THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION

SITE NC59: LITTLE PADDLE RIVER SLIDE

LEGAL LOCATION:	S31-57-8-W5M
NEAREST LANDMARK:	3.5 km Northwest of Mayerthorpe
HIGHWAY CONTROL SECTION	HWY 43:16 km 41.4
DATE OF INITIAL OBSERVATION:	1995
DATE OF LAST INSPECTION:	June 11, 2008
LAST INSPECTED BY:	Thurber Engineering Ltd.
INSTRUMENTS INSTALLED:	3 Slope Inclinometers (1995) 1 Pneumatic Piezometer (1995) 5 Slope Inclinometers (2005) 7 Pneumatic Piezometers (2005) 6 Pneumatic Piezometers (2006)
INSTRUMENTS OPERATIONAL:	1 Slope Inclinometer (2008) 1 Pneumatic Piezometer (2008)
RISK ASSESSMENT:	PF(4) CF(4) = **16** (2008)
LAST UPDATED:	April 2009, Thurber Engineering Ltd.

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1. LOCATION

The site is located on Highway 43:16 about 3.5 km northwest of Mayerthorpe, Alberta, at a location where the highway parallels the Little Paddle River.

2. GENERAL DESCRIPTION OF DISTRESS

The highway is a four-lane divided highway. The initial slide occurred in 1995 and affected the southwest lane of the then-undivided highway embankment over a length of about 75 m. During construction of the new southeast-bound lanes (built southwest of the original highway) in 2004, the slide was reactivated and affected about 120 m of the new highway embankment. The highway embankments are constructed on a gentle slope southwest toward the Little Paddle River located about 80 m from the shoulder of the new highway embankment.

Subexcavation and reconstruction of the newly constructed embankment in 2004 was not sufficient to stop the movement so a geotechnical investigation was undertaken in 2005. It was determined that the movements were occurring in high plastic clay above the interface with the underlying clay till and that it was likely driven by high pore pressures in the clay induced by the placement of the new highway embankment fill.

Based on the recommendations provided, the slide was repaired in 2006 using partial excavation, installation of wick drains, installation of stone columns, and placement of a small toe berm. The highway was paved in 2007. The annual site inspection in 2008 observed that the crack had begun to appear in the new pavement and future monitoring was recommended. Minor cracking has continued in the northwest-bound lanes (original highway).

Part of the new highway construction involved excavating a diversion channel for a triburtary stream of the Little Paddle River. This channel was excavated east of the new Little Paddle River bridge and over-steep slope angles resulted in a 60 m to 70 m slump, in 2007, on the northeast side of the channel. This slope was flattened later that year and, in 2008, the distress was not observed and vegetation cover was dense and healthy.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: Eastern Alberta Plains of the Interior Plains (1969, Atlas of Alberta, University and Government of Alberta).

Bedrock Geology: The bedrock at the site is non-marine clayey sandstone and bentonitic mudstone with some scattered coal and bentonite beds of the Horseshoe Canyon Formation (Map 236). The bedrock elevation is about 660 m (Map 57) which is about 45 m below ground surface. The bedrock dips southeast toward a bedrock channel (sloping northeast) approximately coincident with the present-day Paddle River.

Surficial Geology: A large-scale (1:500,000) surficial geology map indicates that the site is located in an area of fine-grained sediments (silt and clay) deposited in ice-contact lacustrine environment with undulating to hummocky topography (Map 213).

Hydrogeology: The Horseshoe Canyon Formation bedrock would have an expected yield of 0.3 L/s to 1.6 L/s groundwater flow with lesser flows expected from the overlying sediments. The elevation of the regional groundwater table is not well-defined in the vicinity but based on the limited information, is likely near surface. Regional groundwater flow is southeast toward the Paddle River and then northeast along the river. The site is located in an area of known artesian flow conditions.

Stratigraphy: Geotechnical investigations were undertaken in 1995 and 2005. A total of 22 instruments (slope inclinometers and pneumatic piezometers) have been installed at this site. Both investigations, one for slide in the original embankment and the second for the reactivated slide affecting the new embankment, encountered the same soil stratigraphy.

Based on the more-recent investigation, the soil stratigraphy consists of clay fill (from both the new and old embankments) over high plastic clay, and medium plastic clay till. Medium plastic clay with some sand layers is present below ground surface closer to the river. Part of the original highway embankment was built over a layer of peat situated on top of the high plastic clay. Both the high plastic clay and clay till layers dip downward toward the Little Paddle River. The high plastic clay had SPT N values (blows per 300 mm of penetration) ranging from 5 to 15 whereas the clay till had N values of 10 to 19. At the time of the 2005 investigation, the pore water pressures measured in the clay and clay till were between 3 m and 5 m above the estimated long-term values.

4. CHRONOLOGY

1995

A sideslope slump had occurred on the southwest side of the embankment affecting most of the roadway width over a length of about 75 m. The embankment was about 6 m high with 2.5H:1V slopes. A drilling program was proposed for the site in early September and appears to have been undertaken by Shelby Engineering Ltd. later that month. A total of four test holes were drilled in the southwest embankment of the original Hwy 43:16. Three slope inclinometers and one pneumatic piezometer were installed. The slope inclinometers were installed at the top (shoulder of the highway), mid-slope, and toe of the embankment fill. A piezometer was installed with the top inclinometer. The stratigraphy encountered was clay fill overlying native high plastic clay over medium plastic clay till. The test hole at the shoulder encountered a layer of peat between the clay fill and native clay.

Slope inclinometer readings taken in 1995 and 1996 indicated that the failure plane was about 7 m to 8 m below ground surface. However, no details regarding the assessment, recommendations, nor remedial measures were noted in the AT files.

2004

A failure occurred during construction of the new southeast-bound lanes (twinning of Hwy 43:16) in the same location as the historical movements of the northwest-bound lanes (original Hwy 43:16). The slide mass was partly excavated and reconstructed with flatter sideslopes. Later that fall, cracks began re-appearing and movement continued into 2005.

2005

A site reconnaissance was undertaken by Thurber in August. At that time, only one of the previously installed inclinometers (SI1 at the top of the original highway embankment) could be located. There was evidence of patching of the existing highway at this location.

A geotechnical investigation was undertaken by Thurber in September. A total of five slope inclinometers and seven pneumatic piezometers were installed and two additional test holes were drilled. The subsurface soil conditions encountered, in descending order, consisted of new embankment fill, old embankment fill, medium plastic clay, high plastic clay, and medium plastic clay till. The slides of the original and new embankments appeared to be occurring in the high plastic clay just above the interface with the clay till. Excess pore pressures about 3 m to 5 m above long-term levels were measured likely in response to the recent fill placement for the twinning construction. Movement was measured in the new embankment fill but not in the original embankment.

It was recommended that wick drains be installed into the high plastic clay to assist with the reduction of the excess pore pressures to allow construction of the highway to continue. Natural dissipation was estimated to require several years.

Slope stability analyses determined that wick drains alone would be insufficient to provide an appropriate long-term factor of safety; thus, placement of a toe berm was also recommended.

Note that the geotechnical report from this investigation has been provided previously for inclusion in Section G of the Site Binder and it includes the 1995 test hole logs and slope inclinometer readings.

2006

The slide was repaired according to the recommendations provided in 2006. The slide mass was partly excavated and rebuilt and wick drains where installed into the high plastic clay. In addition, stone columns were installed near the toe of the embankment to provide additional resistance against sliding and 3 m high toe berm was constructed. An additional six pneumatic piezometers were installed prior to and during construction to monitor the performance of the embankment. Most of the instrumentation was damaged or destroyed during construction

2007

The first annual site inspection under the GeoHazard assessment program was undertaken by Thurber in May. Shortly prior to the site inspection, Thurber was informed that new cracks had developed and settlement was observed around one of the slope inclinometers. At the time of the investigation, the granular base and asphalt pavement had not yet been placed and final grading was not complete.

No new distress was observed in the existing highway embankment (future northwest-bound lanes); however, the prior cracks in the asphalt were still visible over about 50 m length of highway. The cracks around the slope inclinometer (SI19) appeared to be due to localize settlement. There were new longitudinal cracks noted along the southwest and northeast sides of the new embankment; these cracks also appeared to be related to embankment settlement as the prior, slide-related crack had not reappeared. According to construction personnel, there had been water flowing from the subdrains connected to the wick drain drainage blanket. Some erosion was noted in the ditch from the subdrain and culvert (located southeast of the slide) outlets.

A new slump of about 60 m to 70 m long and was observed along the northeast slope of a creek diversion channel east of the new Little Paddle River bridge (for the southeast-bound lanes). The toe bulge had caused heave of the diversion channel bed. It was determined that the likely cause of this failure was over-steep cut slopes constructed in the native clay through which the diversion channel runs. It was recommended that slope flattening be undertaken where space permitted and that monitoring of this feature continue. This work was undertaken the same summer.

2008

The annual Geohazard inspection was conducted in June. The new highway embankment had been paved and was open to traffic. The previous crack had begun to reappear affecting about 120 m of highway. Based on the remaining pneumatic piezometer, it appeared that construction-induced pore pressures were continuing to decrease. The distress in the original embankment did not appear to have changed significantly. However, it was recommended that additional instrumentation be installed to continue monitoring the slide movements.

The slump near the Little Paddle River bridge was not visible and vegetation growth was heavy. It was noted that there was some undercutting of the aprons at the NE and SE quadrants of the new bridge.

5. REFERENCES

1. University and Government of Alberta, 1969. “Atlas of Alberta”.

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3. Alberta Research Council, 1971. Map No. 57. “Bedrock Topography of the Wabamun Lake Map-Area, NTS 83 G, Alberta”.

4. Hamilton, M.N., Price, M.C., and Landenberg, C.W. (compilers), 1999. Geological Map of Alberta, Alberta Geological Survey, Alberta Energy and Utilities Board, Map No. 236, scale 1:1,000,000.

5. Shetsen, I. 1990. Quaternary Geology, Central Alberta. Alberta Geological Survey, Map 213.

6. Canadian Centre for Mapping, Department of Energy, Mines and Resources, 1989. NTS 1:50,000 Topographic Map, 83 G/14: Mayerthorpe, Alberta.

7. Alberta Transportation, Geotechnical Files.