

August 20, 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 S10(C) – Highway 762:02
2009 Annual Inspection Report**

This letter documents the 2009 annual site inspection of Site S10(C) on Highway 762:02, approximately 22 km south of the junction with Highway 22 and approximately 550 m north of the junction with Highway 549. The highway crosses over a small, unnamed creek at this site with the creek flow conveyed by a 900 mm diameter culvert.

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 12, 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

There is limited background information available regarding this site prior to the 2000 inspection. Minor settlement and cracking of the road surface was noted at this site during the 2000 to 2004 annual inspections and weak and/or compressible foundation materials below the road embankment were postulated as the cause. An overlay was placed at this site in July 2003. It was also noted that the west ditch would pond water during wetter times of the year and required regrading to re-establish drainage towards the culvert at the creek crossing.

During the 2005 inspection more significant cracking and settlement of the road surface was noted along an approximately 15 m long segment of the northbound lane roughly 45 m north of the culvert. It appeared that the cracking had developed during or following the significant rains of June 2005. The road surface had not been critically damaged at that point, however further settlement would likely have necessitated a reduced speed limit. Some significant erosion was

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also noted in the west ditch, south (up gradient) of the culvert inlet and was attributed to flash-flood level runoff during the June 2005 rains.

An overlay was placed over the cracked segment of the northbound lane at some point after the 2005 inspection, and again prior to the 2007 inspection (the site was not inspected in 2006). An approximately 1.3 m wide and 1 m deep sinkhole was noted for the first time in the west embankment slope above the culvert inlet during the 2007 inspection.

SITE OBSERVATIONS

Key observations from the June 2009 inspection are listed below. Please also refer to the attached Figure S10(C)-1 for a site plan.

- The sinkhole in the west embankment slope and above the culvert inlet that was first noted during the 2007 inspection has increased slightly in size in the past year. The sinkhole was approximately 2 to 2.2 m wide at surface at the time of the June 2009 inspection. It was difficult to determine the sinkhole's depth, however it appeared to be comparable to or slightly greater than the approximately 1.7 m measured during the June 2008 inspection. Photo S10(C)-1 shows the sinkhole location relative to the culvert inlet.
- Some soil debris was faintly visible within the culvert, several metres downstream from the culvert inlet. As shown in Photo S10(C)-2, it appeared that the soil was entering the culvert through a breach in the crown of the culvert pipe, however it was not possible to get close enough to the debris to inspect in more detail.
- There was visible cracking and settlement of the northbound lane, as shown in Photos similar to that noted in the previous annual inspections and as shown in Photos S10(C)-3 and 4. It appears that an asphalt overlay had been placed at this site since the June 2008 inspection, therefore the cracking visible during the June 2009 inspection had developed within the past year.
- The slumping along the creek banks downstream of the culvert outlet does not appear to have worsened significantly since the June 2008 inspection.
- A possible slump headscarp or tension crack was noted just upslope (less than 1 m) of the fenceline on the east road embankment slope above the culvert outlet. The crack was just visible through the grass cover, and had negligible aperture and dropdown at the time of the June 2009 inspection.
- Erosion was noted along the segment of the east road ditch immediately south of the culvert outlet (Photo S10(C)-5). It appears that this erosion has worsened slightly since

the 2008 inspection, however at this point it does not pose a threat to the stability of the road surface.

ASSESSMENT

As noted in the previous assessments, there are two geotechnical issues at this site:

- Problems with the culvert.
 - Deformation and possible breaching of the culvert is the likely cause of the sinkhole in the road embankment slope above the culvert inlet.
 - The culvert outlet is too low which causes standing water to back up in the culvert. This may be due to the settlement and deformation of the culvert pipe.
 - The east/west alignment of the culvert is skewed from the overall northeast/southwest alignment of the creek channel, and may be a factor causing the slumping in the creek banks downstream of the culvert outlet.

- Cracking and settlement of the road surface, north of the culvert.
 - The pattern of the cracking suggests that it is the north flank of an east-moving slumping/circular failure of the road fill embankment over the creek. It does not appear to be linked to the slumping in the left creek bank, downstream of the culvert. The damage to the road surface could also be due to settlement of the fill embankment (possibly over organics that were not removed prior to embankment construction) with minor eastwards lateral movement towards the creek channel.
 - The cracking has formed repeatedly through multiple overlays in recent years. The magnitude of settlement has varied over the years. In past annual inspections it has been noted that at times the settlement has almost been significant enough to warrant a reduced speed limit at the site.
 - The accumulated thickness of the multiple overlays have created a steep slope (greater than 45°) along the east shoulder in the cracking area, with slope heights up to approximately 1.3 m.

The above-noted issues have not directly threatened the highway to date beyond creating an ongoing maintenance issue. The sinkhole in the west road embankment slope is also a hazard to the public and perhaps during cattle drives across the site.

The erosion along the east road ditch, south of the culvert outlet, has worsened over the last year however it does not pose a threat to the stability of the highway surface at this point. It is not clear if the erosion will deepen and broaden in the future.

RISK LEVEL

The recommended Risk Level for the cracking and settlement of the road surface north of the culvert is as follows:

- Probability Factor of 9 based on the ongoing cracking and settlement of the road surface north of the culvert location.
- Consequence Factor of 3 based on a judgment that continued settlement of the northbound lane can be treated as a maintenance issue without requiring partial closure of the highway.

Therefore, the current recommended Risk Level for this site is 27.

The Risk Level associated with the problems with the culvert is judged to be lower than the Risk Level for the ongoing damage to the road surface.

RECOMMENDATIONS

Maintenance and Short Term Measures

- AT's maintenance contractor should continue to patch and place overlays at the cracking/settlement area north of the culvert location as required to maintain a suitable running surface.
- It is recommended that the cracking and settlement of the road surface continue to be treated as a maintenance issue. If the root cause of the damage to the road surface is embankment or foundation settlement then a repair consisting of excavation and replacement of the road embankment is likely cost-ineffective relative to ongoing maintenance as required.
- The sinkhole in the west road embankment slope should be backfilled with coarse rock fill. See the recommendations below regarding a culvert repair for further details.
- The eroded segment of the east ditch should be graded out and lined with a geosynthetic product in order to minimize erosion of the exposed soils and promote vegetation growth. This could be supplemented with a series of check dams along the ditch to limit the velocity of the ditch flow, similar in concept to rock check dams as per AT's Best Management Practice #7 for Erosion and Sediment Control along highways.

Long Term Measures

- The apparent breach in the existing culvert should be mitigated by one of the following:
 - Clearing the soil debris from the culvert, installing a new, smaller diameter culvert through the existing 900 mm diameter culvert, and grouting up the annulus between the two culverts. This option is contingent upon it being practical to clear the debris and insert a new culvert along with a smaller diameter culvert being of sufficient size to pass the creek flows at this site. Also, this option would not resolve the issue of the existing culvert outlet being too low or the culvert alignment being skewed from the overall creek alignment.
 - Installing a new culvert immediately adjacent to the existing culvert, preferably using trenchless methods, and sealing/abandoning the existing culvert. The new culvert should be installed along a northeast/southwest bearing to more closely align with the overall creek channel alignment.

In addition to the above, the sinkhole in the west road embankment slope should be backfilled with coarse rock fill (unless the new culvert is installed using a conventional excavation and backfill, during which the sinkhole could also be backfilled).

If possible, the new culvert should be designed to accommodate possible continued settlement of the road fill embankment and possibly also the underlying organic soils because if that is the root cause of the apparent damage to the existing culvert as well as the damage to the road surface, it would not be mitigated with a culvert replacement.

- The annual site inspections should be discontinued unless the culvert is replaced or another repair measure is attempted.

Investigation

No further investigation work for this site is recommended at this time.

Further investigation work to check for fill embankment and/or foundation settlement as the root cause of the apparent culvert deformation and damage and cracking in the road surface could be performed but is not recommended. The data from such an investigation would almost certainly confirm the current recommendation to replace the existing culvert and to continue to treat the road surface cracking as a maintenance issue.

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:

Paul Cavanagh, M.Eng., P.Eng.
Associate Geotechnical Engineer

Attachments: Figure S10(C)-1
Photos S10(C)-1 to S10(C)-5