Resource International, Inc.

FRA-70-12.68 PROJECT 4R
PID NO. 105523
FRANKLIN COUNTY, OHIO

ROADWAY EXPLORATION REPORT

Prepared For:
GPD GROUP
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Columbus, OH 43215

Prepared By:
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Rii Project No. W-13-045

July 2018

RESOURCE INTERNATIONAL, INC.
ISO 9001:2008
Certified QMS
An ISO 9001:2008 QMS Certified Firm

Planning

Engineering

Construction Management

Technology

July 17, 2018

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Re: Roadway Exploration Report
FRA-70-12.68 Project 4R
PID No. 105523
Rii Project No. W-13-045

Mr. Luzier:

Resource International, Inc. (Rii) is pleased to submit this roadway exploration report for the above referenced project. This report includes roadway subgrade recommendations for the design and construction of the proposed FRA-70-12.68 Project 4R in Franklin County, Ohio.

We sincerely appreciate the opportunity to be of service to you on this project. If you have any questions regarding the roadway exploration or this report, please contact us.

Sincerely,

RESOURCE INTERNATIONAL, INC.

Peyman P. Majidi, E.I.
Staff Engineer

Jonathan P. Sterenberg P.E.
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Enclosure: Roadway Exploration Report

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EXECUTIVE SUMMARY

This report is a presentation of the roadway exploration performed for the design and construction of the roadway alignments for FRA-70-12.68 in the City of Columbus in Franklin County, Ohio. The project consists of various roadway improvements along I-70 EB, I-71 NB, Ramp C3, Ramp C5, Ramp A5, Livingston Avenue, Fulton Street, W. Mound Street and South Front Street. Proposed roadway construction along the associated roadways is shown on the vicinity map and boring plan presented in Appendix I. Areas in which the proposed subgrade is within three of the existing grade have been analyzed for subgrade recommendations. In addition, embankment analysis and slope stability has been performed for Ramp A-5.

Between July 8, 2008 and March 22, 2015, nineteen (19) borings were performed along the various alignments within the proposed area of improvement and were advanced to completion depths ranging from 10.0 to 96.7 feet below the existing ground surface.

In general, the borings encountered between 2.0 to 11.0 inches of asphalt overlying between 6.0 to 14.5 inches of concrete and 5.0 to 12.0 inches of aggregate base. Borings B-105-0-9, B-102-1-13 and B-105-1-13 encountered topsoil at the existing ground surface between 3.0 to 7.0 inches. It must be noted that, composite pavement was only encountered in borings B-026-3-13, B-027-0-08, B-027-1-13, B-102-0-09, B-110-1-15, B-278-0-10 and B-279-0-10.

Beneath the surficial materials, existing embankment fill consisting of both granular and cohesive material was encountered in majority of the borings extending to depths ranging from 3.0 to 39.0 feet below the ground surface. It must be noted that only borings B-013-0-09, B-026-3-13, B-027-1-13 and B-278-0-10 did not encounter fill materials in the soils samples. The granular material encountered within the existing fill material was generally described as brown, gray gravel, gravel and sand, gravel with sand and silt, gravel with sand, silt and clay (ODOT A-1-a, A-1-b, A-2-4, A-2-6). The cohesive fill materials encountered were generally described as brown, brown to gray sandy silt, silt and clay, silty clay, clay and elastic clay (ODOT A-4a, A-6a, A-6b, A-7-6, A-7-5). It must be noted that the elastic clay (ODOT A-7-5) was encountered in boring B-110-1-15 at the depth of 22.0 feet below existing ground surface, corresponding to elevation 718.3 ft. msl.

Underlying the existing fill in the borings, natural soils were encountered consisting of both granular and cohesive material. The granular soils encountered were generally described as brown gravel, gravel and sand, coarse and fine sand, gravel with sand and silt, fine sand, gravel with sand, silt and clay (ODOT A-1-a, A-1-b, A-3, A-3a, A-2-4 and A-2-6). The natural cohesive soils encountered were generally described as brown and dark brown clay, silty clay, silt and clay, silt and sandy silt (ODOT A-7-6, A-6b, A-6a, A-4b, A-4a).

Bedrock was encountered in borings B-015-6-13 and B-017-7-13 at depths of 90.0 feet and 67.5 feet below the existing grade, corresponding to elevations 653.1 and 655.5 feet msl, respectively. The bedrock consisted of limestone in boring B-015-6-13 and shale in boring B-017-7-13.

Analyses and Recommendations

Embankment Slope Stability and Settlement Evaluation

Based on the proposed plans and profiles provided by GPD group, it is understood that the proposed embankment fill along Ramps A5 will be approximately 34 feet with side slopes of 2(H):1(V). Rii has performed settlement and slope stability analyses at the most critical cross sections along the alignments.

Based on design information provided by GPD group, approximately 34 feet of fill will be placed at sta. 5015. Embankment settlement analysis of the soil profile from subsurface information from boring B-108-9-15 indicates approximately 6.2 inches of settlement due to the overburden embankment fill with the groundwater level considered at the 100-year return elevation of 715.1 ft. msl. Slope stability analysis of the embankment, indicated a factor of safety of greater than 1.4.

Subgrade Recommendations

Based on roadway design information provided by GPD GROUP, soil borings with ground surface elevation within three feet of the proposed grade and soil borings located in the areas where cut will be required to reach the proposed grade were used in the GB1 analyses. The subgrade soils along the various alignments of the project consisted of both granular and cohesive soils. The granular soils encountered along the alignments were comprised of loose to very dense grave, gravel with sand, gravel with sand and silt, gravel with sand, and silt and clay (ODOT A-1-a, A-1-b, A-2-4, and A-2-6). The cohesive material encountered in the subgrade soils were comprised of medium stiff to hard clay, silty clay, silt and clay, sandy silt, and silt (ODOT A-7-6, A-6a, A-6b, A-4a, and A-4b).

I-70 EB, I-71 NB, Ramp A5, Ramp C3

Seven (7) borings were utilized in the analysis of the subgrade along I-70 EB, I-71 NB, Ramp A5 and Ramp C3. A complete GB1 analysis of soils encountered at the proposed subgrade level along these alignments is presented in Appendix VI. Based on GB1 analysis of the subgrade soils, California Bearing Ratio (CBR) values (based on correlation charts) for the entire alignment ranged from 6 to 12 with an average of 8. However, based on experience with similar subgrade soils and conditions, **it is recommended that pavement design be based on a CBR value of 6** with a corresponding resilient modulus, M_R, of 7,200 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 150 pci and a soil support value (SSV) of 4.4.

Based on the borings utilized for this alignment, the subgrade soils along this alignment is predominantly granular. Therefore, no chemical stabilization could be recommended. However, per ODOT GB1 requirements, if it is elected to perform global stabilization, the entire subgrade should be stabilized using the average site parameters provided in the table below.

Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
16	10	13	11	5	8

Upon completion of the stabilization, the entire subgrade should be proof rolled to verify that stability has been achieved. Please note that the recommended CBR values assume that the materials utilized for the roadway subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of 6.

Street Alignments

Based on design information provided by GPD GROUP, a complete GB1 analysis of the proposed subgrade soils encountered along Livingston Avenue and Fulton Street is presented in Appendix VI. California Bearing Ratio (CBR) values for the entire project ranged from 5 to 8 with an average of 8. However, based on experience with similar subgrade soils **it is recommended that pavement design be based on a CBR value of 6** with a corresponding resilient modulus, M_R, of 7,200 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 150 pci and a soil support value (SSV) of 4.4.

Per ODOT GB1, soils with sulfate content in excess of 3,000 ppm cannot be chemically stabilized due to the potential for sulfate heave in the soil. Based on the results of the testing, the sulfate contents of the subgrade soils range from 227 to 587 ppm. Therefore, no sample with sulfate content greater than 3,000 ppm was encountered.

Based on the ODOT GB1 guidelines, when approximately 30 percent or more of the subgrade area requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, approximately 50 percent of the subgrade area is anticipated to require stabilization based on the soil borings performed (2 of 4 borings). Per ODOT GB1, global stabilization recommendations are based upon the overall average site parameters, as noted in the table below.

Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
6	12	14	12	5	8

Applying the averages in the table above, ODOT GB1 recommends the following global stabilization options within the project limits:

Option 1. Chemically stabilize the entire subgrade with 12-inches of cement, as per ODOT Item 206. For estimating purposes, utilize a cement content of 6.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils.

Option 2. Stone stabilize the entire subgrade via an 12-inch undercut and replacement with ODOT Item 703.16C granular material, Type B, C or D installed over ODOT Item 712.09 Geotextile Fabric, Type D as detailed in accordance with ODOT Item 204.

Please note that the recommended CBR values assume that the materials utilized for the roadway subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of 6.

Pavement design is dependent on the inclusion of adequate surface and subsurface drainage in order to maintain the compacted subgrade near optimum moisture conditions throughout the lifetime of the pavement. If underdrain systems are considered, they should be installed in accordance to the specifications presented in Item 204 of the ODOT Construction and Materials Specifications (CMS).

Please note that this executive summary does not contain all the information presented in the report. The unabridged geotechnical exploration report should be read in its entirety to obtain a more complete understanding of the information presented.

1. INTRODUCTION

The overall purpose of this project is to provide detailed subsurface information and recommendations for the design and construction of the FRA-70-12.68/13.11/14.05C (Project 4R/4H/4A) projects in Columbus, Ohio. The projects represent the central portion of FRA-70-8.93 (PID 77369) I-70/71 south innerbelt improvements project. The FRA-70-12.68 (Project 4R) phase will consist of all work associated with the construction of Ramp C5, starting at the bridge over Souder Avenue and extending east to Front Street. The proposed Ramp C5 will be a two-lane to four-lane ramp that will collect and direct traffic from I-71 northbound and SR-315 southbound as well as I-70 eastbound to exit in downtown at the intersection of Front Street and W. Fulton Avenue. This project includes the construction of six (6) new bridge structures for the proposed Ramp C5 alignment and replacement of three (3) bridge structures, two along I-70 and the Front Street Structure over I-70, as well as the construction of fourteen (14) new retaining walls and a culvert structure to accommodate the new configuration.

This report is a presentation of the roadway exploration performed for the design and construction of the roadway alignments for FRA-70-12.68 in the City of Columbus in Franklin County, Ohio. The project consists of various roadway improvements along I-70 EB, I-71 NB, Ramp C3, Ramp C5, Ramp A5, Livingston Avenue, Fulton Street, W. Mound Street and South Front Street. Proposed roadway construction along the associated roadways is shown on the vicinity map and boring plan presented in Appendix I. Areas in which the proposed subgrade is within three of the existing grade have been analyzed for subgrade recommendations. In addition, embankment analysis and slope stability has been performed for Ramp A-5.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Site Geology

Both the Illinoian and Wisconsinan glaciers advanced over two-thirds of the State of Ohio, leaving behind glacial features such as moraines, kame deposits, lacustrine deposits and outwash terraces. The glacial and non-glacial regions comprise five physiographic sections based on geological age, depositional process and geomorphic occurrence (physical features or landforms). The project area lies within the Columbus Lowland District of the Till Plains Section. This area is characterized by flat to gently rolling ground moraine deposits from the Late Wisconsinan age. The site topography exhibits moderate to high relief. The ground moraine deposits are composed primarily of silty loam till (Darby, Bellefontaine, Centerburg, Grand Lake, Arcanum, Knightstown Tills), with smaller alluvium and outwash deposits bordering the Scioto River, its tributaries and floodplain areas. A ground moraine is the sheet of debris left after the steady retreat of glacial ice. The debris left behind ranges in composition from clay size particles to boulders (including silt, sand, and gravel). Outwash deposits consist of undifferentiated sand and gravel deposited by meltwater in front of glacial ice, and often occurs as valley terraces or low plains. Alluvium and alluvial terrace deposits range in

composition from silty clay size particles to cobbles, usually deposited in present and former floodplain areas.

According to the bedrock geology and topography maps obtained from the Ohio Department of Natural Resources (ODNR), the underlying bedrock consists predominantly of the Middle to Lower Devonian-aged Columbus Limestone. This formation is further subdivided into two members in the central portion of the state, known as the Delhi and Bellepoint Members. The Delhi Member consists of light gray, finely to coarsely crystalline, irregularly bedded, fossiliferous limestone. The Bellepoint Member consists of variable brown, finely crystalline, massively bedded limy dolomite. Both of these members contain chert nodules. Just east of the Scioto River, the underlying bedrock consists of the Upper Devonian Ohio Shale Formation overlying the Middle Devonian-aged Delaware Limestone Formation. The Ohio Shale formation consists of brownish black to greenish gray, thinly bedded, fissile, carbonaceous shale. The Delaware Limestone consists of bluish gray, thin to medium bedded dolomitic limestone with nodules and layers of chert. Regionally, the bedrock surface forms a broad valley aligned roughly north-to-south beneath the Scioto River. According to bedrock topography mapping, the elevation of the bedrock surface ranges from approximately 600 feet mean sea level (msl) in the valley to approximately 625 feet msl near the project limits.

2.2. Existing Conditions

The project alignment is along the I-70/71 south innerbelt, primarily along I-70 eastbound between Souder Avenue and High Street. I-71, SR-315 and I-70 interchange is a major interchange with many entrance and exit ramps that connect the various alignments. I-70 crosses over the Scioto River just east of the I-71 and SR-315 interchange, with three existing bridges that cross the river and converge at the eastern bank into an eight-lane roadway. The roadway then reduces to a six-lane expressway which continues into downtown Columbus and crosses under Front Street and High Street. The existing I-70 is elevated from the surrounding terrain from east of the Scioto River to just west of Front Street and there are existing overpass bridges where the roadway crosses the existing CSX and Norfolk Southern Railroads and Short Street. The roadway profile is lowered from the surrounding terrain where the alignment enters into downtown from just west of Front Street to the end of the project alignment. There is also an entrance ramp from Mound Street to I-70 westbound and an exit ramp from I-70 eastbound to Fulton Street and Livingston Avenue, which is where the existing eight-lane alignment transitions to six lanes. The daily traffic volume along the project alignment is very high. The alignment traverses primarily commercial and government properties. The surrounding terrain across the site is relatively flat-lying, with general slope toward the Scioto River.

3. EXPLORATION

Between July 8, 2008 and March 22, 2015, nineteen (19) borings were performed along the various alignments within the proposed area of improvement and were advanced to completion depths ranging from 10.0 to 96.7 feet below the existing ground surface. The boring locations completed to date are shown on the boring plan provided in Appendix I of this report and summarized in Table 1 below.

Table 1. Test Boring Summary

Boring Number	Station	Offset	Alignment	Latitude	Longitude	Ground [1] Elevation (feet msl)	Boring Depth (feet)
B-013-0-09	126+20.83	26.2' RT.	BL I-70 EB	39.94993	-83.021526	723.0	10.0
B-013-1-15	127+00.32	45.0' LT.	BL I-70 EB	39.95015815	-83.02128731	725.9	35.0
B-015-6-13	5050+28.85	20.8' LT.	BL Ramp C5	39.95057892	-83.01462608	723.0	77.5
B-017-7-13	170+79.36	23.3' RT.	BL I-70 EB	39.95320057	-83.00642506	743.1	96.7
B-025-0-08	5088+53.62	76.0' LT.	BL RAMP C5	39.95335912	-83.00179637	740.4	59.3
B-026-1-13	184+88.08	111.1' RT.	BL I-70 EB	39.95267329	-83.00147319	747.0	50.0
B-026-2-13	5089+73.78	16.5' RT.	BL Ramp C5	39.95311225	-83.00130835	736.8	89.5
B-026-3-13	5091+4.93	11.5' LT.	BL Ramp C5	39.95329676	-83.00084855	756.9	90.0
B-027-0-08	187+70.21	13.2' RT.	BL I-70 EB	39.95286414	-83.00042843	735.9	14.0
B-027-1-13	189+32.64	78.7' RT.	BL I-70 EB	39.95267152	-82.99984676	755.5	49.3
B-102-0-09	257+19.36	11.3' LT.	BL I-71 NB	39.94694	-83.014331	718.9	12.5
B-102-1-13	5007+7.46	0.5' RT.	BL RAMP A5	39.94795601	-83.01463164	719.8	45.0
B-105-0-09	261+46.54	11.9' LT.	BL I-71 NB	39.948065	-83.014768	715.7	10.0
B-105-1-13	5008+89.52	6.5' LT.	BL RAMP A5	39.94845063	-83.01473056	716.1	49.8
B-109-1-15	3001+00.00	55.0' LT.	BL Ramp C3	39.95009704	-83.01971541	736.2	85.0
B-110-1-15	3005+00.00	20.0' LT.	BL Ramp C3	39.94991309	-83.01827608	740.3	75.0
B-111-0-09	3008+11.91	4.6' RT.	BL Ramp C3	39.949346	-83.017438	734.9	30.0
B-278-0-10	19+58.43	10.3' RT.	Fulton Street	39.95327	-83.000492	757.7	15.1
B-279-0-10	22+94.43	2.4' RT.	Fulton Street	39.953408	-82.999307	769.3	11.5

The locations for the current exploration borings performed by Rii were determined and located in the field by Rii representatives. Rii utilized a handheld GPS unit to obtain northing and easting coordinates of the boring locations. Ground surface elevations at the boring locations were interpolated using topographic mapping information provided by GPD GROUP.

The borings performed for this exploration were drilled using CME-55, Mobile B-53, CME-75, truck or CME 750X all-terrain vehicle (ATV) mounted rotary drilling machine, utilizing a 3.25-inch, 4.25-inch inside diameter hollow stem auger or 4.5-inch outside diameter, continuous flight auger to advance the holes. Standard penetration test (SPT) and split spoon sampling were performed variously in each boring. The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted using a 140-pound hammer falling 30.0 inches to drive a 2.0-inch outside diameter split spoon sampler 18.0 inches. DLZ and Rii utilized a calibrated automatic drop hammer to generate consistent energy transfer to the sampler. Driving resistance is recorded on the boring logs in terms of blow per 6.0-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot (N). Standard penetration blow counts aid in determining soil properties applicable in foundation system design. Measured blow count (N) values are corrected to an equivalent (60%) energy ratio, N_{60}, by the following equation. Both values are represented on boring logs in Appendix III.

$$N_{60} = N_m*(ER/60)$$

Where:
N_m = measured N value
ER = drill rod energy ratio, expressed as a percent, for the system used

The automatic hammers for the Mobile B-53, CME 55, CME 75 and CME 750X drill rigs have drill rod energy ratios of 77.9, 85.9, 84.0 and 84.2 percent, respectively.

At the completion of drilling, the borings were backfilled with a mixture of bentonite chips and soil cuttings generated during the drilling process, or sealed with a cement-bentonite grout in accordance with ODOT specifications. For borings performed within the existing roadway, the pavement was patched with either an equivalent thickness of quick set concrete or cold asphalt.

During drilling, field logs were prepared by Rii personnel showing the encountered subsurface conditions. Soil samples obtained from the drilling operation were preserved and sealed in glass jars and delivered to the soil laboratory. In the laboratory, the soil samples were visually classified and select samples were tested, as noted in Table 2.

Table 2. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	AASHTO T265	262
Plastic and Liquid Limits	AASHTO T89, T90	94
Gradation – Sieve/Hydrometer	AASHTO T88	94
Loss On Ignition	ASTM D2974	1
One-Dimensional Consolidation	ASTM D2435	1
Sulfate Content Testing	ODOT 1122	9

The tests performed are necessary to classify existing soil according to the Ohio Department of Transportation (ODOT) classification system and to estimate engineering properties of importance in determining foundation and roadway embankment design and construction recommendations. Results of the laboratory testing are presented on the boring logs in Appendix III. A description of the soil terms used throughout this report is presented in Appendix II.

Hand penetrometer readings, which provide a rough estimate of the unconfined compressive strength of the soil, were reported on the boring logs in units of tons per square foot (tsf) and were utilized to classify the consistency of the cohesive soil in each layer. An indirect estimate of the compressive strength of the cohesive split spoon samples can also be made from a correlation with the blow counts (N_{60}). Please note that split spoon samples are considered disturbed and the laboratory determination of their shear strengths may vary from undisturbed conditions.

4. FINDINGS

Interpreted engineering logs have been prepared based on the field logs, visual examination of samples and laboratory test results. Classification follows the respective version of the ODOT Specifications for Geotechnical Explorations (SGE) at the time the exploration borings were performed. The following is a summary of what was found in the test borings and what is represented on the boring logs. A total of nineteen (19) borings were performed along the various alignment of the project by Rii and DLZ.

4.1. Surface Soils

In general, the borings encountered between 2.0 to 11.0 inches of asphalt overlying between 6.0 to 14.5 inches of concrete and 5.0 to 12.0 inches of aggregate base. Borings B-105-0-9, B-102-1-13 and B-105-1-13 encountered topsoil at the existing ground surface between 3.0 to 7.0 inches.

It must be noted that, composite pavement was only encountered in borings B-026-3-13, B-027-0-08, B-027-1-13, B-102-0-09, B-110-1-15, B-278-0-10 and B-279-0-10.

4.2. Subsurface Soils

Beneath the surficial materials, existing embankment fill consisting of both granular and cohesive material was encountered in majority of the borings extending to depths ranging from 3.0 to 39.0 feet below the ground surface. It must be noted that only borings B-013-0-09, B-026-3-13, B-027-1-13 and B-278-0-10 did not encounter fill materials in the soils samples. The granular material encountered within the existing fill material was generally described as brown, gray gravel, gravel and sand, gravel with sand and silt, gravel with sand, silt and clay (ODOT A-1-a, A-1-b, A-2-4, A-2-6). The cohesive fill materials encountered were generally described as brown, brown to gray sandy silt, silt and clay, silty clay, clay and elastic clay (ODOT A-4a, A-6a, A-6b, A-7-6, A-7-5). It must be noted that the elastic clay (ODOT A-7-5) was encountered in boring B-110-1-15 at the depth of 22.0 feet below existing ground surface, corresponding to elevation 718.3 ft. msl.

Underlying the existing fill in the borings, natural soils were encountered consisting of both granular and cohesive material. The granular soils encountered were generally described as brown gravel, gravel and sand, coarse and fine sand, gravel with sand and silt, fine sand, gravel with sand, silt and clay (ODOT A-1-a, A-1-b, A-3, A-3a, A-2-4 and A-2-6). The natural cohesive soils encountered were generally described as brown and dark brown clay, silty clay, silt and clay, silt and sandy silt (ODOT A-7-6, A-6b, A-6a, A-4b, A-4a).

The relative density of granular soils is primarily derived from SPT blow counts (N_{60}). Based on the SPT blow counts obtained, the granular soil encountered ranged from loose ($5 < N_{60} < 10$ blows per foot [bpf]) to very dense ($N_{60} > 50$ bpf). Overall blow counts recorded from the SPT sampling ranged from 6 bpf to split spoon sampler refusal. Split spoon sampler refusal is defined as exceeding 50 blows from the hammer with less than 6.0 inches of penetration by the split spoon sampler. The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soil encountered ranged from soft ($0.25 < HP \leq 0.5$ tsf) to hard ($HP > 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.5 to over 4.5 tsf (limit of instrument).

Natural moisture contents of the inorganic soil samples tested ranged from 4 to 31 percent. The natural moisture content of the cohesive soil samples tested for plasticity index ranged from 10 percent below to 9 percent above their corresponding plastic limits. In general, the soil exhibited natural moisture contents considered to be significantly below to significantly above optimum moisture levels.

4.3. Bedrock

Bedrock was encountered in borings B-015-6-13 and B-017-7-13 at depths of 90.0 feet and 67.5 feet below the existing grade, corresponding to elevations 653.1 and 655.5 feet msl, respectively. Upon encountering the bedrock surface in these borings, a changeover to rock coring techniques was made. A summary of the top bedrock elevations encountered in each boring is provided in Table 3.

Table 3. Top of Bedrock Elevations

Boring Number	Ground Elevation (feet msl)	Top of Bedrock		Rock Description
		Depth (feet)	Elevation (feet msl)	
B-015-6-13	723.0	67.5	655.5	Limestone
B-017-7-13	742.2	90.0	653.1	Mudstone & Shale

The cored bedrock across the subject site consisted of brown, gray to black shale and limestone. In general, percent recoveries of the rock cores ranged from 51% to 100%, while RQD values ranged from 15% to 88%. The percent recovery and RQD values of the bedrock core runs are summarized in Table 4.

It should be noted that bedrock experiences mechanical breaks during the drilling and coring processes. Rii attempted to account for fresh, manmade breaks during tabulation of the RQD analysis. The quality of the cored bedrock, according to the RQD value, ranged from very poor (RQD ≤ 25%) to very good (86 ≤ RQD ≤ 100%).

Table 4. Rock Core Summary

Boring	Core No.	Depth (feet)	Recovery (%)	RQD (%)
B-015-6-13	RC-1	67.5 to 71.5	51	51
	RC-2	71.5 to 76.5	98	88
	RC-3	76.5 to 77.5	100	67
B-017-7-13	RC-1	90.0 to 91.0	100	79
	RC-2	91.0 to 92.0	100	66
	RC-3	92.0 to 96.7	74	15

4.4. Groundwater

Groundwater was encountered in the borings as presented in Table 5.

Table 5. Groundwater Levels

Boring Number	Ground Surface Elevation (feet msl)	Initial Groundwater		Upon Completion [1]	
		Depth (feet)	Elevation (feet msl)	Depth (feet)	Elevation (feet msl)
B-015-6-13	723.0	33.5	689.5	-	-
B-017-7-13	743.1	57.0	686.1	-	-
B-025-0-08	740.4	26.0	714.4	39.0	701.4
B-026-1-13	747.0	28.5	718.5	-	-
B-026-2-13	736.8	18.5	718.3	-	-
B-026-3-13	756.9	36.0	720.9	-	-
B-027-0-08	735.9	5.0	730.9	-	-
B-027-1-13	755.5	37.0	718.5	-	-
B-102-1-13	719.8	NA	-	NA	-
B-105-1-13	716.1	28.0	688.1	-	-
B-109-1-15	736.2	NA	-	NA	-
B-110-1-15	740.3	53.5	686.8	-	-

1. Where N/A is listed, the groundwater level at completion could not be obtained due to the addition of water or mud as a drilling fluid.

Groundwater was encountered initially during the drilling process in the borings at depths ranging from 5.0 to 57.0 feet below the existing ground surface, which corresponds to elevations ranging from 686.1 to 730.9 feet msl. At the completion of drilling and prior to removing the augers, groundwater was encountered in the auger stem of boring B-025-0-08 at the depth of 39.0 feet, which corresponds to elevation 701.4 feet msl.

Please note that short-term water level readings, especially in cohesive soils, are not necessarily an accurate indication of the actual groundwater level. In addition, groundwater levels or the presence of groundwater are considered to be dependent on seasonal fluctuations in precipitation.

A more comprehensive description of what was encountered during the drilling process may be found on the boring logs in Appendix III.

5. ANALYSES AND RECOMMENDATIONS

Data obtained from the drilling and testing program as well as from a review of existing geotechnical information have been used to determine the roadway support capabilities and the settlement potential for the soil encountered at the site. These parameters have been used to provide guidelines for the subject roadways, as well as the construction specifications related to the placement of embankment fills and general earthwork recommendations, which are discussed in the following paragraphs.

5.1. Embankment Slope Stability and Settlement Evaluation

The compressibility and the estimated long-term shear strength parameters utilized in the settlement and slope stability analyses for the proposed embankment slopes are provided in Table 6 and Table 7, respectively.

Table 6. Compressibility Parameters Utilized in Settlement Analysis

Material Type	γ (pcf)	LL (%)	C_c [1]	C_r [2]	e_o [3]	N_{60}	C' [4]
Dense Gravel (ODOT A-1-a)	130	N/A	N/A	N/A	N/A	40	111
Medium Dense to Dense Gravel with Sand (ODOT A-1-b)	125-130	N/A	N/A	N/A	N/A	19-31	78-98
Medium Dense Gravel with Sand and Silt (ODOT A-2-4)	125	N/A	N/A	N/A	N/A	21	116
Dense Gravel with Sand, Silt and Clay (ODOT A-2-6)	130	N/A	N/A	N/A	N/A	31	83
Medium Dense Coarse and Fine sand (ODOT A-3a)	125	N/A	N/A	N/A	N/A	22	60
Medium Stiff to Very Stiff Silty Clay (ODOT A-6b)	120	37	0.243	0.024	0.561	N/A	N/A
Very Stiff Sandy Silt (ODOT A-4a)	120-135	18-35	0.072 - 0.225	0.007 - 0.023	0.413 - 0.546	N/A	N/A

1. *Per Table 26, Section 5.4.2.5 of FHWA GEC 5.*
2. *Estimated at 5 to 15% of C_c per Section 5.4.2.5 of FHWA GEC 5.*
3. *Per Table 8-2 of Holtz and Kovacs (1981).*
4. *Per Figure 10.6.2.4.2-1 of 2012 AASHTO LRFD BDS.*

Table 7. Long-Term Soil Parameters Utilized in Slope Stability Analyses

Material Type	γ (pcf)	φ' [(1)] (°)	c' (psf)	S_u [(2)] (psf)
Item 203 Embankment	125	30	50	N/A
Loose to medium dense Gravel with Sand and Silt (ODOT A-2-4)	125	31	0	N/A
Medium Stiff to Stiff Silty Clay (ODOT A-6b)	125	27	0	N/A

1. *Per Figure 74, Section 5.6.2.4 of FHWA GEC 5 for cohesive soils, and per Table 10.4.6.2.4-1 of the 2014 AASHTO LRFD BDS.*
2. *Per Table 33 of Section 5.6.5 of FHWA GEC 5.*

Shear strength parameters for embankment fill were estimated using ODOT Geotechnical Bulletin 6 (GB-6) as a guide. The shear strength parameters for the embankment fill listed in Table 7 above are the limiting values based on the assumption that the embankment fill utilized will likely consist of sandy silt and lean clay (ODOT A-4a and A-6a) or qualified granular soils. The recommended borrow material utilized as engineered fill should be tested using remolded samples prepared to simulate the required compaction and density to verify that it meets the minimum friction angle of 30 degrees prior to construction of the slope remediation.

The shear strength parameters for the natural soils were assigned using correlations provided in FHWA Geotechnical Engineering Circular (GEC) No. 5 (FHWA-IF-02-034) Evaluation of Soil and Rock Properties, the 2014 AASHTO LRFD BDS, and based on past experience in the vicinity of the site with projects performed in similar subsurface profiles.

Based on the proposed plans and profiles provided by GPD group, it is understood that the proposed embankment fill along Ramps A5 will be approximately 34 feet with side slopes of 2(H):1(V). Rii has performed settlement and slope stability analyses at the most critical cross sections along the alignments.

Based on design information provided by GPD group, approximately 34 feet of fill will be placed at sta. 5015. Embankment settlement analysis of the soil profile from subsurface information from boring B-108-9-15 indicates approximately 6.2 inches of settlement due to the overburden embankment fill with the groundwater level considered at the 100-year return elevation of 715.1 ft. msl. Slope stability analysis of the embankment, utilizing the parameters in Table 7, indicated a factor of safety of greater than 1.4.

5.2. Subgrade Recommendations

Based on roadway design information provided by GPD GROUP, soil borings with ground surface elevation within three feet of the proposed grade and soil borings located in the areas where cut will be required to reach the proposed grade were used in the GB1 analyses. The subgrade soils along the various alignments of the project consisted of both granular and cohesive soils. The granular soils encountered along the alignments were comprised of loose to very dense grave, gravel with sand, gravel with sand and silt, gravel with sand, and silt and clay (ODOT A-1-a, A-1-b, A-2-4, and A-2-6). The cohesive material encountered in the subgrade soils were comprised of medium stiff to hard clay, silty clay, silt and clay, sandy silt, and silt (ODOT A-7-6, A-6a, A-6b, A-4a, and A-4b). Based on the results of the GB-1 analyses in Appendix VI, the subgrade soils within some areas of the alignments will require stabilization and/or moisture conditioning.

The moisture content of cohesive soil has a significant effect on the physical properties of the material. It must be noted that the moisture contents illustrated on the boring logs and utilized in this analysis represent the conditions during the drilling phase of the project. The referenced borings for subgrade analysis were drilled in July 2008 and March 2015. These soil conditions, especially in the surficial soils, may not coincide with the soil conditions that will be encountered during construction. Consequently, the extent/need for subgrade improvement is entirely dependent on the subgrade conditions (i.e., moisture contents) encountered at the time of construction.

5.2.1. I-70 EB, I-71 NB, Ramp A5, Ramp C3

Seven (7) borings were utilized in the analysis of the subgrade along I-70 EB, I-71 NB, Ramp A5 and Ramp C3. A complete GB1 analysis of soils encountered at the proposed subgrade level along these alignments is presented in Appendix VI. Based on GB1 analysis of the subgrade soils, California Bearing Ratio (CBR) values (based on correlation charts) for the entire alignment ranged from 6 to 12 with an average of 8. However, based on experience with similar subgrade soils and conditions, **it is recommended that pavement design be based on a CBR value of 6** with a corresponding resilient modulus, M_R, of 7,200 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 150 pci and a soil support value (SSV) of 4.4.

Based on the borings utilized for this alignment, the subgrade soils along this alignment is predominantly granular. Therefore, no chemical stabilization could be recommended. However, per ODOT GB1 requirements, if it is elected to perform global stabilization, the entire subgrade should be stabilized using the average site parameters provided in Table 8.

Table 8. Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
16	10	13	11	5	8

Upon completion of the stabilization, the entire subgrade should be proof rolled to verify that stability has been achieved. Please note that the recommended CBR values assume that the materials utilized for the roadway subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of 6.

5.2.2. Street Alignments

Based on design information provided by GPD GROUP, a complete GB1 analysis of the proposed subgrade soils encountered along Livingston Avenue and Fulton Street is presented in Appendix VI. California Bearing Ratio (CBR) values for the entire project ranged from 5 to 8 with an average of 8. However, based on experience with similar subgrade soils **it is recommended that pavement design be based on a CBR value of 6** with a corresponding resilient modulus, M_R, of 7,200 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 150 pci and a soil support value (SSV) of 4.4.

Per ODOT GB1, soils with sulfate content in excess of 3,000 ppm cannot be chemically stabilized due to the potential for sulfate heave in the soil. Based on the results of the testing, the sulfate contents of the subgrade soils range from 227 to 587 ppm. Therefore, no sample with sulfate content greater than 3,000 ppm was encountered.

Based on the ODOT GB1 guidelines, when approximately 30 percent or more of the subgrade area requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, approximately 50 percent of the subgrade area is anticipated to require stabilization based on the soil borings performed (2 of 4 borings). Per ODOT GB1, global stabilization recommendations are based upon the overall average site parameters, as noted in Table 9.

Table 9. Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
6	12	14	12	5	8

Applying the averages in Table 9, ODOT GB1 recommends the following global stabilization options within the project limits:

Option 1. Chemically stabilize the entire subgrade with 12-inches of cement, as per ODOT Item 206. For estimating purposes, utilize a cement content of 6.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils.

Option 2. Stone stabilize the entire subgrade via an 12-inch undercut and replacement with ODOT Item 703.16C granular material, Type B, C or D installed over ODOT Item 712.09 Geotextile Fabric, Type D as detailed in accordance with ODOT Item 204.

Please note that the recommended CBR values assume that the materials utilized for the roadway subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of 6.

Pavement design is dependent on the inclusion of adequate surface and subsurface drainage in order to maintain the compacted subgrade near optimum moisture conditions throughout the lifetime of the pavement. If underdrain systems are considered, they should be installed in accordance to the specifications presented in Item 204 of the ODOT Construction and Materials Specifications (CMS).

5.3. Lateral Earth Pressure

For the soil types encountered in the borings, the "in-situ" unit weight (γ), cohesion (c), effective angle of friction (φ'), and lateral earth pressure coefficients for at-rest conditions (k_o), active conditions (k_a), and passive conditions (k_p) have been estimated and are provided in Table 10 and Table 11.

Table 10. Estimated Undrained (Short-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ	k_a	k_o	k_p
Soft to Stiff Cohesive Soil	115	1,000	0°	N/A	N/A	N/A
Very Stiff to Hard Cohesive Soil	125	3,000	0°	N/A	N/A	N/A
Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense to Dense Granular Soil	130	0	32°	0.27	0.47	6.82
Very Dense Granular Soil	135	0	35°	0.24	0.43	8.56
Compacted Cohesive Engineered Fill	125	1,500	0°	N/A	N/A	N/A
Compacted Granular Engineered Fill	135	0	33°	0.26	0.46	7.41

1. *When below groundwater table, use effective unit weight, $\gamma' = \gamma - 62.4$ pcf and add hydrostatic water pressure.*

Table 11. Estimated Drained (Long-term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ'	k_a	k_o	k_p
Soft to Stiff Cohesive Soil	115	0	24°	0.37	0.59	3.97
Very Stiff to Hard Cohesive Soil	125	0	28°	0.32	0.53	5.07
Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense to Dense Granular Soil	130	0	32°	0.27	0.47	6.82
Very Dense Granular Soil	135	0	35°	0.24	0.43	8.56
Compacted Cohesive Engineered Fill	125	0	28°	0.32	0.53	5.07
Compacted Granular Engineered Fill	135	0	33°	0.26	0.46	7.41

When below groundwater table, use effective unit weight, γ' = γ - 62.4 pcf and add hydrostatic water pressure.

These parameters are considered appropriate for the design of all subsurface structures and any excavation support systems. Subsurface structures (where the top of the structure is restrained from movement) should be designed based on at-rest conditions (k_o). For proposed temporary retaining structures (where the top of the structure is allowed to move), earth pressure distributions should be based on active (k_a) and passive (k_p) conditions. The values in this table have been estimated from correlation charts based on minimum standards specified for compacted engineered fill materials. These recommendations do not take into consideration the effect of any surcharge loading or a sloped ground surface (a flat surface is considered). Earth pressures on excavation support systems will be dependent on the type of sheeting and method of bracing or anchorage.

5.4. Construction Considerations

All site work shall conform to local codes and to the latest ODOT Construction and Materials Specifications (CMS), including that all excavation and embankment preparation and construction should follow ODOT Item 200 (Earthwork).

5.4.1. Excavation Considerations

All excavations should be shored / braced or laid back at a safe angle in accordance to Occupational Safety and Health Administration (OSHA) guidelines. During excavation, if slopes cannot be laid back to OSHA Standards due to adjacent structures or other obstructions, temporary shoring may be required. The following table should be utilized as a general guide for implementing OSHA guidelines when estimating excavation back slopes at the various boring locations. Actual excavation back slopes must be field verified by qualified personnel at the time of excavation in strict accordance with OSHA guidelines.

Table 12. Excavation Back Slopes

Soil	Maximum Back Slope	Notes
Soft to Medium Stiff Cohesive	1.5 : 1.0	Above Ground Water Table and No Seepage
Stiff Cohesive	1.0 : 1.0	Above Ground Water Table and No Seepage
Very Stiff to Hard Cohesive	0.75 : 1.0	Above Ground Water Table and No Seepage
All Granular & Cohesive Soil Below Ground Water Table or with Seepage	1.5 : 1.0	None

5.4.2. Groundwater Considerations

Based on groundwater condition encountered in the borings, groundwater should be anticipated during construction of the roadway. Where encountered during construction, proper groundwater control should be employed and maintained to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or "boiling" condition where soft silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36 inches below the deepest excavation. Note that determining and maintaining actual groundwater levels during construction is the responsibility of the contractor.

6. LIMITATIONS OF STUDY

The above recommendations are predicated upon construction inspection by a qualified soil technician under the direct supervision of a professional geotechnical engineer. Adequate testing and inspection during construction are considered necessary to assure an adequate foundation system and are part of these recommendations.

The recommendations for this project were developed utilizing soil and bedrock information obtained from the test borings that were made at the proposed site for the current investigation. Resource International is not responsible for the data, conclusions, opinions or recommendations made by others during previous investigations at this site. At this time we would like to point out that soil borings only depict the soil and bedrock conditions at the specific locations and time at which they were made. The conditions at other locations on the site may differ from those occurring at the boring locations.

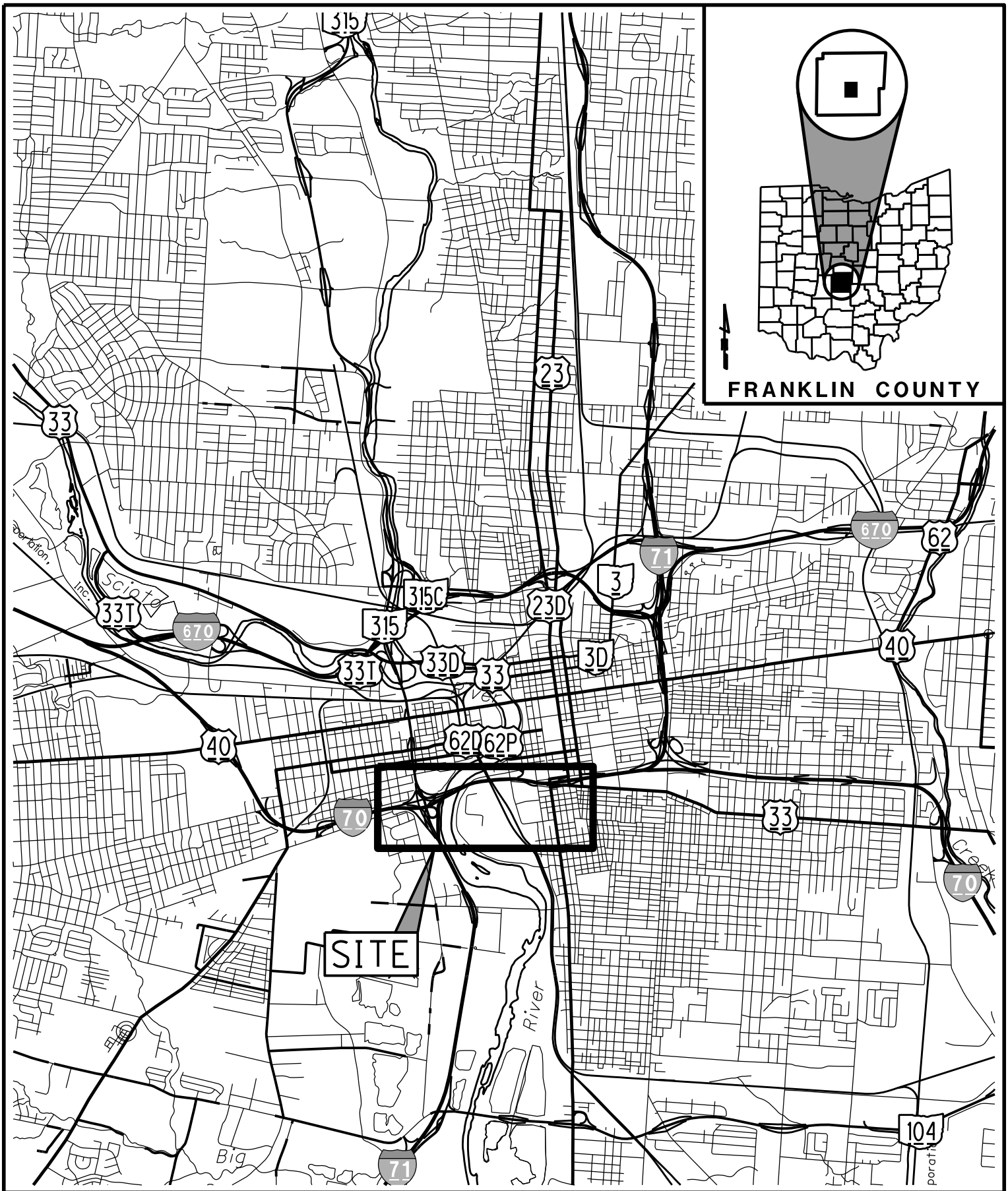
The conclusions and recommendations herein have been based upon the available soil and bedrock information and the design details furnished by a representative of the owner of the proposed project. Any revision in the plans for the proposed construction from those anticipated in this report should be brought to the attention of the geotechnical engineer to determine whether any changes in the foundation or earthwork recommendations are necessary. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the geotechnical engineer.

The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater or surface water within or beyond the site studied. Any statements in this report or on the test boring logs regarding odors, staining of soils or other unusual conditions observed are strictly for the information of our client.

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. Resource International is not responsible for the conclusions, opinions or recommendations made by others based upon the data included.

APPENDIX I

VICINITY MAP AND BORING PLAN



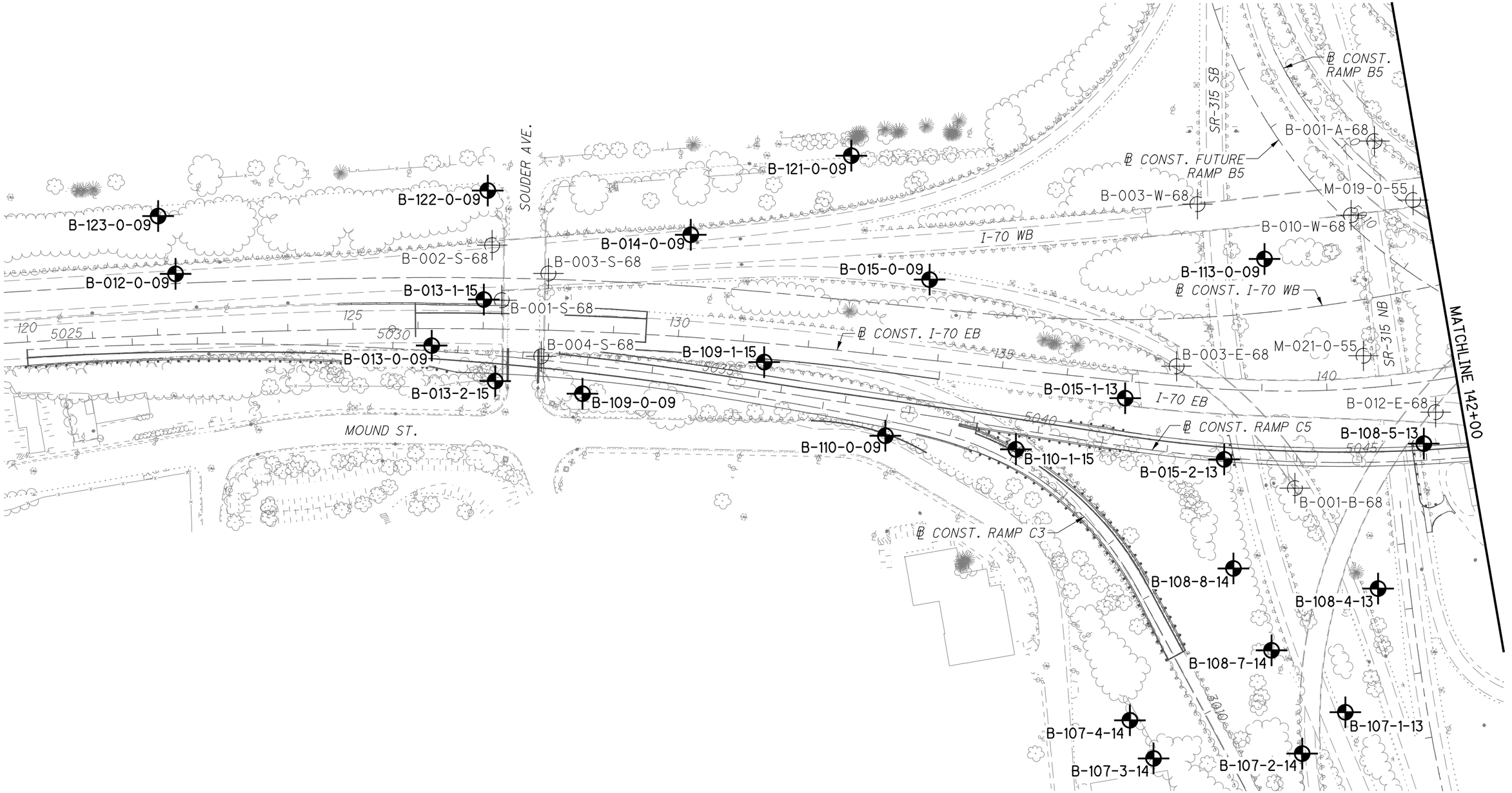
VICINITY MAP

FRA-70-12.68

COLUMBUS, OHIO

RII PROJECT NO. W-13-045	DRAWN RRM
SCALE: 1"=5000' (0 2500 5000)	REVIEWED BRT
	DATE 7-17-18

RESOURCE INTERNATIONAL Rii



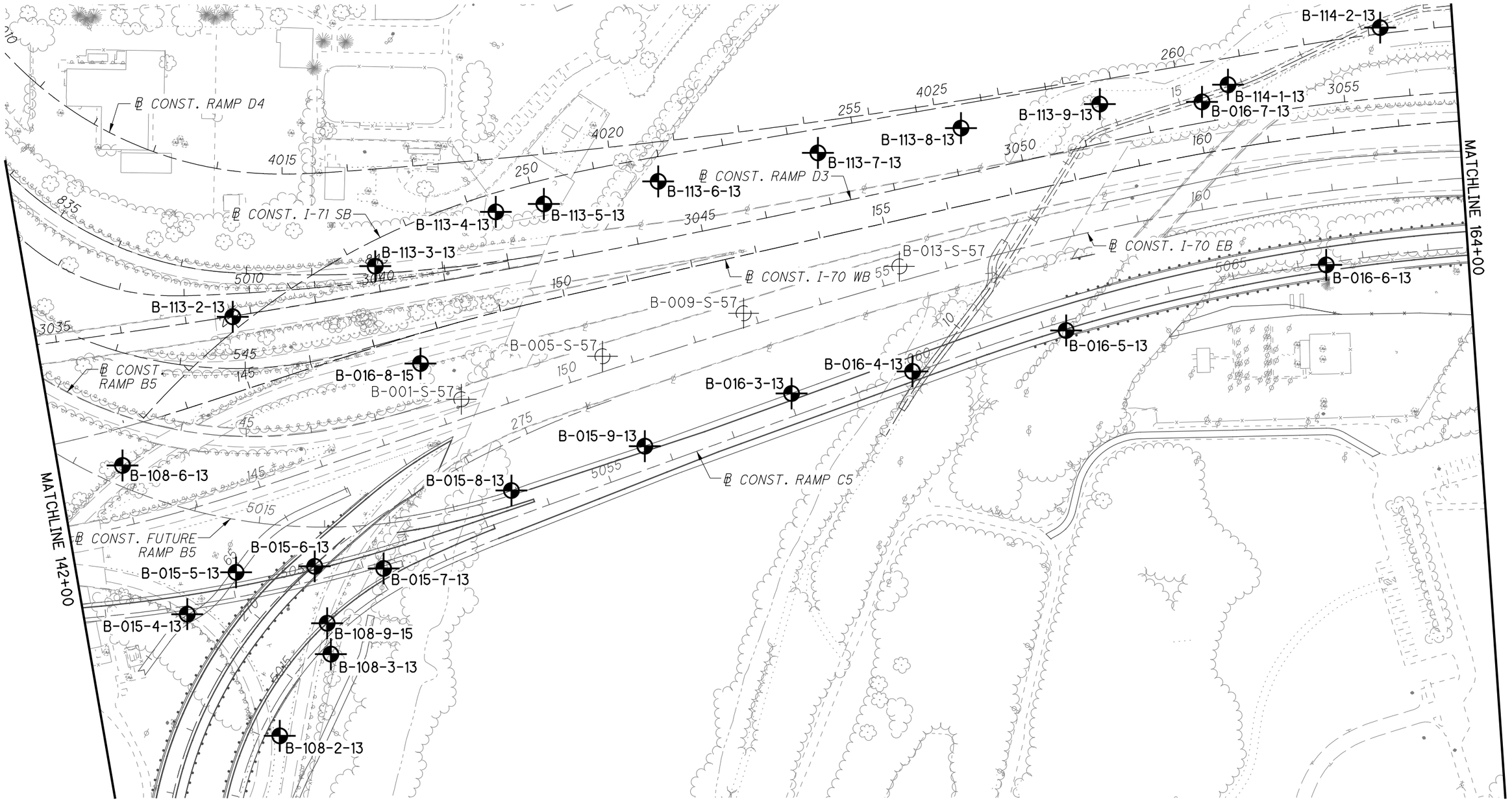
BORING PLAN

FRA-70-12.68 - I-70 EB STA. 120+00 TO STA. 142+00

FRANKLIN COUNTY, OHIO

RII PROJECT NO. W-13-045		DRAWN RRM
SCALE: 1"=150' 0 75 150	N	REVIEWED BRT
		DATE 7-16-18

RESOURCE INTERNATIONAL, INC.



BORING PLAN

FRA-70-12.68 - I-70 EB STA. 142+00 TO STA. 164+00

FRANKLIN COUNTY, OHIO

RII PROJECT NO. W-13-045		DRAWN RRM
SCALE: 1"=150' 0 75 150	N	REVIEWED BRT
		DATE 7-16-18

RESOURCE INTERNATIONAL, INC.

BORING PLAN

FRA-70-12.68 - I-70 EB STA. 164+00 TO STA. 190+50

FRANKLIN COUNTY, OHIO

RII PROJECT NO. W-13-045	DRAWN RRM
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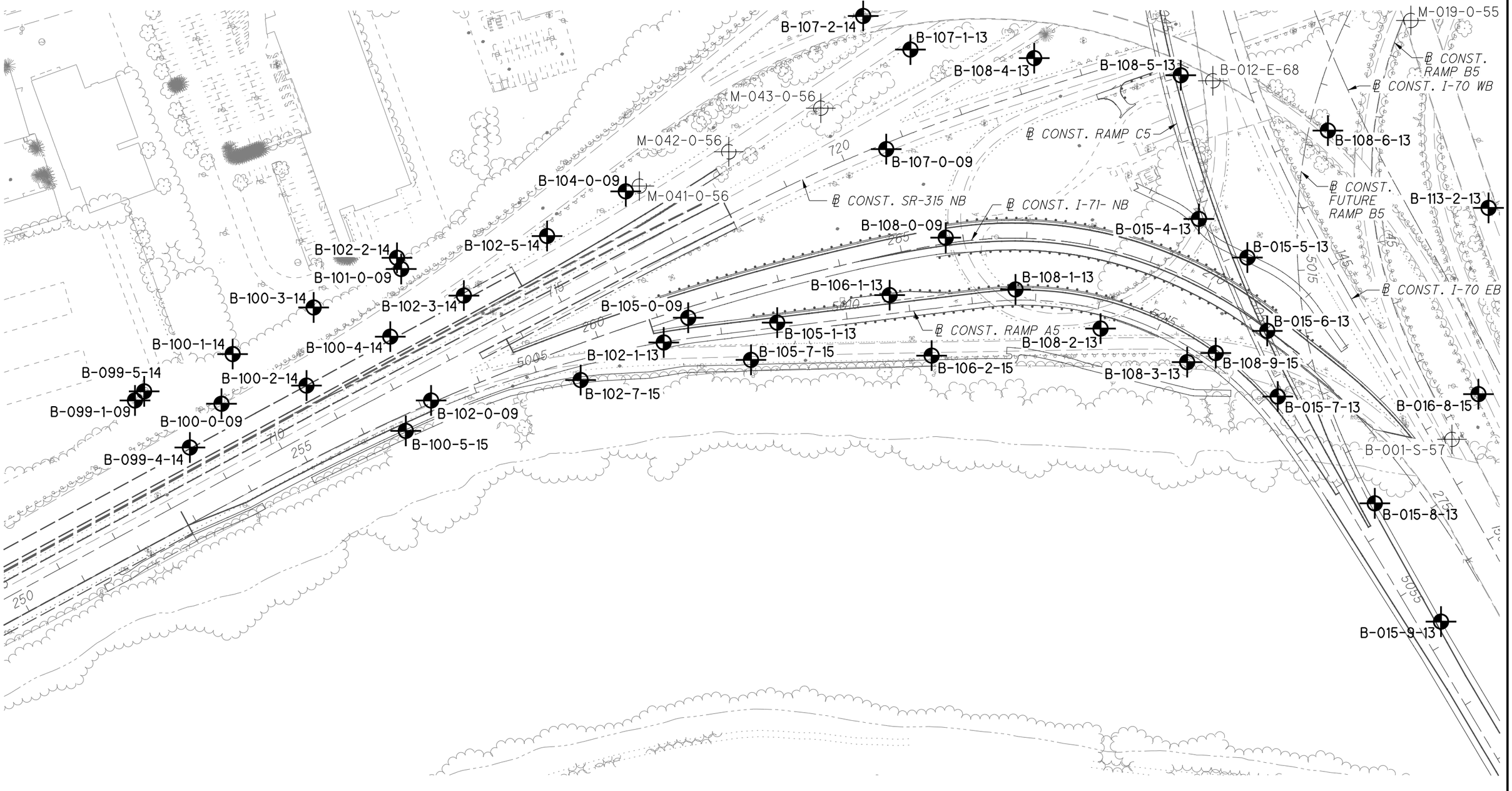
	DATE 7-16-18

RESOURCE INTERNATIONAL, INC.



BORING PLAN

FRA-70-12.68 - I-71 NB STA. 251+00 TO STA. 276+37.29

FRANKLIN COUNTY, OHIO

RII PROJECT NO.
W-13-045

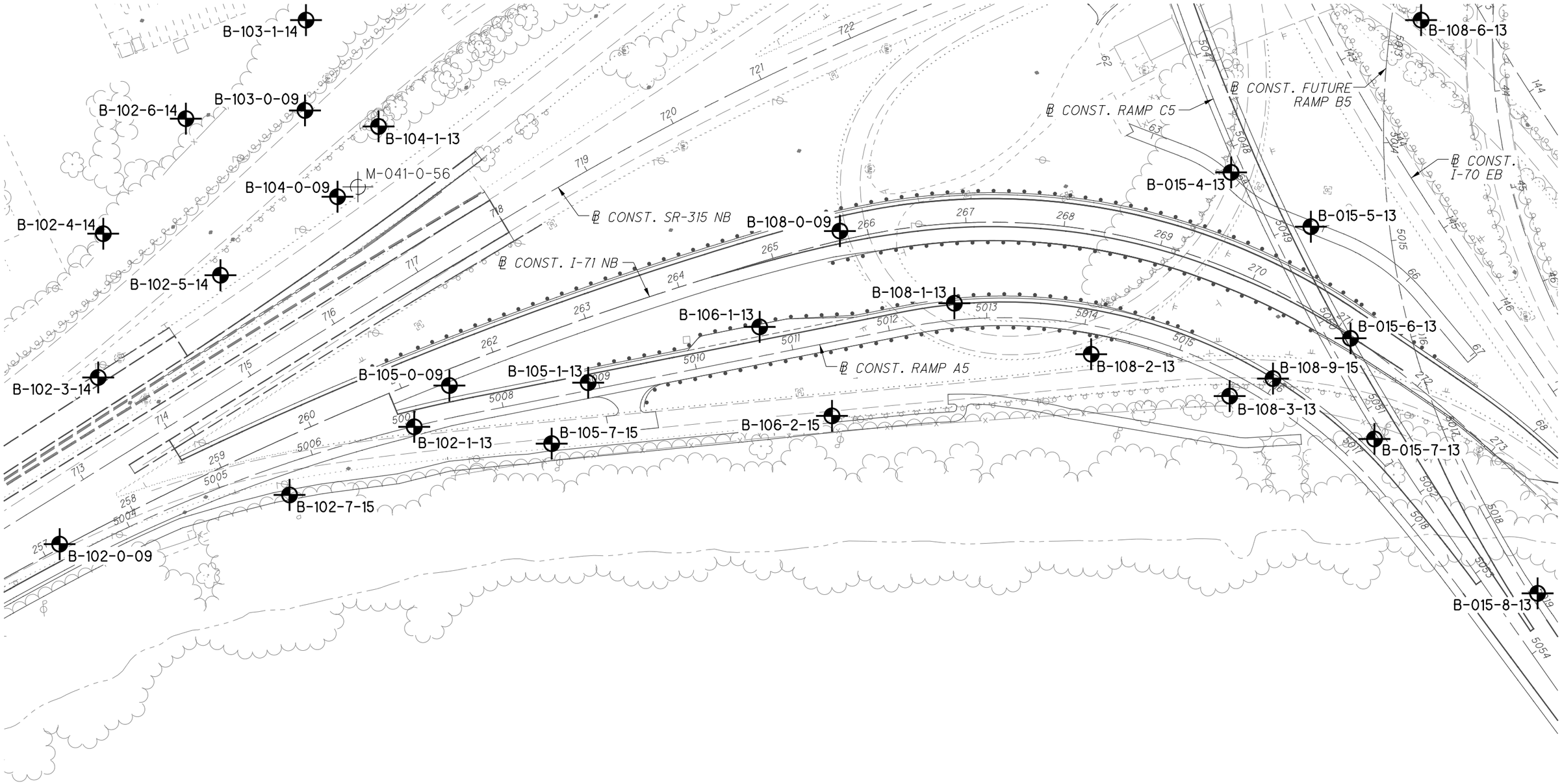
SCALE: 1"=150'
0 75 150

DRAWN
RRM

REVIEWED
BRT

DATE
7-17-18

RESOURCE
INTERNATIONAL, INC.



BORING PLAN

FRA-70-12.68 - RAMP A5

FRANKLIN COUNTY, OHIO

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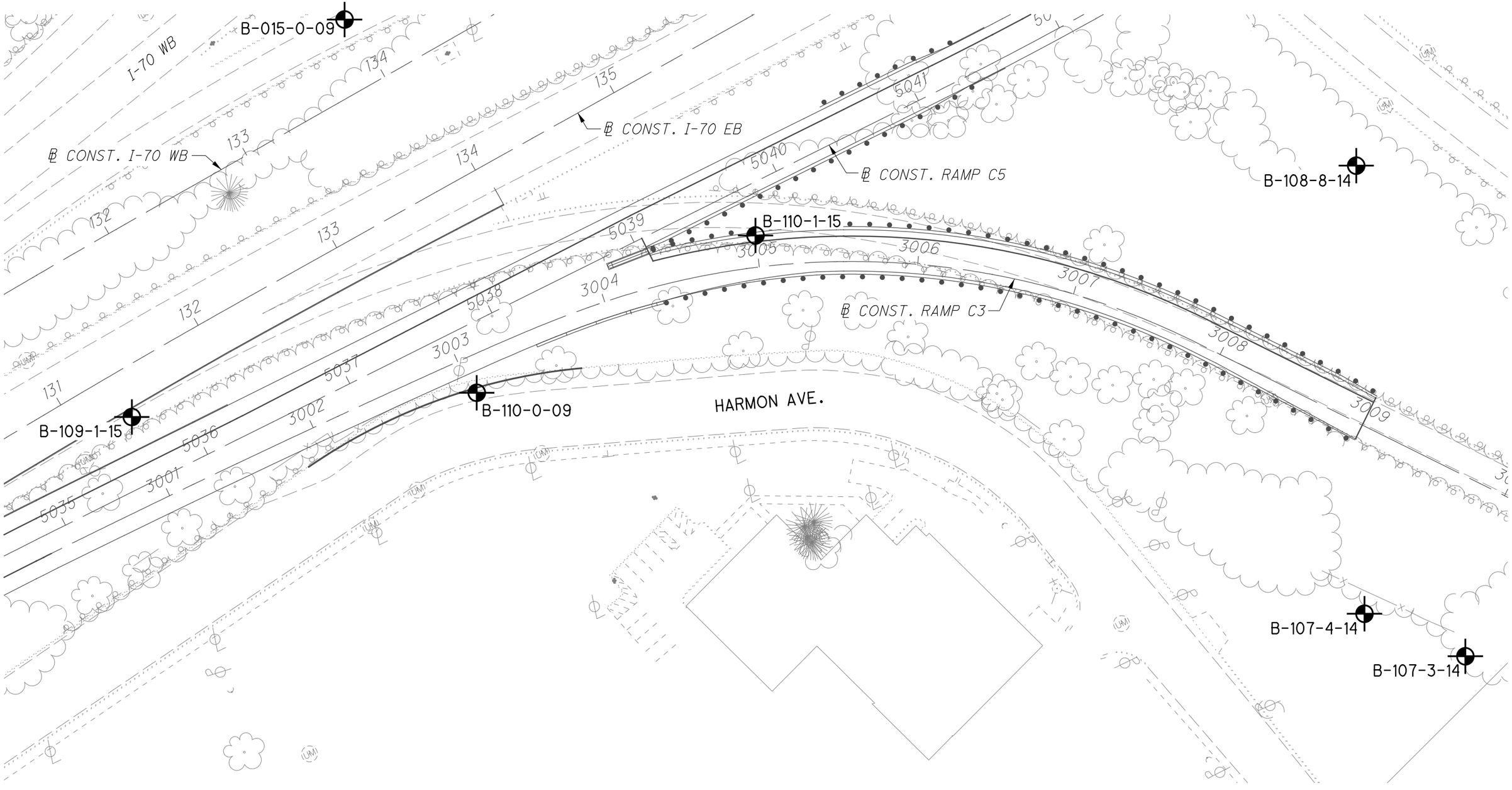
		DATE 7-16-18

RESOURCE INTERNATIONAL, INC.



BORING PLAN

FRA-70-12.68 - RAMP C3

FRANKLIN COUNTY, OHIO

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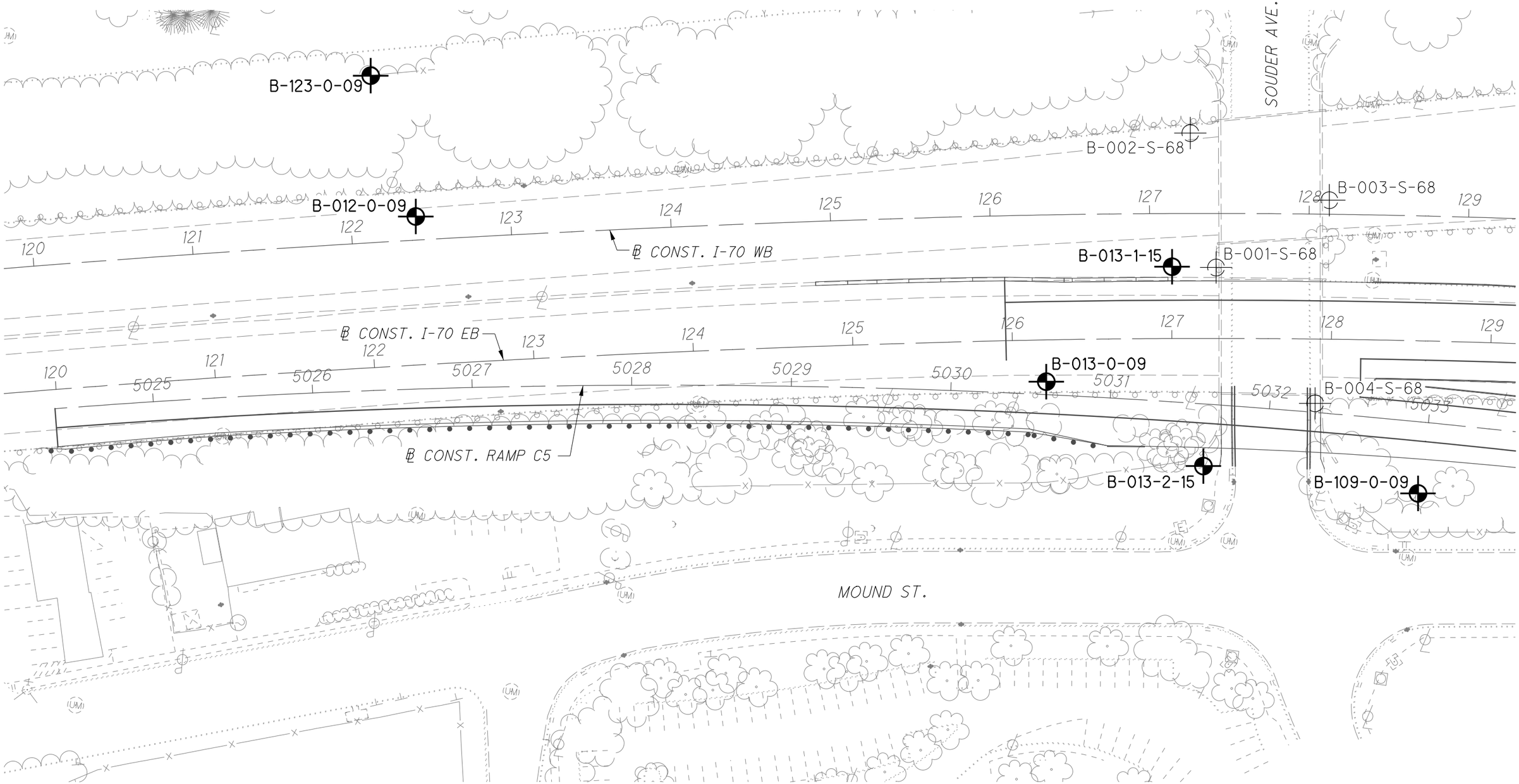
		DATE 7-16-18	



BORING PLAN

FRA-70-12.68 - RAMP C5

FRANKLIN COUNTY, OHIO

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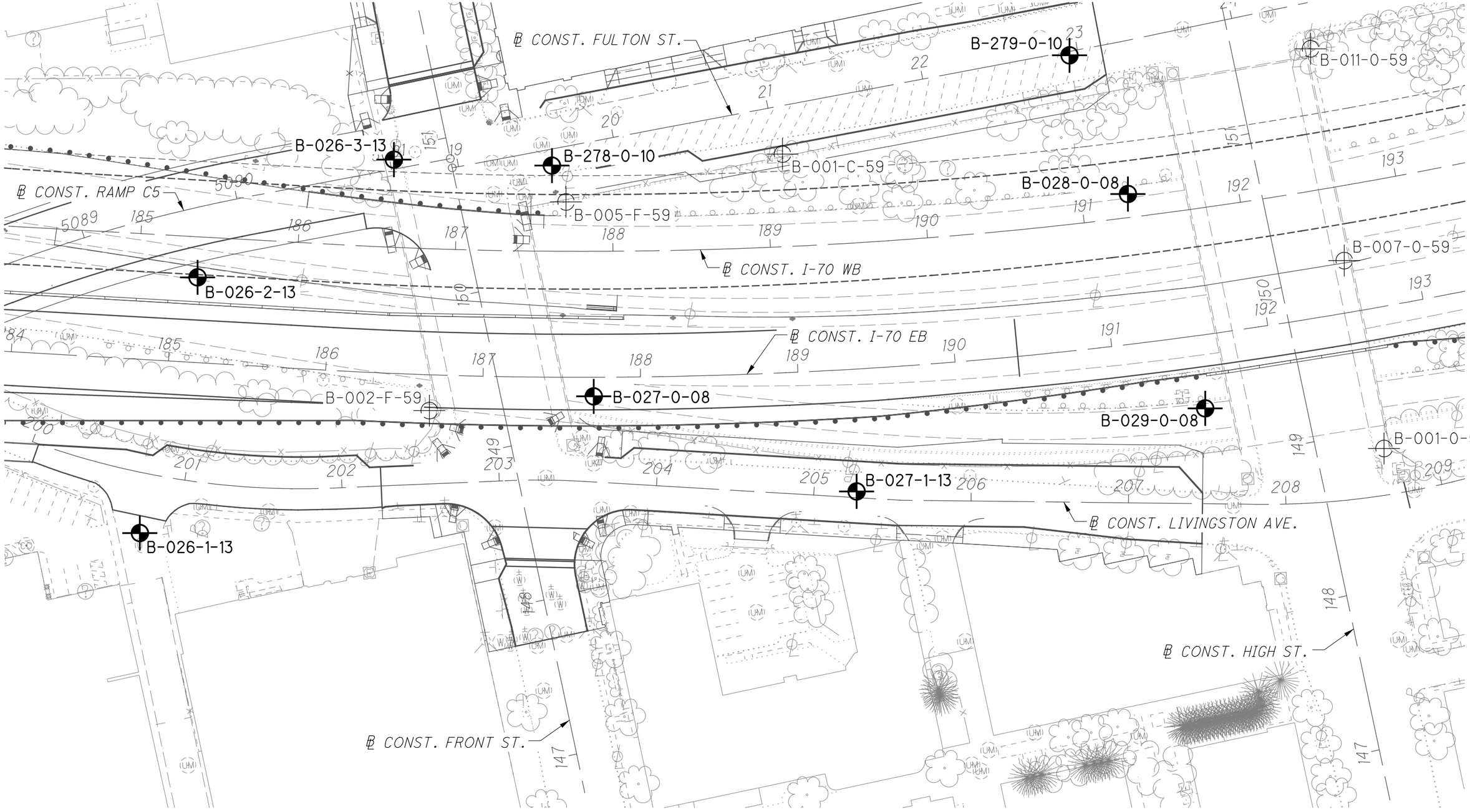
RESOURCE INTERNATIONAL, INC.



BORING PLAN

FRA-70-12.68 - LIVINGSTON AVE.

FRANKLIN COUNTY, OHIO

RII PROJECT NO. W-13-045	DRAWN RRM
SCALE: 1"=60' (0 30 60)	REVIEWED BRT
N	DATE 7-17-18

RESOURCE INTERNATIONAL, INC.

℄ CONST. FRONT ST.

℄ CONST. HIGH ST.

℄ CONST. FULTON ST.

B-278-0-10

B-279-0-10

B-280-0-10

B-005-F-59

B-001-C-59

B-011-0-59

B-028-0-08

B-030-0-08

B-027-0-08

B-007-0-59

℄ CONST. I-70 EB

℄ CONST. I-70 WB

℄ CONST. LIVINGSTON AVE.

BORING PLAN

FRA-70-12.68 - FULTON ST.

FRANKLIN COUNTY, OHIO

RII PROJECT NO.
W-13-045

SCALE: 1"=60'
0 30 60

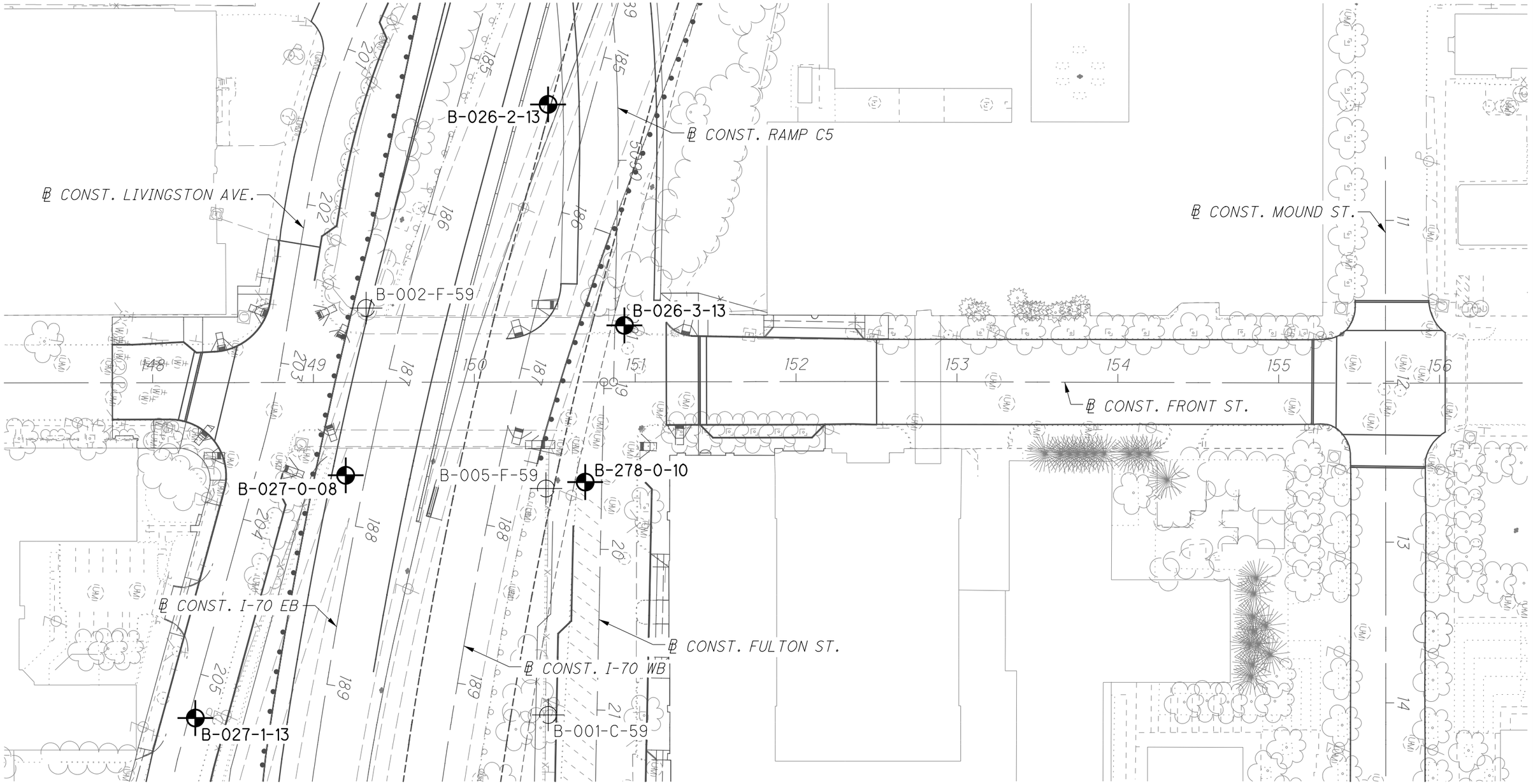
N

DRAWN
RRM

REVIEWED
BRT

DATE
7-16-18

RESOURCE
INTERNATIONAL, INC.



BORING PLAN

FRA-70-12.68 - FRONT ST.

FRANKLIN COUNTY, OHIO

RII PROJECT NO. W-13-045	DRAWN RRM
SCALE: 1"=60' (0 30 60)	REVIEWED BRT
N	DATE 7-17-18

RESOURCE INTERNATIONAL, INC.

℄ CONST. MOUND ST.

℄ CONST. FRONT ST.

℄ CONST. HIGH ST.

B-292-0-10

BORING PLAN

FRA-70-12.68 - MOUND ST.

FRANKLIN COUNTY, OHIO

RII PROJECT NO. W-13-045	DRAWN RRM
SCALE: 1"=60' (0 30 60)	REVIEWED BRT
N	DATE 7-17-18

RESOURCE INTERNATIONAL, INC.

APPENDIX II

DESCRIPTION OF SOIL TERMS

CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart.
The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classifcation		LL_O/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
		AASHTO	OHIO							
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	76 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		76 Min.		36 Min.	41 Min.	$\leq$LL-30	20	
	Clay	A-7-6		76 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

 Sod and Topsoil

 Pavement or Base

 Uncontrolled Fill (Describe)

 Bouldery Zone

Peat

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

DESCRIPTION OF SOIL TERMS

The following terminology was used to describe soils throughout this report and is generally adapted from ASTM 2487/2488 and ODOT Specifications for Geotechnical Explorations.

Granular Soils - The relative compactness of granular soils is described as:
ODOT A-1, A-2, A-3, A-4 (non-plastic) or USCS GW, GP, GM, GC, SW, SP, SM, SC, ML (non-plastic)

Description	Blows per foot – SPT (N_{60})		
Very Loose	Below		5
Loose	5	-	10
Medium Dense	11	-	30
Dense	31	-	50
Very Dense	Over		50

Cohesive Soils - The relative consistency of cohesive soils is described as:
ODOT A-4, A-5, A-6, A-7, A-8 or USCS ML, CL, OL, MH, CH, OH, PT

Description	Unconfined Compression (tsf)		
Very Soft	Less than		0.25
Soft	0.25	-	0.5
Medium Stiff	0.5	-	1.0
Stiff	1.0	-	2.0
Very Stiff	2.0	-	4.0
Hard	Over		4.0

Gradation - The following size-related denominations are used to describe soils:

Soil Fraction		USCS Size	ODOT Size
Boulders		Larger than 12”	Larger than 12”
Cobbles		12” to 3”	12” to 3”
Gravel	coarse	3” to ¾”	3” to ¾“
	fine	¾” to 4.75 mm (¾” to #4 Sieve)	¾” to 2.0 mm (¾” to #10 Sieve)
Sand	coarse	4.75 mm to 2.0 mm (#4 to #10 Sieve)	2.0 mm to 0.42 mm (#10 to #40 Sieve)
	medium	2.0 mm to 0.42 mm (#10 to #40 Sieve)	-
	fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt		0.074 mm to 0.005 mm (#200 to 0.005 mm)	0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay		Smaller than 0.005 mm	Smaller than 0.005 mm

Modifiers of Components - Modifiers of components are as follows:

Term	Range		
Trace	0%	-	10%
Little	10%	-	20%
Some	20%	-	35%
And	35%	-	50%

Moisture Table - The following moisture-related denominations are used to describe cohesive soils:

Term	Range - USCS	Range - ODOT
Dry	0% to 10%	Well below Plastic Limit
Damp	>2% below Plastic Limit	Below Plastic Limit
Moist	2% below to 2% above Plastic Limit	Above PL to 3% below LL
Very Moist	>2% above Plastic Limit	
Wet	≥ Liquid Limit	3% below LL to above LL

Organic Content – The following terms are used to describe organic soils:

Term	Organic Content (%)
Slightly organic	2-4
Moderately organic	4-10
Highly organic	>10

Bedrock – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

DESCRIPTION OF ROCK TERMS

The following terminology was used to describe the rock throughout this report and is generally adapted from ASTM D5878 and the ODOT Specifications for Geotechnical Explorations.

Weathering – Describes the degree of weathering of the rock mass:

Description	Field Parameter
Unweathered	No evidence of any chemical or mechanical alteration of the rock mass. Mineral crystals have a right appearance with no discoloration. Fractures show little or not staining on surfaces.
Slightly Weathered	Slight discoloration of the rock surface with minor alterations along discontinuities. Less than 10% of the rock volume presents alteration.
Moderately Weathered	Portions of the rock mass are discolored as evident by a dull appearance. Surfaces may have a pitted appearance with weathering "halos" evident. Isolated zones of varying rock strengths due to alteration may be present. 10 to 15% of the rock volume presents alterations.
Highly Weathered	Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered rock may be present and some areas of severely weathered materials may be present.
Severely Weathered	Majority of the rock mass reduced to a soil-like state with relic rock structure discernable. Zones of more resistant rock may be present but the material can generally be molded and crumbled by hand pressures.

Strength of Bedrock – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

Bedding Thickness – Description of bedding thickness as the average perpendicular distances between bedding surfaces:

Description	Thickness
Very Thick	Greater than 36 inches
Thick	18 to 36 inches
Medium	10 to 18 inches
Thin	2 to 10 inches
Very Thin	0.4 to 2 inches
Laminated	0.1 to 0.4 inches
Thinly Laminated	Less than 0.1 inches

Fracturing – Describes the degree and condition of fracturing (fault, joint, or shear):

Degree of Fracturing

Description	Spacing
Unfractured	Greater than 10 feet
Intact	3 to 10 feet
Slightly Fractured	1 to 3 feet
Moderately Fractured	

Aperture Width

Description	Width
Open	Greater than 0.2 inches
Narrow	0.05 to 0.2 inches
Tight	Less than 0.05 inches

Surface Roughness

Description	Criteria
Very Rough	Near vertical steps and ridges occur on surface
Slightly Rough	Asperities on the surfaces distinguishable
Slickensided	Surface has smooth, glassy finish, evidence of Striations

RQD – Rock Quality Designation (calculation shown in report) and Rock Quality (ODOT, GB 3, January 13, 2006):

RQD %	Rock Index Property Classification (based on RQD, not slake durability index)
0 – 25%	Very Poor
26 – 50%	Poor
51 – 70%	Fair
71 – 85%	Good
86 – 100%	Very Good

APPENDIX III

BORING LOGS

BORING LOGS

Definitions of Abbreviations

AS = Auger sample

HP = Unconfined compressive strength as determined by a hand penetrometer (tons per square foot)

LOI = Percent organic content (by weight) as determined by ASTM D2974 (loss on ignition test)

PID = Photo-ionization detector reading (parts per million)

QR = Unconfined compressive strength of intact rock core sample as determined by ASTM D2938 (pounds per square inch)

QU = Unconfined compressive strength of soil sample as determined by ASTM D2166 (pounds per square foot)

RC = Rock core sample

REC = Ratio of total length of recovered soil or rock to the total sample length, expressed as a percentage

RQD = Rock quality designation – estimate of the degree of jointing or fracture in a rock mass, expressed as a percentage:

$$\frac{\sum \text{segments equal to or longer than 4.0 inches}}{\text{core run length}} \times 100$$

S = Sulfate content (parts per million)

SPT = Standard penetration test blow counts, per ASTM D1586. Driving resistance recorded in terms of blows per 6-inch interval while letting a 140-pound hammer free fall 30 inches to drive a 2-inch outer diameter (O.D.) split spoon sampler a total of 18 inches. The second and third intervals are added to obtain the number of blows per foot (N).

SS = Split spoon sample

2S = For instances of no recovery from standard SS interval, a 2.5 inch O.D. split spoon is driven the full length of the standard SS interval plus an additional 6.0 inches to obtain a representative sample. Only the final 6.0 inches of sample is retained. Blow counts from 2S sampling are not correlated with N_{60} values.

3S = Same as 2S, but using a 3.0 inch O.D. split spoon sampler.

TR = Top of rock

W = Initial water level measured during drilling

▼ = Water level measured at completion of drilling

Classification Test Data

Gradation (as defined on Description of Soil Terms):

GR = % Gravel
SA = % Sand
SI = % Silt
CL = % Clay

Atterberg Limits:

LL = Liquid limit
PL = Plastic limit
PI = Plasticity Index

WC = Water content (%)

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

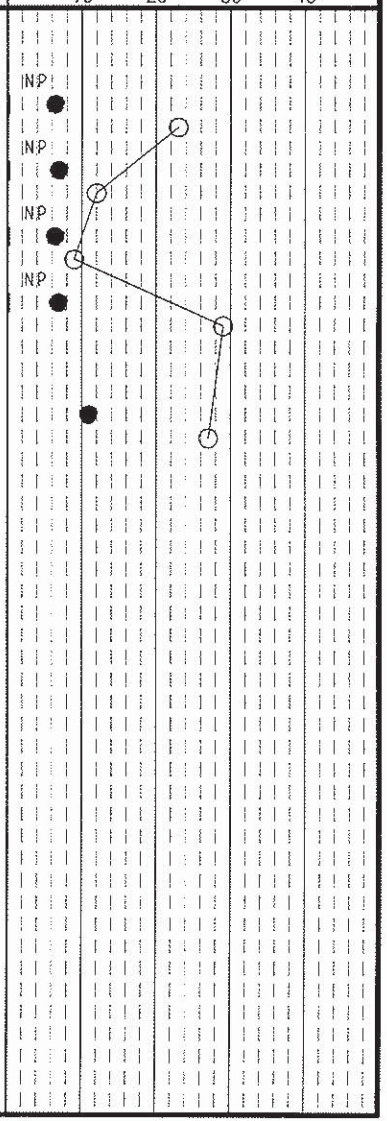
LOG OF: Boring B-013 | *Location:* Sta. 675+45.91, 81.90 ft Rt. of I-70 CL | *Date Drilled:* 8/31/2009

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	723.0													
1.5	721.5						Asphalt Concrete - 7" Aggregate Base - 10"							
		19 11 12	13	1		-	Loose to medium dense brown GRAVEL WITH SAND (A-1-b), little to some silt; moist.		42	28	---	16	--14--	
		4 7 5	10	2					35	29	---	21	--15--	
5		6 4 5	16	3					39	31	---	18	--12--	
		6 15 13	15	4					26	22	---	30	--22--	
10.0 10	713.0	7 13 13	6	5										
							Bottom of Boring - 10.0'							
15														
20														
25														

GRADATION

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / J.K./S.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 127+00.32 / 45.0' LT	**EXPLORATION ID B-013-1-15**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / C.D./N.A.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-70 EB	
PID: 77372 BR ID: FRA-70-1282R	DRILLING METHOD: 4.5" CFA / 3.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 725.9 (MSL) EOB: 35.0 ft.	PAGE 1 OF 2
START: 2/26/15 END: 2/27/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.7	LAT / LONG: 39.950158148, -83.021287305	

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
0.6' - ASPHALT (7.0")	725.3																	
0.4' - AGGREGATE BASE (5.0")	724.9																	
FILL: HARD, BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	722.9	1	40 16 13	38	67	SS-1	4.5+	-	-	-	-	-	-	-	-	8	A-6a (V)	
FILL: DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.		2																
		3																
		4	11 15 16	40	100	SS-2	-	34	30	17	12	7	NP	NP	NP	7	A-1-b (0)	
		5																
		6																
		7	14 12 14	34	100	SS-3	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		8																
		9	19 17 14	40	100	SS-4	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
	715.4	10																
FILL: HARD, BROWN TO GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DRY TO DAMP.		11																
		12	15 9 11	26	100	SS-5	4.5+	-	-	-	-	-	-	-	-	9	A-6a (V)	
		13																
		14	8 8 14	28	100	SS-6	4.5+	20	13	11	36	20	28	17	11	14	A-6a (5)	
		15																
		16																
		17	14 22 21	56	100	SS-7	4.5+	-	-	-	-	-	-	-	-	9	A-6a (V)	
	707.9	18																
DENSE TO VERY DENSE, GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.		19	8 11 14	32	100	SS-8	-	52	19	7	14	8	NP	NP	NP	12	A-1-b (0)	
		20																
		21																
		22																
		23																
		24	17 15 25	52	100	SS-9	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		25																
		26																
	698.9	27																
DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, DAMP.		28																
-ROCK FRAGMENTS PRESENT IN SS-10		29	12 12 18	39	100	SS-10	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 3/14/15 17:33 - U:\GI\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: FRA-70-1282R	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 127+00.32 / 45.0 LT	START: 2/26/15	END: 2/27/15	PG 2 OF 2	B-013-1-15

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
DENSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, DAMP. *(same as above)*	695.9	31																
MEDIUM DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP.	693.9	32																
		33																
-ROCK FRAGMENTS PRESENT IN SS-11	690.9	34	9 9 10	25	100	SS-11	-	61	14	5	13	7	NP	NP	NP	6	A-1-b (0)	
	EOB	35																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 127+19.67 / 80.0' RT	**EXPLORATION ID B-013-2-15**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / C.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-70 EB	
PID: 77372 BR ID: FRA-70-1282R	DRILLING METHOD: 4.25" HSA / RC	CALIBRATION DATE: 10/20/14	ELEVATION: 705.5 (MSL) EOB: 66.5 ft.	PAGE 1 OF 3
START: 1/29/15 END: 2/25/15	SAMPLING METHOD: SPT / HQ	ENERGY RATIO (%): 92	LAT / LONG: 39.949827253, -83.021150673	

MATERIAL DESCRIPTION AND NOTES	ELEV. 705.5	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
0.5' - TOPSOIL (6.0")	705.0																	
FILL: MEDIUM DENSE, BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST. -CINDERS AND STONE FRAGMENTS PRESENT IN SS-1	702.5	1 2 3	5 6 9	23	100	SS-1	-	-	-	-	-	-	-	-	-	11	A-2-6 (V)	
POSSIBLE FILL: DENSE TO VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP. -ROOT FIBERS PRESENT IN SS-2		4 5	24 20 15	54	56	SS-2	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		6 7	10 14 12	40	67	SS-3	-	63	12	8	13	4	NP	NP	NP	6	A-1-b (0)	
	697.5	8																
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL**, LITTLE TO SOME COARSE TO FINE SAND, TRACE TO LITTLE SILT, TRACE CLAY, DAMP TO MOIST. -COBBLES ENCOUNTERED @ 11.0'		9 10	16 18 23	63	100	SS-4	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
		11 12	14 13 14	41	50	SS-5	-	-	-	-	-	-	-	-	-	4	A-1-a (V)	
		13 14	16 20 17	57	72	SS-6	-	71	12	5	9	3	NP	NP	NP	5	A-1-a (0)	
		W 15 16	7 15 21	55	89	SS-7	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
		W 17 18	13 29 50/2"	-	93	SS-8	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
		19 20	7 8 9	26	94	SS-9	-	-	-	-	-	-	-	-	-	10	A-1-a (V)	
-ROCK FRAGMENTS PRESENT IN SS-10		21 22 23 24	6 25 11	55	100	SS-10	-	53	25	7	12	3	NP	NP	NP	12	A-1-a (0)	
-HEAVING SANDS ENCOUNTERED @ 26.0'		25 26 27	5 12 16	43	100	SS-11	-	-	-	-	-	-	-	-	-	12	A-1-a (V)	
-INTRODUCED MUD @ 28.5'		28 29	19 16 20	55	100	SS-12	-	61	24	7	7	1	NP	NP	NP	10	A-1-a (0)	

PID: 77372	BR ID: FRA-70-1282R	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 127+19.67 / 80.0 RT	START: 1/29/15	END: 2/25/15	PG 2 OF 3	B-013-2-15

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
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL**, LITTLE TO SOME COARSE TO FINE SAND, TRACE TO LITTLE SILT, TRACE CLAY, DAMP TO MOIST. *(same as above)*	675.5																	
	673.5																	
HARD, GRAY **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DAMP.			10 28 44	110	100	SS-13	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
			7 27 36	97	72	SS-14	4.5+	24	11	17	34	14	20	14	6	8	A-4a (3)	
	663.5																	
DENSE, BLACK **FINE SAND**, TRACE SILT, WET.			14 10 18	43	100	SS-15	-	-	-	-	-	-	-	-	-	19	A-3 (V)	
	658.5																	
HARD, DARK GRAY **SANDY SILT**, SOME CLAY, SOME FINE GRAVEL, DAMP.			50/4"	-	25	SS-16	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
-BOULDER ENCOUNTERED @ 51.0-52.5'																		
-ROCK FRAGMENTS PRESENT IN SS-16 AND SS-17			50/3"	-	33	SS-17	-	-	-	-	-	-	-	-	-	12	A-4a (V)	
	647.0	TR																
LIMESTONE FRAGMENTS	646.0		50/1"	-	100	SS-18	-	-	-	-	-	-	-	-	-	2	Rock (V)	
AUGER REFUSAL @ 59.5'	645.5																	
GRANITE BOULDER			25		92	RC-1											CORE	

2014 ODOT BORING LOG-RI NE BRIDGE ID - OH DOT.GDT - 3/27/15 18:31 - U:\GI\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: FRA-70-1282R	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 127+19.67 / 80.0 RT	START: 1/29/15	END: 2/25/15	PG 3 OF 3	B-013-2-15

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
LIMESTONE : GRAY AND WHITE, MODERATELY WEATHERED TO UNWEATHERED, MODERATELY STRONG TO STRONG, MEDIUM TO THICK BEDDED, CHERTY, DOLOMITIC, FOSSILIFEROUS, PYRITIC, SLIGHTLY TO HIGHLY FRACTURED, OPEN APERTURES, SLIGHTLY ROUGH.; RQD 58%, REC 98%. *(same as above)* -STYLOLITES PRESENT IN RC-2	643.4	63	71		100	RC-2											CORE	
	639.0	64																
		EOB 65																
		66																

NOTES: SEEPAGE ENCOUNTERED @ 17.0'; GROUNDWATER ENCOUNTERED INITIALLY @ 18.5'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / J.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 170+79.36 / 23.3' RT	**EXPLORATION ID B-017-7-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-70 EB		
PID: 77372 BR ID: FRA-70-1358R	DRILLING METHOD: 4.25" HSA / RC	CALIBRATION DATE: 4/26/13	ELEVATION: 743.1 (MSL) EOB: 96.7 ft.		PAGE 1 OF 4
START: 8/4/13 END: 8/7/13	SAMPLING METHOD: SPT / HQ	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953200568, -83.006425064		

MATERIAL DESCRIPTION AND NOTES	ELEV. 743.1	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
0.9' - ASPHALT (11.0")	742.2																	
0.5' - AGGREGATE BASE (6.0")	741.7																	
FILL: MEDIUM DENSE, GRAY **GRAVEL**, LITTLE FINE TO COARSE SAND, TRACE SILT, TRACE CLAY, MOIST.		1																
		2	4 5 6	14	67	SS-1	-	69	13	5	10	3	NP	NP	NP	7	A-1-a (0)	
		3																
	739.1	4	3 3 5	10	50	SS-2	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
FILL: STIFF TO VERY STIFF, BROWNISH GRAY TO BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		5					3.00	-	-	-	-	-	-	-	-	13	A-6a (V)	
		6																
		7	6 8 12	26	50	SS-3	2.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
	735.1	8																
FILL: VERY DENSE, BROWN **GRAVEL**, TRACE SILT, DAMP.		9	18 25 25	65	44	SS-4	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
	732.6	10																
FILL: STIFF TO HARD, BROWN TO DARK BROWNISH GRAY **SILTY CLAY**, SOME FINE GRAVEL, LITTLE COARSE TO FINE SAND, DRY TO MOIST.		11																
		12	3 9 10	25	50	SS-5	2.00	-	-	-	-	-	-	-	-	12	A-6b (V)	
		13																
		14	1 2 5	9	56	SS-6	1.50	31	11	8	30	20	37	18	19	19	A-6b (6)	
		15																
		16																
		17	5 15 15	39	39	SS-7	2.00	-	-	-	-	-	-	-	-	9	A-6b (V)	
		18																
		19	15 50 28	101	39	SS-8	2.00	-	-	-	-	-	-	-	-	19	A-6b (V)	
		20																
		21																
		22	6 12 9	27	56	SS-9	1.75	-	-	-	-	-	-	-	-	20	A-6b (V)	
		23																
		24	21 6 8	18	56	SS-10	4.50	24	10	9	33	24	40	20	20	18	A-6b (8)	
		25																
		26																
		27	7 8 10	23	83	SS-11	2.50	-	-	-	-	-	-	-	-	16	A-6b (V)	
		28																
		29	WOH 2 10	16	72	SS-12	2.75	-	-	-	-	-	-	-	-	18	A-6b (V)	

PID: 77372	BR ID: FRA-70-1358R	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 170+79.36 / 23.3 RT	START: 8/4/13	END: 8/7/13	PG 2 OF 4	B-017-7-13

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
FILL: STIFF TO HARD, BROWN TO DARK BROWNISH GRAY **SILTY CLAY**, SOME FINE GRAVEL, LITTLE COARSE TO FINE SAND, DRY TO MOIST. *(same as above)*	713.1																	
	711.1																	
FILL: STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, SOME FINE GRAVEL, DAMP.		31																
		32																
		33																
		34	4 4 5	12	50	SS-13	1.75	24	14	12	31	19	33	18	15	20	A-6a (5)	
		35																
		36																
		37																
-WOOD FRAGMENTS RECOVERED FROM 38.5' TO 39.0'		38																
	704.1	39	10 8 8	21	33	SS-14	-	-	-	-	-	-	-	-	-	110		
HARD, DARK BROWN **SILTY CLAY**, SOME FINE TO COARSE SAND, SOME FINE GRAVEL, MOIST.							4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
	701.1	40																
MEDIUM DENSE TO DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, MOIST.		41																
		42																
		43																
		44	2 8 11	25	78	SS-15	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		45																
		46																
		47																
		48																
		W																
		49	10 14 16	39	61	SS-16	-	52	18	10	16	4	21	18	3	10	A-1-b (0)	
		50																
		51																
		52																
		53																
		54	20 30 45	97	72	SS-17	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		55																
		56																
	686.1	W																
		57																
VERY DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE SILT, MOIST.		58																
		59	41 21 50/4"	-	100	SS-18	-	-	-	-	-	-	-	-	-	17	A-2-4 (V)	
-COBBLES PRESENT @ 60.0'		60																
		61																

PID: 77372	BR ID: FRA-70-1358R	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 170+79.36 / 23.3 RT	START: 8/4/13	END: 8/7/13	PG 3 OF 4	B-017-7-13

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 DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE SILT, MOIST. *(same as above)*	681.0	63																
		64	8 20 20	52	83	SS-19	-	-	-	-	-	-	-	-	-	17	A-2-4 (V)	
		65																
		66																
	676.1	67																
HARD, GRAY **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, DAMP.		68																
		69	8 9 16	32	78	SS-20	4.5+	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		70																
		71																
		72																
		73																
		74	12 14 20	44	89	SS-21	4.5+	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		75																
		76																
		77																
		78																
		79	12 22 50	93	44	SS-22	4.5+	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		80																
		81																
		82																
		83																
		84	40 35 50/4"	-	81	SS-23	4.5+	0	2	5	34	59	54	25	29	15	A-7-6 (18)	
		85																
		86																
		87																
		88																
		89	25 50/4"	-	100	SS-24	4.5+	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
AUGER REFUSAL @ 90.0'	653.1	TR 90																
MUDSTONE : GRAY, SLIGHTLY WEATHERED, VERY WEAK, THINLY LAMINATED TO LAMINATED, FRIABLE, FISSILE, HIGHLY FRACTURED TO FRACTURED, OPEN APERTURE, ROUGH; RQD 73%, REC 100%.		91	79		100	RC-1											CORE	
	651.1	92	66		100	RC-2											CORE	
		93																
		94																

PID: 77372	BR ID: FRA-70-1358R	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 170+79.36 / 23.3 RT	START: 8/4/13	END: 8/7/13	PG 4 OF 4	B-017-7-13

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
SHALE : GRAY TO BLACK, HIGHLY WEATHERED, VERY WEAK, THINLY LAMINATED TO LAMINATED, FRIABLE, MODERATELY TO HIGHLY FRACTURED, OPEN APERTURE, SLIGHTLY ROUGH TO ROUGH; RQD 15%, REC 74%. *(same as above)*	648.8	95	15		74	RC-3											CORE	
	646.4	EOB 96																

NOTES: SEEPAGE ENCOUNTERED @ 48.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 57.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS PORTLAND CEMENT / 50 LBS BENTONITE POWDER / 50 GAL WATER

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

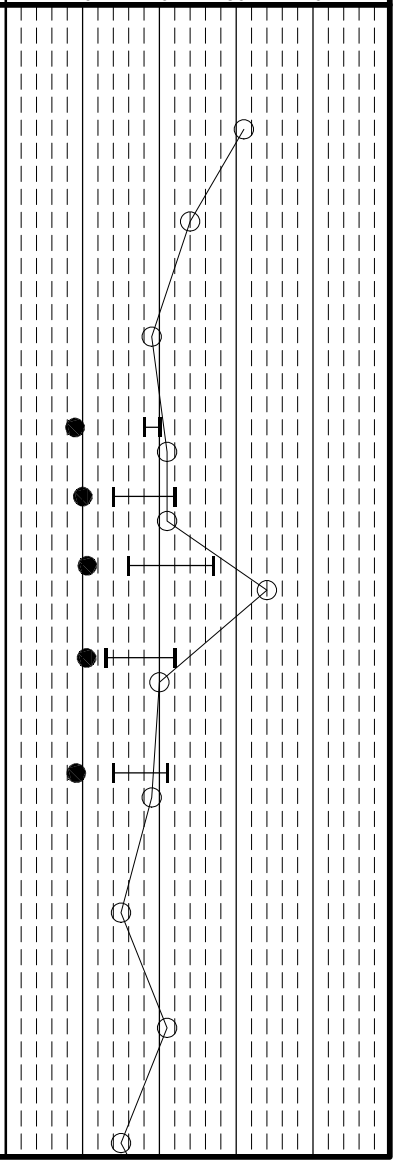
LOG OF: Boring B-025-0-08 | *Location:* Sta. 5088+53.62, 76.0' LT., BL RAMP C5 | *Date Drilled:* 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 26.0'
Water level at completion: 39.0'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	740.4													
1.2	739.2						Asphalt Concrete - 7" Aggregate Base - 7"							
		14 13 17	15	1		4.5+	FILL: Hard brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; contains few brick fragments; damp.							
3.5	736.9													
5		11 10 14	14	2		4.5+	Hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace to little gravel; damp.							
		6 8 11	14	3		4.5+								
10		7 10 11	18	4		4.5+			18	12	---	16	32	22
11.5	728.9	6 10 11	18	5		4.5+			8	15	---	20	36	21
		14 16 17	4	6		4.5+	Hard gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; damp to moist.		12	16	---	18	34	20
13.5	726.9													
15		5 8 12	18	7		4.5+	Very stiff to hard gray SANDY SILT (A-4a), some to "and" fine to coarse sand, trace to little gravel; damp.							
		5 7 12	18	8		4.5+			15	14	---	19	31	21
20		4 6 9	18	9		2.75								
		5 9 12	18	10		4.5								
25	715.4	5 6 9	18	11		2.5								

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-025-0-08 | *Location:* Sta. 5088+53.62, 76.0' LT., BL RAMP C5 | *Date Drilled:* 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 26.0'
Water level at completion: 39.0'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) / Natural Moisture Content, % - / PL — LL / Blows per foot - ○ / Non-Plastic - NP
	715.4														
		3 6 17	13	12		3.5	Very stiff gray SILTY CLAY (A-6b), little fine sand; moist.								
28.5	711.9														
		17 29 37	10	13			Very dense brown GRAVEL WITH SAND (A-1-b), some fine to coarse sand, little silty clay; wet.								67
30							@ 30.0'-38.5', encountered cobbles while augering.								
		29 50/5	6	14					50	21	---	10	14	5	NP 50+
35															
38.5	701.9														
		23 50/6	10	15		4.5+	Hard gray SANDY SILT (A-4a), some fine to coarse sand, trace gravel; damp.								50+
40															
43.5	696.9														
		9 30 37	12	16			Very dense gray GRAVEL WITH SAND (A-1-b), "and" fine to coarse sand, little silt; wet.								68
45															
		22 39 30	15	17					39	26	---	22	--13--		NP 70
50	690.4														

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-025-0-08 | *Location:* Sta. 5088+53.62, 76.0' LT., BL RAMP C5 | *Date Drilled:* 7/24/2008

WATER OBSERVATIONS:
Water seepage at: 26.0'
Water level at completion: 39.0'

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N60) Natural Moisture Content, % - ● PL ⊢ LL Blows per foot - ○ / Non-Plastic - NP (10 20 30 40)
	690.4						Very stiff gray SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.								
55		22 33 26	13	18		2.5									60 ○
57.0	683.4														
							Very dense brown COARSE AND FINE SAND (A-3a), some silt, little gravel; wet.								
59.3	681.1	48 50/3	9	19											50+ ○
							Bottom of Boring - 59.3'								
60															
65															
70															
75															

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / T.F.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 184+88.08 / 111.1' RT	**EXPLORATION ID B-026-1-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.M.	HAMMER: AUTOMATIC	ALIGNMENT: BL I-70 EB		
PID: 77372 BR ID: N/A	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 747.0 (MSL) EOB: 50.0 ft.		PAGE 1 OF 2
START: 9/19/13 END: 9/19/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.7	LAT / LONG: 39.952673289, -83.001473185		

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
0.3' - ASPHALT (4.0")	747.0																	
0.7' - AGGREGATE BASE (8.0")	746.7																	
FILL: MEDIUM DENSE TO VERY DENSE, GRAY TO BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP.	746.0	1	23 14 7	27	50	SS-1	-	-	-	-	-	-	-	-	-	9	A-2-4 (V)	
		4	4 9 9	23	50	SS-2	-	17	34	14	26	9	27	22	5	10	A-2-4 (0)	
		9	12 27 27	70	61	SS-3	-	-	-	-	-	-	-	-	-	8	A-2-4 (V)	
	735.0																	
FILL: DENSE, GRAY AND BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, DAMP.		14	12 17 19	47	33	SS-4	-	63	16	6	10	5	22	18	4	4	A-1-a (0)	
	731.5																	
MEDIUM DENSE TO DENSE, BROWN TO GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST.		17	11 14 20	44	50	SS-5	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		19	9 12 12	31	44	SS-6	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		22	7 9 14	30	56	SS-7	-	31	32	14	19	4	21	18	3	7	A-1-b (0)	
		24	13 15 17	41	61	SS-8	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		27	9 16 17	43	50	SS-9	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
	719.0																	
VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST.		W 29	15 17 25	54	33	SS-10	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	

2015-ODOT BORING LOG-BRIDGE ID - OH DOT.GDT - 8/16/16 08:30 - U:\GI8\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 184+88.08 / 111.1 RT	START: 9/19/13	END: 9/19/13	PG 2 OF 2	B-026-1-13

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 DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST. *(same as above)*	717.0	31	16 16 23	51	33	SS-11	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		32																
		33																
		34	30 32 33	84	39	SS-12	-	70	10	0	18	2	20	16	4	6	A-1-b (0)	
		35																
		36																
		37																
		38																
		39	27 29 33	80	50	SS-13	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		40																
		41																
		42																
		43																
		44	27 25 32	74	67	SS-14	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		45																
		46																
		47																
		48																
		49	25 26 27	69	72	SS-15	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
	697.0	50 EOB																

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 28.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / J.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 5089+73.78 / 16.5' RT	**EXPLORATION ID B-026-2-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: AUTOMATIC	ALIGNMENT: BL RAMP C5		
PID: 77372 BR ID: FRA-70-1390	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 736.8 (MSL) EOB: 89.5 ft.		PAGE 1 OF 3
START: 8/8/13 END: 8/14/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.7	LAT / LONG: 39.953112248, -83.001308349		

MATERIAL DESCRIPTION AND NOTES	ELEV. 736.8	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
0.8' - ASPHALT (9.0")	736.0																	
0.5' - AGGREGATE BASE (6.0")	735.5																	
POSSIBLE FILL: MEDIUM DENSE TO DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP. -STONE FRAGMENTS PRESENT IN SS-1		1																
		2	5 6 8	18	50	SS-1	-	40	28	11	15	6	20	16	4	7	A-1-b (0)	
		3																
		4	2 12 14	34	72	SS-2	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
	731.3	5																
MEDIUM DENSE TO DENSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP. -COBBLES PRESENT THROUGHOUT		6	3 4 8	16	67	SS-3	-	40	24	11	18	7	26	17	9	10	A-2-4 (0)	
		7																
		8	7 10 23	43	33	SS-4	-	-	-	-	-	-	-	-	-	6	A-2-4 (V)	
	726.3	9																
MEDIUM DENSE TO DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST.		10																
		11	14 18 7	32	44	SS-5	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		12																
		13	6 5 4	12	50	SS-6	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
	721.3	14																
MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, TRACE SILT, MOIST.		15 W																
		16	8 6 4	13	33	SS-7	-	-	-	-	-	-	-	-	-	16	A-3a (V)	
	718.8	17																
MEDIUM DENSE, BROWN **GRAVEL AND SAND**, TRACE SILT, TRACE CLAY, MOIST. -INTRODUCED MUD @ 20.0'		18 W																
		19	6 8 11	25	83	SS-8	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
	716.3	20																
DENSE TO VERY DENSE, GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST TO WET.		21																
		22	20 50 50/5"	-	82	SS-9	-	51	19	12	14	4	18	16	2	8	A-1-b (0)	
		23																
		24	20 42 50/4"	-	81	SS-10	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		25																
		26	10 20 33	69	56	SS-11	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
		27																
		28	3 13 23	47	56	SS-12	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		29																

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 3/14/15 17:35 - U:\GI\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: FRA-70-1390	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5089+73.78 / 16.5 RT	START: 8/8/13	END: 8/14/13	PG 2 OF 3	B-026-2-13

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
DENSE TO VERY DENSE, GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST TO WET. *(same as above)*	706.8	31																
		32																
		33																
	702.6	34	11 20 50/2"	-	79	SS-13	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
HARD, GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY.		35					4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
		36																
	699.8	37																
VERY DENSE, GRAY **GRAVEL AND SAND**, TRACE SILT, MOIST.		38																
-ENCOUNTERED LIMESTONE BOULDER @ 40.0'. SWITCHED TO ROCK CORING TECHNIQUES TO CORE BOULDER		39	50/2"	-	100	SS-14	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
		40																
	695.3	41	0		94	RC-1											CORE	
VERY DENSE, GRAY **FINE SAND**, TRACE FINE GRAVEL, TRACE SILT, TRACE CLAY, DAMP. -HEAVING SAND ENCOUNTERED @ 41.5'	693.8	42	24 40 48	114	100	SS-15	-	-	-	-	-	-	-	-	-	10	A-3 (V)	
MEDIUM DENSE, GRAY **COARSE AND FINE SAND**, SOME FINE GRAVEL, LITTLE SILT, TRACE CLAY, MOIST.		43																
		44	4 3 8	14	50	SS-16	-	24	24	29	17	6	15	11	4	17	A-3a (0)	
	689.8	45																
VERY DENSE, GRAY **COARSE AND FINE SAND**, LITTLE SILT, LITTLE FINE GRAVEL, TRACE CLAY, MOIST.		46																
		47																
		48																
		49	5 16 23	51	33	SS-17	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
		50																
		51																
		52																
		53																
		54	9 12 38	65	100	SS-18	-	16	29	33	18	4	15	13	2	11	A-3a (V)	
		55																
		56																
		57																
		58																
		59	17 20 37	74	100	SS-19	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
		60																
		61																
	674.8																	

PID: 77372	BR ID: FRA-70-1390	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5089+73.78 / 16.5 RT	START: 8/8/13	END: 8/14/13	PG 3 OF 3	B-026-2-13

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, GRAY **SANDY SILT**, LITTLE FINE GRAVEL, TRACE CLAY, MOIST. *(same as above)*	674.7	63																
		64	42 42 38	104	89	SS-20	2.00	-	-	-	-	-	-	-	-	14	A-4a (V)	
		65																
		66																
		67																
		68																
		69	12 18 37	71	100	SS-21	3.00	13	23	21	33	10	18	14	4	17	A-4a (2)	
		70																
	664.8	71																
VERY DENSE, GRAY **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE FINE GRAVEL, MOIST.		72																
		73																
		74	15 22 30	67	83	SS-22	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
		75																
		76																
		77																
		78																
		79	15 25 50/5"	-	100	SS-23	-	8	28	50	7	7	NP	NP	NP	17	A-3a (0)	
	654.8	80																
HARD, BROWNISH GRAY **SILTY CLAY**, TRACE TO LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		81																
		82																
		83																
		84	18 22 40	80	89	SS-24	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
		85																
		86																
		87																
		88																
	647.4	89	30 50/5"	-	100	SS-25	4.50	7	5	5	42	41	39	20	19	17	A-6b (12)	
		EOB																

NOTES: SEEPAGE ENCOUNTERED @ 61.0'; GROUNDWATER INITIALLY ENCOUNTERED @ 18.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 150 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750 (SN 98048)	STATION / OFFSET: 5091+04.93 / 11.5' LT	**EXPLORATION ID B-026-3-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / K.S.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL RAMP C5		
PID: 77372 BR ID: FRA-70-1390	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 756.9 (MSL) EOB: 90.0 ft.		PAGE 1 OF 3
START: 8/21/13 END: 8/22/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 82.6	LAT / LONG: 39.953296762, -83.000848553		

MATERIAL DESCRIPTION AND NOTES	ELEV. 756.9	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
0.5' - CONCRETE (6.0")	756.4																	
0.5' - AGGREGATE BASE (6.0")	755.9																	
LOOSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, DAMP.	753.9	1 2	3 2 2	6	33	SS-1	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.		3 4 5	4 9 8	23	39	SS-2	1.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
-COBBLES PRESENT @ 5.0'	751.4	6 7	5 3 3	8	33	SS-3	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
LOOSE, GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, MOIST.	748.9	8 9	WOH 7 7	19	72	SS-4	0.50	8	7	10	46	29	36	19	17	23	A-6b (11)	
SOFT, BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	746.4	10 11 12	5 7 8	21	67	SS-5	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST.		13 14 15	8 16 15	43	61	SS-6	-	32	39	11	15	3	19	17	2	7	A-1-b (0)	
		16 17	8 17 20	51	61	SS-7	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		18 19 20	18 16 13	40	72	SS-8	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		21 22 23	18 12 14	36	83	SS-9	-	42	30	10	13	5	NP	NP	NP	8	A-1-b (0)	
		24 25	6 10 13	32	72	SS-10	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		26 27 28	5 10 12	30	78	SS-11	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
-STONE FRAGMENTS PRESENT THROUGHOUT		29	8 11 16	37	67	SS-12	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 3/14/15 17:35 - U:\GI8\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: FRA-70-1390	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5091+04.93 / 11.5 LT	START: 8/21/13	END: 8/22/13	PG 2 OF 3	B-026-3-13

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
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP TO MOIST. *(same as above)*	726.9																	
	724.9																	
HARD, GRAY **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, DAMP.		31																
		32																
		33																
		34	10 22 24	63	83	SS-13	4.5+	15	11	17	38	19	21	14	7	9	A-4a (4)	
		35																
		36 W																
	719.9	37																
VERY DENSE, BROWN TO BROWNISH GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.		38																
		39	11 26 26	72	83	SS-14	-	-	-	-	-	-	-	-	-	11	A-1-b (V)	
		40																
		41																
		42																
		43																
		44	8 29 50	109	83	SS-15	-	52	14	17	14	3	17	14	3	11	A-1-b (0)	
		45																
		46																
		47																
		48																
		49	10 20 28	66	56	SS-16	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		50																
		51																
	704.9	52																
HARD, GRAY **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, DAMP.		53																
		54	3 22 28	69	78	SS-17	4.5+	12	11	19	40	18	24	14	10	10	A-4a (5)	
		55																
		56																
		57																
		58																
		59	10 44 50/5"	-	88	SS-18	4.5+	-	-	-	-	-	-	-	-	8	A-4a (V)	
		60																
		61																
	694.9																	

PID: 77372	BR ID: FRA-70-1390	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5091+04.93 / 11.5 LT	START: 8/21/13	END: 8/22/13	PG 3 OF 3	B-026-3-13

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 DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, WET. *(same as above)*	694.8	63																
		64	WOH 45 50/3"	-	40	SS-19	-	-	-	-	-	-	-	-	-	20	A-2-4 (V)	
	689.9	65																
VERY DENSE, GRAY TO DARK GRAY **GRAVEL AND SAND**, TRACE SILT, TRACE CLAY, MOIST.		66																
		67																
		68																
		69	8 22 28	69	44	SS-20	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		70																
		71																
		72																
		73																
		74	12 23 28	70	67	SS-21	-	38	28	23	10	1	13	10	3	13	A-1-b (0)	
		75																
		76																
		77																
		78																
		79	37 50/3"	-	33	SS-22	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		80																
		81																
		82																
		83																
		84	10 19 28	65	56	SS-23	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		85																
		86																
	669.9	87																
VERY DENSE, GRAY **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, LITTLE SILT, TRACE CLAY, WET.		88																
		89	12 28 50	107	67	SS-24	-	11	30	39	18	2	NP	NP	NP	10	A-3a (0)	
	666.9	90																
		EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 36.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 376 LBS PORTLAND CEMENT / 100 LBS BENTONITE POWDER / 100 GAL WATER

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

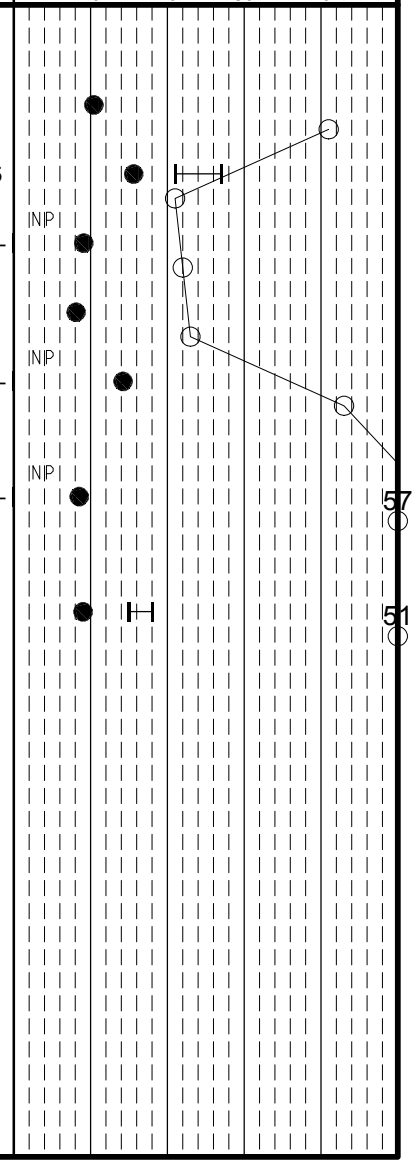
LOG OF: Boring B-027-0-08 | *Location:* Sta. 187+70.27, 12.1' RT., BL I-70 EB | *Date Drilled:* 7/8/2008

WATER OBSERVATIONS:
Water seepage at: 5.0'
Water level at completion: None

FIELD NOTES:
Advanced boring using 3.25" diameter hollowstem augers.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	735.9						Asphalt Concrete Pavement - 7" Portland Cement Concrete - 11" Aggregate Base - 11"							
2.4	733.5	16 23 17	18	1										
3.0	732.9						FILL: Brick fragments, little fine to coarse sand; damp.							
		3 8 12	18	2			Medium dense to dense brown GRAVEL WITH SAND (A-1-b), little to some silt; damp.		19	34	---	25	17	5
5		13 12 9	18	3					39	32	---	10	--19--	
		8 6 16	14	4										
		9 14 28	15	5			@ 7.5'-9.0', contains rust stains.		28	34	---	15	--23--	
10.0	725.9													
		13 26 29	13	6			Dense to very dense brown SANDY SILT (A-4a), trace to little gravel; moist.		17	20	---	25	--38--	
		9 27 22	12	7										
14.0	721.9													
15							Bottom of Boring - 14.0'							
20														
25														

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750 (SN 98048)	STATION / OFFSET: 189+32.64 / 78.7' RT	**EXPLORATION ID B-027-1-13**
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / K.S.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL I-70 EB	
PID: 77372 BR ID: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 755.5 (MSL) EOB: 49.3 ft.	PAGE 1 OF 2
START: 8/7/13 END: 8/7/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 82.6	LAT / LONG: 39.952671524, -82.999846757	

MATERIAL DESCRIPTION AND NOTES	ELEV. 755.5	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
0.2' - ASPHALT (2.0")	755.3																	
0.7' - CONCRETE (8.0")	754.7																	
VERY DENSE, BROWN **SANDY SILT**, SOME FINE GRAVEL, TRACE CLAY, DAMP.	752.5	1	12 36 18	74	33	SS-1	-	-	-	-	-	-	-	-	-	5	A-4a (V)	
MEDIUM STIFF TO STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP TO MOIST.		4	4 2 3	7	72	SS-2	1.75	18	19	15	19	29	33	18	15	13	A-6a (4)	
-COBBLES PRESENT @ 8.0'	747.5	7	4 4 6	14	44	SS-3	1.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
MEDIUM DENSE TO VERY DENSE, BROWN **GRAVEL AND SAND**, TRACE SILT, TRACE CLAY, DAMP TO MOIST.		9	15 11 18	40	44	SS-4	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
-LIMESTONE FRAGMENTS PRESENT IN SS-4		12	8 7 5	17	69	SS-5	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		14	8 9 10	26	72	SS-6	-	52	23	9	8	8	21	18	3	7	A-1-b (0)	
		17	8 32 28	83	44	SS-7	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		19	14 13 10	32	72	SS-8	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
	728.5	24	5 5 8	18	67	SS-9	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
VERY DENSE, GRAY **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP.		29	6 23 32	76	100	SS-10	-	24	25	16	16	19	20	13	7	8	A-2-4 (0)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 3/14/15 17:35 - U:\GI8\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 189+32.64 / 78.7 RT	START: 8/7/13	END: 8/7/13	PG 2 OF 2	B-027-1-13

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 DENSE, GRAY **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP. *(same as above)*	725.5	31																
	723.5	32																
DENSE TO VERY DENSE, GRAY **GRAVEL AND SAND**, TRACE CLAY, TRACE SILT, MOIST.		33																
		34	7 18 15	45	100	SS-11	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
		35																
		36																
	W	37																
		38																
		39	7 18 18	50	100	SS-12	-	15	35	37	6	7	NP	NP	NP	16	A-1-b (0)	
		40																
-COBBLES PRESENT @ 41.0'		41																
		42																
		43																
		44	8 49 50/5"	-	88	SS-13	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		45																
		46																
		47																
		48																
	706.2	49	47 50/3"	-	100	SS-14	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
		EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 37.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750 (SN 98048)	STATION / OFFSET: 5050+28.85 / 20.8' LT	**EXPLORATION ID B-015-6-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / A.D.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL RAMP C5		
PID: 77372 BR ID: FRA-70-1301A	DRILLING METHOD: 3.25" HSA / RC	CALIBRATION DATE: 4/26/13	ELEVATION: 723.0 (MSL) EOB: 77.5 ft.		PAGE 1 OF 3
START: 6/13/13 END: 6/24/13	SAMPLING METHOD: SPT / NQ	ENERGY RATIO (%): 82.6	LAT / LONG: 39.950578918, -83.014626080		

MATERIAL DESCRIPTION AND NOTES	ELEV. 723.0	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
0.2' - ASPHALT (2.0")	722.8																	
FILL: MEDIUM DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP.	720.0	1 2 3	6 8 6	19	78	SS-1	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
FILL: MEDIUM DENSE TO DENSE, DARK BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST. -PETROLEUM ODOR PRESENT IN SS-3	715.0	4 5 6 7 8	3 5 9	19	39	SS-2	-	57	9	8	7	19	33	17	16	16	A-2-6 (1)	
			6 11 13	33	22	SS-3	-	-	-	-	-	-	-	-	-	15	A-2-6 (V)	
FILL: STIFF, BROWN **SILT AND CLAY**, "AND" COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	712.5	9 10	2 2 2	6	33	SS-4	1.50	4	17	36	16	27	29	16	13	17	A-6a (2)	
FILL: MEDIUM DENSE, BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST.	710.0	11 12 13	3 5 5	14	28	SS-5	-	-	-	-	-	-	-	-	-	15	A-2-6 (V)	
FILL: MEDIUM DENSE, BLACK **SANDY SILT**, SOME FINE GRAVEL, TRACE CLAY, WET. -COBBLES PRESENT @ 13.0'	707.5	14 15	9 6 5	15	56	SS-6	-	26	17	18	36	3	NP	NP	NP	26	A-4a (1)	
MEDIUM DENSE, BROWN **SANDY SILT**, SOME FINE GRAVEL, TRACE CLAY, WET.	705.0	16 17 18	5 6 12	25	39	SS-7	-	-	-	-	-	-	-	-	-	23	A-4a (V)	
VERY DENSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST.	702.5	19 20	13 25 22	65	17	SS-8	-	-	-	-	-	-	-	-	-	12	A-2-4 (V)	
VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP. -INTRODUCED WATER @ 22.5'		21 22 23	14 21 22	59	67	SS-9	-	-	-	-	-	-	-	-	-	5	A-1-b (V)	
		24 25	8 18 21	54	72	SS-10	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
		26 27 28	16 19 24	59	78	SS-11	-	51	15	17	15	2	NP	NP	NP	9	A-1-b (0)	
		29	8 30 19	67	67	SS-12	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 3/14/15 17:33 - U:\GI\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: FRA-70-1301A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5050+28.85 / 20.8 LT	START: 6/13/13	END: 6/24/13	PG 2 OF 3	B-015-6-13

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 DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, DAMP. *(same as above)*	693.0	31 32 33 W 34 35 36 37	15 50/5"	-	73	SS-13	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
HARD, BROWNISH GRAY TO GRAY **SILT**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DRY TO MOIST.	686.0	38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57	21 22 26	66	67	SS-14	4.50	-	-	-	-	-	-	-	-	9	A-4b (V)	
			16 29 30	81	72	SS-15	4.50	12	9	14	53	12	20	14	6	12	A-4b (6)	
			16 22 26	66	72	SS-16	4.50	-	-	-	-	-	-	-	-	15	A-4b (V)	
			17 24 28	72	78	SS-17	4.50	-	-	-	-	-	-	-	-	16	A-4b (V)	
VERY DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST TO WET.	666.0	58 59 60 61	27 35 50	117	83	SS-18	-	-	-	-	-	-	-	-	-	18	A-2-4 (V)	

PID: 77372	BR ID: FRA-70-1301A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5050+28.85 / 20.8 LT	START: 6/13/13	END: 6/24/13	PG 3 OF 3	B-015-6-13

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 DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST TO WET. *(same as above)*	660.9	63																
		64	25 47 50/1"	-	100	SS-19	-	33	21	15	23	8	NP	NP	NP	21	A-2-4 (0)	
		65																
		66																
AUGER REFUSAL @ 67.5'	655.5	67 TR	50/5"	-	10	SS-20	-	-	-	-	-	-	-	-	-	15	A-2-4 (V)	
LIMESTONE : VARIGATED GRAY AND BROWN, SLIGHTLY WEATHERED TO UNWEATHERED, STRONG TO VERY STRONG, VERY THIN TO THIN BEDDED, CHERTY, DOLOMITIC, PYRITIC, HIGHLY TO MODERATELY FRACTURED, OPEN TO NARROW APERTURE, VERY ROUGH TO SLIGHTLY ROUGH; RQD 71%, REC 87%.		68																
		69	51		51	RC-1											CORE	
-QU @ 68.3' = 9,274 PSI		70																
		71																
		72																
		73																
		74	88		98	RC-2											CORE	
		75																
		76																
-QU @ 76.9' = 12,661 PSI		77	67		100	RC-3											CORE	
	645.5	EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 33.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 141 LBS PORTLAND CEMENT / 25 LBS BENTONITE POWDER / 40 GAL WATER

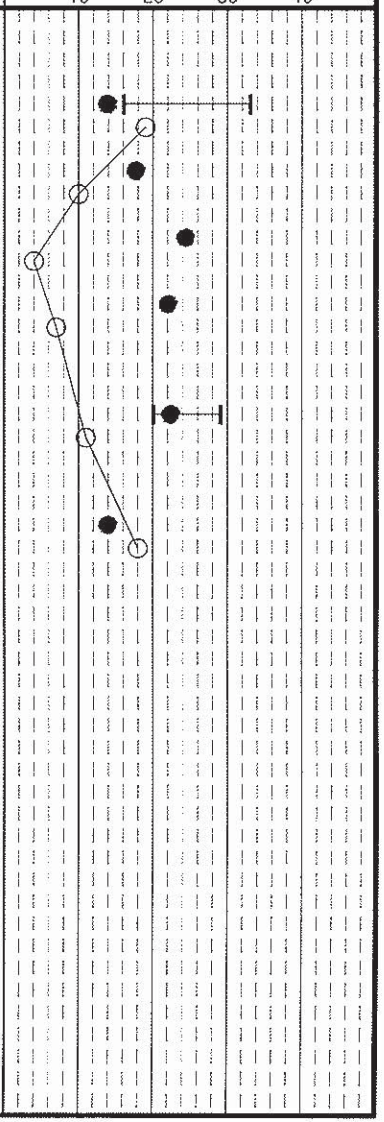
DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants	Project: FRA-70-8.93	Job No. 0221-1004.01
LOG OF: Boring B-102	Location: Sta. 124+68.96, 28.50 ft Rt. of Ramp F3 BL	Date Drilled: 9/3/2009

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None
FIELD NOTES:

Depth (ft)	Elev. (ft) 718.9	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
1.3	717.6						Asphalt Concrete - 7" Portland Cement Concrete - 8"							
		10 10 8	10	1		1.75	FILL: Stiff brown SILTY CLAY (A-6b), some to "and" fine to coarse sand, little gravel; contains few brick fragments; damp.		15	15	---	21	26	23
		6 5 5	18	2		1.5								
5		6 2 2	18	3		1.0								
		6 2 5	13	4		1.0								
8.5	710.4													
		2 4 7	12	5		1.0	FILL: Medium stiff to stiff brown SANDY SILT (A-4a), trace to little gravel; contains few brick fragments; damp to moist.		19	15	---	26	22	18
10														
		5 10 7	3	6										
12.5	706.4						Bottom of Boring - 12.5'							
15														
20														
25														

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

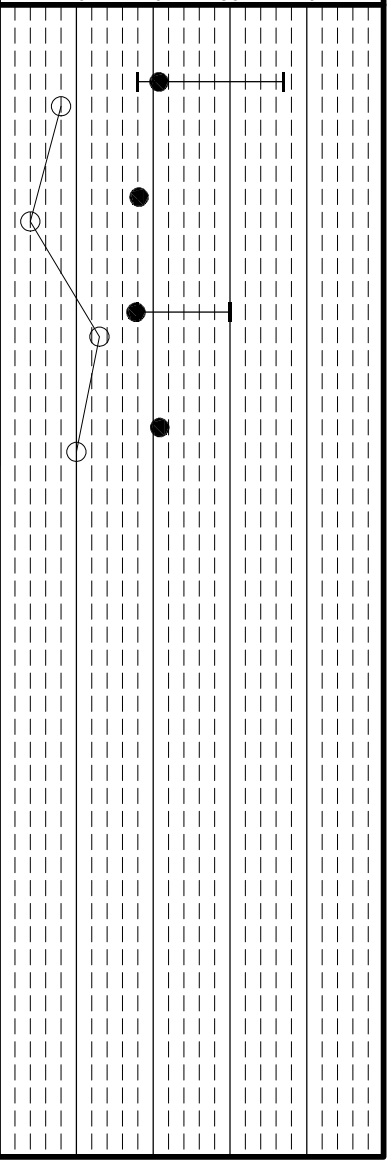
Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-105 | *Location:* Sta. 128+92.42, 78.61 ft Rt. of Ramp F3 BL | *Date Drilled:* 9/3/2009

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None
FIELD NOTES:

Depth (ft)	Elev. (ft) 715.7	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.3	715.4						Topsoil - 3"							
		2 3 5	18	1		1.75	POSSIBLE FILL: Stiff dark brown SILTY CLAY (A-6b), little fine to coarse sand, trace gravel; moist.		9	5	---	12	38	36
		5 2 2	10	2		1.5	@ 1.0'-5.0', contains brick fragments.							
6.0	709.7													
		2 4 9	18	3		1.0	POSSIBLE FILL: Stiff dark brown SILT AND CLAY (A-6a), some to "and" fine to coarse sand, little to some gravel; damp to moist.		18	20	---	19	25	18
		2 4 6	18	4		1.0								
10.0	705.7						Bottom of Boring - 10.0'							

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / J.K.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 3001+00.00 / 55.0' LT	**EXPLORATION ID B-109-1-15**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / M.M.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL RAMP C3		
PID: 77372 BR ID: N/A	DRILLING METHOD: 4.25" HSA	CALIBRATION DATE: 10/20/14	ELEVATION: 736.2 (MSL) EOB: 85.0 ft.	PAGE 1 OF 3	
START: 3/21/15 END: 3/22/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 92	LAT / LONG: 39.950097038, -83.019715408		

MATERIAL DESCRIPTION AND NOTES	ELEV. 736.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
0.5' - ASPHALT (6.0")	735.7																	
1.0' - AGGREGATE BASE (12.0")	734.7																	
FILL: DENSE, GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP.	733.2		10 10 12	34	89	SS-1	-	18	31	17	24	10	NP	NP	NP	9	A-2-4 (0)	
FILL: VERY STIFF TO HARD, GRAY **SILT AND CLAY**, "AND" FINE GRAVEL, LITTLE COARSE TO FINE SAND, DAMP TO WET.			6 5 7	18	67	SS-2	3.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
			7 7 11	28	89	SS-3	4.00	-	-	-	-	-	-	-	-	26	A-6a (V)	
-ROCK FRAGMENTS PRESENT IN SS-4			18 20 18	58	89	SS-4	4.50	37	10	10	23	20	29	17	12	16	A-6a (2)	
			7 9 8	26	89	SS-5	3.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
			18 13 13	40	0	SS-6	-	-	-	-	-	-	-	-	-	-		
-BRICK AND CLAY TILE FRAGMENTS PRESENT IN SS-7			21 50/3"	-	100	SS-7	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 3001+00.00 / 55.0 LT	START: 3/21/15	END: 3/22/15	PG 2 OF 3	B-109-1-15

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)	HOLE SEALED
FILL: VERY STIFF TO HARD, GRAY **SILT AND CLAY**, "AND" FINE GRAVEL, LITTLE COARSE TO FINE SAND, DAMP TO WET. *(same as above)*	706.2																	
	704.2																	
DENSE, GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.			37 12 10	34	67	SS-8	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
	700.7																	
HARD, BROWN **SANDY SILT**, SOME FINE GRAVEL, LITTLE CLAY, DRY.			7 8 9	26	89	SS-9	4.5+	27	25	12	19	17	36	29	7	15	A-4a (0)	
	698.2																	
VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.			8 10 28	58	89	SS-10	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
	695.7																	
VERY DENSE, BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT THROUGHOUT -INTORDUCED WATER @ 45.0'			33 50 50	153	89	SS-11	-	60	17	9	10	4	NP	NP	NP	5	A-1-a (0)	
			18 44 22	101	67	SS-12	-	-	-	-	-	-	-	-	-	4	A-1-a (V)	
	690.7																	
VERY DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT THROUGHOUT			34 25 25	77	67	SS-13	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
			18 32 37	106	67	SS-14	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
	685.7																	
VERY DENSE, GRAY **COARSE AND FINE SAND**, LITTLE FINE GRAVEL, TRACE SILT, MOIST. -ROCK FRAGMENTS PRESENT IN SS-16 -COBBLES PRESENT THROUGHOUT			36 50/6"	-	25	SS-15	-	-	-	-	-	-	-	-	-	15	A-3a (V)	
	683.2																	
VERY DENSE, GRAY **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -COBBLES PRESENT THROUGHOUT			22 23 18	63	89	SS-16	-	70	14	5	7	4	NP	NP	NP	8	A-1-a (0)	
			18 19 19	58	44	SS-17	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
	674.2																	

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 3001+00.00 / 55.0 LT	START: 3/21/15	END: 3/22/15	PG 3 OF 3	B-109-1-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 674.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DENSE, GRAY **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP. *(same as above)*		63																
		64	10 13 17	46	89	SS-18	-	30	22	13	16	19	21	14	7	10	A-2-4 (0)	
	669.2	65																
HARD, GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		66																
		67																
		68																
		69	23 14 18	49	89	SS-19	4.5+	-	-	-	-	-	-	-	-	20	A-6b (V)	
		70																
	664.2	71																
HARD, GRAY **SANDY SILT**, LITTLE CLAY, LITTLE FINE GRAVEL, DAMP.		72																
		73																
		74	22 33 50/3"	-	100	SS-20	4.5+	17	22	15	27	19	22	14	8	9	A-4a (2)	
		75																
		76																
		77																
		78																
		79	26 50/6"	-	100	SS-21	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	
		80																
		81																
		82																
		83																
		84	22 35 43	120	89	SS-22	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	
	651.2	85																
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED PRIOR TO INTRODUCTION OF WATER TO THE BOREHOLE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 376 LBS CEMENT / 100 LBS BENTONITE CHIPS / 80 GAL WATER

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: MOBILE B-53 (SN 624400)	STATION / OFFSET: 3005+00.00 / 20.0' LT	**EXPLORATION ID B-110-1-15**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / N.A.	HAMMER: AUTOMATIC	ALIGNMENT: BL RAMP C3		
PID: 77372 BR ID: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 740.3 (MSL) EOB: 75.0 ft.		PAGE 1 OF 3
START: 3/21/15 END: 3/22/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 77.7	LAT / LONG: 39.949913094, -83.018276075		

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)	HOLE SEALED
0.7' - ASPHALT (8.0")	740.3																	
1.2' - CONCRETE (14.5")	739.6																	
0.4' - AGGREGATE BASE (5.0")	738.4																	
FILL: HARD, BROWNISH GRAY TO GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.	738.0	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	6 9 9	23	100	SS-1	4.5+	-	-	-	-	-	-	-	-	13	A-6a (V)	
			4 9 10	25	50	SS-2	4.5+	8	12	9	36	35	30	17	13	13	A-6a (8)	
			2 10 17	35	100	SS-3	4.5+	-	-	-	-	-	-	-	-	22	A-6a (V)	
			4 5 11	21	100	SS-4	4.5+	-	-	-	-	-	-	-	-	10	A-6a (V)	
	718.3																	
FILL: HARD, GRAY **ELASTIC CLAY**, SOME COARSE TO FINE SAND, SOME SILT, TRACE FINE GRAVEL, MOIST.		24 25 26 27 28 29	21 34 18	67	0	SS-5	-	-	-	-	-	-	-	-	-	-		
			17	-	100	2S-5A	4.5+	5	19	10	40	26	41	30	11	31	A-7-5 (7)	
	713.3																	
VERY DENSE, GRAY **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-6			9 40 38	101	100	SS-6	-	-	-	-	-	-	-	-	-	4	A-1-a (V)	

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 3005+00.00 / 20.0 LT	START: 3/21/15	END: 3/22/15	PG 2 OF 3	B-110-1-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 710.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	709.8																	
MEDIUM DENSE, GRAY **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.	707.3	31	7 8 12	26	100	SS-7	-	-	-	-	-	-	-	-	-	9	A-1-b (V)	
VERY DENSE, GRAY **GRAVEL**, LITTLE COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ROCK FRAGMENTS PRESENT IN SS-8	704.8	32 33 34	10 50/2"	-	75	SS-8	-	67	14	4	9	6	NP	NP	NP	5	A-1-a (0)	
HARD, DARK BROWNISH GRAY TO BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.	699.8	35 36 37	3 6 12	23	100	SS-9	4.00	-	-	-	-	-	-	-	-	27	A-6b (V)	
		38 39	5 9 12	27	100	SS-10	4.25	4	12	18	42	24	39	23	16	18	A-6b (9)	
VERY DENSE, BROWN TO GRAY **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST.		40 41 42	13 19 34	69	100	SS-11	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
		43 44 45	9 24 23	61	100	SS-12	-	56	22	7	10	5	NP	NP	NP	8	A-1-a (0)	
		46 47	9 22 29	66	100	SS-13	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
		48 49	17 32 41	95	39	SS-14	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
		50 51 52 53																
		W 54	15 16 24	52	100	SS-15	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
		55 56 57 58																
		59	17 18 21	51	100	SS-16	-	65	21	6	5	3	NP	NP	NP	5	A-1-a (0)	
	678.3	60 61																

2014 ODOT BORING LOG-RI NE BRIDGE ID - OH DOT.GDT - 3/27/15 18:31 - U:\GI\8\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 3005+00.00 / 20.0 LT	START: 3/21/15	END: 3/22/15	PG 3 OF 3	B-110-1-15

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)	HOLE SEALED
MEDIUM DENSE TO DENSE, GRAY **COARSE AND FINE SAND**, LITTLE SILT, TRACE FINE GRAVEL, TRACE CLAY, MOIST TO WET. *(same as above)*	678.2	63																
		64	7 8 13	27	100	SS-17	-	-	-	-	-	-	-	-	-	17	A-3a (V)	
		65																
		66																
		67																
		68																
		69	16 17 19	47	56	SS-18	-	-	-	-	-	-	-	-	-	26	A-3a (V)	
		70																
		71																
		72																
		73																
		74	13 17 18	45	100	SS-19	-	8	40	30	16	6	NP	NP	NP	15	A-3a (0)	
	665.3	75 EOB																

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 53.5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BENTONITE CHIPS / 40 GAL WATER

DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

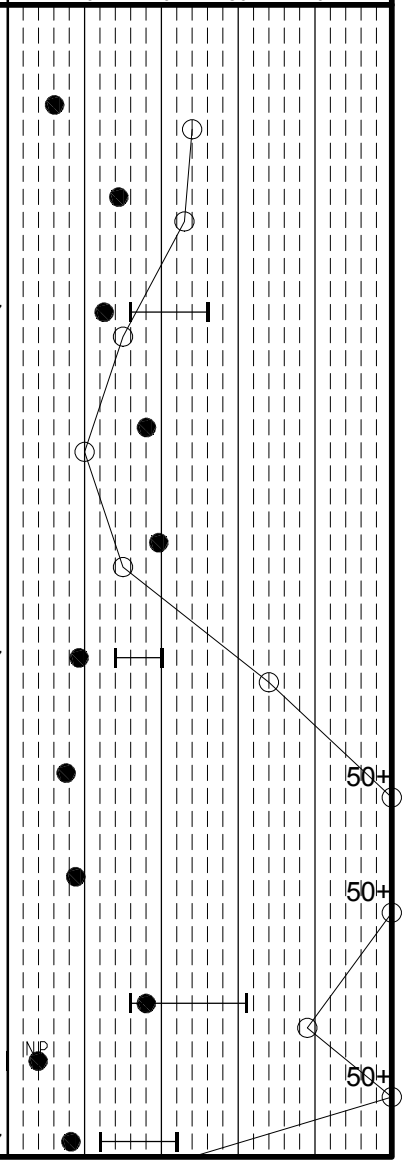
Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-111-0-09 | *Location:* Sta. 3008+11.91, 4.6' RT., BL RAMP C3 | *Date Drilled:* 9/1/2009

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	734.9													
1.0	733.9						Asphalt Concrete - 6" Aggregate Base - 6"							
		9 11 12	8	1			POSSIBLE FILL: Medium dense brown GRAVEL WITH SAND, SILT, AND CLAY (A-2-6); damp.							
3.5	731.4													
5		8 11 11	12	2		4.5+	Very stiff to hard gray SANDY SILT (A-4a), some fine to coarse sand, trace to little gravel; damp.							
		2 7 8	18	3		1.5	@ 6.0'-7.5', stiff.		13	10	---	17	33	27
10		2 5 5	18	4		3.0								
		4 7 8	18	5		4.5+								
15		4 14 19	18	6		--	@ 13.5', becomes brown.		11	13	---	19	40	17
16.0	718.9													
		4 37 50/5	9	7			Very dense brown GRAVEL WITH SAND (A-1-b), little silt; damp.							
18.5	716.4													
20		12 50/5	5	8			Very dense brown SANDY SILT (A-4a), little to some gravel; damp.							
21.0	713.9													
22.5	712.4	17 8 30	12	9		3.0	Very stiff brown SILTY AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.		8	8	---	26	27	31
		48 50/5	10	10			Very dense gray GRAVEL WITH SAND (A-1-b), little silt; damp.		50	22	---	12	--16--	
24.0	710.9													
25	709.9	15 9		11		3.75	Stiff to very stiff gray SANDY SILT (A-4a); damp.		26	19	---	18	20	17

STANDARD PENETRATION (N60)
Natural Moisture Content, % - ●
PL ⊢ LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40



DLZ Ohio, Inc. * 6121 Huntley Road, Columbus, Ohio 43229 * (614) 888-0040

Client: ms consultants | *Project:* FRA-70-8.93 | *Job No.* 0221-1004.01

LOG OF: Boring B-111-0-09 | *Location:* Sta. 3008+11.91, 4.6' RT., BL RAMP C3 | *Date Drilled:* 9/1/2009

WATER OBSERVATIONS:
Water seepage at: None
Water level at completion: None
FIELD NOTES:

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	Graphic Log	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	709.9	10	10											
		10 11 10	12	12		3.75	Stiff to very stiff gray SANDY SILT (A-4a), some fine to coarse sand, little gravel; damp.		13	12	---	17	30	28
		11 9 8	3	13		1.5								
30.0 30	704.9	3 5 9	18	14		1.5	@ 25.5'-27.0', contains rock fragments.							
							Bottom of Boring - 30.0'							

STANDARD PENETRATION (N60)
Natural Moisture Content, % -
PL — LL
Blows per foot - ○ / Non-Plastic - NP
10 20 30 40

35
40
45
50

PROJECT: I-70/I-71 EAST INTERCHANGE
TYPE: ROADWAY
PID: 77370 BR ID:
START: 7/24/10 END: 7/24/10

DRILLING FIRM / OPERATOR: DLZ / K. CONRAD
SAMPLING FIRM / LOGGER: DLZ / S. LARIMER
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 75 TRUCK
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 1/7/10
ENERGY RATIO (%): 79

STATION / OFFSET:
ALIGNMENT: FULTON STREET
ELEVATION: 757.7 (MSL) EOB: 15.0 ft.
COORD: 711819.020 N, 1828187.930 E

EXPLORATION ID B-278-0-10

MATERIAL DESCRIPTION AND NOTES	ELEV. 757.7	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
Asphalt - 6" Concrete - 8" Base - 8"	755.9																	
Stiff brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.	754.7		2 2 2	5	89	SS-1	-	9	11	14	27	39	27	16	11	23	A-6a (7)	
Medium stiff to stiff brown SANDY SILT (A-4a), some to "and" fine to coarse sand, little gravel; damp to moist.	748.7		4 2 2	5	17	SS-2	-	19	21	14	26	20	22	16	6	15	A-4a (2)	
			4 5 7	16	100	SS-3	1.25	18	15	17	31	19	23	16	7	13	A-4a (3)	
			5 9 5	18	83	SS-4	1.50	13	18	19	31	19	23	16	7	16	A-4a (3)	
			3 3 3	8	22	SS-5	0.50	-	-	-	-	-	-	-	-	15	A-4a (V)	
Loose brown SANDY SILT (A-4a), some fine to coarse sand, little gravel; moist.	746.7		WOH 1 6	9	39	SS-6	-	-	-	-	-	-	-	-	-	13	A-4a (V)	
Dense brown GRAVEL WITH SAND (A-1-b), "and" fine to coarse sand, trace silt; damp.	742.7		10 12 13	33	61	SS-7	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
		EOB	11 14 16	40	89	SS-8	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	

NOTES: NO SEEPAGE OR FINAL WATER LEVELS DETECTED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: 0.2 BAG ASPHALT PATCH; 0.2 BAGS BENTONITE CHIPS; SOIL CUTTINGS

PROJECT: I-70/I-71 EAST INTERCHANGE
TYPE: ROADWAY
PID: 77370 BR ID:
START: 7/24/10 END: 7/24/10

DRILLING FIRM / OPERATOR: DLZ / K. CONRAD
SAMPLING FIRM / LOGGER: DLZ / S. LARIMER
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 75 TRUCK
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 1/7/10
ENERGY RATIO (%): 79

STATION / OFFSET:
ALIGNMENT: FULTON STREET
ELEVATION: 769.3 (MSL) EOB: 11.5 ft.
COORD: 711867.570 N, 1828520.490 E

EXPLORATION ID B-279-0-10

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
Asphalt - 4" Granite Pavers - 6" Base - 5"	769.3																	
	768.0	1	50/3"	-	100	SS-1	-	41	32	14	13		NP	NP	NP	14	A-1-b (0)	
POSSIBLE FILL: Medium stiff to stiff brown CLAY (A-7-6), some fine to coarse sand, trace to little gravel; moist.		2																
		3	2 3 2	7	100	SS-2	1.00	10	10	16	25	39	41	18	23	24	A-7-6 (11)	
	765.3	4																
POSSIBLE FILL: Medium stiff brown SILT AND CLAY (A-6a), some fine to coarse sand, trace gravel; moist.		5	2 4 6	13	78	SS-3	0.75	9	14	17	33	27	29	16	13	18	A-6a (6)	
	763.8	6																
Stiff brown SANDY SILT (A-4a), some to "and" fine to coarse sand, little gravel; damp to moist.		7	2 4 4	11	100	SS-4	1.50	20	14	17	30	19	25	15	10	13	A-4a (3)	
		8	4 5 6	14	100	SS-5	1.25	-	-	-	-	-	-	-	-	19	A-4a (V)	
		9	4 5 9	18	89	SS-6	1.25	-	-	-	-	-	-	-	-	12	A-4a (V)	
		10	10 10 8	24	78	SS-7	1.00	-	-	-	-	-	-	-	-	15	A-4a (V)	
	757.8	11 EOB																

NOTES: NO SEEPAGE OR FINAL WATER LEVELS DETECTED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: 0.2 BAG ASPHALT PATCH; 0.2 BAG BENTONITE CHIPS; SOIL CUTTINGS

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750 (SN 98048)	STATION / OFFSET: 5007+07.46 / 0.5' RT	**EXPLORATION ID B-102-1-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL RAMP A5		
PID: 77372 BR ID: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 719.8 (MSL) EOB: 45.0 ft.		PAGE 1 OF 2
START: 6/4/13 END: 6/4/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 82.6	LAT / LONG: 39.947956011, -83.014631636		

MATERIAL DESCRIPTION AND NOTES	ELEV. 719.8	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
0.3' - TOPSOIL (4.0")	719.5																	
FILL: STIFF TO VERY STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP. -SULFATE CONCENTRATION AT 1.0' = 33 PPM		1 2 3	4 5 6	15	67	SS-1	4.00	-	-	-	-	-	-	-	-	13	A-6a (V)	
		4 5	2 3 5	11	44	SS-2	1.50	8	14	19	40	19	33	21	12	13	A-6a (6)	
	711.8	6 7	9 4 4	11	50	SS-3	-	-	-	-	-	-	-	-	-	15	A-6a (V)	
FILL: LOOSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST. -PETROLEUM ODOR AND ROOT FIBERS PRESENT IN SS-4	709.3	8 9 10	3 4 3	10	44	SS-4	-	-	-	-	-	-	-	-	-	7	A-1-b (V)	
LOOSE TO MEDIUM DENSE, BROWN **GRAVEL AND SAND**, LITTLE SILT, TRACE CLAY, MOIST.		11 12 13	3 4 4	11	44	SS-5	-	50	19	9	16	6	NP	NP	NP	11	A-1-b (0)	
		14 15	3 2 2	6	50	SS-6	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
	701.8	16 17 18	2 4 5	12	33	SS-7	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
VERY STIFF, DARK GRAY **SILTY CLAY**, SOME COARSE TO FINE SAND, MOIST.		19 20 21			63	ST-8	2.50	0	1	22	44	33	40	17	23	20	A-6b (13)	
	697.8	22 23																
DENSE TO VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST TO WET. -INTRODUCED WATER @ 26.0'		24 25 26 27 28	9 15 16	43	67	SS-9	-	-	-	-	-	-	-	-	-	7	A-2-4 (V)	
		29	15 26 29	76	33	SS-10	-	40	18	12	20	10	NP	NP	NP	7	A-2-4 (0)	

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5007+07.46 / 0.5 RT	START: 6/4/13	END: 6/4/13	PG 2 OF 2	B-102-1-13

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
DENSE TO VERY DENSE, BROWNISH GRAY **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST TO WET. *(same as above)*	689.8	31																
		32																
		33																
		34	35 44 35	109	72	SS-11	-	-	-	-	-	-	-	-	-	8	A-2-4 (V)	
		35																
-COBBLES PRESENT THROUGHOUT		36																
		37																
		38																
-ONE ROCK RECOVERED FROM BOTTOM OF SHOE IN SS-12		39	9 16 15	43	6	SS-12	-	-	-	-	-	-	-	-	-	0	A-2-4 (V)	
		40	19	-	0	3S-12A	-	-	-	-	-	-	-	-	-	-		
		41																
		42																
		43																
	674.8	44 EOB	7 14 17	43	61	SS-13	-	-	-	-	-	-	-	-	-	10	A-2-4 (V)	
		45																

NOTES: GROUNDWATER NOT ENCOUNTERED PRIOR TO INTRODUCTION OF WATER

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BNTONITE POWDER / 50 GAL WATER

RESOURCE INTERNATIONAL, INC.

PROJECT: FRA-70-12.68 - PHASE 4A	DRILLING FIRM / OPERATOR: RII / S.M.	DRILL RIG: CME-750 (SN 98048)	STATION / OFFSET: 5008+89.52 / 6.5' LT	**EXPLORATION ID B-105-1-13**	
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: RII / S.B.	HAMMER: CME AUTOMATIC	ALIGNMENT: BL RAMP A5		
PID: 77372 BR ID: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 4/26/13	ELEVATION: 716.0 (MSL) EOB: 49.8 ft.		PAGE 1 OF 2
START: 6/4/13 END: 6/4/13	SAMPLING METHOD: SPT	ENERGY RATIO (%): 82.6	LAT / LONG: 39.948450631, -83.014730556		

MATERIAL DESCRIPTION AND NOTES	ELEV. 716.0	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
0.6' - TOPSOIL (7.0")	715.4																	
FILL: STIFF TO HARD, BROWN TO DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DRY TO MOIST.		1	7 8 6	19	50	SS-1	4.50	-	-	-	-	-	-	-	-	7	A-6a (V)	
-ASPHALT FRAGMENTS PRESENT IN SS-2		4	3 2 3	7	56	SS-2	2.75	15	11	16	39	19	36	21	15	18	A-6a (7)	
	708.0	7	2 3 3	8	56	SS-3	1.75	-	-	-	-	-	-	-	-	24	A-6a (V)	
FILL: LOOSE, BROWN **GRAVEL AND SAND**, TRACE SILT, MOIST.	705.5	9	3 3 2	7	33	SS-4	-	-	-	-	-	-	-	-	-	8	A-1-b (V)	
STIFF, DARK GRAY TO BROWNISH GRAY **CLAY**, "AND" SILT, TRACE COARSE TO FINE SAND, MOIST.		12	2 2 2	6	50	SS-5	1.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
-ROOT FIBERS PRESENT IN SS-6		14	1 3 4	10	61	SS-6	2.00	-	-	-	-	-	-	-	-	30	A-7-6 (V)	
-CONSOLIDATION TEST PERFORMED @ 16.3' -TRIAXIAL COMPRESSION TEST PERFORMED @ 16.5'	698.0	17			96	ST-7	2.00	0	1	8	46	45	48	22	26	24	A-7-6 (16)	
STIFF, BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		19	2 4 4	11	61	SS-8	1.25	-	-	-	-	-	-	-	-	15	A-6a (V)	
-COBBLES PRESENT @ 22.0'	694.0																	
VERY DENSE, BROWN **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP.		24	6 24 25	67	78	SS-9	-	34	29	10	19	8	NP	NP	NP	7	A-2-4 (0)	
	689.0																	
DENSE TO VERY DENSE, BROWN TO GRAY **GRAVEL**, SOME COARSE TO FINE SAND, LITTLE SILT, TRACE CLAY, MOIST. -HEAVING SANDS ENCOUNTERED @ 28.0' -INTRODUCED MUD @ 28.0'		W 28	13 16 14	41	61	SS-10	-	-	-	-	-	-	-	-	-	10	A-1-a (V)	

2014 ODOT BORING LOG-RII NE BRIDGE ID - OH DOT.GDT - 3/14/15 17:35 - U:\GI\PROJECTS\2013\W-13-045.GPJ

PID: 77372	BR ID: N/A	PROJECT: FRA-70-12.68 - PHASE 4A	STATION / OFFSET: 5008+89.52 / 6.5 LT	START: 6/4/13	END: 6/4/13	PG 2 OF 2	B-105-1-13

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
DENSE TO VERY DENSE, BROWN TO GRAY **GRAVEL**, SOME COARSE TO FINE SAND, LITTLE SILT, TRACE CLAY, MOIST. *(same as above)*	686.0	31																
		32																
		33																
		34	22 25 30	76	50	SS-11	-	-	-	-	-	-	-	-	-	12	A-1-a (V)	
		35																
		36																
		37																
		38																
		39	14 12 18	41	50	SS-12	-	51	23	12	11	3	NP	NP	NP	14	A-1-a (0)	
		40																
		41																
		42																
		43																
		44	15 16 14	41	50	SS-13	-	-	-	-	-	-	-	-	-	14	A-1-a (V)	
		45																
		46																
	669.0	47																
HARD, GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		48																
		49	19 47 50/3"	-	80	SS-14	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
	666.3	EOB																

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 28.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PUMPED 188 LBS CEMENT / 50 LBS BNTONITE POWDER / 50 GAL WATER

APPENDIX IV

LABORATORY TEST RESULTS

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

DETERMINING SULFATE CONTENT IN SOILS - COLORIMETRIC METHOD

TxDOT Tex-145-E

Project Name: FRA-70-12.68
Project No.: W-13-045

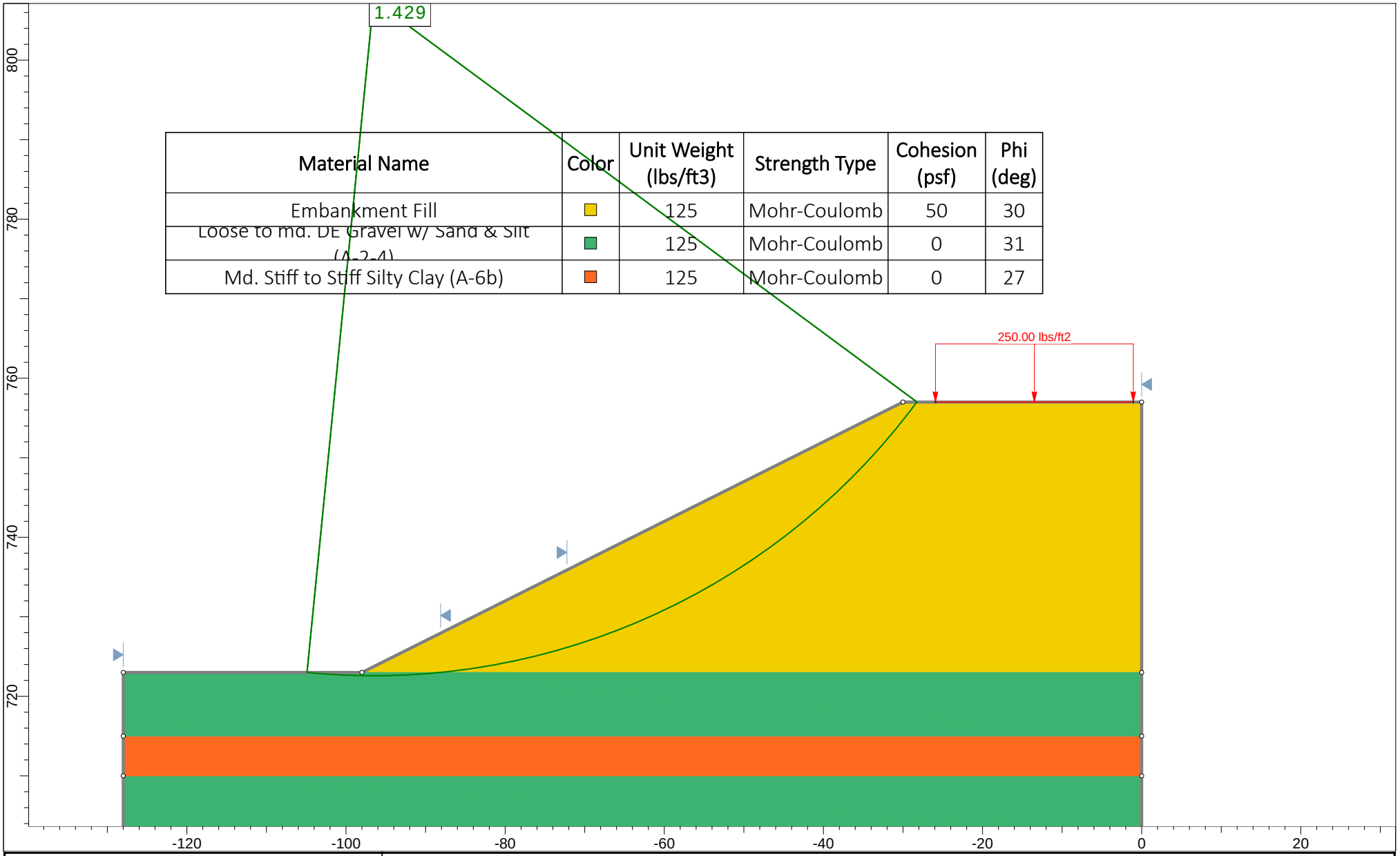
Laboratory Technician: E.M.
Test Date: March 10, 2015

Laboratory Data

Soil Sample	Station	Depth	Soaking Time	Dilution Ratio	Replicate Sample Readings			Average Reading	Sulfate Content (ppm)
					1	2	3		
B-011-0-09		1	24	20	20	26	21	22.33	447
B-013-0-09		1	24	20	3	4	4	3.67	73
B-024-1-13		1.7	24	20	77	70	70	72.33	1447
B-025-0-08		2	24	20	8	8	11	9.00	180
B-027-0-08		2.0	24	20	11	9	11	10.33	207
B-028-0-08		1.0	24	20	26	23	25	24.67	493
B-029-0-08		2.0	24	20	3	4	5	4.00	80
B-032-2-15		6.0	24	20	47	45	44	45.33	907
B-099-0-09		0.2	24	20	4	2	3	3.00	60
B-102-0-09		0.2	24	20	3	3	1	2.33	47
B-102-1-13		0.2	24	20	3	1	1	1.67	33
B-105-1-13		0.2	24	20	3	4	5	4.00	80
B-111-0-09		1.5	24	40	52	53	50	51.67	2067
B-278-0-10		1.5	24	20	36	37	41	38.00	760
B-279-0-10		1.5	24	20	9	11	14	11.33	227
B-280-0-10		1.6	24	20	27	28	33	29.33	587

APPENDIX V

EMBANKMENT SETTLEMENT CALCULATIONS AND SLOPE STABILITY ANALYSIS OUTPUTS



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment Fill		125	Mohr-Coulomb	50	30
Loose to md. DE Gravel w/ Sand & Silt (A-2-4)		125	Mohr-Coulomb	0	31
Md. Stiff to Stiff Silty Clay (A-6b)		125	Mohr-Coulomb	0	27

SLIDEINTERPRET 7.011

Project	FRA-70-12.68 - Ramp A5		
Analysis Description	Embankment Stability Check		
Drawn By	Peyman Majidi	Company Resource International	Scale: 1:200
Date	7/16/2018, 1:02:07 PM	File Name	Ramp A5 stability Check.slim

FRA-70-12.68
Ramp A5 - Station 5015+96.5 (Boring B-108-9-15)

W-13-045 - FRA-70-12.68

Settlement Analysis - Sta. 5015+96.5 , Ramp A5 (Boring log B-108-9-15)

Calculated By: PPM Date: 7/16/2018

Checked By: JPS Date: 7/16/2018

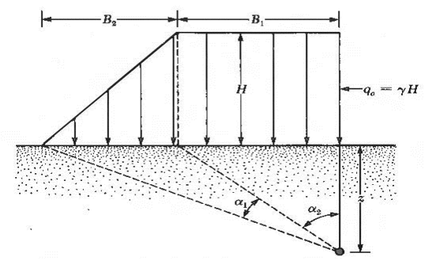
Proposed Ground Surface Elevation @ 756.14 ft msl

γ =	125	pcf	(Regular Embankment Fill)
H =	34.0	ft	Future embankment height equal to average of lower full width height and profile grade.
B_1 =	15.0	ft	Width equal to the largest footing width of the existing foundations
B_2 =	68.0	ft	
D_w =	7.3	ft	Depth below ground surface in boring B-108-9-15 100-year flood = 715.1
$q_0 = \gamma H$ =	4,250	psf	

Layer	Soil Type	Soil Type	Layer Depth (ft)		Elevation (ft msl)		Layer Thickness (ft)	Depth to Midpoint, z (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	α_1 (7)	α_2 (8)	I (9)	$\Delta\sigma_v$ (10) (psf)	σ_{vf}' Midpoint (psf)	S_c (11,12) (ft)	S_c (in)
1	A-2-4	G	0.0	4.0	722.4	718.4	4.0	2.0	125	500	250	250	3,250					21	36	116	0.108	1.438	1.000	4,250	4,500	0.043	0.520
	A-2-4	G	4.0	8.0	718.4	714.4	4.0	6.0	125	1,000	750	750	3,750					12	16	66	0.308	1.190	0.997	4,239	4,989	0.050	0.596
2	A-6b	C	8.0	10.5	714.4	711.9	2.5	9.3	120	1,300	1,150	1,028	4,028	37	0.243	0.036	0.561				0.442	1.018	0.991	4,213	5,242	0.079	0.949
	A-6b	C	10.5	13.0	711.9	709.4	2.5	11.8	120	1,600	1,450	1,172	4,172	37	0.243	0.036	0.561				0.524	0.906	0.984	4,182	5,354	0.074	0.892
3	A-1-b	G	13.0	15.5	709.4	706.9	2.5	14.3	125	1,913	1,756	1,323	4,323					19	22	78	0.590	0.811	0.975	4,142	5,465	0.020	0.237
4	A-4a	C	15.5	18.0	706.9	704.4	2.5	16.8	120	2,213	2,063	1,473	4,473	35	0.225	0.023	0.546				0.641	0.730	0.963	4,094	5,567	0.052	0.626
5	A-6b	C	18.0	20.5	704.4	701.9	2.5	19.3	120	2,513	2,363	1,617	4,617	37	0.243	0.024	0.561				0.681	0.662	0.951	4,040	5,657	0.052	0.625
6	A-1-b	G	20.5	25.5	701.9	696.9	5.0	23.0	130	3,163	2,838	1,858	4,858					28	29	95	0.723	0.578	0.929	3,950	5,808	0.026	0.311
	A-1-b	G	25.5	32.0	696.9	690.4	6.5	28.8	130	4,008	3,585	2,247	5,247					31	30	98	0.756	0.481	0.894	3,799	6,046	0.028	0.341
7	A-1-a	G	32.0	52.0	690.4	670.4	20.0	42.0	130	6,608	5,308	3,142	6,142					40	34	111	0.759	0.343	0.808	3,436	6,578	0.058	0.695
8	A-2-6	G	52.0	57.0	670.4	665.4	5.0	54.5	130	7,258	6,933	3,987	6,987					31	24	83	0.721	0.269	0.731	3,108	7,096	0.015	0.181
9	A-4a	C	57.0	62.0	665.4	660.4	5.0	59.5	125	7,883	7,570	4,313	7,313	18	0.072	0.007	0.413				0.702	0.247	0.703	2,986	7,299	0.006	0.070
10	A-3a	G	62.0	67.0	660.4	655.4	5.0	64.5	125	8,508	8,195	4,626	7,626					22	16	60	0.682	0.228	0.675	2,869	7,495	0.017	0.209

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$; Estimate σ_m of 2,000 psf for moderately overconsolidated soil deposit; Ref. Table 11.2, Coduto 2003
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material and $0.075(C_c)$ for very stiff to hard natural soil deposits; Ref. Section 5.4.2.5 of FHWA GEC 5
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_N N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. $\alpha_1 = \tan^{-1}(B_1+B_2/z) - \tan^{-1}(B_1/z)$
8. $\alpha_2 = \tan^{-1}(B_1/z)$
9. Influence factor for embankment loading (I) = $[(B_1+B_2/B_2)*(\alpha_1+\alpha_2)-B_1/B_2*(\alpha_2)]/\pi$
10. $\Delta\sigma_v = q_0(I)$
11. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')+[C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
12. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Total Settlement Below Existing Ground Surface Elevation: 6.251 in



▼ FIGURE 4.11 Embankment loading

APPENDIX VI

GB1 SUBGRADE STABILIZATION SUMMARY

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.00 7/21/2017

PID:	105523
Alignment:	I-70 EB; I-71 NB; Ramp A5; Ramp C3
County-Route-Section:	FRA-70
No. of Borings:	7
No. of Rigs:	3
Geotechnical Consultant:	Resource International, inc
Prepared By:	peyman p. majidi
Date prepared:	7/16/2018

Rig	A	B	C																					
ER	78	83	92																					

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

Excavate and Replace Stabilization Options	
Global Geotextile (N_{60L}, HP)	0'', 0''
Global Geogrid (N_{60L}, HP)	N/A, N/A

Design CBR	8

% Borings			
$N_{60L} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60L} < 12$	11%	0.5 ≤ HP < 1	0%
$12 \leq N_{60L} < 15$	0%	1 ≤ HP < 2	15%
$N_{60L} \geq 20$	4%	HP ≥ 2	22%
M+	0%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	18''
Maximum	18''
Minimum	18''

% Surface	
Unstable & Unsuitable	0%
Unstable	14%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	25	16	2.74	27	18	10	29	14	43	13	11	5
Maximum	65	30	4.50	33	21	16	81	27	97	26	16	10
Minimum	6	10	1.20	20	16	3	7	3	13	5	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	2	7	3	0	2	0	0	0	0	2	0	11	0	0	0	0	0	27
Percent	0%	7%	26%	11%	0%	7%	0%	0%	0%	0%	7%	0%	41%	0%	0%	0%	0%	0%	100%
% Rock|Cohesive|Granular	0%	52%									48%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Class Percent																			0%

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.00 7/21/2017

#	Boring ID	Station	Offset	Dir	Boring EL.	Proposed Subgrade EL	Cut Fill	Rig
1	B-013-1-15	127+00.3	45	Lt.	725.90	725.90	0.00 F	A
2	B-017-7-13	170+79.4	23.3	Rt.	743.10	744.50	1.40 F	A
3	B-026-2-13	5089+73.78	16.5	Rt.	736.80	736.80	0.00 F	A
4	B-015-6-13	5050+28.85	20.8'	Lt.	723.00	724.50	1.50 F	B
5	B-102-1-13	5007+7.5	0.5'	RT	719.80	717.00	2.80 C	B
6	B-109-1-15	3001+00	55	Lt.	736.20	734.00	2.20 C	C
7	B-110-1-15	3005+00	20	Lt.	740.30	742.00	1.70 F	A

#	Boring ID	Station	Offset	Dir	Boring EL.	Proposed Subgrade EL	Cut Fill	Rig

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

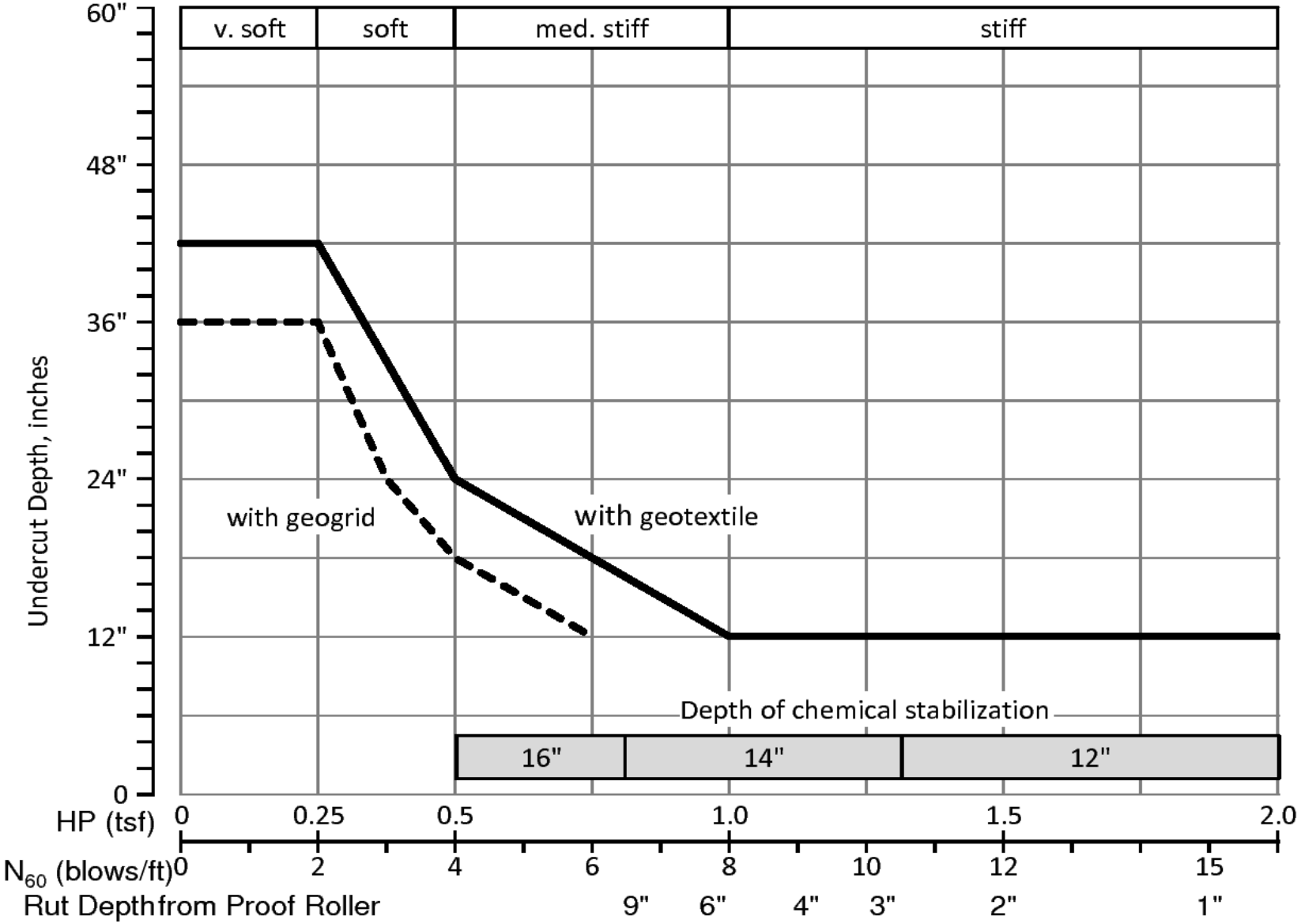
V. 14.00 7/21/2017

#	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
			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	1	1.0	2.5	1.0	2.5	38		4.5							8	14	A-6a	10						
	013-1	2	3.5	5.0	3.5	5.0	40			NP	NP	NP	12	7	19	7	6	A-1-b	0						
	15	3	6.0	7.5	6.0	7.5	34									7	6	A-1-b							
		4	8.5	10.0	8.5	10.0	40	30								8	6	A-1-b							
2	B	1	1.4	2.9	2.8	4.3	14			NP	NP	NP	10	3	13	7	6	A-1-a	0						
	017-7	2	3.5	5.0	4.9	6.4	10		3							13	14	A-6a	10						
	13	3	6.0	7.5	7.4	8.9	26		2							12	14	A-6a							
		4	8.5	10.0	9.9	11.4	65	10								5	6	A-1-a							
3	B	1	1.3	2.7	1.3	2.7	18			20	16	4	15	6	21	7	6	A-1-b	0						
	026-2	2	3.5	5.0	3.5	5.0	34									7	6	A-1-b	0						
	13	3	6.0	7.5	6.0	7.5	16			26	17	9	18	7	25	10	10	A-2-4							
		4	8.5	10.0	8.5	10.0	43	16								6	10	A-2-4							
4	B	1	1.0	2.5	2.5	4.0	19									8	6	A-1-b	0						
	015-6	2	3.5	5.0	5.0	6.5	19			33	17	16	7	19	26	16	10	A-2-6	1						
	13	3	6.0	7.5	7.5	9.0	33									15	10	A-2-6							
		4	8.5	10.0	10.0	11.5	6	19	1.5	29	16	13	16	27	43	17	14	A-6a							
5	B	1	1.0	2.5	-1.8	-0.3	15		4							13	14	A-6a	10	33					Geotextile Option:
	102-1	2	3.5	5.0	0.7	2.2	11		1.5	33	21	12	40	19	59	13	16	A-6a	6			HP		18"	18"
	13	3	6.0	7.5	3.2	4.7	11									15	14	A-6a	10						
		4	8.5	10.0	5.7	7.2	10	10								7	6	A-1-b							
6	B	1	1.5	3.0	-0.7	0.8	34			NP	NP	NP	24	10	34	9	10	A-2-4	0						
	109-1	2	3.5	5.0	1.3	2.8	18		3.5							14	14	A-6a	10						
	15	3	8.5	10.0	6.3	7.8	28		4							26	14	A-6a							
		4	13.5	15.0	11.3	12.8	58	18	4.5	29	17	12	23	20	43	16	14	A-6a							
7	B	1	1.5	3.0	3.2	4.7	16			NP	NP	NP	81	12	93	22	11	A-4b	8						
	110-1	2	3.0	4.5	4.7	6.2	11			22	19	3	72	25	97	21	14	A-4b	8						
	15	3	4.5	6.0	6.2	7.7	8		1.7							22	14	A-6a							
		4	6.0	7.5	7.7	9.2	13	11	1.2							20	14	A-6a							

GB1 Figure B – Subgrade Stabilization

Subgrade Analysis

V. 14.00 9/2/2016



OVERRIDE TABLE

Calculated	New Values	Check to Override
2.74	0.50	☐ HP
16.29	3.00	☐ N60L

Average HP

Average N_{60L}

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.00 7/21/2017

PID:	
Alignment:	Livingston Ave.; Fulton St.
County-Route-Section:	FRA-70
No. of Borings:	4
No. of Rigs:	2

Geotechnical Consultant:	Resource International, Inc.
Prepared By:	Peyman P. Majidi
Date prepared:	7/16/2018

Rig	A	B																						
ER	83	79																						

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

Excavate and Replace Stabilization Options	
Global Geotextile (N_{60L}, HP)	18", 12"
Global Geogrid (N_{60L}, HP)	12", N/A

Design CBR	8

% Borings			
$N_{60L} \leq 5$	6%	HP ≤ 0.5	6%
$N_{60L} < 12$	25%	0.5 ≤ HP < 1	13%
$12 \leq N_{60L} < 15$	0%	1 ≤ HP < 2	44%
$N_{60L} \geq 20$	0%	HP ≥ 2	0%
M+	19%		
Rock	19%		
Unsuitable	19%		

Excavate and Replace at Surface	
Average	23"
Maximum	30"
Minimum	15"

% Surface	
Unstable & Unsuitable	0%
Unstable	75%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	20	6	1.25	29	17	12	28	25	52	14	12	5
Maximum	74	7	1.75	41	19	23	46	39	75	24	18	11
Minimum	5	5	0.50	22	15	6	8	5	13	5	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	2	2	0	0	0	0	0	0	4	0	0	6	1	0	1	0	0	16
Percent	0%	13%	13%	0%	0%	0%	0%	0%	0%	25%	0%	0%	38%	6%	0%	6%	0%	0%	100%
% Rock|Cohesive|Granular	0%	50%									50%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Class Percent																			0%

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.00 7/21/2017

#	Boring ID	Station	Offset	Dir	Boring EL.	Proposed Subgrade EL	Cut Fill	Rig
1	B-027-1-13	189+32.6	78.7	RT.	755.50	755.50	0.00 F	A
2	B-026-3-13	5091+4.93	11.5	LT.	756.90	756.90	0.00 F	A
3	B-278-0-10	19+56.6	10	RT.	757.70	756.70	1.00 C	B
4	B-279-0-10	22+98.4	5	RT.	769.30	768.50	0.80 C	B

#	Boring ID	Station	Offset	Dir	Boring EL.	Proposed Subgrade EL	Cut Fill	Rig

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

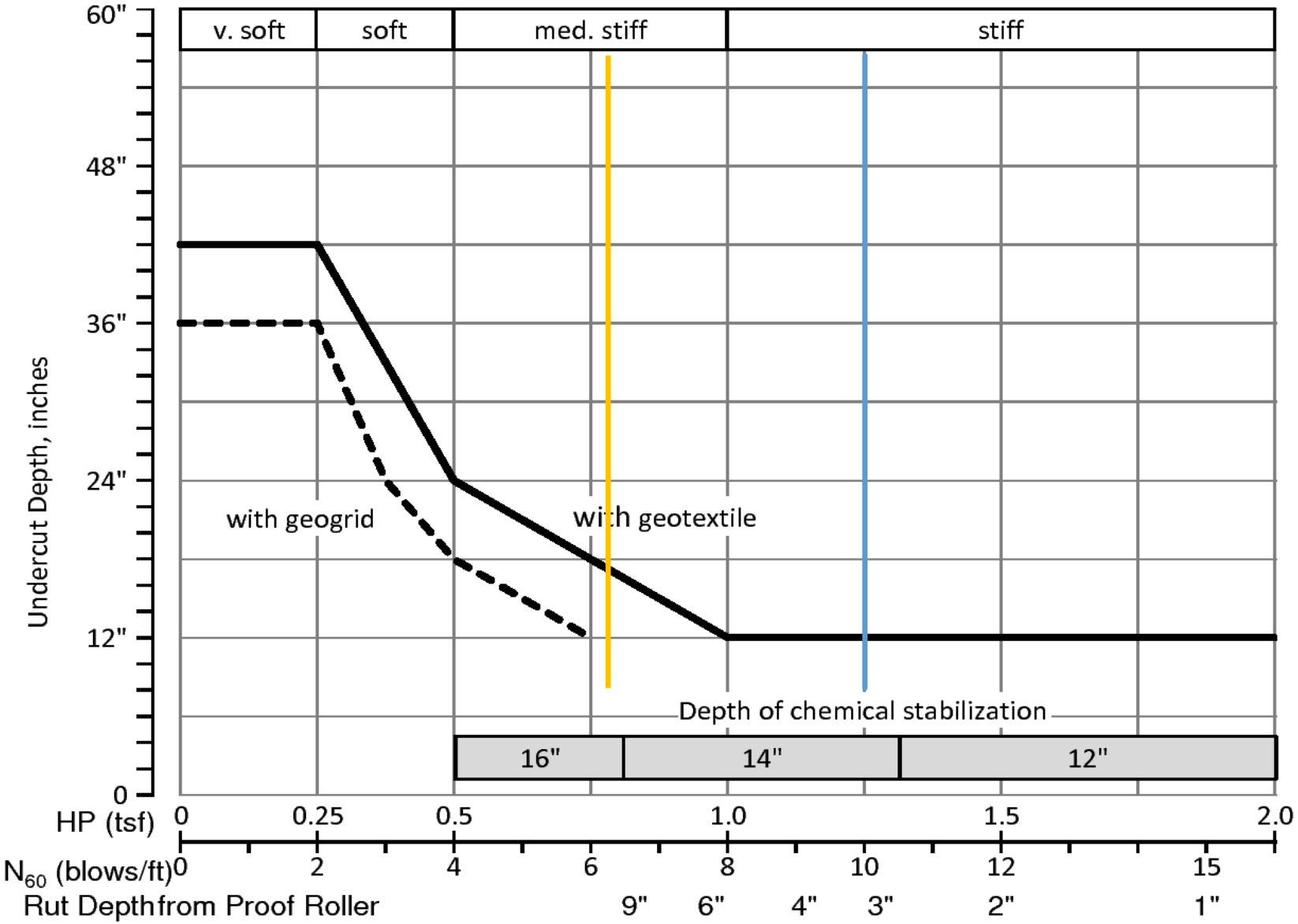
V. 14.00 7/21/2017

#	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
			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	1	1.0	2.5	1.0	2.5	74									5	10	A-4a	8						
	027-1	2	3.5	5.0	3.5	5.0	7		1.75	33	18	15	19	29	48	13	14	A-6a	4						
	13	3	6.0	7.5	6.0	7.5	14		1.5							17	14	A-6a							
		4	8.5	10.0	8.5	10.0	40	7								6	6	A-1-b							
2	B	1	1.0	2.5	1.0	2.5	6									6	6	A-1-a	0						
	026-3	2	3.5	5.0	3.5	5.0	23		1.5							12	14	A-6a	10						
	13	3	6.0	7.5	6.0	7.5	8									8	6	A-1-a							
		4	8.5	10.0	8.5	10.0	19	6	0.5	36	19	17	46	29	75	23	16	A-6b							
3	B	1	1.5	3.0	0.5	2.0	5			27	16	11	27	39	66	23	14	A-6a	7	227		N_{60} & Mc		18"	Geotextile Option:
	278-0	2	3.0	4.5	2.0	3.5	5			22	16	6	26	20	46	15	11	A-4a	2			N_{60} & Mc		12"	30"
	10	3	4.5	6.0	3.5	5.0	16		1.25	23	16	7	31	19	50	13	11	A-4a	3						GEOGRID Option:
		4	6.0	7.5	5.0	6.5	18	5	1.5	23	16	7	31	19	50	16	11	A-4a	3						18"
4	B	1	1.0	1.2	0.2	0.4	50			NP	NP	NP	8	5	13	14	6	A-1-b	0	587					Geotextile Option:
	279-0	2	2.5	4.0	1.7	3.2	7		1	41	18	23	25	39	64	24	18	A-7-6	11			HP & Mc		16"	15"
	10	3	4.0	5.5	3.2	4.7	13		0.75	29	16	13	33	27	60	18	14	A-6a	6						
		4	5.5	7.0	4.7	6.2	11	7	1.5	25	15	10	30	19	49	13	14	A-6a	3						

GB1 Figure B – Subgrade Stabilization

Subgrade Analysis

V. 14.00 9/2/2016



OVERRIDE TABLE

Calculated	New Values	Check to Override
1.25	0.50	☐ HP
6.25	3.00	☐ N60L

Average HP

Average N_{60L}