

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2021 INSPECTION**



| Site Number | Location | Name | Hwy | km |
|-------------------|--------------------|--------------------|-----------|-------|
| PH043A | Daishowa East Hill | Site A - Pile Wall | 986:01 | 33.45 |
| Legal Description | | UTM Co-ordinates | | |
| NE7-85-20 W5M | | 11V E 491380 | N 6246075 | |

| | Date | PF | CF | Total |
|-----------------------------|---|----|---------------------------------------|-------|
| Previous Inspection: | 11-Jun-2020 | 6 | 4 | 24 |
| Current Inspection: | 5-Jul-2021 | 6 | 4 | 24 |
| Road WAADT: | 840 | | Year: | 2020 |
| Inspected By: | Ed Szmata, TRANS Kristen Tappenden, TRANS Max Shannon, TRANS | | Don Proudfoot, TEL Tyler Clay, TEL | |
| Report Attachments: | <input checked="" type="checkbox"/> Photographs <input checked="" type="checkbox"/> Plans <input checked="" type="checkbox"/> Maintenance Items | | | |

| | | |
|--|--|-------------------------------------|
| Primary Site Issue: | <p>Roadway constructed across major landslide. Embankment originally stabilized by diverting unnamed creek on north side of roadway through a culvert within toe berm constructed across valley bottom (Photo 43-05). Embankment failed up to roadway requiring installation of a cantilever pile wall in 2004. Shallow slumping below the wall subsequently. Culvert outlet also became unstable and was eroding/ 'headcutting' through toe berm.</p> <p>Mitigation measures were completed between 2017 to 2019 that involved construction of a gabion drop structure and overflow channel to reduce rates of the creek erosion. The work also included the installation of a driven steel pile retaining wall to allow the construction of the drop structure; further regrading work across the embankment slope that slid during construction; and the construction of an armored swale to repair an erosion gully down the east edge of the embankment fill sideslope.</p> | |
| Dimensions: | Unstable roadway embankment approximately 225 m in length. Distance from roadway to toe of slope approximately 110 m. | |
| Maintenance: | | |
| Observations: | Description | Worsened? |
| <input type="checkbox"/> Pavement Distress | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Slope Movement | <p>During mitigation work a slide was initiated within the lower slope near the new drop structure that was mitigated via a driven steel pile wall (Photo 43-03). There is shallow slide activity with minor retrogression and expansion at the west end of the older buried tangent pile wall on the upper embankment (Photo 43-02). Previous cracking further east from this area have been graded during the mitigation work (Photo 43-01 and 43-04). No evidence of slope movement was observed upslope of the buried pile wall (Photo 43-01).</p> | <input checked="" type="checkbox"/> |

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|--|---|-------------------------------------|
| <input checked="" type="checkbox"/> Erosion | Erosion rills observed at the steel pile wall (Photo 43-03). Vegetation is much more established relative to the 2020 inspection. At the culvert inlet (km 33+500) the south channel bank had worse erosion and additional riprap had fallen away. (Photo 43-06). The swale riprap at the east end of Site A had been washed out (1.7 m wide, 0.8 m deep) and an erosion gully had formed likely the result of a high flow event. (Photo 43-13) | <input checked="" type="checkbox"/> |
| <input type="checkbox"/> Seepage | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Bridge/Culvert Distress | Gabion drop structure had some additional silt buildup at the base (Photo 43-03). Silt buildup at the culvert inlet (Photo 43-06). | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Other | No significant beaver activity noted at the creek between Sites A and B (Photo 43-07). | <input type="checkbox"/> |
| <p>Instrumentation:</p> <p>Spring 2021 measurements: East end of Site A berm</p> <ul style="list-style-type: none"> ▪ SI-4 – Movement at 1.4 mm/yr between 2.6 m to 6.3 m depth, 1.0 mm/yr between and 6.3 m to 8.1 m. ▪ SI-5 – Damaged (last reading June 2020). ▪ SI-6 –No discernible movement over 0.1 m to 5.0 m depth and a rate of movement of 2.9 mm/yr over 5.0 m to 6.8 m depth. <p>Buried Tangent Pile Wall</p> <ul style="list-style-type: none"> ▪ SI04-1 – 4.7 mm/yr between 0.1 m to 2.6 m (above wall); No movement between 1.9 m to 22.1 m (within wall) ▪ SI04-3 – No movement between 0.1 m to 1.4 m (above wall); 6.7 mm/yr between 1.4 m to 20.9 m (within wall) <p>Upslope of roadway</p> <ul style="list-style-type: none"> ▪ SI03-6 – Creep over 4.7 m to 6.0 m depth. <p>Groundwater</p> <ul style="list-style-type: none"> ▪ Pneumatic piezometers PN03-1 and PN03-2 showed decreases in groundwater level of 0.03 m and 0.05 m, respectively, since the fall of 2020 readings. | | |
| <p>Assessment:</p> <p>Pile wall appears to be limiting sliding of area upslope of the wall and is protecting the west portion of Site A embankment. The repair work should reinforce the embankment toe and reduce rates of soil loss from this area and the potential of destabilizing the upper embankment slope.</p> <p>Slide activity in the lower part of the valley slope was initiated during construction that was mitigated via driven steel piles which appears effective. Instruments at the existing buried tangent pile wall indicated increased shallow slide movement rates but this is attributed to the lower slide activity during construction. There is ongoing slide activity directly below the west end of the old wall but it appears shallow and not currently a direct threat to the highway. The embankment above the old pile wall has not exhibited signs of slide movement and slide related pavement damage has not been observed.</p> <p>Erosion and sedimentation buildup was observed around the new erosion mitigation structures. Some maintenance / warranty work is required around the culvert inlet but overall erosion potential is expected to reduce as vegetation becomes better established. The swale riprap requires repair to prevent expansion of the erosion damage. Due to the gradient in this area it may need to have</p> | | |

angular riprap or gabion mattress installed at a select points as check dams to offer containment and help reduce flow energy to reduce the risk of future washouts.

Recommendations:

Cost

Monitoring:

Continue to monitor instruments twice yearly and undertake annual inspections.

Maintenance:

Sediment buildup at the culvert should be monitored and cleaned out as required.

Maintenance work required at the culvert inlet, swale riprap south channel bank requires shaping and additional riprap placement. \$ 30,000

Remove sand accumulation from side of roadway, which is causing channelization of surface runoff, resulting in erosion rills on embankment (maintenance). \$ 10,000

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.

Don Proudfoot, P.Eng.
Principal | Senior Geotechnical Engineer

Tyler Clay, P.Eng.
Geological Engineer

**ALBERTA TRANSPORTATION
GEOHAZARD ASSESSMENT PROGRAM
PEACE REGION (PEACE RIVER DISTRICT)
2021 INSPECTION**



| | | | | |
|--------------------------|--------------------|-------------------------|------------|-----------|
| Site Number | Location | Name | Hwy | km |
| PH043B | Daishowa East Hill | Site B | 986:01 | 33.74 |
| Legal Description | | UTM Co-ordinates | | |
| NW8-85-20 W5M | | 11V E 491630 | | N 6245925 |

| | | | | |
|-----------------------------|--|---------------------------------------|---|--------------|
| | Date | PF | CF | Total |
| Previous Inspection: | 11-Jun-2020 | 7 | 4 | 28 |
| Current Inspection: | 5-Jul-2021 | 7 | 4 | 28 |
| Road WAADT: | 840 | Year: | | 2020 |
| Inspected By: | Ed Szmata, TRANS Kristen Tappenden, TRANS Max Shannon, TRANS | Don Proudfoot, TEL Tyler Clay, TEL | | |
| Report Attachments: | <input checked="" type="checkbox"/> Photographs | | <input checked="" type="checkbox"/> Maintenance Items | |
| | <input checked="" type="checkbox"/> Plans | | | |

| | | | |
|--|--|-------------------------------------|--|
| Primary Site Issue: | An unnamed creek was diverted through a culvert located under a toe berm downslope of the roadway embankment. The culvert was undersized to handle the spring runoff, which overflowed and eroded the west sideslope of the toe berm. Between 2017 to 2019 mitigation was implemented that consisted of construction of a gabion drop structure, riprap berm, and armored culvert inlet within the creek area. The work also included construction of a swale to repair an erosion gully down the east edge of the highway embankment sideslope and lining the highway ditch further east with gabion mattress and ECM.(Photos 43-09 to 43-19) | | |
| Dimensions: | Embankment is about 175 m long and extends 150 m below roadway to toe of slope. | | |
| Maintenance: | . | | |
| Observations: | Description | Worsened? | |
| <input type="checkbox"/> Pavement Distress | | <input type="checkbox"/> | |
| <input checked="" type="checkbox"/> Slope Movement | A landslide in the natural creek valley slope has moved and severed the CPP downpipe. | <input checked="" type="checkbox"/> | |
| <input checked="" type="checkbox"/> Erosion | South ditch erosion has been repaired with TRM near km 34+125 (Photos 43-09). Minor rills were noted between the road and north ditch gabion armour at km 34+000 (Photo 43-10) Previous area of erosion rills at top of embankment at the east end of the site has been graded and TRM installed with vegetation regrowth starting (Photo 43-12). Where the TRM ends at the west end of the site there was increased rill erosion near km 33+650 | <input checked="" type="checkbox"/> | |

| | | |
|--|--|-------------------------------------|
| | (Photo 43-19) Ongoing erosion was noted near the outlet of the CPP down pipe (33+800) due to a leaking joint caused by a local landslide movement (Photo 43-16). No new issues noted at armored swale, gabion drop structure or riprap berm (Photos 43-08 43-11, 43-18). | |
| <input type="checkbox"/> Seepage | | <input type="checkbox"/> |
| <input checked="" type="checkbox"/> Bridge/Culvert Distress | Culvert inlet at 33+800 is still damaged from high flow event and has severely reduced flow capacity. Additional riprap above the inlet had collapsed above it and slid down partially burying it (Photo 43-15). The gabion baskets and mattresses in the bottom two steps of the drop structure have locally settled over the culvert alignment but don't show any significant change in condition since completing the grouting repairs in 2019 (Photo 43-08). | <input checked="" type="checkbox"/> |
| <input checked="" type="checkbox"/> Other | Sediment buildup near the culvert inlet indicative of a flooding during a high flow event. (Photo 43-15) Overland flow and construction access area soils had good vegetation regrowth (Photo 43-17). | <input type="checkbox"/> |
| <p>Instrumentation:</p> <p>Spring 2020 Readings</p> <ul style="list-style-type: none"> ▪ SI-7 – No discernible movement measured. ▪ SI-8 –No movement over 0.3 m to 1.5 m depth, creep over 1.5 m to 4.0 m depth. ▪ SI-9 –No movement over 0.3 m to 2.7 m depth. | | |
| <p>Assessment:</p> <p>The culvert and erosion control mitigation work should reinforce the embankment toe and reduce rates of soil loss from this area and the potential of destabilizing the upper embankment slope. Current erosion control measures appear mostly effective in controlling drainage at the site with the exception of the lower embankment culvert inlet (33+800) which has become damaged apparently during a high flow event. The culvert inlet requires repairs to restore full drain capacity. The end slope of the inlet should be cut steeper and shorter and possibly lined with a stronger SWSP (or reinforced within a concrete headwall) to resist hydraulic uplift forces. The riprap around the culvert needs to be reconfigured and should be "benched" into the slope as is practical to reduce displacement and sliding. The CPP downpipe requires repairs at a leaking joint, which was caused by a local landslide in the lower valley slope.</p> <p>During the spring of 2018 a sinkhole developed beside the lower portion of the drop structure, caused by water flowing under pressure from a separated joint in the underlying C.S.P. culvert creating a subsurface void. The void was grouted and the sinkhole backfilled, however distortions to the overlying gabion baskets/mattresses remain. It is believed the outlet of the C.S.P., which sits in the flow dissipation bowl, froze underwater filling the pipe and than eroding the sinkhole out the side of the pipe and drop structure. Evidence of further void development have not been observed since this repair.</p> | | |

The current instrumentation indicates minor shallow movement (less than 3 m depth) at creep-like rates. No visual indicators of landslide movement are apparent on the slope. The SI closest to the highway (SI-7) has not measured movement.

| Recommendations: | Cost |
|-------------------------|-------------|
|-------------------------|-------------|

Monitoring:

Continue to monitor instruments twice yearly and undertake annual inspections.

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Maintenance:

The outlet of the drop structure should be carefully cleared of excess ice and the outlet of the CSP steamed open in early Spring to reduce the risk of another sinkhole forming.

Repairs required at the culvert inlet at the creek including, inlet replacement, riprap placement and reconfiguration, and joint repair at the CPP down pipe.

\$150k

Remove sand accumulation from side of roadway which is causing channelization of surface runoff on embankments and highway ditch.

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.

Don Proudfoot, P.Eng.
Principal | Senior Geotechnical Engineer

Tyler Clay, P.Eng.
Geological Engineer



STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

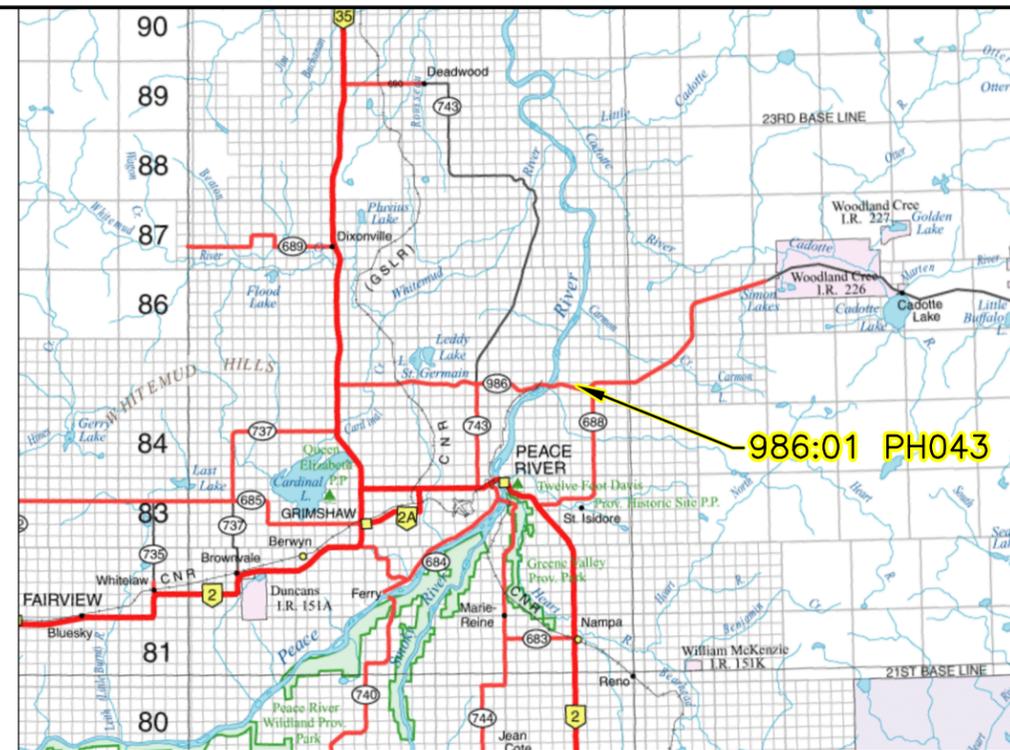
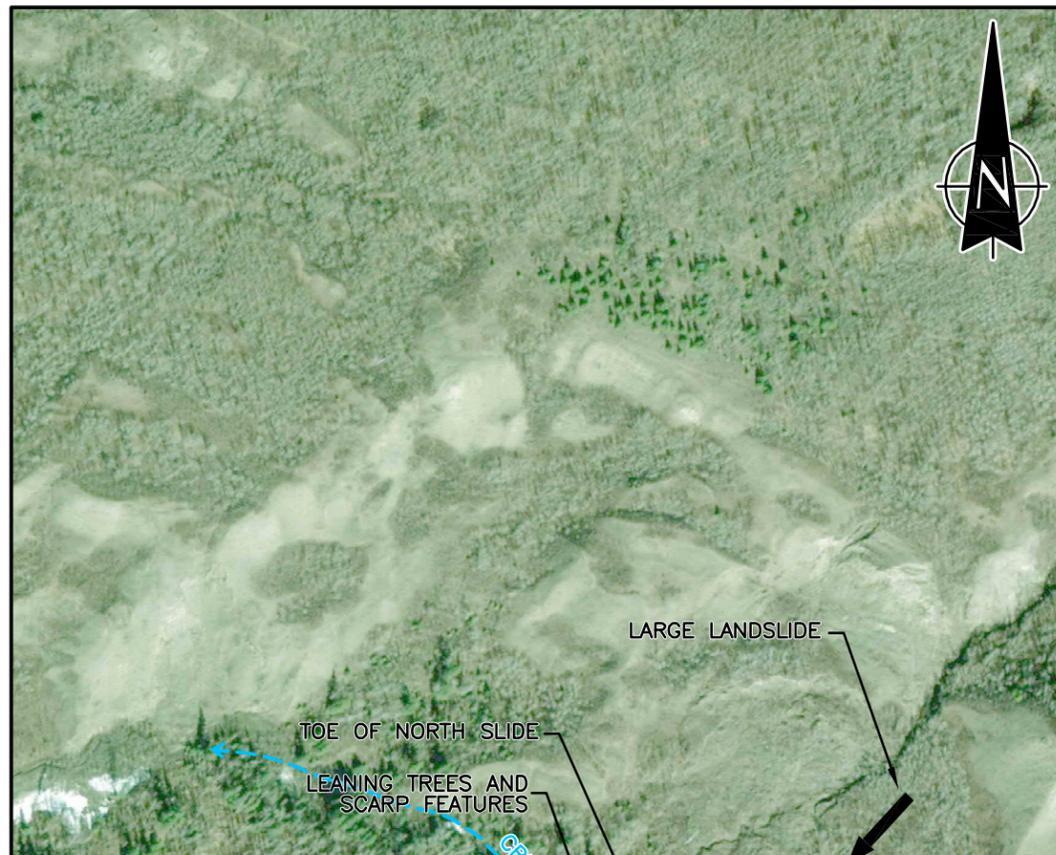
- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

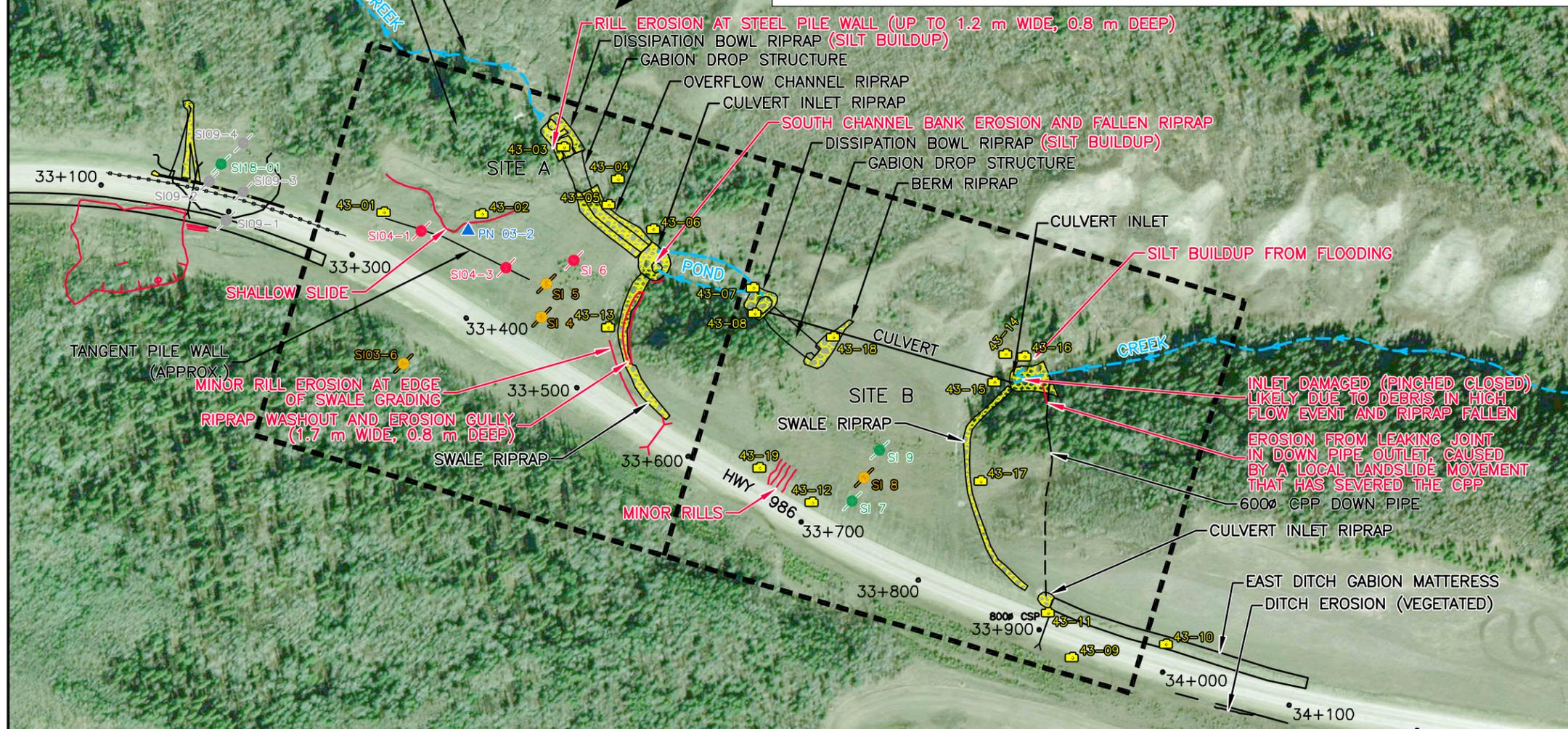
7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.



KEY MAP
SCALE 1:1 000 000

- LEGEND:
- HORIZONTAL CHAINAGE ● 32+100
 - PHOTOGRAPH LOCATION 📷 43-01
 - SLOPE INCLINOMETER
 - NO MOVEMENT
 - CREEP
 - MEASURABLE MOVEMENT (OR RECENTLY SHEARED)
 - PIEZOMETER ▲ PN 004
 - PH41 BOUNDARY - - - - -
 - ARMOURRED CHANNEL 🟡
 - EXTENT 2003 LANDSLIDE - - - - -



- NOTES:
- 1 DRAWING MUST BE USED IN CONJUNCTION WITH THE ATTACHED REPORT REFERENCE 32121 DATED OCTOBER 2021 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 CHAINAGE ARE SHOWN APPROXIMATE ONLY.
 - 4 BASED ON FIELD OBSERVATIONS ON JULY 5, 2021.



PEACE REGION (PEACE RIVER DISTRICT)

**DAISHOWA
HWY 986:01 (PH043)
LOCATION PLAN**

FIGURE PH043-1

| | |
|-------------|------------------|
| DRAWN BY | ICB |
| DESIGNED BY | TTC |
| APPROVED BY | DWP |
| SCALE | 1:4 000 |
| DATE | OCTOBER 12, 2021 |
| FILE No. | 32121-A3D |





Photo 43-01.
At the west edge of Site A looking east towards the buried tangent pile wall. Slope shaping and straw matting was installed within this portion of the slope due to slide movement and access disturbance for the culvert repairs. No change from 2020.



Photo 43-02.
Main slide scarp of active shallow failure downslope of the buried pile wall (33+325) first observed in 2017. Area is vegetated and has shown only minor retrogression and expansion since the previous inspection.



Photo 43-03. Overflow gabion drop structure and dissipation bowl at the previous culvert outlet that had extensive erosion and gully erosion below Site A (33+430). Some rill erosion was noted within the fill areas that were still vegetating. Base of drop structure had a large amount of silt buildup. Minor change from 2020 condition.



Photo 43-04. Looking southwest at the area of previous slumping associated with culvert erosion below pile wall (33+430). Area has since been graded and finished with straw matting.



Photo 43-05.
 Standing at the top of the gabion drop structure looking east towards the overflow channel riprap (33+450). Vegetation has re-established.



Photo 43-06.
 Looking south towards the culvert inlet riprap, riprap swale, and debris deflector (33+500). Note south channel bank erosion, silt buildup and erosion within the riprap swale. Worse from the 2020 condition.



Photo 43-07.
Looking west towards Site A at creek upstream of culvert inlet to Site A (33+500). No significant beaver dam construction was noted.



Photo 43-08.
View of the gabion drop structure and riprap dissipation bowl at the culvert outlet at Site B. (33+600). Vegetation has established well and no apparent additional gabion deformation near the culvert sink hole (left side).



Photo 43-09.
South ditch TRM installation at Site B to repair erosion damage and mitigate against future erosion (34+125).



Photo 43-10.
Looking east towards the north ditch gabion mattress installation at Site B (34+00).



Photo 43-11.
View of culvert inlet and riprap protection near 33+900 on north side of road.



Photo 43-12.
Looking west towards the TRM installation on the upper portion of the slope north of the road (33+700). Some vegetation growth has started.



Photo 43-13. Looking south, upslope towards washed out riprap and extensive erosion damage within the riprap swale at the east side of Site A (33+500), likely the result of a high-flow event.



Photo 43-14. Site B culvert inlet with riprap protection and steel H-beam debris deflector. Inlet become severely damaged and blocked with fallen riprap during a high flow event in 2019/2020 (33+800). Repairs required in this area.



Photo 43-15.
Damage around culvert inlet due to a high flow event. Culvert pipe at the inlet was effectively pinched and twisted shut and was filled with woody debris. Riprap above the inlet had collapsed and slid down over it. Repairs required in this area (33+800).



Photo 43-16.
Looking south towards the outlet of the CPP down pipe near the culvert inlet (33+800). Rill erosion was noted to be occurring upslope from the pipe outlet due to a leaking joint that requires repair. Increased gully erosion was noted on the right side of the pipe.



Photo 43-17.
Looking west towards the highway slope, overland flow area of Site B.



Photo 43-18.
View of the riprap berm located near the top of the gabion drop structure (33+650)



Photo 43-19.
View of the minor rill erosion near the top of the embankment of Site B (33+650) where TRM is not installed.