July 25, 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

This emergency investigation report was prepared by Klohn-Crippen Consultants Ltd. for Alberta Infrastructure Central Region under the Landslide Assessment Contract No. CE053/2000. Authorization to proceed with the investigation was provided on July 17, 2000 from Mr. Lyle Newman.

The site inspection was undertaken on July 18, 2000 by Mr. Darren Ratcliffe, P.Eng., of Klohn-Crippen Consultants Ltd. Mr. Ratcliffe was accompanied by Mr. Lyle Newman and Mr. Frank Vidmar of Alberta Infrastructure.

This report was issued on a preliminary basis on July 19, 2000. Since the site visit, the following information has been supplied to Klohn-Crippen:

- Miscellaneous archive file material dated August 1979 to August 1991;
- "SH837: Jct. SH575 to Threehills Creek Bridge", alignment report prepared November 1992.

This material was reviewed because it is considered that any remedial works constructed at this time should be consistent with the previous designs for the erosion protection of this stretch of highway.

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 to carry out these measures and protect this section of highway with a value of only $500,000. A 2.5 m deep ditch was proposed beside the road against the hill with 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, and sooner or later the forces of nature will dictate the installation of protective measures or significant repairs will be required.

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.

2. SITE OBSERVATIONS

The bedrock in the area consists of interbedded sedimentary strata of the Upper Cretaceous Horseshoe Canyon Formation. The lithologic units in this formation comprise clayey sandstone, bentonitic mudstone, and carbonaceous shale, with minor ironstone, coal and bentonite beds. The road is situated on a weathered bedrock terrace in the Red Deer River valley.

The slide material at the edge of the river appears 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 is about 0.8 m from the edge of the paved surface. By July 25, 2000 the scarp further advanced towards the road and was 0.7 m from the edge of the pavement. The width of the slide at this point is about 4 m, however, cracking and evidence of slide/slumping activity extend for about 14 m. The road surface is about 7 m above river level. The existing riverbank slopes are typically very steep (about 1H:1V or steeper). Erosion of the toe of the riverbank by the river is on going.

The site plan and cross-section are illustrated on the attached Figures. The slide features are also illustrated in the attached photographs.

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, has completely silted up at this location. It would appear that storm runoff is flowing across the road and down the slide zone towards the river. This flow of water is causing both erosion and softening/slumping of slope material. It would appear that a substantial portion of the material that would have comprised the original slope between the road and the river has been eroded away and thereby has reduced the stability of the slope.

3. SITE ASSESSMENT

The scarp appears to be slowly regressing towards the highway. Provided the slope stays dry and significant toe erosion does not occur, the movements may stabilize. However, if there is a significant storm runoff event prior to the excavation of the ditch on the west side of the road, further erosion and slumping could occur leading to loss of pavement. This site should be inspected following any major rainfall in the area.

Based on the risk level criteria provided by Alberta Infrastructure, 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

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

The ditch on the west side should be excavated as soon as possible to carry storm runoff flows in a direction away from the riverbank. A minimum depth of 1 m or greater should be achieved. In the past, excavated material has been dumped on the riverside of the road. The local Environmental Officer should be contacted to confirm if this practice is still acceptable. If so, then excavated material should be placed in selected areas where the stability of the riverbank will not be affected (i.e. where the highway is further from the river). 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 will require reconstruction with pitrun gravel, with riprap provided in a wedge at the toe of the slope extending about 2 m to 3 m above the current water level. The current elevation of the river should be compared to the highwater elevation presented in Section 1 and the top elevation of the riprap adjusted accordingly. This approach is consistent with the recommendations for the economic long-term erosion protection for this site.

A recommended slope configuration of 2H:1V is shown schematically in Figure 3. Some "field fitting" of the design will be necessary to account for the varying slope geometry and to blend in with the existing slopes. In general, the riprap should not extend too far into the river to avoid changes to the flow regime. The riprap should be tapered upstream to reduce the possibility of concentrated erosion.

In order to reconstruct the slope, some placement of gravel and riprap into the river will be required. The local Environmental Officer should be contacted to confirm if this practice is acceptable at this time of year.

A suggested construction methodology is to place the riprap berm first. The berm should be placed in such a manner as to displace the soft material below and that smaller stones shall fill the voids between larger stones so that there is no unfilled space. Compaction of materials is 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 can be subcut and slopes can 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 pitrun 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.

It should be noted that this design is 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. A more detailed assessment is required to deal with all the hydraulic issues involved. The performance of this small section should be monitored after construction particularly as the river level drops. River training with rock spurs may also be required if erosion continues.

The approximate quantities for this configuration are 500 m^3 of pitrun gravel and 40 m^3 of rock riprap and filter material. An estimated cost for this work is about $15,000 to $16,000 depending on the amount of excavation and slope cleaning that is required.

If required, we can prepare a proposal for engineering services to further define the erosion protection needed for this 860 m long highway section. Additional assistance can be provided during the construction phase as required.

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

Yours truly,

KLOHN-CRIPPEN CONSULTANTS LTD.

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FIGURES