File: 2008-1002-a (Site Summary) (GP#36) Date: April 2009

BRIEF SITE SUMMARY AND RISK ASSESSMENT

1. Site (GP#36) — Hwy 40:36 Rock Fall
2. Reference Location along Highway — (i) Hwy 40:36 Rock Fall - South of McIntyre Mine
   (ii) Hwy 40:36 @Km 8.5 or Station 12+300
3. Legal Description — Section 5, Twp 58, Rge 8, W6M
4. UTM Coordinate — N 5,984,205 E 359,652
5. AT File
6. Alberta Transportation Plan and Profile
7. General Description of Instability

According to AIT gradeline mosaic for Hwy 40:36, this Rock Fall site can be located at approximate Station 12+300 (or Km 8.5). The railway track and the Little Smoky River channel are located to the east adjacent to the highway along the toe of the valley slope.

The loosening and falling off of rock from top of a steep rock cut slope (30-40m height) occurred to result in the rolling and bouncing of rock debris (as large as $1m^3$) onto the shoulder edge of highway pavement. This steep rock cut backslope slope was excavated (by blasting-trimming) in the 1998 widening of highway construction. This steep rock cut backslope can be estimated at 0.25H:1V slope and to extend about 100-150m length of highway located along the toe of the Smoky River valley slope along this east fringe of Rocky Mountains. Along the toe of the Smoky River valley, the highway corridor is confined by a railway line along its river bank and by the steep rock cut slope on the valley slope mountain side. The site location is shown in aerial photo in Figure 1.

- The site distress entails the falling off of loose rock chunks from the rock cliff (bluff) onto the highway causing a safety hazard.
- Presently at the affected rock fall area, most of the rock debris has fallen onto the ditch of approximate 4-5m width with a few of large size rock ($1m^3$) close to the pavement edge.
- Most of the rock debris was observed to be confined within the ditch space. However, it is a concern that a protrusion (possibly a bench) at midslope has caused rock bouncing and projectile of rock debris to a further distance away from the ditch width. Another

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concern is the formation of a talus debris cone along the slope toe line which can act as a chute to roll and bounce off the fallen rock onto the roadway. The area of rock debris accumulation can be estimated at about 30m to 40m length along the ditch. Maintenance clean out of this debris talus will be required.

- The rock loosening and rock fall source area was located at the top of the steeply dipping sandstone rock stratum which is underlain by a coal seam. Due to the weathering of the coal seam beneath, the rock stratum above the coal seam formed an overhang as the coal was gradually being undermined by weathering process with the course of time. Then, the cyclic effect of freeze-thaw served to loosen the rock along its jointing.
- It is apparent that this process of rock weakening was ongoing since the completion slope excavation around 1998. It is estimated that, along the top of the rock cut slope, about 15-20m breadth of the rock stratum was being undermined and loosened with weathering of the coal seam beneath. Thus, it was observed that a rock ledge overhang was formed at the top of the rock slope and this rock overhang maybe a potential source of falling in the future when loosened by weathering elements.
- Presently, a gas pipeline was installed (around 2005-06 by Atco Pipelines) buried beneath the backslope ditch.

Note:

The current rock fall site is located just 80m south of and adjacent to a previous GP-8b (Hwy 40:36 Rock Bluff) geohazard site where the runout of soil debris occurred around 1999 requiring cleanout of the ditch and part of roadway. At that time, the debris runout material was mainly gravelly boulder or fractured rock overburden soils (which was derived from overburden mantle above the sedimentary bedrock strata of this rocky mountain fringe area.) Apparently, this GP-8b site was located close to a fault/discontinuity and rock folding zone where weak sheared soil/rock (gouge) material can be present. A minor graben with surface/seeping water flow was observed at this previous site which is located at a minor draw area west of and adjacent to the current rock fall area. After several years of site review, this previous geohazard site was classified inactive (around 2004) as further site deterioration of debris runout was not observed since the debris talus cone(at slope toe) might have attained its angle of repose.

7.1 Maintenance measures of Site

7.1.1 Interim Measure Options

- Clean out the talus cone deposition along the toe of steep cliff rock slope to provide storage space for rock fall debris and to minimize the bouncing off of rock debris onto roadway.
- Installed rock fall sign to discourage stopping along the 100m area of this Rock Fall hazard area
- Maintenance forces are to observe any future loosen of rock to undertake speedy clean up.

7.1.2 Long Term Measure Options

- Scaling off loosened rock with split-blasting excavation especially along the loosened rock zone along the top of slope. Or a benching system to be designed to capture rock debris at intermediate heights; but such intermediate bench may

also be a dilemma as it may cause a bouncing of rock to project the debris onto the roadway.

- Installed rock fall wire nets with proper anchor designs at top and bottom. This will provide entrapment of rock debris.

7.1.3 Inspection Monitoring

- Continue inspection of this site on annual basis to assess any site deterioration with time and decide on appropriate measure to be implemented
- Maintenance forces should monitor this area periodically to provide any required clean up.

8. Date of Initial Observation

Around 1998

9. Date of Recent Observation

2008 Slide Tour

10. Instrumentation Installed

None

11. Instrumentation Operational

None

12. Risk Assessment

(PF 9) * (CF 4) = 36

PF

- The rock fall was assessed active with moderate steady rate. The steady rate of weathering of weak coal seam at the base of a hard rock stratum will continue to be main trigger and source of rock fall. The weathering of the coal layer caused an undermining of the strong top rock layer (sandstone) to form an overhang rock, which eventually undergoes cycles of freeze/thaw weakening and weathering to eventually topple and fall.
- The rate of future rock fall will be a function of seasonal cyclic weathering of the coal seam as well as the level of weak jointing of the rock.

CF

- Vigilant clean out of rock debris of ditch and/or roadway must be carried out periodically by maintenance forces to minimize traffic safety hazard
- Partial closure of road maybe required if the rock debris runs out onto the roadway

- The size of rock debris ($1m^3$ maximum) can cause substantially damage to traffic if it has fallen onto the road and is subsequently run into by moving traffic during the night.
- With the presence of debris talus along slope toe line, the type of hard sandstone (despite a small size rock) can cause substantial damage to traffic, in the event that it can be rolled off and projected directly into the vehicular traffic. It is important to maintain (clean out and restore space regularly) the adequate ditch space to allow the rock to fall vertically and confine the rock fall within the ditch storage space. Regular clean out of talus debris is required to provide sufficient ditch space to allow the trapping of "vertically falling" rock fall within the ditch space.

Note:
The risk assessment is provided based on a categorization of Hazard Probability Factor (PF) and Consequence Factor (CF) as provided by AIT's RFP 2000.
PF 1 to 20 scale
CF 1 to 10 scale

13. Geotechnical Conditions

The site is located in mountainous relief along the east fringes of the Rocky mountains and close to its foothill. This may be a historical rock fall area because the bedrock strata were daylighted by the highway cut alignment at this location. As was noted from a previous geohazard site GP-8b in the vicinity (about 80m south adjacent), the folding and faulting of sedimentary rock is obvious from rock outcrop and exposures.

From published information
The bedrock can generally belong the Paskapoo Formation of the Lower Mesozoic to Lower Cretaceous age. The bedrock can comprise of dark grey to black siltstone, dolomitic siltstone and limestone; silty dolomite, limestone, breccias and gypsum (Triassic); dark grey to black fissile shale and siltstone; black cherty and phosphatic dolomite and limestone; green glauconitic shale and sandstone (Jurassic); thick-bedded, fine to coarse grained, cherty sandstone interbedded with dark grey shale, siltstone and coal (Nikoonassin and Koutenay Formations and other rock types. Coal seams were noted at this site along intermittent beddings of bedrock. A fault zone as well as the folding of horizontal layer of sedimentary bedrock was observed at vicinity of this site.

14. Chronology

1999 1st observation of soil/rock debris fall by MCI
2008 recent observation in 2008 Slide Tour.

END