TRANSPORTATION AND ECONOMIC CORRIDORS
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA & FORT MCMURRAY DISTRICTS
2023 SITE INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC006	11 Km East of Slave Lake	Mitsue Recreation Area	2:46	47.33
Legal Description		**UTM Co-ordinates (NAD 83)**		
NW-7-72-4-W5M		11 N 6122200 E 651552		

	Date	PF	CF	Total
Previous Inspection:	June 07, 2022	14	5	70
Current Inspection:	May 16, 2023	14	5	70
Road AADT:	3,200		**Year:**	2022

Inspected By:	José Pineda, Tarek Abdelaziz (Thurber) Arthur Kavulok, Amy Driessen, Kristen Tappenden (TEC)
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items
Primary Site Issue	Active landslide causing severe deterioration to highway conditions.
Dimensions:	About 80 m wide (parallel to the highway alignment) and 60 m long (perpendicular to the highway alignment)
Site History:	In the Spring of 2019 Mr. Gordon Wolters, local MCI of TEC, noticed a sudden severe depression on the highway surface. TEC requested Thurber to conduct a call out. During Thurber's inspection on June 10, 2019, it became clear that the current landslide area is adjacent to a previously repaired landslide in 2007 (previously known as NC06-1). The repairs at the NC06-1 site included the installation of surface and sub-surface drainage improvement measures and the construction of a toe berm to stabilize the landslide movement. The drainage improvement measures consisted of installing sub-drains, constructing a riprap lined swale, flushing, and tying older sub-horizontal drains to a drainage collection manhole at the bottom of the slope. The site NC06-1 was inspected by Thurber as part of the GRMP until 2012 when it was determined that the 2007 remedial measures appeared to have mitigated the slope movement. The instruments installed at the old landslide site are not read under the current GRMP. In 2020, Thurber installed geotechnical instruments, consisting of slope inclinometers and vibrating wire piezometers, within the active landslide area to assess depth of movement and soil and groundwater conditions. These instruments are currently read under the GRMP.
Maintenance	ACP patch placed in 2021 on the west bound lane covering most of the landslide impacted section of the highway.

Observations:	**Description**	**Worse?**
☑ Pavement Distress	25 mm dip noted on the middle portion of the 2021 ACP patch.	☑

☑ Slope Movement	Reflective wide landslide within the 2021 ACP patch area; diagonal cracks within the landslide area are up to 50 mm wide with up to 25 mm drop across the crack surfaces; multiple tension cracks on the north side slope; guardrail displaced laterally by approximately 300 mm to the north (middle section of the landslide); titling and bent trees in the bush; distinct toe roll near the bush line within the middle section of the landslide	☑
☐ Erosion		☐
☑ Seepage	Water flowing under the 800 mm CSP culvert inlet	☐
☑ Bridge/Culvert Distress	800 mm CSP culvert outlet was damaged; restricted water flow from culvert outlet due to sediment accumulation	☐
☑ Other	Settlement of drill benches, constructed in the winter of 2020 to install geotechnical instruments, created severe open cracks in the highway side slope; the upper settlement crack is about 900 mm from the highway guardrail; water ponding within the highway south ditch	☐

Instrumentation Readings (4 SIs and 7 VWs):

SI20-1, installed in the south ditch of the highway, and SI20-4, installed further downslope of the potential toe of the active landslide, continued to show no discernable movement.

SI20-2 and SI20-3 installed within the extent of the active landslide have shown movements within the upper 3 m. SI20-2 which is closer to the top of the highway embankment, reinitialized on June 5, 2022, showed a maximum rate of movement of 25.8 mm/yr in the fall of 2022. In the spring of 2023, SI20-2 showed a rate of movement of 14.6 mm/yr, and SI20-3 showed a rate of movement of 0.1 mm/yr.

The vibrating wire piezometers showed groundwater depths ranging from 2.12 m in VW20-4A to 7.97 m in VW20-1.

Observations and Assessment (Refer to attached Figures and Photos)**:**

The site condition has deteriorated since the 2022 site inspection visit.

The embankment fill at this location was built on a landslide terrain. The deterioration of the highway condition is due to the retrogression of the ancient landslide towards the highway surface. The active movement at this site is relatively shallow based on the SI readings. However, there is still a potential for a future deep-seated movement of the ancient landslide mass. In addition, there is a dormant landslide to the west of the existing culvert, but it is not currently impacting the highway.

The landslide is still active as evidenced from the further widening/reopening of reflective cracks on the highway surface. The landslide has three distinct moving blocks, and the middle section is the most active one. Within the middle landslide block, there is a distinct dip on the highway surface, more noticeable on the shoulder, and a significant distress in the highway side slope. The dip on the highway surface creates a rough ride to motorists and the side slope's head scarp will continue to retrogress to take out the guardrail and the highway shoulder.

The existing culvert to the west of the active landslide area is in a poor condition.

The highway condition is expected to continue deteriorating until an effective remedial measure is implemented. If an accelerated landslide movement occurs at this site, a partial or full road closure may be required.

Recommendations:

It is recommended that this site be visited again in 2024.

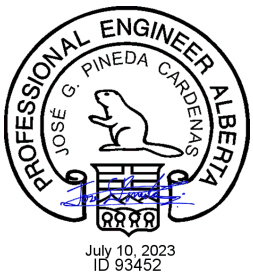
In the short term, the local MCI should monitor the highway periodically for signs of distress and watch closely for the development of new cracks, further opening/widening of existing cracks or drop in highway surface/shoulder (particularly after prolonged rainfall events). Any open surface cracks should be sealed to prevent surface water infiltration into the landslide mass, which would result in further landslide movement and retrogression. Speed reduction signs should also be used, if the highway condition deteriorates significantly, to warn motorists of the existing hazard. Future patching of the highway surface should be done, if needed, to provide a smooth ride to motorists.

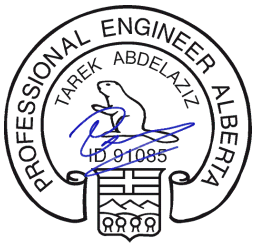
Thurber completed a preliminary engineering assessment for this site in 2022. The selected remedial measure by TEC is to install a shallow pile wall to only address the shallow movement at this site. The repair is currently scheduled for implementation in 2024.

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.

Tarek Abdelaziz, Ph.D., P.Eng.
Principal | Geotechnical Review Engineer





PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
RM SIGNATURE: _____
RM APEGA ID #: 91085
DATE: July 10, 2023
PERMIT NUMBER: P005186
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

José Pineda, M.Eng., P.Eng.
Associate | Senior Geotechnical Engineer

H:\32000\32122 AT GRMP Athabasca and Fort McMurray Districts 2021-2025\CAD\2023 GEO HAZARD\JGP\32122 NC006 Drawings.dwg - 1 - Jun. 20, 2023

N
W E
S

40-70mm WIDE, 100mm DEEP (2019)
TENSION CRACKS BY GUARDRAIL UP TO 70mm WIDE, 150mm DROP, 70mm DEEP (2020)
CRACKS 1m AWAY FROM GUARDRAIL, MORE VEGETATED AND LESS VISIBLE, 8mm DROP (2022);
600mm TO 1.2m DROP, CRACK IS 900mm FROM GUARDRAIL (2023)

CRACK 30mm-60mm WIDE, UP TO 250mm DROP
REFLECTIVE CRACK 10-20mm WIDE, LESS THAN 10 mm DROP (2023)

SETTLEMENT CRACK / WINTER BENCHING

75mm DROP (2019)
100mm DROP IN 2020

ANCIENT TOE ROLL

60mm WIDE, NO DROP (2021)

25mm DIP (2022, 2023)

DORMANT ANCIENT LANDSLIDE (LIDAR)

WEST FLANK

WATER PONDING (2019)
SAME IN 2020

CSP OUTLET
-COVERED WITH 200mm OF SEDIMENT (2019)
500mm SEDIMENT
DAMAGED OUTLET (2020)
STILL FLOWING (2021, 2023)

UTILITY CROSSING

CRACK 50mm-70mm WIDE, NO DROP

CRACK 40mm WIDE, NO DROP
SAME (2022)

CRACK 30mm WIDE, NO DROP; 40mm WIDE, NO DROP (2022)

800mm CSP INLET
-RUSTY, FILLED WITH DEBRIS (2019)
SAME, A LITTLE BIT OF WATER PONDING AT THE INLET. INLET IS 1.2m LOWER THAN SURROUNDING GRADE (2020)
RUSTY, WATER FLOWS BELOW CULVERT (2021)
FILLED WITH DEBRIS, WATER PONDING AND NOT FLOWING INTO CULVERT (2022, 2023)

PATCHED POT HOLES ON EASTBOUND LANE

10-50mm WIDE, 25mm DROP (2023)

POTENTIAL TOE ROLL

SI20-4/ VW20-4A/ WV20-4B 20m

SI20-3/ VW20-3A/ WV20-3B 20m

LEANING TREES

SI20-2/ VW20-2A/ WV20-2B 20m

SI20-1/ VW20-1 25m

TOE BERM CONSTRUCTED IN 2007

300mm Ø CSP OUTFLOW PIPE

DRAINAGE COLLECTION MANHOLE

TP05-6
TP05-4
TP05-2
TP05-5
TP05-1
TP05-3

OLD RIDGE: NC06-1 TOE ROLL (PRIOR TO REPAIRS)

MORE DISTINCT DROP WITHIN FAILED BLOCK DOWNSLOPE OF THE HIGHWAY. FLANKS ARE ALSO MORE DISTINCT. MIDDLE BLOCK SHIFTED GUARDRAIL

0.4m DROP, 50mm WIDE CRACKS

EAST FLANK

RECENT ACTIVE LANDSLIDE

POTHOLE (300mm WIDE x 100mm DEEP)

POTHOLE (200mm WIDE x 100mm DEEP) SAME (2022)

CRACK 10mm WIDE, NO DROP (2019); 50mm WIDE x 10mm DROP (2020); SAME (2021, 2022)

CRACK 20mm WIDE, 30mm DROP (2019); 200mm WIDE x 80mm DROP (2021); 10-20mm WIDE, 15mm DROP (2023)

CRACK 25mm WIDE, NO DROP (2019)

WET AREA; EXTENDED TO THE WEST AND WET IN 2022

~10m-15m OF GUARD RAIL SHIFTED BY 70mm (UPSLOPE OF SIDESLOPE ACTIVE SLUMPING); SAME IN 2020; SHIFTED BY 250mm (2021); SHIFTED BY 300 mm (2023)

CLASS 1M RIPRAP LINED SWALE

SHALLOW BERM

150mm Ø PERFORATED SUBDRAIN PIPE

PN#3 SI#3
PN#2 SI#2
PN#1 SI#1

TH05-2
TH05-1
TH05-3
TH05-4

HWY 2:46

LEGEND

- APPROXIMATE 2020 INSTRUMENT LOCATION (DEPTH (m))
- APPROXIMATE TEST HOLE (TH) LOCATION
- APPROXIMATE TEST PIT (TP) LOCATION
- APPROXIMATE PNEUMATIC PIEZOMETER (PN) LOCATION
- APPROXIMATE SLOPE INCLINOMETER (SI) LOCATION
- INSTRUMENT NON-OPERATIONAL
- ACTIVE HEADSCARP
- DORMANT SCARP CRACK
- CRACK
- GUARD RAIL
- OVERHEAD POWERLINE
- TREE LINE
- GULLY
- 620 GROUND CONTOUR
- 2021 ACP PATCH
- APPROXIMATE DIRECTION AND NUMBER OF PHOTO

NOTES:
1. SITE FEATURES ARE APPROXIMATE
2. LIDAR PROVIDED BY ALBERTA TRANSPORTATION
3. MAY 16, 2023 OBSERVATIONS SHOWN IN RED

0 10 20 30 40 50 60 70 m
SCALE 1:1250

Alberta

NORTH CENTRAL (ATHABASCA AND FORT MCMURRAY DISTRICTS) 2023 GEOHAZARD ASSESSMENT

NC006: HWY 2:46 MITSUE RECREATION AREA (km 47.6) SITE PLAN SHOWING LANDSLIDE FEATURES

FIGURE 1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:1250
DATE	MAY 2023
FILE No.	32122

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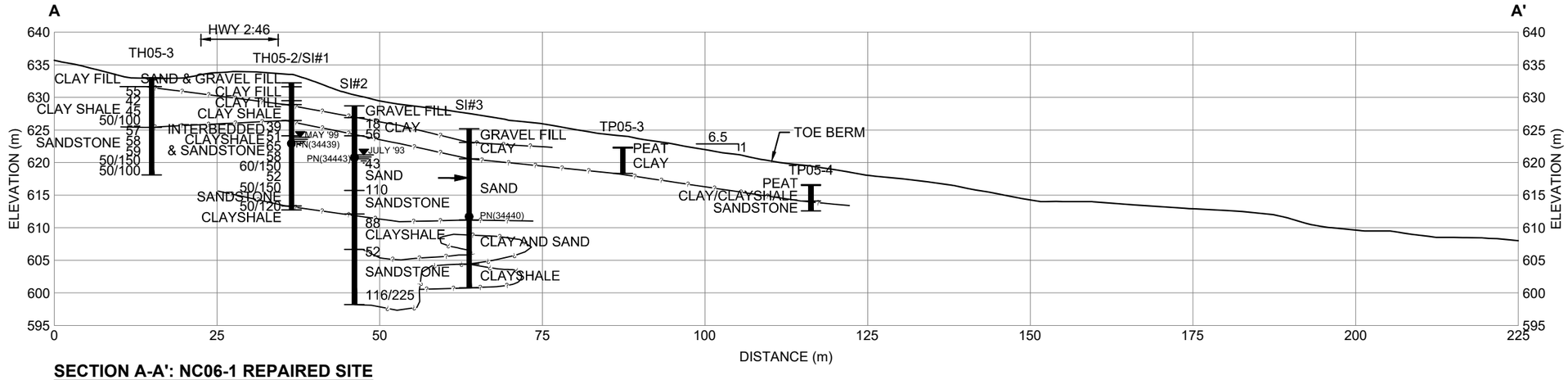
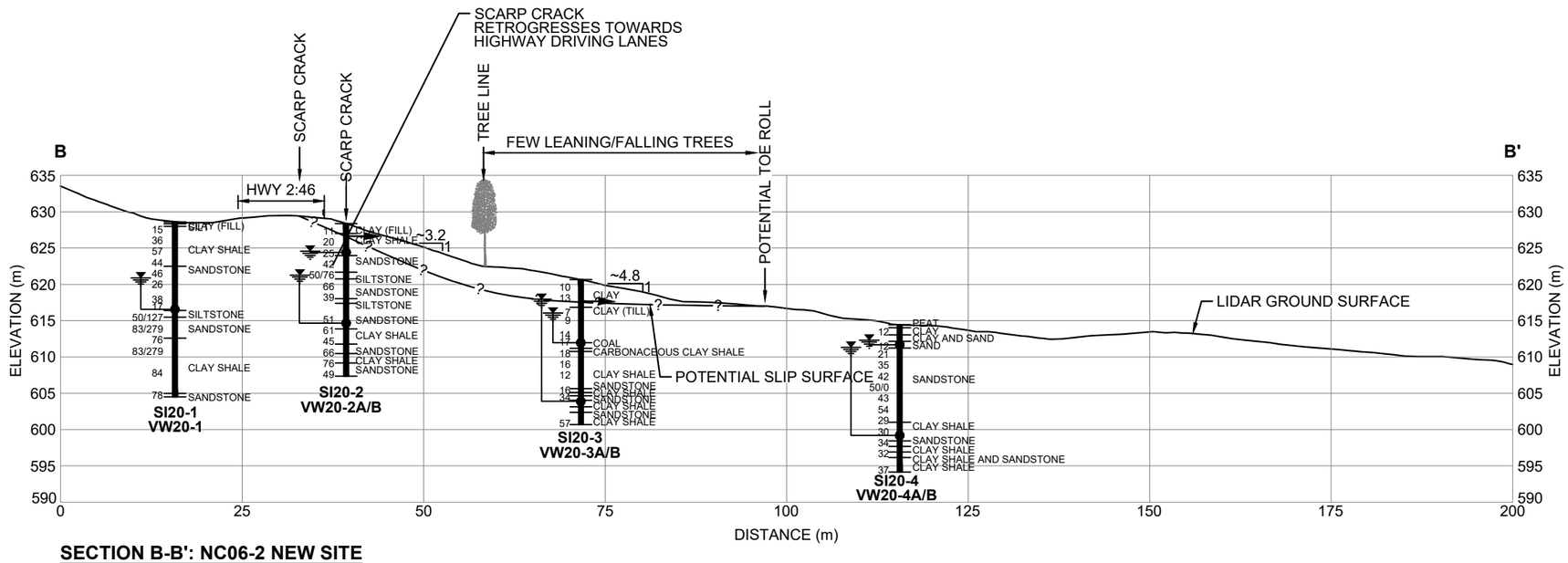


SECTION A-A': NC06-1 REPAIRED SITE



SECTION B-B': NC06-2 NEW SITE

LEGEND

- 15 SPT N VALUE
- WATER LEVEL IN PIEZOMETER
- PNEUMATIC PIEZOMETER TIP LOCATION
- DEPTH OF MOVEMENT IN SLOPE INCLINOMETER

NOTE

DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE TEST HOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN TEST HOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

Alberta

NORTH CENTRAL REGION
(ATHABASCA AND FORT MCMURRAY DISTRICTS)
2023 GEOHAZARD ASSESSMENT

NC006: HWY 2:46 MITSUE RECREATION AREA (km 47.6)
CROSS-SECTIONS

FIGURE 2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:750
DATE	MAY 2023
FILE No.	32122

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Photo No. 1 – Looking east toward the landslide and the 2021 ACP patch; more vegetation grew on the highway side slope within the landslide mass

Photo No. 2 – Looking east at reflective cracks near the western limit of the landslide

Photo No. 3 – Most active landslide block impacting the highway (middle section of landslide mass); note the presence of multiple retrogressive cracks impacting the highway WBL

Photo No. 4 – Looking west at the most active area; note guardrail bowing out by 300 mm

Photo No. 5 – Middle landslide block: Head scarp crack retrogressing into the highway; 600 to 1.2 m drop from original ground

Photo No. 6 – Looking west at active landslide cracks on the highway side slope; these cracks may reflect the failure of the restored drill benches constructed in the winter of 2020 to install geotechnical instruments.

Photo No. 7 – 800 mm diameter culvert inlet. Culvert was rusty, partially blocked with vegetation and filled with garbage.

Photo No. 8 – Looking south at patched potholes on the east bound lane

Photo No. 9 – Looking at 800 mm CSP culvert outlet.