

TECHNICAL MEMORANDUM

To: Hardy Bartle, P. Eng.
MOFLNRO - COASTAL ENGINEERING GROUP
103-2100 Labieux Road
Nanaimo, BC V9T 6E9

From: Eryne Croquet, M. Sc., P. Ag., P. Geo.

Date: November 20, 2018

RE: November 2018, Lost Creek/Lost Murdo FSR Landslide Investigation

Eryne Croquet, M. Sc., P. Ag., P. Geo. of Statlu and Garry Davidson, RFT inspected a landslide near the Lost Creek and Lost Murdo FSRs on November 8, 2018. The landslide occurred sometime between October 31 and November 2, 2018. A local resident notified the Chilliwack Natural Resource District about the landslide on Friday, November 2, suggesting that it most likely occurred November 1 or perhaps October 31. The failure is located on the west-facing slopes near the toe of Mount St. Benedict, about 4 km east of the south end of Stave Lake. The landslide track is about 500 m long (Figure 1). It started from a non-status road, crossed Lost Murdo FSR (FSR number 8466.02), then Lost Creek FSR (8466.01), to deposit just below the road within Davis Lake Provincial Park. The latitude and longitude coordinates for the headwall are Lat. 49.29335, Long. 122.22297.

There was significant rainfall between October 31 and November 3, 2018. Rainfall measured at the Mission West Abbey climate station, about 18 km south of the landslide, showed 24 mm rain on Oct. 31, 48 mm rain on Nov. 1, 4 mm on Nov. 2, and 37 mm on Nov. 3. The rainfall totals where the slide occurred were probably greater than at the climate station due to orographic and topographic differences between the sites. Intense rainfall triggered, or contributed to the triggering of, the landslide.

The slide appears to have started as a debris flow. It either became a debris flood as it lost debris while crossing the Lost Murdo FSR, or was followed by a debris flood. The flow deposited most of its sediment on Lost Murdo FSR. The flood deposits include organic matter and woody debris upslope of where the slide crossed Lost Murdo FSR and the deposit on Lost Creek FSR.

OBSERVATIONS

Scarp

The landslide started from the fillslope of a non-status road where a small stream (S6) crosses the road. There did not appear to be a culvert at the crossing. Water from the stream was flowing down the non-status road instead of across or under it. The small stream built a fan composed of sands that filled the ditch and extended about 1 m onto the road. The road grade is about 5% near the slide initiation zone. Water was pooling on the road surface above the slide scarp (Photo 1).



Photo 1: NSR above the scarp. The surface has standing water. Coarse sand has deposited on the road surface.

The scarp is about 3 m wide and about 2 m high (Photos 2 and 3). There are tension cracks at the edge of and parallel to the scarp. The cracks are about 20 cm from the edge. They are 30 cm deep, less than 10 cm wide, and about 2 m long.



Photo 2: Slide scarp from the NSR above. The tension crack on the left side of the photo is about 10 cm wide.



Photo 3: Looking at the scarp from below. The large log on the right side of the scarp is partially buried under the road surface above. The dog is near where the road fill was before failure.

In the scarp, there is one large (about 1 m diameter) log. The log is perpendicular to the road and juts out about 2 m from the edge of the scarp. The log may have been puncheon or may have supported road fill. It is starting to decompose and that may indicate that fill near the scarp was at least partially supported on decaying organic matter.

The slope gradients in the forest near the scarp range from 40% to 60%. The surficial material is a rubbly sandy till that varies in thickness from about 50 cm to about 2 m. The exposed till in the slide path is compacted or cemented in some places.

We followed the small stream above the landslide scarp from the non-status road to the road above the slide (Murdo 1700 Road). The stream channel has recently moved sand and angular fragments and the vegetation on the edge of the channel has been pushed downhill, as would happen during high streamflow when the water overtops the channel. The stream crosses the upper road in a cross ditch, next to a culvert. Water from the stream was flowing through the culvert and in the cross ditch, as it was designed to. There was no evidence of inordinate water diversions along the Murdo 1700 Road.

Slide Path from Scarp to Lost Murdo FSR

We followed the landslide track from the initiation site to where it crosses Lost Murdo FSR, near the 1 km sign on the road.

The landslide path gradients range from 40% to 60%, with most reaches closer to 40% interspersed by short (2 m high) pitches with 60% gradients. There is bedrock exposed in the steeper reaches. The landslide scoured to highly compacted or cemented till along most of the track between the initiation site and Lost Murdo FSR (Photo 4).



Photo 4: Looking up the landslide path. The slide scoured through the compacted or cemented till. The slope gradient is about 50%. The path is about 5 m wide.



Photo 5: A wide part of the landslide track, with organic material and fine sediment depositing in the forest at the edge of the main path. The slide incised about 1 m. Slope gradients are about 40%.

The landslide path is from about 3 m to 7 m wide. The narrower parts of the runout zone were confined by large stumps that forced the flow to turn slightly. The slide path is incised about 1.5 m at these locations. In wider reaches, the slide incised about 0.5 m.

Fine-textured sediments (sands, small organic debris) deposited in the forest outside the main landslide path (Photo 5).

Lost Murdo FSR Crossing

The landslide crossed the Murdo FSR at a stream channel. There is an 800 mm CMP at the crossing. The inlet of the pipe is completely crushed by the slide debris (Photo 6). The sump at the culvert inlet is filled with angular fragments and sand from the landslide. The slide path is 5 m to 7 m wide where it crossed the Lost Murdo FSR (Photo 7). At the crossing, slope gradients are 40% to 50%. There are coarse woody debris, logs, and stumps on Lost Murdo FSR upslope of the crossing.



Photos 6 and 7: Crushed pipe inlet where at the Lost Murdo FSR. Water is flowing down the road instead of across it. The end of the crushed CMP, where part of the slide continued down the stream channel to The Lost Creek FSR.

The landslide path split into two paths at the road (Photos 8 and 9). Part of the slide crossed the road and continued down the stream channel and the other part followed the ditch and the Lost Murdo FSR, probably when the culvert at the crossing became plugged. The debris completely blocked the ditch, then deposited on the road. The affected road segment is about 150 m long.



Photos 8 and 9: The slide path reaching Lost Murdo FSR. Some of the slide debris flowed down the road and some crossed the road.

The slide debris left the road in three locations – the first is a CMP about 70 m down the road from the slide path (Photo 10), the second is a washout about 120 m from the slide crossing (Photo 11), and the third is at another CMP (Photo 12). The inlet to the CMP closest to the main slide path is completely blocked with sandy rubbly slide debris and no water is flowing through the pipe. At the washout, the slide eroded about 50 cm into the edge of the road and scoured about 20 cm deep. Water was flowing into the washout. At the CMP furthest down the road from the slide, there is some slide debris (rubble and sand) in the sump at the inlet but it is not completely blocking water flow through the culvert.



Photos 10 and 11: The culvert outlet, about 70 m from the slide crossing and the washout.

Water from the stream was flowing down the ditch to the lower culvert. No water was flowing down the landslide path from Lost Murdo FSR to Lost Creek FSR.

The landslide does not appear to have damaged the road prism of Lost Murdo FSR.



Photo 12: The CMP outlet at the bottom of the segment of the Lost Murdo FSR where the landslide sediment deposited. Some landslide sediment deposited in the forest at that outlet, but water is flowing through the culvert.

Lost Creek FSR Crossing

When the landslide reached the Lost Creek FSR, most of the sediment deposited in the ditch for about 100 m past a culvert to another, lower culvert. Debris flowed across the road over the lower culvert. The lower culvert inlet is not blocked and it has water flowing through it (Photo 13). The inlet to the upper culvert is blocked by slide debris, mainly sand and rubble (Photo 14). The sediment that did not flow down the ditch crossed Lost FSR, where it deposited on a bench about 20 m downslope of the road. Most of the sediment that crossed the road was coarse woody debris, organic debris, and large woody debris.

Slope gradients near the crossing are 70% for about 20 m, where the gradients decrease to about 30% on a bench top. The surficial material is a moderately well-drained rubbly till veneer to mantle.

The slide deposited fine sediment and organic debris (stumps and logs) on Lost Creek FSR (Photo 15). The road does not appear to be damaged by the slide and vehicles can drive past the deposit.



Photos 13 and 14: The culvert near where the slide crossed Lost Creek FSR. Photo 13 shows the lower culvert, with water flowing in the pipe. Photo 14 shows the upper culvert that has a blocked inlet, with no water flowing through the pipe.



Photo 15: Looking down the Lost Creek FSR near where the landslide crossed the road. The slide entered the road on the left and deposited large woody debris and fine textured sediment on the road, but did not completely block the road.

There is no culvert at the landslide location because the road was constructed on bedrock. There is bedrock in the road cut and the scar above the road is scoured to bedrock (Photo 16).



Photo 16: The landslide reached Lost Creek FSR where the road was constructed on bedrock. Note the bedrock exposed in the slide track.



Photos 17 and 18: Landslide debris filled in the ditch between where the slide hit the road and the upper culvert. Between the upper and lower culverts, there was less sediment in the ditch.

LANDSLIDE VOLUME AND AREA AFFECTED

It is challenging to estimate the volume of sediment moved by the landslide. The landslide deposited debris in several locations on Lost Murdo and Lost Creek FSRs and within the landslide track, making it difficult to estimate the size of the deposit. However, using the measured slide length, track width, and depth of incision, it is possible to estimate the range of area affected and volume. The landslide length is about 170 m, from the scarp to the end just downslope of Lost Creek FSR. The track width varied between 3 m and 7 m, so the area affected ranges between 510 m² and 1190 m². If the depth of sediment scoured is between 1 m and 1.5 m, the resultant slide volume could be between 510 m³ and 1785 m³.

RECONSTRUCTION RECOMMENDATIONS

There are several locations that need remedial works to prevent further landslides and to repair damage caused by the recent landslide.

Preventative Works on Nearby Non-status Roads

Evaluate the non-status road (NSR) that the landslide initiated from for deactivation. This +/- 300 metre long road appears to be a good candidate for deactivation next summer. Road deactivation should reduce the likelihood for future landslides by stabilizing stream crossings and pulling back unsupported or oversteepened fill. This road will require a detailed deactivation assessment and plan before work can proceed.

In addition the non-status road (NSR) where the landslide initiated, there are at least three other NSRs that should be assessed for deactivation. These roads are shown on Figure 1. These roads should be reviewed and if needed deactivated. Priority should be given to the NSR that produced the November 2018 slide.

Slide Scarp/Initiation Site

To reduce the immediate hazard of additional failures from the initiation site, pull back road fill at the scarp. Do not sidecast pulled back fill. Install a cross ditch at the stream crossing to provide a path for the stream to cross the road. Remove decaying timber and/or organic matter from under the fill.

Lost Murdo FSR Crossing

To repair the Lost Murdo FSR where the slide crossed the road, inspect the damaged culvert. If the damaged 800 mm CMP cannot be salvaged, replace the culvert with a larger 1000 mm CMP to accommodate anticipated increased sediment transport in the channel. Add a sump at the culvert inlet and a ditch block to prevent water and debris from flowing down the road.

Remove slide debris from the road and the ditch. Repair the road where the washout damaged the edge. Inspect the culverts that are about 70 m and 120 m from the landslide crossing. Repair or replace them, as necessary.

Lost Creek FSR Crossing

Remove the landslide debris from the Lost Creek FSR and the roadside ditch. Pull back as much of the debris from below the road that can be safely reached. Do not sidecast excavated debris.

Additional failures at the landslide initiation site are possible until the non-status road is deactivated. To prevent future landslides from crossing the road, construct a berm with large boulders, lock blocks, or logs at the edge of the road. The upslope side of the berm should be slightly higher in elevation than where the landslide hit the road and it should continue downslope for about 10 m. The berm will direct flow into the ditch rather than across the road. It should remain in place until the upslope, non-status roads are deactivated.

Inspect the culverts at the two crossings near the slide. Repair or replace damaged culverts with appropriately-sized CMPs. Clean the sumps at the culvert inlets.

There are existing signs on the Lost FSR warning users of the landslide hazard on this road segment. These should remain in place.

SHORT TERM MEASURES TO IMPROVE WORKER SAFETY

Reconstruction crews, industrial road users, and local residents should avoid lingering beneath the potentially unstable NSR during periods of intense snow melt or when moderate to heavy precipitation is forecast or occurring until the NSR where the landslide initiated has been deactivated.

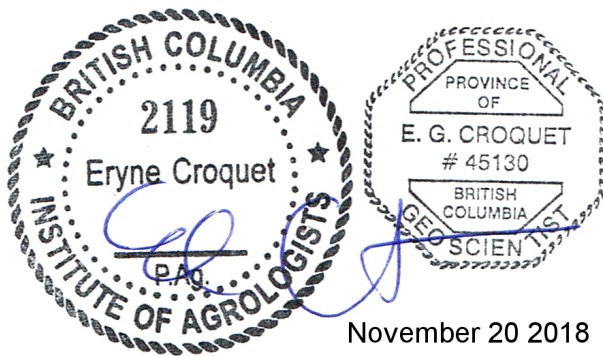
In the event of another failure, crews should retreat to a safe location and avoid the area until the slide track and headwall has been assessed by a qualified professional.

CONCLUSION

In early November 2018, a landslide was probably triggered by heavy rainfall and decaying organic matter in oversteepened road fill. It ran downhill as a debris flow, damaged culverts, and deposited on two downslope roads. The landslide resulted in approximately 1100 m² of soil disturbance and perhaps 1785 m³ of total debris. Hazards can be mitigated by deactivating upslope non-status roads, which requires assessing those roads and preparing detailed deactivation plans. Lost Creek and Lost Murdo FSRs can be repaired by removing slide debris, restoring the road running surface, and replacing or upgrading damaged culverts. Workers, road reconstruction crews, and residents should avoid prolonged exposure beneath the potentially unstable NSR during inclement weather until the NSR has been deactivated and weathered by a few regionally significant run off events.

Yours truly,

Statlu Environmental Consulting Ltd.



A blue ink signature, likely belonging to Drew Brayshaw, is written to the right of the professional seals.

Prepared by:

Eryne Croquet, M. Sc., P. Ag., P. Geo
Agrologist and Geoscientist

Reviewed by:

Drew Brayshaw, Ph. D., P. Geo.
Senior Geoscientist and Hydrologist

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