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THURBER

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION

SITE NC18: PEMBINA RIVER BRIDGE

LEGAL LOCATION:	**NE15-57-05-W5M**
NEAREST LANDMARK:	**12 KM NORTH OF CHERHILL**
Highway Control Section:	**HWY 764:02 km 12**
Date of Initial Observation:	**1990**
Date of Last Inspection:	**2003**
Last Inspected By:	**Thurber Engineering Ltd. (Thurber)**
Instruments Installed:	**7 Slope Inclinometers (1997), 3 Standpipe Piezometers (1996)**
Instruments Operational:	**7 Slope Inclinometers (2004), 2 Standpipe Piezometers (2004)**
Risk Assessment:	PF(3) · CF(4) = **12**
Last Updated:	July 2004 – Thurber Engineering Ltd.

1. LOCATION

The site is located at the Pembina River crossing on Hwy 764:02 (Bridge File #9333) about 12 km north of Cherhill, on Highway 43, as shown on Figure NC18-1, Section F.

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

The site is located on a meander of the Pembina River with the south abutment on the outside bank. The valley wall height at this location is approximately 14 m. The south slope rises sharply to the surrounding upland elevation. The north abutment fill rests on a flood plain on the inside of the meander loop.

A detailed review of available information is provided in Thurber letter to UMA Engineering dated July 16, 1996, and is attached in Section G. The results of a geotechnical investigation undertaken by Thurber are provided in a report to UMA Engineering Ltd. dated December 12, 1996 (text also included in Section G). This information is summarized below. Site features are shown on the site plan and cross-section drawings (Figures NC18-1 and NC18-2), attached in Section F.

Distress to the south and north abutment concrete faces of the Pembina River Bridge had been observed for a number of years prior to a major repair undertaken in 1997. This distress included significant movement of the south pier and settlement of the road surface north of the north abutment. In addition, some of the H-piles at both abutments had broken out of the faces of the abutments. The cause of this distress was determined to be instability of the south abutment slope.

The movement of the south slope was confirmed to be due to artesian pressures in the 1996 investigation. The slope failure surface was situated within layered sand and clay deposits as deep as 15 m below ground level at mid-slope of the abutment. It appears that the cracking on the south approach roadway was consistent with a natural (pre-construction) slope trend in the area. In addition, over-steepening due to the abutment fill placement at the crest of the slope had contributed to the destabilization of the slope.

Settlement was observed within the north abutment fill prior to 1996, and slope inclinometer movements indicated a shallow lateral (eastward) spreading of the abutment fill.

The major repairs in 1997 involved extending the bridge further south so the abutment fill could be removed and installing subhorizontal and vertical drain pipes to relieve artesian pressures beneath the site. The repairs, soil stratigraphy, and potential failure surfaces are noted on Figure NC18-2 and subhorizontal drain

layout is shown in Figure NC18-3. A buttress fill was also constructed in 1997 along the east side of the north approach fill to improve its stability.

A total of 15 Slope Inclinometers (SI) and 4 Standpipe Piezometers (SP) were installed by AT at this site prior to 1996, including ten SI's and two SP's on the south abutment and five SI's and two SP's on the north abutment. In 1996, Thurber installed eight additional SP's, seven on the south abutment and one on the north. As of 2004, the operational instrumentation includes two slope inclinometers (SI#22 and SI#21) and one standpipe piezometers (SP96-1) on the south abutment, and five slope inclinometers (SI#7, SI#8, SI#9, SI#23 and SI#24) and one standpipe piezometer (SP#2) on the north abutment. The latest readings for these instruments are provided in Sections C and D of the binder.

A significant flow volume has been observed from the drain outlets since installation. No buildup of sediment has been noted in the clean-out points. As of 2004, only insignificant slope movement and water level changes were observed at the south and north abutments since the start of measurement in 2002 and no obvious signs of distress were visible so it appears that the remedial work undertaken in 1997 is performing well.

A shallow slump formed within the backslope on the west side of the south approach, as first noted during the 2002 inspection.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: East Alberta Plains (1969, Atlas of Alberta, University and Government of Alberta).

Bedrock Geology: The bedrock at the site is grey sandstone, mudstone, bentonite, and scattered coal beds of the Cretaceous Wapiti Formation. Bedrock is expected to be greater than 30 m below ground surface. A preglacial bedrock valley thalweg is located just north of the site were it follows the north side of the meanders of the current Pembina River.

Surficial Geology: The uplands at this site to either side of the river valley are located in an ice-contact lacustrine deposit where the soils are expected to consist of a mantle of clay overlying a glacial till deposit. The topography is rolling from the relief in the till formation. In the river valley, the site is located in a fine sediment fluvial deposit where soils are expected to consist of layers of sand, silt, and clay. The topography within the valley will be fairly flat with only limited relief.

Hydrogeology: The sandstone bedrock at the site may be able to provide up to 2 L/s of groundwater flow. However, an area of artesian flow is located beneath the south portion of this site. The area is shaped in plan view like an upside-down

"U" with the east leg passing beneath the Oldman Lake and the west loosely following Coyote Creek. Wells drilled in these legs encountered flowing conditions. The closest well was located in NW5-57-04-W5M. Groundwater is at approximate elevation 670 m and flow directions are generally downward in this area with the exception of the deeper artesian conditions at the south end of the site. Interpolated near-surface horizontal flow is toward the Pembina River.

The site is located south of the thalweg of a pre-glacial buried channel. A large area of known artesian flow conditions is located within the pre-glacial valley deposits with its margin approximately 1 km south and east of the site, based on published hydrogeological mapping, and may be connected hydraulically to the lower sand deposits.

Stratigraphy:

A geotechnical investigation was undertaken by Thurber in September 1996 to complement existing Alberta Transportation information. The soil stratigraphy is complex but in general consists of lacustrine clay over clay till to a depth of approximately 20 m below the upland level, overlying interlayered sand and clay deposits with some silt zones. Bedrock was encountered infrequently. The south abutment fill appears to consist of firm to stiff clay and the north abutment fill of silt and clay fill with some sand zones that are relatively loose.

Test hole logs from holes completed in February 1991 and September 1996 are included in Section G.

4. CHRONOLOGY

1990

AT installed a drainage pipe ("Big O") across Hwy 764 just south of the bridge at Station 0+965 (as shown on a June 1989 plan). An impermeable liner was placed on the bottom and north (downhill) sides and the pipe sloped from the centreline to the subsurface drains in each ditch about 3.2 m below ground level. Installation details are shown on the plan included in Section G.

1991

Pressuremeter testing was undertaken by AT at the bridge site in the south approach area. The testing was carried out at 3.9 m, 5.6 m, and 6.9 m. Continuous Shelby tube samples were taken over the corresponding intervals for laboratory comparison. The site plan and test hole logs are included in Section G.

1995

Four inclinometers were installed in September/October but were not read until October 1996 and were subsequently destroyed during the 1997 construction.

1996

A site visit and review of proposed repair measures was done by Thurber and the final report (included in Section G) was dated July 16, 1996, under File 15-550-103.

In September, eight test holes were drilled at the site by Thurber to sample for laboratory testing and installation of standpipe piezometers. The supplementary geotechnical report issued on December 12, 1996, under File 17-550-103, is included in Section G.

1997

Major repairs were undertaken to stabilize both approaches including:

- constructed a sideslope berm on the east side of the north abutment fill to address the roadway settlement;
- placed a facing of free-draining coarse granular material on the north abutment headslope to assist in draining the existing fill;
- unloaded the south abutment which required the installation of another bridge pier and an extension of the bridge deck;
- installed a drainage system (horizontal and vertical) to relieve artesian pressures;

2002

An annual inspection was done by Thurber. Recommendations for repairing the backslope slump on the east side of the south abutment were: cutback slope to flatten, maintain west ditch to prevent water flow across the slope, reshape lower portion of slope to close cracks and provide lateral drainage, and place topsoil and seed to reduce future erosion. In addition, it was recommended that the headslope outflow pipe should be cleared yearly. A copy of this report is included in Section B.

2003

The annual inspection undertaken by Thurber noted on-going problems including that the backslope repair was not undertaken as recommended and high river flow events are plugging the outflow pipes. A copy of this report is in Section B with supporting drawings and photographs in Section F.

REFERENCES

1. Thurber Engineering Ltd., September 16, 2003. "North Central Region Landslide Assessment, HWY764:02 Pembina River Bridge North of Cherhill (NC18), 2003 Annual Inspection Report." File 15-16-167.

2. Thurber Engineering Ltd., March 12, 2003. "North Central Region Landslide Assessment: SH764:02 Pembina River Bridge North of Cherhill (NC18), 2002 Annual Inspection Report." File 15-16-11.

3. Thurber Engineering Ltd., December 12, 1996. "Pembina River Bridge on SH764:02, Bridge File #9333 – Supplementary Geotechnical Investigation." File 17-550-103.

4. Thurber Engineering Ltd., July 16, 1996. "Re: Pembina River Bridge on SH764, Bridge File #9333 – Geotechnical Review of Proposed Rehabilitation Work." File 17-550-103.

5. Alberta Research Council, 1990. "Quaternary Geology, Central Alberta."

6. Alberta Research Council, 1972. "Hydrogeology of the Wabamun Lake Area, Alberta." Report 72-8.

7. Research Council of Alberta, 1970. "Bedrock Topography of the Wabamun Lake Map-area, NTS 83G, Alberta."

8. University and Government of Alberta, 1969. "Atlas of Alberta."