BRIDGE FOUNDATION INVESTIGATION
ATLANTA BELTLINE SOUTHWEST CORRIDOR
Atlanta BeltLine over Martin Luther King Jr. Drive
Fulton County, Georgia

Prepared for:
Perkins + Will
1315 Peachtree St. NE
Atlanta, Georgia 30309

Prepared by:
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Atlanta, Georgia 30324
(404) 873-4761

April 7, 2014

Project No. 6151-13-0211
BRIDGE FOUNDATION INVESTIGATION (LRFD)

PROJECT NUMBER  CSSTP-0009-00(396), Fulton County
P.I. NUMBER  0009396
LOCATION (See Map)  Atlanta BeltLine over Martin Luther King Jr. Drive

GENERAL INFORMATION

GEOLOGIC FORMATION  This project is located in the Stonewall Formation of the Georgia Piedmont Physiographic Province. Bedrock in this formation is described as “intercalated fine-grained biotite gneiss, hornblende-plagioclase amphibolite, and sillimanite-biotite schist”.

SUBSURFACE FEATURES  Hard rock and very dense soil were encountered from elevations 926 to 946 feet. Shallower elevations of hard layers are likely lenses and boulders than top of bedrock. Groundwater was not encountered at the boring locations; however our experience in the Atlanta area indicates that groundwater usually follows the top of partially weathered rock or other hard layers such as bedrock.

SITE CLASSIFICATION  We recommend a site class of C per AASHTO LRFD 3.10.3.1.

1.0 -- FOUNDATION RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Bents</th>
<th>Pile Footing (Type)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment 1</td>
<td>H</td>
</tr>
<tr>
<td>Abutment 2</td>
<td>H</td>
</tr>
</tbody>
</table>

1.1 -- Pile Properties

<table>
<thead>
<tr>
<th>Pile Type</th>
<th>Nominal Compression Stress (ksi)</th>
<th>Nominal Tension Stress (ksi)</th>
<th>Factored Structural Resistance (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP 50 ksi</td>
<td>45</td>
<td>45</td>
<td>600</td>
</tr>
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</table>
1.2 -- DESIGN LOADS

<table>
<thead>
<tr>
<th>Bents</th>
<th>Maximum Factored Foundation Load (kips)</th>
<th>Service Load (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment 1</td>
<td>372.8</td>
<td>269.3</td>
</tr>
<tr>
<td>Abutment 2</td>
<td>372.8</td>
<td>269.3</td>
</tr>
</tbody>
</table>

2.1 -- PILE FOUNDATION LOADS

<table>
<thead>
<tr>
<th>Bents</th>
<th>Pile Type</th>
<th>Size (in)</th>
<th>Resistance Factor</th>
<th>Driving Resistance (kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment 1</td>
<td>H</td>
<td>14 X 89</td>
<td>0.65</td>
<td>575</td>
</tr>
<tr>
<td>Abutment 2</td>
<td>H</td>
<td>14 X 89</td>
<td>0.65</td>
<td>575</td>
</tr>
</tbody>
</table>

3.0 -- FOUNDATION ELEVATIONS

<table>
<thead>
<tr>
<th>Bents</th>
<th>Pile Size (in)</th>
<th>Minimum Tip</th>
<th>Estimated Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment 1</td>
<td>14 X 89</td>
<td>927 feet</td>
<td>927 feet</td>
</tr>
<tr>
<td>Abutment 2</td>
<td>14 X 89</td>
<td>921 feet</td>
<td>919 feet</td>
</tr>
</tbody>
</table>

4.0 -- GENERAL NOTES

**Elevations**
All elevations are based on the existing condition topographic data presented in the construction plans for this project.

**Waiting Period**
None required.

**As Built Foundation Information**
The as built foundation information should be forwarded to the Geotechnical Engineering Bureau upon completion of the foundation system.

**Special Problems**
Several residential properties are within the vicinity of this project. Vibration from pile driving may be destructive. Furthermore, based on the bottom of pile cap, the pile at the north abutment will be about 12 feet long. Boulders are also anticipated at about elevation 940, above bedrock, at abutment 2. For these reason we recommend that pilot holes be used to reach competent rock at both abutments 1 and 2.
4.1 -- PILE FOUNDATION NOTES

PDO Driving resistance after minimum tip elevations are achieved in conjunction with Special Provision 520 Piling for LRFD and Special Provision 523 Dynamic Pile Testing. PDA tests should be performed at Abutments 1 and 2.

DRIVING RESISTANCE Driving resistance is based on the following field verification method and resistance factor:

<table>
<thead>
<tr>
<th>Verification Method</th>
<th>Resistance Factor</th>
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</thead>
<tbody>
<tr>
<td>PDA</td>
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</tbody>
</table>

Drivability The piles are rock socketed, so drivability analyses were not performed.

Pilot Holes (for H-piles) Pilot Holes should be set up for H-piles to socket piles into hard rock. Use a maximum pilot hole diameter of 24”. The holes should be filled with concrete to the top of the rock after the piles are driven. Pilot holes should be set up to the following elevations: 927 feet, or 5 feet into rock at the north abutment and 919 feet, or 1 foot into rock at the south abutment.

Static Load Test In lieu of PDA testing, a test pile at each abutment may be established and axially loaded. Unless failure occurs first, each test pile should be loaded to the maximum loads noted below:

<table>
<thead>
<tr>
<th>Bents</th>
<th>Pile Type</th>
<th>Size (in)</th>
<th>φ</th>
<th>Maximum Load (kips)</th>
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<tr>
<td>Abutment 1</td>
<td>H</td>
<td>14 X 89</td>
<td>0.75</td>
<td>500</td>
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<tr>
<td>Abutment 2</td>
<td>H</td>
<td>14 X 89</td>
<td>0.75</td>
<td>500</td>
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</table>

Temporary Shoring Shoring may be required to construct the pile footings at abutments 1 and 2 if the excavations cannot be safely sloped back.

Retaining Wall Foundation The following soil design parameters are recommended for use for the proposed cantilever wing walls:

- Cohesion, c = 0 psf
- Soil Unit Weight, γ = 120 pcf
- Angle of Internal Friction, φ = 32°
- Coefficient of Sliding Friction, μ = 0.35

The maximum allowable soil bearing pressure is 2,000 lb/ft². The geotechnical engineer should observe the bearing surface and existing fill.
Very loose or otherwise unsuitable soil should be undercut and replaced with compacted fill.

5.0 – QA / QC

The information, conclusions and/or recommendations contained in this report are for information purposes only. The complete report, in its entirety, must be reviewed and understood if such data are to be used for design, estimating or construction purposes. The Geotechnical Consultant assumes no liability for any party’s usage of this summary beyond that which it was intended.

Prepared By: AMEC Environment & Infrastructure, Inc.

Daimia T. Gunning, P.E.
Senior Engineer

Reviewed By:

Roy E. Moore, P.E.
Associate
Delete Sub-Section 520.3.05.B and substitute the following:

520.3.05.B. Drill Pilot Holes
When pilot holes are required, drill them to the diameter and approximate depth specified on the Plans.

Backfill voids and holes with Class A or better concrete. Furnishing and placing backfill concrete is an incidental part of the work.

The following are not considered pilot holes:
- Holes created by spudding (punching)
- Holes dug to drive piling that is too long to fit leads
- Holes dug to replace a template (if permitted)

Where pilot holes are required in granular material and the material cannot be sealed off using “mudding” drilling methods, drill the pilot hole as follows:

1. Place a casing pipe with a large enough diameter around the boring device.
2. Hold the casing in position until the pilot hole is completed and the pile driving progresses deep enough into the hard material to keep loose material out of the pilot hole.

The use of casing is incidental to the work.

Office of Materials and Research
DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

PROJECT NO. CSSTP-0009-00(396), Fulton County
P.I. No. 0009396

SECTION 520—PILING

Delete Sub-Section 520.3.05.D.1 and substitute the following:

520.3.05.D.1. Determine Driving Resistance
Drive piles in one continuous operation. Determine the driving resistance of the piling based on the method specified in the plans, which will be one of the following methods (a – c):

a. Upon completion of the dynamic pile testing in accordance with Special Provision Section 523. The pile bearing will be determined by computing the penetration per blow with less than ¼-inch (6-mm) rebound averaged through 12 inches (305 mm) each of penetration. When it is considered necessary by the Engineer, the average penetration per blow may be determined by averaging the penetration per blow through the last 10 to 20 blows of the hammer. In soft material the driving resistance may be determined, at the Engineer’s discretion, after delaying driving operations and performing pile re-strikes.

b. Upon completion of the loading test in accordance with Sub-Section 520.3.05.D.2.

c. Using FHWA-modified Gates Formula as provided below:

\[ R_{ndr} = 1.75 \left( E_d \right)^{0.5} \log_{10} \left( 10N_b \right) - 100 \]  
\[ R_{ndr} = 7 \left( E_d \right)^{0.5} \log_{10} \left( 10N_b \right) - 550 \]

Where:

\[ R_{ndr} \]  = nominal pile driving resistance measured during pile driving
\[ E_d = \]  developed hammer energy. This is the kinetic energy in the ram at impact for a given blow. If ram velocity is not measured, it may be assumed equal to the potential energy of the ram at the height of the stroke, taken as the ram weight times the actual stroke (ft-lb for U.S units, kN-m for S.I. units)
\[ N_h = \text{Number of hammer blows for 1.0 inch of pile permanent set (blows/in)} \]

These resistance formulas apply only when:

- The hammer has a free fall.
- The head of the pile is not broomed, crushed, spalled, or excessively crimped.
- The penetration rate is reasonably uniform.

Determining driving resistance by formula is not a Pay Item. Provide the facilities for determining driving resistance by formula as an incidental part of the work.

Once the driving resistance has been determined by one of the methods noted above, do not continue to drive piles if the Engineer determines that the piles have reached practical refusal. Practical refusal is defined as 20 blows per inch with the hammer operating at the highest setting or setting determined by the Engineer and less than ¼-inch (6-mm) rebound per blow. The Engineer will generally make this determination within 2 inches (51 mm) of driving. However, the Engineer will not approve the continuation of driving at practical refusal for more than 12 inches (305 mm). When the required pile penetration cannot be achieved by driving without exceeding practical refusal, use other penetration aids such as jetting, spudding, predrilling or other methods approved by the Engineer.

d. **Wave Equation:** Use the Wave Equation Analysis for Piles (WEAP) program to evaluate the suitability of the proposed driving system chosen from the methods noted above (including the hammer, follower, capblock and pile cushions) as well as to estimate the driving resistance to achieve the pile bearing requirements and to evaluate pile driving stresses. Use the WEAP program to show that the hammer is capable of driving to a resistance equal to at least twice the factored design load plus the scour and down drag resistance (if applicable) shown in the Plans without overstressing the piling in compression or tension.

Perform the WEAP analysis with personnel who are experienced in this type work, and have performed this analysis on a minimum of 15 projects. Provide a list of the qualifications and experience of the personnel to perform the WEAP analysis for this Project.

The Engineer may modify the scour resistance shown in the plans if the dynamic pile test is used to determine the actual soil resistance through the scour zone. Also, the Engineer may make modifications in scour resistance when the Contractor proposes drilling and/or jetting to reduce the soil resistance in the scour zone.

A minimum of two weeks prior to beginning any pile driving operations, submit to the Engineer for evaluation and approval the following information on all of the proposed pile driving system(s) to be used on the Project including but not limited to:

i. Pile driving hammer
ii. Hammer and pile cushion types, properties and thicknesses
iii. Drive head weight
iv. Pile type, properties and length
v. Other information on the driving system required by the Engineer
vi. A WEAP program output indicating the approximate depth or elevation where the pile will achieve the bearing required

If WEAP analyses show that the hammer(s) will overstress the pile, modify the driving system or method of operation as required to prevent overstressing the pile. Resubmit the modified pile driving system information and WEAP program output to the Engineer for re-evaluation. Do not begin pile driving operations until the Engineer has approved the qualifications of the personnel, the WEAP program output, and the pile driving system(s).

Approval of the pile driving system(s) is also based on satisfactory field trials with dynamic pile testing. Obtain approval from the Engineer for the pile driving system(s) based on satisfactory field performance.

If piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided that the hammer is properly sized and cushioned, will not damage the pile, and will develop the required resistance.

For penetration of weak soils by concrete piles, use thick cushions and/or reduced stroke to control tension stresses during driving.

Office of Materials and Testing
SPECIAL PROVISION
PROJECT No. CSSTP-0009-00(396), Fulton County
P.I. No. 0009396

SECTION 523 - DYNAMIC PILE TESTING

523.1 General Description

The work consists of performing dynamic pile testing using the Pile Driving Analyzer (PDA) to monitor the driving of piles with accelerometer and strain gauges attached to the piles. Piles to be dynamically tested will be identified in the Special Provision or on the Plans. Prior to pile driving, the Engineer will determine production or test piles to be dynamically tested. Perform the dynamic pile testing in accordance with ASTM D4945-08.

Take dynamic measurements during driving of any required piles. Drive the pile as shown in the Special Provisions or on the Plans.

523.2 Materials

Furnish measuring instruments for dynamic pile testing. Attach instruments near the top of the piles with bolts placed in drilled holes. Furnish materials, labor and equipment necessary for installation of the instruments.

523.3 Construction Requirements

Measure wave speed prior to driving piles. Wave speed measurements will not be required for Steel H piles or metal shell piles. When wave speed measurements are performed, place the piles in a horizontal position not in contact with other piles.

Perform dynamic pile testing during driving. Modify the driving to reduce the stress and/or eliminate the damage, should the recommended stress level be exceeded or if damage occurs (determined visually or as indicated by the instrumentation).

Do not exceed the following maximum driving stresses, as determined by the dynamic pile testing:

1. For Steel piles:
0.9 $F_y$, where $F_y = \text{Yield strength of steel}$

2. For Prestressed Concrete Piles:

   **Compression:**
   
   $$\sigma_{dr} = (0.85f'_c - f_{pe})$$

   **Tension in Normal Environments:**
   
   $$\sigma_{dr} = (0.095\sqrt{f'_c} + f_{pe})$$

   **Tension in Severe Corrosive Environments:**
   
   $$\sigma_{dr} = \varphi_{daf_{pe}}$$

where:

- $\sigma_{dr} =$ maximum allowed driving stress, ksi
- $f'_c =$ specified minimum 28-day compressive strength of concrete, ksi
- $f_{pe} =$ effective prestress in concrete, ksi, (after all losses) at the time of driving taken as 0.78 times the initial prestress force

Re-drive friction piles that do not obtain bearing after a freeze period of a minimum of 24 hours or for a period designated on the Plans, whichever is longer. Reset the gauges if required. Re-strike the pile with a warm hammer until a maximum penetration of 3 inches (76 mm) or 40 blows is reached, whichever occurs first. The Engineer may modify the Pile Driving Objective based on the results of the PDA work.

Provide two weeks’ notice prior to the driving of designated piles and cooperate with the Engineer in connection with the performance of Dynamic Pile Testing.

Provide a complete report consisting of but not limited to PDA field monitoring data, results of CAPWAP computer analyses, and recommendations such as pile lengths and driving criteria. Submit the report electronically in PDF format and the electronic data files of the PDA analysis and CAPWAP to the Geotechnical Bureau and allow seven (7) calendar days for review and approval before proceeding with driving production piles.

**523.4 Measurement**

The Dynamic Pile Tests performed in accordance with these Specifications will be counted separately for payment. (Refer to plans summary sheet for the required amount of PDA testing.)

**523.5 Payment**

The Dynamic Pile Test completed and accepted will be paid for at the Contract unit Price. This payment will be full compensation for all costs of complying with this specification, including
incidentals, additional work, and any delays incurred in conjunction therewith.

Payment will be made under:

Item No. 523. Dynamic Pile Test_________________ ................................. Per Each

Office of Materials and Testing
<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>N-COUNT</th>
<th>SAMPLES</th>
</tr>
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<tbody>
<tr>
<td>966</td>
<td></td>
<td><strong>SPT-1</strong></td>
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<tr>
<td>961</td>
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<td>3-3-3 (N = 6)</td>
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<tr>
<td>956</td>
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<td><strong>SPT-2</strong></td>
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<tr>
<td>951</td>
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<td>2-3-3 (N = 6)</td>
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<td>5-5-6 (N = 11)</td>
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<td>886</td>
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<td><strong>RC-1</strong></td>
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<tr>
<td>881</td>
<td></td>
<td>19 73</td>
</tr>
</tbody>
</table>

**SOIL CLASSIFICATION AND REMARKS**

- **FILL**: Loose light brown and white micaceous silty fine sand (N = 6)
- **RESIDUUM**: Loose to medium dense light brown, white and brown micaceous silty fine sand (N = 6)
- **BEDROCK**: Very soft to moderately hard black and white biotite gneiss (N = 6)

**SOIL TEST BORING RECORD**

- **BORING NO.**: MLK-N2
- **PROJECT**: Atlanta BeltLine Southwest Corridor
- **LOCATION**: Atlanta, Georgia
- **DRILLED**: September 27, 2013
- **PROJECT NO.**: 6151-13-0211.02.04

**SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.**

**EQUIPMENT**: CME-550x (Auto-Hammer)
**METHOD**: 3 1/4" HSA
**HOLE DIA.**: 8 inches
**REMARKS**: No groundwater encountered at time of boring

**PREPARED BY**: DKR **CHECKED BY**: DTG

**NOTE**: This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Interfaces between strata are approximate. Transitions between strata may be gradual.
**SOIL CLASSIFICATION AND REMARKS**

See key sheet for explanation of symbols and abbreviations used below.

- Very soft to soft light brown, white and light gray biotite gneiss
- Rock Coring Terminated at 46.5 feet

**SOIL TEST BORING RECORD**

- **BORING NO.:** MLK-N2
- **PROJECT:** Atlanta BeltLine Southwest Corridor
- **LOCATION:** Atlanta, Georgia
- **DRILLED:** September 27, 2013
- **PROJECT NO.:** 6151-13-0211.02.04

**PREPARED BY:** DKR  
**CHECKED BY:** DTG

**This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Interfaces between strata are approximate. Transitions between strata may be gradual.**
FILL - Loose red-brown micaceous silty fine SAND

Loose to medium dense red-brown slightly micaceous clayey fine SAND

Loose light brown micaceous silty fine SAND

RESIDUUM - Loose light yellow, light brown, brown and white slightly micaceous silty fine SAND

PARTIALLY WEATHERED ROCK - Sampled as very dense light brown and brown micaceous silty fine SAND with rock fragments

Augur Refusal at 27 feet

Quartz sampled as hard light gray gravel

Rock Coring Terminated at 29 feet due to a broken bit. Hole could not be advanced past bit.

DRILLER: Premier Drilling, LLC.
EQUIPMENT: CME-550x (Auto-Hammer)
METHOD: 3 1/4” HSA
HOLE DIA.: 8 inches
REMARKS: No groundwater encountered at time of boring. Offset boring performed. See boring MLK-S1C.
PREPARED BY: DKR CHECKED BY: DTG

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
Sampling started at 28.5 feet

**RESIDUUM** - Loose light brown and white micaceous silty fine SAND

**PARTIALLY WEATHERED ROCK** - Sampled as very dense brown, white and light brown micaceous silty fine SAND with rock fragments

**RESIDUUM** - Dense brown, white and light brown micaceous silty fine SAND

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**BORING NO.:** MLK-S1c  
**PROJECT:** Atlanta BeltLine Southwest Corridor  
**LOCATION:** Atlanta, Georgia  
**DRILLED:** October 2, 2013  
**PROJECT NO.:** 6151-13-0211.02.04  
**PREPARED BY:** DKR  
**CHECKED BY:** DTG
### Soil Classification and Remarks

**Residuum** - Dense brown, white and light brown micaceous silty fine sand

Auger refusal at 48 feet

**Bedrock** - Soft to moderately hard black and white biotite gneiss with soil seams throughout

Rocks coring terminated at 63 feet

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### Soil Test Boring Record

**Boring No.:** MLK-S1c  
**Project:** Atlanta BeltLine Southwest Corridor  
**Location:** Atlanta, Georgia  
**Drilled:** October 2, 2013  
**Project No.:** 6151-13-0211.02.04

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**Driller:** Premier Drilling, LLC  
**Equipment:** CME-550x (Auto-Hammer)  
**Method:** 3 1/2" HSA  
**Hole Dia.:** 8 inches  
**Remarks:** No groundwater encountered at time of boring. This is the offset boring for MLK-S1b.

**Prepared By:** DKR  
**Checked By:** DTG

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**This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Interfaces between strata are approximate. Transitions between strata may be gradual.**
SOIL CLASSIFICATION AND REMARKS

FILL - Loose red, light brown and white micaceous silty fine SAND

No Recovery

Loose light brown and red micaceous silty fine SAND

RESIDUUM - Loose red micaceous clayey fine SAND

Loose white, red-brown, light brown and gray slightly micaceous silty fine SAND

Medium dense white, light brown and gray-brown micaceous silty fine SAND

PARTIALLY WEATHERED ROCK: Sampled as very dense light brown and white silty fine SAND with rock fragments

PREPARED BY: DKR  CHECKED BY: DTG

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING NO.: MLK-S2
PROJECT: Atlanta BeltLine Southwest Corridor
LOCATION: Atlanta, Georgia
DRILLED: October 1, 2013
PROJECT NO.: 6151-13-0211.02.04
Auger refusal at 46 feet

Bedrock - Soft to moderately hard black and white biotite gneiss with soil seams throughout

Rock coring terminated at 61.4 feet

Soil Test Boring Record

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<thead>
<tr>
<th>Depth (ft)</th>
<th>Soil Classification</th>
<th>Remarks</th>
</tr>
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Soil Test Boring Report

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<td>28/80</td>
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</table>

Soil Classification and Remarks

See key sheet for explanation of symbols and abbreviations used below.

SPT (bpf)

NM (%)

FINES (%)

PL (%)

% REC

RQD

SYMBOLS AND ABBREVIATIONS USED BELOW.

This record is a reasonable interpretation of subsurface conditions at the exploration location. Subsurface conditions at other locations and at other times may differ. Interfaces between strata are approximate. Transitions between strata may be gradual.

Boring No.: MLK-S2
Project: Atlanta BeltLine Southwest Corridor
Location: Atlanta, Georgia
Drilled: October 1, 2013
Project No.: 6151-13-0211.02.04