ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
NORTH CENTRAL REGION – ATHABASCA
2019 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
NC070-1	Approximately 2 km northeast of Hangingstone River and 40 km south of Fort McMurray	Truck Staging Area	63:10	18.8
Legal Description		**UTM Co-ordinates (NAD 83)**		
SE ¼ and SW¼ -3-86-9-W4M		12 N 6253630 E 478921		

	Date	PF	CF	Total
Previous Inspection:	May 08, 2018	8	5	40 (TSA site)
Current Inspection:	June 11, 2019	8	5	40 (TSA site)
Road AADT:	7240		**Year:**	2018
Inspected By:	Tarek Abdelaziz, Jose Pineda (Thurber) Rishi Adhikari, Arthur Kavulok, Randy Hilligas (TRANS)			
Report Attachments:	☑ Photographs ☑ Plans ☐ Maintenance Items			

Primary Site Issue:	**West landslide:** A deep-seated landslide affecting the existing Truck Staging Area (TSA) facility and former highway lanes (currently Hwy 63 northbound lanes) at this location
Dimensions:	About 300 m wide (along the highway alignment) and 310 m long (from the south edge of the TSA pad to the north of the former highway north and southbound lanes)
Site History and Remediation	The TSA is located on the south side of Highway 63. Construction of the TSA facility commenced in late 2005/early 2006. A landslide developed in the spring of 2006 within the southeast side of the TSA backslope (referred to herein as the East Landslide). The remedial measures to stabilize the East Landslide, completed between fall 2006 and spring 2008, included the construction of a toe berm within the south side of the pad, raising the TSA pad by 0.8 m, backslope flattening above the berm, and installation of shallow sub-drains to reduce ground water levels within the backslope area. In spring 2008, upon completion of the remedial measures for the East Landslide and placement of the gravel base for the pad, a landslide developed in the southwest side of the site (referred to herein as the West Landslide) and affected the highway condition and the construction of the TSA pad. The landslide features included the appearance of seepage zones in the southwest backslope, formation of a geyser/spring immediately to the south edge of the pad, cracks on the southwest edge of the TSA and on the TSA pad, and diagonal crack and dip in the highway surface by the west entrance ramp. Additional sub-drains were installed in 2008 to reduce ground water levels within the southwest backslope area. Detailed inspection of the landslide area indicated that the landslide extended from the south edge of the TSA to the north side of existing highway. Due to the accelerated movement of the West Landslide at that time, it was decided not to pave the TSA pad and to re-visit the highway twinning plan at this location. Survey pins installed on the highway surface indicated that between 2006 and 2009, the highway shifted to the north by up to 1.25 m and bulged by about 300 mm due to the West landslide movement.

	Proposed remedial measures in winter 2009 to reduce the West landslide movement rates included the following three stages: **Stage 1:** Installation of two arrays of sub-horizontal drains to depressurize the sandstone aquifer. This measure was completed by Prairie North Construction Ltd. (PNCL) in November 2009 and included the installation of 51 sub-horizontal drains (22 in Manhole #1 and 29 and Manhole# 2), a common 300 mm diameter CSP outflow pipe, 500 mm diameter S.W.S.P below the highway, and a riprap lined channel at the north side of the highway; **Stage 2:** Breaching of a berm that was constructed in 2005/2006 to divert runoff from a gully to the west around the TSA; installation of eight sub-drains within the pad; construction of drainage channels and swales, and two centerline culverts to reduce ground water levels within the west landslide area and drain the wet areas located within the south side of the highway. This work was completed by Weinrich Contracting Ltd. (WCL) between January and July 2013 under AT Contract # 14112; ***Stage 3:*** Construction of an earth-fill toe berm on the north side of the highway. The construction of the West Landslide toe berm was completed in May 2015. The construction of the East Landslide toe berm started shortly after the completion of the construction of the west toe berm and was completed in October 2015. The as-constructed East Landslide toe berm was smaller in size than the designed berm due to the lack of borrow material. The berm construction work was supervised by EBA Tetra Tech under AT Contract # 15106. The construction of the West landslide berm included the installation of four perforated sub-drains (S1 to S4) below the footprint of the berm, the extension of the C2 CSP pipe using a 600 mm diameter HDPE pipe, and the extension of the riprap channel at the outlet of the C3 CSP pipe. The existing riprap channel at the outlet of the 500 mm diameter outflow pipe was extended further north between the berms. The riprap channels of sub-drain pipes S3 and S4 were tied into the riprap channel running to the north of the outlet of the 500 mm diameter outflow pipe located between the edges of the East and West Landslide toe berms. A final inspection of the berm area was completed by Thurber in July 2016 and the deficiencies were reported in a letter submitted to EBA on July 11, 2016. The deficiencies included re-contouring the slump occurred within the north side slope of the west landslide toe berm, surface drainage improvement of the highway north ditch to avoid ponding of water, cleaning up the accumulated sediment at the outlets of the new sub-drain pipes and the 500 mm diameter pipe, and re-shaping and armoring the new riprap channel in the area located between the edges of the toe berms.
Maintenance:	**TSA Site:** After construction completion of Stage 1 of the repairs in 2009, the existing diagonal crack near the west entrance ramp was sealed and an ACP patch was placed at the dip location to provide a smooth ride on the highway surface. Highway cracks were sealed in early 2015 under AT Contract # 15106. Highway cracks were sealed again in the summer of 2017. Highway cracks sealed in late 2017.

Observations:	Description	Worse?
☑ Pavement Distress	25 mm dip on the highway surface near the end of the west entrance ramp and in the highway surface near SI08-12; 50 to 75 mm dip on the highway surface near the east flank of the west landslide; cracks on the highway surface sealed in 2017 did not open	☐
☑ Slope Movement	Few longitudinal and diagonal cracks in the highway surface (sealed in 2017 and the majority were not open during the site visit); bulging of highway surface and shifting of highway to the north by about 1.25 m; about 100 mm of settlement/drop along the west side of the TSA pad bounded by previous head scarp cracks	☐
☐ Erosion		☐
☑ Seepage	No flow from the sub-horizontal drains in MH#2; a few of the drains are flowing in MH#1; no flow into MH#4; steady flow into MH#3, water slowly flowing out of the 500 mm CSP culvert connected to MH#1&#2 common outflow pipe; the outlet of the 500 mm diameter CSP pipe is completely buried under silt; steady flow from the outlets of the C3 culvert and the HDPE extension pipe; standing water at two locations to the south side of the entrance ramp between culverts C2 and C3; standing water in the riprap-lined channel to the south of the entrance ramp; backslope slump the east of the twin culverts blocks ditch drainage; none to minor flow from outlets of subdrain pipes S1, S2, S3 and S4; outlets of sub-drain pipes S1 and S2 are partially to fully buried under sediment	☐
☐ Bridge/Culvert Distress		☐
☑ Other	Highway backslope have grown bigger in size During winter time, icing issues have been noted along the entrance ramp near the C1 culvert. The C3 culvert pipe becomes plugged with ice during winter time. Vegetation growing on TSA pad; tall shrubs within the riprap lined channel to the south of C1 inlet	☐

Instrumentation: (23 SIs, 75 PZs)

East Landslide Area: The slope inclinometers either showed no perceptible movements or creep movements of 1.8 mm/yr. Groundwater levels did not change significantly in most of the piezometers.

In the pneumatic piezometers, the variations in ground water levels ranged from a reduction of less than 0.7 in PN09-3B m to an increase of 0.14 m in PN08-4.

The groundwater levels decreased in standpipe piezometers TH08-3, TH08-5, TH08-6, TH08-7 and PH08-1 by 0.02 m, 0.31 m, 0.14 m, 0.18 m and 0.85 m, respectively, since the fall of 2018 readings. The groundwater levels increased in vibrating wire piezometers VW17-2A, VW17-2B, VW18-7A and VW18-7B by 0.05 m, 0.07 m, 0.06 m and 0.07 m, respectively, since the fall of 2018 readings.

Vibrating wire piezometers VW17-2C, VW17-3A, VW17-3B, VW17-3C, VW18-5A, VW18-5B, VW18-5C, VW18-6A, VW18-6B, VW18-6C, VW18-7C, VW18-8A, VW18-8B and VW18-8C showed decreases in groundwater level ranging from 0.01 m to 1.57 m since the fall of 2018 readings.

West Landslide Area: The slope inclinometers either showed no perceptible movements or creep movements at rates varying between 0.1 and 2.9 mm/yr.

The groundwater levels decreased in pneumatic piezometers PN08-8, PN08-10, PN08-13, PN08-16, PN09-2B, PN09-10R and PN08-23A from 0.07 to 0.98 m since the fall of 2018 readings. Pneumatic piezometers PN08-11 and PN09-23B showed no change in groundwater level since the fall of 2018 readings.

PN09-2B, installed in the sandstone aquifer below the TSA pad continued to show a below groundwater level (i.e. 9.29 m in Spring 2019). PN09-23B, installed in the clay shale formation below the TSA pad continued to show an above ground water level of 10.99 m.

The groundwater levels increased in standpipe piezometers SP08-13, PH08-4, PH08-9 and PH08-14 from 0.02 m to 0.34 m since the fall of 2018 readings. The groundwater levels decreased in standpipe piezometers PH08-2, PH08-5, PH08-10, PH08-11, PH08-12, PH08-13, PH08-15, PH08-17 and PH08-18 from 0.01 m to 1.17 m since the fall of 2018 readings.

The groundwater levels decreased in vibrating wire piezometers VW11-12RA, VW11-12RB, VW12-15RB, VW12-25A, VW12-25B, VW12-26, VW12-27A, VW12-28B, VW12-29A and VW12-29B from 0.08 to 0.70 m since the fall of 2018 readings. The groundwater levels increased in VW12-5RA and VW12-28A by 0.03 m and 0.04 m, respectively, since the fall of 2018 readings.

VW11-12RB, VW12-15RB, VW12-25B, VW12-28B, and VW12-29B, installed within the clayshale formation below the west landslide toe berm, continued to show above groundwater levels ranging from 1.06 m in VW11-12RB to 6.89 m in VW12-25B.

The groundwater levels in the nested vibrating wire piezometers installed in the TSA pad (VW17-1A to VW17-1C) ranged from an increase of 0.21 m in VW17-1A to a decrease of 0.50 m in VW17-1B. VW17-1A and VW17-1B, installed in the clay shale formation showed groundwater levels of -4.71 m (above ground water level) and 5.52 m, respectively. VW17-1C, installed in the sandstone aquifer showed a below ground water level of 5.34 m.

Four of the MH#1 sub-horizontal drains were flowing at a total flow rate of 2.24 L/min. Three sub-horizontal drains in MH#2 were showing slow drips. The total flow rate increased by 1.16 L/min since the previous monitoring event in the fall of 2018.

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

In general, the site conditions did not change significantly since the last site visit completed in 2018.

East Landslide: The site observations and the instrument readings indicated the remedial measures implemented between 2008 and 2015 have been successful to reduce the landslide movement rates.

Although the size of the east toe berm is smaller than the original design due to the lack of borrow material, the existing berm has been effective to reduce the landslide movement rates.

West Landslide:

The site observations and current instrument readings indicate the landslide has continued to display creep movements since the implementation of Stages 1 to 3 of the repair measures.

The settlement of the pad is likely a reflection of the extremely slow consolidation process in response

to the implementation of Stage 1 of the remedial measures or an indication of the ongoing slow creep movement. It should be noted that the settlement of the pad may continue for several years to come until the consolidation settlement of the weak clay shale formation is completed. Although the ground water levels decreased significantly (by up to 15 m) in the deep sandstone aquifer and remained relatively unchanged afterwards, most of the deep piezometers installed in the clay shale formation below the pad only showed a slight reduction in the above-ground water levels since construction completion. Due to the high plasticity and low permeability of the clay shale formation, it will take several years to reduce ground water levels in the shale below the TSA pad surface. The progressive dissipation of pore water pressures will result in ongoing settlement of the TSA pad.

The outlets of the flowing sub-horizontal drains show silt accumulation, and the reduction in the flow rates from the sub-horizontal drain pipes indicates that the drains may get plugged in the future. In addition, the outlet of the outflow pipe is buried under silt, which could impede the drainage from the manholes, resulting in accelerated landslide movement if left untreated.

Subdrain pipes S1, S2, S3, and S4 may have been plugged and this may result in increase in groundwater levels below the west landslide toe berm.

The sub-drain pipe connected to MH#4 is not draining and this may result in further increase in ground water levels to the south of the TSA pad.

The highway back slope slump continues to block surface water flow in the south ditch of the highway. The existing slump may eventually affect the integrity of the existing power poles along the crest of the slope.

Poor surface water drainage within the ditch located to the south side of the entrance ramp may result in elevated ground water levels within the highway and is probably the main reason for the icing issue within the entrance ramp.

Recommendations:

Since the highway conditions did not change significantly over the last couple of years, it is recommended to skip the 2020 site inspection and visit the site again in 2021.

East landslide:

Continue to read the instruments on a semi-annual basis.

West landslide:

Continue to read the instruments on a semi-annual basis to assess the ongoing effectiveness of the implemented remedial measures (Stages 1 to 3).

Since the posted speed on the highway northbound lanes (i.e. former highway 63 northbound and southbound lanes) was increased to 110 km per hour, it is recommended that ACP overlay be placed at this location to smoothen the roadway surface.

It is necessary to establish a periodic maintenance protocol to flush the sub-horizontal drains and sub-drains installed below the pad to prevent increases in ground water levels in response to progressive plugging of the drain pipes (guidelines to do this work were provided to the local MCI). In addition, the flow from the C3 culvert pipe will need to be monitored and the pipe should be steamed, as required, so that the surface water can drain freely during winter time. The inability to maintain the C3 culvert may result in flooding the highway surface during the spring season and elevated ground water levels to the south side of the highway.

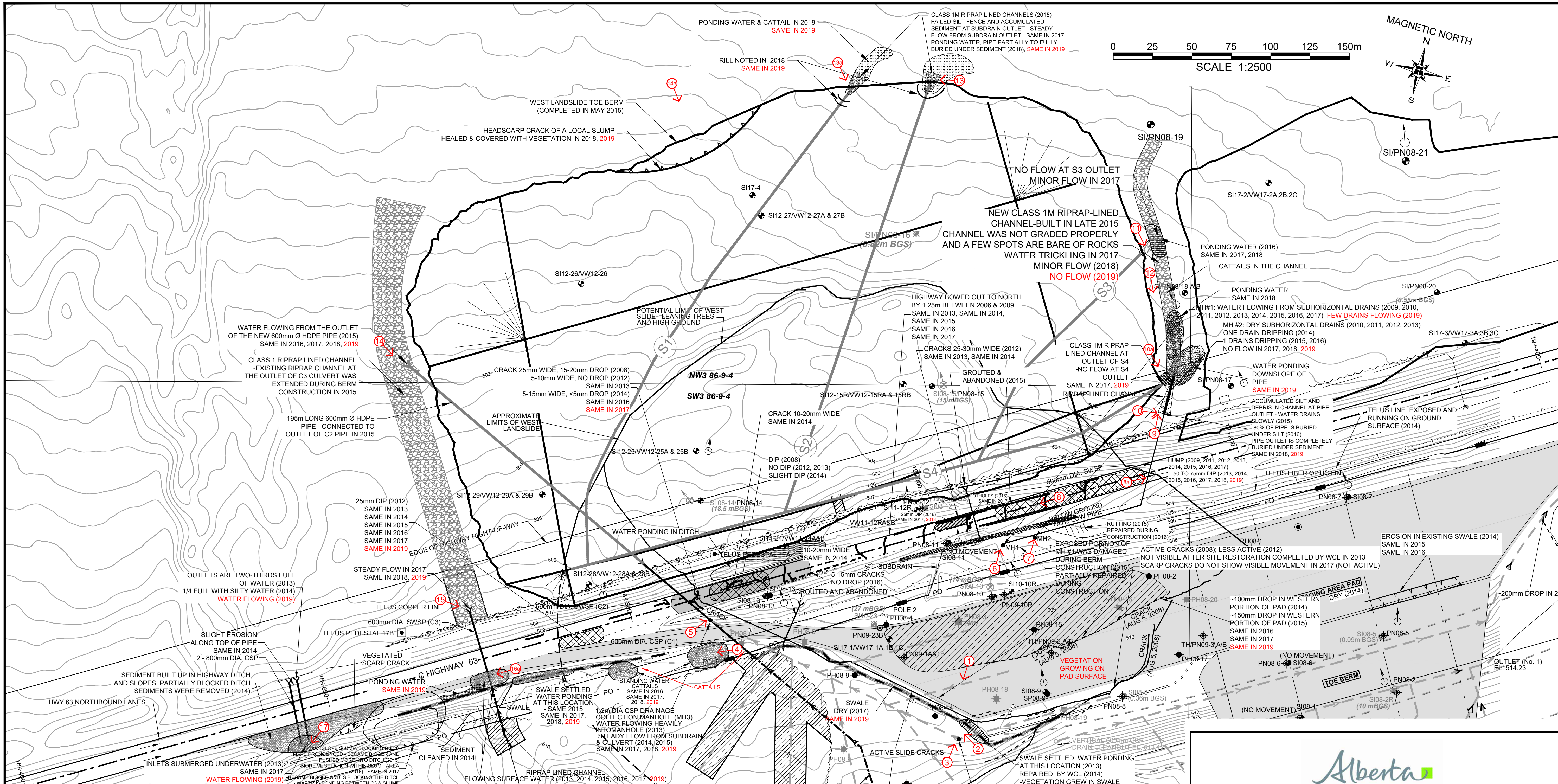
It is crucial to expose the outlet of the 500 mm diameter outflow pipe, remove accumulated sediment at the outlet, and to regrade the riprap channel at the outlet of the pipe between the east and west landslide toe berms to enhance surface drainage.

It is also necessary to remove accumulated sediment at the outlets of subdrain pipes S1 and S2,

located to the north side of the highway, and to expose the outlets of these pipes. Flushing of subdrain pipes S1 to S4 is also recommended to enhance sub-surface drainage below the west landslide toe berm.

Consideration should be given for enhancing the surface drainage characteristics of the swale/ditch located to the south of the entrance ramp between the C1 culvert and the highway twin culverts. It is recommended to drain the standing water to the south of the ramp into the existing swale. In addition, minor grading of the bottom of the ditch is recommended at the slump location (i.e. remove the least amount of dirt) to improve the drainage in the ditch. Alternatively, consideration may be given for auger boring a smooth wall steel pipe below the toe of the slump. This will require salvaging existing riprap from the existing swale, re-shaping/deepening of the existing swale/ditch, armoring the new ditch, and negotiations with TELUS.

If a periodic maintenance program is implemented for the drainage measures, the TSA facility could be open to public, but the pad surface will need to be cleared of vegetation and slightly re-surfaced with gravel. Paving the TSA pad should be delayed to reduce the cost of future maintenance. Frequent maintenance of the pad surface will be required since it is anticipated that that the settlement of the clay shale formation due to depressurization of the sandstone aquifer will continue to occur for several years.



MAGNETIC NORTH
N
W
E
S
0 25 50 75 100 125 150m
SCALE 1:2500
PONDING WATER & CATTAIL IN 2018
SAME IN 2019
CLASS 1M RIPRAP LINED CHANNELS (2015)
FAILED SILT FENCE AND ACCUMULATED SEDIMENT AT SUBDRAIN OUTLET - STEADY FLOW FROM SUBDRAIN OUTLET - SAME IN 2017
PONDING WATER, PIPE PARTIALLY TO FULLY BURIED UNDER SEDIMENT (2018), SAME IN 2019
RILL NOTED IN 2018
SAME IN 2019
WEST LANDSLIDE TOE BERM (COMPLETED IN MAY 2015)
HEADSCARP CRACK OF A LOCAL SLUMP HEALED & COVERED WITH VEGETATION IN 2018, 2019
SI/PN08-19
SI/PN08-21
NO FLOW AT S3 OUTLET
MINOR FLOW IN 2017
SI17-4
SI12-27/VW12-27A & 27B
SI17-2/VW17-2A,2B,2C
NEW CLASS 1M RIPRAP-LINED CHANNEL-BUILT IN LATE 2015
CHANNEL WAS NOT GRADED PROPERLY AND A FEW SPOTS ARE BARE OF ROCKS
WATER TRICKLING IN 2017
MINOR FLOW (2018)
NO FLOW (2019)
PONDING WATER (2016)
SAME IN 2017, 2018
CATTAILS IN THE CHANNEL
SI12-26/VW12-26
PONDING WATER
SAME IN 2018
MH#1: WATER FLOWING FROM SUBHORIZONTAL DRAINS (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017) FEW DRAINS FLOWING (2019)
MH #2: DRY SUBHORIZONTAL DRAINS (2010, 2011, 2012, 2013)
ONE DRAIN DRIPPING (2014)
1 DRAINS DRIPPING (2015, 2016)
NO FLOW IN 2017, 2018, 2019
SI/PN08-20
SI17-3/VW17-3A,3B,3C
HIGHWAY BOWED OUT TO NORTH BY 1.25m BETWEEN 2006 & 2009
SAME IN 2013, SAME IN 2014, SAME IN 2015, SAME IN 2016, SAME IN 2017
POTENTIAL LIMIT OF WEST SLIDE - LEANING TREES AND HIGH GROUND
WATER FLOWING FROM THE OUTLET OF THE NEW 600mm Ø HDPE PIPE (2015)
SAME IN 2016, 2017, 2018, 2019
CLASS 1 RIPRAP LINED CHANNEL -EXISTING RIPRAP CHANNEL AT THE OUTLET OF C3 CULVERT WAS EXTENDED DURING BERM CONSTRUCTION IN 2015
CRACK 25mm WIDE, 15-20mm DROP (2008)
5-10mm WIDE, NO DROP (2012)
SAME IN 2013
5-15mm WIDE, <5mm DROP (2014)
SAME IN 2016
SAME IN 2017
NW3 86-9-4
SW3 86-9-4
CRACKS 25-30mm WIDE (2012)
SAME IN 2013, SAME IN 2014
GROUTED & ABANDONED (2015)
CLASS 1M RIPRAP LINED CHANNEL AT OUTLET OF S4
-NO FLOW AT S4 OUTLET
SAME IN 2017, 2019
RIPRAP-LINED CHANNEL
WATER PONDING DOWNSLOPE OF PIPE
SAME IN 2019
ACCUMULATED SILT AND DEBRIS IN CHANNEL AT PIPE OUTLET - WATER DRAINS SLOWLY (2015)
-80% OF PIPE IS BURIED UNDER SILT (2016)
PIPE OUTLET IS COMPLETELY BURIED UNDER SEDIMENT
SAME IN 2018, 2019
TELUS LINE EXPOSED AND RUNNING ON GROUND SURFACE (2014)
195m LONG 600mm Ø HDPE PIPE - CONNECTED TO OUTLET OF C2 PIPE IN 2015
APPROXIMATE LIMITS OF WEST LANDSLIDE
SI12-15R/VW12-15RA & 15RB
CRACK 10-20mm WIDE
SAME IN 2014
SI12-25/VW12-25A & 25B
DIP (2008)
NO DIP (2012, 2013)
SLIGHT DIP (2014)
HUMP (2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017)
- 50 TO 75mm DIP (2013, 2014, 2015, 2016, 2017, 2018, 2019)
TELUS FIBER OPTIC LINE
500mm DIA. SWSP
25mm DIP (2012)
SAME IN 2013
SAME IN 2014
SAME IN 2015
SAME IN 2016
SAME IN 2017
SAME IN 2019
SI12-29/VW12-29A & 29B
EDGE OF HIGHWAY RIGHT-OF-WAY
WATER PONDING IN DITCH
SI 08-14/PN08-14 (18.5 mBGS)
SI11-12R
VW11-12RA&B
RUTTING (2015)
REPAIRED DURING CONSTRUCTION (2016)
EXPOSED PORTION OF MH #1 WAS DAMAGED DURING BERM CONSTRUCTION (2015), PARTIALLY REPAIRED DURING CONSTRUCTION
ACTIVE CRACKS (2008); LESS ACTIVE (2012)
NOT VISIBLE AFTER SITE RESTORATION COMPLETED BY WCL IN 2013
SCARP CRACKS DO NOT SHOW VISIBLE MOVEMENT IN 2017 (NOT ACTIVE)
EROSION IN EXISTING SWALE (2014)
SAME IN 2015
SAME IN 2016
TELUS PEDESTAL 17A
10-20mm WIDE
SAME IN 2014
5-15mm CRACKS
NO DROP (2016)
GROUTED AND ABANDONED
SUBDRAIN
NO MOVEMENT
OUTLETS ARE TWO-THIRDS FULL OF WATER (2013)
1/4 FULL WITH SILTY WATER (2014)
WATER FLOWING (2019)
STEADY FLOW IN 2017
SAME IN 2018, 2019
SI12-28/VW12-28A & 28B
TELUS COPPER LINE
600mm DIA. SWSP (C2)
600mm DIA. SWSP (C3)
TELUS PEDESTAL 17B
600mm DIA. CSP (C1)
~100mm DROP IN WESTERN PORTION OF PAD (2014)
~150mm DROP IN WESTERN PORTION OF PAD (2015)
SAME IN 2016
SAME IN 2017
SAME IN 2019
STAGING AREA PAD
DRY (2014)
~200mm DROP IN 2015
SLIGHT EROSION ALONG TOP OF PIPE
SAME IN 2014
2 - 800mm DIA. CSP
VEGETATED SCARP CRACK
HIGHWAY 63
VEGETATION GROWING ON PAD SURFACE
(NO MOVEMENT)
TOE BERM
OUTLET (No. 1) EL. 514.23
SEDIMENT BUILT UP IN HIGHWAY DITCH AND SLOPES, PARTIALLY BLOCKED DITCH - SEDIMENTS WERE REMOVED (2014)
HWY 63 NORTHBOUND LANES
PONDING WATER
SAME IN 2019
SWALE SETTLED -WATER PONDING AT THIS LOCATION - SAME 2015
SAME IN 2017, 2018, 2019
STANDING WATER, CATTAILS
SAME IN 2016
SAME IN 2017, 2018, 2019
CATTAILS
1.2m DIA CSP DRAINAGE COLLECTION MANHOLE (MH3)
WATER FLOWING HEAVILY INTO MANHOLE (2013)
STEADY FLOW FROM SUBDRAIN & CULVERT (2014, 2015)
SAME IN 2017, 2018, 2019
SWALE
DRY (2017)
SAME IN 2019
ACTIVE SLIDE CRACKS
SWALE SETTLED, WATER PONDING AT THIS LOCATION (2013)
REPAIRED BY WCL (2014)
-VEGETATION GREW IN SWALE
-WATER PONDING IN THE SWALE
SAME IN 2018, 2019
SEDIMENT CLEANED IN 2014
INLETS SUBMERGED UNDERWATER (2013)
SAME IN 2017
WATER FLOWING (2019)
RIPRAP LINED CHANNEL
FLOWING SURFACE WATER (2013, 2014, 2015, 2016, 2017, 2019)
ESTIMATED LIMIT OF SEMI-ACTIVE LANDSLIDE
RIPRAP LINED CHANNEL
STEADY SURFACE WATER FLOW (2013, 2014, 2016, 2017)
-CATTAIL GROWING (2018)
TALL BUSHES IN CHANNEL (2019)
CRACK (OCT, 2009)
1.2m DIA CSP DRAINAGE COLLECTION MANHOLE (MH4)
NO FLOW INTO MANHOLE (2014)
SAME IN 2015, SAME IN 2016, NO FLOW INTO MANHOLE, WATER IS 3m FROM TOP OF MANHOLE
SAME IN 2018, 2019
INLET PARTIALLY BLOCKED AND FULLY SUBMERGED UNDERWATER
ROCK REMOVED FROM THE PIPE BY WCL (2014)
PARTIALLY BLOCKED WITH VEGETATION (2017)
- CLEARED OF VEGETATION
- GOOD FLOW
SAME IN 2018, 2019
SW3 86-9-4
ADDITIONAL DROP ACROSS BACKSLOPE SCARP CRACKS
-300mm DROP (2015)
100mm DROP (2019)
- MORE VEGETATION WITHIN SCARP CRACK AREA
EDGE OF RIGHT-OF-WAY

LEGEND

- STANDPIPE PIEZOMETERS (PH08-13)
- PNEUMATIC PIEZOMETER (PN) (PN08-1)
- SLOPE INCLINOMETER (SI) (SI08-1)
- VIBRATING PIEZOMETER (VW) (VW12-1)
- BUSH LINE
- POWER POLE AND OVERHEAD POWER LINE
- BURIED TELUS LINE
- ABOVE GROUND SHAW CABLE
- DAMAGED / SHEARED OFF STANDPIPE OR SLOPE INCLINOMETER
- EXISTING SUBDRAIN
- SWALE
- APPROXIMATE LOCATIONS OF TELUS PEDESTALS 17A & 17B
- HIGHWAY CENTERLINE
- ASPHALT PATCH
- EXISTING CULVERT
- DIRECTION OF MOVEMENT (18.7 mBGS) DEPTH AT WHICH INSTRUMENT IS SHEARED OFF/BROKEN
- PHOTOGRAPH NUMBER AND APPROXIMATE LOCATION AND DIRECTION

NOTES:

1. IN 2012, TELUS INSTALLED A 7m DEEP CABLE BETWEEN PEDESTALS 17A & 17B AND ABANDONED THE EXISTING BURIED CABLE ONLY BETWEEN THESE LOCATIONS.
2. IN 2012, SHAW INSTALLED A 7m DEEP CABLE IN THE NORTH DITCH, BETWEEN STATIONS 18+660 AND 19+210, AND ABANDONED THE EXISTING ABOVE GROUND CABLE FOR A DISTANCE OF ABOUT 550m ALONG THE HIGHWAY ALIGNMENT.
3. SUBDRAINS S1 TO S4 ARE 200mm Ø PERFORATED PIPES AND WERE INSTALLED DURING BERM CONSTRUCTION IN 2015.
4. CRACKS ON HIGHWAY SURFACE WERE SEALED DURING WEST BERM CONSTRUCTION IN 2015.
5. THE HIGHWAY NEW SOUTHBOUND LANES WERE CONSTRUCTED IN 2015 TO THE NORTH OF THE TOE OF THE WEST LANDSLIDE. FORMER HIGHWAY LANES PRIOR TO CONSTRUCTION ARE CURRENTLY THE HIGHWAY NORTHBOUND LANES.
6. JUNE 11, 2019 OBSERVATIONS ARE SHOWN IN RED.

Alberta

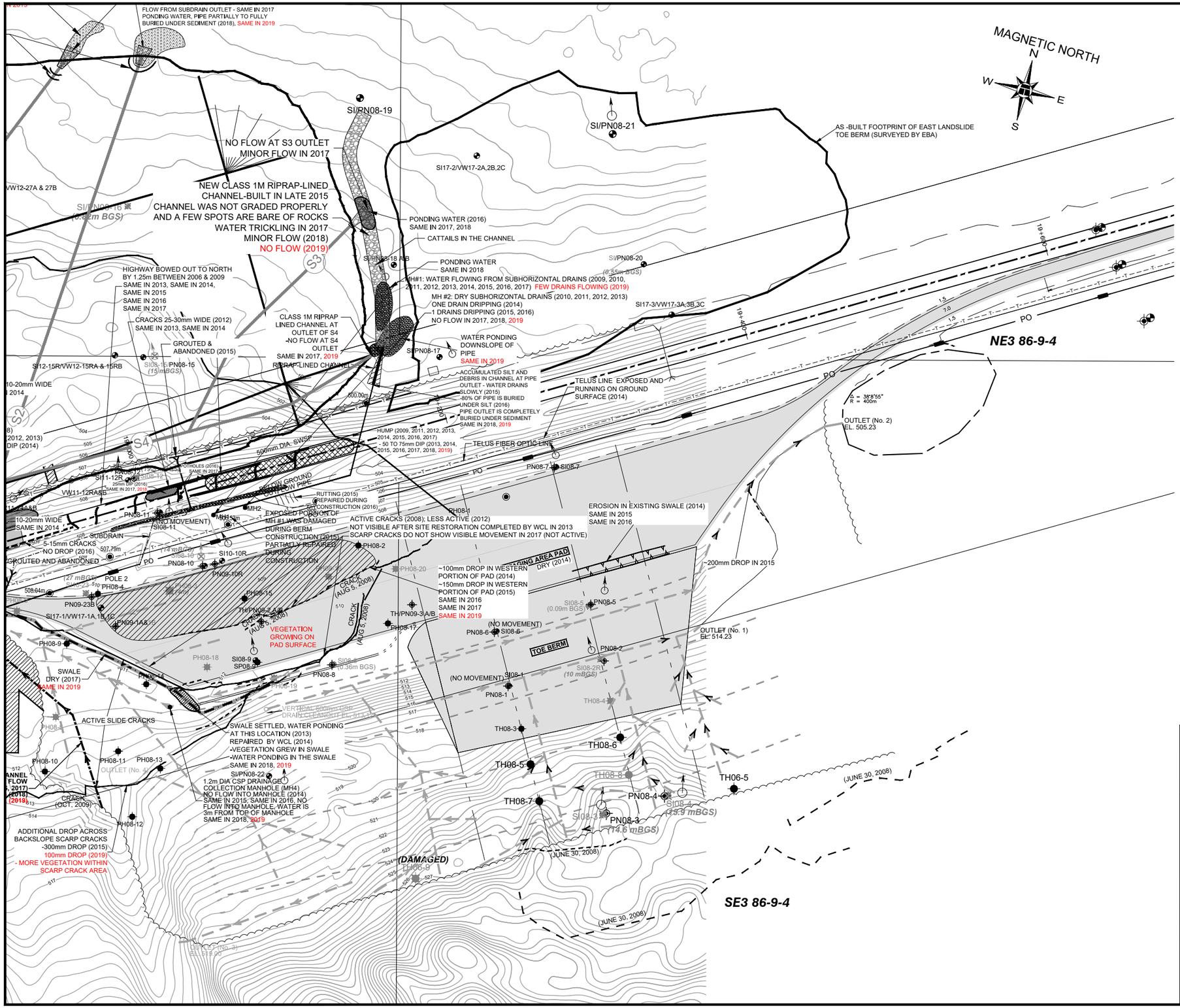
NORTH CENTRAL REGION (ATHABASCA AREA) 2019 GEOHAZARD ASSESSMENT

NC070-1: HWY 63:10 TRUCK STAGING AREA SITE PLAN

DWG No. 13357-NC070-1-1

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:2500
DATE	SEPTEMBER 2019
FILE No.	13357

THURBER ENGINEERING LTD.



LEGEND

- PH08-13 — STANDPIPE PIEZOMETERS
- PN08-1 — PNEUMATIC PIEZOMETER (PN)
- SI08-1 — SLOPE INCLINOMETER (SI)
- VW12-1 — VIBRATING PIEZOMETER (VW)
- BUSH LINE
- PO — POWER POLE AND OVERHEAD POWER LINE
- T — BURIED TELUS LINE
- S — ABOVE GROUND SHAW CABLE
- 507.67m — BURIED LINE HYDROVAC LOCATION / ELEVATION
- DAMAGED / SHEARED OFF STANDPIPE OR SLOPE INCLINOMETER
- EXISTING SUBDRAIN
- SWALE
- APPROXIMATE LOCATIONS OF TELUS PEDESTALS 17A & 17B
- HIGHWAY CENTERLINE
- ASPHALT PATCH
- EXISTING CULVERT
- 517 — EXISTING GROUND ELEVATION CONTOUR
- DIRECTION OF MOVEMENT (18.7 mBGS) DEPTH AT WHICH INSTRUMENT IS SHEARED OFF / BROKEN

NOTES:

1. IN 2012, TELUS INSTALLED A 7m DEEP CABLE BETWEEN PEDESTALS 17A & 17B AND ABANDONED THE EXISTING BURIED CABLE ONLY BETWEEN THESE LOCATIONS.
2. IN 2012, SHAW INSTALLED A 7m DEEP CABLE IN THE NORTH DITCH, BETWEEN STATIONS 18+660 AND 19+210, AND ABANDONED THE EXISTING ABOVE GROUND CABLE FOR A DISTANCE OF ABOUT 550m ALONG THE HIGHWAY ALIGNMENT.
3. TELUS AND SHAW CABLES WERE RELOCATED IN 2015 DURING THE CONSTRUCTION OF THE EAST AND WEST LANDSLIDE TOE BERMS.
4. JUNE 11, 2019 OBSERVATIONS ARE SHOWN IN RED.

0 25 50 75 100 125 150m

SCALE 1:2500

Alberta

NORTH CENTRAL REGION (ATHABASCA AREA) 2019 GEOHAZARD ASSESSMENT

NC070-1: HWY 63:10 TRUCK STAGING AREA SITE PLAN SHOWING EXISTING INSTRUMENT LOCATIONS

DWG No. 13357-NC070-1-2

DRAWN BY	ML
DESIGNED BY	JGP
APPROVED BY	TSA
SCALE	1:2500
DATE	SEPTEMBER 2019
FILE No.	13357

THURBER ENGINEERING LTD.

Photo No.1 – West landslide vegetated head scarp crack (Looking South)

Photo No.2 – Looking west at the riprap-lined swale to the south of the TSA pad; minor water ponding within the swale

Photo No.3 – Manhole # 4; note that no flow was observed, and water was measured at 3 m from top of manhole

Photo No.4 – Looking at highway south ditch to the west of the TSA pad; note standing water and cattail vegetation (Looking West)

Photo No.5 – Manhole #3; note steady flow from the subdrain and culvert pipes

Photo No.6 – Manhole 1; note water flowing from sub-horizontal drains

Photo No.7 – Manhole 2; no water was observed

Photo No.8 – HWY 63 NBL; note presence of a hump and dip on highway lanes near the western flank of landslide (Looking West); highway cracks did not open since they were sealed in 2017

Photo No.8a – HWY 63 NBLs; not presence of a hump and dip on highway lands near the eastern flank of landslide (Looking East); highway cracks did not open since they were sealed in 2017

Photo No.9 – Water Ponding in the riprap channel located downslope of the 500 mm outflow pipe (Looking North)

Photo No.10 – Ponding water, accumulated silt and debris at the outflow pipe outlet. Pipe is buried under sediment

Photo No.10a – Subdrain S4; no flow observed

Photo No.11 – Subdrain S3; no flow observed

Photo No.12 – Water Ponding within the riprap lined channel located between the east and west landslide berms (Looking South)

Photo No.13 – Subdrain pipe outlet S2; pipe was completely buried under silt; water was ponding at the outlet of the pipe

Photo No.13a – Subdrain pipe outlet S1; pipe was partially buried under silt; water was ponding at the outlet of the pipe

Photo No.14 – C2 extension (600 mm HDPE pipe outlet); water is flowing out of the pipe

Photo No.14a – Vegetated head scarp crack of an old local slump on the north side of the western toe berm (Looking South)

Photo No.15 – C3 culvert outlet; water is flowing out of the pipe

Photo No.16 – Looking south at the highway back slope slump; note that the toe is blocking the ditch flow

Photo No.16a –Water ponding within the section of the vegetated riprap -lined swale located to the east of the backslope slump (looking west from the east of the slump)

Photo No.17 – Two 800 mm SWSP culvert inlets; note existing erosion around the SWSP inlets (looking south)