S5 – CHIN COULEE

Background

The Chin Coulee site is located on Highway 36:02, approximately 20 km south of Taber and on the north approach slope to the highway bridge across the Chin Coulee Reservoir.

The slope instability at this site consists of deep-seated landsliding in the north valley slope along with relatively shallower movements in the fill embankment immediately below the highway. Based on a review of historical airphotos of this site it is believed that the highway fill embankment may have infilled a drainage gully in the valley slope.

The overall landslide mass has an elevation difference of approximately 50 m from the reservoir level to the headscarp adjacent to the highway. The width of the landslide is approximately 350 m at the reservoir shoreline. The length of the landslide is approximately 200 m. The overall angle of the landslide is approximately 13°. The overall landslide is inferred to be deep seated with a failure surface at a depth of about 30 to 40 m near the highway (scarp) and 17 m near the reservoir (toe). Therefore, the overall toe of the landslide is likely below the reservoir level. The failure surface is thought to be along weak zones in the bedrock and overlying till. The exact position of the overall landslide crest relative to the highway is not clear, and it is judged that this landslide mechanism could encompass the entire highway.

The SI GA98-3 that was installed in the shallower movement area in the fill embankment immediately downslope of the highway has previously sheared off at a depth of approximately 15 m below ground surface. The road fill embankment slope in this area has an inclination of approximately 20°.

The landslide has shown large scale movements on two known occasions since the 1950's, with some possible ongoing shallower movements contained within the overall landslide mass. The ongoing movements are impacting the south/downslope shoulder of the highway. There remains a risk of reactivation of the larger landslide mass, which could have a more significant impact on the road.

This site has been inspected and monitored by AT and consultant personnel since 1979. The landslide most recently experienced significant movement in 1997. Additional instruments have been installed since that time and regular assessments and monitoring are ongoing. In 2002 the National Research Council (NRC) commenced inSAR satellite-based ground movement monitoring of this site, however limited data is available to date.

AMEC has submitted a design package for upslope relocation of the road through the slide area to AT. AMEC understands that upslope relocation of the road will be considered if additional movement damages the existing road.

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 May 26, 2004. The weather at the time of the site assessment was partly cloudy with a strong wind.

Please refer to Appendix S5 for a site plan illustrating the layout of the site. The assessment covered the highway surface through the landslide area, the adjacent upslope ditch, and the slope face below the highway down to the reservoir shoreline.

Observations

The following points summarize the observations made during the site assessment. Please also refer to Appendix S5 for annotated photographs illustrating key observations.

- The shallow slumping immediately downslope of the road continues to be active. The scarp of the shallow slumping consists of a 1.5 to 2 m high, very steep to near-vertical face of exposed soil as shown in Photos S5-1, S5-2 and S5-6.

- The guardrail along the downslope edge of the road continues to be undermined by the shallow slumping immediately downslope of the road, as shown in Photos S5-1 and S5-2. The amount of undermining does not appear to have increased significantly since the previous assessment.

- A number of possible new tension cracks were noted on the lower portion of the slope below the highway, approximately 1/3 of the way up from the reservoir shoreline. Photos S5-7 to S5-9 show some of these potential tension cracks. The approximate locations of the new tension cracks are shown on Figure S5-1, however they have not been surveyed in.

Discussion

There are two items that should be considered with respect to future monitoring of this site:

- AMEC understands that AT is planning a Functional Planning Study for Highway 36 in this area in the near future and there is a possibility that Highway 36 will be moved to a new alignment to the west of the current location. The new alignment of the highway would head more directly north from the north end of the existing bridge over the Chin Coulee Reservoir and ascend the north valley wall in a through-cut similar to the existing south approach to the bridge. The potential construction time frame for such work is in the order of 10 or more years into the future.

- There is a possibility that the operating level of the Chin Coulee Reservoir may be raised by 1 m, although this is unconfirmed at present.

Assessment and Risk Level

The active, shallow slumping immediately downslope of the guardrail has already undermined a portion of the guardrail and has the potential to undermine additional segments of the guardrail

and possibly the downslope edge of the road as well. It is not considered likely that significant portions of the road would be taken out of service by a sudden retrogression of the shallow slumping, however this cannot be entirely ruled out. The potential for reactivation of the overall deep-seated landslide at this site also exists, and could result in loss of a large portion of the road alignment.

The possible new tension cracks on the lower portion of the slope may indicate a reactivation of the overall slope movement. The condition of the new tension cracks should be checked again in future assessments to see if they widen or extend.

Overall, AMEC recommends that the Risk Level for this site be maintained at the values recommended following the July 2003 assessment. As before, on the basis that two separate modes of failure could affect this highway, two recommended Risk Levels are provided:

- For the shallow modes of failure, the Probability Factor is taken as 10 since the rate of movement is moderate and ongoing. A Consequence Factor of 2 is assigned to this slide type on the basis that only a portion of the road would be lost. Based on the above, the Risk Level for the relatively shallow movements at this site is calculated as 20.

- For a deep-seated mode of failure, the Probability Factor is taken as 6 since the movement appears to be inactive, but with some uncertainty. A Consequence Factor of 5 is assigned to this slide type on the basis that a large portion of the road would be lost. Based on the above, the Risk Level for the deep-seated movements at this site is calculated as 30.

These values are unchanged since the previous assessment. Depending on the observations from future visual monitoring of the new cracks on the lower portion of the slope, the Probability Factor may increase in the future.

Recommendations

AMEC recommends the following future work for this site:

The semi-annual instrument readings should be continued.
The annual assessments should be continued.

Particular attention should be paid to the future data from the slope inclinometer at Borehole 2002-1 in the upslope ditch of the road, as this will provide an indication of whether or not deep-seated slope movement encompassing the existing road is occurring. The condition of the new cracks noted on the lower portion of the slope should also be visually monitored and assessed in the future with respect to the stability of the road alignment. As noted in previous reports, the planned strategy for this site is to continue monitoring and implement the existing design for the upslope realignment of the existing highway only if and when it is required due to reactivation of slope movement encompassing the road alignment.

The potential raising of the operating level of the Chin Coulee Reservoir should be confirmed with the reservoir operator. Raising the operating level of the reservoir could increase the probability of shoreline erosion effects and possible rapid drawdown from a higher reservoir level than in previous years, both of which could be detrimental to the stability of the overall slope. The potential change in operating level should therefore be considered with respect to the risk to the highway and they may be merit in revising the previous stability analysis.
It should be noted that the two piezometers installed by the previous consultant on the lower portion of the slope below the road are no longer functioning. Therefore, the two piezometers installed in Borehole 2002-2 in the upslope ditch at the road will be the only source of future piezometric data in the valley slope unless additional piezometers are installed. If the reservoir level is raised and further movement is detected in the slope inclinometers and/or the piezometric levels in Borehole 2002-2 are seen to increase, then consideration should be given to replacing the piezometers installed in the slope below the road in order to update the stability analysis.

If the upcoming Functional Planning Study concludes that the highway may be relocated in the future, then this should be factored into the planning of future investigation and monitoring at this site.

The slope face along the south shoulder of the road should be regraded in order to restore support to the guardrail posts. The regrading of the slope face in this area will also help by closing up any open tension cracks that could receive water during rain events.

The exposed soils on the slope face along the south shoulder of the road should be covered with a rolled erosion control product (RECP). This will provide a physical barrier to reduce the amount of surface erosion and infiltration of runoff into the unstable slope face immediately downslope of the guardrail. Given the steepness and dryness of the exposed soils on the slope face, it will be difficult to permanently revegetate this area.

If any further data from the NRC inSAR satellite based ground movement monitoring project becomes available, it should be incorporated into the monitoring program.
AMEC understands that limited data is available to date from the NRC project, and the potential for further data to be gathered is unclear at this time. AMEC can provide a full range of inSAR services if requested by AT.