

August 28, 2009

CG25309.B

Alberta Transportation
2nd Floor, 803 Manning Road NE
Calgary, AB T2E 7M8

Attn: Mr. Ross Dickson

**Re: Southern Region Geohazard Assessment Program
Site S19 – King Creek, Highway 40
June 2009 Inspection Report**

This letter documents the June 2009 site inspection of the King Creek crossing on Highway 40, which is located approximately 200 m north of the junction between Highway 40 and Highway 742 in the Kananaskis River valley.

AMEC Earth & Environmental (AMEC), a division of AMEC Americas Limited, performed this inspection in partial fulfillment of the scope of work for the supply of geotechnical services for Alberta Transportation's (AT's) Southern Region (AT contract CE061/08).

The site inspection was performed on June 10, 2009 by Mr. Andrew Bidwell, P.Eng., and Mr. Bryan Bale, EIT of AMEC in the company of Mr. Ross Dickson and Mr. Neil Kjelland, P.Eng. of AT.

BACKGROUND

This site was first inspected by AMEC in July 2005 during the geohazard review of the Highway 40 / Highway 541 corridor¹. After the corridor review, an annual site inspection was performed by AMEC and AT personnel in 2007² but not in 2008. Please refer to the reports on the corridor review and 2007 inspection for further details. In summary:

- There is a debris flow hazard along the creek channel extending upstream from the highway crossing. This hazard was first documented by Cruden and Eaton during their

¹ AMEC report "Geohazards Review, Highway 40/Highway 541 Corridor, Southwestern Alberta", submitted to AT on April 10, 2006, AT contract number CE044/2004, AMEC project number CG25211.

² AMEC report "Southern Region Geohazard Assessment, Annual Assessment Report, 2007", submitted to AT on November 6, 2007, AT contract number CE044/2004, AMEC project number CG25263.

1984/1985 review of potential geohazards with respect to infrastructure development in Kananaskis Country.

- The source material for potential debris flows accumulates in the narrow bedrock canyon upstream of the highway crossing.
- Debris flows can occur along the King Creek channel and may be triggered by heavy precipitation and the melting of relatively heavy annual snow packs in the spring. It is also possible for “rain on snow” events in the spring to trigger debris flows.
- Debris flow deposits were noted within the bedrock canyon and along the active floodplain of the alluvial fan downstream of the canyon outlet during the 1984 and 1985 traverses by Cruden and Eaton as well as during the 2005 and 2007 inspections by AMEC.
- Debris flows along the King Creek channel have the potential to damage the highway culvert and embankment due to:
 - Debris impact, possibly intensified by blockage of the bedrock canyon upstream of the highway (by avalanches from tributary gullies and/or damming by debris), that would result in a headpond forming and subsequently breaching or overtopping with a larger and more powerful debris flow.
 - Blockage of the highway culvert by debris and the potential for a large headpond of water to form along the upstream side of the embankment. Even though the culvert has a large diameter, an accumulation of logs and various sized rocks could build up around the inlet and cause a blockage.
- There is also a possibility of debris flows causing flooding of the former gravel pit downstream of the highway embankment and perhaps some concurrent damage to the adjacent highway maintenance yard and provincial park administration and residential facilities. This could occur if the creek channel shifts through an existing levee along the left bank of the channel adjacent to the gravel pit, either under peak flow conditions or possibly intensified by a peak flow following the overtopping and breach of a debris dam or culvert blockage upstream.

The June 2009 site inspection was recommended in order to follow-up on the 2005 and 2007 inspections, given that the recommended Risk Level for this site is one of the highest along the Highway 40 / Highway 541 corridor.

SITE OBSERVATIONS

The June 2009 site inspection was very brief and consisted solely of a visual review of the debris accumulation along the segment of the creek channel immediately upstream of the culvert inlet. The amount of debris accumulation along the channel in June 2009 was comparable to that noted during the 2005 and 2007 inspections. The culvert inlet and the length of the culvert pipe were clear of debris at the time of the inspection.

ASSESSMENT

The site conditions have not changed significantly since the 2005 inspection and likely also since the 1984/1985 review by Cruden and Eaton. The assessment of the debris flow hazard at this site is unchanged from the 2007 inspection. In summary:

There is a possibility of the following worst case scenario occurring:

- Peak creek flow volumes in the spring/early summer cause the culvert inlet to become mostly blocked with debris over a short period of time (e.g. in the order of 1 to 2 days).
- Prompt mobilization of heavy equipment is required to clear the accumulated debris from the culvert inlet and prevent full blockage and impoundment of water on the upstream side of the highway embankment. If full blockage occurred and a significant volume of water was impounded, a sudden breach of the debris blocking the culvert would release a volume of water that would likely overtop the levee along the south side of the creek channel downstream of the highway. This would flood the sports fields in the former gravel pit and possibly also impact on the provincial park and highway maintenance yard facilities.

Granted, this is for a worst case scenario but one that is considered possible during the lifetime of the highway given the evidence of previous large debris flows at this site. It is judged that for a 'typical' year, the area upstream of the culvert inlet and the culvert itself are of sufficient size to accommodate annual debris accumulations/flow.

The installation of "trash rack" style barriers in the creek floodplain a short distance upstream of the culvert inlet has been recommended in the previous assessments in order to protect against debris accumulation around the culvert inlet and provide additional buffer against the culvert becoming at least partially blocked under the worst case scenario described above. A supplementary culvert installed at a higher inlet elevation (e.g. 2 to 3 m above the existing culvert inlet) using trenchless methods could also help by providing an "emergency drain" for water from upstream of the highway fill embankment in the event of culvert blockage by debris. Based on discussions at site with AT during the 2007 and 2009 inspections, it is understood that AT does not want to pursue these recommendations based on the relatively low probability of a

“worst case” magnitude debris flow and given that any such construction would be along and within the creek channel within a provincial park and therefore likely have very stringent regulatory requirements with respect to site disturbance and permanent changes to the conditions along the creek channel.

RISK LEVEL

The recommended Risk Level for this site is unchanged from the previous assessment, and is summarized as follows:

- Probability Factor of 10 based on the channel morphology and condition upstream of the highway and the debris flow deposits along the channel that suggest that debris flows of some magnitude occur most years.
- Consequence Factor as follows:
 - For most years, a Consequence Factor of 1 because the annual debris flows occur without consequence to the highway.
 - For the estimated most likely worst case scenario, a Consequence Factor of 5.

Therefore, the recommended Risk Levels for this site are 10 and 50, for ‘typical’ years and the worst-case (but lower probability) scenario, respectively.

As noted in past reports, it is possible that future avalanching and/or forest fires could reduce the tree cover on the slopes in the upper portion of the King Creek watershed and increase the runoff/erosion that erodes debris into the creek channel. The Probability Factor may rise under such conditions.

RECOMMENDATIONS

As noted in the Assessment section, it is understood that AT currently does not want to pursue the recommended proactive measures to manage the risk to the highway from the possible “worst case” debris flow scenario. Therefore, no further work is recommended for this site.

The annual or bi-annual site inspections by AT and AMEC personnel should be discontinued unless AT or maintenance contractor personnel report significant debris accumulation around the culvert inlet or on the creek floodplain a short distance upstream of the culvert inlet.



CLOSURE

This report has been prepared for the exclusive use of Alberta Transportation for the specific project described herein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. AMEC Earth & Environmental, a division of AMEC Americas Limited, cannot accept responsibility for such damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report has been prepared in accordance with accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

We trust that this meets your needs at this time. Please contact the undersigned if you have any questions or require any further information.

Respectfully Submitted,

**AMEC Earth & Environmental,
a division of AMEC Americas Limited**

Andrew Bidwell, M.Eng., P.Eng.
Associate Geological Engineer

APEGGA Permit to Practice No. P-04546

Reviewed by:

Pete Barlow, M.Sc., P.Eng.
Principal Geotechnical Engineer