November 14, 2000

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

Mr. Lyle Newman
Construction Services Coordinator

Dear Mr. Newman:

Central Region Landslide Assessment
SH837:02 River Scour @ km 1.9
Emergency Geotechnical Inspection Report – Nov. 2000 Follow-up Inspection

This emergency investigation follow-up report was prepared by Klohn Crippen Consultants Ltd. for Alberta Infrastructure Central Region under the Landslide Assessment Contract No. CE053/2000.

The follow-up site inspection was undertaken on November 10, 2000 by Mr. Darren Ratcliffe, P.Eng., and Mr. Brian Rogers, P.Eng., of Klohn Crippen Consultants Ltd. Mr. Ratcliffe and Mr. Rogers were accompanied by Mr. Lyle Newman, Mr. Roger Skirrow, Mr. Nelson Chipiuk, Mr. Allan Engel and Mr. Frank Vidmar of Alberta Infrastructure.

The Emergency site visit and remedial recommendations report for this site was issued on July 25, 2000. Since that time, some remedial work has been completed, as follows:

- Excavation of the road ditch to about 0.5 m deep at the base of the hill slopes;
- Placement of pit run gravel in the scour area.

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. 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 bring it up 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 in to the river have been proposed. In 1988, it was agreed that it was unreasonable to spend the $1M to $1.5M required to carry out these measures and protect this section of highway which has a value of only $500,000. However, a 2.5 m deep ditch was proposed beside the road against the hill, with a target for the 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 from the 1:100 year flood (highwater elevation 688.6 m). The resulting 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 Infrastructure 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 by Mr. Frank Vidmar of Alberta Infrastructure. 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 Infrastructure 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.

Based on a site visit in July 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 become 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 on going.

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.

Subsequent to the site visit, the following recommendations were provided (for detailed recommendations, please refer to our original report):

- This site should be inspected following any major rainfall in the area.

- The ditch on the west side should be excavated to carry storm runoff flows in a direction away from the riverbank. It should be noted that continuing maintenance of the ditch is anticipated due to sloughing of the backslope above the road.

- The area of failed slope requires reconstruction with compacted pit run gravel, with Class II rock riprap provided in a wedge at the toe of the slope extending about 2 m to 3 m above the current water level. A slope configuration of about 2H:1V was recommended. The general intent was to reinstate the highway shoulder and the slope to match the typical existing riverbank conditions on either side.

  A suggested construction methodology was to place the riprap berm first. The berm would be placed in such a manner as to displace the soft material below and that smaller stones would fill the voids between larger rocks. Compaction of riprap materials was not required, however, it should be

ensured that there is no tendency for stones to move or slide after placement. With the berm in place, the base area and slopes could be cleaned of loose debris as required to produce a competent base and reduce the risk of a failure plane forming at the interface between the gravel and native soil. As the pit run gravel is placed and compacted, a filter zone between the gravel and the riprap should be provided to prevent the loss of fines from the gravel. The filter zone could consist of concrete sand or filter fabric material.

It was noted that this design was in response to the "emergency" nature of the investigation. The riprap design provided may not be completely effective and may not prove to be a permanent solution. River training with rock spurs may also be required if erosion continues.

2. SITE OBSERVATIONS

The work completed at the site was inspected on November 10, 2000 and is described below. The main features of the site are also illustrated in the attached photographs.

- The ditch on the west side of the road was excavated to a depth of about 0.5 m. This should be sufficient to direct runoff water flows away from the riverbank.

- 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.

3. RECOMMENDATIONS

Without any riprap at the toe of the slope it is uncertain how long the gravel will remain in place. It is recommended that some form of protection berm of Class II rock riprap or similar, be placed followed by additional compacted pit run gravel to reinstate the slope to about 2H:1V. The berm can comprise traditional Class II rock riprap, or the use of broken concrete could be considered, if available. To place the berm, a crane or similar equipment could be used to lower the rocks into place with final arrangement by hand placement. Alternatively, lightweight construction equipment could traverse the ice surface and work from an ice platform. The pit run gravel can be placed by dumping from the road edge and compacting in horizontal lifts with hand operated tampers.

Again, it should be noted that these are temporary measures to repair specific instances of river scour along this length of highway. If required, a proposal can be prepared for engineering services to further define the erosion protection needed for this 860 m long

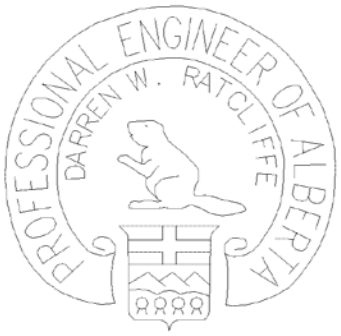
highway section. However, based on the cost of the major works to the whole length of the section, it is probably more cost effective to repair the erosion features as they occur. Based on previous reports, it is possible that a significant storm could wash out the entire road. At this time the highway could be reconstructed to RCU 209 design standard with erosion protection.

It is recommended that this length of highway be added to the list of sites to be inspected on an annual basis under the Landslide Assessment Contract.

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

Yours truly,

KLOHN CRIPPEN CONSULTANTS LTD.



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