ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – HIGH LEVEL
2020 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
PH006-1	North of Paddle Prairie	Tompkins Landing	697:02	16.97-17.62
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:	16-May-2019	10	4	40
Current Inspection:	5-Jun-2020	10	4	40
Road AADT:	290		**Year:**	2020
Inspected By:	Rocky Wang, TRANS Ed Szmata, TRANS		Ken Froese, 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 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: 150t patching planned	
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. Skin slide formed in 2020 below twin culvert outlets	☑
☑ Seepage	Seepage observed from the GBC between Sta. 17+300 and 17+400	☐
☑ Bridge/Culvert Distress	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+400 covered with dirt; inlet of S CSP badly corroded.	☑
☐ Other		☐
Instrumentation (as of Fall 2020):		
Destroyed	SI02-2, -3, -4, and -5 sheared off between 2004 and 2009. PN02-4 was destroyed in 2005 and PN02-1 in 2008.	
Inclinometers	SI-1 has not shown a discernable movement pattern; SI-5 has cumulative movements of 77 mm in the upper 4 m and 315 mm below that depth. The corresponding average rates of movement since 2007 are 2.4 mm/year and 7.5 mm/year but current rates have accelerated to 11 mm/yr and 34 mm/yr, respectively.	

	Movement rates in SI-12 have also accelerated in 2020. The 7 m zone is currently moving at 11 mm/year (cumulative displacement of 52 mm) compared to the average rate of 1.5 mm/year since 2007; the 12 m zone is currently moving at 4 mm/year (cumulative displacement of 14 mm) compared to the average rate of 0.4 mm/year since 2007. SI-13 had a relative steady movement rate of about 10.2 mm/yr since 2007 over the 2 m to 15 m depth interval (tends to accelerate in the summer and slow over the winter); however, the current movement rate has accelerated to 65 mm/year and the cumulative movement is about 248 mm.
Piezometers	PN02-3 has shown a slightly decreasing trend since 2012 but mostly stable at the current water level at 7.3 m below ground. PN02-5 has varied somewhat over the last few years but increased significantly in Spring 2020 to a water level of 11.0 m below ground surface before it was damaged (lawn mower) by the Fall 2020 readings.

Assessment:

It appears that 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. Alberta Transportation 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. As shown on the drawing, there continues to be ongoing deterioration of the site. Erosion on the north sideslope and in the north ditch have begun to reform through the recently-placed gravel fill. A sinkhole is forming over one of the culverts at Sta. 17+400. There is general deterioration of the site and increasing undulation of the pavement surface. As there was little maintenance done in 2019, the crack patterns increased in length and width and additional gullies have formed in the ditches and on the sideslopes.

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 inlets of the pair 600 mm culverts should be uncovered, and the ditch regraded to ensure proper flow. This pipe should be lined and grouted (or excavated and replaced) to stop the piping that has created the sinkhole. The outlets should also be exposed, and the surrounding ditch regraded to limit the potential for future obstruction.
- 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.

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.

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.

These options are relatively expensive, and the economical option may be to continue with routine maintenance with consideration given to vertical grade adjustments when distortions warrant. Light-weight fill could be considered to reduce some of the driving force; however, the impact may not be worth the cost nor the future difficultly with regrading as the light-weight would limit the depth to which grade adjustments could be made.

It is understood that there is consideration being given to constructing a bridge at this location. As both sides of the valley have significant 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.

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.

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LEGEND

- SLOPE INCLINOMETER INSTALLED BEFORE 2002
- (10) DEPTH OF MOVEMENT (m) AND DIRECTION
- SLOPE INCLINOMETER INSTALLED IN 2002 BY AMEC
- SLOPE INCLINOMETERS (not in use)
- (1) DIRECTION AND NUMBER OF PHOTO

SEDIMENT

(DITCH EROSION (2m FROM MAX 80 SIGN)
300-500mm WIDE, 300mm DEEP (2018)
300-500mm WIDE , 500mm DEEP (2019)
600mm WIDE, 550mm DEEP (2020)

17+600

17+643

TOMPKINS FERRY LANDING

APPROXIMATE SPRING 2020 HIGH WATER LINE (TYP)

OLD HIGHWAY ALIGNMENT

GRAVEL PLACED WITH DOZER

2006 SCARPS

GRABEN

APPROXIMATE SPRING 2018 HIGH WATER MARK

EROSION

0.5m SCARP

HWY 697:02

17+500

1.8m HIGH (POSSIBLY FRESH)

INLET CORRODED AND COVERED WITH DIRT COMPLETELY COVERED (2018)
NORTH PIPE INLET BURIED, SOUTH INLET OPEN BUT BADLY ERODED (2019-2020)

9m LENGTH OF CRACKS: COVERED BY ROAD GRAVEL (2016)

2019:200mm WIDE, 150mm DEEP
2020: 300-500mm WIDE, 250mm DEEP

RUNNING WATER

SLOPE

SEDIMENT ACCUMULATED IN DITCH; SOME VEGETATION GROWING (2019)

BERM (DITCH BLOCK)

0.5m SCARP

CRACK WIDTH:
25mm (2009); 35mm (2010)
40-50mm (2011); 90mm (2012)
60-90mm (2016);
60-150mm (2017)
40-100mm (2019-2020)

20-40mm WIDE

PADDLE PRAIRIE SIGN

ONGOING SLOW MOVEMENT

ACCUMULATED SEDIMENT

0.7m Ø SINKHOLE, 0.1m DEEP (PATCHED 2017)

EROSION CHANNEL UP TO 350mm DEEP (2016)
REFORMED (2018)
PARTIALLY REGRADED (2020)

SI02-3 (22)

SI-1

SI-10

DIP IN THE ROAD MORE PRONOUNCED (2010, 2011);
20mm DEEP RUT AND ALLIGATOR CRACKING IN WBL OUTER WHEEL PATH;
50mm IN 2019 AND CRACKING WORSE

SI-5

12

600mmØ CSP CULVERTS;
OUTLETS 300mm BELOW DITCH LINE;
OUTLETS ¼ FULL OF SILT (2016); ½ FULL (2019)

ALLIGATOR CRACKS AND RUTS IN OUTSIDE WHEEL PATH

SKIN SLIDE FORMED BELOW CULVERT OUTLET

PONDED WATER (2010)
MOIST BUT NO PONDED WATER (2011, 2012); DRY (2016)

SEDIMENT

SI-12

SI-3

SI-6

TOO SHORT

SI-4

EROSION GULLY

GRABEN

SEEPAGE FROM GBC

SI-2

SI02-5 (18)

CRACKS ALONG SHOULDER

RUT WITH ALLIGATOR CRACK

2017 PATCH

SI-7

SI02-6

SLOW ACTIVE MOVEMENT

SIGNS OF RECENT MOVEMENT OBSERVED ALONG THE SCARP (AGAIN IN 2017)

ACP CRACK NOT VISIBLE IN 2011-2012

PEACE RIVER

MATCHLINE

200mm WIDE, 400mm DEEP

SI-13

(14) TOO SHORT

ALLIGATOR CRACKING

SI02-1 (DESTROYED)

(15)

CRACK

HIGH SPOT OF HUMP

SI02-4

(13)

FLOW

GULLY 700mm WIDE, 500mm DEEP

17+300

TILTED TREES

ADDITIONAL CRACKING

DITCH EROSION

DIP

EROSION GULLY (WELL VEGETATED)

ACP RUTTING AND ALLIGATOR CRACKING

0.3m DEEP (2018)
0.4m DEEP (2019)

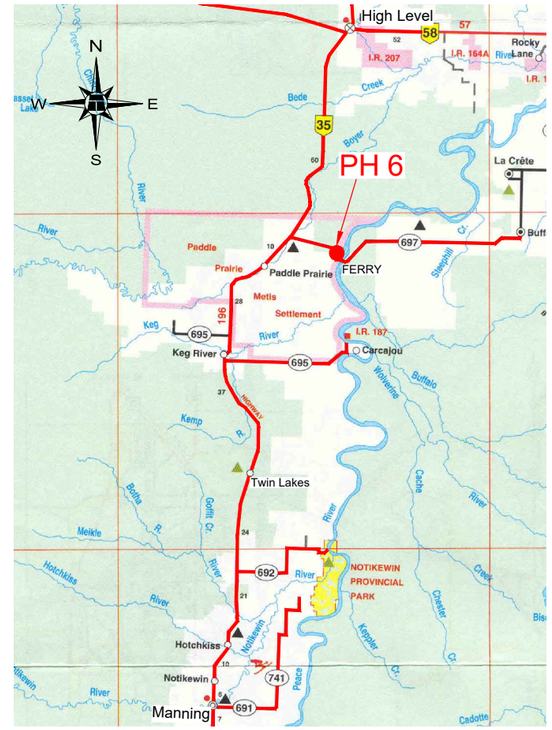
SLIDE BLOCK

TOE ROLLS

0 20 40 60 80 m

SCALE 1:1500

SITE PLAN
1:1500



SITE PLAN
1:1500

NOTES:

1. BASE PLAN COPIED FROM AMEC DRAWING (FIGURE 1 - PROJECT EG08628.33 DATED JUN. 2003)
2. SLOPE INCLINOMETERS SI's 3, 7, 10, 11 AND SI02-6 WERE DESTROYED
3. FEATURE LOCATIONS ARE APPROXIMATE.
4. PREVIOUS OBSERVATIONS SHOWN IN BLACK
5. JUNE 2020 OBSERVATIONS SHOWN IN RED
6. SI's THAT REMAIN OPERATIONAL ARE SI-1, -5, -12, AND -13

Alberta

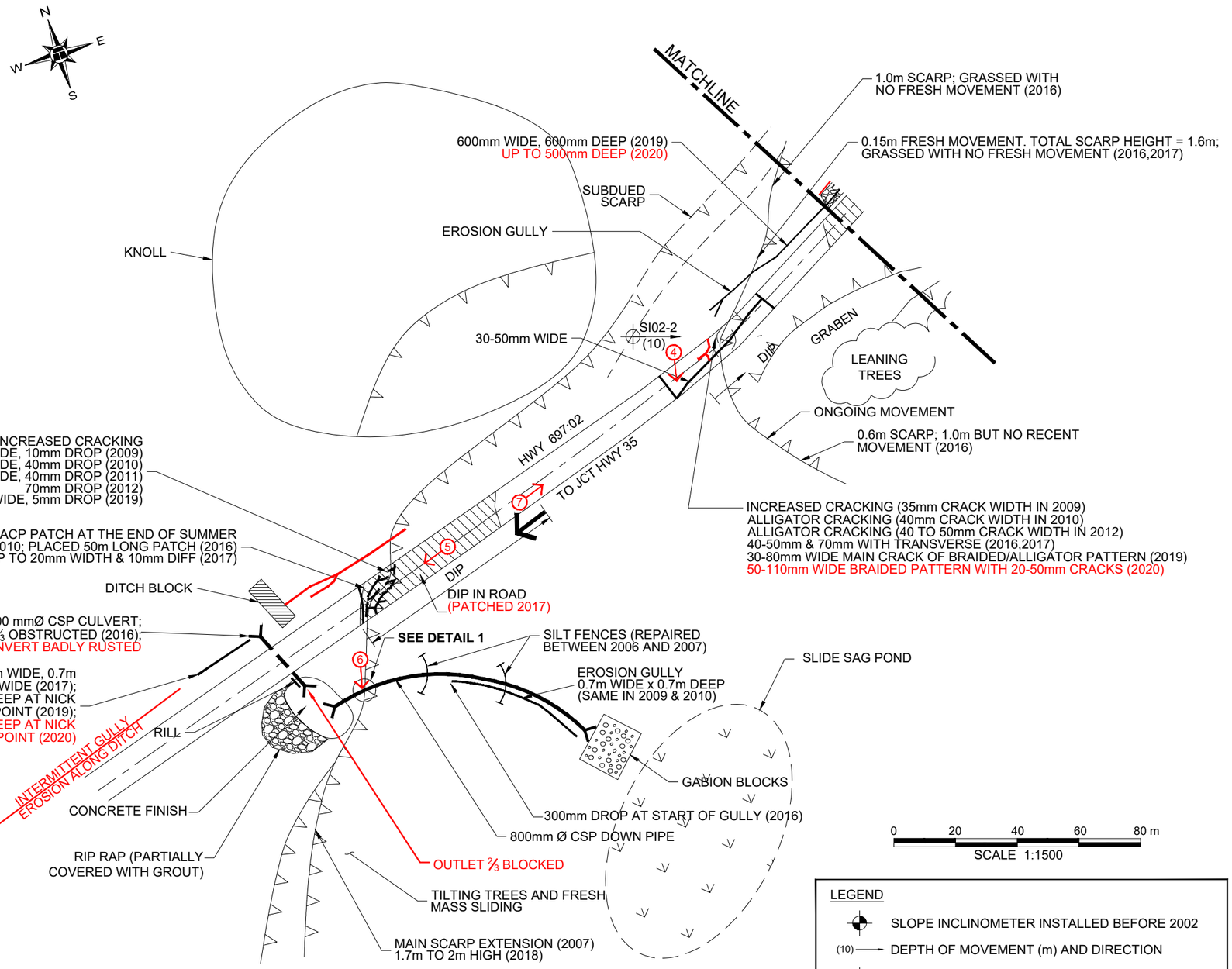
PEACE REGION (PEACE RIVER / HIGH LEVEL)

PH006-1: HWY 697:02 - TOMPKINS LANDING SLIDE 2020 GEOHAZARD ASSESSMENT

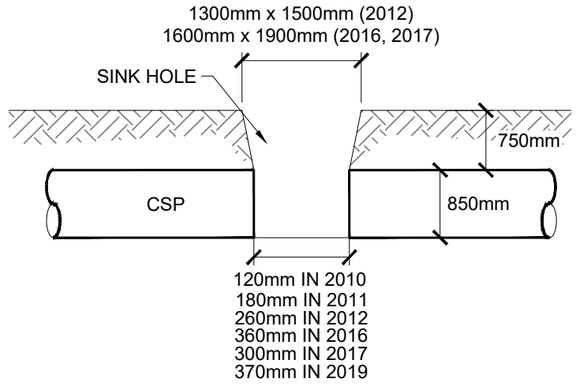
DWG No. 13351-PH006-1-1

DRAWN BY	KLW
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	DECEMBER 2020
FILE No.	13351

THURBER ENGINEERING LTD.



SITE PLAN
1:1500



DETAIL 1
1:75

0 20 40 60 80 m
SCALE 1:1500

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Alberta

PEACE REGION (PEACE RIVER / HIGH LEVEL)

PH006-1: HWY 697:02 - TOMPKINS LANDING SLIDE 2020 GEOHAZARD ASSESSMENT

DWG No. 13351-PH006-1-2

DRAWN BY	KLW
DESIGNED BY	KEF
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	DECEMBER 2020
FILE No.	13351

THURBER ENGINEERING LTD.

Photo 1 – Looking southwest at one of the dips in the road and deteriorating asphalt surface. A second dip is visible further up the road.

Photo 2 – Looking south at slope with ongoing movement in the northeast portion of the site. Note that much of the vegetation along the river bank was destroyed by flooding in Spring 2018 and covered again with silt and debris in Spring 2020 (higher water level than 2018).

Photo 3 – Looking southwest at erosion in north ditch.

Photo 4 – Alligator cracking near the southwest end of the site.

Photo 5 – Looking southwest at recent patch near southwest portion of the site.

Photo 6 – Sinkhole at separated 800 mm CSP downpipe south of the highway.

Photo 7 – Looking east at dips in the road (minor with yellow arrow, major with red arrow).

Photo 8 – Looking west at ditch erosion near bottom of valley.

Photo 9 – Cracks on highway near bottom of valley.