Alberta TRANSPORTATION

CENTRAL REGION
GEOHAZARDS RISK ASSESMENT
SITE INSPECTION FORM

Klohn Crippen Berger

SITE NUMBER AND NAME	HIGHWAY & KM	PREVIOUS INSPECTION DATE	INSPECTION DATE
C24 H564:10 Slide	32.29 – 32.47	Oct. 26, 2009	**May 18, 2010**

LEGAL DESCRIPTION	NAD 83 COORDINATES	RISK ASSESMENT
SW 21-27-18-W4	N 5686020 E 396380	PF: 2 CF: 2 TOTAL: **4**

SUMMARY OF SITE INSTRUMENTATION:	INSPECTED BY:
None operational LAST READING DATE:	PROFESSIONAL ENGINEER OF ALBERTA DARREN W. RATCLIFFE

PRIMARY SITE ISSUE:

Large slide below highway. Substantial dip and cracking appeared in highway in 2007 and spring 2008.

APPROXIMATE DIMENSIONS:

DATE OF ANY REMEDIAL ACTION: South ditch repaired in fall 2007. Slope repair completed June 30, 2008.

ITEM	CONDITION EXISTS		DESCRIPTION AND LOCATION	NOTICABLE CHANGE FROM LAST INSPECTION	
	YES	NO		YES	NO
Pavement Distress	X		Road surface reinstated in fall of 2007 and spring 2008. Cracks observed in gravel road surface. Cracks typically covered over by road grading operations.	X	
Slope Movement	X		The slope immediately northeast of the stabilized area has slumped below the road level.	X	
Erosion		X	South ditch reinstated with gravel filled geo-cell in fall 2007. Minor migration of gravel from cells.		X
Seepage		X			X
Culvert Distress		X			X

COMMENTS

Refer to previous reports, the attached letter and photos.

It is recommended that slope inclinometers be installed at road level and on the bench below the road to determine the rate and location of movement.

Klohn Crippen Berger

May 25, 2010

Alberta Transportation
Central Region
#401, 4902 – 51 Street
Red Deer, Alberta
T4N 6K8

Mr. Dennis Grace, P.Eng.
Project Engineer

Dear Mr. Grace:

Central Region GeoHazard Assessments
Site C24 H564:10 Kenilworth Lake Slide
May 2010 Site Assessment Report

Alberta Transportation has initiated a process of risk management at specific geohazard sites that includes a document control system. This annual site assessment report forms Section B of the document control system for the above site.

The site was inspected on May 18, 2010 by Mr. Darren Ratcliffe of Klohn Crippen Berger Ltd. Photographs from the inspection are attached.

This report was prepared by Klohn Crippen Berger Ltd. for Alberta Transportation Central Region under Contract No. CE101/2008.

1. PROJECT BACKGROUND

1.1 Site Location

About 20 km southeast of Drumheller and south of the Red Deer River, Highway 564:10 (previously known as Duck Lake Road) descends into a coulee (known as East Coulee) to join with Highway 569. On the east side of the coulee, a large slide developed and resulted in an apparent dip in the highway grade. The slide area is about 300 m wide with a steep scarp relatively close to edge of highway. Instrumentation was installed at the site in July 1985.

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1.2 Site History

June - November 1979

In 1979 it was proposed to widen the existing road in this location by cutting the slope above and filling below, adopting 3H:1V slopes. The installation of horizontal drains at observed spring sources was also recommended. Test holes drilled in the area identified highly variable soil strengths and bentonitic layers in the soil.

It is assumed that the work was done as planned in the summer of 1979. In November 1979, a crack was observed in the road surface that was 30 mm wide and had settled about 70 mm. Cracks on the downhill slope had opened up to 50 mm wide and were over 1 m deep.

July 1985

In July 1985, a site investigation was undertaken at the slide location. Four locations were drilled; hole details are presented in Table 1. The drilling indicated that the subsurface conditions comprised medium to high plasticity sandy clay over high plasticity clayshale and sandstone. Four slope inclinometers and three standpipe piezometers were installed. The instruments indicated that the water level and the shear movement generally corresponded with the clay-clayshale interface.

Table 1 July 1985 Test Hole Summary

Hole ID	Location	Elevation (m) (Local Datum)	Total Depth (m)	Depth to Clayshale (m)	Water Depth (m)	Movement Depth (m)	Movement Elevation (m)
SI #1	5+263, 37 m LT	199.3	18.6	16.7	16.0	16.8	182.5
SI #2	5+331, 47 m LT	200.8	11.0	5.0	5.2	5.8	195.0
SI #3	5+220, 16 m LT	202.4	11.0	7.9	5.6	8.2	194.2
SI #4	5+298, 17 m LT	208.3	12.5	10.5 (more likely 7.0)		8.2	200.1

Liquid limits in the overburden soils ranged from 35% to 80% with an average moisture content of about 15%. SPT blow count values typically ranged from 12 to 23 blows per 300 mm, but were reduced to about 3 to 4 blows per 300 mm in soft wet zones. A direct shear test was performed on an overburden sample from test hole SI #1 at a depth of 9.1 m. The test indicated a friction angle of 33°; however, the material at this depth is about 7 m above the observed shear plane.

The clayshale liquid limits ranged from about 55% to 190%, indicating the presence of highly bentonitic, low strength layers. Natural moisture contents were typically about 25%.

1986 - 1991

Over the period 1986 to 1990, numerous complaints from various landowners were received and resulted in an Alberta Transportation memorandum dated January 1990 describing the section of highway as "winding, traversing rugged terrain and there is evidence of road settlement and landslides on the hillside". It was believed at the time that the road was constructed over some old underground mine shafts, however a review of an EUB plan indicates that the highway is to the east of the eastern limit of the mine activity. It was recommended in 1990 that this section of road not be paved.

A study of two alternative road alignments was carried out at this time and was summarized in a memorandum dated June 1991. The outcome was that in view of the very high cost of the alternatives, it was recommended that the alignment follow the existing road. It was recommended that any effects of the slide investigated in 1985 be repaired with periodical maintenance as the most economical procedure.

2007 – 2008

In August 2007, the movement area observed was about 70 m long and the road surface appeared to have dropped by about 1 m. Cracking was observed at the crest of the slope and in numerous locations below the highway. Barricades were erected to close the lane beside the top of the slope. The slide was likely reactivated by ground saturation from the high regional precipitation in 2007. The level of movement had effectively closed half the highway. A summary of the instrumentation status as of August 2007 is provided in Table 2 below.

Table 2 August 2007 Instrument Readings

Hole ID	Observation
SI #1	Sheared at 10 m
SP #1	Sheared at 4.3 m
SI #2	Destroyed
SP #2	Sheared at 5.5 m
SI #3	Sheared at 7 m
SP #3	Water level at 3.1 m
SI #4	Sheared at 4 m

In the fall of 2007, the roadway was reinstated and the backslope ditch was protected with gravel-filled geo-cells. To reduce the driving stresses on the failure plane, the slope below the active area was excavated to match the adjacent steep slope section. The intent was to stabilize the slope with soil nails immediately thereafter. However, due to mechanical difficulties with the soil nail launcher in cold weather, the nailing had to be delayed until the spring of 2008 when the ambient air temperature was warm enough for the launcher to achieve satisfactory nail penetration. As part of the fall 2007 construction, 300 m of guardrail was installed.

Due to the road not being stabilized immediately after it was rebuilt, cracks began to form in the road. By the end of November, a crack approximately 50 mm wide had appeared extending about 4 m into the road structure over a 20 m long length. The area had also noticeably settled. Cracking and settlement continued into the spring of 2008.

To repair the zone of cracking and settlement, a portion of the road along the line of the crack was excavated and the back face of the excavation was soil nailed. A GRS (geosynthetic reinforced soil) wall was then constructed to reinstate the highway and restore the grade. Areas on either side of the GRS wall were also soil nailed. A total of about 650 soil nails were installed at the site.

2. SITE OBSERVATIONS

The site has been monitored at least twice per year since the 2007/2008 construction. Some cracking and settlement have been observed in the remediated area. However, in the May 2010, it was noted that the area immediately east of the soil nailed area had slumped and a near vertical backscarp was apparent adjacent to the roadway, as shown in Photo 1 below. Some minor cracking was also apparent in the roadway above the new slump zone.

Photo 1 Site Conditions May 18, 2010 (SI4 in foreground, see Figure 1)

3. RECOMMENDATIONS

Based on the observed new movement and cracking in the area, it is recommended that slope inclinometers be installed to monitor the location and current rate of movement. It is suggested that 4 slope inclinometers be installed at the crest of the slope along the roadway and an additional 2 slope inclinometers be installed on the bench below the road level.

In order to access the bench below the road, a tracked rig will be required and a section of guardrail will have to be removed and replaced. The instruments would be installed using a combination of auger drilling and air rotary drilling. It is anticipated that the instruments on the bench will be about 20 m deep and the instruments at road level will be about 25 m to 35 m deep. The cost of the instrument installations is expected to be about $52,000, including KCB costs as shown in Table 3.

Table 3 Site Investigation Cost Estimate

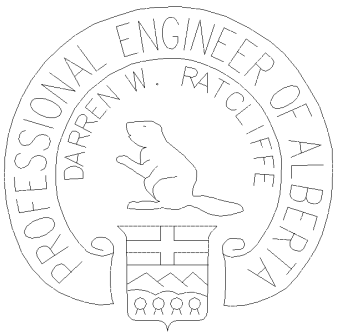
Item	Quantity	Unit	Rate	Total
Contractor Costs				
Mob / Demob	1	LS	3000	3000
Traffic Accomodation				
Drilling Time	72	hrs	250	18000
SI Pipe	140	m	50	7000
Anchors, Caps, etc.	6	ea	200	1200
Casing Protectors	6	ea	100	600
Grout Plant	6	days	135	810
Subsidence	6	days	450	2700
Travel Time	12	hrs	95	1140
Support Truck	6	days	225	1350
Drilling Consumables	140	m	5	700
Contractor Subtotal				***$36,500***
KCB Costs				
Field Engineer	80	hrs	110	8800
Reporting	30	hrs	110	3300
Review	8	hrs	180	1440
Subsidence	6	days	250	1500
Truck & Fuel	6	days		600
KCB Subtotal				***$15,640***
Total				**$52,140**

Please contact the undersigned if you have any questions regarding this letter.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Danelle Stutt, EIT
Geotechnical Engineer



Darren W. Ratcliffe, P.Eng.
Project Manager

APEGGA Permit to Practice No. 9196