File: 2008-1002a (Site Summary) (GP#32) Date: April 2009

BRIEF SITE SUMMARY AND RISK ASSESSMENT

1. Site (GP#32) — Hwy 40:34 S-Curve
   (i) Previous Alignment
   Old Fill Footprint Slide
   (ii) Present Alignment
   Erosion Rilling at bottom of
   High Fill (BF 76751) downstream (d/s) slope
2. Reference Location along Highway — Same
3. Legal Description — Section 13, Twp 57, Rge 7, W6M
4. UTM Coordinate — N 5,976,637 E 374,425
5. AT File
6. Alberta Transportation Plan and Profile
7. General Description of Instability

The construction of a realignment of the previous stretch of S-CURVE roadway was carried out around 2003/2004. (The "S-CURVE" was a section of the previous highway alignment with very tight back-to-back curves very prone to traffic accidents.) The new alignment replaces the previous S-CURVE roadway section. The new alignment provides a larger radius curve of higher geometric standard and a more safe traffic passage. After construction of the new alignment, several areas of geotechnical distress were revealed to exist.

The geotechnical distress areas for this site entail both the upstream and downstream locations of the bridge culvert (BF 76751). At upstream of the bridge culver, it entails (i) Previous Alignment – Old Fill Footprint Slide. At downstream of bridge culvert, it entails (ii) Present Alignment – Rilling erosion at downstream side of high fill slope (as the main concern).

(i) Previous Alignment – Old Fill Footprint Slide

At completion (late 2004) of realignment construction, sliding movement of the valley slope occurred at the old fill footprint upon excavation removal (late 2004 or early 2005) of the old fills of the previous alignment.

Previously under the surcharge of old fill embankment, this wet valley slope was under the footprint and its instability was suppressed. It was assessed that the "off-loading" removal of the old fill surcharge has triggered the sliding of the "newly unearthed" valley slope of very wet seepage soils.

As experienced during excavation of adjacent cut slope for the new alignment, wet sandy soil was anticipated in the vicinity area. During the 2004 construction of the new alignment, the excavation of a cut slope in adjoining area was hampered by an adversely high and strong flowing groundwater flow regime (in sandy gravelly soils) and required a staged dewatering drawdown measure with use of staged excavation and installation of subdrains (to depress groundwater regime) along ditches along toe of the new excavation slopes along the new alignment.

At the "off-loaded and unearthed" creek slope beneath the old alignment, the slope movement was stabilized with slope flattening and installation of finger drains with toe berming (a small gravel berm along the newly restored creek bank toe area).

(ii) Present Alignment –

a) Rilling erosion at downstream side of high fill slope (major concern)
b) Channel Slope Conditions upstream of a new culvert (BF 76751)

A high fill (40m to 50m height) embankment was constructed across a steep creek gorge crossing. And a new bridge culvert (350m in length and 3m diameter) was constructed beneath at steep grade (17%) The culvert inlet area was lined with prefabricated concrete blocks of "Ajax interlock" hard armour. The culvert outlet area was protected with heavy riprap lining.

Due to the steep grade and vast erosive flow energy anticipated at culvert outfall zone, a review of the stability and integrity of channel lining armor (at outfall zone) was planned to assess whether any under-scour of channel and toe instability may develop at outfall zones at toe area of the embankment as well as adjacent valley slopes. The site review (2008 Slide Tour) revealed substantial rilling erosion has occurred at bottom of d/s slope of high fill embankment.

a) Rilling erosion at downstream (d/s) side of high fill slope

The downstream slope of high fill (with a long 350m bridge culvert beneath) was inspected to be undergoing serious riling erosion and ditch erosion over a 4-5 year duration since completion of construction in 2004. The fill is about 40-50m high (3H:1V) and was constructed across a narrow gorge with a creek at the bottom and the surface area of d/s slope narrows drastically to a spout at bottom portion of this high fill. Ditch water from highway also added to outfall down the skirt channels of this high fill slope. This source of surface water and "funneling" configuration of surface flow contributed to a concentrating and convergence of flow to create excessive erosion.

- Along skirt ditch channel of the fill slope (i.e. ditch abutting to the natural valley slope), surface water flow has shifted and eroded its flowing path out of its designed ditch channel. This spillage of flow has invoked erosion of a new channel down along the sides of fill which buttressed to the valley walls. The original skirt channel was constructed as a riprap lining channel running from top of embankment down to the toe of slope (creek level and culvert outlet). At the top of embankment, this skirt channel is connected to highway gradeline to accept the surface water from highway ditches. Therefore, the flows down these skirt ditch channel should not be meager.

- This is serious rilling erosion along the lower half of the high fill slope and will deteriorate to cause serious erosion of toe of this high fill slope. This riling erosion was caused by concentrated flow of surface runoffs.
  - This is a 3H:1V high fill slope (about 40m to 50m in height) down a steep gorge. Concentration and convergence of surface runoff has caused this erosion. It can be rationalized that the narrowing down of a slope surface (down the gorge) invokes a convergence surface water flow resulting flow concentration eroding bottom half of the slope face. Due to the funnel effect (like concentrating the flow from a wide top of a V and the narrow bottom of a V) of flow concentration and its accumulated flow energy, the erosion scouring has accumulatively eroded extensive riling along the lower slope of this high fill over a 5 year duration since 2003 completion of S curve realignment. It will be required to design "roughness measures" to slow down the flow velocity and to design repairs to the eroded riling slope areas as well as the eroded skirted ditch channel as well.

  - At time of 2004 construction of new alignment, lack of topsoil in the area prohibited the growth of grass cover as a soft erosion protection blanket along slope face. This induced an easier erosive environment along slope face susceptible to surface water erosion. However, it is comforting to recall that the fill embankment was constructed with more sturdy erosion resistant soils (sandy, gravelly CL clay till soils). The construction history of use of sturdy soils will render the potential of speedily deep erosion scour less likely. However, the planning of early remediation of the riling erosion is advisable before the site deteriorates.

  - As this eroded toe area is located at a far off bottom location, it was often overlooked at its early distress stage due to difficult access and, in often times, allowed to deteriorate into a vast problem.

b) For channel conditions of a new culvert (BF 76751)

Along the upstream channel and its valley slopes (on Hinton side)
- There are several "kick-out" slumping of valley slope (on the Hinton Side) at the lower elevation (about 6m height above creek bank) along the reconstituted creek channel at upstream of culvert inlet.

At the inlet apron of the new culvert
- The A-jax (Pre-Cast inter-Lock) Concrete armor protection of the inlet apron (for the culvert) appeared to be in good conditions.
- There is an erosion scour at top of a toe bench with the eroded scour running down the bench slope to the side of the culvert inlet. This scour was caused by surface water runoff.
  - It is appropriate to construct a swale to channel the water flow to an adjacent downfall ditch. And then the eroded scour area can be denture in-filled with erosion resistant granular fills or riprap lining material.

At the outlet Apron of the new culvert
- This a very steep grade bridge culvert (about 350m in length and at about 17% grade). There was a caution whether riprap protection at the outfall may or may not withstand the outflow impact energy and if it may cause erosion scour at the outlet channel.

- The outlet area of channel and its riprap protection was inspected as performing well and in good conditions. No apparent erosion from culvert outflow can be noted.
- There is a "flexible Big O" pipe outfalling groundwater flow into the creek channel at culvert outlet location. The rate of water outfall can be estimated at about 2 to 4 liters per minute. This water flow was most probably collected from the subdrains that were installed below the ditches along the toes of the adjacent backslope cuts (sandy and very wet excavation slopes requiring staging of dewatering during construction) along the highway just to the west (toward Grande Cache direction). For future maintenance, it is important to ensure clean out of outlet of this Big O pipe and no blockage of outlet is to occur in the future.

8. Date of Initial Observation

2005 Completion of New S curve alignment and removal of old fill embankment of old alignment

9. Recent Observation

2008 July 2008 Slide Tour

10. Instrumentation Installed

None

11. Instrumentation Operational

None

12. Risk Assessment

<u>(i) Previous Alignment</u> – Old Fill Footprint Slide

PF (5) * CF (2) = 10

PF (5)
- Active with slow to moderate rate of ongoing movement
- Future rate of movement remains to be observed with time.

CF (2)
- The "off-loaded and new unearthed" creek valley slope movement should not affect safety of new alignment roadway due to wide spatial separation.
- However, slumping of "unearthed valley slope" may be environmentally unfriendly.

<u>(ii) Present Alignment</u> – Rilling erosion at downstream side of high fill slope (major concern)

PF (8) * CF (3) = 24

PF (8)
- Active with slow to moderate rate of ongoing rilling erosion scour movement has obviously happened

- Catastrophic and imminent failure of embankment slope not likely because more sturdy fill (sandy, gravelly, CL clay till) was utilized for construction.

CF (3)

- Toe stability of a high (40-50m) fill embankment can develop with rilling erosion is allow to deteriorate. Then, sliding of toe area of high fill can occur.
- Roadway closure will be unlikely. Roadway will not be affected as yet and will be dependent on the rate of retrogression of future toe instability to be observed with time.
- Appropriate erosion protection and stabilization measures be invested at this early stage prior to site deterioration.

Important Note:

For this riling erosion (ii) site, it is appropriate and advisable to prioritize the investigation and design of erosion protection and stabilization measures at this early stage prior to site deterioration.

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 at a tributary creek of the Smoky River along the fringes of the Rock Mountains. The bedrock is of sedimentary deposition (sandstone and clayshale strata) and most overburden soil can be noted are sandy, gravelly and CL clay materials derived from decay and decomposition of sedimentary rocks. Along this alignment, it was investigated that the overburden soils of sandy gravelly till, clay and clayey tills overly bedrocks of shale and sandstone. For bedrock materials, outcrops and exposures of clayshale and sandstone can be observed along the roadway and creek valley slope of this steep gorge.

14. Chronology

2004 Construction of S-Curve new alignment
2005 Removal of old fill along old alignment and sliding of old valley "Fill Footprint" slope
2008 Observation of rilling erosion at d/s slope of high fill embankment (BF 76751). A priority strategy to investigate and design remediation is advisable.

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