MEMORANDUM

TO: Brad Eldridge, P.E.  
   Project Management Coordinator  
   Division of Highway Design

FROM: William Broyles, P.E.  
   Geotechnical Branch Manager  
   Division of Materials

BY: Danny Moleh  
   Geotechnical Branch

DATE: April 29, 2004

SUBJECT: Boone County  
   FD52 008 0237 008-013 D  
   KY 237 Widening (N. Bend Rd toward KY 8)  
   Station 15+50 to 205+50  
   Item # 6-152.00  
   Mars # 6979201D  
   Geotechnical Engineering Roadway Report

An abbreviated geotechnical engineering report is completed for the subject project. Florence & Hutcheson, Inc. performed the drilling and sampling. The Geotechnical Branch performed the testing. The purpose of the investigation was to define the soil and subsurface conditions. Reduced size geotechnical notes sheet and a soil profile sheet are attached. The CADD input for these sheets is being e-mailed to Burgess & Niple, as DGN files, for incorporation into the roadway plans.

Testing indicated that natural moisture contents exceeded optimum moisture in some areas of the project. Subgrade problems are anticipated due to the low CBR value of the soils. Therefore, to stabilize the subgrade and to prevent possible ponding beneath the pavement a minimum of one foot rock roadbed will be required for the entire project. The rock roadbed will consist of Kentucky Coarse Aggregate # 2’s, 3’s or 23’s wrapped with Geotextile Fabric. The actual thickness will be determined by the Engineer on construction and may depend on seasonal fluctuations in the water table. The rock roadbed will be required directly beneath the roadway template and extending under the curb and gutter. Wrapping the Kentucky Coarse Aggregates with fabric is cost effective because it prevents the soils or DGA from filtrating into these coarse aggregates. The rock roadbed will also serve as a drainage blanket by placing short sections of perforated drain pipe (4 ft.) into the bottom of the coarse aggregates. The drain pipe should be located at the drop inlets.

No durable rock was encountered during the subsurface investigation. Therefore, Select Rock Quantities were not calculated by the design consultant and little or no durable rock will be available from roadway excavation for construction purposes.
The non-durable shale bedrock on this project is highly subject to weathering. Therefore, all embankments containing non-durable shale are to be constructed in accordance with the current edition of Section 206 of the Standard Specifications for Road and Bridge Construction. This special construction method will break down the shale into a soil characteristic allowing the embankments to be constructed as shown. If this construction method is not followed, the shale will break down in a few years causing settlement and potential embankment failures.

Geotechnical recommendations are as follows:

1). In accordance with Section 206 of the current Standard Specifications, the moisture content of embankment material shall not vary from the optimum moisture content as determined by KM 64-511 by more than +2 percent or less than -2 percent. This moisture content requirement shall have equal weight with the density requirement when determining the acceptability of embankment construction. Refer to the Family of Curves for moisture/density correlation.

2). All soils, whether from roadway or borrow, may require manipulation to obtain proper moisture content prior to compaction. Direct payment shall not be permitted for rehandling, hauling, stockpiling, and/or manipulating soils.

3). Excavation of surface ditches and channel changes adjacent to embankment areas shall be performed prior to the placement of the adjacent embankments. The material excavated for the channel changes and surface ditches is suitable for embankment construction if dried to proper moisture content in accordance with Section 206 of the current Standard Specifications.

4). The contractor is responsible for conducting any operations necessary to excavate the cut areas to the required typical section. These operations shall be incidental to the roadway price.

5). Some of the soil horizons and slopes on the project are subject to erosion. Necessary procedures in accordance with Sections 212 and 213 of the current Standard Specifications shall be followed on construction.

6). Embankments, measured vertically from the toe of the slope to roadway grade except where noted otherwise, shall be constructed on 2:1 or flatter slopes for embankments under 35 ft.

7). In order to provide a working platform for embankment construction, Granular Embankment shall be placed over all soft and/or saturated foundation areas that may be detected during construction, as directed by the Engineer. The Granular Embankment shall be in accordance with the current edition of Section 805 of the Standard Specifications for Road and Bridge Construction. The required thickness is estimated to be 2 ft but the actual thickness and locations of this treatment shall be determined by the Engineer during construction and may depend on seasonal fluctuations in the water table. This material shall be wrapped with Type IV Geotextile Fabric in accordance with Section 214 & 843 of the Standard Specifications for Road and Bridge Construction, current edition. For quantity estimation purposes, this shall include the following area.
8). The pond at the following location and any others designated by the Engineer shall be drained and any soft or saturated material shall be removed (approximately 2 foot). Use of this excavated material shall be limited to final dressing of roadway slopes, as directed by the Engineer. The ponds shall be stabilized with Granular Embankment. The Granular Embankment shall be in accordance with the current edition of Section 805 of the Standard Specifications for Road and Bridge Construction. The estimated thickness of this treatment is estimated to be 2 foot, but the actual thickness shall be determined by the Engineer. This material shall be underlain with Type III Geotextile Fabric in accordance with Section 214 & 843 of the Standard Specifications for Road and Bridge Construction, current edition.

Station 96+00

9). All embankment construction using non-durable shale will be in accordance with Section 206 of the current Standard Specifications for Road and Bridge Construction, Embankments Principally of Non-Durable Shale.

10). The contractor shall construct foundation embankment benches and transverse benches as indicated on the plans and/or as directed by the Engineer, prior to placement of embankments in areas requiring such benches.

11). Foundation embankment benches shall be placed in accordance with Standard Drawing RGX-010 at the locations listed below and/or as directed by the Engineer.

Station 15+50 to 16+75
Station 26+75 to 29+25
Station 79+75 to 80+25
Station 93+25 to 94+25
Station 145+25 to 146+25
Station 164+75 to 165+75
Station 167+75 to 168+25
Station 204+25 to 205+50

12). Transverse benching and/or perforated pipe underdrains shall be installed at the following approximate locations and any others designated by the Engineer. Contrary to Standard Drawing RDP-006, transverse benches and perforated pipe underdrains shall be placed on both the upgrade and downgrade cut to fill transitions.

Station 89+05
Station 101+25

13). Perforated pipe for subgrade drainage shall be placed in vertical sags in accordance with RDP-005 at the following approximate locations and/or where designated by the Engineer.

Station 24+36
Station 54+99
Station 67+31
Station 79+98
Station 96+88
14). Appropriate treatment, as outlined in the Standard Specifications, shall apply to all cisterns, septic tanks, and associated lateral lines within the construction limits.

15). A minimum of one foot rock roadbed shall be constructed over the entire project and extending under the curb and gutter. This platform shall be constructed using Kentucky Coarse Aggregate # 2’s, 3’s or 23’s, in accordance with the current edition of Section 805 of the Standard Specifications for Road and Bridge Construction. The working platform/rock roadbed shall be wrapped with Geotextile Fabric, Type IV in accordance with Section 214 & 843 of the current Standard Specifications. The actual thickness may need to be adjusted by the Engineer during construction and may depend on seasonal fluctuations in the water table.

16). Short sections of 4 inch perforated drain pipe (approximately 4 foot long) shall be used to drain the working platform (for the curb and gutter section) into the drop inlets, as directed by the Engineer.

**DESIGN RECOMMENDATIONS . . .**

1). The project should be designed for a minimum 1 foot rock roadbed. A CBR design value of 11.0 is recommended for the rock, and a CBR design value of 2.0 is recommended for the soil beneath the rock. The rock shall consist of Kentucky Coarse Aggregate # 2’s, 3’s or 23’s. The placement of this material is incidental to the unit bid price for roadway excavation or embankment-in-place.

2). Calculate a cost comparison of a 1 foot rock roadbed vs a 2 foot rock roadbed. If feasible use the 2 foot rock roadbed.

**cc:** Kentucky Transportation Center
Division of Design (Plan Processing Section)
TEBM for Pavement Design
Division of Construction
TEBM for Construction (District) 2 copies
TEBM for Preconstruction (District)
Burgess & Niple

**Attachments**
### AASHTO Classification of Soils and Soil-Aggregate Mixtures

<table>
<thead>
<tr>
<th>Group Classification</th>
<th>Granular Materials</th>
<th>黏土 or less passing 0.075 mm</th>
<th>Silt-Clay Materials</th>
<th>More than 35 passing 0.075 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine sands (FS)</td>
<td>A-1</td>
<td>A-2</td>
<td>A-3</td>
<td>A-4</td>
</tr>
<tr>
<td>Coarse sands (CS)</td>
<td>A-1</td>
<td>A-2</td>
<td>A-3</td>
<td>A-4</td>
</tr>
<tr>
<td>Fine gravels (FG)</td>
<td>A-1</td>
<td>A-2</td>
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<td>A-4</td>
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<tr>
<td>Coarse gravels (CG)</td>
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<td>A-3</td>
<td>A-4</td>
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<tr>
<td>Silts (S)</td>
<td>A-1</td>
<td>A-2</td>
<td>A-3</td>
<td>A-4</td>
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<tr>
<td>Clays (C)</td>
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<td>A-2</td>
<td>A-3</td>
<td>A-4</td>
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<tr>
<td>Organic soils (O)</td>
<td>A-1</td>
<td>A-2</td>
<td>A-3</td>
<td>A-4</td>
</tr>
</tbody>
</table>

**Characteristics of Fraction:**

- Particle size
- Liquid Limit
- Plasticity Index

**Unified Soil Classifications**

- **MAJOR DIVISIONS:**
  - coarse-grained soils
  - fine-grained soils
  - unclassified materials

- **SYMBOLS:**
  - OR: Well-graded gravels or gravels and stones, with or without some fines.
  - OP: Nearly well-graded gravels or gravels and stones, with or without some fines.
  - OM: Nearly well-graded silts or silts and stones, with or without some fines.
  - OL: Nearly well-graded clays or clays and stones, with or without some fines.
  - OW: Well-graded gravels or gravels and stones, with or without some fines.
  - OP: Nearly well-graded gravels or gravels and stones, with or without some fines.
  - OM: Nearly well-graded silts or silts and stones, with or without some fines.
  - OL: Nearly well-graded clays or clays and stones, with or without some fines.
  - UK: Nearly well-graded silts or silts and stones, with or without some fines.
  - SU: Nearly well-graded clays or clays and stones, with or without some fines.
  - NU: Nearly well-graded silts or silts and stones, with or without some fines.
  - SU: Nearly well-graded clays or clays and stones, with or without some fines.
  - UU: Nearly well-graded silts or silts and stones, with or without some fines.
  - S: Nearly well-graded clays or clays and stones, with or without some fines.

**GEOLOGICAL SYMBOL SHEET**

- **AI:** Activity Index
- **LI:** Liquidity Index
- **S+C:** Silt + Clay (C finer than No. 200 Silt)
- **○:** Rockline Soundings
- **○:** Disturbed Sample Boring
- **○:** Undisturbed Sample Boring
- **○:** Undisturbed Sample Boring & Rock Core
- **○:** Rock Core
- **<○:** Slope Instrumentation
- **OW:** Observation Well
- **WF:** Water Elevation
- **VS (psf):** Field Vane Shear Strength
- **N:** Penetration Resistance
- **Qu (psf):** Undrained Compressibility Strength
- **UU (psf):** Unconsolidated Undrained Triaxial Strength
- **M:** Moisture Content
- **RY:** Kentucky Method
- **STD:** Rock Quality Designation (Standard Method)
- **SDF:** Silt Dull Durability Index (Durability Test)
- **REC:** Core Recovery
- **Θ:** Angle of Internal Friction (Total Stress)
- **c:** Cohesion (Total Stress)
- **τ:** Cohesion (Effective Stress)
- **ϕ:** Total Unit Weight
- **RB:** Rock Disintegration Zone
- **OB:** Intermediate Bench
- **IB:** Intermediate Bench
- **R:** Refusal
- **NR:** Refusal Not Encountered

**NOTE:** Include visual descriptions.
GEOTECHNICAL NOTES

II. In accordance with Section 206 of the current Standard Specifications, the moisture content of embankment material shall not vary from the maximum moisture content as determined by the American Society of Civil Engineers (ASCE) by more than 2 percent or less than 2 percent. This moisture content requirement shall take into account the density requirement when determining the acceptability of embankment construction. Refer to the Family of Curves for embankment construction.

III. All work, whether from roadway or borrow, may require explanation to obtain proper moisture content prior to construction. Direct payment shall not be permitted for rehandling, reshaping, reshoveling, and/or recompacting earth.

IV. Excavation of surface ditches and channel changes adjacent to embankment areas shall be performed prior to the placement of the adjacent embankments. The material excavated for the channel changes and surface ditches is suitable for embankment construction if dried to proper moisture content in accordance with Section 206 of the current Standard Specifications.

V. The contractor is responsible for conducting any operations necessary to excavate the cut areas to the required TOPSOIL section. These operations shall be beneficial to the roadway price.

VI. The subgrade surfaces and slopes on the project are subject to control. Necessary procedures in accordance with Sections 204 and 205 of the current Standard Specifications shall be followed on construction.

VII. Embankments, measured vertically from the top of the slope to roadway grade except where noted, are to be constructed on 3:1 or flatter slope for embankments under 35 ft.

VIII. In order to provide a working platform for embankment construction, granular base embankment shall be placed over topsoil and/or existing foundation areas that may be detected during construction, as directed by the Engineer. The granular embankment shall be in accordance with the current edition of Section 206 of the standard Specifications for Road and Bridge Construction.

IX. All embankment construction using non-durable shales shall be in accordance with Section 206 of the current Standard Specifications for Road and Bridge Construction. Embankments Principally of Non-Durable Shales.

X. The contractor shall construct foundation embankment benches and transverse benches as indicated on the plans and/or as directed by the Engineer, prior to placement of embankments in areas requiring such benches.

XI. Foundation embankment benches shall be placed in accordance with Standard Drawing RS-065 at the locations listed below and/or as directed by the Engineer.

XII. Transverse benches, shoulders, and perforated pipe underdrains shall be placed at the following approximate locations and/or where directed by the Engineer, contrary to standard drawings RSM-365 and RSM-366. Transverse benches and perforated pipe underdrains shall be placed on both the upgrade and downgrade out to 500 ft. transitions.

XIII. Perforated pipe for subdrainage shall be placed in vertical cuts in accordance with RSM-005 at the following approximate locations and/or where directed by the Engineer.

XIV. Appropriate treatment, as outlined in the Standard Specifications, shall apply to all ditches, earthworks, and associated intertrench within the construction limits.

XV. A minimum of one foot rock roadbed shall be constructed over the entire project and extending under the curbs and gutter. This platform shall be constructed using Kentucky Crushed Aggregates # 2A, 2B or 21A, in accordance with the current edition of Section 206 of the Standard Specifications for Road and Bridge Construction. The working platform/rock roadbed shall be wrapped with Geotextile Fabric Type IE in accordance with Section 204 & 205 of the current Standard Specifications. The subgrade should be treated according to the treatment outlined in the standard specifications and may depend on seasonal fluctuations in the water table.

XVI. Short sections of 4 inch perforated drain pipes approximately 4 feet long shall be used to drain the working platform (or the curbs and gutter gastrodrain) into the drain tubes, as directed by the Engineer.

KENTUCKY DEPARTMENT OF HIGHWAYS
COUNTY OF
BOONE
Hand leveling and staking were performed in the period of 09/05/05.  For this project, the procedure used was to survey the alignment of the road and then establish the topographic contour measurements to specified location(s) as shown on the drawings.  Even though some minor discrepancies and variations may exist, the survey and road alignment measurements were based on the surveying equipment and procedures used in the field.  The surveying equipment and techniques were in accordance with the standards required by the Kentucky Transportation Cabinet.

NOTICE: Without regard to the accuracy of the surveyor's measurements, all survey work hereinafter described and referenced is based on the road alignment and contour measurements as shown on the drawings.  The surveyor is not responsible for any errors or omissions made in the field, including any errors made in the construction of the road.  The surveyor's measurements are not to be taken as a substitute for the approval of the project by the Kentucky Transportation Cabinet.  Any changes to the project should be approved by the Kentucky Transportation Cabinet before any construction is begun.  The surveyor is not responsible for any errors or omissions made in the field, including any errors made in the construction of the road.  The surveyor's measurements are not to be taken as a substitute for the approval of the project by the Kentucky Transportation Cabinet.  Any changes to the project should be approved by the Kentucky Transportation Cabinet before any construction is begun.

KENTUCKY
DEPARTMENT OF HIGHWAYS
COUNTY OF
BOONE

PROJECT NUMBER
505, PROFILE, KY 237
STA. 15+95 TO 35+00