S4 – WILLOW CREEK

Background

The Willow Creek site is located on the east side of Highway 2:08, approximately 4.7 km north of the bridge over the Oldman River.

The landslide at this site is occurring in the west slope of the Willow Creek valley, which is located to the east of Highway 2. The valley slope is approximately 15 m high and the crest of the valley slope is approximately 22 m from the east edge of the highway. The landslide is located along the outside of a bend in the creek channel. It appears that movement of the landslide is triggered by erosion along the toe of the slope at the west bank of the creek which in turn leads to rotational failures within the landslide mass along with block toppling failures along the near-vertical bluff of exposed soils at the crest of the valley slope. The toppling failures along the overall crest of the landslide have led to retrogression of the slope crest near the fenceline. This retrogression appears to typically occur in increments in the order of 1 to 2 m at a time, rather than at a more gradual, steady pace.

This site has been monitored by AIT and consultant personnel since 1993. A series of SI's and piezometers were installed in 1994 and were read at various times up to the spring of 2003. During that time the SI's did not measure any significant movement. The SI's are not well-suited to provide early warning of crest retrogression given that the slope crest retrogression occurs as a result of block toppling failures along the existing crest rather than lateral movement along weak soil/bedrock layers underlying the slope. Therefore, the SI's are no longer being read on a regular basis and the current monitoring strategy for this site is based on regular surveys of the slope crest position and visual observations of the slope condition.

Please refer to Section A of the site binder for a more detailed discussion of the site background.

Site Assessment

The site assessment was performed on June 29, 2005. The weather at the time of the site assessment was sunny with a light breeze. The inspection covered the area between the northbound lanes and the slope crest, as well as a traverse down to the creek bank below the central portion of the landslide.

Please refer to Appendix S4 for a site plan (Figure S4-1) and representative cross-sections (Figures S4-2 and S4-3) from the site.

Observations

The following points summarize the observations made during the site assessment. Please also refer to Appendix S4 for a site plan, annotated photographs and figures illustrating key observations.

The overall condition of the landslide is generally the same as in previous years, however the following developments were noted to have occurred since the 2004 inspection:

- As shown in Photos S4-2, S4-3 and S4-4, additional retrogression has occurred along the crest of the central portion of the landslide area to the west of the fenceline. The retrogression appeared to be very recent and likely occurred during the June 2005 significant rainfall events. The current distance between the vertical/overhanging scarp (approximately 2 m high) at the crest of the slope and the east edge of the northbound lanes is approximately 22 m. The point of maximum westward retrogression of the slope crest is at the fenceline adjacent to SI #8.

- Significant additional movement at the north flank of the landslide around SI #10. This area is shown in Photo S4-5. Tension cracks were first noted in this area during the summer of 2002 when they were hairline cracks just visible through the grass cover with negligible lateral and vertical displacement. The cracking in this areas has now developed to have an aperture in the order of 0.5 to 1.0 m with maximum vertical drops in the order of 1 to 2 m. There were several locations along the tension cracks where blocks of soil with live grass had fallen down into the open cracks, therefore during 2005 and likely in the past few weeks.

- Significant additional toe erosion due to the high creek flow levels resulting from the heavy rainfall events in June 2005. Bank erosion visible on east bank, as shown in Photo S4-6. Some fresh tension cracking adjacent to recent bank erosion, but overall no significant additional landslide movement resulting from recent toe erosion was visible at the time of the inspection.

Assessment and Risk Level

- The observations from the 2005 site inspection show that the landslide remains active and continues to retrogress towards the northbound lanes of Highway 2.

- The ongoing landslide movement has continued to reduce the offset between the slope crest and the east shoulder of the northbound lanes of the highway. At the time of the inspection, the minimum offset between the slope crest and the edge of the pavement was approximately 22 m. Ongoing landslide movement at this site will result in the crest of the valley slope retrogressing further to the west, and reducing the offset between the east shoulder of the northbound lanes of the

highway and the slope crest. It will likely take some time, possibly many years, before the slope crest retrogression begins to directly undermine the northbound lanes of the highway. It is also possible that changes to the erosion conditions at the toe of the slope resulting from hydrological changes to Willow Creek (i.e. channel shifting upstream or downstream of the site, long-term flow volumes and patterns) may affect the rate of retrogression towards the highway.

Therefore, AMEC recommends the following Risk Level factors for this site:

- Probability Factor of 9 because the landslide is active and westward crest retrogression towards the highway will continue.

- Consequence Factor of 2 for the present location of the landslide relative to the northbound lanes of the highway.

Therefore, the current recommended Risk Level for this site is equal to 18, which is the same as recommended following the 2004 assessment.

Stabilization of this landslide would likely be a major undertaking that could involve significant river training works and possibly significant earthworks on the slope itself. This work would require construction of an access route for construction equipment down to the toe of the valley slope. Therefore, the potential effort required to stabilize the landslide should be considered relative to the effort associated with realigning a segment of Highway 2 away from the potential future crest position of the valley slope. In any case, it would be prudent to consider AIT's options for managing the risk at this site before the eventual retrogression of the valley slope crest towards the highway reduces the amount of time available to implement any repairs or mitigative measures.

Recommendations

AMEC recommends the following future work for this site:

The annual assessments at this site should be continued.

Perform a slope crest and creek bank position survey in summer of 2005. The current crest position should then be compared to the 2003 survey in order to provide further information towards estimating the average rate of retrogression towards the highway.
This work is scheduled for the week of July 25, 2005 and will include picking up both the current slope crest position (for comparison to the 2003 and 2004 surveys) and the creek bank position (for comparison with future surveys).