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KANSAS DEPARTMENT OF TRANSPORTATION

MEMO TO: Jim L. Kowach, P.E.
Chief, Bureau of Design

ATTENTION: Ken Hurst, P.E.
Engineering Manager, State Bridge Office

FROM: Delmar L. Thompson, P.G. Regional Geologist, Lawrence

DATE: April 7, 2004

SUBJECT: Bridge Foundation Geology Report

RE: Project 16-75 K-7428-01
K-16 over Spring Creek
Bridge No. 16-75-37.34(058)
Pottawatomie County

Three copies of the above report are attached to this memorandum. Engineering Geology Bridge Sheets have been drawn on the Microstation Workstation. The file has been placed on the Design file server under the file name 74283734.dgn. Three copies of the drill sounding logs are attached to this report. If questions arise over the contents of this report, please contact the Lawrence Regional Geology Office.

LSI:AJG:RWH:DLT:drs
Attachments
c: Bureau of Construction and Maintenance
District IV
Regional Geology Offices
Project File

BUREAU of MATERIALS and RESEARCH

GEOTECHNICAL UNIT
GEOLOGY SECTION

BRIDGE FOUNDATION GEOLOGY REPORT

16-75 K-7428-01
K-16 over Spring Creek
Bridge No. 16-75-37.34(058)

Pottawatomie County

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Delmar Thompson, P.G.
Regional Geologist

April 2004

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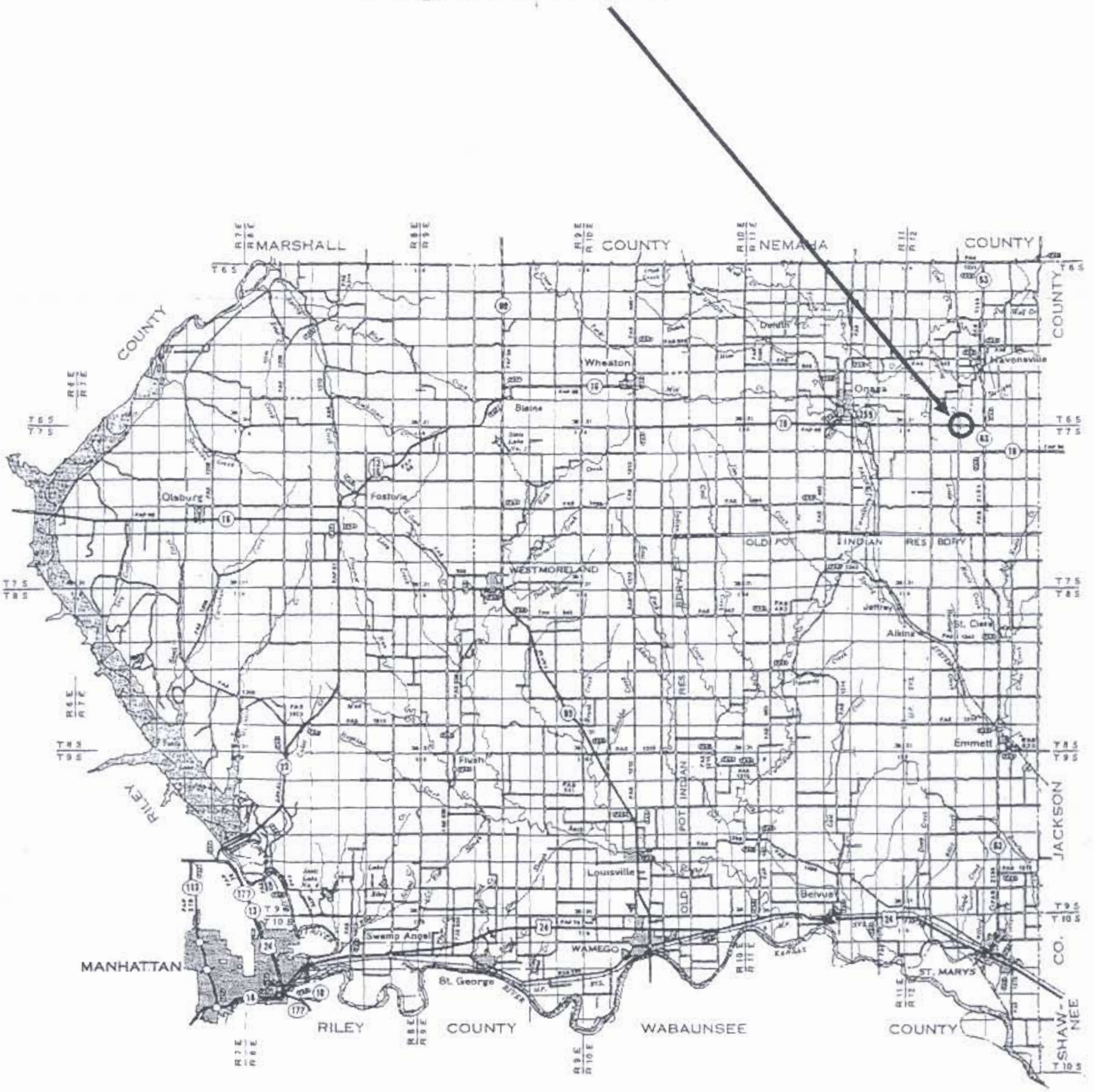

Pottawatomie County

INTRODUCTION

The content of this report supplies geologic information pertaining to the design of a new structure for Highway 16 over Spring Creek. Location of this bridge site is approximately 6.8 km (4.23 mi) East of Jct. K-16 and County road 259, and approximately 1.61 km (1.0 mi) west of K-63.

GEOLOGIC FOUNDATION MATERIAL

MANTLE

The soil mantle is classified as all unconsolidated material above bedrock. Most of the mantle is composed of alluvium and fill for the existing bridge. Alluvial deposits are comprised of silty clay, with traces of sand and gravel. Large cobbles and boulders of Limestone have been placed in a matrix of concrete to prevent erosion of the channel and around the wing walls of the existing bridge. Thickness of the soil mantle varies from 2.9 m (9.51 ft) to 7.0 m (22.97 ft).

BEDROCK

The bedrock of the proposed bridge site is unique consisting of several structural features. Bedrock within the eastern portion of Pottawatomie County is part of a structural phenomenon know as the Nemaha Anticline (Nemaha Uplift). The design location of the new bridge is several kilometers east of the anticlines main fold axis, which trends north and slightly east. The eastern limb of the anticline dips south and east between 5-12° regionally. Bedrock at the designed location follows the east limb trend and includes a small syncline and an apparent anticline.. According to drill logs, the east limb of the anticline shows a dramatic displacement between lithologies. Directly below the designed location for abutment two, within a 6.0 m (19.69 ft) horizontal, beds within this apparent antiform are displaced by approximately 2.5 m (8.20 ft). Interpolation between these beds gives a dip of approximately 21°. Generally, dipping beds within Kansas do not exceed 3-4°. A 21° dip is quite large even for this geologically structured active area. Another more likely explanation for such a displacement is a fault. Faults are known to be associated with the Nemaha Uplift and would include the well known Humboldt fault near Tuttle Creek and Manhattan. These faults are considered to be slightly active and could potentially create a fair amount of damage in future seismic events. Without much surface evidence structural interpretation of these faults and exact locations are ambiguous without extensive field work.

Lower Permian Series
Gearyan Stage
Council Grove Group
Grenola Limestone Formation

Salem Point Shale Member

The Salem Point Shale Member is olive grey and slightly calcareous. Core samples of the "Salem Point" appear slightly wavy bedded, crumbly, and argillaceous. Approximately 2.19 m (7.19 ft) of the Salem Point Shale Member was cored.

Burr Limestone Member

The Burr Limestone Member contains an upper and lower limestone layer and a shale layer in between. The upper limestone is approximately 1.2 m (3.94 ft) thick and light grey. It contains few shale seams, plentiful plant debris, and is horizontally bedded. At the top of the upper "Burr Limestone", approximately 0.2 m (0.67 ft) is pitted, suggesting dissolution of small amounts of dolomite. The shale layer separating the upper and lower limestone layers is approximately 0.55 m (1.80 ft) thick. It is dark grey, slightly wavy bedded with no fossil content observed. The lower limestone is approximately 0.83 m (2.72 ft) thick. It is grey, wavy bedded, and contains an abundance of fossil clasts. The abundance of fossil clasts suggests an ancient high energy environment. The lower limestone is argillaceous and grades into the middle shale layer above. The overall cored thickness of the Burr Limestone Member is 2.6 m (8.53 ft).

Legion Shale Member

The Legion Shale Member is dark grey to grey. It is argillaceous and becomes crumbly and swells considerably when hydrated. The "Legion Shale" is slightly wavy bedded and calcareous. Approximately 1.0 m (3.28 ft) of the Legion Shale Member was cored.

Sallyards Limestone Member

The Sallyards Limestone Member is a light grey, thin limestone bed. It contains small styolitic shale seams and it's texture is distinctly pebbly with small fossil fragments. Thickness of the Sallyards Limestone Member is approximately 0.4 m (1.31 ft).

Roca Shale Formation

The Roca Shale Formation contains a variety of colors and lithologies. The upper 1.61 m (5.28 ft) is a blue-grey, swelling calcareous shale with some locations containing a limestone lens of approximately 0.4 m (1.31 ft). The limestone lens was interpreted from power auger soundings only. Below the upper portion, is approximately 5.64 m (18.50 ft) of alternating shale and limey shale layers with various colors of grey, olive-grey and maroon. Bedding is mostly wavy bedded and small limestone stringers less than 0.1 m (0.33 ft) are present. Total cored thickness of the Roca Shale Formation was 7.25 m (28.79 ft).

FOUNDATION RECOMMENDATIONS

ABUTMENT FOUNDATIONS

PILE FOOTINGS

Because of structural deforamtion within the bedrock, and the high potential of scour, we recommend the design of pile footings for both abutments of the proposed bridge. It is recommended that pre-drilled point bearing H-pile be used at both abutment locations with the H-pile founded 0.46 m (1.5 ft) into the Burr Limestone Member. It is also recommended that an oversized hole (with diameter of 0.46 m (1.5 ft)) be used for the pre-drilled locations. After placing pile at desired elevation, the oversized hole should be filled with concrete to the mantle/bedrock contact. Next, sand should be used in the annular space around the pile from the mantle/ bedrock contact to the base of the abutment. Pile footings should be designed for loads no greater than 9 ksi or 490 kN (55 tons) for 10x42 H-pile.

The following table lists the suggested design pile tip elevations for the abutment foundations of the proposed structure. Due to drastic changes in bedrock elevation, cross-sections of the abutments have been prepared from interpolated geology. Elevations are given from A-A′ for Abutment 1, and B-B′ for Abutment 2. Cross-sections were drawn along the axis of the abutments, 6.7 m (21.98 ft) left and right from centerline to the edge of the bridge.

PILE FOOTING DESIGN
ABUTMENTS

K-16 over Spring Creek
Br. No. 16-75-37.34(058)

Location	Centerline Station	Elevation Top of Bedrock at Centerline	Pile Tip Elevation (Predrilled elevation)
Abutment 1	10+598.881	366.90	A - centerline - A′ 366.49 - 365.99 - 365.26
Abutment 2	10+613.881	366.94	B - centerline - B′ 366.52 – 365.79 - 365.08

The following note should be placed in the Construction Plans:

Pile Note:

It should be understood that bedrock is based on interpolations from power auger and core hole soundings. Because of bedrock deformation the above elevation recommendations are the best possible interpolations according to field data. During construction, elevations may vary from those listed above.

SPREAD FOOTING OPTION

Spread footings are also an option to support the abutments of the proposed structure. However, spread footings are not a desirable option because of bedrock structural deformation, and high potential of erosion. Due to the possible intense folding and/or faulting, excavation of a spread footing could potentially be extremely cumbersome and costly. If spread footings are chosen, they should be placed in firm competent limestone of the Burr Limestone Member for all locations. The maximum design bearing pressure for spread footings for this proposed structure should not exceed 1436 kPa (15 tsf) for the Burr Limestone Member. The recommended bottom footing elevations for spread footing design are listed in the table below. As mentioned above, due to structural deformation of bedrock, cross-sections have been prepared for base of footing elevations. Cross-sections are of the same dimensions and orientations used above in the pile tip elevation recommendation.

SPREAD FOOTING DESIGN

K-16 over Spring Creek
Br. No. 16-75-37.34(058)

Location	Station	Elevation Top of Bedrock at Centerline	Elevation Base of Footing
Abutment 1	10+598.881	366.90	A - centerline - A′ 366.65 – 366.18 – 365.42
Abutment 2	10+613.881	366.94	B - centerline - B′ 366.68 – 365.95 - 365.24

If the designer chooses spread-footing foundations, the following notes should be included in the Construction Plans:

Note:

It should be understood that bedrock is based on interpolations from power auger and core hole soundings. Because of bedrock deformation the above elevation recommendations are the best possible interpolations according to field data. During construction, elevations may vary from those listed above.

If spread footings are designed for this structure, place the following notes in the plans:

Spread Footings:

"All excavation below the top of rock or the top of footing within 1.0 m of the edge of the footing will be done by hand equipment only, no machine rock excavation is allowed below the top of the footing. Cut the rock to neat lines shown on the plans. Do not use side forms but cast the concrete against the rock. Allow no loose material within the footing when the footing is considered ready to pour. If the material at the bottom of the footing does not match the material shown on the geology sheet do not precede until the regional geologist reviews the site".

"For all bridge spread footing locations, drill a 40-50 mm hole 1.5-m deep in the presence of the Engineer to verify the quality and soundness of the material below the footing. For footings less than 10 m^2 drill one hole in the center of the footing and for footings greater than 10 m^2 drill one hole at each corner".

"When the material in the sides of the footing is shale, do not allow water to pond in the footing excavation pit. Many Kansas shale members weather quickly in the presence of water. Once the excavation in shale is complete, place the reinforcing steel and concrete in less than 24 hours to minimize the exposure time of the shale. If the water cannot be cut off, then seal coarse of Grade 25 concrete may be used to encase the bottom of the footing. Consult the State Bridge Office before attempting a seal coarse. If water is persistent, then tremie the concrete to the seal course. Do not allow the concrete to be placed on or through water where mixing or washing of the concrete can occur. Do not allow concrete to be placed if water is moving through the footing".

Backfill the spread footing excavation with crushed stone to within one meter of the top of bedrock and then fill with commercial grade concrete.

INVESTIGATIVE CORE HOLE

An investigative core hole will be required at both Abutments of the proposed structure.

FOUNDATION INSPECTION

Please contact the Lawrence Regional Geology Office when construction begins on the pier foundations so that our personnel may observe the bedrock at the design bearing elevations.

LATERALLY LOADED PILE

Design parameters for laterally loaded pile using a 0.91 m (3.0 ft.) diameter shaft are as follows:

Mantle: Stiff clay

Effective weight=67.242
C1=3.045 EE50=0.005

GAM1=0.067 K=1728.000

Limestone: Upper Burr Limestone Member

Qu= 143.59 tsf

NPPY = 3 , GAM1 = 0.150 kcf

YP (I,J)	PP (I,J)
0.0	0.0000
0.0012	344.616 k/ft
0.0072	430.770 k/ft

Shale: Middle Burr Limestone Member

N/A

Limestone: Lower Burr Limestone Member

Qu= 327.59 tsf

NPPY = 3 , GAM1 = 0.155 kcf

YP (I,J)	PP (I,J)
0.0000	0.0000
0.0012	786.216 k/ft
0.0072	982.770 k/ft

Shale: Legion Shale Member

Qu= 5.74 tsf

NPPY = 3 , GAM1 = 0.135 kcf

YP (I,J)	PP (I,J)
0.0000	0.0000
0.0210	9.643 k/ft
0.0610	17.220 k/ft

Limestone: Sallyards Limestone Member

N/A

Shale: Roca Shale Formation

Qu= 15.92 tsf

NPPY = 3 , GAM1 = 0.140 kcf

YP (I,J)	PP (I,J)
0.0000	0.0000
0.0210	26.746 k/ft
0.0610	47.760 k/ft