Resource International, Inc.

LOR-18-1.60
INTERSECTION IMPROVEMENTS
LORAIN COUNTY, OHIO
PID No. 116214

DRAFT GEOTECHNICAL EXPLORATION REPORT

Prepared For:
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Prepared By:
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Rii Project No. W-23-179

February 2024

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February 7, 2024

Mr. Nate Wonsick, P.E., CPESC
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Re: DRAFT Geotechnical Exploration Report
LOR-18-1.60 Intersection Improvements
Lorain County, Ohio
PID No. 116214
Rii Project No. W-23-179

Mr. Wonsick:

Resource International, Inc. (Rii) is pleased to submit this DRAFT geotechnical exploration report for the above referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This draft report includes recommendations for the proposed LOR-18-1.60 intersection improvements project in Lorain County, Ohio.

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

Sincerely,

RESOURCE INTERNATIONAL, INC.

Johnnatan Garcia-Ruiz, Ph.D.
Staff Engineer

Jonathan P. Sterenberg, P.E.
Vice President – Geotechnical Services

Enclosure: DRAFT Geotechnical Exploration Report

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APPENDICES

EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a geotechnical exploration report for the proposed LOR-18-1.60 intersection improvements project in Lorain County, Ohio. The project will extend from approximately 440 feet west to approximately 430 feet east of the intersection along SR 18, and approximately 450 feet south to 450 feet north along SR 511. It is understood that the proposed improvements will consist of replacing the existing two-way stop-controlled intersection with a single lane roundabout.

Exploration and Findings

On December 19 and 20, 2023, a total of eight (8) roadway borings, designated as B-001-0-23 through B-008-0-23, were drilled to completion depths ranging from 7.5 to 8.5 feet below the existing grade/ground surface. Six (6) of the borings were conducted within the existing pavement section along SR 511 (B-001-0-23 through B-004-0-23) and SR 18 (B-005-0-23 and B-008-0-23) alignments, while the other two (2) borings were conducted south of the existing SR 18 eastbound lane pavement, within the footprint of the proposed realignment of the SR 18 west and east approaches to proposed roundabout (B-006-0-23 and B-007-0-23). Four (4) pavement cores where also collected, one at each boring location performed within the existing roads, with exception of borings B-002-0-23 and B-003-0-23. The boring locations are illustrated on the boring plan presented in Appendix I of this report.

All roadway borings were performed in the area of the proposed intersection improvement. Borings B-001-0-21 through B-004-0-23 performed within the driving lanes along SR 511 encountered full depth asphalt pavement section. Borings B-005-0-23 and B-008-0-23 performed within the driving lanes along SR 18 encountered composite pavement (asphalt over concrete) section, while borings B-006-0-23 and B-007-0-23, performed within the footprint of the proposed realignment of the SR 18 encountered gravel at the existing surface. Slag base material was encountered below the asphalt section in borings B-001-0-23 through B-004-0-23, while aggregate base materials were encountered below the concrete section in boring B-008-023.

Below the surface material in boring B-001-0-23 and B-004-0-23, material identified as existing fill was encountered extending to depths of 3.0 and 2.2 feet below existing grade, respectively.

Beneath the existing fill and pavement materials, natural cohesive soils were encountered to boring termination depths. The cohesive soils were described as dark and mottled brown to gray silt and clay, silty clay, and clay (ODOT A-6a, A-6b, A-7-6).

Bedrock was not encountered in any of the borings performed for this investigation.

Groundwater was encountered during drilling activities in boring B-001-0-23 at a depth of 2.0 feet below the existing grade. Groundwater was not encountered during drilling nor upon completion and removal of the auger, in any of the other borings performed during this investigation.

Analysis and Recommendations

Pavement Subgrade Recommendations

The subgrade soils are anticipated to consist of predominantly as very stiff to hard silt and clay, silty clay, and clay (ODOT A-6a, A-6b, A-7-6). In borings B-001-0-23 and B-004-0-23, existing fill described as medium dense to dense gravel with sand (ODOT A-1-b) previously stabilized, and hard silty clay (ODOT A-6b) are anticipated at the subgrade elevation. Based on the soil conditions encountered during the drilling phase, it is estimated that approximately 53 percent of the subgrade soils within the upper portions of the anticipated subgrade will require some level of stabilization under ODOT GDM.

Based on the Subgrade Analysis performed according to ODOT GDM, the overall average site parameters are noted as follows:

Overall Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
10	20	19	16	13	5

After applying the averages in the above table and considering the conditions and type of soils encountered within the proposed roundabout project limits, the following stabilization alternatives can be considered to globally stabilize the subgrade within the project limits:

Option 1: **Stone stabilize the entire subgrade via 12-inches of over excavation and replacement to proposed subgrade 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.**

Option 2: **Chemically stabilize the entire subgrade with 14 inches of lime, per ODOT Construction and Materials Specification (CMS) Item 206. For estimating purposes, utilize a lime content of 5.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils. Actual depth of chemical stabilization may vary based on the conditions encountered during construction.**

Please note that the aforementioned chemical stabilization depths, as well as the excavation and replacement depths, are to be measured from the proposed subgrade elevation, which is estimated to be approximately 1.7 feet below the existing grade. In addition, please note that the depths of stabilization provided above are estimated based on the soil conditions encountered in the borings performed during the field exploration. Actual depth of stabilization may differ from the recommendations provided. Per ODOT GDM requirements, the entire subgrade should be proof rolled to identify the actual limits of unstable subgrade and depth of stabilization required. The actual depths and limits of Item 204 should be determined by the Geotechnical Engineer in the field based on the results of proof rolling and subgrade observations in accordance with ODOT CMS Item 204. Upon completion of the stabilization, the entire subgrade should be proof rolled in accordance with Item 204 to verify that stability has been achieved

California Bearing Ratio (CBR) values for the entire project ranged from 3 to 7 with an average of 5. Based on the variable soil types and marginal conditions encountered in the borings performed for this investigation, **it is recommended that pavement design be based on a CBR of 5 with a corresponding resilient modulus, M_R, of 6,000 psi**. Correlation charts indicate a modulus of subgrade reaction (K) of 135 pci and a soil support value (SSV) of 3.8

Please note that the recommended design CBR of 5 consider that the subgrade has been stabilized in accordance to the recommendations provided in Section 5.1 of this report.

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

1.0 INTRODUCTION

This report is a presentation of the geotechnical exploration performed for the proposed LOR-18-1.60 intersection improvements project in Lorain County, Ohio. The project will extend from approximately 440 feet west to approximately 430 feet east of the intersection along SR 18, and approximately 450 feet south to 450 feet north along SR 511. Based on the information provided by LJB, it is understood that the proposed improvements will consist of replacing the existing two-way, stop-controlled intersection with a single lane roundabout. A vicinity map depicting the location of the site is provided on the boring plan in Appendix I.

This exploration was performed in accordance with the latest Ohio Department of Transportation (ODOT) Specification for Geotechnical Explorations (SGE) and the ODOT Geotechnical Design Manual (GDM).

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 Site Geology

Physiographically, the study area lies within the Galion Glaciated Low Plateau of the Central Lowland Till Plains. This area is characterized as a rolling upland, transitioning between the gently rolling Till Plain and the hilly Glaciated Allegheny Plateau, and is typically comprised of medium-to low-lime Wisconsinan-age till overlying Mississippian-age shales and sandstones. The soil at the site consists of clayey till (Hiram, Yorkshire, Lake Tills) deposited as a ground moraine. Ground moraines are deposited during the retreat of a glacier, resulting in an undifferentiated mixture of clay, silt, sand and gravel. The nearby West Branch Black River contains limited sand and gravel outwash. 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.

Based on bedrock geology and topography maps obtained from the Ohio Department of Natural Resources (ODNR), the bedrock underlying the glacial deposits consists of the Mississippian-aged Logan and Cuyahoga Formations undivided. The Logan Formation consists of gray, yellow and brown sandstone and siltstone. The sandstone layers contain lenses and beds of coarse sand grains to fine-pebble conglomerate and the siltstone contains shale interbeds and partings and is locally fossiliferous. The Cuyahoga Formation consists of gray, olive, brown and yellow sandstone, siltstone and shale. The sandstone is silty to conglomeratic and the siltstone and shale are locally fossiliferous and intertongue and intergrade. The undivided formation ranges between 250 to 1050 feet thick. According to bedrock topography mapping, the bedrock surface forms a small irregularly shaped plateau that extends slightly to the east. The bedrock slopes downward to the north and south of the intersection and then down to the southeast toward a small valley underlying the West Branch Black River. The bedrock beneath the site lies at an approximate elevation of 825 feet msl (mean sea level). ODNR maps indicate the bedrock surface is approximately 80 feet below the ground surface.

2.2 Existing Site Conditions

The project site is located in Brighton Township, about 4.7 miles west of the Village of Wellington, in Lorain County, Ohio. Both the existing SR 18 and SR 511 consist of two-way, bidirectional, asphalt paved roadways with partial shoulders (2.0 to 6.0 feet wide) within the project limits and spans predominantly rural residential area and farm lands. The existing pavement at the intersection appears to be in fair condition with longitudinal cracking observed, alligator cracking within the wheel paths, and shoulder drop off near the pavement edges. Regionally, the site drains to the southeast toward the West Branch Black River.

3.0 EXPLORATION

On December 19 and 20, 2023, a total of eight (8) roadway borings, designated as B-001-0-23 through B-008-0-23, were advanced to depths ranging from 7.5 to 8.5 feet below the existing ground surface. Six (6) of the borings were conducted within the existing pavement section along SR 511 (B-001-0-23 through B-004-0-23) and SR 18 (B-005-0-23 and B-008-0-23) alignments. The remaining two (2) borings were conducted south of the existing SR 18 eastbound lane pavement, within the footprint of the proposed realignment of the SR 18 west and east approaches to proposed roundabout (B-006-0-23 and B-007-0-23). Four (4) pavement cores where also collected, one at each of the boring location performed within the existing roads, with exception of borings B-002-0-23 and B-003-0-23 which were initially scheduled to be performed off the roadway but had to be offset to within the pavement along SR 511 due to utility conflicts. The borings locations are illustrated on the boring plan presented in Appendix I and summarized in Table 1.

Table 1. Test Boring Summary

Boring Number	Reference Alignment	Station	Offset	Latitude	Longitude	Ground Elevation (feet msl)[1]	Boring Depth (feet)
B-001-0-23	CL 511	383+27	1' RT	41.169915	-82.309129	902.3	7.5
B-002-0-23	CL 511	385+55	11' Rt	41.170539	-82.309042	905.4	7.5
B-003-0-23	CL 511	388+13	16' LT	41.171249	-82.309089	905.1	7.5
B-004-0-23	CL 511	391+88	4' LT.	41.172276	-82.308970	906.3	7.5
B-005-0-23	CL 18	80+12	7' LT	41.171173	-82.310608	906.6	8.0
B-006-0-23	CL 18	82+19	27' RT	41.171048	-82.309863	905.9	7.0
B-007-0-23	CL 18	86+05	20' RT	41.170993	-82.308232	904.4	8.5
B-008-0-23	CL 18	88+68	9' LT	41.171034	-82.307504	903.6	7.5

1. Ground surface elevations were interpolated using topographic mapping information provided by LJB.

Rii utilized a handheld GPS unit to obtain latitude and longitude coordinates at the boring locations. Approximate ground surface elevations at the boring locations were interpolated using topographic mapping information provided by LJB.

The roadway borings were drilled with a Mobile B-53 rotary drilling machine, utilizing a 4.5-inch outside diameter continuous flight auger to advance the holes. In general, standard penetration test (SPT) and continuous split spoon sampling was performed to boring termination depths. The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted by letting a 140-pound hammer free fall 30.0 inches to drive a 2.0-inch outer diameter (O.D.) split spoon sampler 18.0 inches. Driving resistance is recorded on the boring logs in terms of blows 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). SPT blow counts aid in estimating soil characteristics used to calculate bearing capacities and settlement potential. Measured blow count (N_m) values are corrected to an equivalent (60%) energy ratio, N_{60}, by the following equation. Both values are represented on the boring logs presented in Appendix III.

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

Where:

N_{60} = energy corrected number of blows required to drive split spoon sampler final 12 inches in 1.5-foot sampling intervals

N_m = measured N value

ER = drill rod energy ratio, expressed as a percent, for the system used

The automatic hammer for the Mobile B-53 drill rig used for this project was calibrated on March 31, 2022 and have a drill rod energy ratio of 79.0 percent.

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 unconfined compressive strength of the cohesive split spoon sample can also be made from a correlation with the blow counts (N_{60}). Please note that split spoon samples are considered to be disturbed and the laboratory determination of their shear strengths may vary from undisturbed conditions.

Upon completion of the drilling operations, the boreholes were backfilled with a mixture of bentonite chips or soil cuttings or the combination of both. The pavement surface at the boring locations performed within the existing pavement were patched with asphalt cold patch.

During drilling, Rii personnel prepared field logs 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 have been tested, as noted in Table 2.

Table 2. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	ASTM D 2216	34
Plastic and Liquid Limits	AASHTO T89, T90	15
Gradation – Sieve/Hydrometer	AASHTO T88	15
Gradation – Sieve ONLY	AASHTO T88	2
Loss on Ignition	ASTM D2974	2
Sulfate Content – Colorimetric Method	ODOT S1122	8

The tests performed are necessary to classify existing soil according to the ODOT classification system and to estimate engineering properties of importance for pavement and foundation 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.

4.0 FINDINGS

Interpreted engineering logs have been prepared based on the field logs, visual examination of samples and laboratory test results. Classification follows the current version of the ODOT SGE. The following is a summary of what was found in the test borings and what is represented on the boring logs.

4.1 Surface Materials

The borings performed for the proposed intersection improvements encountered either a composite (HMA over concrete) pavement section, a full depth asphalt pavement section, or gravel at the ground surface. Borings B-001-0-21 through B-004-0-23, performed within the driving lanes of SR 511, encountered 12.75 to 14.0 inches of asphalt. Borings B-005-0-23 and B-008-0-23, performed within the driving lanes of SR 18, encountered 12.5 and 8.0 inches of asphalt, overlying 8.0 and 9.25 inches of concrete, respectively. Borings B-006-0-23 and B-007-0-23, performed south of the existing SR 18 eastbound lane, encountered 11.0 and 3.0 inches of gravel, respectively. Slag base material was encountered below the asphalt section in borings B-001-0-23 through B-004-0-23, with thickness ranging from 5.0 to 7.0 inches, while aggregate base material was encountered below the concrete section in boring B-008-023. Surface material found at each boring and pavement core location are summarized in Table 3.

Table 3. Surface Material Summary

Boring ID	Gravel (in)	Asphalt Thickness (in)	Concrete Thickness (in)	Aggregate Base (in)	Slag Base (in)
B-001-0-23	-	12.75	-	-	7.0
B-002-0-23 [1]	-	14.0	-	-	5.0
B-003-0-23 [1]	-	13.0	-	-	5.0
B-004-0-23	-	13.0	-	-	6.0
B-005-0-23	-	12.5	8.0	-	-
B-006-0-23	11.0	-	-	-	-
B-007-0-23	3.0	-	-	-	-
B-008-0-23	-	8.0	9.25	4.75	-

1. *No pavement cores were obtained at borings B-002-0-23 and B-003-0-23. Pavement thicknesses were measured from within the borehole.*

It should be noted that the in general the pavement cores collected seems to be in fair condition, exhibiting only minor deterioration. For further details please see the boring logs in Appendix III and the pavement core logs in Appendix V.

4.2 Subsurface Soils

Below the surface material in boring B-001-0-23 and B-004-0-23, material identified as existing previously stabilized fill was encountered extending to depths of 2.7 and 2.2 feet below existing grade, respectively. This fill material within boring B-001-0-23 and B-004-0-23 was described as previously stabilized fill according to its reaction to phenolphthalein in the lab. In addition, below the previously stabilized fill in boring B-001-0-23, material identified as existing fill was encountered extending to a depth of 3.0 feet below existing grade. In general, the fill materials were described as gravel with sand (ODOT A-1-b) previously stabilized, and silty clay (ODOT A-6b). Slag fragments were observed within the fill materials in borings B-001-0-23.

Beneath the fill material in these borings and the surface material in the rest of the borings, natural cohesive soils were encountered to boring termination depths. The cohesive soils were described as dark and mottled brown to gray silt and clay, silty clay, and clay (ODOT A-6a, A-6b, A-7-6).

The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soils encountered across the site ranged from medium stiff ($0.5 < HP \leq 1.0$ tsf) to hard ($HP > 4.5$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.75 tsf to over 4.5 tsf (limit of instrument). Overall blow counts recorded from the SPT blow count (N_{60}) sampling ranged from 8 bpf to 40 bpf.

Natural moisture contents of the soil samples tested ranged from 14 to 26 percent. The natural moisture contents of the cohesive soil samples tested for plasticity index ranged from 2 percent below to 7 percent above their corresponding plastic limits. In general, the soils exhibited natural moisture contents estimated to be moderately below to significantly above optimum moisture levels.

Sulfate testing was performed in the upper soil samples obtained at each boring within. Based on the results of the testing performed, the sulfate contents of the subgrade soils ranged from less than 100 to 360 parts per million (ppm or mg/kg of material). Results of the sulfate testing at the boring location tested are provided on the respective boring log in Appendix III.

Soil samples observed to contain organic matter in boring B-006-0-23 and B-007-0-23, were tested by loss on ignition (LOI) with results of 2.3 and 4.5 percent, respectively.

4.3 Bedrock

Bedrock was not encountered in any of the borings performed for this investigation.

4.4 Groundwater

Groundwater was encountered during drilling activities in boring B-001-0-23 at a depth of 2.0 feet below the existing grade. Groundwater was not encountered during drilling, or upon completion and removal of the auger, in any of the other borings performed during this investigation. It should be noted that borings B-001-0-23, B-003-0-23, and B-006-0-23, cave-in at depths ranging from 6.4 to 7.0 feet below the existing grade.

Please note that short-term water level readings 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.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the drilling and testing program have been used to determine pavement foundation and support capabilities for the soils encountered at the site. These parameters have been used to provide guidelines for the design of the pavement foundation systems, as well as the construction specifications related to the placement of the pavement and general earthwork recommendations, which are discussed in the following paragraphs. This report, and the recommendations contained herein, has been written under the consideration that the construction will be performed in accordance with the latest version of the ODOT Construction and Materials Specifications (CMS).

5.1 Pavement Subgrade Recommendations

With exception of borings B-001-0-23 and B-004-0-23, the soils at the anticipated subgrade elevation will consist predominantly of natural cohesive soils described as very stiff to hard silt and clay, silty clay, and clay (ODOT A-6a, A-6b, A-7-6). In borings B-001-0-23 and B-004-0-23, existing fill described as medium dense to dense gravel with sand (ODOT A-1-b) previously stabilized and hard silty clay (ODOT A-6b) are anticipated at the subgrade elevation. Based on the soil conditions encountered during the drilling phase, it is estimated that sections of the subgrade soils will require some level of stabilization under ODOT GDM. At the time of this report, no profile information was available for the proposed improvements; therefore, the ODOT Subgrade Analysis was performed based on the consideration that the profile grade for the proposed roundabout, and its legs along SR 18 and SR 511, will be similar to that of the existing intersection. Therefore, the proposed subgrade is considered to be approximately 1.7 feet below existing grade. The GDM subgrade analysis spreadsheet summary is presented in Appendix III.

5.1.1 Subgrade Stabilization

Based on the ODOT GDM, when approximately 30 percent or more of the subgrade requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, based on the soil borings performed, approximately **53 percent** of the subgrade area within the proposed roundabout project limits, is anticipated to require stabilization. Therefore, based on the Subgrade Analysis spreadsheet, global stabilization would be warranted for the proposed LOR-18-1.60 intersection improvement subgrade soils**.** Per ODOT GDM, global stabilization recommendations are based upon the overall average site parameters, noted in Table 4.

Table 4. Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
10	20	19	16	13	5

After applying the averages in Table 4 and considering the conditions and type of soils encountered within the proposed roundabout project area, the following stabilization alternatives can be considered to globally stabilize the subgrade within this project:

Option 1: **Stone stabilize the entire subgrade via 12 inches of over excavation and replacement to proposed subgrade 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.**

Option 2: **Chemically stabilize the entire subgrade with 14 inches of lime, per ODOT CMS Item 206. For estimating purposes, utilize a lime content of 5.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils. Actual depth of chemical stabilization may vary based on the conditions encountered during construction.**

Please note that the aforementioned chemical stabilization depths, as well as the excavation and replacement depths, are to be measured from the proposed subgrade elevation, which is estimated to be approximately 1.7 feet below the existing grade. In addition, please note that the depths of stabilization provided above are estimated based on the soil conditions encountered in the borings performed during the field exploration. Actual depth of stabilization may differ from the recommendations provided.

Per ODOT GDM requirements, the entire subgrade should be proof rolled to identify the actual limits of unstable subgrade and depth of stabilization required. The actual depths and limits of Item 204 should be determined by the Geotechnical Engineer in the field based on the results of proof rolling and subgrade observations in accordance with ODOT CMS Item 204. Upon completion of the stabilization, the entire subgrade should be proof rolled in accordance with Item 204 to verify that stability has been achieved.

5.1.2 Subgrade Design Considerations

California Bearing Ratio (CBR) values for the entire project ranged from 3 to 7 with an average of 5. Based on the variable soil types and marginal conditions encountered in the borings performed for this investigation, **it is recommended that pavement design be based on a CBR of 5 with a corresponding resilient modulus, M_R, of 6,000 psi**. Correlation charts indicate a modulus of subgrade reaction (K) of 135 pci and a soil support value (SSV) of 3.8.

As previously discussed, the exposed subgrade soil should be observed and proof rolled to identify any soft, wet or weak zones prior to placement of new aggregate base or pavement materials. If the subgrade presents evidence of soft, wet or weak soils, then it is recommended that the soils be stabilized via the methods discussed in Section 5.1. Please note that the recommended design CBR of 5 consider that the subgrade has been stabilized in accordance to the recommendations provided in Section 5.1.

Where excavation and replacement with engineered fill is selected as stabilization method, and due to the weak nature of the soils, the geotextile fabric should be placed at the bottom of the over excavation prior to the placement of the backfill materials.

Please note that the recommended design CBR of 5 also assume that the materials utilized for the road 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 5.

Per ODOT GDM, soils with sulfate content in excess of 5,000 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 less than 100 to 360 ppm. Therefore, soil with sulfate content greater than 5,000 ppm was not encountered in any boring.

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.

5.2 Disposal of Slag Base and Backfill

Under the definition of “Construction and Demolition Debris” in the Ohio Administrative Code (OAC) OAC-3745-400-01 rules, slag is excluded from the definition and thus would not be accepted by a C&DD landfill. Therefore, the slag waste cannot go to a C&DD landfill.

However, under the definition of “Solid Waste” in the OAC-3745-27-01 rules, slag is included in the definition of solid waste. Therefore, any of the slag removed from the embankment or base material would need to be either disposed of on-site, or disposed of in a solid waste landfill.

The solid waste landfill must be informed that the material type is slag so that the landfill can record and report the quantities as required by the Ohio EPA. The solid waste landfill should be contacted in advanced and informed of the waste type. Then the landfill has the option of either accepting or rejecting the material even if the testing indicates that it should be acceptable.

Rii recommends if soil underlying the slag material is to be removed and disposed, the soil should be tested to determine if heavy metals (13 Priority Pollutants) leached into the soil and the concentration prior to determining if the soil can be reused, taken to a C&DD landfill, or taken to a soil recycler. If the underlying soil compounds exceeding the TCLP action levels, the material may not be acceptable for a C&DD landfill and may need to be treated as hazardous. If underlying soil below the slag is to remain, the owner is not required to analyze and characterize the soil.

There are no regulations that would prohibit relocating the slag material on a property that is owned by the same agency. However, the potential for contaminants in the leachate from the slag into the subsurface soil and receiving waters should be evaluated for compliance.

It is our recommendation that if the slag is to be relocated and stockpiled on site, the material should be placed in an area where a bottom liner of approximately 2.0 feet of clay (ODOT A-7-6), with a permeability lower than 10^{-7} cm/sec, are present below the stockpile to minimize the potential for infiltration into the groundwater. Additionally, it is recommended that a clay cap (or liner sheeting) be constructed over the stockpile and sloped to provide positive drainage of surface runoff and prevent infiltration through the slag material.

5.3 Construction Considerations

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

The extent/need for subgrade stabilization is entirely dependent on the subgrade conditions (i.e., moisture contents) encountered at the time of construction. If required, the method of stabilization employed is a function of the type of instability encountered the location (i.e., depth) of the instability and the resources available.

All proposed subgrade surfaces should be shaped to promote positive drainage, with a minimum slope of 2.0 percent or 0.25 inches per foot. Adequate drainage is necessary for maintaining the stability of the subgrade. Care should be taken during final grading so that no areas of potential ponding or standing water remain at the subgrade surface.

Materials utilized for engineered fill should conform to the latest ODOT CMS.

Any slag base material encountered under the pavement section, as in borings B-001-0-23 through B-004-0-23, should not be considered suitable for reuse as a base material.

5.3.1 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 5. 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 Groundwater Considerations

Based on the groundwater observations made during drilling, little to no seepage of groundwater is anticipated to be encountered during construction at the site. Where/if groundwater is encountered, proper groundwater control measures should be implemented to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or “boiling” condition if soft/loose silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 24.0 inches below the deepest excavation. Any seepage or groundwater encountered at this site should be able to be controlled by pumping from temporary sumps. Note that determining and maintaining actual groundwater levels during construction is the responsibility of the contractor.

6.0 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 our recommendations.

The recommendations for this project were developed utilizing soil information obtained from the test borings that were made at the proposed site. At this time we would like to point out that soil borings only depict the soil 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

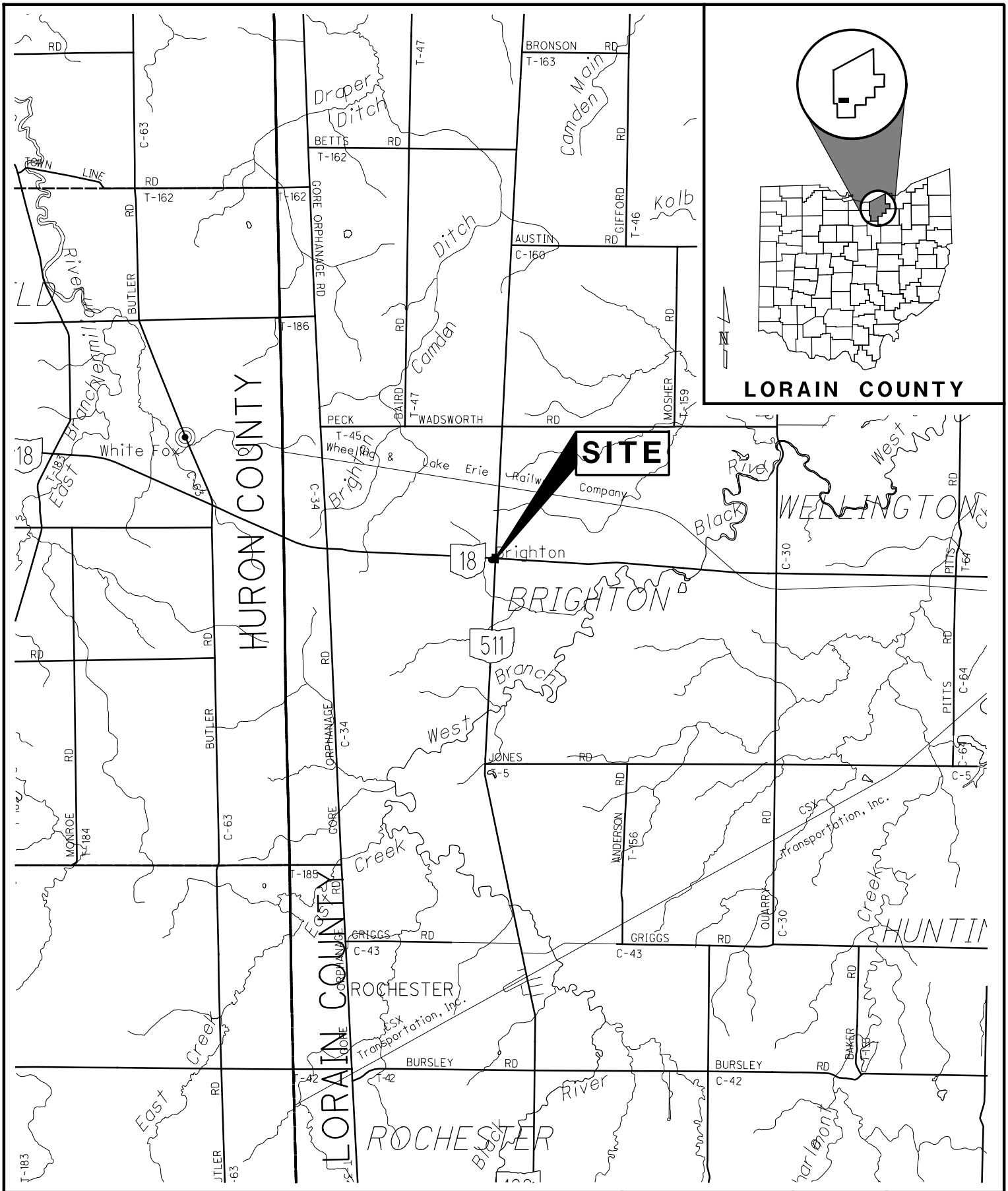
necessary. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the geotechnical engineer.

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

LOR-18-1.60 INTERSECTION IMPROVEMENTS

LORAIN COUNTY, OHIO

RII PROJECT NO. W-23-179	DRAWN JAS
SCALE: 1"=5000' (0, 2500, 5000)	REVIEWED JGR
	DATE 1/30/2024

RESOURCE INTERNATIONAL Rii

BORING PLAN

LOR-18-1.60 INTERSECTION IMPROVEMENTS

LORAIN COUNTY, OHIO

RII PROJECT NO. W-23-179	DRAWN JAS
SCALE: 1"=100' (0 50 100)	REVIEWED JGR
N	DATE 1/29/2024

RESOURCE INTERNATIONAL Rii

APPENDIX II

DESCRIPTION OF SOIL TERMS

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 – ODOT A-1, A-2, A-3, A-4 (non-plastic)
The relative compactness of granular soils is described as:

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 – ODOT A-4, A-5, A-6, A-7, A-8
The relative consistency of cohesive soils is described as:

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		Size
Boulders		Larger than 12”
Cobbles		12” to 3”
Gravel	coarse	3” to ¾“
	fine	¾” to 2.0 mm (¾” to #10 Sieve)
Sand	coarse	2.0 mm to 0.42 mm (#10 to #40 Sieve)
	fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt		0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay		Smaller than 0.005 mm

Modifiers of Components - The following modifiers indicate the range of percentages of the minor soil components:

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 - ODOT
Dry	Well below Plastic Limit
Damp	Below Plastic Limit
Moist	Above PL to 3% below LL
Wet	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.

APPENDIX III

BORING LOGS:

B-001-0-23 through B-008-0-23

BORING LOGS

Definitions of Abbreviations

AS = Auger sample

GI = Group index as determined from the Ohio Department of Transportation classification system

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

LL_o = Oven-dried liquid limit as determined by ASTM D4318. Per ASTM D2487, if LL_o/LL is less than 75 percent, soil is classified as "organic".

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_m).

N_{60} = Measured blow counts corrected to an equivalent (60 percent) energy ratio (ER) by the following equation: $N_{60} = N_m*(ER/60)$

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 (%)

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 383+27 / 1' RT	**EXPLORATION ID B-001-0-23**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 511	
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 902.3 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.169915, -82.309129	

MATERIAL DESCRIPTION AND NOTES	ELEV. 902.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
1.1' - ASPHALT (12.75")																			
	901.4																		
0.58' - SLAG BASE (7.0")																			
	900.8																		
STABILIZED FILL: DENSE, GRAY AND BLACK **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST. -Slag fragments throughout SS-1A		W 900.3	30 22 4	34	100	SS-1A	-	43	25	18	- 14 -		-	-	-	18	A-1-b (V)	200	
	899.6																		
FILL: HARD, BROWN **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -Slag fragments in SS-1B	899.3					SS-1B	4.25	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
HARD, MOTTLED BROWN AND GRAY **SILTY CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.			4 8 10	24	67	SS-2	4.5+	3	8	13	30	46	34	18	16	17	A-6b (10)	-	
			8 9 11	26	92	SS-3	4.5+	-	-	-	-	-	-	-	-	18	A-6b (V)	-	
			6 11 13	32	89	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
	894.8	EOB																	

NOTES: GROUNDWATER ENCOUNTERED INITIALLY @ 2.0'; CAVE-IN DEPTH @ 7.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 385+55 / 11' RT	**EXPLORATION ID B-002-0-23**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 511		
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 905.4 (MSL) EOB: 7.5 ft.		PAGE 1 OF 1
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.170539, -82.309042		

MATERIAL DESCRIPTION AND NOTES	ELEV. 905.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
1.2' - ASPHALT (14.0")																			
	904.2																		
0.4' - SLAG BASE (5.0")																			
	903.8																		
VERY STIFF TO HARD, DARK BROWN TO MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.		1																	
		2	6 3 4	9	33	SS-1	3.25	9	4	14	35	38	32	16	16	19	A-6b (10)	320	
		3																	
		4	6 8 10	24	81	SS-2	4.5+	8	5	10	31	46	34	18	16	17	A-6b (10)	-	
		5	8 10 14	32	78	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		6																	
		7	11 10 14	32	100	SS-4	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	897.9	EOB																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 388+13 / 16' LT	**EXPLORATION ID B-003-0-23**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 511	
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 905.1 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.171249, -82.309089	

MATERIAL DESCRIPTION AND NOTES	ELEV. 905.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
1.1' - ASPHALT (13.0")	904.0	1																	
0.4' - SLAG BASE (5.0")	903.6																		
VERY STIFF, MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	902.1	2	2 4 3	9	33	SS-1	2.75	6	3	8	42	41	34	18	16	25	A-6b (10)	180	
VERY STIFF TO HARD, MOTTLED BROWN AND GRAY **CLAY**, SOME SILT, LITTLE FINE GRAVEL, LITTLE COARSE TO FINE SAND, DAMP TO MOIST.	897.6	3 4 5 6 7 EOB	3 4 6	13	81	SS-2	3.50	15	3	9	26	47	44	20	24	23	A-7-6 (14)	-	
			5 9 12	28	78	SS-3	4.5+	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
			9 11 13	32	100	SS-4	4.5+	-	-	-	-	-	-	-	-	16	A-7-6 (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 6.8'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 391+88 / 4' LT	**EXPLORATION ID**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 511	**B-004-0-23**	
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 906.3 (MSL) EOB: 7.5 ft.	PAGE	
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.172276, -82.308970	1 OF 1	

MATERIAL DESCRIPTION AND NOTES	ELEV. 906.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
1.1' - ASPHALT (13.0")																			
	905.2	1																	
0.5' - SLAG BASE (6.0")																			
	904.7																		
STABILIZED FILL: MEDIUM DENSE, GRAY **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST.	904.1	2	10 7 6	17	61	SS-1A	-	45	17	11	- 27 -		-	-	-	15	A-1-b (V)	-	
HARD, MOTTLED BROWN AND GRAY **CLAY**, AND FINE GRAVEL, LITTLE SILT, LITTLE COARSE TO FINE SAND, MOIST.	903.3					SS-1B	4.50	39	3	7	18	33	43	17	26	21	A-7-6 (9)	190	
HARD, MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.		3	6 8 13	28	94	SS-2	4.5+	6	6	12	29	47	37	18	19	17	A-6b (12)	-	
		4																	
		5	10 12 15	36	75	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		6																	
		7	11 10 15	33	100	SS-4	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
	898.8	EOB																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 80+12 / 7' LT	**EXPLORATION ID B-005-0-23**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 18		
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 906.6 (MSL) EOB: 8.0 ft.		PAGE 1 OF 1
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.171173, -82.310608		

MATERIAL DESCRIPTION AND NOTES	ELEV. 906.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
1.0' - ASPHALT (12.5")	905.6																		
0.7' - CONCRETE (8.0")	904.9																		
HARD, MOTTLED BROWN AND GRAY **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.	903.1	2	4 4 6	13	69	SS-1	4.25	12	4	12	30	42	43	17	26	22	A-7-6 (14)	360	
HARD, MOTTLED BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP.	898.6	4	4 7 11	24	100	SS-2	4.5+	6	7	12	30	45	37	18	19	17	A-6b (12)	-	
		6	8 11 13	32	100	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		EOB 8	7 9 12	28	100	SS-4	4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE .

000-23 RII STA ODOT LOG SUIL(8.5 X 11) - OH DOT.GDT - 1/30/24 10:34 - U:\GI8\PROJECTS\2023\W-23-179.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 82+19 / 27' RT	**EXPLORATION ID B-006-0-23**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 18		
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 905.9 (MSL) EOB: 7.0 ft.		PAGE 1 OF 1
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.171048, -82.309863		

MATERIAL DESCRIPTION AND NOTES	ELEV. 905.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
0.9' - GRAVEL (11.0")	905.0																		
VERY STIFF TO HARD, MOTTLED DARK BROWN AND BROWN TO GRAY **CLAY**, SOME SILT, LITTLE TO SOME FINE GRAVEL, LITTLE COARSE TO FINE SAND, DAMP TO MOIST.		1	3 2 4	8	72	SS-1	3.00	12	4	10	32	42	42	19	23	25	A-7-6 (13)	160	
-SS-2: LOI = 2.3%		2 3	3 4 4	11	78	SS-2	2.50	23	4	9	24	40	46	18	28	22	A-7-6 (14)	-	
		4 5	4 6 9	20	92	SS-3	4.5+	-	-	-	-	-	-	-	-	16	A-7-6 (V)	-	
		6	6 8 9	22	100	SS-4	4.5+	-	-	-	-	-	-	-	-	16	A-7-6 (V)	-	
	898.9	EOB 7																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING; CAVE-IN DEPTH @ 6.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS .

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 86+05 / 20' RT	**EXPLORATION ID**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 18	**B-007-0-23**	
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 904.4 (MSL) EOB: 8.5 ft.	PAGE	
START: 12/20/23 END: 12/20/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.170993, -82.308232	1 OF 1	

MATERIAL DESCRIPTION AND NOTES	ELEV. 904.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
0.3' - GRAVEL (3.0")	904.1																		
VERY STIFF, DARK BROWN AND BROWN TO MOTTLED GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MODERATELY ORGANIC, MOIST. -SS-1: LOI = 4.5%	901.9	1–2	4 4 5	12	61	SS-1	3.00	10	5	10	34	41	39	20	19	26	A-6b (12)	<100	
VERY STIFF, GRAY AND BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	898.9	3	4 6 10	21	78	SS-2	3.75	5	6	11	32	46	33	19	14	17	A-6a (10)	-	
		4–5	4 8 8	21	78	SS-3	2.75	-	-	-	-	-	-	-	-	20	A-6a (V)	-	
MEDIUM STIFF TO VERY STIFF, BROWN AND GRAY **SILTY CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	895.9	6	2 3 4	9	86	SS-4	0.75	-	-	-	-	-	-	-	-	23	A-6b (V)	-	
	EOB	7–8	4 5 10	20	100	SS-5	2.25	-	-	-	-	-	-	-	-	20	A-6b (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS .

RESOURCE INTERNATIONAL, INC.

PROJECT: LOR-18-1.60 INTERSECTION IMP.	DRILLING FIRM / OPERATOR: RII / IS/BG	DRILL RIG: MOBILE B53 (62440)	STATION / OFFSET: 88+68 / 9' LT	**EXPLORATION ID B-008-0-23**	
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / JK	HAMMER: AUTOMATIC	ALIGNMENT: CL R/W 18		
PID: 116214 SFN:	DRILLING METHOD: 4.5" CFA	CALIBRATION DATE: 3/21/22	ELEVATION: 903.6 (MSL) EOB: 7.5 ft.		PAGE 1 OF 1
START: 12/19/23 END: 12/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79	LAT / LONG: 41.171034, -82.307504		

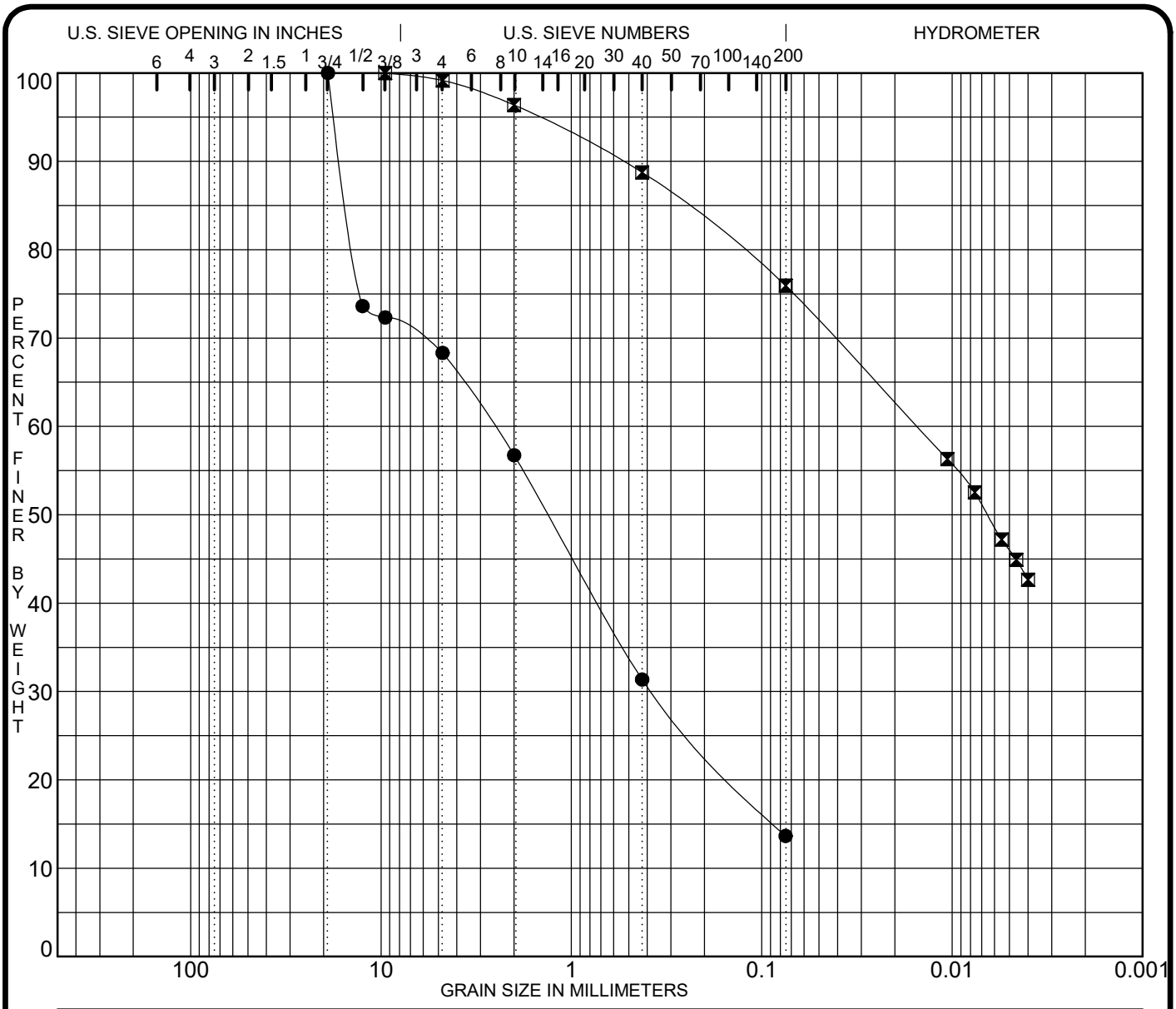
MATERIAL DESCRIPTION AND NOTES	ELEV. 903.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
0.7' - ASPHALT (8.0")	902.9																		
0.8' - CONCRETE (9.25")	902.1																		
0.3' - AGGREGATE BASE (4.75")	901.8					SS-1A	-	-	-	-	-	-	-	-	-	-	A-2-4 (V)	100	
VERY STIFF, MOTTLED BROWN AND GRAY **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, DAMP.	900.6		3 4 9	17	47	SS-1B	3.50	14	15	14	28	29	29	18	11	16	A-6a (5)	-	
VERY STIFF TO HARD, MOTTLED BROWN AND GRAY **CLAY**, SOME SILT, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP TO MOIST.			4 4 6	13	72	SS-2	3.00	10	2	8	31	49	49	18	31	23	A-7-6 (18)	-	
			3 4 8	16	100	SS-3	4.5+	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
	896.1	EOB	7 7 12	25	100	SS-4	4.5+	-	-	-	-	-	-	-	-	14	A-7-6 (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 12.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS. PAVEMENT PATCHED WITH CONCRETE .

APPENDIX IV

Lab Test Results



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

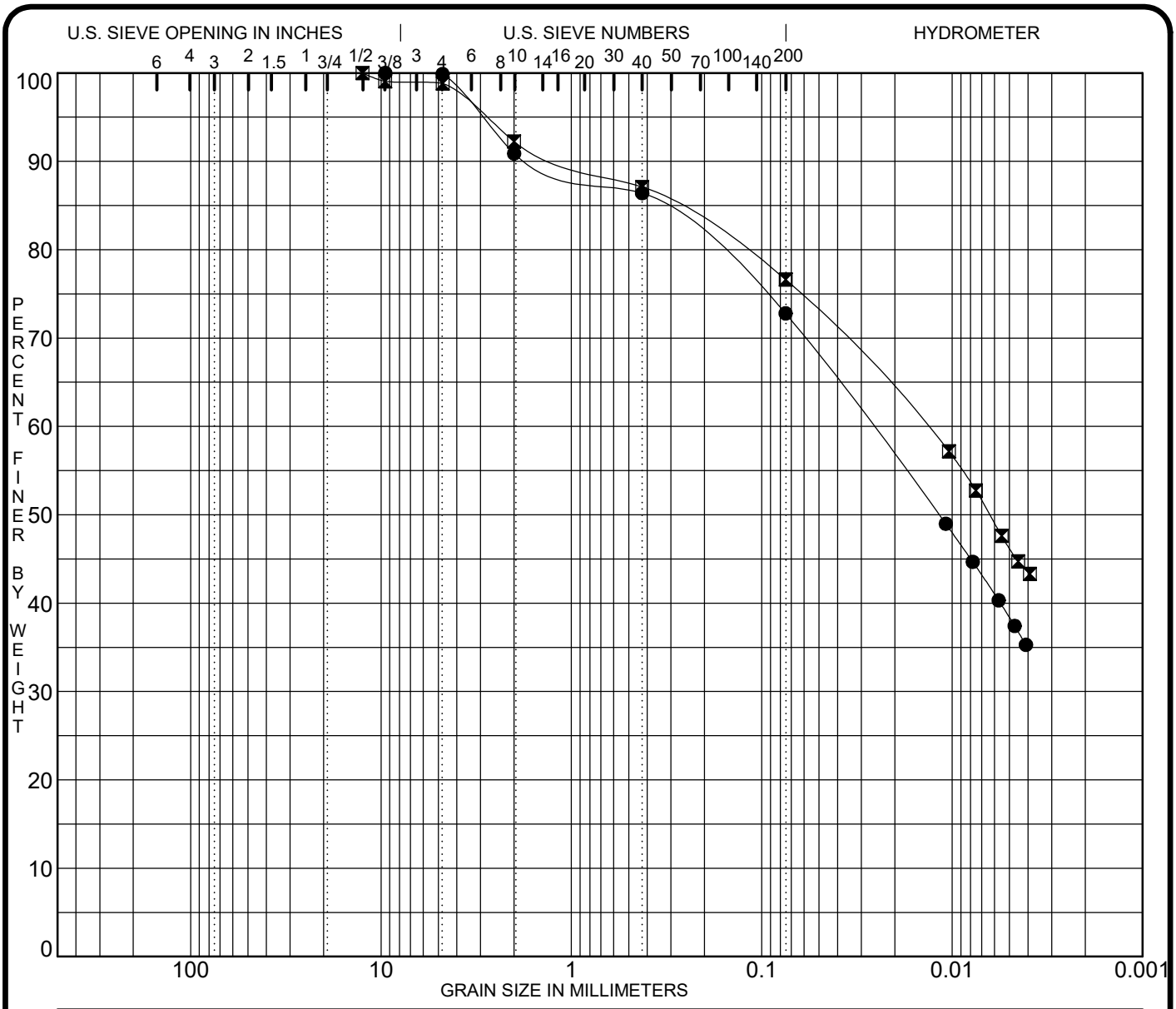
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-001-0-23**	**1.5**		**200**		**18**					
⊠	**B-001-0-23**	**3.0**	**A-6b**			**17**	**34**	**18**	**16**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-001-0-23**	**2.55**	**1.33**	**0.372**		**0.0**	**43.3**	**25.4**	**17.7**	**13.7**	
⊠	**B-001-0-23**	**0.02**	**0.01**			**0.0**	**3.6**	**7.6**	**12.8**	**29.9**	**46.0**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

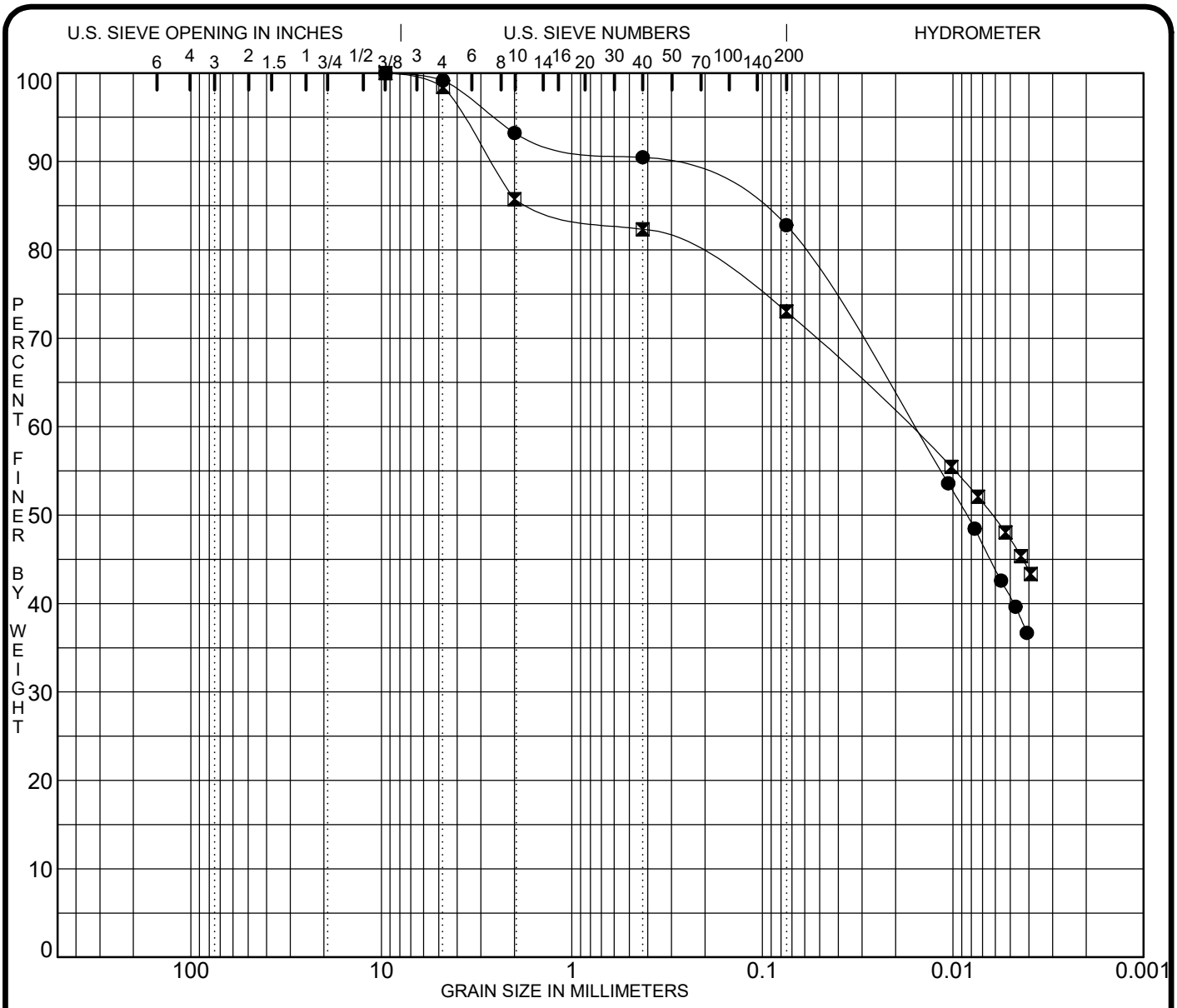
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-002-0-23**	**1.5**	**A-6b**	**320**		**19**	**32**	**16**	**16**		
⊠	**B-002-0-23**	**3.0**	**A-6b**			**17**	**34**	**18**	**16**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-002-0-23**	**0.03**	**0.01**			**0.0**	**9.1**	**4.5**	**13.6**	**34.4**	**38.3**
⊠	**B-002-0-23**	**0.01**	**0.01**			**0.0**	**7.8**	**5.1**	**10.5**	**30.4**	**46.3**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

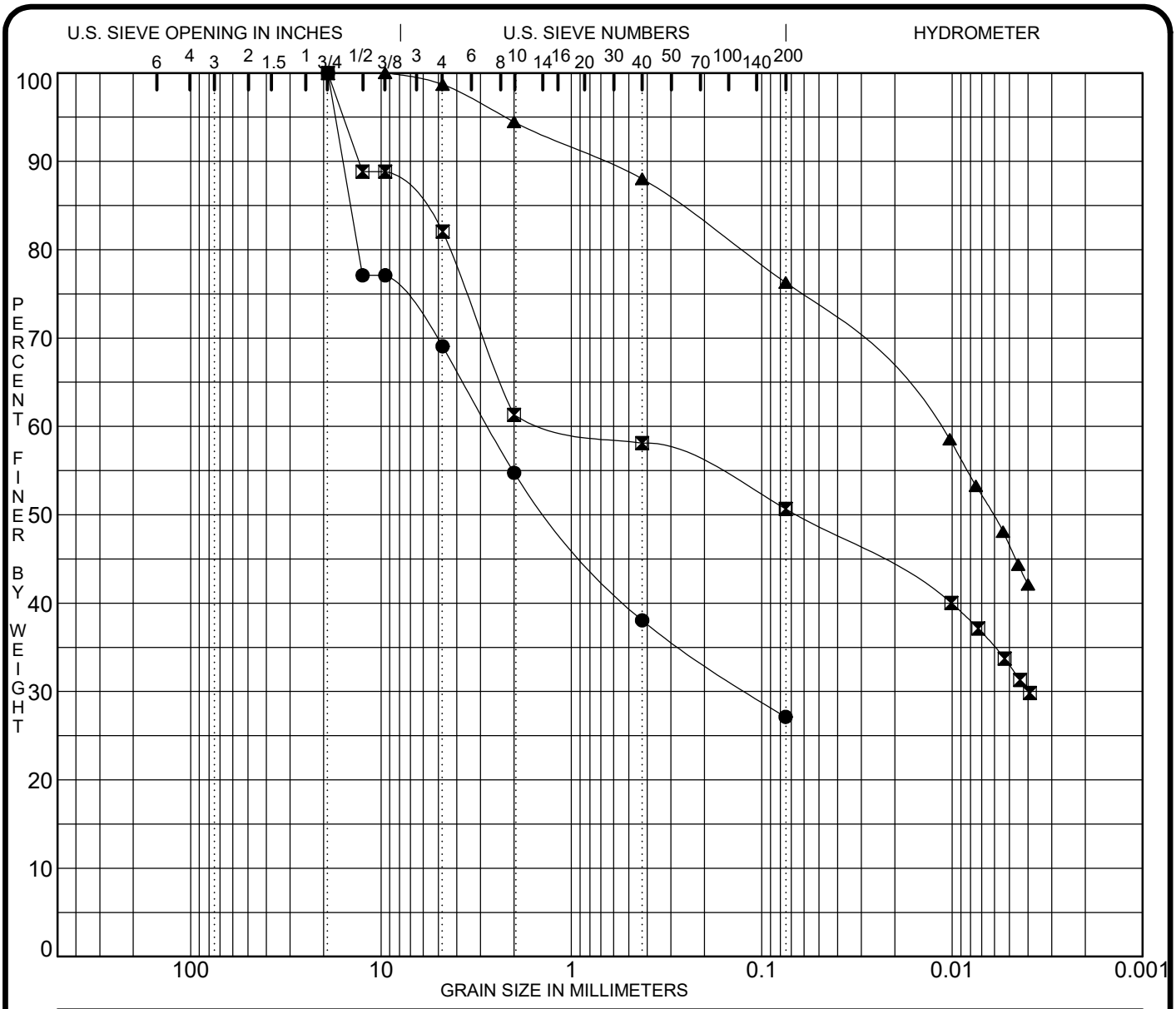
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-003-0-23**	**1.5**	**A-6b**	**180**		**25**	**34**	**18**	**16**		
⊠	**B-003-0-23**	**3.0**	**A-7-6**			**23**	**44**	**20**	**24**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-003-0-23**	**0.02**	**0.01**			**0.0**	**6.8**	**2.8**	**7.7**	**42.1**	**40.7**
⊠	**B-003-0-23**	**0.02**	**0.01**			**0.0**	**14.3**	**3.4**	**9.3**	**25.8**	**47.2**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

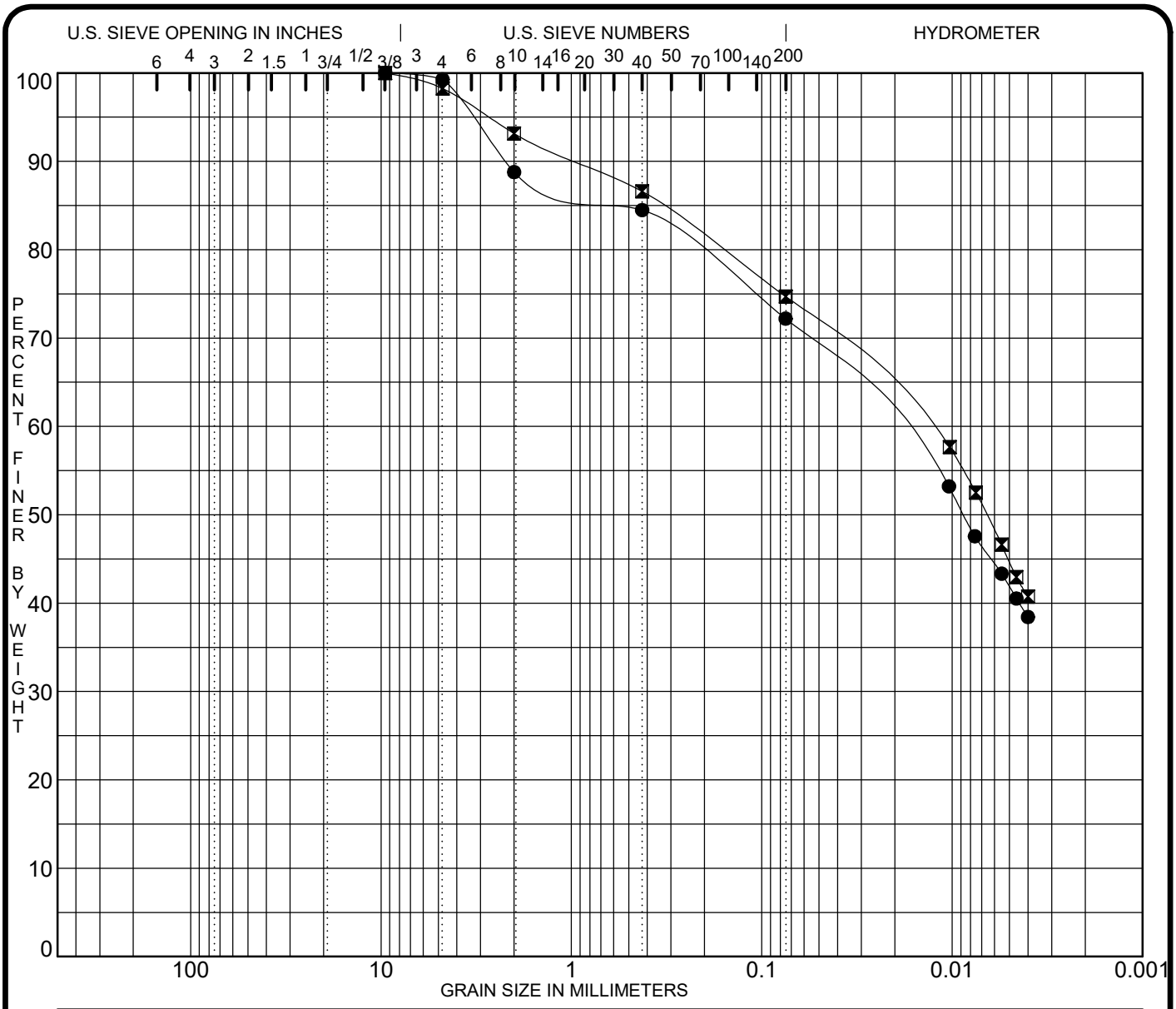
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-004-0-23**	**1.5**		**193**		**15**					
⊠	**B-004-0-23**	**2.2**	**A-7-6**			**21**	**43**	**17**	**26**		
▲	**B-004-0-23**	**3.0**	**A-6b**			**17**	**37**	**18**	**19**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-004-0-23**	**2.75**	**1.29**	**0.118**		**0.0**	**45.2**	**16.7**	**10.9**	**27.1**	
⊠	**B-004-0-23**	**1.06**	**0.07**	**0.004**		**0.0**	**38.7**	**3.2**	**7.5**	**17.7**	**33.0**
▲	**B-004-0-23**	**0.01**	**0.01**			**0.0**	**5.5**	**6.4**	**11.7**	**29.8**	**46.5**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

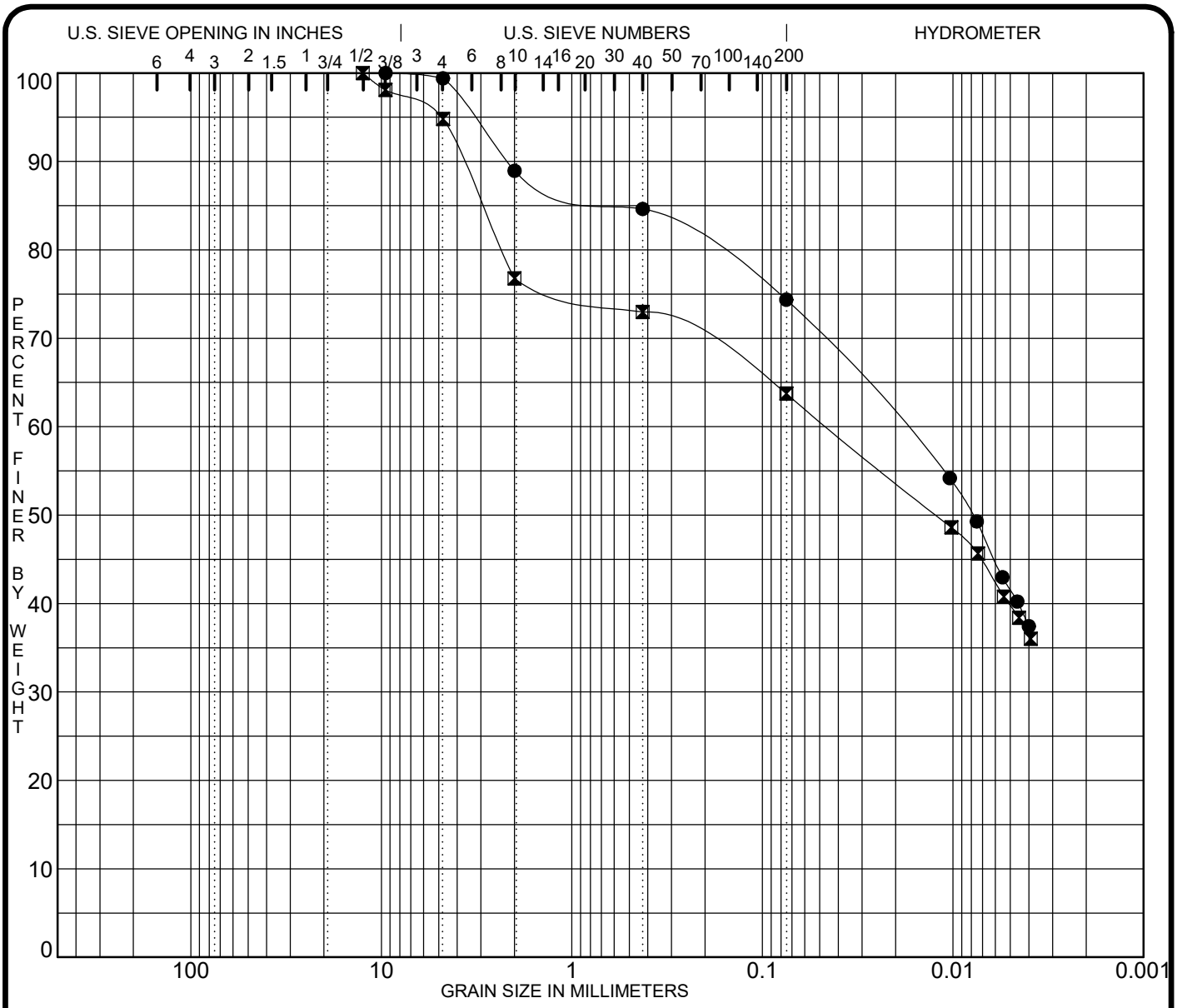
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-005-0-23**	**2.0**	**A-7-6**	**360**		**22**	**43**	**17**	**26**		
⊠	**B-005-0-23**	**3.5**	**A-6b**			**17**	**37**	**18**	**19**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-005-0-23**	**0.02**	**0.01**			**0.0**	**11.2**	**4.3**	**12.3**	**30.4**	**41.8**
⊠	**B-005-0-23**	**0.01**	**0.01**			**0.0**	**6.9**	**6.5**	**11.9**	**30.0**	**44.7**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

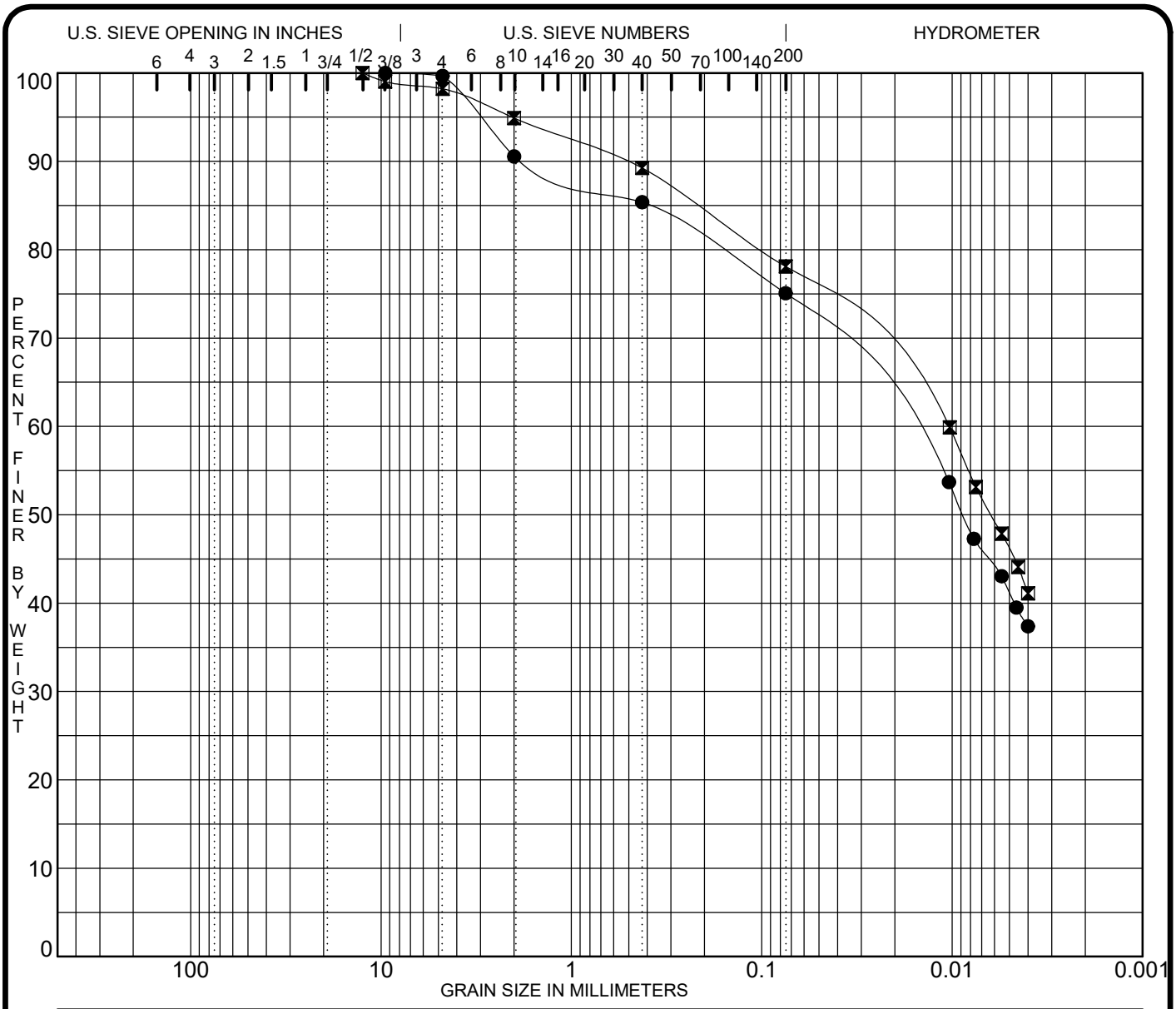
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-006-0-23**	**1.0**	**A-7-6**	**160**		**25**	**42**	**19**	**23**		
⊠	**B-006-0-23**	**2.5**	**A-7-6**		**2.3**	**22**	**46**	**18**	**28**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-006-0-23**	**0.02**	**0.01**			**0.0**	**11.1**	**4.3**	**10.3**	**32.9**	**41.5**
⊠	**B-006-0-23**	**0.05**	**0.01**			**0.0**	**23.2**	**3.8**	**9.2**	**24.0**	**39.8**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

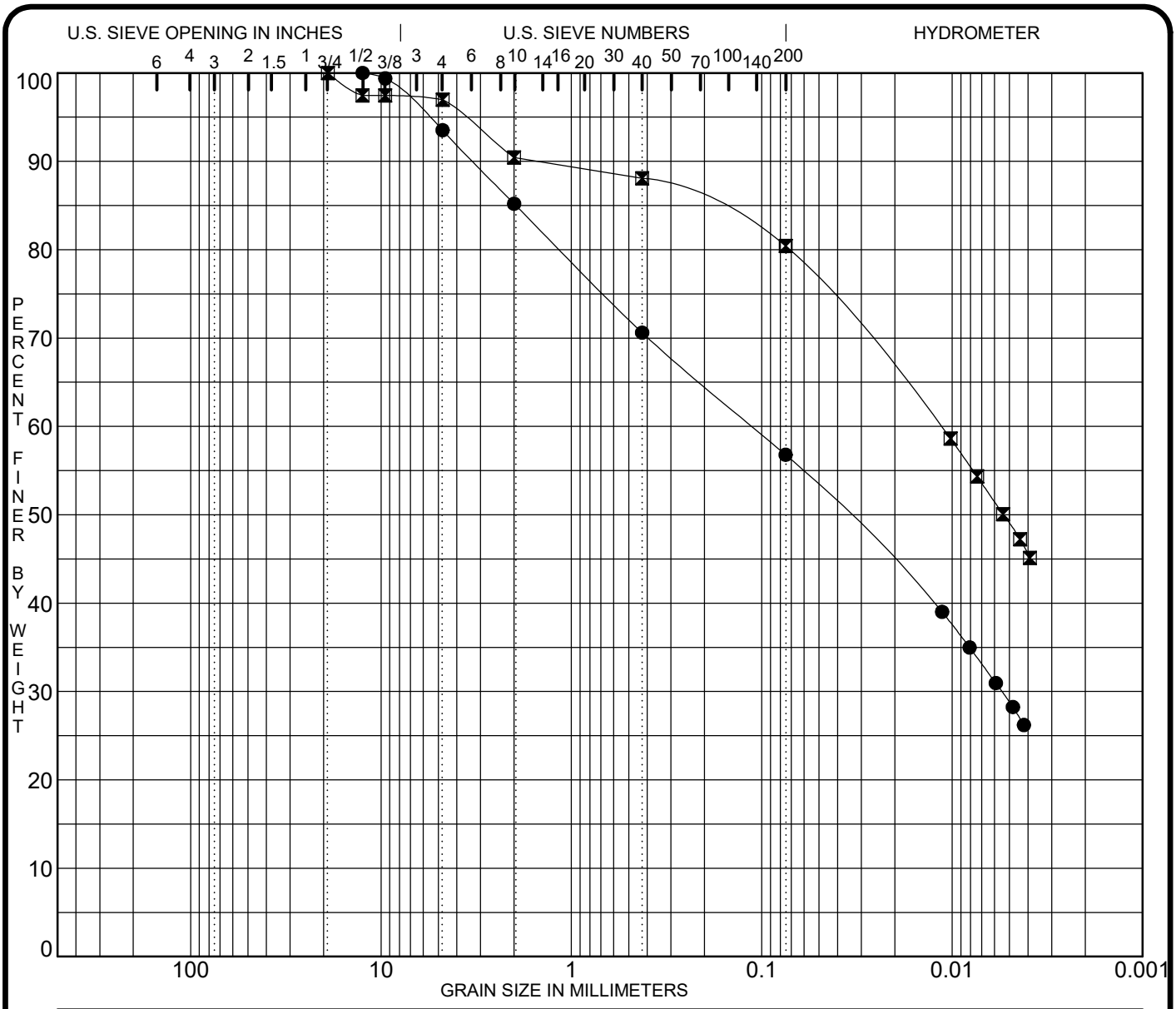
	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-007-0-23**	**1.0**	**A-6b**	**87**	**4.5**	**26**	**39**	**20**	**19**		
⊠	**B-007-0-23**	**2.5**	**A-6a**			**17**	**33**	**19**	**14**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-007-0-23**	**0.02**	**0.01**			**0.0**	**9.4**	**5.2**	**10.3**	**33.9**	**41.2**
⊠	**B-007-0-23**	**0.01**	**0.01**			**0.0**	**5.1**	**5.6**	**11.2**	**32.0**	**46.1**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.



COBBLES	GRAVEL		SAND		SILT OR CLAY
	coarse	fine	coarse	fine	

	Specimen ID	Depth	Classification	SC(ppm)	LOI%	MC%	LL	PL	PI	Cz	Cu
●	**B-008-0-23**	**1.4**	**A-6a**	**100**		**16**	**29**	**18**	**11**		
⊠	**B-008-0-23**	**2.9**	**A-7-6**			**23**	**49**	**18**	**31**		

	Specimen ID	D60	D50	D30	D10	%Gravel coarse	%Gravel fine	%Sand coarse	%Sand fine	%Silt	%Clay
●	**B-008-0-23**	**0.11**	**0.04**	**0.005**		**0.0**	**14.8**	**14.6**	**13.8**	**28.0**	**28.8**
⊠	**B-008-0-23**	**0.01**	**0.01**			**0.0**	**9.6**	**2.3**	**7.7**	**31.4**	**49.0**

PROJECT **LOR-18-1.60 INTERSECTION IMPROVEMENTS** PROJECT NO. **W-23-179**

GRADATION CURVES

Resource International, Inc.

APPENDIX V

Pavement Core Data Sheet

6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT: LOR-18-1.60 Intersection Improvements
LOCATION: Lorain County, Ohio
JOB No.: W-23-179

BORING/CORE No.: B-001-0-23
DATE CORE OBTAINED: 12/19/2023
CORE OBTAINED BY: IS, BG & JK

Core Composition

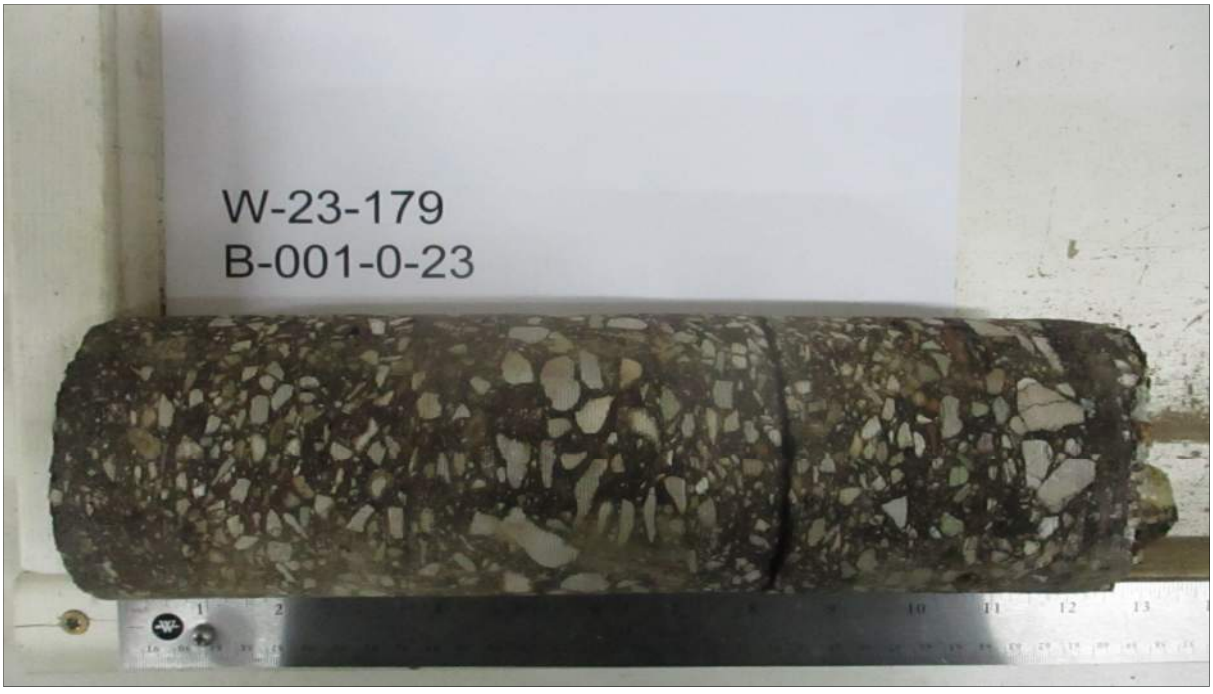
Core Number	Layer Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other	Other	Other
B-001-0-23	1.25	7	✓							
	2.50	6	✓							
	1.00	5	✓							
	1.75	4		✓						
	1.25	3	✓							
	2.25	2	✓							
	2.75	1		✓						
	7.00						✓			

Comments/Remarks

- The core separated between layers 2 & 3, but the core is in fair condition.

- Aggregate Base:
  Slag with bitumen on the surface

Total Pavement Thickness =	12.75 in.	Total Asphalt Thickness =	12.75 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	7.00 in.



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	LOR-18-1.60 Intersection Improvements
LOCATION	Lorain County, Ohio
JOB No.	W-23-179
BORING/CORE No.	B-004-0-23
DATE CORE OBTAINED	12/19/2023
CORE OBTAINED BY	IS, BG & JK

Core Composition

Core Number	Layer Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
B-004-0-23	1.50	7	✓							
	2.25	6	✓							
	1.00	5	✓							
	1.50	4		✓						
	1.00	3	✓							
	2.00	2	✓							
	3.75	1		✓						
	6.00						✓			

Comments/Remarks

- The core separated between layers 2 & 3, but the core is in fair condition.

- Aggregate Base:
  Slag with bitumen on the surface

Total Pavement Thickness =	13.00	in.	Total Asphalt Thickness =	13.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	6.00	in.

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Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	LOR-18-1.60 Intersection Improvements
LOCATION	Lorain County, Ohio
JOB No.	W-23-179
BORING/CORE No.	B-005-0-23
DATE CORE OBTAINED	12/19/2023
CORE OBTAINED BY	IS, BG & JK

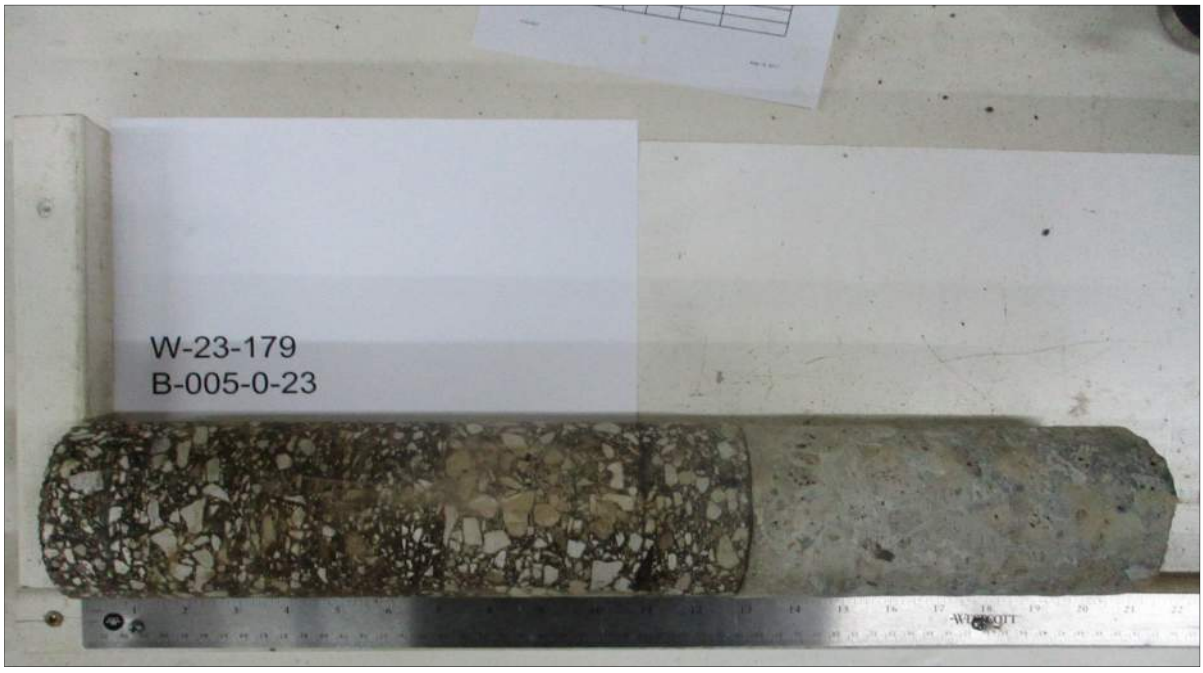
Core Composition

Core Number	Layer Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
B-005-0-23	1.25	6	✓							
	2.00	5	✓							
	3.75	4	✓							
	3.50	3		✓						
	2.00	2	✓							
	8.00	1				✓				

Comments/Remarks

- The core separated between layers 1 & 2, but the core is in fair condition.

Total Pavement Thickness =	20.50	in.	Total Asphalt Thickness =	12.50	in.	Total Concrete Thickness =	8.00	in.	Total Base Thickness =	0.00	in.



6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	LOR-18-1.60 Intersection Improvements
LOCATION	Lorain County, Ohio
JOB No.	W-23-179
BORING/CORE No.	B-008-0-23
DATE CORE OBTAINED	12/19/2023
CORE OBTAINED BY	IS, BG & JK

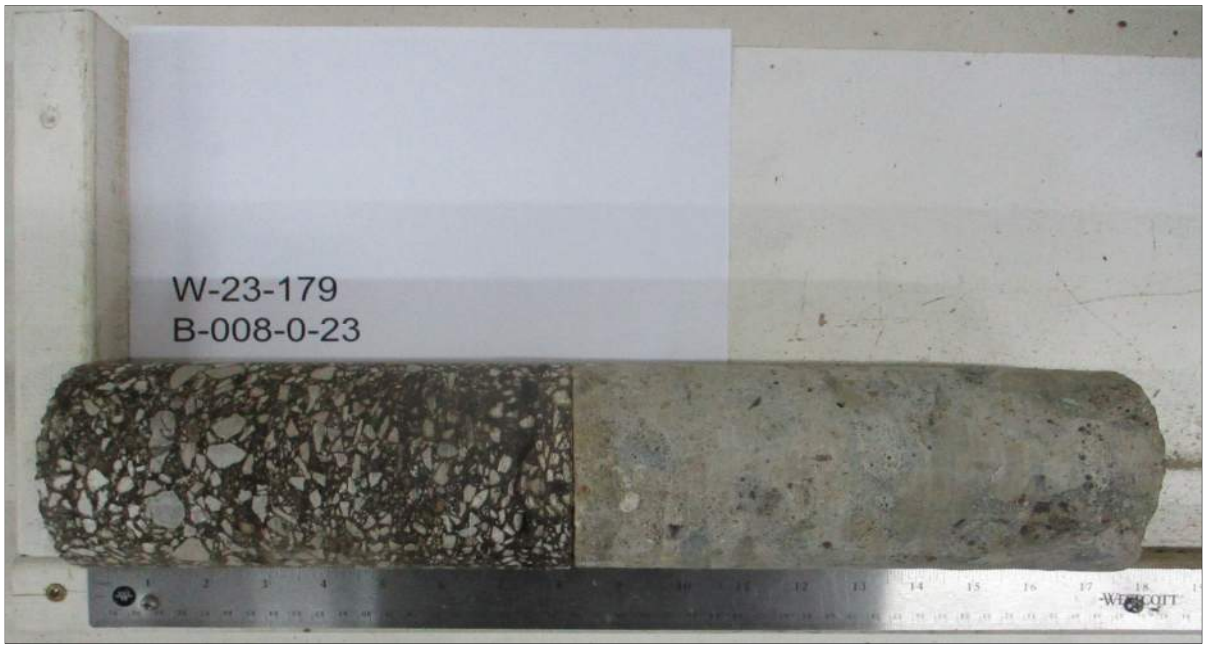
Core Composition

Core Number	Layer Thickness (in.)	Pavement Layer Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other	Other	Other
B-008-0-23	1.50	5	✓							
	1.50	4		✓						
	2.25	3	✓							
	2.75	2	✓							
	9.25	1				✓				
	4.75						✓			

Comments/Remarks

- The core separated between layers 1 & 2.
- Layer 2 has a horizontal crack @ 7.25".
- Aggregate Base:
  Sand with gravel (visual)

Total Pavement Thickness =	17.25	in.	Total Asphalt Thickness =	8.00	in.	Total Concrete Thickness =	9.25	in.	Total Base Thickness =	4.75	in.



Appendix VI

ODOT Subgrade Analysis

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

LOR-18-1.60
116214

LOR-18-1.60 Intersection Improvements

Resource International, Inc.

Prepared By: Johnnatan Garcia-Ruiz, Ph.D.
Date prepared: Thursday, January 18, 2024

Resource International, Inc.
Jon Sterenberg, P.E.
6350 Presidential Gateway
Columbus, Ohio 43231
614-823-4949
jonathans@resourceinternational.com

NO. OF BORINGS: 8

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	CL R/W 511	383+27	1	RT	Mobile B53	79.0	902.3	900.6	1.7 C
2	B-002-0-23	CL R/W 511	385+55	11	RT	Mobile B53	79.0	905.4	903.7	1.7 C
3	B-003-0-23	CL R/W 511	388+13	16	LT	Mobile B53	79.0	905.1	903.4	1.7 C
4	B-004-0-23	CL R/W 511	391+88	4	LT	Mobile B53	79.0	906.3	904.6	1.7 C
5	B-005-0-23	CL R/W 18	80+12	7	LT	Mobile B53	79.0	906.6	904.9	1.7 C
6	B-006-0-23	CL R/W 18	82+19	27	RT	Mobile B53	79.0	905.9	904.9	1.0 C
7	B-007-0-23	CL R/W 18	86+05	20	RT	Mobile B53	79.0	904.4	902.9	1.5 C
8	B-008-0-23	CL R/W 18	88+68	9	LT	Mobile B53	79.0	903.6	901.9	1.7 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.5	3.0	-0.2	1.3	4			NP	NP	NP				18	6	A-1-b	0	200					
	001-0	SS-2	3.0	4.5	1.3	2.8	24		4.5	34	18	16	30	46	76	17	16	A-6b	10						
	23	SS-3	4.5	6.0	2.8	4.3	26		4.5							18	16	A-6b	16						
		SS-4	6.0	7.5	4.3	5.8	32	4	4.5							17	16	A-6b	16						
2	B	SS-1	1.5	3.0	-0.2	1.3	9		3.25	32	16	16	35	38	73	19	16	A-6b	10	320		N_{60} & Mc		12"	206 Lime or 204 Geotextile
	002-0	SS-2	3.0	4.5	1.3	2.8	24		4.5	34	18	16	31	46	77	17	16	A-6b	10						
	23	SS-3	4.5	6.0	2.8	4.3	32		4.5							16	16	A-6b	16						
		SS-4	6.0	7.5	4.3	5.8	32	9	4.5							16	16	A-6b	16						
3	B	SS-1	1.5	3.0	-0.2	1.3	9		2.75	34	18	16	42	41	83	25	16	A-6b	10	180		N_{60} & Mc		12"	206 Lime or 204 Geotextile
	003-0	SS-2	3.0	4.5	1.3	2.8	13		3.5	44	20	24	26	47	73	23	18	A-7-6	14			N_{60} & Mc			
	23	SS-3	4.5	6.0	2.8	4.3	28		4.5							18	18	A-7-6	16						
		SS-4	6.0	7.5	4.3	5.8	32	9	4.5							16	18	A-7-6	16						
4	B	SS-1	1.5	2.2	-0.2	0.5	17									15	6	A-1-b	0						
	004-0	SS-1A	2.2	3.0	0.5	1.3	17		4.5	43	17	26	18	33	51	21	18	A-7-6	9	190		Mc			
	23	SS-2	3.0	4.5	1.3	2.8	28		4.5	37	18	19	29	47	76	17	16	A-6b	12						
		SS-3	4.5	6.0	2.8	4.3	36	17	4.5							16	16	A-6b	16						
5	B	SS-1	2.0	3.5	0.3	1.8	13		4.25	43	17	26	30	42	72	22	18	A-7-6	14	360		N_{60} & Mc		12"	206 Lime or 204 Geotextile
	005-0	SS-2	3.5	5.0	1.8	3.3	24		4.5	37	18	19	30	45	75	17	16	A-6b	12						
	23	SS-3	5.0	6.5	3.3	4.8	32		4.5							16	16	A-6b	16						
		SS-4	6.5	8.0	4.8	6.3	28	13	4.5							17	16	A-6b	16						
6	B	SS-1	1.0	2.5	0.0	1.5	8		3	42	19	23	32	42	74	25	18	A-7-6	13	160		N_{60} & Mc		12"	206 Lime or 204 Geotextile
	006-0	SS-2	2.5	4.0	1.5	3.0	11		2.5	46	18	28	24	40	64	22	18	A-7-6	14			N_{60} & Mc			
	23	SS-3	4.0	5.5	3.0	4.5	20		4.5							16	18	A-7-6	16						
		SS-4	5.5	7.0	4.5	6.0	22	8	4.5							16	18	A-7-6	16						
7	B	SS-1	1.0	2.5	-0.5	1.0	12		4.5	39	20	19	34	41	75	26	16	A-6b	12	100		N_{60} & Mc		12"	206 Lime or 204 Geotextile
	007-0	SS-2	2.5	4.0	1.0	2.5	21		3	33	19	14	32	46	78	17	14	A-6a	10			Mc			
	23	SS-3	4.0	5.5	2.5	4.0	21		4.5							20	14	A-6a	10						
		SS-4	5.5	7.0	4.0	5.5	9	9	0.75							23	16	A-6b	16						
8	B	SS-1	1.4	2.9	-0.3	1.2	17		3.5	29	18	11	28	29	57	16	14	A-6a	5	100					
	008-0	SS-2	2.9	4.4	1.2	2.7	13		3	49	18	31	31	49	80	23	18	A-7-6	18			N_{60} & Mc			
	23	SS-3	4.4	5.9	2.7	4.2	16		4.5							21	18	A-7-6	16						
		SS-4	5.9	7.4	4.2	5.7	25	13	4.5							14	18	A-7-6	16						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

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PID: 116214

County-Route-Section: LOR-18-1.60
No. of Borings: 8

Geotechnical Consultant: Resource International, Inc.
Prepared By: Johnnatan Garcia-Ruiz, Ph.D.
Date prepared: 1/18/2024

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

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

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	3%	HP ≤ 0.5	0%
$N_{60} < 12$	19%	0.5 < HP ≤ 1	3%
$12 \leq N_{60} < 15$	13%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	56%	HP > 2	91%
M+	31%		
Rock	0%		
Unsuitable	0%		

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

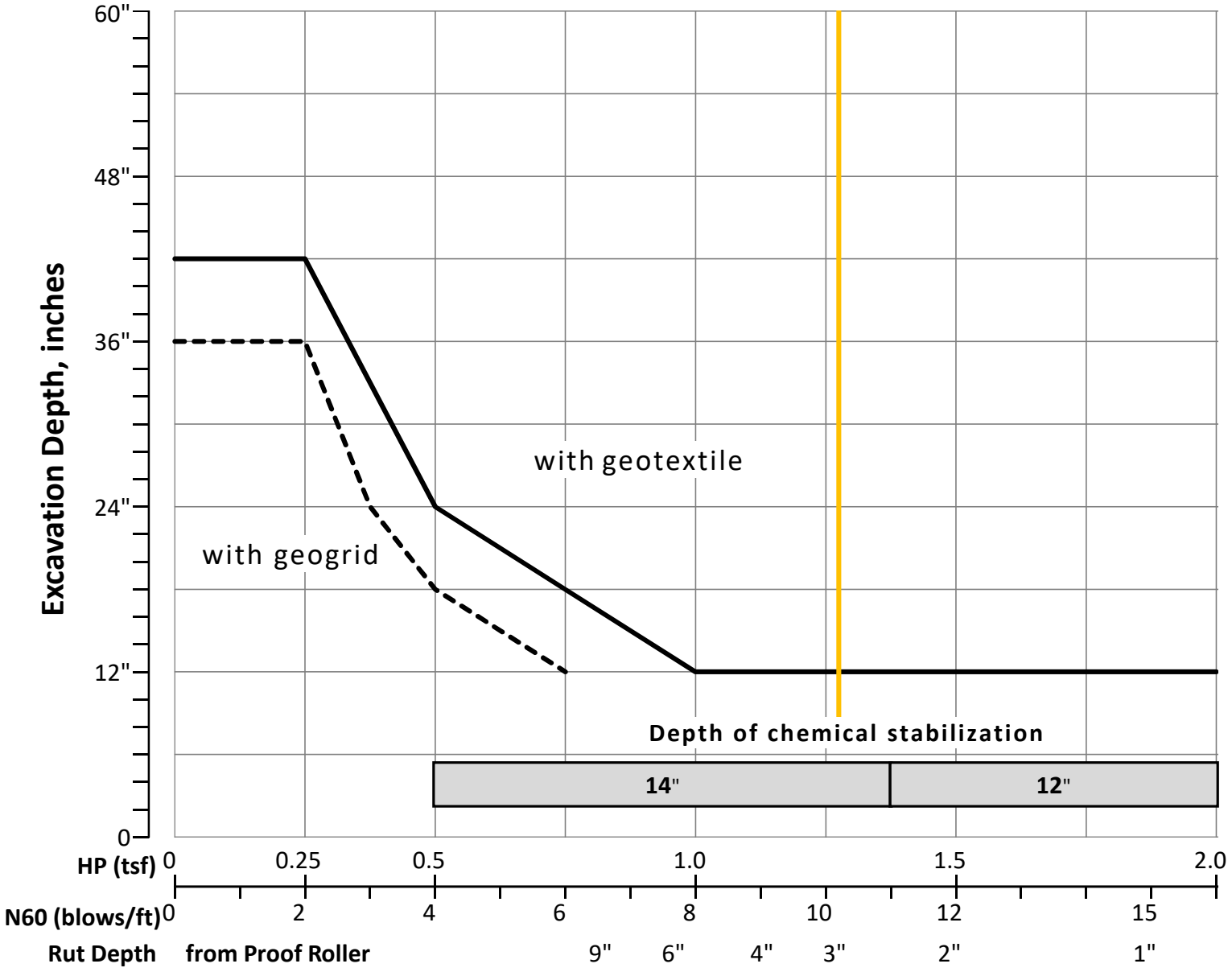
% Proposed Subgrade Surface	
Unstable & Unsuitable	53%
Unstable	53%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	20	10	3.98	38	18	20	30	42	72	19	16	13
Maximum	36	17	4.50	49	20	31	42	49	83	26	18	18
Minimum	4	4	0.75	29	16	11	18	29	51	14	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	0	2	0	0	0	0	0	0	0	0	0	3	15	0	12	0	0	32
Percent	0%	0%	6%	0%	0%	0%	0%	0%	0%	0%	0%	0%	9%	47%	0%	38%	0%	0%	100%
% Rock|Granular|Cohesive	0%	6%									94%								100%
Surface Class Count	0	0	2	0	0	0	0	0	0	0	0	0	3	7	0	7	0	0	19
Surface Class Percent	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%	16%	37%	0%	37%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.98		☐ HP
10.25		☐ N60L

Average HP
Average N_{60L}