<table>
<thead>
<tr>
<th>Revised Soil Survey Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 24, 2015</td>
</tr>
<tr>
<td>Matthew G. Moore, P.E.</td>
</tr>
</tbody>
</table>

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**Project Description**

From: 0.219 Mi. South of Rte. 718  
To: 0.107 Mi. North of Rte. 718  
Project UPC No.: 104805
November 24, 2015

Project: HSIP-023-707, P101, M-501
UPC #: 104805
From: 0.219 Mi. South of Rte. 718
To: 0.107 Mi. North of Rte. 718
Length: 0.326 mi.

To: Culpeper District Location & Design

Subject: Revised Soil Survey Report, Route 29 & 718 Intersection, Culpeper County

This revised soil survey report is based on a total of eight (8) soil borings performed on May 13, 2015. The borings were extended to depths ranging between 5.0 feet and 10.0 feet below existing ground surface elevations. The existing pavement was investigated at four of the borings locations. The purpose of the project is to improve the Route 29 and Route 718 intersection for safety. According to Integrated Project Management (IPM) system information, the project is currently scheduled for construction to begin in year 2016.

**Soil Description & Groundwater**

Strata consisting of Clay (CL), Silt (ML), silty Sand (SM) and/or fat Clay (CH), with mica content, were encountered at the boring locations. Soil descriptions are provided as an attachment. Groundwater was not encountered within the borings. The borings were backfilled upon completion and long-term groundwater reading was not performed. Auger refusal, possibly indicating the top of rock, was not encountered.
Existing Pavement Structure

Existing pavement was investigated at four of the boring locations. At two of the boring locations (BH-3 & BH-5), the pavement structure was first cored, before augering through, in order to retain samples and observe the condition of material layers. The pavement structure material thicknesses, asphalt concrete (AC) and base/sub-base aggregate, are provided in the table below. The stations and offsets are approximate.

<table>
<thead>
<tr>
<th>Boring Location</th>
<th>*Station</th>
<th>Offset</th>
<th>AC Thickness &amp; Location</th>
<th>Ex. Aggregate Thickness</th>
<th>Total Pavement Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH-3</td>
<td>114+75</td>
<td>35' Left</td>
<td>12” -Mainline</td>
<td>6”</td>
<td>18”</td>
</tr>
<tr>
<td>BH-5</td>
<td>117+00</td>
<td>30’ Right</td>
<td>12”-Mainline</td>
<td>3”</td>
<td>15”</td>
</tr>
<tr>
<td>BH-7</td>
<td>201+25</td>
<td>15’ Right</td>
<td>3”-Route 718</td>
<td>6”</td>
<td>9”</td>
</tr>
<tr>
<td>BH-8</td>
<td>120+85</td>
<td>5’ Right</td>
<td>4”- Ex. Rte. 29 intersection/crossover to Rte. 718</td>
<td>6”</td>
<td>10”</td>
</tr>
</tbody>
</table>

* The stations are based on the Route 29 or Route 718 alignments shown on the plans.

Pavement Structure Recommendations

Recommended materials and thicknesses for new pavement structures are as follows:

New Pavement- Route 29 & 718 Mainline, Turn Lanes & Crossovers

For Surface: Use 1.5 inches of Asphalt Concrete, Type SM-9.5D.

For Intermediate: Use 3.0 inches of Asphalt Concrete, Type IM-19.0A.*

For Base: Use 6.0 inches of Asphalt Concrete, Type BM-25.0A.

For Subbase: Use 8.0 inches of Aggregate Base, Type I, Size No. 21-B.

New Pavement- Route 29 & 718 Shoulders

For Surface: Use 1.5 inches of Asphalt Concrete, Type SM-9.5D.

For Base: Use 3.0 inches of Asphalt Concrete, Type IM-19.0.0A.*

For Subbase: Use 14.0 inches of Aggregate Base, Type I, Size No. 21-B.

*BM-25.0A can be substituted for IM-19.0A if the new pavement will not be subjected to traffic for more than 30 days prior to placing the asphalt concrete surface mix.
The plans obtained through Integrated Project Manager indicate that the existing Route 29 and Route 718 pavements are to be milled and replaced with variable depths of asphalt concrete in order to achieve final grade and geometric design. It is recommended to mill a minimum of 1.5” to remove the existing wearing surface and replace with a minimum of 1.5” of SM-9.5 surface mix to match the new pavement structures recommended above. If asphalt concrete thicknesses greater than 1.5” will be required to meet final proposed grade after milling, use intermediate and/or base mix asphalt concrete. Asphalt concrete mixes should be placed with minimum and maximum lift thicknesses in accordance with Chapter 6 of the VDOT Manual of Instructions (MOI – Materials). Variable depth milling may be required to meet the minimum lift thicknesses. It should be noted that the minimum mill and replace depth for existing pavement structure indicated above is not based on structural design life and the new wearing surface should only be considered a functional overlay. A structural rehabilitation or overlay design was not applied to the existing mainline pavement structures.

The pavement structure recommendation, for Route 29 and Route 718 mainline, was based on the 1993 AASHTO Guide for Design of Pavement Structures. A resilient modulus value of 4500 psi, 27,818 vehicles per day in year 2016 (two-way traffic) and a growth rate of 1.0 percent were used for calculating the required structural number. Traffic data was provided on the current plan set title sheet.

Widening of existing pavement should include demolition and removal of existing shoulder pavement. Additionally, construct new pavement structure adjacent to existing mainline in accordance with WP-2 of the VDOT Road and Bridge Standards.

The subbase stone should be connected to UD-4 edge-drain and CD-2 under-drain per VDOT Road and Bridge Standards with positive drainage to outlet points or the subbase stone can be day-lighted to embankment slopes or ditches if enough adequate freeboard is available. For crown sections, edge-drain should be placed along both sides of proposed pavement and along the low side, only, for super-elevated sections. If elevation, placement, easement or right-of-way constraints do not allow for construction of UD-4 or CD-2 per the Standards, Culpeper Materials should be informed for any modifications to the Standards and/or changes to the pavement structure recommendations provided above.
Earthwork & Materials

Regular Excavation

Soils from planned cuts along the Route 29 alignment between stations 113+00 and 117+00 can be used with for construction of embankment. It is recommended to plan on limiting cut soils between Station 119+25 and the end of project to 3.0 feet below proposed subgrade, widening slopes beyond structural areas or wasting off-site.

Unsuitable Subgrade & Embankment Stabilization

It is recommended to plan for stabilizing or removing unsuitable subgrade in cut areas and stabilizing embankment/fill soils as follows:

- Route 29, Station 111+20 to 111+85, proposed crossover – remove soils within 4.0 feet of proposed subgrade elevation for the new pavement and up to 20.0 feet from the baseline (both sides). Place 12.0” of VDOT Size No. 3 or 357 Open-Graded Coarse Aggregate over geotextile Embankment Stabilization Fabric. Cap the No. 3 or No. 357 stone with 6.0” of VDOT Size No. 57 Open-Graded Coarse Aggregate and then place compacted regular excavation or borrow soils up to proposed subgrade elevation.

- Route 29 NBL, Station 119+25 to end of project, proposed turn lane, crossover and shoulders – remove soils from within 6.0” of proposed subgrade for mainline pavement and up to 2.0 feet beyond paved shoulders. For the proposed turn lane and crossover, replace the undercut with 6.0” of Select Material, Type I, CBR-30 over geotextile Subgrade Stabilization Fabric. For the proposed new pave shoulder beyond, east of, the proposed crossover shoulder, replace undercut with 6.0” Select Material, Type I only.

Plan for wasting undercut soils. Generally, subgrade observation and preparation should be in accordance with the current version of the VDOT Road and Bridge Specifications. The Select Material should be connected to UD-4 or day-lighted for drainage. The depth of the UD-4 should be deepened to below the Select Material in accordance with VDOT Road and Bridge Standards (modified UD-4).

Slopes

All cut and fill slopes should be no steeper than a ratio of 2 horizontal to 1 vertical (2H: 1V).

Earthwork Volumes

Use 15.0% shrinkage factor for earthwork volume computations. Use average 6.0” for vegetation and topsoil removal.

Borrow

Borrow soils should have a minimum CBR value of 5.0, maximum Liquid Limit (LL) of 45 and maximum plasticity index of 20.
Source of Materials

Aggregates

Two sources for aggregate material, located within the Culpeper District and near to the project location, are provided below along with recent test results data for selected products.

Luck Stone Corp- Culpeper

Aggregate Base Material, Type I, Size No. 21-A – maximum dry density 144.6 lbs. / cu. ft. at 6.8% optimum moisture content.

Aggregate Base Material, Type I, Size No. 21-B – maximum dry density 146.2 lbs. / cu. ft. at 6.3% optimum moisture content.

Select Material, Type I, CBR-30 – maximum dry density 145.3 lbs. / cu. ft. at 6.6% optimum moisture content.

Cedar Mountain Stone – Mitchells

Aggregate Base Material, Type I, Size No. 21-A – maximum dry density 162.2 lbs. / cu. ft. at 4.8% optimum moisture content.

Aggregate Base Material, Type I, Size No. 21-B – maximum dry density 161.4 lbs. / cu. ft. at 4.9% optimum moisture content.

Select Material, Type I, CBR-30 – maximum dry density 160.6 lbs. /cu. ft. at 5.8% optimum moisture content.

For Open-Graded Aggregate, Size No. 57, a unit weight of 102.0 lbs. / cu. ft. is recommended for quantity calculations.

Matthew G. Moore, P.E.
Geotechnical/Pavement Engineer
Culpeper District Materials

Attachments:
Appendix A – Approximate Boring Locations
Appendix B – Boring Logs
Appendix A

Approximate Boring Locations
Approximate Boring Locations
Appendix B

Boring Logs
### Field Data

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Elevation (ft)</th>
<th>Soil Recovery (%)</th>
<th>Rock Recovery (%)</th>
<th>Strata Legend</th>
<th>Joints</th>
<th>Dips</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>436.0</td>
<td>0.0 / 436.0</td>
<td>Ground water</td>
<td>WOW</td>
<td>2</td>
<td>133</td>
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<tr>
<td>0.25</td>
<td>435.75</td>
<td>2.25 / 433.75</td>
<td>3-in TOPSOIL</td>
<td>WOW</td>
<td>2</td>
<td>175</td>
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<td></td>
<td></td>
<td>Tops</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

- **Soil**: Brown, SILTY SAND, contains mica, very loose, moist SM
- **Strata Legend**: Ground water was not encountered during drilling
- **Remarks**: Boring terminated at 5.0 ft

### Lab Data

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<tr>
<th>Moisture Content (%)</th>
<th>Plasticity Index</th>
<th>Fines Content (% - #200)</th>
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<td>25.0</td>
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<td>42.2</td>
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### Remarks
- Rig Type: CME 55.
- Drilling backfilled upon completion.
- The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.

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### FIELD DATA

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>ELEVATION (ft)</th>
<th>STANDARD PENETRATION HAMMER BLOWS</th>
<th>SOIL RECOVERY (%)</th>
<th>CORE RECOVERY (%)</th>
<th>STRATA DESIGNATION</th>
<th>DIP °</th>
<th>ROCK QUALITY DESIGNATION</th>
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<td>TOPSOIL Tops</td>
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<td>2-in TOPSOIL</td>
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</tr>
<tr>
<td>0.2</td>
<td>448.8</td>
<td>3</td>
<td>89</td>
<td>4</td>
<td>Red, SILT, contains mica, firm, moist</td>
<td>ML</td>
<td>25.2</td>
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</tr>
<tr>
<td>2.0</td>
<td>447.0</td>
<td>3</td>
<td>89</td>
<td>4</td>
<td>Brown, SILT, trace sand, contains mica, stiff, moist</td>
<td>ML</td>
<td>17.5</td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>444.5</td>
<td>3</td>
<td>100</td>
<td>4</td>
<td>SAME, SANDY SILT</td>
<td>ML</td>
<td>35 N.P. 19.6 51.9</td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>441.5</td>
<td>3</td>
<td>100</td>
<td>4</td>
<td>SAME,</td>
<td>ML</td>
<td>14.7</td>
<td></td>
</tr>
</tbody>
</table>

**REMarks:** Rig Type: CME 55. Boring backfilled upon completion. The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.

**DATE(s)** Drilled: 5/13/15 - 5/13/15

**Drilling Method(s):** 3.25 in HSA

**SPT Method:** Automatic

**Other Test(s):**

**Driller:** O. Gomez (DMY)

**Logger:** Assefa A. (VDOT)

**GROUND WATER**

Ground water was not encountered during drilling

No long term measurements taken

**Boring Terminated at 10.0 ft**
FIELD DESCRIPTION OF STRATA

Date(s) Drilled: 5/13/15 - 5/13/15
Drilling Method(s): 3.25 in HSA
SPT Method: Automatic
Other Test(s):
Driller: O. Gomez (DMY)
Logger: Assefa A. (VDOT)

GROUND WATER
Ground water was not encountered during drilling
No long term measurements taken

REMARKS:
Rig Type: CME 55.
Boring backfilled upon completion and patched with fast setting concrete.
The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.

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**FIELD DATA**

**SOIL**

- **SAMPLE INTERVAL**: 5.0 ft
- **SOIL RECOVERY (%):** 100
- **CORE RECOVERY (%):** 100
- **STRAVA LEGEND**: 0.5

**ROCK**

- **DIP °**: 1.5

**GROUND WATER**

- Ground water was not encountered during drilling
- No long term measurements taken

**FIELD DESCRIPTION OF STRATA**

1. **3-in TOPSOIL**
   - **Top**: 0.0 / 450.0
   - **Characteristics**: Red, SILT, contains mica, firm, moist ML

2. **2.0 / 448.0**
   - **Characteristics**: SAME, stiff ML

3. **4.5 / 445.5**
   - **Characteristics**: SAME, ML

4. **7.5 / 442.5**
   - **Characteristics**: Light Orange, SANDY SILT, contains mica, very stiff, moist ML

**Boring Terminated at 10.0 ft**

**LAB DATA**

- **LIQUID LIMIT**: 43
- **PLASTICITY INDEX**: 14
- **MOISTURE CONTENT (%):** 17.8
- **FINE CONTENT (%):** 68.9
- **DIP °**: 17.1

**REMARKS**

- Rig Type: CME 55.
- Unidentified utility line was damaged and Boring backfilled upon completion.
- The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.
### Field Data

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Soil</th>
<th>Rock</th>
<th>Joint</th>
<th>Strata Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 / 445.0</td>
<td>13-in Asphalt ASPH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 / 443.9</td>
<td>3-in Crushed Aggregate CRA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.35 / 443.65</td>
<td>Dark Brown, Silty Sand, trace gravel, contains mica, medium dense, moist SM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0 / 442.0</td>
<td>Same, Light Brown, Silty ML</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Boring Terminated at 5.0 ft

**Remarks:**
- Rig Type: CME 55.
- Boring backfilled upon completion and patched with fast setting concrete.
- The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.
**FIELD DESCRIPTION OF STRATA**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Soil Recovery (%)</th>
<th>Core Recovery (%)</th>
<th>Strata</th>
<th>Strata Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 0.5</td>
<td>55</td>
<td></td>
<td>4</td>
<td>4-in TOPSOIL</td>
</tr>
<tr>
<td>0.5 - 1.0</td>
<td>3</td>
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<td>Tops</td>
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<td>1.0 - 1.5</td>
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<td>5.0 - 5.5</td>
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**GROUNDS WATER**

Ground water was not encountered during drilling

No long term measurements taken

**LAB DATA**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>MOISTURE CONTENT (%)</th>
<th>PLASTICITY INDEX</th>
<th>ENGINEERING MEMORY (%)</th>
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</thead>
<tbody>
<tr>
<td>0.0 / 443.0</td>
<td>43</td>
<td>20.7</td>
<td>28.9</td>
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**Remarks:**

- Rig Type: CME 55
- Boring backfilled upon completion.
- The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.
### FIELD DESCRIPTION OF STRATA

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Elevation (ft)</th>
<th>Soil Recovery (%)</th>
<th>Core Recovery (%)</th>
<th>Strata Designation</th>
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<tbody>
<tr>
<td>0.0-0.5</td>
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<td>4-in ASPHALT, ASPH</td>
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<td>0.3-0.8</td>
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<td>6-in CRUSHED AGGREGATE, CRA</td>
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<td>Brown, LEAN CLAY, trace gravel, contains mica, very stiff, moist, CL</td>
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<td>3.0-5.0</td>
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<td>SAME, Gray, CL</td>
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**GROUND WATER**

- Ground water was not encountered during drilling
- No long term measurements taken

**FIELD DATA**

- Date(s) Drilled: 5/13/15 - 5/13/15
- Drilling Method(s): 3.25 in HSA
- SPT Method: Automatic
- Other Test(s): Driller: O. Gomez (DMY), Logger: Assefa A. (VDOT)

**LAB DATA**

- Moisture Content (%): 9.7
- Plasticity Index (PI): 14.3

**REMARKS:** Rig Type: CME 55. Boring backfilled upon completion and patched with fast setting concrete.

The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.

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**FIELD DATA**

<table>
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<tr>
<th>DEPTH (ft)</th>
<th>ELEVATION (ft)</th>
<th>SOIL</th>
<th>ROCK</th>
<th>DIP °</th>
<th>PENETRATION HAMMER BLOWS</th>
<th>SOIL RECOVERY (%)</th>
<th>SAMPLE INTERVAL</th>
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**LAB DATA**

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<tr>
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<th>PLASTICITY INDEX</th>
<th>LIQUID LIMIT</th>
<th>FINES CONTENT (%)</th>
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</tbody>
</table>

**GROUND WATER**

- Ground water was not encountered during drilling
- No long term measurements taken

**FIELD DESCRIPTION OF STRATA**

- **0.0 / 443.0**
  - 4-in ASPHALT
  - Asph

- **0.3 / 442.7**
  - 6-in CRUSHED AGGREGATE
  - CRA

- **0.8 / 442.2**
  - Brown, FAT CLAY, trace sand, contains mica, stiff, moist
  - CH

- **3.0 / 440.0**
  - SAME, LEAN CLAY
  - CL

- Boring Terminated at 5.0 ft

**REMARKS:**

- Rig Type: CME 55.
- Boring backfilled upon completion and patched with fast setting concrete.
- The station and elevation information was estimated from the plan and are to be considered approximate not a result from professional survey.