KLOHN CRIPPEN

June 11, 2002

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

**Mr. Melvin Mayfield, P.Eng.**
**Project Engineer**

Dear Mr. Mayfield:

**Central Region Landslide Assessment Site C18**
**SH837:02 River Scour @ km 1.9**
**2002 Annual Inspection Report**

Alberta Transportation has initiated a process of risk management at site-specific slope movement sites that includes a 3-ring binder document control system. This Annual Inspection report forms Section B of the document control system for the above site. The annual site inspection was undertaken on May 16, 2002 by Mr. Darren Ratcliffe, P.Eng. of Klohn Crippen Consultants Ltd. Mr. Ratcliffe was accompanied by Mr. Roger Skirrow, P.Eng., and Mr. Melvin Mayfield, P.Eng., of Alberta Transportation.

This report was prepared by Klohn Crippen Consultants Ltd. for Alberta Transportation Central Region under Contract No. CE053/2000.

# 1. PROJECT BACKGROUND

About 10 km northwest of Drumheller, SH837 was constructed at the base of the Red Deer River valley. The highway is primarily used by tourists in the summer as part of the "Dinosaur Trail" to access the Royal Tyrrell Museum of Paleontology, the Midlands Provincial Park and the surrounding Badlands area.

The highway is located at the toe of a steep valley slope (about 1.5H:1V) and for a length of about 860 m is directly adjacent to the Red Deer River. It is believed that the road was constructed on an original trail along a narrow terrace in the area and the surfacing was placed on native material. Drilling was performed in 1981 and indicated about 0.5 m to 5.5 m of medium to high plasticity clay (weathered bedrock) over sandstones and shales.


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For this 860 m long section of the highway, the surfacing consisted of gravel and an oil-bound surface.
Over the last twenty years numerous proposals have been put forward to improve this highway to a minimum RCU 209 design standard. Due to the narrow terrace, various types of reinforced earth retaining walls or riprap protected granular fills pushed out into the river have been proposed. In 1988, it was agreed that it was unreasonable to spend the $1.0M to $1.5M required to carry out these measures and protect this section of highway. Instead, a 2.5 m deep ditch was proposed beside the road at the base of the hill, with a target for the riverside fill slopes towards the river set at 2H:1V. Guardrails were also proposed to be installed adjacent to the river. Although a nominal ditch was constructed at the toe of the valley slopes, no other improvement works were undertaken.

A study in 1992 recommended providing a 0.5 m minimum freeboard above the 1:100 year flood level (highwater elevation 688.6 m). The recommended bank protection measures using Class II rock riprap would cost about $700,000 for the 860 m long section. This section of road has washed away at least twice, most recently in either 1948 or 1951. Without the installation of protective measures at the toe of the slope, additional repair work should be expected in the future along this section of highway.

During the summer of 2000, Alberta Transportation noted an instability in the riverbank at about km 1.9 in the 860 m section adjacent to the river. The slide was observed for at least the first two weeks of July while highway patching work in the area was carried out. Deterioration in the condition of the slope following a period of rain was reported on July 14, 2000. A joint site inspection was undertaken on July 18, 2000 by Mr. Darren Ratcliffe, P.Eng., of Klohn Crippen Consultants Ltd. and by Mr. Lyle Newman and Mr. Frank Vidmar of Alberta Transportation to determine the nature and condition of the slide. Further deterioration of the slide area was subsequently reported to Klohn Crippen on July 25, 2000.

The slide material at the edge of the river appeared to consist of fine-grained, clay-rich soil-like material, most likely consisting of weathered bedrock material. The material was observed to be highly erodable and becomes very soft when wet. At about 0.9 m below the road level, a saturated sandy seam was observed in the scarp.

At this location, the highway pavement is 6.7 m wide and the scarp of the slip was about 0.8 m from the edge of the paved surface. By July 25, 2000 the scarp had further advanced towards the road and was 0.7 m from the edge of the pavement. The width of the slide at this point was about 4 m, however, cracking and evidence of slide/slumping activity extended for about 14 m. The road surface was about 7 m above river level. The existing riverbank slopes are typically very steep (about 1H:1V or steeper) and erosion of the toe of the riverbank by the river was ongoing.

Sloughing of the steep backslopes above the road was highly apparent. The road ditch on the west side of the road, at the toe of the backslope, had completely silted up at this location. It appeared that storm runoff was flowing across the road and down the slide zone towards the river. This flow of water was causing both erosion and softening/slumping of slope material. It appeared that a substantial portion of the material that would have comprised the original slope between the road and the river had been eroded away and thereby reduced the stability of the slope.

In the fall of 2000, the ditch on the west side of the road was excavated to a depth of about 0.5 m. Pit run gravel was placed in the scour zone by dumping over the edge of the scarp. No riprap was placed at the toe. Despite significant movement of the gravel out into the river, a shoulder of about 2 m wide has been formed at the road edge. This has significantly improved the safety of the highway.

In May 2001, the area was largely unchanged from the previous fall, but precipitation levels had been low. However, in July higher precipitation levels were experienced in the area. The resulting runoff caused the gravel to slide and create a scarp at the road edge. To alleviate the hazard to traffic, native fill was placed at the top of the slide area to create a shoulder. In a matter of days, the new fill had also slid down towards the river.

The current features of the site are illustrated in Figure 1 and in the attached photographs.

## 2. SITE OBSERVATIONS

The slide is essentially unchanged from the previous visit on October 3, 2001, however additional minor cracks are forming at the crest of the riverbank and in the highway surface. The location of the cracks would tend to suggest that the near vertical bank that is located immediately to the north is becoming unstable.

Barricades have been placed to warn motorists of the dangerous edge. The ditch on the west side of the road has been cleaned out and should perform satisfactorily until such time as siltation re-occurs.

## 3. SITE ASSESSMENT

From a review of the riverbank along the highway section, it is believed that river erosion is not a major factor in the observed instability. Areas along the river, on the outside of the same river bend, are well vegetated and are showing no signs of erosion. The primary trigger for the observed instability is the change in road camber at the top of the slide. It would appear that the highway grade concentrates the sheet runoff flow moving down the road over the bank in the area of the slide.

It is observed that the native material becomes very soft when wet. The combination of the very steep slope, the close proximity to the Red Deer River, and the runoff flow softening the slope material is creating the slide conditions. It is therefore concluded that this is more of a slope stability issue than a toe erosion issue.

The slide area appears to be extending both upstream and downstream. Beyond the slide itself, cracks are appearing at the crest of the riverbank. The location of the cracks would tend to suggest that the near vertical banks located immediately to the north and south are becoming unstable. The overall extent of the unstable riverbank measures approximately 40 m.

It is apparent that placing fill material from the top is not stabilizing the area and the practice should be stopped as it could create more instability.

As discussed, it is intended that specific instances of instability along this length of highway would be repaired. Based on the high cost to upgrade the whole length of the section, it is probably more cost effective to repair the critical features as they occur. Based on previous reports, it is possible that a significant storm could wash out a significant section of road. If major repairs to the entire section are undertaken, the highway could be reconstructed to RCU 209 design standard with erosion protection. It is recommended that the road camber also be adjusted to drain the water away from the river towards the ditch at this time, if not carried out as part of the remedial work discussed later.

Based on the risk level criteria provided by Alberta Transportation, a risk rating of 42 has been assigned to this site. This is based on a probability factor of 7 for an inactive slide but with a high probability of remobilization and a consequence factor of 6 as closure of the highway is possible following a heavy storm.

## 4. RECOMMENDATIONS

It is believed that the most efficient remedial action to take is the use of a protection/retention toe berm in conjunction with compacted pit run gravel to reinstate the slope to about 2H:1V (Figure 3). To effectively stabilize the slope, the reinstatement must occur working from the bottom to the top.

At the request of DFO, the toe berm is to comprise traditional Class II rock riprap with no instream work occurring between April 16 and June 30. To place the berm, a backhoe or similar equipment could be used to lower the rocks into place. The pit run gravel can be placed by dumping from the road edge and compacting in horizontal lifts with hand operated tampers or small compaction equipment.

A more economical solution may be to develop an access trail from the south side of the slide area using a “Bobcat” or similar small-sized equipment. At the river edge, it will be necessary to push out a narrow strip of gravel, say 1.5 m wide, to gain access to the slide area. The bobcat would then be used to transport construction materials to the toe area. The length of the trail would be no longer than about 10 m and would be constructed in water no deeper than about 50 mm to 150 mm deep (based on fall river levels). The amount of gravel placed to form the temporary path would be about 3 $m^3$ and this would be removed upon completion of the stabilizing berm. The stabilizing berm itself would be constructed in very shallow (less than about 100 mm deep) water or above the river level (based on fall water levels).

A quote obtained from Quadrock Trucking and Excavating in Drumheller indicated a delivered cost of \$15/$m^3$ for pit run gravel and \$50/$m^3$ for rock of nominal dimensions of 0.6 m. It is estimated that 80 $m^3$ of rock and 1000 $m^3$ of gravel are required. Based on these quantities, the estimated cost for the materials is \$19,000. Including an allowance for placement and compaction, and the provision and removal of the access trail, the total cost for the project is about \$35,000.

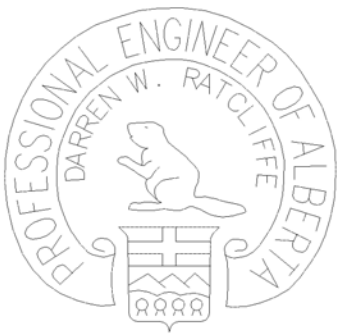
The provision of an asphalt curb was recommended to direct water further along the road away from the slide area. A more effective long-term solution is to change the grade of the highway pavement to direct drainage to the side ditch away from the river. This would require the placement of about 75 $m^3$ of asphalt to provide about a 2% cross fall over a length of about 100 m. The cost for the overlay would be about \$15,000 to \$20,000.

Due to the highly erodable nature of the local bedrock, the backslope ditch rapidly silts up with transported sediment. In the past, the ditches have been cleaned out and the spoil placed on the riverside slopes. In the future, it is recommended that areas be delineated along this section of highway where waste fill placement can occur. Suitable sites are located along the river where the distance from the road to the river is greater than 20 m.

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

Yours truly,

**KLOHN CRIPPEN CONSULTANTS LTD.**

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Darren Ratcliffe, P.Eng.
Senior Geotechnical Engineer

# FIGURES