ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION–GRANDE PRAIRIE
2023 INSPECTION REPORT

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
GP004a	Burnt River Bridge (BF73877)	Burnt River Bridge (West Approach Slide)	49:06	10.586
GP004d (Not Visited)		Burnt River Bridge (East Approach Slide)		11.000
Legal Description		**UTM Co-ordinates**		
NW¼10-078-04-W6M		11U E 403300	N 6178800	

	Date	PF	CF	Total
Previous Inspection:	18-May-2022	12	7	84
Current Inspection:	29-May-2023	12	7	84
Road AADT:	960		**Year:**	2022
Inspected by:	Rishi Adhikari, AT Max Shannon, AT		Don Proudfoot, Thurber Nicole Wilder, Thurber	
Report Attachments:	☑ Photographs	☑ Plans	☐ Maintenance Items	

Primary Site Issue:	See previous annual inspection and call out reports from the Geohazard binder for a complete historical perspective of this site. <u>West Approach Slides:</u> The west approach to the Burnt (Saddle) River Bridge (BF73877) was constructed as a side hill embankment through a deep-seated landslide that is activated by meandering of the Burnt River, which is situated about 200 m downslope of the roadway. In 1991, the highway alignment through the Burnt (Saddle) River crossing at this site was shifted further upslope with the intention of locating the highway outside of the landslide area. Between 2010 and 2012, two smaller landslides developed near the backscarp of the deep-seated landslide and likely accounted for distress and cracking of roadway embankment and pavement. These two smaller scarps have now coalesced. <u>East Approach Slide:</u> This was not assessed in 2022.
Dimensions:	<u>West Approach Slides:</u> The larger deep-seated main landslide is about 480 m in width along the backscarp and extends about 250 m downslope into the Burnt (Saddle) River. The backscarp was traced into the backslope of the highway and further southeast of the previously observed cracks. Little Slide No. 1 and Little Slide No. 2 were identified as separate slides during previous inspections. These two slides appeared to have merged into one.
	<u>East Approach Slide:</u> Not assessed in 2022.

Maintenance:	An ACP patch was placed on the pavement affected by the West Approach Sides in 2021.	
Observations:	**Description**	**Worsened?**
☑ Pavement Distress	Cracks were observed on the pavement affected by the West Approach Slides along profiles observed in previous years, which are showing through the milled pavement. There is a steep (~1.3 m) drop off on the south side of the highway from numerous patches over the years.	☑
☑ Slope Movement	The roadway was affected by landslides at the west approach to the Burnt River Bridge (BF73877) crossing (the east side was not looked at this year). The west approach slide appeared to have worsened as the scarp crack has shown through the milled pavement with a measured vertical drop of up 80 mm and it is open to 120 mm and may be a retrogression of the deep-seated slide movement. The scarp crack was also tracked about 180 m further east south of the highway.	☑
☑ Erosion	River erosion is ongoing at the toe of the larger deep-seated landslide on the west as the Burnt River continuously erodes the toe of the north valley slope. The scour holes in the erosion gully along the south ditch appeared a bit larger and some were filled with water.	☑
☑ Seepage	The previously ponded water area on the north side of the Highway was wet during the 2023 inspection and a larger area was wet from what appeared to be a spring. The area that previously had reeds appeared to have been cut by a lawn mower. The two scour holes within the erosion gully formed to the northwest of the site were wet and had some water in them in 2023. There was also some seepage observed above an existing 200 mm diameter CSP subdrain downslope of the scarp crack.	☑
☐ Bridge/Culvert Distress		☐
☑ Other	A 1.5 m diameter sinkhole was observed over an existing 800 mm diameter CSP culvert.	☑
Instrumentation:		
SI-16	Installed about 70 m downslope of the Hwy 49:06 EBL at approximately the middle height of the Burnt River north valley slope. This SI showed a rate of 0.6 mm/year at a depth between 22 m and 28 m below ground surface.	
PN-13	Installed about 10 m upslope of the Hwy 49:06 EBL had previously showed a water level of 0.32 m below ground surface during the fall 2021; however, the instrument would not stabilize since spring 2022 and is likely damaged.	
PN-15	Installed about 10 m downslope of the Hwy 49:06 WBL and showed an decrease in water level of 5.41 m since the fall 2022 readings, the piezometer shows a water level of 9.56 m below ground surface.	

Assessment:

West Approach Slides:

The distress of the roadway embankment and pavement is due to the retrogression of the original deep-seated landslide. The slide may have been exacerbated by seepage emanating from the backslope above the highway and a high groundwater level. This section of the highway has already been realigned once to alleviate the impacts of the original landslides.

The origin of the large deep-seated landslide that effects the roadway was very likely triggered by river erosion at the toe of the north valley slope in a meander loop of the Burnt River. The long-term mitigation measures would be to either realign the highway further upslope, which may require relocating the highway on the upper plateau completely out of the river valley and implement riverbank reinforcement at the toe of the valley slope. The river re-alignment would likely require bypassing a bend and require drop structures. The actual extent and configuration of riverbank reinforcement would need to be assessed by a river hydraulics specialist.

The effects to the roadway caused by two smaller slides which have merged may be maintained in the short term with regular patching and sealing of the cracks and milling. However, this does not eliminate the threat to the roadway from the landslide of much larger scale as these slides may be a retrogression of it and they will likely continue to show through ACP patches each year as observed.

TEC suggested that a subdrain may be constructed in the north ditch to lower the groundwater table there and that the eastbound lane shoulder be built out with gravel so that the shoulder can be re-established and eliminate the sharp drop off.

Because the natural soil conditions through the site are poor and the size of the slide, the conventional slope stabilization measures techniques such as pile walls and toe berms might not be suitable for this site.

East Approach Slide:

No inspection was performed at this site this year.

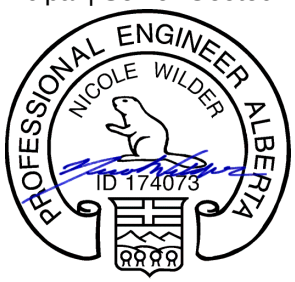
Recommendations:

	Ballpark Cost
Same recommendations as provided in 2022 are still valid and repeated below.	
MAINTENANCE: Due to continued patching/milling of the roadway the south shoulder of the road is currently quite steep and sharp. Consideration should be given to add some compacted gravel on the south side slope to minimize the differential drop. This work may be done at the next time TEC is patching the roadway.	$15,000
SHORT TERM: The aperture/extent of the cracks in the pavement affected by the West Approach Slides should be regularly monitored for signs of development and deterioration. Open cracks should be sealed or patched as soon as practical. A subdrain could be constructed in the north ditch. The presence of a spring and permanent wet ditch area suggest that there is a high water table at the ditch level	$150,000
LONG TERM: Realign the highway out of the river valley or realign the river to allow a toe berm buttress and river channel armouring works to be installed. The extent and associated cost for each of these options would need to be further assessed.	

Closure

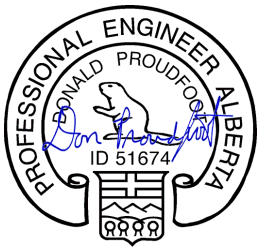
It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

Yours very truly,
Thurber Engineering Ltd.
Don Proudfoot, P.Eng.
Principal | Senior Geotechnical Engineer



August 30, 2023

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: Don Proudfoot
RM APEGA ID #: 51674
DATE: August 30, 2023
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)



August 30, 2023

Nicole Wilder, M.Eng., P.Eng.
Geotechnical Engineer

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

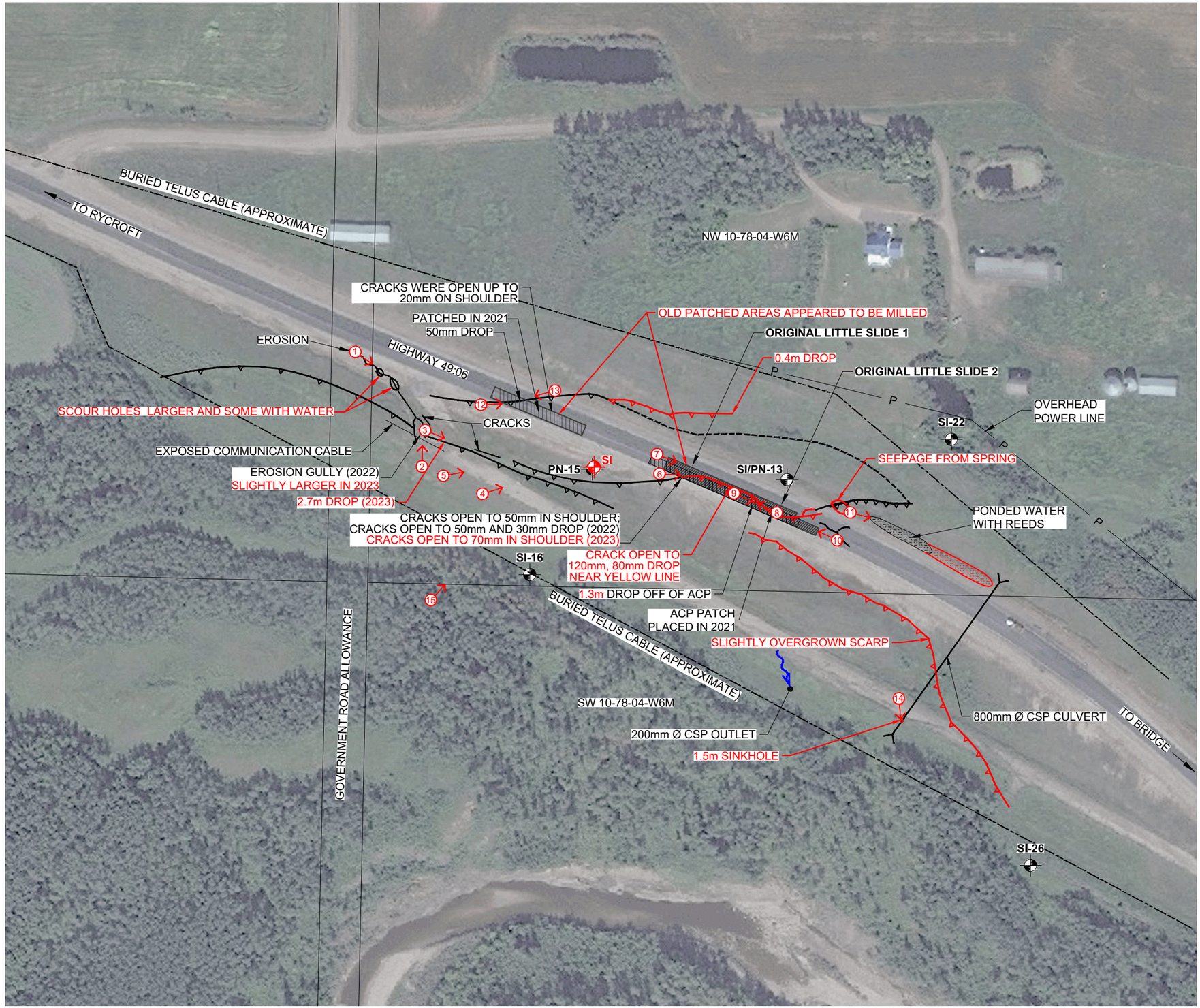
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

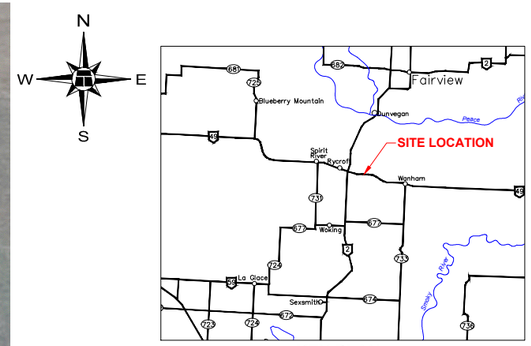
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

H:\32000\32123 AT GRMP Grande Prairie District North 2021-2025\CAD\2023\NPW\32123-GP004A-1.dwg - 1n - Aug. 25, 2023





KEY PLAN
SCALE: 1:2 000 000

LEGEND

- APPROXIMATE INSTRUMENT LOCATION
- SI — SLOPE INCLINOMETER
- PN — PNEUMATIC PIEZOMETER
- SCARP CRACK
- POSSIBLE SCARP RETROGRESSION
- SEEPAGE
- ⑧ — 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 20 40 60 80 100 120m
SCALE 1:2000

Alberta

PEACE REGION (GRANDE PRAIRIE DISTRICT - NORTH)
GP004A-1: HWY 49:06 BURNT RIVER BRIDGE

2023 INSPECTION FIGURE

DWG No. 32123-GP004A-1-1

DRAWN BY	ML
DESIGNED BY	NPW
APPROVED BY	RVC
SCALE	1:2000
DATE	AUGUST 2023
FILE No.	32123

THURBER ENGINEERING LTD.

Photo 1. Looking southeast at erosion gully that had formed in the south ditch which had pooling water in it in 2022 but only some of the scour holes had water in 2023. Photo credit: Nicole Wilder.

Photo 2. Looking north from edge of erosion gully. Note the ditch along south side of highway tails off and has been the contributor to this erosion. Photo credit: Nicole Wilder.

Photo 3. Looking southeast at where scarp crosses the old highway alignment. Photo credit: Don Proudfoot.

Photo 4. Looking northeast at southern slide scarp which crosses the old highway alignment. Photo credit: Nicole Wilder.

Photo 5. Looking southeast from old highway alignment at south slide scarp. Photo Credit: Nicole Wilder.

Photo 6. Looking east from the shoulder of the EBL of Hwy 49:06 at the westmost dip in the 2021 ACP patch. Photo Credit: Nicole Wilder.

Photo 7. Looking east from the shoulder of the EBL of Hwy 49:06 at the dip in the 2021 ACP patch. Photo Credit: Don Proudfoot.

Photo 8. Looking northwest from the middle of Hwy 49:06 from the south end of the 2021 ACP patch. Photo Credit: Nicole Wilder.

Photo 9. Looking east from near the middle of the 2021 ACP patch where crack continues into WBL. Photo Credit: Nicole Wilder.

Photo 10. Looking northwest from the EBL of Hwy 49:06 at the south end of the site. Photo Credit: Nicole Wilder.

Photo 11. Looking southeast at ponded water and reeds on north side of highway. Photo Credit: Don Proudfoot.

Photo 12. Looking southeast at the northwest end of the site at scarp crack open on the SBL shoulder. Photo Credit: Nicole Wilder.

Photo 13. Looking southwest at the northwest end of the site at the scarp crack. Photo Credit: Don Proudfoot.

Photo 14. Looking south at 1.5 m diameter sinkhole. Photo Credit: Nicole Wilder.

Photo 15. Looking north at westmost scarp that leads into the backslope and scarp just north of the old road. Photo Credit: Drone-Nicole Wilder.

Photo 16. Looking northwest at river and river bank slumping. Photo Credit: Drone- Nicole Wilder.