THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

August 26, 2011 File: 15-16-258

Alberta Transportation
2nd Floor, Provincial Building
111 – 54 Street
Edson, Alberta
T7E 1T2

Attention: Mr. Cliff Corner

NORTH CENTRAL REGION GEOHAZARD ASSESSMENT
HWY 43:16 WHITECOURT EAST HILL (NC1)
2011 ANNUAL INSPECTION REPORT

Dear Sir:

This letter documents the 2011 annual site inspection of the Hwy 43:16 (km 1.9) Whitecourt East Hill site at legal land description NW26-59-12-W5M (Figure NC1-1A, Section F). Thurber Engineering Ltd. (Thurber) undertook this inspection in partial fulfillment of our Geotechnical Services for Geohazard Assessment, Instrumentation Monitoring and Related Work contract (CE103/2008) with Alberta Transportation (AT).

Mr. Don Law, P.Eng. and Mr. Ken Froese, P.Eng., of Thurber undertook the inspection on May 17, 2011, in the presence of Mr. Roger Skirrow, P. Eng., Mr. Neil Kjelland, P.Eng., and Mr. Reg Faulkner of AT.

1. BACKGROUND AND RECENT WORK

Thurber last visited the site in June 2010 and the site conditions at that time are described in our Part B assessment letter provided in the site binder. Additional information for the site is provided in the Geotechnical File Review in Section A of the binder.

2. SITE OBSERVATIONS

The changes in condition since last year are shown on the attached site sketch plan and cross-section, provided for inclusion in Section F of the site binder. Selected photographs taken during the visit are also attached.

2.1 Roadway

The roadway surface was inspected during the reconnaissance for the full length of the hill. The three sets of cracks located between Stations 1+840 and 1+980 have changed slightly since the 2010 site visit; specifically, the crack pattern has been reflected through the patching undertaken in August 2010.

The approximate locations of the cracks are shown on the site plan (Figure NC1-1A, attached for inclusion in Appendix F) with a detailed view of the crack patterns given in Figure NC1-2. Photographs of the cracks are attached.

The extension of the west crack into the median first observed in 2006 has not extended further; however, the differential first noted in 2009 has increased to 30 mm with the crack width increasing to between 5 mm and 10 mm. A second crack in the median was observed at the time of the 2011 site visit. The crack differential in the driving lanes was not present due to the recent patching but remained at about 20 mm at the north shoulder outside of the patch. The buckling of the guardrail first observed in 2008 at the shoulder of the west crack has not changed. The measured centre-to-centre distance between the posts on either side of the buckled section was 381 mm in 2008 and has not changed as of the 2011 visit.

At the time of the 2007 site visit, a transverse crack was noted extending through the driving lanes toward the centre median near the east end of the east crack. The crack had extended to the centre median at the time of the 2008 site visit but has not extended further since. The height differential across the east crack remained at 20 mm in the shoulder and has been eliminated by the patching within the east traveling lanes.

The set of cracking at the catch basin east of the east cracks was first observed in 2009. One of the cracks was not visible but the others had reflected through the recent patch and widths had returned to previous dimensions.

A gentle dip in the eastbound lanes at about Station 1+850 (opposite the west cracks) along with a short crack was observed in 2007. This dip is located over a culvert and a crack pattern had developed at the time of the 2008 visit. Although no further extensions of the crack pattern have been noted since 2009, cracks widths have increased and the dip appears to be slightly more pronounced as of the 2011 visit.

2.2 Toe Berm, Side Slopes and Back Slopes

The toe berm area north of the highway at Stations 1+600 to 1+800 exhibited no signs of slope movement (such as cracking, slumping, or seepage). In addition, no visual evidence of slope movement was noted in the back and side slope areas on either side of the highway.

As noted in previous years, some leaning trees were observed within the treed area located downslope of the highway and southeast of the toe berm (see Figure NC1-1A) and there was some potential slight increase in tree leaning was noted in the vicinity of SI06-4 during the 2011 visit. However, no tension cracks or seepage were observed in this area and no significant changes were noted from previous site visits.

During the 2007 visit, a sinkhole was noted in the Town of Whitecourt right-of-way, located east of SP06-3 approximately as shown on Figure NC1-1A. This sinkhole increased in plan to approximately 0.7 m by 1.2 m and remained at about 0.3 m in depth since the 2010 visit. There is concern that it may be the result of a break in the storm sewer line causing piping of soil into the sewer and it is understood that the Town of Whitecourt was notified by AT in 2009.

The ground movements measured by the slope inclinometers installed at the site are summarized as follows:

- Movement has been recorded in the past at a depth of about 13 m in SI #5 located on the southwestern corner of the toe berm as shown on the site plan. There had been no discernable movement since 2005 and the apparent oscillation of cumulative movement in the last three years is likely within the variation of the instrument. The cumulative movement is currently 19 mm.

- Minor movement had been noted in SI01-1A and also at SI01-2A, located as shown on the site plan, at depths of about 13 m and 8 m, respectively. The current rate of movement at SI01-2A has increased from 0.1 to 2.0 mm/year from Spring 2010. This is compared to the maximum movement rate of 13.1 mm/year measured in 2001. The water level measured by the pneumatic piezometer installed near SI01-2A was 10.3 m below ground surface (same level since Spring 2008). Both SI01-1A and the associated piezometer were destroyed and have not been read since Fall 2005.

- The joint separation at SI12 was repaired in March 2006 and a new baseline reading was established at that time. No movement has been observed since the repair. SI10 and SI11 located toward the northwest extent of the berm have not recorded movement since installation in 1993.

- Ongoing movement was recorded in the two operational instruments located in the back slope in the vicinity of the bin wall near the bottom of the hill (SI#30 and SI#31, located approximately as shown on Drawing No. NC1-1 included in Section D of the binder). No discernable movement has observed at the lower movement zones in either instrument for about the last five years. Shallow movement zones with significant displacement have been identified between 0 m and 2 m in both SIs but there has been no visual evidence of shallow slope movement of the slope observed to date except for a noticeable lean of the SI casings which could be related to seasonal frost action and/or creep. The current cumulative movement in this shallow zone is 345 mm at SI-31 and SI-30 sheared off at a depth of 1.8 m with cumulative movement of 487 mm recorded as of Fall 2010.

- A trend of ongoing movement is noticeable in all four of the slope inclinometers installed in March 2006 (SI06-1 through -4). Total cumulative movements for these inclinometers have increased from Spring 2010 by 2 mm (10 mm total), 1 mm (6 mm total), and 6 mm (18 mm total), respectively for SI06-1, -2, and -4. At SI06-3, the movement rate has decreased compared to Fall 2010 but the pattern is seasonal and has maintained a steady average rate since Fall 2007 with cumulative movement increased from 16 mm in Spring 2010 to 20 mm in Spring 2011. Current rates of movements in these inclinometers are between 1 mm to 7 mm per year with SI06-1 at its highest rate since Fall 2007 and SI06-4 since Spring 2008. SI06-1, SI06-3, and SI06-4 are located north (downslope) of the highway in and adjacent to the area of leaning trees. SI06-2 located upslope of the highway.

- The water levels measured at the standpipes SP06-3, -5, and -8 have been steady since Spring 2008. As in Spring 2010, SP06-4, -6, and -7 were dry and SP06-2 was dry as of Fall 2010 and all remained dry in Spring 2011. SP06-9 was destroyed as of Spring 2008. SP06-1 has shown a strong seasonal trend and the water level has increased in Spring 2011 to a historical high of 3.4 m below ground surface. SP06-1 is located the furthest north in the toe berm of active piezometers. The cross-section shown on Figure NC1-1B (attached for inclusion in Section F) has been updated with the Spring 2011 water levels.

2.3 Culverts at Station 1+650

Inspection was undertaken of the two culverts at this location; an upper culvert directing surface water from above the walking path to the ditch on the south side of the highway, and a lower centerline culvert which transmits the water across the highway right of way to the base of the toe berm fill located north of the highway. A half-round culvert connects the outlet of the upper culvert to the inlet of the lower

culvert. The outlets of two subdrain pipes discharge into the half-round culvert, and the ditch flow from upslope areas flows onto a concrete spillway and over the lip of the half-round culvert.

Maintenance of the concrete spillway was undertaken in 2001. Based on the results of the 2011 inspection, the subdrain and ditch water appear to be entering the centreline culvert in a controlled manner and the asphalt patch between the spillway and half-round culvert is in good shape. The two small sinkholes repaired in 2006 have not re-appeared. Flows measured from the subdrains at the culvert inlet on the south side of the highway (Sta. 1+650) and from another subdrain outlet on the north side (Sta. 1+480, not shown on the drawing) are summarized in Table 1. The inlet from the half-round culvert into the culvert beneath the highway is about two-thirds plugged with riprap and debris.

TABLE 1 – SUMMARY OF CULVERT AND SUBDRAIN FLOW

Year	Subdrain Outlets Sta. 1+650		Subdrain Outlet Sta. 1+480 (l/min)
	East (l/min)	West (l/min)	
2006	1.5	Dry	8.5
2007	3.5	Dry	9.5
2008	Not Recorded		
2009	3.5	Dry	13.0
2010	2.3	Dry	11.9
2011	3.0	Dry	6.8

Sinkholes were observed beside the asphalt path at some of the small diameter culvert crossings below the path. It is understood that maintenance of the path and associated culvert crossings is the responsibility of the Town of Whitecourt.

2.4 Bin Wall Area (Station 1+200)

The bin wall and backslope area above the bin wall near the bottom of the east hill were inspected. The bin wall is located between the access road to the McConnell property and the highway, near Station 1+200 at the bottom of the hill. The trail above the bin wall was paved with asphaltic concrete in 2003.

The three tension cracks first noted during the 2004 site visit in the trail above the east end of the bin wall had not widened or extended compared to the June 2009 visit; however, there was a set of new cracks at the south end observed in 2011. There was no differential height across the cracks. Crack sealing was undertaken following the June 2009 visit and has not been undertaken again as of the 2011 visit.

The slight bulging noted in the east wing of the bin wall has not changed since first observed by Thurber.

Photographs of the tension cracks in the asphalt pavement and of the bin wall are attached.

3. ASSESSMENT

The observations made during the site reconnaissance and the recent slope inclinometer readings from the pre-2006 instrumentation indicate that slope movements at this site remain relatively minor with variations in the rate of movement likely indicative of seasonal or climactic effects. The 2006 instrumentation readings showed some movement from baseline readings taken at the time of installation which may indicate some slow creep movements of the slope.

Although patching eliminated much of the differential height within the east and west cracks in the roadway surface, the crack pattern has reflected through indicating that movement is still occurring which is consistent with the continued creep observed in the slope inclinometers. The reason for continued slope movements at this location may be a result of not extending the toe berm far enough to the east during twinning operations to stabilize the area east of Station 1+780. Elevated groundwater levels may also be a significant contributing factor to the instability at the location of the highway distress. The remainder of the roadway side slope, where the toe berm exists, appears to be stable at the present time.

The crack development is not significantly affecting the trafficability of the roadway surface at present. Ongoing movements in this area may be expected, and an increased rate of movement may follow shortly after heavy or prolonged precipitation events. The ongoing movement may result in a reduction in the ride quality in this section of the roadway in the future, possibly to the extent where trafficability and safety are compromised.

The gentle dip and cracking observed in the roadway surface at the culvert (approximate Station 1+770) may be a result of settlement of the culvert backfill. No sinkhole development was noted; however, the cracks have widened slightly each year since 2008 indicating the possibility that further settlement or material loss (piping) is occurring.

A minor increase in the cracking was noted in the trail located on the back slope above the bin wall. Although there are no visible signs of distress in the slope or binwall, there has been an increase in the rate of movement measured at the slope inclinometers within the upper few metres below ground surface.

4. RISK LEVEL

The risk level for this site has been assessed as follows:

PF(6) * CF(3) = 18

This risk level is applicable to the area of distress on the roadway in the upper portion of the hill (Stations 1+800 to 1+900). A Probability Factor of 6 is considered appropriate since the slide is active but with a slow, indeterminate movement pattern. A Consequence Factor of 3 is applicable since the embankment is relatively high and a partial closure of the road may be required as a result of slide movement. This risk level is the same as that applied in previous years. Other areas of the site are considered to have a lower risk rating.

5. RECOMMENDATIONS

5.1 Short Term

No short-term measures are recommended at this time other than continued crack sealing to reduce infiltration of surface water into the slope.

5.2 Long Term

The following remedial measures are considered feasible, based on the current information available:

- A possible long term measure is the extension of the toe berm to the east to buttress the slope at the location of the slope movement, potentially in conjunction with subsurface drainage.

- A potential additional remedial measure is the installation of horizontal subdrains below the roadway to drain subsurface water away from the area and lower piezometric levels. This measure would be undertaken in conjunction with a toe berm to improve the long term performance; however, it is not considered a long term remedial measure on its own due to the potential for plugging with time.

Based on previous similar projects the cost for the construction of the remedial measures is expected to be in the order of $550,000 to $750,000.

5.3 Investigation

No additional investigation is recommended at this time.

5.4 Maintenance and Future Monitoring

As noted in previous annual reports, it is expected that frost action will continue to have a negative effect on the concrete and half-round culvert in the vicinity of Station 1+650. Although the asphalt patch is currently maintaining the flow, maintenance of this facility will likely be required in future years.

As per previous reports, it is recommended that crack sealing be undertaken regularly to reduce water flow into the slide area through the pavement surface. The cracked section should be monitored routinely in case the differential across the cracks noticeably reduces ride quality. Crack sealing should also be undertaken at the culvert dip location as there is the possibility for piping or pumping of the underlying soils if given access to water and the cracks appear to be deteriorating from traffic loading.

It is recommended to continue monitoring the existing instrumentation on a semi-annual basis, and to potentially reduce the geotechnical inspections to every two years following the 2012 inspection depending on the results of that inspection. In addition, the quality of the ride over the west and east cracks in the westbound lanes should be monitored at least monthly by the MCI, and if significant changes occur an interim engineering site reconnaissance and assessment should be undertaken.

6. CLOSURE

We trust this assessment and recommendations meet with your needs at this time. Please contact the undersigned should questions arise or if the site conditions worsen.

Yours very truly,
Thurber Engineering Ltd.
Don Law, P.Eng.
Review Principal

Ken Froese, P.Eng.
Project Engineer
/lg

Attachments

- Photographs 1 to 12

cc: Mr. Roger Skirrow, P.Eng., Director of Geotechnical Services, AT