ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA
2018 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC088	62 Km N of Wandering River	**NBL Pavement Distress**	63:06	6.0
Legal Description		**UTM Co-ordinates (NAD 83)**		
S-30-77-14-W4M		12 6172629 E 426672		

	Date	PF	CF	Total
Previous Inspection:	October 16, 2017 (Call Out)	13	5	65 (Highway 63 NBL)
Current Inspection:	May 8, 2018	13	6	78 (Highway 63 NBL)
Road AADT:	4,970		**Year:**	2017
Inspected By:	Tarek Abdelaziz and José Pineda (Thurber) Arthur Kavoluk and Rocky Wang (TRANS)			
Report Attachments:	☑ Photographs	☑ Plans	☐ Maintenance Items	

Primary Site Issue	**Major issue:** A landslide above the old pipe alignment causing a severe pavement distress on the highway lanes. **Other issues:** Winter 2018 deficiencies identified during the May 2018 site inspection visit.
Dimensions:	The pavement distress section is about 25 to 30 m long. The landslide is **a**bout 30 m wide parallel to the highway and 40 m long perpendicular to the highway alignment.
Site History:	The NBL embankment was constructed during the Hwy 63 twinning project. Up to 14 m of fill was placed to construct the NBL at the subject location to cross the valley of an existing creek. A 1200 mm CSP pipe was connected to the existing 1200 mm concrete pipe to convey the creek flow below the new embankment. It is understood that the highway was built in 2014 and paved in October 2016. In the fall of 2017, the CSP pipe collapsed at about 30 m from the inlet location (as per the information provided by AT). Slumping and erosion were also noted at the outlet of the concrete pipe (west side of SBL embankment). Recommendations were provided in the fall 2017 callout report to install a new pipe and to grout the old pipe. The proposed alignment of the new pipe was provided in the callout report. The recommended alignment of the replacement pipe was selected to avoid areas of potential instability on the east and west sides of the highway. ACP patch was placed in 2017 and the guardrail was severely distorted and had to be replaced in 2017. In the winter of 2018, a new 170 m long 1.2 m dia. SWSP culvert was installed through the embankment using the pilot tube micro-tunneling technology. The new pipe was installed immediately to the north of the existing culvert (installed from the outlet location on the west side towards the inlet location on the east side), and the old culvert was grouted and abandoned. As per the information provided by AT, the construction involved excavating a pit at the toe of the west embankment, where an old localized slump existed. During the May 2018 site inspection, a huge cavity was noted at the toe of the west embankment and the flow bypassed the new pipe to wash out the old slump. The CCTV inspection of the new pipe indicated a rupture at 12 m from the outlet location. Identified issues of the west embankment were provided under a different cover.

Observations:	Description	Worse?
☑ Pavement Distress	Up to 300 mm dip on the Highway NBLs; guardrail settled within the dip area by at least 40 mm	☑
☑ Slope Movement	15 m long x 30 m wide localized slump above the SWSP inlet location near the bottom of the slope; guardrail shifted laterally towards east by 100 to 150 mm	☑
☑ Erosion	A portion of the north creek bank to the east of the culvert inlet caved in resulting in restricted channel capacity, and diversion of the stream flow to the south of the culvert inlet; inadequate riprap protection of the creek bed and banks resulting in erosion issues within the bank; 600 mm long, 250 mm wide, and 1.8 m deep saturated cavity developed near the SWSP culvert inlet	☑
☑ Seepage	Disturbance of north riprap channel during construction resulted in uncontrolled discharge of surface water into the creek banks above the pipe inlet	☑
☐ Bridge/Culvert Distress		☐
☑ Other	Slopes are bare of vegetation; the creek bed is lower to the south of the new pipe inlet, resulting in ponding of water prior to entering the culvert; north and south riprap channels are distorted and partially covered with dirt	☑

Instrumentation (1SI and 2 PNs):

SI17-1 located on the top of the slope was paved over and the flush mounted SP17-3 installed within the east slope of the median ditch was covered with thick accumulations of sand and salt and could not be located.

Although SI17-2 located near the bottom of the slope did not show a distinct zone of movement, a potential zone of movement was noted in the SI plot between 0 and 7.4 m depth. The upper 2 m of the movement appeared to be related to the shallow slump developed at the bottom of the slope. The movement between 2 and 7 m depth appeared to be related to a bigger size landslide. The rate of movement was 170 mm per year and 130 mm per year between 0 and 2 m depth (shallow slump) and 2 and 7 m depth (deep landslide), respectively. A total cumulative movement of 180 mm was recorded in the SI. The reading will be confirmed during the fall 2018 monitoring event.

The current groundwater levels were measured at a depth of 3.5 to 4.5 m below ground surface at PN17-2A and B.

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

Major issue:

The site observations and instrumentations indicate the potential presence of a deep-seated landside below the 14 m high highway embankment. Near the bottom of the slope, the slip surface is located within the organic deposits underlying the clay fill. It appears that the failure of the original pipe as well as inadequate subgrade preparation below the new fill are the main triggers for the landslide movement.

It is anticipated the landslide will continue to impact the highway conditions and the observed dip will continue to get worse with time. The landslide is moving at a very high rate and there is a risk of losing the highway lanes and the failure may have an impact the new pipe.
The existing pavement distress is a major hazard to motorists and is causing a rough ride to motorists.

Other issues:

The existing slump above the culvert inlet may have been triggered due to improper placement of fill around and above the new inlet of the culvert, and the erosion of the creek banks. The erosion issues along the creek banks above and around the culvert inlet are due to the steepness of the slopes, inadequate protection of the creek banks and bed, and uncontrolled discharge of surface water from the disturbed north riprap-lined channel.

The existing slump near the bottom of the slope is anticipated to get bigger with time and it may eventually fail, impact the integrity of the pipe, and block the stream channel. Blockage of the culvert inlet and the stream channel may result in the saturation of the embankment fill. The loss of lateral toe support near the bottom of the embankment and the saturation of the embankment fill, if occur, will result in accelerated movement of the major landslide.

The highway embankment side slopes are bare of vegetation; making them more prone to erosion and slumping.

Recommendations:

Short Term Measures

In the short term, the MCI should periodically monitor the highway for additional movement. Speed reduction and landslide warning signs should be placed along the highway at this location. If the dip becomes severe, ACP patch should be placed on the highway surface. The thickness of the patch should be kept to the minimum needed to provide a smooth ride to travellers. This is to avoid excessive loading of the crest of the slope at the landslide location.

Short to Intermediate Term Measures

The following provides the short to intermediate term recommendations to deal with construction deficiencies:

- Excavate the existing slump near the bottom of the slope and replace it with granular fill. Since the excavation will take place at the toe of the unstable slope, it is recommended that the slump be excavated and backfilled in small sections. Each section should be excavated and backfilled before the next section is excavated. Uncontrolled excavations will cause massive movement in the side slope.
- The bank slopes around the new pipe inlet should be reshaped, flattened (as needed), and armored with riprap underlain by a non-woven geotextile. Armouring the creek bed is also recommended.
- The disturbed riprap-lined north and south channels should be slightly regraded to contain the highway ditch flow and armored with additional riprap that daylights into the banks of the creek.
- It may be necessary to fill the low area located to the south of the culvert inlet location (i.e. this is the area where the water is currently ponding at the decommissioned pipe inlet location)
- The cavity adjacent to the new pipe should be backfilled and sealed unless excavated during slump repair. The cavity may have been developed due to improper placement of backfill or in response to the creek flow bypassing the new culvert inlet at some point during or shortly after construction.
- Remove the debris from the channel to allow unrestricted flow into the culvert and reshape the creek banks to direct flow into the pipe.
- Track pack, topsoil and seed the slope.

Due to soft and wet ground conditions, light equipment would be required to access the work area. Another constraint would be handling the creek flow during the implementation of the repairs. Environmental approvals will also be required for instream activities. The ball park cost to complete the above ranges from $300,000 to $400,000 (excluding engineering).

Long Term Measures:

The following provides potential long-term remedial options:

Option 1: Construct a toe berm to buttress the landslide. This option will require instream work to divert the creek flow, land acquisition, extending existing pipe, tree clearing, and the reconstruction of the riprap lined channels. Regularity authority approvals will be required to complete this option. The ballpark cost of this option is in the range of $600,000 to $700,000), excluding engineering.

Option 2: Excavate and replace the landslide mass with gravel or geogrid reinforced clay. This option will require temporary closure of the highway and the construction of a detour. The ballpark cost of this option is in the range of $1,000,000 (geogrid reinforced clay) to $1,600,000 (gravel), excluding engineering.

Option 3: Offload the top of the slope and backfill excavated mass using light weight fill (i.e. cellular concrete or EPS blocks). This option may require partial closure of the highway (i.e. alternating lane traffic). The ballpark cost of this option is in the range of $700,000 to $900,000 (excluding engineering), depending on the depth of replacement.

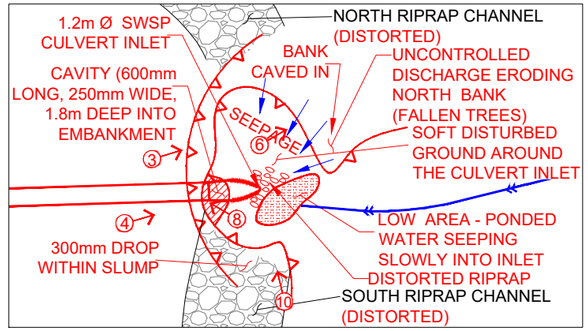
Option 4: Construct a 35 to 40 m long tied-back tangent pile wall along the east side of the highway along with slope flattening above the culvert location. This option does not require closure of the highway. The ballpark cost of this option is in the range of $1,000,000 to 1,400,000 (excluding engineering).

There may be additional methods that could be considered; however, this should be determined based on the results of the instrumentation and additional analyses.

Prior to the design of a long term remedial option, it is recommended to install a replacement instrument (SI with 2 PNs attached to the casing) near the top of the slope to the east of the guardrail to confirm the depth of movement near the highway surface. This should provide valuable information to assess the most feasible repair option at this site. The new instrument could be installed concurrently with the installation of the southbound lane instrumentation.

H:\13000\13357 Geohazard Assessment - Athabasca (CON0017605)\Drafting\2018\JGP\13357 NC88-1-1~2.dwg - 1NN - Aug. 13, 2018

APPROXIMATE NORTH EDGE OF NEW FILL
SLIGHT DEPRESSION
TENSION CRACK
SLIGHT HUMP IN NEW FILL
APPROXIMATE LIMIT OF LANDSLIDE (2017)
STEEP FILL
NEW CULVERT OUTLET
100mm WIDE 200mm DEEP
40-90mm WIDE 100-250mm DEEP
TENSION CRACK (2017)
200mm WIDE 200mm DEEP
C1 (1200mm Ø CONCRETE) GROUTED AND ABANDONED IN 2018
OVER STEEP FILL
APPROXIMATE SOUTH EDGE OF NEW FILL
DETAILS OF WEST EMBANKMENT FAILURE WERE PROVIDED ON A SEPARATE REPORT
NORTHBOUND LANE CENTER LINE
SOUTHBOUND LANE CENTER LINE
RIGHT OF WAY BOUNDARY
RECOMMENDED NEW PIPE ALIGNMENT BY THURBER (2017)
REPLACEMENT CULVERT: 1.2m Ø SWSP CULVERT INSTALLED BY OTHERS IN 2018
C3 (800mm Ø CSP)
SILT FENCE
NORTH RIPRAP CHANNEL (DISTORTED)
SI17-1 PN17-1A PN17-1B
SI17-2 PN17-2A PN17-2B
SP17-3
SEE DETAIL
SOUTH RIPRAP CHANNEL (DISTORTED)
300mm DEEP x 200mm WIDE (2017)
200-300mm DROP ON HIGHWAY
C2 (1200mm Ø CSP) (GROUTED AND ABANDONED 2018)
GUARDRAIL REPLACED IN 2017- GUARDRAIL SHIFTED TOWARDS EAST BY 100-150mm
- VISIBLE IN MAY 2017
- NOT VISIBLE IN OCTOBER 2017 DUE TO GRADING WORK TO INSTALL GEOTECHNICAL INSTRUMENTS
- NOT VISIBLE IN MAY 2018
APPROXIMATE LIMITS OF AREA GRADED BY OTHERS IN WINTER OF 2018 - BARE OF VEGETATION SLOPE
BH6-1D
DUGOUT FULL OF WATER SAME IN 2018
6+000
A
A'
N
S
E
W
350
355
360
650



CULVERT INLET DETAILS
SCALE: 1:400

LEGEND

- APPROXIMATE THURBER TEST HOLE LOCATION
- SI — SLOPE INCLINOMETER
- PN — PNEUMATIC PIEZOMETER
- SP — STANDPIPE PIEZOMETER
- APPROXIMATE AMEC TEST HOLE LOCATION
- PAVED OVER INSTRUMENT
- CULVERT NUMBER AND DIAMETER (AS OF 2017)
- HIGHWAY CENTER LINE
- GUARD RAIL
- CRACK / SCARP
- EXTENT OF HIGHWAY PATCH IN SUMMER OF 2017 (APPROX.)
- EXTENT OF DIP IN MAY 2018
- CREEK
- PHOTOGRAPH NUMBER, AND APPROXIMATE DIRECTION AND LOCATION

NOTES :
1. LIDAR FLOWN BEFORE NORTHBOUND LANE WAS CONSTRUCTED. CONTOURS ARE BASED ON 2007 LIDAR DATA.
2. FEATURE LOCATIONS ARE APPROXIMATE.
3. PREVIOUS OBSERVATIONS SHOWN IN BLACK.
4. MAY 8, 2018 FEATURES SHOWN IN RED.

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

Alberta

2018 GEOHAZARD ASSESSMENT
NORTH CENTRAL REGION (ATHABASCA AREA)

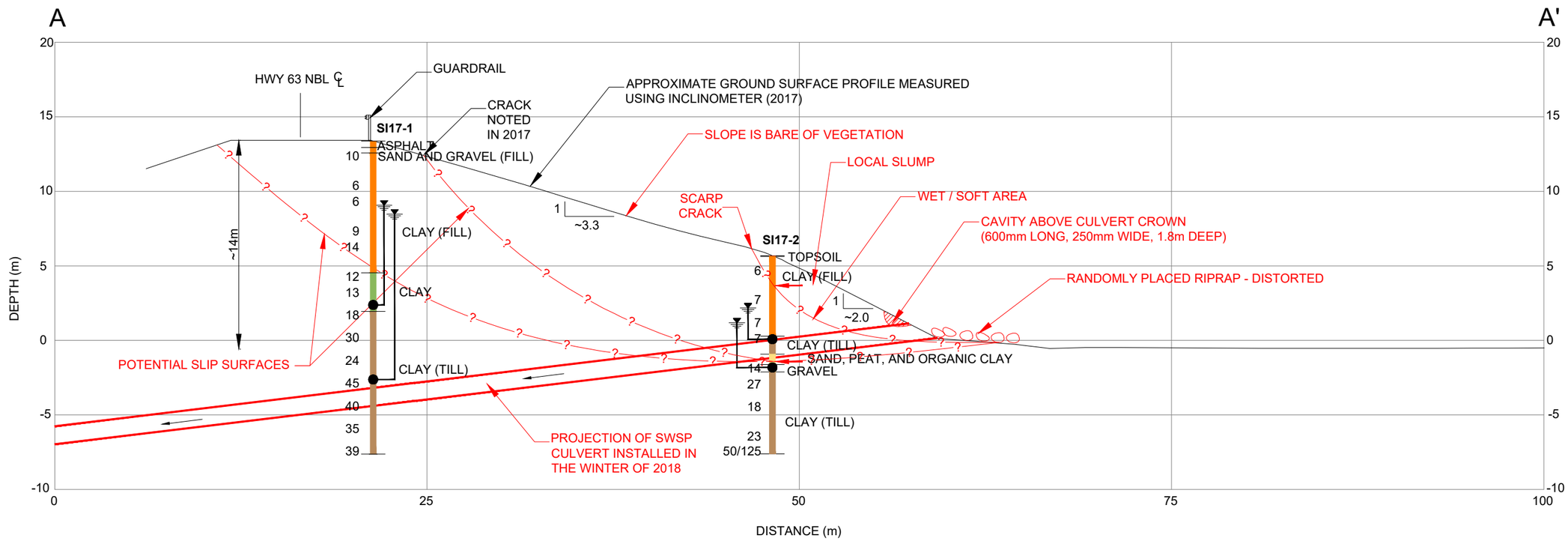
NC088: HWY 63:06 NBL PAVEMENT DISTRESS SKETCH SHOWING SITE FEATURES (MAY 8, 2018 GEOHAZARD INSPECTION)

DWG No. 13357-NC088-1-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:1000
DATE	AUGUST 2018
FILE No.	13357

THURBER ENGINEERING LTD.

H:\13000\13357 Geohazard Assessment - Athabasca (CON0017605)\Drafting\2018\JGP\13357 NC88-1-1~2.dwg - 2NN - Aug. 13, 2018



LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN PIEZOMETER (MAY 28, 2018)
- DEPTH OF MOVEMENT IN SLOPE INCLINOMETER

NOTES:
1. CROSS - SECTION A - A' IS BASED ON SIMPLE FIELD MEASUREMENTS COMPLETED IN 2017 AND HENCE IT MAY VARY FROM EXISTING CONDITIONS.
2. MAY 8, 2018 FEATURES ARE SHOWN IN RED.
3. THE ELEVATION OF SI17-2 IS UNKNOWN AND IS ONLY SHOWN FOR ILLUSTRATION.

Alberta

2018 GEOHAZARD ASSESSMENT
NORTH CENTRAL REGION (ATHABASCA AREA)

NC088: HWY 63:06 NBL PAVEMENT DISTRESS
CROSS - SECTION A - A'

DWG No. 13357-NC088-1-2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:300
DATE	AUGUST 2018
FILE No.	13357

THURBER ENGINEERING LTD.

Photo No. 1 - North riprap lined channel leading to the inlet of the new pipe (looking north). Note the presence of disturbed riprap, seeping/ponding water into the slope beside and above the culvert inlet location, and existing cracks.

Photo No. 2 - Water Flowing in an uncontrolled manner fom the mouth of the north riprap lined channel to the creek bank

Photo No. 3 - Uncontrolled discharge of surface flow from the north channel into the slope (looking east)

Photo No. 4 - New pipe Inlet Area (looking east) – Disturbed bank slopes, riprap, and silt fences. The banks are not armored and there is not enough riprap at the inlet location

Photo No. 5 - New pipe Inlet Area (looking east) – Restricted flow to the culvert inlet, partially due to caved in bank slope (note the presence of deadfall). Creek flow is partially ponding to the south of the culvert inlet

Photo No. 6 - Caved in Bank with trees partially blocking the new pipe

Photo No. 7 - Cavity noted above the crown of the new pipe.

Photo No. 8 - Water seeping into the cavity

Photo No. 9 – Disturbed riprap in the south riprap lined channel leading to the new pipe inlet (looking south)

Photo No. 10 - Looking West at the highway embankment side slope. Note that the slope is bare of vegetation

Photo No. 11 – Looking north at new cracks developed on the east embankment side slope (about 25 m above the culvert location)– Signs of localized slump above the culvert location

Photo No. 12 – Looking north at the highway surface. Note the pavement distress and the distortion of the guardrail within the dip area