ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2022 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
PH081	Shaftesbury Trail	Shaftesbury Trail North Slides	684:02	28.4
Legal Description		**UTM Co-ordinates**		
NW¼ 19-083-021 W5M		11U E 481381	N 6230300	

	Date	Slide	PF	CF	Total
Previous Inspection:	6-July-2021	South slides	11	2	22
		North slide	9	4	36
Current Inspection:	26-May-2022	South slides	11	2	22
		North slide	9	4	36
Road AADT:	860			**Year:**	2021
Inspected By:	Tyler Clay, TEL Ed Szmata, TRANS Max Shannon, TRANS				
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items				

Primary Site Issue:	Two landslide features are present to the east of Hwy 684:02 in the crest of the steep high riverbank slope above an arm in the Peace River. The backscarps have sharp 3 m drop offs and are retrogressing towards the highway to the west and are now encroaching into the highway right-of-way (Photos 1 to 3). Both landslides have failed down to the sandy till ledge which is about 5 m below the existing ground surface. There is a marked gas utility pipeline at the backscarp of Slide 1. A landslide (first observed in 2019), evidenced by a dip and cracking in the pavement, was observed to the north of Slides 1 and 2. The location of this slide is above a subdivision at km 28.6. (Photo 4).	
Dimensions:	Slide 1 is about 13 m wide, with a 3 m drop off along the backscarp which is about 3.4 m east of the NBL guardrail. (Drone Photos 1 and 2). Slide 2 is about 14 m wide, with a 3 m drop off along the backscarp which is about 7.6 m east of the NBL guardrail. (Drone Photos 3 and 4) The slide at km 28.6 is approximately 25 m wide. Tension cracking had been observed to the highway centreline.	
History and Date of any Remediation:	It is not known when the south landslides began to occur. The north slide appeared in 2019.	
Maintenance:	The road was repaved, and new guardrail installed in 2021.	
Observations:	**Description**	**Worsened?**
☑ Pavement Distress	There are no signs of any cracking in the pavement structure above Slides 1 and 2. A transverse crack was visible in the asphalt south of the km 28.6 slide across both lanes.	☑

	Previous tension cracks were not observed since road was repaved and no apparent expansion from the previous inspection (Photo 4).	
☑ Slope Movement	Active slumping is occurring at the south landslides with bare backslopes (Photos 1 to 3). Slide 1 has shown some signs of ravelling and retrogression in the southern flank since 2021. The minimum offset from the headscarp to the guardrail was 3.4 m. The backscarp at Slide 2 did not appear to have significant change and there is 7.6 m offset to the guardrail which is unchanged from the 2021 inspection. There is no longer a noticeable dip in the pavement and guardrail at the new slide at km 28.6 since repaving and new guardrail installation in 2021.	☑
☐ Erosion		☐
☐ Seepage		☐
☐ Bridge/Culvert Distress		☐
☑ Other	There is a marked natural gas utility pipeline that appears to cross beneath the highway from west to east at the south end of Slide 1 and could possibly be affected by Slide 1. Thurber did not find any record of the pipeline	☐

Instrumentation:

Spring 2022 data from instrumentation installed during the 2020 geotechnical investigation is summarized below.

Slide 1:
TH20-7 Vibrating Wire (VW) – the VW tip is approximately 18 mbgs and has been dry since installation.

TH20-7 Slope Inclinometer (SI) – no confirmed zones of movement since installation. There is potential movement zone within the upper 2 m with less than 15 mm of cumulative movement.

Slide 2:
TH20-8 VW - the VW tip is approximately 12 mbgs and has recorded groundwater depth range between approximately 5 to 5.7 mbgs.

KM 28.6 Slide:
TH20-6 VW (x2) – the upper VW tip is approximately 8.5 mbgs and the recorded groundwater depth is approximately 8 mbgs, and the lower VW tips is approximately 20 mbgs and the recorded groundwater depth is approximately 17 mbgs.

TH20-6 SI - no confirmed zones of movement since installation.

Assessment:

Intermittent movement and retrogression is occurring at Slides 1 and 2 and the headscarps are expected to continue to move toward the highway. The newer slide at km 28.6 previously caused distress in the old pavement and guardrail and is located above a residential subdivision with a higher consequence of failure.

It is possible that the landslides are caused by fluctuations in a perched groundwater table that is within the alluvial terrace soils that sit above of the harder/denser soil and bedrock layers, combined with softening and weathering of the very steep riverbank slope. The surface soils overlie hard bedrock at the new north landslide. If a failure occurred, the landslide at km 28.6 could slide over the steep face of the bedrock into the back yards of the residences.

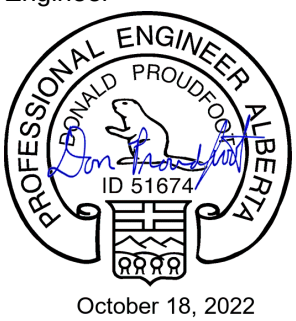
Thurber has performed a geotechnical investigation and preliminary engineering assessment at the km 28.6 slide and the report is in progress.

Recommendations:	**Cost**
Short Term Regularly inspect the road and crest of the riverbank to check for cracks and possible backscarp retrogression. Post slide warning signs and be prepared to build an emergency detour in the upslope ditch if the landslides retrogress closer to within a few meters of the NBL of the highway.	Maintenance
Prepare a preliminary engineering assessment with repair options and "A" estimates for the each of the landslide areas based on the test holes completed as part of the recent geotechnical drilling investigation.	Investigation
Long Term Given the proximity of the highway to the steep riverbank slope, and the presence of private residences on the west side of the highway, the most feasible long-term remedial solution is likely a pile wall at each of the south landslide locations to protect the road from the landslides.	$1-2 Million
At the north landslide, a concrete pile wall anchored into bedrock might be a good long-term solution.	$1 Million

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



October 18, 2022

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: Don Proudfoot
RM APEGA ID #: 51674
DATE: October 18, 2022
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Tyler Clay, P.Eng.
Geological Engineer

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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.

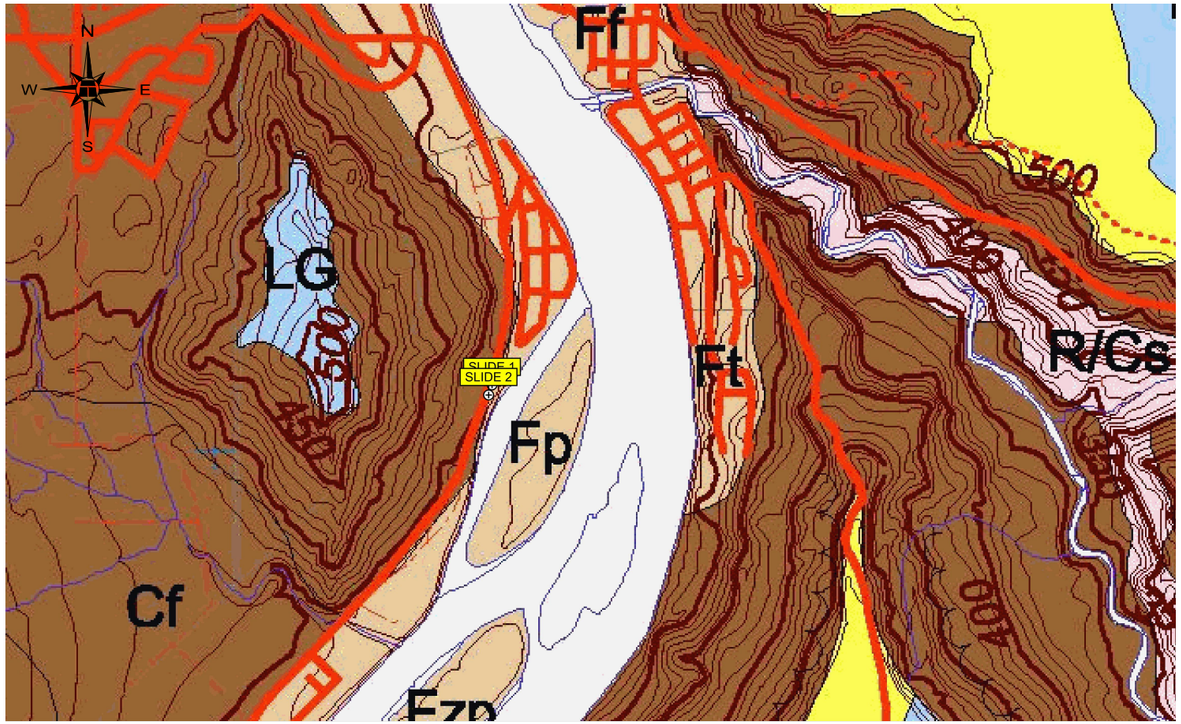
d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted 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.



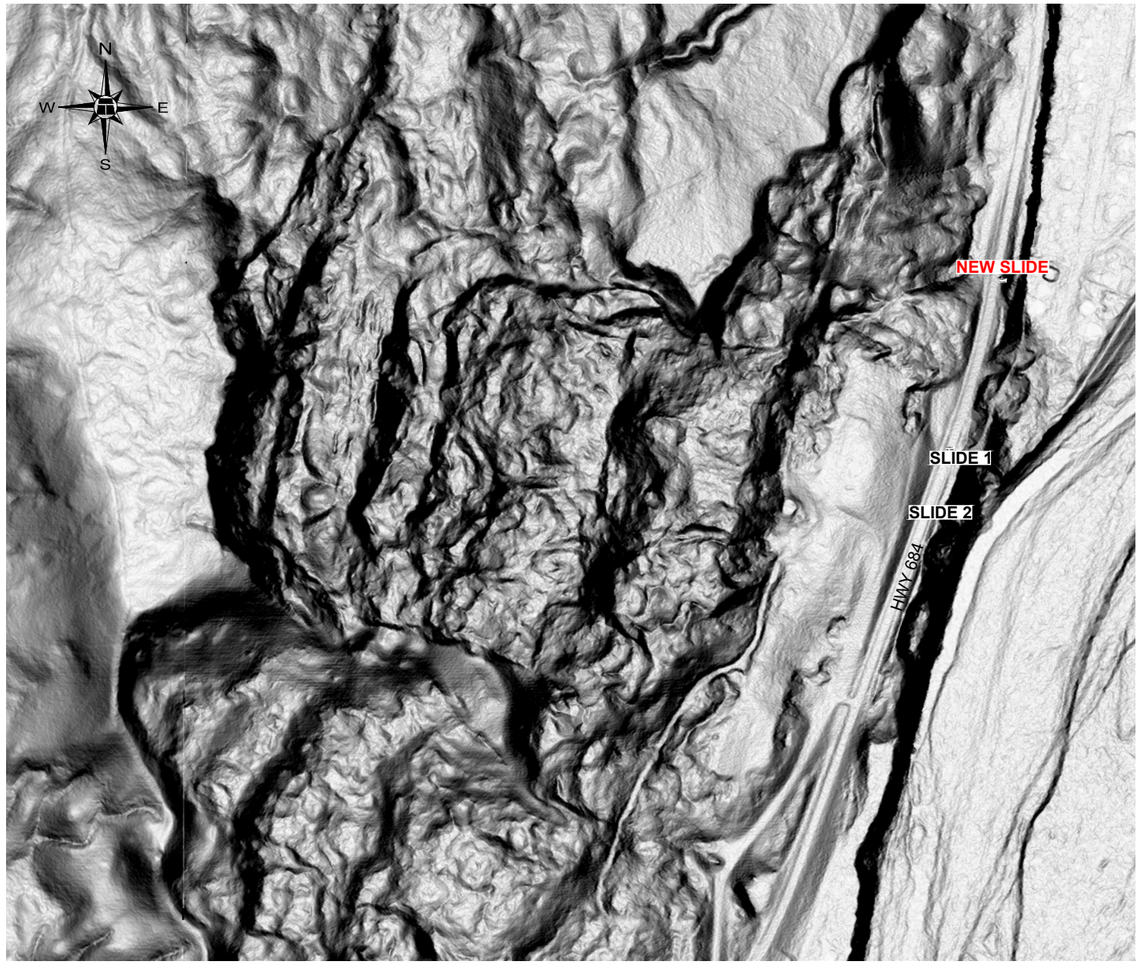
SURFICIAL GEOLOGY MAP
APPROX. SCALE 1:30000

LEGEND

- ROAD, PAVED
- FLUVIAL DEPOSITS
- AEOLIAN DEPOSITS
- COLLUVIAL DEPOSITS
- GLACIOLACUSTRINE DEPOSITS

REFERENCE:

R.C. Paulen, Map 291, Surficial Geology of the Grimshaw Area (NTS 84C/SW), 2004, Alberta Geological Survey/Alberta Energy and Utilities Board. 1:100,000 Scale.



SITE LOCATION PLAN
SCALE 1:6000

0 50 100 150 200 300 m
SCALE 1 : 6 000

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PH081-1: HWY 684:02, KM 28.4
SHAFTESBURY TRAIL NORTH SLIDES
SITE LOCATION PLAN AND SURFICIAL GEOLOGY MAP

DWG No. 32121-PH081-1-1

DRAWN BY	ML
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	SEPTEMBER 2022
FILE No.	32121

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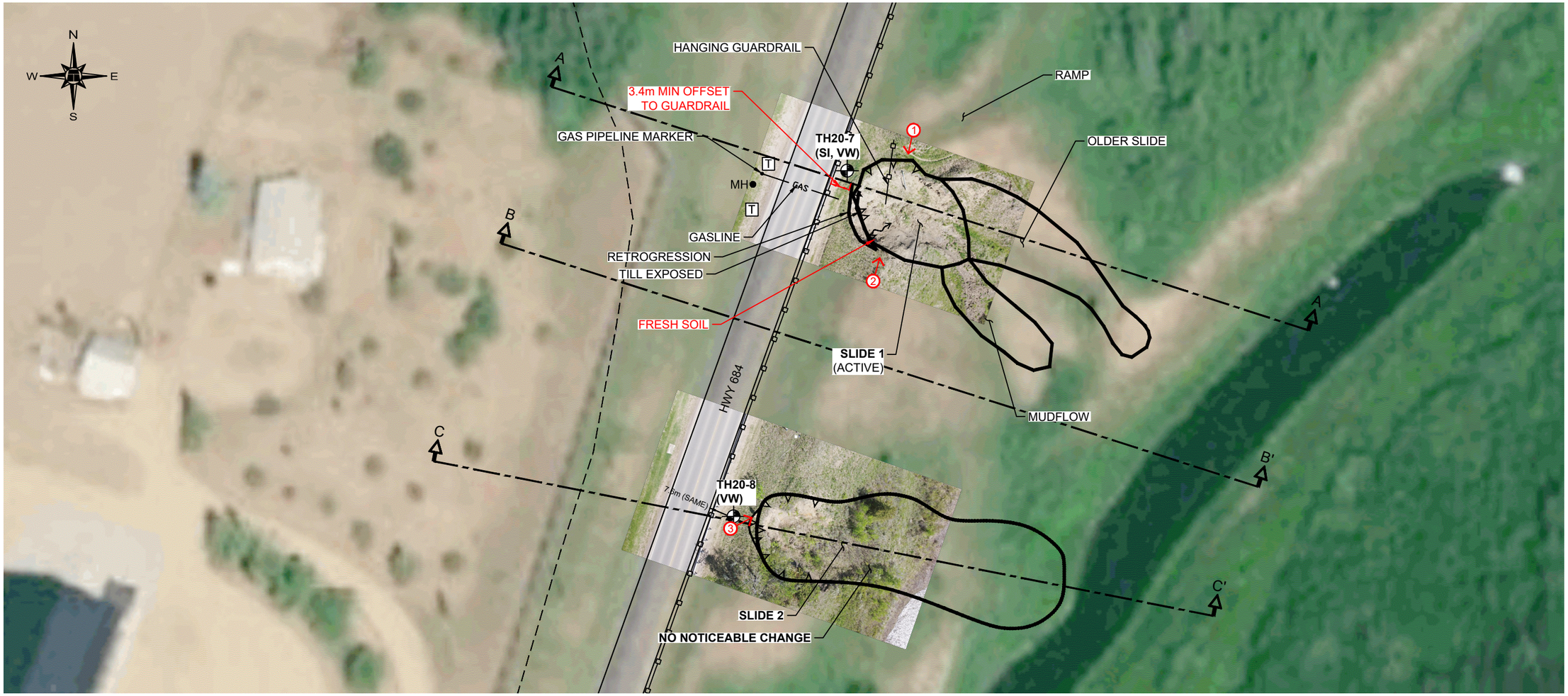

0 10 20 30 40 50m

SCALE 1:750

SATELLITE IMAGERY FROM ESRI WORLD IMAGERY (DOWNLOADED 2022-09-28)

LEGEND

- TOP OF BACKSLOPE
- GUARDRAIL
- T — TELUS PEDESTAL
- MH● — MANHOLE
- SEEPAGE
- SCARP CRACK
- DIRECTION AND NUMBER OF PHOTO
- APPROXIMATE TEST HOLE LOCATION
- SI — SLOPE INCLINOMETER
- VW — VIBRATING WIRE PIEZOMETER

NOTES :

1. FEATURE LOCATIONS ARE APPROXIMATE
2. MAY 25, 2022 OBSERVATIONS SHOWN IN RED.

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PH081-1: HWY 684:02, KM 28.4
SHAFTESBURY TRAIL NORTH SLIDES
2022 SITE INSPECTION PLAN

DWG No. 32121-PH081-1-2

DRAWN BY	ML
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:750
DATE	SEPTEMBER 2022
FILE No.	32121

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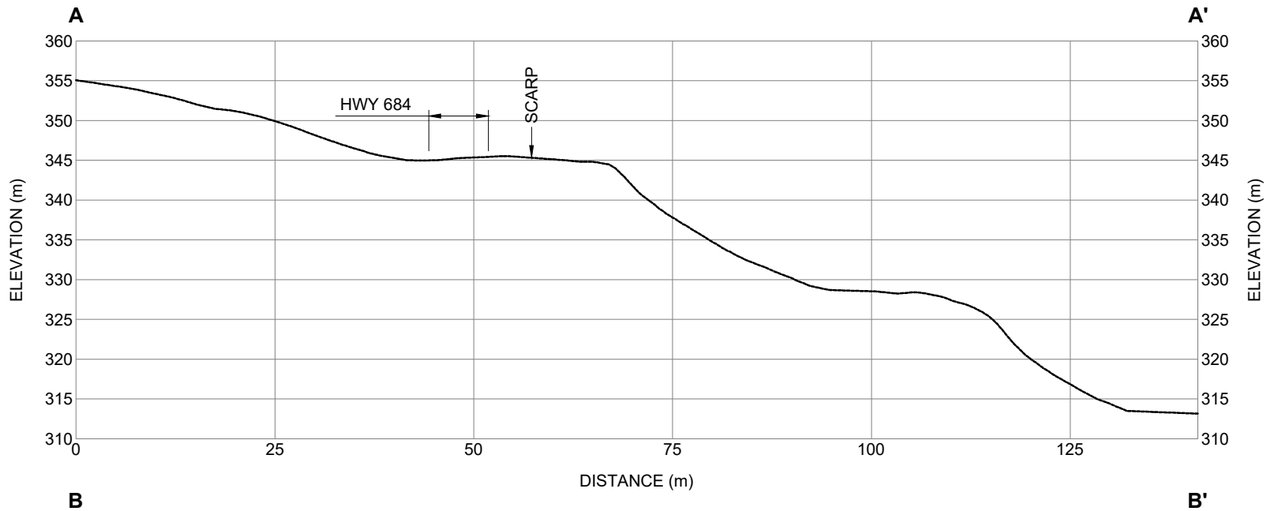

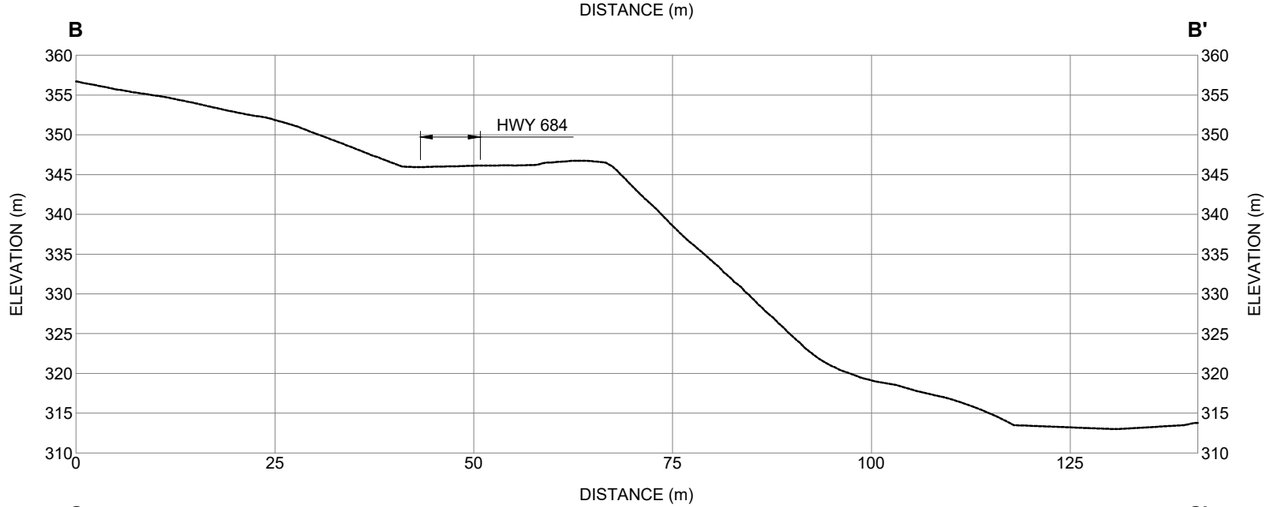

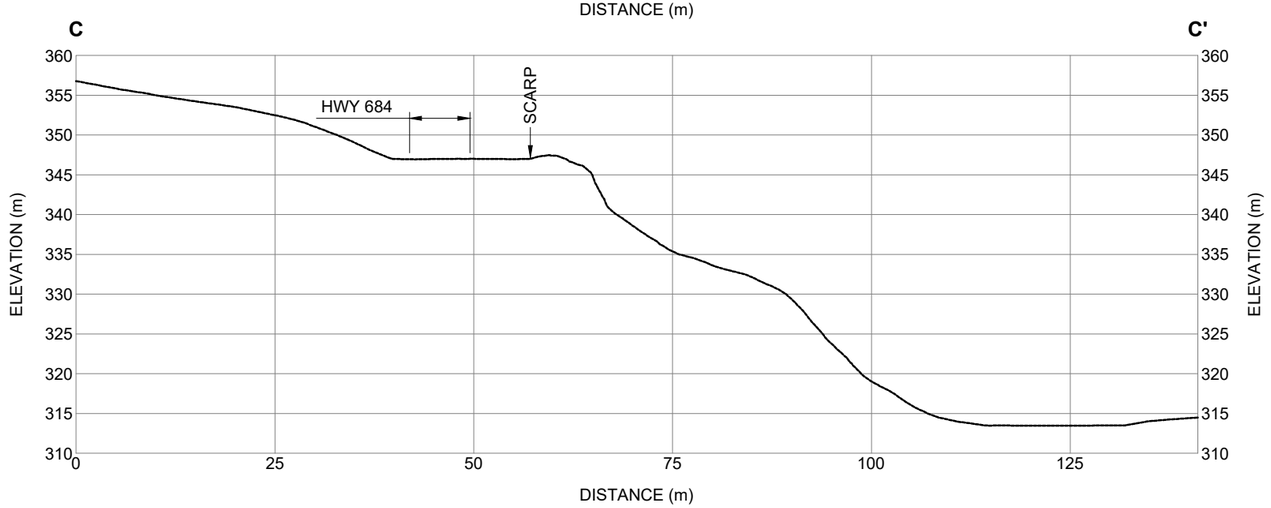

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PH081-1: HWY 684:02, KM 28.4
SHAFTESBURY TRAIL NORTH SLIDES
CROSS-SECTIONS

DWG No. 32121-PH081-1-3

DRAWN BY	ML
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:750
DATE	SEPTEMBER 2022
FILE No.	32121

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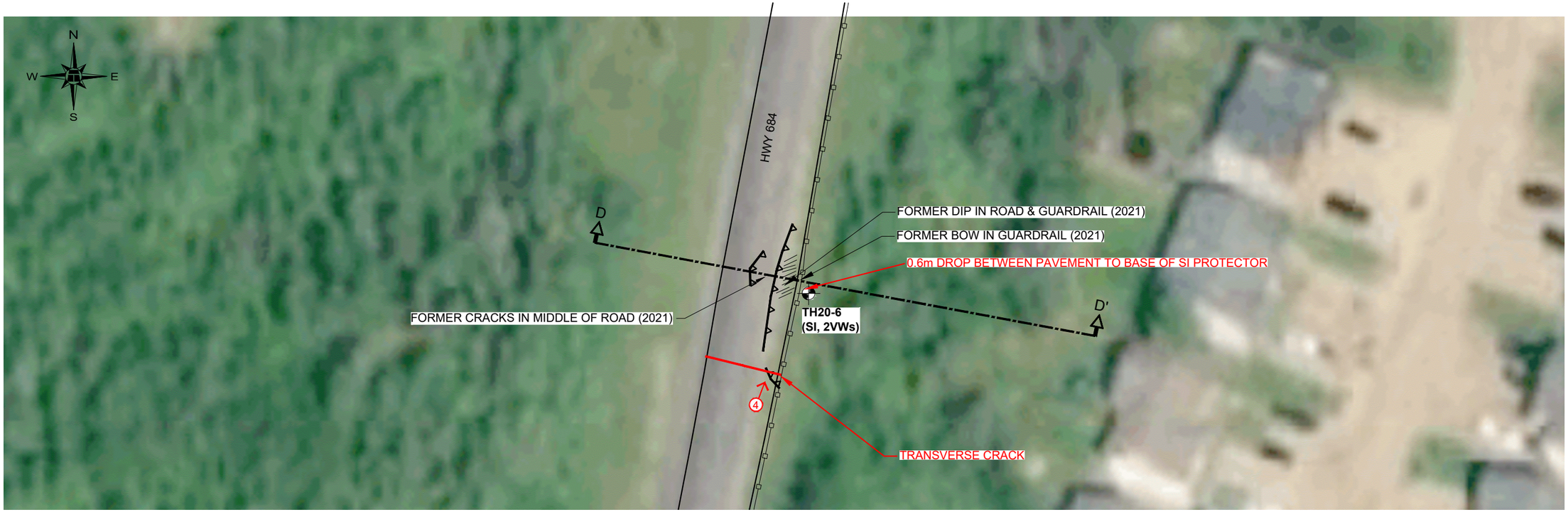
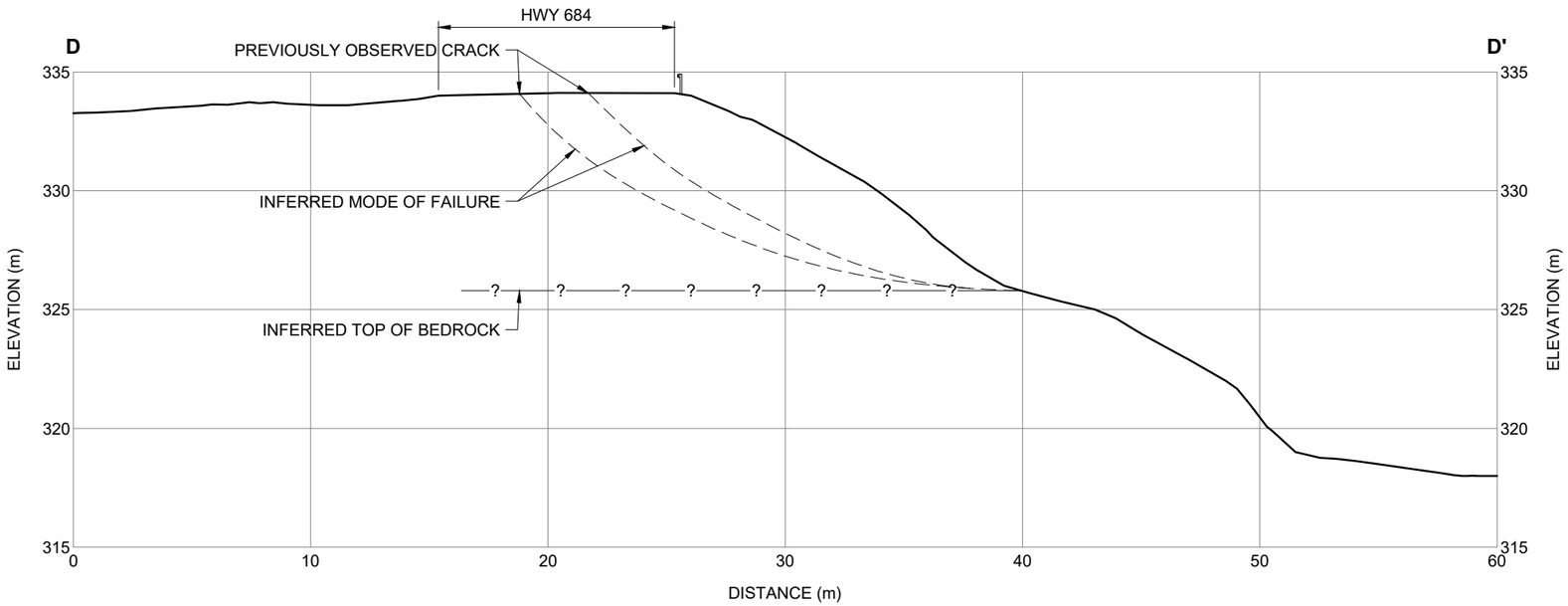


PH081-1 SITE PLAN
SCALE 1:500

0 5 10 15 20 25 30m
SCALE 1:500



SECTION D-D'
SCALE 1:250

LEGEND

- SCARP CRACK
- GUARDRAIL
- DIRECTION AND NUMBER OF PHOTO
- APPROXIMATE TEST HOLE LOCATION
- SI — SLOPE INCLINOMETER
- VW — VIBRATING WIRE PIEZOMETER

NOTES :

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SATELLITE IMAGERY FROM ESRI WORLD IMAGERY (DOWNLOADED 2022-09-28)

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PEACE REGION (PEACE RIVER DISTRICT)

PH081-1: HWY 684:02, KM 28.4
SHAFTESBURY TRAIL NORTH SLIDES
2022 SITE INSPECTION PLAN AND CROSS-SECTION

DWG No. 32121-PH081-1-4

DRAWN BY	ML
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	SEPTEMBER 2022
FILE No.	32121

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	**Photo 1.** Looking southwest from the north flank of Slide 1. Fresh soil was visible and there was minor retrogression of the south flank since 2021. Minimum offset from the main scarp to the guardrail was 3.4 m.
	**Photo 2.** Looking northeast from the south side of the main scarp of Slide 1. No major retrogression was observed on the north flank relative to the 2021 condition.

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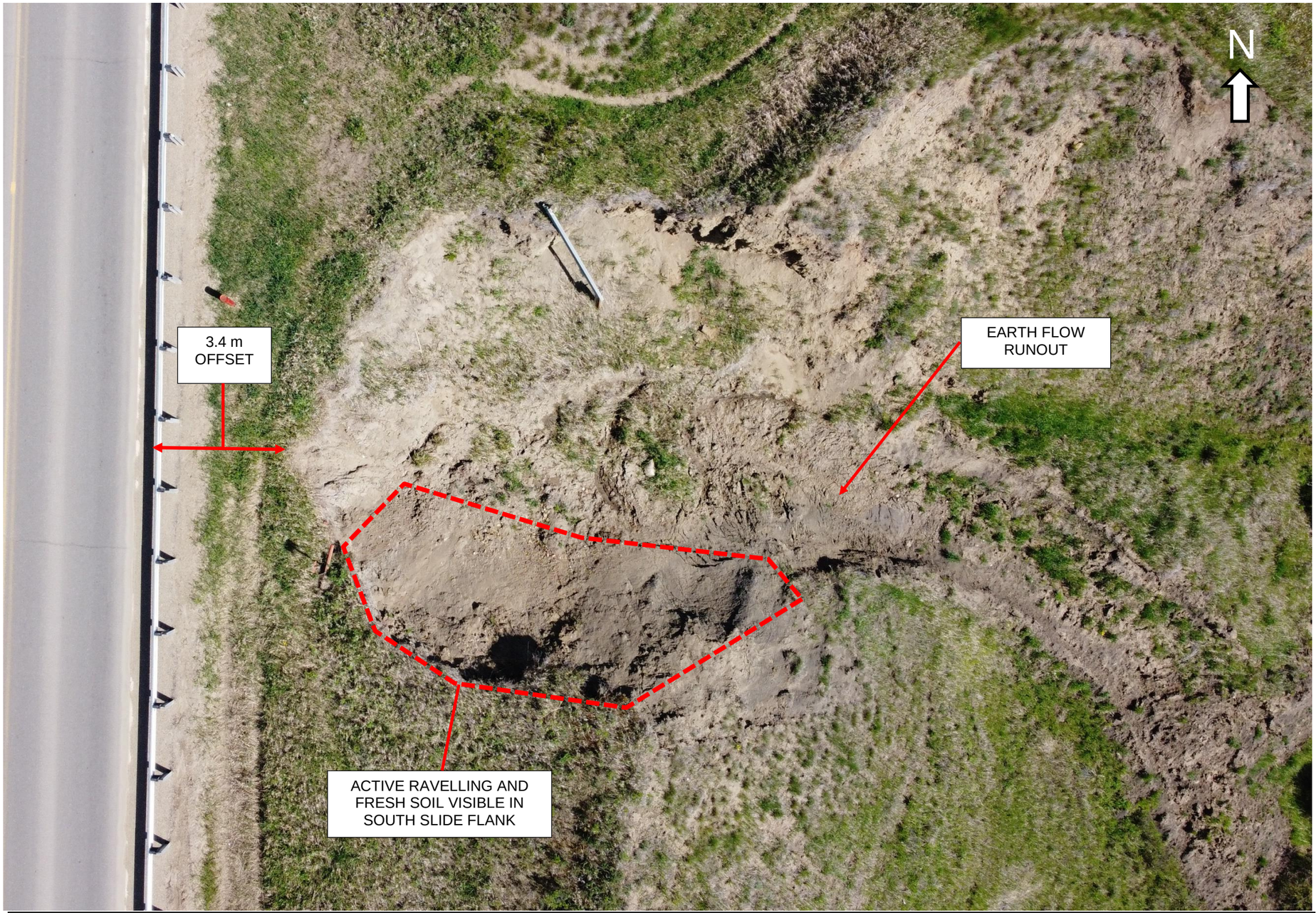
	**Photo 3.** Looking northeast from the south flank of Slide 2.
	**Photo 4.** Looking north at the slide at km 28.6. Transverse crack across the pavement is visible. No significant change relative to the 2021 condition.



PH081 - Drone Photo 1
Aerial plan view of Slide 1.

PH081 - Drone Photo 2
Aerial oblique view of Slide 1 looking towards the west.

PH081 - Drone Photo 3
Aerial plan view of Slide 2.

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PH081 - Drone Photo 4
Aerial oblique view of Slide 2 looking towards the west.