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1022.9 (MSL) EOB: 25.0 ft.
START: 7/8/19 END: 7/8/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.160177, -83.232401

EXPLORATION ID B-016-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1022.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
8.5" ASPHALT AND 8.0" BASE (DRILLERS DESCRIPTION)	1021.5	1																
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE TO SOME SAND, LITTLE GRAVEL, SS-3 CONTAINS TRACE BLACK ORGANICS, DAMP TO MOIST		2	4 3 5	10	33	SS-1	3.50	11	13	11	29	36	35	18	17	15	A-6b (9)	
		3	3 3 5	10	56	SS-2	2.75	11	7	9	31	42	39	19	20	19	A-6b (12)	
	1016.9	4 5	4 6 7	17	67	SS-3	4.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
VERY STIFF, BROWN MOTTLED WITH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST		6	4 5 5	13	100	SS-4	3.50	1	3	8	35	53	46	21	25	21	A-7-6 (15)	
	1012.4	7 8																
HARD, GRAY AND BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP		9	4 4 6	13	78	SS-5	3.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
	1009.9	10 11																
VERY STIFF, BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST		12	7 7 9	21	100	SS-6	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
	1007.4	13 14																
VERY STIFF TO HARD, BROWN AND GRAY BECOMING GRAY, **SILTY CLAY**, LITTLE SAND, TRACE TO LITTLE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP		15	4 5 7	16	100	SS-7	2.50	1	2	6	31	60	53	21	32	24	A-7-6 (19)	
		16 17	5 6 8	18	100	SS-8	3.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
		18 19	6 7 11	23	100	SS-9	4.5+	4	5	9	35	47	35	19	16	18	A-6b (10)	
		20 21	7 8 8	21	100	SS-10	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
	997.9	22 23 24 EOB 25	4 6 8	18	100	SS-11	4.50	-	-	-	-	-	-	-	-	17	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:	EXPLORATION ID B-017-0-18	
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1026.0 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1	
START: 7/8/19 END: 7/8/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.162036, -83.230831		

MATERIAL DESCRIPTION AND NOTES	ELEV. 1026.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
7.0" ASPHALT AND 10.0" BASE (DRILLERS DESCRIPTION)																		
@1.0' TO 1.4'; SS-1A IS GRANULAR BASE	1024.6					SS-1A	-	-	-	-	-	-	-	-	-	-		
VERY STIFF TO HARD, BROWN MOTTLED WITH ORANGISH BROWN, **SILT AND CLAY**, SOME SAND, TRACE TO SOME GRAVEL, CONTAINS TRACE IRON STAINING, DAMP TO MOIST			2 2 4	8	33	SS-1B	4.5+	8	10	11	34	37	33	18	15	15	A-6a (9)	
			4 3 4	9	33	SS-2	4.5+	27	18	8	24	23	31	17	14	9	A-6a (4)	
			7 4 4	10	56	SS-3	4.00	-	-	-	-	-	-	-	-	25	A-6a (V)	
	1015.5		4 5 6	14	61	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
STIFF TO HARD, BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, CONTAINS IRON STAINING, DAMP TO MOIST			3 5 6	14	89	SS-5	4.25	-	-	-	-	-	-	-	-	20	A-6b (V)	
			4 5 10	20	67	SS-6	1.75	11	9	12	36	32	37	19	18	17	A-6b (10)	
			3 4 7	14	83	SS-7	2.75	-	-	-	-	-	-	-	-	20	A-6b (V)	
			4 6 7	17	67	SS-8	3.75	-	-	-	-	-	-	-	-	26	A-6b (V)	
@21.0' TO 22.5'; SS-9 CONTAINS GYPSUM			5 9 11	26	100	SS-9	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
	1001.0	EOB	7 9 14	30	89	SS-10	4.50	-	-	-	-	-	-	-	-	19	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 8/21/19 15:04 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\UNI-42-3.91\GINT FILES\UNI-42-3.91.GPJ

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1024.4 (MSL) EOB: 25.0 ft.
START: 6/25/19 END: 6/25/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.162115, -83.230388

EXPLORATION ID B-018-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" ASPHALT (DRILLERS DESCRIPTION)	1024.4 / 1024.1																	
HARD, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		1	3 7 7	20	67	SS-1	4.5+	4	6	12	36	42	35	18	17	16	A-6b (11)	
		2																
		3																
		4	5 5 7	17	78	SS-2	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
		5																
		6																
		7	3 5 7	17	78	SS-3	4.25	-	-	-	-	-	-	-	-	20	A-6b (V)	
		8																
		9	3 5 7	17	78	SS-4	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
	1013.9	10																
VERY STIFF TO HARD, LIGHT BROWN AND GRAY, **CLAY**, SOME SILT, TRACE TO LITTLE GRAVEL, LITTLE SAND, DAMP		11	4 7 11	25	78	SS-5	4.00	19	6	9	32	34	42	21	21	18	A-7-6 (11)	
		12																
		13	4 8 13	29	78	SS-6	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
	1008.9	14																
HARD, LIGHT BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		15	5 8 14	31	78	SS-7	4.25	-	-	-	-	-	-	-	-	18	A-6b (V)	
		16																
		17	6 11 15	36	100	SS-8	4.5+	-	-	-	-	-	-	-	-	22	A-6b (V)	
		18																
		19	7 12 18	42	100	SS-9	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
		20																
		21																
@23.5' TO 25.0'; SS-10 CONTAINS GYPSUM		22	7 14 18	45	100	SS-10	4.5+	3	5	7	29	56	38	21	17	18	A-6b (11)	
	999.4	23																
	EOB	24																
		25																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-019-0-18	
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1024.2 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1	
START: 6/25/19 END: 6/25/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.162331, -83.230562		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1024.2																		
4.0" ASPHALT (DRILLERS DESCRIPTION)	1023.9																	
HARD, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP TO MOIST		1																
		2	4 4 5	13	67	SS-1	4.5+	6	5	11	38	40	34	18	16	17	A-6b (10)	
		3	2 2 5	10	56	SS-2	4.50	5	7	10	38	40	34	18	16	17	A-6b (10)	
		4	2 3 6	13	56	SS-3	4.50	-	-	-	-	-	-	-	-	18	A-6b (V)	
		5	3 4 5	13	67	SS-4	4.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
		6																
		7	4 5 6	15	78	SS-5	4.5+	-	-	-	-	-	-	-	-	18	A-6b (V)	
		8																
		9	4 3 5	11	78	SS-6	4.25	-	-	-	-	-	-	-	-	23	A-6b (V)	
		10																
		11	5 5 10	21	100	SS-7	4.5+	4	5	13	47	31	27	18	9	19	A-4a (8)	
		12																
		13	3 9 13	31	78	SS-8	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
		14																
		15	5 10 11	29	78	SS-9	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
		16																
		17	6 10 11	29	78	SS-10	4.5+	-	-	-	-	-	-	-	-	21	A-6b (V)	
		18																
		19	7 11 13	34	100	SS-11	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
		20																
		21																
		22																
		23																
		24																
HARD, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, MOIST	1011.2																	
HARD, GRAY AND BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST	1008.7																	
	999.2	25 EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1019.3 (MSL) EOB: 7.5 ft.
START: 6/25/19 END: 6/25/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.163127, -83.229588

EXPLORATION ID B-020-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.5" ASPHALT MILLINGS AND GRAVEL (DRILLERS DESCRIPTION)	1019.3 / 1018.5	1																
HARD, BROWN AND BROWNISH GRAY BECOMING BROWN MOTTLED WITH GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, SS-2 AND SS-3 CONTAIN TRACE IRON STAINING, DAMP TO MOIST		2	4 4 6	14	78	SS-1	4.5+	7	8	12	36	37	36	20	16	18	A-6b (10)	
		3	1 3 5	11	56	SS-2	4.5+	5	9	15	34	37	38	20	18	20	A-6b (10)	
		4	WOH 4 7	15	67	SS-3	4.5+	-	-	-	-	-	-	-	-	21	A-6b (V)	
		5	2 6 8	20	100	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
	1011.8	6 EOB																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1016.7 (MSL) EOB: 7.5 ft.
START: 6/25/19 END: 6/25/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.163788, -83.228723

EXPLORATION ID B-021-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1016.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.5" ASPHALT MILLINGS AND GRAVEL (DRILLERS DESCRIPTION)	1015.9																	
STIFF TO VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST		1	2 2 2	6	67	SS-1	2.00	9	7	10	34	40	36	18	18	22	A-6b (11)	
		2	WOH WOH 2	3	67	SS-2	1.25	4	7	11	34	44	39	18	21	24	A-6b (12)	
		3	1 1 2	4	56	SS-3	1.50	-	-	-	-	-	-	-	-	34	A-6b (V)	
		4	WOH 2 3	7	67	SS-4	2.00	-	-	-	-	-	-	-	-	25	A-6b (V)	
	1009.2	5 EOB																
		6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1010.8 (MSL) EOB: 7.5 ft.
START: 6/27/19 END: 6/27/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.164708, -83.227895

EXPLORATION ID B-022-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1010.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
13.0" ASPHALT (DRILLERS DESCRIPTION)	1009.7																	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	1007.8	1	4 4 4	10	78	SS-1	3.25	4	5	11	38	42	36	19	17	20	A-6b (11)	
HARD, BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP		2	3 6 6	16	78	SS-2	4.5+	4	4	8	34	50	41	20	21	19	A-7-6 (13)	
		3	4 8 11	25	67	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
	1003.3	4	4 3 5	10	67	SS-4	4.5+	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		EOB 5																
		6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1001.9 (MSL) EOB: 7.5 ft.
START: 6/26/19 END: 6/26/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.154532, -83.233787

EXPLORATION ID B-023-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1001.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
8.0" ASPHALT AND 8.0" BASE (DRILLERS DESCRIPTION)	1000.6	1																
VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, CONTAINS IRON STAINING, DAMP	998.9	2	7 5 4	12	33	SS-1	3.50	14	11	11	33	31	29	17	12	16	A-6a (7)	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST TO DAMP		3	3 4 5	12	22	SS-2	3.00	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		4	3 4 4	10	56	SS-3	3.75	9	8	8	27	48	45	20	25	20	A-7-6 (15)	
	994.4	5	3 5 7	16	67	SS-4	4.5+	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		EOB 6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 997.6 (MSL) EOB: 7.5 ft.
START: 6/26/19 END: 6/26/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.155053, -83.234579

EXPLORATION ID B-024-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 997.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
8.0" ASPHALT AND 8.0" BASE (DRILLERS DESCRIPTION)	996.3	1																
MEDIUM DENSE, BROWN AND GRAY, **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP	994.6	2	7 6 7	17	22	SS-1	-	44	21	9	15	11	NP	NP	NP	7	A-2-4 (0)	
VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST	993.1	3 4	3 3 6	12	56	SS-2	3.50	3	5	11	31	50	46	21	25	22	A-7-6 (15)	
HARD, BROWN AND GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP	990.1	5 6 7 EOB	3 5 8	17	78	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	
			3 8 10	23	78	SS-4	4.5+	-	-	-	-	-	-	-	-	18	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:	EXPLORATION ID B-025-0-18	
TYPE: CULVERT	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 990.8 (MSL) EOB: 40.0 ft.	PAGE 1 OF 2	
START: 7/1/19 END: 7/1/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.155697, -83.235267		

MATERIAL DESCRIPTION AND NOTES	ELEV. 990.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
6.0" TOPSOIL (DRILLERS DESCRIPTION)	990.3	1																
STIFF TO VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST		2	3 2 3	7	33	SS-1	3.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		3	2 3 3	8	56	SS-2	1.50	1	3	13	34	49	42	19	23	25	A-7-6 (14)	
		4	2 3 5	10	67	SS-3	2.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		5	3 5 7	16	67	SS-4	3.25	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
	982.8	6																
STIFF TO HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		7																
		8																
		9	4 10 15	33	100	SS-5	4.5+	4	5	10	36	45	30	19	11	15	A-6a (8)	
		10																
		11	4 8 10	23	67	SS-6	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		12																
		13	5 8 15	30	100	SS-7	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		14																
		15	5 8 16	31	100	SS-8	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
		16																
@18.5' TO 40.0'; BECOMES GRAY		17	4 4 8	16	100	SS-9	3.50	10	4	8	36	42	31	19	12	16	A-6a (9)	
		18																
		19	5 5 9	18	100	SS-10	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		20																
		21	4 4 8	16	100	SS-11	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		22																
		23	4 6 10	21	100	SS-12	2.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
		24																
		25	5 8 11	25	100	SS-13	2.00	5	5	9	37	44	32	19	13	18	A-6a (9)	
		26																
		27																
		28																
		29																

PID: 107822	SFN:	PROJECT: UNI-42-03.91	STATION / OFFSET:	START: 7/1/19	END: 7/1/19	PG 2 OF 2	B-025-0-18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
STIFF TO HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP *(continued)*	960.8	31																
		32																
		33																
		34	6 6 13	25	100	SS-14	2.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
		35																
		36																
		37																
		38																
		39	5 8 12	26	100	SS-15	2.00	3	4	8	38	47	34	20	14	19	A-6a (10)	
	950.8 EOB	40																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:
TYPE: CULVERT	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 994.9 (MSL) EOB: 40.0 ft.
START: 6/26/19 END: 6/26/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.155431, -83.235303

EXPLORATION ID B-026-0-18

MATERIAL DESCRIPTION AND NOTES	ELEV. 994.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.0" ASPHALT AND 6.0" BASE (DRILLER DESCRIPTION)	993.6	1																
VERY STIFF, BROWNISH GRAY, **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, CONTAINS ASPHALT FRAGMENTS, MOIST TO DAMP **(FILL)**	990.4	2 3 4	15 5 4	12	33	SS-1	3.50	-	-	-	-	-	-	-	-	20	A-2-4 (V)	
		3 4	2 2 3	7	22	SS-2	3.00	37	22	7	14	20	NP	NP	NP	9	A-2-4 (0)	
STIFF TO VERY STIFF, BROWNISH GRAY AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		5 6	1 2 3	7	44	SS-3	1.50	3	7	8	32	50	39	20	19	24	A-6b (12)	
		7	2 2 3	7	67	SS-4	3.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
	984.4	8																
		9	2 2 2	5	67	SS-5	2.50	-	-	-	-	-	-	-	-	25	A-6b (V)	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, SOME SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST TO DAMP		10 11 12	2 3 4	9	67	SS-6	2.50	2	7	14	25	52	53	23	30	26	A-7-6 (19)	
	979.4	13																
		14 15	4 6 10	21	78	SS-7	4.5+	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
STIFF TO HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		16 17	6 8 8	21	67	SS-8	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
		18																
@18.5' TO 22.5'; SS-9 AND SS-10 BECOME BROWN WITH GRAY AND ORANGISH BROWN, CONTAINS IRON STAINING		19 20	4 7 9	21	78	SS-9	4.5+	4	5	10	37	44	34	19	15	16	A-6a (10)	
		21 22	3 5 8	17	78	SS-10	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
		23																
@23.5' TO 40.0'; SS-11 TO SS-15 BECOME GRAY		24 25	3 5 7	16	100	SS-11	2.75	-	-	-	-	-	-	-	-	20	A-6a (V)	
		26 27	6 6 7	17	100	SS-12	2.78	-	-	-	-	-	-	-	-	18	A-6a (V)	
		28																
		29	3 5 5	13	78	SS-13	3.25	-	-	-	-	-	-	-	-	16	A-6a (V)	

PID: 107822	SFN:	PROJECT: UNI-42-03.91	STATION / OFFSET:	START: 6/26/19	END: 6/26/19	PG 2 OF 2	B-026-0-18

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
STIFF TO HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST *(continued)*	964.9	31 32 33 34 35 36 37 38 39 40	2 3 4	9	100	SS-14	2.25	4	4	8	37	47	31	19	12	19	A-6a (9)	
	954.9	EOB	3 4 5	12	100	SS-15	1.50	-	-	-	-	-	-	-	-	19	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET:	EXPLORATION ID B-027-0-18	
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 999.7 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1	
START: 7/1/19 END: 7/1/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78	LAT / LONG: 40.156251, -83.236250		

MATERIAL DESCRIPTION AND NOTES	ELEV. 999.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" TOPSOIL (DRILLERS DESCRIPTION)	999.4																	
VERY STIFF TO HARD, BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP		1																
		2	2 2 5	9	67	SS-1	3.75	1	3	9	30	57	47	23	24	20	A-7-6 (15)	
		3																
		4	2 2 6	10	78	SS-2	4.5+	2	4	9	32	53	41	21	20	20	A-7-6 (12)	
		5	2 4 7	14	78	SS-3	4.5+	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		6																
		7	2 5 10	20	78	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		8																
		9	2 6 7	17	78	SS-5	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
	989.2	10																
HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING AND TRACE ROOT HAIRS, DAMP		11																
		12	2 5 6	14	67	SS-6	4.5+	4	5	8	35	48	33	18	15	17	A-6a (10)	
	986.7	13																
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL, MOIST TO DAMP		14	2 4 6	13	67	SS-7	3.00	-	-	-	-	-	-	-	-	17	A-4a (V)	
		15																
@16.0' TO 17.5'; CONTAINS GYPSUM		16																
		17	2 6 8	18	67	SS-8	2.50	13	10	19	31	27	25	16	9	16	A-4a (5)	
	981.7	18																
VERY STIFF, BROWN AND GRAY BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, SS-11 CONTAINS TRACE IRON STAINING, DAMP		19	2 5 8	17	67	SS-9	3.75	-	-	-	-	-	-	-	-	17	A-6a (V)	
		20																
		21																
		22	3 6 7	17	67	SS-10	3.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		23																
		24	4 5 8	17	78	SS-11	3.25	6	4	8	38	44	32	18	14	17	A-6a (10)	
	974.7	EOB 25																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 8/21/19 15:05 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\UNI-42-3.91\GINT FILES\UNI-42-3.91.GPJ

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / J. LITTERAL	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1000.8 (MSL) EOB: 7.5 ft.
START: 7/3/19 END: 7/3/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.156957, -83.237453

EXPLORATION ID B-028-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1000.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.5" ASPHALT MILLINGS AND GRAVEL (DRILLERS DESCRIPTION)	999.7																	
HARD, BROWN, **SILTY CLAY**, SOME GRAVEL, SOME SAND, DAMP **(FILL)**	997.8	1	4 6 5	15	44	SS-1	4.5+	27	13	9	24	27	33	16	17	10	A-6b (6)	
HARD, BROWN, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, CONTAINS ASPHALT AND BRICK FRAGMENTS, SS-2 CONTAINS NO INTACT SOIL FOR HP READINGS, DAMP **(FILL)**	993.3	2	3 2 4	8	17	SS-2	-	-	-	-	-	-	-	-	-	13	A-6a (V)	
		3	4 7 9	22	67	SS-3	4.5+	4	6	9	34	47	34	19	15	16	A-6a (10)	
		4	5 8 9	24	83	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		EOB 5																
		6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-029-0-18
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:	
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1001.2 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 7/3/19 END: 7/3/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.157659, -83.238521	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.5" ASPHALT MILLINGS AND GRAVEL (DRILLERS DESCRIPTION)	1001.2																	
STIFF TO VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE TO SOME GRAVEL, LITTLE SAND, CONTAINS IRON STAINING AND TRACE ASPHALT FRAGMENTS, DAMP TO MOIST **(FILL)**	1000.4	1	3 4 6	14	17	SS-1	3.75	-	-	-	-	-	-	-	-	18	A-6b (V)	
		2	2 3 3	8	22	SS-2	2.75	-	-	-	-	-	-	-	-	23	A-6b (V)	
		3	1 1 2	4	11	SS-3	1.25	-	-	-	-	-	-	-	-	21	A-6b (V)	
		4	2 3 4	10	44	SS-4	2.50	13	7	9	30	41	39	19	20	20	A-6b (11)	
	993.7	5 EOB																
		6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1003.3 (MSL) EOB: 7.5 ft.
START: 7/3/19 END: 7/3/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.158239, -83.239579

EXPLORATION ID B-030-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1003.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
5.0" TOPSOIL (DRILLERS DESCRIPTION)	1002.9																	
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL, DAMP			2 3 3	8	22	SS-1	4.00	-	-	-	-	-	-	-	-	14	A-4a (V)	
@1.5' TO 3.0'; SS-2 NO RECOVERY	1000.3	1	2 2 3	7	0	SS-2	-	-	-	-	-	-	-	-	-	-		
VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP TO MOIST		2	2 3 4	10	33	SS-3	3.00	5	6	10	31	48	44	20	24	20	A-7-6 (14)	
		3	3 3 4	10	44	SS-4	3.75	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
		4	4 5 4	13	56	SS-5	2.75	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
	995.8	5 6 7 EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1024.1 (MSL) EOB: 7.5 ft.
START: 6/20/19 END: 6/20/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.161868, -83.230414

EXPLORATION ID B-031-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1024.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
12.0" GRAVEL AND ASPHALT MILLINGS (DRILLERS DESCRIPTION)	1023.1																	
HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP TO MOIST		1	3 4 5	13	67	SS-1	4.5+	4	7	13	36	40	32	17	15	16	A-6a (10)	
		2	3 6 6	17	100	SS-2	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
		3	3 4 4	11	83	SS-3	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	
		4	5 5 6	15	56	SS-4	4.5+	-	-	-	-	-	-	-	-	18	A-6a (V)	
	1016.6	5 EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-032-0-18	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:		
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1014.2 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1	
START: 6/20/19 END: 6/20/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.160862, -83.230040		

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1014.2																		
4.0" TOPSOIL	1013.9																	
VERY STIFF TO HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP		1	3 3 2	7	78	SS-1	4.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
		2	3 7 6	18	89	SS-2	4.5+	3	7	11	36	43	29	18	11	15	A-6a (8)	
		3	4 5 8	18	983	SS-3	4.5+	-	-	-	-	-	-	-	-	15	A-6a (V)	
		4	3 5 8	18	94	SS-4	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
		5	5 7 8	21	100	SS-5	3.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
	1006.7	6																
		7 EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1010.5 (MSL) EOB: 7.5 ft.
START: 6/20/19 END: 6/20/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.159833, -83.229511

EXPLORATION ID B-033-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1010.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
22.0" GRAVEL AND ASPHALT MILLINGS (DRILLERS DESCRIPTION)																		
	1008.7					SS-1A	-	-	-	-	-	-	-	-	-	4		
@1.5' TO 1.8'; SS-1A IS ASPHALT MILLINGS VERY STIFF TO HARD, GRAY AND ORANGISH BROWN, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, SS-2 CONTAINS TRACE IRON STAINING, SS-3 CONTAINS IRON STAINED DESSICATION CRACKS, DAMP		1	12 5 4	13	56	SS-1B	4.5+	3	8	12	39	38	28	17	11	15	A-6a (8)	
		2	2 3 5	11	67	SS-2	2.25	-	-	-	-	-	-	-	-	17	A-6a (V)	
		3	6 4 7	15	78	SS-3	4.5+	6	15	16	35	28	30	18	12	15	A-6a (6)	
		4	5 7 7	20	89	SS-4	2.25	-	-	-	-	-	-	-	-	16	A-6a (V)	
	1003.0	5 EOB																
		6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1000.5 (MSL) EOB: 7.5 ft.
START: 6/20/19 END: 6/20/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.162418, -83.233818

EXPLORATION ID B-034-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1000.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
12.0" GRAVEL AND ASPHALT MILLINGS (DRILLERS DESCRIPTION)	999.5	1																
HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP	997.5	2	4 6 7	18	67	SS-1	4.5+	3	5	9	35	48	37	19	18	17	A-6b (11)	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		3	5 7 12	27	100	SS-2	4.5+	3	7	10	34	46	33	19	14	15	A-6a (10)	
		4																
		5	6 8 11	27	100	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	
		6																
	993.0	7 EOB	9 10 12	31	83	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:	EXPLORATION ID B-035-0-18
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:	
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1009.5 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 6/20/19 END: 6/20/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.161418, -83.233236	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
1009.5																		
4.0" TOPSOIL (DRILLERS DESCRIPTION)	1009.2																	
HARD, BROWN, **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, CONTAINS TRACE ROOT HAIRS, DAMP	1008.0		3 3 4	10	44	SS-1	4.5+	39	21	9	20	11	25	17	8	13	A-2-4 (0)	
VERY STIFF, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, MOIST TO DAMP		1	3 2 3	7	50	SS-2	3.50	5	4	8	34	49	42	19	23	22	A-7-6 (14)	
		2	3 3 4	10	56	SS-3	3.75	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		3	2 3 4	10	44	SS-4	2.50	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
		4	3 2 3	7	100	SS-5	2.75	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
	1002.0	5																
	EOB	6																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: UNI-42-03.91	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET:
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: 107822 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/21/17	ELEVATION: 1020.0 (MSL) EOB: 7.5 ft.
START: 6/20/19 END: 6/20/19	SAMPLING METHOD: SPT	ENERGY RATIO (%): 84	LAT / LONG: 40.160365, -83.232877

EXPLORATION ID B-036-0-18

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1020.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
14.0" GRAVEL AND ASPHALT MILLINGS (DRILLERS DESCRIPTION)	1018.8	1																
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		2	3 4 6	14	17	SS-1	-	-	-	-	-	-	-	-	-	15	A-6b (V)	
		3	3 5 6	15	67	SS-2	4.5+	2	5	12	37	44	35	18	17	17	A-6b (11)	
		4	3 4 6	14	61	SS-3	3.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
		5	3 3 5	11	56	SS-4	4.5+	-	-	-	-	-	-	-	-	18	A-6b (V)	
	1012.5	6 EOB																
		7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

APPENDIX C

SULFATE CONTENT DATA

OHIO DEPARTMENT OF TRANSPORTATION

DETERMINING SULFATE CONTENT IN SOILS

SUPPLEMENT 1122

Project C-R-S:	UNI-42-3.91
PID No:	107822
Report Date:	7/30/2019
Consultant:	NEAS Inc.
Technician:	L. Rosenbeck

Boring ID & Sample #	Station	Offset	Latitude & Longitude or State Plane Coordinates		Elevation	Soaking Time (hr)	Replicate Sample Readings						Sulfate Content (ppm)
							1		2		3		
							Dilution	Reading	Dilution	Reading	Dilution	Reading	
B-001-0-18 SS-1			40.153160	-83.239505	1003.1	16.5	20	2	20	1	20	2	**33**
B-002-0-18 SS-2			40.153758	-83.239010	1002.6	16.5	20	7	20	5	20	6	**120**
B-003-0-18 SS-1			40.154621	-83.238049	993.8	22.1	20	7	20	7	20	8	**147**
B-004-0-18 SS-2			40.155233	-83.237433	990.3	18.3	20	6	20	6	20	6	**120**
B-005-0-18 SS-1			40.155305	-83.237466	990.5	18.3	20	13	20	13	20	12	**253**
B-006-0-18 SS-2			40.155999	-83.236631	998.2	17.68	20	9	20	10	20	7	**173**
B-008-0-18 SS-1			40.156455	-83.236546	997.6	18.1	20	7	20	6	20	5	**120**
B-009-0-18 SS-1			40.157011	-83.235749	1004.8	16.5	20	12	20	11	20	12	**233**
B-010-0-18 SS-3			40.157843	-83.234785	1011.2	16.27	20	9	20	7	20	7	**153**
B-011-0-18 SS-2			40.158797	-83.234063	1012.7	16.5	20	7	20	6	20	7	**133**
B-012-0-18 SS-1			40.159558	-83.233034	1017.0	16.22	20	8	20	7	20	7	**147**
B-016-0-18 SS-1			40.160177	-83.232401	1022.9	16.5	20	6	20	7	20	7	**133**
B-019-0-18 SS-1			40.162331	-83.230562	1024.2	18.4	20	17	20	15	20	16	**320**
B-020-0-18 SS-1			40.163127	-83.229588	1019.3	16.2	20	9	20	9	20	10	**187**
B-021-0-18 SS-1			40.163788	-83.228723	1016.7	16.23	20	44	20	50	20	47	**940**
B-022-0-18 SS-1			40.164708	-83.227895	1010.8	18.1	20	6	20	5	20	5	**107**
B-023-0-18 SS-2			40.154532	-83.233787	1001.9	18.1	20	13	20	9	20	9	**207**
B-024-0-18 SS-2			40.155053	-83.234579	997.6	18.1	20	8	20	7	20	8	**153**

B-026-0-18 SS-1			40.155431	-83.235303	994.9	18.4	20	15	20	14	20	15	**293**
B-027-0-18 SS-1			40.156251	-83.23625	999.7	18.4	20	4	20	4	20	4	**80**
B-028-0-18 SS-2			40.156957	-83.237453	1000.8	20.33	20	48	20	47	20	49	**960**
B-029-0-18 SS-1			40.157659	-83.238521	1001.2	20.3	20	11	20	13	20	14	**253**
B-030-0-18 SS-1			40.158239	-83.239579	1003.3	20.3	20	1	20	1	20	1	**20**
B-031-0-18 SS-1			40.161868	-83.230414	1024.1	22.25	20	13	20	9	20	11	**220**
B-032-0-18 SS-2			40.160862	-83.23004	1014.2	22.15	20	6	20	7	20	5	**120**
B-033-0-18 SS-1B			40.159833	-83.229511	1010.5	22.2	100	32	100	30	100	29	**3033**
B-034-0-18 SS-1			40.162418	-83.233818	1000.5	16.28	20	4	20	6	20	4	**93**
B-035-0-18 SS-1			40.161418	-83.233236	1009.5	20.4	40	0	20	3	20	2	**33**
B-036-0-18 SS-2			40.160365	-83.232877	1020.0	22.2	20	3	20	3	20	1	**47**

APPENDIX D

GEOTECHNICAL BULLETIN 1 (GB1)
ANALYSIS SPREADSHEETS

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

UNI-42-03.91
PID 107822
Subgrade Exploration
U.S. Route 42

NEAS Inc.

Prepared By: KCA
Date prepared: Monday, August 19, 2019

Brendan P. Andrews
2868 East Kemper Road
Cincinnati, OH 45241

(920) 427-0671
brendan.andrews@neasinc.com

NO. OF BORINGS: 22

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
2	B-002-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
3	B-003-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
4	B-004-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
5	B-005-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
6	B-006-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
7	B-007-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
8	B-008-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
9	B-009-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
10	B-010-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
11	B-011-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
12	B-012-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
13	B-013-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
14	B-014-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
15	B-015-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
16	B-016-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
17	B-017-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
18	B-018-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
19	B-019-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
20	B-020-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
21	B-021-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
22	B-022-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.5	3.0	0.0	1.5	9		4.5	26	17	9	38	29	67	16	12	A-4a	6	33		N_{60} & Mc		12"	
	001-0	SS-2	3.0	4.5	1.5	3.0	8		2.5	47	21	26	22	64	86	26	18	A-7-6	16			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	12		3.5							17	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	21	8	4.5							17	14	A-6a	10						
2	B	SS-1	1.5	3.0	0.0	1.5	29									9	10	A-2-4	0						
	002-0	SS-2	3.0	4.5	1.5	3.0	34		4.5	36	19	17	31	45	76	15	16	A-6b	11	120					
	18	SS-3	4.5	6.0	3.0	4.5	22		4.5							16	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	36	22	4.5							17	16	A-6b	16						
3	B	SS-1	1.5	3.0	0.0	1.5	16		4.5	29	18	11	34	27	61	16	14	A-6a	6	147					
	003-0	SS-2	3.0	4.5	1.5	3.0	12		3.5							26	16	A-6b	16			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	10		2.5	40	22	18	37	47	84	25	17	A-6b	11						
		SS-4	6.0	7.5	4.5	6.0	17	10	3							26	16	A-6b	16						
4	B	SS-1	1.5	3.0	0.0	1.5	18			NP	NP	NP	21	32	53	13	11	A-4a	4						
	004-0	SS-2	3.0	4.5	1.5	3.0	18		4.5	33	18	15	29	30	59	14	14	A-6a	7	120					
	18	SS-3	4.5	6.0	3.0	4.5	18		4.5							16	14	A-6a	10						
		SS-4	6.0	7.5	4.5	6.0	13	13	4.5							16	14	A-6a	10						
5	B	SS-1	1.5	3.0	0.0	1.5	9		3.25	41	18	23	27	56	83	21	18	A-7-6	13	253		N_{60} & Mc		12"	
	005-0	SS-2	3.0	4.5	1.5	3.0	23		3	36	20	16	30	45	75	19	16	A-6b	10			Mc			
	18	SS-3	4.5	6.0	3.0	4.5	20		2.5							16	10	A-4a	8						
		SS-4	6.0	7.5	4.5	6.0	8	8	2.5	25	16	9	27	17	44	14	11	A-4a	2						
6	B	SS-1	1.5	3.0	0.0	1.5	10		4.5							14	10	A-4a	8			N_{60} & Mc		12"	
	006-0	SS-2	3.0	4.5	1.5	3.0	12		3.75	40	20	20	30	52	82	21	16	A-6b	12	173		N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	12		4.5	34	19	15	29	40	69	17	14	A-6a	9						
		SS-4	6.0	7.5	4.5	6.0	13	10	2.5							17	14	A-6a	10						
7	B	SS-1	1.0	2.5	-0.5	1.0	13		4.5	34	18	16	27	29	56	13	16	A-6b	7						
	007-0	SS-2	3.5	5.0	2.0	3.5	9		4.5	34	20	14	34	50	84	16	15	A-6a	10			N_{60}			
	18	SS-3	6.0	7.5	4.5	6.0	20		4.5							16	14	A-6a	10						
		SS-4						9																	
8	B	SS-1	1.0	2.5	-0.5	1.0	8		3.5	47	25	22	38	46	84	27	22	A-7-6	14	120		N_{60} & Mc		12"	
	008-0	SS-2	3.5	5.0	2.0	3.5	8		3	52	23	29	31	54	85	25	20	A-7-6	18			N_{60} & Mc			
	18	SS-3	6.0	7.5	4.5	6.0	8		2.5							20	18	A-7-6	16						
		SS-4						8																	
9	B	SS-1	1.5	3.0	0.0	1.5	8		2.5	36	18	18	37	39	76	21	16	A-6b	11	233		N_{60} & Mc		12"	
	009-0	SS-2	3.0	4.5	1.5	3.0	11		2.25							21	16	A-6b	16			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	18		3.5	40	20	20	36	48	84	20	16	A-6b	12						
		SS-4	6.0	7.5	4.5	6.0	20	8	4.5							16									

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
10	B	SS-2	1.5	3.0	0.0	1.5	8		2.5	54	23	31	31	58	89	30	20	A-7-6	19			N_{60} & Mc		12"	
	010-0	SS-3	3.0	4.5	1.5	3.0	13		3.25	45	21	24	33	54	87	26	18	A-7-6	15	153		N_{60} & Mc			
	18	SS-4	4.5	6.0	3.0	4.5	14		4.5							20	18	A-7-6	16						
		SS-5	6.0	7.5	4.5	6.0	17	8	4.25							25	18	A-7-6	16						
11	B	SS-2	1.5	3.0	0.0	1.5	8		4.25	39	21	18	47	43	90	25	16	A-6b	11	133		N_{60} & Mc		12"	
	011-0	SS-3	3.0	4.5	1.5	3.0	7		2.75	58	24	34	31	58	89	27	21	A-7-6	20			N_{60} & Mc			
	18	SS-4	4.5	6.0	3.0	4.5	13		3							25	18	A-7-6	16						
		SS-5	6.0	7.5	4.5	6.0	18	7	2.25							22	18	A-7-6	16						
12	B	SS-1	1.5	3.0	0.0	1.5	17		4.5	35	19	16	34	43	77	16	16	A-6b	10	147					
	012-0	SS-2	3.0	4.5	1.5	3.0	11		4.5							17	16	A-6b	16			N_{60}			
	18	SS-3	4.5	6.0	3.0	4.5	15		4.5	34	18	16	27	28	55	15	16	A-6b	6						
		SS-4	6.0	7.5	4.5	6.0	11	11	2.75							24	18	A-7-6	16						
13	B	SS-1	1.0	2.5	-0.5	1.0	14		4.5	34	18	16	33	37	70	13	16	A-6b	9						
	013-0	SS-2	3.5	5.0	2.0	3.5	13		4.5	34	18	16	37	44	81	17	16	A-6b	10						
	18	SS-3	6.0	7.5	4.5	6.0	13		3.5							22	16	A-6b	16						
								13																	
14	B	SS-1	1.0	2.5	-0.5	1.0	11		4.5	39	21	18	36	49	85	19	16	A-6b	11			N_{60} & Mc		12"	
	014-0	SS-2	3.5	5.0	2.0	3.5	11		3.5							18	16	A-6b	16			N_{60}			
	18	SS-3	6.0	7.5	4.5	6.0	22		4							21	16	A-6b	16						
		SS-4						11																	
15	B	SS-1	1.0	2.5	-0.5	1.0	11										16	A-6b	16			N_{60}		12"	
	015-0	SS-2	3.5	5.0	2.0	3.5	15		4.5	39	21	18	37	47	84	19	16	A-6b	11			Mc			
	18	SS-3	6.0	7.5	4.5	6.0	15		4							22	16	A-6b	16						
		SS-4						11																	
16	B	SS-1	1.5	3.0	0.0	1.5	10		3.5	35	18	17	29	36	65	15	16	A-6b	9	133		N_{60}		12"	
	016-0	SS-2	3.0	4.5	1.5	3.0	10		2.75	39	19	20	31	42	73	19	16	A-6b	12			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	17		4.5							20	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	13	10	3.5	46	21	25	35	53	88	21	18	A-7-6	15						
17	B	SS-1B	1.5	2.5	0.0	1.0	8		4.5	33	18	15	34	37	71	15	14	A-6a	9			N_{60}		12"	
	017-0	SS-2	3.5	5.0	2.0	3.5	9		4.5	31	17	14	24	23	47	9	14	A-6a	4			N_{60}			
	18	SS-3	6.0	7.5	4.5	6.0	10		4							25	14	A-6a	10						
		SS-4						8																	
18	B	SS-1	1.0	2.5	-0.5	1.0	20		4.5	35	18	17	36	42	78	16	16	A-6b	11						
	018-0	SS-2	3.5	5.0	2.0	3.5	17		4.5							16	16	A-6b	16						
	18	SS-3	6.0	7.5	4.5	6.0	17		4.25							20	16	A-6b	16						
		SS-4						17																	

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
19	B	SS-1	1.5	3.0	0.0	1.5	13		4.5	34	18	16	38	40	78	17	16	A-6b	10	320					
	019-0	SS-2	3.0	4.5	1.5	3.0	10		4.5	34	18	16	38	40	78	17	16	A-6b	10			N_{60}			
	18	SS-3	4.5	6.0	3.0	4.5	13		4.5							18	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	13	10	4.5							19	16	A-6b	16						
20	B	SS-1	1.5	3.0	0.0	1.5	14		4.5	36	20	16	36	37	73	18	16	A-6b	10	187					
	020-0	SS-2	3.0	4.5	1.5	3.0	11		4.5	38	20	18	34	37	71	20	16	A-6b	10			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	15		4.5							21	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	20	11	4.5							17	16	A-6b	16						
21	B	SS-1	1.5	3.0	0.0	1.5	6		2	36	18	18	34	40	74	22	16	A-6b	11	940		N_{60} & Mc		**18"**	
	021-0	SS-2	3.0	4.5	1.5	3.0	3		1.25	39	18	21	34	44	78	24	16	A-6b	12			HP & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	4		1.5							34	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	7	3	2							25	16	A-6b	16						
22	B	SS-1	1.5	3.0	0.0	1.5	10		3.25	36	19	17	38	42	80	20	16	A-6b	11	107		N_{60} & Mc		**12"**	
	022-0	SS-2	3.0	4.5	1.5	3.0	16		4.5	41	20	21	34	50	84	19	18	A-7-6	13						
	18	SS-3	4.5	6.0	3.0	4.5	25		4.5							16	18	A-7-6	16						
		SS-4	6.0	7.5	4.5	6.0	10	10	4.5							15	18	A-7-6	16						

PID: PID 107822

County-Route-Section: UNI-42-03.91
No. of Borings: 22

Geotechnical Consultant: NEAS Inc.
Prepared By: KCA
Date prepared: 8/19/2019

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	14''

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12''
Average(HP):	0''
Global Geogrid Average(N60L):	0''
Average(HP):	0''

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	3%	HP ≤ 0.5	0%
$N_{60} < 12$	41%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	22%	1 < HP ≤ 2	5%
$N_{60} \geq 20$	16%	HP > 2	91%
M+	27%		
Rock	0%		
Unsuitable	0%		

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

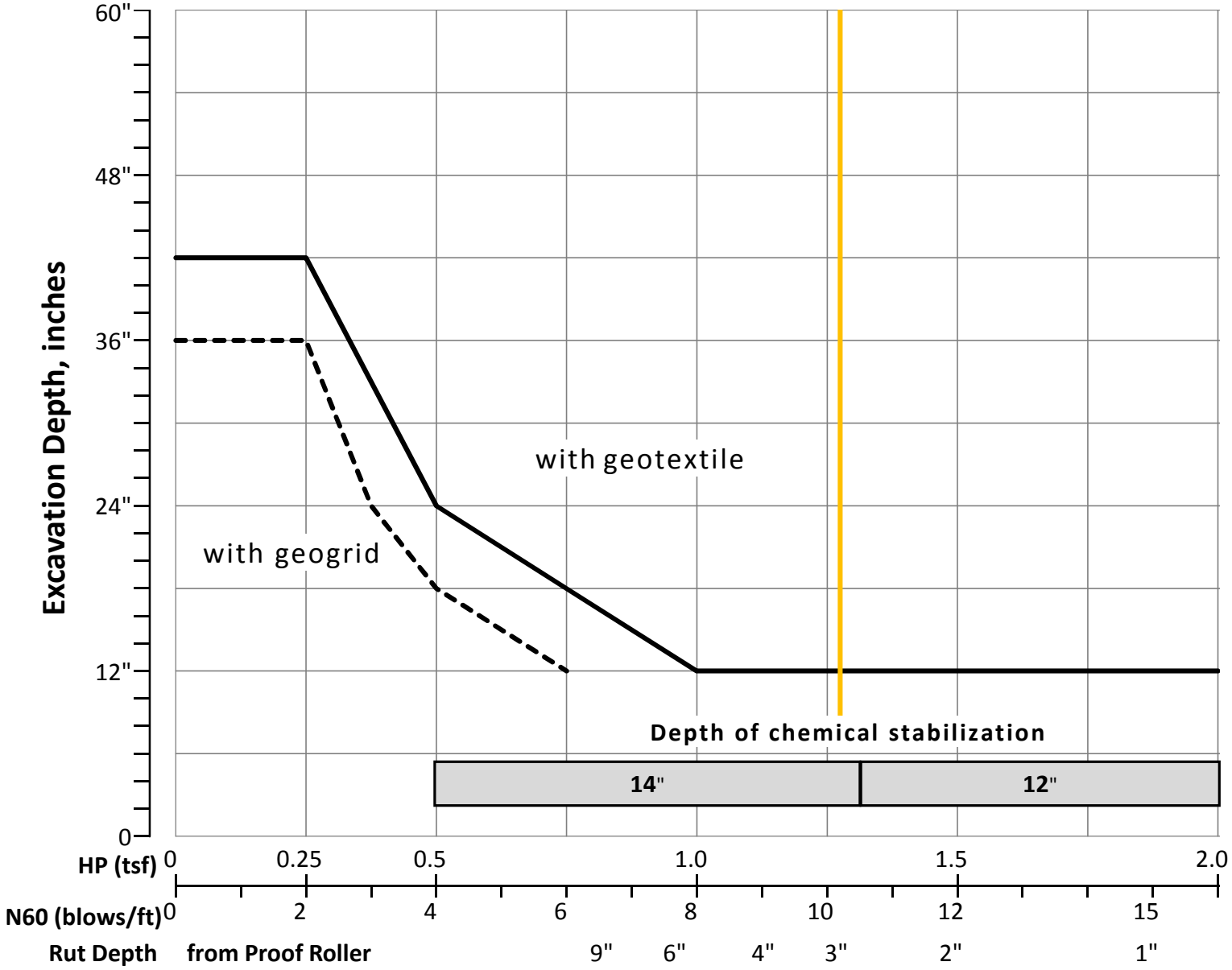
% Proposed Subgrade Surface	
Unstable & Unsuitable	68%
Unstable	68%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	14	10	3.76	38	19	18	33	42	75	19	16	12
Maximum	36	22	4.50	58	25	34	47	64	90	34	22	20
Minimum	3	3	1.25	25	16	9	21	17	44	9	10	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	1	0	0	0	0	0	5	0	0	12	45	0	17	0	0	80
Percent	0%	0%	0%	1%	0%	0%	0%	0%	0%	6%	0%	0%	15%	56%	0%	21%	0%	0%	100%
% Rock|Granular|Cohesive	0%	8%									93%								100%
Surface Class Count	0	0	0	1	0	0	0	0	0	3	0	0	5	27	0	8	0	0	44
Surface Class Percent	0%	0%	0%	2%	0%	0%	0%	0%	0%	7%	0%	0%	11%	61%	0%	18%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.76	0.50	☐ HP
10.27	6.00	☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

UNI-42-03.91
PID 107822
Subgrade Exploration
Industrial Parkway

NEAS Inc.

Prepared By: KCA
Date prepared: Monday, August 19, 2019

Brendan P. Andrews
2868 East Kemper Road
Cincinnati, OH 45241

(920) 427-0671
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NO. OF BORINGS: 9

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-023-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C
2	B-024-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C
3	B-026-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C
4	B-027-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C
5	B-007-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
6	B-008-0-18	US-42				CME-55T Truck	78	0.0	-1.5	1.5 C
7	B-028-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C
8	B-029-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C
9	B-030-0-18	INDUSTRIAL PKWY				CME-55T Truck	78	0.0	-1.5	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.5	3.0	0.0	1.5	12		3.5	29	17	12	33	31	64	16	14	A-6a	7						
	023-0	SS-2	3.0	4.5	1.5	3.0	12		3							21	18	A-7-6	16	207		N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	10		3.75	45	20	25	27	48	75	20	18	A-7-6	15						
		SS-4	6.0	7.5	4.5	6.0	16	10	4.5							18	18	A-7-6	16						
2	B	SS-1	1.5	3.0	0.0	1.5	17			NP	NP	NP	15	11	26	7	10	A-2-4	0						
	024-0	SS-2	3.0	4.5	1.5	3.0	12		3.5	46	21	25	31	50	81	22	18	A-7-6	15	153		N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	17		4.5							16	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	23	12	4.5							18	16	A-6b	16						
3	B	SS-1	1.5	3.0	0.0	1.5	12		3.5							20	10	A-2-4	0	293		N_{60} & Mc		**12"**	
	026-0	SS-2	3.0	4.5	1.5	3.0	7		3	NP	NP	NP	14	20	34	9	10	A-2-4	0			N_{60}			
	18	SS-3	4.5	6.0	3.0	4.5	7		1.5	39	20	19	32	50	82	24	16	A-6b	12						
		SS-4	6.0	7.5	4.5	6.0	7	7	3.5							22	16	A-6b	16						
4	B	SS-1	1.5	3.0	0.0	1.5	9		3.75	47	23	24	30	57	87	20	20	A-7-6	15	80		N_{60}		**12"**	
	027-0	SS-2	3.0	4.5	1.5	3.0	10		4.5	41	21	20	32	53	85	20	18	A-7-6	12			N_{60}			
	18	SS-3	4.5	6.0	3.0	4.5	14		4.5							17	18	A-7-6	16						
		SS-4	6.0	7.5	4.5	6.0	20	9	4.5							17	18	A-7-6	16						
5	B	SS-1	1.0	2.5	-0.5	1.0	13		4.5	34	18	16	27	29	56	13	16	A-6b	7						
	007-0	SS-2	3.5	5.0	2.0	3.5	9		4.5	34	20	14	34	50	84	16	15	A-6a	10			N_{60}			
	18	SS-3	6.0	7.5	4.5	6.0	20		4.5							16	14	A-6a	10						
		SS-4						9																	
6	B	SS-1	1.0	2.5	-0.5	1.0	8		3.5	47	25	22	38	46	84	27	22	A-7-6	14	120		N_{60} & Mc		**12"**	
	008-0	SS-2	3.5	5.0	2.0	3.5	8		3	52	23	29	31	54	85	25	20	A-7-6	18			N_{60} & Mc			
	18	SS-3	6.0	7.5	4.5	6.0	8		2.5							20	18	A-7-6	16						
		SS-4						8																	
7	B	SS-1	1.5	3.0	0.0	1.5	15		4.5	33	16	17	24	27	51	10	16	A-6b	6						
	028-0	SS-2	3.0	4.5	1.5	3.0	8									13	14	A-6a	10	960		N_{60}			
	18	SS-3	4.5	6.0	3.0	4.5	22		4.5	34	19	15	34	47	81	16	14	A-6a	10						
		SS-4	6.0	7.5	4.5	6.0	24	8	4.5							17	14	A-6a	10						
8	B	SS-1	1.5	3.0	0.0	1.5	14		3.75							18	16	A-6b	16	253					
	029-0	SS-2	3.0	4.5	1.5	3.0	8		2.75							23	16	A-6b	16			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.0	4.5	4		1.25							21	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	10	4	2.5	39	19	20	30	41	71	20	16	A-6b	11						
9	B	SS-2	1.5	3.0	0.0	1.5	7										18	A-7-6	16	20		N_{60}		**15"**	
	030-0	SS-3	3.0	4.5	1.5	3.0	10		3	44	20	24	31	48	79	20	18	A-7-6	14			N_{60}			
	18	SS-4	4.5	6.0	3.0	4.5	10		3.75							23	18	A-7-6	16						
		SS-5	6.0	7.5	4.5	6.0	13	7	2.75							25	18	A-7-6	16						

PID: PID 107822

County-Route-Section: UNI-42-03.91
No. of Borings: 9

Geotechnical Consultant: NEAS Inc.
Prepared By: KCA
Date prepared: 8/19/2019

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	No
	Lime Stabilization	Option
206	Depth	14''

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12''
Average(HP):	0''
Global Geogrid Average(N60L):	0''
Average(HP):	0''

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	3%	HP ≤ 0.5	0%
$N_{60} < 12$	50%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	24%	1 < HP ≤ 2	6%
$N_{60} \geq 20$	15%	HP > 2	85%
M+	18%		
Rock	0%		
Unsuitable	0%		

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

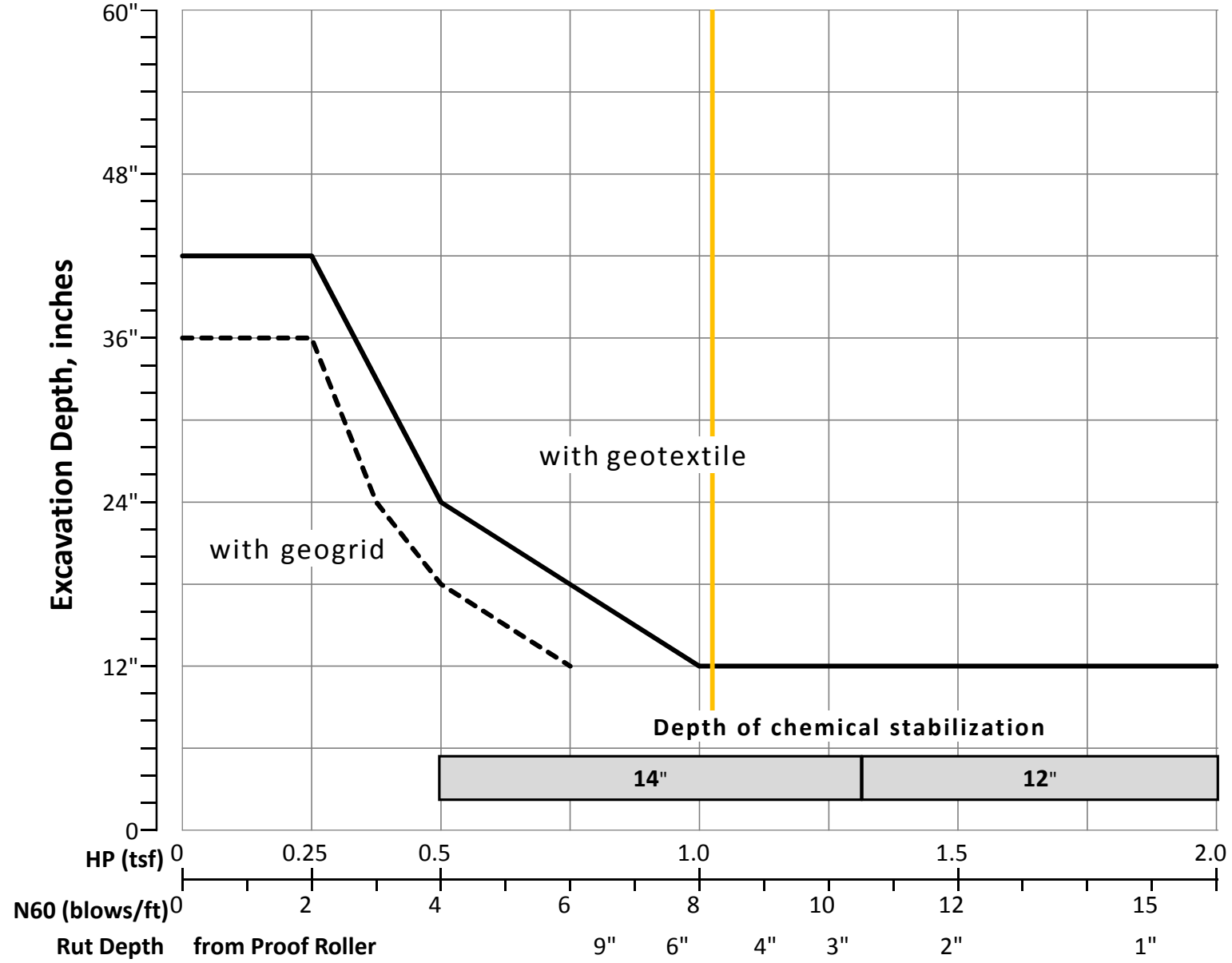
% Proposed Subgrade Surface	
Unstable & Unsuitable	72%
Unstable	72%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	12	8	3.60	40	20	20	29	41	70	18	16	12
Maximum	24	12	4.50	52	25	29	38	57	87	27	22	18
Minimum	4	4	1.25	29	16	12	14	11	26	7	10	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	3	0	0	0	0	0	0	0	0	6	10	0	15	0	0	34
Percent	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	0%	0%	18%	29%	0%	44%	0%	0%	100%
% Rock|Granular|Cohesive	0%	9%									91%								100%
Surface Class Count	0	0	0	3	0	0	0	0	0	0	0	0	3	4	0	8	0	0	18
Surface Class Percent	0%	0%	0%	17%	0%	0%	0%	0%	0%	0%	0%	0%	17%	22%	0%	44%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.60	0.50	☐ HP
8.22	6.00	☐ N60L

Average HP
Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

UNI-42-03.91
PID 107822
Subgrade Exploration
Ramps B and D

NEAS Inc.

Prepared By: KCA
Date prepared: Monday, August 19, 2019

Brendan P. Andrews
2868 East Kemper Road
Cincinnati, OH 45241

(920) 427-0671
brendan.andrews@neasinc.com

NO. OF BORINGS: 8

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-014-0-18	US-42				CME-55T Truck	78	0.0	-1.3	1.3 C
2	B-018-0-18	US-42				CME-55T Truck	78	0.0	-1.3	1.3 C
3	B-031-0-18	Ramp B				CME-55T Truck	78	0.0	-1.3	1.3 C
4	B-032-0-18	Ramp B				CME-55T Truck	78	0.0	-1.3	1.3 C
5	B-033-0-18	Ramp B				CME-55T Truck	78	0.0	-1.3	1.3 C
6	B-034-0-18	Ramp D				CME-55T Truck	78	0.0	-1.3	1.3 C
7	B-035-0-18	Ramp D				CME-55T Truck	78	0.0	-1.8	1.8 C
8	B-036-0-18	Ramp D				CME-55T Truck	78	0.0	-1.8	1.8 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.0	2.5	-0.3	1.2	11		4.5	39	21	18	36	49	85	19	16	A-6b	11			N_{60} & Mc		12"	
	014-0	SS-2	3.5	5.0	2.2	3.7	11		3.5							18	16	A-6b	16						
	18	SS-3	6.0	7.5	4.7	6.2	22		4							21	16	A-6b	16						
		SS-4						11																	
2	B	SS-1	1.0	2.5	-0.3	1.2	20		4.5	35	18	17	36	42	78	16	16	A-6b	11						
	018-0	SS-2	3.5	5.0	2.2	3.7	17		4.5							16	16	A-6b	16						
	18	SS-3	6.0	7.5	4.7	6.2	17		4.25							20	16	A-6b	16						
		SS-4						17																	
3	B	SS-1	1.5	3.0	0.2	1.7	13		4.5	32	17	15	36	40	76	16	14	A-6a	10	220					
	031-0	SS-2	3.0	4.5	1.7	3.2	17		4.5							16	14	A-6a	10						
	18	SS-3	4.5	6.0	3.2	4.7	11		4.5							17	14	A-6a	10						
		SS-4	6.0	7.5	4.7	6.2	15	11	4.5							18	14	A-6a	10						
4	B	SS-1	0.0	1.5	-1.3	0.2	7		4							17	14	A-6a	10			N_{60} & Mc		15"	
	032-0	SS-2	1.5	3.0	0.2	1.7	18		4.5	29	18	11	36	43	79	15	14	A-6a	8	120					
	18	SS-3	3.0	4.5	1.7	3.2	18		4.5							15	14	A-6a	10						
		SS-4	4.5	6.0	3.2	4.7	18	7	4.5							16	14	A-6a	10						
5	B	SS-1B	2.0	3.0	0.7	1.7	13		4.5	28	17	11	39	38	77	15	14	A-6a	8	3033					
	033-0	SS-2	3.0	4.5	1.7	3.2	11		2.25							17	14	A-6a	10			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.2	4.7	15		4.5	30	18	12	35	28	63	15	14	A-6a	6						
		SS-4	6.0	7.5	4.7	6.2	20	11	2.25							16	14	A-6a	10						
6	B	SS-1	1.5	3.0	0.2	1.7	18		4.5	37	19	18	35	48	83	17	16	A-6b	11	93					
	034-0	SS-2	3.0	4.5	1.7	3.2	27		4.5	33	19	14	34	46	80	15	14	A-6a	10						
	18	SS-3	4.5	6.0	3.2	4.7	27		4.5							16	14	A-6a	10						
		SS-4	6.0	7.5	4.7	6.2	31	18	4.5							17	14	A-6a	10						
7	B	SS-2	1.5	3.0	-0.3	1.2	7		3.5	42	19	23	34	49	83	22	18	A-7-6	14	33		N_{60} & Mc		15"	
	035-0	SS-3	3.0	4.5	1.2	2.7	10		3.75							22	18	A-7-6	16			N_{60} & Mc			
	18	SS-4	4.5	6.0	2.7	4.2	10		2.5							27	18	A-7-6	16						
		SS-5	6.0	7.5	4.2	5.7	7	7	2.75							18	18	A-7-6	16						
8	B	SS-1	1.5	3.0	-0.3	1.2	14									15	16	A-6b	16						
	036-0	SS-2	3.0	4.5	1.2	2.7	15		4.5	35	18	17	37	44	81	17	16	A-6b	11	47					
	18	SS-3	4.5	6.0	2.7	4.2	14		3.5							19	16	A-6b	16						
		SS-4	6.0	7.5	4.2	5.7	11	11	4.5							18	16	A-6b	16						

PID: PID 107822

County-Route-Section: UNI-42-03.91
No. of Borings: 8

Geotechnical Consultant: NEAS Inc.
Prepared By: KCA
Date prepared: 8/19/2019

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12''

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12''
Average(HP):	0''
Global Geogrid Average(N60L):	0''
Average(HP):	0''

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	33%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	13%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	20%	HP > 2	97%
M+	17%		
Rock	0%		
Unsuitable	0%		

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

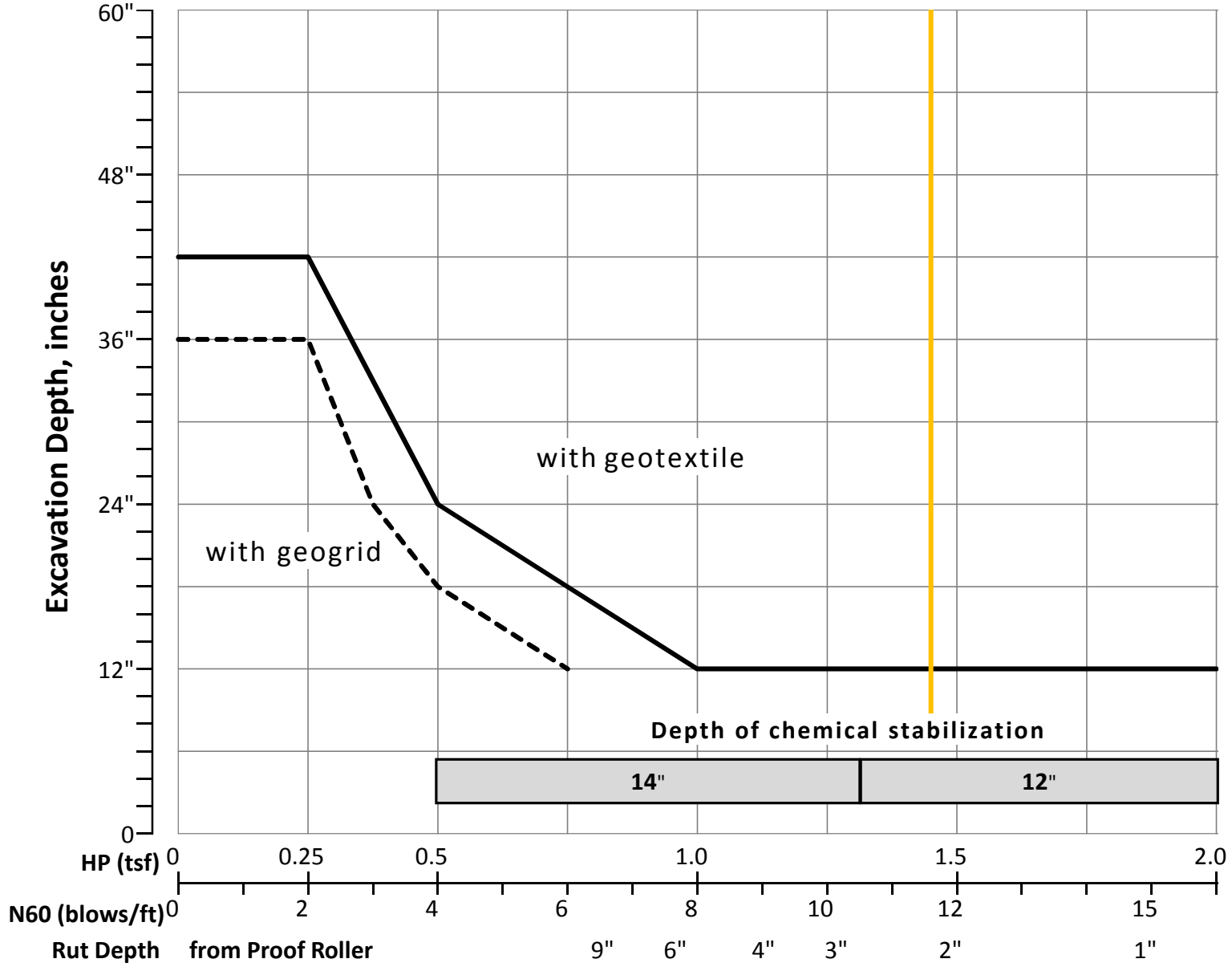
% Proposed Subgrade Surface	
Unstable & Unsuitable	26%
Unstable	26%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	16	12	4.04	34	18	16	36	43	79	18	15	12
Maximum	31	18	4.50	42	21	23	39	49	85	27	18	16
Minimum	7	7	2.25	28	17	11	34	28	63	15	14	6

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	15	11	0	4	0	0	30
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	37%	0%	13%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%					0%						100%						100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0	3	0	0	19
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	42%	42%	0%	16%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

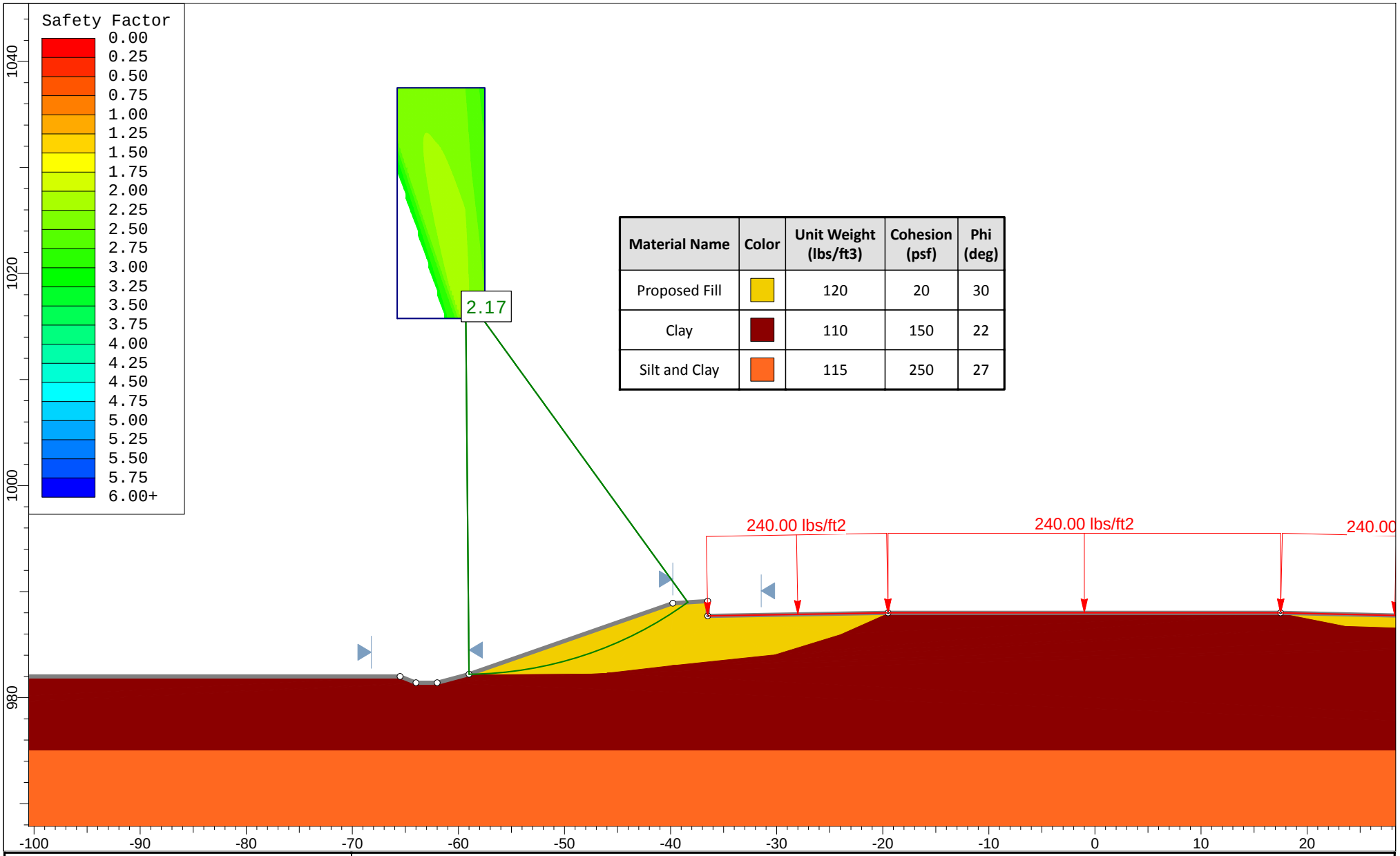
Calculated Average	New Values	Check to Override
4.04	0.50	☐ HP
11.63	6.00	☐ N60L

Average HP
Average N_{60L}

APPENDIX E

EMBANKMENT STABILITY ANALYSIS

U.S. ROUTE 42 – STA. 214+50

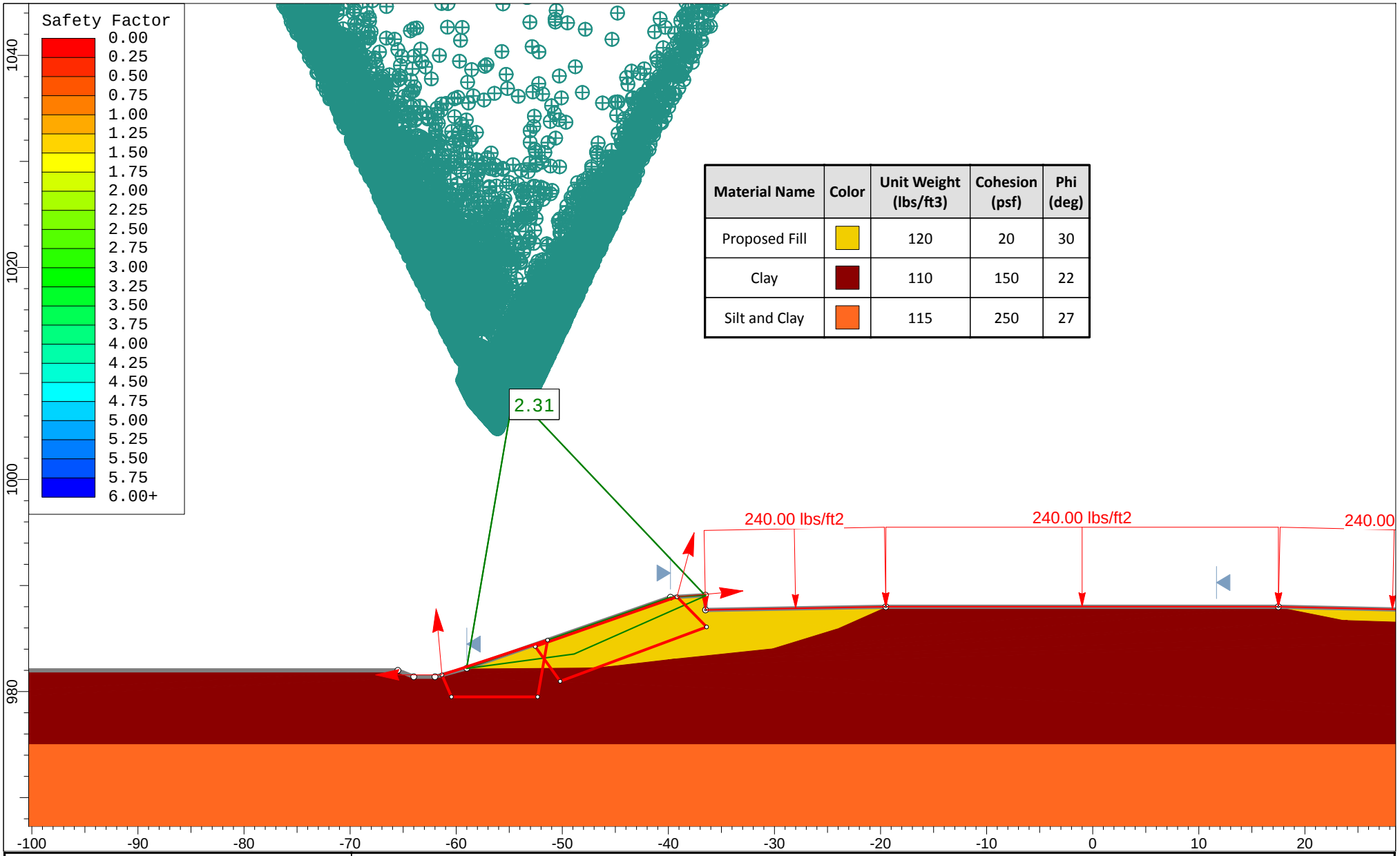


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Proposed Fill		120	20	30
Clay		110	150	22
Silt and Clay		115	250	27

rocscience

SLIDEINTERPRET 7.038

Project	UNI-42-3.91/4.38, PID 107822		
Analysis Description	Embankment Stability Anlaysis - US-42 STA. 214+50 - Effective Stress - Circular Failure		
Drawn By	KCA	Scale 1:150	Company NEAS Inc.
Date	9/4/2019, 2:05:11 PM		File Name STA214+50_CircularEffective_090419.slim

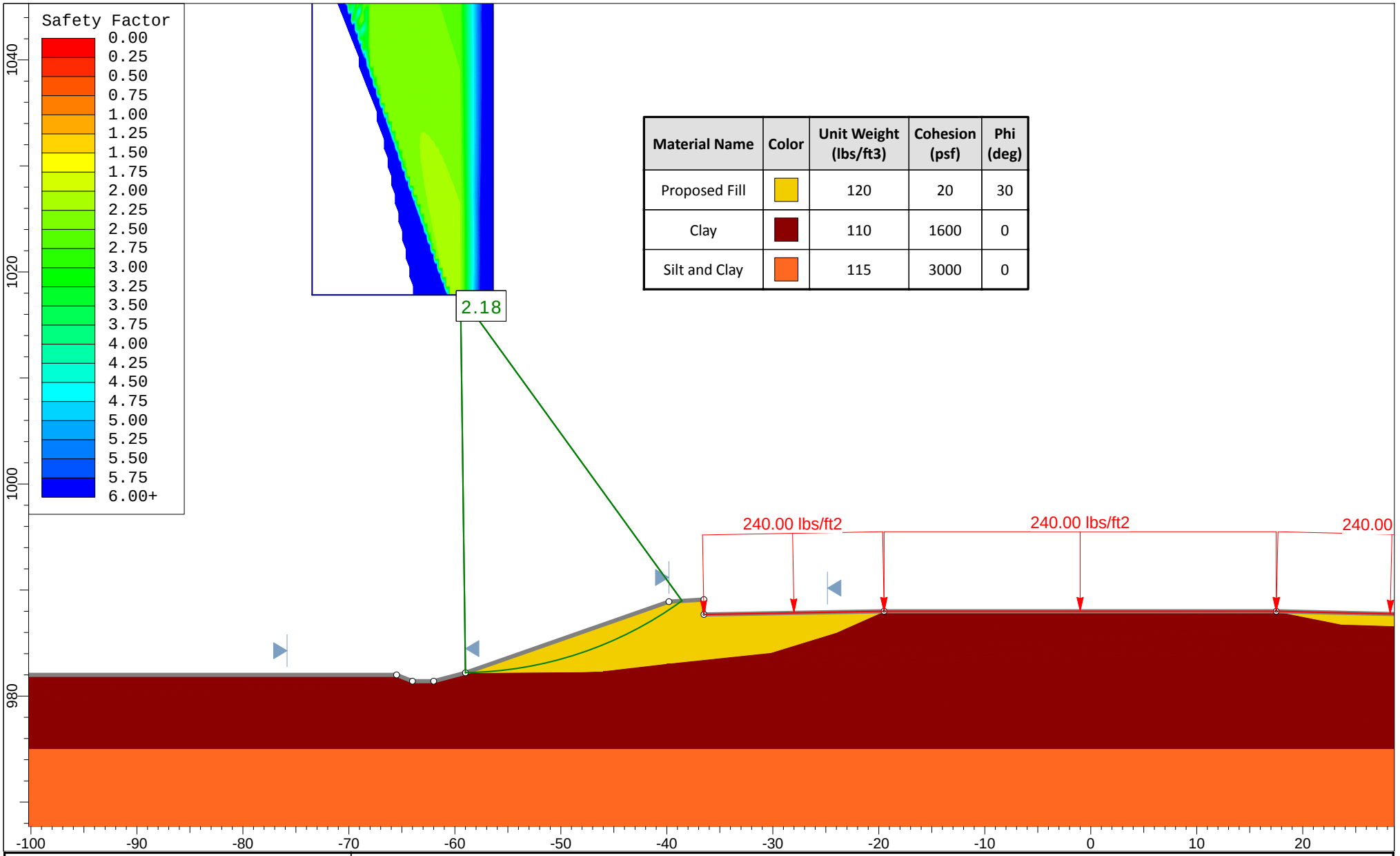


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Proposed Fill		120	20	30
Clay		110	150	22
Silt and Clay		115	250	27

rocscience

SLIDEINTERPRET 7.038

Project	UNI-42-3.91/4.38, PID 107822		
Analysis Description	Embankment Stability Anlaysis - US-42 STA. 214+50 - Effective Stress - Block Failure		
Drawn By	KCA	*Scale* 1:150	*Company* NEAS Inc.
Date	9/4/2019, 2:05:11 PM	*File Name*	STA214+50_BlockEffective_090419.slim

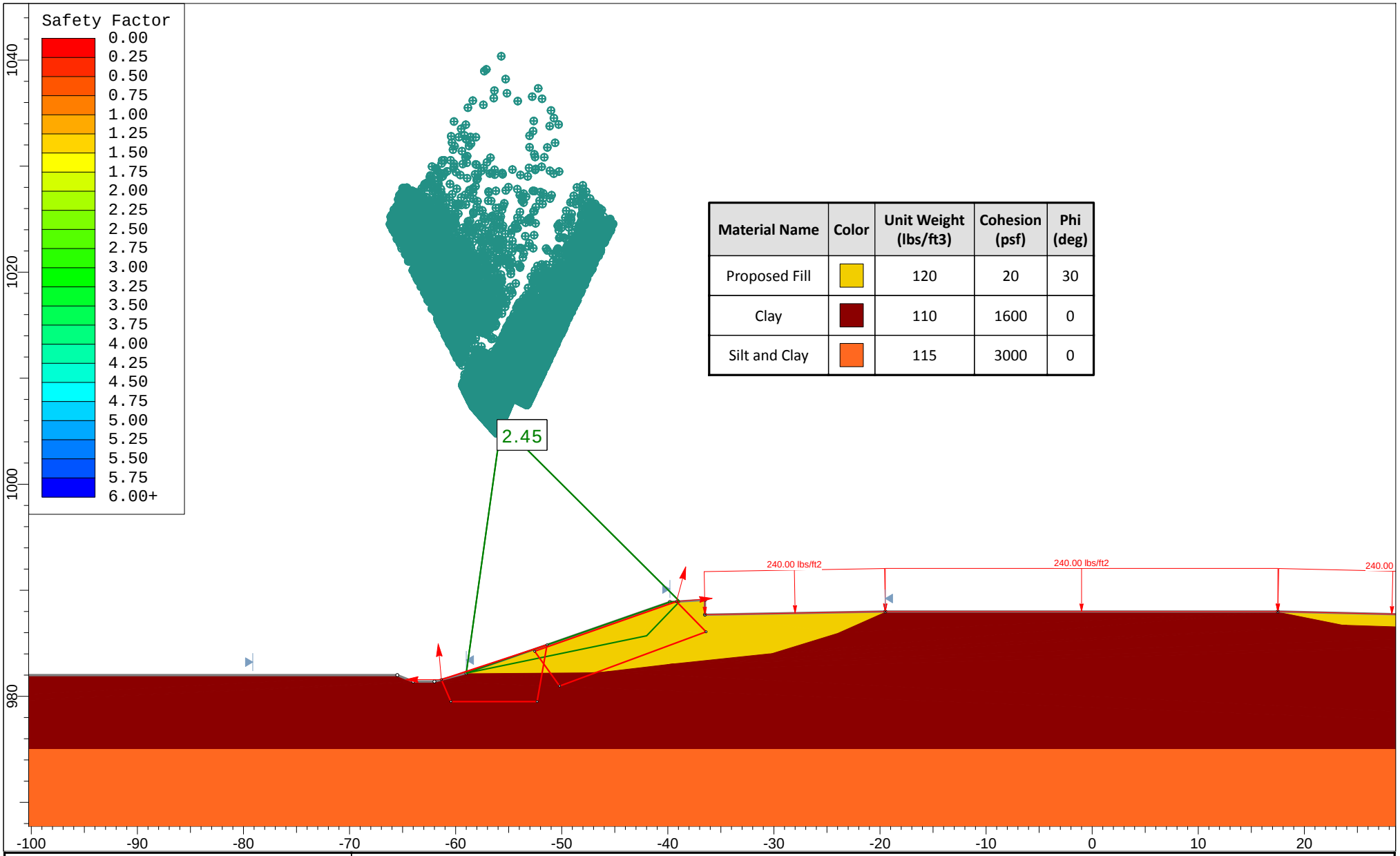


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Proposed Fill		120	20	30
Clay		110	1600	0
Silt and Clay		115	3000	0

rocscience

SLIDEINTERPRET 7.038

Project	UNI-42-3.91/4.38, PID 107822		
Analysis Description	Embankment Stability Anlaysis - US-42 STA. 214+50 - Total Stress - Circular Failure		
Drawn By	KCA	*Scale* 1:150	*Company* NEAS Inc.
Date	9/4/2019, 2:05:11 PM	*File Name*	STA214+50_CircularTotal_090419.slim



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Proposed Fill		120	20	30
Clay		110	1600	0
Silt and Clay		115	3000	0

rocscience

SLIDEINTERPRET 7.038

Project	UNI-42-3.91/4.38, PID 107822		
Analysis Description	Embankment Stability Anlaysis - US-42 STA. 214+50 - Total Stress - Block Failure		
Drawn By	KCA	*Scale* 1:150	*Company* NEAS Inc.
Date	9/4/2019, 2:05:11 PM	*File Name*	STA214+50_BlockTotal_090419.slim

APPENDIX F

BEARING RESISTANCE CALCULATIONS

Objective: **To evaluate the bearing resistance of shallow foundation on level soil.**
Method: **In accordance with ODOT Bridge Design Manual, 2017 [Sect. 204.6.2.2] LRFD Bridge Design Specifications, 7th Ed., 2017, [Sect. 10.6.3.1.2a].**

Givens:

Soil Design Parameters (Average Below Footing):

Drained Conditions (Effective Stress):

$\phi'_{fd} := 21\ deg$ — Effective angle of internal friction

$\gamma_{fd} := 115\ \frac{lbf}{ft^3}$ — Unit weight

$c'_{fd} := 75\ \frac{lbf}{ft^2}$ — Effective Cohesion

Undrained Conditions (Total Stress):

$\phi_{fdu} := 0\ deg$ — Angle of internal friction (Same as Drained Conditions if Sand)

$Su_{fdu} := 600\ \frac{lbf}{ft^2}$ — Undrained Shear Strength

Footing Geometry:

$D_f := 2.5\ ft$ — Footing cover at Toe
Note: Where the potential for scour, erosion or undermining exists, spread footings shall be located to bear below the macimum depth of scour or undermining. Spread footings shall be located below the depth potential frost. **LRFD BDS 10.6.1.2**

$B := 1\ ft$ — Footing base width

$B' := 1\ ft$ — Footing effective base width

$L' := 4\ ft$ — Footing effective length (assumed to equal actual length)

$d_w := 0\ ft$ — Depth of groundwater below ground surface

Compute Bearing Resistance:

Drained Conditions (Effective Stress):

$$N_q := \text{if}\left(\phi'_{fd} > 0\ ,\ e^{\pi \cdot \tan(\phi'_{fd})} \cdot \tan\left(45\ deg + \frac{\phi'_{fd}}{2}\right)^2\ ,\ 1.0\right) \qquad N_q = 7.07$$

$$N_c := \text{if}\left(\phi'_{fd} > 0\ ,\ \frac{N_q - 1}{\tan(\phi'_{fd})}\ ,\ 5.14\right) \qquad N_c = 15.81$$

$$N_\gamma := 2 \cdot (N_q + 1) \cdot \tan(\phi'_{fd}) \qquad N_\gamma = 6.2$$

Compute shape correction factors per **LRFD [Table 10.6.3.1.2a-3]**:

$s_c := \text{if}\left(\phi'_{fd} > 0\,,\ 1 + \left(\frac{B'}{L'}\right)\cdot\left(\frac{N_q}{N_c}\right),\ 1 + \left(\frac{B'}{5\cdot L'}\right)\right)$ $\quad s_c = 1.112$

$s_q := \text{if}\left(\phi'_{fd} > 0\,,\ 1 + \left(\frac{B'}{L'}\cdot\tan\left(\phi'_{fd}\right)\right),\ 1\right)$ $\quad s_q = 1.096$

$s_\gamma := \text{if}\left(\phi'_{fd} > 0\,,\ 1 - 0.4\cdot\left(\frac{B'}{L'}\right),\ 1\right)$ $\quad s_\gamma = 0.9$

Load inclination factors:

$i_q := 1$

$i_\gamma := 1$

$i_c := 1$

Assumed to be 1.0, see **LRFD BDS C10.6.3.1.2a**. "Most geotechnical engineers do not used the load inclination factors". If desired, use LRFD Equations [10.6.3.1.2a-5] thru [10.6.3.1.2a-9].

Compute groundwater depth correction factors per **LRFD [Table 10.6.3.1.2a-2]**:

$C_{wq} := \text{if}\left(d_w \geq D_f,\ 1.0\,,\ 0.5\right)$ $\quad C_{wq} = 0.5$

$C_{w\gamma} := \text{if}\left(d_w \geq (1.5\cdot B) + D_f,\ 1.0\,,\ 0.5\right)$ $\quad C_{w\gamma} = 0.5$

Depth Correction Factor per Hanson (1970):

$d_q := \text{if}\left(\frac{D_f}{B'} \leq 1\,,\ 1 + 2\cdot\tan\left(\phi'_{fd}\right)\cdot\left(1 - \sin\left(\phi'_{fd}\right)\right)^2\cdot\frac{D_f}{B'},\ 1 + 2\cdot\tan\left(\phi'_{fd}\right)\cdot\left(1 - \sin\left(\phi'_{fd}\right)\right)^2\cdot\text{atan}\left(\frac{D_f}{B'}\right)\right)$

$d_q = 1.38$

Compute modified bearing capacity factors **LRFD [Equation 10.6.3.1.2a-2 to 10.6.3.1.2a-4]:**

$N_{cm} := N_c\cdot s_c\cdot i_c$ $\quad N_{cm} = 17.583$

$N_{qm} := N_q\cdot s_q\cdot i_q$ $\quad N_{qm} = 7.749$

$N_{\gamma m} := N_\gamma\cdot s_\gamma\cdot i_\gamma$ $\quad N_{\gamma m} = 5.577$

Compute nominal bearing resistance, **LRFD [Eq 10.6.3.1.2a-1]:**

$q_{nd} := c'_{fd}\cdot N_{cm} + \gamma_{fd}\cdot D_f\cdot N_{qm}\cdot d_q\cdot C_{wq} + 0.5\cdot\gamma_{fd}\cdot B'\cdot N_{\gamma m}\cdot C_{w\gamma}$ $\quad q_{nd} = 3012.1\ \frac{lbf}{ft^2}$

Compute factored bearing resistance, **LRFD [Eq 10.6.3.1.1]:**

$\phi_b := 0.55$ Bearing resistance factor **LRFD Table 11.5.7-1.**

$q_{Rd} := \phi_b\cdot q_{nd}$ $\quad q_{Rd} = 1.7\ ksf$ Factored bearing resistance Drained Conditions

Undrained Conditions (Effective Stress):

$$N_q := \text{if}\left(\phi_{fdu} > 0\,,\, e^{\pi \cdot \tan\left(\phi_{fdu}\right)} \cdot \tan\left(45\ \textit{deg} + \frac{\phi_{fdu}}{2}\right)^2\,,\, 1.0\right) \qquad N_q = 1$$

$$N_c := \text{if}\left(\phi_{fdu} > 0\,,\, \frac{N_q - 1}{\tan\left(\phi_{fdu}\right)}\,,\, 5.14\right) \qquad N_c = 5.14$$

$$N_\gamma := 2 \cdot \left(N_q + 1\right) \cdot \tan\left(\phi_{fdu}\right) \qquad N_\gamma = 0$$

Compute shape correction factors per **LRFD [Table 10.6.3.1.2a-3]**:

$$s_c := \text{if}\left(\phi_{fdu} > 0\,,\, 1 + \left(\frac{B'}{L'}\right) \cdot \left(\frac{N_q}{N_c}\right)\,,\, 1 + \left(\frac{B'}{5 \cdot L'}\right)\right) \qquad s_c = 1.05$$

$$s_q := \text{if}\left(\phi_{fdu} > 0\,,\, 1 + \left(\frac{B'}{L'} \cdot \tan\left(\phi_{fdu}\right)\right)\,,\, 1\right) \qquad s_q = 1$$

$$s_\gamma := \text{if}\left(\phi_{fdu} > 0\,,\, 1 - 0.4 \cdot \left(\frac{B'}{L'}\right)\,,\, 1\right) \qquad s_\gamma = 1$$

Load inclination factors:

$i_q := 1$

$i_\gamma := 1$

$i_c := 1$

Assumed to be 1.0, see **LRFD BDS C10.6.3.1.2a**. "Most geotechnical engineers do not used the load inclination factors". If desired, use LRFD Equations [10.6.3.1.2a-5] thru [10.6.3.1.2a-9].

Compute modified bearing capacity factors **LRFD [Equation 10.6.3.1.2a-2 to 10.6.3.1.2a-4]:**

$$N_{cm} := N_c \cdot s_c \cdot i_c \qquad N_{cm} = 5.397$$

$$N_{qm} := N_q \cdot s_q \cdot i_q \qquad N_{qm} = 1$$

$$N_{\gamma m} := N_\gamma \cdot s_\gamma \cdot i_\gamma \qquad N_{\gamma m} = 0$$

Depth Correction Factor per Hanson (1970):

$$d_q := \text{if}\left(\frac{D_f}{B'} \le 1\,,\, 1 + 2 \cdot \tan\left(\phi_{fdu}\right) \cdot \left(1 - \sin\left(\phi_{fdu}\right)\right)^2 \cdot \frac{D_f}{B'}\,,\, 1 + 2 \cdot \tan\left(\phi_{fdu}\right) \cdot \left(1 - \sin\left(\phi_{fdu}\right)\right)^2 \cdot \text{atan}\left(\frac{D_f}{B'}\right)\right)$$

$d_q = 1$

Compute nominal bearing resistance, **LRFD [Eq 10.6.3.1.2a-1:**

$$q_{nu} := Su_{fdu} \cdot N_{cm} + \gamma_{fd} \cdot D_f \cdot N_{qm} \cdot d_q \cdot C_{wq} + 0.5 \cdot \gamma_{fd} \cdot B' \cdot N_{\gamma m} \cdot C_{w\gamma} \qquad q_{nu} = 3382\ \frac{\textit{lbf}}{\textit{ft}^2}$$

Compute factored bearing resistance, **LRFD [Eq 10.6.3.1.1]:**

$\phi_b := 0.55$ Bearing resistance factor **LRFD Table 11.5.7-1.**

$q_{Ru} := \phi_b \cdot q_{nu}$ $\quad q_{Ru} = 1.9\ \textit{ksf}$ Factored bearing resistance Undrained Conditions

Factored Bearing Resistance Drained vs. Undrained Conditions:

Drained Conditions: $q_{Rd} = 1.7\ \textit{ksf}$

Undrained Conditions: $q_{Ru} = 1.9\ \textit{ksf}$