ALBERTA TRANSPORTATION AND ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2024 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
PH006-1	North of Paddle Prairie	Tompkins Landing	697:02	16.90-17.50
Legal Description		**UTM Co-ordinates**		
NW30-103-19-W5M / E25-103-20-W5M		11U E 491,100	N 6,425,466	

	Date	PF	CF	Total
Previous Inspection:	28-Apr-2022	11	4	44
Current Inspection:	30-May-2024	11	4	44
Road AADT:	270		**Year:**	2024
Inspected By:	Rocky Wang, TEC Robert Senior, TEC Paul Catt, TEC		Ken Froese, Thurber Tyler Clay, Thurber	
Report Attachments:	☐ Photographs	☑ Plans	☐ Maintenance Items	

Primary Site Issue:	Deep-seated, valley wall slope movements	
Dimensions:	490 m of highway affected by, or adjacent to, active landslide movement.	
Date of Remediation:	None	
Maintenance:	2004: Overlay of highway 2006: Silt fence repair at the west end of the site 2010: Asphalt patch over southwest portion 2015: Asphalt patch (50m long) 2017: Gravel placed along north shoulder and asphalt patch on road 2020: Asphalt patch (150t) 2021: Patching and milling at top of valley	
Observations:	**Description**	**Worsened?**
☒ Pavement Distress	Diagonal cracks and dips in the road over the slide blocks increasing in width and differential.	☒
☒ Slope Movement	Ongoing slow slope movement.	☒
☒ Erosion	Several active erosion gullies in the upslope ditch. Significant gullies forming below twin culvert outlets.	☒
☒ Seepage	Seepage previously observed from the GBC between Sta. 17+300 and 17+400.	☐
☒ Bridge/Culvert	800 mm CSP downpipe in southwest site is being pulled apart by slope movement. Adjacent 600 mm CSP centerline culvert inlet becoming obstructed, and invert badly corroded. Inlet of N 600 mm CSP culvert at 17+367 covered with dirt; inlet of S CSP badly corroded.	☒
☐ Other		☐

Instrumentation (as of Spring 2024):	
Destroyed	SI02-2, -3, -4, and -5 sheared off between 2004 and 2009. PN02-4 was destroyed in 2005 and PN02-1 in 2008 and PN02-05 in 2021. SI-1 was blocked or sheared at 3 m below ground surface in 2024.
Inclinometers	SI-5 had a movement rate of 7.7 mm/yr over 0.1 m to 11.1 m depth since the spring of 2023 readings which is consistent with the long term trend of since 1999.The movement had been slower than average until the fall of 2020. The total displacement is about 435 mm and is measured over the total depth of the inclinometer. SI-13 had a rate of movement rate of 20.4 mm/yr over 1.7 m to 14.5 m depth as compared to the overall rate of 13.1 mm/year. Since the fall of 2020, the overall rate has accelerated to 24.8 mm/yr. This accelerated movement coincides with the acceleration observed in SI-5 and an increase in the groundwater level as noted below. The total displacement is about 337 m and is measured over the total depth of the inclinometer. Based on previous instrument readings and site observations, it appears that the two operational SIs at this site were installed too shallow to intercept the main slip surface of the slide but are, nonetheless, moving significantly within the overall slide blocks.
Piezometers	The groundwater level decreased in the pneumatic piezometer PN02-3 by 0.25 m since the spring of 2023. PN02-3 had shown a trend of increasing groundwater levels since the fall of 2020 readings; however, the current readings are still within the historical range of the instrument.

Assessment:

The highway is situated on a deep-seated rotational slide extending the full height of the Peace River valley. This large-scale movement is likely based in clay shale bedrock near the bottom of the river valley with the slide initially triggered, and kept moving, by river erosion at the toe of the slope. TEC personnel have indicated that the slide seems to accelerate when river levels are low. There may also be contribution from water-bearing sand and gravel layers providing water to the slip surface further reducing the shear strength of the soils. Through this site, the depth of the shear plane seems to be 20 m or deeper with intermediate scarps creating graben features. It is anticipated that this large-scale slide will continue to move with rates dependant on seasonal rainfall and the water level in the river. As the movement is deep-seated, remediating the slide will be difficult and may be limited to controlling localized issues. The most-active movement is occurring at Sta. 17+015 where continued deformation has led to frequent milling, patching, and resulted in call-out inspections in 2022 and 2024. The undulating highway surface between this location and the ferry dock is also problematic for heavy and high loads. The pavement has continued to deteriorate with the cracks increasing in frequency, density, and width.

Erosion on the north sideslope and in the north ditch have begun to reform through frequent regrading. One of the twin culverts inlets has become buried under sediment. The functioning one is badly eroded and the gully at the outlet had become wider and deeper and is likely contributing to the development of a shallow landslide scarp along the river shoreline.

It should be noted that the SI's that can still be read likely do not extend deep enough to fully penetrate the base (main) slip surface of the landslide

Recommendations:

Short-Term:

- The gap in the 800 mm culvert should be repaired to reduce the amount of runoff into the slide mass. The culvert could be excavated and replaced; alternatively, a collar could be used to span the gap with one end not fastened to allow for future movement. The sinkhole should be backfilled with compacted low- to medium-plastic clay.
- The pair of 600 mm culverts should be replaced and the outlet(s) properly armoured to dissipate the energy from the water flow. Alternatively, the flow should be conveyed to the river edge either in a riprap channel, half-culvert, or elephant trunk with consideration given to the potential for ice damage. Ideally, the flow would be kept in the upslope ditch and managed at the flatter ground at the ferry dock but it is understood that this can lead to soft ground, icing problems, and slippery conditions during ice bridge operations.

- The erosion gullies should be regraded and protected from future erosion with armour (like riprap) or TRM until vegetation can be re-established. Note that heavy sanding on this hill during winter will limit vegetation development within 2 m of the highway.
- Routine crack sealing, milling, and patching should be undertaken, as necessary, to maintain a safe riding surface and reduce water infiltration.
- The section of the highway that spans the landslide blocks east and downhill of about Sta. 16+950 should be converted to gravel as that may be less expensive to maintain than asphalt. Once all the asphalt and GBC have been removed, the highway subgrade should be reprofiled at a lower elevation, the superelevation and crossfall fixed, and then rebuilt with surfacing gravel. This way, when further movements distort the highway, it can be regraded without having to mill or patch. It will require more frequent maintenance but should be less expensive in the long-term. Ditch repairs and linings should be carried out in combination with the highway regrading work.

Long-Term remediation options:

a) Install horizontal drains into the water-bearing sand and gravel layers. Additional drilling investigation would be required to identify the depths and extents of such layers so the drain installation could be targeted.
b) Place riprap armouring or re-directive rock vanes along the toe of the slope to reduce river erosion at the toe. It is estimated that this protection would need to be about 700 m in length to be effective. Also note that the efficacy of rock vanes in a river of this size has not been evaluated. Option b) would likely need to be completed together with Option a) to make a noticeable impact on slope stability.
c) Re-align the highway perpendicular to the slope to minimize the amount of the valley wall that is crossed and to take advantage of unloading in the upper cut section and buttressing in the lower fill section.

It is understood that there is consideration being given to constructing a bridge at this or other suitable locations in the general region of the site. As both sides of the valley have instability, the alignment of the bridge should be selected to minimize exposure to active slide movements and to facilitate perpendicular alignments up the valley slopes as a balance cut-fill alignment (where the cut unloads the upper portion of the slope and the material is placed as fill on the lower portion to buttress the slope) will have less ongoing stability issues than the current sidehill alignments. Some studies have been carried out by Others to evaluate suitable alignments for a new bridge and approach roads.

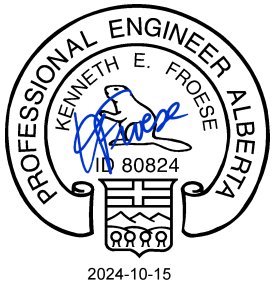
Ongoing Investigation:

- It is suggested that GeoHazard inspections be continued annually and that bi-annual instrumentation readings should continue as scheduled.
- If mitigative measures are being considered, it is recommended that additional drilling be undertaken including the installation of deep slope inclinometers (or shape accel arrays which could handle larger deformations) to confirm the depth of the main slip surface at various locations on the hillside. A shallow drilling program could be considered to delineate asphalt and gravel thickness which would assist in preparing cost estimates for construction should the road be converted to gravel. Given the frequency at which this road has been patched and milled, the asphalt thickness will be highly variable.

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, M.Eng., P.Eng.
Partner | Senior Geotechnical Engineer



PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: Don Proudfoot
RM APEGA ID #: 51674
DATE: October 15, 2024
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Ken Froese, P.Eng.
Associate | Senior 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.

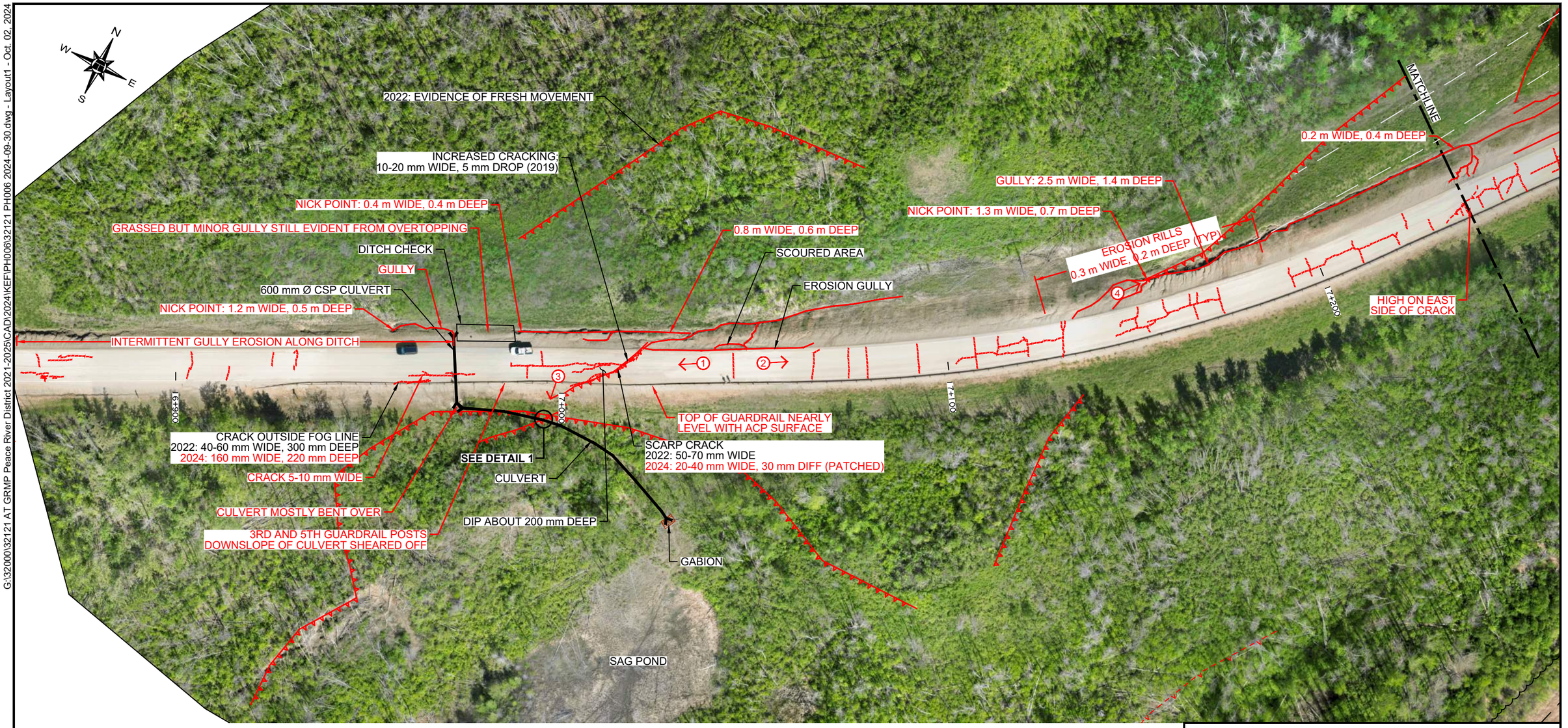
d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted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

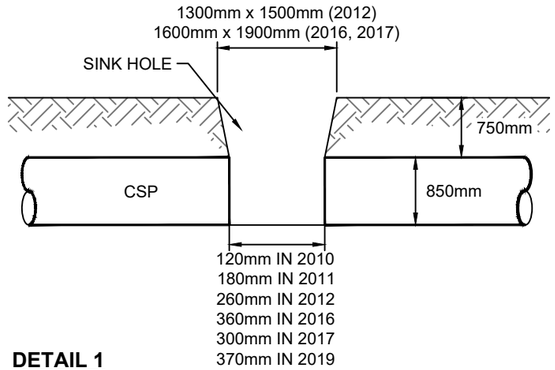
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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.





DETAIL 1
1:75

LEGEND

- SCARP
- POTENTIAL SCARP
- CRACK
- ① DIRECTION AND NUMBER OF PHOTO

NOTES:

1. CRACK PATTERN RESET IN 2024 USING NEW ORTHOMOSAIC. CONSULT 2022 CALL-OUT DRAWINGS FOR HISTORICAL INFORMATION
2. FEATURE LOCATIONS ARE APPROXIMATE
3. PREVIOUS OBSERVATIONS (WHERE RETAINED) ARE SHOWN IN BLACK
4. MAY 2024 OBSERVATIONS SHOWN IN RED.
5. 2024 ORTHOMOSAIC DERIVED FROM UAV IMAGERY FLOWN BY THURBER IN MAY 2024

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

Alberta

PEACE REGION (PEACE RIVER/HIGH LEVEL)

PH006-1: HWY 697:02 - TOMPKINS LANDING SLIDE

DWG No. 32121-PH006-1-1

DRAWN BY	KLP
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:1000
DATE	AUGUST 2024
FILE No.	32121

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LEGEND

- SCARP
- POTENTIAL SCARP
- CRACK
- APPROXIMATE INSTRUMENT LOCATION
- (SI) SLOPE INCLINOMETER
- (PN) PNEUMATIC PIEZOMETER
- DIRECTION AND NUMBER OF PHOTO

NOTES:

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OLD HIGHWAY ALIGNMENT
PADDLE PRAIRIE SIGN
DITCH CHECK
SI-1
GULLY
PN02-3
START OF DITCH REGRADING
MATCHLINE
0.2 m WIDE, 0.4 m DEEP
ALLIGATOR CRACKING
30 mm WIDE
PN02-5
SI-5
SI-13
HIGH ON EAST SIDE OF CRACK
TWIN CULVERTS: ONLY ONE CULVERT INLET VISIBLE, BADLY CORRODED
GULLY: 0.8 m WIDE, 1 m DEEP
CRACK: 150 mm WIDE AND INFILLED WITH GRAVEL; HIGHER ON SOUTH SIDE
17+500
17+400
17+300
17+200
FERRY DOCK
TREE LINE
SHORE LINE
WATER LINE
PEACE RIVER

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

Alberta

PEACE REGION (PEACE RIVER/HIGH LEVEL)

PH006-1: HWY 697:02 - TOMPKINS LANDING SLIDE

DWG No. 32121-PH006-1-2

DRAWN BY	KLP
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	1:1000
DATE	AUGUST 2024
FILE No.	32121

THURBER ENGINEERING LTD.

Photo 1 – Looking west at the main scarp crack near the top of the valley at Sta. 17+015.

Photo 2 – Looking northeast at dips in the road (yellow arrow and red arrow).

Photo 3 – Sinkhole at separated 800 mm CSP downpipe south of the highway.

Photo 4 – Looking northeast at deep erosion gully in upslope ditch.

Photo 5 – Diagonal crack across the highway at Sta. 17+240.

Photo 6 – Looking northeast across the diagonal crack from Photo 5 at another dip in the highway (red arrow).

Photo 7 – Looking northwest at the partially visible inlet of only one of the twin culverts.

Photo 8 – Looking southwest at accumulating sediment at bottom of valley.

Photo 9 – Cracks on highway near bottom of valley.

Photo 10 – Looking northeast at cracks on the highway and recent regrading on the upslope side.

Photo 11 – Looking south at slope with ongoing movement in the northeast portion of the site. Much of this vegetation has regrown since it was destroyed by flooding in Spring 2018.

Photo 12 – Erosion gully forming on downslope side of highway at outlet of twin culverts.