SOUTHERN REGION GRMP
SITE INSPECTION FORM

SITE NUMBER AND NAME: **S026 Elkwater Slides**	HIGHWAY & KM: 41:03, 35.169	PREVIOUS INSPECTION DATE: June 7, 2021	INSPECTION DATE: **May 11, 2023**
LEGAL DESCRIPTION SE-18-008-02 W4M and 16-07-008-02 W4M	NAD 83 COORDINATES: UTM 12 Northing 5499046 Easting 553536	RISK ASSESMENT: Site A: PF: 7 CF: 6 TOTAL: 42 (Slides) Site B: PF: 8 CF: 4 TOTAL: 32 (Pile wall)	
AVERAGE ANNUAL DAILY TRAFFIC (AADT): 660 (north), 400 (south), (Ref. No. 138060)		CONTRACTOR MAINTENANCE AREA (CMA): 23	

SUMMARY OF SITE INSTRUMENTATION:	INSPECTED BY:
Site A: Two piezometers and two slope inclinometers (SIs). The Measurand ShapeAccelArray (SAA) is inoperable, and the reading box was decommissioned in spring 2019 by KCB at the request of AT. Site B: One SI LAST READING DATE: June 2023	Peter Roy (KCB) Alex Frotten (AT) Roger Skirrow (AT)

PRIMARY SITE ISSUE: Landsliding on fill slopes and back slopes on cut and fill side hill locations in a valley. Toe erosion from the creek and high groundwater table appear to be the triggering mechanisms.

APPROXIMATE DIMENSIONS: The extent of landsliding is continuous over approximately 600 m from the south end to the north end of the site and between sites A and B, as previously identified in GRMP reports. The fill slopes vary from 5 to 10 m high, sloped at approximately 4H:1V to 5H:1V.

DATE OF ANY REMEDIAL ACTION:
Site A: Shallow drainage installed near south end of site (in 1970s or 1980s, no records available). Numerous patches over the years. The slope at Site A was regraded in fall 2016, overlay placed in fall 2017, and new overlay after the 2021 Section B site visit.

Site B: H-pile wall 60 m long constructed at Site B in 2012 The pile wall repair was preceded by a temporary repair consisting of slope excavation and reconstruction, and a soil nailing program.

ITEM	CONDITION EXISTS		DESCRIPTION AND LOCATION	NOTICABLE CHANGE FROM LAST INSPECTION	
	YES	NO		YES	NO
Pavement Distress	X		Overlay at Site A in after 2021 Section B inspection. Cracking through pavement overlay has redeveloped at previous slide locations. The extent and width of cracking at Site B seems unchanged.	X	
Slope Movement	X		Site A: Slope movement (translational) in west direction. Site B: Sliding is occurring below the pile wall, exposing the piles and causing loss of soil behind the pile wall.	X	
Erosion	X		Erosion on embankment slope at culvert outlet to south of side-hill site.		X
Seepage	X		Wet areas noted on back slopes (upslope of highway) and near toe of slope near stream (downslope of highway).		X
Culvert Distress		X	Erosion at outlet of culvert		X

COMMENTS

Entire valley slope in the subject area is a landslide zone with instability features located upslope and downslope of the highway and a general trend of movement to the west, towards the creek. Numerous embankment fill slides are present to the west of road. Toe of landslide appears to be at creek level where erosion is occurring due to stream being partially blocked by slide movement. The general area of the site (Cypress Hills) was not glaciated in the last ice age.

Site A (embankment fill slides due to movement on the west side of the highway):

Ongoing movement observed at the site since 2018. Back slope slides are still active and snowplow strikes are visible on the road surface. Cracking has reflected through the recent overlay and settlement of the various slides is visible on the pavement surface. Deformation since 2021 is small-scale but ongoing, however there have been no sudden changes at the site.

Fill settlement up to 0.5 m at east edge of pavement. Up to 1.0 m of asphalt exposed at shoulder of highway. Guard rail, HTCB or fill placement is required at locations where there are steep drop offs at the edge of the pavement, due to the narrow shoulder outside of the lanes and to protect road users.

Water levels in the ditch downstream of the instability zones appears unchanged from 2021 observations to most recent inspection.

Pavement cracking extending into centre of northbound lane. Area of sliding is 40 m wide at edge of pavement of the southbound lane.

The embankment slope below the highway is experiencing a series of semi-continuous slope failures:

- Pavement cracking extending into southbound lane (to within 1 m of centreline) at waypoint 1 Area of sliding is 18 m wide at edge of pavement of the southbound lane.
- Pavement cracking extending to 0.5 m past edge of pavement into southbound lane at waypoint 2. Area of sliding is 5 m wide at edge of pavement of the southbound lane.
- Pavement cracking extending to 1.0 m past centreline into northbound lane at waypoint 3. Area of sliding is 25 m to 30 m wide at edge of pavement of the southbound lane.

<u>Site B (H-pile wall)</u>

The pile wall at Site B has been exposed by soil sliding downslope of the wall. KCB monitors the wall during spring and fall instrument readings. There have been no significant changes when compared to 2021 observations. A small amount of ground cracking was observed between the highway and pile wall.

Pavement cracking upslope of the pile wall was noted at the southern end of the wall, where the wall ends. Transverse pavement cracking south of pile wall appears to be unchanged since 2021.

Cracking and slope movement is also present north of the northern extent of the pile wall, outflanking the pile wall. The guardrail at the north edge of the pile wall has a noticeable dip.

Slope movements below pile wall have exposed the piles over a length of 30 m at the north limit of the wall. The piles were measured as leaning between 0.2° and 0.6° from vertical in 2023, which note very little change from previously measured in 2021. The upper 2 to 3 m of pile wall is exposed and unsupported. Below the exposed section of H-piles is a 2 m high section where sloughed material from between and behind the pile wall has eroded out and covered the piles. Voids are up to 0.5 m deep behind the pile wall, and erosion is ongoing. Sloughing is due to seepage and infiltration.

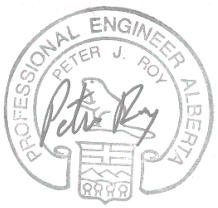
Well-developed toe roll near creek level beyond the edge of the trees below pile wall. Wet conditions present at toe of slope. Seepage and surface water runoff has resulted in exposed soils being eroded and deposited at toe of slope.

Candidate repair options for this site are:

Site A – Carry out additional ground investigation, including boreholes and installation of additional geotechnical instrumentation, to assess the depth of movement in recently active areas for repair design options evaluation. Potential repair options include additional pile walls in slide areas, with drainage trenches installed at the toe of the landslide zone to lower the groundwater table and improve slope stability.

Site B - Candidate repairs include extending the existing H-pile wall to the north and the addition of timber lagging between H-piles to minimize material loss from between the piles (this work could be completed by the HMC). Drill boreholes and install two additional two slope inclinometers adjacent to the pile-wall.

Ditch drainage through the whole S026 area should be improved to minimize infiltration into the slide zones. The highway surface should continue be regraded in areas where it has deflected and cracked, to improve the smoothness of the highway through this site. Highway regrading should include milling the existing asphalt, and not placing more material which adds weight to the failure zones.



13 Oct. 2023
ID 141695

Peter Roy, P.Eng.
Civil Engineer

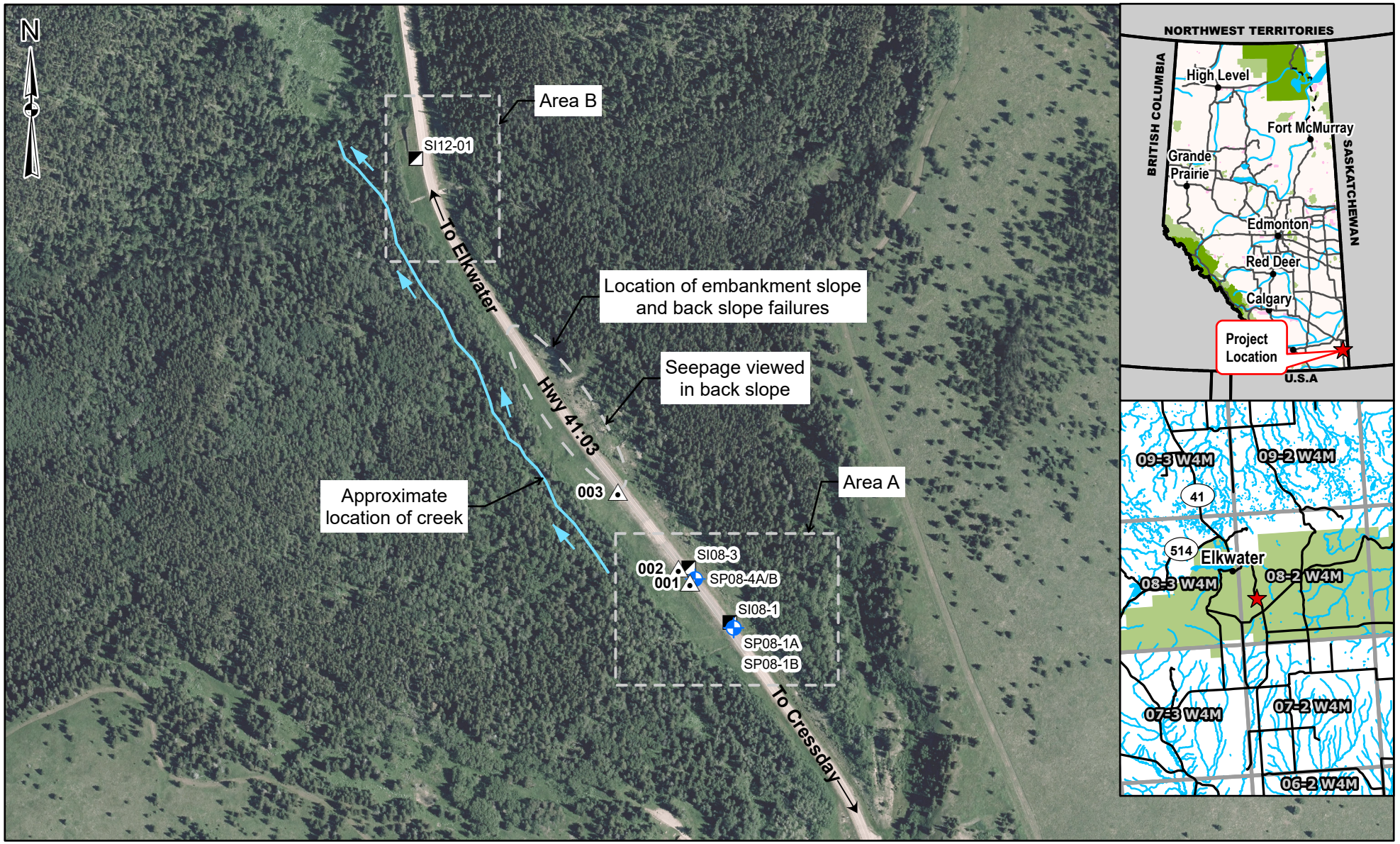
PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.

RM SIGNATURE: Pamela Jones

RM APEGA ID #: 187607

DATE: 13 Oct. 2023

PERMIT NUMBER: P009196
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)



Legend

- GPS Waypoint (May 11, 2023)
- Slope Inclinometer (SI)
- Standpipe Piezometer (SP)
- Flow Direction
- Creek

0 200 Metres

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM ZONE 11N
3. IMAGE SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS AND THE GIS USER COMMUNITY.

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

TITLE: Site Plan
S026 - Elkwater Slides
Hwy 41:03, km 35.169

SCALE	PROJECT No.	FIG No.
1:5,500	A05116A03	1

File: Z:\AC\GY\Alberta\A05116A03 ABT Southern Region GRMP\400 Drawings\2023\01_ProFile\Section B\ABT_Southern_SectionB_230713\ABT_Southern_SectionB_230717.aprx Date: Time: Creator: : aharrison

Photo 1 **Site A: Cracking has redeveloped through the pavement overlay. Photo was taken facing south on May 11, 2023.**

Photo 2 **Site A: Pavement cracking and settlement. Photo was taken facing north on May 11, 2023.**

Photo 3 **Site A: East shoulder asphalt up to 1 m in height. Photo was taken facing south on May 11, 2023.**

Photo 4 **Site B: Pile wall is located downslope to the west of the highway. Soil movement downslope of the wall has exposed 2 to 3 m of steel pile over a length of approximately 30 m. Photo was taken facing north on May 11, 2023.**

Photo 5 **Site B: Exposed steel piles. Photo was taken facing northeast on May 11, 2023.**

Photo 6 **Site B: Erosion of material between piles has contributed to voids up to 0.5 m behind the wall. Photo taken facing northeast on May 11, 2023.**

Photo 7 **Site B: South slope below the pile wall. Photo was taken facing west, downslope on May 11, 2023.**

Photo 8 **Site B: Dip in guard rail north of the pile wall. Photo taken facing north on May 11, 2023.**