ALBERTA TRANSPORTATION

GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION–GRANDE PRAIRIE DISTRICT - NORTH
2023 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
GP012B	Ksituan River West Valley Slope (east of Jct. with Hwy 725)	Ksituan Pile Wall	49:04	2.398

Legal Description	UTM Co-ordinates
NW¼10-079-08-W6M	11U E 364030 N 6189796

	Date	PF	CF	Total
Previous Inspection:	28-May-2020	3	6	18
Current Inspection:	29-May-2023	11	2	22
Road AADT:	1360		**Year:**	2022
Inspected by:	Rishi Adhikari, TEC Max Shannon, TEC		Don Proudfoot, Thurber Nicole Wilder, Thurber	
Report Prepared By:	Nicole Wilder, Don Proudfoot (Review)			
Report Attachments:	☑ Photographs	☑ Plans	☐ Maintenance Items	

Primary Site Issue:	A landslide previously affected the highway prior to a toe berm and pile wall being constructed. In 2008, a shallow landslide occurred in the upper portion of the toe berm.	
Dimensions:	The approximate width of the landslide was about 90 m, including a 10 m extension observed in 2023, and the landslide extended from the crest to the toe of the berm. The maximum depth of the backscarp along the crest of the toe berm was about 0.5 m.	
Date of any remediation:	Highway was stabilized with the construction of a toe berm in 2001 and sixty buried slope stabilization piles in 2002. The toe berm was about 7 m in height and constructed at a 2H:1V sideslope due to the right-of-way restriction.	
Maintenance:	The pavement was overlaid after the last inspection.	
Observations:	**Description**	**Worsened?**
☑ Pavement Distress	Several longitudinal and transverse cracks were observed in the pavement in the north and southbound lanes in different locations than previously observed which may be related to slope movement.	☑
☑ Slope Movement	Failure of the 2H:1V sideslope of the toe berm located below the pile wall constructed in 2002. Fresh sloughing was observed and the soil was moist in 2017. In 2020 the scarp appeared to be slightly active. The fence posts at the bottom of the slope were pushed over from movement of the toe, and they were tilted over more with some posts now horizontal. The backscarp extended approximately 10 m to the northwest since the last inspection and there was 15 m wide subtle overgrown scarp above the existing gabion wall.	☑
☐ Erosion		☐
☑ Seepage	Seepage was observed near the base of the toe roll.	☑

☑ Bridge/Culvert Distress	At the inlet of the 1.6 m SPCSP culvert, there previously has been some debris accumulation such as fallen tree trunks, however at the time of the inspection the debris was gone.	☐
☑ Other	As a result of the landslide in the toe berm, displaced mass has been accumulated at the toe and encroached into the right-of-way of the sour natural gas pipeline located adjacent to the highway	☑

Instrumentation:

SI-1 SI-3	Installed in the 2002 slope stabilization piles. A very small amount of movement has been detected in SI-1 and no discernable movement was detected in SI-3. The current rate of movement at SI-1 is 0.1 mm/yr within depths from 9.2 m and 12.2 m below existing ground surface.
SI-2	Installed 10 m downslope of the 2002 pile wall. This SI was bent at the top and during the spring 2021 readings the probe got stuck at 25 m; hence is assumed to have sheared off at this depth below the ground surface..
SI-4	Installed at the toe of the lower berm sideslope. This SI was damaged and not able to be read in fall 2020.
SI-6	Installed about 18 m northeast of the lower sideslope berm toe (further towards the Ksituan River). This SI showed a current rate of movement of 0.1 mm /yr between a depth of 1.1 m and 2.3 m below existing ground surface.
SI-8	Installed in the 2002 pile wall. This SI showed a slight increase in the rate of slope movement; the current rate is: 0.4mm/yr within depths from 0.9 to 19.2 m below existing ground surface
PN-4A PN-4B PN-5A PN-5B	Installed at the toe of the lower berm sideslope. Piezometers PN-4A, PN-4B and PN-5A were destroyed. Piezometer PN5B showed a slight decrease in groundwater level of 0.23 m, since the spring 2022 readings.

Assessment:

A slope failure has occurred in the toe berm, which was constructed at a slope angle of 2H:1V. The toe berm was constructed of locally obtained clayey colluvium soils of high plasticity, which typically undergo a gradual loss of cohesion with time. Based on local experience of the sites with similar soil conditions, the onset of the shallow landslides typically occurs in about 10 to 20 years following the completion of fill placement. Once the landslide has developed, the stability of the fill slope deteriorates. Over time, this has been observed at this site as the toe berm slide appears slightly worse than what was observed in 2020. This may become a concern as the slide mass moves down it will reduce the passive support of the pile wall.

The most cost-effective measure could be to flatten the upper portion of the toe berm by cutting the crest of the toe berm into the pile wall location. However, it is recommended that stability analyses be carried out to assess the impact of reducing the size of the toe berm on the global stability of the pile wall and highway embankment.

The scarp of the toe berm slump has extended northwest since the last inspection, there is now a scarp crack above the gabion wall and some noticeable crack in the pavement between these two locations. This suggests that the slope between the north end of the pile wall and the bridge culvert might be creeping and if this continues it might be necessary to stabilize this section of the highway embankment at some time in the future.

Recommendations:	**Ballpark Cost**
The site should be monitored at an increased frequency of every two years for slide progression as the back scarp extended 10 m to the northwest and cracks are now present above the gabion wall and in the highway pavement. If further movement is noted it might become necessary to extend the toe berm and pile wall further northwest.	Monitoring
As displaced material from the landslide has been encroaching into the right-of-way of the sour natural gas pipeline, a dialog should be opened between AT and the pipeline owner/operator in order to implement remediation measure in the future.	$1,000
Subject to slope stability checks, consideration could be given to flattening the berm sideslope back toward the pile wall to check the slumping that is occurring.	$50,000
It is suggested that the willows that were cut near the inlet of the culvert be removed from this area so that they don't get washed into and block the inlet.	

CLOSURE

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Don Proudfoot, P.Eng.
Principal | Senior Geotechnical Engineer

PROFESSIONAL ENGINEER ALBERTA
NICOLE WILDER
ID 174073

August 31, 2023

PROFESSIONAL ENGINEER ALBERTA
DONALD PROUDFOOT
ID 51674

August 31, 2023

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: Don Proudfoot
RM APEGA ID #: 51674
DATE: August 31, 2023
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Nicole Wilder, P.Eng.
Geotechnical Engineer

H:\32000\32123 AT GRMP Grande Prairie District North 2021-2025\CAD\2023\NPW\32123-GP012B-1.dwg - 1 - Aug. 25, 2023

100mm Ø SPCSP CULVERT
GABION WALL
TO B.C.
SUBTLE GROWN OVER SCARP
KITSVAN RIVER
NW 10-79-08-W6M
CREEK
CSP CULVERT
HAIRLINE CRACKS POSSIBLY SLIDE RELATED
0.7m HIGH TOE ROLL
FENCE POSTS TILTED FORWARD AND MANY WERE NOW HORIZONTAL ALONG THE DISTINCT TOE ROLL
300mm DROP
SI-3
SI-6
PN-5A
SEEPAGE
TOE
SI-2
PN-4A/B
SI-4
TELUS CABLE (APPROXIMATE)
HIGHWAY 49:04
SI-8
SI-1
WILLOWS WERE CUT WITH A SAW AND LEFT ON GROUND HERE
APPROXIMATE LOCATION OF SPACED CONCRETE PILE WALL (2002)
WATER DISSIPATION BARRIERS (TYP)
BACKSLOPE FAILURE
SW 10-79-08-W6M
TO RYCROFT
SIMILAR CONDITION IN 2023

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W
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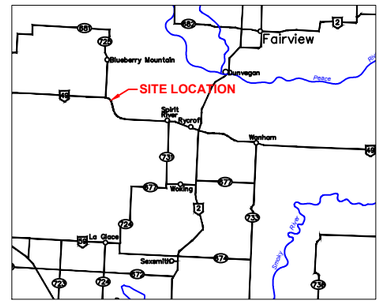

KEY PLAN
SCALE: 1:2 000 000

LEGEND

- APPROXIMATE INSTRUMENT LOCATION
- SI SLOPE INCLINOMETER
- PN PNEUMATIC PIEZOMETER
- SCARP CRACK
- CRACK (APPROXIMATE)
- BARBED WIRE FENCE (APPROXIMATE)
- SPECTRA MIDSTREAM SOUR NATURAL GAS PIPELINE (APPROXIMATE)
- GUARDRAIL
- WATER FLOW DIRECTION
- RUT
- DIRECTION AND NUMBER OF PHOTO

NOTES :

1. FEATURE LOCATIONS ARE APPROXIMATE
2. PREVIOUS OBSERVATIONS SHOWN IN BLACK
3. MAY 29, 2023 FEATURES SHOWN IN RED

0 10 20 30 40 50 60m
SCALE 1:1000

AIR PHOTO FROM ESRI WORLD IMAGERY EXPORTED ON AUGUST 17, 2023

Alberta

PEACE REGION (GRANDE PRAIRIE)

GP012B-1: HWY 49:04 KSITUAN PILE WALL
2023 INSPECTION FIGURE

DWG No. 32123-GP12B-1-1

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	RVC
SCALE	1:1000
DATE	AUGUST 2023
FILE No.	32123

THURBER ENGINEERING LTD.

Photo 1. Looking southwest at backslope failure on other side of highway. Photo credit: Nicole Wilder.

Photo 2. Looking southeast from the southeast bound lane at cracking in pavement. Photo credit: Nicole Wilder.

Photo 3. Looking southwest towards the landslide in the toe berm. Photo credit: Don Proudfoot.

Photo 4. Looking southeast at water dissipation barriers that are grown over. Photo credit: Nicole Wilder.

Photo 5. Looking northwest along the toe of the landslide. The fence posts are bent over further from movement of the toe bulge. Photo Credit: Nicole Wilder.

Photo 6. Looking at the toe bulge and bent over posts. Photo Credit: Nicole Wilder.

Photo 7. Looking northwest along the gabion wall. Photo Credit: Don Proudfoot.

Photo 8. Looking southeast at somewhat overgrown slumping from head scarp. Photo Credit: Nicole Wilder.

Photo 9. Looking northwest towards the 6.1 m diameter SPCSP centerline culvert outlet. Photo Credit: Nicole Wilder.

Photo 10. Looking northwest at a scarp crack in the highway sideslope. Photo Credit: Nicole Wilder.