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

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
PH060	East Hill	35+680 to 36+180 Site 3	2:60	35.95
Legal Description		**UTM Co-ordinates**		
W28 & E29-083-21 W5M		11V E 483450	N 6231395	

	Date	PF	CF	Total
Previous Inspection:	9-Jun-2020	13	4	52
Current Inspection:	25-May-2022	13	4	52
Road WAADT:	3990		**Year:**	2021
Inspected By:	Ed Szmata, TRANS Roger Skirrow, TRANS Max Shannon, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
Report Attachments:	☑ Photographs ☑ Plans		☐ Maintenance Items	

Primary Site Issue:	Large landslide referred to as Site 3 previously encompassed highway in the 1980s. The upslope area was mitigated by major crest unloading. Mitigated downslope of roadway by the construction of large toe berms. The area is still potentially unstable and ongoing shallow and deep-seated movements are occurring on the downslope side. The shallow slump (first observed in 2013) upslope of highway at 35+900 continues to slowly retrogress. Deep active gully erosion and headcutting is also occurring within engineered berm below roadway which is progressing slowly towards roadway. In 2016 a shallow landslide developed on the northeast facing backslope within a through-cut area at 35+835. Large slide movement and earth flow activity occurred in Spring 2016 between 35+700 to 35+900 approximately 150 m to 200 m below the roadway. The debris from these mass movements partially blocked the Heart River.	
Dimensions:	Site 3 is 350 m wide; extends 200 m upslope of the roadway to just below the crest of the valley and between 200 m and 450 m downslope of the roadway to the Heart River. The 2013 shallow slump at 35+900 is 35 m wide and developed 100 m from the roadway. The new shallow landslide at 35+835 was 30 m wide at the main scarp and 40 m long extending to the south roadway ditch. The earth flow within the gully at 35+700 affects an area approximately 70 m wide (note there are two gully head sources) and 180 m long. The composite slide/flow at 35+900 is approximately 65 m wide and 165 m long with an exposed main scarp several meters high.	
Maintenance:	No maintenance activity since 2011.	
Observations:	**Description**	**Worsened?**
☐ Pavement Distress		☐

☑ Slope Movement	Retrogressive slumping along Heart River is actively continuing, which encompasses the lower portions of the large toe berm constructed downslope of the roadway to stabilize the initial landslide in this area. Areas have ongoing movement and erosion with some minor retrogression/lateral expansion of the main 2016 slide area which is offset approximately 180 m from highway (Photo 60-04). Overgrown scarp near 35+750 shows no sign of recent movement. Shallow slide/flow on the backslope at 35+830 has further movement with a 3 m backscarp and toe that partially encroaches into the ditch (Photo 60-05). Slide has formed off the erosion gully to the east near 35+650 (partially into the PH059 site extents) (Photo 60-03).	☑
☑ Erosion	Ongoing erosion at the culvert outlet and gullying immediately below roadway at 35+700 where there is active slumping on the gully walls (Photos 60-02). A 2.7 m drop has formed in the erosion gully offset approximately 28 m from the highway. The erosion and gullying significantly expands approximately 125 m downslope of the highway where trees and thicker vegetation becomes sparse. Increased gully incision and ongoing erosion of the flanks (Photo 60-03). Minor ditch erosion is ongoing on both sides of the roadway between 35+850 and 36+000. At 36+050, active gully erosion is ongoing on the upper portion of the toe berm below the roadway (Photo 60-06). Erosion extends into the north ditch and is up to 0.6 m wide and 0.6 m deep.	☑
☐ Seepage		☐
☑ Bridge/Culvert Distress	Erosion ongoing at culvert outlet at 35+700 which is believed to be at least partially blocked (Photo 60-01). Scour depth beneath the bottom of the culvert outlet is 0.7 m.	☐
☐ Other		☐

Instrumentation:

SI12 - No discernible movement.

SI13 – Creep (0.5 mm/yr) over 2.2 m to 4.7 m depth since the fall of 2021 readings.

SI88 - No discernible movement.

SI89 – Sheared at 12.8 m below top of casing as of Spring 2021

SI91 – Sheared at 13.1 m below top of casing as of Spring 2019

Assessment:

Small deep-seated movements are occurring within the fill embankment downslope of roadway indicating low Factors of Safety. The Spring 2019 instrument readings indicate an accelerating trend of annual movement rate since 2016 from an average of approximately 7 mm/yr between the years 2013 to 2016 to approximately 10 mm/yr since 2017 at SI 89. Prior to 2016, the average annual movement rate was approximately 3 to 4 mm/yr (not including initial movement picked up within the same year following the SI installation in 1996). SI 91, located in the base of the valley slope was sheared off at 13.1 m depth in the recent Spring 2019 readings. SI89 was found sheared in the Spring 2021 readings located in the upper valley slope above the erosion gully at KM 36+050. Surficial observations of active movement have not been observed in these areas, likely due to the relatively small magnitude, but the risk level for this site has been adjusted accordingly due to the concerning trend of increased movement rates. A significant volume of material has been displaced from the valley toe in localized areas due to gullying and mass soil flow events and could be a factor in this trend. The movement leading to shearing at SI 89 may be driven by a loss of toe material at the erosion gully to the south.

In general, the shallow slumping upslope of roadway is active but currently has limited to no effect the highway.

The landslide within the backslope at 35+835 is part of backslope and ditch repair work that has been completed along east hill in the summer of 2022.

The mass movement near the valley base below 35+900 is expected to retrogress upslope and could cause instabilities that could potentially impact the highway in the future as toe support is lost. No slope instrumentation exists above this area to monitor potential impacts to the highway if movement were to occur.

The erosion gullies at 36+075 and 35+700 do not threaten the highway in their current state but a drainage structure (e.g. trunk drain) should be considered in the next 5 to 10 years to reduce rate of retrogression.

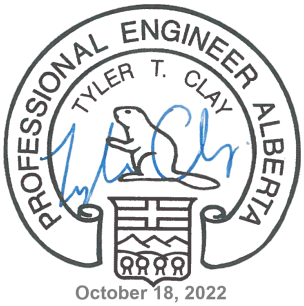
The erosion gully near the culvert outlet at 35+675 should be graded and armored to reduce the rate of the gully headcutting further towards the highway and causing further damage. The culvert here should also be relined or replaced.

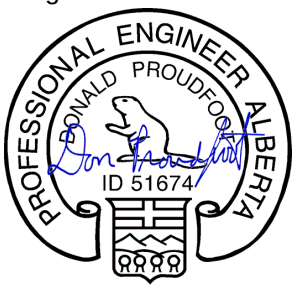
Recommendations:	**Cost**
Continue to monitor instruments twice yearly and undertake annual inspections.	
Consider redirecting surface runoff further downslope of headcutting/gullying that is occurring at 36+000 and 35+700. The upper erosion gully at 35+675 should be graded and armored with rock riprap or gabion mattress. South ditch repairs and armoring up to the gully headwall should also be carried out between 35+900 to 36+025.	$200,000

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

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.

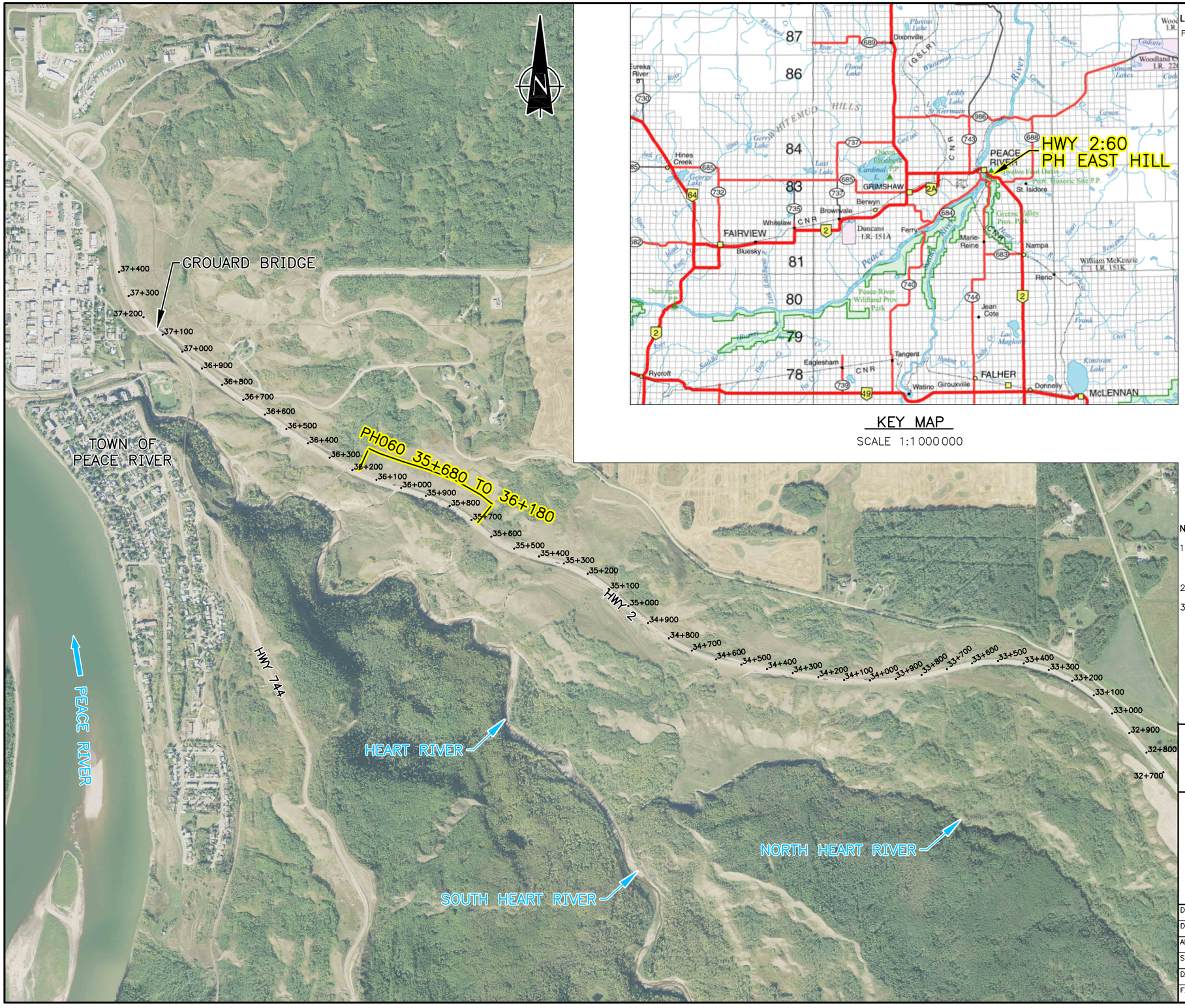
d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted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



KEY MAP

SCALE 1:1 000 000

LEGEND:

PH060 EXTENT

NOTES:

1 DRAWING MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 32121 DATED OCTOBER 2022 AND IS SUBJECT TO THE STATEMENT OF LIMITATIONS AND CONDITIONS INCLUDED IN THE REPORT.

2 AIR PHOTO BASE FROM TARIN RESOURCE SERVICES LTD. 0.4 m/PIXEL (2012).

3 CHAINAGE SHOWN ARE APPROXIMATE ONLY.

0 0.1 0.2 0.3 0.4 0.5 1.0 km

Alberta Transportation

PEACE REGION (PEACE RIVER DISTRICT)

PEACE RIVER EAST HILL
HWY 2:60 (PH060)
KEY MAP

FIGURE PH060-1

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:15 000
DATE	OCTOBER 13, 2022
FILE No.	32121–A6C

THURBER ENGINEERING LTD.

PH061 36+180 TO 37+130

36+800

HWY 2

36+700

36+600

36+500

SHARP DROP OFF AT EDGE OF ACP

61-02

36+400

EROSION RILL

61-03

61-01

2016 SLIDE

DITCH EROSION
(VARIES 0.6 m D x 0.3 m W
TO 0.3 m D x 0.6 m W)

2013 SLIDE

36+300

RILL EROSION

NEW SHALLOW SLUMP

TOP OF GULLYING
INLET OF CSP
PURPOSELY BLOCKED

61-06

2009 ELEPHANT
TRUNK DRAIN

BEDROCK EXPOSED

61-07

RIVER CHANNEL
NO LONGER AT TOE

61-08

SLIDE TOE
IN DITCH

SI 89 (SHEARED 2021)

2016 EARTH FLOW
BASE OF GULLY
(ACTIVE)

60-06

SI 13

SI 88

SI 12

TOP OF GULLYING

60-05

TOP OF GULLYING
(2.7 m DROP)

ACTIVE SCARP

TOP OF SCARP

2016 SLIDE AREA
(APPROXIMATE EXTENT)

SI 91 (SHEARED 2018)

60-04

PH060 35+680 TO 36+180

SITE 3

36+200

36+100

36+000

DITCH EROSION

35+900

2016 SLIDE
(MORE MOVEMENT)

35+800

60-05

DITCH EROSION

35+700

59-02

60-01

60-02

35+600

CULVERT INLET BLOCKED

REPAIRED DITCH WITH RIP

PH059 34+770 TO

DITCH E

35+500

700 CSP

35+400

HWY 2

35+300

CULVERT INLET

GABION CULVERT OUTLET

60-03

DITCH EROSION

59-04

35+200

SI 67

ACTIVE EROSION
GULLY AND SLIDING

SI 81

SI 75

SI 69

800 CS

FLANK OF OLD SCARP

59-05

SI 82 (SHEARED 2012)

59-06

PN/SP 004

ACTIVE EROSION GULLY
AND SLIDE AREA

300 CSP VERTICAL

ACTIVE GULLYING EROSION

HEART RIVER

LARGE SCARP FEATURE

1.3m WIDE X 0.7m DEEP

SCA

LEGEND:

- HORIZONTAL CHAINAGE (37+130 GROUARD BRIDGE) — 35+900
- PHOTOGRAPH LOCATION — 41-01
- SLOPE INCLINOMETER
  - NO MOVEMENT — SI 64
  - CREEP — SI 32
  - MEASURABLE MOVEMENT (OR RECENTLY SHEARED) — SI 82
- PIEZOMETER — PN 004
- PH060 EXTENT

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2 PHOTO BASE IMAGE COMBINED FROM 2012 AIR PHOTO (TARIN RESOURCES SERVICES LTD.), THURBER DRONE IMAGERY (2022), MACINTOSH PERRY DRONE SURVEY (2022).

3 SLIDE FEATURES, PHOTOGRAPHS AND CHAINANGE ARE SHOWN APPROXIMATE ONLY.

0 50 100 150 200 250 m

Alberta Transportation

PEACE REGION (PEACE RIVER DISTRICT)

PEACE RIVER EAST HILL
HWY 2:60 (PH060) STA. 35+680 TO 36+180
LOCATION PLAN

FIGURE PH060-2

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:5 000
DATE	OCTOBER 13, 2022
FILE No.	32121-A7C

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	**Photo 60-01.** Close-up of hanging culvert outlet (35+700). Ongoing erosion below culvert and rilling above. Rill erosion slightly deeper but no major change from the 2020 condition. Scour depth below culvert inlet was 0.7 m.
	**Photo 60-02.** Looking downslope at erosional gullying below culvert shown in Photo 60-01 (35+700). Active slumping on gully walls. Worse from the 2020 condition.

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	**Photo 60-03.** Overhead drone image of gully and slide area below the culvert outlet at 35+700, offset approximately 125 m from the highway. Mass movement occurred in 2016, increased gully incision, ongoing erosion of the flanks and further retrogression of slide on the right (east) side. Gully sidewalls are intermittently stable.
	**Photo 60-04.** Overhead drone image of a major slide/earth flow that occurred in 2016. Ongoing erosion of exposed scarp but overall minor retrogression since that time. Slide area is offset approximately 180 m from the highway (35+950).

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	**Photo 60-05.** Shallow slide/flow within through-cut area on the south cut slope (35+830). First observed in 2016, further displacement of the slide mass since 2020. Backscarp is now 3 m high and the slide toe is partially blocking the ditch.
	**Photo 60-06.** Headcutting and erosional gullying occurring below roadway (36+050).