Appendix F - Summary of the Geotechnical Findings

GEOTECHNICAL OVERVIEW

STATEWIDE CORRIDOR PLANNING

CAMPBELL, PENDLETON, BRACKEN, AND MASON COUNTIES

KENTUCKY 9 “AA” HIGHWAY WIDENING STUDY

ITEM NO. 9-165.00

FOR

HNTB CORPORATION

OCTOBER 2001

INVESTIGATION BY

H.C. NUTTING COMPANY

W.O. # 71287.007

INTRODUCTION

The H.C. Nutting Company is pleased to team with HNTB to provide the Geotechnical Overview on this Ky. 9 “AA” Highway widening study for the Kentucky Transportation Cabinet. Henry Mathis, P.E., Senior Consultant, Doug Smith, P.G., Senior Geologist, and Sarah Johnson, Engineering Geologist, and others in the H.C. Nutting Company assisted in the preparation of this overview.

The report format and outline follows the requirements described in the Kentucky Transportation Cabinet’s Geotechnical Manual, section GT-801, page 1. The primary focus of this study is to identify geological conditions that could adversely affect the design and construction of this project. Where adverse geological conditions are noted, site-specific recommendations for construction are provided.

The study begins in Campbell County at 0.5 MP north of the Campbell/Pendleton County line, extends across Plendleton and Bracken Counties and ends at the 13.99 MP in Mason County for a total of approximately 28 miles.

In preparation of this report, Henry Mathis and Sarah Johnson reviewed the alignment in the field utilizing design profiles and embankment cross sections from the original geotechnical reports, and U.S.G.S. Quadrangle Maps. Discussions were held with KTC district construction and maintenance personnel, and Geotechnical Branch personnel concerning past geotechnical problems with the original “AA” highway construction and present maintenance problems. Subsurface investigations, laboratory and engineering analyses were not part of this study.

The Geotechnical Overview includes a description of the geology, recommendations for the embankment slope design, general geotechnical recommendations, and Geological Quadrangle Maps with the KY 9 alignment plotted on the maps. The geologic quadrangles used for this study include the New Richmond, Butler, Moscow, Berlin, Brookville, and Germantown quadrangles.

GEOLOGY

The alignment of this section of KY 9 is underlain by Ordovician-aged shale and limestone bedrock, including the Point Pleasant, Kope, Fairview, and Grant Lake formations, as well as Quaternary alluvial, colluvial, and glacial deposits.

This region of Kentucky lies on the eastern flank of the Cincinnati Arch, which has given rise to a regional dip to the northeast, generally on the order of 1 ft. per 100 to 200 ft. in the study area. However, smaller-scale synclines and anticlines may produce local dips that are contrary to the regional trend.

The bulk of the alignment is underlain by the Kope Formation, which consists predominately of a gray, calcareous, uncemented shale interbedded with 2” to 6”

thick (occasionally up to 9” thick) hard, crystalline, fossiliferous limestone layers. The formation consists of 70 to 90% shale, typically with 2 to 3 ft. intervals of shale between limestone layers. The Kope Formation historically is a poor embankment performer and is subject to slumping and weathering.

The Point Pleasant Formation underlies the Kope Formation, and is found along the lower valley walls of the deeper valleys in the western and central portions of the alignment. The Point Pleasant consists of shale interbedded with 2” to 15” thick limestone layers. The formation is composed of approximately 60% limestone.

Overlying the Kope Formation is the Fairview Formation. In the western and central portions of the alignment, the Fairview is only found in isolated patches on the highest ridge tops. However, as the alignment moves down-dip and towards the east, the formation becomes more prevalent. The Fairview Formation also consists of interbedded shale and limestone, with more abundant and more closely spaced limestone beds than the underlying Kope. Hard, coarsely crystalline or argillaceous limestone layers constitute up to 30-50% of the formation, and occur in ½ to 15” thick layers (typically less than 5”). As with the Kope, the shale is relatively weak.

Above the Fairview, the Grant Lake Formation is found on the higher ridge tops in the eastern portion of the alignment. The Grant Lake Formation consists of relatively thinly bedded, discontinuous, wavy-bedded, rubbly limestone layers up to 6” thick interbedded with calcareous shale. The limestone composes approximately 80% of the formation.

The overburden soils consist primarily of residual soils derived from the shale and limestone bedrock. The residual soils are generally 5 to 10 ft. thick, and are typically stiff to very stiff relatively plastic clays. The depth of the RDZ typically varies from 20 to 25 feet. Previous geotechnical reports indicate that minor amounts of colluvium are found at the toes of slopes. Alluvial deposits consisting of cobbles, gravel, sand, silt and clay are found in floodplains of creeks. In the northern-most section of the alignment, in the vicinity of Flagg Spring Creek, Illinoian-aged lacustrine and glacial outwash deposits are encountered. The lacustrine deposits consist primarily of silt and clay. The outwash deposits consist of sand and gravel with minor silt and clay. An earlier geotechnical study indicated that the glacial and alluvial deposits could range up to 60 ft. in thickness in this stream valley.

GENERAL RECOMMENDATIONS

1. Soil depths in the cuts vary from 5 to 10 feet deep with an estimated average stripping depth of 6". The glacial and alluvial deposits in some stream valleys could range up to 60 feet in depth. A soil shrinkage factor of 2 percent is suggested for the project. This value should be applied as outlined in the current edition of the Design Guidance Manual. The base of the rock disintegration zone (RDZ) is estimated to be 20 to 25 feet below the top of

ground. The rock swell factor is estimated at five percent below the rock disintegration zone. Material in the RDZ should have a zero percent swell.

2. A CBR design value of 3.0 is suggested for the subgrade, if the subgrade consists of soil, shale and limestone rock. If there is sufficient soil free of limestone floaters and rock fragments existing in the cuts, chemical stabilization (lime) should be utilized for the subgrade with a conservative estimated CBR design value of 9.5 assigned to the stabilized soil subgrade.
3. The project is located in Seismic Risk Zone 2, which is defined as an area of some damage due to earthquake activity.
4. Rock outcrop was present in the entire stream crossing; therefore, the culverts probably will be designed for a non-yielding foundation with an estimated allowable bearing value of 8 to 10 TSF (tons / $ft.^2$). The bridges probably will be spread footings on rock, point bearing piles and / or drilled shafts with an estimated allowable bearing value of 8 to 10 TSF. This value may be increased with site-specific laboratory testing on the proposed rock foundations. Scour may control the base of the footing elevations for spread footings on rock.
5. Since springs are likely to be encountered throughout the project it is very important to control the drainage using spring boxes and perforated pipe underdrains especially in areas of side hill cut and fill situations. Springs are very likely to occur at the base of the Fairview Formation, which is the contact between the Fairview and Kope formations.
6. Embankments constructed of non-durable shales (SDI < 95) shall be placed and compacted as specified in the current edition of KTC Standard Specifications for Road and Bridge Construction.
7. Embankments over 30 feet in height shall be constructed on 3 horizontal and 1 vertical slopes.
8. Foundation embankment benching and longitudinal perforated pipe underdrains shall be placed in accordance with the current edition of Standard Drawing RGX-010 and RDP-006 and / or as directed by the Engineer. One foot of Coarse Aggregate for Rock Drainage Blanket meeting the requirements of Section 805 of the KTC Standard Specifications for Road and Bridge Construction shall be placed on all benches. This drainage blanket shall be wrapped with Type IV Geotextile Fabric meeting the requirements of Section 843 of the current standard specifications.
9. Treatment of embankments at bridge end-bent structures shall be in accordance with Standard Drawing No. RGX-104-04 and RGX-105-05 except the pile core shall be constructed of granular embankment with a maximum size rock of 3 inches. Using this granular embankment in-lieu of soil, shale and limestone mixture will permit designing the embankments on a 2 horizontal 1 vertical slope. The side slopes beyond the granular embankments shall be transitioned to flatter slopes (3 horizontal to 1 vertical) for embankments heights over 30 feet.
10. In the areas where side hill fill is to be placed over unstable hillsides, the unstable material shall be removed to rock and the embankment benches, longitudinal perforated pipe underdrains and rock drainage blankets constructed as specified in note eight (8).