THURBER

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

Site Number	Location	Name	Hwy	km
PH42	Daishowa East Hill	Pumping Well	986:01	33.2
Legal Description		**UTM Co-ordinates**		
NE7-85-20 W5M		11V E 491155	N 6246175	

	Date	PF	CF	Total
Previous Inspection:	20-Jun-2017	3	6	18
Current Inspection:	11-Jun-2020	3	6	18
Road WAADT:	900		**Year:**	2019
Inspected By:	Ed Szmata, TRANS Rocky Wang, TRANS		Don Proudfoot, TEL Tyler Clay, TEL	
Report Attachments:	☑ Photographs ☑ Plans		☐ Maintenance Items	

Primary Site Issue:	Roadway and embankment have history of active landsliding. Headscarp extends across both driving lanes (Photos 42-01and 42-03). Site was remediated once (successfully in short term) with a series of pumping wells installed on upslope side of roadway. The pumps required ongoing maintenance that was impractical to sustain and eventually the pumps were no longer effective at reducing the rate of landslide movement. Mitigation work was completed between the fall of 2016 to the summer of 2018 involving construction of a 98 m long reinforced tangent pile wall to mitigate a landslide affecting the highway.	
Dimensions:	Slide is 100 m wide and extends from east bound driving lane to (presumably) creek approximately 150 m downslope of roadway.	
Maintenance:	Road patching 2015/16.	
Observations:	**Description**	**Worsened?**
☐ Pavement Distress	ACP was in good condition at the time if the inspection with no signs of cracking or subsidence along previously observed extents of pavement damage due to slide movement (Photos 42-01 and 42-03).	☐
☐ Slope Movement	No observations of slope movement were evident at the road surface or below the pile wall along or outside the previous landslide extents (Photos 42-01 and 42-04).	☐

☑ Erosion	Previous gully erosion in the south ditch was repaired and ditch has been armored with a gabion mattress. Minor rill erosion was noted between the road edge and edge of the gabion. (Photo 42-05).	☐
☐ Seepage		☐
☐ Bridge/Culvert Distress		☐
☐ Other		☐

Instrumentation:
Legacy SI instrumentation (installed in 2009):
SI09-1 - Upslope of roadway; sheared at 2.6 m after September 2013
SI09-2 - Downslope of roadway; sheared at 16.8 m after June 2011
SI09-3 - Downslope of roadway; sheared at 11.0 m after May 2010
SI09-4 - Downslope of roadway; sheared at 9.8 m after September 2010

New instrumentation has been installed to monitor performance of the pile wall and includes the following: 9 vibrating wire (VW) piezometers,1 slope inclinometer (SI), 3 shape accelerometer arrays (SAA), 14 vibrating wire strain gauges (SG), and 9 load cells. Battery issues at the datalogger resulted in data collection gaps for the SAA's.

SI18-1 (installed in the bench downslope of the pile wall) has not shown any discernible movement since it was reinitialized during Spring 2019.

Wall deflections have been measured in SAA17-P20 and SAA17-P40 over the length of the piles and over the combined length of the piles and waler cap beam with a maximum total resultant movement up to 49 mm. These deflections are within expected design limits.

SAA18-1 (installed in the bench downslope of the pile wall) showed an average rate of movement of 4.3 mm/yr over 0.5 m to 12.5 m depth since Fall 2019 with a total cumulative movement of 7.6 mm. SAA17-P40 has shown a total cumulative movement of 4.1 mm over 0.5 m to 12.5 m depth since June 2018, indicating that the bench below the pile wall has moved 3.5 mm in the downslope direction relative to the pile wall during this time span. On this basis, the soil bench is still providing support to the wall.

Strain Gauge Summary: Compared to the Fall 2019 readings, the strain gauges have shown changes in measured microstrain ranging from an increase in tension at 0.5 m depth from the pile cut-off elevation on the downslope pile face, to an increase in compression at 8.5 m depth from the pile cut-off elevation on the upslope pile face. Overall, the strain gauges on the upslope pile face below 14.5 m depth showed an overall increase in tension since Fall 2019, while the gauges above this depth mostly showed an increase in compression. Conversely, the strain gauges on the downslope pile face installed below 14.5 m depth showed an overall trend of increasing compression, while the strain gauges installed above this depth showed mainly increases in tension.

VW Summary (at pile wall): VW17-1A and VW17-3B showed increases in groundwater level of 0.05 m and 0.73 m, respectively, since the Fall 2019. VW17-2B showed a decrease in groundwater level of 0.42 m compared to the fall of 2019 readings. The current groundwater levels in VW17-1B and VW17-3B are the same as those measured Fall 2019. VW17-1A, VW17-1B and VW17-3A

recorded all-time high groundwater levels between March 14, 2020 and April 18, 2020, while VW17-3B showed an all-time high groundwater level on June 11, 2020. VW17-2A has been dry since installation. The piezometers near the pile wall have shown an overall trend of gradually increasing groundwater levels since the end of construction.

VW Summary (at upslope ditch): VW18-1 and VW18-3 showed increases in groundwater level of 3.32 m and 3.69 m, respectively, since Fall 2019. VW18-2 showed an increase in groundwater level of 3.94 m compared to when it was last read on June 19, 2019. The current groundwater levels in VW18-1, VW18-2 and VW18-3 are the highest ever recorded for their respective instruments.

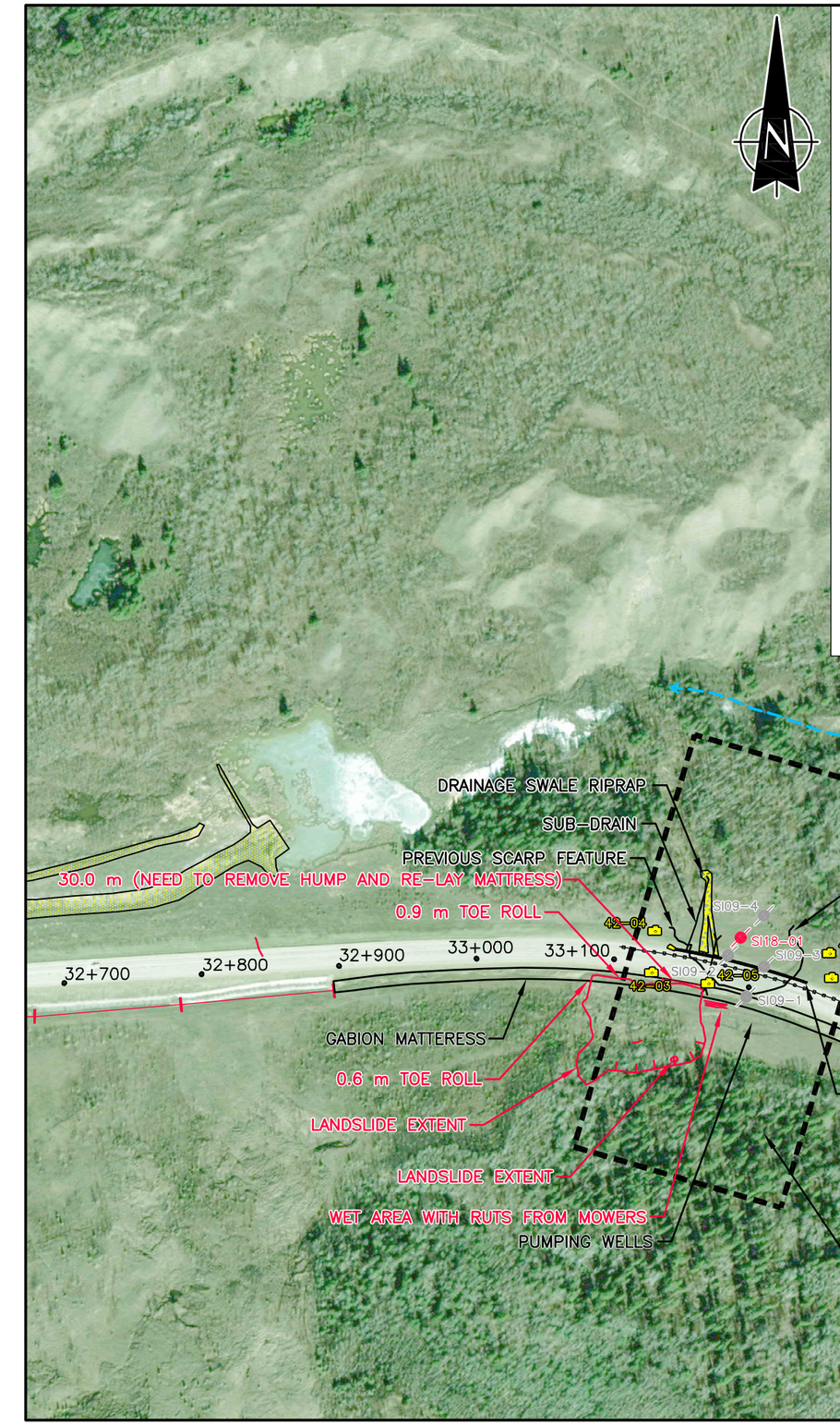
Load Cell Summary: All of the load cells have shown an increase in measured load compared to the Fall 2019 readings, ranging from an increase of 1.84 kN in VC2017 (anchor P40C) to an increase of 5.55 kN in VC2014 (anchor P40B) Load cells VC2013 (anchor P20B), VC2016 (anchor P20C), VC2014 (P40B), VC2017 (P40C), VC2015 (anchor P60B) and VC2018 (anchor P60C) all recorded all-time high anchor loads between April 10, 2020 and April 21, 2020. The load cells show an overall trend of increasing load, with higher measured loads during the winter months in response to frost heave pressures.

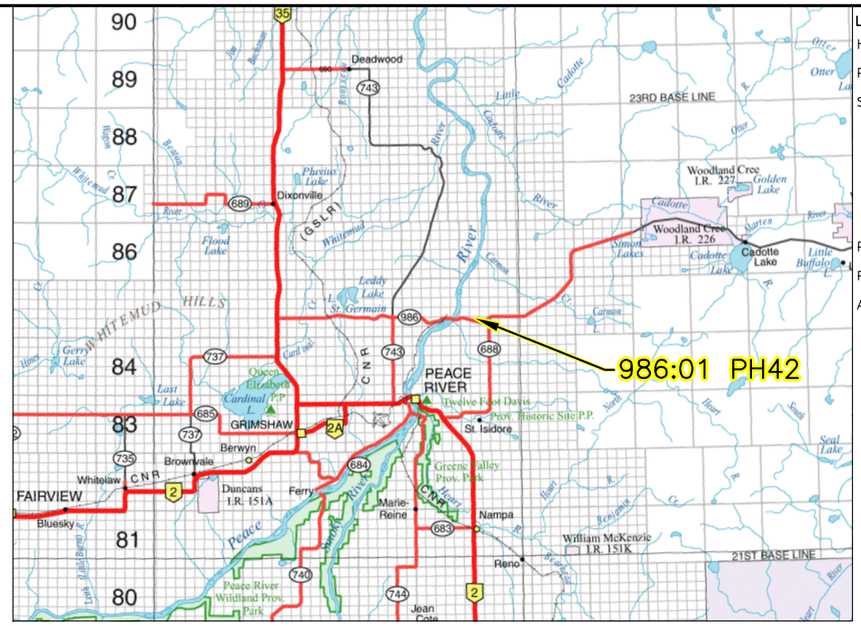
Assessment:

The anchored retaining wall is designed to support the roadway and relies on passive support of the downslope bench. Future readings should be done to check if the bench exhibits faster downslope movement relative to the pile wall. The wall relies on lateral support from the bench and if significant downslope movement is measured another row of tie-back soil anchors would be required below the existing anchors. Based on observations since construction completion the wall appears effective in supporting the highway and the risk of embankment failure due to landslide movement at this site is expected to be significantly reduced. Residual movement in the failure surface upslope of the wall within the roadway is possible and may require future overlays to accommodate potential cracking and subsidence within the ACP. The site should be monitored to assess the wall performance and potential expansion of the slide area laterally and upslope of the wall.

It is recommended to create a post-construction monitoring and design performance review plan (i.e. Asset Management Plan) to provide recommendations for ongoing monitoring and for future pass-off from construction / design to operations.

Recommendations:	**Cost**
Continue to visually monitor as part of annual inspections. New instrumentation should have bi-annual readings / data collected regularly to monitor the mitigation performance.	-





KEY MAP

SCALE 1:1 000 000

LEGEND:

- HORIZONTAL CHAINAGE — 32+100
- PHOTOGRAPH LOCATION — 42-01
- SLOPE INCLINOMETER
  - NO MOVEMENT — SI 64
  - CREEP — SI 82
  - MEASURABLE MOVEMENT (OR RECENTLY SHEARED) — SI 82
  - NON OPERATIONAL — SI 82
- PIEZOMETER — PN 004
- PH41 BOUNDARY
- ARMOURED CHANNEL

NOTES:

1 DRAWING MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 13351 DATED DECEMBER 2017 AND IS SUBJECT TO THE STATEMENT OF LIMITATIONS AND CONDITIONS INCLUDED IN THE REPORT.

2 AIR PHOTO BASE FROM ESRI (DIGITAL GLOBE, 2016).

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

0 50 100 200 300 m

Alberta Transportation

PEACE REGION (PEACE RIVER/HIGH LEVEL)

DAISHOWA
HWY 986:01 (PH42)
LOCATION PLAN

FIGURE PH42-1

DRAWN BY	ICB
DESIGNED BY	TTC
APPROVED BY	DWP
SCALE	1:4 000
DATE	DECEMBER 14, 2020
FILE No.	13351-C6A

THURBER ENGINEERING LTD.

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	**Photo 42-01.** Looking west across the repaired slide area. Guardrail and pavement surface replaced.
	**Photo 42-02.** Looking west at the new pile wall and regraded slope below.

	**Photo 42-03.** Looking east at the replaced highway segment that previously had cracking and settlement across the roadway due to landslide movement (33+210). Road surface was in good condition at time of inspection.
	**Photo 42-04.** Looking southeast at the new pile wall and drainage swales.

Photo 42-05.
New gabion mattress installed in the south ditch across the entire site extents to repair previous erosion damage. Minor rill erosion was noted between the road edge and edge of the gabion. Previous non-functioning pumping wells were decommissioned and VW piezometers were added with a datalogger.