ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION – GRANDE PRAIRIE DISTRICT
2020 INSPECTION

THURBER ENGINEERING LTD.

Site Number	Location	Name	Hwy	km
GP28	West of Whitecourt	2 Creeks - 0.4 km east of Bridge	43:12	34.5
Legal Description		**UTM Co-ordinates (NAD 83)**		
SW27-61-16-W5		11U N 6,017,300 E 543,965		

	Date	PF	CF	Total
Previous Inspection:	May 13, 2019	7	5	35
Instrumentation Visit:	Sept 26, 2019	11	5	55
Current Inspection:	June 18, 2020	11	5	55
Road AADT:	7,560		**Year:**	2019
Inspected By:	Barry Meays (Thurber) Roger Skirrow, Ed Szmata (AT)			
Report Attachments:	☑ Photographs ☑ Plans ☑ Maintenance Items			

Primary Site Issue:	Landslide cutting across most of the eastbound lanes of the twinned highway, and toeing out in the creek. Also, high groundwater levels affecting the pavement subgrade/surface.	
Dimensions:	Slide about 80 m along highway by 150 m to the creek. Wet subgrade affecting ~500 m of eastbound lanes and 60 m of westbound lanes.	
Date of any remediation:	In 2003, 1 m deep pavement drains installed beneath the eastbound lanes highway surface, along with a 315 m long, average 2.5 m deep, 400 mm dia. subdrain installed along the median, that outlets via a culvert beneath the eastbound lanes to the creek (the median subdrain was connected to an existing subdrain that was already draining the original westbound lanes). In 2015, installation of two pumps in pump wells with discharge lines connected to the 2003 median subdrain, along with a power connection from the overhead power lines, and a central monitoring station which relays some of the information remotely. Also, Class 2 riprap was keyed into the base of a 100-m length of the north edge of the creek and up along the bank, to protect the creek bank from toe erosion.	
Maintenance:	Semi regular crack filling, patching, overlaying of the eastbound lanes takes place, with some less frequent patching of the westbound lanes. Both highway directions were overlayed in 2017. The power supply for the pump was damaged by a vehicle and repaired in 2017.	
Observations:	**Description**	**Worse?**
☑ Pavement Distress	On May 13, 2019, only two short pavement cracks (5 m long in the EB shoulder and 6 m long in the EB driving lane) were visible which had reflected through the 2017 overlay. In the fall of 2019 this crack had opened up and reflected more continuously through the eastbound lanes, & was up to 75mm wide and 0.4 m deep in 2020.	☑
☑ Slope Movement	The slide continues to move, at rates varying up to 30 mm/yr, depending on the groundwater levels and the effectiveness of the pumping system into the subdrains.	☑
☑ Erosion	Some along the north ditch west of the culvert inlets.	☑
☑ Seepage	Seepage zones exist in the site area at random locations along the valley slope.	☐

☐ Bridge/Culvert Distress		☐
☑ Other	The manhole cover was missing over the culvert that the subdrain carries flow beneath the hwy eastbound lanes.	☑

Instrumentation read Oct 1, 2020/Remote data updated Nov. 10, 2020**: SI02-2** = 2 mm/yr @12.5 to 14m – Was blocked/repaired and probe can't go down past blockage depth; **SI15-13** = was moving at 22 mm/yr @ 12.5 to 14.5 m in 2019 [before Shearing Off at 14.6m in fall, 2019].

Piezometers mBGS: SP02-05=4.5, SP02-07=2.6, SP02-08=3.2. VWP15-13U=5.7, VWP15-13L=Dry @ 18.3, SP14-2=2.3, MW14-3=1.9, MW14-4=1.9, MW14-5=3.0, PW14-1=1.7, MW14-6=2.1, MW14-7=2.3, PW14-2=2.5, PW15-3=2.4, MW15-12=13.2, MW14-8=1.8, MW14-9=1.7, MW14-10=8.6, MW14-11=16.5.
Precip. Gauge Data: Showed above average precipitation from October, 2019.

NOTE: Almost all of the piezometers indicated slightly lower recorded groundwater levels in the fall, 2020 compared to the spring, 2020 levels.

Assessment:

The original highway (now the westbound lanes) was constructed in 1958. Twinning of the new highway with eastbound lanes took place in 2000/2001, and cracks were noted immediately after construction. A geotechnical investigation was performed by Thurber in 2002, that included the installation of 3 inclinometers and some piezometers, which led to the 2003 remedial measures listed above. A high groundwater table exists in this area, complicated by numerous seepage areas. It was found that the slide movement is occurring along a carbonaceous shale layer at a depth of about 14 m below surface near the treeline downstream of the highway, and movements are sensitive to groundwater levels.

In August 2014 a preliminary engineering study also provided some conceptual design alternatives for landslide stabilization. One alternative was a pile wall. The second (lower cost) alternative was addressing subdrainage to further lower the groundwater table, consisting of a Stage 1 horizontal directional drill (HDD) installed with a perforated pipe outletting near the west end of the site, or (Stage 2) a series of tangent vertical drains filled with drainage gravel that allows gravity drainage from east to west through the slide zone. Armoring the creek bank with riprap was considered a supplementary remedial measure that could benefit both alternatives.

Another geotechnical investigation was performed by Thurber in November 2014, as part of flood mitigation contract 15746, to address the subdrainage alternative. It consisted of the installation of 10 monitor wells and 2 pump wells. The Stage 1 subdrainage option was modified to include the installation of pump wells to lower the water table, after detailed design discussions for the HDD option indicated the effectiveness could be very limited. This led to the 2015 remedial measures described above (which included installation of one additional pump well and one monitoring well), as part of Construction Contract #16793.

PW15-3 had been pumping steadily (excluding power disruptions) since construction completion in November 2015, until November 2016, when a semi-truck hit the power source and it became non-functional. In January 2017, the slightly shallower PW14-2 was turned on and it had been pumping steadily until October 18, 2017 when it ceased functioning for unknown reasons. On Aug. 29, 2017 a Call Out was performed to help identify the problem in PW15-3, and it was determined that there is something wrong with the pump (either an electrical connection down at the pump, or the pump may be silted up in the well). Similar potential problems are presumed for PW14-2. Both pumps having a 90 gal/min capacity were set at 60 gal/min during installation, however the flow volume control was somewhat questionable. The deeper seated PW15-3 has a slightly larger radius of effectiveness. Recorded movements were about 7 mm/year during operation of PW15-3 in 2016, and were about 10 mm/year during operation of PW14-2 in 2017. With neither well pumping, the recorded movements increased to an average of 20 mm/year since the fall of 2017. The impact of variable seasonal precipitation was not accounted for in these average movements. Between spring and fall of 2019, the rate of movement had increased, shearing off SI15-13 at a depth of14.6 m, and re-opened a continuous crack across the highway eastbound lanes (likely the former slide scarp reflected through the 2017 overlay).

The pumping has somewhat limited effectiveness, keeping the groundwater levels in the vicinity of the headscarp of the slide lower than static levels, but perhaps not as low as desired. The slide movements appear quite sensitive to groundwater level fluctuations. Increased precipitation events or during spring

thaw cause higher groundwater levels, which appear to increase slide movements. The movements noted in the summer of 2016 with PW15-3 pumping were during a period of higher than usual precipitation. Power disruptions cause the pump to shut down, and create near instantaneous recharge levels in the site vicinity. Conversely, after pumping resumes again, it takes some time to re-attain the lowered groundwater levels achieved prior to pump shutoff.

Recommendations:

Maintenance:

- Crack filling, milling, patching, and/or overlays should be performed on the affected hwy on an as-required basis.
- Remove all of the silt fence from this site that was placed during construction.
- Replace the missing cover from the Manhole covering the subdrain that diverts water southwards beneath the eastbound hwy lanes, and install warning marker posts to avoid somebody falling in and mowers damaging it in the future.

Short Term:

The slide should be regularly monitored for progression of slide movements, especially during spring thaw and periods of high precipitation. If significant movements in the road occur during an event, the eastbound lanes may have to be temporarily shut down and traffic re-routed to the westbound lanes, while repairs are implemented.

Continue monitoring the effects of the pumping (once the pump wells are functional) for performance information (groundwater levels and related movements). The flow rate(s) may be able to be adjusted slightly from their current 60 gal/min settings, but will first require some experimentation during the repair/maintenance visit.

However, currently both PW15-3 and PW14-2 are non-functional. A maintenance/cleaning visit should be performed preferably prior to spring flows (and should be routinely scheduled every 2 years or so). The PW15-3 and PW14-2 assemblies need to be removed from the pump wells, then: 1) Water-jet and airlift (with a compressor) to clean up and re-generate the well to help prevent plugging and to blow out debris accumulation. The power overloading should be assessed by checking and repairing (if necessary), all wires and switches. 2) Adjust the position of the low-level shutoff and high-level turn-on indicators. 3) Set-up a warning signal (or alarm via e-mail) to alert the remote monitoring system when low pump or high water levels and/or pump shutoff (or power shutdown) has occurred. This could be performed by programming it into the system if the telemetry is still operational, however a possible trip to the site may be required if it doesn't work properly by on-line programming.

A proposal has been submitted to AT for trouble-shooting the two pump wells PW15-3 and PW14-2, blowing out/cleaning up the wells, checking the electrical connections, and repairing (or replacing) the pumps. This was performed in Nov. 2020 and overseen by the maintenance contractor, with Thurber assistance, and a summary report will follow.

Estimated Cost = $75,000

Medium Term

Consider installing the Stage 2 Tangent Vertical Drains, described in our 2015 geotechnical investigation. However, an additional pump may need to be installed at the downstream end to lift water up to the median subdrain culvert (slightly above creek elevation), so that it could flow into the creek.

Estimated Cost = $3 million

Long Term

Install a 105-m long cantilever pile wall (if feasible, depends on additional geotechnical investigation and analysis) along the south edge of the pavement;

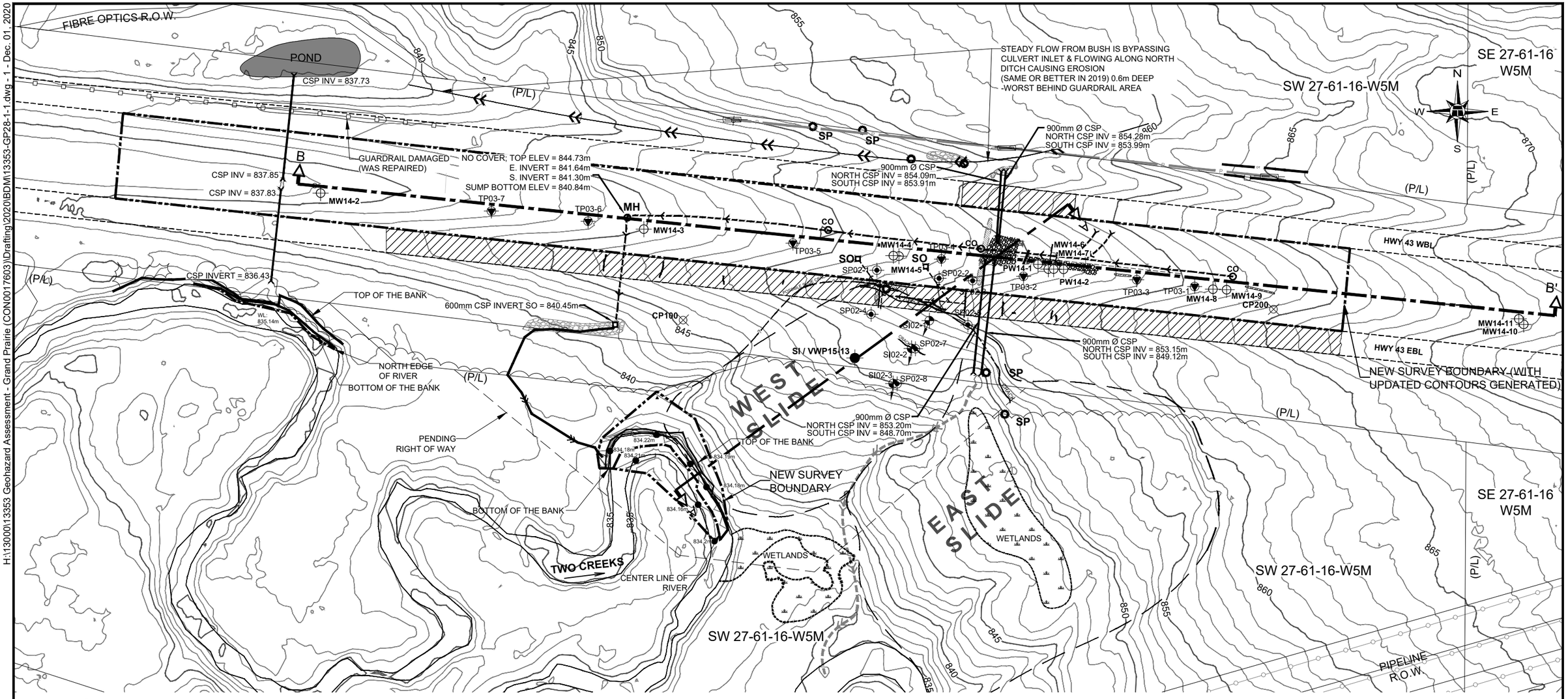
Estimated Cost = $4 million

OR

Install a 135 m long tied-back pile wall ~20 m from the edge of pavement

Estimated Cost = $7.5 million

H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\BDM\13353-GP28-1-1.dwg - 1 - Dec. 01, 2020



LEGEND

- CHANNEL - CONTINUOUS FLOW
- CHANNEL - INTERMITTENT FLOW
- SUBDRAIN PIPE (400mm Ø)
- SLIDE OUTLINE
- CRACK — HIGHWAY CRACKS OBSERVED IN 2003 & 2014
- HIGHWAY CRACKS SURVEYED NOVEMBER 9, 2015
- ACP PATCH
- 2014 MONITOR WELL / PUMP WELL LOCATION
- RIP RAP
- TP03- TEST PIT AND YEAR INSTALLED
- SI02- INCLINOMETER AND YEAR INSTALLED
- SP02- STANDPIPE PIEZOMETER AND YEAR INSTALLED
- POWER POLE
- P — OVERHEAD POWER LINE
- OT — BURIED TELUS LINE
- ROHL GEOMATICS (BURIED)
- SP SPRING
- SO SUBDRAIN OUTLET
- TREE LINE
- (P/L) PROPERTY LINES (P/L)
- HIGHWAY SHOULDER
- CO CLEANOUT
- CREEK WATER ELEVATIONS
- CP100 BENCHMARK
- APPROXIMATE INSTRUMENT LOCATION (2015)
- VWP VIBRATING WIRE PIEZOMETER
- SI SLOPE INCLINOMETER

NOTES:

1. FEATURES SURVEYED BY WSP ON NOV. 4, 2014.
2. TREE LINE COULD VARY FROM WHAT IS SHOWN FOR EAST SLIDE AREA DUE TO RECENT FORESTRY ACTIVITIES.
3. JUNE 18, 2020 FEATURES SHOWN IN RED.

0 20 40 60 80 100 120m
SCALE 1:2000

Alberta

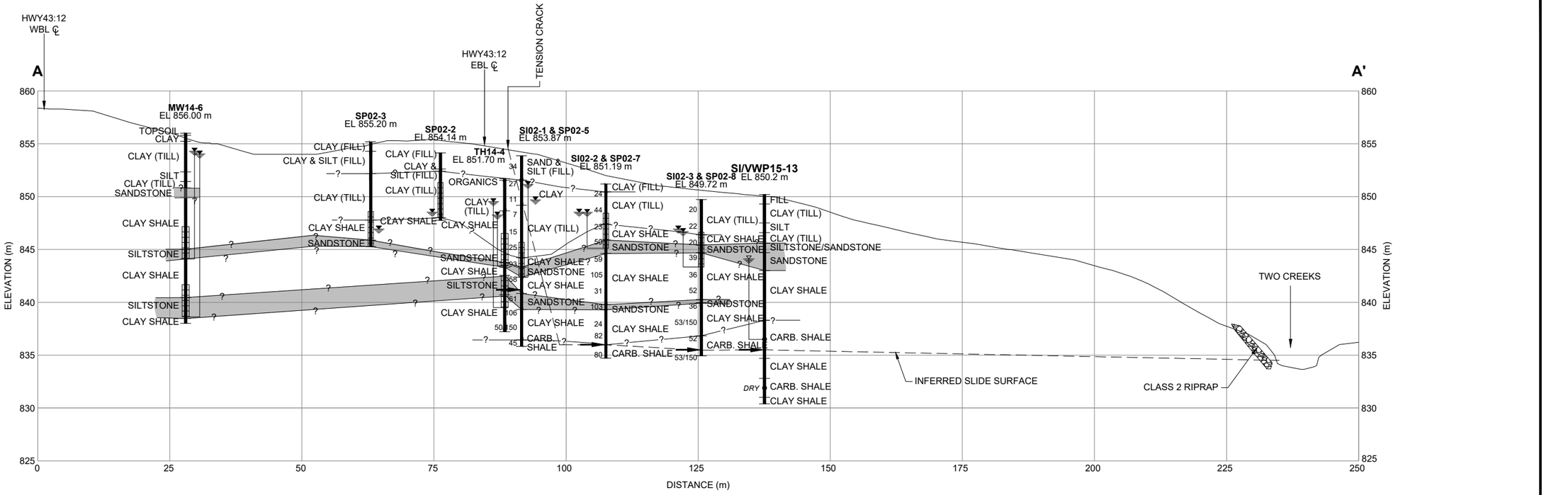
PEACE REGION (GRANDE PRAIRIE)
GP28-1: HWY 43:12 km 34.3 TO 35.0 TWO CREEKS

2020 INSPECTION PLAN

DWG No. 13353-GP28-1-1

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:2000
DATE	JUNE 18, 2020
FILE No.	13353

THURBER ENGINEERING LTD.



LEGEND

- 15 — SPT N VALUE
- WATER LEVEL IN PIEZOMETER (JANUARY 29, 2015, EXCEPT WHERE NOTED)
- STANDPIPE PIEZOMETER OR PUMP WELL SCREENED INTERVAL
- DEPTH OF MOVEMENT IN SLOPE INCLINOMETER
- WATER LEVEL IN PIEZOMETER (NOVEMBER 20, 2015)
- VIBRATING WIRE PIEZOMETER TIP

- TP03- TEST PIT AND YEAR INSTALLED
- SI02- INCLINOMETER AND YEAR INSTALLED
- SP02- STANDPIPE PIEZOMETER AND YEAR INSTALLED
- MW14- MONITOR WELL AND YEAR INSTALLED
- SANDSTONE / SILTSTONE LAYERS

NOTES:

1. 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.
2. VERTICAL SCALE EXAGGERATED.
3. JUNE 18, 2020 FEATURES SHOWN IN RED.

Alberta

PEACE REGION (GRANDE PRAIRIE)
GP28-1: HWY 43:12 km 34.3 TO 35.0 TWO CREEKS

CROSS-SECTION A-A'

DWG No. 13353-GP28-1-2

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	H 1:800 V 1:400
DATE	JUNE 18, 2020
FILE No.	13353

THURBER ENGINEERING LTD.

H:\13000\13353 Geohazard Assessment - Grand Prairie (CON0017603)\Drafting\2020\BDM\13353-GP28-1-3.dwg - 3 - Dec. 01, 2020

FRESH DITCH EROSION

ELECTRICAL TRANSFORMER, METER SOCKET, HOUSING, AND STAND INSTALLED

ROUGH AREA

INSTALLED GUARDRAILS (SEE SHEET 7 FOR DETAILS)

NO COVER; TOP ELEV = 844.73m
E. INVERT = 841.64m
S. INVERT = 841.30m
SUMP BOTTOM ELEV = 840.84m

REPAIRED MANHOLE
MH LID MISSING IN 2020

900mm Ø CSP
NORTH CSP INV = 854.28m
SOUTH CSP INV = 853.99m

900mm Ø CSP
NORTH CSP INV = 854.09m
SOUTH CSP INV = 853.91m

STEADY FLOW IN SUBDRAIN (SAME)

6m LONG CRACK IN EASTBOUND DRIVING LANE

INSTALLED PUMP AND MONITOR WELLS

SEEPAGE

CRACK

INTERMITTENT CRACK

CONTINUOUS CRACK

DIP

SLIGHT DIP

600mm CSP INVERT SO = 840.45m
(STEADY FLOW - 140mm DEEP)

REPAIRED CLEANOUT

900mm Ø CSP
NORTH CSP INV = 853.15m
SOUTH CSP INV = 849.12m

3 - 3m LENGTHS OF SILT FENCE STILL EXIST, AND A 20m LONG x 0.2m DEEP x 0.3m WIDE EROSION GULLY. OTHERWISE EVERYTHING LOOKS GOOD

900mm Ø CSP
NORTH CSP INV = 853.20m
SOUTH CSP INV = 848.70m

GRAVEL PLACED TO FLATTEN / SMOOTH SIDE SLOPE

SI/VWP15-13

INSTALLED GEOTECHNICAL INSTRUMENTATION

COLLAPSED SILT FENCE

WEST SLIDE

MAIN SLIDE CRACK UP TO 75mm WIDE & UP TO 0.4m DEEP (OPEN VERTICAL) & UP TO 30mm ELEVATION DROP ACROSS CRACK (SOUTH SIDE LOWER)

KNOB ROUGH

SILT FENCE

STEADY FLOW - RIPRAP WORKING WELL

INSTALLED RIPRAP ARMOURING (GOOD SHAPE)

PENDING RIGHT OF WAY

WATER FLOW IN CREEK IS BEING DIRECTED LATERALLY ACROSS THE STREAM INTO THE FRONT FACE OF RIPRAP

TWO CREEKS

CENTER LINE OF RIVER

WETLANDS

SW 27-61-16-W5M

EAST SLIDE

WETLANDS

LEGEND (SEE DRAWING 13353-GP28-1-1 FOR FULL LEGEND)

- 2015 MONITOR WELL / PUMP WELL LOCATION
- GEOTECHNICAL INSTRUMENTATION
- DIRECTION AND NUMBER OF PHOTO

NOTES:

1. FEATURES SURVEYED BY WSP BETWEEN NOV. 4, 2014 AND NOV. 10, 2015.
2. CREEK WATER LEVEL APPROXIMATELY 834.2m ON NOV. 4, 2014.
3. UPPER DRAINAGE SYSTEM WORKING GOOD.
4. JUNE 18, 2020 FEATURES SHOWN IN RED.

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

Alberta

PEACE REGION (GRANDE PRAIRIE)
GP28-1: HWY 43:12 km 34.3 TO 35.0 TWO CREEKS

2020 INSPECTION PLAN

DWG No. 13353-GP28-1-3

DRAWN BY	ML
DESIGNED BY	BDM
APPROVED BY	DWP
SCALE	1:1000
DATE	JUNE 18, 2020
FILE No.	13353

THURBER ENGINEERING LTD.

Photo 1 – Looking east at some fresher erosion, caused by flow coming from the bush and bypassing the culvert inlets, and flowing westwards along the south highway ditch.

Photo 2 – Looking west along the north ditch at former erosion from flow further east that has grassed in.

Photo 3 – Looking at a missing lid overtop of the manhole west of the instrumentation that directs water southwards beneath the hwy.

Photo 4 – Looking east along the median at the instrumentation and guardrails from the highway cross culverts.

Photo 5 – Looking west along the median at the two pump wells and the Central Monitoring Station (CMS). There are still a couple of small sparsely grassed areas beside the CMS.

Photo 6 – Looking east along the median at a minor erosion gully. Note the silt fence still remaining east of the central monitoring station.

Photo 7 – Looking south at the inside of the CMS (control panel door closed).

Photo 8 - Looking west along the open slide crack in the highway eastbound lanes. Note the slight dip in the highway south of this crack.

Photo 9 - Looking southeast at the main scarp crack along the south edge of the pavement. Note the subtle scarp extending southeast of the hwy along the top edge of the knob.

Photo 10 – Looking east at the crack along the outside edge of the EB driving lane.

Photo 11 - Looking southeast across the riprap armouring the creek.

Photo 12 – Looking southwest at the riprap armour. The creek flows adjacent to the front face of the riprap, however no erosion has taken place on the unprotected bank.

Photo 13 – Looking east across the riprap armour.

Photo 14 - Looking north at the subdrain outlet and riprapped drainage channel south of the highway.