



**Forest
Practices
Board**

Maintenance of the Cooke Creek Forest Service Road near Enderby

Complaint Investigation #15083

FPB/IRC/202

October 2016

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Board Commentary

The Board investigated a complaint from a member of the public about the maintenance of the Cooke Creek Forest Service Road at Dale Lake. The investigation found that BC Timber Sales (BCTS) did not adequately maintain the road, and the Okanagan Shuswap Natural Resource District (district) did not design a culvert to accommodate expected peak flows.

Building and maintaining roads, bridges and drainage structures in the challenging and varied terrain of British Columbia comes with significant risks. The financial, social and environmental impacts of a road-related failure can be substantial.

There are established ways to manage the risk of road-related failures. Legislation requires forest roads to be maintained and drainage structures to be designed to accommodate expected water flows. Environmental management systems are used to ensure activities are planned, executed, verified and checked. Government policies and manuals require roads to be risk rated, and inspections to be carried out and documented at specified intervals, and after significant storms, to ensure that any issues are identified and addressed. Government may do this work itself, or it may require licensees or BCTS to do it, but the risk management approach is similar: know what you are responsible for, identify the risks, regularly inspect, and take action based on those inspections or concerns expressed by the public.

Both the district and BCTS had roles in the maintenance and inspection of the Cooke Creek Forest Service Road. The Board's investigation into this complaint revealed failures on the part of both organizations over many years.

The Board is concerned that the district and BCTS did not comply with legislation and their own risk management policies, procedures and systems. Improvements are needed in training, management, record-keeping, and the way in which public concerns and complaints are recorded and acted upon.

This investigation also highlights important steps that anyone responsible for resource road maintenance should consider when determining potential risks associated with construction and maintenance of a road.

In light of this, the Board recommends the following:

By November 30, 2016, the Okanagan Shuswap Natural Resource District and BC Timber Sales prepare an action plan describing how they will avoid similar design and maintenance issues in the future.

The Complaint

In May 2014, Dale Lake, near Enderby, overflowed and caused a debris flood down Cooke Creek. The debris flood washed out two sections of the Cooke Creek Forest Service Road (FSR) and overtopped the Enderby-Mabel Lake Road. The road was damaged extensively and impassable for two days.

On May 29, 2014, the Forest Practices Board received a complaint about the maintenance of the Cooke Creek FSR. The complainant said that he warned staff at the Okanagan Shuswap Natural Resource District, Ministry of Forests, Lands and Natural Resource Operations (district) in 2012 and again in 2013 that the culverts at the outlet of Dale Lake needed maintenance and could possibly fail.

The complainant believes that the debris flood could have been prevented if district staff had acted on his warnings. He is concerned that similar events may occur in the future unless more attention is paid to road maintenance.

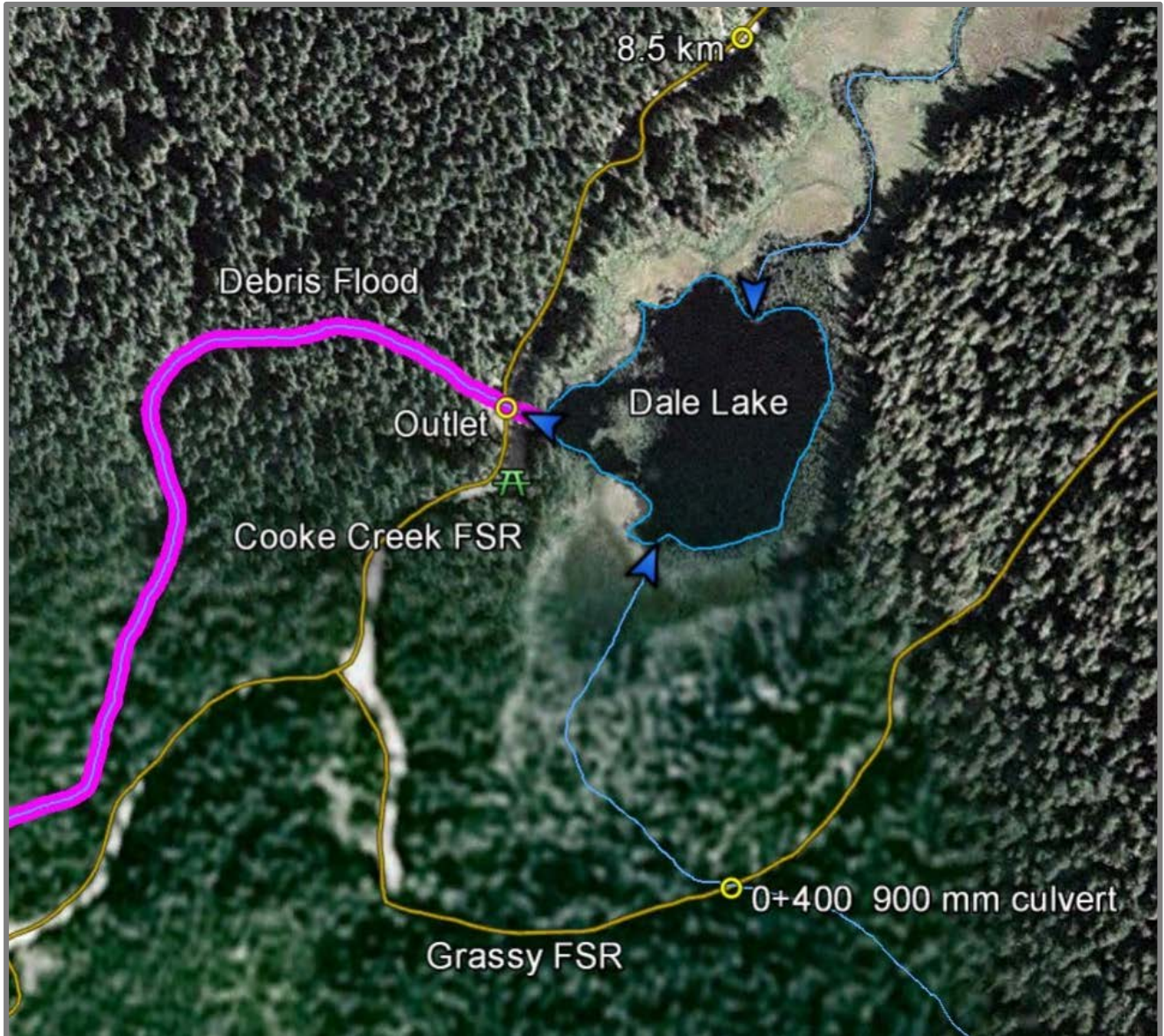
With the agreement of the complainant, the Board decided not to investigate the complaint until a government investigation into the cause of the debris flood was complete. The government released its report on what caused the debris flood in November 2015 and the Board began its investigation of the complainants concern with maintenance of the Cooke Creek FSR a month later.

Background

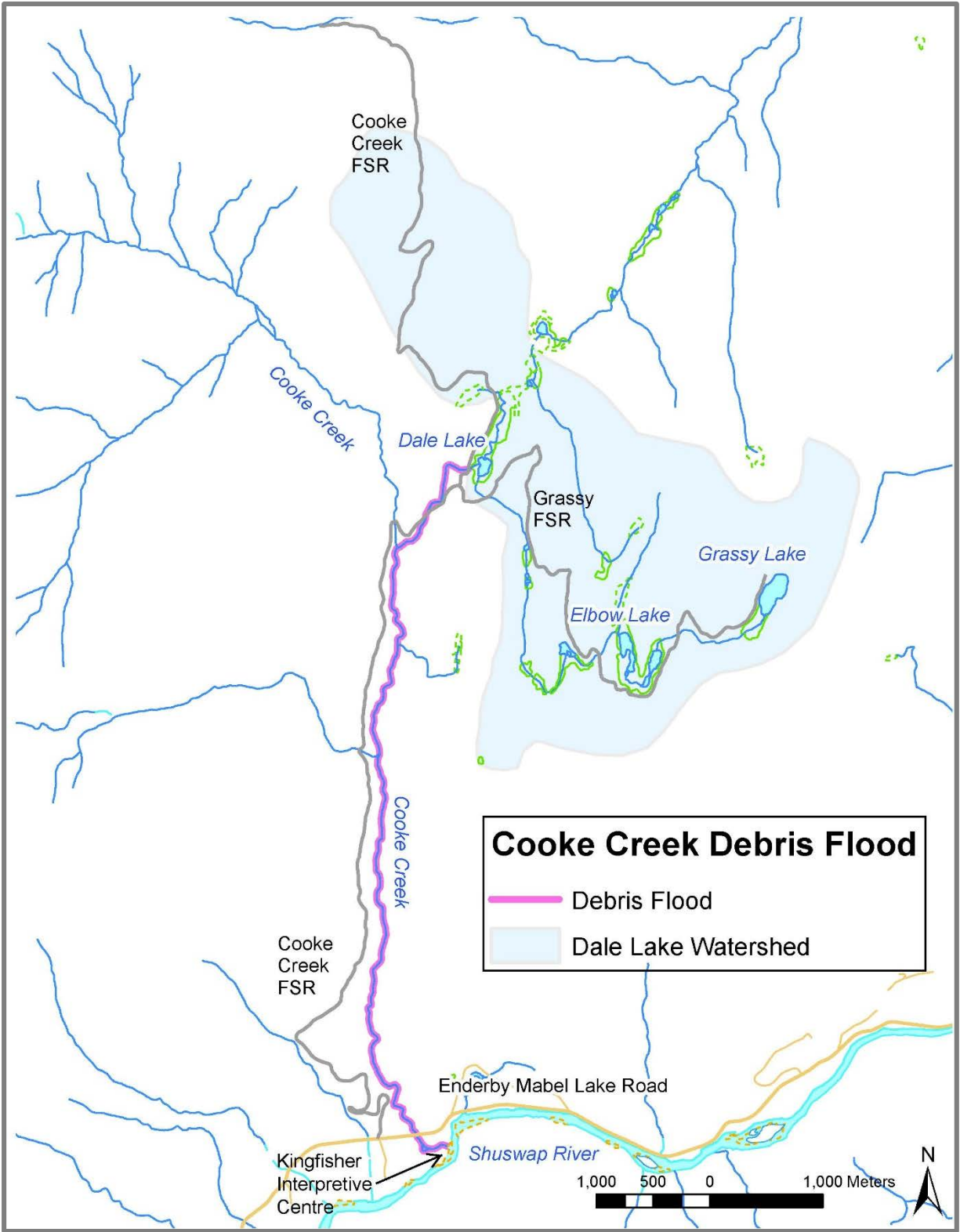
Dale Lake is located about 25 kilometres northeast of Enderby, in the north Okanagan. It is accessible via the Enderby-Mabel Lake Road and the Cooke Creek FSR. The lake sits within a 10-square-kilometre watershed that also includes Grassy Lake, Elbow Lake and several ponds and wetlands. Dale Lake drains into a creek that joins Cooke Creek which, in turn, flows about 7 kilometres downstream to the Shuswap River (see Maps 1 and 2). There is a small recreation site beside the lake outlet at the 8.2-kilometre point of the Cooke Creek FSR (see Figure 1).



Figure 1. The Dale Lake recreation site on September 25, 2011. The top of a beaver proof culvert is visible in the lower left.



Map 2. Dale Lake (2004 imagery).



Map 2. Cooke Creek Forest Service Road and Dale Lake Watershed.

Records show that there was a wood culvert at the outlet of Dale Lake on the Cooke Creek FSR until September 1985, when it was replaced with a 900-millimetre diameter corrugated metal pipe (CMP), (or culvert) covered with three metres of fill. Riverside Forest Products installed a 3-metre extension to the CMP in 1987, bringing its total length to 17 metres. The culvert was periodically blocked by debris and beaver activity, and it required maintenance. In 1987, a fire crew spent six man days removing heavy debris from upstream of the CMP. A July 1992 district inspection report noted that a debris catch in front of the culvert needed to be cleaned out, and it was. A debris catch is visible in Figure 5.

In May 2004, BC Timber Sales (BCTS) discovered that the Dale Lake culvert was plugged and the inlet was under 10 feet of water. Water also overtopped the FSR at a low section at the 8.5 kilometre point (see Map 1). BCTS cleaned out the culvert with a backhoe, however it continued to plug up. BCTS monitored and cleaned out the culvert over a period of four days until the lake level fell and remained at the elevation of the culvert (see Figures 2-5).



Figure 2. May 27, 2004 – Culvert inlet is 10 feet below the surface.



Figure 3. May 27, 2004 – Water from Dale Lake overtopping the Cooke Creek FSR at the 8.5-kilometre point.



Figure 4. May 27, 2004 – The culvert inlet has been unplugged and the lake is draining.



Figure 5. May 31, 2004 – The culvert is once again functional. The metal pipes of the debris catch are intended to prevent debris from entering the culvert.

A BCTS inspection in May 2005 noted that "the Dale Lake beaver appears to be quiet. CMP is open." On March 25, 2007, a local snowmobiler discovered water from Dale Lake overtopping and running down the FSR at the 8.5-kilometre point. He took a picture and reported it to the district that night (see Figure 6). The snowmobiler recalls seeing machine tracks heading up the FSR the next day and he assumed that the district addressed the problem.



Figure 6. March 25, 2007 – Water from Dale Lake running down the Cooke Creek FSR at the 8.5-kilometre point



Figure 7. October 4, 2007 – The culvert inlet is damaged and almost completely submerged. A second culvert with a beaver proof add-on was installed five days later.

The continuing need to maintain the culvert, and beaver activity in particular, prompted the district to install a 900-millimetre culvert with a "beaver proof add-on" at the outlet of Dale Lake in October 2007. The T-shaped add-on is designed to prevent plugging by beavers, and it is hinged so that it can be pulled up by a machine and cleaned out if necessary. The new beaver proof culvert was installed approximately one metre higher than the original culvert, which remained in place.

An October 11, 2010, picture shows that the original lower culvert is controlling the lake level. The beaver proof culvert is above the lake level; however, a watermark shows that water was passing through it previously (see Figures 8 and 9).



Figure 8. October 11, 2010 – The beaver proof add-on attached to the culvert inlet. The original, lower culvert is just visible behind the rectangular piece of material, (possibly plywood). Note the floating blocks of wood.



Figure 9. Close up of the previous photo. The arrow points to the lower culvert inlet.

The complainant is a retired district employee and outdoorsman. In retirement he has done maintenance work for the district, clearing blowdown and maintaining recreation sites. He has camped at the Dale Lake recreation site and is generally interested in and aware of road maintenance issues and practices. In August 2012, the complainant was at Dale Lake and he photographed the beaver proof culvert (see Figures 10 and 11). The beaver proof add-on was not seated on the culvert correctly – it was held aloft about 10 degrees by debris. The complainant emailed the photos to the recreation officer at the district and suggested that a machine could "remove all the old blocks of wood that are jammed all around the old lower outlet pipe." He also thought the machine could push the beaver proof-add on back into place. The complainant offered to supervise the work if funding was available.



Figure 10. August 21, 2012 – The beaver proof add-on is not seated properly. The original, lower culvert is obscured by debris. Some of the blocks of wood that can be seen floating in Figure 8, taken two years earlier, now appear to be restricting the lower culvert. Cooke Creek FSR is visible in the top left.



Figure 11. A water line is visible on the beaver proof add-on indicating it was controlling the lake level.

On June 9, 2013, the complainant emailed the district recreation officer:

I was up at Dale Lake and see that the "beaver proof" culvert is worse than last year. There's quite a bit of wood material (parts of trees, big blocks of hemlock wood, etc.) jammed. The run off is now over for the season. I think it's just a matter of time before the new culvert and the old one which is lower than the new one may become plugged with debris and if so, it may well take out the road there which then will be a big expense to repair to say nothing of the debris which will wash into Cooke Cr.

It's a shame the lower end of both culverts are so high. A lot of rainbow trout pan-size fish keep trying to leap up into the culvert to make it into the lake.

District staff inspected the beaver proof culvert three days later on June 12, 2013. Inspection photos show that the beaver proof add-on was held aloft by debris (see Figure 12). Staff cleaned it out and ensured that it was seated properly (Figures 13 and 14). The inspection report noted "Dual 800-mm CMPS are located at this crossing - drainage appears to be an ongoing issue. Recommend on-going monitoring inspections."



Figures 12, 13, 14. June 13, 2013 – Ministry inspection photos. (Left) The beaver proof add-on held aloft by debris. (Middle) Staff pulled up the add-on to clean it out. (Right) The add-on was put back in place.

The complainant photographed the outlet area a month later on July 12, 2013 (see Figures 15 and 16). On July 18, 2013, he emailed the photos to district staff stating that the beaver proof add-on had settled down but that it still needed to be bolted in place and debris removed. He also noted that the original, lower culvert was "mostly blocked."



Figure 15. July 12, 2013 – The beaver proof add-on is controlling the lake level.



Figure 16. July 12, 2013 – Close-up of the lower culvert inlet described as "mostly blocked" by the complainant. The upper beaver proof culvert is visible in the top right.



Figure 17. September 17, 2013 – The beaver proof culvert inlet.

In the fall of 2013, Tolko employees were planning cutblocks north of Dale Lake. As part of this work, they looked for fish and barriers to fish in the creek that flows out of Dale Lake. They took pictures of the beaver proof culvert inlet and the outlets of both culverts on September 17, 2013 (see Figures 17, 18 and 19). The pictures show that the beaver proof culvert was maintaining the level of the lake and the original culvert appeared to be almost completely blocked, as there was only a trickle of water at the outlet.



Figure 18. September 17, 2013 – The beaver proof culvert outlet. The original, lower culvert is just visible to the right, indicated by the arrow.



Figure 19. September 17, 2013 – The original culvert outlet is passing only a small amount of water indicating that it is almost completely blocked. Rust marks show how high the flow was in the past.

On January 14, 2014, the district manager issued a road use permit to Tolko for the section of the Cooke Creek FSR between the 8 and 10 kilometre points. This section included the outlet of Dale Lake.

In the early morning of May 2, 2014, water from Dale Lake overtopped the Cooke Creek FSR, washed out the two culverts and sent a debris flood down Cooke Creek. The debris flood washed out the Cooke Creek FSR in two locations and overtopped the Enderby-Mabel Lake Road. It destroyed timber, utilities, and inundated the Kingfisher Salmon Hatchery and Interpretive Centre with debris, killing 60 000 salmon (See Map 2 and Figures 20-23).

On May 9, 2014, the Compliance and Enforcement Branch (C&E) of the ministry began an investigation into the debris flood. On May 29, 2014, the complainant submitted his complaint to the Board. With the agreement of the complainant, the Board decided not to investigate the complaint until the C&E investigation was complete.

On November 18, 2015, C&E released its investigation report to the public, including the complainant. The following news report summarizes the outcome of the investigation:

Global News by Kimberly Davidson – November 18, 2015

VERNON—An extensive investigation into the Cooke Creek debris flood that happened east of Enderby reveals it may not have been a natural occurrence.

On May 2, 2014, Dale Lake spilled its banks, broke through a roadway, and spilled down Cooke Creek, picking up debris as it went. The massive debris flow knocked out a bridge, took down power lines and destroyed about 100 metres of road. The Kingfisher Interpretive Centre was hit especially hard.

Now the Ministry of Forests, Lands and Natural Resource Operations believes someone may have tampered with the culverts at Dale Lake, causing the slide.

Patrick Tobin is a Compliance and Enforcement Branch Manager with the Thompson Okanagan Region of the Ministry. He says geomorphologists, engineering specialists and dam experts were brought to the site, and 26 people were interviewed. Aerial photographs were taken and evidence on site was examined before it was determined the problem was probably human-caused. "It's the most likely outcome," says Tobin.

The ministry is asking anyone with information to come forward by calling the Natural Resource Violation line at 1 (844)-NRO-TIPS, or go to their website.

Reports can be anonymous. Anyone found guilty of causing environmental damage as a result of tampering with culverts on Crown land could face fines between \$575 and \$100,000.

The Board began investigating the complaint in December 2015 after considering the C&E investigation report. As of October 2016, the C&E investigation remains open.



Figure 20. May 2, 2014 – Dale Lake, less than five hours after the debris flood. The recreation site is the snow covered area in the top right corner.



Figure 21. May 14, 2014 – Outlet of Dale Lake looking downstream. The ATV is parked on the Cooke Creek FSR beside the recreation site.



Figure 22. May 14, 2014 – Outlet of Dale Lake looking towards the lake. Picture taken from the Cooke Creek FSR.



Figure 23. May 2, 2014 – The Enderby-Mabel Lake Road.

The Investigation

Section 123 of the *Forest and Range Practices Act* requires the Board to deal with public complaints about forest practices. Road maintenance is a forest practice. This investigation considered the following questions:

1. Who was responsible for maintaining the Cooke Creek FSR, including the culverts at the outlet of Dale Lake?
2. Was the road maintained in accordance with legislative requirements?
3. Was the response to the complainant's concerns adequate?
4. Was the beaver proof culvert designed in accordance with legislated requirements?

Who was responsible for maintaining the Cooke Creek FSR, including the culverts at the outlet of Dale Lake?

FSRs are public assets on Crown land, and they must be maintained until they are deactivated.¹ Either a district manager, a BC Timber Sales manager (timber sales manager) or a road use permit (RUP) holder is responsible for maintaining a FSR. Only a district manager can issue a RUP and require its holder to assume all or part of the maintenance responsibility.²

When BCTS was created, district managers and timber sales managers agreed on a list of FSRs that the timber sales manager would be responsible for maintaining. These were typically roads that accessed BCTS operating areas. For these roads, the timber sales manager is responsible for maintenance until industrial use is required and the district manager issues a RUP. The district manager assigned the timber sales manager with maintenance responsibility for the first 10 kilometres of the Cooke Creek FSR in December 2003, and the timber sales manager agreed to the assignment in January 2004.

The following table lists the parties responsible for maintaining the portion of the Cooke Creek FSR that includes Dale Lake.

Party Responsible for Maintenance of Cooke Creek FSR at Dale Lake	Start Date	End Date
District Manager	1983 ³	Oct. 24, 1989
Riverside Forest Products (RUP)	Oct. 25, 1989	Dec. 31, 1995 ⁴
District Manager	Jan. 1, 1996	Jan. 6, 2004
Timber Sales Manager	Jan. 7, 2004	Jan. 13, 2014
Tolko Industries (RUP)	Jan. 14, 2014	Open

¹ Section 79(3) *Forest Planning and Practices Regulation*.

² Section 79(4) *Forest Planning and Practices Regulation*.

³ The first inspection on file was received by the regional manager on January 25, 1984. This inspection likely occurred when the road was snow-free in 1983.

⁴ The RUP indicates it expires December 31, 1995, unless extended.

Finding

Since 1983, maintenance of the section of the Cooke Creek FSR that includes Dale Lake has been the responsibility of the district manager, Riverside Forest Products, the timber sales manager and Tolko Industries.

Was the road maintained in accordance with legislative requirements?

A person who maintains an FSR must ensure that the structural integrity of the road prism and clearing width are protected; the drainage systems are functional; and the road can be safely used by industrial users.⁵

An exception to these requirements is permitted if a road is not being used by industrial users. In that situation, a road is considered a "wilderness road" and the maintainer must ensure structural integrity of the road prism and clearing width and the function of the drainage systems "only to the extent necessary to ensure there is no material adverse effect on forest resources."⁶ Additionally, the requirement for safe industrial use does not apply to a wilderness road. The section of the Cooke Creek FSR relevant to this complaint has not been used for industrial purposes since 1996. Since then, and until Tolko was issued a RUP in January 2014, the district manager and the timber sales manager were responsible for maintaining the FSR.

What does "must ensure" mean? From a legal perspective, to ensure means to make certain. How does a district manager or a timber sales manager ensure, or make certain, that it meets these maintenance requirements? The Ministry of Forests, Lands and Natural Resource Operations (FLNRO) Engineering Manual is the district manager's and the timber sales manager's primary reference for road and bridge administration, design, construction, maintenance and deactivation. It lists mandatory procedures and best practices to ensure compliance with legislation.

With respect to road maintenance, the Engineering Manual states that it is government policy to inspect and maintain FSRs, taking into consideration their level of use, strength and durability, and potential impacts on user safety and values at risk of damage or loss.

The Engineering Manual provides a system for determining the risk associated with a road and suggests an inspection schedule to manage that risk. Risk is determined by considering the likelihood and consequences of damage to a value. For example, a road on steep and unstable terrain above a fish stream might be considered higher risk than a road on flat and stable terrain. The Engineering Manual states that it is a best practice to inspect "moderate", "high" or "very high" risk-rated roads at least once a year, plus additional inspections after major storms and before annual freshets. A "low" or "very low" risk-rated road is inspected at least once every two years, or every three years if the road is blocked to public access.

Documenting the risk assessment process and inspections are key parts of risk management and demonstrating due diligence. The Engineering Manual provides an example of an inspection form – an inspection must include basic information such as the date, the inspector, the reason for the inspection, the section of road inspected and the location of any issues noted. Once road inspections

⁵ Section 79(6) *Forest Planning and Practices Regulation*.

⁶ Section 81 *Forest Planning and Practices Regulation*.

are completed and documented, the results can be used to schedule maintenance activities and plan expenditures.

BCTS has also implemented an environmental management system under its ISO 14001:2004 certification. BCTS's environmental field procedure for roads, bridges and major culverts describes procedures to reduce the risk of negative impacts of its activities. Understanding which sites and structures require inspection and documenting inspection results are critical parts of the procedure.

The Cooke Creek FSR

Both the district and BCTS rated the Cooke Creek FSR as a high-risk road. This means that it should be inspected at least once a year. The district and BCTS searched their files for inspections of the Cooke Creek FSR and records of maintenance activities. Appendix 1 is a chronology of documented inspections and maintenance activities that apply to the section of the Cooke Creek FSR in the vicinity of Dale Lake.

Appendix 1 shows that regular inspections were carried out between 1999 and 2005. BCTS accepted maintenance responsibility for the first 10 kilometres of the Cooke Creek FSR in January 2004 and was responsible for maintaining the road to a wilderness standard until January 2014. BCTS should have completed at least 10 inspections between 2004 and 2013, but there are only 4 documented – 2 in 2004 and 2 in 2005. There are no BCTS inspections on file since October 2005. BCTS cannot demonstrate that it regularly inspected and maintained the original culvert at Dale Lake since October 2005 or the beaver proof culvert since it was installed in October 2007.

District staff likely maintained the FSR in March 2007 in response to the snowmobiler's report of water flowing down the FSR, and they were also on site in October 2007 when the beaver proof culvert was installed. But aside from the district's June 12, 2013, inspection in response to the complainant's concern, there are no other inspection reports on file since the beaver proof culvert was installed in 2007.

The district and BCTS told the Board that a lack of documentation does not mean that the road was not inspected:

This acknowledged weakness in the Ministry's documentation, which will be rectified, does not translate into weakness in our history of inspections and maintenance on the FSR, but in our recording of those operations.

A month after the district's June 2013 inspection, the complainant sent photos and a message to district staff⁷ that the lower culvert was "mostly blocked" and "very little water is actually flowing through." A photo taken in September 2013 by a Tolko employee shows only a trickle of water coming out of the lower culvert, indicating that it was almost completely blocked.

BCTS and the district told the Board that if there was in fact an issue with the function of the culverts, the Tolko employees would have noticed it and should have reported it. Tolko told the Board that its employees were looking for fish and barriers to fish at the site, and did not consider the function of the culverts. Regardless, the complainant noted that the lower culvert was "mostly blocked" and the

⁷ The email was sent to the recreation officer responsible for the Dale Lake recreation site and a resource technician in the district's engineering section.

Tolko photos confirm that. As the lower culvert was almost completely blocked, BCTS did not ensure that drainage was maintained to the extent necessary to prevent adverse effects to forest resources.

Planning and conducting inspections based on risk, documenting the results and addressing any issues identified, as set out in the Engineering Manual, would demonstrate diligence and ensure that forest resources were not adversely affected. By not conducting regular inspections, BCTS did not ensure, or make certain, that there would be no adverse effects on forest resources.

Finding

BCTS did not ensure that the structural integrity of the road prism and clearing width were protected and did not ensure that the drainage systems were functional to the extent necessary to ensure there was no material adverse effect on forest resources. BCTS did not comply with section 79(6) of the *Forest Planning and Practices Regulation*.

The district and BCTS told the Board that “the legal responsibility for maintenance of the FSR rested solely with Tolko Industries Ltd. at the time of the debris flood.” While it is true that Tolko was responsible for maintaining the relevant section of the Cooke Creek FSR once it received a road use permit on January 14, 2014, Tolko was not the subject of this investigation because the complaint was specifically about the actions of the district and BCTS. The Board notes that the Cooke Creek FSR was likely covered with snow when the permit was issued and it is not certain whether the road was accessible at the time the debris flood occurred, or if so, the date that it became accessible. The Board therefore makes no findings with respect to Tolko’s responsibilities under the road use permit.

Was the response to the complainant's concerns adequate?

The complainant emailed⁸ district staff on August 24, 2012, with concerns about the culverts at the outflow of Dale Lake. The district recreation officer thanked the complainant for his information and said he would pass it on to engineering staff. There is no record of district or BCTS action in response to the concern. The lack of response was not appropriate, as the complainant’s concerns were legitimate and his photos showed that there was an issue with the lower culvert.

On June 9, 2013, the complainant emailed the recreation officer and a resource technician in the district's engineering section with concerns that the culverts could become plugged and "take out the road." The district told the Board that it inspected and maintained the beaver proof culvert on June 12, 2013, in response to the complainant. That is an adequate response to the complainant's June 9, 2013, email.

The complainant contacted the same staff a month later on July 18, 2013, with concerns that the lower culvert was plugged and debris needed to be removed. Neither the district nor BCTS responded to him.

⁸ The complainant's emails appear in Appendix 2.

Why didn't BCTS or the district take action to address the complainant's July 18, 2013, email? The district and BCTS told the Board:

Read in its entirety, including its solicitation for work, and in context with earlier emails from the complainant and the Ministry's work on the culverts a little over a month earlier, along with staff familiarity with the drainage situation on the FSR, we feel the District's response was adequate.

District staff and BCTS knew the complainant was knowledgeable about road maintenance and the culverts at the outflow of Dale Lake. They also responded immediately to his June 9, 2013, email, which demonstrates that they took his concerns seriously. When the complainant identified similar issues a month later, the Board would expect a similar response. Instead, the district and BCTS did nothing, and the reasons provided are not compelling. The complainant said the lower culvert was mostly blocked and very little water was getting through, and Tolko's September 17, 2013, photos confirm that.

Finding

The district's response to the complainant's August 24, 2012, and July 18, 2013, concerns was inadequate.

Was the beaver proof culvert designed in accordance with legislated requirements?

District staff installed the beaver proof culvert at the outlet of Dale Lake in October 2007. When a person installs a bridge or culvert as part of road maintenance or construction, section 74 of the *Forest Planning and Practices Regulation* (FPPR) requires that it be designed to pass the highest peak flow that can reasonably be expected while the structure is in place. For a culvert that will remain on site for over three years, it must be able to accommodate the peak flow expected over a 100-year period.

There is no documentation on file demonstrating that the beaver proof culvert was designed to pass the peak flow expected in a 100-year period.

Finding

In 2007, the district did not design the beaver proof culvert at the outlet of Dale Lake to accommodate the peak flow expected while the structure was in place. The district did not comply with section 74 of the FPPR.

Could the culverts accommodate the peak flow expected?

Although there is no design, the investigation considered whether the beaver proof culvert and the original culvert could accommodate the peak flow expected in 100 years. To do this, the Board engaged a professional engineer with extensive experience in bridge and culvert planning, design and construction. At this point it is necessary to clarify the size of the culverts installed at the outlet of Dale Lake. FLNRO records from 1985 indicate that the original culvert was 900 millimetres in diameter. The district's July 2013 inspection noted "dual 800 mm CMPs" were present at the outlet of Dale Lake. In May 2016, the Board measured the remains of both culverts and determined that the

original culvert was 800 millimetres in diameter and the beaver proof culvert was 900 millimetres in diameter.

Culverts are typically sized to pass a design flow with a headwater depth less than 1.5 times the culvert diameter. For example, an 800-millimetre culvert submerged 400 millimetres under water should be able to pass the design flow. This limitation is intended to avoid excessive water pressures around the culvert inlet which can lead to piping⁹ and saturation of the road fill.

Based on a headwater depth 1.5 times the diameter, the nominal capacity of an 800-millimetre corrugated steel culvert is about 1.0 m³/second and the nominal capacity of a 900-millimetre corrugated steel culvert is about 1.4 m³/second.

To estimate the 100-year peak flow, the Board's consultant used three methods. Based on his experience and professional judgement, the most reasonable of the three was the method developed specifically for BC watersheds that uses streamflow data collected by the Water Survey of Canada (WSC). The WSC data includes the influences of snowmelt, as peak flows in most streams and rivers in the interior are dominated by snowmelt during spring freshet. He estimated the peak flow to be 6.2 m³/second.

In April 2016, BCTS hired a consultant to analyze the hydrology of the Dale Lake area. The consultant estimated peak flow using three different methodologies, including the method used by the Board's consultant. All three methods indicated a 100-year peak flow greater than the hydraulic capacity of the culverts as determined by the Board's consultant.

It is plausible that Dale Lake is large enough to have some attenuating effect on peak flows. In other words, it has the capacity to accommodate inflows until the water level rises enough to drive the outflows through the culverts. However, attenuation in the lake was not enough to prevent a failure. A ministry geomorphologist examined the Dale Lake watershed and climate data and considered inflows and outflows. He estimated that Dale Lake could have filled up within three days.

Finding

The culverts could not accommodate the peak flow expected over a 100-year period.

The Board's consulting engineer concluded that the two culverts were undersized and if a hydrologic analysis had been conducted, it should have recommended significantly more capacity. Increased capacity could be provided by a larger culvert or additional culverts.

What happened?

Any event causing elevated levels in Dale Lake could have caused the road embankment to fail, even without overtopping. Headwater pressure around the pipe inlet could have caused piping and/or seepage flows through the embankment, which could also lead to a complete failure of the roadway. The road survived at least two earlier events where water was documented overtopping the road. The fact that the crossing survived extreme water levels before does not mean it could endure them indefinitely. Seepage and piping routes through the road fill can develop over time, enlarging and

⁹ Piping occurs when water erodes fine particles and finds its way through fill material typically along the contact zone between the outside of the culvert and soil.

initiating the failure process. A combination of head pressure, piping flows, fill saturation and overtopping and erosion of the road surface likely caused the outburst flood, releasing the stored flows catastrophically.

BCTS and the district believe that human tampering with the culvert caused elevated water levels that led to the debris flood. While that is possible, the structures at the outlet of Dale Lake were undersized and contributed to elevated lake levels.

Conclusions

This investigation considered the following questions:

1. Who was responsible for maintaining the Cooke Creek FSR, including the culverts at the outlet of Dale Lake?
2. Was the road maintained in accordance with legislative requirements?
3. Was the response to the complainant's concerns adequate?
4. Was the beaver proof culvert designed in accordance with legislated requirements?

Since 1983, maintenance of the section of the Cooke Creek FSR that includes Dale Lake has been shared by the district manager, the timber sales manager and two road use permit holders. BCTS was responsible for maintaining the relevant section of road from January 7, 2004, until January 13, 2014. Tolko has held a road use permit for the relevant section of road since then, and is responsible for maintenance.

The Engineering Manual states that it is government policy to inspect and maintain FSRs, taking into consideration their level of use, strength and durability, and potential impacts on user safety and values at risk of damage or loss. Despite this, and the fact that it has an environmental management system under its certification scheme, where regular road inspections are done based on an established risk rating system, BCTS cannot demonstrate that it inspected the relevant section of the Cooke Creek FSR since 2005.

BCTS did not adequately maintain the road because it did not ensure that the structural integrity of the road prism and clearing width were protected, and it did not ensure that the drainage systems were functional to the extent necessary to ensure there was no material adverse effect on forest resources. BCTS did not comply with section 79(6) of the FPPR.

When the district installed the beaver proof culvert at the outlet of Dale Lake in 2007, it did not design it to accommodate the peak flow expected in 100 years. The district did not comply with section 74 of the FPPR. In retrospect, despite the lack of a design, the culverts were undersized and could not accommodate the peak flow. The district failed to recognize the risk that inadequate drainage structures posed to the road and downstream resources.

The complainant expressed concerns about the structures at the outlet of Dale Lake in August 2012, early June 2013 and July 2013. District staff only acted on the June 2013 email. The district's lack of response to the August 2012 and July 2013 concerns was inappropriate.

The Cooke Creek debris flood was caused by the failure of two culverts at the outlet of Dale Lake. The inflow of water to Dale Lake exceeded the capacity of the culverts and the water level rose. A combination of head pressure, piping flows, fill saturation and overtopping and erosion of the road surface likely caused the outburst flood, releasing the stored flows catastrophically.

The complainant's concern that similar events could occur in the future unless more attention is paid to road maintenance is valid.

Appendix 1: Cooke Creek FSR Inspections and Maintenance (including Dale Lake)

DATE	INSPECTION	WORK DONE
1983. District manager responsible for maintenance		
1983 (exact date unknown). Inspection filed at the regional office on January 25, 1984.	Inspection noted an "old wooden culvert" at the 8.1 kilometre point. Unknown ministry inspector	
May 10, 1984	Ministry inspection (regional staff). Old log bridge 8' high noted at Dale Creek "needs work"	
September 12-13, 1985		District replaced log structure with 900 mm diameter, 14-metre long CMP
1987		Riverside Forest Products installed a 3-metre extension to the CMP to allow for a wider road surface.
October 25, 1989. Riverside Forest Products responsible for maintenance.		
July 8, 1992	District inspection noted "the debris catch at Dale Lk needs clean out."	
July 13, 1992		Debris catch at Dale Lake cleaned out.
January 1, 1996. District manager responsible for maintenance		
October 1999	Small Business Forest Enterprise Program (SBFEP) inspection. "Surface of rd seems stable."	
April 2000	Small Business Forest Enterprise Program (SBFEP) inspection. "Surface of rd seems stable."	
May 7, 2001	SBFEP inspection of 0-14.1 Cooke Creek FSR.	
October 1, 2002	SBFEP inspection	
April 28 and May 12, 2003	BCTS inspection on April 28. Returned on May 12 to look at concerns identified on April 28 at the 12.1-kilometre point.	
July 9, 2003	BCTS inspection of 11 – 14.1 kilometre Cooke Creek FSR. Inspection mentions "Rec site at 8.2 kilometre. No danger trees at rec site."	

January 7, 2004. BC Timber Sales responsible for maintenance.		
May 27, 28, 29, 31, 2004	BCTS knew the culvert at Dale Lake was plugged.	The inlet of the culvert at Dale Lake was under 10 feet of water. The culvert was only passing 20% of its capacity. An excavator cleaned out the inlet. A large piece of plywood came to the surface. The inlet continued to plug up. The excavator continued to clean the inlet on May 28 th . The inspector returned on the 29 th to keep the inlet open by hand. On the 31 st the inspector returned, cleaned out the inlet and noted that the lake had returned to its normal level.
October 2004	BCTS inspection 0-10 km	
May 3, 2005	BCTS inspection 0-10 km. "Dale Lake beaver seems to be quiet. CMP is open."	
October 2005	BCTS inspection 0-10 km after heavy rains.	
March 26, 2007		District likely maintained the culvert in response to the snowmobiler's report of water running down the Cooke Creek FSR from Dale Lake.
October 9,10,12, 2007		District installed beaver proof culvert
June 12, 2013	District inspection of beaver proof culvert. The inspection was a response to the complainant's June 9,2013 email where he expressed concerns about the culverts. The inspection report noted that the beaver proof culvert was "found to be plugged with coarse woody debris."	Inspection report stated "Beaver stop raised, cleaned and restored to working order. Dual 800 mm CMPs are located at this crossing – drainage appears to be an on-going issue. Recommend on-going monitoring inspections."
January 14, 2014. Tolko Industries responsible for maintenance.		
May 2, 2014. Debris flood occurred.		

Notes:

These are all of the documented inspections and maintenance work on file that apply to the section of the Cooke Creek FSR that includes Dale Lake.

The Small Business Forest Enterprise Program (SBFEP) became BC Timber Sales (BCTS) in April 2003.

Appendix 2: Emails from the Complainant to the District

From: XXX

Sent: Friday, August 24, 2012 9:41 PM

To: XXX FLNR:EX

Subject: Dale Lake

When I was up Cooke Cr. to Dale lake early this summer I noticed that the beaver proof culvert thing that XXX had installed a few yrs. back had come partially apart and was damaged. I was up the other day and see it's still the, same. As the water has dropped considerably, the thing has settled back down a bit from what it was earlier.

I believe it is repairable but would need a backhoe with an extended reach or a small excavator to remove all the old blocks of wood that are jammed all around the old lower outlet pipe. I think a bit of pressure from a hoe bucket would lower the plastic thingy enough to re-establish some hardware and cinch it all up tight again.

I also think that lower culvert pipe while being a security outflow for extra water escapement during runoff, is rather counterproductive to the overall water level of Dale lake and the fishery there. It's so low that even with all the woody debris and other stuff partially plugging it, it lets too much water escape from the lake area. You can't see this 2nd. Pipe in the photos but it's there a fair bit lower than the beaver proof pipe culvert.

-- Now to later this fall would be an ideal time to repair this before snow falls and before the lake water level starts to rise again.

--- If you have any \$ available you might consider getting this done and also I would happy to oversee some machine work to get it done.

Cheers, if you get this, I guess you haven't retired yet.

XXX.

From: XXX

Sent: Sunday, June 9, 2013 3:18 PM

To: XXX FLNR:EX

Cc: XXX FLNR:EX

Subject: FW: Dale Lake

Hi XXX, I was up at Dale lake and see that the 'beaver proof culvert is worse than last year. There's quite a bit of wood material (parts of trees, big blocks of hemlock wood) etc. jammed. The run off is now over for the season. I think it's just a matter of time before the new culvert and the old one which is lower than the new one may become plugged with debris and if so, it may well take out the road there which then will be a big expense to repair to say nothing of the debris which will wash into Cooke Cr.

It's a shame the lower end of both culverts are so high. A lot of rainbow trout pan size fish keep trying to leap up into the culvert to make it into the lake.

XXX.

p.s. the board walk at Spruce lake has wintered well, no problems with it.

From: XXX

Sent: July-18-13 7:32 AM

To: XXX FLNR:EX'

Cc: XXX FLNR:EX'

Subject: Dale Lake

Hi XXX,

I was up at Dale lake a few days ago and see that the 'beaver proof' culvert I mentioned to you before has now settled back down. However, it is still not fastened at the bottom of the 'hinge', in other words, it will rise up and down with water levels. Wouldn't take a whole lot with a backhoe with a long reach to clean out the woody debris you see in my photos, get a chain fastened on the end, lift it up on its hinge and clean out the debris that is trapped at the bottom of the hinge area, then insert bolts and fasten it properly so it stays in place as it should. You can also see in one photo that the older, lower original culvert is now mostly blocked with woody debris, mud etc. by the beaver. Very little water is actually flowing through. This has caused the lake to keep up to a higher level and most overflow is now going through the new culvert higher up. I think this is a good thing as I'm pretty sure the one culvert will handle runoff and this situation has caused the lake to remain at a more desirable level for fishing, canoeing, kayaking etc.

The Cooke Cr. Forest Road leading up off the Mabel Lake road has several windfall and overhanging trees that should be cut off as far as Dale Lake.

I didn't go into Elbow or Spruce Lake. If there is ever the funding to have this done, I would be interested in doing it, none of the trees are large and a couple days or so would do it.

XXX.



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