March 1, 2021

Alberta Transportation
2nd Floor, 803 Manning Road NE
Calgary, Alberta
T2E 7M8

Alex Frotten, E.I.T.
Construction Engineer

Dear Mr. Frotten:

Southern Region Geohazard Risk Management Plan
S063 Hwy 3:09, km 1.38 Call-Out Report

1 INTRODUCTION

As part of the Geohazard Risk Management Program (GRMP) contract for the southern region, Klohn Crippen Berger Ltd. (KCB) was requested by Alberta Transportation (AT) to conduct a call-out inspection at a surface runoff erosion site on the east side of Highway 3, approximately 2 km west of Lethbridge, Alberta. This location has not been previously visited under the contract.

Volker Stevin (VS) is the maintenance contractor (MC) for the site, located in Contractor Maintenance Area (CMA) 25. The site was located using the AT Maps portal as Latitude: 49.711348 and Longitude: -112.874872. The Alberta Township Survey legal land description is NE Sec 2, Twp 9, Rge 22 W4. The location has been identified using the Alberta Infrastructure and Transportation Extranet AT Map portal and is referenced as Hwy 3:09, km 1.38.

The site was visited on September 9, 2020 by Mr. Chris Morgan, P.Eng., and Ms. Margot Lederman, P.Eng., of KCB. Mr. Alex Frotten, E.I.T., and Mr. Curtis Nagel of AT also attended the call-out site visit. The site location is shown on Figure 1, and features of interest are shown on Figure 2.

The weather during the site visit was sunny, dry, and 24°C. Photographs from the site walkover are included in Appendix I.

This call-out report was prepared by KCB for the AT Southern Region under Contract No. CON0017609. KCB's site observations, assessments, and recommendations for short- and long-term remediation works are presented herein.

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2 BACKGROUND

The Lethbridge RV site was identified as a geohazard site for monitoring based on a landowner complaint by the Bridgeview RV Resort in July 2020 relating to ongoing slope erosion from highway drainage culverts, and overland flooding due to inadequate capacity of the drainage channel from the highway to the river (the drainage right of way is the responsibility of AT).

At the site, the highway is aligned approximately southeast to northwest. The highway is located on a raised embankment, up to 25 m higher than the ground elevation on the east and west sides of the highway. The call-out report only visited the east side of the highway and was conducted by parking at Bridgeland RV Resort and walking the north side of the embankment.

Historical information was provided by Mr. Curtis Nagel (Maintenance Contract Inspector for CMA 25) and is largely anecdotal. The available background information includes the following:

- The embankment was reported as constructed in the late 1960s, and the highway was previously managed by the City of Lethbridge. Management of Highway 3 within the city limits was reportedly transferred to AT in 2000.
- The land that the RV Park now occupies was reported as being constructed on an old highway maintenance yard (date of RV Park construction is unknown).
- A reinforced concrete underdrain (culvert) is present at the toe of the highway embankment. The underdrain provides an outlet for surface water from the area to the west of the highway to report to the Oldman River. The catchment area west of the highway was reported to include an irrigation return channel from farmland west of the highway.
- The highway underdrain is reported to be a 900-mm-diameter reinforced concrete culvert with a flow management flap valve (as seen at the east embankment toe). AT reported that a portion of the creek channel west of the highway flooded and washed out at some point in the past, which resulted in a large amount of sediment being transported through the highway underdrain, and clogging up the channel and culverts. AT also reported that the overland flooding in the RV Park was largely due to flows through the underdrain (during spring snow melt or during periods of heavy precipitation), and that heavy flows continued to wash sediment through the underdrain, further reducing the capacity of culverts and flow channels.
- The highway underdrain reports to the Oldman River via a single channel through the RV Park. The channel right of way runs perpendicular to the highway right of way. AT reported that AT was responsible for the channel right of way.
- Highway surface drainage is reported as independent from the highway underdrain and is believed to consist of vertical drains at the edge of the pavement, connecting to cross drains beneath the highway, which report to three concrete vaults on the east side of the highway. Each of the three vaults are reported by AT to discharge to the east via a buried slope drain. The slope drains are reportedly 1 m diameter corrugated steel pipe (CSP). The

CSP slope drains were reportedly installed in 1967. AT reported that there may have previously been a collector drain at the eastern downstream toe of the highway embankment, but AT had been unable to locate it.

- AT reported that the highway surface drainage is silting up and does not appear to be cleaned out regularly. Winter sand from highway maintenance was reported to be silting up the drainage pipes and vaults.
- Due to the age of the slope drain, the buried CSP culverts have corroded over time, particularly at the invert. Slope drain corrosion has resulted in leakage from the culverts, leading to the loss of function and the erosion gullies visible on the embankment side slope.

Building on the available background information, observations of site features are included in Section 3.

3 SITE OBSERVATIONS

3.1 General

The geohazard at this site consists of erosion of the highway embankment due to discharge from road surface drainage. The erosion is due to leakage from the buried corroded CSP slope drain (installed in the 1960s) which takes highway surface runoff to the downstream toe of the embankment. Due to corrosion of the culvert invert, flows are not contained in the culvert, leading to washout of soil around the slope drain and retrogression of the erosion gully up the slope as the CSP separates at undermined joints. Annotated site photographs are included as Appendix I.

- The highway embankment was estimated to be up to 25 m with an average slope of 2.5H:1V to 3H:1V. The embankment construction material is unknown, but the material exposed in erosion gullies was observed to be silty and sandy fill.
- The east slope was vegetated with grasses at the time of the site visit. AT reported that the extent of cut grass at the toe of the slope delineated the approximate edge of the AT right of way.
- The embankment was observed to be in good condition, with no clear evidence of slope instability or erosion (other than at the buried CSP locations). A possible area of tension cracking over a 5 m length was noted on the lower third of the slope in proximity to the highway underdrain outlet (waypoint 46), which could be a localized feature.
- The highway pavement appeared to be in good condition with no evidence of cracking, dislocation, or slope instability. Transverse cracking was noted on the highway surface and appears to be located over highway surface drainage pipes and inlet grates.
- A buried slope drain is present to convey highway drainage to the embankment toe. AT has reported that there are three buried slope drains along this section of embankment, but the most noticeable feature was midway along the slope. The erosion gully was

approximately 7 m downslope from the guardrail, and was approximately 2 m deep and 3 m to 5 m wide.

- The erosion gully appears to be due to a CSP slope drain installed in the 1960s corroding at the invert, leading to erosion around the buried pipe and joint separation as ongoing surface water runoff from the highway causes the erosion gully to retrogress up the slope towards the highway. Without remedial actions, surface erosion will continue to retrogress up the slope, ultimately undermining the guard rail and shoulder of the highway.
- A possible sinkhole was observed upslope of the erosion gully, near to a utility box (waypoint 48). The possible sinkhole was estimated as approximately 1.2 m diameter and less than 0.3 m deep.

3.1.1 Sediment Runoff

The erosion gully on the highway embankment is visible in air photo imagery in Google Earth, and is shown in Photos 7 to 10 (Appendix I). Highway runoff from the slope drain discharges into the erosion gully and there is no visible collector drains at the toe of the slope.

The RV Park owners reported that highway runoff leads to sediment discharge and overland flooding in the RV Park due to inadequate capacity of the existing drainage channel from the highway to the river (AT's responsibility). Sediment discharge is a concern, because site drainage reports directly to the Oldman River. Overland flooding is not a geohazard but is a concern for the landowner, particularly during heavy rainfall events and snow melt.

Based on site discussions, there are two sources of sediment and surface water reporting to the RV Park drainage channel.

- Surface runoff from the highway embankment, including discharge from a buried slope drain that has corroded and degraded leading to the erosion gully.
- Discharge from the sediment clogged highway underdrain (900-mm-diameter reinforced concrete culvert) that is located at the downstream embankment toe (waypoint 44). The underdrain is reported to convey surface water flow from the west side of the highway to the single shallow drainage channel through the RV Park to the Oldman River. The downstream end of the culvert is covered with a flap valve that has been bolted open (approximately 100 mm gap at the base), and the flap valve is approximately 2/3 clogged with sediment due to runoff erosion on the west side of the highway (discussed in Section 2).

Surface runoff reports to a shallow (less than 0.5 m deep) partly sediment infilled drainage channel that runs perpendicular to the highway right of way through the RV Park. The channel deepens slightly in the downstream direction. Along the channel route, there are three concrete culverts (estimated diameter 450 mm) where roads and pathways in the RV Park cross the channel.

At the time of the site visit, the culverts and the drainage channel were partly silted up and did not appear to be maintained (grass was well established at the partially plugged culverts). The original channel appeared to have been shallow and relatively narrow, and the capacity is further reduced due to sediment deposition over time.

At the northeast end of the drainage channel, a bridge-sized CSP culvert (estimated diameter of 1500 mm) is present. Downstream of the CSP culvert is an overgrown and partly obstructed drainage channel that reports to the Oldman River.

A second highway underdrain (900-mm-diameter reinforced concrete culvert) was located southeast of the RV Park (beneath the on ramp) (waypoint 49). The on-ramp underdrain was observed to be approximately 1/3 infilled with sediment.

4 ASSESSMENT

The geohazard concern at the site (primary issue) is considered to be the result of ongoing highway drainage through corroded buried CSP culverts, leading to the surface expression of the erosion gulley and ongoing retrogression of the erosion, as the CSP is undermined and separates at culvert joints. The erosion gully has the potential to increase in size during rainfall events and ultimately will begin to undermine the W-beam guardrail and shoulder of the highway. There is a risk of sinkholes or localized erosion features forming in the embankment or the highway due to ongoing internal erosion. The unknown condition of the internal drainage system along the embankment and potential deterioration could cause the phreatic surface in the embankment to increase, leading to potential slope instability.

5 RISK LEVEL

A risk level of 54 was assigned to the primary site issue 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 occurring); and
- Consequence Factor varies from 1 (relatively small area of erosion) to 10 (sites where the eroded material could flow into fish bearing rivers or affect water quality and aquatic resources).

The 2020 risk level was determined using AT's risk level system for erosion, and is presented as follows:

- Probability Factor – A rating of 9 was selected, because the erosion is expected to be active at moderate rainfall events due to the culvert discharging surface water onto the erosion gully. The gully was approximately 2 m deep and 3 m to 5 m wide.

- Consequence Factor – A rating of 6 was selected, because the site is within 500 m of the Oldman River. High fill slopes are present and a loss of a portion of the roadway is possible resulting in sediment transport to the Oldman River. A consequence factor of 3 was discussed during the call-out site visit but was increased to 6 following a desktop review of its proximity to the Oldman River.

The 2020 risk level was based on KCB and AT site observations. This site should be visited on the 2021 Southern Region GRMP annual tour, and the risk ranking reevaluated.

6 RECOMMENDATIONS

The following subsections discuss the recommended short- and long-term remediation works for the subject site.

6.1 Short-Term

Recommended management options to mitigate slope erosion include:

- Hydrovac the pavement drains and collector vaults, to remove accumulated debris and improve highway surface drainage;
- Carry out a CCTV camera survey to determine the material type and condition of the highway surface water drainage system; and
- Complete a topographic and hydrotechnical evaluation for highway runoff and RV Park surface drainage. Upgrade the surface drainage channel to the Oldman River to reduce the potential for overland flooding. Include sediment retention structures where necessary.

In addition to short-term maintenance activities, it is recommended that a clean-out and a CCTV camera survey is carried out to reduce potential sediment accumulations and establish the condition of the underdrain.

6.2 Long-Term

Recommended options to repair slope erosion include:

- Repair the erosion gully and reinstate the slope drain using a buried culvert; and
- Construct a collector drain for surface runoff and drainage from the highway embankment at the downstream toe.

7 CLOSING

This report is an instrument of service of Klohn Crippen Berger Ltd. (KCB). The report has been prepared for the exclusive use of Alberta Transportation (Client) for the specific application to the Southern 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. 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.
2. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

We look forward to continuing a constructive and successful working partnership with Alberta Transportation. Please do not hesitate to contact the undersigned at 403.731.6859 if you have any questions, comments, or concerns regarding this report.

Yours truly,
KLOHN CRIPPEN BERGER LTD.

2021-03-01

Margot Lederman, P.Eng.
Civil Engineer

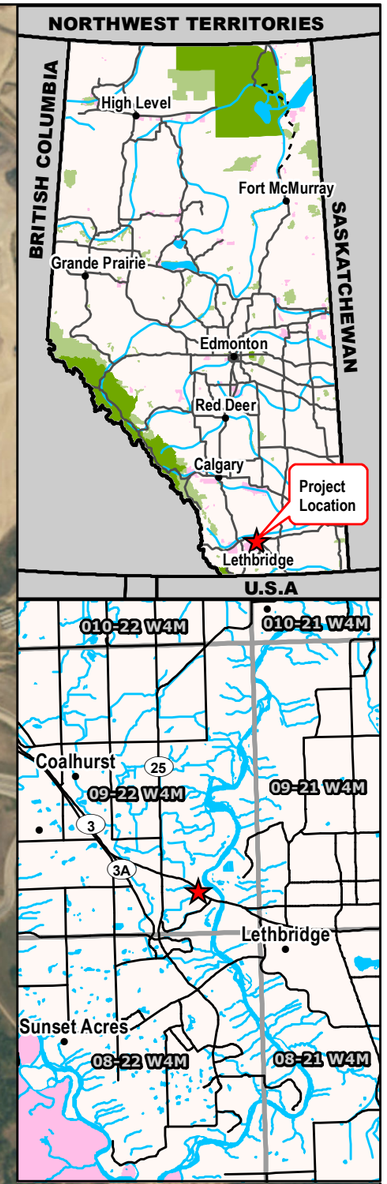
Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer, Associate

cc: Chris Morgan, M.Sc., P.Eng. (Klohn Crippen Berger Ltd.)

Attachments:
Figure
Appendix I: Site Walkover Photographs

PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.
RM SIGNATURE: _____
RM APEGA ID #: 187607
DATE: 1 Mar. 2021
PERMIT NUMBER: P009196
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

FIGURES



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NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 12N
3. IMAGE SOURCE: World Imagery, ESRI ArcGIS Online. Source date August 31, 2018 (Lethbridge County)

CLIENT
Alberta
Klohn Crippen Berger

PROJECT
SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE
Site Location Plan
Hwy 3: Lethbridge RV Section D Site
Hwy 3:09, km 1.38

SCALE	PROJECT No.	FIG No.
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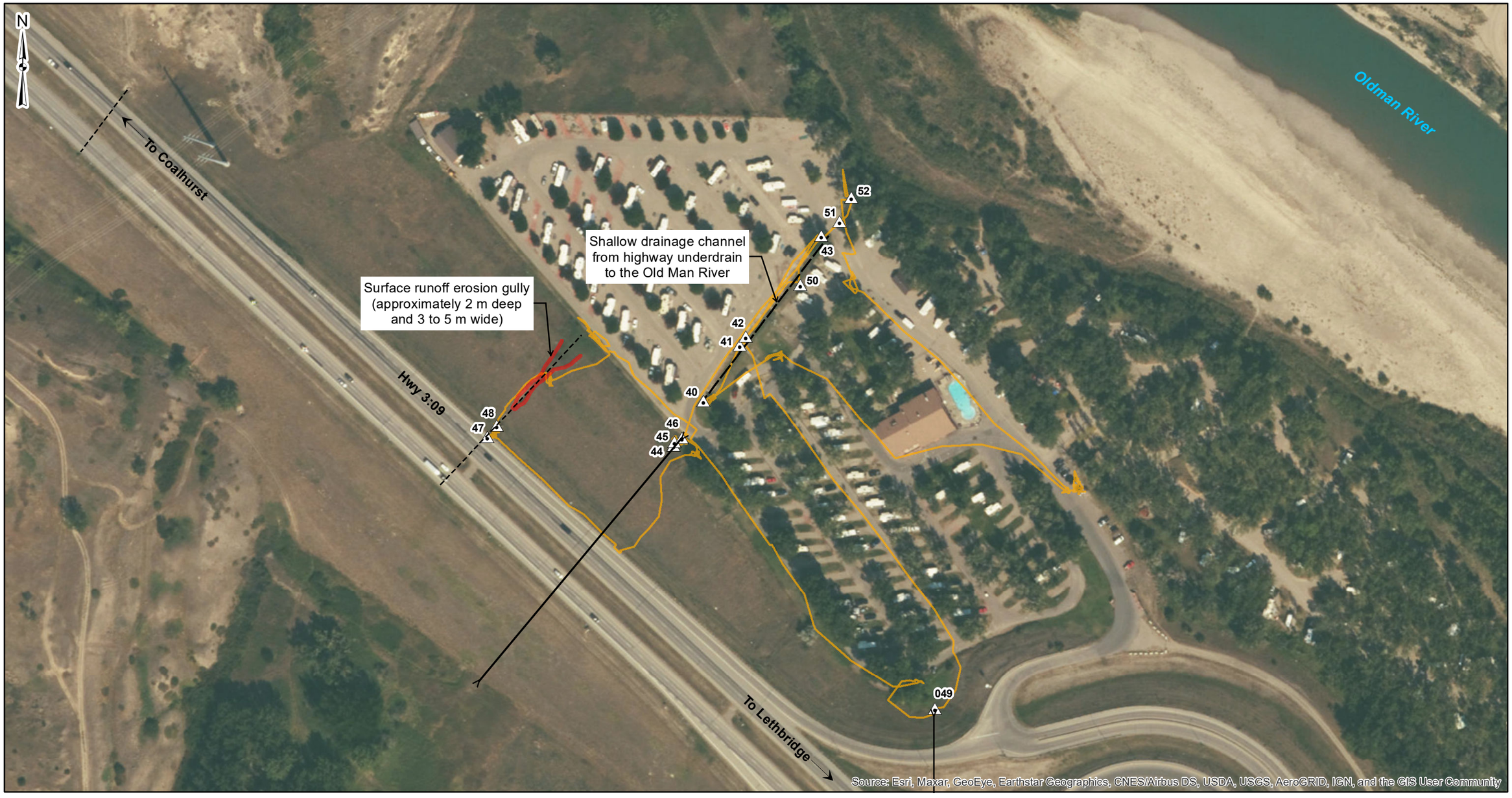

Legend

- GPS Waypoint (September 9, 2020)
- GPS Track (September 9, 2020)
- Highway surface drainage
- Drainage channel
- Highway underdrain (900 mm reinforced concrete culvert)
- Surface runoff erosion gullies on embankment side slope

0 100 Metres

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM Zone 12N
3. IMAGE SOURCE: World Imagery, ESRI ArcGIS Online. Source date August 31, 2018 (Lethbridge County)

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
Hwy 3: Lethbridge RV Section D Site
Hwy 3:09, km 1.38

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APPENDIX I

Site Walkover Photographs

Appendix I – Photographs

Photo 1 **View from crest of highway embankment looking downslope towards the RV Park and river. Photo taken facing northeast on September 9, 2020.**

Photo 2 **Crack in pavement surface over highway drainage. Photo taken facing southwest on September 9, 2020.**

Photo 3 **Crest of highway embankment looking northwest. Photo taken September 9, 2020.**

Photo 4 **Crest of highway embankment looking southeast. RV Park is located at the toe of the embankment, adjacent to the river. Photo taken on September 9, 2020.**

Photo 5 **Highway embankment from toe of slope. Photo taken facing southeast from the RV Park on September 9, 2020.**

Photo 6 **Highway embankment from toe of slope. Photo taken facing southeast from the RV Park on September 9, 2020.**

Photo 7 **Highway drainage includes three buried CSP culverts (reportedly installed in the 1960s and 1 m diameter). The culverts have rusted out leading to erosion gullies forming on the slope. Photo taken on September 9, 2020.**

Photo 8 **The CSP culvert has rusted over time and separated at joints, causing the erosion gully to retrogress up the slope. Photo taken facing southwest on September 9, 2020.**

Photo 9 **Surface runoff erosion gully (approximately 2 m deep and 3 to 5 m wide) viewed from crest of embankment. Photo was taken facing northeast on September 9, 2020.**

Photo 10 **Surface runoff erosion gully viewed from midway down the embankment. Photo was taken facing west on September 9, 2020.**

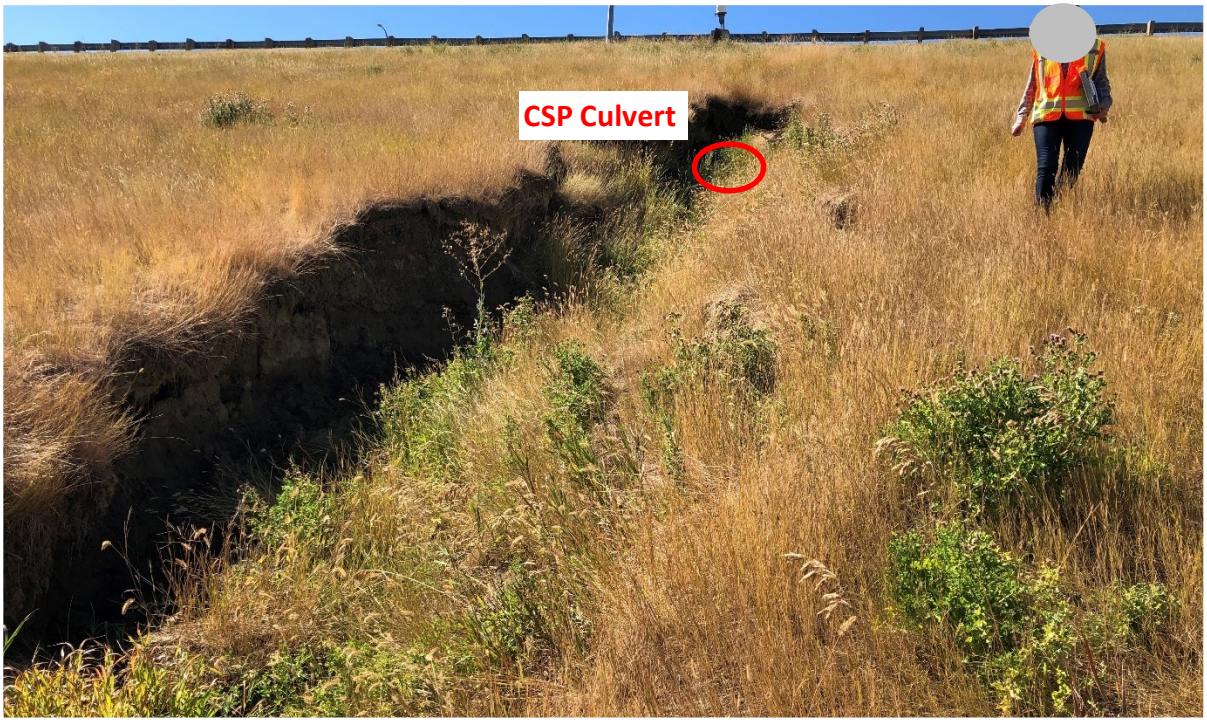

Photo 11 **Underdrainage from the west side of the highway to the east side of the highway (and the river) is provided by a 900 mm (32”) diameter reinforced concrete pipe with a flap valve. The underdrainage is not connected to the highway road surface drainage. Photo was taken facing southwest on September 9, 2020.**

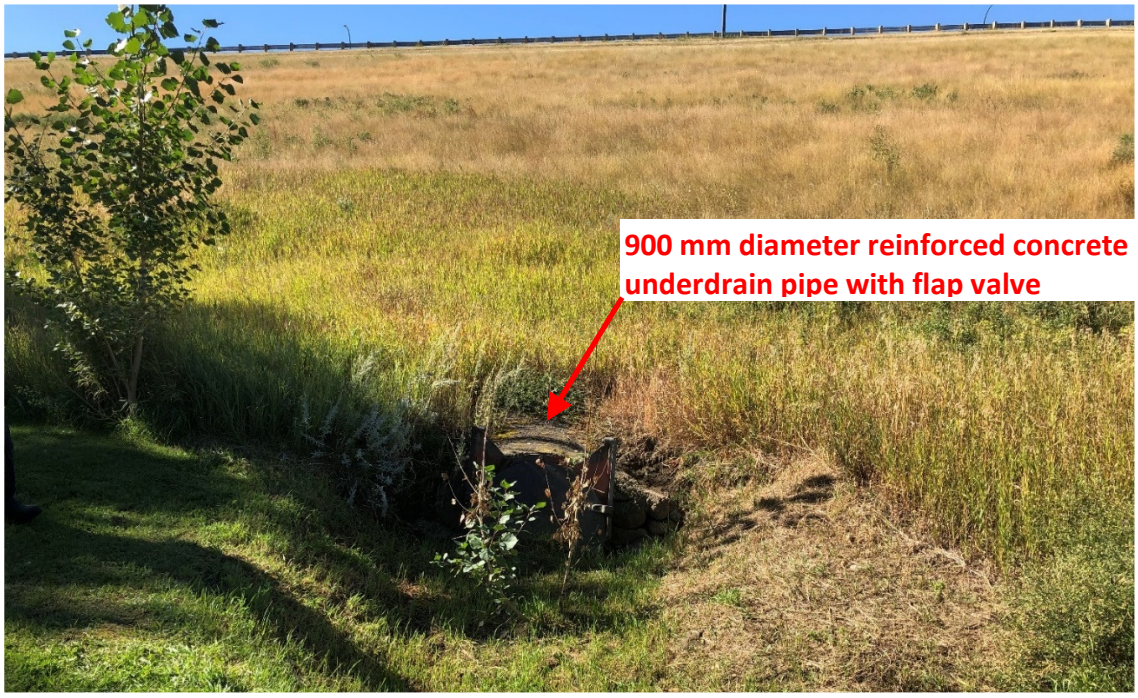

Photo 12 **The flap valve is bolted open, but the outflow channel has silted up due to sediment from the west side of the highway washing through the underdrain culvert.**

Photo 13 **Shallow drainage channel and partially infilled concrete culvert immediately downstream of the flap valve. Photo taken facing northeast on September 9, 2020.**

Photo 14 **Shallow open drainage channel from the underdrain pipe to the river (red dashed line). Photo taken facing north on September 9, 2020.**

Photo 15 **Shallow drainage channel from the concrete underdrain to the river. View from RV Park towards highway. Photo taken facing southwest on September 9, 2020.**

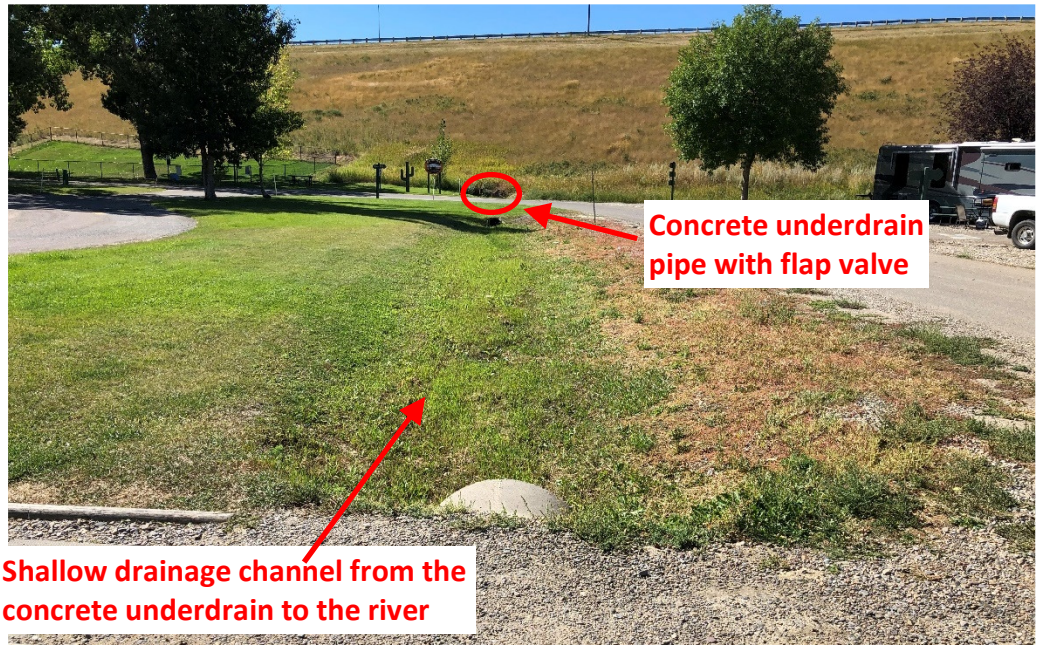

Photo 16 **Shallow drainage channel from the concrete underdrain to the river. Several silted up culverts are located along the drainage channel which contributes to overland flooding in the RV Park. Photo taken facing northeast on September 9, 2020.**

Photo 17 **Unobstructed CSP culvert at northeast end of irrigation return channel. The culvert discharges into an overgrown channel that reports to the river. Photo taken facing north on September 9, 2020.**

Photo 18 **Overgrown drainage channel between the CSP culvert and the river. Photo taken on September 9, 2020.**