THURBER ENGINEERING LTD.
Suite 200, 9636 - 51st Avenue
EDMONTON, Alberta T6E 6A5
Phone (780) 438-1460
Fax (780) 437-7125
www.thurber.ca

THURBER

ALBERTA TRANSPORTATION
LANDSLIDE RISK ASSESSMENT

SECTION A: GEOTECHNICAL FILE REVIEW

NORTH CENTRAL REGION

SITE NC25: WEST LINDBERGH HILL

LEGAL LOCATION:	**NE27-56-05-W4M**
NEAREST LANDMARK:	**16 KM EAST OF JCT HWYS 28 AND 646**
Highway Control Section:	**HWY 646:04**
Date of Initial Observation:	**2002**
Date of Last Inspection:	**2003**
Last Inspected By:	**Thurber Engineering Ltd. (Thurber)**
Instruments Installed:	**4 Slope Inclinometers (2002), 4 Standpipe Piezometers (2002)**
Instruments Operational:	**4 Slope Inclinometers, 4 Standpipe Piezometers (2003)**
Risk Assessment:	PF(10) · CF(6) = **60**
Last Updated:	July 2004 – Thurber Engineering Ltd.

1. LOCATION

The site is located along Hwy 646:04 on the north side of the highway about 16 km east of the junction of Highways 41 and 646 (Elk Point) as shown on Figure NC25-1, Section F.

2. GENERAL DESCRIPTION OF SLOPE INSTABILITY

The area of distress is located in a sidehill cut/fill section in a 60 m deep valley. The slope is approximately 15 m high and at an overall slope angle of about 4.5H:1V at the location of the slope instability.

A tension crack extends over a 50 m long section of the highway pavement in an arc pattern involving the full pavement width. The slope is failing to the north side, downslope to Moosehills Creek located approximately 250 m away from the toe of the slope. The crack was up to 5 mm wide with a 5 mm differential on the east side and a 100 mm wide tension crack was observed in the side slope approximately 4 m south of the pavement surface.

The side slope area adjacent to the slide has light bush and tree cover with no obvious signs of instability. There are indications of a slight toe bulge further down the slope which might also result from a small erosion channel in the area. Further downslope, a well site has been cut into the toe of the slope with the excavated material placed higher on the slope. No movements were observed in this 20° cut slope.

The back slope above the ditch immediately adjacent to the slide area has light bush cover which was disturbed or cleared in the last 15 years; however, no active slope movements were observed. Further upslope (about 10 m vertically) of the highway, the tree growth is older and active shallow slumping is occurring. Fallen and leaning trees and a 10 m-wide graben feature were also noted in the areas traversed.

The site has had history of instability going back to about 1982. Movement has been noted three times since then. Previous repairs have involved patching, crack repair, and the installation of a sub-drain pipe about 1 m below pavement surface under the north portion of the highway. A preliminary geotechnical investigation was carried out in 2002.

Several slope inclinometers (SIs) and standpipe piezometers have been installed at the site to monitor ground movements and groundwater levels. The locations of the instruments are shown on Figure NC25-1, Section F, and the test hole logs are included in Section G. All 4 SI's and 4 standpipe piezometers are still functional (as of 2003) and the latest readings for these are provided in Sections C and D.

A cross-section of the site in Section G, shows the stratigraphy of the site and the inferred slip surface. The slide affecting the highway appears to be part of a series of successive failure blocks involving the full valley slope. It is possible that the distress may be a reactivation of previous slope instability at this location. The 2002 preliminary geotechnical investigation and recent inclinometer results indicate that the slip surface appears to be located within a high plastic clay that is about 7.5 to 10 m below the ground surface. This slip surface likely exits near the toe of the existing slope with the back scarp located in the south shoulder and ditch. The movement rate was measured at about 40 to 50 mm per year. The groundwater table is between 6 m and 8 m below the ground surface.

A gas well and associated infrastructure are located near the toe of the slope.

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 marine dark grey shale and fine-grained sand, and sandy shale of the Cretaceous Lea Park Formation. The bedrock is approximately 45 m below top of valley elevation.

Surficial Geology: The site is located in a fine-grained ice-contact fluvial deposit immediately adjacent to a stream and slopewash eroded deposit. Surficial soils are expected to consist of interbedded or fingered sands, silts, and clays. The topography is undulating to hummocky.

Hydrogeology: The near-surface till formation in the area may be able to provide up to 2 L/s of groundwater flow. Bedrock formations would be limited to 0.1 L/s of groundwater flow. Groundwater flow directions are expected to be downward toward Moosehills Creek.

Stratigraphy: A stratigraphic cross-section from the 2003 preliminary conceptual design report is included in Section G. The test holes encountered sand and clay fill over interbedded layers of clay, clay till, and sand. Clay shale was encountered at all locations between 10 and 17 m below ground.

4. CHRONOLOGY

2002

Thurber carried out an Emergency Call Out geotechnical site reconnaissance of the slide area at which time cracking with some differential settlement was observed.

A preliminary geotechnical investigation was carried out in September. At that time, four slope inclinometers and four standpipe piezometers were installed.

2003

The preliminary conceptual design report prepared by Thurber recommended two potential remediation options:

- Construct a 15 to 20 m wide clay berm along an 80 m length of the toe of the slope with a subdrain for an estimated cost of $200,000 to $270,000. This was the preferred option.
- Excavate and replace, construct a retaining wall, install a drainage blanket and subdrain on the existing slope, regrade the sideslope, and construct a 20 to 25 m wide clay berm along the toe of the slope. The estimated cost for this option was between $350,000 and $500,000.

2004

The gas well located near the toe of the slope will govern the size of the toe berm that can be constructed. Thurber was given approval to carry out a supplementary investigation consisting of two test pits in the toe area and surveying of the gas well facility to assess the impact on the berm design.

REFERENCES

1. Thurber Engineering Ltd., March 20, 2003. "Hwy SH646:04 West Lindbergh Hill, Preliminary Conceptual Design." File 15-16-157

2. Thurber Engineering Ltd., June 27, 2002. "SH 646:04 Highway Distress Near Lindbergh, Alberta." File 15-16-143 (Emergency Call Out)

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

4. Alberta Research Council, 1976. "Hydrogeology of the Vermilion area, Albert." Report 75-5

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

6. Department of Mines and Technical Surveys, Geological Survey of Canada, 1951. Map 1002A: "Geological Map of Alberta."