

LANDSLIDE RISK ASSESSMENT  
SOUTHERN REGION

**SITE S9: NEAR WATER VALLEY**

LEGAL LOCATION: LSD 3-16-29-6 W5M

REFERENCE LOCATION  
ALONG HIGHWAY: 17 km west of Water Valley, AB

UTM COORDINATES: 5705000 N 653700 E (NAD27)  
NTS Map Sheet 82 O/7 (Wildcat Hills)

AI FILE: SH579:02

AI PLAN & PROFILE:

Date of Initial Observation: August 20, 1999

Date of Last Inspection: Annual inspection in July 2003.  
SI read in May, 2003.

Instruments Installed: October 26, 1999 – 1 Slope Inclinator

Risk Assessment:  $PF(5) * CF(4) = 20$   
(reduced from  $7*4 = 28$  in June 2002)

Last updated by: AMEC, August 2003

Comments:

## **Location**

The slide area is located on SH 579, approximately 17 km west of Water Valley, AB.

## **General Description Of Instability**

The road in the slide area is oriented northeast-southwest and traverses a slope above an unnamed tributary of Grease Creek. The total height of the slope ranges between approximately 30 and 40 m. The slope angles below the road (i.e. where the slide occurred) are in the order of 15 to 20 degrees.

On or about August 20, 1999, a landslide occurred at this location following a period of abnormally heavy rains. The slide was observed to be a deep-seated, rotational-translational failure, measuring approximately 125 m wide by 50 m in length. The overall angle of the slide was approximately 16 degrees. The main scarp extended as far upslope as the centerline of the road, and was reported to be 0.5 m high and near-vertical. A 75 m long and 7.5 to 10 m wide graben formed, incorporating the downslope edge of the road and requiring the closure of the westbound lane. The toe of the slide roughly corresponded to the toe of the slope, with localized encroachments of the slide mass into the creek. A “toe bulge” of accumulated material measuring approximately 120 m in width and 0.25 to 0.4 m in height was noted along the toe of the slide.

The surface of rupture of the landslide was inferred to be along a weak layer at the till/bedrock interface beneath the slope, at a depth of approximately 12 m below the road surface. The heavy rainfall during August 1999 was likely a triggering factor as well.

## **Geological Setting/Geotechnical Conditions**

Published geological information<sup>1</sup> indicates that slopes in the area are covered with glacial till beneath a veneer of colluvium/slope wash. The bedrock that underlies the till is visible in nearby road cuts but not in the immediate vicinity of the site. Varying thicknesses of fill were placed for the construction of the road, ranging from 0 to an estimated 3 m.

A borehole drilled downslope of the road after the remedial measures were implemented showed the following stratigraphic sequence:

0 - 3 m	Fill – low to medium plastic clay till.
3 - 8.5 m	Clay Till – low to medium plastic, stiff to very stiff.
8.5 - 12 m	Clay Till – low plastic, hard.
12 - 16.8 m	Mudstone Bedrock

(End of hole at 16.8 m)

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<sup>1</sup> Shetsen, I., Map of “Quaternary Geology, Southern Alberta”. Alberta Research Council. 1987.

It is believed that a perched groundwater table exists at a shallow depth beneath the slope face. Test pits excavated in the upslope road ditch encountered very moist to wet conditions. A regional groundwater table was also inferred to be above the level of the adjacent valley floor, as evidenced by numerous seepage zones discharging along the toe of the valley slope. The borehole drilled downslope of the reconstructed road encountered seepage at 11.7 m depth, roughly corresponding to the elevation of the adjacent valley floor.

### **Chronology**

Table A1 provides the Chronological Background of the slide.

### **Past Investigations**

A geotechnical investigation and parametric stability analysis of the slope was performed by Geo-Engineering (M.S.T.) Ltd. in September, 1999. The results of the investigation suggested the failure mode described above. A number of remedial measures were recommended (see following section) and implemented in October, 1999. After remedial work was complete, a slope inclinometer was installed by Geo-Engineering downslope of the reconstructed road.

### **Remedial Measures**

The following remedial measures were recommended and implemented for the site of the 1999 landslide:

- Shifting the affected road segment northwest by 10 m (including a 2.5H:1V cut slope above the new road alignment).
- Lowering the current road grade by 1 m.
- Regrading the upper portion of the slide area to unload the slope and improve surface drainage.
- Improving subsurface drainage, with the installation of a French drain parallel to, and beneath, the upslope road ditch and discharging into culvert going below road.
- Repairing existing culverts draining upslope road ditch.
- Lining the upslope road ditch with gravel.

The details of these recommendations can be found in the Geo-Engineering report.

In addition, a slope inclinometer was installed downslope of the reconstructed road alignment. The depth of installation was 16.8 m, slightly below the elevation of the adjacent valley floor. The purpose of this slope inclinometer was to monitor for ongoing movement at this site following reconstruction of the road.

## **Monitoring Results**

The slope inclinometer was initialized on December 15, 1999. The first reading by AMEC following initialization was on May 19, 2000. The initial data set for the slope inclinometer displacement plot was reset to the spring 2000 readings in order to filter out any apparent, but false, movement due to the comparison of data obtained by different consultants using different probes. The September 2000 readings showed no significant further movement, however, the May 2001 reading indicated that there are possible shear zones at 7.6 m, 10.7 m and from 13.1 to 15 m. Each of these zones showed approximately 2 mm of downslope movement between May 2000 and May 2001. No additional movement has been noted in these zones in subsequent readings.

## **Additional Comments**

In addition to the investigation at this landslide site, limited records from a number of previous investigations at nearby sites along SH 579 were located during the review of AI's files. These other sites are briefly described as follows:

Immediately west of the 1999 landslide - Four slope inclinometers and two piezometers installed by AT&U in October, 1987. Three of these slope inclinometers sheared off in 1990, apparently due to massive slumping occurring in September, 1990 where part of road was reported to have dropped 1.5 m. The records noted anecdotal evidence of a groundwater spring buried by road construction. The current status of this slide and the monitoring instrumentation is unknown.

Harold Creek Slide at Sta. 10+680, SH579:02 – A large, deep-seated landslide above Harold Creek, west of the site of the 1999 landslide. This landslide appears to have occurred in 1989, and a slope inclinometer was installed by Golder Associates. The status of this slide and the slope inclinometer is not known.

**Table A1**  
**S9: Near Water Valley - Chronological Background**

<b>YEAR</b>	<b>MONTH</b>	<b>DESCRIPTION</b>
1999	August 20	Approximate date of landslide, following a period of heavy rainfall.
	September	Field reconnaissance by Geo-Engineering, preliminary geotechnical assessment/stability analysis and recommendation of remedial measures.
	October	Implementation of recommended remedial measures. Installation of slope inclinometer by Geo-Engineering.
	December	Slope inclinometer initialized by Geo-Engineering.
2000	May	Slope inclinometer read by AMEC. <ul style="list-style-type: none"> <li>• 2 mm of downslope movement in three possible shear zones: 7.6 m, 10.7 m, and 13.1-15 m.</li> </ul>
	Sept.	Slope inclinometer read by AMEC. No additional movement noted.
2001	May	Slope inclinometer read by AMEC Possible shear zones at 7.6 m, 10.7 m and 13.1-15 m evident on plot. Annual inspection by AMEC and AT personnel.
	October	Slope inclinometer read by AMEC. No additional movement noted.
2002	April	Slope inclinometer read by AMEC. No additional movement noted.
	May	Annual inspection by AMEC and AT personnel. Reduced Probability Factor from 7 to 5.
2003	May	Slope inclinometer read by AMEC. No additional movement noted.
	July	Annual inspection by AMEC and AT personnel. Recommend switching to annual (spring) instrument readings, and discontinuing annual inspections unless the slope inclinometer shows additional movement.

### **S9 – Near Water Valley**

The Water Valley site was visited on July 7, 2003. Photographs from this site visit are included in Appendix S9, along with a site plan, air photograph, and a detailed discussion of the visit. This discussion has also been submitted in separate unbound sheets for inclusion in Appendix B of the Near Water Valley binder. The following is a brief summary of the assessment.

No significant changes since the last inspection were noted. No additional movement has been measured in the potential movement zones in the slope inclinometer since they were noted in the Spring 2001 instrument readings.

The Risk Level at this site was kept at 20. The potential for continued movement is a concern, however AMEC recommends that future instrument readings be taken on an annual basis, in the spring. The annual inspections should be discontinued unless conditions change. Please refer to the discussion in Appendix S9 for further details.

**APPENDIX S9**  
**Near Water Valley**

## **1.0 Site Visit**

The Annual Inspection site visit was conducted on July 7, 2003. At the time of the visit, the weather was clear and calm.

## **2.0 Significant Observations**

The condition of the site was essentially the same as observed during the May 2002 site inspection.

The segment of the road that was reconstructed after the slope failure in 1999 appeared to be in good condition. The cut slope above the road showed some minor erosion channels, but in general the seeding has taken well. The guardrail did not show any deformation (Photos 1, 3).

The old site to the west also appeared in good condition. The slope indicators at that site had previously been confirmed to be blocked and/or destroyed.

## **3.0 Changes from Previous Visits**

As noted above, no significant changes since the previous inspection were observed in the road surface, toe or cut slopes in the repaired area. The potential movement zones noted in the Spring 2001 readings of the slope inclinometer have not shown any further movement. As the road is gravel surfaced, new scarps or tension cracks may be somewhat masked.

No significant changes since the previous inspection were noted for the old site to the west.

## **4.0 Discussion**

There do not appear to be any significant geotechnical concerns for this site at this time. The potential movement zones noted in the Spring 2001 readings of the slope inclinometer are a concern as the slope may still be moving or be prone to future movement along the bedrock contact and/or shear planes in the overlying material. However, the instrument readings since the spring of 2001 have not shown any additional movement and no signs of instability have been noted on the slope face below the road.

## **5.0 Assessment**

The repair measures appear to be performing adequately and there has been no measured activity along the potential movement zones previously identified in the slope inclinometer. On this basis, the Probability Factor with respect to this slide should be kept at 5.

It is possible that a reactivation of the slide area could have a similar effect as the previous failure, which resulted in a significant loss of a portion of the highway. On this basis a Consequence Factor of 4 is assigned to this slide.



Based on the above, the Risk Level at this site is calculated as 20, which is the same as calculated in the Spring 2002 Assessment Report.

## **6.0 Recommendations**

**Monitoring of the slope inclinometer should continue, but the reading frequency should be changed to annual (spring).** Therefore, the next reading should be taken in the spring of 2004.

**The annual site inspections should be discontinued.** No significant changes have been noted over the past few years. Future site inspections should only be performed if the spring SI readings indicate that additional slope movement has occurred or if additional geotechnical issues are reported.