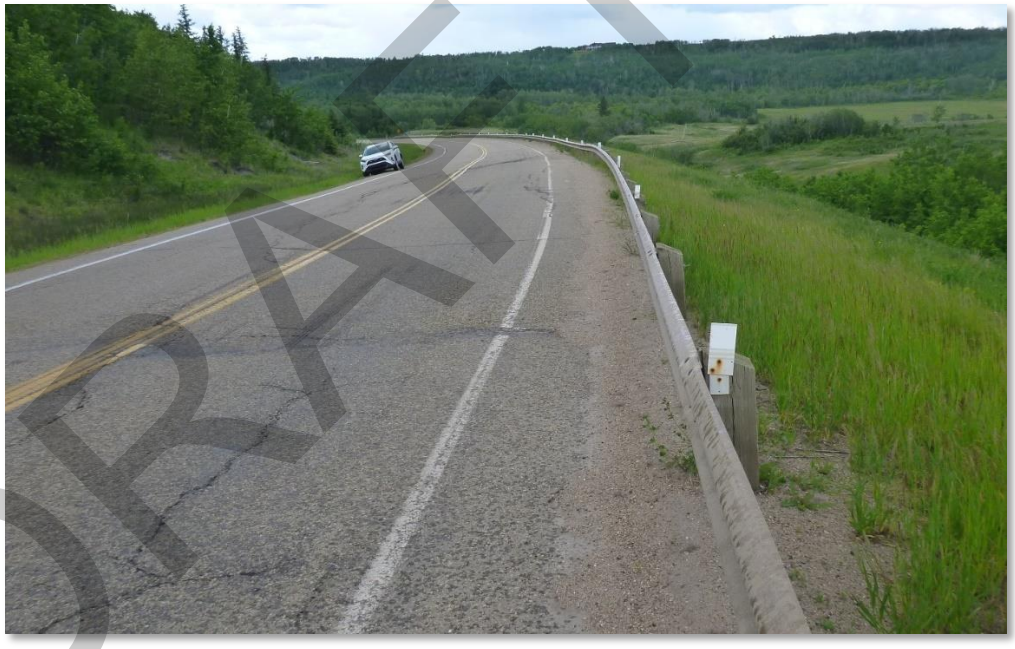
Klohn Crippen Berger

Alberta Transportation and Economic Corridors



Hwy 53:12, km 0.684; East of Battle River Slide

Call-Out Report

DRAFT

A05116A02

August 2024

August 16, 2024

Alberta Transportation and Economic Corridors
4th Floor, Provincial Building
4920 – 51st Street
Red Deer, Alberta
T4N 6K8

Tony Penney, P.Eng.
Construction Engineer

Dear Mr. Penney:

CON0022160 Central Region GRMP
Unnumbered Site; H53:12, km 0.684 East of Battle River Slide
Section D – Call-Out Report – DRAFT

1 INTRODUCTION

As part of the Geohazard Risk Management Program (GRMP) contract for the Central Region, Klohn Crippen Berger Ltd. (KCB) completed a call-out inspection at an area of pavement distress at Hwy 53:12, km 0.684 (the site). The site is located on the east slope of the Battle River Valley approximately 650 m east of the Battle River and 17 km east of Donalda, Alberta. The approximate site coordinates are 5826301 N, 409478 E (UTM Zone 12, NAD 83). The legal land description for the site is 16-35-41-17 W4. A site plan is presented in Figure 1.

The site was inspected on June 17, 2024 during the Section B Inspection tour by Chris Gräpel, P.Eng. and James Lyons, P.Eng. of KCB and Rocky Wang, P.Eng., and Tony Penney, P.Eng. of Alberta Transportation and Economic Corridors (TEC).

The call-out report was prepared for TEC under Contract No. CON022160 as part of the Central Region GRMP. Site background information and KCB's site observations, assessments, and recommendations are presented herein.

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2 BACKGROUND

2.1 General

The Central Region GRMP 2024 Section B Inspection tour was completed between June 17 and 19, 2024. A call-out inspection for the site was completed on June 17, 2024. During the first day of the tour, KCB and TEC were driving past the site when TEC observed that the site conditions appeared worse than the last time they were in the area, prompting the call-out inspection. TEC was previously aware of the pavement distress (cracking and settlement) at the site, likely due to highway embankment instability.

No record of previous inspections or repairs was found by KCB when preparing this report. However, based on review of available aerial imagery (Abadata2 2024) there appears to have been movement as far back as 1997 and regular pavement patching at the site since at least 2013.

The paved two-lane highway at the site is a side-hill-fill embankment oriented northeast-southwest on the east valley slope. The Battle River valley at the site is approximately 50 m to 60 m deep and the site is located approximately 25 m up the east valley slope (i.e., above the Battle River water level). The highway embankment slope is approximately 20 m to 25 m tall with a compound slope ranging from approximately 1H:1V to 2H:1V. The overall grade of the highway along the site parallel to the slide is estimated to be between 5% and 10%.

The site's 2023 Average Annual Daily Traffic (AADT) was 820 vehicles eastbound and 700 vehicles westbound on Hwy 53:12 (Traffic Count Station No. 997079 and 116350, respectively) (AT 2023).

2.2 Surficial Geology

The surficial geology and bedrock stratigraphy have been identified using geological maps provided by the Alberta Geological Survey. 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 moraine deposits. The foundation soil at the site consists of clayey and sandy till moraine deposits up the east valley slope, but towards the river valley bottom (west of the site) the foundation soil likely transitions to colluvial deposits.

Map 600 Bedrock Geology of Alberta (AGS 2013b) indicates that the bedrock at the site is part of the Horseshoe Canyon formation. The Horseshoe Canyon formation is comprised of pale grey, fine- to very fine-grained, feldspathic sandstone interbedded with siltstone, bentonitic mudstone, carbonaceous mudstone, concretionary sideritic layers, and laterally continuous coal seams. It includes a white, pedogenically altered sandstone and mudstone interval at the top and is nonmarine to locally marginal marine. Based on observations of bedrock outcrops on the natural slope north of the unnamed creek, it appears that the thickness of the overburden at the site is relatively thin, and bedrock is close to ground surface. This observation coincides with a nearby water well (Well ID 2023111) drilled in 2006 where bedrock was encountered at approximately 8 m below ground surface (GoA 2024).

The groundwater conditions were assessed by reviewing Alberta Water Well records. Records for one residential water well, approximately 170 m west of the site on the north side of the unnamed creek, was available for KCB's review. The report (Well ID 2023111) indicates that deeper bedrock units (mudstone/siltstone) are water-bearing (GoA 2024). The static water level recorded during drilling the water well was approximately 47 m below ground surface. Based on contour map provided on the Alberta Water Wells' website, the site and the water well are at similar elevations (approximately elevation 705 m and 695 m, respectively), indicating the ground water table at the site may be quite deep.

3 KEY SITE OBSERVATIONS

The site inspection was completed on June 17, 2024. The weather during the site visit was approximately 15°C and sunny. Photographs are included in Appendix I, and the location of site features are presented in Figure 1. KCB's key observations made during the site inspection are as follows:

- Pavement distress in the form of tension cracks and settlement was observed along the slide extents in the south (eastbound) and north (westbound) lanes.
  - The pavement cracking is approximately 35 m long and is up to approximately 5 mm wide. (Photos 1 and 2).
  - The settlement observed was approximately 25 mm to 50 mm and in the north (westbound) lane. Black skid marks were observed in the settlement area, indicating where vehicles have been braking before driving over the site (Photo 2).
- The shape and extent of the pavement distress indicates a well-developed slide movement pattern.
- A dip in the north (westbound) guardrail was observed above the slide (Photos 1 and 2).
- The embankment slide is estimated to be 35 m wide at the crest and up to 25 m tall, with a compound slope of approximately 2H:1V for the upper 10 m to 15 m of the slope and 1H:1V for the lower 10 m to 15 m of the slope.
- During the inspection, some vehicles were observed slowing down and moving into the south (eastbound) land to avoid the area of pavement settlement.
- Ground cracks were observed in the north highway embankment slope, approximately 10 m offset from the north guardrail, along and approximately parallel to the tree line. The embankment slope is well-vegetated with grass, shrubs, and trees, which could have hidden additional ground cracks and/or settlement (Photo 3).
- A minor scarp (height up to 1 m tall) was observed approximately 10 m to 15 m downslope of the guardrail (Photo 4). The minor scarp is located where the embankment slope steepens (i.e., transitions from approximately 2H:1V to 1H:1V). Based on a review of Google Maps (2024) imagery, KCB estimates the secondary scarp is between 75 m and 80 m long.

- A private fence along the highway passes through the treed area, limiting KCB and TEC's ability to inspect the lower portion of the highway embankment slope (Photo 5). Downslope of the fence, evidence of movement (sliding) and erosion was observed in the bottom third of the slope. The unnamed creek along the toe of the slope is likely exacerbating the erosion along the bottom portion of the slope.
- Dense vegetation was observed in the south (eastbound) ditch, which could indicate poor drainage, as ponded water may be infiltrating the highway embankment, raising the groundwater level within the embankment and foundation, contributing to slope instability (Photo 6).

4 ASSESSMENT

4.1 General

KCB's assessment of the site is as follows:

- The site demonstrates signs of slope instability, suspected to be caused by an over-steepened north highway embankment slope, a potentially high groundwater table due to poor drainage in the south (eastbound) ditch and possible groundwater drainage from bedrock (buried springs) into the sidehill fill, and erosion in the bottom 10 m to 15 m portion of the north highway (likely worsened by the unnamed creek erosion along the toe of the north embankment slope).
  - The slope instability may be caused by loosely placed or weak embankment fill. However, no construction records were available for KCB's review while preparing this report.
- The dense vegetation and uneven grade (i.e., localized flatter sections) of the south (eastbound) ditch upslope of the area of embankment instability is likely causing poor drainage at the site. After significant precipitation events, the ponded water upstream will likely infiltrate into the embankment and potentially raise the ground water table within it.
- The pavement settlement along the head scarp is significant enough that there is evidence (i.e., black skid marks) of vehicles braking before/while driving over the site once the road users realize the degree of settlement. During the inspection, westbound motorists were observed slowing down and moving into the eastbound lane to avoid the area of settlement. Additional settlement could further reduce the driveability of this section of the highway. It could also increase the risk of a collision due to westbound motorists moving into the eastbound lane, as the site has poor site lines due to the horizontal and vertical alignment of the highway.

4.2 Risk Level

Risk levels for AT GRMP sites are determined according to the following:

Risk Level = Probability Factor X Consequence Factor

Where TEC's risk level is defined as follows:

- Probability Factor varies from 1 (inactive, very low probability of slide occurrence) to 20 (catastrophic slide is occurring).
- Consequence Factor varies from 1 (shallow cut slopes where slide may spill into ditches, or fills where slide does not impact pavement, minor consequence of failure, no immediate impact to driver safety, maintenance issue) to 10 (sites where the safety of public and significant loss of infrastructure facilities or privately owned structures will occur if a slide occurs. Sites where rapid mobilization of a large-scale slide is possible).

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

- Probability Factor – A rating of 9 was selected because the slide appears active with a moderate rate of ongoing movement.
- Consequence Factor – A rating of 4 was selected for this site, for if a slide occurs, partial road closure or significant detours would be required.

A total Risk Level of 36 was assigned for this site.

5 RECOMMENDATIONS

KCB's recommendations include the following:

- The slide at the site appears to be active and should be monitored regularly. The site should be given a GRMP site number and inspected as part of the Section B Inspections (e.g., every two years).
- In addition to the Section B Inspections, TEC's Maintenance Contract Inspector (MCI) should regularly inspect the site. Due to the observed lower slope erosion and poor drainage, the site should be inspected by the MCI after significant precipitation events (e.g., spring freshet and heavy and/or prolonged rainfall).
- A drilling investigation should be completed to assess the condition of the embankment fill and foundation materials. During the investigation, two piezometers should be installed to assess groundwater conditions in the fill and foundation, and one slope inclinometer should be installed to determine the depth and rate of movement. The slope inclinometer should be installed close to the guardrail, or just past the guardrail to assess depth of sliding as close to the rest of the embankment slope as possible. Understanding the depth and rate of movement, and the groundwater conditions, would be key information when preparing a repair design (e.g., installing a H-pile wall or excavating and replacing the highway

embankment fill with geogrid reinforced granular fill and subsurface drainage). If requested by TEC, KCB can prepare and submit a proposal for a site investigation and preliminary engineering services.

- KCB estimates a drilling and instrumentation installation program would cost approximately $55,000 – $70,000. This cost estimate includes the cost for a drilling subcontractor, utility locates, instruments, KCB coverage, a geotechnical data report, and three site visits to read the instruments following installation.
- KCB estimates engineering services to prepare a repair design (e.g., pile wall or geogrid-reinforced granular fill) would cost approximately $100,000 – $150,000 (including topographic survey and laboratory testing to support design work).
- High-level estimates for construction costs to repair the slide (including 15% contingency) are approximately $900,000 – $1,200,000 (Tarek et. al. 2011) for a driven H-pile wall or $1,500,000 to rebuild the north embankment slope with geogrid-reinforced granular fill. A dig-out-and-replace repair would result in a short-term single lane diversion into the ditch that will hinder traffic flow. This cost estimate does not include costs associated with construction monitoring and administration services during the construction

6 CLOSING

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the use of Alberta Transportation and Economic Corridors (Client) for the specific application to the Central Region Geohazard Risk Management Program (Contract No. CON0022160).

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; however, the use of this report will be at the user's sole risk absolutely and in all respects, and KCB makes no warranty, express or implied. This report may not be relied upon by any person other than the Client without KCB's written consent.

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. The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
4. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

James Lyons, P.Eng.
Civil Engineer

Reviewed by: Chris Gräpel, M.Eng., P.Eng.

JL:bb

7 REFERENCES

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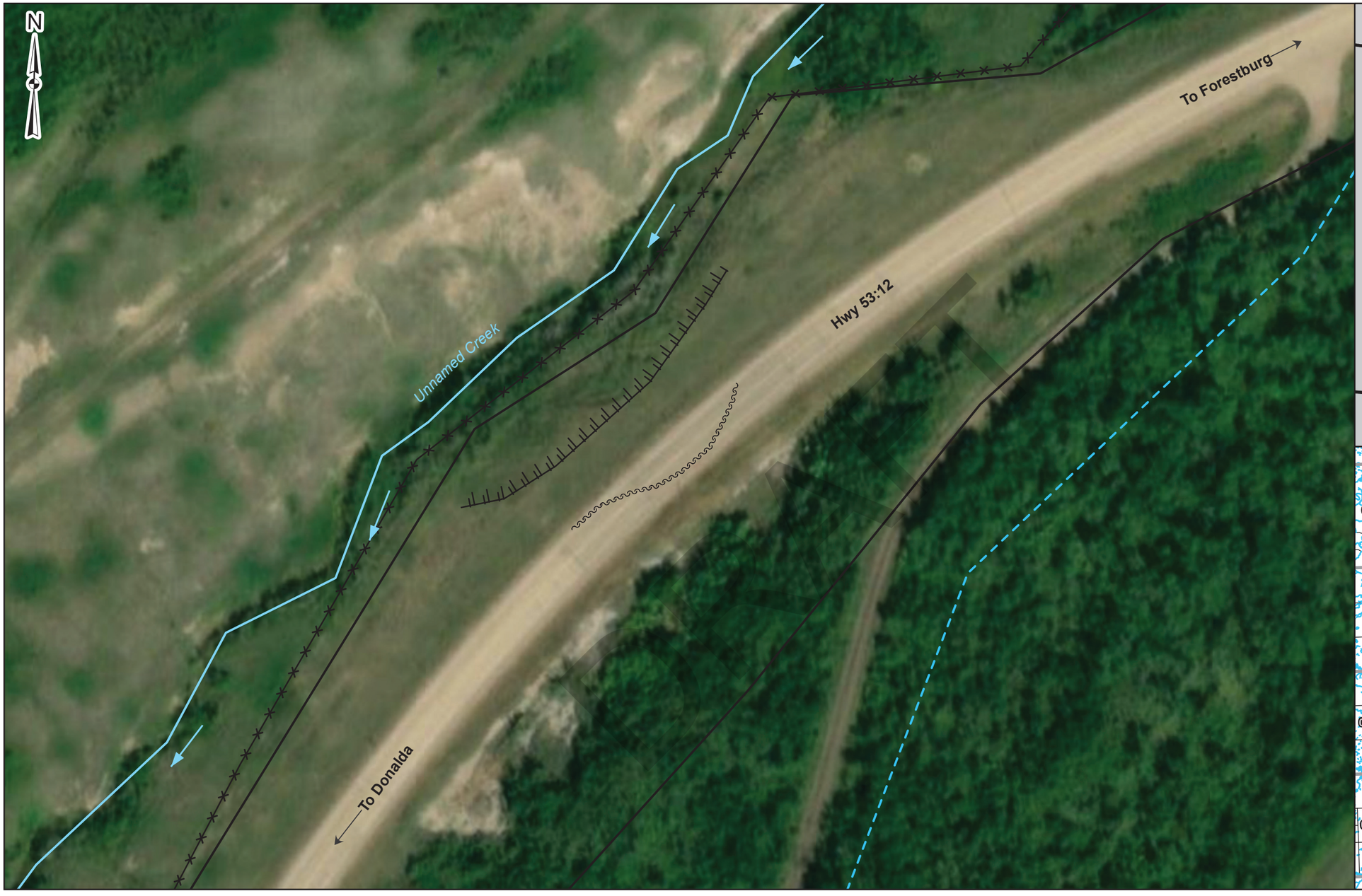
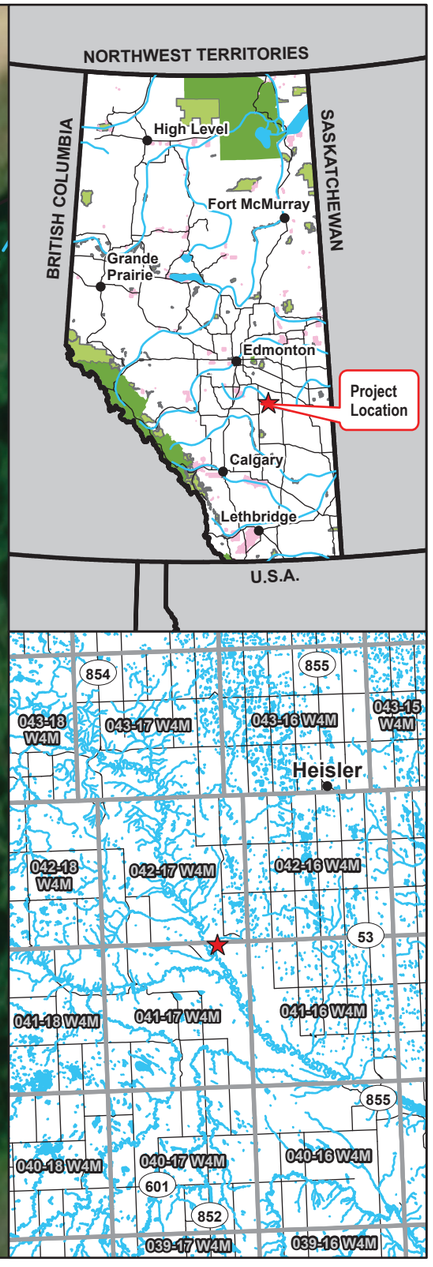
FIGURE





Legend

- Flow Direction
- Watercourse
- Crack
- Scarp
- Highway Right-of-Way
- Telus Trench
- Fence

0 50 Metres

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM ZONE 12N
3. IMAGE SOURCE: 2024 MICROSOFT CORPORATION, MAXAR, CNES DISTRIBUTION AIRBUS DS.

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: CENTRAL REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
Unnumbered Site - H53 East of Battle River Slide
Hwy 53:12

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

File: Z:\AIED\MA\05116A02 ABT Central Region GRMP\400 Drawings\GIS\02_ProFiles\2024\Section B\AT_CentralRegion_SectionB_240627\AT_CentralRegion_SectionB_240627.aprx Date: Time: Creator: : EQuine

APPENDIX I

Photographs

Appendix I
Inspection Photographs

Photo 1 **Pavement distress (tension cracks and settlement) in the eastbound and westbound lanes above the slide. Pavement cracking extends across the north (westbound) lane into the middle of the south (eastbound) lane. Settlement was estimated to be between approximately 25 mm to 50 mm. Photo taken June 17, 2024, facing west.**

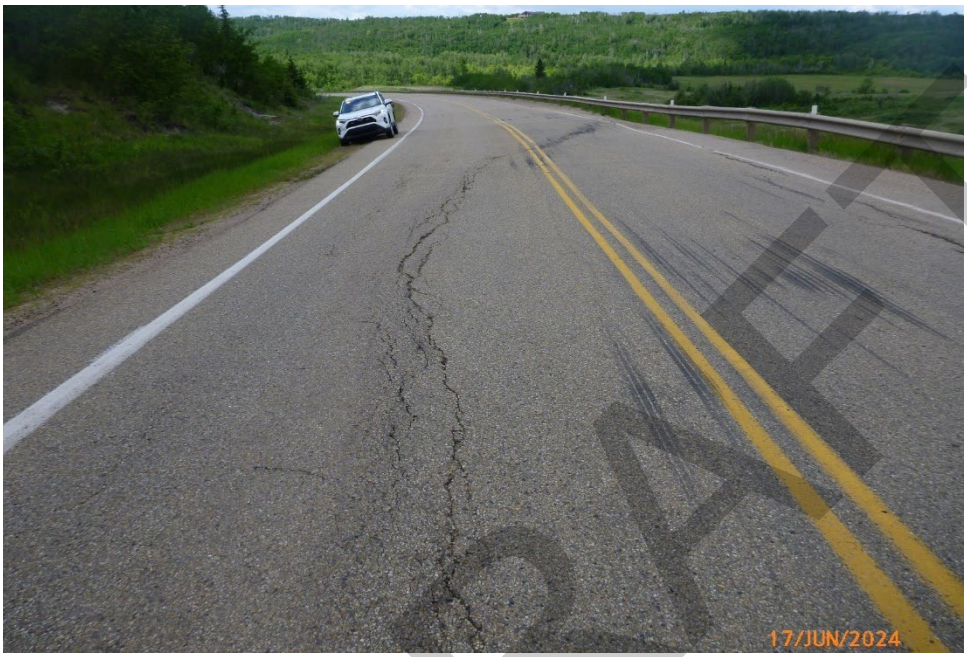


Photo 2 **Tension cracking in north (westbound) lane extending into the south (eastbound) lane. Photo taken June 17, 2024, facing east.**

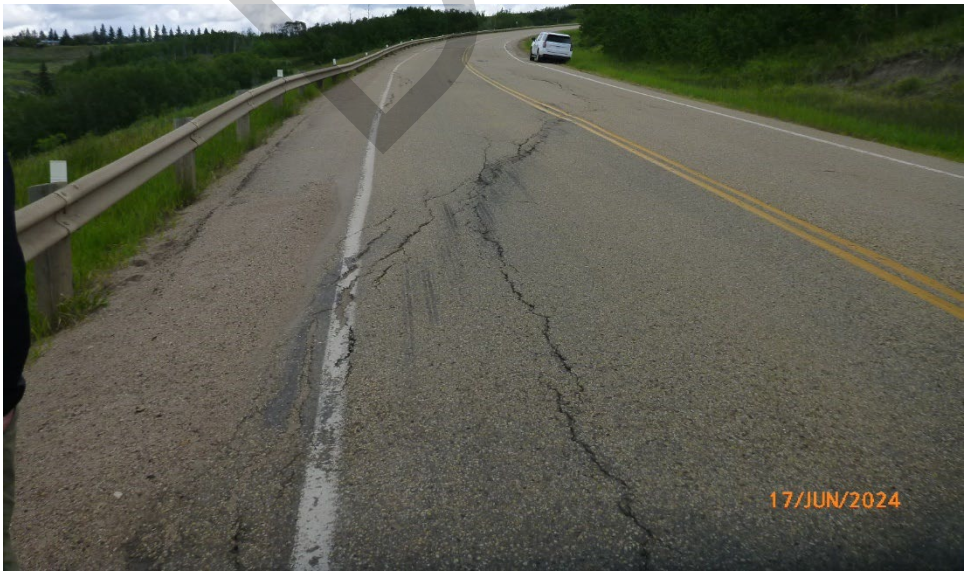


Photo 3 **The north (westbound) highway embankment slope is well vegetated, potentially obscuring ground cracks and/or settlement. Photo taken June 17, 2024, facing northwest.**

Photo 4 **Minor scarp (indicated by red arrow) located approximately 10 m downslope (north) of the guardrail. The minor scarp is approximately 1 m in height. Photo taken June 17, 2024, facing southeast.**

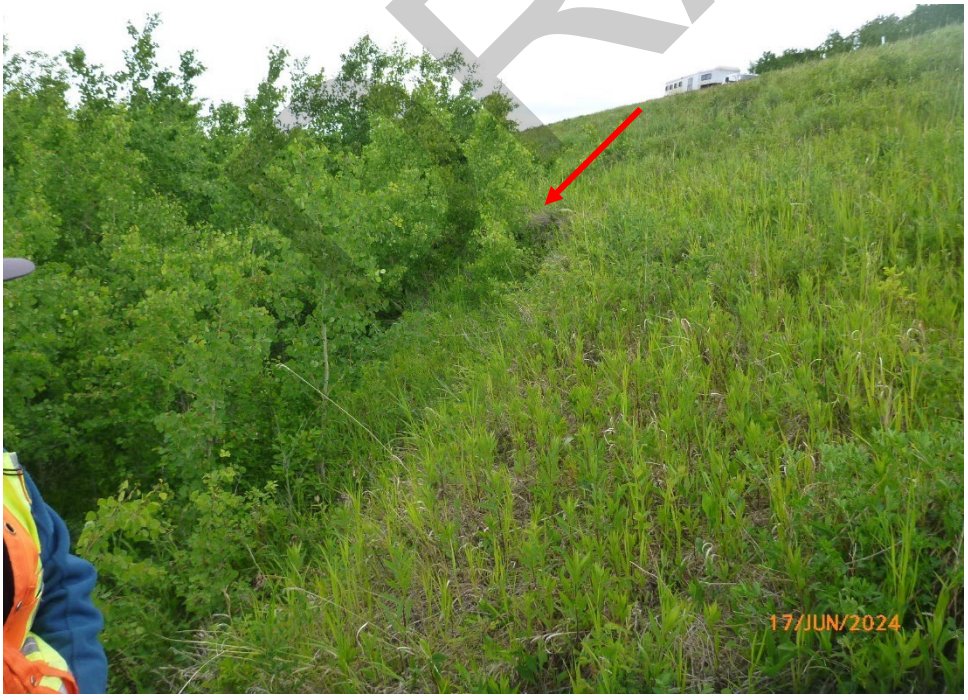


Photo 5 **Private fence located downslope of the highway and minor scarp. Evidence of a movement and erosion was observed downslope (north) of the fence (indicated by red arrow). Photo take June 27, 2024, facing west.**

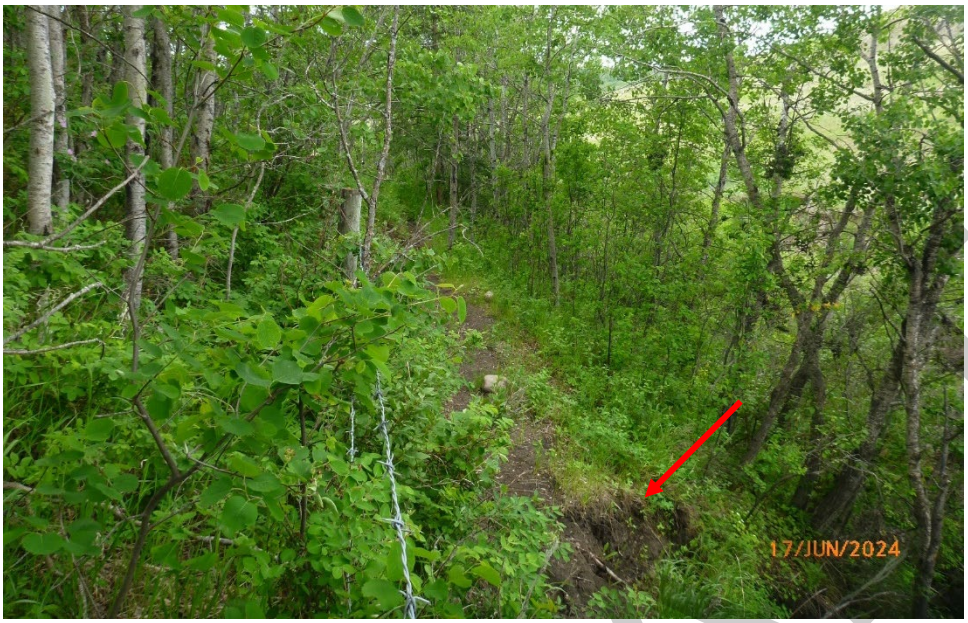


Photo 6 **Area of dense vegetation in south (eastbound) lane could indicate an area with poor drainage and surface water infiltration into the highway embankment (overall, the ditch is graded to facilitate positive drainage). Photo taken June 17, 2024, facing west.**