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THURBER

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

PEACE REGION
(SWAN HILLS)

SITE SH14: SALT CREEK SLIDE

LEGAL LOCATION:	**NE34-76-14-W5M**
NEAREST LANDMARK:	**4 KM NORTH OF JCT HWY 679 AND 750**
Highway Control Section:	**HWY 750:04 km ~1**
Date of Initial Observation:	**1988**
Date of Last Inspection:	**2004**
Last Inspected By:	**Thurber Engineering Ltd. (Thurber)**
Instruments Installed:	**2 Slope Inclinometers (2002), 2 Standpipe Piezometers (2002)**
Instruments Operational:	**2 Slope Inclinometers (2004), 2 Standpipe Piezometers (2004)**
Risk Assessment:	PF(10) · CF(4) = **40**
Last Updated:	July 2004 – Thurber Engineering Ltd.

1. LOCATION

The site is located on the west side of Highway 750:04 approximately 4 km north of the junction of Highways 679 and 750 (Figure SH7-1 and -2, Section F).

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

This section of the highway is located on a sidehill embankment fill approximately 7.5 m high at the slide location. A toe berm is present along the lower part of the slope. The upper part of the slope above the toe berm is approximately 4.3 m high with 11° side slopes and is well covered with grass. The toe berm is about 9 m wide and 3 m high with side slopes of 9° to 15°. Two 150 mm-diameter CSP culverts are at the toe of the berm and were likely installed to provide drainage during previous slide repairs. The area to the west of the embankment fill is flat-lying ground covered in natural bush.

The instability consists of a 40 m-long slump in the west side slope. The asphalt surface has arc-shaped cracks. An intermediate scarp about 100 mm high is present near the top of the upper slope. The upper portion of the slide has pushed out a barbed-wire fence about 0.6 m at the contact between the upper slope and toe berm. Two Telus cables have been routed overland along the fence line over the slide area. Erosion and shallow instability have also been observed in the west ditch where it descends the edge of the sidehill fill to the northwest of the slide area. See Figure SH14-3 and -4, Section F, for a plan and cross-section sketch of the distress at the site.

The site has a history of instability going back to 1988 when a slide occurred in July on the west side of the highway. At that time, the slide was about 80 m wide with a 25 m crack at the highway centreline and 0.3 m of differential settlement. Following a brief test pit investigation, it was recommended that a toe berm be constructed along the west side and a subdrain be installed below the east ditch to stabilize the slope. The berm was constructed sometime after the 1988 visit.

In 2001, Thurber commenced annual assessments of the site after AT took over responsibility for the site from the MD of Big Lakes in that same year. The annual inspection reports are included in Section B with figures and photographs in Section F.

The instrumentation at this site consists of two standpipes and two standpipe piezometers installed by Thurber in 2002. As of 2004, all instrumentation was still functional. Copies of the routine monitoring inspections and instrumentation plots are included in Sections C and D.

The slope inclinometers indicate a slip surface about 5.2 m below ground level at the shoulder of the highway and 4 m below ground at the berm location. The slide

creep rate was between 19 and 24 mm/year in 2003 which was reduced from 18 to 63 mm/year in 2002. The piezometric surface is about 2 to 2.5 m below ground surface and has been fairly stable at that depth.

The instability may be due to groundwater seepage out of the sidehill, buried organic layers and weak clay fill and foundation soils. Since the site had experienced a sliding event leading to berm construction in 1994, it is possible that the natural and fill materials were at or close tc their residual strength values prior to the more recent slide event in the upper slope. The overall height and inclination of the highway embankment and toe berm fills is too steep for the existing relatively weak and wet clay foundation soils. The slide appears to be moving in two blocks: an upper block which is spilling out onto the berm and pushing out the fence and a lower, more deeply-seated block that extends below the slope and the toe berm. The upper slope is still creeping and will continue to affect the highway until further stabilization measures are carried out.

In the last few years, asphalt patching maintenance to the highway surface has been carried out to preserve a smooth surface. Long-term measures recommended have included drains through the slide area, replacement of the upslope subdrain, reconstruction of the failed slope, and enlarging the toe berm.

3. GEOLOGICAL/GEOTECHNICAL CONDITIONS

Physiographic Region: Boundary between Lesser Slave Lowland to the south and Utilcuma Upland to the north (1969, Atlas of Alberta, University and Government of Alberta).

Bedrock Geology: The bedrock at the site is marine dark grey shale and silty shale, with ironstone partings and concretions of the Smoky Group.

Surficial Geology: No information available.

Hydrogeology: The deeper bedrock at this site (Dunvegan Formation) may be capable of providing groundwater flow up to 0.4 L/s while the shallower Smoky Group is only capable of up to 0.1 L/s. Near-surface groundwater flow is interpreted to be downward at this location with horizontal flow likely toward the Salt Creek which flows to the southwest to Buffalo Bay of Lesser Slave Lake.

Stratigraphy: Based on Thurber's 2002 geotechnical investigation, the soils at the site consisted, in descending order: topsoil (in some test holes), clay fill, gravel fill, clay, clay till (interbedded with sand in one test hole). Bedrock was not encountered. The native clay below the fill soils was silty, medium to high plastic, and contained sand, gravel, oxides, and slickensides. Natural moisture contents ranged between 16% and 40%. The clay till was medium plastic, silty, sandy, contained some coal, oxides, gravel, and sand lenses, and had moisture contents

between 15% and 21%. In SI02-2, two sand layers were encountered in the clay till at 5.9 and 9.0 m below ground surface. Test hole locations are shown on Figure 15-16-154-1 along with the test hole logs in Appendix A of the installation letter report in Section G. AT's 1988 test pits indicate the presence of organic layers within and below the road embankment fill.

4. CHRONOLOGY

The history of this site was taken from Thurber's files and conversations with AT personnel documented therein and from a review of AT file for the control section.

1988

AT undertook an internal geotechnical investigation of the slide site. In July, three test pits were dug at the site: one at the crest, one partway down the slope, and one in the east backslope. At the time of the investigation, the slide was 80 m wide and 30 m high with the crest running along the highway centreline for about 25 m causing 0.3 m of differential settlement. The fenceline at the toe was displaced 1 to 2 m and an A.G.T. pedestal had been broken off. A.G.T. personnel were in the process of rerouting the lines to the west onto private lands. The test pit at the crest encountered, in descending order, silty clay fill, thin organic layer of branches and roots, silty clay, 0.3 m-thick organic layer, and high plastic grey clay. The test hole began to slough severely at 4.5 m deep. The second test pit encountered similar soils except for the upper clay fill and organic layer. Again, sloughing was severe below 4.0 m. The third test pit, in the east ditch, encountered, in descending order, silty clay, fine-grained sand, medium plastic clay, fine to medium grained sand. Seepage was observed from upper sand layer and the lower sand was saturated and sloughing.

It was hypothesized that the slide was the result of groundwater flow, as observed in Test Pit 3, saturating the silty clay fill. The slide plane was presumed to be through the thick organic layer about 4 to 5 m below ground with the crest of the slide at the highway centreline and the toe just beyond the fence. A toe berm of about 120 m in length and 5 m wide was proposed along with a subdrain in the east ditch from Sta. 46+600 to 46+400 daylighting at Sta. 46+330. The cost for the subdrain was estimated at $7,000. Test pit logs, sketches, and photos are included in Section G. It is assumed that the berm construction happened in the same year given the urgent nature of the repairs.

2001

Although Alberta Transportation (AT) did not take over responsibility for the highway from the MD of Big Lakes until July, it was inspected in June by Thurber after being added to the annual landslide assessments program in this year. At that time, the observed distress as a 40 m-long slump in the west sideslope of the

sidehill embankment fill. Arc-shaped cracks were visible on the west lane and had been recently sealed. An intermediate scarp near the top of the upper slope was 100 mm in height and a toe roll had visibly displaced the barbed-wire fence. The west ditch along the highway also showed signs of shallow instability due to erosion as it descended the edge of the sidehill fill.

In September, an asphalt patch was placed over the affected section of highway.

2002

A annual landslide assessment inspection was undertaken by Thurber in June. A measurement of the asphalt thickness indicated that about 275 mm of asphalt has been placed over time at the slide location. Additional distress was observed since the last inspection: three cracks had reappeared in the recent patch and additional bowing-out of the fence.

Geotechnical instrumentation was installed by Thurber consisting of two slope inclinometers and two standpipe piezometers. The logs for the test holes, showing instrumentation details, are provided in Appendix G.

2003

The annual inspection conducted by Thurber in June identified signs of additional movement since the conditions observed the year before. Several cracks have re-appeared or lengthened/widened in the 2001 patch; however, no signs of additional toe movement were observed.

REFERENCES

1. Thurber Engineering Ltd., July 18, 2003. "Peace River (Swan Hills) Region Landslide Assessment, SH750:04 Embankment Slump (SH14), Salt Creek, 2003 Annual Inspection Report." File 15-16-166.

2. Thurber Engineering Ltd., January 9, 2003. "Peace River (Swan Hills) Region Landslide Assessment, SH750:04 Embankment Slump (SH14), Salt Creek, 2002 Annual Inspection Report." File 15-76-13.

3. Thurber Engineering Ltd., September 3, 2002. "SH750:04 – Salt Creek Slide, Slope Indicator and Piezometer Installations." File 15-16-154.

4. Thurber Engineering Ltd., December 18, 2001. "Peace River (Swan Hills) Region Landslide Assessment, SH750 Embankment Slump (SH14), 2001 Annual Inspection Report." File 15-76-13.

5. Alberta Transportation and Utilities, July 19, 1988. Internal Memorandum: "S.R. 750:04 – Sideslope Failure, Sta. 46+490 Geotechnical Investigation."

6. Alberta Research Council, 1980. "Earth Sciences Report 79-3, Hydrogeology of the Winagami area, Alberta." Included "Hydrogeological Map, Winagami, Alberta, 83 N."

7. Research Council of Alberta, 1970. "Bedrock Geology of Northern Alberta – West Half."

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