August 20, 2021

Alberta Transportation
4th Floor, Provincial Building
4920 51 Street
Red Deer, Alberta
T4N 6K8

Tony Penney, P.Eng.
Construction Engineer

Dear Mr. Penney:

Central Region GRMP
Hwy 838:02, km 22.0 – 23.0 (Near Bleriot Ferry) Call-Out Report

1 INTRODUCTION

As part of the Geohazard Risk Management Program (GRMP) contract for central region, Klohn Crippen Berger Ltd. (KCB) was requested by Alberta Transportation (AT) to conduct a call-out inspection of an embankment erosion site on Hwy 838:02:06, km 22.0 – 23.0. The sites are located on the east and west passages of the Bleriot Ferry in Drumheller, Alberta. The site features were visually observed and documented using pictures and drone video capturing. The legal land description of the site is 6-15-30-21-W4M and 6-16-30-21-W4M. A site plan is presented in Figure 1.

The site was inspected on August 16, 2021, by Mr. Chris Gräpel, P.Eng. and Mr. Ismail Atique, E.I.T. of KCB. Photographs from the site inspection are included in Appendix I.

This call-out report was prepared for AT Central Region under Contract No. CON0017608. KCB's site observations, assessments, and recommendations for short-term and long-term remedial actions are presented herein.

2 BACKGROUND

AT requested a call-out to the area because of erosion gullies have formed over the last several years in the ditches on either side of Hwy 838:02 km 22.0 – 23.0. Hwy 838 is a two-lane asphalt road and the areas of interest for this call-out report are on opposite sides of Red Deer River near Bleriot Ferry, in the Alberta Badlands, oriented in the east-west direction. The Red Deer River is approximately 0.5 km away from the site. This Bleriot Ferry site was not formally assessed in a call-out in the past.

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The 2020 Average Annual Daily Traffic (AADT) was 160 vehicles per day going west on Hwy 838 at the intersection of Township Rd 302, Range Rd 211, and Hwy 838, approximately 1.1 km East of the site (Traffic Counts Reference No. 109260, West) and 210 vehicles per day at the intersection of Hwy 837 and 838, approximately 1.1 km East of the site at section 02:08 (Traffic Counts Refence No. 107250, East).

The surficial geology and the bedrock stratigraphy have been identified using geological maps provided by Alberta Geological Survey. The bedrock formation and compositions were found to be similar to site C018, which is approximately 10.6 kilometers south of the Bleriot Ferry site on the west bank of the Red Deer River. According to MAP 601: Surficial Geology of Alberta from the Alberta Geological Survey (AGS 2013a), the surficial soil of the area consists of colluvial and glaciolacustrine deposits. It is likely that the surficial soil at the site consists of silty and sandy glaciolacustrine deposits found at the crest of the embankment slope on the prairie flatlands and colluvial slope and slump deposits induced by gravity on the embankment slope.

In addition, MAP 600: Bedrock Geology of Alberta (AGS 2013b), indicates that the bedrock of the area is part of the Horseshoe Canyon formation. The Horseshoe Canyon formation comprises of the following layers:

- pale grey, fine- to very fine grained, feldspathic sandstone interbedded with siltstone,
- bentonitic mudstone, carbonaceous mudstone, concretionary sideritic layers,
- and laterally continuous coal seams; includes white, pedogenically altered sandstone and mudstone interval attop nonmarine to locally marginal marine

The bedrock found at the C018 site is similarly part of the “Upper Cretaceous Horseshoe Canyon Formation from the Edmonton Group” comprising of:

- fine-grained sandstone,
- bentonitic mudstone,
- and carbonaceous mudstone, with coal seams and bentonite beds

The Bleriot Ferry site stratigraphy most likely consists of the same layers aforementioned.

Marine bedrock and soils derived from marine bedrock in the Red Deer River valley has a history of experiencing deep erosion gullies at the various valley highway crossings in the central and southern regions due to its dispersive nature. The erosion observed at the site is consistent with erosion observed at various other Badland erosion sites.

3 SITE OBSERVATIONS

The site was visited on August 16, 2021. The weather during the site visit was 20°C, cloudy and with slight wind. KCB’s observations made during the site visits are as follows:

- The east and west approaches to the Bleriot Ferry were initially viewed to assess the extent of erosion on each side of the Red Deer River. The erosion on the west side was

considerably less developed than on the east side. KCB focused our attention thereafter on the east side, as per the AT call-out request.

- At Hwy 838:02:06, km 22.0 – 23.0, The highway appears to have been constructed in a natural ravine with backslopes up to 20 m high excavated into natural slopes to allow for highway construction. The upper part of the highway, above top of bedrock appears to have been constructed in a cut which likely followed former ravine.
- The highway centerline slope through the cut where the erosion has taken place is approximately 12%.
- The cut slopes appear to be sloped 3H:1V and appear to be either well-vegetated or sparsely vegetated where bedrock is exposed. The cut slopes do not appear to be eroding. The extent of vegetation appears to be denser and taller (trees and shrubs) on the north-facing slope which tends to be exposed to less intense sunlight.
- The embankment slopes were noticed to be between 3H:1V to 2H:1V and appeared to be cut into bedrock in the lower portions of the site. The height of embankment varies from about 2 m in the upper reaches of the highway to 6 to 8 m in the lower portions of the highway where the embankment is partially constructed on the valley bottom. Some sections of the highway embankment have experienced rilling erosion between the edge of pavement and the ditch (Photo 5).
- The highway has a narrow-paved shoulder about 1 m wide. There was no safe place for KCB's field crew to park at the side of the highway to walk down to the ditch. Observations were made from our vehicle and via drone.
- A private property exists on Range Road 212A, intersecting with Hwy 838:02, at the valley bottom on the south side of the highway. Two aggressive dogs were running free in this area which caused KCB to avoid parking our vehicle in this area to walk up the eroding ditches.
- There was sparse and intermittent vegetation on the embankment side slopes or in the ditch, which is typical for sites with exposed bedrock in the badlands. Portions of the ditch near or above top of bedrock were well-vegetated. The ditch on the south-facing slope appeared to be well vegetated below top of bedrock as shown on Photo 4. W-beam guardrails are present on the lower portion of the road where the fill appears to be greater than 4 m high.
- The bedrock is exposed in the lower portions of the highway cut. Ditch erosion appears to start either just above or below the top of the bedrock on the north and south embankments of the road. Please refer to the site map (Figure 1) for approximate start and end points of the ditch erosion. The gullies have a maximum depth estimated to be between 1 and 2 m, a maximum width between 2 m and 5 m and side slope angles that vary from near vertical to approximately 1H:1V. They run at a length of approximately 600 m in the east to west direction. Please refer to Figure 1 for approximate extents of the erosion gullies.

- The eroded material from the ditches does not appear to be conveyed directly to the Red Deer River. The drainage from the ditches flows downgrade until it reaches flat ground and culverts before the water passes beneath Hwy 838 or Range Road 212A at the base of the valley slope. Some potential for eroded sediments to settle and be deposited appears to exist before water is discharged through culverts towards the Red Deer River.
- There is a natural slope failure approximately halfway up the east approach on the south side. The slope at this location is approximately 20 m high and the zone of accumulation of failure materials appears to have partially blocked the ditch, shifting ditch flow closer to the highway. The highway embankment at this location is about 3 to 4 m high, so the impact of a partially blocked ditch has not resulted in ponding of water that appears to have impacted the pavement surface.

4 ASSESSMENT

KCB's assessment of the site is as follows:

- The high backslopes are in good condition and are not experiencing erosion.
- The erosion in the ditches is relatively deep, but the proximity of the gully erosion is at least 2 m below the edge of the pavement and does not present as much of a hazard to traffic as other Badlands ditch erosion sites, e.g., C017 or C035.
- KCB reviewed the need for guardrails due to the steepness of the embankment slopes combined with the location of the ditch erosion. Our assessment is described later in this section.
- The ditches in the bedrock will continue to erode. Eventually the erosion will deepen, causing the embankment slope to slide into the ditch, resulting in settlement and cracking of the pavement, or formation of a near-vertical scarp close to the edge of pavement. Delay of erosion repair will lead to a larger cost to repair erosion that will become deeper and wider in the coming years.

We assessed the need for guardrails at the Hwy 838 site. Hwy 838:02 has a speed limit of 80km/h. The lane width is either 3.5m – 3.7m with a shoulder width of 1.0m. The total AADT, according to the Alberta Transportation Traffic Counts for Hwy 838:02 is 160 vpd. In accordance with the Alberta Transportation Roadside Design Guide (2018), the clear zone is determined to be 2.5m – 3.0 m from the edge of the driving lane for a cut slope of 3:1. The erosion gullies are not within the clear zone; however, the embankment slopes are experiencing rilling erosion within the clear zone and immediately outside it. As shown in Photos 5 and 6. From the AT Roadside Design Guide - Figure H3.6 Sideslope Improvement Versus Barrier Installation, the cost-effective approach for the AADT and the average embankment height at the site would be to improve (i.e., flatten) the side-slopes. However, in the same figure, note 1 states that a "guardrail is required if there are any non-traversable hazards or fixed objects on the embankment or at the base of the embankment". Flattening the side slopes could be done as part of a longer-term ditch-erosion repair project. In the short term, AT should install guardrails.

5 RISK LEVEL

Risk levels have not been previously prepared for the subject site to date. Risk levels for AT GRMP sites are determined according to the following:

Risk Level = Probability Factor X Consequence Factor

Where the AT risk level is defined as follows:

- Probability Factor varies from 1 (Inactive, very low probability of erosion) to 20 (Mass wasting of great volumes of soil is occurring).
- Consequence Factor varies from 1 (Relatively small area of erosion involved confined to ditch or backslope) to 10 (Sites where the eroded material could directly flow into fish bearing rivers or affect water quality and aquatic resources).

The risk level was determined using AT's risk level system and is presented as follows:

- Probability Factor – A rating of 11 was selected because the erosion is active with an increasing rate because of the gully formations.
- Consequence Factor – A rating of 3 was selected for the site because there is a potential for the loss of the roadway embankments if they are left untreated.

A total Risk Level of 33 was assigned for the subject site.

6 RECOMMENDATIONS

Recommended short-term and long-term remedial actions for the site are discussed in the following subsections.

6.1 Short-Term

Guardrails should be installed.

The MCI should monitor the site for increased erosion during or after high-runoff events.

6.2 Long-Term

Repairs of the erosion will involve backfilling the gullies, re-establishing embankment side slopes, and armouring the ditches so that erosion does not occur again. Design of ditch armouring will involve assessing peak runoff velocity (return period of design storm event needs to be decided by AT). The ditch slope is quite steep and will likely require some form of hard armouring (e.g., riprap) with revegetation of disturbed soil surfaces. A seed mix suitable for badlands regions should be used. It is possible in some locations on the Hwy 838 site that the exposed bedrock or soils derived from bedrock will be too salty to grow any kind of vegetation. The design of ditch repairs should consider that the bedrock appears to be dispersive.

The estimated costs for repair of both ditches with backfilled erosion gullies armoured with Class 1 riprap on a non-woven geotextile filtering layer would be in the ballpark of $500,000 to $800,000.

7 CLOSING

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Alberta Transportation (Client) for the specific application to the central region GRMP, and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
3. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

Please contact the undersigned if you have questions or comments about this report. Yours truly,

Yours truly,

KLOHN CRIPPEN BERGER LTD.

Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer, Associate

CG:kc

ATTACHMENTS
Figure
Appendix I Photographs

REFERENCES

Alberta Geological Survey (AGS). 2005. Map 101, Hydrogeological map of the Drumheller area, Alberta, NTS 82P. Retrieved August 20, 2021 from: http://ags.aer.ca/data-maps-models/maps.htm

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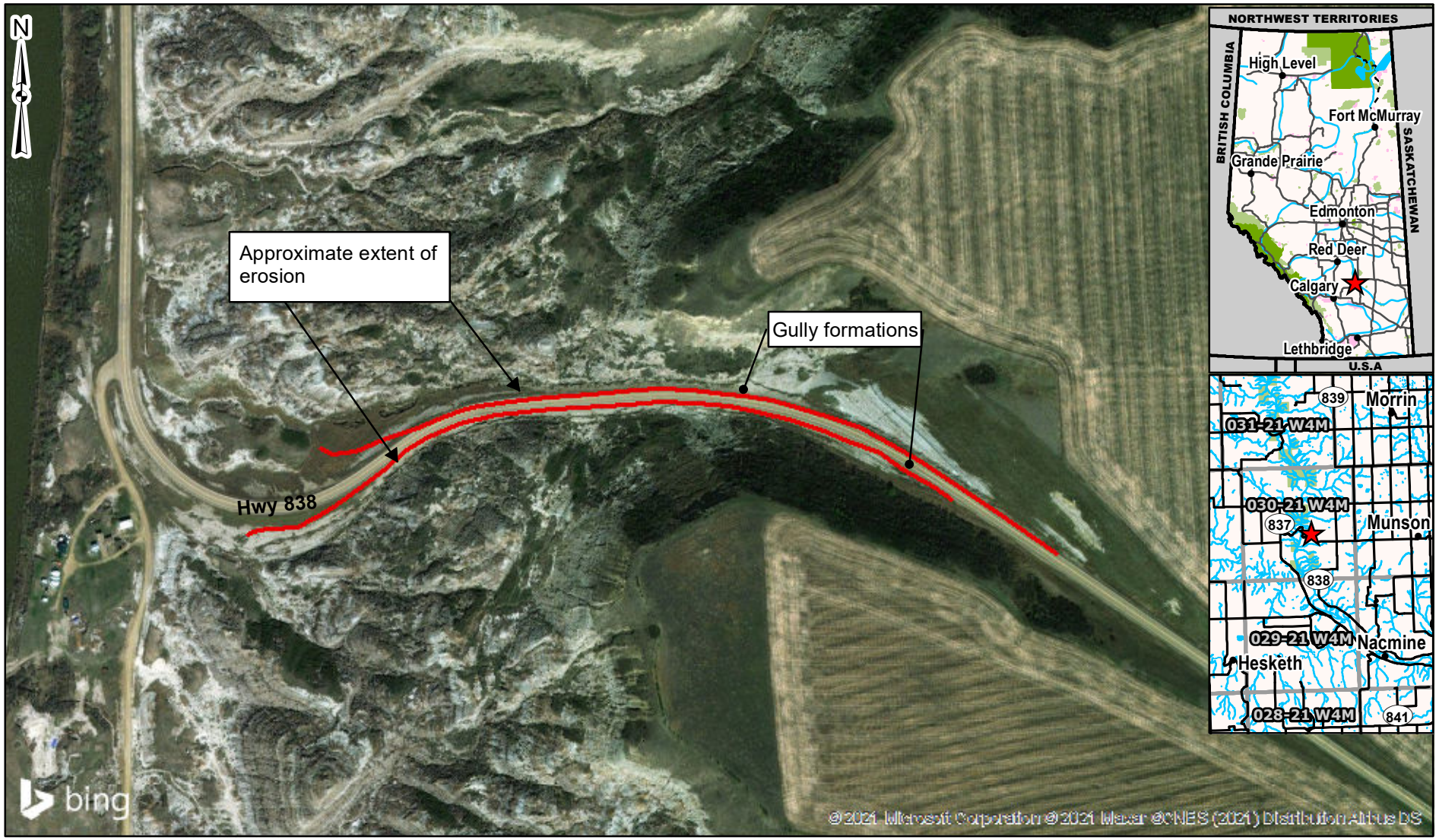
FIGURES



Legend

Erosion Boundary

Metres
0 100

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 11N
3. IMAGE SOURCE: Bing Aerial Imagery, Microsoft Corporation, 2021

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
Unnamed Site - Near Bleriot Ferry
Hwy 838:02

SCALE	PROJECT No.	FIG No.
1:4,000	A05116A02	1

Time: 15:17:40 PM
Date: August 18, 2021
File: C:\Users\aharrison\Desktop\Files for Ismail\Imagery_Atique.mxd Date: August 18, 2021 Time: 15:17:40 PM Creator: aharrison

APPENDIX I

Photographs

Appendix I
Photographs

Figure 1 **Oblique aerial photo of the site: Hwy 838:02 east of Bleriot Ferry. This footage was taken August 16, 2021, facing west.**

Figure 2 **Oblique air photo of the site east of the Red Deer River. This footage was taken August 16, 2021, facing west**

Figure 3 **Oblique air photo of the erosion gullies at the toe of the north and south embankments and rilling erosion on the south embankment slope. W-beam guardrails exist along the lower/downhill portions of the road. Photo taken August 16, 2021, facing west.**

Figure 4 **Oblique air photo of the highway highlighting the erosion gullies and rilling erosion along the north and south embankments. Photo taken August 16, 2021, facing east.**

Figure 5 **Large and deep gullies formed and rilling erosion of the road embankment. Photo was taken August 16, 2021, facing south.**

Figure 6 **Large gullies and rilling erosion along the embankment slope. Photo was taken August 16, 2021, facing south.**

Figure 7 **Northern side of the road shoulder cracking due to eroding road embankment. Photo was taken on August 16, 2021, facing north-west.**

Figure 8 **North natural slope eroding into the ditch. Photo was taken on August 16, 2021, facing north-west.**