BRIEF FILE REVIEW (LANDSLIDE RISK ASSESSMENT)

1)	**Site (GP3)**	Hwy 40:38 Cutbank South Slide
2)	**Reference Location along Highway:**	• Hwy 40:38 approximately 1 km south of Cutbank River Bridge • Approximate Station 88+700 to Station 88+800 on highway mosaic
3)	**Legal Description:**	SE Section 21, Twp 65, Rge 5, W6M
4)	**UTM Coordinate:**	Northing 6057981.093 Easting -237750.170
5)	**AI File:**	Hwy 40:38

6) **Alberta Infrastructure Plan and Profile (attached in Section F)**
- Site plan (aerial photo)
- Sketch of instrumentation Plan

7) **General Description of Instability**

This slide was caused by the downcutting of a tributary creek to the Cutbank River which runs parallel to this sidehill alignment. The Cutbank River Valley slope is comprised mainly lacustrine deposits with a high groundwater table. The slide area was located along a 100 m stretch close to the midslope elevation of the valley wall.

In the original grading construction in early 1980's, the optimal setback from the crest of the steep creek bank was utilized to optimize cuts into the backslope. Surface drainage was accommodated by installation of centreline culverts connecting to downdrain CSPs along the crest of the creek slope and outfalling into the creek. During the 1981 to 1994 operation of the highway as gravel road, this section of road might have been undergoing minor movement in adjustment to downcutting of the creek and maintenance forces might have been re-leveling the settlements by with surface gravel. Movements of the creek valley slope left the downdrain CSP overhanging the slipped slope face.

In 1995, pavement construction was complete. In 1996, cracking/settlement of pavement followed by sliding of the roadway occurred. The shear movement was monitored at approximately 8 m depth (SI# 1A) from road elevation at the shoulder. The movement zone was at mid-height of the creek valley slope. The slide was caused by creek downcutting; high groundwater table and seepage; and lacustrine clay with low strength.

Phase 1 Berming Remediation was attempted in Winter 1996 with minor berming design and was unsuccessful. The slide recurred. Phase 2 entailed the shifting of alignment towards the backslope and was undertaken (September 1997) in combination with the use of lightweight "hog fuel-wood waste" to replace the soil material and lighten the head of the reconstructed slope to provide extra redundancy in the safety of the shifted roadway. The highway performed well after the shifting of alignment. The slide remediation was successful. However, high groundwater was observed along the backslope ditch and seepage was evident across roadway into the buried lightweight "hog fuel" caused leachate outflow. Leachate effluent was observed to exit from the lightweight "hog fuel" pile despite its encapsulation with impermeable membrane.

Recent action (Summer 2000) was undertaken by EBA to design and construct remedial measures for the leachate effluent, including removal of the "wood waste" and reconstruction with fill material. The slope reconstruction design included a drainage layer at the base as well as edge drains at the sides. The removal and disposal of the lightweight "hog fuel" as well as reconstruction of the slope was carried out in December 2000 under the supervision of EBA.

8) **Date of Initial Observation**

- October 1994 (AI Geotechnical Section) site review of roadway corridor prior to pavement construction.

9) **Date of Last Inspection**

- July 1999 (AI and EBA Spring Slide Tour)

10) **Instrument Installed**

November 1994

- 4 SI's (SI# 1 to 4) (old) installed as precautionary measure along the crest of the creek valley slope; to act as a warning system for any movements; the slide scarp deteriorated along creek valley slope and the originally constructed downdrain pipe were overhanging above the slope face along this section of highway. (only 1 SI remained in 2000)

October 1996 (for Phase I remedy - minor berming)

- 1 SI (SI#1A) installed to investigate the depth of slippage after sliding occurred (retrogression of headscarp caused pavement cracking and 1 m settlement of pavement). Slope movement data from this SI provided information for design of Phase 1 slope remediation by minor berming in the Winter 1996 to 1997.

Dec 1997 (after Phase II remedy - shifting of roadway)

- 5 SI's (CBS# 1 to 5) and piezometers installed along the crest and toe berm area to monitor the performance of slope after Phase 2 slope remediation. Phase 2 slope remediation included shifting of the alignment towards backslope in Summer of 1997 and the use of lightweight fill (wood chips) to lighten the reconstructed slope.

11) **Instrument Operational**

Slope Indicator and Piezometers:

- CBS #11 (i.e. old SI #4)
- CBS #1 to #5

12) **Risk Assessment**

PF (3) * CF (4) = 12

PF = 3

- Slide can be considered inactive; low probability of remobilization as a result of berming and shifting of alignment. The lightweight "hog fuel" fill material was incorporated into the shifted alignment (1997 excavation into the backslope) only to provide extra redundancy in the safety of the shifted roadway. The sole shifting of alignment into more competent ground would have been adequate for slope stability purposes.
- The sole shifting of the alignment (without incorporating lightweight fill) was considered an adequately safe design for this slide remediation. Prior to deciding on the shifting of the alignment (1997), it was attempted to maintain the old alignment and repair the slide slope with the use of lightweight fill. However, site deterioration occurred to force the abandonment of the old alignment as well as the use of the lightweight fill already transported to site. Thus, for disposal of the material, the lightweight material was incorporated to replace the cut material and utilized mainly to provide extra redundancy on safety of shifted highway.
- The recent (November 2000) removal of the lightweight material (leachate problem) and reconstruction of the slope with common fill is considered a safe design equivalent to the original 1997 shifting of alignment. The slope reconstruction included drains at the base of the fill construction as well as edge drains (along the sides) that will lower the shallow groundwater along the backslope ditch area. The effect of such drainage measures will be observed to determine whether lateral drains are still required along the backslope ditch.
- Downcutting of creek might still be problematic to the slope along this creek valley stretch in the long-term and any resulting potential movement is being monitored with SI instrumentation.

CF = 4

- Closure of road would be a direct and unavoidable result of a slide occurrence.
- This road is the main connection between Grande Cache and Grande Prairie with substantial industrial (all season) and road user traffics. A detour route is not apparent.

Note:
This Risk Assessment rating is based on the Scheme proposed by AI in the Request for Proposal. (2000)

Probability Factor (PF) :	1 to 20 scale
Consequence Factor (CF) :	1 to 10 scale

13) **Geotechnical Conditions**

- The failure site is located along a tributary creek valley at midslope elevation of the Cutbank River Valley south wall. The surficial deposit is generally wet lacustrine clay with silt/sand laminations and a shallow groundwater regime. As well, seepage was observed along the creek valley slope. Contrasting with the north valley wall of the Cutbank River where rock outcrop and shallow surficial deposits were noted, thick surficial deposit of 10 to +20 m thickness below creek bed can be anticipated on this south side of the Cutbank River.
- Aerial photo review indicates slumping along the adjacent Cutbank River valley slopes as well as water ponding at slumped terraces. Slope movements and seepage conditions are apparent for the area.
- Sedimentary bedrock of soft Upper Cretaceous mudstone/sandstone is anticipated for this area.
- Downcutting by the creek increased the steepness of slope at the creek bank.
- High groundwater table at backslope ditch level and seepage toward the creek was observed.
- Weak lacustrine clay deposits at above and below the bottom of creek bed elevations
- Lacustrine clay deposit in combination with shallow groundwater conditions created conditions inductive to failures of creek slope triggered by the vertical degradation of the creek due to erosion.

14) **Chronology**
Historical setting:

- Early 1980's, this 200 to 300 m section of sidehill cut was constructed along the tributary creek of the Cutbank River valley with optimum setback from the crest of a steep creek slope. The slide occurred at the upland end of the creek valley where downcutting of the creek continues.
- Early 1980 to 1994, this highway operated as a gravel road. Minor settlement and slope movements might have been occurring at the present slide area. Re-levelling of the movement area with surface gravel might have been carried out by maintenance forces.
- In the 1994 site inspection (AI Geotechnical Section), the creek valley was observed as very steep but well vegetated. Retrogression of the valley wall scarp close to the alignment shoulder was considered to be very likely. It was noted that the deterioration of the creek valley wall resulted in the downdrain installation hanging out of the slope. It is noted that high groundwater levels and seepage flow from the backslope can be a factor for deterioration of the slope.
- November 1994, installation of 4 SI's along the creek slope crest as forewarning system was undertaken by AI.
- 1995, pavement construction was completed.
- Summer 1996, sliding of paved roadway occurred close to upland area where slope indicator instrumentation was not installed.
- Summer 1996, EBA investigated the slide with installation of 1 SI and presented Phase 1 remediation design of minor berming.

- Winter 1996, implementation of Phase 1 minor berming construction was not successful.
- Summer 1997, Phase 2 remediation design with shifting of alignment towards backslope and use of lightweight fill at head of slide was successful. Site performs well to date.
- Fall 2000, removal of lightweight "hog fuel" fill was carried out to eliminate leachate. The slope was reconstructed to 3H:1V and drainage measures (basal drains and edge drains) were installed.

Past investigations

- 1996 to 1997, high groundwater close to backslope ditch level and from backslope upland evident (site observation).
- Weak lacustrine soil and seepage flow evident (observation during 1997 shifting of alignment).

15) **Action**

- Instrumentation and visual monitoring should be continued.
- Bioengineering (e.g. live staking) should be implemented along the creek bank to provide further erosion protection along the riparian area that was disturbed by the 1996-1997 slope remediation works. This erosion protection measure was AI's commitment to Forestry at the time of "hog fuel" disposal (November 2000) and should be carried out in Spring 2001.

END