Klohn Crippen Berger

Alberta Transportation
Site S35– Highway 940 Corridor
Highway 940, km 25.9, 67.7,82.2,82.4 and 90.9, North of Coleman
Site Data – Summary Binder

Section A
File Review

1 SITE LOCATION

Five geohazard sites fall within the Site S35 along highway 940 Corridor north of Coleman, Alberta. The location of each site is referenced from the intersection of Highway 940 and Highway 3, north of Coleman. Each site is assigned a distance in km, for its proximity to the intersection. The location of each site is summarized below:

Table 1 Location of Geohazards on Highway 940 Corridor

Site	Geohazard	Latitude	Longitude	LSD	NTS Map Sheet
S35 – km 25.9	Erosion Gully	49° 48.3358' N	114°27.0337' W	SW 11-10-4 W5	82G09
S35 – km 67.7	Mean Creek Culvert	50° 8.0335' N	114° 26.2227' W	NE 35-13-4 W5	82J01
S35 – km 82.2	Creek Bank Erosion	50° 11.8698' N	114° 34.5173' W	SE 26-14-5 W5	82J02
S35 – km 82.4	Creek Bank Erosion	50° 11.9343'N	114° 34.6358' W	SE 26-14-5 W5	82J02
S35 – km 90.9 (Bridge)	Wilkinson Creek Bridge	50° 16.1013' N	114° 35.4968' W	SW 23-15-5 W5	82J07

2 SITE DESCRIPTION

The highway 940 corridor is an unpaved, two lane gravel road with an alignment of northwest/southeast. Five geohazard sites are monitored and each is summarized below.

The geohazard at S35 km 25.9 site is an erosion gully in the slope above the left creek bank encroaching into an approximately 9 m wide segment of the downslope edge of the road. There is a swale in the road surface along and parallel to the downslope edge of the road and extending approximately 5 m southbound from the head of the gully. This swale directs surface runoff into the head of the gully. The downslope (southeast) edge of the road is immediately adjacent to the crest of the slope above the left creek bank. The slope is approximately 10 m high. The primary cause of the gully erosion appears to be the surface runoff from the road being directed into the head of the gully.

The geohazard at S35 km 67.7 site is culvert erosion, from the Mean Creek running northeast to southwest across the highway via two culverts: north culvert is 1600 mm and south culvert is 900 mm

Klohn Crippen Berger Ltd. • Suite 301, 2627 Ellwood Drive SW • Edmonton AB T6X 0P7 • CANADA
780.444.0706 t • 780.481.2431 f • www.klohn.com

in diameter. The inlet of the 1600 mm culvert on the east side of the road remains angled upwards with negligible soil cover over the culvert inlet. Two concrete lock-blocks have been placed over the inlet to prevent it from deforming further upwards. The 900 mm diameter culvert has an approximately 50 mm wide separation in the crown of the culvert. The separation is restricted to the upper portion of the culvert with the bottom segments still intact.

The geohazard at S35 km 82.2 site is creek erosion along the right bank of the creek. The rock fill slope between the road and the creek channel is approximately 6 m high. Cobble to boulder-sized rock fill was placed along an approximately 10 m segment of the slope between the downslope edge of the road and the right creek bank to buttress the slope between the road and the right creek bank and to provide erosion protection.

The geohazard at S35 km 82.4 site is creek erosion on the downslope edge of the highway and is at risk of becoming undermined by erosion along the right bank of Wilkinson Creek, which is a few meters downslope of the highway. The creek bank at this site is 5 m to 6 m high at 48º to 50° slope, with gravel to boulder sized bed and bank material.

The geohazard at S35 km 90.2 Wilkinson Creek Bridge site is prone to flooding and wash outs. The washouts have been repaired by trucking suitable road fill and rebuilding the washed-out segment. The highway southbound of the bridge consists of a relatively low height fill embankment constructed on the relatively flat creek floodplain on the valley floor. There is a low levee along the left bank of the creek that is prone to overtopping by high creek flows. The floodwaters then flow along the east side and overtop the highway surface and continue to flow northwards along the floodplain on the west side of the highway to rejoin the main channel a short distance downstream of the bridge.

3 CHRONOLOGICAL BACKGROUND

The table below provides a brief chronological background of each site. The first noted inspection report was 2009 Site Inspection Report.

Table 2 Chronological Background of Site S35 – Highway 940 Corridor

Date	Description
2009	Annual inspection was completed by AMEC and AT personnel. Five sites were inspected: S35 km 25.9: Inspection of the erosion gully resulted in little change from the site assessment in 2008. The 2008 inspection reports were not available. In summary, AMEC observed a swale in the road surface parallel to the downslope edge of the road and extending approximately 5 m southbound from the head of the gully. This swale directs surface runoff into the head of the gully. The erosion gully has formed in a 38º to 40° inclination slope of exposed bedrock and rocky soil above the left creek bank. At the time of the site inspection the gully had encroached approximately 0.1 m to 0.2 m into the downslope edge of the road. The gully encroachment into the road was approximately the same as the 2008 inspection. Two survey stakes were installed at the upslope extent of the gully for future monitoring.

	AMEC recommended reducing the rate of gully erosion by directing surface runoff from the road surface away from the gully area. The road surface should be graded to shed surface runoff towards the upslope side of the road. Also, installing a guardrail along the downslope side of the road to keep traffic away from the undermined edge of the existing road. S35 km 67.7: Inspection of the highway crossing of Mean Creek culvert noted the inlet of the 1600 mm culvert remains angled upwards, without significant change from the 2008 inspection. There is negligible soil cover over the culvert. The remainder of the 1600 mm culvert appears to be aligned properly and it was open and clear of debris at the time of the site inspection. Overall, there appears to be little change to the condition of this culvert – some erosion remains visible around the base of the culvert where the culvert segments are separated at the top. There was no water flow outside of the culvert due to culvert separation. At the time of the inspection there was a large area of ponded water 1 m deep upstream of the culvert inlets. Field access trail/ditch block was installed immediately south of the culvert inlets to force the creek flow into the culverts to prevent creek flow along the east highway ditch. There is somewhat of a shoreline eroded along the south side of the ponded water, which suggests that the water level in June 2009 was a typical level at approximately 1.5 m below the highway grade. AMEC recommended survey of the creek channel elevation upstream and downstream of the highway to determine the optimum inlet elevation for the 1600 mm culvert. Also, the inlet of the 1600 mm culvert should be reconstructed at a lower elevation to lessen ponding. S35 km 82.2: Inspection of the creek erosion appeared to be in the same condition from the September 2008 repair inspection. AMEC noted cobble to boulder-sized rock fill was placed along an approximately 10 m segment of the slope between the downslope edge of the road and the right creek bank for erosion protection. S35 km 82.4: Inspection of the creek erosion on the downslope edge of the highway is at risk of becoming undermined by erosion along the right bank of Wilkinson Creek. Willows are abundant on the slope. There is minor erosion occurring from the crest of the slope due to runoff from the road and the toe of the slope exposed to streamflow appears stable. The slope appeared to be in the same condition from the 2008 inspection. S35 km 90.2: The Wilkinson Creek Bridge was inspected due to a history of flooding and roadway washed out from peak flows during spring runoff. At the time of the inspection the water elevation in the creek was less than 1 m below the highway surface elevation. Based on the alignment and elevation of the highway on the south approach to the Wilkinson Creek bridge relative to the creek channel alignment and floodplain elevation, future washouts during peak flows along the creek are likely to occur. It does not appear that future washouts will lead to erosion of the south embankment or approach to the existing bridge. AMEC recommends protecting the bank and channel training measures to reduce the risk of channel overtopping during high creek flows. Realignment of this segment of Highway 940 along with repositioning of the bridge crossing to a more suitable location at less risk from future flood events and creek channel shifts.

4 SITE GEOLOGY, HYDROGEOLOGY, AND GEOMORPHIC SETTING

According to the Canada Centre for Mapping, Natural Resources Canada, E Topo Maps the typical ground surface elevation and district for each site along the highway 940 corridor is summarized in Table 3 below.

Table 3 Typical Ground Surface Elevation

Site	Ground Surface Elevation ft. above mean sea level (a.m.s.l.)	District
S35 km 25.9	5800	Blairmore
S35 km 67.7	5850	Langford Creek
S35 km 82.2	6200	Fording River
S35 km 82.4	6200	Fording River
S35 km 90.9 (Bridge)	5450	Mount Head

Alberta Geological Survey (AGS) Map 600 was referenced to determine the Highway 940 corridor lands within the Southern Rocky Mountains and Foot Hills zone.

The geological history of the site was obtained from Quaternary Geology, Central Alberta Atlas (Shetsen, I, 2007), prepared by Alberta Research Council, Natural Resource Division, Alberta. The surficial geology for each geohazard site is summarized in Table 4. The surficial geology consists of draped moraine on bedrock uplands and plains: discontinuous till over bedrock surface slightly modified by ice and stream erosion; till is generally less than 3m thick; flat to undulating topography.

The bedrock types at each geohazard site (identified on AGS Map 600) is summarized in Table 4.

Table 4 Bedrock Types at Each Site

Site	Formation Group	Formation Description
S35 km 25.9	Lower Cretaceous-Blairmore Group	CROWSNEST FORMATION: trachyte and phonolite volcanic breccia, crystal and lithic tuff, volcanic sandstone and mudstone; minor trachytic flows MILL CREEK FORMATION: interbedded mudstone, siltstone, and very fine grained quartz sandstone with subordinate coarser grained quartz sandstone and conglomerate; tuff and bentonite beds increase in abundance upwards; colours include greenish grey, olive grey, purple, and red; shallow marine (lower part) to fluvial (upper part) BEAVER MINES FORMATION: fine- to coarse-grained, greenish-grey, feldspathic sandstone interbedded with greenish-grey mudstone and laminated siltstone; subordinate conglomerate (some with volcanic pebbles), bentonite, tuff, and caliche; nonmarine GLADSTONE FORMATION: fine-grained sandstone, siltstone, and mottled green and maroon shale with sideritic concretionary layers (lower part, nonmarine); fossiliferous, grey-green, calcareous, fine-grained sandstone, shale and coquina (upper part, marginal marine) CADOMIN FORMATION: erosion-resistant chert- and quartzite-pebble conglomerate interbedded with fine- to coarse-grained quartz sandstone, siltstone, and mudstone (commonly carbonaceous); alluvial and pediment deposits
S35 km 67.7	Jurassic and Lower Cretaceous – Fernie Formation and Kootenay Group	ELK FORMATION: interbedded sandstone, siltstone, mudstone, shale, and locally, chert-pebble conglomerate and thin coal layers; nonmarine MIST MOUNTAIN FORMATION (Jurassic-Cretaceous): interbedded sandstone and siltstone with dark grey to black mudstone; rare conglomerate; thin to thick coal seams; nonmarine

		MORRISSEY FORMATION: fine- to medium-grained quartz and chert sandstone; rare interbeds of carbonaceous mudstone, siltstone, and coal; marginal marine to nonmarine FERNIE FORMATION: medium grey to black shale (weakly to strongly fissile); limestone (including phosphatic, cherty, and oolitic varieties); siltstone; sandstone (some phosphatic); locally chert conglomerate at base; marine
S35 km 82.4	Lower Cretaceous-Blairmore Group	CROWSNEST FORMATION: trachyte and phonolite volcanic breccia, crystal and lithic tuff, volcanic sandstone and mudstone; minor trachytic flows MILL CREEK FORMATION: interbedded mudstone, siltstone, and very fine grained quartz sandstone with subordinate coarser grained quartz sandstone and conglomerate; tuff and bentonite beds increase in abundance upwards; colours include greenish grey, olive grey, purple, and red; shallow marine (lower part) to fluvial (upper part) BEAVER MINES FORMATION: fine- to coarse-grained, greenish-grey, feldspathic sandstone interbedded with greenish-grey mudstone and laminated siltstone; subordinate conglomerate (some with volcanic pebbles), bentonite, tuff, and caliche; nonmarine GLADSTONE FORMATION: fine-grained sandstone, siltstone, and mottled green and maroon shale with sideritic concretionary layers (lower part, nonmarine); fossiliferous, grey-green, calcareous, fine-grained sandstone, shale and coquina (upper part, marginal marine) CADOMIN FORMATION: erosion-resistant chert- and quartzite-pebble conglomerate interbedded with fine- to coarse-grained quartz sandstone, siltstone, and mudstone (commonly carbonaceous); alluvial and pediment deposits
S35 km 90.9 (Bridge)	Mike River Formation, Pakowki Formation, and Belly River Group	DRYWOOD CREEK FORMATION: sandstone; shale; minor coal; coquina; nonmarine to marine LUNDBRECK FORMATION: greenish-grey and red shale; channel-fill sandstone bodies; pedogenic limestone; carbonate concretions; nonmarine CONNELLY CREEK FORMATION: channel-fill sandstone bodies with wood, plant debris, and coaly fragments; shale; minor coquina; predominantly nonmarine, deltaic, fluvial PAKOWKI FORMATION: recessive, dark grey to greenish-grey mudstone and shale; minor, silty, thin- to medium-bedded sandstone; chert pebble bed at base; typically <25 m thick; marine MILK RIVER FORMATION (GROUP): very fine to medium-grained sandstone (some thick bedded and massive to cross-stratified), mudstone, and siltstone; local carbonaceous mudstone and minor coal layers in upper part; marine offshore, shoreface, and fluvial

Hydrogeological map from AGS does not show any artesian ground water flow. The direction of groundwater flow is in all directions. From the instruments readings in 2011, the groundwater depth is between 7.96 m to 9.47 m below ground surface.

CURRENT SITE PROBLEMS

The record of site problems is provided in Table 1. Sites S35 km 82.2, S35 km 82.4, and S35 km 90.2 underwent construction in 2008. Table 3 summarizes the probability factor, consequence factor, and risk rating for each site based on criteria provided by Alberta Infrastructure & Transportation relating to safety.

Table 3 Risk Rating Based on Probability and Consequence Factors

Site	Consequence Factor	Probability Factor	Risk Rating
S35 km 25.9	4	11	44
S35 km 67.7	5	5	25
S35 km 82.2	2	5	10
S35 km 82.4	2	5	10
S35 km 90.9 (Bridge)	9	6	54

5 PREVIOUS SITE INVESTIGATIONS

The sites were inspected by AMEC and AT in 2008 and 2009. Reports from 2008 were not available.

6 REPAIR WORK AND MITIGATIVE MEASURES IMPLEMENTED

Repairs and mitigation measures were implemented in 2008 for Sites S35 km 82.2, S35 km 82.4, and S35 km 90.2. Refer to the Table 1 Chronological Background of Site S35 – Highway 940 Corridor for these details.

7 MONITORING OVERVIEW

There are no instruments at the site, therefore, the only monitoring of the site is based on visual inspection.

REFERENCES

Alberta Geological Survey (2005). Map 207 Quaternary Geology Southern Alberta. Retrieved from: http://ags.aer.ca/publications/MAP_207.html

Alberta Geological Survey (2005). Map 101 Hydrogeological Map of the Drumheller, Alberta, NTS 82P Retrieved from: http://ags.aer.ca/publications/MAP_101.html

Alberta Geological Survey (2013). Map 600 Bedrock Geology of Alberta. Retrieved from: http://ags.aer.ca/publications/MAP_600.html

Amec Earth & Environmental (2009). Southern Region Geohazard Assessment Program, Highway 940, Wilkinson Creek Bridge Area, June 2009 Inspection Report.

Amec Earth & Environmental (2009). Southern Region Geohazard Assessment Program, Highway 940, KM 25.9, June 2009 Inspection Report.

Amec Earth & Environmental (2009). Southern Region Geohazard Assessment Program, Highway 940, KM 82.2-82.4 Creek Erosion, June 2009 Inspection Report.

Amec Earth & Environmental (2009). Southern Region Geohazard Assessment Program, Highway 940, Mean Creek Culverts, KM 67.7 June 2009 Inspection Report.

Canadian Centre for Mapping (1970). ETopo Map, Blairmore Alberta, 82G09 Edition 2 UTM Zone11.

Canadian Centre for Mapping (1980). ETopo Map, Langford Creek Alberta, 82J01 Edition 3 UTM Zone11.

Canadian Centre for Mapping (1975). ETopo Map, Fording River Alberta, 82J02 Edition 2 UTM Zone11

Canadian Centre for Mapping (1978). ETopo Map, Mount Head Alberta- Birtish Columbia, 82J07 Edition 3 UTM Zone11